GW - 19

GENERAL CORRESPONDENCE

YEAR(S):

2004-1996

1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131A
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

MONTHLY GAS STORAGE REPORT

Loco Hills GSF LTD (Company) 158 Deer Creek Drive Aledo Texas 76008 (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year [illegible] 2004

WELL NAME AND NUMBER	LOCATION UNIT SEC. TWP. RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (MCF)	WITHDRAWAL (MCF)
Leonard State #3 Loco Hills GSF Well #3 API # 30-15-06194	L 22 17S 29E	378#	0	852.44

TOTALS

TOTAL CAPACITY (MMCF) 109.3

BEGINNING STORAGE (MMCF) 1.20

NET CHANGE (MMCF) .85

ENDING STORAGE (MMCF) .35

CALCULATED RESERVOIR PRESSURE @ END OF MONTH 110#

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature [signature]

Printed Name & Title John A. Smith

Date [illegible] 11/2005 Telephone No. [illegible]

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131B
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

ANNUAL LPG STORAGE REPORT

Loco Hills GSF LTD (Company) — 158 Deer Creek Drive Aledo, Texas 76008 (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year 2004

WELL NAME AND NUMBER	LOCATION UNIT SEC. TWP. RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (BBLS)	WITHDRAWAL (BBLS)
Leonard State #1 API# 30-15-06192 Loco Hills GSF #1	L 22 17S 29E	390#	59,877.46	44,763.59

TOTALS

CALCULATED RESERVOIR PRESSURE @ END OF YEAR 115.5#

TOTAL CAPACITY (BBLS) 69,272

BEGINNING STORAGE (BBLS) 0

NET CHANGE (BBLS) 15,113.46

ENDING STORAGE (BBLS) 15,113.46

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature [signature]

Printed Name & Title John B Smith Terminal Operator

Date Jan 11, 2005 Telephone No. (505) 677-2331

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131B
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

ANNUAL LPG STORAGE REPORT

Loco Hills GSF LTD (Company) — 158 Deer Creek Drive Aledo, Texas 76008 (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year 2004

WELL NAME AND NUMBER	LOCATION UNIT SEC. TWP. RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (BBLS)	WITHDRAWAL (BBLS)
Leonard State #2 API # 30-15-06193 Loco Hills GSF #2	K 22 17S 29E	379 #	23,386.41	23,462.63

TOTALS

CALCULATED RESERVOIR PRESSURE @ END OF YEAR 111.5 #

TOTAL CAPACITY (BBLS) 71,429

BEGINNING STORAGE (BBLS) 771

NET CHANGE (BBLS) 923.78

ENDING STORAGE (BBLS) 1694.78

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature John B. Smith

Printed Name & Title John B. Smith Terminal Operator

Date Jan 11, 2005 Telephone No (505)-677-2331

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131B
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

ANNUAL LPG STORAGE REPORT

Loco Hills GSF LTD (Company) 158 Deer Creek Drive Aledo, Texas 76003 (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year 2004

WELL NAME AND NUMBER	LOCATION UNIT SEC. TWP. RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (BBLS)	WITHDRAWAL (BBLS)
Leonard state #3 Loco Hills GSF #3 API # 30-15-06194	L 22 17S 29E	378#	2,444.97	24,509.23

TOTALS

CALCULATED RESERVOIR PRESSURE @ END OF YEAR 110#

TOTAL CAPACITY (BBLS) 71,429

BEGINNING STORAGE (BBLS) 22,293

NET CHANGE (BBLS) 24,508.23

ENDING STORAGE (BBLS) 228.74

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature [signature]

Printed Name & Title John B. Smith Terminal Operator

Date 1/11/2005 Telephone No. (505) 677-2331

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

RECEIVED
FEB 16 2005
Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131A
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

MONTHLY GAS STORAGE REPORT

Loco Hills GSF LTD (Company) 158 Deer Creek Drive (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year Jan, 2005

WELL NAME AND NUMBER	LOCATION UNIT SEC. TWP. RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (MCF)	WITHDRAWAL (MCF)
Leonard State #1 API # 30-15-06192 Loco Hills GSF Well #1	L 22 17S 29E	390#	8,041.84	14,370.86

TOTALS

TOTAL CAPACITY (MMCF) 1.06

BEGINNING STORAGE (MMCF) 23.13

NET CHANGE (MMCF) 6.63(-)

ENDING STORAGE (MMCF) 16.50

CALCULATED RESERVOIR PRESSURE @ END OF MONTH 115.5#

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature [signature]

Printed Name & Title John B Smith Terminal Operator

Date 2/11/05 Telephone No (505) 677-2331

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

RECEIVED
2005
...ation Division
... Saint Francis Drive
Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131A
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

MONTHLY GAS STORAGE REPORT

Loco Hills GSF LTD (Company) 158 Deer Creek Drive Aledo, Texas 76008 (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year JAN, 2005

WELL NAME AND NUMBER	LOCATION UNIT SEC. TWP. RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (MCF)	WITHDRAWAL (MCF)
Leonard State #2 Loco Hills GSF #2 30-15-06193	L 22 17S 29E	379.5#	0	2,599.99

TOTALS

TOTAL CAPACITY (MMCF) 109.3

BEGINNING STORAGE (MMCF) 2.60

NET CHANGE (MMCF) 2.60(-)

ENDING STORAGE (MMCF) 0

CALCULATED RESERVOIR PRESSURE @ END OF MONTH 111.5#

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature John B. Smith

Printed Name & Title John B Smith Technical Operator

Date 2/11/05 Telephone No. (505) 677-2331

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

RECEIVED
2005
Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, N

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131A
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

MONTHLY GAS STORAGE REPORT

Loco Hills GSF LTD — (Company)

158 Deer Creek Drive Aledo Texas 76008 — (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year Jan, 2005

WELL NAME AND NUMBER	LOCATION UNIT SEC. TWP. RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (MCF)	WITHDRAWAL (MCF)
Leonard State #3 Loco Hills GSF Well #3 API # 30-15-06194	L 22 17S 29E	378#	0	349.98

TOTALS

TOTAL CAPACITY (MMCF) 109.3

BEGINNING STORAGE (MMCF) .35

NET CHANGE (MMCF) .35

ENDING STORAGE (MMCF) 0

CALCULATED RESERVOIR PRESSURE @ END OF MONTH 110#

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature John B Smith

Printed Name & Title John B. Smith

Date 2/11/05 Telephone No (505) 677-2331

Wildcat Measurement

Calibration Certificate

Pressure Recorder

Serial Number: 265-WC325

Pressure Range 1000# **p.s.i. accuracy +/-** 0.2% **% Full Scale** ____ **p.s.i.** ____

Increasing Pressure *Applied Pressure*	*Indicated Pressure*	*Difference*	Decreasing Pressure *Applied Pressure*	*Indicated Pressure*	*Difference*
0.0#	0.0#	0.0	800.0#	800.0#	0.0
100.0#	100.0#	0.0	600.0#	600.0#	0.0
300.0#	300.0#	0.0	400.0#	400.0#	0.0
500.0#	500.0#	0.0	200.0#	200.0#	0.0
700.0#	700.0#	0.0	0.0#	0.0#	0.0
1000.0#	1000.0#	0.0			

Calibrated By: Crystal **Gauge** **Deadweight** ____

This Is To Certify That This Recorder Has Been Inspected And Tested.

Remarks ____

Date Of Calibration 03/25/2004 **Inspector:** [signature]

ARROW GAS COMPANY

LOCO HILLS PLANT

BRINE HOLDING POND

CONSTRUCTION PLANS

INDEX TO DRAWINGS

Copy 1 of 2
Rcvd. OCD 5/23/83

JOB NO. 22250

ARROW GAS COMPANY		
	SCALE	DRAWN BY / REVISED
MANN ENGINEERING COMPANY ROSWELL, NEW MEXICO		
DATE: MAY 83	APPROVED BY	DRAWING NUMBER: 1 OF 6

CONSTRUCTION NOTES & MATERIALS

1. All subgrade and berm embankment fill shall be compacted to a minimum of 90% maximum density (modified Proctor).

2. CPE Liner shall be 30 mil. CP-UR Flexseal Chlorinated Polyethylene Lining Material by B. F. Goodrich, or approved equal from berm to berm; and 30 mil. CP6 Flexseal Reinforced Chlorinated Polyethylene Lining Material by B. F. Goodrich, or approved equal on slopes and tops of berms.

3. Fabric Underlay shall be 55 mil. SUPAC-N Nonwoven Geotextile 5NP by Phillips Fibers Corporation, or approved equal.

4. Separation Fabric shall be 55 mil. SUPAC-N Nonwoven Geotextile 5NP by Phillips Fibers Corporation, or approved equal.

5. PVC Underliner shall be 20 mil. PVC Flexseal Polyvinyl Chloride Lining Material by B. F. Goodrich, or approved equal.

6. Gravel shall be ½" to 1" washed gravel containing no crushed rock.

7. PVC Pipe - 4" PVC, SDR 41, perforated with 5/8" Ø holes in upper half of pipe on 2' staggered spacing ea. side: 4" PVC, SDR 26, solid drain line, solvent weld all joints.

8. Sump - Manufactured fiberglass well with fitted lid and sealed bottom, (min.) ¼" wall thickness, 24" O.D. x 9'-0".

9. Anchor & Tie Down - Liners and tie down tubes to be placed in anchor trench, back filled and compacted to specs.

10. Seams - Use bodied adhesive for CPER liner. Solvent weld PVC underliner, see details.

11. Inlet and Outlet Pipe shall be 3", SDR 17, Yellowmine PVC Pipe with Certa-Lok Joints by Certainteed Corporation, or approved equal.

ESTIMATED QUANTITIES

Item	Quantity
Excavation	5,766 Cu. Yds.
Embankment (Neat Line)	4,481 Cu. Yds.
Shrink (15%)	791 Cu. Yds.
Surplus Material	494 Cu. Yds.
Underliner	68,159 Sq. Ft.
Liner - Unreinforced	25,450 Sq. Ft.
Liner - Reinforced	41,924 Sq. Ft.
Fabric Underlay	44,020 Sq. Ft.
Separation Fabric	1,176 Sq. Ft.
Leak Detection Sumps	2 Ea.
Perf. 4" Leak Detection Pipe	184 Lin. Ft.
Non Perf. 4" Leak Detection Pipe	170 Lin. Ft.
Gravel	21 Cu. Yds.
Washed Sand	783 Cu. Yds.
3" Inlet-Outlet Pipe	200 Lin. Ft.
Inlet-Outlet Structure	1 Ea.

NOTES

1. Estimated quantities are shown for information only - Contractor is responsible for determining his own quantities for bidding purposes.

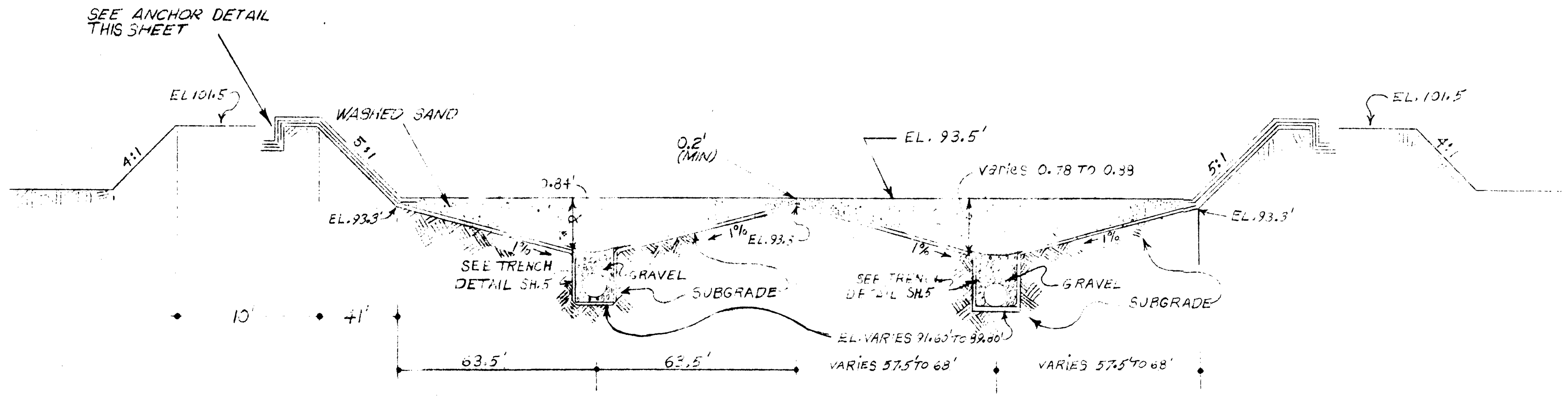
2. Estimated quantities shown for lining materials do not include any allowances for laps, nor waste at corners and/or structures, nor for tie downs.

3. Surplus material will be disposed of on site as directed by the Engineer.

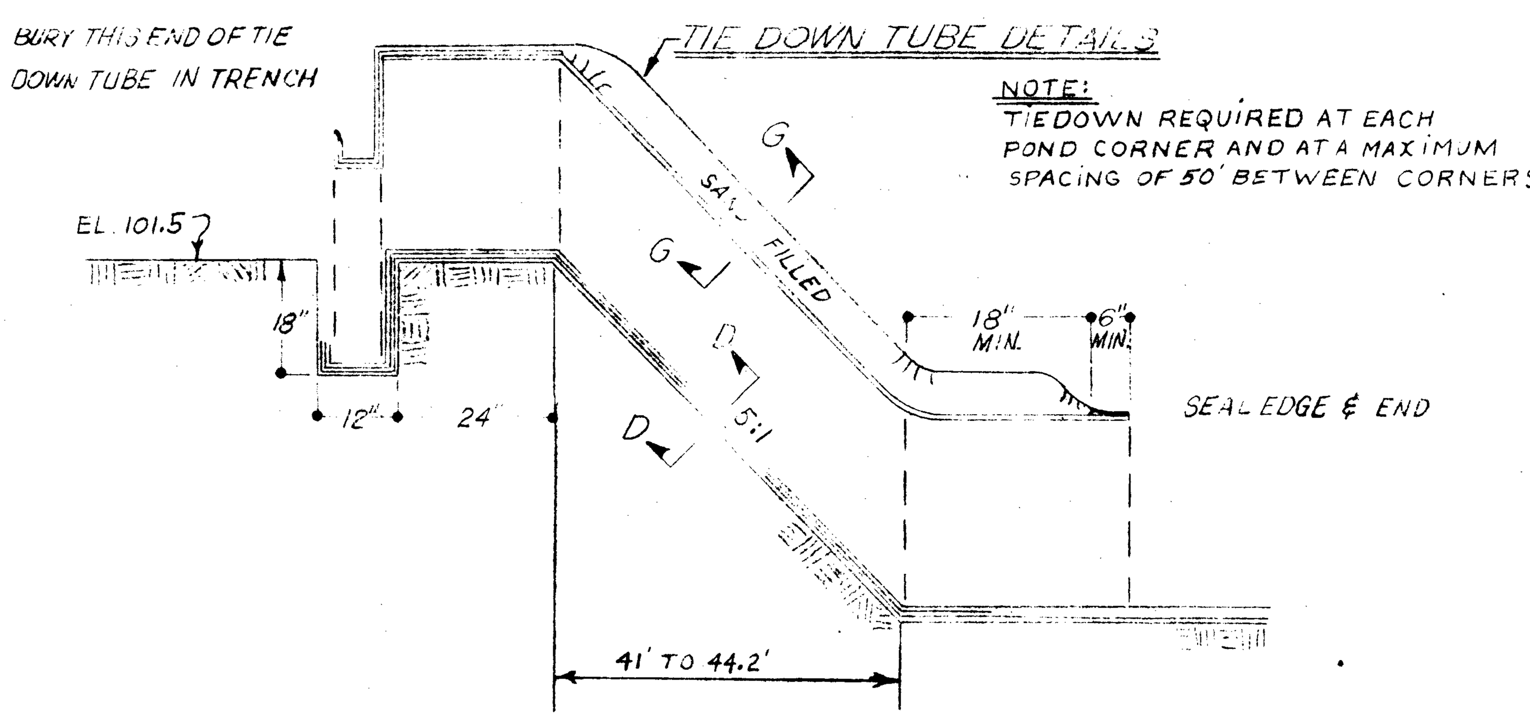
JOB NO 22250

ARROW GAS COMPANY		
GENERAL NOTES ESTIMATED QUANTITIES	SCALE N/A	DRAWN BY REVISED
MANN ENGINEERING COMPANY ROSWELL, NEW MEXICO		
DATE 5-13-83	APPROVED BY	DRAWING NUMBER 2 OF 6

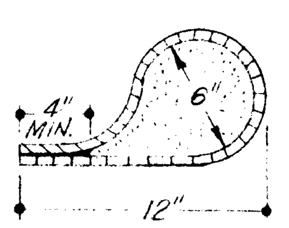
℄ STATE HIGHWAY NO. 83
LEGEND
POWER POLE
POWER LINE
VALVE
WATER LINE
FENCE
FENCE CORNER
WELL
PUMP
X 100.0 SPOT ELEV.
GRADE BRAKE
DIRECTION OF FLOW
FINISH SUBGRADE ELEV.
GATE
OFFICE
B.M. 100.00 FLOOR
STORAGE TANKS
END 3" LINE
3" LINE
PUMP PAD
APPROX. TOE OF FILL SLOPE
BY OWNER
INLET-/OUTLET PIPING
THIS CONTRACT
LEAK DETECTION SUMP - SEE DETAIL
LEAK DETECTION PIPE - SEE DETAIL
INLET-OUTLET SEE DETAIL
EDGE OF POND BOTTOM
BERM = 101.50
SLOPE 5:1
SLOPE 4:1
377'
335'
BASE LINE
0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
ARROW GAS COMPANY
POND PLAN
MANN ENGINEERING COMPANY
ROSWELL, NEW MEXICO
DATE 5-2-83
3 OF 6



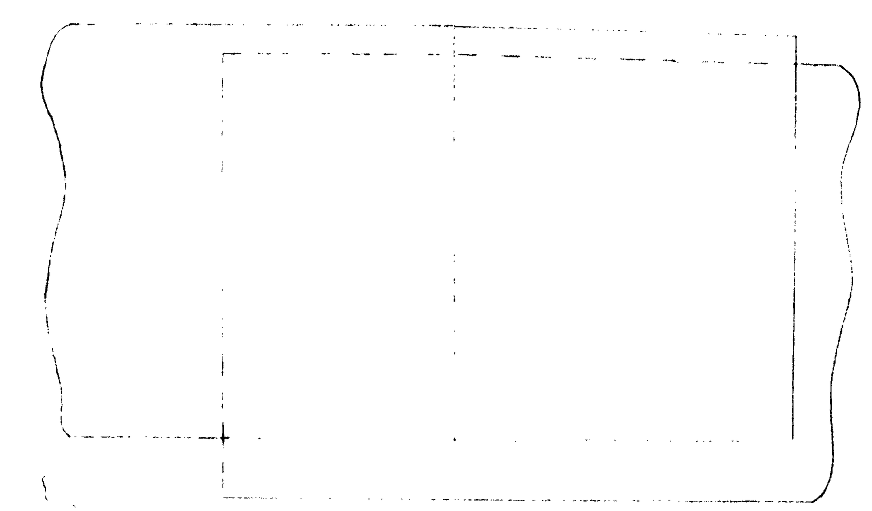
SECT. 'A-A'
NOT TO SCALE

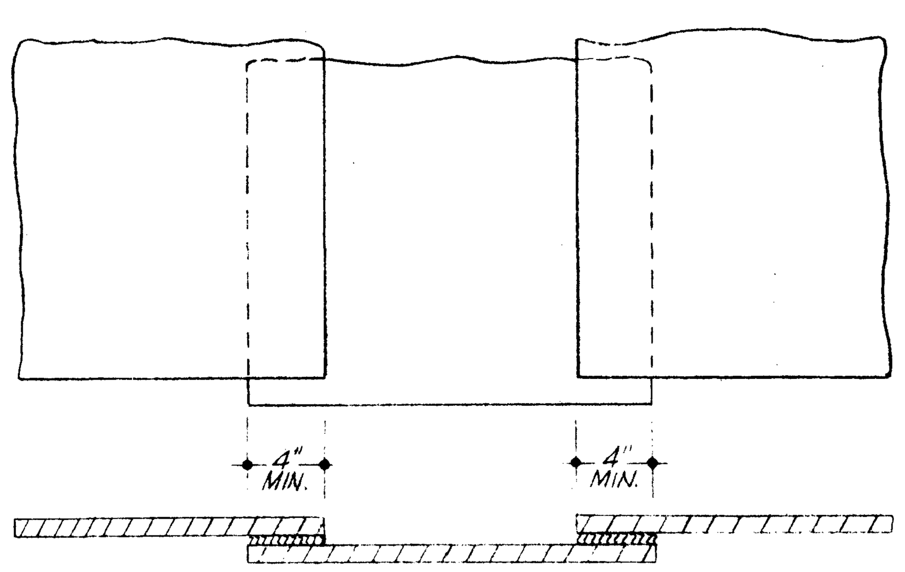


ANCHOR TRENCH DETAILS
NO SCALE

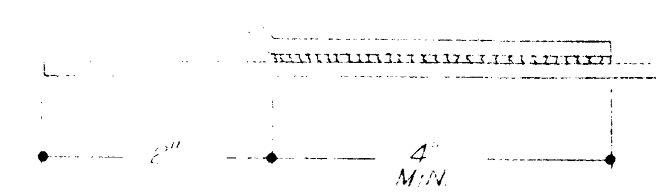


SECT. 'G-G'
NO SCALE





FLAT SEAM SEALING DETAILS
FOR LINER AND UNDERLINER SEE NOTE 10



ANGLED SEAM SEALING DETAILS
FOR LINER AND UNDERLINER SEE NOTE 10

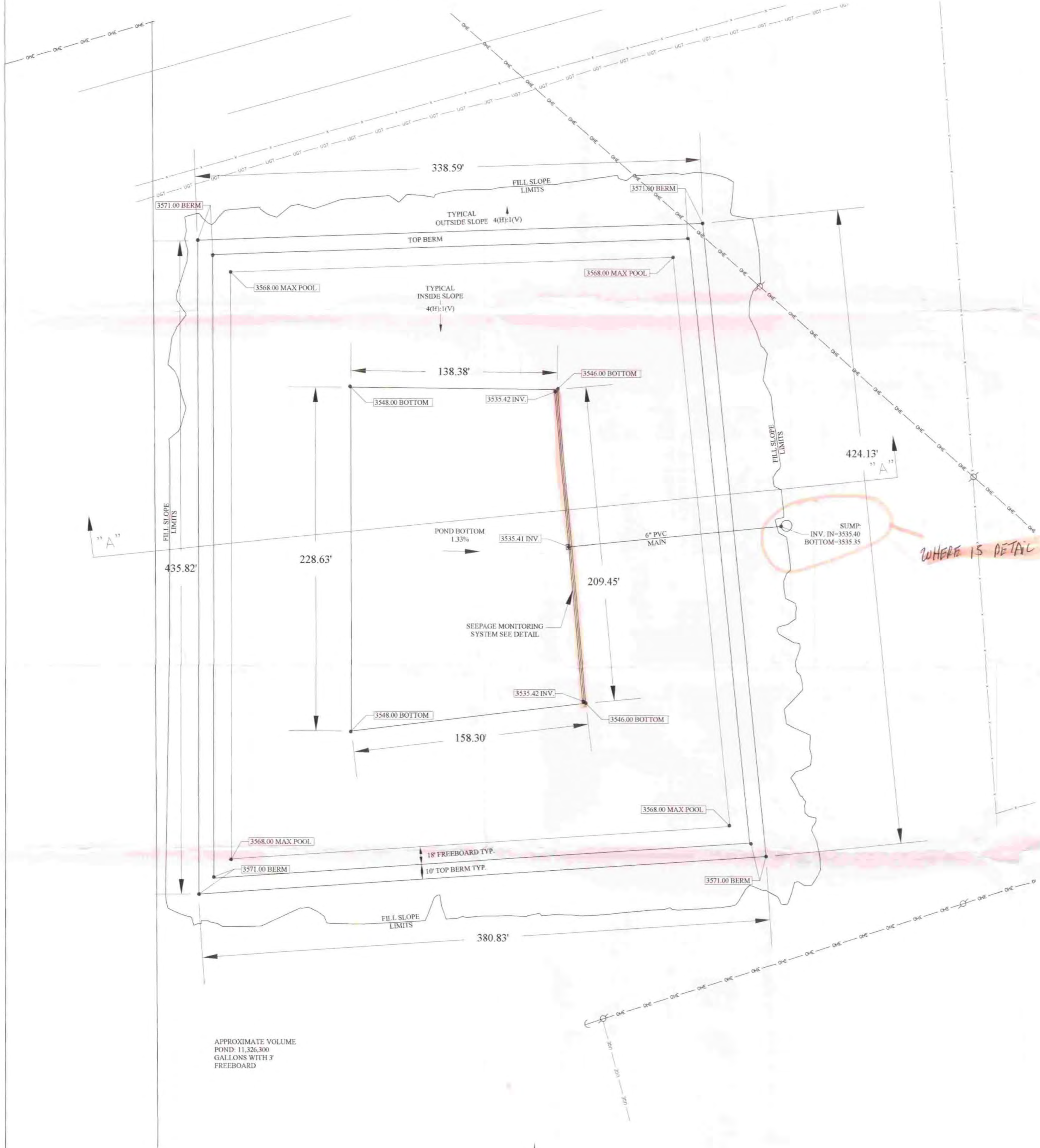
JOB NO. 22250

ARROW GAS COMPANY		
MISCELL. DETAILS	SCALE	DRAWN BY / REVISED
MANN ENGINEERING COMPANY ROSWELL, NEW MEXICO		
DATE: MAY 83	APPROVED BY	DRAWING NUMBER: 4 OF 6

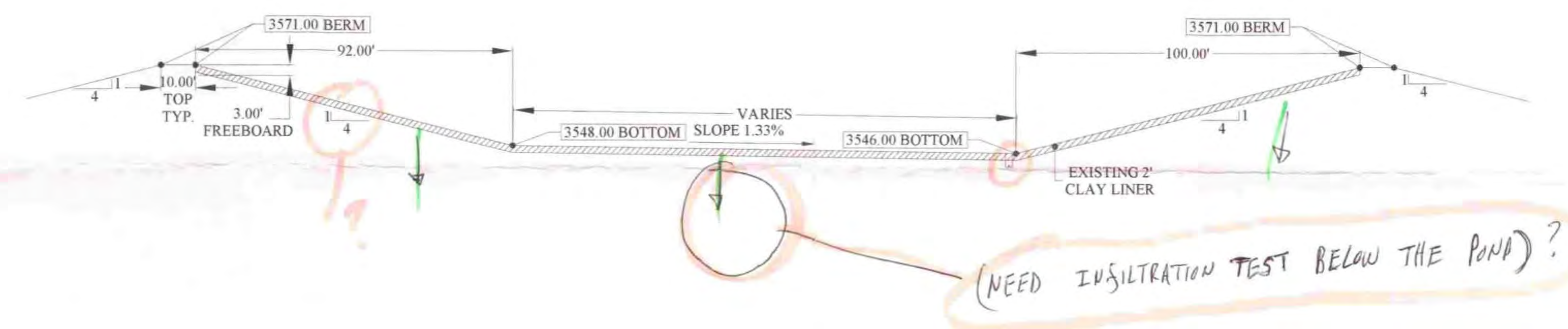
JOB NO. 22250

ARROW GAS COMPANY		
MISCELL. DETAILS	SCALE	DRAWN BY / REVISED
MANN ENGINEERING COMPANY ROSWELL, NEW MEXICO		
DATE: MAY 83	APPROVED BY	DRAWING NUMBER: 5 OF 6

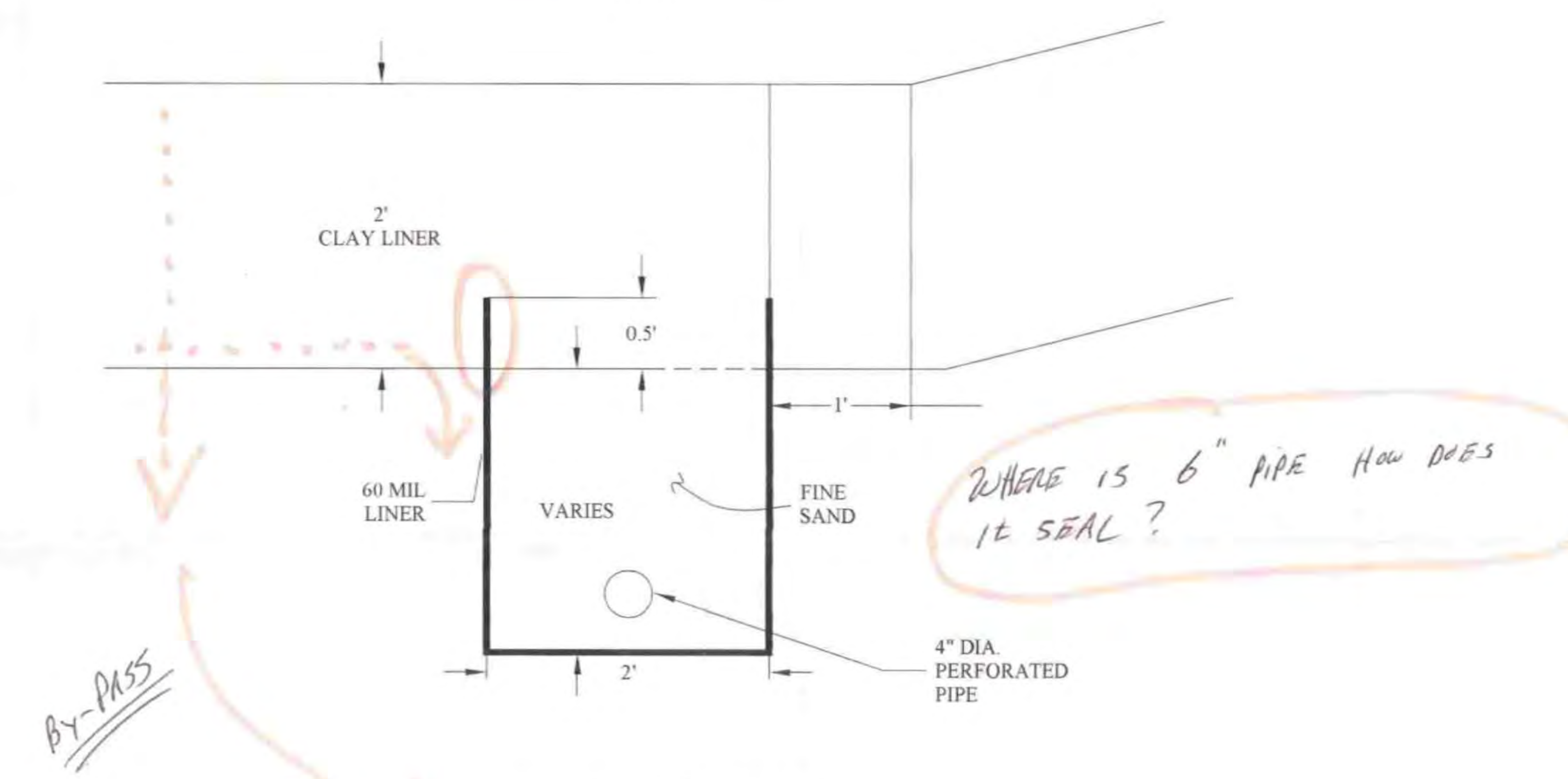

CUT
FILL
2+45 C-0.0
2+45 F-0.0
665 C.Y.
2+25
C-0.0
F-4.49
631 C.Y.
2+15
C-0.0
F-4.02
674 C.Y.
1+95 C-0.0
1+95 F-0.53
165 C.Y.
510 C.Y.
1+74
C-3.28
F-0.53
4749 C.Y.
915 C.Y.
0+76
C-3.26
F-0.73
507 C.Y.
227 C.Y.
0+55 C-0.0
0+55 F-0.73
482 C.Y.
0+35
C-0.0
F-2.52
3.65 C.Y.
SCALE: HORZ. 1"=20' VERT. 1"=10'
0+25
C-0.0
F-2.41
357 C.Y.
0+05 C-0.0
0+05 F-0.0
5+00
6+00
7+00
8+00
9+00
ARROW GAS CO.
LOCO HILLS PLANT
POND X-SEC'S
MANN ENGINEERING CO.
ROSWELL, NEW MEXICO
MAY 1983
6 OF 6



APPROXIMATE VOLUME
POND: 11,326,300
GALLONS WITH 3'
FREEBOARD



TYPICAL "A"–"A"
N.T.S



SEEPAGE MONITORING
SYSTEM DETAIL
N.T.S

WHERE IS BENCH MARK?
FOR ELEVATIONS

NOTES:

1) CONTRACTOR SHALL VERIFY QUANTITY ESTIMATES.
2) ALL MATERIALS AND SUBSTITUTIONS OF MATERIALS MUST MEET OR EXCEED NMOCD REQUIREMENTS AND REQUIRES APPROVAL OF PROJECT ENGINEER. — WHAT REQUIREMENTS
3) CONTRACTOR TO ADD BENTONITE TO EXISTING 2' THICK CLAY LINER & RECOMPACT TO 95% ASTM D-698 @ OPTIMUM TO 4% ABOVE OPTIMUM MOISTURE. — WILL THEY REMOVE ROCKS?
4) PERCENTAGE OF BENTONITE TO BE ADDED WILL BE DETERMINED BY FIELD TEST PLOTS PRIOR TO CONSTRUCTION.
5) SW 101 BENTONITE TO BE PROVIDED BY OWNER.
6) SEE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS. — WHAT SPEC'S MUST BE REFERENCED

WILL THIS BE IN-SITU OR BATCH PROCESSING

WHAT IF SOIL IS EXPOSED TO FREEZING, THAW CYCLES
WHAT ABOUT DE-HYDRATION?

LEGEND	
	ANCHOR
	POWER POLE
	GUY WIRE
	WELL
	PUMP HEAD
	VENT PIPE
OHE	OVERHEAD ELECTRIC
	ABOVEGROUND FAS-LINE
UGT	UNDERGROUND TELEPHONE
UGPL	UNDERGROUND PIPELINE
	4 STRAND BARB WIRE

CLAY LINED BRINE POND
LOCO HILLS GSF, LTD.
BUSINESS LEASE No. BL-635

REV	DATE	DESCRIPTION
5	12/21/2004	REVISED
4	11/17/2004	REVISED
0	04/07/2003	FINAL PLAT
00	03/14/2003	PRELIMINARY PLAT
	03/05/2003-03/06/2003	DATE OF SURVEY

PETTIGREW AND ASSOCIATES
1110 N. GRIMES HOBBS, N.M. 88240
(505) 393-9827

BRINE POND DESIGN
LOCO HILLS GSF, LTD.
LOCO HILLS, NEW MEXICO

PROJECT# 2003.1016 DRN BY: C. JOHNSON
DWG \AutoCAD Loco Hills GSF\dwg\Loco Hills GSFR5.dwg
BOOK# SHEET

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131A
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

MONTHLY GAS STORAGE REPORT

Loco Hills GSF LTD (Company) 158 Deer Creek Drive Aledo, Texas 76008 (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year Dec-2004

WELL NAME AND NUMBER	LOCATION UNIT SEC. TWP. RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (MCF)	WITHDRAWAL (MCF)
Leonard State #2 Loco Hills GSF #2 30-15-06193	L 22 17S 29E	379.5#	0	10,008,08

TOTALS

TOTAL CAPACITY (MMCF) 109.3

BEGINNING STORAGE (MMCF) 12.60

NET CHANGE (MMCF) 10

ENDING STORAGE (MMCF) 2.60

CALCULATED RESERVOIR PRESSURE @ END OF MONTH 111.5#

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature John B. Smith

Printed Name & Title John B Smith Technical Operator

Date Jan 11 2005 Telephone No. (505) 677-2331

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131A
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

MONTHLY GAS STORAGE REPORT

Loco Hills GSF LTD (Company) 158 Deer Creek Drive Aledo, Texas 76008 (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year Dec, 2004

WELL NAME AND NUMBER	LOCATION UNIT SEC. TWP. RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (MCF)	WITHDRAWAL (MCF)
Conrad State #1 Loco Hills GSF #1 API # 30-15-06192	22 22 17S 29E	390#	3,800.34	31,214.93

TOTALS

TOTAL CAPACITY (MMCF) 106

BEGINNING STORAGE (MMCF) 50.54

NET CHANGE (MMCF) 27.41

ENDING STORAGE (MMCF) 23.13

CALCULATED RESERVOIR PRESSURE @ END OF MONTH 115.5#

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature John B. Smith

Printed Name & Title John B. Smith Terminal Operator

Date Jan 11, 2005 Telephone No. (505) 677-2331

Price, Wayne

From: Price, Wayne
Sent: Wednesday, December 29, 2004 8:24 AM
To: 'Mitchel Johnson'; Price, Wayne
Subject: RE: LHGSF Public Notice

Got your E-mail, will be working on your project today!

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
Sent: Thursday, December 23, 2004 11:56 AM
To: wprice@state.nm.us
Subject: LHGSF Public Notice

Wayne,

I just wanted to make sure you got my email yesterday. Do you have everything you need so we can get public notice out?

Thank you,

itchel Johnson
co Hills GSF
fice: 817-441-6568
l: 817-371-7933

Price, Wayne

From: Mitchel Johnson [mitchel_lhgsf@hotmail.com]
Sent: Wednesday, December 22, 2004 12:16 PM
To: WPrice@state.nm.us
Cc: R@rthicksconsult.com
Subject: RE: Loco Hills - Alternative Abatement Standards

Wayne,

Was Randy's email sufficent information or do you need something else so we can get notice out?

Thank you,

Mitchel Johnson
Loco Hills GSF
office: 817-441-6568
cell: 817-371-7933

----Original Message Follows----
From: "Randall Hicks" <R@rthicksconsult.com>
To: "'Price, Wayne'" <WPrice@state.nm.us>
CC: "'Mitchel Johnson'" <mitchel_lhgsf@hotmail.com>
Subject: Loco Hills - Alternative Abatement Standards
Date: Tue, 21 Dec 2004 13:44:41 -0700

Wayne

We need your input on including the alternative abatement standards language in the Public Notice.

Section 10.0 of the Best Management Practices Plan (page 18) has the following language:

The simple calculations regarding the potential for pond seepage to enter
ground water (Tables 5 and 6) demonstrate that a formal application for Alternative Abatement Standards is premature. If the predictions presented
in Tables 5 and 6 are incorrect, monitoring will detect unexpected seepage the errors and permit us to correct any problem long before any impact on ground water. Nevertheless, NMOCD recommended that we present a petition for alternative abatement standards in the event that brine seepage unexpectedly enters ground water. This document is an application for provisional Alternative Abatement Standards.

Table 5 shows that if the liner behaves as designed, the brine seepage will not reach ground water during the operational life of the pond. The seepage will penetrate less than 10 meters during the projected 30-year pond life. Table 6 shows that if the liner performs as designed and the hydraulic characteristics of the Ruster are similar to what were measured at WIPP, then we expect brine seepage to reach ground water in about 190,000 years. Bottom line - these spreadsheets suggest brine will not reach ground water in the foreseeable future.

I elected NOT to include the provision for AAS in the public notice because I was hopeful that NMOCD would agree that such a petition is not needed at this time. However, to honor what we said in our meetings, we included all of the analysis and supporting data for a petition for Alternative Abatement Standards in the event that NMOCD feels that such an application is necessary. Yes, I should have done these seepage calculations long ago; but one starts to think about different things as one reaches the "finish line", eh?

If everything fails - the liner, the geology, the 3 layers of vadose zone monitoring - then brine can enter ground water and we should be looking at AAS. We included a failure analysis in Table 6 that shows a brine transport time of 1.9 years if everything goes bad that could go bad. To repeat, if the liner is installed correctly and the geology is similar to WIPP and the vadose zone monitoring works then AAS should not be required at this time.

Let us know what you think. I attach the spreadsheets (provided to you earlier) from which we created these two tables. You can play around with input values and decide what you want to do about AAS and the Public Notice.

Thanks

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

<< Tables5-6-7ofBMP.xls >>

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Tuesday, December 21, 2004 1:45 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'
Subject: Loco Hills - Alternative Abatement Standards

Wayne

We need your input on including the alternative abatement standards language in the Public Notice.

Section 10.0 of the Best Management Practices Plan (page 18) has the following language:

The simple calculations regarding the potential for pond seepage to enter ground water (Tables 5 and 6) demonstrate that a formal application for Alternative Abatement Standards is premature. If the predictions presented in Tables 5 and 6 are incorrect, monitoring will detect unexpected seepage the errors and permit us to correct any problem long before any impact on ground water. Nevertheless, NMOCD recommended that we present a petition for alternative abatement standards in the event that brine seepage unexpectedly enters ground water. This document is an application for provisional Alternative Abatement Standards.

Table 5 shows that if the liner behaves as designed, the brine seepage will not reach ground water during the operational life of the pond. The seepage will penetrate less than 10 meters during the projected 30-year pond life. Table 6 shows that if the liner performs as designed and the hydraulic characteristics of the Ruster are similar to what were measured at WIPP, then we expect brine seepage to reach ground water in about 190,000 years. Bottom line – these spreadsheets suggest brine will not reach ground water in the foreseeable future.

I elected NOT to include the provision for AAS in the public notice because I was hopeful that NMOCD would agree that such a petition is not needed at this time. However, to honor what we said in our meetings, we included all of the analysis and supporting data for a petition for Alternative Abatement Standards in the event that NMOCD feels that such an application is necessary. Yes, I should have done these seepage calculations long ago; but one starts to think about different things as one reaches the "finish line", eh?

If everything fails – the liner, the geology, the 3 layers of vadose zone monitoring – then brine can enter ground water and we should be looking at AAS. We included a failure analysis in Table 6 that shows a brine transport time of 1.9 years if everything goes bad that could go bad. To repeat, if the liner is installed correctly and the geology is similar to WIPP and the vadose zone monitoring works then AAS should not be required at this time.

Let us know what you think. I attach the spreadsheets (provided to you earlier) from which

Table 7: Calculated TDS of Ground Water for Alternative Abatement Standards

	Value	Units	Source
Pond Seepage Rate			
Surface Area of Pond	1000	meters2	Survey
Vertical Unsaturated Hydraulic Conductivity of Rustler	5.00E-11	m/sec	Estimate from Table 6
Hydraulic Gradient (unsaturated)	1		
Calculated Brine Flux at Closure (Unsaturated Flow)	5.00E-08	m3/sec	Darcy's Law
Ground Water Flux Beneath Pond			
Hydraulic Conductivity of Rustler	1.00E-07	m/s	Estimate based upon site observations and Table 6
Area of Flow (3 meter thick aquifer)	3000	m2	Calculation
Hydraulic Gradient of Rustler	0.022857143		Measured
Ground Water Flow	6.86E-06	m3/s	Darcy's Law
Mixing Calculation			
TDS of Fluid in Vadose Zone (Cb)	250,000.00	mg/L	Saturated Brine
TDS of Ground Water (Cgw)	2,500	mg/L	Measured
Flux of Ground Water (Qgw)	7.E-06	m3/s	Calculated
Unsaturated Flux of Brine to Ground Water (Qb)	5.00E-08	m3/s	Calculated
TDS of Ground Water after Mixing	4,291.62	mg/L	Cf =((Qb*Cb)+(Qgw*Cgw))/(Qb+Qgw)

From: Price, Wayne
Sent: Tuesday, December 21, 2004 9:17 AM
To: 'Mitchel Johnson'; Price, Wayne
Cc: Anderson, Roger; MacQuesten, Gail; Leach, Carol; Fesmire, Mark
Subject: RE: Loco Hills GSF

Good Morning Mitchel:

I started working on the proposal yesterday. During our last meeting on October 28, 2004 it was my understanding that Loco Hills GSF would apply for alternate abatement standards. The public notice that Randy Hicks supplied and the one you supplied (attached) does not mention alternate abatement standards. Please clarify.

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
Sent: Tuesday, December 21, 2004 8:43 AM
To: wprice@state.nm.us
Subject: Loco Hills GSF

Wayne,

I hope things are well and your ready for a great Holiday. I've attached a letter to you and a copy of the Public Notice we are ready to send. The last contact we had you said that you needed a couple of weeks to work on another project. If all possible, could you please review these letters and comment if we need to change anything.

Thank you,

Mitchel Johnson
Loco Hills GSF
office: 817-441-6568
cell: 817-371-7933

Price, Wayne

From: Mitchel Johnson [mitchel_lhgsf@hotmail.com]
Sent: Tuesday, December 21, 2004 8:43 AM
To: wprice@state.nm.us
Subject: Loco Hills GSF

PublishPublicNotice.doc Noticetointerestedpartiesfor Lo...

Wayne,

I hope things are well and your ready for a great Holiday. I've attached a letter to you and a copy of the Public Notice we are ready to send. The last contact we had you said that you needed a couple of weeks to work on another project. If all possible, could you please review these letters and comment if we need to change anything.

Thank you,

Mitchel Johnson
Loco Hills GSF
office: 817-441-6568
cell: 817-371-7933

LOCO HILLS GSF
158 Deer Creek Drive ▲ Aledo, Texas 76008 ▲ 817 441 6568▲ Fax: 817-441-5880

December 20, 2004

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF
Section 22, T17S, R29E:

Dear Wayne:

Pettigrew Engineers will submit the engineering plans and specifications for our proposed clay-lined brine storage pond no later than Thursday of this week. We believe that the submission of these plans and specifications will create an administratively complete submission for the proposed Stage I/II Abatement Plan and the proposed exemption to Rule 50.

We ask that you review the attached letter to interested parties, which we sent to NMOCD in November. After NMOCD approval, we would like to send this letter to those on the mailing list, which we understand is available at the following address:

(http://www.emnrd.state.nm.us/ocd/bureaus/Environmental/Discharge_Permits/WQCC%20Mailing%20List.doc)

if possible, we would like to send this notification out tomorrow to those on the list and all landowners within 1 mile of the site and the Eddy County Commission.

If we can transmit the attached notification tomorrow, then we will meet the requirement of notification of these individuals in advance of a formal public notice, which we hope can be published no later than Saturday in the Artesia Daily News and the Albuquerque Journal. We propose the following public notice for these newspapers.

> Loco Hills GSF, 158 Deer Creek Drive, Aledo, Texas 76008 has submitted an application for an exemption from the inter-liner leak detection requirements of NMOCD Rule 50 for its Loco Hills LPG Storage facility located in Section 22, T17S, R29E, NMPM, Eddy County, New Mexico. Up to 9,000,000 gallons of saturated brine will be temporarily stored in an engineered clay-lined pond. The brine is periodically injected into subsurface storage caverns which causes stored LPG to rise to the surface for distribution. The application for the exemption from Rule 50 also addresses how solid waste, spills, leaks, and other accidental

discharges to the surface will be managed. Ground water most likely to be affected by any accidental discharge is at a depth of approximately 90 feet and has a total dissolved solids content of approximately more than 100,000 mg/l. However, samples from nearby water wells suggest the background TDS concentration of the ground water is about 2500 mg/L. Part of the application is a Stage II Abatement Plan that proposes to restore ground water quality to background concentrations through a pump-and-use strategy. Site evidence suggests that the source of the elevated TDS in ground water is a seepage pond that was used until the 1960s by a previous owner. Although the total volume of this past release is unknown, the extent of ground water impairment is less than 80 acres. unknown?

A copy of the abatement plan can be viewed by the public at the Division's main office in Santa Fe or at the Division's District office in Artesia. The abatement plan can be accessed by the public electronically from the NMOCD web site. Any person seeking to comment on a Stage 1 abatement plan, or to comment or request a public hearing on a Stage 2 abatement plan, must file written comments or hearing requests with the Division within thirty (30) days of the date of public notice, or within thirty (30) days of receipt by the Director of a proposed significant modification of a Stage 2 abatement plan. Requests for a public hearing must set forth the reasons why a hearing should be held. A public hearing shall be held if the Director determines that there is significant public interest or that the request has technical merit.

If you can review and provide suggestions for improving this public notice or the notification to interested parties, we will submit the final language to the newspapers via email, with a copy of that transmission to NMOCD. As required, we will send the notice to interested parties in advance of the publication of the public notice. We thank you for your attention to this matter.

Sincerely,
Loco Hills GSF

Mitch Johnson
President

Copy
Randall Hicks, Hicks Consultants

LOCO HILLS GSF
158 Deer Creek Drive ▲ Aledo, Texas 76008 ▲ 817 441 6568▲ Fax: 817-441-5880

November 2004

RE: Loco Hills GSF
Section 22, T17S, R29E:

Sir or Madam:

Loco Hills GSF proposes to implement a voluntary ground water restoration program at their LPG storage facility near Loco Hills, New Mexico. Impairment of ground water occurred during the drilling and construction of the subsurface LPG storage caverns in the late 1950s to the early 1960s. Ground water, which is about 90 feet below ground surface within thin limestone and sandstone beds of the Rustler Formation, exhibits a total dissolved solids (TDS) concentration greater than 100,000 mg/L. About 500 feet down gradient from the facility, ground water TDS decreases to less than 50,000 mg/L. We believe ground water is at background concentrations about 1000-2000 feet down gradient from the facility. The documented ground water impairment affects neither surface water nor habitat. Only the two supply wells at the facility are affected by the ground water impairment. Loco Hills GSF acquired the facility in 2003.

The proposed aggressive ground water pumping uses a facility supply well to capture the ground water zone exhibiting the highest TDS concentrations. Down gradient from the facility, natural restoration will return ground water to background conditions over time. Loco Hills GSF is acquiring the private property and some State of New Mexico land affected by the ground water impairment. Loco Hills GSF has requested restriction of water supply development on Federal and State land potentially affected. The land acquisition and institutional controls will protect public health during the ground water restoration program.

Aggressive ground water pumping as proposed by Loco Hills GSF requires expansion of the LPG storage facility, coupled with exportation of ground water from the site through brine sales and evaporation. To facilitate this inter-dependent environmental and business strategy, Loco Hills GSF proposes to construct an 11,000,000 gallon brine storage pond. Because the subsurface beneath the proposed pond is dominated by very low permeability clay and gypsum, Loco Hills GSF is requesting an exemption from the secondary liner requirement of NMOCD Rule 50. Instead of

installing a primary synthetic liner and a secondary clay liner, Loco Hills GSF proposes to allocate resources from purchase and installation of a synthetic liner to ground water restoration, the installation of an engineered clay/bentonite liner with seepage detection, and a comprehensive monitoring and reporting program.

Loco Hills GSF has summarized the environmental conditions at the site and the proposed actions in a document that is available at the NMOCD offices in Santa Fe and Artesia, New Mexico. Individuals can request an electronic version of the report from:

Katie Lee
R.T. Hicks Consultants, Ltd.
901 Rio Grande NW F-142
Albuquerque, New Mexico 87104
505-266-5004
Katie@rthicksconsult.com

Sincerely,
Loco Hills GSF

Mitch Johnson
President

Copy
Randall Hicks, Hicks Consultants

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

November 10, 2004

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E

Dear Wayne:

Today, Katie Lee of my staff is transmitting the following two documents (without appendices) to you via email:

1. Best Management Practices Plan, which includes
   a. Application for an Exemption to the Secondary Liner Requirement of Rule 50
   b. Petition for provisional alternative abatement standards
2. Stage I/II Abatement Plan

Tomorrow, we will send one complete hard copy and several compact discs to your office and the NMOCD Artesia District Office. We hope that you will find these documents administratively complete and ready for public notice.

Attached to this letter is our proposed notification to adjacent landowners, the NMOCD mailing list, and other interested parties identified by Rule 19. Please provide any comments on this notification and we will amend the language and mail these notifications as soon as possible. Once again, we thank you in advance for your attention to this matter.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall Hicks

Randall Hicks
Principal

Copy: Mitchell Johnson

P.S. – the watercolor that graces the jacket of our report is "Morning in Crazy Hills" by our staff hydrogeologist/artist David Hamilton

LOCO HILLS GSF

158 Deer Creek Drive ▲ Aledo, Texas 76008 ▲ 817 441 6568▲ Fax: 817-441-5880

November 2004

RE: Loco Hills GSF
Section 22, T17S, R29E:

Sir or Madam:

Loco Hills GSF proposes to implement a voluntary ground water restoration program at their LPG storage facility near Loco Hills, New Mexico. Impairment of ground water occurred during the drilling and construction of the subsurface LPG storage caverns in the late 1950s to the early 1960s. Ground water, which is about 90 feet below ground surface within thin limestone and sandstone beds of the Rustler Formation, exhibits a total dissolved solids (TDS) concentration greater than 100,000 mg/L. About 500 feet down gradient from the facility, ground water TDS decreases to less than 50,000 mg/L. We believe ground water is at background concentrations about 1000-2000 feet down gradient from the facility. The documented ground water impairment affects neither surface water nor habitat. Only the two supply wells at the facility are affected by the ground water impairment. Loco Hills GSF acquired the facility in 2003.

The proposed aggressive ground water pumping uses a facility supply well to capture the ground water zone exhibiting the highest TDS concentrations. Down gradient from the facility, natural restoration will return ground water to background conditions over time. Loco Hills GSF is acquiring the private property and some State of New Mexico land affected by the ground water impairment. Loco Hills GSF has requested restriction of water supply development on Federal and State land potentially affected. The land acquisition and institutional controls will protect public health during the ground water restoration program.

Aggressive ground water pumping as proposed by Loco Hills GSF requires expansion of the LPG storage facility, coupled with exportation of ground water from the site through brine sales and evaporation. To facilitate this inter-dependent environmental and business strategy, Loco Hills GSF proposes to construct an 11,000,000 gallon brine storage pond. Because the subsurface beneath the proposed pond is dominated by very low permeability clay and gypsum, Loco Hills GSF is requesting an exemption from the secondary liner requirement of NMOCD Rule 50. Instead of

installing a primary synthetic liner and a secondary clay liner, Loco Hills GSF proposes to allocate resources from purchase and installation of a synthetic liner to ground water restoration, the installation of an engineered clay/bentonite liner with seepage detection, and a comprehensive monitoring and reporting program.

Loco Hills GSF has summarized the environmental conditions at the site and the proposed actions in a document that is available at the NMOCD offices in Santa Fe and Artesia, New Mexico. Individuals can request an electronic version of the report from:

Katie Lee
R.T. Hicks Consultants, Ltd.
901 Rio Grande NW F-142
Albuquerque, New Mexico 87104
505-266-5004
Katie@rthicksconsult.com

Sincerely,
Loco Hills GSF

Mitch Johnson
President

Copy
Randall Hicks, Hicks Consultants

Price, Wayne

From: Price, Wayne
Sent: Tuesday, December 21, 2004 9:17 AM
To: 'Mitchel Johnson'; Price, Wayne
Cc: Anderson, Roger; MacQuesten, Gail; Leach, Carol; Fesmire, Mark
Subject: RE: Loco Hills GSF

Good Morning Mitchel:

I started working on the proposal yesterday. During our last meeting on October 28, 2004 it was my understanding that Loco Hills GSF would apply for alternate abatement standards. The public notice that Randy Hicks supplied and the one you supplied (attached) does not mention alternate abatement standards. Please clarify.

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
Sent: Tuesday, December 21, 2004 8:43 AM
To: wprice@state.nm.us
Subject: Loco Hills GSF

Wayne,

I hope things are well and your ready for a great Holiday. I've attached a letter to you and a copy of the Public Notice we are ready to send. The last contact we had you said that you needed a couple of weeks to work on another project. If all possible, could you please review these letters and comment if we need to change anything.

Thank you,

Mitchel Johnson
Loco Hills GSF
office: 817-441-6568
cell: 817-371-7933

Price, Wayne

From: Mitchel Johnson [mitchel_lhgsf@hotmail.com]
Sent: Tuesday, December 21, 2004 8:43 AM
To: wprice@state.nm.us
Subject: Loco Hills GSF

PublishPublicNotice.doc Noticetointerestedpartiesforlo...

Wayne,

I hope things are well and your ready for a great Holiday. I've attached a letter to you and a copy of the Public Notice we are ready to send. The last contact we had you said that you needed a couple of weeks to work on another project. If all possible, could you please review these letters and comment if we need to change anything.

Thank you,

Mitchel Johnson
Loco Hills GSF
office: 817-441-6568
cell: 817-371-7933

LOCO HILLS GSF

158 Deer Creek Drive ▲ Aledo, Texas 76008 ▲ 817 441 6568▲ Fax: 817-441-5880

December 20, 2004

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF
Section 22, T17S, R29E:

Dear Wayne:

Pettigrew Engineers will submit the engineering plans and specifications for our proposed clay-lined brine storage pond no later than Thursday of this week. We believe that the submission of these plans and specifications will create an administratively complete submission for the proposed Stage I/II Abatement Plan and the proposed exemption to Rule 50.

We ask that you review the attached letter to interested parties, which we sent to NMOCD in November. After NMOCD approval, we would like to send this letter to those on the mailing list, which we understand is available at the following address:

(http://www.emnrd.state.nm.us/ocd/bureaus/Environmental/Discharge_Permits/WQCC%20Mailing%20List.doc)

if possible, we would like to send this notification out tomorrow to those on the list and all landowners within 1 mile of the site and the Eddy County Commission.

If we can transmit the attached notification tomorrow, then we will meet the requirement of notification of these individuals in advance of a formal public notice, which we hope can be published no later than Saturday in the Artesia Daily News and the Albuquerque Journal. We propose the following public notice for these newspapers.

> Loco Hills GSF, 158 Deer Creek Drive, Aledo, Texas 76008 has submitted an application for an exemption from the inter-liner leak detection requirements of NMOCD Rule 50 for its Loco Hills LPG Storage facility located in Section 22, T17S, R29E, NMPM, Eddy County, New Mexico. Up to 9,000,000 gallons of saturated brine will be temporarily stored in an engineered clay-lined pond. The brine is periodically injected into subsurface storage caverns which causes stored LPG to rise to the surface for distribution. The application for the exemption from Rule 50 also addresses how solid waste, spills, leaks, and other accidental

discharges to the surface will be managed. Ground water most likely to be affected by any accidental discharge is at a depth of approximately 90 feet and has a total dissolved solids content of approximately more than 100,000 mg/l. However, samples from nearby water wells suggest the background TDS concentration of the ground water is about 2500 mg/L. Part of the application is a Stage II Abatement Plan that proposes to restore ground water quality to background concentrations through a pump-and-use strategy. Site evidence suggests that the source of the elevated TDS in ground water is a seepage pond that was used until the 1960s by a previous owner. Although the total volume of this past release is unknown, the extent of ground water impairment is less than 80 acres.

A copy of the abatement plan can be viewed by the public at the Division's main office in Santa Fe or at the Division's District office in Artesia. The abatement plan can be accessed by the public electronically from the NMOCD web site. Any person seeking to comment on a Stage 1 abatement plan, or to comment or request a public hearing on a Stage 2 abatement plan, must file written comments or hearing requests with the Division within thirty (30) days of the date of public notice, or within thirty (30) days of receipt by the Director of a proposed significant modification of a Stage 2 abatement plan. Requests for a public hearing must set forth the reasons why a hearing should be held. A public hearing shall be held if the Director determines that there is significant public interest or that the request has technical merit.

If you can review and provide suggestions for improving this public notice or the notification to interested parties, we will submit the final language to the newspapers via email, with a copy of that transmission to NMOCD. As required, we will send the notice to interested parties in advance of the publication of the public notice. We thank you for your attention to this matter.

Sincerely,
Loco Hills GSF

Mitch Johnson
President

Copy
Randall Hicks, Hicks Consultants

LOCO HILLS GSF

158 Deer Creek Drive ▲ Aledo, Texas 76008 ▲ 817 441 6568▲ Fax: 817-441-5880

November 2004

RE: Loco Hills GSF
Section 22, T17S, R29E:

Sir or Madam:

Loco Hills GSF proposes to implement a voluntary ground water restoration program at their LPG storage facility near Loco Hills, New Mexico. Impairment of ground water occurred during the drilling and construction of the subsurface LPG storage caverns in the late 1950s to the early 1960s. Ground water, which is about 90 feet below ground surface within thin limestone and sandstone beds of the Rustler Formation, exhibits a total dissolved solids (TDS) concentration greater than 100,000 mg/L. About 500 feet down gradient from the facility, ground water TDS decreases to less than 50,000 mg/L. We believe ground water is at background concentrations about 1000-2000 feet down gradient from the facility. The documented ground water impairment affects neither surface water nor habitat. Only the two supply wells at the facility are affected by the ground water impairment. Loco Hills GSF acquired the facility in 2003.

The proposed aggressive ground water pumping uses a facility supply well to capture the ground water zone exhibiting the highest TDS concentrations. Down gradient from the facility, natural restoration will return ground water to background conditions over time. Loco Hills GSF is acquiring the private property and some State of New Mexico land affected by the ground water impairment. Loco Hills GSF has requested restriction of water supply development on Federal and State land potentially affected. The land acquisition and institutional controls will protect public health during the ground water restoration program.

Aggressive ground water pumping as proposed by Loco Hills GSF requires expansion of the LPG storage facility, coupled with exportation of ground water from the site through brine sales and evaporation. To facilitate this inter-dependent environmental and business strategy, Loco Hills GSF proposes to construct an 11,000,000 gallon brine storage pond. Because the subsurface beneath the proposed pond is dominated by very low permeability clay and gypsum, Loco Hills GSF is requesting an exemption from the secondary liner requirement of NMOCD Rule 50. Instead of

installing a primary synthetic liner and a secondary clay liner, Loco Hills GSF proposes to allocate resources from purchase and installation of a synthetic liner to ground water restoration, the installation of an engineered clay/bentonite liner with seepage detection, and a comprehensive monitoring and reporting program.

Loco Hills GSF has summarized the environmental conditions at the site and the proposed actions in a document that is available at the NMOCD offices in Santa Fe and Artesia, New Mexico. Individuals can request an electronic version of the report from:

Katie Lee
R.T. Hicks Consultants, Ltd.
901 Rio Grande NW F-142
Albuquerque, New Mexico 87104
505-266-5004
Katie@rthicksconsult.com

Sincerely,
Loco Hills GSF

Mitch Johnson
President

Copy
Randall Hicks, Hicks Consultants

Price, Wayne

From: Price, Wayne
Sent: Wednesday, December 01, 2004 10:52 AM
To: 'Mitchel Johnson'; Price, Wayne
Subject: RE: LHGSF status

Dear Mitchel:

We are short handed here at OCD and I have over 200 other projects that I must enter in our data base system. Some of these projects are over two years old. I hope to get to yours within two weeks. Thanks for your patience.

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
Sent: Wednesday, December 01, 2004 9:59 AM
To: wprice@state.nm.us
Subject: LHGSF status

Wayne,

I hope you had a great Thanksgiving. Can you please update me on how things are going on our project and when we can get the Public Notice out? Please let me know if there is anything you are still waiting on.

Thank you,

Mitchel Johnson
Loco Hills GSF
office: 817-441-6568
cell: 817-371-7933

R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

November 10, 2004

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E

Dear Wayne:

Today, Katie Lee of my staff is transmitting the following two documents (without appendices) to you via email:

1. Best Management Practices Plan, which includes
   a. Application for an Exemption to the Secondary Liner Requirement of Rule 50
   b. Petition for provisional alternative abatement standards
2. Stage I/II Abatement Plan

Tomorrow, we will send one complete hard copy and several compact discs to your office and the NMOCD Artesia District Office. We hope that you will find these documents administratively complete and ready for public notice.

Attached to this letter is our proposed notification to adjacent landowners, the NMOCD mailing list, and other interested parties identified by Rule 19. Please provide any comments on this notification and we will amend the language and mail these notifications as soon as possible. Once again, we thank you in advance for your attention to this matter.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall Hicks

Randall Hicks
Principal

Copy: Mitchell Johnson

P.S. – the watercolor that graces the jacket of our report is "Morning in Crazy Hills" by our staff hydrogeologist/artist David Hamilton

LOCO HILLS GSF
158 Deer Creek Drive ▲ Aledo, Texas 76008 ▲ 817 441 6568▲ Fax: 817-441-5880

November 2004

RE: Loco Hills GSF
Section 22, T17S, R29E:

Sir or Madam:

Loco Hills GSF proposes to implement a voluntary ground water restoration program at their LPG storage facility near Loco Hills, New Mexico. Impairment of ground water occurred during the drilling and construction of the subsurface LPG storage caverns in the late 1950s to the early 1960s. Ground water, which is about 90 feet below ground surface within thin limestone and sandstone beds of the Rustler Formation, exhibits a total dissolved solids (TDS) concentration greater than 100,000 mg/L. About 500 feet down gradient from the facility, ground water TDS decreases to less than 50,000 mg/L. *We believe ground water is at background* concentrations about 1000-2000 feet down gradient from the facility. The documented ground water impairment affects neither surface water nor habitat. Only the two supply wells at the facility are affected by the ground water impairment. Loco Hills GSF acquired the facility in 2003.

The proposed aggressive ground water pumping uses a facility supply well to capture the ground water zone exhibiting the highest TDS concentrations. Down gradient from the facility, natural restoration will return ground water to background conditions over time. Loco Hills GSF is acquiring the private property and some State of New Mexico land affected by the ground water impairment. Loco Hills GSF has requested restriction of water supply development on Federal and State land potentially affected. The land acquisition and institutional controls will protect public health during the ground water restoration program.

Aggressive ground water pumping as proposed by Loco Hills GSF requires expansion of the LPG storage facility, coupled with exportation of ground water from the site through brine sales and evaporation. To facilitate this inter-dependent environmental and business strategy, Loco Hills GSF proposes to construct an 11,000,000 gallon brine storage pond. Because the subsurface beneath the proposed pond is dominated by very low permeability clay and gypsum, Loco Hills GSF is requesting an exemption from the secondary liner requirement of NMOCD Rule 50. Instead of

installing a primary synthetic liner and a secondary clay liner, Loco Hills GSF proposes to allocate resources from purchase and installation of a synthetic liner to ground water restoration, the installation of an engineered clay/bentonite liner with seepage detection, and a comprehensive monitoring and reporting program.

Loco Hills GSF has summarized the environmental conditions at the site and the proposed actions in a document that is available at the NMOCD offices in Santa Fe and Artesia, New Mexico. Individuals can request an electronic version of the report from:

Katie Lee
R.T. Hicks Consultants, Ltd.
901 Rio Grande NW F-142
Albuquerque, New Mexico 87104
505-266-5004
Katie@rthicksconsult.com

Sincerely,
Loco Hills GSF

Mitch Johnson
President

Copy
Randall Hicks, Hicks Consultants

November 2004

Best Management Practices Plan
Stage I & II Abatement Plan

Loco Hills Gas Storage Facility
Loco Hills, New Mexico

R.T. Hicks Consultants, Ltd.

901 Rio Grande Blvd. NW, Suite F-142, Albuquerque, NM 87104

R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

November 10, 2004

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E

Dear Wayne:

Today, Katie Lee of my staff is transmitting the following two documents (without appendices) to you via email:

1. Best Management Practices Plan, which includes
    a. Application for an Exemption to the Secondary Liner Requirement of Rule 50
    b. Petition for provisional alternative abatement standards
2. Stage I/II Abatement Plan

Tomorrow, we will send one complete hard copy and several compact discs to your office and the NMOCD Artesia District Office. We hope that you will find these documents administratively complete and ready for public notice.

Attached to this letter is our proposed notification to adjacent landowners, the NMOCD mailing list, and other interested parties identified by Rule 19. Please provide any comments on this notification and we will amend the language and mail these notifications as soon as possible. Once again, we thank you in advance for your attention to this matter.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall Hicks

Randall Hicks
Principal

Copy: Mitchell Johnson

P.S. – the watercolor that graces the jacket of our report is "Morning in Crazy Hills" by our staff hydrogeologist/artist David Hamilton

November 2004

Best Management Practices Plan
Stage I & II Abatement Plan

Loco Hills Gas Storage Facility
Loco Hills, New Mexico

R.T. HICKS CONSULTANTS, LTD.

901 RIO GRANDE BLVD. NW, SUITE F-142, ALBUQUERQUE, NM 87104

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

November 10, 2004

RECEIVED
NOV 15 2004
Environmental Bureau
Oil Conservation Division

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E

Dear Wayne:

Today, Katie Lee of my staff is transmitting the following two documents (without appendices) to you via email:

1. Best Management Practices Plan, which includes
   a. Application for an Exemption to the Secondary Liner Requirement of Rule 50
   b. Petition for provisional alternative abatement standards
2. Stage I/II Abatement Plan

Tomorrow, we will send one complete hard copy and several compact discs to your office and the NMOCD Artesia District Office. We hope that you will find these documents administratively complete and ready for public notice.

Attached to this letter is our proposed notification to adjacent landowners, the NMOCD mailing list, and other interested parties identified by Rule 19. Please provide any comments on this notification and we will amend the language and mail these notifications as soon as possible. Once again, we thank you in advance for your attention to this matter.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall Hicks

Randall Hicks
Principal

Copy: Mitchell Johnson

P.S. – the watercolor that graces the jacket of our report is "Morning in Crazy Hills" by our staff hydrogeologist/artist David Hamilton

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Monday, November 01, 2004 6:55 AM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'; 'Debra P. Hicks'
Subject: loco Hills - Clay Liner thickness

Wayne

I copied the section below from your Interim Guidance. Loco Hills plans on meeting these specifications by creating a clay/bentonite liner that is at least 2 feet thick (see yellow). We do not plan on creating a 3-foot thick clay/benonite liner. Again, our target permeability will be 1 E-8 cm/sec, which is 10 times less permeable than the guidance and 100 times more permeable than our best laboratory test (using fresh water not brine) for the clay/bentonite mixture.

Please understand that the thickness of the liner does not change the seepage rate – it only changes the time required for the seepage to break through the liner. Studies do show, however, that as the liner thickness increases so does the quality of the liner with respect to meeting target permeability. Because we plan on conducting tests during construction, we are confident that we can achieve our target permeability with a liner that is at least 2-feet thick – per the interim guidance.

D. DISPOSAL AND STORAGE PITS

Unless otherwise provided in 19.15.2.50 NMAC, disposal and storage pits must be constructed with a primary and secondary liner with a leak detection system installed between the two liners . The liners may be synthetic liners, clay liners where the bottoms and sides have a hydraulic conductivity no greater than 1×10^{-7} centimeters per second, or an alternative liner or barrier approved by the OCD which is certified by a professional engineer registered to practice in the State of New Mexico. All disposal and storage pits must contain a leak detection system as described in Section II.F. Pit liner systems will be designed and constructed as follows:

1. Wall Slopes

The outside slope of pit walls will be no steeper than 3:1 horizontal to vertical (Figure 1). The inside slope of pit walls will be no steeper than 2:1 horizontal to vertical, except for clay liners which have slope specifications as set out in subsection 2 below.

2. Clay Liners

(a) Barriers constructed with natural clay materials will be at least two feet thick, placed in six-inch lifts, and compacted to 95 percent of the material's Standard Proctor Density (ASTM D-698).

Also expect the requested seepage rate calculation spreadsheet. We are getting some data on the Rustler from the WIPP Library to complete the spreadsheet. These calculations will probably be added to the Application for the Exemption to Rule 50. Our preliminary work using **assumed** values suggests that the seepage from the brine pond will not reach ground water during the life of the pond and that appropriate closure of the pond will prevent the seepage from reaching ground water at any time in the reasonably foreseeable future. Thus, these calculations – if they prove out – may eliminate the need for proceeding with Alternative Abatement Standards. Let's see what develops, however.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Subject: RE: Loco Hills GSF
OCD will meet with you on Oct 28 1:30 pm OCD conference room.

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Monday, October 25, 2004 1:52 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'
Subject: Loco Hills GSF
Wayne

I am furiously working on creating an administratively complete Stage I/II Abatement Plan for the Loco Hills GSF facility and a Permit under Rule 19 for the proposed clay-lined pond (e.g. a request for an exemption to the double liner requirements).

Could we meet this Thursday to go over our submission and basically get it ready for public notice?

I will call you later today or tomorrow to set a time/date.

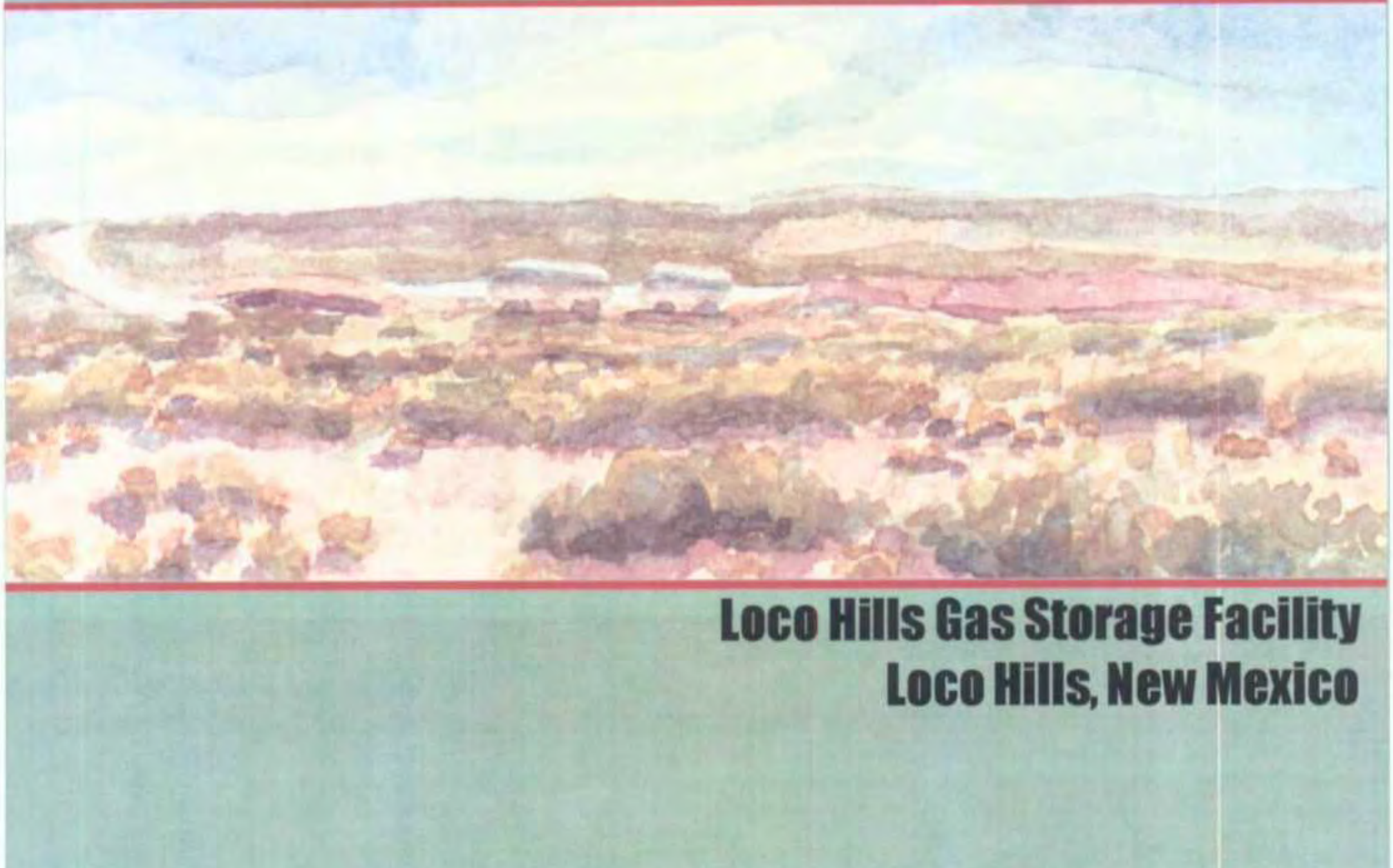
Thanks

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

the sender and destroy all copies of this message. -- This email has been scanned by the MessageLabs Email Security System.

November 2004

Best Management Practices Plan & Stage I & II Abatement Plan



Loco Hills Gas Storage Facility
Loco Hills, New Mexico

R.T. HICKS CONSULTANTS, LTD.

901 RIO GRANDE BLVD. NW, SUITE F-142, ALBUQUERQUE, NM 87104

November 10, 2004

RECEIVED

NOV 15 2004

Oil Conservation Division
Environmental Bureau

Best Management Practices Plan

PETITION FOR PROVISIONAL ALTERNATIVE ABATEMENT STANDARDS

APPLICATION FOR AN EXEMPTION TO RULE

LOCO HILLS GAS STORAGE FACILITY

LOCO HILLS, NEW MEXICO

Prepared for:

Loco Hills GSF, Ltd.
158 Deer Creek Drive
Aledo, Texas 76008

R.T. HICKS CONSULTANTS, LTD.

901 RIO GRANDE BLVD. NW, SUITE F-142, ALBUQUERQUE, NM 87104

TABLES

PLATES

APPENDICES

1.0 INTRODUCTION

This document presents environmental management protocols for the Loco Hills Gas Storage Facility (Loco Hills GSF) located in NW SW Section 22 Township 17S Range 29E near Loco Hills, New Mexico. Part of this Best Management Practices Plan is an application for an exception to Pit Rule 50, requesting permission to reallocate resources from the installation of primary and secondary liners towards ground water restoration, the installation of an engineered clay/bentonite liner with a seepage detection system, and a comprehensive monitoring and reporting program. We believe this site has unique conditions and that the proposals herein present solutions that will bring equal protection to ground water that the installation of primary and secondary liners would. This document also provides a petition for provisional alternative abatement standards, if required.

During the construction of a proposed brine storage pond (late 2003), geologists, engineers, and construction managers independently concluded that the earth material at the site could be employed as a natural clay liner. Testing of the native material demonstrated that, with proper construction techniques and the addition of bentonite clay, the permeability of a clay liner could exceed the performance standards of WQCC Regulations and NMOCD Rules and Guidance. The subsurface is dominantly fine-grained material and clay that overlays a confined water-bearing zone. Bedded gypsum which is also present in the subsurface contributes to the low permeability of the sedimentary sequence. We believe that this hydrogeologic setting creates a favorable site for a clay-lined brine storage pond.

As a result of these observations regarding the quality of the native clay, the hydraulic properties of subsurface materials, and the current condition of ground water quality, Loco Hills Gas Storage Facility (Loco Hills GSF) proposed to forego the expense of two synthetic liners and inter-liner leak detection (which are the design criteria of Rule 50) in favor of allocating resources toward ground water restoration and creation of a clay-lined pond that meets all regulatory performance criteria.

This proposal for a clay-lined pond and an exemption from certain requirements of NMOCD Rule 50 makes sense at this unique site because the principal purpose of Rule 50 is prevention of ground water impairment. At this site, NMOCD has documentation of ground water impairment since 1981. Therefore, the goal for actions at this site should be prevention of additional impairment of fresh water down gradient from this site. Loco Hills GSF voluntarily proceeded with preparation of an

Abatement Plan, which is a separate submission but an integral part of facility permitting process.

Allocation of resources on a double-lined pond to prevent 100,000 mg/L TDS ground water from degrading to a predicted concentration of 100,100 mg/L TDS water simply did not make sense if such a resource allocation delayed or prevented an effective ground water restoration program. Moreover, predictions presented in this plan strongly suggest that the small volume of water that will seep from the proposed clay-lined pond will never enter the ground water system.

To reiterate, this site has unique natural properties that demand unique solutions. We are not proposing to install a single-lined brine storage pond over an area of fresh water. Such a proposal is not only inconsistent with the purpose of Rule 50, it is inconsistent with the environmental tenets of Loco Hills GSF, R.T. Hicks Consultants and, Pettigrew and Associates. The plan presented herein combined with the Abatement Plan is true to proper environmental stewardship in that it restores ground water quality while protecting public health and the environment.

2.0 NAME AND ADDRESS OF LANDOWNER

As of August 1, 2004, the land upon which Loco Hills GSF resides is leased from and owned by:

Regional Office
State of New Mexico,
Commission of Public Land
Jim Carr
1004 Piasano
Carlsbad, NM 88220

Phone: 505.885.1323

Main Office
State of New Mexico,
Commission of Public Land
Jerry King
310 Old Santa Fe Trail
PO Box 1148
Santa Fe, NM 87504

Phone: 505.827.4003

The owners of Loco Hills GSF are currently negotiating a land transfer with the State Land Office and are planning to acquire adjacent land from a private landowner. As a condition of approval of this Best Management Practices Plan, which includes an application for an exemption from certain requirements of Rule 50 and a provisional petition for Alternative Abatement Standards, the 40 acres upon which the facility resides and land adjoining the facility to the east and south will be owned by:

Loco Hills GSF
Attention: Mitchell Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Plate 1 is a map showing the land status after the above-referenced transaction. Adjacent to the 40-acre parcel currently owned by the State of New Mexico are two parcels Loco Hills GSF plans to acquire from Bogle Farms. Loco Hills GSF is also negotiating with the Bureau of Land Management to restrict water supply well development on Federal land south of the facility. The Loco Hills GSF facility is located in NW SW Section 22 Township 17S Range 29E.

3.0 DESCRIPTION OF TYPES & QUANTITIES OF FLUIDS AT THE FACILITY

Table 1 outlines the fluid storage locations at the facility, their capacity, and the types of fluids kept. See Appendix A for a map showing the locations of these ponds and tanks.

Table 1: Surface Fluid Storage at Loco Hills GSF

Type of Storage	Maximum Capacity	Stored Liquid	Location
Pond #1	2 million gallons	10 lb. Brine	SE Corner of facility
Pond #2 (proposed)	7-11 million gallons	10 lb. Brine	Western portion of facility
Above ground storage steel tank	30,000 gallons	Propane or Butane	Tank Area
#2	30,000 gallons	Propane or Butane	Tank Area
#3	18,000 gallons	Propane or Butane	Tank Area
#4	18,000 gallons	Propane or Butane	Tank Area

4.0 DESCRIPTION OF FLUID MANAGEMENT & SOLID DISPOSAL FACILITIES

Loco Hills GSF proposes to manage brine in two surface impoundments and three subsurface salt caverns that will also store liquid propane or butane. Appendix B includes a letter and supporting reports from Pettigrew & Associates, P.A. regarding the construction of pond #2. *Plans and specifications for this proposed clay-lined pond will be submitted to NMOCD under separate cover.* In Appendix C of this submission, Loco Hills GSF has provided the sonic inspection of cavern number one (Propane Well #1). Plans and specifications for the other propane storage wells were submitted separately to NMOCD [Note: all commitments made by Loco Hills GSF appear in blue text and italics to ease review of this document]

Currently, Loco Hills GSF moves the brine from Pond #1 to the subsurface storage caverns to displace the product to the surface and permit loading of the product to customers. During the spring and summer, when demand for propane and butane is low, staff inject propane or butane to cavern storage, which results in brine production into the storage ponds.

After NMOCD approval of the mechanical integrity of each injection well/cavern and approval of this plan with the exemption from Rule 50, Loco Hills GSF plans to employ all three salt caverns for storage of propane and butane. As Table 2 shows, the total capacity for subsurface storage is 8.75 million gallons.

Table 2: Subsurface Fluid Storage at Loco Hills GSF

Cavern #1	2.75 MM gallons	Served by injection well 1
Cavern #2	3 MM gallons	Served by injection well 2
Cavern #3	3 MM gallons	Served by injection well 3

Because Loco Hills GSF anticipates the need to construct one or two additional storage caverns, we propose to provide sufficient surface storage for 13 million gallons of brine (Ponds 1 and 2 on Table 1). Refer to the map in Appendix A for the locations of the existing caverns.

As described below, *Loco Hills GSF plans to maintain Pond #1 below 20-30% of capacity for most of the year until this pond is repaired or replaced. In both ponds Loco Hills GSF will maintain a freeboard of 3 feet (vertical)* so that no overtopping of brine occurs.

When the brine level in Pond #2 falls more than 3-6 feet below the proposed maximum working level, as it may when sales of propane and butane call for injection of brine, Loco Hills GSF will transfer excess brine from Pond #1 to Pond #2. We know that allowing the clay liner of Pond #2 to dry can cause desiccation cracks and thereby compromise the low permeability of the liner. *Loco Hills GSF will attempt to minimize fluid level fluctuations in Pond #2. If inspection of the clay liner shows desiccation and possible loss of integrity, Loco Hills GSF will install a sprinkler or watering system slightly above the high water mark. When necessary, Loco Hills GSF will apply water to the clay to maintain the moisture content and the low permeability.* Fortunately, lowest pond levels are normally expected during the winter when evaporation and solar gain are lowest. Loco Hills GSF will generally employ ground water for this sprinkling program.

We also know that intense precipitation can cause erosion of the clay liner. We propose installation of a geotextile material between the top of the berm to the working fluid level of the pond. *Under separate cover with the plans and specifications, Loco Hills GSF will provide the specifications for this material with the plans and specifications for the pond.*

Later in this plan, we describe the proposed pond seepage monitoring and ground water monitoring program.

We understand that the primary liner of Pond #1 is compromised and Loco Hills GSF routinely pumps fluid from the leak detection system back into Pond #1. *Loco Hills GSF plans to employ the leak detection well to capture fluid released from the primary liner of Pond #1. After approval of this Best Management Practices Plan, Loco Hills GSF will begin to employ Pond #2 as the primary method of fluid management, as described above. As soon as possible, Loco Hills GSF will empty Pond #1 and attempt to repair the primary liner.* If the leak cannot be found and/or repaired, we anticipate that this pond will remain only partially full and any leakage from the primary liner may be captured. Loco Hills GSF may elect to abandon the use of this pond and replace it with another. *Until the pond is repaired or replaced, Loco Hills GSF will continue to monitor the leak detection monitor well for brine storage Pond #1 weekly.*

The voluntary restoration of ground water impairment caused by others is a critical element of the Best Management Practices Plan. As described in the Stage I/II Abatement Plan, Loco Hills proposes to re-direct resources from a previously approved synthetic double liner system to the proposed ground water restoration program and construction of a clay-lined storage pond.

As shown in Appendix B, the measured permeability of the proposed liner material (10% bentonite mixed with 90% native clay) is about 4×10^{-10} cm/sec. We believe we can achieve a permeability of 1×10^{-8} cm/sec, which allows the 100 meter by 100 meter pond to release as little as 23 gallons per day. A later section of this submission explains how Loco Hills GSF will protect water quality from this anticipated seepage.

We propose a rigorous program of engineering design, construction quality assurance testing, and post-construction testing. We will conduct post-construction permeability testing using a ring infiltrometer to show that the final liner performance exceeds the 1×10^{-7} cm/sec minimum permeability required by NMOCD guidance and our 1×10^{-8} cm/sec target permeability. As described in a later section, Loco Hills GSF will continually monitor the seepage rate of the clay liner. A separate submission that includes the plans and specifications for the proposed clay-lined pond describe many of these protocols in more detail. Appendix D presents the ASTM Standard we propose to follow to perform post construction testing of the liner permeability.

As Table 1 shows, Loco Hills GSF manages propane and butane in the above ground storage tanks, pending sale or storage. *All drums containing materials other than fresh water will be stored on an impermeable pad with curbing. All empty drums will be stored on their sides with the bungs in place and lined up on a horizontal plane. Chemicals in other containers such as sacks or buckets will also be stored on an impermeable pad with curbing. All process and maintenance areas that show evidence that leaks or spills are reaching the ground surface will be either paved and curbed or have some type of spill collection device incorporated into the design. All above ground storage tanks that contain fluids other than fresh water are bermed to contain a volume of one and one-third the total volume of the largest tank. All new additions or modifications to existing facilities will place tanks on an impermeable pad within a berm. All above ground saddle tanks will have impermeable pad and curb type containment unless they contain fresh water or fluids that are gases at atmospheric temperature and pressure. All tanks, drums, and other containers will be clearly labeled to identify their contents and other emergency information if the tank were to rupture, spill, or ignite. All systems designed for spill collection/prevention, and leak detection will be inspected weekly to ensure proper operation and to prevent overtopping or system failure. All spills and releases will be reported according to OCD Rule 116 and WQCC 1203 to the OCD Artesia District office.*

Periodically, Loco Hills GSF creates solid waste. Wind-blown dust and sand enters surface storage ponds and must be removed to maintain the capacity of the ponds. On-site disposal of pond sediment poses no threat to ground water because the quality of the underlying ground water is so poor that seepage of any leachate caused by disposal would not cause a measurable impact. Nevertheless, Loco Hills GSF wishes to maintain the surface at its productive capacity and to eliminate any eyesore caused by stored pond sediment. *We propose to do the following to address any sediment removed from ponds:*

- *Place the pond sediment in an area of the site that is already disturbed by past activities and allow the sediment to dry.*
- *Compact then cover the sediment with 1-2 feet of loose caliche and/or available coarse-grained material.*
- *Cover the loose caliche with 3-5 feet of Dockum Group clay and grade the surface to blend with the landscape.*
- *Cover the clay with 1-3 feet of topsoil and seed with native grasses.*

We employed this restoration protocol for the pond sediment waste pile that was stored over the former unlined brine pond, which was retired in the 1980s, with no observed adverse affects.

The loose caliche will reduce any upward capillary rise of salt. The clay will act as a reservoir for soil moisture and enhance the ability of vegetation growth on the topsoil.

Any other solid waste material will be shipped to an appropriate commercial or municipal landfill/landfarm. Loco Hills GSF will comply with all applicable solid waste regulations and NMOCD Rules regarding solid waste.

5.0 DESCRIPTION OF UNDERGROUND FACILITIES

Loco Hills GSF has completed a sonar examination of cavern number one (Propane Well 1) and the complete report is on file at the New Mexico Oil Conservation Division. A summary of the findings of this report is included in Appendix C.

The basic engineering designs of the propane wells are outlined in Table 3 below. *Brine water will be injected and withdrawn through the tubing and gas products and will be injected and withdrawn through the casing/tubing annulus.* Deviations may occur once a month for up to 24 hours due to maintenance.

The Abatement Plan contains well logs for Monitoring Wells on the site.

Table 3. Propane Well Characteristics

Well #	Depth of Casing (ft)	Total Depth of Tubing (ft)	Total Depth of Well (ft)	Casing Diameter (in)	Tubing Diameter (in)
1	525	619	640	5.5	2.875
2	507	624	unknown	5.5	2.875
3	500	617	unknown	5.5	2.875

6.0 CONTINGENCY PLAN FOR SPILL REPORTING AND CLEAN-UP

A SPCC plan and a SWPP plan will be completed after NMOCD approval of this Best Management Practices Plan and the exemption of the clay lined pond from Rule 50. Loco Hills GSF will adhere to all spill reporting requirements outlined in OCD Rules.

7.0 HYDROGEOLOGICAL DEMONSTRATION THAT ACTIVITIES WILL NOT ENDANGER FRESH WATER, PUBLIC HEALTH OF THE ENVIRONMENT

We refer the reader to the Stage I/II Abatement Plan for a complete description of the environmental setting of the facility. The Abatement Plan also describes the location of existing monitoring wells and piezometers referenced in the following section. Table 4 shows the depth to water and the elevation of potentiometric surface. The Abatement Plan presents analytical results from Monitoring Wells.

As part of this BMP, Loco Hills commits to plug the two abandoned water wells at the site. A driller licensed in the State of New Mexico will develop the plugging and abandonment protocol with Hicks Consultants. Loco Hills GSF will submit the plan for plugging and abandonment after approval of this BMP and the exemption from Rule 50.

Table 4. Depth to Water and Elevation of Potentiometric Surface, Loco Hills GSF in ft.

	Supply Well 1 N. of High. 82	Supply Well 2 W. of lined Brine Pit	Monitoring Well 1 S.S. corner of lined Brine Pit	Bear Grass Draw Monitoring Well 1	Bear Grass Draw Piez. 1 129 ft.	Piez 1-1 100 ft. E. of new Clay Pit	Piez. 1-2 88 ft. E. of new Clay Pit
Pecos V. Pump., 2002		36 3511.3					
Driller 5/2/2003			83 3465.9				
R. T. Hicks 10/8/2003	86.58 3462.7						
R. T. Hicks 6/25/2004	77.1 3472.2	81.3 3465.95	83.72 3465.18	78.48 3464.64	102.59 3440.51	86.64 3467.51	86.76 3467.59
LH GSF 7/21/2004		83.25 3464	83.84 3465.06			86.76 3467.39	86.87 3467.48
LH GSF 7/22/2004		90.54 3456.71	83.5 3465.4			98.17 3455.98	84.67 3469.68
P1-3 at 36 ft.deep and the three piezometers at P-2 on the north side of the clay pond are all dry. The piezometers at P-2 are at depths of 60, 82, 110 feet bgs.							

7.1 ESTIMATED POND SEEPAGE

The proposed clay-lined pond will release very small volumes of brine to the subsurface. The released brine will flow downward under saturated or unsaturated flow. The rate at which the released brine flows in response to gravity depends upon many factors, the most important of which is the vertical hydraulic conductivity of the clay liner and underlying earth material.

Table 5 presents a simple method of approximating the vertical transport distance of brine from the bottom of the pond. In this table we assume that the clay liner will absorb brine until the liner is fully saturated. After saturation of the liner, brine will migrate through the liner under a hydraulic gradient of 1.0. Although laboratory testing indicates that the saturated hydraulic conductivity of the liner may be as low as 1×10^{-10} cm/s, we elected to use a value of 5×10^{-8} cm/s in our calculations.

Table 5: Pond Seepage Rate and Depth of Seepage Penetration

Parameter	Symbol	Value	Units	Source of Data
Liner Hydraulic Conductivity	Kl	5×10^{-8} 5×10^{-10}	cm/sec m/sec	Estimate based upon laboratory permeability tests in Appendix B
Surface Area of Pond	A	10000	m2	Esimate from survey, see Appendix A
Hydraulic Gradient	dh/dl	1		Assume saturated flow and unit gradient
Total Discharge from Pond	Q	5×10^{-6} 5×10^{-3} 4.32×10^{-2} 114.29	m3/sec liter/sec liters/day gallons/day	Darcy's Law
Operational life of pond		30	years	Professional Judgement
Volume released from liner over life		4,730.40	m3	Calculation Q x time
Available porosity of Rustler clay/silt and limestone and liner		5%		WIPP Compliance Certification (Appendix E) and Professional Judgment
Calculate depth of seepage penetration		9.46	meters	Depth = Seepage/(area of pond * porosity)

As Table 5 shows, brine migration through the saturated liner is about 115 gallons per day assuming we meet the target liner hydraulic conductivity of 5 x 10^{-8} cm/s. Over the projected 30 year lifetime of the pond, a total of 4700 cubic meters of brine will exit the bottom of the liner. According to tests conducted at WIPP, the effective porosity of the uppermost Rustler Formation (the Forty-niner Member) ranges between 9.1% and 24%. We believe that the background water content of these siltstones and claystones would be about 50% of the effective porosity; therefore we employed an available porosity of 5% as a conservative value. With these assumptions, brine will migrate less than 10 meters below the clay liner during the 30-year life of the pond.

Table 6 (on the following page) is another simple calculation that provides a range of values for the time required for any pond seepage to reach underlying ground water detection devices.

We first note that 12 years are necessary for the brine to pass through the linter. Using assumptions from the same sources as Table 5, we estimated that the minimum time required for brine to migrate from below the liner to ground water (assuming saturated conditions exist beneath the pond) is 1.9 years. Because the hydraulic conductivity of the Rustler Formation varies by at least 5 orders of magnitude, the maximum time required for brine to reach ground water is about 190,000 years. However, we know from our drilling program that saturated conditions do not exist beneath the site. While we do not have data on the unsaturated hydraulic conductivity of the Rustler Formation, our experience allows us to suggest that the time required for brine to enter ground water via unsaturated flow would be many decades and may be longer than the predicted maximum time of 190,000 years for saturated conditions.

As suggested in Table 5, the most likely scenario is brine seepage that creates saturated conditions to a depth of 10 meters below the bottom of the pond. When such saturated conditions are observed, the pond will be closed, saturated flow conditions will cease, and the residual chloride in the vadose zone will be effectively sequestered for many centuries, probably forever. The alternating beds of sand, clay, and gypsum create an effective barrier between the pond and ground water. The Department of Energy has evaluated the vertical migration of fluids through the Rustler Formation at WIPP and found that migration can occur over geologic time (more than 10,000 years) under saturated flow conditions. At the Loco Hills GSF site, we conclude that the migration of brine seepage to ground water would require much more than 10,000 years under unsaturated flow conditions.

The proposed monitoring program will allow us to determine if the small seepage volume will ever reach ground water. We propose to revise these simple estimates presented in Tables 5 and 6 when our vadose zone monitoring devices (e.g. the pan lysimter) provides site-specific data.

Table 6: Time for Seepage to Reach Ground Water

Liner hydraulic conductivity	Kl	5×10^{-8}	cm/sec	Comments
Hydraulic gradient	dh/dl	1	no units	Assumes liner is saturated
Pore space in liner	n	30%		Assumes interconnected pore space only
Pore Velocity in Liner	V	1.67×10^{-7}	cm/sec	V = (K dh/dl)/n
		5.26×10^{0}	cm/year	
		5.26×10^{-2}	m/year	
liner thickness		0.66	meters	minimum thickness of liner based upon guidance
transport time through liner		12.6	years	
Maximum K of Rustler Clay/Sand/Gypsum Package	Kr	0.0001 1×10^{-6}	cm/sec m/sec	calculation Table L-1 WIPP Permit Jan 30/03, Appendix E
Kh/Kv ratio		20		Professional Judgement
Vertical K of Rustler Package	Krv	5×10^{-6}	cm/sec	calculation
Hydraulic Gradient in Rustler	dh/dl	1×10^{0}		
Thickness of Rustler		20 2000	meters cm	Well logs
Available pore space in Rustler		15%		WIPP Permit Documents, Appendix E
Vertical Pore Velocity in Rustler		3×10^{-5}	cm/sec	calculation
Transport time (saturated conditions)		6×10^{7}	sec	calculation
Minimum time required for brine to migrate to ground water		1.9	years	
Minimum K of Rustler Clay/Sand/Gypsum Package	Kr	1×10^{-9}	cm/sec	Table L-1 WIPP Permit Document, Appendix E
Kh/Kv ratio		20		Professional Judgement
Vertical K of Rustler Package	Krv	5×10^{-11}	cm/sec	calculation
Hydrualic Gradient in Rustler	dh/dl	1×10^{0}		
Thickness of Rustler		20	meters	Well logs
		2,000	cm	
Available pore space in Rustler		15%		as above
Vertical Pore Velocity in Rustler		3×10^{-10}	cm/sec	
Maximum time required for brine to migrate to ground water		6×10^{12} 190,258.8	sec years	

8.0 MONITORING AND REPORTING PROGRAM

After NMOCD approval of this BMP and exemption to Rule 50, Loco Hills GSF will construct additional monitoring devices around the pond. In addition to the existing well and piezometer network described in the State I/II Abatement Plan, Loco Hills GSF proposes to construct two additional seepage detection piezometers: one on the west side and one on the south side of the proposed clay-lined pond. The design of these additional piezometers are the same as P-1 and P-2 (see Stage I/II Abatement Plan).

Eight shallow seepage detection piezometers are planned to monitor any seepage from Pond #2 into near surface caliche layer (see Stage I/II Abatement Plan for a description of this caliche layer). Although the exact placement of these eight shallow devices will be determined in the field, we anticipate two seepage detection devices on each side of the pond. *We will employ the same basic design as P-1 and P-2 for these seepage detection devices, except the total depth will be the base of the caliche horizon (about 20 feet) and only one piezometer will monitor seepage into the caliche horizon. Loco Hills GSF will collect data from these seepage detection piezometers on a monthly basis.*

Measuring the effect of the pond (if any) on ground water quality is important. *We propose a ground water monitoring program that consists of quarterly measurements of specific conductance and chloride from the two on-site water supply wells, the two existing monitoring wells, P-1 and other monitoring wells drilled in response to NMOCD conditions for approval of this BMP and exemption to Rule 50. We propose to obtain non-pumping water levels from the monitoring wells, piezometers and supply wells during these quarterly monitoring events. We also plan to obtain pumping water levels from each quarter.*

We will also monitor the volume of water pumped from each well and the volume of brine exported from the facility. Because the high TDS of ground water causes failure of flow meters, *we plan to monitor the volume of pumped water by simply measuring the flow rate from each well every month then multiplying the flow rate by the amount of time each well was operating.*

We will monitor the stage height in each impoundment on a weekly basis. We will monitor the volume of water pumped from the leak detection system in Pond #1.

During the first two years of operation under this Best Management Practices

Plan, Loco Hills GSF plans to collect ground water elevation data on a monthly basis, assemble monthly brine sales data, and provide reports to NMOCD in March of each year. After the first two years of operation, Loco Hills GSF will meet with NMOCD and adjust the monitoring and reporting schedule and present the plan to characterize the southern (down gradient) portion of the high TDS ground water zone.

Monitoring the seepage rate from the clay lined pond is also important. Loco Hills GSF anticipates that the seepage rate will decrease over time. The Plans and Specifications for the pond show the design and operation of the proposed seepage rate measurement device, which is essentially a pan lysimeter. *Loco Hills GSF will report the monthly seepage rate to NMOCD with the scheduled submissions.*

9.0 CONTINGENCY PLAN

Loco Hills GSF anticipates that the proposed ground water extraction program described in the Abatement Plan will continue to cause improvement of water quality (lower TDS) at the site.

In the unlikely event that the seepage detection well(s) or other devices suggest that seepage from the clay-lined pond will cause impairment of fresh water or a threat to public health and the environment, then Loco Hills GSF will meet with NMOCD to determine the best course of action. One alternative is inspection and repair of the clay liner to reduce the amount of seepage. A second alternative is moving forward with Alternative Abatement Standards, as described below. A final alternative is installation of a synthetic liner and leak detection system for Pond #2. In the absence of an agreement between NMOCD and Loco Hills GSF on an approach to protect fresh water from unexpected seepage, Loco Hills GSF will abide by any hearing order issued by the NMOCD on this matter.

Because Loco Hills GSF can operate their facility in a way that permits the drainage and repair of Pond #2, these contingency plans are viable.

10.0 PROVISIONAL PETITION FOR ALTERNATIVE ABATEMENT STANDARDS

The simple calculations regarding the potential for pond seepage to enter ground water (Tables 5 and 6) demonstrate that a formal application for Alternative Abatement Standards is premature. If the predictions presented in Tables 5 and 6 are incorrect, monitoring will detect unexpected seapage the errors and permit us to correct any problem long before any impact on ground water. Nevertheless, NMOCD recommended that we present a petition for alternative abatement standards in the event that brine seepage unexpectedly enters ground water. This document is an application for provisional Alternative Abatement Standards.

We believe that implementation of the proposed Abatement Plan will restore ground water quality to background conditions or simply remove all of the water in the ground water zone. Alternative Abatement Standards are not proposed as a strategy for restoration ground water quality due to the past actions of previous operators and are not part of the Abatement Plan.

As suggested above, the only reason Alternative Abatement Standards would be necessary at this site is if the pond liner failed and the alternating clay, sand, and gypsum/anhydrite beds do not behave in a manner remotely similar to what is observed at the WIPP site. The proposed monitoring plan will provide ample warning if the liner and geohydrologic system does not behave as anticipated. If this system failure occurs during the operational life of the facility (50-250 years), then ground water pumping required to operate the facility will capture all brine seepage from this pond. The ground water zone requiring Alternative Abatement Standards during this period is defined by the area between the pond and Supply Well #2.

Table 7 presents a simple calculation that predicts the TDS in ground water beneath the pond. This calculation assumes that the monitoring program discovers the system failure and brine moves downward under unsaturated flow conditions. Although work at WIPP suggests that the anhydrite beds are essentially impermeable in the absence of solution cavities or fractures, Table 7 assumes that the unsaturated hydraulic conductivity of the Rustler is the same as the minimum measured saturated hydraulic conductivity at the WIPP site. We believe this is a conservative assumption. We also assume a hydraulic gradient of unity. An online search using the key words "unsaturated hydraulic conductivity, measured" and discovered numerous references that measure unsaturated hydraulic gradients near unity. For the saturated hydraulic conductivity of the Rustler, we relied upon the work conducted at the WIPP site and our observations at the Loco Hills GSF facility to provide a reasonable value.

The resultant concentration for the provisional Alternative Abatement Standards is slightly above 4,000 mg/L. If NMOCD believes that a petition for Alternative Abatement Standards is necessary for approval of the clay-lined pond, we propose an alternative standard of 5,000 mg/L TDS and 3,000 mg/L chloride. We propose that the point of compliance for these standards is the on-site supply well SW-#2. We propose the monitoring well in Bear Grass Draw BGD MW-1 as the point of compliance at the boundary of the zone of Alternative Abatement Standards (e.g. where ground water will meet background quality).

If all of the systems fail (the liner, the monitoring system, and our conclusions regarding the site hydrogeology), compliance with the ground water standards would impose an unreasonable burden on the facility. This is because the facility would need to continue the pumping strategy outlined in the Abatement Plan long after the facility closes, 50-350 years from now. Moreover, there is not a reasonable relationship between compliance with the standards and the cost of restoration of ground water at this site.

Table 7. Calculated TDS of Ground Water for Provisional Alternative Abatement Standards

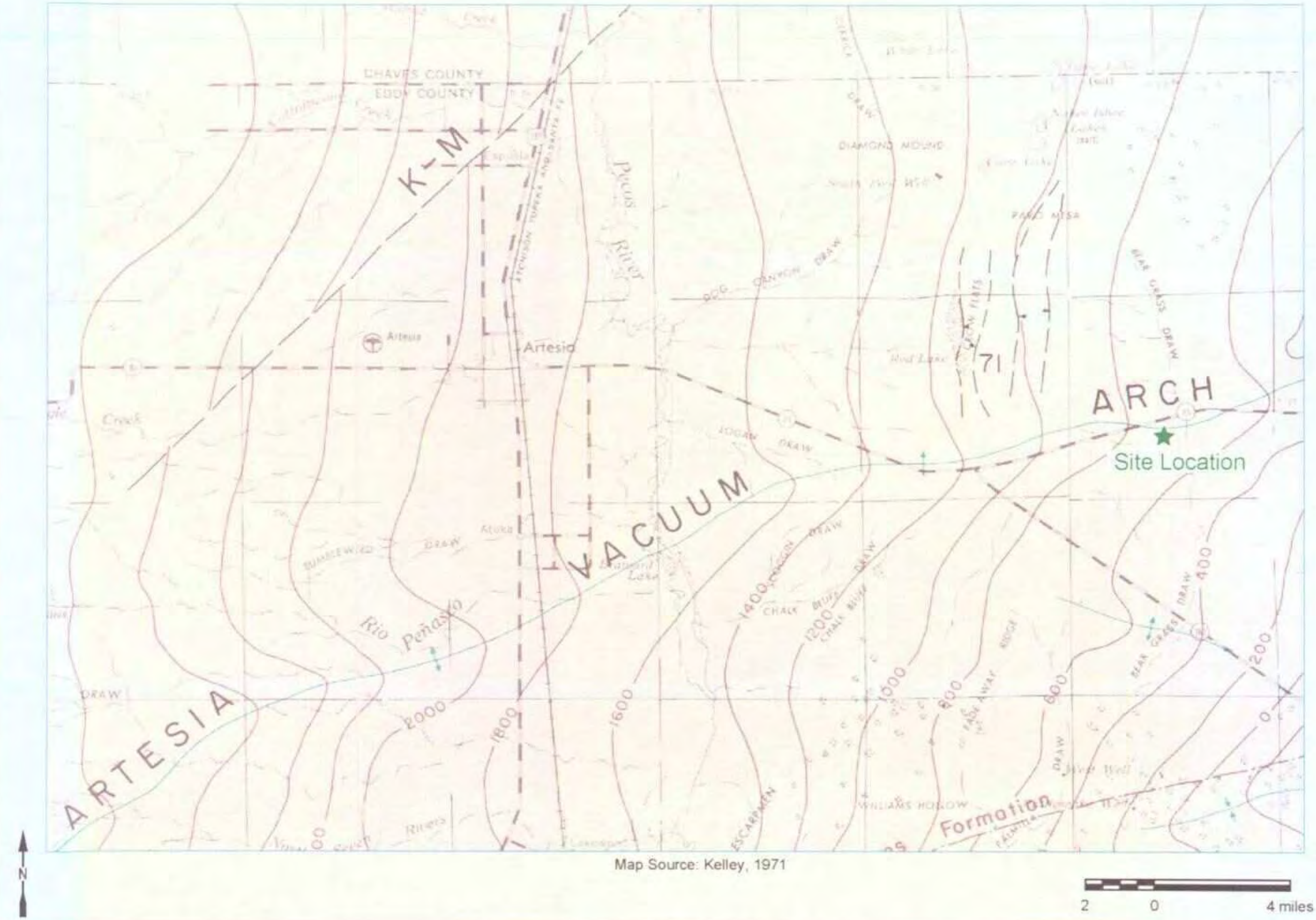
	Value	Units	Source
Pond Seepage Rate			
Surface Area of Pond	1000	$meters^2$	Survey
Vertical Unsaturated Hydraulic Conductivity of Rustler Formation	5×10^{-11}	m/sec	Estimate from Table 6
Hydraulic Gradient (unsaturated)	1		
Calculated Brine Flux at Closure (Unsaturated Flow)	5 x 10-8	m^3/sec	Darcy's Law
Ground Water Flux Beneath Pond			
Hydraulic Conductivity of Rustler	1×10^{-7}	m/s	Estimate based upon site observations and Table 6
Area of Flow (3 Meter Thick Aquifer)	3000	m^2	Calculation
Hydraulic Gradient of Rustler Formation	0.02285		Measured
Ground Water Flow	6.86×10^{-6}	m^3/sec	Darcy's Law
Mixing Calculation			
TDS of Brine in Vadose Zone (Cb)	250,000	mg/L	Saturated Brine
TDS of Ground Water (Cgw)	2,500	mg/L	Measured
Flux of Ground Water (Qgw)	7×10^{-6}	m^3/sec	Calculated
Unsaturated Flux of Brine to Ground Water (Qb)	5×10^{-8}	m^3/sec	Calculated
TDS of Ground Water after Mixing	4,291.62	mg/L	Cf = ((Qb*Cb) + (Qgw*Cgw)) / (Qb + Qgw)

11.0 CLOSURE PLAN

The Loco Hills gas storage facility will cease operation when gas or liquid storage is no longer required in salt caverns, which we believe will occur within 50-250 years. During this long period of operation, ground water pumping will not only remedy the ground water impairment caused by past operators.

At closure, the facility owner will empty the caverns of stored product by filling the caverns with brine. Any brine remaining at the surface will be sold or otherwise removed from the site.

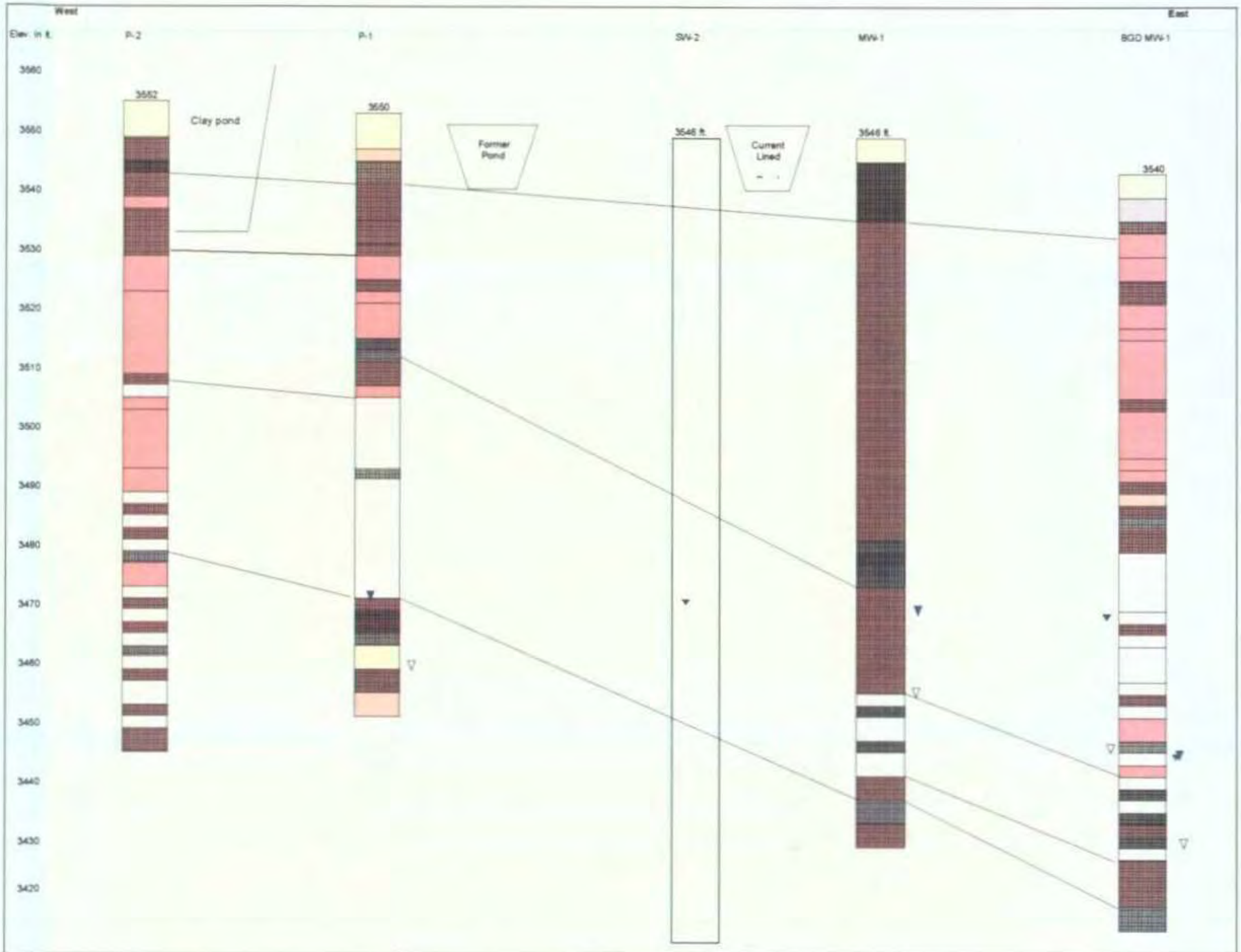
At the end of operations, a relatively small volume of brine seepage might reside in the pore space of the unsaturated zone (between the bottom of the clay liner and the uppermost ground water zone). Closure of the clay-lined pond calls for exposure of the liner and some of the underlying Rustler Formation, rinsing the exposed material to remove entrained salt, collection and disposal/management of the collected rinse water, then permitting the exposed material to dry. Loco Hills GSF would then re-compact the dried liner/Rustler material, import clean soil and re-vegetate the site. This action will effectively sequester any residual chloride in the vadose zone.



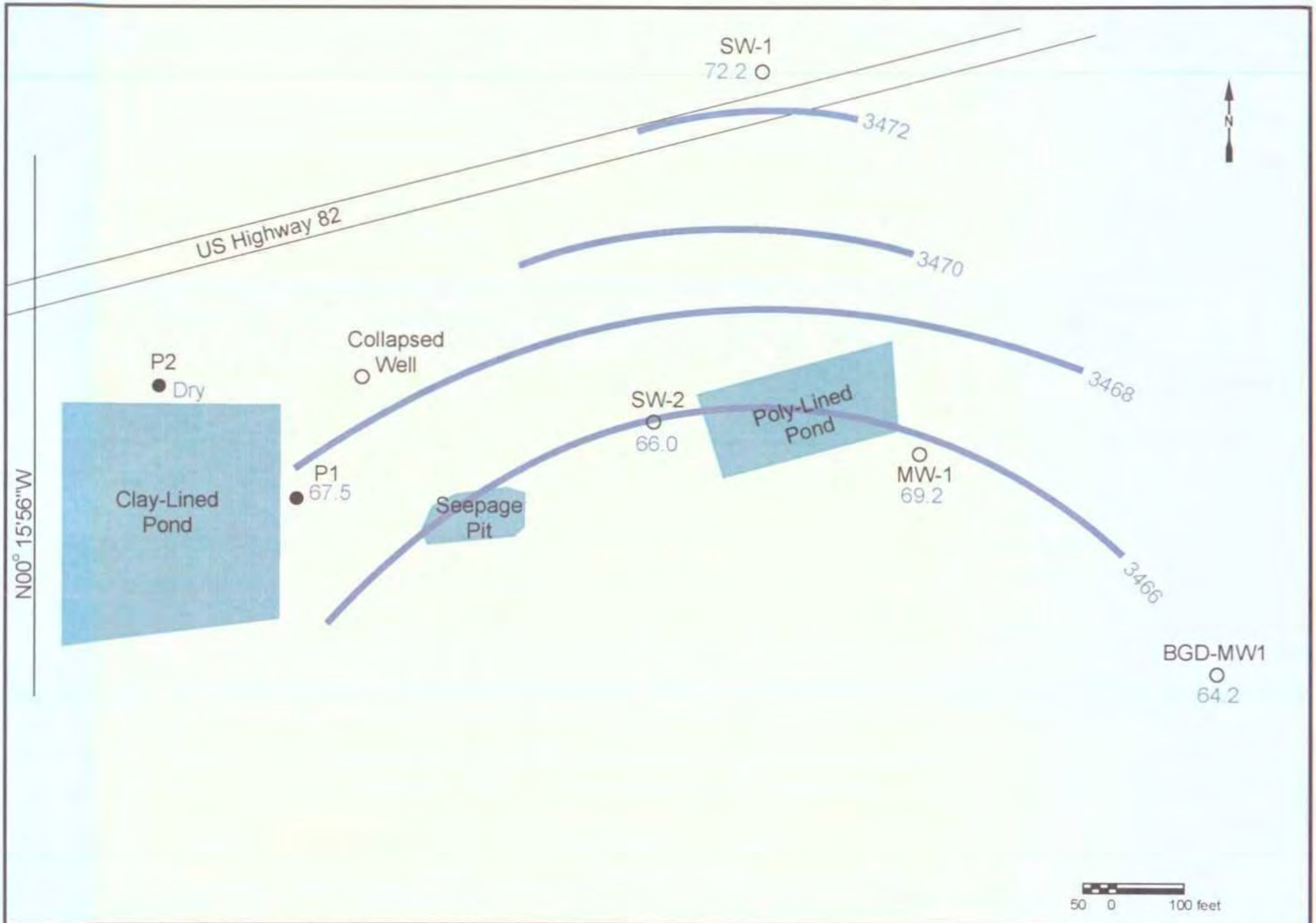
R.T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87104
505.266.5004 Fax: 505.246.1818

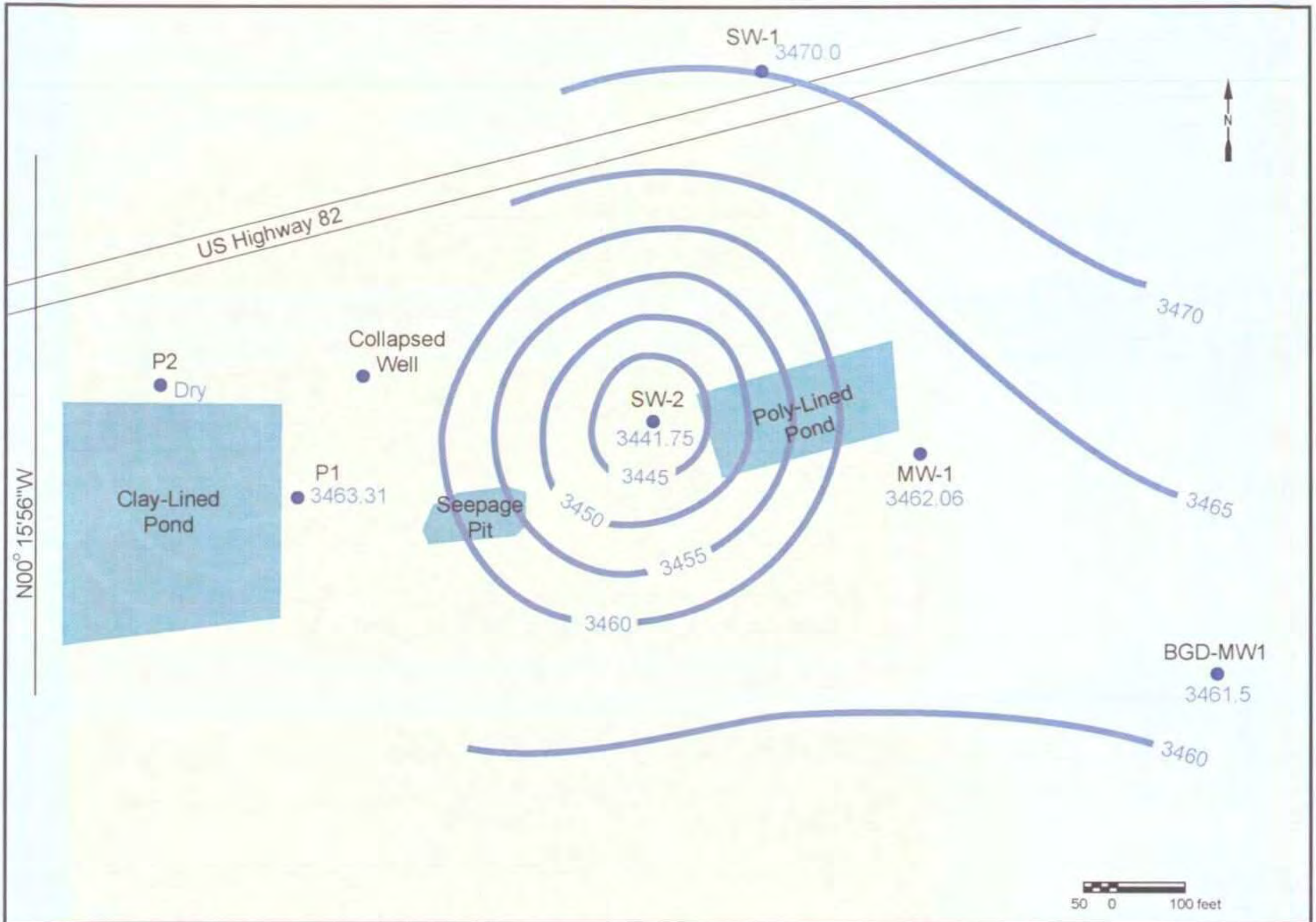
Loco Hills GSF	Plate 3
Structure Contour Map	August 2004



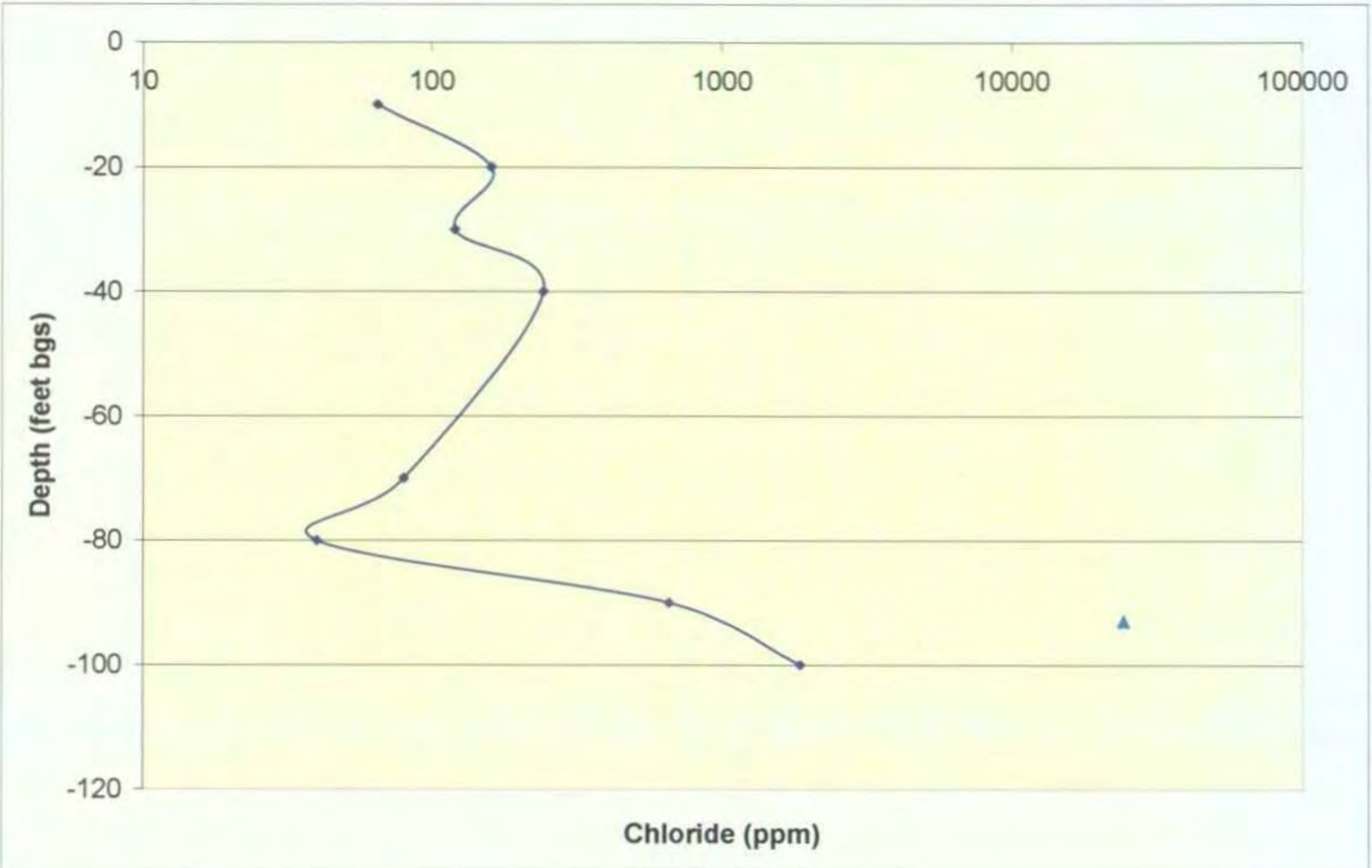
R.T. Hicks Consultants, Ltd. 901 Rio Grande Blvd. NW, Suite F-142 Albuquerque, New Mexico 87104	Hydrogeologic Cross Section	Plate 4
	Loco Hills GSF	August 2004



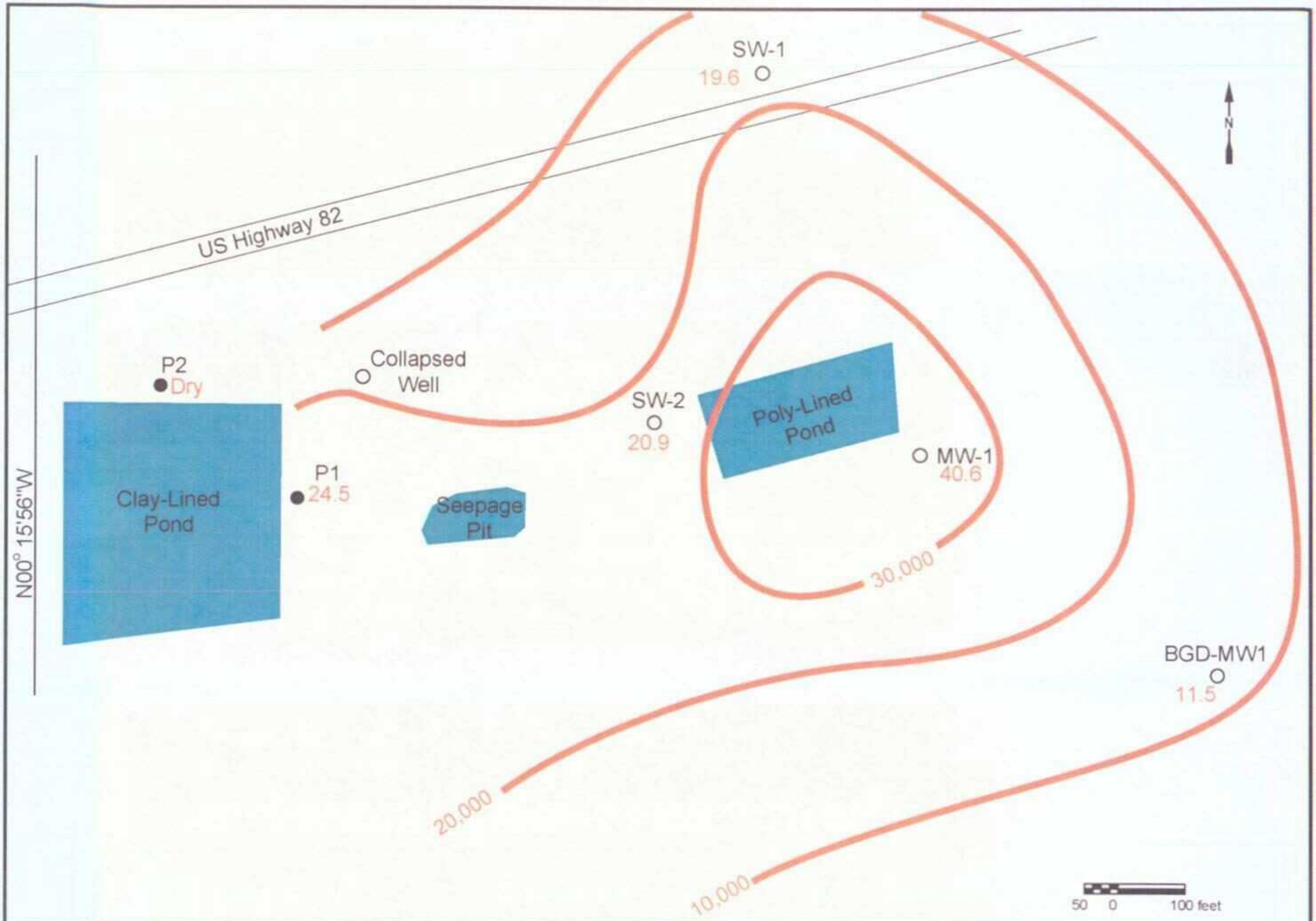
R.T. HICKS CONSULTANTS, LTD. 901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87104 505.266.5004 Fax: 505.246.1818	Loco Hills GSF	Plate 5
	Potentiometric Surface Map Static	August 2004



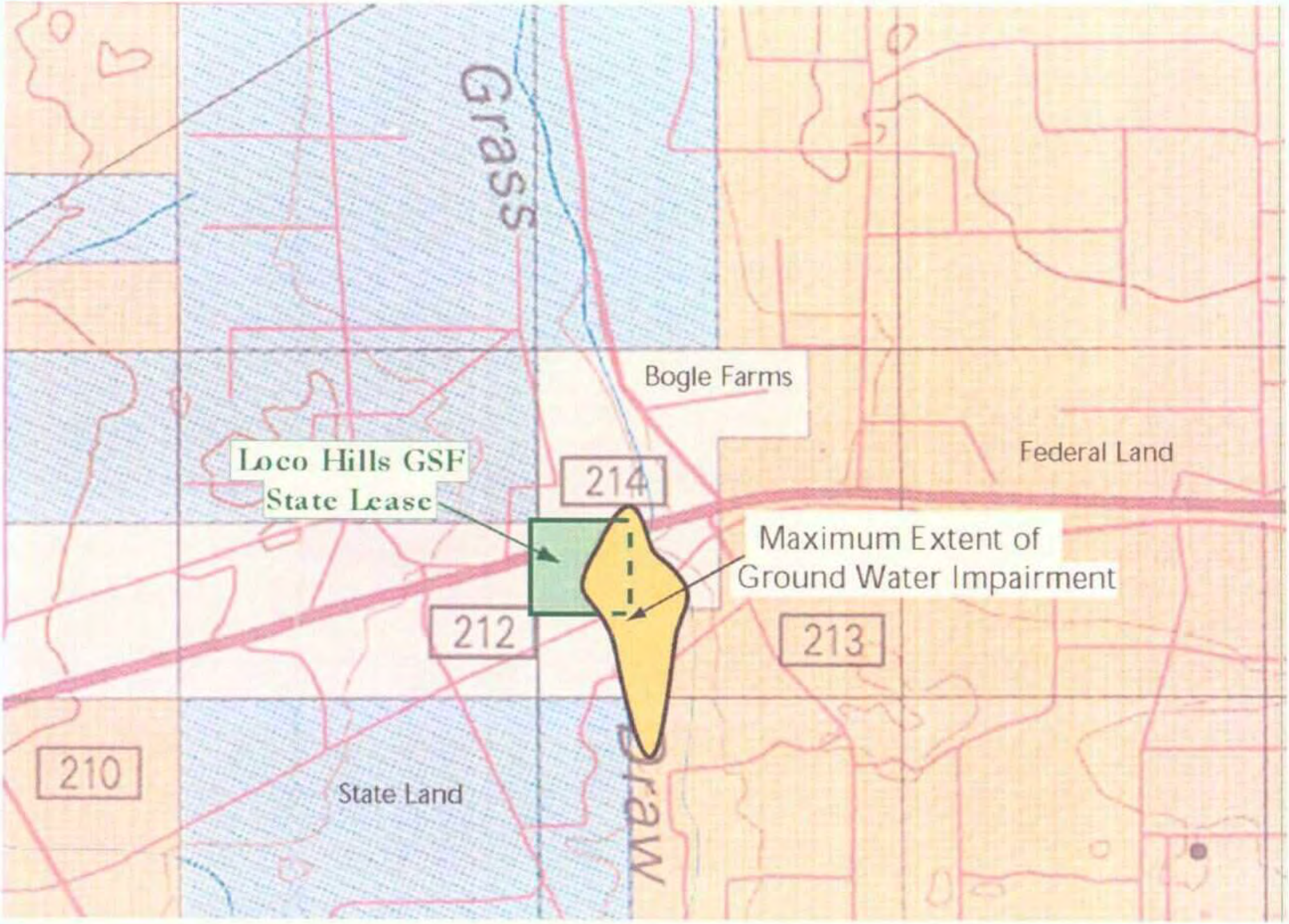
R.T. HICKS CONSULTANTS, LTD.	Loco Hills GSF	Plate 6
901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87104 505.266.5004 Fax: 505.246.1818	Potentiometric Surface Map, August 17, 2004	August, 2004



R.T. Hicks Consultants, Ltd. 901 Rio Grande Blvd. NW, Suite F-142 Albuquerque, New Mexico 87104	Chloride in Cuttings (ppm) and Ground Water	Plate 7
	Loco Hills GSF	Jul-04



R.T. HICKS CONSULTANTS, LTD.	Loco Hills GSF	Plate 8
901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87104 505.266.5004 Fax: 505.246.1818	Chloride in Ground Water (10^3 mg/L)	August 2004



R.T. Hicks Consultants, Ltd. 901 Rio Grande Blvd. NW, Suite F-142 Albuquerque, NM 87104 505.266.5004 Fax: 505.266.0745	Loco Hills GSF	Plate 9
	Maximum Extent of Ground Water Impairment	October 2004

ABATEMENT PLAN APPENDIX A

WELL LOGS

NEED FIELD LOGS (COPY)

Logger:	David Hamilton	Client:	Well ID:
Driller:	Dubose Drilling	LHGSF	
Drilling Method:	Air Rotary	Project Name:	
Start Date:	6/17/2004		P-1
End Date:	6/18/2004	Location:	
Notes:		Loco Hills	

Depth (feet): 0.0, 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0, 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0, 62.0, 64.0, 66.0, 68.0, 70.0, 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0, 92.0, 94.0, 96.0, 98.0, 100.0

Description
Surface, sand, some gypsum, some clay, red, 0-7 ft.
Sand, light red, dry, 7-9 ft.
Caliche, sand, 9-12 ft.
Clay, caliche, red, dry, 12-14 ft.
Clay, red, dry, 14-17 ft.
Clay, some sand, minor caliche, red, dry, 17-22 ft.
Clay, some sand, red, dry, 22-25 ft.
Sand, clay, red, dry, 25-27 ft.
Clay, red, dry, 27-28 ft.
Sand, some clay, light red, dry, 28-32 ft.
Sand, silt, clay, light red, dry, 32-39 ft.
Limestone, light grey, dry, 39-41 ft.
Sand, limestone, 41-42 ft.
Clay, red, soft, 42-46 ft.
Clay, sand and caliche, 46-48 ft.
Gypsum, white, dry, 48-61ft.
Gypsum, hard, white, 61-63 ft.
Gypsum, white, dry, 63-82 ft.
Clay, red, moist, 82-84 ft.
Clay, red, gypsum, 84-87 ft.
Clay, gypsum, hard, 87-88 ft.
Sand, clay, limestone, 88-91 ft.
Gypsum, clay, tan, dry, 91-93 ft.
Gravel, wet, 93-97 ft., est. 1-2 gal./min.
Sand, clay, tan, 97-101ft.

NEED TO SAMPLE FOR CHLORIDES

Lithology

?

Piezometer Construction

Cement

Bentonite

Bentonite and Cuttings

Bentonite

Sand

Bentonite

Bentonite and Cuttings

Bentonite

Sand

Bentonite

Sand

R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	Loco Hills GSF	Plate D-1
		July 2004

Logger:	David Hamilton	Client: LHGSF	Well ID: BGD MW-1
Driller:	Dubose Drilling		
Drilling Method:	Air Rotary	Project Name:	
Start Date:	6/17/2004		
End Date:	6/18/2004	Location: Loco Hills	
Notes:			

Depth (feet)	Description	Well and Piezometer Construction
0.0 – 5	Surface, 0-5 ft.	Cement
5 – 9	Sand, clay, grey, 5-9 ft.	Cement
9 – 11	Sand, caliche, tan, 9-11 ft.	Bentonite
11 – 14	Clay, sand, red, 11-14 ft.	Bentonite and cuttings
14 – 19	Sand, clay, red, 14-19 ft.	Bentonite and cuttings
19 – 22	Clay, red, little sand, 19-22 ft.	Bentonite and cuttings
22 – 26	Sand, clay, red, 22-26 ft.	Bentonite and cuttings
26 – 29	Clay, sand, red, 26-29 ft.	Bentonite and cuttings
29 – 39	Sand, clay, red, dry, 29-39 ft.	Bentonite and cuttings
39 – 41	Clay, red, 39-41 ft.	Bentonite and cuttings
41 – 48	Sand, clay, red, 41-48 ft.	Bentonite and cuttings
48 – 49	Clay, sand, 48-49 ft.	Bentonite and cuttings
49 – 51	Sand, clay, 49-51 ft.	Bentonite and cuttings
51 – 54	Clay, red, soft, some sand, 51-54ft.	Bentonite and cuttings
54 – 55	Sand, tan, 54-55 ft.	Bentonite and cuttings
55 – 62	Clay, red, some sand and gypsum, 55-62 ft.	Bentonite and cuttings
62 – 74	Gypsum, white, dry, 62-74 ft.	Bentonite and cuttings
74 – 80	Gypsum, clay, soft, 74-80 ft.	Bentonite and cuttings
80 – 87	Gypsum, white, dry, 80-87 ft.	Bentonite
87 – 93	Clay, gypsum, moist, 87-93 ft.	Sand
93 – 97	Clay, sand, red, moist, 93-97 ft.	Sand
97 – 100	Clay, gypsum, sand, 97-100 ft.	Sand
100 – 102	Clay, sand, red, 100-102 ft.	Sand
102 – 105	Gypsum, 102-105 ft.	Sand
105 – 109	Limestone, gypsum, 105-109 ft.	Sand
109 – 114	Clay, limestone, gypsum, 109-114 ft.	Bentonite
114 – 117	Gypsum, 114-117 ft.	Bentonite
117 – 125	Clay, red, 117-125 ft.	Bentonite
125 – 129	Clay, grey-blue, 125-129 ft.	Sand
130.0		

Depth scale: 0.0, 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0, 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0, 62.0, 64.0, 66.0, 68.0, 70.0, 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0, 92.0, 94.0, 96.0, 98.0, 100.0, 102.0, 104.0, 106.0, 108.0, 110.0, 112.0, 114.0, 116.0, 118.0, 120.0, 122.0, 124.0, 126.0, 128.0, 130.0

Lithology

18K CL^- 6/25/04
28K CL^- 7/14/04
climbing up

R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	Loco Hills GSF	Plate D- 2
		July 2004

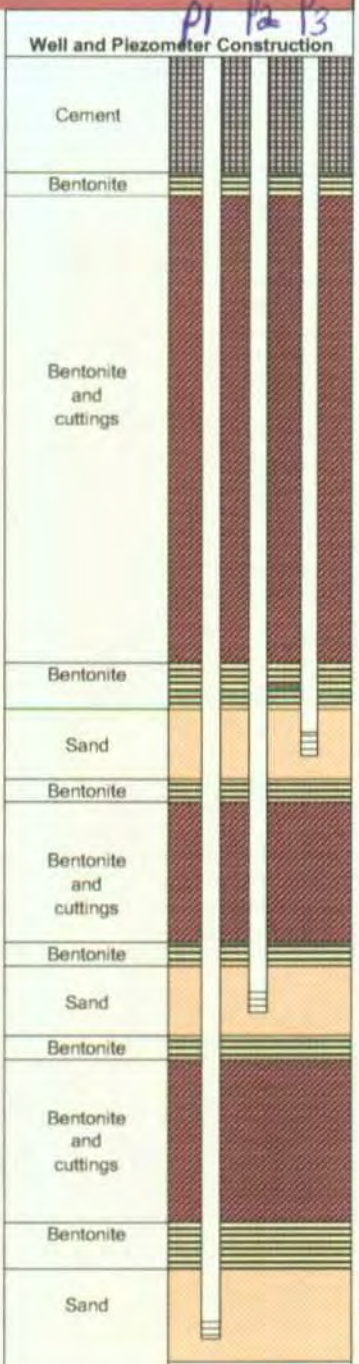
Logger:	David Hamilton	Client:	Well ID:
Driller:	Dubose Drilling	LHGSF	
Drilling Method:	Air Rotary	Project Name:	
Start Date:	6/23/2004		
End Date:	6/24/2004	Location:	P-2
Notes:		Loco Hills	

Depth (feet)	Description
0.0–6.0	Surface, 0-6 ft.
6.0–10.0	Clay, red, dry, 6-10 ft.
10.0–12.0	Clay, red, dry, little caliche 10-12 ft.
12.0–16.0	Clay, red, dry, 12-16 ft.
16.0–18.0	Clay, red, dry, little sand, 16-18 ft.
18.0–27.0	Clay, red, dry, 18-27 ft.
27.0–33.0	Clay, sand, red, dry, 27-33 ft.
33.0–47.0	Sand, clay, red, dry, 33-47 ft.
45.0–50.0	Clay, red, gypsum, 45-50 ft.
50.0–53.0	Clay, sand, red, slightly soft, 50-53 ft.
53.0–63.0	Sand, clay, red, 53-63 ft.
63.0–67.0	Clay, sand, red, some gypsum, 63-67 ft.
67.0–69.0	Gypsum, white, dry, 67-69 ft.
69.0–75.0	Clay, red, gypsum, 69-75 ft.
75.0–78.0	Gypsum, clay, red, some blue, 75-78 ft.
78.0–83.0	Clay, red, gypsum, some sand, 78-83 ft.
83.0–88.0	Gypsum, clay, grey and red, 83-88 ft.
88.0–99.0	Clay, grey and red, some gypsum, 88-99 ft.
99.0–103.0	Gypsum, white, dry, 99-103 ft.
103.0–105.0	Clay, red, some silt and gypsum, soft, 103-105 ft.
105.0–110.0	Clay, red, dry, 105-110 ft.

Depth (feet): 0.0, 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0, 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0, 62.0, 64.0, 66.0, 68.0, 70.0, 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0, 92.0, 94.0, 96.0, 98.0, 100.0, 102.0, 104.0, 106.0, 108.0, 110.0

Lithology

Well and Piezometer Construction



now WET

As of 2/25/05

R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
505-266-5004

Loco Hills GSF

Plate D-3

July 2004

Logger:		Client:	Well ID:
Driller:		LHGSF	
Drilling Method:		Project Name:	
Start Date:	5/1/2003		
End Date:	5/1/2003	Location:	MW-1
Notes:		Loco Hills	

Depth (feet)	Description
0.0	Surface, very fine grained sand, red, 0-5 ft.
2.0	
4.0	Caliche, sand, clay, 5-14 ft.
6.0	
8.0	
10.0	
12.0	
14.0	Clay, red, very sandy, 14-30 ft.
16.0	
18.0	
20.0	
22.0	
24.0	
26.0	
28.0	
30.0	Clay, some fine gravel, 30-67 ft.
32.0	
34.0	
36.0	
38.0	
40.0	
42.0	
44.0	
46.0	
48.0	
50.0	
52.0	
54.0	
56.0	
58.0	
60.0	
62.0	
64.0	
66.0	
68.0	Conglomerate, limestone, grey to dark grey, 67-77 ft.
70.0	
72.0	
74.0	
76.0	Clay, red, 77-88 ft.
78.0	
80.0	
82.0	
84.0	
86.0	
88.0	
90.0	Clay, red, very sticky, 88-93 ft.
92.0	
94.0	Limestone, gypsum, white to light grey, some fractured, 93-109 ft.
96.0	
98.0	
100.0	
102.0	
104.0	
106.0	
108.0	Clay, red, 109-113 ft.
110.0	
112.0	Clay, blue grey, 113-116 ft.
114.0	
116.0	Clay, red, silty, 116-120 ft.
118.0	
120.0	

Lithology

NOT DRILLED BY HICKS!

R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	Loco Hills GSF	Plate D-4
		July 2004

Table 7: Calculated TDS of Ground Water for Alternative Al

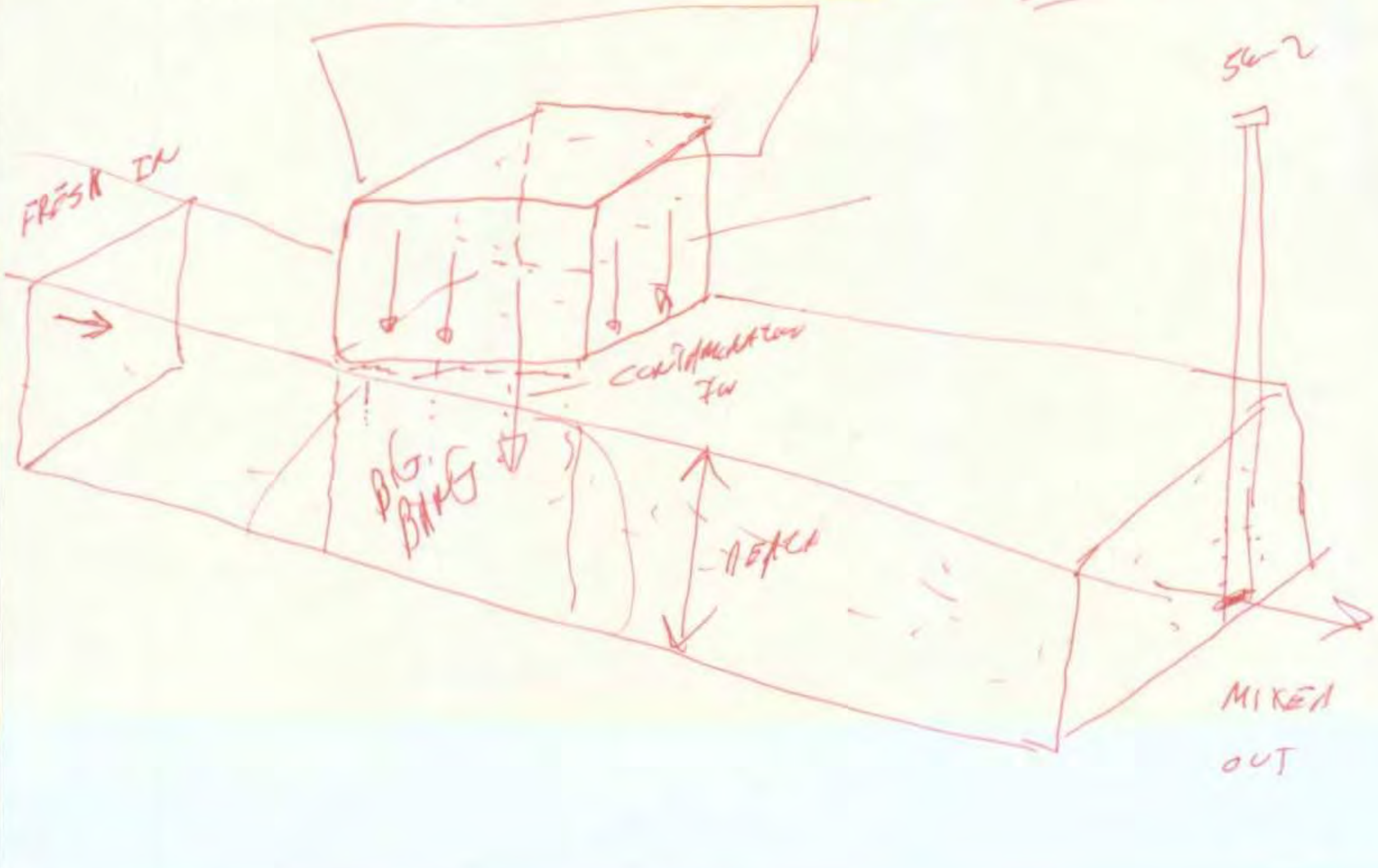
	Value	Units	
Pond Seepage Rate			
Surface Area of Pond	1000	meters2	
Vertical Unsaturated Hydraulic Conductivity of Rustler	5.00E-09	m/sec	5×10^{-7} cm/sec
Hydraulic Gradient (unsaturated)	1		
Calculated Brine Flux at Closure (Unsaturated Flow)	5.00E-06	m3/sec	
Ground Water Flux Beneath Pond			
Hydraulic Conductivity of Rustler	1.00E-07	m/s	
Area of Flow (3 meter thick aquifer)	3000	m2	
Hydraulic Gradient of Rustler	0.005		TAKEN FROM RHICK POTENTIOMETRIC MAP
Ground Water Flow	1.50E-06	m3/s	
Mixing Calculation			
TDS of Fluid in Vadose Zone (Cb)	250,000.00	mg/L	
TDS of Ground Water (Cgw)	2,500	mg/L	
Flux of Ground Water (Qgw)	2.E-06	m3/s	
Unsaturated Flux of Brine to Ground Water (Qb)	5.00E-06	m3/s	
TDS of Ground Water after Mixing	192,884.62	mg/L	> EXCEEDS EXISTING CONTAMINATION WHICH IS ≈ 30-40K CL 60-80 K TDS

ɔatement Standards

Source
Survey
Estimate from Table 6
Darcy's Law
Estimate based upon site observations and Table 6
Calculation
Measured
Darcy's Law
Saturated Brine
Measured
Calculated
Calculated Cf =((Qb*Cb)+(Qgw*Cgw))/(Qb+Qgw)

Table 7: Calculated TDS of Ground Water for Alternative Al

	Value	Units	
Pond Seepage Rate			
Surface Area of Pond	1000	meters2	
Vertical Unsaturated Hydraulic Conductivity of Rustler	5.00E-11	m/sec	(WIPP) 5×10^{-9} cm/sec
Hydraulic Gradient (unsaturated)	1		
Calculated Brine Flux at Closure (Unsaturated Flow)	5.00E-08	m3/sec	
Ground Water Flux Beneath Pond			
Hydraulic Conductivity of Rustler	1.00E-07	m/s	
Area of Flow (3 meter thick aquifer)	3000	m2	
Hydraulic Gradient of Rustler	0.022857143		
Ground Water Flow	6.86E-06	m3/s	
Mixing Calculation			
TDS of Fluid in Vadose Zone (Cb)	250,000.00	mg/L	
TDS of Ground Water (Cgw)	2,500	mg/L	
Flux of Ground Water (Qgw)	7.E-06	m3/s	
Unsaturated Flux of Brine to Ground Water (Qb)	5.00E-08	m3/s	
TDS of Ground Water after Mixing	4,291.62	mg/L	— 5000 mg/L



ɔatement Standards

Source

Survey

Estimate from Table 6

Darcy's Law

Estimate based upon site observations
and Table 6

Calculation

Measured

Darcy's Law

Saturated Brine

Measured

Calculated

Calculated

Cf =((Qb*Cb)+(Qgw*Cgw))/(Qb+Qgw)

RBDMS Map

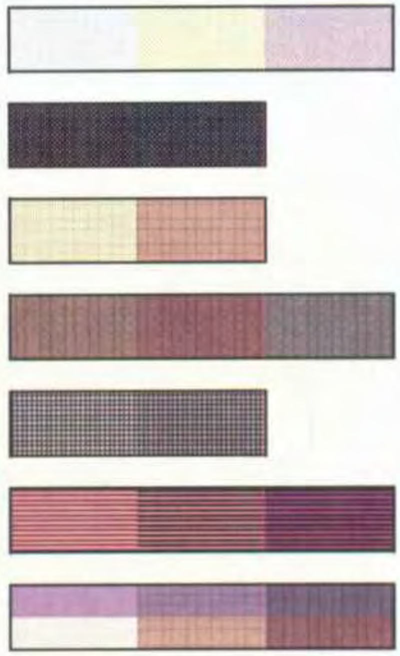
Oil Conservation Division

MapNotes

DrawnBy

2/24/2005 11:14:09 AM

Well Log Legend



Anhydrites, white, yellow, and limey

Gravels

Sands, coarse to fine grained

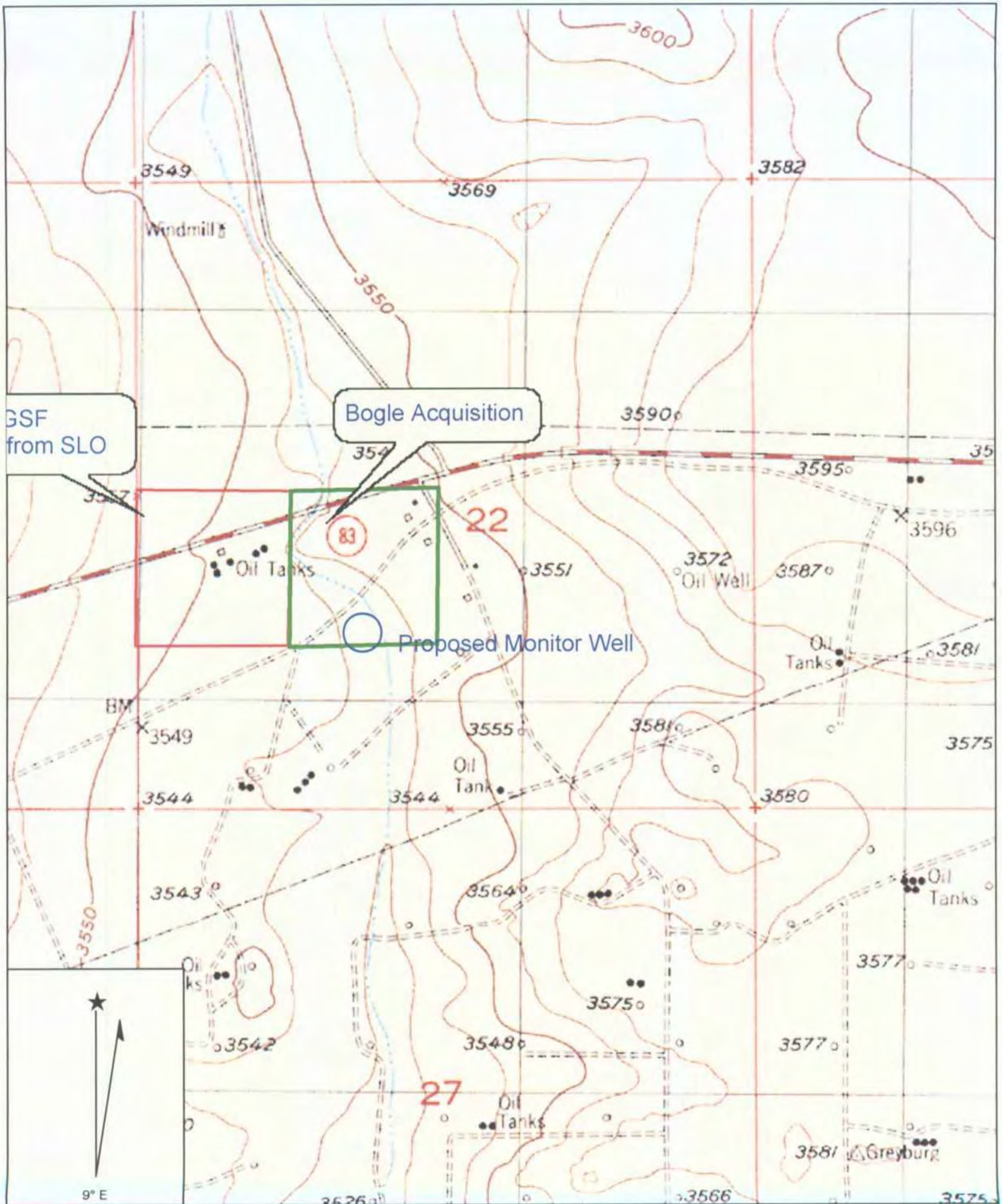
Silts, tan, brown, red and grey

Limestone, light grey, grey

Clays, dry, wet, red to dark red

Hydrocarbon impacted lithology

BMP PLATE 1

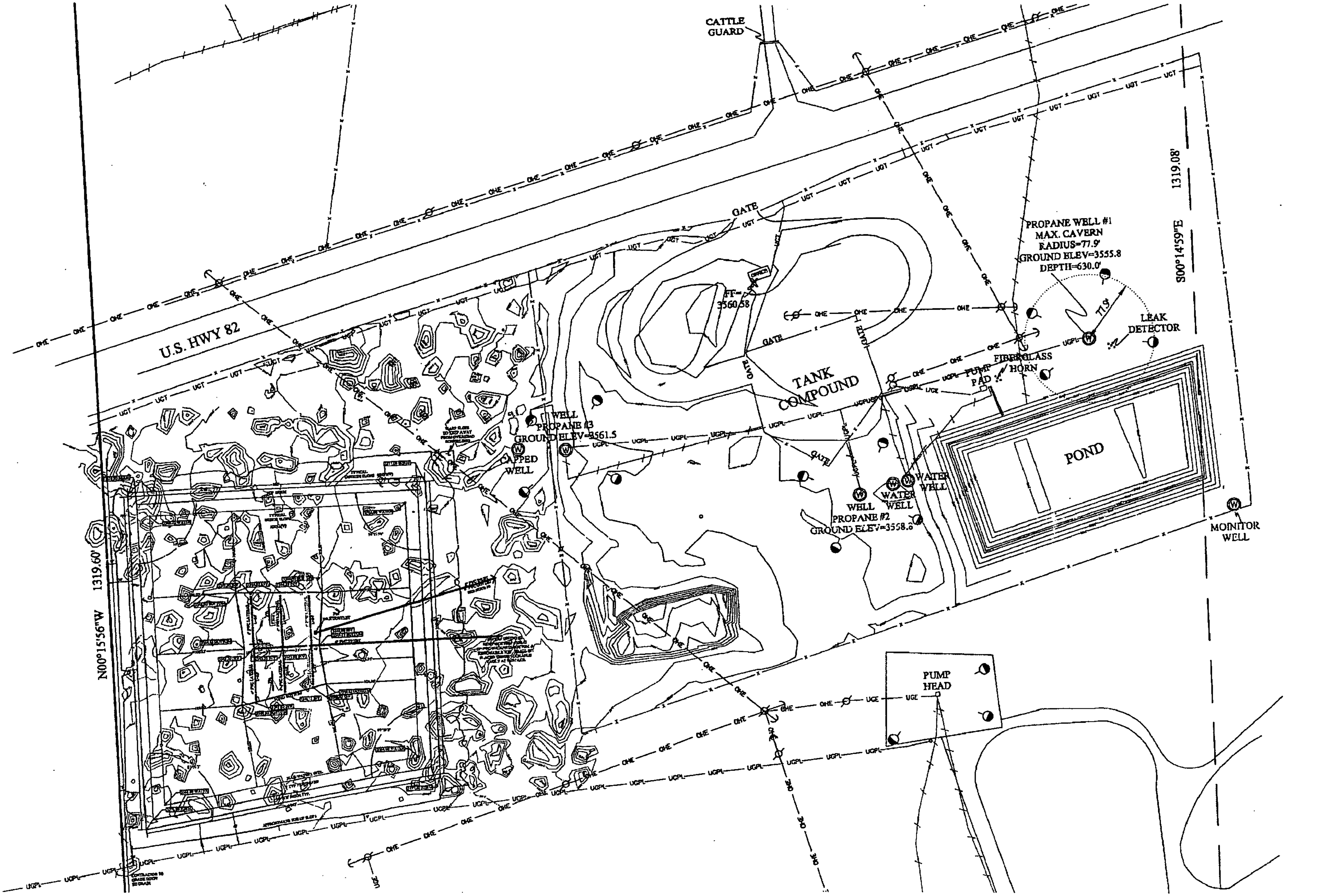


Name: RED LAKE SE
Date: 5/11/2004
Scale: 1 inch equals 1000 feet

Location: 032.8174199° N 104.0605926° W
Caption: Plate 1: Parcel Map

BMP APPENDIX A

SITE MAP



CATTLE GUARD
U.S. HWY 82
GATE
GATE
GATE
GATE
FF=3560.58
TANK COMPOUND
PROPANE WELL #1
MAX. CAVERN RADIUS=77.9'
GROUND ELEV=3555.8
DEPTH=630.0'
77.9'
LEAK DETECTOR
FIBERGLASS HORN
PUMP PAD
POND
WELL PROPANE #3
GROUND ELEV=3561.5
CAPPED WELL
WATER WELL
WATER WELL
WELL PROPANE #2
GROUND ELEV=3558.6
MONITOR WELL
PUMP HEAD
1319.08'
S00°14'59"E
1319.60'
N00°15'56"W

BMP APPENDIX B

PETTIGREW SUPPORT

PETTIGREW and ASSOCIATES
1110 N. GRIMES
HOBBS, NEW MEXICO 88240
(505) 393-9827 voice
(505) 393-1543 fax

10 November, 2004

R. T. Hicks Consultant, LTD.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

RE: Loco Hills GSF

Dear Mr. Hicks,

Pettigrew & Associates, P.A. is in communication with Loco Hills GSF to prepare engineering drawings and specifications for an 11 million gallon clay-lined pond located near Loco Hills, New Mexico. Pettigrew & Associates, P.A. will also prepare a construction quality assurance plan for the installation of the earthwork components of the soil/bentonite mixture, with a minimum thickness of two feet. This program will be developed to assure that the construction of the soil components are in compliance with the project specifications and to demonstrate achievement of the construction regulatory requirements. Pettigrew & Associates, P.A. will provide full time construction observation and quality assurance during construction of the clay lined pond.

Pettigrew & Associates, P.A. proposes to specify a mixture of 10% bentonite/90% native clay. Based upon the tests conducted by Amec Earth and Environmental, Inc. we are confident that this mixture should exceed the minimum permeability requirements established in the NMOCD guidance and meet the target value established in the 2004 Best Management Practices Plan for Loco Hills GSF. A graphic representation of the test results is attached to this correspondence.

The sequence of proposed construction includes:

- Existing clay will be stripped from Pond #2 and stockpiled.

- The existing native soils will be mixed with bentonite (as described in the American Petroleum Institute (API) Standard 13A) at a rate of 10% in order to achieve a hydraulic conductivity of not more than 1×10^{-7} centimeters per second based upon the density and moisture content determined by ASTM D 698 at 95% compaction. The subgrade shall be shaped to the plan grades prior to addition of the bentonite mix so as to permit the construction of a uniform compacted course. Mixing shall take place immediately after the application of the bentonite. The bentonite, native soils and water shall be thoroughly blended by mechanical means, as approved by the Project Engineer, until a uniform mixture is obtained.

- A two foot thick clay liner will be placed in six inch lifts. There shall be a six inch (6") minimum overlap between passes. Compaction shall begin immediately after mixing has been completed. Each lift will be tested for compaction.

Should you have any questions regarding this transmittal, please do not hesitate to contact me.

Sincerely,

Pettigrew & Associates, P.A.

Debra P. Hicks

Debra P. Hicks, PE/LSI
President

Attachments

amec

PROJECT:	UNKNOWN	JOB NO:	2-119-000075
LOCATION:	UNKNOWN	WORK ORDER NO:	13
MATERIAL:	0% CLAY	LAB NO:	17
SAMPLE SOURCE:	UNKNOWN	DATE SAMPLED:	UNKNOWN
SAMPLE PREP:	REMOLDED TO 95% MAX DRY DENSITY AND OPT. MOISTURE MAX DRY DENSITY D698A 116.2 pcf @ 12.4% OPT. MOISTURE		

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER (ASTM D5084-00) METHOD "C"

AVERAGE PERMEABILITY		1.41E-05 cm/sec	
INITIAL LENGTH OF SPECIMEN		7.14 cm	
INITIAL DIAMETER OF SPECIMEN		7.14 cm	
INITIAL WATER CONTENT		12.3 %	
INITIAL DRY UNIT WEIGHT		110.7 pcf	
INITIAL VOLUME		285.9 cu.cm	
PERMEANT LIQUID		BOTTLED WATER	
MAGNITUDE OF TOTAL BACK PRESSURE		66.5 psi	
EFFECTIVE CONSOLIDATION STRESS		5.0 psi	
RANGE OF HYDRAULIC GRADIENT USED	6.5	to	6.0
FINAL LENGTH OF SPECIMEN		7.14 cm	
FINAL DIAMETER OF SPECIMEN		7.14 cm	
FINAL WATER CONTENT		22.9 %	
FINAL DRY UNIT WEIGHT		110.7 pcf	
FINAL VOLUME		285.9 cu.cm	
DEGREE OF SATURATION (BEFORE AND AFTER TEST)	60%	and	111%
SPECIFIC GRAVITY USED IN CALCULATIONS OF SATURATION		2.795	

TIME INTERVAL (sec)	K (cm/sec)	K (ft/yr)
3,535	1.41E-05	15
3,939	1.41E-05	15
4,273	1.44E-05	15
4,890	1.38E-05	14

AASHTO R18

REVIEWED BY

amec

PROJECT:	UNKNOWN	JOB NO:	2-119-000075
LOCATION:	UNKNOWN	WORK ORDER NO:	13
MATERIAL:	5% CLAY	LAB NO:	18
SAMPLE SOURCE:	UNKNOWN	DATE SAMPLED:	UNKNOWN
SAMPLE PREP:	REMOLDED TO 95% MAX DRY DENSITY AND OPT. MOISTURE		
TARGET:	MAX DRY DENSITY D698A 115.4 pcf @ 12.8% OPT. MOISTURE		

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER (ASTM 5084-90) "CV" METHOD C

AVERAGE PERMEABILITY		3.22E-07 cm/sec	
INITIAL LENGTH OF SPECIMEN		7.14 cm	
INITIAL DIAMETER OF SPECIMEN		7.14 cm	
INITIAL WATER CONTENT		12.4 %	
INITIAL DRY UNIT WEIGHT		110.3 pcf	
INITIAL VOLUME		17.45 cu.in	
PERMEANT LIQUID		BOTTLED WATER	
MAGNITUDE OF TOTAL BACK PRESSURE		65.5 psi	
EFFECTIVE CONSOLIDATION STRESS		5 psi	
RANGE OF HYDRAULIC GRADIENT USED	10.8	to	8.8
FINAL LENGTH OF SPECIMEN		7.65 cm	
FINAL DIAMETER OF SPECIMEN		7.16 cm	
FINAL WATER CONTENT		26.0 %	
FINAL DRY UNIT WEIGHT		102.3 pcf	
FINAL VOLUME		18.80 cu.in	
DEGREE OF SATURATION (BEFORE AND AFTER TEST)	65%	and	110%
SPECIFIC GRAVITY USED IN CALCULATIONS OF SATURATION		2.675	

TIME INTERVAL sec	K cm/sec	K ft/yr.
646	3.20E-07	0.33
673	3.22E-07	0.33
701	3.23E-07	0.33
730	3.22E-07	0.33

AASHTO R18

REVIEWED BY

amec

PROJECT:	UNKNOWN	JOB NO:	2-119-000075
LOCATION:	UNKNOWN	WORK ORDER NO:	13
MATERIAL:	10% CLAY	LAB NO:	19
SAMPLE SOURCE:	UNKNOWN	DATE SAMPLED:	UNKNOWN
SAMPLE PREP:	REMOLDED TO 95% MAX DRY DENSITY AND OPT. MOISTURE		
TARGET:	MAX DRY DENSITY D698A 109.2 pcf @ 14.0% OPT. MOISTURE		

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER (ASTM 5084-90) "CV" METHOD C

AVERAGE PERMEABILITY		4.32E-10 cm/sec	
INITIAL LENGTH OF SPECIMEN		7.14 cm	
INITIAL DIAMETER OF SPECIMEN		7.14 cm	
INITIAL WATER CONTENT		14.0 %	
INITIAL DRY UNIT WEIGHT		104.1 pcf	
INITIAL VOLUME		17.45 cu.in	
PERMEANT LIQUID		BOTTLED WATER	
MAGNITUDE OF TOTAL BACK PRESSURE		81.4 psi	
EFFECTIVE CONSOLIDATION STRESS		5 psi	
RANGE OF HYDRAULIC GRADIENT USED	16.0	to	12.8
FINAL LENGTH OF SPECIMEN		7.20 cm	
FINAL DIAMETER OF SPECIMEN		7.19 cm	
FINAL WATER CONTENT		24.8 %	
FINAL DRY UNIT WEIGHT		101.8 pcf	
FINAL VOLUME		17.84 cu.in	
DEGREE OF SATURATION (BEFORE AND AFTER TEST)	63%	and	105%
SPECIFIC GRAVITY USED IN CALCULATIONS OF SATURATION		2.651	

TIME INTERVAL sec	K cm/sec	K ft/yr.
186759	4.31E-10	0.00
198779	4.33E-10	0.00
301110	4.32E-10	0.00
400330	4.32E-10	0.00

AASHTO R18

REVIEWED BY

amec

PROJECT:	UNKNOWN	JOB NO:	2-119-000075
LOCATION:	UNKNOWN	WORK ORDER NO:	13
MATERIAL:	15% CLAY	LAB NO:	20
SAMPLE SOURCE:	UNKNOWN	DATE SAMPLED:	UNKNOWN
SAMPLE PREP:	REMOLDED TO 90% MAX DRY DENSITY AND OPT. MOISTURE		
TARGET:	MAX DRY DENSITY D698A 109.23 pcf @ 15.6% OPT. MOISTURE		

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER (ASTM 5084-90) "CV" METHOD C

AVERAGE PERMEABILITY		1.74E-08 cm/sec	
INITIAL LENGTH OF SPECIMEN		7.15 cm	
INITIAL DIAMETER OF SPECIMEN		7.15 cm	
INITIAL WATER CONTENT		15.7 %	
INITIAL DRY UNIT WEIGHT		103.6 pcf	
INITIAL VOLUME		17.52 cu.in	
PERMEANT LIQUID		BOTTLED WATER	
MAGNITUDE OF TOTAL BACK PRESSURE		66 psi	
EFFECTIVE CONSOLIDATION STRESS		5 psi	
RANGE OF HYDRAULIC GRADIENT USED	15.4	to	9.8
FINAL LENGTH OF SPECIMEN		7.57 cm	
FINAL DIAMETER OF SPECIMEN		7.36 cm	
FINAL WATER CONTENT		31.4 %	
FINAL DRY UNIT WEIGHT		92.4 pcf	
FINAL VOLUME		19.65 cu.in	
DEGREE OF SATURATION (BEFORE AND AFTER TEST)	70%	and	105%
SPECIFIC GRAVITY USED IN CALCULATIONS OF SATURATION		2.651	

TIME INTERVAL sec	K cm/sec	K ft/yr.
5281	1.72E-08	0.02
6025	1.73E-08	0.02
8383	1.75E-08	0.02
9660	1.74E-08	0.02

AAP AASHTO R18

REVIEWED BY CJ

BMP APPENDIX C

SONAR REPORT

ECHO - LOG

Propane Well #1

1st. Survey

04/21/2003 033020

SOCON Cavity Control, Inc.
4070 Washington Blvd. Texas 77705, USA
Phone (409) 840-5554+5557 Fax (409) 840-4424
e-mail: lawrence@socon.com

Summary of results

Well details

All depths are given as:	**MD**
Datum level for all depths:	**surface**
Shoe of the cemented 13 3/8"-casing:	525.0 ft
Shoe of the - casing during the surveying:	525.0 ft
Reference depth for ECHO-LOG:	**525.0 ft**
Depth correction:	+12.0 ft

Details of survey equipment

Measuring vehicle used:	L 110
Tools used:	Echo tool BSE 17, BSE 17 Fibre-gyro-compass

General details

Number of runs:	1
Measured horizontal sections:	19
Measured tilted sections:	20
Lowest survey depth:	643.0 ft

Maximum and minimum dimensions with ref. to the measuring axis

Reference direction:	**magnetic north**

Determination out of 36 vertical sections derived from horizontally and tilted measured data at 5 degree intervals:

minimum radius:	0.0 ft
depth:	650.1 ft
direction:	0°
maximum radius:	77.9 ft
depth:	630.0 ft
direction:	60°
highest point of cavern:	522.2 ft
horizontal distance:	8.1 ft
direction:	345°
lowest point of cavern:	651.4 ft
horizontal distance:	5.4 ft
direction:	75°
lowest point in the measuring axis:	650.2 ft

Determination out of 37 horizontal sections in the depths between 192.3 m and 259 m at 5/15 degree intervals:

maximum radius:	77.9 ft
depth:	630.0 ft
direction:	60°
maximum diameter:	138.2 ft
depth:	625.0 ft
direction:	85 - 265°

Volume

volume:	65,456 bbls.
depth range:	525.0 ft <--> 650.0 ft

Interpretation

Supposing a rectilinear propagation of ultrasonic waves all recorded echo travel times were converted into distances by using the subsequent speeds of sound:

1798.0 m/s (5899.0 ft/s) to 1798.0 m/s (5899.0 ft/s) in brine (measured)

In the case of recording several echoes along one trace of echo signals, the representative echo signal was selected according to the level of amplitude, transmission time, density of measured points and the shape of the cavern.

Horizontal sections

19 horizontal sections at following measured depths are included as graphical plots in this report:

525.0 ft	530.0 ft	540.0 ft	550.0 ft	560.0 ft	570.0 ft	580.0 ft
590.0 ft	595.0 ft	600.0 ft	605.0 ft	610.0 ft	615.0 ft	620.0 ft
625.0 ft	630.0 ft	635.0 ft	640.0 ft	643.0 ft		

The following 4 sections are constructed:

644.0 ft	646.0 ft	648.0 ft	650.0 ft

Tilted sections

20 sections recorded with tilted echo-transducer at following measured depths are presented in the vertical sections:

12 sections of these with upwards-tilted echo-transducer:

Depth / Tilting Angle

540.0 / 54	540.0 / 60	540.0 / 66	540.0 / 72	540.0 / 78	540.0 / 84
640.0 / 9	640.0 / 12	640.0 / 15	640.0 / 17	640.0 / 21	640.0 / 24

8 sections of these with downwards-tilted echo-transducer:

Depth / Tilting Angle

600.0 / 6	600.0 / 12	600.0 / 18	600.0 / 24	600.0 / 30	600.0 / 36
600.0 / 42	600.0 / 48				

Vertical sections

The shape of the cavern was determined by interpretation of all horizontally and tilted measured data and is presented by 36 vertical sections in this report.

Maximum plots (top view)

The maximum plot presents the largest extension of the cavern in a top view. The first picture shows the areas of all horizontal sections and the area resulting out of the vertical sections (hatched). The resulting total area is shown in the second picture (cross hatching) together with the largest single area.

In both pictures the total centre of gravity of the cavern is shown with its distance and its direction referring to the measuring axis.
The total centre of gravity is derived out of the envelope, which is the connection line of the largest cavern extension in every direction

Perspective views

Several perspective drawings are included in this report to give a quick review of detailed relations.

Pockets in the cavern wall

Pockets in the cavern wall, which have been identified by the tilted echo-transducer, were transferred from the vertical sections to the respective horizontal sections.
The resulting additional areas have been added to the calculated areas.

LOG - Data

You will find the graphic representations of the following LOG data at the end of this report:

Parameter	from	to
CCL:	589'	498'
Temperature:	500'	640'
Pressure:	500'	640'
Speed of sound:	500'	640'

Volume list

Depth (ft)	Radius (ft)	Area (ft²)	Depth range (ft) from	to	Volume (bbls.) partial	total
525.0	16.1	813	525.0	527.5	362	362
530.0	15.3	733	527.5	535.0	979	1340
540.0	14.2	630	535.0	545.0	1122	2462
550.0	15.6	767	545.0	555.0	1366	3828
560.0	16.6	865	555.0	565.0	1540	5368
570.0	20.1	1269	565.0	575.0	2260	7628
580.0	20.7	1343	575.0	585.0	2392	10021
590.0	23.7	1765	585.0	592.5	2357	12378
595.0	26.0	2125	592.5	597.5	1892	14270
600.0	30.4	2906	597.5	602.5	2588	16858
605.0	31.0	3023	602.5	607.5	2692	19549
610.0	29.7	2778	607.5	612.5	2474	22023
615.0	36.3	4147	612.5	617.5	3693	25717
620.0	41.7	5451	617.5	622.5	4854	30571
625.0	68.0	14511	622.5	627.5	12922	43493
630.0	61.9	12028	627.5	632.5	10711	54204
635.0	51.1	8196	632.5	637.5	7299	61502
640.0	35.1	3868	637.5	641.5	2756	64258
643.0	24.8	1929	641.5	643.5	687	64945
644.0	18.4	1060	643.5	645.0	283	65228
646.0	11.4	409	645.0	647.0	146	65374
648.0	7.8	190	647.0	649.0	68	65442
650.0	5.0	78	649.0	650.0	14	65456

BMP APPENDIX D

ASTM STANDARD

Designation: D 5093 – 02

Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring[1]

This standard is issued under the fixed designation D 5093; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope *

1.1 This test method describes a procedure for measuring the infiltration rate of water through in-place soils using a double-ring infiltrometer with a sealed inner ring.

1.2 This test method is useful for soils with infiltration rates in the range of 1×10^{-7} m/s to 1×10^{-10} m/s. When infiltration rates $\geq 1 \times 10^{-7}$ m/s are to be measured Test Method D 3385 shall be used.

1.3 All observed and calculated values shall conform to the guide for significant digits and rounding established in Practice D 6026.

1.3.1 The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

1.4 This test method provides a direct measurement of infiltration rate, not hydraulic conductivity. Although the units of infiltration rate and hydraulic conductivity are similar, there is a distinct difference between these two quantities. They cannot be directly related unless the hydraulic boundary conditions, such as hydraulic gradient and the extent of lateral flow of water are known or can be reliably estimated.

1.5 This test method can be used for natural soil deposits, recompacted soil layers, and amended soils such as soil bentonite and soil lime mixtures.

1.6 The values stated in SI units are to be regarded as standard. The values in parentheses are for information only.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 3385 Test Method for Infiltration Rate of Soils in Field Using Double Ring Infiltrometers[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock Used in Engineering Design and Construction[2]

D 6026 Practice for Using Significant Digits in Geotechnical Data[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *infiltration*—downward entry of liquid into a porous body.

3.1.2 *infiltration rate, I*—quantity of liquid entering a porous material (m^3) per unit area (m^2) per unit time (s), expressed in units of m/s.

3.1.3 *infiltrometer*—a device used to pond liquid on a porous body and to allow for the measurement of the rate at which liquid enters the porous body.

3.1.4 For definitions of other terms used in this test method, see Terminology D 653.

4. Summary of Test Method

4.1 The infiltration rate of water through soil is measured using a double-ring infiltrometer with a sealed or covered inner ring (Fig. 1). The infiltrometer consists of an open outer and a sealed inner ring. The rings are embedded and sealed in trenches excavated in the soil. Both rings are filled with water such that the inner ring is submerged.

4.2 The rate of flow is measured by connecting a flexible bag filled with a known weight of water to a port on the inner ring. As water infiltrates into the ground from the inner ring, an equal amount of water flows into the inner ring from the flexible bag. After a known interval of time, the flexible bag is removed and weighed. The weight loss, converted to a volume, is equal to the amount of water that has infiltrated into the ground. An infiltration rate is then determined from this volume of water, the area of the inner ring, and the interval of

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.04 on Hydrologic Properties of Soil and Rocks.

Current edition approved July 10, 2002. Published September 2002. Originally published as D5093–90. Last previous edition D5093–90(1997).

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

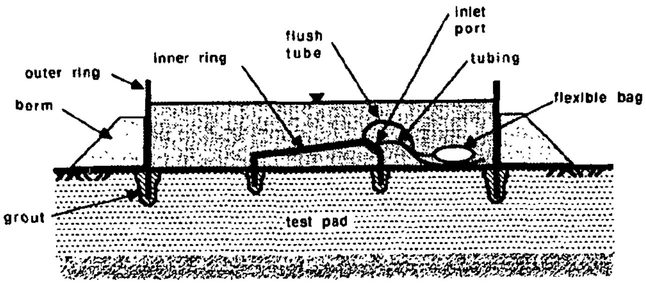


FIG. 1 Schematic Of A Double-Ring Infiltrometer With A Sealed Inner Ring

time. This process is repeated and a plot of infiltration rate versus time is constructed. The test is continued until the infiltration rate becomes steady or until it becomes equal to or less than a specified value.

5. Significance and Use

5.1 This test method provides a means to measure low infiltration rates associated with fine-grained, clayey soils, and are in the range of 1×10^{-7} m/s to 1×10^{-9} m/s.

5.2 This test method is particularly useful for measuring liquid flow through soil moisture barriers such as compacted clay liner or covers used at waste disposal facilities, for canal and reservoir liners, for seepage blankets, and for amended soil liners such as those used for retention ponds or storage tanks.

5.3 The purpose of the sealed inner ring is to: (*1*) provide a means to measure the actual amount of flow rather than a drop in water elevation which is the flow measurement procedure used in Test Method D 3385 and (*2*) to eliminate evaporation losses.

5.4 The purpose of the outer ring is to promote one-dimensional, vertical flow beneath the inner ring. The use of large diameter rings and large depths of embedments helps to ensure that flow is essentially one-dimensional.

5.5 This test method provides a means to measure infiltration rate over a relatively large area of soil. Tests on large volumes of soil can be more representative than tests on small volumes of soil.

5.6 The data obtained from this test method are most useful when the soil layer being tested has a uniform distribution of pore space, and when the density and degree of saturation and the hydraulic conductivity of the material underlying the soil layer are known.

5.7 Changes in water temperature can introduce significant error in the volume change measurements. Temperature changes will cause water to flow in or out of the inner ring due to expansion or contraction of the inner ring and the water contained within the inner ring.

5.8 The problem of temperature changes can be minimized by insulating the rings, by allowing enough flow to occur so that the amount of flow resulting from a temperature change is not significant compared to that due to infiltration, or by connecting and disconnecting the bag from the inner ring when the water in the inner ring is at the same temperature.

5.9 If the soil being tested will later be subjected to increased overburden stress, then the infiltration rate can be expected to decrease as the overburden stress increases. Laboratory hydraulic conductivity tests are recommended for studies of the influence of level of stress on the hydraulic properties of the soil.

NOTE 1—The quality of the result produced by this standard depends on the competence of the personnel performing it and the suitability of the equipment and facilities being used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this standard are cautioned that compliance with Practice D 3740 does not in itself ensure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors

6. Apparatus

6.1 *Infiltrometer Rings*—The rings shall be constructed of a stiff, corrosion-resistant material such as metal, plastic, or fiberglass. The shape of the rings can be circular or square. However, square rings are recommended because it is easier to excavate straight trenches in the soil. The rings can be of any size provided: (*1*) the minimum width or diameter of the inner ring is 610 mm (24 in.); and (*2*) a minimum distance of 610 mm is maintained between the inner and outer ring. The following is a description of a set of rings that can be constructed from commonly available materials, incorporates the requirements described above, and has worked well in the field.

6.1.1 *Outer Ring*—A square ring (Fig. 2) comprised of four sheets of aluminum approximately 3.6 m by 910 mm by 2 mm (12 ft by 36 in. by 0.080 in.) The top edge of the aluminum sheet is bent 90° in order to provide rigidity. A hole is provided in the center of the top edge. One edge of each sheet is bent 90°. Holes are drilled along each side edge so that the sheets can be bolted at the corners. A flat rubber gasket provides a seal at each corner. A wire cable approximately 15 m long with a clamp may be needed to tie the top edges together.

6.1.2 *Inner Ring*—A square ring (Fig. 3), 1.52 m (5 ft) on a side, made of fiberglass provided with two ports. The top is shaped in such a way as to vent air from the ring as it is filled. A port is provided at the highest point so that any air that accumulates in the ring during the test can be flushed out. One port must be located at the top of the ring. The other port must be located beneath the top port. A150 mm (6 in.) skirt, that is embedded into the soil, is provided along the edge of the ring. Barbed fittings that accept flexible tubing are attached to the ports. Handles are provided at each corner of the inner ring.

6.2 *Flexible Bag*—Two clear flexible bags with a capacity of 1000 to 3000 mL. Intravenous bags available from medical

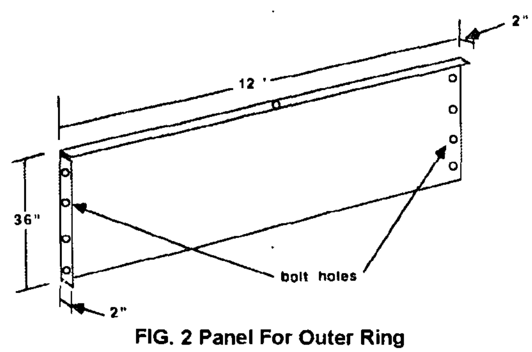


FIG. 2 Panel For Outer Ring

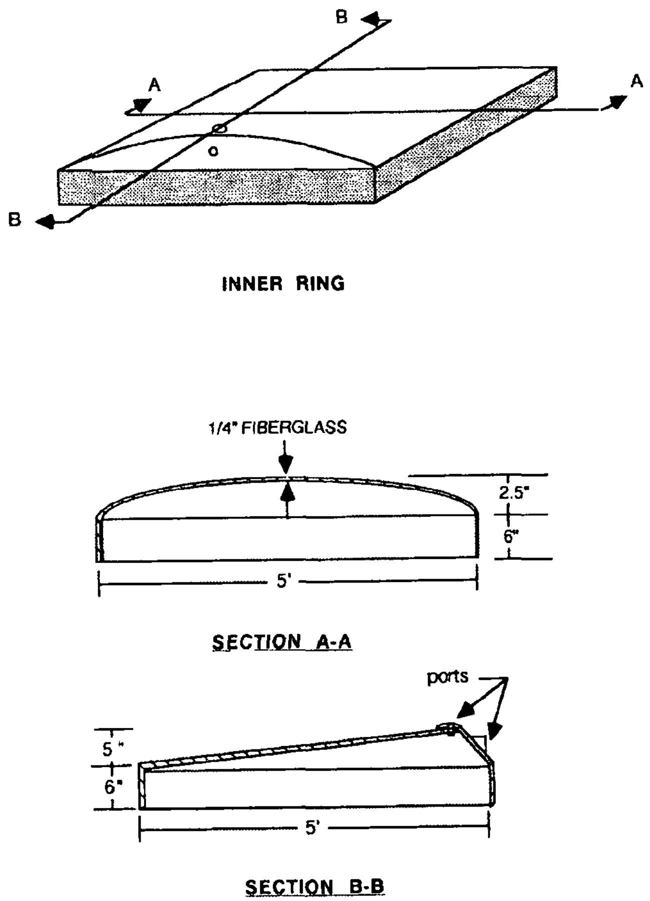


FIG. 3 Inner Ring

supply stores work well. A means for attaching a shut-off valve to the bag shall be provided. The shut-off valve shall be provided with a barbed fitting that will connect to the inlet tube on the inner ring.

6.3 *Tubing*—Clear, flexible tubing approximately 4.5 m (15 ft) long with a minimum ID of 6 mm (¼ in.)

6.4 *Scissors or Knife.*

6.5 *Excavation Tools.*

6.5.1 *Mason's Hammer*—Hammer with a blade approximately 120 mm long and 40 mm wide.

6.5.2 *Trenching Machine*—Capable of excavating a trench with a maximum width of 150 mm (6 in.) and a depth of 460 mm (18 in.)

6.5.3 *Chain Saw*—(Optional—see Note 2) Equipped with a carbide-tipped chain and bar.

6.5.4 *Hand Shovel*, garden type.

6.6 *Levels*—A surveyor's level and rod and a carpenter's level.

6.7 *Buckets*—Five buckets with a capacity of approximately 20 L (5 gal.)

6.8 *Blocks*—Cinder blocks to serve as a platform for the flexible bag.

6.9 *Cover*—An opaque cover to place on top of the outer ring. The cover can be a tarp or plywood supported by wooden beams.

6.10 *Grout*—A bentonite grout for filling the trenches and sealing the rings in place.

6.11 *Mixing Equipment*—A large (four bag) grout mixer for mixing the bentonite grout.

6.12 *Trowel.*

6.13 *Thermometer*—Readable to 0.5°C with a range of 0 to 50°C.

6.14 *Scale*—Capacity of 4000 g and an accuracy of 1 g.

6.15 *Watch*—Readable to 1 s.

6.16 *Water Supply*—Preferably water of the same quality as that involved in the problem being examined. Approximately 5600 L (1400 gal) are needed for this test.

6.17 *Splash Guard*—Plywood, rubber sheet, or burlap 600 by 600 mm (2 by 2 ft).

7. Test Site

7.1 The test requires an area of approximately 7.3 by 7.3 m (24 by 24 ft).

7.2 The slope to the test area should be no greater than approximately 3 %.

7.3 The test may be set up in a pit if infiltration rates are desired at depth rather than at the surface.

7.4 The test area shall be covered with a sheet of plastic to keep the surface from drying.

7.5 Representative samples of the soil to be tested shall be taken before and after the test to determine its moisture content, density, and specific gravity. The thickness of the layer being tested shall be determined as well as the approximate hydraulic conductivity of the layer beneath it.

8. Procedure

8.1 *Assembly of Outer Ring*—Wipe off gaskets and side edges of the outer ring. Align gasket between the edges and bolt edges together.

8.2 *Excavation of Trenches*:

8.2.1 Place both rings on the area to be tested. Center the inner ring within the outer ring. Make sure that the outer ring is square by using the tape measure to check that the length of the diagonals are equal.

8.2.2 If plastic is covering the test area, cut out thin strips along the edge of each ring so that the trenches can be excavated. Leave as much of the plastic on as possible in order to keep the soil from drying.

8.2.3 Use the bottom edge of each ring to scribe a line on the ground to use as a guide for excavating the trenches.

8.2.4 Note the orientation of the rings and set them aside.

8.2.5 Use the surveyor's level and check the ground elevation where the corners of each ring will be. Note the high spots and excavate deeper in these areas so that the rings will be level.

8.2.6 Use the trenching machine and excavate a trench for the outer ring. The trench should be about 146 mm (18 in.) deep. Excavate deeper at high spots.

8.2.7 Use a small hand shovel to remove any loose material in the trenches.

8.2.8 Place the outer ring in the trench and use the carpenter's level to check that the top of the ring is reasonably level (±30 mm). Also check that the outer ring is square. Remove the ring and excavate any areas keeping the ring from being level and square.

8.2.9 Set the outer ring aside and cover the trenches to prevent the soil from drying.

8.2.10 Use the mason's hammer and excavate a trench 50 by 110 mm (2 by 4.5 in.) for the inner ring. Excavate deeper in high spots so that the inner ring will sit level in the trench. Excavate the trench carefully so that the surrounding soil is disturbed as little as possible. When using the mason's hammer, it is best to start by digging down several inches in one spot and then advancing the trench forward by chopping down on the soil. Do not pry the soil up as this tends to lift up large wedges of soil, opens cracks, and causes the trench to be oversized.

8.2.11 Place the inner ring in the trench to check the fit. Excavate any areas where the ring does not fit. Use a surveyor's level to check the elevation of the corners of the ring. The inner ring needs to be level or slightly tilted so that the back end is slightly lower than the front end.

8.2.12 Set the ring aside and cover the trenches.

NOTE 2—A chain saw that is equipped with a carbide-tipped chain and a bar may be used to excavate the trenches. Use of a chain saw will not only reduce the time needed to excavate the trench but will also greatly decrease the amount of grout needed to fill the trenches. If a chain saw is used, the trenches need only be 25 mm (1 in.) wide. A chain saw will not work well in some soils. A trial trench should be made to determine if it will work.

8.3 *Installation of Rings*:

8.3.1 Use the grout mixer to prepare enough grout to fill the trenches. The hydraulic conductivity of the grout should be less than approximately 1×10^{-8} m/s.

8.3.2 Fill the trenches to within 2.5 mm (1 in.) of the top of the trench. Rod or tamp the grout to remove any entrapped air.

8.3.3 Lift the inner ring and center it over the inner ring trench. Lower it into the trench and slowly push it down. Keep the ring level as it is pushed into place.

8.3.4 Use a surveyor's level to check that the ring is level.

8.3.5 Use a trowel to press the grout against the outside wall of the ring in order to ensure a good seal.

8.3.6 Cover the grout with plastic to prevent desiccation.

8.3.7 Lift the outer ring and center it over the outer ring trench.

8.3.8 Keep the ring level and push it into place.

8.3.9 Use the carpenter's level to make sure that the ring is level.

8.3.10 Use a trowel to push the grout against both the inside and the outside of the ring to ensure a good seal.

8.3.11 Cover the grout with plastic to prevent desiccation.

8.3.12 Place several cinder blocks between the inner and outer rings in the vicinity of the ports on the inner ring. These blocks will be used as a platform to stand on when connecting the fittings to the inner ring and also to support the flexible bags. The blocks should be no higher than 100 mm (4 in.)

8.3.13 Pile soil along the outside of the outer ring to a height of at least 30 cm (12 in.) This soil places an overburden pressure on the grout that will prevent it from being pushed out of the trench when the rings are filled with water.

8.4 *Filling the Rings*:

8.4.1 Fill two buckets with water and place one on each back corner of the inner ring. The buckets are placed on the inner ring to counteract the uplift force that acts on the ring as it is being filled. Make sure that the buckets are placed on the edge of the ring, not in the center as this may overstress the ring and cause it to crack. Do not to spill any water around the inner ring as this will make it difficult to check for leaks in the seal.

8.4.2 Place an empty bucket upside down on the ground near the top port on the inner ring. Place a second bucket on the first bucket. Fill the second bucket with water. Cut a length of the flexible tubing long enough to reach from the top bucket to the top port on the inner ring. Siphon the water from the bucket to the inner ring. Allow the siphoning to continue until the depth of the water in the inner ring is approximately 25 mm (1 in.). Avoid spilling any water around the inner ring during this filling process as this will make it difficult to check for leaks. Any other suitable method for adding the required volume of water to the inner ring may also be used.

8.4.3 Let the water stand in the inner ring for at least 30 min. Check for leaks in the inner ring seal and repair any that are found.

8.4.4 Start filling the outer ring slowly so as not to scour the soil and muddy the water. Direct the water so that it hits a splashboard first. Fill the outer ring until the water level is approximately 100 mm (4 in.) above the top of the inner ring. While the rings are being filled, use a board or shovel handle to gently tap the inner ring to dislodge air bubbles that are trapped inside. Continue tapping on the inner ring until bubbles cease to emerge from the top port.

8.4.5 Remove the buckets from the top of the inner ring.

8.5 *Installation of Fittings and Tubing*:

8.5.1 Wrap the threads of the two barbed fittings with TFE-fluorocarbon tape.

8.5.2 Saturate the fittings and connect them to the inner ring. Screw one of the barbed fittings into the top port and the other barbed fitting into one of the lower ports. Use caution when screwing the fittings into the ports as the threads in fiberglass inner rings can be easily damaged.

8.5.3 Cut two lengths of the clear flexible tubing, one 900-mm (3-ft) piece and one 1800-mm (6-ft) piece.

8.5.4 Saturate the tubing by placing it under water. Be sure to remove all air bubbles.

8.5.5 Connect one end of the 1.8-m (6-ft) piece to the fitting in the top port and seal the other end with a plug fitting. Do not let air into the tube during this process. This tube is the flush tube.

8.5.6 Connect the end of the 900-mm (3-ft) piece to the barbed fitting in the lower port. Prop the open end of this tube on the cinder block platform. Water is being drawn into this tube so be sure not to allow the open end of the tube to float to the surface and draw in air or sink to the bottom and draw in mud. This tube is the inlet tube.

8.6 *Covering the Rings*:

8.6.1 Cover the rings with either a tarp or plywood. The purpose of the cover is to minimize evaporation, minimize temperature changes, and inhibit the growth of algae.

8.6.2 Provide a means in the cover that makes it convenient to access the front of the inner ring to connect and disconnect the measurement bag.

8.7 *Maintaining the Water Level*:

8.7.1 Place a mark indicating the water elevation on the inside wall of the outer ring near the cinder blocks.

8.7.2 Observe the water level within the outer ring during the test and refill the ring to this mark before the water level drops more than 25 mm (1 in.) below the mark. Record the date, time, and the amount of water added.

8.8 *Purging the Inner Ring*—During the test, air may accumulate beneath the inner ring. This air may introduce error in flow measurements and consequently should be purged on a regular basis as follows.

8.8.1 Disconnect bag, if one is present, from end of inlet tube.

8.8.2 Lift the plugged end of the flush tube out of outer ring and below the water level in the outer ring so that water can be siphoned out of inner ring.

8.8.3 Remove plug from end of flush tube. Water and air if present will start to flow out of inner ring. If air completely fills the tube, the syphon will be lost. If this happens, saturate the tube and restart the siphon.

8.8.4 Allow water to flow from end of tube until air ceases to emerge from inner ring. Replace plug in end of flush tube and place tube back into outer ring. Note the approximate volume of purged air. Volume can be determined by multiplying the flow area of the flush tube by the height of the air bubbles which flow out of the tube.

8.8.5 Wait at least 30 min before taking any flow measurements.

8.8.6 Purge the inner ring on a weekly basis until no significant amount of air is found.

8.9 *Measurements*:

8.9.1 Attach the shut-off valve to the flexible bag and fill the bag with water. Remove all air bubbles from the bag. Use water that has been degassed or allow the bag to sit overnight so that the water can degas. If left to sit overnight, remove any air bubbles. Do not overfill the bag so that the water inside is under pressure.

8.9.2 Dry the outside of the bag and record its weight to the nearest gram.

8.9.3 With the shut-off valve closed, attach the bag to the open end of the inlet tube connected to the inner ring. Be sure not to trap any air bubbles in the inlet tubing or in the valve when attaching the bag. Lay the bag down on the cinder block platform.

8.9.4 Record the time, date, temperature of the water in the outer ring, and the depth of the water in the outer ring, and then carefully open the shut-off valve on the bag. Check that the inlet tube is not pinched and that the bag is arranged in such a manner that water can flow freely from it into the inner ring.

8.9.5 Sometime before the bag empties, close the shut-off valve, disconnect the bag from the inlet tube, and record the date, time, temperature of the water in the outer ring and the depth of the water in the outer ring. Be sure to prop the open end of the inlet hose as pointed out in 8.5.6. Do not leave the bag on long enough to empty as this will create a suction in the inner ring and cause leaks in the grout seal.

8.9.6 Dry the bag and record the weight of it to the nearest gram.

8.9.7 Refill the bag and repeat 8.9.2-8.9.6 until the infiltration rate (see Section 9) becomes steady or drops below a predetermined value.

NOTE 3—The reading times are governed primarily by the length of time the bag can remain connected to the inner ring without emptying. This length of time can only be determined through experience. Initially, flow rates will be high and the bag may need to be disconnected after several hours. As the test progresses, the flow rate will slow and the length of time it takes the bag to empty may increase to several days or weeks.

A second important factor that governs when readings should be made is the temperature of the water. In order to minimize the effects of temperature changes on the measured flow rate, the bag should be disconnected from the inner ring when the water is at the same temperature (within ±2°C) as when the bag was connected. More consistent readings are usually obtained if readings are made between 7 am and 9 am.

NOTE 4—It is not necessary to have the bag connected to the inner ring continuously. Flow only needs to be measured over timed intervals so that a plot of infiltration rate versus time can be constructed. The infiltration rate is not influenced by whether or not the bag is connected to the inlet tube. If the flow rate is high, it is more convenient to connect the bag to the inner ring for several hours a day and leave the inlet tube open in the outer ring for the remainder of the time.

NOTE 5—When connecting or disconnecting the bag from the inner ring, do not raise the bag above the level of the water in the outer ring with the shut-off valve open. This would cause an uplift force to act on the inner ring and could cause it to rise out of the trench.

8.10 *Ending Test*:

8.10.1 Remove the fittings and tubing from the inner ring.

8.10.2 Drain water from rings.

8.10.3 Excavate the grout from around the rings and pull the rings out of the ground.

8.10.4 Excavate a narrow trench in the area encompassed by the inner ring and take moisture content samples every 25 mm (1 in.) to a depth of 150 mm (6 in.) below the observed wetting front. An alternative to this is to push a thin-walled sampling tube into the soil, extrude the soil, and slice it every 25 mm (1 in.) for moisture content samples.

9. Calculation

9.1 Calculate the infiltration rate for each timed interval as follows:

$$I\ (\mathrm{m/s}) = \frac{Q}{tA} \times 10^{-6} \quad (1)$$

where:

Q = volume of flow, mL,
= $W_1 - W_2$
W_1 = initial weight of bag, g,
W_2 = final weight of bag, g,

t = time of flow, s = $t_2 - t_1$,
t_1 = time shut-off valve on bag was opened,
t_2 = time shut-off valve was closed, and
A = area of inner ring, m^2.

9.2 Calculate the amount of flow which resulted from any temperature fluctuations for each timed interval (see Note 6). If the flow due to temperature fluctuations is greater than 20 % of the total flow measured, then correct the flow used to calculate the infiltration rate by this amount.

NOTE 6—Expansion and contraction of the inner ring due to temperature changes will cause water to flow into or out of the measurement bag. The inner ring should be calibrated to determine if the flow resulting from temperature change is significant compared to flow due to infiltration. Calibration can be performed by sealing the inner ring to the bottom of a small plastic pool. Fill the pool and ring with water and allow the temperature to reach equilibrium. Connect a measurement bag to the inner ring and add ice to the pool water to lower the temperature several degrees. Allow the temperature to reach equilibrium and remove the bag. Determine the weight loss/gain and convert it to a volume of water. Divide this volume of water by the change in temperature to obtain a calibration factor for temperature changes.

9.3 Note the volume of air expelled from the weekly purging of the inner ring. Compare this volume of air with the volume of infiltration that occurred during the time the air collected in the inner ring. If this volume is significant, (that is, 20 % of that used to determine infiltration in 9.1,) then adjust the infiltration rates in 9.1 to account for it.

Page _of __

DATA FORM FOR SDRI TEST

Project: __________
Inner ring info: __________
Outer ring info: __________
Liner thickness (m): __________

$I = \frac{Q}{A\,t} \times 10^{-6}$

I = infiltration (m/sec)
Q = quantity of flow (mL)
t = interval of time (sec)
A = area of inner ring (m2) ______

Date (on / off)	Initial Time (sec)	Final Time (sec)	t Interval of Time (sec)	Initial Wt. of Bag (grams)	Final Wt. of Bag (grams)	Q Quan. of Flow (mL)	I Infiltration (m/sec)	Temp (C) (on / off)	Water Depth (m) (on / off)

NOTES:

FIG. 4 Data Sheet For Infiltration Test Using A Double-Ring Infiltrometer With A Sealed Inner Ring

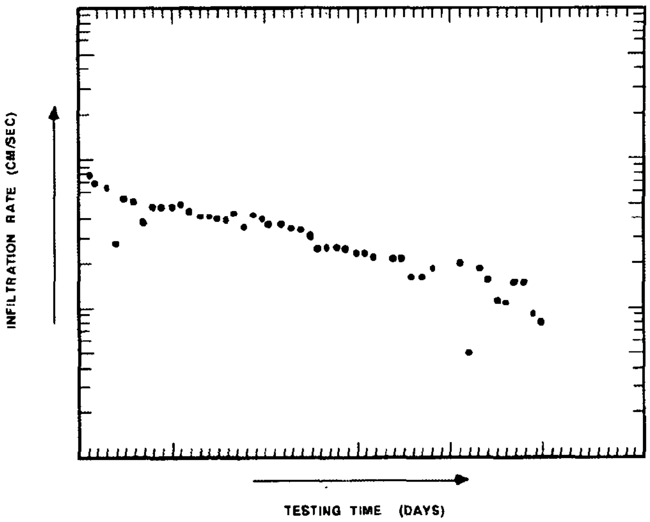


FIG. 5 Infiltration Rate Versus Time On A Semi-log Plot

10. Report

10.1 Report the following information:

10.1.1 A data sheet such as the one shown in Fig. 4,

10.1.2 A semi-log plot of infiltration versus time such as that shown in Fig. 5,

10.2 Additional optional information that can be presented in the report includes the following,

10.2.1 Thickness of layer tested,

10.2.2 A description of material beneath the layer tested,

10.2.3 Total and dry density of the layer tested,

10.2.4 Initial moisture content of the layer tested,

10.2.5 Initial degree of saturation,

10.2.6 Moisture contents of samples taken after termination of test,

10.2.7 Estimate of the depth to the saturation front.

11. Precision and Bias

11.1 *Precision*—Due to the nature of the soil or rock materials tested by this test method, it is either not feasible or too costly at this time to produce multiple specimens which have uniform physical properties. Any variation observed in the data is just as likely to be due to specimen variation as to operator or laboratory testing variation. Subcommittee D18.04 welcomes proposals that would allow for development of a valid precision statement.

11.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

12. Keywords

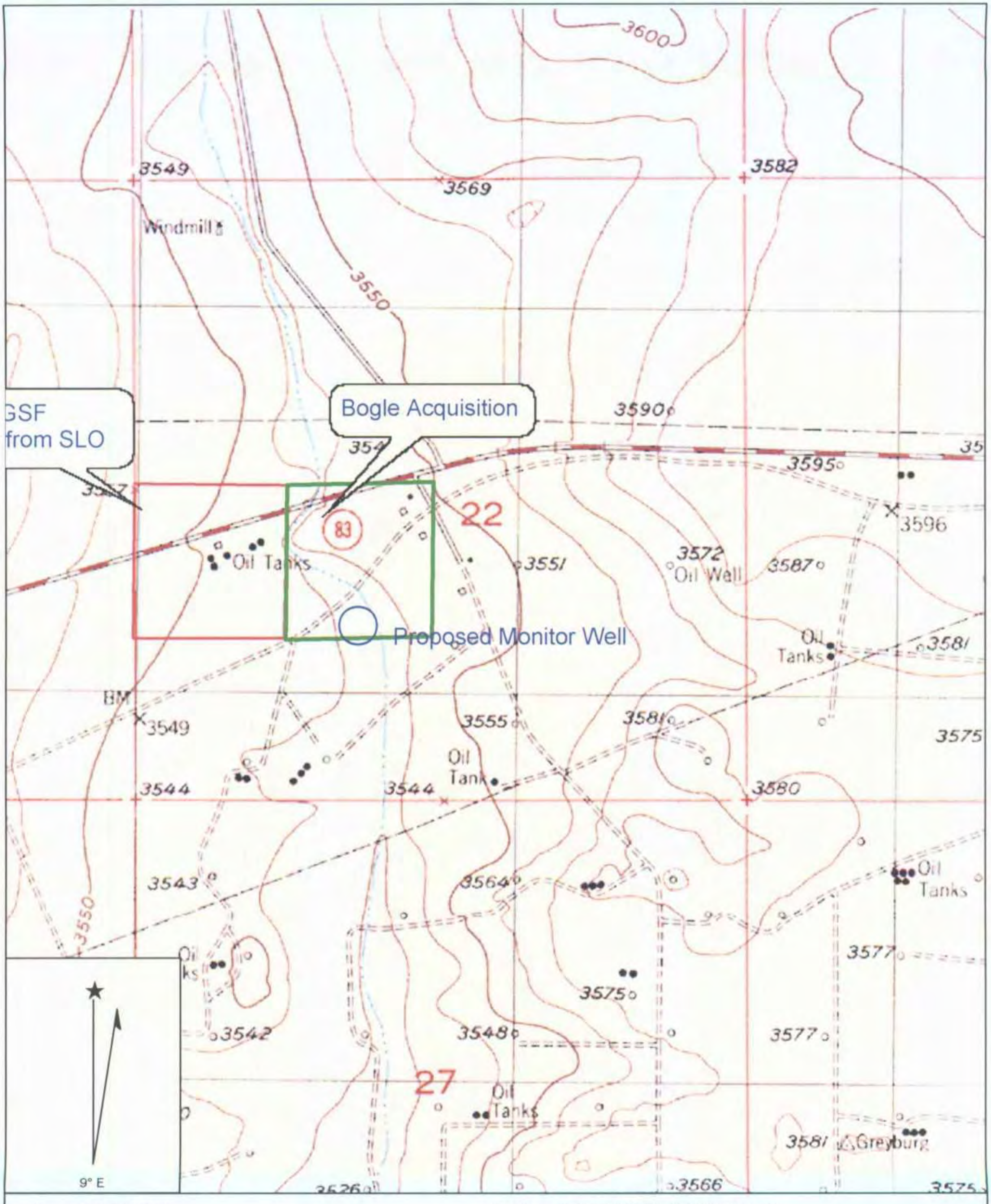
12.1 double ring infiltration; in-place infiltration; soil moisture infiltrometer

TABLES

PLATES

APPENDICES

BMP PLATE 1



Name: RED LAKE SE
Date: 5/11/2004
Scale: 1 inch equals 1000 feet

Location: 032.8174199° N 104.0605926° W
Caption: Plate 1: Parcel Map

BMP APPENDIX C

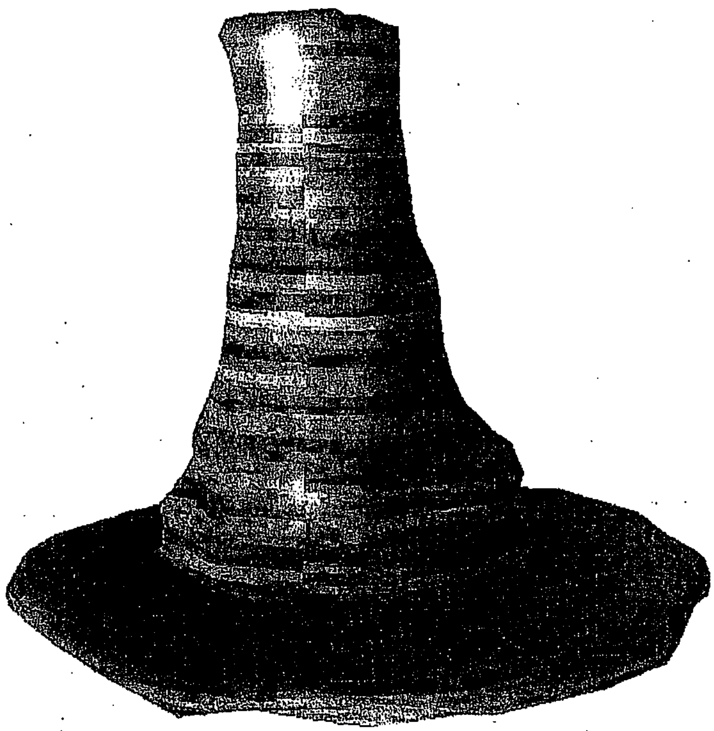
SONAR REPORT

ECHO - LOG

Propane Well #1

1st. Survey

04/21/2003 033020



SOCON Cavity Control, Inc.
4070 Washington Blvd. Texas 77705, USA
Phone (409) 840-5554+5557 Fax (409) 840-4424
e-mail: lawrence@socon.com

Summary of results

Well details

All depths are given as:	**MD**
Datum level for all depths:	**surface**
Shoe of the cemented 13 3/8"-casing:	525.0 ft
Shoe of the - casing during the surveying:	525.0 ft
Reference depth for ECHO-LOG:	**525.0 ft**
Depth correction:	+12.0 ft

Details of survey equipment

Measuring vehicle used:	L 110
Tools used:	Echo tool BSE 17, BSE 17 Fibre-gyro-compass

General details

Number of runs:	1
Measured horizontal sections:	19
Measured tilted sections:	20
Lowest survey depth:	643.0 ft

Maximum and minimum dimensions with ref. to the measuring axis

Reference direction: **magnetic north**

Determination out of 36 vertical sections derived from horizontally and tilted measured data at 5 degree intervals:

minimum radius:	0.0 ft
depth:	650.1 ft
direction:	0°
maximum radius:	77.9 ft
depth:	630.0 ft
direction:	60°
highest point of cavern:	522.2 ft
horizontal distance:	8.1 ft
direction:	345°
lowest point of cavern:	651.4 ft
horizontal distance:	5.4 ft
direction:	75°
lowest point in the measuring axis:	650.2 ft

Determination out of 37 horizontal sections in the depths between 192.3 m and 259 m at 5/15 degree intervals:

maximum radius:	77.9 ft
depth:	630.0 ft
direction:	60°
maximum diameter:	138.2 ft
depth:	625.0 ft
direction:	85 - 265°

Volume

volume:	65,456 bbls.
depth range:	525.0 ft <--> 650.0 ft

Interpretation

Supposing a rectilinear propagation of ultrasonic waves all recorded echo travel times were converted into distances by using the subsequent speeds of sound:

1798.0 m/s (5899.0 ft/s) to 1798.0 m/s (5899.0 ft/s) in brine (measured)

In the case of recording several echoes along one trace of echo signals, the representative echo signal was selected according to the level of amplitude, transmission time, density of measured points and the shape of the cavern.

Horizontal sections

19 horizontal sections at following measured depths are included as graphical plots in this report:

525.0 ft	530.0 ft	540.0 ft	550.0 ft	560.0 ft	570.0 ft	580.0 ft
590.0 ft	595.0 ft	600.0 ft	605.0 ft	610.0 ft	615.0 ft	620.0 ft
625.0 ft	630.0 ft	635.0 ft	640.0 ft	643.0 ft		

The following 4 sections are constructed:

644.0 ft	646.0 ft	648.0 ft	650.0 ft

Tilted sections

20 sections recorded with tilted echo-transducer at following measured depths are presented in the vertical sections:

12 sections of these with upwards-tilted echo-transducer:

Depth / Tilting Angle

540.0 / 54	540.0 / 60	540.0 / 66	540.0 / 72	540.0 / 78	540.0 / 84
640.0 / 9	640.0 / 12	640.0 / 15	640.0 / 17	640.0 / 21	640.0 / 24

8 sections of these with downwards-tilted echo-transducer:

Depth / Tilting Angle

600.0 / 6	600.0 / 12	600.0 / 18	600.0 / 24	600.0 / 30	600.0 / 36
600.0 / 42	600.0 / 48				

Vertical sections

The shape of the cavern was determined by interpretation of all horizontally and tilted measured data and is presented by 36 vertical sections in this report.

Maximum plots (top view)

The maximum plot presents the largest extension of the cavern in a top view. The first picture shows the areas of all horizontal sections and the area resulting out of the vertical sections (hatched). The resulting total area is shown in the second picture (cross hatching) together with the largest single area.

In both pictures the total centre of gravity of the cavern is shown with its distance and its direction referring to the measuring axis.
The total centre of gravity is derived out of the envelope, which is the connection line of the largest cavern extension in every direction

Perspective views

Several perspective drawings are included in this report to give a quick review of detailed relations.

Pockets in the cavern wall

Pockets in the cavern wall, which have been identified by the tilted echo-transducer, were transferred from the vertical sections to the respective horizontal sections.
The resulting additional areas have been added to the calculated areas.

LOG - Data

You will find the graphic representations of the following LOG data at the end of this report:

Parameter	from	to
CCL:	589'	498'
Temperature:	500'	640'
Pressure:	500'	640'
Speed of sound:	500'	640'

Volume list

Depth (ft)	Radius (ft)	Area (ft²)	Depth range (ft) from	to	Volume (bbls.) partial	total
525.0	16.1	813	525.0	527.5	362	362
530.0	15.3	733	527.5	535.0	979	1340
540.0	14.2	630	535.0	545.0	1122	2462
550.0	15.6	767	545.0	555.0	1366	3828
560.0	16.6	865	555.0	565.0	1540	5368
570.0	20.1	1269	565.0	575.0	2260	7628
580.0	20.7	1343	575.0	585.0	2392	10021
590.0	23.7	1765	585.0	592.5	2357	12378
595.0	26.0	2125	592.5	597.5	1892	14270
600.0	30.4	2906	597.5	602.5	2588	16858
605.0	31.0	3023	602.5	607.5	2692	19549
610.0	29.7	2778	607.5	612.5	2474	22023
615.0	36.3	4147	612.5	617.5	3693	25717
620.0	41.7	5451	617.5	622.5	4854	30571
625.0	68.0	14511	622.5	627.5	12922	43493
630.0	61.9	12028	627.5	632.5	10711	54204
635.0	51.1	8196	632.5	637.5	7299	61502
640.0	35.1	3868	637.5	641.5	2756	64258
643.0	24.8	1929	641.5	643.5	687	64945
644.0	18.4	1060	643.5	645.0	283	65228
646.0	11.4	409	645.0	647.0	146	65374
648.0	7.8	190	647.0	649.0	68	65442
650.0	5.0	78	649.0	650.0	14	65456

BMP APPENDIX D

ASTM STANDARD

Designation: D 5093 – 02

Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring[1]

This standard is issued under the fixed designation D 5093; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope *

1.1 This test method describes a procedure for measuring the infiltration rate of water through in-place soils using a double-ring infiltrometer with a sealed inner ring.

1.2 This test method is useful for soils with infiltration rates in the range of 1×10^{-7} m/s to 1×10^{-10} m/s. When infiltration rates $\geq 1 \times 10^{-7}$ m/s are to be measured Test Method D 3385 shall be used.

1.3 All observed and calculated values shall conform to the guide for significant digits and rounding established in Practice D 6026.

1.3.1 The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

1.4 This test method provides a direct measurement of infiltration rate, not hydraulic conductivity. Although the units of infiltration rate and hydraulic conductivity are similar, there is a distinct difference between these two quantities. They cannot be directly related unless the hydraulic boundary conditions, such as hydraulic gradient and the extent of lateral flow of water are known or can be reliably estimated.

1.5 This test method can be used for natural soil deposits, recompacted soil layers, and amended soils such as soil bentonite and soil lime mixtures.

1.6 The values stated in SI units are to be regarded as standard. The values in parentheses are for information only.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 3385 Test Method for Infiltration Rate of Soils in Field Using Double Ring Infiltrometers[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock Used in Engineering Design and Construction[2]

D 6026 Practice for Using Significant Digits in Geotechnical Data[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *infiltration*—downward entry of liquid into a porous body.

3.1.2 *infiltration rate, I*—quantity of liquid entering a porous material (m^3) per unit area (m^2) per unit time (s), expressed in units of m/s.

3.1.3 *infiltrometer*—a device used to pond liquid on a porous body and to allow for the measurement of the rate at which liquid enters the porous body.

3.1.4 For definitions of other terms used in this test method, see Terminology D 653.

4. Summary of Test Method

4.1 The infiltration rate of water through soil is measured using a double-ring infiltrometer with a sealed or covered inner ring (Fig. 1). The infiltrometer consists of an open outer and a sealed inner ring. The rings are embedded and sealed in trenches excavated in the soil. Both rings are filled with water such that the inner ring is submerged.

4.2 The rate of flow is measured by connecting a flexible bag filled with a known weight of water to a port on the inner ring. As water infiltrates into the ground from the inner ring, an equal amount of water flows into the inner ring from the flexible bag. After a known interval of time, the flexible bag is removed and weighed. The weight loss, converted to a volume, is equal to the amount of water that has infiltrated into the ground. An infiltration rate is then determined from this volume of water, the area of the inner ring, and the interval of

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.04 on Hydrologic Properties of Soil and Rocks.

Current edition approved July 10, 2002. Published September 2002. Originally published as D5093–90. Last previous edition D5093–90(1997).

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

*A Summary of Changes section appears at the end of this standard.

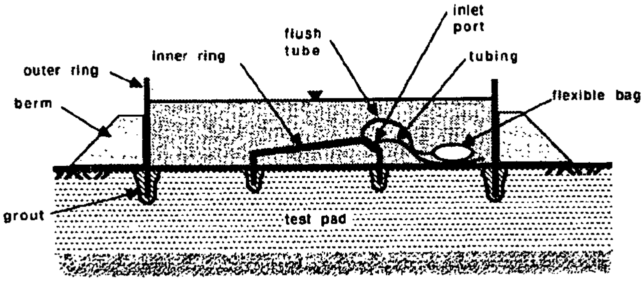


FIG. 1 Schematic Of A Double-Ring Infiltrometer With A Sealed Inner Ring

time. This process is repeated and a plot of infiltration rate versus time is constructed. The test is continued until the infiltration rate becomes steady or until it becomes equal to or less than a specified value.

5. Significance and Use

5.1 This test method provides a means to measure low infiltration rates associated with fine-grained, clayey soils, and are in the range of 1×10^{-7} m/s to 1×10^{-9} m/s.

5.2 This test method is particularly useful for measuring liquid flow through soil moisture barriers such as compacted clay liner or covers used at waste disposal facilities, for canal and reservoir liners, for seepage blankets, and for amended soil liners such as those used for retention ponds or storage tanks.

5.3 The purpose of the sealed inner ring is to: (*1*) provide a means to measure the actual amount of flow rather than a drop in water elevation which is the flow measurement procedure used in Test Method D 3385 and (*2*) to eliminate evaporation losses.

5.4 The purpose of the outer ring is to promote one-dimensional, vertical flow beneath the inner ring. The use of large diameter rings and large depths of embedments helps to ensure that flow is essentially one-dimensional.

5.5 This test method provides a means to measure infiltration rate over a relatively large area of soil. Tests on large volumes of soil can be more representative than tests on small volumes of soil.

5.6 The data obtained from this test method are most useful when the soil layer being tested has a uniform distribution of pore space, and when the density and degree of saturation and the hydraulic conductivity of the material underlying the soil layer are known.

5.7 Changes in water temperature can introduce significant error in the volume change measurements. Temperature changes will cause water to flow in or out of the inner ring due to expansion or contraction of the inner ring and the water contained within the inner ring.

5.8 The problem of temperature changes can be minimized by insulating the rings, by allowing enough flow to occur so that the amount of flow resulting from a temperature change is not significant compared to that due to infiltration, or by connecting and disconnecting the bag from the inner ring when the water in the inner ring is at the same temperature.

5.9 If the soil being tested will later be subjected to increased overburden stress, then the infiltration rate can be expected to decrease as the overburden stress increases. Laboratory hydraulic conductivity tests are recommended for studies of the influence of level of stress on the hydraulic properties of the soil.

NOTE 1—The quality of the result produced by this standard depends on the competence of the personnel performing it and the suitability of the equipment and facilities being used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this standard are cautioned that compliance with Practice D 3740 does not in itself ensure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors

6. Apparatus

6.1 *Infiltrometer Rings*—The rings shall be constructed of a stiff, corrosion-resistant material such as metal, plastic, or fiberglass. The shape of the rings can be circular or square. However, square rings are recommended because it is easier to excavate straight trenches in the soil. The rings can be of any size provided: (*1*) the minimum width or diameter of the inner ring is 610 mm (24 in.); and (*2*) a minimum distance of 610 mm is maintained between the inner and outer ring. The following is a description of a set of rings that can be constructed from commonly available materials, incorporates the requirements described above, and has worked well in the field.

6.1.1 *Outer Ring*—A square ring (Fig. 2) comprised of four sheets of aluminum approximately 3.6 m by 910 mm by 2 mm (12 ft by 36 in. by 0.080 in.) The top edge of the aluminum sheet is bent 90° in order to provide rigidity. A hole is provided in the center of the top edge. One edge of each sheet is bent 90°. Holes are drilled along each side edge so that the sheets can be bolted at the corners. A flat rubber gasket provides a seal at each corner. A wire cable approximately 15 m long with a clamp may be needed to tie the top edges together.

6.1.2 *Inner Ring*—A square ring (Fig. 3), 1.52 m (5 ft) on a side, made of fiberglass provided with two ports. The top is shaped in such a way as to vent air from the ring as it is filled. A port is provided at the highest point so that any air that accumulates in the ring during the test can be flushed out. One port must be located at the top of the ring. The other port must be located beneath the top port. A150 mm (6 in.) skirt, that is embedded into the soil, is provided along the edge of the ring. Barbed fittings that accept flexible tubing are attached to the ports. Handles are provided at each corner of the inner ring.

6.2 *Flexible Bag*—Two clear flexible bags with a capacity of 1000 to 3000 mL. Intravenous bags available from medical

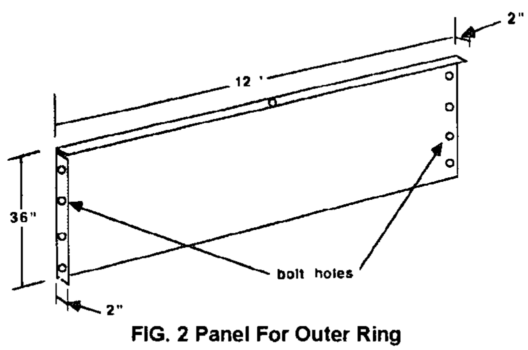


FIG. 2 Panel For Outer Ring

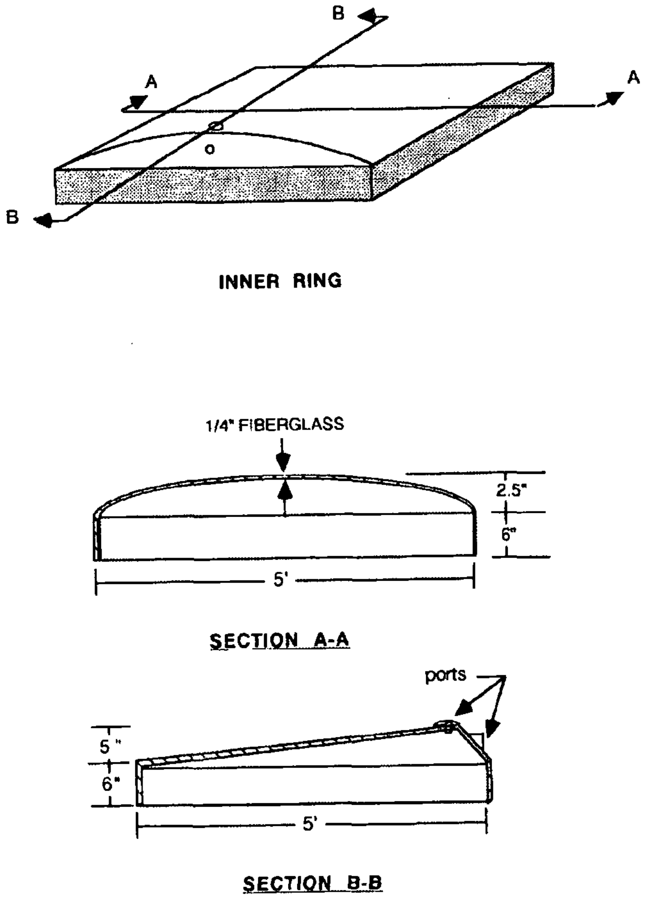


FIG. 3 Inner Ring

supply stores work well. A means for attaching a shut-off valve to the bag shall be provided. The shut-off valve shall be provided with a barbed fitting that will connect to the inlet tube on the inner ring.

6.3 *Tubing*—Clear, flexible tubing approximately 4.5 m (15 ft) long with a minimum ID of 6 mm (¼ in.)

6.4 *Scissors or Knife.*

6.5 *Excavation Tools.*

6.5.1 *Mason's Hammer*—Hammer with a blade approximately 120 mm long and 40 mm wide.

6.5.2 *Trenching Machine*—Capable of excavating a trench with a maximum width of 150 mm (6 in.) and a depth of 460 mm (18 in.)

6.5.3 *Chain Saw*—(Optional—see Note 2) Equipped with a carbide-tipped chain and bar.

6.5.4 *Hand Shovel*, garden type.

6.6 *Levels*—A surveyor's level and rod and a carpenter's level.

6.7 *Buckets*—Five buckets with a capacity of approximately 20 L (5 gal.)

6.8 *Blocks*—Cinder blocks to serve as a platform for the flexible bag.

6.9 *Cover*—An opaque cover to place on top of the outer ring. The cover can be a tarp or plywood supported by wooden beams.

6.10 *Grout*—A bentonite grout for filling the trenches and sealing the rings in place.

6.11 *Mixing Equipment*—A large (four bag) grout mixer for mixing the bentonite grout.

6.12 *Trowel.*

6.13 *Thermometer*—Readable to 0.5°C with a range of 0 to 50°C.

6.14 *Scale*—Capacity of 4000 g and an accuracy of 1 g.

6.15 *Watch*—Readable to 1 s.

6.16 *Water Supply*—Preferably water of the same quality as that involved in the problem being examined. Approximately 5600 L (1400 gal) are needed for this test.

6.17 *Splash Guard*—Plywood, rubber sheet, or burlap 600 by 600 mm (2 by 2 ft).

7. Test Site

7.1 The test requires an area of approximately 7.3 by 7.3 m (24 by 24 ft).

7.2 The slope to the test area should be no greater than approximately 3 %.

7.3 The test may be set up in a pit if infiltration rates are desired at depth rather than at the surface.

7.4 The test area shall be covered with a sheet of plastic to keep the surface from drying.

7.5 Representative samples of the soil to be tested shall be taken before and after the test to determine its moisture content, density, and specific gravity. The thickness of the layer being tested shall be determined as well as the approximate hydraulic conductivity of the layer beneath it.

8. Procedure

8.1 *Assembly of Outer Ring*—Wipe off gaskets and side edges of the outer ring. Align gasket between the edges and bolt edges together.

8.2 *Excavation of Trenches*:

8.2.1 Place both rings on the area to be tested. Center the inner ring within the outer ring. Make sure that the outer ring is square by using the tape measure to check that the length of the diagonals are equal.

8.2.2 If plastic is covering the test area, cut out thin strips along the edge of each ring so that the trenches can be excavated. Leave as much of the plastic on as possible in order to keep the soil from drying.

8.2.3 Use the bottom edge of each ring to scribe a line on the ground to use as a guide for excavating the trenches.

8.2.4 Note the orientation of the rings and set them aside.

8.2.5 Use the surveyor's level and check the ground elevation where the corners of each ring will be. Note the high spots and excavate deeper in these areas so that the rings will be level.

8.2.6 Use the trenching machine and excavate a trench for the outer ring. The trench should be about 146 mm (18 in.) deep. Excavate deeper at high spots.

8.2.7 Use a small hand shovel to remove any loose material in the trenches.

8.2.8 Place the outer ring in the trench and use the carpenter's level to check that the top of the ring is reasonably level (±30 mm). Also check that the outer ring is square. Remove the ring and excavate any areas keeping the ring from being level and square.

8.2.9 Set the outer ring aside and cover the trenches to prevent the soil from drying.

8.2.10 Use the mason's hammer and excavate a trench 50 by 110 mm (2 by 4.5 in.) for the inner ring. Excavate deeper in high spots so that the inner ring will sit level in the trench. Excavate the trench carefully so that the surrounding soil is disturbed as little as possible. When using the mason's hammer, it is best to start by digging down several inches in one spot and then advancing the trench forward by chopping down on the soil. Do not pry the soil up as this tends to lift up large wedges of soil, opens cracks, and causes the trench to be oversized.

8.2.11 Place the inner ring in the trench to check the fit. Excavate any areas where the ring does not fit. Use a surveyor's level to check the elevation of the corners of the ring. The inner ring needs to be level or slightly tilted so that the back end is slightly lower than the front end.

8.2.12 Set the ring aside and cover the trenches.

NOTE 2—A chain saw that is equipped with a carbide-tipped chain and a bar may be used to excavate the trenches. Use of a chain saw will not only reduce the time needed to excavate the trench but will also greatly decrease the amount of grout needed to fill the trenches. If a chain saw is used, the trenches need only be 25 mm (1 in.) wide. A chain saw will not work well in some soils. A trial trench should be made to determine if it will work.

8.3 *Installation of Rings*:

8.3.1 Use the grout mixer to prepare enough grout to fill the trenches. The hydraulic conductivity of the grout should be less than approximately 1×10^{-8} m/s.

8.3.2 Fill the trenches to within 2.5 mm (1 in.) of the top of the trench. Rod or tamp the grout to remove any entrapped air.

8.3.3 Lift the inner ring and center it over the inner ring trench. Lower it into the trench and slowly push it down. Keep the ring level as it is pushed into place.

8.3.4 Use a surveyor's level to check that the ring is level.

8.3.5 Use a trowel to press the grout against the outside wall of the ring in order to ensure a good seal.

8.3.6 Cover the grout with plastic to prevent desiccation.

8.3.7 Lift the outer ring and center it over the outer ring trench.

8.3.8 Keep the ring level and push it into place.

8.3.9 Use the carpenter's level to make sure that the ring is level.

8.3.10 Use a trowel to push the grout against both the inside and the outside of the ring to ensure a good seal.

8.3.11 Cover the grout with plastic to prevent desiccation.

8.3.12 Place several cinder blocks between the inner and outer rings in the vicinity of the ports on the inner ring. These blocks will be used as a platform to stand on when connecting the fittings to the inner ring and also to support the flexible bags. The blocks should be no higher than 100 mm (4 in.)

8.3.13 Pile soil along the outside of the outer ring to a height of at least 30 cm (12 in.) This soil places an overburden pressure on the grout that will prevent it from being pushed out of the trench when the rings are filled with water.

8.4 *Filling the Rings*:

8.4.1 Fill two buckets with water and place one on each back corner of the inner ring. The buckets are placed on the inner ring to counteract the uplift force that acts on the ring as it is being filled. Make sure that the buckets are placed on the edge of the ring, not in the center as this may overstress the ring and cause it to crack. Do not to spill any water around the inner ring as this will make it difficult to check for leaks in the seal.

8.4.2 Place an empty bucket upside down on the ground near the top port on the inner ring. Place a second bucket on the first bucket. Fill the second bucket with water. Cut a length of the flexible tubing long enough to reach from the top bucket to the top port on the inner ring. Siphon the water from the bucket to the inner ring. Allow the siphoning to continue until the depth of the water in the inner ring is approximately 25 mm (1 in.). Avoid spilling any water around the inner ring during this filling process as this will make it difficult to check for leaks. Any other suitable method for adding the required volume of water to the inner ring may also be used.

8.4.3 Let the water stand in the inner ring for at least 30 min. Check for leaks in the inner ring seal and repair any that are found.

8.4.4 Start filling the outer ring slowly so as not to scour the soil and muddy the water. Direct the water so that it hits a splashboard first. Fill the outer ring until the water level is approximately 100 mm (4 in.) above the top of the inner ring. While the rings are being filled, use a board or shovel handle to gently tap the inner ring to dislodge air bubbles that are trapped inside. Continue tapping on the inner ring until bubbles cease to emerge from the top port.

8.4.5 Remove the buckets from the top of the inner ring.

8.5 *Installation of Fittings and Tubing*:

8.5.1 Wrap the threads of the two barbed fittings with TFE-fluorocarbon tape.

8.5.2 Saturate the fittings and connect them to the inner ring. Screw one of the barbed fittings into the top port and the other barbed fitting into one of the lower ports. Use caution when screwing the fittings into the ports as the threads in fiberglass inner rings can be easily damaged.

8.5.3 Cut two lengths of the clear flexible tubing, one 900-mm (3-ft) piece and one 1800-mm (6-ft) piece.

8.5.4 Saturate the tubing by placing it under water. Be sure to remove all air bubbles.

8.5.5 Connect one end of the 1.8-m (6-ft) piece to the fitting in the top port and seal the other end with a plug fitting. Do not let air into the tube during this process. This tube is the flush tube.

8.5.6 Connect the end of the 900-mm (3-ft) piece to the barbed fitting in the lower port. Prop the open end of this tube on the cinder block platform. Water is being drawn into this tube so be sure not to allow the open end of the tube to float to the surface and draw in air or sink to the bottom and draw in mud. This tube is the inlet tube.

8.6 *Covering the Rings*:

8.6.1 Cover the rings with either a tarp or plywood. The purpose of the cover is to minimize evaporation, minimize temperature changes, and inhibit the growth of algae.

8.6.2 Provide a means in the cover that makes it convenient to access the front of the inner ring to connect and disconnect the measurement bag.

8.7 *Maintaining the Water Level*:

8.7.1 Place a mark indicating the water elevation on the inside wall of the outer ring near the cinder blocks.

8.7.2 Observe the water level within the outer ring during the test and refill the ring to this mark before the water level drops more than 25 mm (1 in.) below the mark. Record the date, time, and the amount of water added.

8.8 *Purging the Inner Ring*—During the test, air may accumulate beneath the inner ring. This air may introduce error in flow measurements and consequently should be purged on a regular basis as follows.

8.8.1 Disconnect bag, if one is present, from end of inlet tube.

8.8.2 Lift the plugged end of the flush tube out of outer ring and below the water level in the outer ring so that water can be siphoned out of inner ring.

8.8.3 Remove plug from end of flush tube. Water and air if present will start to flow out of inner ring. If air completely fills the tube, the syphon will be lost. If this happens, saturate the tube and restart the siphon.

8.8.4 Allow water to flow from end of tube until air ceases to emerge from inner ring. Replace plug in end of flush tube and place tube back into outer ring. Note the approximate volume of purged air. Volume can be determined by multiplying the flow area of the flush tube by the height of the air bubbles which flow out of the tube.

8.8.5 Wait at least 30 min before taking any flow measurements.

8.8.6 Purge the inner ring on a weekly basis until no significant amount of air is found.

8.9 *Measurements*:

8.9.1 Attach the shut-off valve to the flexible bag and fill the bag with water. Remove all air bubbles from the bag. Use water that has been degassed or allow the bag to sit overnight so that the water can degas. If left to sit overnight, remove any air bubbles. Do not overfill the bag so that the water inside is under pressure.

8.9.2 Dry the outside of the bag and record its weight to the nearest gram.

8.9.3 With the shut-off valve closed, attach the bag to the open end of the inlet tube connected to the inner ring. Be sure not to trap any air bubbles in the inlet tubing or in the valve when attaching the bag. Lay the bag down on the cinder block platform.

8.9.4 Record the time, date, temperature of the water in the outer ring, and the depth of the water in the outer ring, and then carefully open the shut-off valve on the bag. Check that the inlet tube is not pinched and that the bag is arranged in such a manner that water can flow freely from it into the inner ring.

8.9.5 Sometime before the bag empties, close the shut-off valve, disconnect the bag from the inlet tube, and record the date, time, temperature of the water in the outer ring and the depth of the water in the outer ring. Be sure to prop the open end of the inlet hose as pointed out in 8.5.6. Do not leave the bag on long enough to empty as this will create a suction in the inner ring and cause leaks in the grout seal.

8.9.6 Dry the bag and record the weight of it to the nearest gram.

8.9.7 Refill the bag and repeat 8.9.2-8.9.6 until the infiltration rate (see Section 9) becomes steady or drops below a predetermined value.

NOTE 3—The reading times are governed primarily by the length of time the bag can remain connected to the inner ring without emptying. This length of time can only be determined through experience. Initially, flow rates will be high and the bag may need to be disconnected after several hours. As the test progresses, the flow rate will slow and the length of time it takes the bag to empty may increase to several days or weeks.

A second important factor that governs when readings should be made is the temperature of the water. In order to minimize the effects of temperature changes on the measured flow rate, the bag should be disconnected from the inner ring when the water is at the same temperature (within ±2°C) as when the bag was connected. More consistent readings are usually obtained if readings are made between 7 am and 9 am.

NOTE 4—It is not necessary to have the bag connected to the inner ring continuously. Flow only needs to be measured over timed intervals so that a plot of infiltration rate versus time can be constructed. The infiltration rate is not influenced by whether or not the bag is connected to the inlet tube. If the flow rate is high, it is more convenient to connect the bag to the inner ring for several hours a day and leave the inlet tube open in the outer ring for the remainder of the time.

NOTE 5—When connecting or disconnecting the bag from the inner ring, do not raise the bag above the level of the water in the outer ring with the shut-off valve open. This would cause an uplift force to act on the inner ring and could cause it to rise out of the trench.

8.10 *Ending Test*:

8.10.1 Remove the fittings and tubing from the inner ring.

8.10.2 Drain water from rings.

8.10.3 Excavate the grout from around the rings and pull the rings out of the ground.

8.10.4 Excavate a narrow trench in the area encompassed by the inner ring and take moisture content samples every 25 mm (1 in.) to a depth of 150 mm (6 in.) below the observed wetting front. An alternative to this is to push a thin-walled sampling tube into the soil, extrude the soil, and slice it every 25 mm (1 in.) for moisture content samples.

9. Calculation

9.1 Calculate the infiltration rate for each timed interval as follows:

$$I\,(\mathrm{m/s}) = \frac{Q}{tA} \times 10^{-6} \quad (1)$$

where:

Q = volume of flow, mL,
 = $W_1 - W_2$
W_1 = initial weight of bag, g,
W_2 = final weight of bag, g,

t = time of flow, s = $t_2 - t_1$,
t_1 = time shut-off valve on bag was opened,
t_2 = time shut-off valve was closed, and
A = area of inner ring, m^2.

9.2 Calculate the amount of flow which resulted from any temperature fluctuations for each timed interval (see Note 6). If the flow due to temperature fluctuations is greater than 20 % of the total flow measured, then correct the flow used to calculate the infiltration rate by this amount.

NOTE 6—Expansion and contraction of the inner ring due to temperature changes will cause water to flow into or out of the measurement bag. The inner ring should be calibrated to determine if the flow resulting from temperature change is significant compared to flow due to infiltration. Calibration can be performed by sealing the inner ring to the bottom of a small plastic pool. Fill the pool and ring with water and allow the temperature to reach equilibrium. Connect a measurement bag to the inner ring and add ice to the pool water to lower the temperature several degrees. Allow the temperature to reach equilibrium and remove the bag. Determine the weight loss/gain and convert it to a volume of water. Divide this volume of water by the change in temperature to obtain a calibration factor for temperature changes.

9.3 Note the volume of air expelled from the weekly purging of the inner ring. Compare this volume of air with the volume of infiltration that occurred during the time the air collected in the inner ring. If this volume is significant, (that is, 20 % of that used to determine infiltration in 9.1,) then adjust the infiltration rates in 9.1 to account for it.

Page __ of __

DATA FORM FOR SDRI TEST

Project: ______
Inner ring info: ______
Outer ring info: ______
Liner thickness (m): ______

$I = \frac{Q}{A\,t} \times 10^{-6}$

I = infiltration (m/sec)
Q = quantity of flow (mL)
t = interval of time (sec)
A = area of inner ring (m2) ______

Date	Initial time (sec)	Final time (sec)	t Interval of Time (sec)	Initial Wt. of Bag (grams)	Final Wt. of Bag (grams)	Q Quan. of Flow (mL)	I Infiltration (m/sec)	Temp. (C)	Water Depth (m)

NOTES:

FIG. 4 Data Sheet For Infiltration Test Using A Double-Ring Infiltrometer With A Sealed Inner Ring

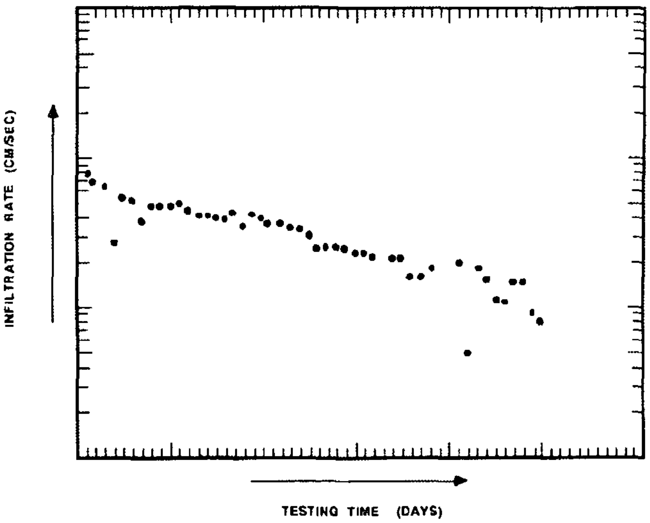


FIG. 5 Infiltration Rate Versus Time On A Semi-log Plot

10. Report

10.1 Report the following information:

10.1.1 A data sheet such as the one shown in Fig. 4,

10.1.2 A semi-log plot of infiltration versus time such as that shown in Fig. 5,

10.2 Additional optional information that can be presented in the report includes the following,

10.2.1 Thickness of layer tested,

10.2.2 A description of material beneath the layer tested,

10.2.3 Total and dry density of the layer tested,

10.2.4 Initial moisture content of the layer tested,

10.2.5 Initial degree of saturation,

10.2.6 Moisture contents of samples taken after termination of test,

10.2.7 Estimate of the depth to the saturation front.

11. Precision and Bias

11.1 *Precision*—Due to the nature of the soil or rock materials tested by this test method, it is either not feasible or too costly at this time to produce multiple specimens which have uniform physical properties. Any variation observed in the data is just as likely to be due to specimen variation as to operator or laboratory testing variation. Subcommittee D18.04 welcomes proposals that would allow for development of a valid precision statement.

11.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

12. Keywords

12.1 double ring infiltration; in-place infiltration; soil moisture infiltrometer

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the 1990(1997) edition.

(1) Requirement to follow Practice D 6026 added to Section 1.
(2) Standard note regarding quality of test results add to Section 5.
(3) Added Practices D 3740 and D 6026to Section 2.

BMP APPENDIX E

WIPP DOCUMENTS

TABLE L-1
HYDROLOGICAL PARAMETERS FOR ROCK UNITS ABOVE THE SALADO AT WIPP

Unit		Hydraulic Conductivity	Storage Coefficient	Transmissivity	Permeability	Thickness	Hydraulic Gradient
Santa Rosa		2×10^{8} to 2×10^{6} m/s (1) (2)	Specific capacity 0.029 to 0.041 /s/m	6×10^{7} to 6×10^{5} m^2/s (3)	10^{10} m^2	0 to 91 m	0.001 (5)
Dewey Lake		10^{8} m/s	Specific storage 1×10^{5} (1/m) (2)	2.8×10^{6} to 2.8×10^{4} m^2/s (4)	5.01×10^{17} m^2	152 m	0.001 (5)
Rustler	Forty-niner	1×10^{13} to 1×10^{11} m/s (anhydrite) 1×10^{9} m/s (mudstone) (2)	Specific storage 1×10^{5} (1/m) (2)	8×10^{8} to 8×10^{9} m^2/s	0 m^2	13 to 23 m	NA (6)
	Magenta	$1 \times 10^{8.5}$ to $1 \times 10^{6.5}$ m/s (2)	Specific storage 1×10^{5} (1/m) (2)	4×10^{4} to 1×10^{9} m^2/s	6.31×10^{14} m^2	7 to 8.5 m	3 to 6
	Tamarisk	1×10^{13} to 1×10^{11} m/s (anhydrite) 1×10^{9} m/s (mudstone) (2)	Specific storage 1×10^{5} (1/m) (2)	$<2.7 \times 10^{11}$ m^2/s	0 m^2	26 to 56 m	NA (6)
	Culebra	$1 \times 10^{7.5}$ to $1 \times 10^{5.5}$ m/s (2)	Specific storage 1×10^{5} (1/m) (2)	1×10^{3} to 1×10^{9} m^2/s	2.1×10^{14} m^2	4 to 11.6 m	0.003 to 0.007 (5)
	Unnamed lower member	6×10^{15} to 1×10^{13} m/s 1.5×10^{11} to 1.2×10^{11} m/s (basal interval)	Specific storage 1×10^{5} (1/m) (2)	2.9×10^{10} to 2.2×10^{13} m^2/s 2.9×10^{10} to 2.4×10^{10} m^2/s (basal interval)	0 m^2	29 to 38 m	NA (6)

Matrix characteristics relevant to fluid flow include values used in this table such as permeability, hydraulic conductivity, gradient, etc.)

Table Notes:

(1) The Santa Rosa Formation is not present in the western portion of the WIPP site. It was combined with the DeweyLake Red Beds in three-dimensional regional groundwater flow modeling (Corbet and Knupp, 1996),

Fluid pressure above hydrostatic is a hydrologic characteristic of the Salado (and the Castile) that plays a potentially important role in the repository behavior. It is difficult to ~~accurately~~ measure natural pressures in these formations ***accurately*** because the boreholes or repository excavations required to access the rocks decrease the stress in the region measured. Stress released instantaneously decreases fluid pressure in the pores of the rock, so measured pressures must be considered as a lower bound of the natural pressures. Stress effects related to test location and the difficulty of making long-duration tests in lower-permeability rocks result in higher pore pressures observed to date in anhydrites. The highest observed pore pressure***s*** in halite-rich units, near Room Q, ***are*** ~~is~~ on the order of 9 ***MPa***, whereas the highest pore pressures observed in anhydrite are ***approximately*** 12.~~5~~ ***MPa*** (~~Beauheim et al. 1993, 139~~; ***Beauheim and Roberts 2002, p. 82***). Far-field pore pressures in halite-rich and anhydrite beds in the Salado at the repository level are expected to be similar because the anhydrites are too thin and of too low permeabilities to have liquid pressures much different than those of the surrounding salt. For comparison, the hydrostatic pressure for a column of brine at the depth of the repository is about 7 ***MPa***, and the lithostatic pressure calculated from density measurements in ERDA-9 is about 15 ***MPa***.

Fluid pressure***s*** in sedimentary basins that are much higher or much lower than hydrostatic are referred to as abnormal pressures by the petroleum industry, where they have received considerable attention. In the case of the Delaware Basin evaporites, the high pressures are almost certainly maintained because of the large compressibility and plastic nature of the halite and, to a lesser extent, the anhydrite. The lithostatic pressure at a particular horizon must be supported by a combination of the stress felt by both the rock matrix and the pore fluid. In highly deformable rocks, the portion of the stress that must be borne by the fluid exceeds hydrostatic pressure but cannot exceed lithostatic pressure.

Brine content within the Salado is estimated at 1 to 2 percent by weight, although the thin clay seams have been ***inferred*** ~~observed~~ by Deal et al. (1993, ***pp.*** 4-3) to contain up to 25 percent brine by volume. Where sufficient permeability exists, this brine will move towards areas of lower hydraulic potential, such as a borehole or mined section of the Salado.

Observation of the response of pore fluids in the Salado to changes in pressure boundary conditions at walls in the repository, in boreholes without packers, in packer-sealed boreholes, or in laboratory experiments is complicated by low permeability and low porosity. Qualitative data on brine flow to underground workings and exploratory boreholes ~~have been~~ ***were*** collected routinely ***between*** ~~since~~ 1985 ***and 1993*** under the Brine Sampling and Evaluation Program (BSEP) and have been documented in a series of reports (Deal and Case 1987; Deal et al. 1987, 1989, 1991a, 1991b, ~~and~~ 1993, ***and 1995***). ~~These and other investigations are discussed in Appendix SUM (Section 3.3.1.3).~~ A discussion of alternative conceptual models for Salado fluid flow is given in Appendix ***PA, Attachment*** MASS, Section MASS.7. Additional data on brine inflow are available from the Large-Scale Brine Inflow Test (Room Q). Flow has been observed to move to walls in the repository, to boreholes without packers, and to packer-sealed boreholes. These qualitative and relatively short-term observations suggest that brine flow in the fractured DRZ is a complex process. In some locations, evidence for flow is no longer observed where it once was; in others, flow has begun where it once was not observed. In many cases, observations and experiments must last for months or years to obtain useful results.

For *PA* modeling, brine flow is a calculated term dependent on local hydraulic gradients and properties of the Salado units. Data on pore pressure and permeability of halite and anhydrite layers are available from the Room Q tests and other borehole tests ***as summarized in Beauheim and Roberts (2002)***, and these data form the basis for the quantification of the material properties used in the *PA*. See Section 6.4.3.2 for a description of the repository fluid flow model.

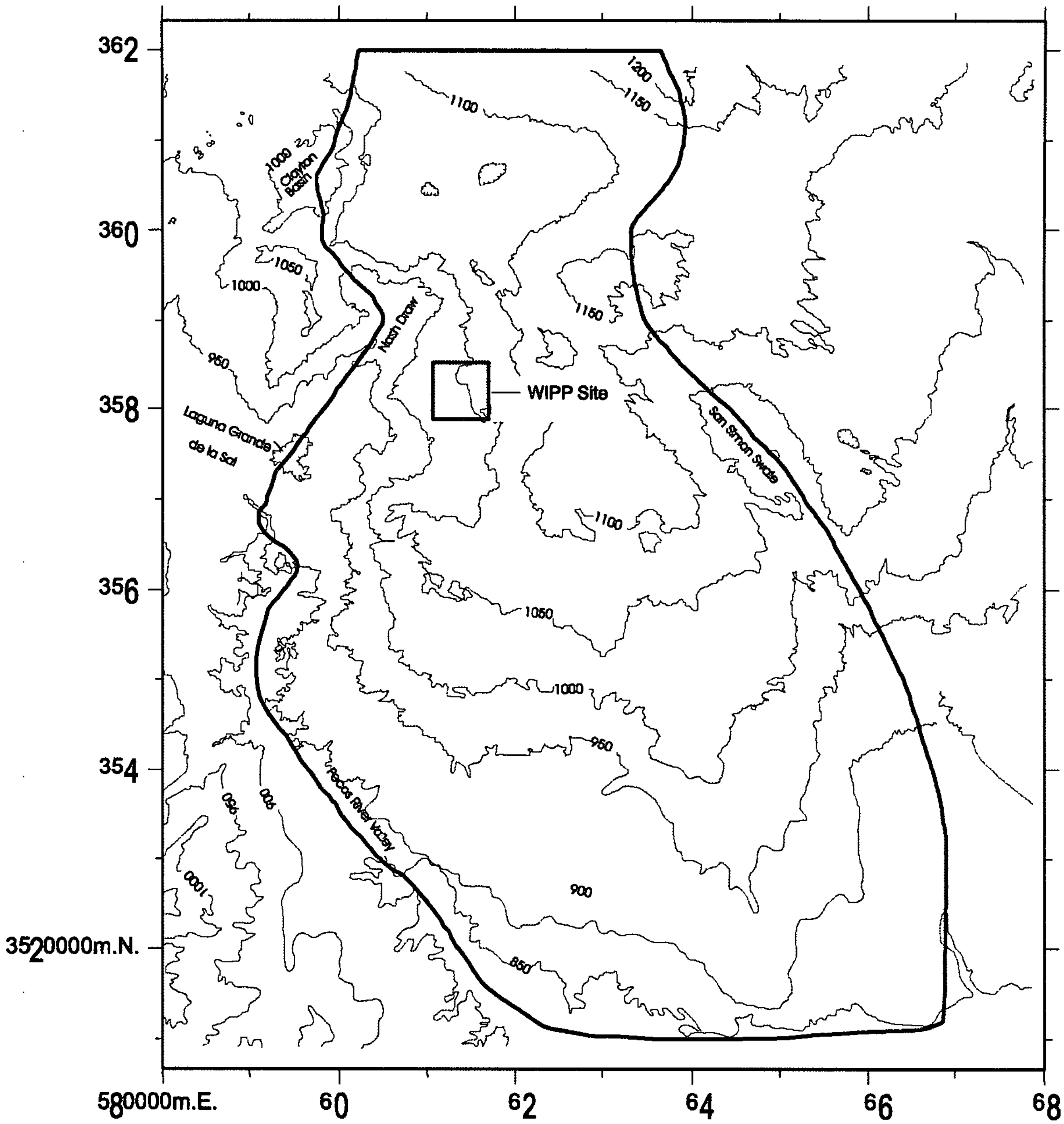
Because brine is an important factor in repository performance, several studies of its chemistry have been conducted. Initial investigations were reported in Powers et al. (*CCA* Appendix GCR, Section 7.5) and were continued once access to the underground was established. The most comprehensive data were developed by the BSEP (Deal and Case 1987; Deal et al. 1987, 1989, 1991a, 1991b, 1993, ***1995***). Results are summarized in Table 2-~~5~~*6*. *CCA* Appendix SOTERM discusses the role of brine chemistry in the conceptual model for actinide dissolution. The conceptual model is described in Section 6.4.3.5.

2.2.1.4 Units Above the Salado

In evaluating groundwater flow above the Salado, the DOE considers the Rustler, Dewey Lake, Santa Rosa, and overlying units to form a groundwater basin with boundaries coinciding with selected groundwater divides as discussed in Section 2.2.1.1. The model boundary follows Nash Draw and the Pecos River valley to the west and south and the San Simon Swale to the east (Figure 2-~~29~~*33*). The boundary continues up drainages and dissects topographic highs along its northern part. These boundaries represent groundwater divides whose positions remain fixed over the past several thousand years and 10,000 years into the future. For reasons described in Section 2.2.1.2.1, the lower boundary of the groundwater basin is the upper surface of the Salado. Nash Draw and the Pecos River are areas where discharge to the surface occurs. Hunter ~~in~~ *(*1985*)* described discharge at Surprise Spring and into saline lakes in Nash Draw. She reported groundwater discharge into the Pecos River between Avalon Dam north of Carlsbad and a point south of Malaga Bend as approximately 0.92 m^3/~~sec~~ (32.5 ft^3/~~sec~~), mostly in the region near Malaga Bend.

Within this groundwater basin, hydrostratigraphic units with relatively high permeability are called conductive units, and those with relatively low permeability are called confining layers. The confining layers consist of halite and anhydrite and are perhaps five orders of magnitude less permeable than conductive units.

In a groundwater basin, the position of the water table moves up and down in response to changes in recharge. The amount of recharge is generally a very small fraction of the amount of rainfall; this condition is expected for the WIPP. Modeling of recharge changes within the groundwater basin as a function of climate variation is discussed in Section 6.4.9. The water table would stabilize at a particular position if the pattern of recharge remained constant for a long time. The equilibrated position depends, in part, on the distribution of hydraulic conductivity in all hydrostratigraphic units in the groundwater basin. However, the position of the water table depends mainly on the topography and geometry of the groundwater basin and the hydraulic conductivity of the uppermost strata. The position of the water table can adjust slowly to changes in recharge. Consequently, the water table can be at a position that is very much different from its equilibrium position at any given time. Generally, the water table drops



Note: Contour level for elevation above mean sea level is 50 meters

N

0 20 m

CCA-045-2

Figure 2-~~29~~*33*. Outline of the Groundwater Basin Model Domain on a Topographic Map

very slowly in response to decreasing recharge but might rise rapidly in times of increasing recharge.

The asymmetry of response occurs because the rate at which the water table drops is limited by the rate at which water flows through the entire basin. In contrast, the rate at which the water table rises depends mainly on the recharge rate and the porosity of the uppermost strata. From groundwater basin modeling, the head distribution in the groundwater basin appears to equilibrate rapidly with the position of the water table.

The groundwater basin conceptual model (Corbet and Knupp 1996) described above has been implemented in a numerical model, as described in ~~Section 6.4.6.2 and~~ *CCA* Appendix MASS, Section MASS.14.2. This model has been used to simulate the interactive nature of flow through conductive layers and confining units for a variety of possible rock properties and climate futures. Thus, this model has allowed insight into the magnitude of flow through various units. The DOE has used this insight as a basis for model simplifications used in *PA* that are described here and in Chapter 6.~~0.~~

One conclusion from the regional groundwater basin modeling is pertinent here. In general, vertical leakage through confining layers is directed downward over all of the controlled area. This downward leakage uniformly over the WIPP site is the result of a well-developed discharge area, Nash Draw and the Pecos River, along the western and southern boundaries of the groundwater basin. This area acts as a drain for the laterally conductive units in the groundwater basin, causing most vertical leakage in the groundwater basin to occur in a downward direction. This conclusion is important in *PA* simplifications related to the relative importance of lateral flow in the Magenta versus the Culebra, which will be discussed later in this chapter and in Section 6.4.6.

Public concern was expressed that groundwater flow to the spring supplying brine to Laguna Grande de la Sal could be related to the presence of karst features. The EPA examined information regarding the hydrology of the units above the Salado and DOE's conceptualization of the groundwater flow model, including supplementary information submitted in letters dated May 2, 1997 (Docket A-93-02, Item V-B-6 (6)), and May 14, 1997 (Docket A-93-02, Item II-I-31), and the EPA concluded that the information was adequate.

The EPA concluded, based on WIPP field observations and site-specific hydrologic information, there is no indication that any cavernous or other karst-related flow is present within the WIPP site boundary. The EPA concurred with DOE's conceptualization of groundwater flow in the Culebra, which includes the presence of fractures within the Culebra and recharge and discharge areas for groundwater that are more consistent with potential discharge to areas south and west of the WIPP.

2.2.1.4.1 Hydrology of the Rustler Formation

The Rustler is of particular importance for WIPP because it contains the most transmissive units above the repository. Fluid flow in the Rustler is characterized by very slow rates of vertical leakage through confining layers and faster lateral flow in conductive units. To illustrate this point, regional modeling with the groundwater basin model indicates that lateral specific discharges in the Culebra, for example, are perhaps two to three orders of magnitude greater than the vertical specific discharges across the top of the Culebra.

Because of its importance, the Rustler continues to be the focus of studies to understand better the complex relationship between hydrologic properties and geology, particularly in view of water-level rises observed in the Culebra and Magenta (e.g., SNL 2003a; also see Appendix DATA). An example of the complex nature of Rustler hydrology is the variation in Culebra transmissivity (T). Culebra T varies over three orders of magnitude on the WIPP site itself and over six orders of magnitude on the scale of the regional groundwater basin model with lower T east of the site and higher T west of the site in Nash Draw (e.g., Beauheim and Ruskauff 1998). As discussed below, site investigations and studies (e.g., Holt and Powers 1988; Beauheim and Holt 1990; Powers and Holt 1995; Holt 1997; Holt and Yarbrough 2002; Powers et al. 2003) suggest that the variability in Culebra T can be explained largely by the thickness of Culebra overburden, the location and extent of upper Salado dissolution, and the occurrence of halite in the mudstone units bounding the Culebra (see Section 2.1.3.5).

2.2.1.4.1.1 ~~Unnamed Lower Member~~ *Los Medaños*

The unnamed lower member was named the Los Medaños by Powers and Holt (1999).~~The unnamed lower member makes up~~***The Los Medaños is treated as*** a single hydrostratigraphic unit in WIPP models of the Rustler, although its composition varies. Overall, it acts as a confining layer. The basal interval of the *Los Medaños*~~unnamed lower member~~, approximately 19.5 m (64 ft) thick, is composed of siltstone, mudstone, and claystone and contains the water-producing zones of the lowermost Rustler. Transmissivities of 2.9×10^{-10} m^2/~~sec~~ (2.7×10^{-4} ft^2/day) and 2.4×10^{-10} m^2/~~sec~~ (2.2×10^{-4} ft^2/day) were reported by Beauheim (1987a, *p.* 50) from tests at well H-16 that included this interval. The porosity of the ~~unnamed lower member~~ *Los Medaños* was measured in 1995 as part of testing at the H-19 hydropad ***(TerraTek 1996)***. Two claystone samples had effective porosities of 26.8 and 27.3 percent. One anhydrite sample had an effective porosity of 0.2 percent. The transmissivity values correspond to hydraulic conductivities of 1.5×10^{-11} m/~~sec~~ (4.2×10^{-6} ft/day) and 1.2×10^{-11} m/~~sec~~ (3.4×10^{-6} ft/day). Hydraulic conductivity in the lower portion of the ~~unnamed lower member~~ *Los Medaños* is believed by the DOE to increase to the west in and near Nash Draw, where dissolution at the underlying Rustler-Salado contact has caused subsidence and fracturing of the sandstone and siltstone.

The remainder of the *Los Medaños* ~~unnamed lower member~~ contains mudstones, anhydrite, and variable amounts of halite. The hydraulic conductivity of these lithologies is extremely low. It is for this reason the *Los Medaños* ~~unnamed lower member~~ is treated as a single hydrostratigraphic unit that overall acts as a confining unit. The conceptual model incorporating the ~~unnamed lower member~~ *Los Medaños* is discussed in Section 6.4.6.1. Important hydrologic model properties~~ of the unnamed lower member are discussed in Section 6.4.6.1 and are summarized in Appendix PAR (Table PAR-31).~~ ***of the Los Medaños are summarized in Appendix PA.***

As described in Section 2.1.3.5, the Los Medaños contains two mudstone layers: one in the middle of the Los Medaños and one immediately below the Culebra. An anhydrite layer separates the two mudstones. The lower and upper Los Medaños mudstones have been given

the designations M1/H1 and M2/H2, respectively, by Holt and Powers (1988). This naming convention is used to indicate the presence of halite in the mudstone at some locations at and near the WIPP site. Powers (2002a) has mapped (Figure 2-15) the margins delineating the occurrence of halite in both mudstone layers. Whereas early researchers (e.g., Snyder 1985) interpreted the absence of halite west of these margins as evidence of dissolution, Holt and Powers (1988) interpreted it as reflecting changes in the depositional environment, not dissolution. However, Holt and Powers (1988) concluded that dissolution of Rustler halite may have occurred along the present-day margins. The presence of halite in the Los Medaños mudstones is likely to affect the conductivity of the mudstones, but its greater importance is the implications it has for the conductivity of the Culebra. As discussed in Section 2.2.1.4.1.2, the Culebra transmissivity in locations where halite is present in M2/H2 and M3/H3 (a mudstone in the lower Tamarisk Member of the Rustler) is assumed to be an order of magnitude lower than where halite does not occur (Holt and Yarbrough 2002).

Fluid pressures in the Los Medaños have been continuously measured at well H-16 since 1987. During this period, the fluid pressure has remained relatively constant at between 190 and 195 psi or a head of approximately 137 m (450 ft). Given the location of the pressure transducer (an elevation of 811.96 m amsl), the current elevation of the Los Medaños water level at H-16 is approximately 949 m amsl. No other wells in the WIPP monitoring network are completed to the Los Medaños. Thus, H-16 provides the only current head information for this member.

2.2.1.4.1.2 The Culebra *Dolomite Member*

The Culebra is of interest because it is the most transmissive ***saturated*** unit ***above*** ~~at~~ the WIPP ***repository***~~site~~ and hydrologic research has been concentrated on the unit for ***nearly two*** ~~over a~~ decades. Although it is relatively thin, it is an entire hydrostratigraphic unit in the WIPP hydrological conceptual model, and it is the most important conductive unit in this model. Implementation of the Culebra in the conceptual model is discussed in detail in Section 6.4.6.2. Model discussions cover groundwater flow and transport characteristics of the Culebra. These are supported by parameter values in Table 6-20, 6-21, 6-22, and 6-23. Additional background for the Culebra model is in *CCA* Appendix MASS, Sections MASS.14 and MASS.15.

The two primary types of field tests ~~that are being~~ used to characterize the flow and transport characteristics of the Culebra are hydraulic tests and tracer tests.

The hydraulic testing consists of pumping, injection, and slug testing of wells across the study area (for example, Beauheim 1987a, *p.* 3). The most detailed hydraulic test data exist for the WIPP hydropads (for example, H-19). The hydropads generally comprise a network of three or more wells located within a few tens of meters of each other. Long-term pumping tests have been conducted at hydropads H-3, H-11, and H-19 and at well WIPP-13 (Beauheim 1987b~~,~~ ~~1987c,~~; 1989; Beauheim et al. 1995*; **Meigs et al. 2000***). These pumping tests provided transient pressure data at the hydropad and over a much larger area. Tests often included use of automated data-acquisition systems, providing high-resolution (in both space and time) data sets. In addition to long-term pumping tests, slug tests and short-term pumping tests have been conducted at individual wells to provide pressure data that can be used to interpret the transmissivity at that well (Beauheim 1987a). (Additional short-term pumping tests have been conducted in the WQSP wells [***Beauheim and Ruskauff 1998***~~Stensrud 1995~~]). Detailed cross-hole hydraulic testing has ~~recently~~ been conducted at the H-19 hydropad (~~Kloska et al. 1995~~***Beauheim 2000***).

The hydraulic tests are designed to yield pressure data for the interpretation of such characteristics as transmissivity, permeability, and storativity. The pressure data from long-term pumping tests and the interpreted transmissivity values for individual wells are used for the generation of transmissivity fields in *PA* flow modeling (see Appendix ***PA, Attachment*** TFIELD, Sections TFIELD~~-2~~ ***5.0 and TFIELD-6.0***). Some of the hydraulic test data and interpretations are also important for the interpretation of transport characteristics. For instance, information about the vertical distribution of ~~the~~ permeability ~~values~~ interpreted from the hydraulic tests at a given hydropad ~~are~~ ***is*** needed for interpretations of tracer test data at that hydropad.

To evaluate transport properties of the Culebra, a series of tracer tests ~~has been~~ ***were*** conducted at six locations (the H-2, H-3, H-4, H-6, H-11, and H-19 hydropads) near the WIPP site. Tests at the first five of these locations consisted of two-well dipole tests and/or multiwell convergent flow tests and are described in detail in Jones et al. (1992). Tracer tests at the H-19 hydropad and additional tracer tests performed at the H-11 hydropad are described in ~~Beauheim et al. (1995)~~***Meigs et al. (2000)***. The ~~more recent~~ ***1995-1996*** tracer test program consisted of single-well injection-withdrawal tests and multi-well convergent flow tests ***(Meigs and Beauheim 2001)***. Unique features of this testing program include the single-well test at both H-19 and H-11, the injection of tracers into six wells during the H-19 convergent-flow test, the injection of tracer into upper and lower zones of the Culebra at the H-19 hydropad, repeated injections under different convergent-flow pumping rates, and the use of tracers with different free-water diffusion coefficients. The ***1995-1996*** ~~recent~~ tracer tests were specifically designed to evaluate the importance of heterogeneity (both horizontal and vertical) and diffusion on transport processes.

The Culebra is a fractured dolomite with nonuniform properties both horizontally and vertically. Examination of core and shaft exposures has revealed that there are multiple scales of porosity within the Culebra including fractures ranging from microscale to potentially large, vuggy zones, and interparticle and intercrystalline porosity ***(Holt 1997)***. Porosity measurements made on core samples give porosity measurements ranging from 0.03 to 0.30 (Kelley and Saulnier 1990; ***TerraTek 1996***). This large range in porosity for small samples is expected given the variety of porosity types within the Culebra. However, the effective porosity for flow and transport at larger scales will have a smaller range due to the effects of spatial averaging. The core measurements indicate that the Culebra has significant quantities of connected porosity.

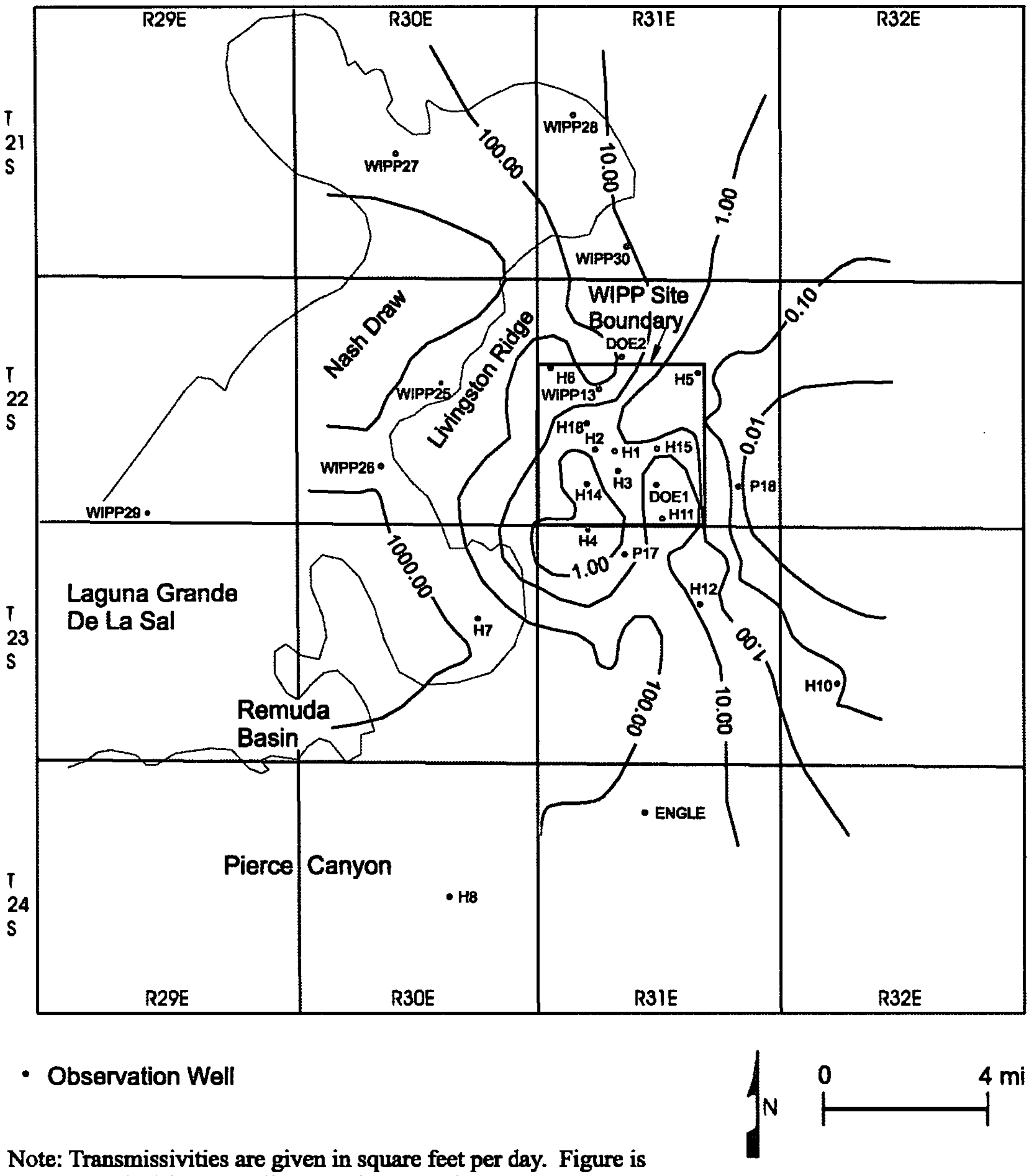
Flow in the Culebra occurs within fractures, within vugs where they are connected by fractures, and to some extent within interparticle porosity where the porosity (and permeability) is high, such as chalky lenses. At any given location, flow will occur in response to hydraulic gradients in all places that are permeable. When the permeability contrast between different scales of connected porosity is large, the total porosity can effectively be conceptualized by dividing the system into advective porosity (often referred to as fracture porosity) and diffusive porosity (often referred to as matrix porosity). The advective porosity can be defined as the portion of the porosity where flow is the dominant process (for example fractures and to some extent vugs connected by fractures and interparticle porosity). Diffusive porosity can be defined as the portion of the porosity where diffusion is the dominant process (for example, intercrystalline porosity and to some extent microfractures, vugs and portions of the interparticle porosity.)

For the Culebra in the vicinity of the WIPP site, defining advective porosity is not a simple matter. In some regions the permeability of the fractures is inferred to be significantly larger than the permeability of the other porosity types, thus advective porosity can be conceptualized as predominantly fracture porosity (low porosity). In some regions, there appear to be no high permeability fractures. This may be due to a lack of large fractures or may be the result of gypsum fillings in a portion of the porosity. Where permeability contrasts between porosity types are small, the advective porosity can be conceptualized as a combination of fractures, vugs connected by fractures, and permeable portions of the interparticle porosity. In each case, the diffusive porosity can be conceptualized as the porosity where advection is not dominant.

The major physical transport processes that affect actinide transport through the Culebra include advection (through fractures and other permeable porosity), diffusion from the advective porosity into the rest of the connected porosity (diffusive porosity) and dispersive spreading due to heterogeneity. Diffusion can be an important process for effectively retarding solutes by transferring mass from the porosity where advection (flow) is the dominant process into other portions of the rock. Diffusion into stagnant portions of the rock also provides access to additional surface area for sorption. ~~A f~~*F*urther discussion of transport of actinides in the Culebra as either dissolved species or as colloids is given in Section 6.4.6.2. Parameter values determined from tests of the Culebra are given in *CCA* Appendix PAR and are described in Section 6.4.6.2.2. A summary of input values to the conceptual model *is*~~are~~ in Tables 6-22 and 6-23.

Fluid flow in the Culebra is dominantly lateral and southward except in discharge areas along the west or south boundaries of the basin. Where transmissive fractures exist, flow is dominated by fractures but may also occur in vugs connected by microfractures and interparticle porosity. Regions where flow is dominantly through vugs connected by microfractures and interparticle porosity have been inferred from pumping tests and tracer tests. Flow in the Culebra may be concentrated along zones that are thinner than the total thickness of the Culebra. In general, the upper portion of the Culebra is massive dolomite with a few fractures and vugs, and appears to have low permeability. The lower portion of the Culebra appears to have many more vuggy and fractured zones and to have~~ a~~ significantly higher permeability (Meigs and Beauheim *2001*).

There is strong evidence that the permeability of the Culebra varies spatially and varies sufficiently that it cannot be characterized with a uniform value or range over the region of interest to the WIPP. The transmissivity of the Culebra varies spatially over six orders of magnitude from east to west in the vicinity of the WIPP (Figure 2-~~30~~*34*). Over the site, Culebra transmissivity varies over three to four orders of magnitude. *CCA* Appendix TFIELD, Section TFIELD.2 contains the data used to develop Figure 2-~~30~~*34*, which shows variation in transmissivity in the Culebra in the WIPP region. ***Attachment TFIELD to Appendix PA***~~Appendix MASS (SectionMASS.15, including MASS Attachment 15-6)~~ provides ***the*** modeling rationale and~~. The discussion in Appendix TFIELD~~ addresses how data collected over a number of years were correlated for the generations of transmissivity fields.



Note: Transmissivities are given in square feet per day. Figure is modified from Cauffman et al. 1990 (Figure 5.22a). See Appendix TFIELD for details of the performance assessment implementation.

CCA-048-2

Figure 2-~~30~~*34*. Transmissivities of the Culebra

Transmissivities are from about 1×10^{-9} m^2/~~sec~~ (1×10^{-3} ft^2/day) at well P-18 east of the WIPP site to about 1×10^{-3} m^2/~~sec~~ (1×10^{3} ft^2/day) at well H-7 in Nash Draw (see Figure 2-2 for the locations of these wells and see Figure 4-8 in *CCA* Appendix FAC for a Culebra isopach map).

Transmissivity variations in the Culebra are believed to be controlled by the relative abundance of open fractures rather than by primary (that is, depositional) features of the unit. Lateral variations in depositional environments were small within the mapped region, and primary features of the Culebra show little map-scale spatial variability, according to Holt and Powers (*CCA* Appendix FAC). Direct measurements of the density of open fractures are not available from core samples because of incomplete recovery and fracturing during drilling, but observation of the relatively unfractured exposures in the WIPP shafts suggests that the density of open fractures in the Culebra decreases to the east. ~~Qualitative correlations have been noted between transmissivity and several geologic features possibly related to open-fracture density, including (1) the distribution of overburden above the Culebra, (2) the distribution of halite in other members of the Rustler, (3) the dissolution of halite in the upper portion of the Salado, and (4) the distribution of gypsum fillings in fractures in the Culebra (see Section 2.1.3.5.2 and Figure 2-12).~~

Recent investigations have made a significant contribution to the understanding of the large variability observed for Culebra transmissivity (e.g., Holt and Powers 1988; Beauheim and Holt 1990; Powers and Holt 1995; Holt 1997; Holt and Yarbrough 2002; Powers et al. 2003). The spatial distribution of Culebra transmissivity is believed to be due strictly to deterministic post-depositional processes and geologic controls (Holt and Yarbrough 2002). The important geologic controls include Culebra overburden thickness, dissolution of the upper Salado, and the occurrence of halite in the mudstone Rustler units (M2/H2 and M3/H3) above and below the Culebra (Holt and Yarbrough 2002). Culebra transmissivity is inversely related to thickness of overburden because stress relief associated with erosion of overburden (see Section 2.1.5.2) leads to fracturing and opening of preexisting fractures. Culebra transmissivity is high where dissolution of the upper Salado has occurred and the Culebra has subsided and fractured. Culebra transmissivity is observed to be low where halite is present in overlying and/or underlying mudstones. Presumably, high Culebra transmissivity leads to dissolution of nearby halite (if any). Hence, the presence of halite in mudstones above and/or below the Culebra can be taken as an indicator for low Culebra transmissivity. Details of the geologic-based transmissivity model for the Culebra are given in Attachment TFIELD (Section TFIELD-3.0) to Appendix PA and summarized below.

The Culebra has been tested hydraulically at 42 locations, yielding reliable transmissivity values. These values (log T) are plotted as a function of depth to Culebra (overburden thickness) in Figure 2-35. As shown, the Culebra transmissivities fall into two populations separated by a cutoff (termed 'high-T' cutoff) equal to -5.4 (log T [m^2/s]). These data suggest a bimodal distribution for transmissivity with one population having high transmissivity and the other low transmissivity, with the difference attributed to open, interconnected fractures ("fracture interconnectivity") for the high-transmissivity population (Holt and Yarbrough 2002). Using these data, Holt and Yarbrough (2002) constructed a linear Culebra transmissivity model relating log T to the deterministic geologic controls described above. The linear model is expressed as follows:

$$Y(\mathbf{x}) = \beta_1 + \beta_2 d(\mathbf{x}) + \beta_3 I_f(\mathbf{x}) + \beta_4 I_D(\mathbf{x}), \qquad (2.1)$$

where Y(x) is log T (x), β_i (I = 1 to 4) are regression coefficients, x is a two-dimensional location vector, d(x) is the overburden thickness at x (expressed in UTM coordinates and

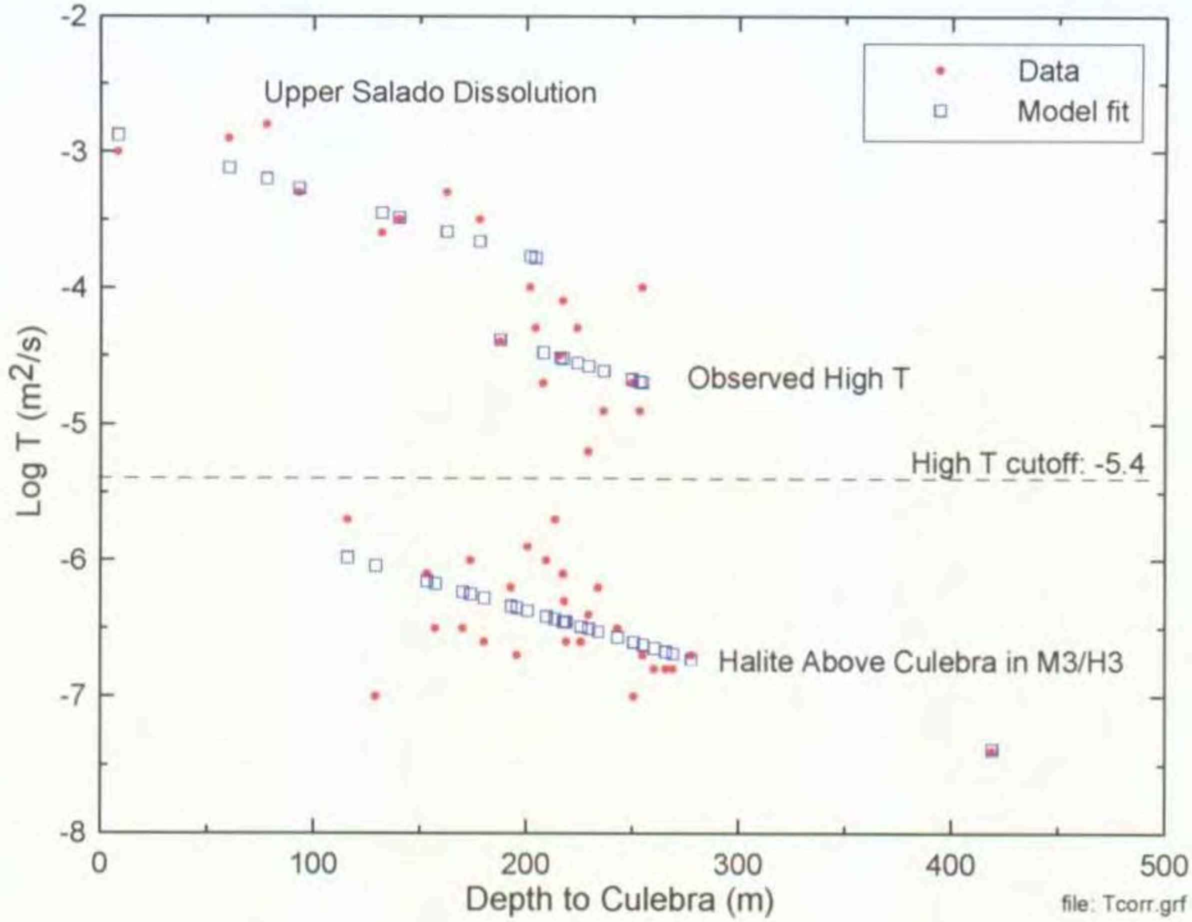


Figure 2-35. Correlation Between Culebra Transmissivity (log T (m^2/s)) and Overburden Thickness for Different Geologic Environments (after Holt and Yarbrough 2002)

meters), $I_f(x)$ is the fracture-interconnectivity indicator at x (equal to 1 when log T (m^2/s) > -5.4 or 0 when log T (m^2/s) < -5.4), and I_D (x) is the dissolution indicator (equal to 1 when Salado dissolution has occurred at (x) and 0 when it has not). In this model, coefficient β_1 is the intercept value, β_2 is the slope of Y(x)/d(x), and β_3 and β_4 represent adjustments to the intercept for the occurrence of open, interconnected fractures and Salado dissolution, respectively. Based on linear-regression analysis, Holt and Yarbrough (2002) estimated the coefficients in Equation (2.1). These estimates are summarized in Table 2-7. Predictions of the Culebra transmissivity model represented by Equation (2.1) are shown in Figure 2-35.

The regression model expressed by Equation (2.1) cannot adequately predict transmissivity in the regions where halite is present both in M2/H2 and M3/H3. In these regions, Culebra

Table 2-7. Estimates of Culebra Transmissivity Model Coefficients

β_1	β_2	β_3	β_4
-5.441	-4.636 × 10-3	1.926	0.678

porosity is thought to be at least partially filled with halite, reducing transmissivity. For these regions, Equation (2.1) is modified as follows:

$$Y(\mathbf{x}) = \beta_1 + \beta_2 d(\mathbf{x}) + \beta_3 I_f(\mathbf{x}) + \beta_4 I_D(\mathbf{x}) + \beta_5 I_H(\mathbf{x}). \qquad (2.2)$$

$I_H(x)$ is a halite indicator function equal to 1 in locations where halite occurs in both the M2/H2 and M3/H3 intervals and 0 otherwise. The coefficient β_5 is equal to –1 to assure that the model in Equation (2.2) reduces the predicted transmissivity values by one order of magnitude where halite occurs in both the M2/H2 and M3/H3 intervals.

In the region east of the upper Salado dissolution margin and west of the M2/H2 and M3/H3 margins, high transmissivity depends, in part, on the absence of gypsum fracture fillings. No method has yet been determined for predicting whether fractures will or will not be filled with gypsum at a given location, so the distribution of high and low transmissivity is treated stochastically in this region. Predictions of transmissivity in this region make use of an isotropic spherical variogram model. Fitted parameters for the variogram model are described in Attachment TFIELD (Section TFIELD-4.3) of Appendix PA.

Geochemical and radioisotope characteristics of the Culebra have been studied. There is considerable variation in groundwater geochemistry in the Culebra. The variation has been described in terms of different hydrogeochemical facies that can be mapped in the Culebra (see Section 2.4.2). A halite-rich hydrogeochemical facies exists in the region of the WIPP site and to the east, approximately corresponding to the regions in which halite exists in units above and below the Culebra ~~(Figure 2-10)~~ (*Figure 2-15*), and in which a large portion of the Culebra fractures are gypsum filled (Figure 2-~~12~~*17*). An anhydrite-rich hydrogeochemical facies exists west and south of the WIPP site, where there is relatively less halite in adjacent strata and where there are fewer gypsum-filled fractures.

The Culebra groundwater geochemistry studies continue. Culebra water quality is evaluated semiannually at six wells, three north (WQSP-1, WQSP-2, and WQSP-3) and three south (WQSP-4, WQSP-5, and WQSP-6) (WIPP MOC 1995) of the surface structures area (see Figure 2-3 for well locations). Five rounds of semiannual sampling of water quality completed before the first receipt of waste at the WIPP were used to establish the initial Culebra water-quality baseline for major ion species including Na^+, Ca^{2+}, Mg^{2+}, K^+, Cl^-, SO_4^{2-}, and HCO_3^{2-} (Crawley and Nagy 1998). In 2000, this baseline was expanded to include five additional rounds of sampling that were completed before first receipt of RCRA-regulated waste (IT Corporation 2000). Table 2-8 gives the 95 percent confidence intervals presented in SNL (2001) for the major ion species determined from the 10 rounds (semiannual sampling for 5 years) of baseline sampling. Culebra water quality is extremely variable among the six sampling wells, as shown by the Cl^- concentrations that range from approximately 6,000 mg/L at WQSP-6 to 130,000 mg/L at WQSP-3.

Radiogenic isotopic signatures suggest that the age of the groundwater in the Culebra is on the order of 10,000 years or more (see, for example, Lambert 1987, Lambert and Carter 1987, and Lambert and Harvey 1987~~ in the bibliography~~). The radiogenic ages of the Culebra groundwater and the geochemical differences provide information potentially relevant to the groundwater flow directions and groundwater interaction with other units and are important constraints on

Table 2-8. Ninety-Five Percent Confidence Intervals for Culebra Water-Quality Baseline

Well I.D.	Cl^- Conc. (mg/L)	SO_4^{2-} Conc. (mg/L)	HCO_3^- Conc. (mg/L)	Na^+ Conc. (mg/L)	Ca^{2+} Conc. (mg/L)	Mg^{2+} Conc. (mg/L)	K^+ Conc. (mg/L)
WQSP-1	31100-39600	4060-5600	45-54	15850-21130	1380-2030	940-1210	322-730
WQSP-2	31800-39000	4550-6380	43-53	14060-22350	1230-1730	852-1120	318-649
WQSP-3	113900-145200	6420-7870	23-51	62600-82700	1090-1620	1730-2500	2060-3150
WQSP-4	53400-63000	5620-7720	31-46	28100-37800	1420-1790	973-1410	784-1600
WQSP-5	13400-17600	4060-5940	42-54	7980-10420	902-1180	389-535	171-523
WQSP-6	5470-6380	4240-5120	41-54	3610-5380	586-777	189-233	113-245

conceptual models of groundwater flow. Previous conceptual models of the Culebra (see for example, Chapman 1986, Chapman 1988, LaVenue et al. 1990, and Siegel et al. 1991 ~~in the bibliography~~) have not been able to consistently relate the hydrogeochemical facies, radiogenic ages, and flow constraints (that is, transmissivity, boundary conditions, etc.) in the Culebra.

The groundwater basin modeling that ~~has been~~ *was* conducted, although it did not model solute transport processes, provides flow fields that can be used to develop the following concepts that help explain the observed hydrogeochemical facies and radiogenic ages. The groundwater basin model combines and tests three fundamental processes: (1) it calculates vertical leakage, which may carry solutes into the Culebra; (2) it calculates lateral fluxes in the Culebra (directions as well as rates); and (3) it calculates a range of possible effects of climate change. The presence of the halite-rich groundwater facies is explained by vertical leakage of solutes into the Culebra from the overlying halite-containing Tamarisk by advective or diffusive processes. Because lateral flow rates here are low, even slow rates of solute transport into the Culebra can result in high solute concentration. Vertical leakage occurs slowly over the entire model region, and thus the age of groundwater in the Culebra is old, consistent with radiogenic information. Lateral fluxes within the anhydrite zone are larger because of higher transmissivity, and where the halite and anhydrite facies regions converge, the halite facies signature is lost by dilution with relatively large quantities of anhydrite facies groundwater. Response of groundwater flow in the Culebra as the result of increasing recharge is modeled through the variation in climate, discussed in Section 6.4.9.

Groundwater levels in the Culebra in the WIPP region ~~have been~~ *were* measured ~~continuously~~ ***prior to*** ~~for several decades~~ ***the CCA in numerous wells (Figure 2-2).*** ~~Water-level rises have been observed in the WIPP region and are attributed to three causes as discussed below. The extent of water-level rise observed at a particular well depends on several factors, but the proximity of the observation point to the cause of the water-level rise appears to be a primary factor.~~ ***The Culebra monitoring wells as of the end of 2002 are shown in Figures 2-3 and 2-4; plugged and abandoned wells are not shown in these figures. Beginning in 1989, a general***

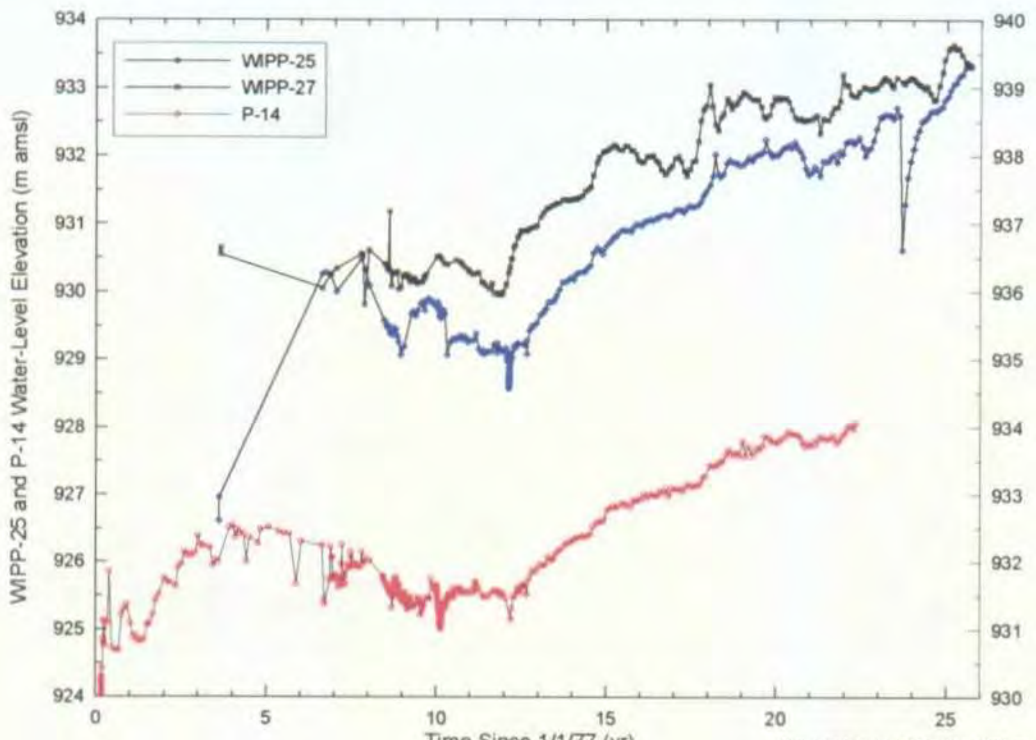


Figure 2-36. Water-level Trends in Nash Draw Wells and at P-14 (see Figure 2-2 for well locations)

long-term rise has been observed in both Culebra and Magenta water levels (Figure 2-36) over a broad area of the WIPP site including Nash Draw (SNL 2003a). At the time of the CCA this long-term rise was recognized, but was thought (outside of Nash Draw) to represent recovery from the accumulation of hydraulic tests that had occurred since the late 1970s and the effects of grouting around the WIPP shafts to limit leakage. Water levels in Nash Draw were thought to respond to changes in the volumes of potash mill effluent discharged into the draw (Silva 1996); however, correlation of these water levels with potash mine discharge cannot be proven because sufficient data on the timing and volumes of discharge are not available. As the rise in water levels has continued since 1996, observed heads have exceeded the ranges of uncertainty established for the steady-state heads in most of the 32 wells used in the calibration of the transmissivity fields described in CCA Appendix TFIELD. Although recovery from the hydraulic tests and shaft leakage has unquestionably occurred, the DOE has implemented a program to identify other potential causes for the water-level rises (SNL 2003b).

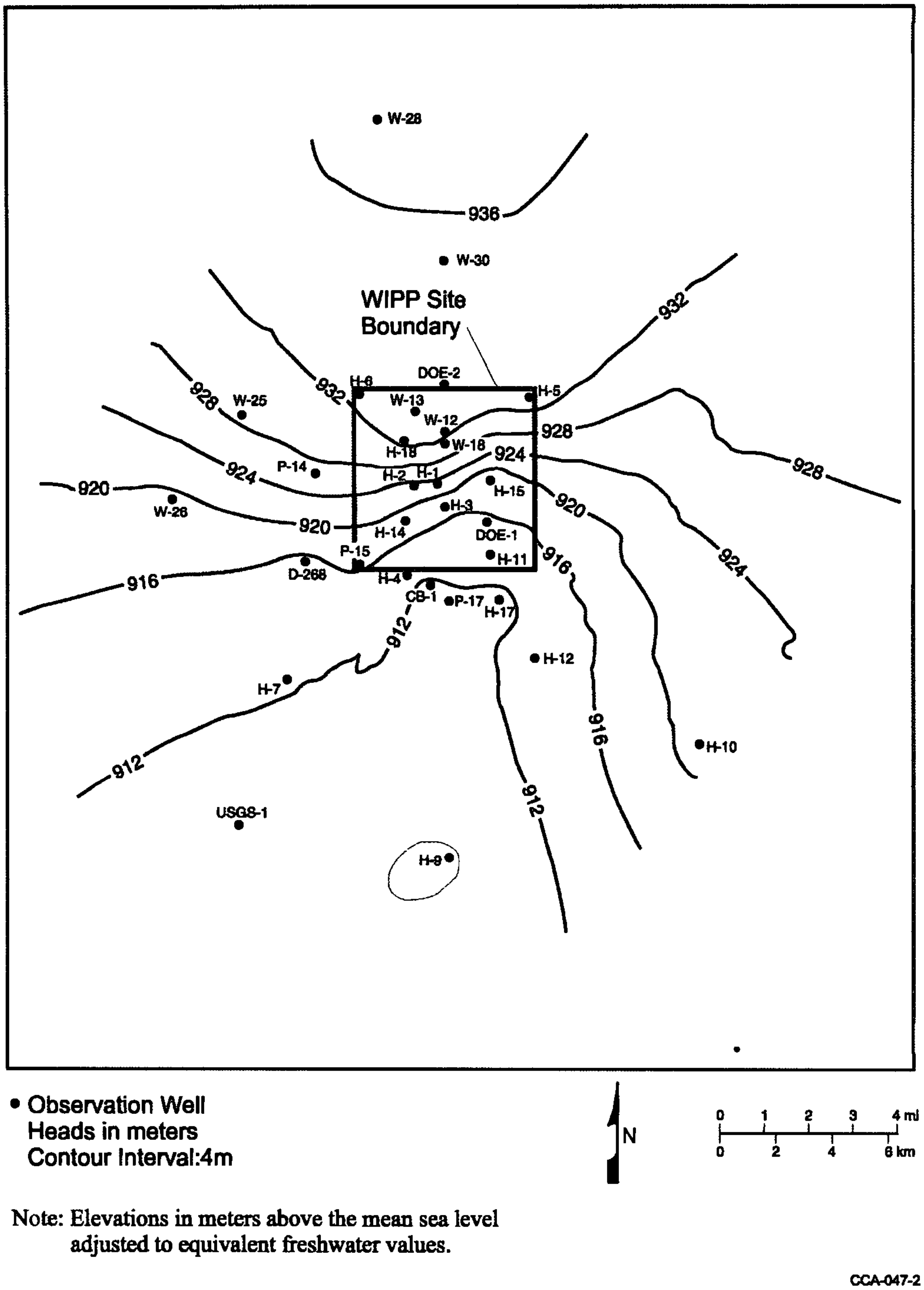
~~In the vicinity of the WIPP site, water-level rises are unquestionably caused by recovery from drainage into the shafts. Drainage into shafts has been reduced by a number of grouting programs over the years, most recently in 1993 around the AIS. Northwest of the site, in and near Nash Draw, water levels appear to fluctuate in response to effluent discharge from potash mines. Correlation of water-level fluctuation with potash mine discharge cannot be proven because sufficient data on the timing and volumes of discharge are not available.~~

Although Culebra heads have been rising, the head ~~Head~~ distribution in the Culebra ~~(see Figure 2-31)~~ ***(see Figure 2-37)*** is consistent with groundwater basin modeling results (discussed in ~~Section 6.4.6 and~~ Appendix ***PA, Attachment*** MASS, Section MASS.14.2) indicating that the generalized direction of groundwater flow ***remains*** north to south. However, caution should be used when making assumptions based on groundwater-level data alone. Studies in the Culebra have shown that fluid density variations in the Culebra can affect flow direction (Davies 1989, p. 35). The fractured nature of the Culebra, coupled with variable fluid densities, can also cause localized flow patterns to differ from general flow patterns. Water-level rises in the vicinity of the H-9 hydropad, about 10.46 km (6.5 mi) south of the site, are not thought to be caused by either WIPP activities or potash mining discharge ***and have been included in the DOE program to investigate Culebra water-level rises in general.*** ~~They remain unexplained~~. The DOE continues to monitor groundwater levels throughout the region, but only water-level changes at or near the site have the potential to ~~affect performance~~ ***impact the prediction of disposal system performance***. The DOE has implemented water-level changes in its conceptual model through variations in climate as discussed in Section 6.4.9. These variations bring the water ~~level~~***table*** to the surface for some calculations. ~~This modeling simplification bounds the possible effects of anomalous water level changes regardless of their origin.~~ ***The DOE has also used recent (late 2000) Culebra heads in flow and transport calculations for this recertification application, as discussed in Appendix PA, Attachment TFIELD, Section TFIELD-6.2.***

Inferences about vertical flow directions in the Culebra have been made from well data collected by the DOE. Beauheim (1987a) reported flow directions towards the Culebra from both the ~~unnamed lower member~~*Los Medaños* and the Magenta over the WIPP site, indicating that the Culebra acts as a drain for the units around it. This indication is consistent with results of groundwater basin modeling. A more detailed discussion of Culebra flow and transport can be found in ***Appendix PA, Attachment TFIELD*** ~~Appendices (MASS [(Sections MASS.14 and MASS.15]) and TFIELD)~~.

In response to an EPA letter dated March 19, 1997 (Docket A-93-02, Item II-I-17), supplemental information to the CCA pertinent to groundwater flow and geochemistry within the Culebra was provided by the DOE in a letter dated May 14, 1997 (Docket A-93-02, Item II-I-31). In that letter, the DOE explained the conceptual model of Culebra groundwater flow used in the CCA. The CCA conceptual model, referred to as the groundwater basin model, offers a three-dimensional approach to treatment of supra-Salado rock units, and assumes that vertical leakage (albeit very slow) occurs between rock units of the Rustler (where hydraulic gradients exist). Flow in the Culebra is considered transient, but is not expected to change significantly over the next 10,000 years. This differs from previous interpretations, wherein no flow was assumed between the Rustler units.

In an attachment to the May 14, 1997 letter, the DOE concluded that the presence of anhydrite within the Rustler units did not preclude slow downward infiltration, as previously argued by the DOE, and that the observed geochemistry and flow directions can be explained with different recharge areas and Culebra travel paths. The EPA reviewed the groundwater flow and recharge conceptualization and concluded that it provides a realistic representation of site conditions.



~~**Figure 2-31. Hydraulic Heads in the Culebra**~~

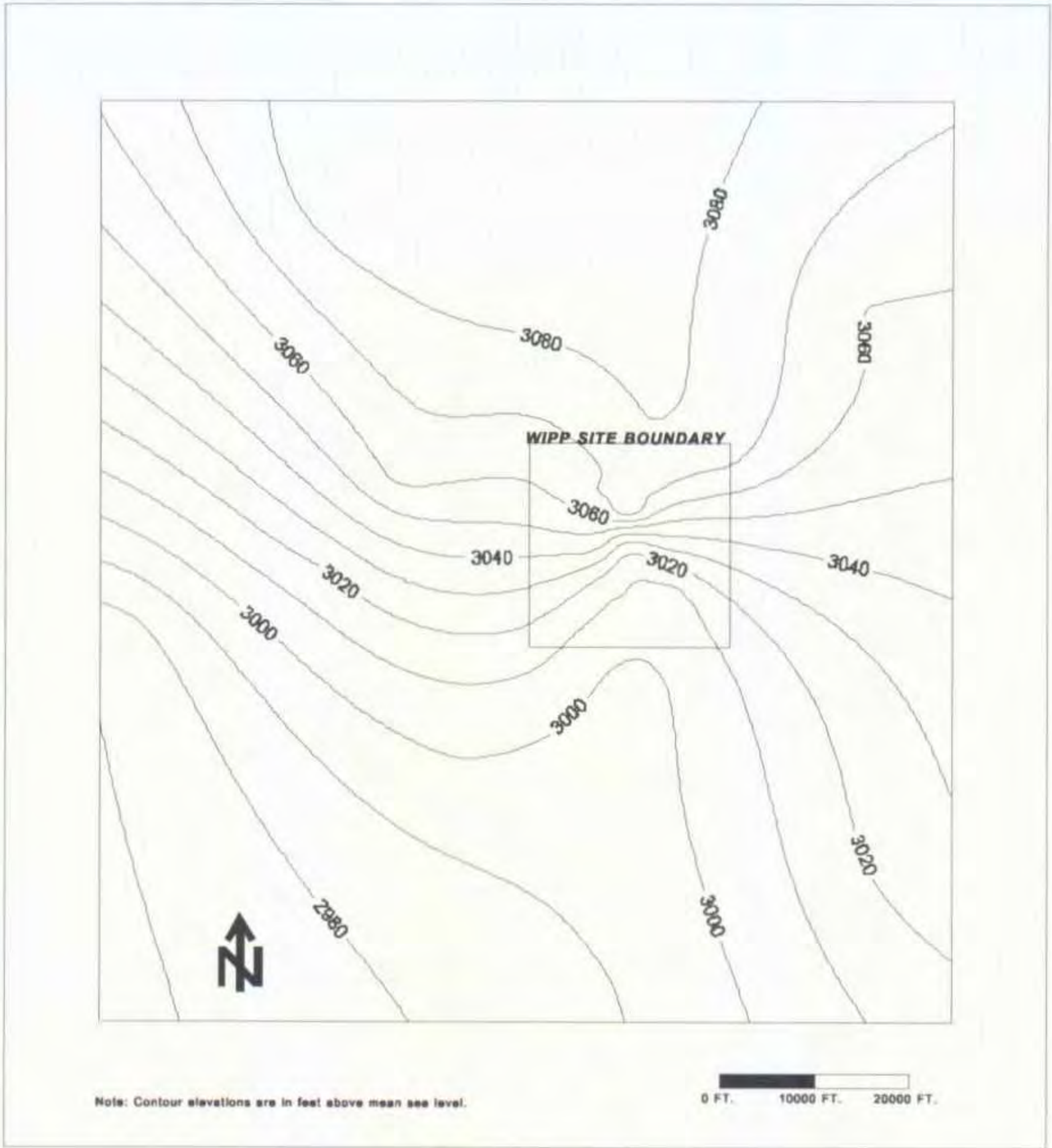


Figure 2-37. Hydraulic Heads in the Culebra

During the CCA review, the EPA found that information on the Culebra in the CCA lacked a detailed discussion on the origin of the transmissivity variations relative to fracture infill/dissolution, integration of climatic change, and loading/unloading events. These are important aspects to understanding not only current transmissivity differences, but also potential future transmissivity variations that could affect PA calculations. The EPA's review stated, however, that the determination of the specific origin of fractures was not necessary because conditions were not expected to change during the regulatory period.

The DOE provided supplemental information in letters in 1997 (Docket A-93-02, Items II-I-03, II-I-24, II-I-31, II-H-44, and II-H-46) indicating that dissolution of fracture fill (which has the potential to alter fracture permeability) is unlikely to occur. The EPA accepted the DOE's position that infiltrating waters would most likely become saturated with calcium sulfate and consequently would not dissolve anhydrite or gypsum fracture fill. Further information on the EPA review of anhydrite and gypsum fracture fill dissolution is contained in EPA Technical Support Document for Section 194.14: Content of Compliance Certification Application, Section IV.C (Docket A-93-02, Item V-B-3).

The Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment reports the annual assessment of the Compliance Monitoring Parameters (COMPs) pursuant to the SNL Analysis Plan, AP-069. The first assessment, for calendar year 1998 (SNL 2000a), showed that changes in Culebra water levels were considered minor. During the assessment of the COMP 'changes in groundwater flow' for calendar year 2001 (SNL 2002), estimated freshwater Culebra heads in 15 wells were identified as above the ranges of uncertainty estimated for steady-state conditions at those wells. At 8 of the 15 wells, the measured water levels exceed the uncertainty range before being converted to freshwater head. In these cases, conversion to freshwater head using any feasible fluid density can only increase the deviation from the range. The freshwater head values from late 2000 were used to calibrate the Culebra transmissivity (T) fields used to simulate the transport of radionuclides through the Culebra (Appendix PA, Attachment TFIELD).

Because transport through the Culebra is a minor component of the total predicted releases from the repository, these changes in head values have little or no effect on the total releases to the accessible environment. The COMP assessment for the calendar year 2001 concluded that the current head values do not indicate a condition adverse to the predicted performance of the repository. However, because Culebra water levels are above expected values at most wells, work has been initiated to investigate the reason for the change and further evaluate the impact on performance.

Additional background for the Culebra model is in Appendix PA, Attachment TFIELD. Additional information on long-term pumping test data is documented in Meigs et al. (2000) and slug tests and short-term pumping tests are documented in Beauheim et al. (1991b) and Beauheim and Ruskauff (1998).

Several new publications on the Culebra updating the original CCA information have been released. Transport properties and tracer tests of the Culebra performed at the H-11 and H-19 hydropads are described in Meigs et al. (2000). The 1995-96 tracer test program, which consisted of single-well injection-withdrawal tests and multiwell convergent flow tests, is documented in Meigs and Beauheim (2001). The higher permeability of the lower Culebra has been addressed in Meigs and Beauheim (2001, p. 1116).

2.2.1.4.1.3 ~~The~~ Tamarisk

The Tamarisk acts as a confining layer in the groundwater basin model. Attempts were made in two wells, H-14 and H-16, to test a 2.4-m (7.9-ft) sequence of the Tamarisk that consists of claystone, mudstone, and siltstone overlain and underlain by anhydrite. Permeability was too low to measure in either well within the time allowed for testing; consequently, Beauheim (1987a, ***pp.*** 108-110) estimated the transmissivity of the claystone sequence to be one or more orders of magnitude less than that of the tested interval in the ~~unnamed lower member~~ ***Los Medaños*** (that is, less than approximately 2.7×10^{-11} m^{2}~~3~~/~~sec~~ [2.5×10^{-5} ft^{2}/day]). The porosity of the Tamarisk was measured in 1995 as part of testing at the H-19 hydropad (TerraTek 1996). Two claystone samples had an effective porosity of 21.3 to 21.7 percent. Five anhydrite samples had effective porosities of 0.2 to 1.0 percent.

Fluid pressures in the Tamarisk have been measured continuously at well H-16 since 1987. From 1998 through 2002, the pressures increased approximately 20 psi, from 80 to 100 psi (185 to 230 ft of water), probably in a continuing recovery response to shaft grouting conducted in 1993 to reduce leakage. Given the location of the pressure transducer, the elevation of Tamarisk water level has increased from 899 to 913 m amsl (2,950 to 2,995 ft amsl) during this period. Currently, no other wells in the WIPP monitoring network are completed to the Tamarisk. Thus, H-16 provides the only information on Tamarisk head levels.

Similar to the Los Medaños, the Tamarisk includes a mudstone layer (M3/H3) that contains halite in some locations at and around the WIPP site. This layer is considered to be important because of the effect it has on the spatial distribution of transmissivity of the Culebra as described in Section 2.2.1.4.1.2. The M3/H3 margin is described in Section 2.1.3.5 and mapped in Figure 2-15.

The Tamarisk is incorporated into the conceptual model as discussed in Section 6.4.6.3. The role of the Tamarisk in the groundwater basin model is in ***CCA*** Appendix MASS, Section MASS.14.1. Tamarisk hydrological model parameters are in Appendix ***PA, Attachment*** PAR, Table PAR-~~29~~***25***.

2.2.1.4.1.4 ~~The~~ Magenta

The Magenta is a conductive hydrostratigraphic unit about 7.9 m (26 ft) thick at the WIPP. The Magenta is saturated except near outcrops along Nash Draw, and hydraulic data are available from ~~15~~ ***22*** wells ***including 7 wells recompleted to the Magenta between 1995 and 2002 (SNL 2003a).*** According to Mercer (~~65~~ ***CCA*** Appendix HYDRO, ***p. 65***), transmissivity ranges over five orders of magnitude from 1×10^{-9} to 4×10^{-4} m^{2}/~~sec~~ (4×10^{-3} to 3.75×10^{2} ft^{2}/day). ***A slug test performed in H-9c, a recompleted Magenta well (see Figure 2-5 for well location), yielded a transmissivity of 6×10^{-7} m^{2}/s (0.56 ft^{2}/day), which is consistent with Mercer's findings (SNL 2003a).*** The porosity of the Magenta was measured in 1995 as part of testing at the H-19 hydropad ***(TerraTek 1996)***. Four samples had effective porosities ranging from 2.7 to 25.2 percent.

The hydraulic transmissivities of the Magenta, based on sparse data, show a decrease ~~in conductivity~~ from west to east, with slight indentations of the contours north and south of the WIPP that correspond to the topographic expression of Nash Draw. In most locations, the hydraulic conductivity of the Magenta is one to two orders of magnitude less than that of the Culebra. The Magenta does not have hydraulically significant fractures in the vicinity of the

WIPP. Treatment of the Magenta in the model is discussed in Section 6.4.6.4 with modeling parameters in Table 6-2~~2~~*4*.

Based on Magenta water levels measured in the 1980s (Lappin et al. 1989) when a wide network of Magenta monitoring wells existed, ~~T~~*t*he hydraulic gradient ***in the Magenta*** across the site varies from 3 to 4 m/km (16 to 20 ft/mi) on the eastern side, steepening to about 6 m/km (32 ft/mi) along the western side near Nash Draw (Figure 2-~~32~~*38*).

Regional modeling using the groundwater basin model indicates that leakage occurs into the Magenta from the overlying Forty-niner and out of the Magenta downwards into the Tamarisk. Regional modeling also indicates that flow directions in the Magenta are dominantly westward, similar to the slope of the land surface in the immediate area of the WIPP. This flow direction is different than the dominant flow direction in the next underlying conductive unit, the Culebra. This difference is consistent with the groundwater basin conceptual model, in that flow in shallower units is expected to be more sensitive to local topography.

Inferences about vertical flow directions in the Magenta have been made from well data collected by the DOE. Beauheim (1987a, *p.* 137) reported flow directions downwards out of the Magenta over the WIPP site, consistent with results of groundwater basin modeling.

However, Beauheim (1987a, *p.* 139) concluded that flow directions between the Forty-niner and Magenta would be upward in the three boreholes from which reliable pressure data are available for the Forty-niner (H-3, H-14, and H-16), which is not consistent with the results of groundwater modeling. This inconsistency may be the result of local heterogeneity in rock properties that affect flow on a scale that cannot be duplicated in regional modeling.

As is the case for the Culebra, groundwater elevations in the Magenta have changed over the period of observation. The pattern of changes is similar to that observed for the Culebra ***(see Section 2.2.1.4.1.2)***, and is ***being investigated under the current DOE hydrology program (SNL 2003b).*** ~~attributed to the same causes (see Section 2.2.1.4.1.2).~~

2.2.1.4.1.5 ~~The~~ Forty-niner

The Forty-niner is a confining hydrostratigraphic layer about 20 m (66 ft) thick throughout the WIPP area and consists of low-permeability anhydrite and siltstone. Tests by Beauheim (1987a, 119-123 and Table 5-2) in H-14 and H-16 yielded transmissivities of about 3×10^{-8} to 8×10^{-8} m^2/sec (3×10^{-2} to 7×10^{-2} ft^2/day) and 3×10^{-9} to 6×10^{-9} m^2/sec (5×10^{-3} to 6×10^{-3} ft^2/day), respectively, ***for the medial siltstone unit of the Forty-niner. Tests of the siltstone in H-3d provided transmissivity estimates of 3.8×10^{-9} to 4.8×10^{-9} m^2/s (3.5×10^{-3} to 4.5×10^{-3} ft^2/day) (Beauheim et al. 1991b, Table 5-1). The porosity of the Forty-niner was measured as part of testing at the H-19 hydropad (TerraTek 1996). Three claystone*** samples had effective porosities ranging from 9.1 to 24.0 percent. Four anhydrite samples had effective porosities ranging from 0.0 to 0.4 percent. Model consideration of the Forty-niner is in Section 6.4.6.5. Modeling parameters are in ***CCA*** Appendix PAR, Table PAR-27.

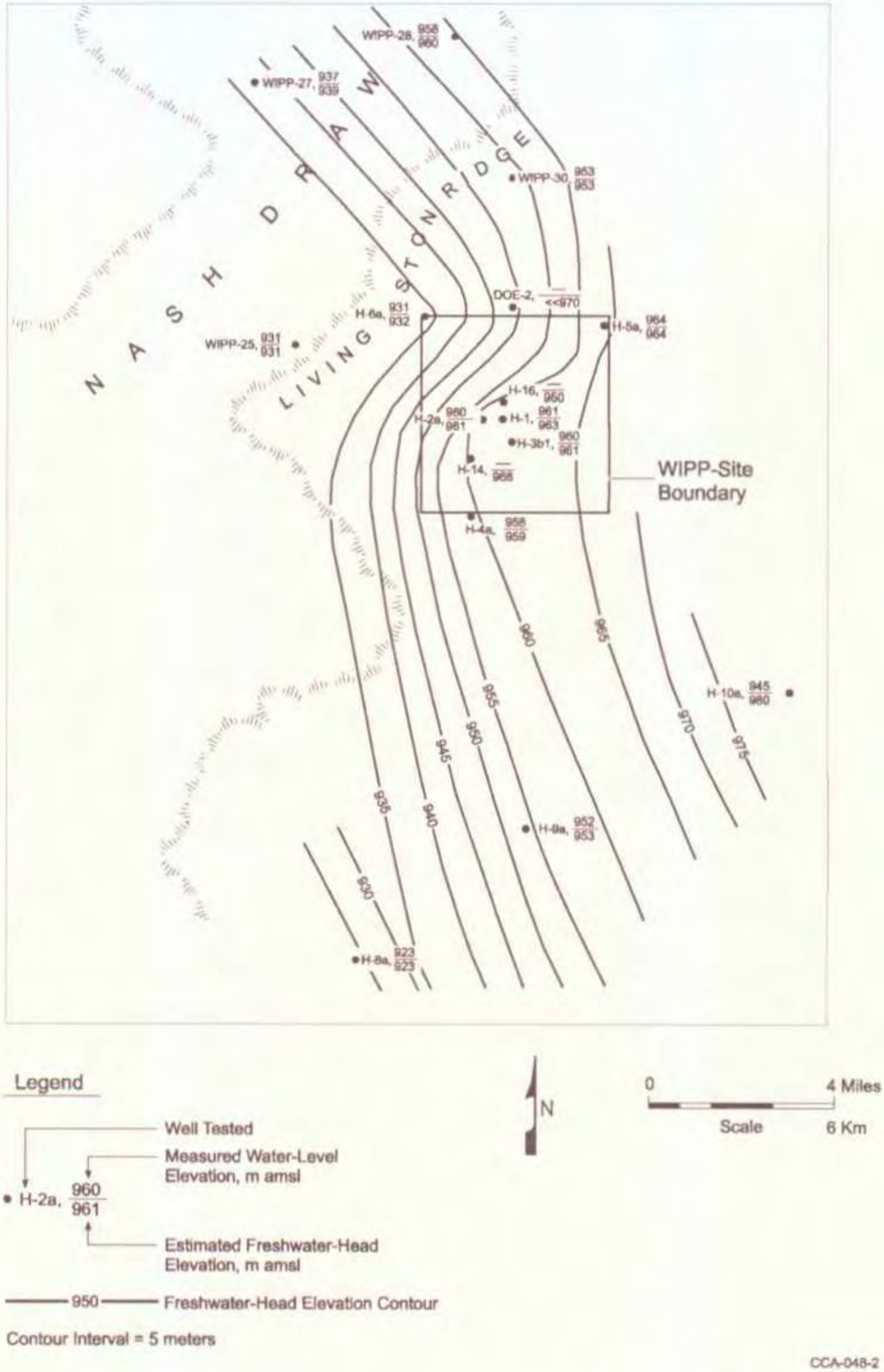


Figure 2-~~32~~*38*. Hydraulic Heads in the Magenta *(1980s)*

and the range of values entered here are those used in that study for the Dewey Lake/Triassic hydrostratigraphic unit.

(2) Values or ranges of values given for these entries are the values used in three-dimensional regional groundwater flow modeling (Corbet and Knupp, 1996). Values are estimated based on literature values for similar rock types, adjusted to be consistent with site-specific data where available. Ranges of values include spatial variation over the WIPP site and differences in values used in different simulations to test model sensitivity to the parameter.

(3) The range of values given here for transmissivity of the Santa Rosa is estimated for the center of the site. Transmissivity is the product of the thickness of the productive interval times its hydraulic conductivity. Thickness of the Santa Rosa is estimated to be 30 meters at the center of the WIPP site, and the range of derived transmissivities are based on the range of hydraulic conductivity values used by Corbet and Knupp (1996) for the combined Dewey Lake/Triassic unit.

(4) The range of values given here by transmissivity of the Dewey Lake is estimated for the center of the site. Transmissivity is the product of the thickness of the productive interval times its hydraulic conductivity. Thickness of the Dewey Lake is estimated to be 140 meters at the center of the WIPP site, and the range of derived transmissivities are based on the range of hydraulic conductivity values used by Corbet and Knupp (1996) for the combined Dewey Lake/Triassic unit.

(5) Hydraulic gradient is a dimensionless term describing change in the elevation of hydraulic head divided by change in horizontal distance. Values given in these entries are determined from potentiometric surfaces. The range of values given for the Culebra reflects the highest and lowest gradients observed within the WIPP site boundary. Values for the Dewey Lake and Santa Rosa are assumed to be the same as the gradient determined from the water table. Note that the Santa Rosa Formation is absent or above the water table in most of the controlled area, and that the concept of a horizontal hydraulic gradient is not meaningful for these regions.

(6) Flow in units of very low hydraulic conductivity is slow, and primarily vertical. The concept of a horizontal hydraulic gradient is not applicable.

Sources: Beauheim, 1986; Domenico and Schwartz, 1990; Domski, Upton, and Beauheim, 1996; Earlough, 1977.

[redacted]
[redacted] Desk,
[redacted]

SEP 16 1998

SAND--98-0049

SANDIA REPORT

SAND98-0049 · UC-721
Unlimited Release
Printed September 1998

Analysis of Hydraulic Tests of the Culebra and Magenta Dolomites and Dewey Lake Redbeds Conducted at the Waste Isolation Pilot Plant Site

Richard L. Beauheim, Gregory J. Ruskauff

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Contract DE-AC04-94AL85000.

Approved for public release; further dissemination unlimited.

Sandia National Laboratories

Printed in the United States of America. This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831

Prices available from (615) 576-8401, FTS 626-8401

Available to the public from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Rd
Springfield, VA 22161

NTIS price codes
Printed copy: A11
Microfiche copy: A01

SAND98-0049
Unlimited Release
Printed September 1998

Analysis of Hydraulic Tests of the Culebra and Magenta Dolomites and Dewey Lake Redbeds Conducted at the Waste Isolation Pilot Plant Site

Richard L. Beauheim
Geohydrology Department 6115
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-0735

Gregory J. Ruskauff
Duke Engineering & Services, Inc.
1650 University Boulevard NE, Suite 300
Albuquerque, NM 87102-1732

ABSTRACT

This report completes documentation of hydraulic-test interpretations used as input to the Compliance Certification Application for the Waste Isolation Pilot Plant (WIPP). Interpretations are presented for 21 tests of the Culebra Dolomite Member of the Rustler Formation conducted at 15 well locations near the WIPP site, one test of the Magenta Member, and one test of the Dewey Lake Redbeds. Single-well pumping tests were conducted in the Culebra at H-19b2, WQSP-4, WQSP-5, and WQSP-6. Slug tests were conducted at H-10b, WIPP-27, and WIPP-28. Multiwell pumping tests were conducted on the H-2, H-6, H-7, H-9, H-11, and H-19 hydropads, where well spacings vary between 36 and 141 ft (11 and 43 m). Interpretable responses to pumping tests at H-9, P-14, WQSP-1, and WQSP-2 were monitored at wells 1,295 to 11,125 ft (395 to 3,390 m) away. The transmissivity of the Culebra ranges from approximately 4 x 10^{-2} to 2 x 10^{3} ft^2/d (4 x 10^{-8} to 2 x 10^{-3} m^2/s) at the tested locations. The Culebra behaves hydraulically as a double-porosity medium at nine of the locations, where open fractures are thought to dominate hydraulic responses. The slug-test data from WIPP-27 and WIPP-28 are inadequate for differentiation of single- from double-porosity behavior. At the four locations where the Culebra transmissivity is 1.2 ft^2/d (1.3 x 10^{-6} m^2/s) or lower, the Culebra responds as a single-porosity medium. Culebra storativity was found to range from 4.7 x 10^{-6} to 6.4 x 10^{-3}. The ratio of maximum to minimum Culebra transmissivity was found to be 1.6 or lower at three tested locations, reflecting little to no hydraulic anisotropy although transport anisotropy determined from tracer tests is significant. Hydraulic boundaries or other evidence of heterogeneity in hydraulic properties were indicated by the responses observed during testing at seven of the high-transmissivity, double-porosity locations. The transmissivity of the Magenta at H-19b1 is 0.38 ft^2/d (4.1 x 10^{-7} m^2/s), the highest value yet encountered on the WIPP site. However, as at all other locations where both the Culebra and Magenta have been tested, the transmissivity of the Magenta is much lower than that of the Culebra at H-19. The transmissivity of a saturated fractured zone within the upper Dewey Lake Redbeds at WQSP-6A, 0.44 mile (0.71 km) southwest of the WIPP disposal panels, is estimated to be approximately 360 ft^2/d (3.9 x 10^{-4} m^2/s). This zone of saturation appears to extend south of WQSP-6A, but not to the northeast over the disposal panels.

ACKNOWLEDGMENTS

The authors wish to thank the many field crews responsible for carrying out the tests discussed in this report. We also wish to thank Randy Roberts, Al Lappin, and Levy Kroitoru for their helpful reviews. Bob Jones' assistance with manuscript preparation is especially appreciated.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

CONTENTS

Tables

Figures

1. INTRODUCTION

This report presents interpretations of hydraulic tests conducted at 15 well locations in the vicinity of the Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico (Figure 1-1) between 1980 and 1996. The WIPP is a U.S. Department of Energy (DOE) facility to demonstrate safe disposal of transuranic wastes arising from the nation's defense programs. The WIPP repository lies within bedded halite of the Salado Formation, 2,155 ft (655 m) below ground surface. The tests reported herein were, with two exceptions, conducted in the Culebra Dolomite Member of the Rustler Formation, which overlies the Salado Formation (Figure 1-2). The remaining tests were conducted in the Magenta Member of the Rustler and in the overlying formation, the Dewey Lake Redbeds. This report completes the documentation of hydraulic-test interpretations used as input to the WIPP Compliance Certification Application (US DOE, 1996).

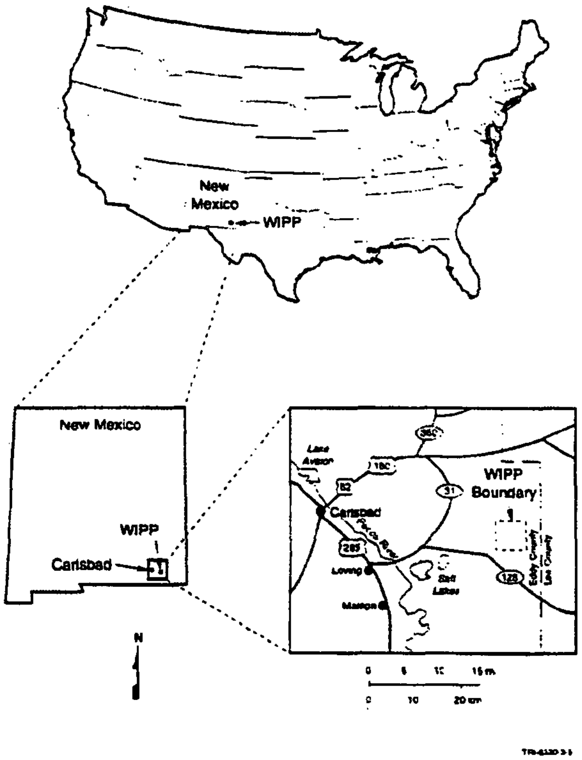


Figure 1-1. Location of the Waste Isolation Pilot Plant.

The Culebra is the most transmissive water-saturated unit overlying the WIPP repository and, as such, represents a possible pathway for transport of radionuclides to the accessible environment if the repository is ever breached through inadvertent human intrusion. As part of the characterization of the WIPP site, extensive testing of the Culebra has been performed at 43 well locations to determine its hydraulic and, in some cases, transport characteristics. The Magenta is typically one or more orders of magnitude less transmissive than the Culebra at any given location and, consequently, has been tested less extensively than the Culebra. Data are now available for the Magenta from 15 well locations. The Dewey Lake Redbeds have not been found to be saturated over most of the WIPP site. The test reported herein was performed in the first well on the WIPP site completed to an unambiguously saturated portion of the Dewey Lake.

The tests of the Culebra discussed in this report include multiwell (interference) pumping tests conducted at hydropads H-2, H-6, H-7, H-9, H-11, and H-19, and at test wells P-14, WQSP-1, and WQSP-2, and from single-well hydraulic tests conducted in wells H-10b, H-19b2, WIPP-27, WIPP-28, WQSP-4, WQSP-5, and WQSP-6 (Figure 1-3). Interpretations of a slug test of the Magenta conducted in well H-19b1 and of a single-well

System	Series	Group	Formation	Member	Approximate Thickness* (m)	(ft)
Quaternary	Recent		Surficial Deposits		3	10
	Pleistocene		Mescalero Caliche		10	30
			Gatuña			
Triassic		Dockum	Undivided		3	10
Permian	Ochoan		Dewey Lake Redbeds		150	500
			Rustler	Forty-niner	16	60
				Magenta	7	24
				Tamarisk	26	85
				Culebra Dolomite	7	24
				unnamed	37	120
			Salado		600	2000
			Castile		400	1300
	Guadalupian	Delaware Mountain	Bell Canyon		310	1000
			Cherry Canyon		335	1100
			Brushy Canyon		550	1800

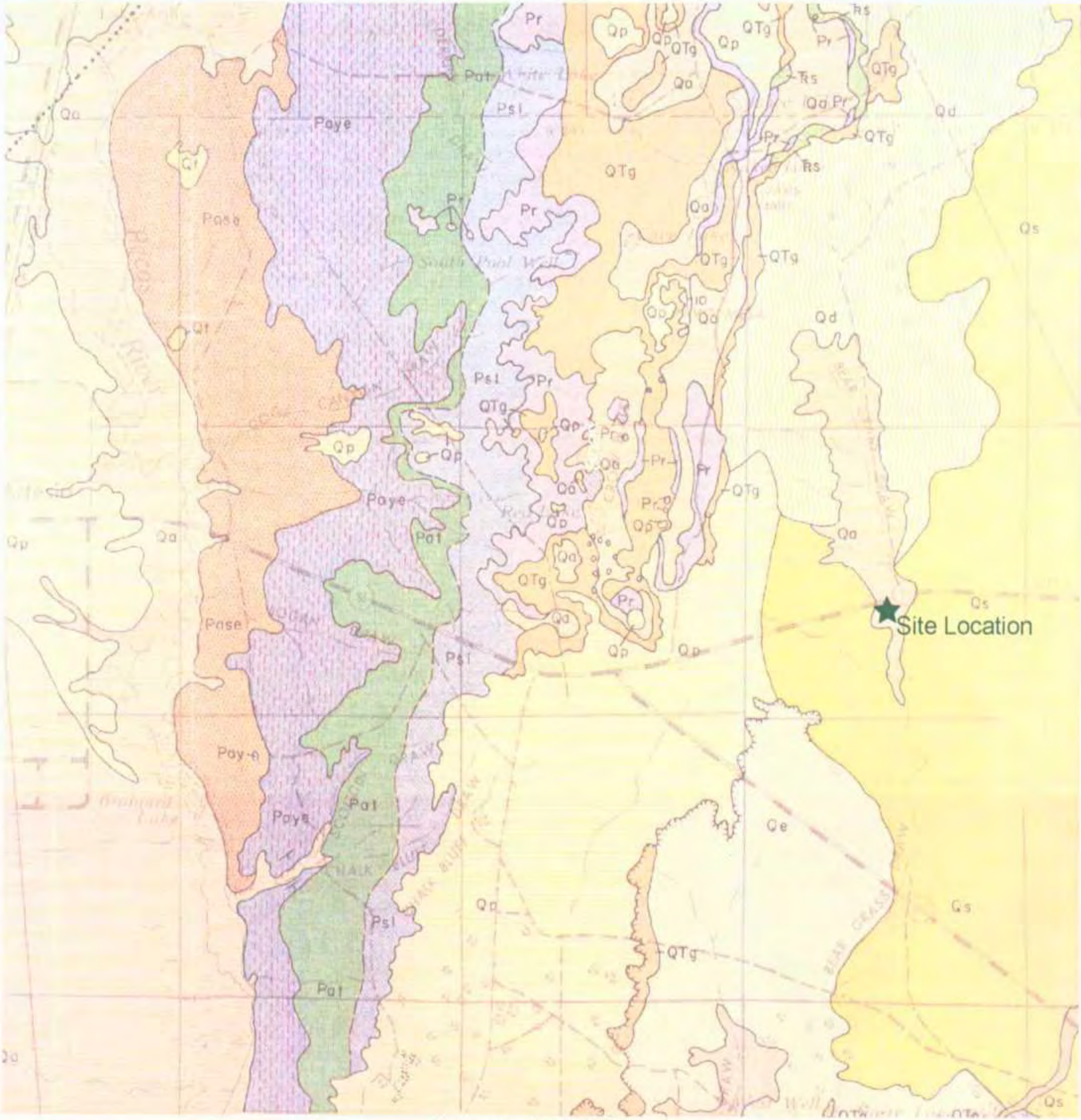
* At center of WIPP site.

Figure 1-2. WIPP area stratigraphic column.

pumping test of the Dewey Lake Redbeds conducted in well WQSP-6A are also included. INTERA, Inc. (now Duke Engineering & Services, Inc., Austin, TX) conducted the tests at H-7, H-11, H-19, P-14, and the WQSP wells under the technical direction of Sandia National Laboratories (Albuquerque, NM), Hydro Geo Chem, Inc. (Tucson, AZ) was responsible for the design and performance of the tests at H-2, H-6, and H-9, and the US Geological Survey (USGS) conducted the tests at H-10b, WIPP-27, and WIPP-28.

The analyses presented herein were performed under the Sandia National Laboratories WIPP Quality Assurance Program Description, Revision R (on file in the Sandia WIPP Central Files [SWCF] under WPO#37209), and the following Quality Assurance Procedures (QAPs):

- QAP 6-2 (Preparing, Reviewing, and Approving Technical Information Documents);
- QAP 9-1 (QA Requirements for Conducting Analyses);
- QAP 17-1 (WIPP Quality Assurance Records Source Requirements);
- QAP 19-1 (WIPP Computer Software Requirements); and
- QAP 20-2 (Preparing, Reviewing, and Approving Scientific Notebooks).

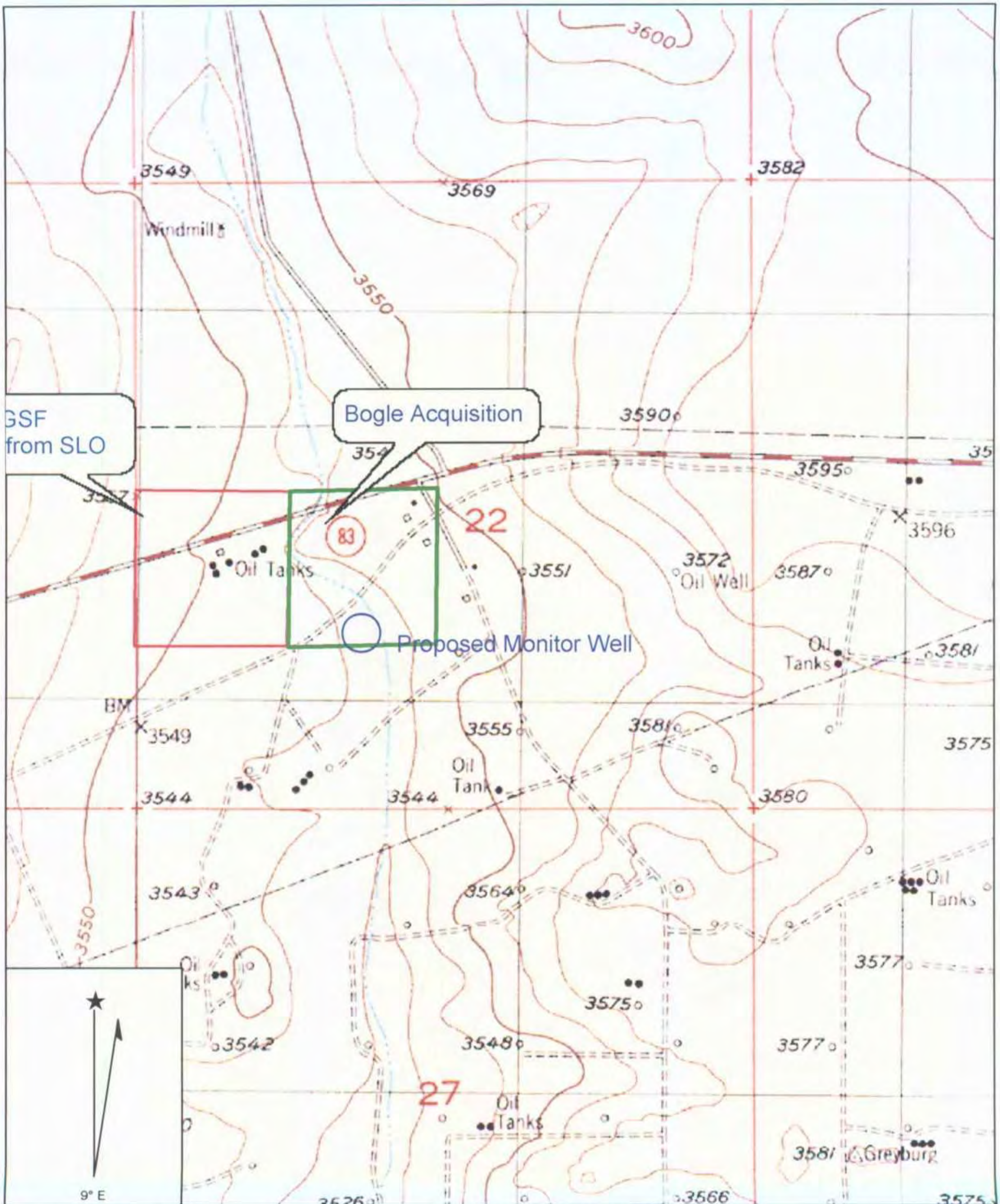


Map source: Kelley, 1971

N

1.5 0 3 miles

R.T. HICKS CONSULTANTS, LTD. 901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87104 505.266.5004 Fax: 505.266.0745	Loco Hills GSF	Plate 2
	Surface Geologic Map	August 2004



Name: RED LAKE SE
Date: 5/11/2004
Scale: 1 inch equals 1000 feet

Location: 032.8174199° N 104.0605926° W
Caption: Plate 1: Parcel Map

Logger:	David Hamilton	Client:	Well ID:
Driller:	Dubose Drilling	LHGSF	
Drilling Method:	Air Rotary	Project Name:	
Start Date:	6/17/2004		
End Date:	6/18/2004	Location:	P-1
Notes:		Loco Hills	

Depth (feet)	Description
0.0–7.0	Surface, sand, some gypsum, some clay, red, 0-7 ft.
7.0–9.0	Sand, light red, dry, 7-9 ft.
9.0–12.0	Caliche, sand, 9-12 ft.
12.0–14.0	Clay, caliche, red, dry, 12-14 ft.
14.0–17.0	Clay, red, dry, 14-17 ft.
17.0–22.0	Clay, some sand, minor caliche, red, dry, 17-22 ft.
22.0–25.0	Clay, some sand, red, dry, 22-25 ft.
25.0–27.0	Sand, clay, red, dry, 25-27 ft.
27.0–28.0	Clay, red, dry, 27-28 ft.
28.0–32.0	Sand, some clay, light red, dry, 28-32 ft.
32.0–39.0	Sand, silt, clay, light red, dry, 32-39 ft.
39.0–41.0	Limestone, light grey, dry, 39-41 ft.
41.0–42.0	Sand, limestone, 41-42 ft.
42.0–46.0	Clay, red, soft, 42-46 ft.
46.0–48.0	Clay, sand and caliche, 46-48 ft.
48.0–61.0	Gypsum, white, dry, 48-61ft.
61.0–63.0	Gypsum, hard, white, 61-63 ft.
63.0–82.0	Gypsum, white, dry, 63-82 ft.
82.0–84.0	Clay, red, moist, 82-84 ft.
84.0–87.0	Clay, red, gypsum, 84-87 ft.
87.0–88.0	Clay, gypsum, hard, 87-88 ft.
88.0–91.0	Sand, clay, limestone, 88-91 ft.
91.0–93.0	Gypsum, clay, tan, dry, 91-93 ft.
93.0–97.0	Gravel, wet, 93-97 ft., est. 1-2 gal./min.
97.0–101.0	Sand, clay, tan, 97-101ft.

Depth scale: 0.0, 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0, 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0, 62.0, 64.0, 66.0, 68.0, 70.0, 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0, 92.0, 94.0, 96.0, 98.0, 100.0

Lithology

Piezometer Construction

Interval
Cement
Bentonite
Bentonite and Cuttings
Bentonite
Sand
Bentonite
Bentonite and Cuttings
Bentonite
Sand
Bentonite
Sand

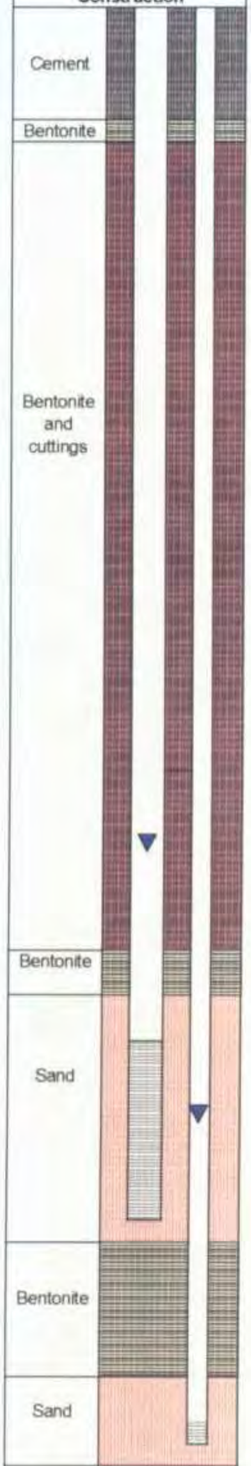
R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	Loco Hills GSF	Plate D-1
		July 2004

Logger:	David Hamilton	**Client:**	**Well ID:**
Driller:	Dubose Drilling	LHGSF	
Drilling Method:	Air Rotary	**Project Name:**	
Start Date:	6/17/2004		
End Date:	6/18/2004	**Location:**	**BGD MW-1**
Notes:		Loco Hills	

Depth (feet)	Description
0.0	Surface, 0-5 ft.
2.0	
4.0	Sand, clay, grey, 5-9 ft.
6.0	
8.0	Sand, caliche, tan, 9-11 ft.
10.0	Clay, sand, red, 11-14 ft.
12.0	
14.0	Sand, clay, red, 14-19 ft.
16.0	
18.0	Clay, red, little sand, 19-22 ft.
20.0	
22.0	Sand, clay, red, 22-26 ft.
24.0	
26.0	Clay, sand, red, 26-29 ft.
28.0	
30.0	Sand, clay, red, dry, 29-39 ft.
32.0	
34.0	
36.0	
38.0	Clay, red, 39-41 ft.
40.0	
42.0	Sand, clay, red, 41-48 ft.
44.0	
46.0	
48.0	Clay, sand, 48-49 ft.
50.0	Sand, clay, 49-51 ft.
52.0	Clay, red, soft, some sand, 51-54ft.
54.0	Sand, tan, 54-55 ft.
56.0	
58.0	Clay, red, some sand and gypsum, 55-62 ft.
60.0	
62.0	
64.0	
66.0	
68.0	Gypsum, white, dry, 62-74 ft.
70.0	
72.0	
74.0	
76.0	Gypsum, clay, soft, 74-80 ft.
78.0	
80.0	
82.0	Gypsum, white, dry, 80-87 ft.
84.0	
86.0	
88.0	Clay, gypsum, moist, 87-93 ft.
90.0	
92.0	Clay, sand, red, moist, 93-97 ft.
94.0	
96.0	Clay, gypsum, sand, 97-100 ft.
98.0	
100.0	Clay, sand, red, 100-102 ft.
102.0	Gypsum, 102-105 ft.
104.0	
106.0	Limestone, gypsum, 105-109 ft.
108.0	
110.0	Clay, limestone, gypsum, 109-114 ft.
112.0	
114.0	Gypsum, 114-117 ft.
116.0	
118.0	Clay, red, 117-125 ft.
120.0	
122.0	
124.0	Clay, grey-blue, 125-129 ft.
126.0	
128.0	
130.0	

Lithology

Well and Piezometer Construction



<u>R.T. Hicks Consultants, Ltd</u> 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	**Loco Hills GSF**	**Plate D- 2** **July 2004**

Logger:	David Hamilton	Client: LHGSF	Well ID: P-2
Driller:	Dubose Drilling	Project Name:	
Drilling Method:	Air Rotary		
Start Date:	6/23/2004	Location: Loco Hills	
End Date:	6/24/2004		
Notes:			

Depth (feet)	Description
0.0–6.0	Surface, 0-6 ft.
6.0–10.0	Clay, red, dry, 6-10 ft.
10.0–12.0	Clay, red, dry, little caliche 10-12 ft.
12.0–16.0	Clay, red, dry, 12-16 ft.
16.0–18.0	Clay, red, dry, little sand, 16-18 ft.
18.0–27.0	Clay, red, dry, 18-27 ft.
27.0–33.0	Clay, sand, red, dry, 27-33 ft.
33.0–47.0	Sand, clay, red, dry, 33-47 ft.
45.0–50.0	Clay, red, gypsum, 45-50 ft.
50.0–53.0	Clay, sand, red, slightly soft, 50-53 ft.
53.0–63.0	Sand, clay, red, 53-63 ft.
63.0–67.0	Clay, sand, red, some gypsum, 63-67 ft.
67.0–69.0	Gypsum, white, dry, 67-69 ft.
69.0–75.0	Clay, red, gypsum, 69-75 ft.
75.0–78.0	Gypsum, clay, red, some blue, 75-78 ft.
78.0–83.0	Clay, red, gypsum, some sand, 78-83 ft.
83.0–88.0	Gypsum, clay, grey and red, 83-88 ft.
88.0–99.0	Clay, grey and red, some gypsum, 88-99 ft.
99.0–103.0	Gypsum, white, dry, 99-103 ft.
103.0–105.0	Clay, red, some silt and gypsum, soft, 103-105 ft.
105.0–110.0	Clay, red, dry, 105-110 ft.

Depth (feet): 0.0, 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0, 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 52.0, 54.0, 56.0, 58.0, 60.0, 62.0, 64.0, 66.0, 68.0, 70.0, 72.0, 74.0, 76.0, 78.0, 80.0, 82.0, 84.0, 86.0, 88.0, 90.0, 92.0, 94.0, 96.0, 98.0, 100.0, 102.0, 104.0, 106.0, 108.0, 110.0

Lithology

Well and Piezometer Construction

Well and Piezometer Construction
Cement
Bentonite
Bentonite and cuttings
Bentonite
Sand
Bentonite
Bentonite and cuttings
Bentonite
Sand
Bentonite
Bentonite and cuttings
Bentonite
Sand

R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	Loco Hills GSF	Plate D-3 July 2004

Logger:		Client:	Well ID:
Driller:		LHGSF	
Drilling Method:		Project Name:	
Start Date:	5/1/2003		MW-1
End Date:	5/1/2003	Location:	
Notes:		Loco Hills	

Depth (feet)	Description
0.0	Surface, very fine grained sand, red, 0-5 ft.
2.0	
4.0	
6.0	
8.0	Caliche, sand, clay, 5-14 ft.
10.0	
12.0	
14.0	
16.0	
18.0	
20.0	Clay, red, very sandy, 14-30 ft.
22.0	
24.0	
26.0	
28.0	
30.0	
32.0	
34.0	
36.0	
38.0	
40.0	
42.0	
44.0	
46.0	
48.0	Clay, some fine gravel, 30-67 ft.
50.0	
52.0	
54.0	
56.0	
58.0	
60.0	
62.0	
64.0	
66.0	
68.0	
70.0	Conglomerate, limestone, grey to dark grey, 67-77 ft.
72.0	
74.0	
76.0	
78.0	
80.0	
82.0	Clay, red, 77-88 ft.
84.0	
86.0	
88.0	
90.0	
92.0	Clay, red, very sticky, 88-93 ft.
94.0	
96.0	
98.0	
100.0	Limestone, gypsum, white to light grey, some fractured, 93-109 ft.
102.0	
104.0	
106.0	
108.0	
110.0	Clay, red, 109-113 ft.
112.0	
114.0	Clay, blue grey, 113-116 ft.
116.0	
118.0	Clay, red, silty, 116-120 ft.
120.0	

Lithology

R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	Loco Hills GSF	Plate D-4
		July 2004

The remainder of this report has been omitted in this hard copy due to its size, but may be found in the electronic submission.

November 10, 2004

Stage I & II Abatement Plan

LOCO HILLS GAS STORAGE FACILITY
LOCO HILLS, NEW MEXICO

Prepared for:

Loco Hills GSF, Ltd.
158 Deer Creek Drive
Aledo, Texas 76008

R.T. HICKS CONSULTANTS, LTD.
901 RIO GRANDE BLVD. NW, SUITE F-142, ALBUQUERQUE, NM 87104

TABLES

PLATES

APPENDICES

1.0 INTRODUCTION

Loco Hills GSF proposes to voluntarily restore ground water quality beneath the Loco Hills Gas Storage Facility (Loco Hills GSF) near Loco Hills, New Mexico. The site is located in the NW SW Section 22 Township 17S Range 29E, about 5 miles west of Loco Hills, New Mexico. Previous operators of the site caused the ground water impairment in the 1950s-1960s during the construction of bedded salt storage caverns beneath the site.

Data in NMOCD files from 1981 show that the total dissolved solids (TDS) of ground water beneath the site exceeded 120,000 mg/L. When the current owner took possession of the facility in 2003, the quality of underlying ground water was not materially different. Because of voluntary efforts implemented by the current owners, the chloride concentration in ground water has decreased from about 75,000 mg/L (2003 data) to about 41,000 mg/L (2004 data). Ground water beneath the site lies within 2- to 4-foot thick sandstone and limestone units at a depth of about 80 feet below land surface. About 60 feet of clay and anhydrite (or gypsum) beds create a leaky aquitard overlying the water-bearing units.

Loco Hills GSF proposes to pump the chloride-rich ground water into a clay-lined storage pond for use at the gas storage facility. Evaporation from the pond and the sale of brine for oil well drilling will cause a net export of water from the site. The withdrawal of saline water introduced to the ground water system by past practices will allow background quality ground water to naturally flow into the area and restore ground water quality.

As described in the accompanying *Best Management Practices Plan and Application for an Exemption to Rule 50 (BMP)*, a small volume of saturated brine will seep through the clay liner of the storage pond into the underlying earth material. Predictions presented in the BMP allow us to conclude that this seepage will not enter ground water. Nevertheless, the pumping program proposed in this abatement plan can capture any seepage from the pond that unexpectedly enters the ground water system.

1.1 DESCRIPTION OF THE SITE

The 2004 Best Management Practices Plan describes the Loco Hills GSF (LH GSF) as it now exists. Plate 1 is a map showing the location of the site. The site is located in the NW SW Section 22 Township 17S Range 29E.

1.2 SITE HISTORY AND NATURE OF THE RELEASE

Table 1 (attached) provides the chronology of the development of the site.

After examination of the data presented herein, we have determined that discharges to a former seepage pit in the 1950s caused brine to enter a permeable caliche horizon that exists throughout much of the site at a depth of about 10 feet below land surface. Brine then flowed within the caliche layer down dip to the location of two water supply wells, one of which is still operational. Because these wells had no sanitary surface seal, they provided an excellent conduit between the brine-saturated caliche layer and the underlying ground water zone. In 1981, the operator of the site notified NMOCD that the ground water beneath the site exhibited a chloride concentration of more than 60,000 mg/L. Because the water analysis of 1981 was probably similar to recent analyses, we conclude that the total dissolved solids of the ground water in 1981 exceeded 120,000 mg/L. The background TDS of the ground water of the area is about 2,500 mg/L. When Loco Hills GSF assumed ownership of the facility in 2003, chloride concentration in ground water ranged from 40,000 mg/L to about 75,000 mg/L. Because of the voluntary actions of the owners, chloride in ground water now ranges between 19,000 and 41,000 mg/L.

No evidence exists that suggests that the operations of Loco Hills GSF have contributed to the observed high TDS in ground water. As suggested above, the contrary appears to be the case. All evidence suggests that the ground water impairment occurred during the construction of the salt caverns in the 1950s.

1.3 SUMMARY OF PREVIOUS INVESTIGATIONS

This Stage I & II Abatement Plan summarizes all previous hydrogeologic investigations. All hydrogeologic investigations were conducted by R.T. Hicks Consultants, Ltd. Pettigrew and Associates conducted all engineering testing and design of the clay-lined brine storage pond, which are included in the BMP.

2.0 SITE HYDROLOGY

2.1 REGIONAL GEOLOGY

Plate 2 is a surface geologic map of the area (Kelley, 1971). The map shows that Quaternary alluvium (Qa) underlies the site. Up dip from the site (northeast) are exposures of the Permian Rustler Formation (Pr). North of the site, Kelley maps the Triassic Santa Rosa Sandstone (Trs) overlying the Rustler.

The axis of the Artesia Vacuum Arch passes along the southern boundary of the Loco Hills GSF (Plate 3). This structural feature is a 75-mile long, southwest to northeast trending anticline (Kelley, 1971). The Artesia Vacuum Arch extends from approximately 25 miles west of the Pecos River to the east of the LH GSF. North of the LH GSF, regional dip is slight and to the north. South of the LH GSF, dip is also slight and to the southeast.

2.2 SITE LITHOLOGY

Our surface examination revealed a very thin veneer of Quaternary Alluvium at and near the site. Throughout the site and on adjacent land, natural scours and man-made excavations exposed red clay beds, similar to those of the Dockum Group. We found no evidence of the Santa Rosa Sandstone in the outcrop.

From the three boreholes drilled in the field program and the well log from the boring of MW-1, we constructed an east-west cross section with a depth extending to 130 feet (Plate 4, and Appendix A). In all of the boreholes, a caliche layer is present below the surface at depths up to 15 feet. It is variable in thickness from 2 feet in P-2 to 10 feet in MW-1. Below this caliche layer, we found red clays with some layers containing clastic material. These clay beds extended to depths of at least 46 feet at P-1 to 92 feet at MW-1. This lithology belongs to the Dockum Group Redbeds.

We observed a change in lithology in the lower half of the boreholes. From careful inspection of the well logs for MW-1 and BGD MW-1, we can correlate a gypsum, clay, and limestone sequence between 90 and 130 feet below surface. This lithology belongs to the Rustler Formation.

Our attempts at correlation of the Dockum Group claystone and sandstone illustrate the typical discontinuous bedding. Correlation of units within the Rustler was only slightly more successful (see Plate 4). In BGD MW-1, we found that individual Rustler beds are 10 to 20 feet lower in elevation than at the site. This difference is probably due to the gentle, southeastern dip caused by the Artesia-Vacuum Arch and/or the regional dip toward the Permian Basin center. Correlation is difficult due to the large variation of gypsum thickness in the four borings. At P-1, drilling exposed over 30 feet of continuous gypsum. At P-2, 450 feet to the northwest, the bit penetrated 46 feet of inter-bedded red clay and gypsum. At MW-1, in the southeastern corner of the LH GSF, the driller observed only 12 feet of gypsum, all below the water level. At BGD MW-1, 1,580 feet further to the southeast of MW-1, 50 feet of inter-bedded clay, gypsum, and limestone exist.

2.3 MAGNITUDE AND EXTENT OF SALT IN THE VADOSE ZONE

Chloride analysis of cuttings from P-1 show low levels of chloride to a depth of at least 80 feet (Plate 7) and higher chloride concentrations at 90 feet (the depth of the first ground water zone) and at 100 feet (the depth of the second water-bearing zone). As shown on Plate 4 and 5, this boring/well is about 150 feet from the edge of the former seepage pit.

As stated earlier, we believe that chloride from the former seepage pit entered the subsurface via a fractured caliche layer that extends throughout most of the site. Brine migrated in this layer to other parts of the site and drained to ground water via the existing and abandoned water wells. The chloride content of cuttings from P-1 suggest that the residual chloride in the vadose zone is not present throughout the site.

2.4 SURFACE WATER HYDROGEOLOGY

Plate 1 shows that the Loco Hills GSF lies adjacent to Bear Grass Draw, about 4.5 miles west of Loco Hills, New Mexico. Bear Grass Draw is mapped as an ephemeral drainage with "headwaters" about 4 miles north of the Loco Hills GSF. Bear Grass Draw drains to a closed basin about 9 miles south of the facility. Our field inspection found neither a developed channel for this drainage nor evidence of water flow within the recent past. We performed our first inspection on October 8, 2003, during a 2-day precipitation event that caused flooding north of Artesia. We performed a second, more exhaustive inspection of Bear Grass Draw on November 3, 2003 and found no evidence of an active watercourse.

2.5 GROUND WATER HYDROGEOLOGY

2.5.1 Nearby Water Supply Wells and Springs

One windmill, now abandoned, lies within Bear Grass Draw north of the facility (see Plate 1). Adjacent to this abandoned windmill is a newly constructed water supply well. A second windmill exists within the Draw about 4.5 miles south of the facility. Examination of the records at the Office of the State Engineer and our reconnaissance identified no water wells within several miles of the facility, except for the active well north of the facility and the wells located on the facility. Neither examination of maps nor field reconnaissance found any evidence of springs in the area.

2.5.2 Results of Field Programs

During the field program of June, 2004, we obtained water levels from:

- P-1, on the east side of the new clay pond;
- SW-1 and SW-2, the supply wells;
- MW-1, the monitoring well; and
- BGD MW-1 and BGD P-1, a monitoring well and piezometer (see Table 2).

Table 2. Depth to Water and Elevation of Potentiometric Surface, Loco Hills GSF in ft.

	Supply Well 1 N. of High. 82	Supply Well 2 W. of lined Brine Pit	Monitoring Well 1 S.S. corner of lined Brine Pit	Bear Grass Draw Monitoring Well 1	Bear Grass Draw Piez. 1 129 ft.	Piez 1-1 100 ft. E. of new Clay Pit	Piez. 1-2 88 ft. E. of new Clay Pit
Pecos V. Pump., 2002		36 3511.3					
Driller 5/2/2003			83 3465.9				
R. T. Hicks 10/8/2003	86.58 3462.7						
R. T. Hicks 6/25/2004	77.1 3472.2	81.3 3465.95	83.72 3465.18	78.48 3464.64	102.59 3440.51	86.64 3467.51	86.76 3467.59
LH GSF 7/21/2004		83.25 3464	83.84 3465.06			86.76 3467.39	86.87 3467.48
LH GSF 7/22/2004		90.54 3456.71	83.5 3465.4			98.17 3455.98	84.67 3469.68
P1-3 at 36 ft.deep and the three piezometers at P-2 on the north side of the clay pond are all dry. The piezometers at P-2 are at depths of 60, 82, 110 feet bgs.							

No water exists in any of the piezometers in P-2 at the time of writing. With this data, we have constructed a potentiometric surface for the site. Ground water flow is to the south-southeast (See Plate 5). We note from curvature of the potentiometric surface contours that there exists a small depression in the potentiometric surface near SW-2. We believe that recent continual pumping of the supply well is creating an impact on the potentiometric surface. Water levels obtained for this map occurred after all pumping at the site had ceased for several days.

Plate 6 is a potentiometric surface map using data after pumping of Supply Well #2 for 2 days. The pumping water level in SW-2 is 102 feet just before the pump begins one of the approximately 12 minute long pumping cycles (after 15 minutes of no pumping) and is 104 feet at the end of the pumping cycle. To create Plate 6, we used the average of these two measurements for SW-2. We used the water levels in nearby wells obtained at the end of the 5-day pumping period.

Ground water beneath the site resides in confined water bearing zones. Chemical evidence shows that at P-1 and BGD MW-1 we encountered ground water at approximately 95 feet in sandy beds underneath gypsum. At MW-1, the driller reported ground water at 93 feet in a fractured limestone. Water levels rose 10-13 feet from the first encounter in all borings. Furthermore, in BGD P-1, the piezometer nested with and isolated from BGD MW-1, the monitoring well; the water level also rose about 12 feet above its screened height. As stated above, chloride analysis of cuttings from P-1 show low levels of chloride to a depth of at least 80 feet (Plate 7) and higher chloride concentrations at 90 feet (the depth of the first ground water zone) and at 100 feet (the depth of the second water-bearing zone). The static water level in P-1 is about 86 feet from ground surface. Background chloride concentrations at a depth of 80 feet in this well are not possible unless the saline ground water is confined in lower hydrostratigraphic units. We conclude that the water-bearing zones are confined and that there are multiple layers of confined water in the Bear Grass Draw area. Plate 4 shows the location of the water bearing zone and the static water level in each well.

At P-1, the driller estimated flow at 1-2 gallons per minute while at BGD MW-1, flow was only sufficient to make drilling difficult. The supply wells provide sufficient water for the needs of the facility. At SW-2, the well must be on a timer to prevent cavitation of the pump. We conclude that the transmissivity of the hydrostratigraphic units is very low where ground water is present. The steep hydraulic gradient in this area also suggests a low transmissivity.

Published reports suggest the Rustler Formation in Eddy County suggest a hydraulic conductivity for the claystone/dolomite/anhydrite section of the formation ranges between 1 and 20 feet/day. This value is consistent with textbook values for similar consolidated sedimentary rock.

2.6 MAGNITUDE, EXTENT AND ORIGIN OF TDS IN GROUND WATER

The total dissolved solids (TDS) of ground water beneath the site exceed 100,000 mg/L. Table 3 shows the results of recent sampling at the site. Chloride concentrations are highest in MW-1 and the deep piezometer in

Table 3. Chloride Concentrations in Wells at Loco Hills GSF in mg./l.

	Supply Well 1 N. of High. 82	Supply Well 2 W. of lined Brine Pit	Monitoring Well 1 S.S. corner of lined Brine Pit	Bear Grass Draw Monitoring Well 1	Bear Grass Draw Piez. 1 129 ft.	Piez 1-1 100 ft. E. of new Clay Pit	Piez. 1-2 88 ft. E. of new Clay Pit
Arrow Gas 1981	60,680						
Cardinal Labs 5/28/2003	45,988	42,987	74,977				
Cardinal Labs 6/12/2004	32,990	42,987	58,982				
R. T. Hicks 6/25/2004			52,984	16,622	18,540	22,298	22,549
LH GSF 7/14/2004	19,619	20,927	40,588	11,497	28,258	15,329	24,559

Bear Grass Draw (BGD P-1, see Plate 8). The lowest chloride concentrations are in BGD MW-1 and P-1. At 4.5 miles south of the site and less than a mile north of the site, windmills in Bear Grass Draw supply water that is suitable for livestock.

The horizontal extent of the ground water body that exceeds 250 mg/L chloride and 1000 mg/L TDS could be quite large. Plate 9 presents our estimate of the maximum extent of high TDS water caused by past actions at the facility. The geometry of the high TDS ground water represented in Plate 9 assumes that the saturated zone beneath the site actually extends south of BGD MW-1. Published reports suggest that individual ground water zones within the Rustler Formation are discontinuous. Our site investigation confirms the discontinuity of the ground water zone as P-2 is dry. We believe that the extent of subsurface high TDS water may be significantly smaller than that displayed on Plate 9 and the proposed testing program will better define the extent of high TDS ground water.

The high TDS value for ground water beneath the facility is not surprising because a previous owner used an earthen seepage pit to dispose of brine during the drilling and expansion of the salt caverns. To create a storage capacity (void) in the caverns of more than 9,000,000 gallons, the previous owner disposed of about 36,000,000 gallons of saturated brine (saturated brine is 26% NaCl). On Plate 4, we suggest that this former seepage pit penetrated the caliche horizon at 6-10 feet below ground surface. Brine discharged to this pit would fully saturate this permeable zone that overlies the red clay of the Dockum Group. The brine in the caliche would flow down dip (east) toward the current supply well SW-2 and perhaps downhill (north) toward the adjacent older supply well with collapsed casing (see Plate 8). Although no records exist that describe the construction of these supply wells, they are clearly quite old. Descriptions of these wells in NMOCD files indicate the wells are 150 feet deep. In measuring the water level in SW-2, we encountered several obstructions that suggest split casing. We conclude that the brine moved from the caliche to ground water via the conduit formed by SW-2 and by the collapsed well west of SW-2.

While we do not know the exact depth of SW-2, we presume it is 150 feet deep as indicated in NMOCD files. Because of the density difference between brine and the natural ground water, brine migration through the well bore would displace the water in the bottom of the well casing. The density of the brine combined with the head caused by the leakage from the caliche would force the brine into the water bearing units like an injection well. The fact that separate confined units exhibit similar levels of chloride (see BGD MW-1 v. BGD P-1) requires a source that is a conduit between these two confined saturated units, not seepage from the surface.

From the discussion above, we can conclude that the vertical extent of high TDS water at the site extends from the potentiometric surface to the total depth of the supply wells.

2.6.1 Fate and Transport of High TDS Ground Water

Ground water flows south in the area of the facility. The hydraulic conductivity of the saturated units within the Rustler Formation are quite low. In the absence of ground water pumping at the facility, the calculated rate of transport (pore velocity) is:

$V = (K * dh/dl)/n$

Where
N = porosity (about 25%)
K = 1 foot/day to 10 feet/day
dh/dl = 0.02

The calculated rate of transport ranges between 35 and 350 feet/year. The estimated maximum down gradient extent of ground water quality impairment shown in Plate 9 suggests a migration rate of about 75 feet/ year.

As stated earlier, we believe that the impairment of ground water quality occurred when a previous operator constructed the gas storage caverns in the mid 1950s. During this time, the center of mass of chloride and TDS migrated about 300 feet from Supply Well #2, which is the source of the chloride input to ground water. Thus, the migration rate of the plume's center of mass is less than 10 feet per year (300 feet/45 years).

Provided that the Loco Hills GSF facility remains in operation, ground water pumping will retard the natural migration of high TDS water. Approval of the Stage II Abatement Plan, which requires the construction of the proposed 11,000,000 gallon clay-lined storage lagoon, will permit more aggressive ground water pumping. We believe this aggressive pumping strategy will cause the complete restoration of ground water quality in the area affected by past releases. Details concerning the construction of the proposed clay-lined storage pond are in the Best Management Practices Plan.

2.6.2 Summary of Support to Our Hydrogeologic Hypothesis

We believe that several lines of evidence support the hypothesis that brine from the seepage pit impacted ground water due to migration through the conduit of SW-2.

1. The more permeable limestone and sands within the dominant clay and gypsum in P-1 and MW-1 were dry and showed no evidence of seepage from the pit to ground water.
2. The clay and gypsum underlying the site are aquitard and would restrict the downward migration of brine from the surface to ground water.
3. Because ground water is confined at the site, the fluid mechanics reduce the probablity that seepage from the former brine pond could ever enter ground water.
4. The chloride concentration in the vadose zone at P-1 is very low, indicating that brine did not migrate through the deep vadose zone near the seepage pit.
5. The slope of the caliche and the nature of SW-2 create a reasonable pathway for brine to migrate to ground water.
6. The geometry of the high TDS ground water also suggests migration via SW-2.

We conclude that the hydrogeology of the site favor employing a clay-lined lagoon, provided that seepage from the lagoon does not enter the caliche layer described above.

3.0 PROPOSED MONITORING PROGRAM

For the first two years of implementation of this Abatement Plan, Loco Hills GSF will:

1. Determine volume of water pumped from each supply well on a monthly basis.
2. Obtain quarterly water levels in all monitoring wells,
3. Obtain quarterly water samples from all monitoring wells.
4. Use on-site field techniques to measure the chloride concentration of the water samples.
5. On an annual basis, Loco Hills will also submit water samples to a laboratory for analysis of TDS and chloride.

For the first two years, Loco Hills GSF will provide NMOCD with the results of the monitoring program in March of each year. The purpose of this initial monitoring is to collect data that will assist in better understanding the hydraulic response to the proposed abatement plan pumping and the behavior of the aquifers in general. Armed with this knowledge, we can propose the most efficient program to complete the necessary characterization of the extent of high TDS ground water. The second annual report will present the proposed characterization plan.

Before two years of Abatement Plan activities are complete, Loco Hills will present a plan to better define the southern extent of high TDS ground water. We will also present a plan to better define the vertical extent and magnitude of the release.

4.0 QUALITY ASSURANCE PLAN

With the annual reports, Loco Hills GSF will present evidence that the sampling and analysis is consistent with the techniques listed in Subsection B of 20.6.2.3107 NMAC and with 20.6.4.13 NMAC of the Water Quality Standards for Interstate and Intrastate Surface Waters in New Mexico 20.6.4 NMAC.

5.0 ASSESSMENT OF ABATEMENT OPTIONS

We evaluated the following options:

- Option 1: Pump, Treat, Inject
- Option 2: Limited ground water extraction and natural attenuation
- Option 3: Aggressive ground water pumping and natural attenuation

We rejected pump and treat as a remedial alternative because the high cost of this alternative provided no greater protection of human health or the environment than the other two alternatives. Supply wells for domestic or agricultural use do not exist at the site or within the area 4.5 miles down gradient of the site. The State Land Office, who manages most of the land in this area down gradient of the site, plans to prohibit construction of any supply wells on this down gradient property. Loco Hills GSF is currently communicating with the BLM regarding a similar restriction for any U.S. Government land that may be affected by the release. In the absence of a pathway for high TDS ground water to enter the environment, mechanical treatment of the ground water is not necessary. The other two options will create the same result, albeit over a longer time. However, in the absence of a viable gas storage business at the Loco Hills facility, pump and treat or alternative abatement standards may be the only option available to the New Mexico State Land Office, who is the current owner of the property.

In the absence of NMOCD approval of the proposed clay-lined brine storage pond, limited ground water pumping and natural attenuation is the recommended alternative, provided Loco Hills GSF can remain open. Loco Hills GSF will pump Supply Well #2 to meet its current needs for make-up water. Periodically, Loco Hills GSF will sell brine, creating the need for additional make-up water and ground water extraction. Within the past 12 months, this pumping protocol appears to have reduced the chloride concentration of Supply Well #1 and MW-1 by 30% and 20% respectively. Examination of the potentiometric surface also suggests that this limited pumping protocol is removing much of the ground water within the area of highest chloride. By removing the majority of the chloride mass from ground water at the facility, natural attenuation will allow the down gradient portion of the ground water plume to meet regulatory water quality mandates. Under a limited ground water pumping strategy, natural restoration of ground water may require decades.

The preferred abatement is Option 3, aggressive ground water extraction at the site coupled with natural attenuation down gradient of the site. Loco Hills GSF will actively market the sale of brine to enhance the exportation of ground water from the site. Loco Hills GSF will also examine the possibility of constructing additional storage caverns. For example, construction of a fourth storage cavern will require a significant volume of ground water and sale of the produced brine. The pumping of ground water required to support aggressive sale of brine and the potential construction of a fourth storage cavern will accelerate the restoration of ground water quality relative to limited pumping and natural attenuation of Option 2. Moreover, more aggressive ground water pumping from Supply Well #2 will capture more of the highest TDS ground water than Option 2. Implementation of this option requires NMOCD approval of the proposed clay-lined storage pond.

6.0 DESIGN AND SUPPORT OF THE PREFERRED ABATEMENT OPTION

The design of the preferred abatement option is described below.

1. Supply Well #2 withdraws ground water and discharges the water into the clay-lined pond or directly into a newly-drilled salt well for creation of a fourth storage cavern.
2. Evaporation of the water in the clay-lined pond and brine sales create the need for make-up water from Supply Well #2 to meet the needs of the facility. Supply Well #1 pumps only when Supply Well #2 cannot meet the needs for facility operations.
3. Pumps move water from the clay-lined pond to a smaller brine pond where Loco Hills GSF can adjust salinity for brine sales or injection into gas storage caverns.
4. Pumps may also move water from the clay-lined pond to a newly-drilled salt well for creation of a new cavern.
5. Loco Hills GSF and the State Land Office will create a "negative easement" that restricts drilling water supply wells on the land affected by the impairment caused by previous operators (State Land and private property which will be acquired by Loco Hills GSF). Loco Hills and the Bureau of Land Management will create an "environmental right of way" that will restrict development of water supply wells on Federal land potentially affected by the impairment caused by previous operators. These institutional controls, which will be registered at the County Clerk's office with the deed (for the private land), prevent any pathway between the ground water and the environment during the pumping and natural attenuation abatement process described below.
6. Pumping Supply Well #2 captures the majority of the brine released to ground water by past operators because the center of mass of chloride in ground water is within the capture zone of Supply Well #2. Plate 6 displays the estimated capture zone of Supply Well #2 during the pumping and ground water exportation abatement option.
7. The reduction of the mass of chloride in ground water (due to ground water extraction) at the source (near Supply Well #2) will accelerate natural attenuation of the chloride and TDS

plume of ground water impairment located down gradient, on State and private land.

8. Pumping on site and natural attenuation down gradient will restore the ground water to the quality required by Rule 19.

The net rate of ground water extraction and the resultant ground water restoration depends upon the demand for brine for oil field drilling operations, the evaporation from the storage lagoons and the input of seepage into the ground water system from the clay-lined pond. While Loco Hills GSF cannot control the demand for brine, they can increase their market share of brine sales by always having brine available. Increased storage capacity allows Loco Hills GSF to maintain an inventory of brine for sales while keeping sufficient brine on-hand for facility needs. Loco Hills GSF can also increase the rate of evaporation by increasing the storage capacity of the lagoons. In concert, these two practices can have a profound impact on the volume of ground water pumped and exported each year.

With respect to the potential seepage of brine from the clay-lined pond into ground water, our predictions strongly suggest brine will not enter ground water. The BMP presents these predictions in detail and concludes that during the operational life of the clay-lined pond (30 years), brine seepage will fully saturate the clay liner (2 feet thick) and about 10 feet of the underlying Rustler Formation claystones, siltstones and limestones. Closure of the clay-lined pond calls for exposure of the liner and some of the underlying Rustler Formation, rinsing the exposed material to remove entrained salt, collection and disposal/management of the collected rinse water, then permitting the exposed material to dry. Loco Hills GSF would then re-compact the dried liner/Rustler material, import clean soil and re-vegetate the site. As explained in the BMP, this closure process will effectively sequester any remaining subsurface brine.

As stated earlier, the migration rate of the plume's center of mass is less than 10 feet per year (300 feet/45 years). A net withdrawal of ground water will restore the ground water zone over time because agressive pumping of Supply Well #2 will effectively capture this mass of chloride and TDS . In fact, the changes of the ground water pumping protocols implemented by Loco Hills GSF over the past 12 months appears to have reduced chloride concentrations in on-site wells by at least 20%. Aggressive pumping under the preferred option will increase this restoration rate.

It is also possible that aggressive pumping will de-water the saturated zone that is impaired by past operations. Ground water zones within the Rustler Formation are not always continuous. At the site, the ground water zone that underlies the site does not extend to P-2 on the north side of the proposed pond. We also know that BGD MW-1 does not produce much water and may be at the southern margin of the ground water zone. Upon completion of the proposed monitoring program, we can better estimate the time required for complete ground water restoration under the preferred strategy.

The gas storage facility at Loco Hills is more than 40 years old. We anticipate that the need for storage in salt caverns will exist in New Mexico for 50-250 years, or longer. Continued operation beyond the 30-year life expectancy of the proposed clay-lined pond may require construction of new ponds or other techniques to manage brine. Loco Hills GSF proposes to operate the facility in conformance with this Abatement Plan until the ground water meets the standards set forth in Rule 19. The time for meeting these standards could be several years or several decades. The proposed abatement plan, which includes institutional controls to restrict water well construction down gradient from the facility, protects fresh water, human health and the environment.

The proposed implementation schedule is presented below.

9-Nov-04	Loco Hills GSF presents this Abatement Plan and the accompanying BMP.
15-Nov-04	Submit plans and specifications for construction of the clay-lined pond. These plans will include a quality assurance plan for installation of the clay liner, a protocol for post-construction testing of the liner permeability and other information.
16-Nov-04	Loco Hills GSF issues notice to the public as directed by NMOCD.
November, 2004	Publication of notices in newspapers
December, 2004	Public Notice period ends
January, 2005	Loco Hills addresses any NMOCD and public comments/questions. Possible hearing on the application
February, 2005	Address any final questions/comments at hearing. Approval of clay-lined pond and Abatement Plan.
March, 2005	Construction of the pond is complete. Post construction testing will verify that the liner meets the permeability requirements of NMOCD.
2005	Brine transferred from 2,000,000-gallon pond to clay-lined pond and ground water extraction and an aggressive brine sales effort commence.
2006	Repair or replacement of 2,000,000-gallon brine pond is complete. Submission of 2005 annual monitoring report.
2007	Submission of 2006 annual monitoring report and plan for characterization of southern extent of high TDS in ground water.

7.0 POST CLOSURE PLAN

When eight consecutive sampling events or other evidence demonstrates to the satisfaction of NMOCD that the water quality standards of Rule 19 are met, Loco Hills GSF will petition for closure of the Abatement Plan. Loco Hills GSF will plug and abandon monitoring wells that are solely associated with the Abatement Plan and restore the ground surface at monitoring well sites as required by the landowners.

Abatement Plan Table 1

Table 1. Loco Hills Historicity

Date	Event
1952	The salt caverns and water supply wells now used by Loco Hills GSF, Ltd. were created by Sacra Brothers, a propane distributor. Sacra Brothers probably employed an unlined seepage pit to dispose of more than 30,000,000 gallons of brine generated during the construction of the caverns
1959	Ownership changed from Sacra Brothers to Arrow Gas Company, presumably due to the acquisition of Sacra Brothers Propane by Arrow Gas Company.
1981	Arrow Gas reported to NMOCD that ground water quality below facility was at least 60,680 ppm, presumably due to facility operation actions.
1995	Arrow Gas sold to National Propane and the facility changed hands.
2000	Ownership changed from National Propane to Columbia Propane, and the facility changed hands
2001	Operator Name Change from Columbia Propane to AmeriGas Eagle Propane
Jul-04	AmeriGas sold property to current owners Loco Hills GSF, Ltd.
Apr-04	Loco Hills GSF, Ltd. begins process to install a new storage pond at the facility
Jul-04	NMOCD issues a Public Notice of the proposed Discharge Permit as required by the WQCC Regulations
Aug-04	NMOCD approves the WQCC Discharge Permit of Loco Hills GSF
Oct-04	Loco Hills GSF proposes to modify their approved WQCC Discharge Plan by adding a ground water quality restoration program and proposing a clay lined pond after soil samples suggest that a clay lined pond could be approved under WQCC Regulations.
Nov-04	The new clay lined pond was completed and tested for compaction.
Dec-04	NMOCD and Loco Hills agree that a clay liner with a demonstrated low permeability should be sufficient to meet WQCC requirements, but NMOCD notes that Loco Hills GSF does not own the land. The WQCC Regulations would prohibit a clay-lined pond in the absence of surface ownership of the site.
Jan-04	Loco Hills GSF, Ltd. takes action to acquire land from Bogle Farms and the State of New Mexico.
Jun-04	In a meeting with NMOCD, Loco Hills GSF, Ltd. was notified that the facility would no longer be governed by WQCC Regulations, but would be under NMOCD Rule 50. Loco Hills GSF, Ltd. was notified that this facility would fall under the new Rule 50, which does not allow for a single lined pond without an exemption petition. Rule 50 allowed "grandfathering" of certain single-lined ponds if the operator petitioned NMOCD for continued use before May 2004.
Aug-04	Loco Hills GSF, Ltd. submits Stage I & II Abatement Plan and a Best Management Practices Plan for approval to NMOCD, requesting exemption from Rule 50 and outlining how facility operation is meeting NMOCD goals of preventing ground water impact, and protecting human health and the environment with the current facility design.

TABLES

PLATES

APPENDICES

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

Loco Hills GSF Meeting Agenda
October 28, 2004

Objectives:

- Clarify The Path Forward for Exemption to Rule 50
    a. Submit Stage I/II Abatement Plan tomorrow
    b. Submit BMP and request for exemption from Rule 50 for clay-lined pond tomorrow
    c. November: Loco Hills begins public notice process of persons identified (see attachment) after approval of notice by NMOCD
    d. November: NMOCD reviews documents for administrative completeness and then Loco Hills issues public notice for Stage I/II Abatement Plan
    e. December: Loco Hills GSF and NMOCD address any outstanding technical details during 30-day public notice period
    f. December: Director determines if public comment warrants a hearing. Copies of any public comments are transmitted to Loco Hills GSF. Any hearing is set for January.
    g. January: After NMOCD approval of plan, Loco Hills submits engineering plans and specifications for demolition of existing liner, construction of new liner, construction quality assurance plan, post construction testing by Hicks Consultants and NMOCD (double-ring infiltrometer)
    h. February: Construction, post-construction testing with results to NMOCD
    i. March: Drill two deep seepage detection piezometers and eight shallow seepage detection piezometers
    j. March: brine from caverns and existing pond begin to fill new storage pond

- Identify Administrative Gaps and "Show Stoppers" in the proposed Stage I/II Abatement Plan and Best Management Practices Plan
    a. Out with the old liner and in with a new liner – goal is 1 E-8 cm/sec permeability created by addition of 10% bentonite to native clay
    b. At a leakage rate of 1 E-8 cm/sec, brine *could* intercept ground water after 2500 years. Therefore, alternative abatement standards are not required because ground water will meet standards long before seepage discharges ground water.
    c. Three vadose zone monitoring systems and two saturated zone monitoring systems will detect a liner failure long before any brine reaches ground water. Calculations suggest that brine seepage through the 2-foot thick liner will require about 50 years
    d. The closure plan effectively sequesters brine in the upper vadose zone.
    e. Monitoring and contingency plan allows plenty of time to rectify any situation, including installation of synthetic liner.

For the Abatement Plan, Loco Hills will provide notice to

(a) surface owners of record within one (1) mile of the perimeter of the geographic area where the standards and requirements set forth in Subsection B of Section 19.15.1.19 NMAC are exceeded;

(b) the county commission where the geographic area where the standards and requirements set forth in Subsection B of Section 19.15.1.19 NMAC are exceeded is located;

(c) the appropriate city official(s) if the geographic area where the standards and requirements set forth in Subsection B of Section 19.15.1.19 NMAC are exceeded is located or is partially located within city limits or within one (1) mile of the city limits [NOT APPLICABLE];

*(d) those persons, **as identified by the Director [emphasis added]**, who have requested notification, who shall be notified by mail;*

*(e) the New Mexico Trustee for Natural Resources, and any other local, state or federal governmental agency affected, **as identified by the Director [emphasis added]** which shall be notified by certified mail;*

(f) the appropriate Governor or President of any Indian Tribe, Pueblo or Nation if the geographic area where the standards and requirements set forth in Subsection B of Section 19.15.1.19 NMAC are exceeded is located or is partially located within tribal boundaries oar within one (1) mile of the tribal boundaries, who shall be notified by certified mail [NOT APPLICABLE];

For the proposed exemption to Rule 50, Loco Hills will provide notice to:

the surface owner of record where the pit is to be located and to such other persons as the division may direct

Same mailing list

$\boxed{\text{Combine PN}}$

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Tuesday, October 26, 2004 8:34 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'; 'Debra P. Hicks'
Subject: RE: Loco Hills GSF

Wayne

I am confident that we can make this time work.

I would like to make sure that Carol Leach pops her head in the meeting perhaps toward the end as she was present in the meeting with the Lt. Governor.

The agenda for the meeting is simple:

1. We plan to go over the Stage I/II Abatement Plan proposal first, to make sure we submit a document that is not only administratively complete, but one that also has a reasonable chance for NMOCD support.

2. Coupled with this presentation of the Abatement Plan is the proposed path forward for the permitting of the clay-lined pond under Rule 50. We will be asking for an exemption from the double-liner/leak detection standard in Rule 50.

After this meeting, which will clearly take more than an hour on our side, we should have a clear idea of a FINAL submission to NMOCD that will permit publication of a notice. I hope that you will be available after lunch to help us work through any remaining technical details of our submission.

Thanks for your efforts!

-----Original Message-----
From: Price, Wayne [mailto:WPrice@state.nm.us]
Sent: Tuesday, October 26, 2004 3:01 PM
To: Randall Hicks (E-mail)
Cc: Randall Hicks (E-mail 2)
Subject: FW: Loco Hills GSF

Randy the only time I can get everyone together is at 10:30-11:30 am OCT 28. Please confirm receipt of this message.
-----Original Message-----
From: Price, Wayne
Sent: Tuesday, October 26, 2004 2:31 PM
To: 'Randall Hicks'; Price, Wayne
Cc: 'Mitchel Johnson'

BILL RICHARDSON
Governor
Joanna Prukop
Cabinet Secretary

Mark E. Fesmire, P.E.
Director
Oil Conservation Division

October 21, 2004

Randall T. Hicks
R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

Hand-delivered

Re: Loco Hills Gas Storage Facility

Dear Mr. Hicks:

During our meeting on October 19, 2004, you requested that the Oil Conservation Division (OCD) provide you with an outline of the process for seeking approval of a clay-lined brine pit with a designed seepage rate.

Background

Loco Hills intends to propose a clay-lined brine storage pit, with a designed seepage rate. (The exact seepage rate has yet to be determined.) The brine to be stored in the pit contains approximately 100,000 parts per million (ppm) chlorides. The groundwater underneath the Loco Hills facility contains approximately 40,000 ppm chlorides, due to existing contamination at the site. Groundwater standards call for chlorides not to exceed 250 ppm. Although the groundwater underneath the Loco Hills facility greatly exceeds standards, it is nevertheless protectable because protectable waters from Bear Grass Draw flow under and combine with the waters underneath the Loco Hills facility.

Loco Hills proposes to abate existing contamination at the site by pumping out contaminated water. By pumping out more contaminated water than they introduce through the clay-lined pit, Loco Hills contends that its project will result in a net environmental gain to the state.

Applicable Rules - General

OCD rules require brine pits to be double-lined with leak detection. 19.15.2.50.C(2)(b)(ii) and (iii) NMAC. The OCD may grant an exemption to those requirements "if the operator demonstrates that the granting of such exemption will not endanger fresh water, public health or the environment." 19.15.2.50.G(2) NMAC.

OCD rules require Stage I and Stage II abatement plans for the abatement of existing contamination. The purpose of a Stage I abatement plan is to design and conduct a site investigation that will adequately define site conditions and provide the data necessary to select and design an effective abatement option. See 19.15.1.19.E(3) NMAC. The purpose of a Stage II abatement plan is to select and design an abatement option that, when implemented, will result in attainment of the abatement standards. See 19.15.1.19.E(4) NMAC. Abatement standards require chlorides not to exceed 250 ppm.

If the person responsible for abatement is not able to meet the abatement standards using commercially accepted abatement technology, he may propose that compliance is "technically infeasible." 19.15.1.19.B(5) NMAC. In no event shall a proposed technical infeasibility demonstration be approved for any water contaminant if its concentration is greater than 200% of the abatement standard for the contaminant. 19.15.1.19.B(5)(b) NMAC.

The person responsible for abatement may petition for approval of alternative abatement standards. The petition must make the specific showings required under 19.15.1.19.B(6)(a) NMAC, designed to show the problems with the existing standards, the feasibility of the proposed standard, and that compliance with the proposed standard "will not create a present or future hazard to public health or undue damage to property."

<u>Process for Seeking Approval</u>

To operate a clay-lined brine pit, Loco Hills must seek an exemption to the liner requirements set out in 19.15.2.50.C(2)(b)(ii) and (iii) NMAC. To obtain that exemption, Loco Hills must demonstrate that the granting of such exemption will not endanger fresh water, public health or the environment. 19.15.2.50.G NMAC. The OCD understands that Loco Hills intends to make that showing by demonstrating that its proposed abatement plan will remove more contamination than is introduced through the proposed pit. Because the liner exemption is linked to the abatement proposal, the two issues must be considered together. Additionally, as we discussed, the OCD will not grant one permit without granting the other. Because it appears that Loco Hill's abatement plan may not result in the groundwater meeting the standards for contaminants, Loco Hills may also need to petition for approval of alternative abatement standards under 19.15.1.19.B(6)(a) NMAC. (Loco Hills will not be eligible for a "technical infeasibility" finding under 19.15.1.19.B(5) unless it can reduce the concentration of chlorides to below 500 ppm.) The suggests the following procedure for requesting an exemption to pit liner requirements and approval of an abatement plan:

1. File a consolidated application with the environmental bureau of the OCD making the following requests:
   a. an exemption to the pit liner requirements, demonstrating that the granting of the exemption will not endanger fresh water, public health or the environment. 19.15.2.50.G NMAC.
   b. approval of a Stage I abatement plan under 19.15.1.19.E(3) NMAC. If Loco Hills does not have complete information defining site conditions, OCD may establish assumed conditions for the plan with a timetable for additional information and provide for revision of the permit to reflect the conditions as they exist at that time.
   c. approval of a Stage II abatement plan under 19.15.1.19.E(4) NMAC demonstrating that the plan will attain abatement standards, and must contain the information required under 19.15.1.19.E(4)(b) NMAC. If the plan cannot meet abatement standards, Loco Hills must also include a petition for alternative abatement standards under 19.15.1.19.B(6)(a) NMAC. The petition for alternative abatement standards must contain the information set out in 19.15.1.19.B(6)(b) NMAC and make the showings required by 19.15.1.19.B(6)(a) NMAC.

2. The OCD will make every effort to review the Stage I and Stage II abatement plans immediately upon receipt for administrative completeness. Once the OCD concludes that they are administratively complete, Loco Hills should put them out for public notice and comment, as required under 19.15.1.19.G NMAC. This includes written notice to the appropriate persons, and advertisement, as approved by the OCD, in a newspaper of general circulation in the state and in a newspaper of general circulation in the affected county. The rules require 30 days for public comment.

3. The OCD will set the application for hearing upon receipt of an administratively complete application. That way, if a hearing is necessary, it may be conducted immediately upon the close of the public comment period. The rules require a public hearing if the OCD receives any objections to the plan, or if Loco Hills files a petition for an alternative abatement standard. If the OCD determines that no hearing is necessary, the hearing will be dismissed and the matter will be decided administratively. The hearing may be held before the Oil Conservation Commission rather than a division examiner, if you or the OCD requests that action.

As you will see from this brief outline, once the OCD receives an administratively complete application, process can move quickly. The time from receipt of an administratively complete application to a decision could be as short as six weeks. The OCD is committed to a prompt review of the application, a prompt hearing (if necessary) and a prompt decision on the application. The OCD suggests that Loco Hills contact us once they have prepared a draft application so that our technical staff can assist in assuring an administratively complete application.

Sincerely,

Mark Fesmire, P.E.
Director, Oil Conservation Division

Cc: Joanna Prukop
Sonya Carrasco-Trujillo
Mitch and Mitchell Johnson
William Carr
Roger Anderson

NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

BILL RICHARDSON
Governor
Joanna Prukop
Cabinet Secretary

Mark E. Fesmire, P.E.
Director
Oil Conservation Division

October 21, 2004

Randall T. Hicks
R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142
Albuquerque, NM 87104

Hand-delivered

Re: Loco Hills Gas Storage Facility

Dear Mr. Hicks:

During our meeting on October 19, 2004, you requested that the Oil Conservation Division (OCD) provide you with an outline of the process for seeking approval of a clay-lined brine pit with a designed seepage rate.

Background

Loco Hills intends to propose a clay-lined brine storage pit, with a designed seepage rate. (The exact seepage rate has yet to be determined.) The brine to be stored in the pit contains approximately 100,000 parts per million (ppm) chlorides. The groundwater underneath the Loco Hills facility contains approximately 40,000 ppm chlorides, due to existing contamination at the site. Groundwater standards call for chlorides not to exceed 250 ppm. Although the groundwater underneath the Loco Hills facility greatly exceeds standards, it is nevertheless protectable because protectable waters from Bear Grass Draw flow under and combine with the waters underneath the Loco Hills facility.

Loco Hills proposes to abate existing contamination at the site by pumping out contaminated water. By pumping out more contaminated water than they introduce through the clay-lined pit, Loco Hills contends that its project will result in a net environmental gain to the state.

Applicable Rules - General

OCD rules require brine pits to be double-lined with leak detection. 19.15.2.50.C(2)(b)(ii) and (iii) NMAC. The OCD may grant an exemption to those requirements "if the operator demonstrates that the granting of such exemption will not endanger fresh water, public health or the environment." 19.15.2.50.G(2) NMAC.

OCD rules require Stage I and Stage II abatement plans for the abatement of existing contamination. The purpose of a Stage I abatement plan is to design and conduct a site investigation that will adequately define site conditions and provide the data necessary to select and design an effective abatement option. See 19.15.1.19.E(3) NMAC. The purpose of a Stage II abatement plan is to select and design an abatement option that, when implemented, will result in attainment of the abatement standards. See 19.15.1.19.E(4) NMAC. Abatement standards require chlorides not to exceed 250 ppm.

If the person responsible for abatement is not able to meet the abatement standards using commercially accepted abatement technology, he may propose that compliance is "technically infeasible." 19.15.1.19.B(5) NMAC. In no event shall a proposed technical infeasibility demonstration be approved for any water contaminant if its concentration is greater than 200% of the abatement standard for the contaminant. 19.15.1.19.B(5)(b) NMAC.

The person responsible for abatement may petition for approval of alternative abatement standards. The petition must make the specific showings required under 19.15.1.19.B(6)(a) NMAC, designed to show the problems with the existing standards, the feasibility of the proposed standard, and that compliance with the proposed standard "will not create a present or future hazard to public health or undue damage to property."

Process for Seeking Approval

To operate a clay-lined brine pit, Loco Hills must seek an exemption to the liner requirements set out in 19.15.2.50.C(2)(b)(ii) and (iii) NMAC. To obtain that exemption, Loco Hills must demonstrate that the granting of such exemption will not endanger fresh water, public health or the environment. 19.15.2.50.G NMAC. The OCD understands that Loco Hills intends to make that showing by demonstrating that its proposed abatement plan will remove more contamination than is introduced through the proposed pit. Because the liner exemption is linked to the abatement proposal, the two issues must be considered together. Additionally, as we discussed, the OCD will not grant one permit without granting the other. Because it appears that Loco Hill's abatement plan may not result in the groundwater meeting the standards for contaminants, Loco Hills may also need to petition for approval of alternative abatement standards under 19.15.1.19.B(6)(a) NMAC. (Loco Hills will not be eligible for a "technical infeasibility" finding under 19.15.1.19.B(5) unless it can reduce the concentration of chlorides to below 500 ppm.) The suggests the following procedure for requesting an exemption to pit liner requirements and approval of an abatement plan:

1. File a consolidated application with the environmental bureau of the OCD making the following requests:
   a. an exemption to the pit liner requirements, demonstrating that the granting of the exemption will not endanger fresh water, public health or the environment. 19.15.2.50.G NMAC.
   b. approval of a Stage I abatement plan under 19.15.1.19.E(3) NMAC. If Loco Hills does not have complete information defining site conditions, OCD may establish assumed conditions for the plan with a timetable for additional information and provide for revision of the permit to reflect the conditions as they exist at that time.
   c. approval of a Stage II abatement plan under 19.15.1.19.E(4) NMAC demonstrating that the plan will attain abatement standards, and must contain the information required under 19.15.1.19.E(4)(b) NMAC. If the plan cannot meet abatement standards, Loco Hills must also include a petition for alternative abatement standards under 19.15.1.19.B(6)(a) NMAC. The petition for alternative abatement standards must contain the information set out in 19.15.1.19.B(6)(b) NMAC and make the showings required by 19.15.1.19.B(6)(a) NMAC.

2. The OCD will make every effort to review the Stage I and Stage II abatement plans immediately upon receipt for administrative completeness. Once the OCD concludes that they are administratively complete, Loco Hills should put them out for public notice and comment, as required under 19.15.1.19.G NMAC. This includes written notice to the appropriate persons, and advertisement, as approved by the OCD, in a newspaper of general circulation in the state and in a newspaper of general circulation in the affected county. The rules require 30 days for public comment.

3. The OCD will set the application for hearing upon receipt of an administratively complete application. That way, if a hearing is necessary, it may be conducted immediately upon the close of the public comment period. The rules require a public hearing if the OCD receives any objections to the plan, or if Loco Hills files a petition for an alternative abatement standard. If the OCD determines that no hearing is necessary, the hearing will be dismissed and the matter will be decided administratively. The hearing may be held before the Oil Conservation Commission rather than a division examiner, if you or the OCD requests that action.

As you will see from this brief outline, once the OCD receives an administratively complete application, process can move quickly. The time from receipt of an administratively complete application to a decision could be as short as six weeks. The OCD is committed to a prompt review of the application, a prompt hearing (if necessary) and a prompt decision on the application. The OCD suggests that Loco Hills contact us once they have prepared a draft application so that our technical staff can assist in assuring an administratively complete application.

Sincerely,

Mark Fesmire, P.E.
Director, Oil Conservation Division

Cc: Joanna Prukop
Sonya Carrasco-Trujillo
Mitch and Mitchell Johnson
William Carr
Roger Anderson

Price, Wayne

From: MacQuesten, Gail
Sent: Friday, September 24, 2004 5:02 PM
To: Fesmire, Mark; Leach, Carol; Anderson, Roger; Olson, William; Price, Wayne
Subject: Loco Hills letter

Attached is the final version of the letter to the Lt. Governor regarding Loco Hills. (I assume that Brenda made it pretty and put it on the right letterhead.) Joanna called on Friday and said that it has been faxed to the Lt. Governor. Copies will probably go out Monday to everyone on the "cc" list. Mark, I was holding your change, because I assumed Joanna would have changes and I could make all the changes at once. But Joanna sent it out "as is" and I didn't make your change. In the future, I'll follow a "change as you go" policy. Gail

Lt. Gov. letter.doc

Saturated Brine Storage Pit Issue

LHGSF seeks approval for a saturated brine storage pit, with a capacity in excess of 9 million gallons. If approved, the pit would be one of the largest saturated brine storage pits in New Mexico. Saturated brine storage pits permitted under the Water Quality Act (for example, saturated brine pits associated with natural gas processing plants or brine solution mining) are double-lined, with leak detection. Pits permitted under the Oil and Gas Act are governed by 19.15.2.50 NMAC (Rule 50), which requires double lining with leak detection. Double-liners protect groundwater from seepage and leaks, while leak detection system alerts operator if leaks do occur, so they can be fixed promptly.

In August 2003, the OCD approved LHGSF's original proposal for a double-lined pit with leak detection, by approving a discharge plan for the facility under the Water Quality Act. During the construction of the pit, a consultant hired by LHGSF informally asked the OCD whether it would approve a clay-lined pit without leak detection. According to the consultant, the proposed pit would allow a certain amount of seepage, but LHGSF would propose an abatement plan for existing contamination at the site that would more than make up for the amount of seepage. The OCD responded that such approval would require review by the technical staff to assure that the plan would protect groundwater, and the plan would have to go through the public notice process. LHGSF proceeded to construct a clay-lined pit without leak detection, and without approval from the OCD.

After construction, LHGSF formally requested a modification to its discharge plan that would allow use of the clay-lined pit. During discussions concerning the requested modification, the OCD determined that it did not have authority to regulate the pit under the Water Quality Act, and that the Oil and Gas Act applied. The OCD informed LHGSF that the facility would be evaluated under the Oil and Gas Act and Rule 50, and explained that an exemption to Rule 50's requirements could be granted only upon a showing that the exemption would not endanger fresh water, public health or the environment. During a series of meetings, LHGSF attempted to make that showing, implying that there was no protectable groundwater in the area, that the geologic conditions at the site were appropriate for a clay-lined pit, and that the pit had a permeability factor of 1×10^{-8} cm/sec., which according to LHGSF's own calculations would result in a release of approximately 40 gallons per day. OCD's investigation, however, showed that there was protectable groundwater at the site that is used by adjacent landowners. OCD's site inspection revealed that the site geology did not contain significant barriers to infiltration. Further, the "clay" used to construct the pit had not been screened and, in fact, contained sands and large chunks of gypsum that would affect permeability. Finally, post construction tests showed the actual permeability of the pit to be 1×10^{-5} cm/sec., making the pit 1000 times more permeable than represented by LHGSF, allowing the release of approximately 40,000 gallons per day.

LHGSF's current proposal to remedy these deficiencies is incomplete. Although LHGSF claims that adding bentonite to the existing clay will result in a permeability of 1×10^{-7} cm/sec. or less, it has not even created the specifications required to meet that permeability level.

Abatement Issue

Although Mr. Johnson's letter focuses on LHGSF's application for an exemption to Rule 50's liner/leak detection requirement, a second issue also needs to be resolved. It appears that a prior operator used pits to store saturated brine during the mining of the caverns to create the storage facility, and that the current double-lined pit used by LHGSF to store brine has been leaking.

OCD has asked LHGSF to submit an abatement plan under 19.15.1.19 NMAC (Rule 19), including a plan to investigate the extent of the contamination and a proposal to abate the contamination. Once an administratively complete plan is submitted, the plan must be put out for public comment, and evaluated by OCD's technical staff. LHGSF has not yet submitted an administratively complete plan under Rule 19.

Options

The OCD suggests the following options to resolve the saturated brine pit issue:

1. Construct the double-lined pit with leak detection as approved in August 2003. This would require removing a portion of the clay base, screening it to remove rocks and sharp objects that could tear the liner, replacing the screened material and installing a synthetic double liner with leak detection.

2. Seek an exemption under Rule 50 allowing use of a clay secondary liner for a primary synthetic liner with leak detection. This would require removing the existing clay liner so the material could be screened and re-compacted for use as a secondary liner, installation of a leak detection system and a synthetic primary liner.

3. Seek an exemption under Rule 50 allowing use of a single clay liner. LHGSF would need to demonstrate that it could design and install a clay liner that would not endanger fresh water, public health or the environment.

Regardless of which option LHGSF chooses regarding the pit, LHGSF will also have to submit a Rule 19 abatement plan to mitigate the existing ground water contamination at the site. If LHGSF chooses a pit option that does not involve adding to the contamination already at the site, approval of the pit will not be tied to approval of the abatement plan. If, as in its most recent proposal, LHGSF chooses to request approval of a pit that allows seepage, the Rule 50 exemption request will have to be considered along with LHGSF's plan to abate existing and future contamination at the site.

LHGSF's choice will affect the time it will take to resolve the issues. Construction of a double-lined pit with leak detection, as approved in August 2003, could begin immediately. An exemption to Rule 50 that does not involve adding to the contamination at the site could be reviewed and approved administratively or, if opposed, after a hearing. An exemption to Rule 50 that involves adding to the contamination at the site must be considered with an abatement plan, and would have to go through the public notice process required by Rule 19.

Conclusion

This agency recognizes and applauds your commitment to encouraging small business development in New Mexico's communities of need, and has no intent to stand in the way of that development. However, the OCD is charged with the duty of protecting the human health and the environment. We hope that the options outlined above will provide guidance for LHGSF to meet environmental requirements and move forward with its project.

Sincerely,

Joanna Prukop

Cabinet Secretary

Cc: Mitch Johnson
Randy Hicks
Mark Fesmire
Bill Carr

Lt. Governor Diane Denish
State Capitol Suite 417
Santa Fe, NM _______

Re: Loco Hills Gas Storage Facility

Dear Lt. Governor Denish:

Thank you for forwarding the letter dated September 15, 2004 from Mr. Mitch Johnson concerning the Loco Hills Gas Storage Facility (LHGSF). I have looked into the matter with our Oil Conservation Division (OCD) staff, and wish to address Mr. Johnson's concerns.

Regulatory Authority Issue

Mr. Johnson asks you to intervene in support of his argument that the OCD regulate the LHGSF under Water Quality Control Commission (WQCC) rules issued pursuant to the Water Quality Act, rather than under Oil Conservation Commission (OCC) rules issued pursuant to the Oil and Gas Act. Mr. Johnson suggests that the OCD's decision to apply the OCC rules was political. That decision was a legal decision, dictated by the applicable statutes.

Approximately a year and a half ago, the OCD's director instructed the staff to review the adequacy of safety regulations concerning gas storage, in light of several gas-related accidents that had occurred in New Mexico and around the country. During the course of that review, the staff discovered that the storage of gas in man-made salt caverns, which the OCD had previously regulated under WQCC rules, must instead be regulated under the Oil and Gas Act.

The Water Quality Act does not apply to matters within the jurisdiction of the Oil and Gas Act. See NMSA 1978, §74-6-12(G). The OCD previously (and mistakenly) viewed man-made salt caverns for gas storage as a class of injection well covered by the Water Quality Act. However, the Oil and Gas Act specifically gives the OCC the power to regulate the subsurface storage of natural gas, NMSA 1978, §70-2-12(B)(13), and the OCC has used that power to adopt regulations covering the injection of liquefied petroleum gas. See 19.15.9.701 NMAC. Because LHGSF's gas storage facility is regulated under the Oil and Gas Act, the pit associated with that facility is regulated under the Oil and Gas Act. See 19.15.2.50.A NMAC. And abatement of any contamination caused by that facility is addressed under the Oil and Gas Act. See 19.15.1.19 NMAC.

Mr. Johnson's characterization of this legal decision as political is puzzling because whether the OCD regulates the facility under the Water Quality Act or the Oil and Gas Act, the goal remains the same: prevention of groundwater contamination. Although Mr. Johnson apparently believes that the Water Quality Act is more favorable to him, the OCD does not share that view. He interprets the Act as allowing water pollution that is confined within the boundary of the property, citing NMSA 1978, §74-6-12(C). But that provision applies only "when the water does not combine with other waters." Protectable waters from the Bear Grass Draw flow under and combine with the waters underneath the LHGSF facility. If the facility and associated pit are not designed to protect groundwater quality, they cannot be approved under either the Water Quality Act or the Oil and Gas Act.

LOCO HILLS GSF, LTD

Propane/Butane Storage & Sales
158 Deer Creek Drive
Aledo, TX 76008
817-441-6568 phone
817-441-5880 fax

Send to: NMOCD	**From:** Mitchel Johnson
Attention: Mark Fesmire	**Date:** 9/16/04
Office location:	**Office location:**
Fax number: 505-476-3462	**Phone number:**

☐ Urgent ☐ Reply ASAP ☐ Please comment ☐ Please review ☐ For your information

Total pages, including cover:

Comments:

Mr. Fesmire,

I hope things are well. The following package was faxed to Lt. Governor Denish yesterday (I did not have your fax number until this morning) and I wanted to make you aware of it and that you had a copy. I will be putting a copy in the mail for you, too. Please notify me if you have any questions.

Thank you,

Mitchel Johnson
Loco Hills GSF

LOCO HILLS GSF

158 Deer Creek Drive Aledo, Texas 76008 817 441 6568 Fax: 817-441-5880

September 15, 2004

Lt. Governor Diane Denish
State Capitol, Suite 417
Santa Fe, New Mexico, 87501

RE: Loco Hills GSF

Dear Lt. Governor Denish:

We write this letter because your mission statement affirms your commitment to encouraging small business development in New Mexico's communities of need. We are such a business and the Artesia-Loco Hills area is such a community. The specific issue at hand is a failure to obtain an environmental permit for the Loco Hills GSF facility near Artesia. While the New Mexico Oil Conservation Division has been responsible for issuing said permit, we do not believe that the root cause for this failure is technical or regulatory. We believe the root cause of the failure lies in politics.

Our consultants for this project hypothesize that the political climate created by your administration's focus on environmental initiatives in the oil field, while laudable in the larger picture, have worked against environmental improvement at our facility. Moreover, the inability to obtain an environmental permit for our facility has failed to nurture small-business growth in the a community of need, will cause economic hardship to rural New Mexicans who depend upon propane for winter heating (see attached letter) and is creating a liability for the State of New Mexico Land Office.

Our consultants believe we can obtain the necessary permit if the NMOCD reverses its recent ruling that our facility be governed by the NMOCD Rules and instead provide regulation of this facility under the Water Quality Control Commission Regulations, as NMOCD has done since 1981. The attached letter from our consultants demonstrates that the NMOCD could oversee site activities under the WQCC Regulations and describes the chain of events that lead to this letter.

We ask that your office intervene by

- Requesting NMOCD to review their recent ruling in light of the attached letter or by
- Requesting the New Mexico Environment Department counsel to arbitrate this issue after evaluating our position and the opinion of NMOCD legal staff.

Finally, since there are two sides to every story we urge you to speak with Mr. Fesmire of NMOCD to understand their side.

Sincerely,

Mitch Johnson
President
Loco Hills GSF

Copy

Randall Hicks, Hicks Consultants
William Carr, Holland and Hart
Patrick Lyons, State Land Office
Mark Fesmire, NMOCD

R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

September 15, 2004

Mr. Mitchell Johnson
Loco Hills GSF
Via E-Mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E

Dear Mitchell:

You asked that I provide background information to support your letter to Lt. Governor Denish. I believe the information provided herein will be sufficient to allow the State of New Mexico to implement a path forward similar to that described below:

1. Consider the Loco Hills GSF August 2004 Best Management Practices Plan an application for a discharge permit under the WQCC Regulations and issue a public notice as soon as possible.
2. During the Public Notice period, evaluate the Best Management Practices Plan and a forthcoming set of plans and specifications for a clay-lined pond from Pettigrew and Associates. The engineering plans and specifications will demonstrate that the addition of bentonite to the native clay will cause a 2-foot thick liner to exhibit a permeability of less than 1×10^{-7} cm/sec. These plans will also specify testing of the clay during construction and post-construction testing of the liner.
3. Request any clarification of information or commitments set forth in the submittals. Request additional information as required. Obtain and consider any public comment.
4. Approve the Discharge Permit with the condition that Loco Hills GSF move forward with remedy proposed in the August 2004 Stage I/II Abatement Plan.

Project Goals

The Loco Hills Gas Storage Facility (Loco Hills GSF) stores liquid propane and butane in deep, man-made salt caverns. The State of New Mexico owns the property on which the facility resides and has leased the site to numerous operators for more than 30 years. Storing propane during the summer for release when it is needed for winter heating results in an overall lower price to generally low income, rural households. Your family-run small business desires to expand their operation from a 2,000,000 gallon storage capacity to nearly 9,000,000 gallons. This expansion fuels the economy of Eddy County and provides lower cost fuel to more rural New Mexicans. Facility expansion is the primary goal.

A secondary goal of this project is restoration of ground water quality impairment caused by the large businesses that formerly operated the facility. Our analysis shows that site activities from the 1950s to the 1960s caused impairment of ground water beneath the facility and ground water is no longer fit for domestic or agricultural use. The New Mexico Oil Conservation Division has been aware of this man-made impairment since 1981. Without any prompting from NMOCD, your family volunteered to implement a ground water quality restoration program.

Expansion of the facility from 2,000,000 to 9,000,000 gallons requires an environmental permit for a brine storage pond. In the winter, stored propane is extracted by pumping brine into the salt caverns thereby forcing the propane to the surface for transport and sales. In the spring and summer, we inject less expensive propane into the caverns for storage and brine flows out of the cavern and into a storage pond. Inappropriate environmental practices of the past allowed brine to impair the site's ground water and all parties recognize that a well-designed pollution prevention program is critical.

Restoration of ground water quality requires appropriate allocation of the financial resources of your family-run business. We understand that you do not have the financial resources of ChevronTexaco or Yates Petroleum. In order to cure the environmental problem that was caused by others and that was known to the agency for more than 20 years, we recommended that we eliminate a double-lined brine storage pond (which was previously approved for use by the NMOCD under the WQCC Regulations) in favor of a less expensive clay-lined pond. The money saved by this change would be allocated to environmental restoration and to keeping the cost of stored propane at a minimum. At this location, I remain convinced that a properly designed and constructed clay-lined pond can offer a higher level of environmental protection than a pond with two synthetic liners. Moreover, synthetic lined ponds have a finite lifespan, typically 5-20 years. Any synthetic pond at this location will eventually fail. Pettigrew Associates is completing the design of a clay-lined pond that will, over the long-term, provide a greater net environmental benefit than the previously-approved synthetic lined pond.

Due to the increasing price of crude oil, the cost of a synthetic liner system for the proposed brine pond is more than $250,000. In order to proceed with the environmental restoration program, we understand that you must install a less expensive clay-lined pond. Your proposed clay lined pond can be approved under the WQCC Regulations because the commitments in the Best Management Practices Plan and the engineering design will meet all of the regulatory criteria specified in these Regulations. We are unsure if NMOCD would approve an exemption to the NMOCD Rules and allow the proposed clay-lined pond under NMOCD Rules.

Permits and Politics

At a meeting in December 2003, NMOCD stated that they could issue an environmental permit, a discharge permit under the Water Quality Control Commission (WQCC) Regulations, for a clay-lined pond provided Loco Hills GSF met specific conditions. Although your family has agreed to those conditions presented in December, there is no approved WQCC permit. As shown in Table 1, NMOCD elected to change the regulatory venue for the facility, requiring a permit under the NMOCD Rules- creating a further delay. The chronology listed on Table 1 provides some insight on the reasons for the lack of progress toward an approved environmental permit.

Looking back from where we are now, we find the decision to change the regulatory venue quite puzzling, and we believe that politics played a role. NMOCD administered this site under the WQCC Regulations since April 7, 1981. Loco Hills obtained an approved

WQCC Discharge Permit in 2003 (See Table 1) for a double-lined pond. We met with NMOCD to discuss how to gain approval of a clay-lined pond under the WQCC Regulations in December 2003. In June 2004, after the provision in Rule 50 for approval for existing clay-lined ponds had ceased, and after we submitted the attached letter showing that the proposed clay-lined pond *must* be approved pursuant to the WQCC Regulations, NMOCD found that WQCC regulations do not apply to the site.

We think that the contentious issues of oil and gas pits on Otero Mesa combined with further contentious debates over the NMOCD Rule 50 (The Pit Rule) and the NMOCD Pit Guidelines have lead NMOCD to believe that the current administration will not permit any storage ponds like the proposed clay-lined pond under the NMOCD Rules. The WQCC Regulations allow a small seepage rate from storage ponds, provided such seepage does not pose a threat to fresh water, human health or the environment. We believe that NMOCD changed the rules in June 2004 to stop an approval of a pond that meets the WQCC mandates but allows a small volume of brine seepage despite the fact that ground water quality beneath the site has TDS that exceeds 10,000 ppm.

Bull!!!

Moreover, every time we meet criteria set forth by NMOCD to get an approved permit under NMOCD Rules, NMOCD identifies new criteria and the process is delayed further. Indeed, the devil lies in the details and much of the back and forth regarding criteria is a normal part of the permitting process. We continue to be surprised by the new criteria set forth by NMOCD. This supports my hypothesis that the State of New Mexico simply does not desire approval of this clay-lined pond.

Mr. Carr and I have worked with Roger Anderson and the rest of the NMOCD Environmental Bureau for more than a decade. We have never experienced such problems until June 2004, after the aforementioned oil and gas pit issues (e.g. Otero Mesa). The staff at NMOCD are experts in their fields and have always worked very hard to protect the environment while protecting the State's interests in conservation of natural resources (including water). I cannot explain why State approval of this environmental permit has been so difficult unless politics are in play.

State Liability

We believe that the Lt. Governor should also understand that the liability of the State of New Mexico grows larger as the delay of this permitting issue continues. In the absence of an approved permit, Loco Hills will acquire neither the State Lease upon which the facility resides nor the adjacent land that has been contaminated by the actions of past operators. If the land acquisition of Loco Hills GSF fails due to the inability to obtain a permit, the adjacent rancher could be persuaded to file suit not only against the previous operators of the site but also the State Land Office who leased the property for 30 years. Because the NMOCD, a sister agency to the SLO, did nothing regarding the ground water impairment, the liability of the state for punitive damages could be greater. This type of lawsuit is occurring in Lea County as we speak.

WQCC Regulations v. NMOCD Rules

I have discussed the issue of regulatory venue for this facility with Mr. Carr. We both agree that the WQCC Regulations may be applied to the site. The site has been regulated under these regulations without challenge since 1981. NMOCD continues to regulate *similar facilities, such as brine extraction wells, under the WQCC Regulations.* The jurisdiction of the WQCC Regulations is sufficiently broad to capture the permitting process of the proposed clay-lined pond.

The authority of the NMOCD to regulate this site under NMOCD Rules does not have the same degree of precedent as regulation under the WQCC Regulations. This is because Rule 50 is new and the agency has a two-decade record of overseeing these types of facilities under the WQCC Regulations. Regardless of precedent, we do not understand how regulation of the brine storage pond under the NMOCD Rules furthers the purpose of the New Mexico Oil and Gas Act, which is prevention of waste.

Clearly the enumeration of the powers of the NMOCC (70-2-12.B.13) allows for regulation of the storage of natural gas or its products. However, the caverns at the site are the storage vessels, not the proposed pond. We do not dispute the power of the Oil and Gas Act or NMOCD Rules to regulate the storage of liquefied gas and prevent waste. Nor do we dispute that the NMOCD may regulate the pond under Rule 50, if it elects to do so. Regulation under the WQCC Regulations simply appears more consistent with the precedent and the fact that the pond is an industrial device that facilitates the flow of liquefied gas from subsurface storage to surface storage.

Conclusion

The NMOCD can regulate the Loco Hills GSF brine storage pond under the WQCC Regulations or NMOCD Rules. We believe that permitting under the WQCC Regulations not only provides protection of fresh water, public health and the environment, but allows your facility to expand and accelerates the restoration of ground water. Because of the increased cost of synthetic liners and the time wasted in this process, we believe that continuing regulation under the NMOCD Rules could effectively put your company out of business.

I hope this background information will be helpful in explaining our situation to the Lt. Governor. I look forward to seeing these issues resolved soon.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T. Hicks

Randall Hicks
Principal

Table 1: Chronology of Recent Permitting Issues

July, 2003	Loco Hills GSF submits an application to modify the existing environmental permit for the site. They propose to construct a large double-lined brine storage pond.
August, 2003	NMOCD approves this permit modification under the Water Quality Control Commission Regulations – the regulations that governed the site since the 1980s. Loco Hills is ready to construct the pond with two synthetic liners
October 2003	The pond construction company, Pettigrew Associates, and Hicks Consultants conclude that the native clay at the site and the environmental conditions favor the use of a single clay liner. Site testing and an examination of the ground water hydrology of the site support this conclusion.
December 2003	NMOCD states that a properly constructed and maintained clay-lined pond may be approved under the WQCC Regulations IF Loco Hills GSF could acquire the property from the State of New Mexico.
January-April, 2004	NMOCC hears then promulgates NMOCD Rule 50, which requires double lining of storage ponds.
December-May, 2004	Loco Hills GSF negotiates an agreement to acquire the site from the State Land Office and adjacent private property from Bogle Farms.
May 31, 2004	R.T. Hicks Consultants submits the attached DRAFT letter that outlines how Loco Hills has met the conditions discussed in the December meeting and shows how the NMOCD can approve the proposed clay-lined pond under the WQCC Regulations.
June 3, 2004	In a meeting to resolve outstanding issues, NMOCD informs Loco Hills GSF that the proposed pond is NOT regulated by the WQCC but falls under the newly promulgated NMOCD Rule 50. Much of the work conducted by Loco Hills from December to June is voided by this finding.
June 9, 2004	NMOCD and Loco Hills GSF meet to identify a path forward to gain approval of the clay-lined pond under Rule 50.
June-August, 2004	Loco Hills implements many of the work elements identified at the June 9 meeting. While the tests support our conclusion that the site is suitable for a clay-lined pond, post-construction testing of the pond demonstrates the need for additional engineering and improvement of the existing liner.
August 17, 2004	Loco Hills submits the information collected during the course of the past year. In this submittal, Loco Hills also commits to installing a clay liner that meets NMOCD guidelines and installing *20* different monitoring devices in five separate zones to measure any seepage from the clay liner. As instructed by NMOCD, we ask for a hearing before the NMOCC to consider this application.
September 1, 2004	Mr. William Carr of Holland and Hart receives a motion dated *August 32, 2004 [sic] from NMOCD requesting dismissal of your* application before the NMOCC.

R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

May 31, 2004

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E
Discharge Plan Modification and Request to Discharge for 120 Days without an Approved Plan

Dear Wayne:

First and foremost, we appreciate your rapid review of our May 12, 2004 Discharge Permit modification and request to discharge for 120 days without an approved permit. In anticipation of NMOCD approval of the permit, Loco Hills GSF has begun the proposed quarterly monitoring of ground water at the site. Next month, we plan to submit the results of the first monitoring event. It will be interesting to see if the recent rains in the area combined with the increased use of water supply well #1 (adjacent to the lined pond) has created a decrease in the TDS of water supply well #2 (north of the highway).

Second, we would be pleased to meet with NMOCD to finalize the permit conditions and to outline what is required to obtain permission to discharge without an approved plan (beginning August 1, 2004). We fully understand that NMOCD cannot approve this proposed permit without developing a suitable plan to monitor the discharge and to close the facility.

However, I was a little confused by your e-mail; specifically your comment "*The issue of allowing brine pond seepage into the underlying groundwater is an issue that requires higher authority's input.*" I also am not certain why we would need attorneys present for the meeting.

I ask you to refer to the Water Quality Control Commission Regulations to aid in following my discussion. According to my reading of these regulations, the NMOCD cannot disapprove a permit application solely on the basis of the small volume of seepage. Below, I present Section 20.6.2.3109.C of the Regulations (italics) and my comments regarding these regulations.

C. Provided that the other requirements of this Part are met and the proposed discharge plan, modification or renewal demonstrates that neither a hazard to public health nor undue risk to property will result, the secretary ***shall*** (emphasis added by Hicks) *approve the proposed discharge plan, modification or renewal if the following requirements are met:*

The discharge permit application calculates a very small seepage rate from the clay-lined impoundment, it proposes a ground water extraction program, and calls for the transfer of property from State and private ownership to Loco Hills GSF. Because of these actions, the proposed plan will cause neither a hazard to public health nor an undue risk to property. We have had no indication from NMOCD that our actions would cause a hazard to public health. We understood from our December meeting that the fact that Loco Hills GSF did not own the property did cause a permit approval problem. We understand that Loco Hills GSF will own the property by mid-August, after completion of the land transfer with the State Land Office. Acquisition of the property by Loco Hills GSF will eliminate the outstanding issue of undue risk to property.

(1) ground water that has a TDS concentration of 10,000 mg/l or less will not be affected by the discharge, ***or*** (emphasis added by Hicks)

Below the site, ground water has a TDS concentration in excess of 10,000 mg/l. This high TDS was caused by past actions on the State Lease. The release of brine from past owners of the facility has affected ground water with a TDS concentration of less than 10,000 mg/l. The discharge permit application calls for a ground water extraction program that will mitigate the effect of these past actions and capture any leakage from the impoundment. The ground water extraction program, which is an integral part of the permit, will prevent any impact to water with a TDS concentration of 10,000 mg/l or less. NMOCD could approve the proposed discharge permit based upon this portion of the regulations. Seepage from the clay-lined impoundment into this ground water is really not the problem. The differential pressure head caused by this seepage in the absence of a ground water extraction program would be a problem. Our proposal calls for ground water extraction to mitigate any minor problem caused by seepage.

(2) the person proposing to discharge demonstrates that approval of the proposed discharge plan, modification or renewal will not result in either concentrations in excess of the standards of Section 20.6.2.3103 NMAC or the presence of any toxic pollutant at any place of withdrawal of water for present or reasonably foreseeable future use, except for contaminants in the water diverted as provided in Subsection D of Section 3109 NMAC, ***or*** (emphasis added by Hicks)

Loco Hills GSF went forward with the land transfer with the SLO to allow the NMOCD to approve the permit for a clay-lined pond under this portion of the regulations. By purchasing the property, we understood that the "place of reasonably foreseeable future use" becomes the down-gradient property line. With some permanent restrictive covenants on the property, our understanding is certainly true. Rather than implement such covenants to permit approval under this section, NMOCD should examine the discharge permit and approve the plan under a different section of the Regulations.

(3) the proposed discharge plan conforms to either Subsection a or b below and Subsection c below.

(b) Discharges from industrial, mining or manufacturing operations.

We understand that the Loco Hills GSF facility is a discharge from an industrial facility and falls under this provision of the Regulations.

(i) the discharger has demonstrated that the amount of effluent that enters the subsurface from a surface impoundment will not exceed 0.5 acre-feet per acre per year;

The calculated amount of brine that will enter the subsurface from the proposed clay-lined impoundment is 40 gallons per day or 14,600 gallons per year or 0.04 acre-feet per year. We used conservative assumptions in our calculations of seepage rate. Provided that NMOCD concurs with us that the proposed site activities prevent a hazard to public health and an undue risk to property, then NMOCD can (must) approve the discharge permit under this section of the Regulations. Because we have no nitrogen in the brine, sections C.3.b.i and C.3.b.ii do not apply to this discharge permit application.

The regulations state that NMOCD **shall** approve a discharge permit application that calls for less than 0.5 acre-feet per year of seepage from a clay-lined impoundment provided that the discharger demonstrates that approval of the permit will not cause a hazard to public health or an undue risk to property. We believe that the proposed permit application makes such a demonstration. If our submissions have not clearly made this demonstration, please identify where we fall short.

We clearly understand that transfer of the property from the State Land Office to Loco Hills GSF will be a requirement of discharge permit approval (to eliminate the "undue risk to property" requirement of the Regulations). We understand that we need to work with NMOCD to create an appropriate monitoring and reporting plan. We also understand that NMOCD may have some additional technical issues that we must resolve. However, we do not believe that we need attorneys to debate an issue regarding seepage from a lined lagoon that is clearly spelled out in the Regulations.

We are prepared to meet with NMOCD on Thursday of this week, June 3, to resolve any outstanding technical issues. We respectfully request that NMOCD permit the publication of a notice for this proposed modification as soon possible. We request that NMOCD consider our request to discharge for 120 days without an approved plan (beginning August 1, 2004) in the event that the discharge permit cannot be approved (with conditions) by August 1, 2004.

Thanks again for your attention to this important issue.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall Hicks
Principal

Copy: Mitchell Johnson

New Mexico Propane Gas Association
7119 E. Shea Blvd - #109-128
Phoenix, AZ 85254
Phone: 480-922-1056 - Fax: 480-991-5476

September 5, 2004

New Mexico Oil Conservation Committee
Mark Fesmire
1220 South St. Francis Drive
Santa Fe, NM 87505

Dear Mr. Fesmire;

Recently, information concerning the Loco Hills GSF supply terminal has been brought to my attention. Among our supply points for propane within the state of New Mexico, the Loco Hills terminal is one of, if not the most strategic location and distribution point. Not only is it the largest propane storage facility for domestic use, it is the only domestic storage facility within New Mexico. As a marketer and consumer, I must write to you in support of expansion of this facility. I am not an investor, nor am I a partner in any venture located at this facility.

In recent years our industry, and our consumers have been stressed by inconsistent supply of quality grade 5 propane at the peak demand period during winter months. Competition with other industries for petro chemicals force suppliers to pay premium prices during peak months, due to the lack of sufficient storage in New Mexico. Many times during holiday periods our retail facilities across our great state have rationed delivery quantities due to the high demand and lack of supply.

A new pond has been proposed and presented to your committee for approval, yet our members have not received confirmation of this pond from its investors. As another winter draws near, all companies are concerned with where and how we will be able to meet the demand. With the ABO facility at Artesia, New Mexico scheduled for termination in January 2005 and the Monument facility near Hobbs, New Mexico closed, where will we secure quality product for our customers? Our answer is Loco Hills GSF. This new pond will increase our storage capacity from 2 million gallons to 9 million gallons, 450% increase in storage for New Mexicans! With this consistent supply, radical fluctuations in pricing will be dramatically reduced. Savings to New Mexico consumers will be realized by stable pricing during peak demand months.

The clay lined pond was designed to the specifications of a reputable certified New Mexico engineer to meet the specifications set forth by the NMOCD, successfully meeting the minimum specifications for permeability and leak detection. This clay lined pond as designed, is less permeable than a poly lined pond. Lining of the clay pond with poly would only create a barrier to trap residue between the clay and poly liner. Costs associated with lining the pond with a less permeable material would be in excess of $250,000.00 .

As the winter of 2004 approaches, I pray that you and your distinguished members review and approve this facility. New Mexico is counting on this new facility to bring stable pricing to our great state. If I may be of any assistance to you, please do not hesitate to call me.

Thank you for your time in this matter.

Sincerely,

Mr. Bryan B. Stegall
President
New Mexico Propane Gas Association
1.505.644.5076 cell
1.505.527.1054 NM fax

HOLLAND&HART LLP

William F. Carr
wcarr@hollandhart.com

September 2, 2004

2004 SEP 2 PM 3 58

BY HAND DELIVERY

Mark E. Fesmire, P.E.
Director
Oil Conservation Division
Energy, Minerals & Natural Resources Department
1220 South St. Francis Drive
Santa Fe, NM 87504

Re: Application for Loco Hills GSF for Approval of its Stage I and II Abatement Plans and Best Management Practices Plan and an Exemption to Division Rule 50, Eddy County, New Mexico.

Dear Mr. Fesmire:

For months Loco Hills GSF has been attempting to obtain regulatory approval for a clay-lined pit that would enable it to improve its operation at the gas storage facility it operates in Eddy County New Mexico. The improvements would include not only a more efficient storage of propane and butane at the site but would also address contamination of groundwater caused by a prior operator, thereby restoring water quality under the site.

During the course of this effort Loco Hills GSF has experienced numerous delays including, for example, changes in the regulatory scheme. These delays have put at risk Loco Hills' plan to proceed with this project and subjecting it to a loss of both the desired economic and environmental benefits.

Loco Hills GSF has not attempted to avoid any part of the state regulatory scheme. It met with the Division in early August and requested that its application go directly to hearing before the Oil Conservation Commission. The application set for hearing on September 9 is the result of what Loco Hills understood to be the outcome of that meeting.

HOLLAND & HART LLP

If the concerns of the Division that are now contained in its Motion to Dismiss had been expressed earlier, Loco Hills would not have filed its application for the September 9 hearing. Now that Loco Hills is aware of these concerns, it has decided not to oppose the Motion to Dismiss.

Very truly yours,

Robert Jutspt for

William F. Carr
of Holland & Hart LLP

WFC:keh
Enclosures

cc: Gail MacQuesten
Mitchel Johnson
Randall Hicks

3275158_1.DOC

2004 AUG 32 PM 2 11

STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION COMMISSION

APPLICATION OF LOCO HILLS GSF FOR APPROVAL OF ITS STAGE I AND II ABATEMENT PLANS AND BEST MANAGEMENT PRACTICES PLAN AND AN EXEMPTION TO DIVISION RULE 50, EDDY COUNTY, NEW MEXICO.

CASE NO. 13339

OIL CONSERVATION DIVISION'S MOTION TO DISMISS

The Oil Conservation Division (OCD) moves to dismiss the application filed by Loco Hills GSF (Loco Hills) for approval of its stage I and II abatement plans and best management practices plan and an exemption to Rule 50. The issues are not ripe for decision by the Commission. Loco Hills should be required to develop the information necessary to decide the issues by following the required administrative processes.

Loco Hills' application includes a request for approval of its stage I and II plans to abate existing water pollution at the site. Abatement of water pollution is conducted under an administrative process pursuant to Rule 19. As described in the rule, the purpose of a stage I abatement plan is to design and conduct a site investigation that will adequately define site conditions, and provide the data necessary to select and design an effective abatement option. Rule 19.E(3). The purpose of the stage II abatement plan is to select and design an abatement option that will result in attainment of the abatement standards and requirements set out in the rule. Rule 19.E(4)(a). Once the applicant has filed administratively complete stage I and II plans, the applicant must follow the extensive public notice requirements set out in the rule. These requirements include written notice to surface owners, the county commission, the appropriate city officials, those persons who have requested notification, the New Mexico trustee for natural resources, and any other local, state or federal governmental agency affected, and the appropriate governor or president of any affected Indian tribe, pueblo or nation. See Rule 19.G(1). In addition, the applicant must publish notice in a newspaper of general circulation in the affected county and in a newspaper of general circulation in the state. The published notice must include a description of the source extent and estimated volume of the release, whether the release occurred into the vadose zone, ground water or surface water, a description of the proposed stage I or stage II abatement plan, and a statement that written comments and requests for public hearing must be received by the director within 30 days of the date of publication. Rule 50.G(2). The plans themselves must be available for public view. Rule 50.G(2)(e). After the 30-day public comment period the OCD reviews the plan for approval, and attempts to resolve issues raised in the public comments. If the disputes are not resolved, the director may schedule the abatement plan for public hearing.

Loco Hills has attempted to bypass the Rule 19 administrative procedures by submitting their most recent stage I and stage II plans directly to the Commission for hearing. Had the plans been submitted to the OCD under the process set out by Rule 19 they would have been rejected as administratively incomplete because of Loco Hills' failure to provide a plan to delineate the horizontal and vertical extent of contamination and their failure to provide a public notification proposal. See Rules 19.E(3) and

19.E(4)(b). Once the administrative deficiencies had been corrected, the plans would have gone out for public comment. After public comments were received, the plans and comments would have been reviewed by the OCD for technical sufficiency.

Loco Hills cannot remedy this procedural defect by dismissing the Rule 19 abatement issues and proceeding to hearing on their request for an exemption to Rule 50. Loco Hills' abatement plan is the central to their request for an exemption to Rule 50's liner requirements. Loco Hills' argument, in a nutshell, is that they acknowledge that the clay-lined pond they are proposing will leak chloride contaminated water, but they argue that they will pump out more contaminated water under their abatement plan than they will introduce through their exempted pond, resulting in a net environmental gain. Their application seeks the Commission's approval of this concept, and approval of an exemption to Rule 50, before they provide details on how the pond will be constructed and how contamination will be minimized. For example, they have not provided specifications for the proposed pond ("Loco Hills GSF will provide NMOCD a complete set of engineering drawings and specifications for the proposed clay-lined pond #2 after approval of this Best Management Practices Plan and NMOCD approval of the required exemption from Rule 50." Best Management Plan (BMP), August 17, 2004, page 2.) And although they claim that adding bentonite to the existing clay in the pond will result in a permeability of 1 E-7 or less, they have not done the work to make that showing ("Upon approval of this BMP and the requested exemption from Rule 50, Loco Hills GSF will retain Pettigrew and Associates to create the specifications required to improve the existing clay liner such that it meets a permeability of 1 E-7 or less." BMP, August 17, 2004, page 5).

The OCD recognizes that the director has the authority under Rule 1216 to set the hearing in any matter before the Commission. But this case is not ready for hearing before either the Commission or a division examiner. Loco Hills has not followed the administrative process set out in Rule 19 to develop the facts necessary to evaluate an abatement plan, and has not gone through the public notice procedures that are essential to the proper development of an abatement plan.

Conclusion

The OCD respectfully moves the Commission to dismiss Loco Hills' application. Loco Hills may then re-apply through the correct administrative processes.

RESPECTFULLY SUBMITTED,
this 1st day of September, 2004 by

Gail MacQuesten
Assistant General Counsel
Energy, Minerals and Natural Resources Department of the State of New Mexico
1220 S. St. Francis Drive
Santa Fe, NM 87505
(505) 476-3451

Attorney for The New Mexico Oil Conservation Division

Certificate of Service

I hereby certify that I a true and correct copy of the foregoing pleading was transmitted to Mr. Carr, attorney for Loco Hills GSF, by fax (983-6043) and e-mail wcarr@hollandhart.com) this 1st day of September, 2004.

Gail MacQuesten

Price, Wayne

From: Mitchel Johnson [mitchel_lhgsf@hotmail.com]
Sent: Monday, August 30, 2004 1:14 PM
To: wprice@state.nm.us
Cc: r@rthicksconsult.com; wcarr@hollandhart.com
Subject: Loco Hills GSF

Dear Wayne:

We directed R.T. Hicks Consultants, Ltd. to submit a Stage I/II Abatement Plan and a Best Management Practices Plan to your office. Separately, Mr. William Carr submitted a request to present our petition for an exemption from Rule 50 at the September hearing. We hope to resolve any remaining technical or regulatory questions posed by the NMOCD prior to the September hearing, in order to avoid any negative NMOCD testimony regarding our petition. We hope that NMOCD will approve our request administratively, without a hearing, as the regulations permit.

In either case, hearing or no, our company, our consultants and our engineers will have work to do when NMOCD approves our basic strategy described in our submissions. Our first step is providing NMOCD with a set of engineering design drawings and specifications that will allow us to construct the proposed clay liner. In these specifications, we will include a protocol for quality assurance testing during construction as well as post-construction testing of the liner permeability. We are cognizant of the fact that our work does not stop when NMOCD approves the concepts presented in these submissions.

In the absence of NMOCD approval of an exemption to Rule 50 for the project, we will need to evaluate many other options. The biggest question would be would we purchase the State Land or the private land. Also, we may have to go with the existing pond or a smaller pond if we are required to use a double poly liner. The size of a double poly lined pond will be much smaller than the clay-lined pond due to the much increased cost of liners. A smaller pond necessitates less ground water pumping and creates a much longer time for restoration of ground water contamination caused by past operations. A smaller pond would restrict the revenues that we would be able to generate. We continue to maintain that NMOCD approval of the clay-lined pond creates a net environmental benefit for the State of New Mexico and the affected stakeholders.

We look forward to working out the remaining details of our conceptual designs presented in our submissions. Thank you for your efforts associated with our project.

Thank you,

Mitchel Johnson
Loco Hills GSF
office: 817-441-6568
cell: 817-371-7933

HOLLAND & HART LLP

William F. Carr
wcarr@hollandhart.com

2004 AUG 17 PM 4 20

August 17, 2004

VIA HAND DELIVERY

Mark E. Fesmire, P.E.
Director
Oil Conservation Division
New Mexico Department of Energy
Minerals and Natural Resources
1220 South Saint Francis Drive
Santa Fe, New Mexico 87505

Case 13339

Re: **Application of Loco Hills GSF for approval of a Stage I and II Abatement Plan and Best Management Practices Plan and an exemption to Division Rule 50, Eddy County, New Mexico.**

Dear Mr. Fesmire:

On this date, Loco Hills GSF delivered to the Oil Conservation Division for its review and consideration its proposed Stage I and Stage II Abatement Plans and Best Management Practices Plan for its facility located in the NW/4 SW/4 of Section 22, Township 17 South, Range 29 East, NMPM, Eddy County, New Mexico. These documents were sent by e-mail to Mr. Wayne Price with hard copies to follow. Since the operation of this facility in accordance with these plans meets all of the Division's requirements and since all adjacent surface owners, Bogel Farms and the State Land Office, have been notified of this application as required by Rule 50.G(2), Loco Hills GSF submits that it has complied with all Division requirements for approved of an exemption to Rule 50 without hearing.

However, at our meeting with you and your staff on August 3, 2004, we were advised that this application would be set for hearing. As you may recall, Loco Hills is concerned that additional time delays in obtaining administrative approval of this petition for exemption could further delay its aggressive groundwater restoration program at this site and have severe economic consequences on its ability to operate this facility in the most environmentally sensitive way. At the time of that meeting we requested that the application be heard by the Commission at its September 9, 2004 meeting.

Loco Hills requests that you treat this letter and the Stage I and Stage II Abatement Plans and its Best Management Practices Plan as its petition for exemption to the requirements of Rule 50 for a double liner and leak detection system for a pit located at this facility.

Loco Hills also requests that this application be set for hearing before the Oil Conservation Commission at its September 9, 2004 meeting and that following notice and hearing the requested exemption be granted.

We enclose a copy of a proposed legal advertisement for this case. Loco Hills will also provide notice of this request for hearing to the surface owners of record under and adjacent to this facility and to such other persons as the Division may direct.

Your attention to this request is appreciated.

Very truly yours,

William F. Carr

William F. Carr
Attorney for Loco Hills (GSF)

Enclosure

cc: Mr. Mitchell Johnson
Mr. Randall Hicks

Case 13339: **Application of Loco Hills GSF for approval of its Stage I and II Abatement Plans and Best Management Practices Plan and an exemption to Division Rule 50, Eddy County, New Mexico.** Pursuant to the provisions of Rule 50.G (2) of the General Rules of the Division, applicant seeks approval of its Stage I & II Abatement Plan and Best Management Practices Plan for the Loco Hills Gas Storage Facility and an exemption to the requirements of Rule 50 for a double liner and leak detection system for a pit located at this facility in the NW/4 SW/4 of Section 22, Township 17 South, Range 29 East, NMPM, Eddy County, where ground water beneath the site exceeds 100,000 ppm total dissolved solids. This facility is located approximately 5 miles west of Loco Hills, New Mexico.

NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

BILL RICHARDSON
Governor
Joanna Prukop
Cabinet Secretary

Mark E. Fesmire, P.E.
Director
Oil Conservation Division

August 05, 2004

Mr. Mitchel Johnson
Loco Hills GSF, LLC
158 Deer Creek Drive
Aledo,Texas 76008

Re: Loco Hills Gas Storage Facility
UL L Section 22-Township 17 South-Range 29 East
NMPM Eddy County, New Mexico

Subject: Technical meeting presented by Loco Hills GSF (LHGSF) on August 03, 2004 proposing alternate abatement standards and requesting OCD to approve a path forward which will allow a single clay-lined pond if certain standards are met.

Dear Mr. Johnson:

The New Mexico Oil Conservation Division (OCD) sent Loco Hills GSF, LLC (LHGSF) a letter on July 22, 2004 (attached) notifying LHGSF that the facility will now be permitted under rule 701.H for the storage wells, rule 50 for the surface impoundments, and rule 19 for the abatement of water pollution and OCD's intent is to amend the original order by rolling over the existing permits conditions into the new amended order.

OCD also reviewed the request to modify the permit to include a single clay lined pond designed to have seepage. OCD denied that request because Rule 50 requires all ponds to be double lined with leak detection unless an exemption is granted where the operator demonstrates that the proposed design will not endanger fresh water, public health or the environment. OCD noted that groundwater underlying the site had already been contaminated from previous operations and the underlying geology of the site was not an adequate barrier for protection of groundwater.

On August 03, 2004 LHGSF presented additional technical information concerning the site. The agenda included site hydrology, magnitude and extent of groundwater impairment, probable cause of groundwater impairment and a path forward to exempt the pond from double liner requirement.

During the meeting LHGSF shared with OCD the most recent data concerning the post testing of the clay liner. The clay liner bottom and sides were retested for "as built" permeability and the results were noted to be $1x10^{-5}$ cm/sec which is 1000 times more permeable than what was originally proposed $1x10^{-8}$ cm/sec. The field infiltration device also showed similar results. In addition the clay liner was noted to have impurities such as gypsum crystals, large rocks, and sand layers that were exposed due to erosion.

LHGSF indicated they plan to propose alternate abatement standards for the groundwater below the site, demonstrate that seepage will not increase magnitude and extent of impairment e.g. seepage will not cause degradation of fresh water, install adequate monitoring devices, like Ciniza Refinery, and stated that OCD needs to help define, then approve a Path Forward which will allow a clay-lined pond if certain standards are met.

OCD pointed out rule 50 standards are double lined with leak detection and rule 50 does not have a current standard for a single lined pond. LHGSF then requested that OCD develop and state a standard in a letter so LHGSF would have an opportunity to met those standards. The ideal was that OCD technical staff would not object during a hearing if LHGSF meets these standards.

OCD pointed out that their concerns about the pond construction and quality of the clay material were valid. The current pond as constructed would have allowed approximately 40,000 gals of brine water to seep into the ground per day. However, in the spirit of cooperation OCD agreed to list their requirements. They are as follows:

1. In order for OCD to evaluate any path forward regarding pond construction and alternate abatement standards LHGSF must submit for OCD approval an Abatement Plan pursuant to Rule 19.

2. In order for OCD to evaluate a single lined pond, LHGSF must demonstrate that the operation would be equivalent or better than a double lined pond with leak detection. LHGSF must demonstrate that the permeability of the clay liner would meet or exceed standards for synthetic liners $1x10^{-8}$ cm/sec as originally proposed. In addition, a leak detection system in the vadose would have to be installed directly below the pond to detect pond leakage. A seepage water collection system would have to be installed to collect all seepage water. LHGSF would have to propose a contingency plan for OCD approval to remove all fluids from the pond within 48 hours of discovery of pond seepage or failure of the system.

3. LHGSF would have to demonstrate how they would achieve quality assurance and control of pre and post construction requirements.

4. LHGSF shall demonstrate how they plan on operating, maintaining and monitoring the new pond. OCD may add additional approval conditions.

5. LHGSF would be required to submit for OCD approval a detailed description of construction and scaled drawings of the proposed pond system before construction begins. Detailed as built drawings would be required.

6. LHGSF shall demonstrate to OCD how they plan on installing and operating a pond groundwater monitoring system. At a minimum OCD will require nested wells installed on all four sides of the pond. OCD may require additional wells if deemed warranted.

7. LHGSF shall describe how they will investigate and repair the existing water wells on site. This plan shall include plugging any present conduits that may exist.

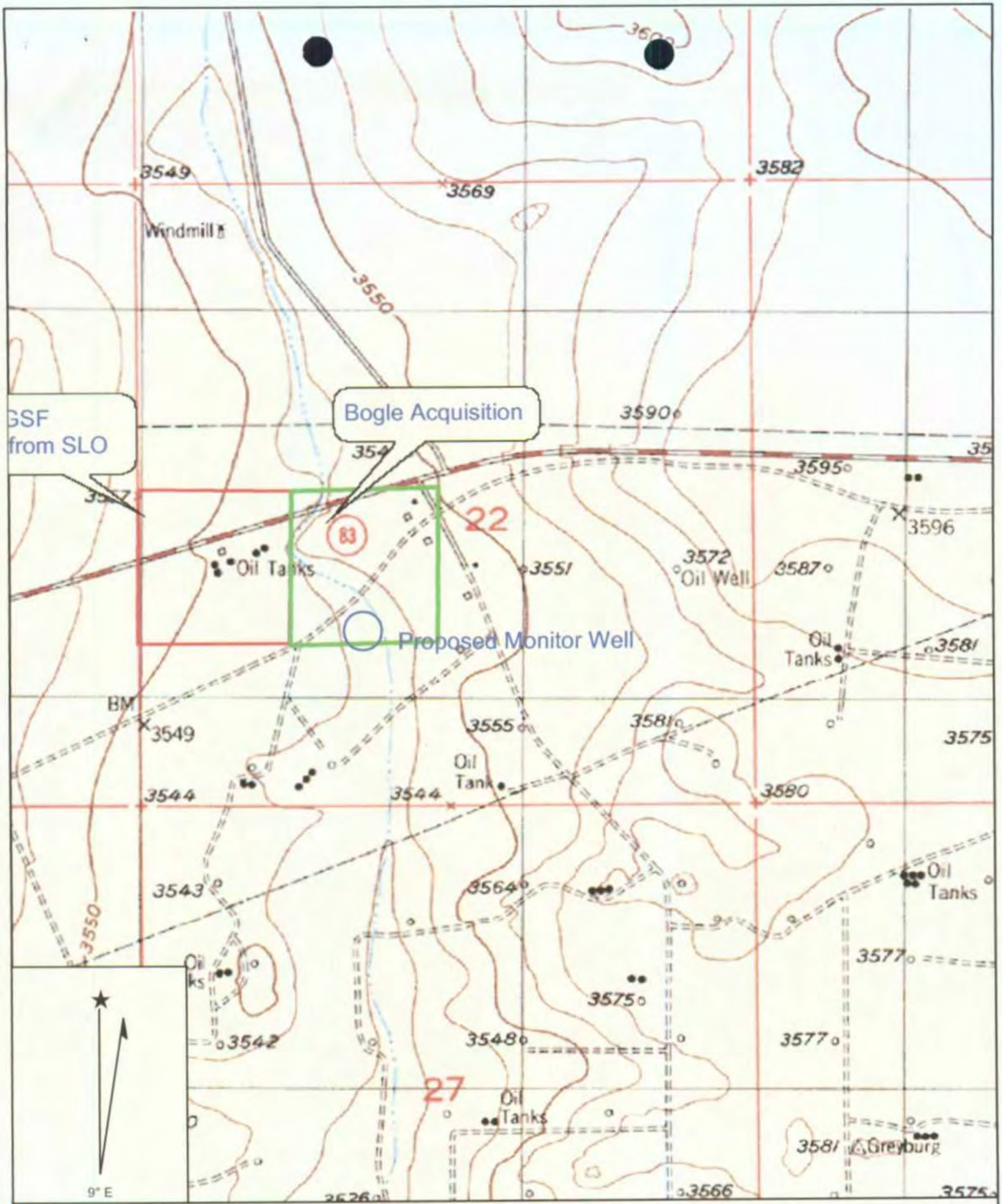
Please be aware that the Division has not established a "finish line" in this correspondence. Based on the very short time frame the Division had to evaluate LHGSF's August 3, 2004 proposals, there may be additional questions and during the review process OCD may request additional information and may impose additional requirements. If you have any questions, please contact Wayne Price of my staff at (505-476-3487) or E-mail wprice@state.nm.us. On behalf of the staff of the OCD, I wish to thank you and your staff for your cooperation during this review process.

Sincerely,

Roger C. Anderson
Environmental Bureau Chief

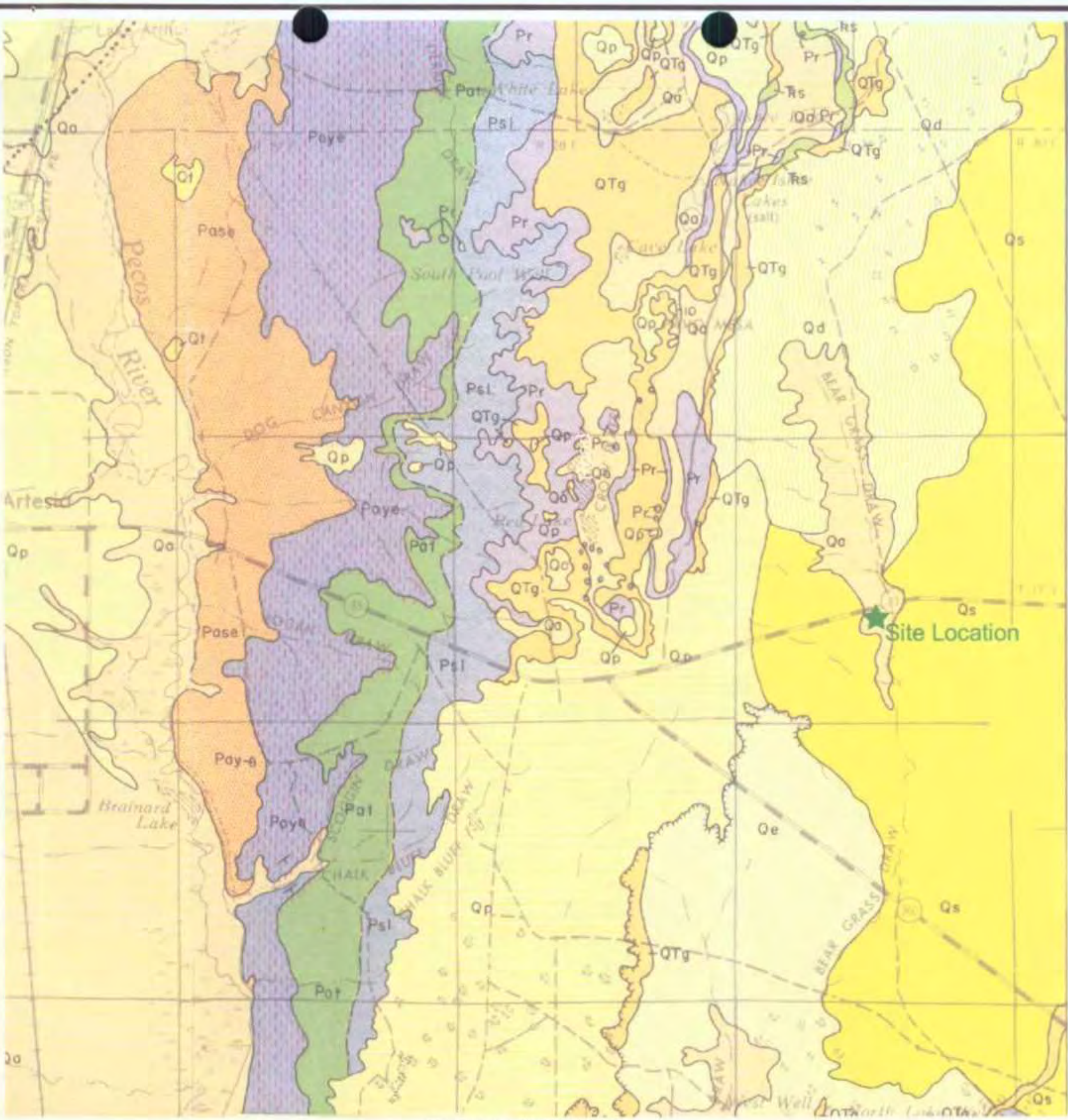
RCA/lwp

PLATES



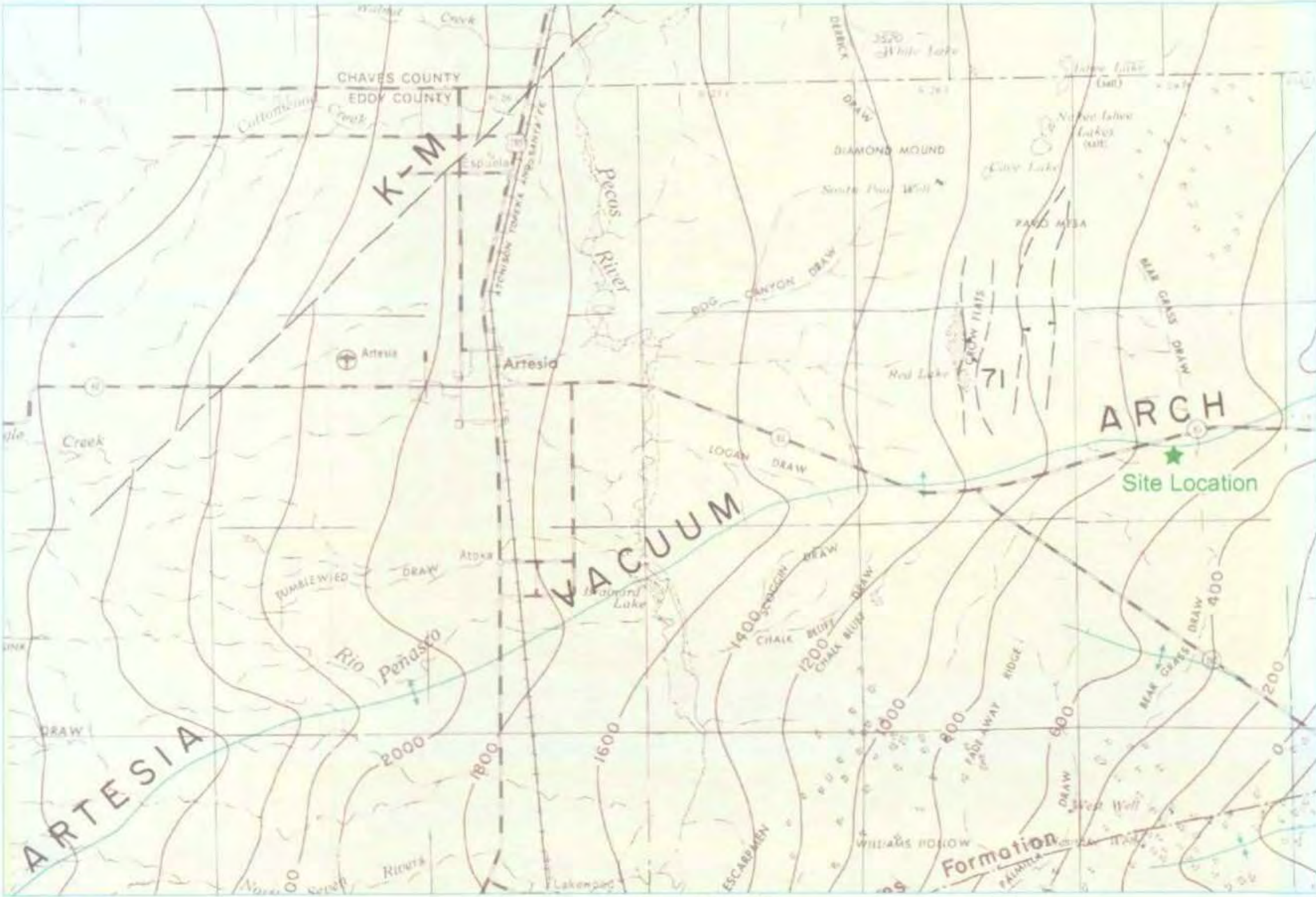
Name: RED LAKE SE
Date: 5/11/2004
Scale: 1 inch equals 1000 feet

Location: 032.8174199° N 104.0605926° W
Caption: Plate 1: Parcel Map



Map source: Kelley, 1971

R.T. HICKS CONSULTANTS, LTD.	Loco Hills GSF	Plate 2
901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87104 505.266.5004 Fax: 505.266.0745	Surface Geologic Map	July, 2004

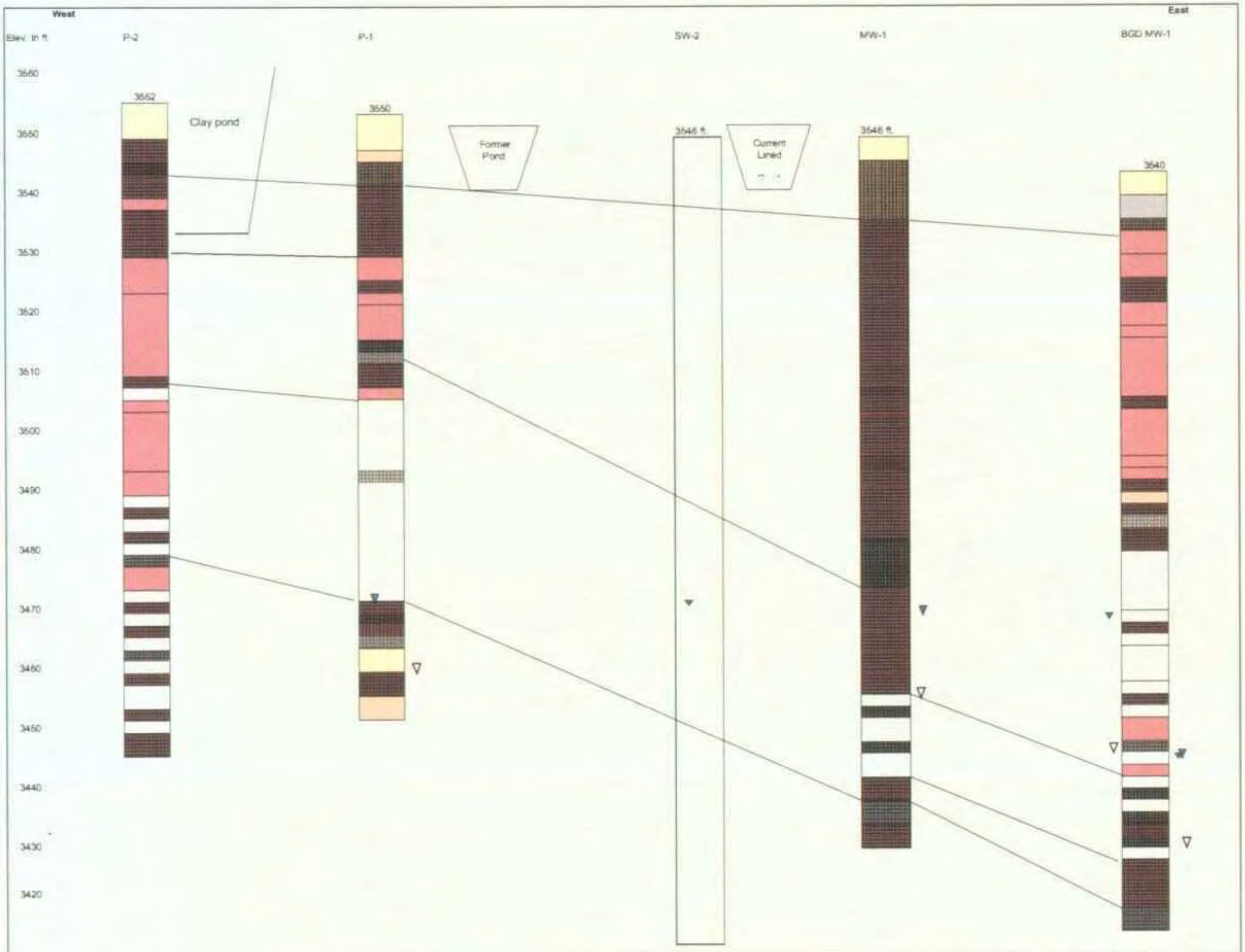


Map Source: Kelley, 1971

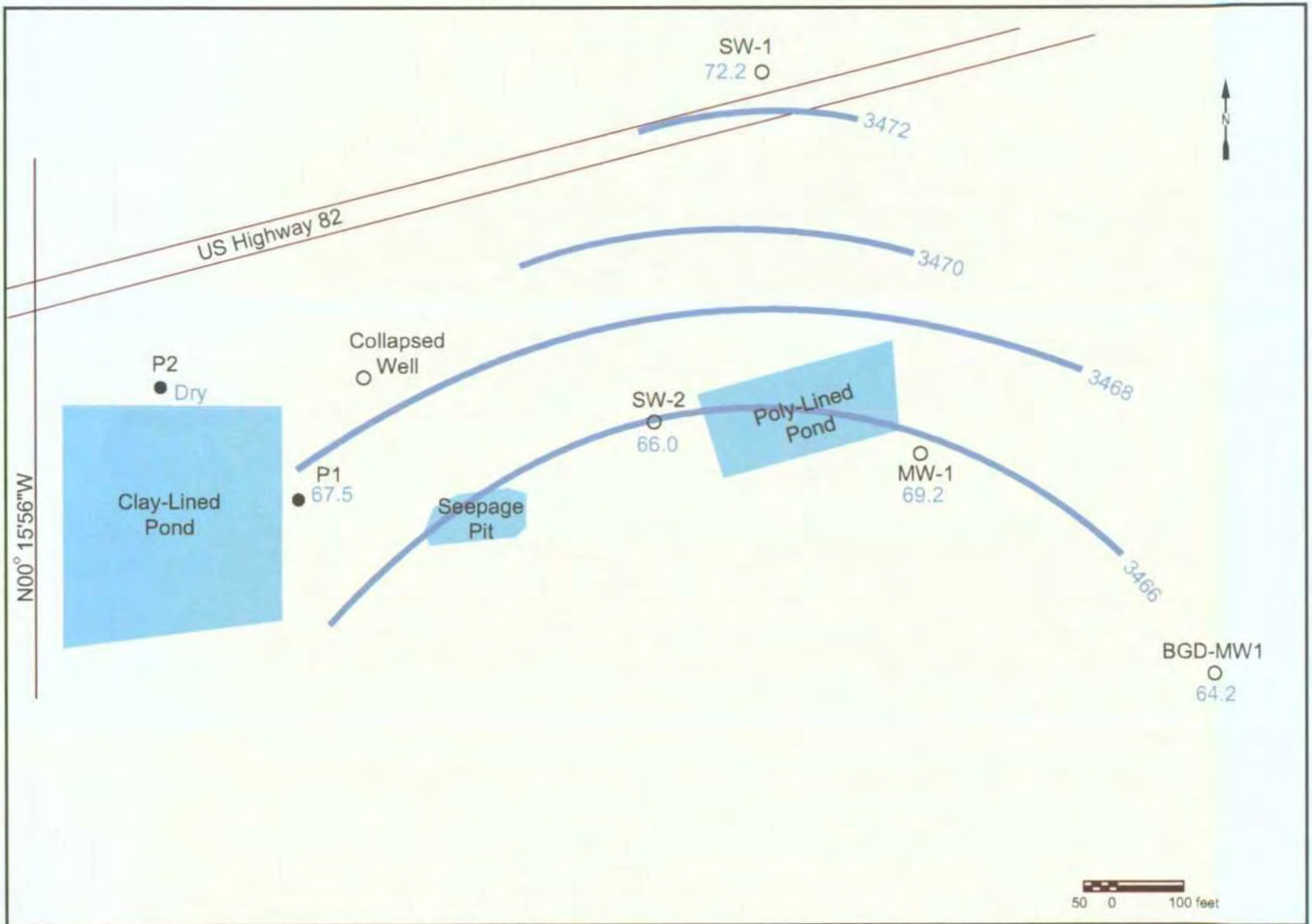
N

2 0 4 miles

R.T. Hicks Consultants, Ltd. 901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87104 505.266.5004 Fax: 505.246.1818	Loco Hills GSF	Plate 3
	Structure Contour Map	July, 2004

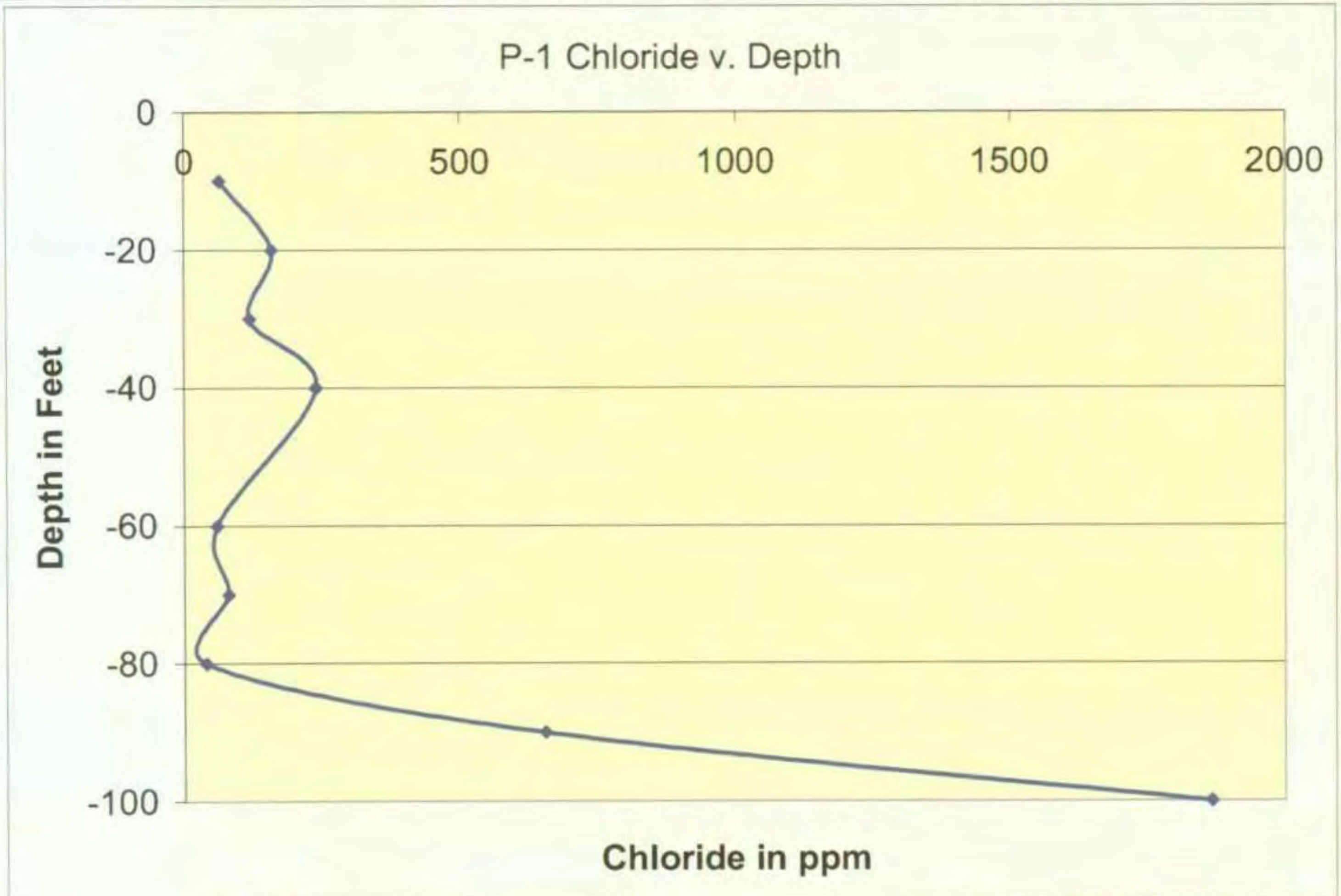


R.T. Hicks Consultants, Ltd. 901 Rio Grande Blvd. NW, Suite F-142 Albuquerque, New Mexico 87104	Hydrogeologic Cross Section	Plate 4
	Loco Hills GSF	Jul-04

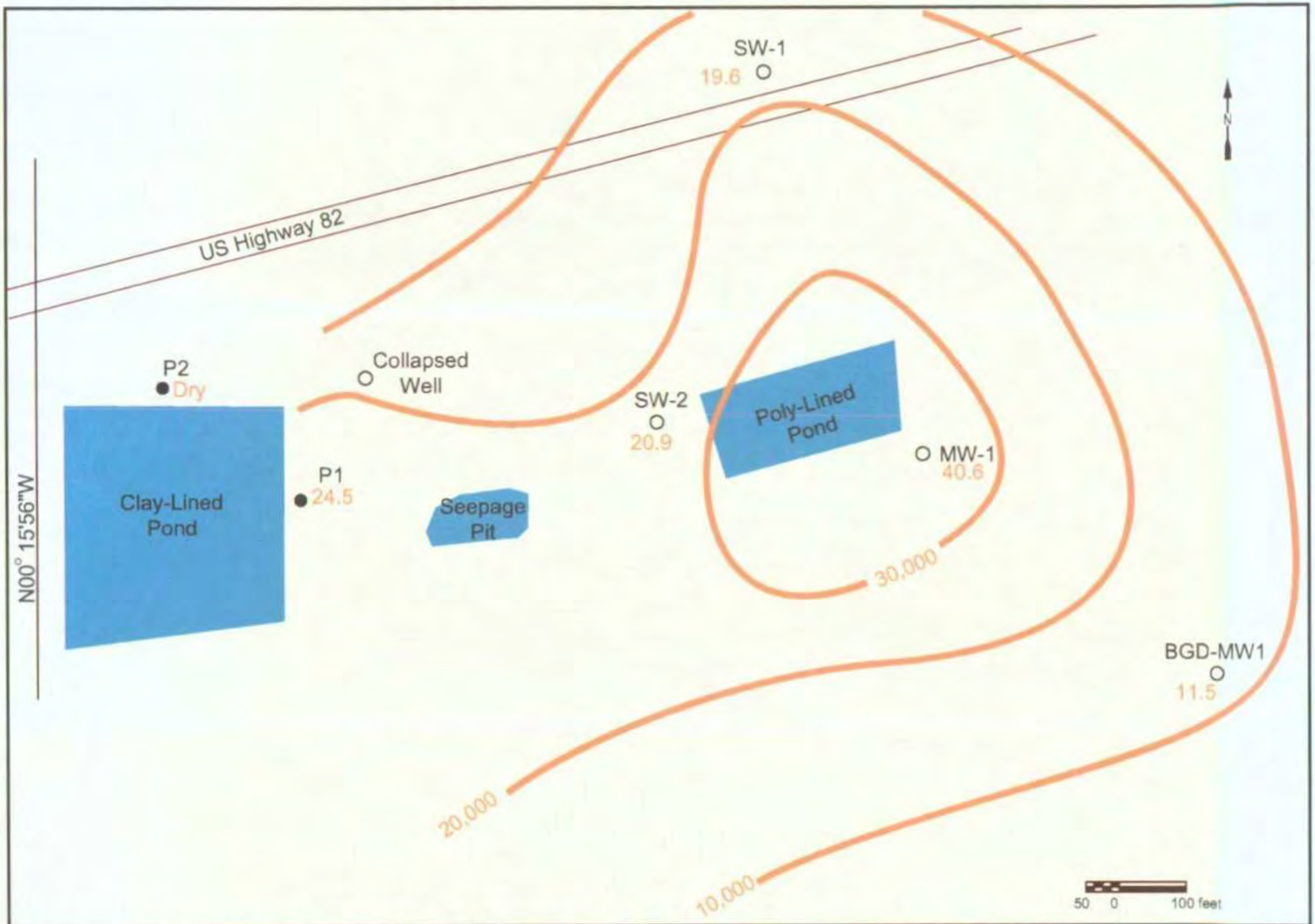


R.T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87104
505.266.5004 Fax: 505.246.1818

Loco Hills GSF	Plate 5
Potentiometric Surface Map	July, 2004



R.T. Hicks Consultants, Ltd. 901 Rio Grande Blvd. NW, Suite F-142 Albuquerque, New Mexico 87104	Chloride vs. Depth in P-1	Plate 6
	Loco Hills GSF	Jul-04



R.T. HICKS CONSULTANTS, LTD.	Loco Hills GSF	Plate 7
901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87104 505.266.5004 Fax: 505.246.1818	Chloride in Ground Water (10^3 mg/L)	July, 2004

Logger:	David Hamilton	**Client:**	**Well ID:**
Driller:	Dubose Drilling	LHGSF	
Drilling Method:	Air Rotary	**Project Name:**	
Start Date:	6/17/2004		
End Date:	6/18/2004	**Location:**	P-1
Notes:		Loco Hills	

Depth (feet)	Description
0.0 – 6.0	Surface, sand, some gypsum, some clay, red, 0-7 ft.
6.0	Sand, light red, dry, 7-9 ft.
8.0 – 10.0	Caliche, sand, 9-12 ft.
12.0	Clay, caliche, red, dry, 12-14 ft.
14.0 – 16.0	Clay, red, dry, 14-17 ft.
18.0 – 20.0	Clay, some sand, minor caliche, red, dry, 17-22 ft.
22.0	Clay, some sand, red, dry, 22-25 ft.
24.0 – 26.0	Sand, clay, red, dry, 25-27 ft.
28.0	Clay, red, dry, 27-28 ft.
30.0	Sand, some clay, light red, dry, 28-32 ft.
32.0 – 36.0	Sand, silt, clay, light red, dry, 32-39 ft.
38.0	Limestone, light grey, dry, 39-41 ft.
40.0	Sand, limestone, 41-42 ft.
42.0 – 44.0	Clay, red, soft, 42-46 ft.
46.0	Clay, sand and caliche, 46-48 ft.
48.0 – 58.0	Gypsum, white, dry, 48-61ft.
60.0	Gypsum, hard, white, 61-63 ft.
62.0 – 80.0	Gypsum, white, dry, 63-82 ft.
82.0	Clay, red, moist, 82-84 ft.
84.0	Clay, red, gypsum, 84-87 ft.
86.0	Clay, gypsum, hard, 87-88 ft.
88.0	Sand, clay, limestone, 88-91 ft.
90.0 – 92.0	Gypsum, clay, tan, dry, 91-93 ft.
94.0 – 96.0	Gravel, wet, 93-97 ft., est. 1-2 gal./min.
98.0 – 100.0	Sand, clay, tan, 97-101ft.

Lithology

Piezometer Construction

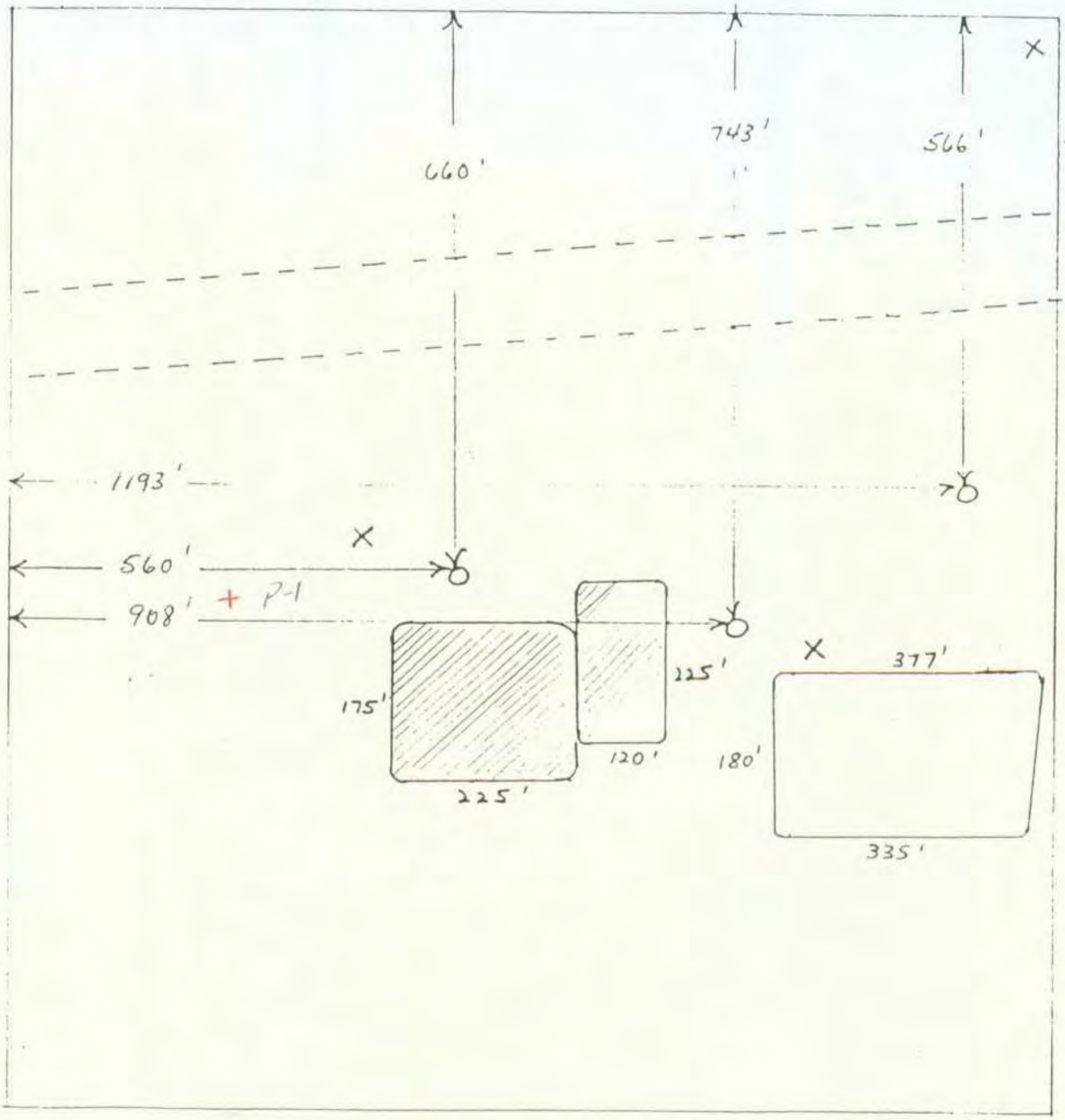
R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
505-266-5004

Loco Hills GSF

Plate D-1

July 2004

HILLS - UNDERGROUND STORAGE
(Not to exact scale)
NW¼-SW¼ Sec. 22
1" equals approx.200'



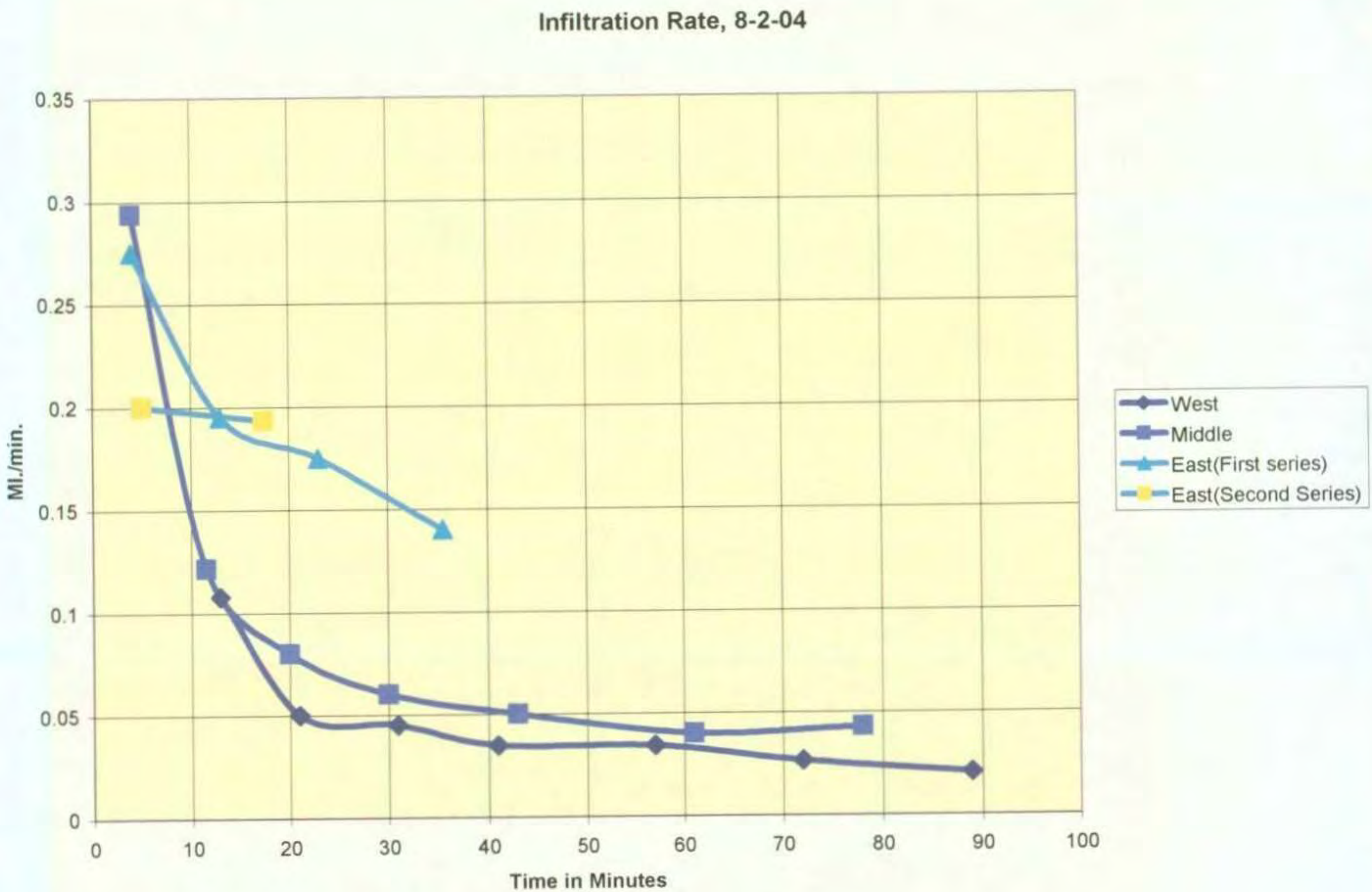
- - - - U.S. 82 Highway Right of Way

X Water Wells

O Propane Storage Wells

Abandoned and filled-in former brine storage pond

New brine storage pond



Infiltration Rate, 8-2-04
Ml./min.
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
80
90
100
Time in Minutes
West
Middle
East(First series)
East(Second Series)

Table 1: Surface Fluid Storage at Loco Hills GSF

Type of Storage	Maximum Capacity	Stored Liquid	Location
Pond #1	2 million gallons	10 lb. Brine	SE Corner of facility
Pond #2	7-11 million gallons	10 lb. Brine	Western portion of facility
Above ground storage steel tank #1	30,000 gallons	Propane or Butane	Tank Area
#2	30,000 gallons	Propane or Butane	Tank Area
#3	18,000 gallons	Propane or Butane	Tank Area
#4	18,000 gallons	Propane or Butane	Tank Area

Table 2: Subsurface Fluid Storage at Loco Hills GSF

Cavern #1	2.75 MM gallons	Served by injection well 1
Cavern #2	3 MM gallons	Served by injection well 2
Cavern #3	3 MM gallons	Served by injection well 3

Table 3: Pre-Construction Clay Liner Seepage Calculations

Average Saturated Hydraulic Conductivity		Method	Pond Surface Area	Hydraulic Gradient	Seepage Rate	
cm/sec	m/day		m2	m/m	liters	gallons
1.72E-08	1.49E-05	Lab	10000	1	1.49E+02	40

Table 4. Depth to Water and Elevation of Potentiometric Surface, Loco Hills GSF in ft.							
	Supply Well 1 N. of High. 82	Supply Well 2 W. of lined Brine Pit	Monitoring Well 1 S.S. corner of lined Brine Pit	Bear Grass Draw Monitoring Well 1	Bear Grass Draw Piez. 1 129 ft.	Piez 1-1 100 ft. E. of new Clay Pit	Piez. 1-2 88 ft. E. of new Clay Pit
Pecos V. Pump., 2002		36 3511.3					
Driller 5/2/2003			83 3465.9				
R. T. Hicks 10/8/2003	86.58 3462.7						
R. T. Hicks 6/25/2004	77.1 3472.2	81.3 3465.95	83.72 3465.18	78.48 3464.64	102.59 3440.51	86.64 3467.51	86.76 3467.59
LH GSF 7/21/2004		83.25 3464	83.84 3465.06			86.76 3467.39	86.87 3467.48
LH GSF 7/22/2004		90.54 3456.71	83.5 3465.4			98.17 3455.98	84.67 3469.68
P1-3 at 36 ft.deep and the three piezometers at P-2 on the north side of the clay pond are all dry. The piezometers at P-2 are at depths of 60, 82, 110 feet bgs.							

Table 5. Chloride Concentrations in Wells at Loco Hills GSF in mg./l.							
	Supply Well 1 N. of High. 82	Supply Well 2 W. of lined Brine Pit	Monitoring Well 1 S.S. corner of lined Brine Pit	Bear Grass Draw Monitoring Well 1	Bear Grass Draw Piez. 1 129 ft.	Piez 1-1 100 ft. E. of new Clay Pit	Piez. 1-2 88 ft. E. of new Clay Pit
Arrow Gas 1981	60,680						
Cardinal Labs 5/28/2003	45,988	42,987	74,977				
Cardinal Labs 6/12/2004	32,990	42,987	58,982				
R. T. Hicks 6/25/2004			52,984	16,622	18,540	22,298	22,549
LH GSF 7/14/2004	19,619	20,927	40,588	11,497	28,258	15,329	24,559

NMOCD – Loco Hills GSF Meeting
August 3, 2004

Agenda

1. Site Hydrogeology –
    a. Ground Water in thin permeable lenses of the Rustler Formation
    b. Ground water zones pinch-out laterally
    c. Natural TDS is about 2500 mg/L
    d. Ground water is confined by thick clay and gypsum layers
    e. Low transmissivity, steep gradient
2. Magnitude and Extent of Ground Water Impairment
    a. 100,000 mg/L TDS more or less on site
    b. 70,000 mg/L TDS more or less in Bear Grass Draw
    c. Probably 500-1000 feet east-west
    d. Probably 1000-2000 feet north south
    e. Water quality is improving with time
3. Probable Cause of Ground Water Impairment
    a. Discharge of about 36,000,000 gallons of brine into Seepage Pit during expansion/construction of the cavities the 1950's
    b. Seepage saturates caliche horizon then drains into ground water via water supply wells
    c. Periodic discharges to seepage pit during operations
    d. TDS of supply well >60,000 ppm chloride in 1981
4. Path Forward to exempt pond from double liner requirement
    a. Show that seepage will not increase magnitude and extent of impairment - seepage will not cause degradation of fresh water
    b. Install adequate monitoring devices, like at the Ciniza Refinery
    c. Alternative Abatement Standards could provide sufficient reason to approve a clay-lined pond with seepage detection devices
    d. NMOCD needs to help define then approve a Path Forward which will allow a clay-lined pond if certain standards are met

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Friday, July 23, 2004 1:22 PM
To: 'Price, Wayne'

Wayne

Here is the protocol used, with site specific modification, for the seepage tests at Loco Hills GSF.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Designation: D 5093 – 02

Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring[1]

1. Scope *

1.1 This test method describes a procedure for measuring the infiltration rate of water through in-place soils using a double-ring infiltrometer with a sealed inner ring.

1.2 This test method is useful for soils with infiltration rates in the range of 1×10^{-7} m/s to 1×10^{-10} m/s. When infiltration rates $\geq 1 \times 10^{-7}$ m/s are to be measured Test Method D 3385 shall be used.

1.3 All observed and calculated values shall conform to the guide for significant digits and rounding established in Practice D 6026.

1.3.1 The method used to specify how data are collected, calculated, or recorded in this standard is not directly related to the accuracy to which the data can be applied in design or other uses, or both. How one applies the results obtained using this standard is beyond its scope.

1.4 This test method provides a direct measurement of infiltration rate, not hydraulic conductivity. Although the units of infiltration rate and hydraulic conductivity are similar, there is a distinct difference between these two quantities. They cannot be directly related unless the hydraulic boundary conditions, such as hydraulic gradient and the extent of lateral flow of water are known or can be reliably estimated.

1.5 This test method can be used for natural soil deposits, recompacted soil layers, and amended soils such as soil bentonite and soil lime mixtures.

1.6 The values stated in SI units are to be regarded as standard. The values in parentheses are for information only.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 3385 Test Method for Infiltration Rate of Soils in Field Using Double Ring Infiltrometers[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock Used in Engineering Design and Construction[2]

D 6026 Practice for Using Significant Digits in Geotechnical Data[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *infiltration*—downward entry of liquid into a porous body.

3.1.2 *infiltration rate, I*—quantity of liquid entering a porous material (m^3) per unit area (m^2) per unit time (s), expressed in units of m/s.

3.1.3 *infiltrometer*—a device used to pond liquid on a porous body and to allow for the measurement of the rate at which liquid enters the porous body.

3.1.4 For definitions of other terms used in this test method, see Terminology D 653.

4. Summary of Test Method

4.1 The infiltration rate of water through soil is measured using a double-ring infiltrometer with a sealed or covered inner ring (Fig. 1). The infiltrometer consists of an open outer and a sealed inner ring. The rings are embedded and sealed in trenches excavated in the soil. Both rings are filled with water such that the inner ring is submerged.

4.2 The rate of flow is measured by connecting a flexible bag filled with a known weight of water to a port on the inner ring. As water infiltrates into the ground from the inner ring, an equal amount of water flows into the inner ring from the flexible bag. After a known interval of time, the flexible bag is removed and weighed. The weight loss, converted to a volume, is equal to the amount of water that has infiltrated into the ground. An infiltration rate is then determined from this volume of water, the area of the inner ring, and the interval of

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.04 on Hydrologic Properties of Soil and Rocks.

Current edition approved July 10, 2002. Published September 2002. Originally published as D5093–90. Last previous edition D5093–90(1997).

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

*A Summary of Changes section appears at the end of this standard.

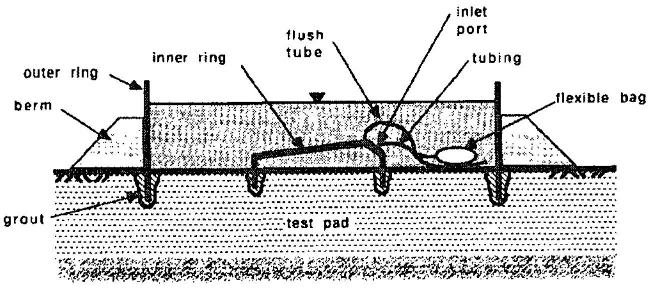


FIG. 1 Schematic Of A Double-Ring Infiltrometer With A Sealed Inner Ring

time. This process is repeated and a plot of infiltration rate versus time is constructed. The test is continued until the infiltration rate becomes steady or until it becomes equal to or less than a specified value.

5. Significance and Use

5.1 This test method provides a means to measure low infiltration rates associated with fine-grained, clayey soils, and are in the range of 1×10^{-7} m/s to 1×10^{-9} m/s.

5.2 This test method is particularly useful for measuring liquid flow through soil moisture barriers such as compacted clay liner or covers used at waste disposal facilities, for canal and reservoir liners, for seepage blankets, and for amended soil liners such as those used for retention ponds or storage tanks.

5.3 The purpose of the sealed inner ring is to: (*1*) provide a means to measure the actual amount of flow rather than a drop in water elevation which is the flow measurement procedure used in Test Method D 3385 and (*2*) to eliminate evaporation losses.

5.4 The purpose of the outer ring is to promote one-dimensional, vertical flow beneath the inner ring. The use of large diameter rings and large depths of embedments helps to ensure that flow is essentially one-dimensional.

5.5 This test method provides a means to measure infiltration rate over a relatively large area of soil. Tests on large volumes of soil can be more representative than tests on small volumes of soil.

5.6 The data obtained from this test method are most useful when the soil layer being tested has a uniform distribution of pore space, and when the density and degree of saturation and the hydraulic conductivity of the material underlying the soil layer are known.

5.7 Changes in water temperature can introduce significant error in the volume change measurements. Temperature changes will cause water to flow in or out of the inner ring due to expansion or contraction of the inner ring and the water contained within the inner ring.

5.8 The problem of temperature changes can be minimized by insulating the rings, by allowing enough flow to occur so that the amount of flow resulting from a temperature change is not significant compared to that due to infiltration, or by connecting and disconnecting the bag from the inner ring when the water in the inner ring is at the same temperature.

5.9 If the soil being tested will later be subjected to increased overburden stress, then the infiltration rate can be expected to decrease as the overburden stress increases. Laboratory hydraulic conductivity tests are recommended for studies of the influence of level of stress on the hydraulic properties of the soil.

NOTE 1—The quality of the result produced by this standard depends on the competence of the personnel performing it and the suitability of the equipment and facilities being used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this standard are cautioned that compliance with Practice D 3740 does not in itself ensure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors

6. Apparatus

6.1 *Infiltrometer Rings*—The rings shall be constructed of a stiff, corrosion-resistant material such as metal, plastic, or fiberglass. The shape of the rings can be circular or square. However, square rings are recommended because it is easier to excavate straight trenches in the soil. The rings can be of any size provided: (*1*) the minimum width or diameter of the inner ring is 610 mm (24 in.); and (*2*) a minimum distance of 610 mm is maintained between the inner and outer ring. The following is a description of a set of rings that can be constructed from commonly available materials, incorporates the requirements described above, and has worked well in the field.

6.1.1 *Outer Ring*—A square ring (Fig. 2) comprised of four sheets of aluminum approximately 3.6 m by 910 mm by 2 mm (12 ft by 36 in. by 0.080 in.) The top edge of the aluminum sheet is bent 90° in order to provide rigidity. A hole is provided in the center of the top edge. One edge of each sheet is bent 90°. Holes are drilled along each side edge so that the sheets can be bolted at the corners. A flat rubber gasket provides a seal at each corner. A wire cable approximately 15 m long with a clamp may be needed to tie the top edges together.

6.1.2 *Inner Ring*—A square ring (Fig. 3), 1.52 m (5 ft) on a side, made of fiberglass provided with two ports. The top is shaped in such a way as to vent air from the ring as it is filled. A port is provided at the highest point so that any air that accumulates in the ring during the test can be flushed out. One port must be located at the top of the ring. The other port must be located beneath the top port. A150 mm (6 in.) skirt, that is embedded into the soil, is provided along the edge of the ring. Barbed fittings that accept flexible tubing are attached to the ports. Handles are provided at each corner of the inner ring.

6.2 *Flexible Bag*—Two clear flexible bags with a capacity of 1000 to 3000 mL. Intravenous bags available from medical

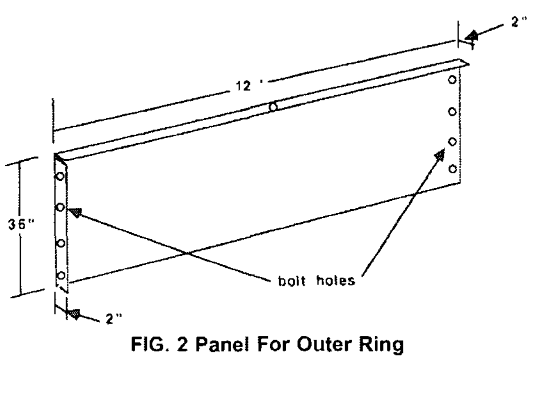


FIG. 2 Panel For Outer Ring

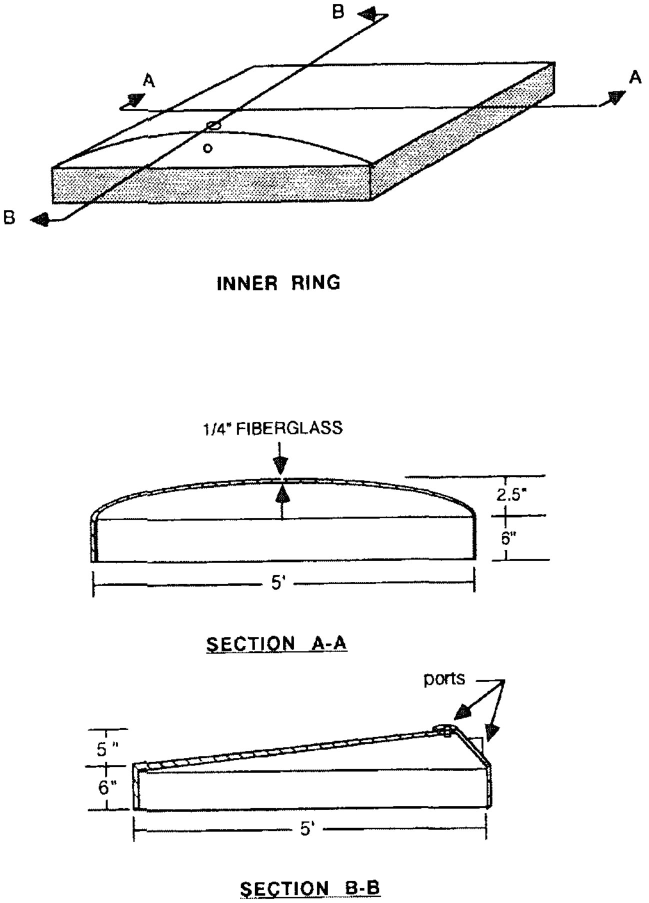


FIG. 3 Inner Ring

supply stores work well. A means for attaching a shut-off valve to the bag shall be provided. The shut-off valve shall be provided with a barbed fitting that will connect to the inlet tube on the inner ring.

6.3 *Tubing*—Clear, flexible tubing approximately 4.5 m (15 ft) long with a minimum ID of 6 mm (¼ in.)

6.4 *Scissors or Knife.*

6.5 *Excavation Tools.*

6.5.1 *Mason's Hammer*—Hammer with a blade approximately 120 mm long and 40 mm wide.

6.5.2 *Trenching Machine*—Capable of excavating a trench with a maximum width of 150 mm (6 in.) and a depth of 460 mm (18 in.)

6.5.3 *Chain Saw*—(Optional—see Note 2) Equipped with a carbide-tipped chain and bar.

6.5.4 *Hand Shovel*, garden type.

6.6 *Levels*—A surveyor's level and rod and a carpenter's level.

6.7 *Buckets*—Five buckets with a capacity of approximately 20 L (5 gal.)

6.8 *Blocks*—Cinder blocks to serve as a platform for the flexible bag.

6.9 *Cover*—An opaque cover to place on top of the outer ring. The cover can be a tarp or plywood supported by wooden beams.

6.10 *Grout*—A bentonite grout for filling the trenches and sealing the rings in place.

6.11 *Mixing Equipment*—A large (four bag) grout mixer for mixing the bentonite grout.

6.12 *Trowel.*

6.13 *Thermometer*—Readable to 0.5°C with a range of 0 to 50°C.

6.14 *Scale*—Capacity of 4000 g and an accuracy of 1 g.

6.15 *Watch*—Readable to 1 s.

6.16 *Water Supply*—Preferably water of the same quality as that involved in the problem being examined. Approximately 5600 L (1400 gal) are needed for this test.

6.17 *Splash Guard*—Plywood, rubber sheet, or burlap 600 by 600 mm (2 by 2 ft).

7. Test Site

7.1 The test requires an area of approximately 7.3 by 7.3 m (24 by 24 ft).

7.2 The slope to the test area should be no greater than approximately 3 %.

7.3 The test may be set up in a pit if infiltration rates are desired at depth rather than at the surface.

7.4 The test area shall be covered with a sheet of plastic to keep the surface from drying.

7.5 Representative samples of the soil to be tested shall be taken before and after the test to determine its moisture content, density, and specific gravity. The thickness of the layer being tested shall be determined as well as the approximate hydraulic conductivity of the layer beneath it.

8. Procedure

8.1 *Assembly of Outer Ring*—Wipe off gaskets and side edges of the outer ring. Align gasket between the edges and bolt edges together.

8.2 *Excavation of Trenches*:

8.2.1 Place both rings on the area to be tested. Center the inner ring within the outer ring. Make sure that the outer ring is square by using the tape measure to check that the length of the diagonals are equal.

8.2.2 If plastic is covering the test area, cut out thin strips along the edge of each ring so that the trenches can be excavated. Leave as much of the plastic on as possible in order to keep the soil from drying.

8.2.3 Use the bottom edge of each ring to scribe a line on the ground to use as a guide for excavating the trenches.

8.2.4 Note the orientation of the rings and set them aside.

8.2.5 Use the surveyor's level and check the ground elevation where the corners of each ring will be. Note the high spots and excavate deeper in these areas so that the rings will be level.

8.2.6 Use the trenching machine and excavate a trench for the outer ring. The trench should be about 146 mm (18 in.) deep. Excavate deeper at high spots.

8.2.7 Use a small hand shovel to remove any loose material in the trenches.

8.2.8 Place the outer ring in the trench and use the carpenter's level to check that the top of the ring is reasonably level (±30 mm). Also check that the outer ring is square. Remove the ring and excavate any areas keeping the ring from being level and square.

8.2.9 Set the outer ring aside and cover the trenches to prevent the soil from drying.

8.2.10 Use the mason's hammer and excavate a trench 50 by 110 mm (2 by 4.5 in.) for the inner ring. Excavate deeper in high spots so that the inner ring will sit level in the trench. Excavate the trench carefully so that the surrounding soil is disturbed as little as possible. When using the mason's hammer, it is best to start by digging down several inches in one spot and then advancing the trench forward by chopping down on the soil. Do not pry the soil up as this tends to lift up large wedges of soil, opens cracks, and causes the trench to be oversized.

8.2.11 Place the inner ring in the trench to check the fit. Excavate any areas where the ring does not fit. Use a surveyor's level to check the elevation of the corners of the ring. The inner ring needs to be level or slightly tilted so that the back end is slightly lower than the front end.

8.2.12 Set the ring aside and cover the trenches.

NOTE 2—A chain saw that is equipped with a carbide-tipped chain and a bar may be used to excavate the trenches. Use of a chain saw will not only reduce the time needed to excavate the trench but will also greatly decrease the amount of grout needed to fill the trenches. If a chain saw is used, the trenches need only be 25 mm (1 in.) wide. A chain saw will not work well in some soils. A trial trench should be made to determine if it will work.

8.3 *Installation of Rings*:

8.3.1 Use the grout mixer to prepare enough grout to fill the trenches. The hydraulic conductivity of the grout should be less than approximately 1×10^{-8} m/s.

8.3.2 Fill the trenches to within 2.5 mm (1 in.) of the top of the trench. Rod or tamp the grout to remove any entrapped air.

8.3.3 Lift the inner ring and center it over the inner ring trench. Lower it into the trench and slowly push it down. Keep the ring level as it is pushed into place.

8.3.4 Use a surveyor's level to check that the ring is level.

8.3.5 Use a trowel to press the grout against the outside wall of the ring in order to ensure a good seal.

8.3.6 Cover the grout with plastic to prevent desiccation.

8.3.7 Lift the outer ring and center it over the outer ring trench.

8.3.8 Keep the ring level and push it into place.

8.3.9 Use the carpenter's level to make sure that the ring is level.

8.3.10 Use a trowel to push the grout against both the inside and the outside of the ring to ensure a good seal.

8.3.11 Cover the grout with plastic to prevent desiccation.

8.3.12 Place several cinder blocks between the inner and outer rings in the vicinity of the ports on the inner ring. These blocks will be used as a platform to stand on when connecting the fittings to the inner ring and also to support the flexible bags. The blocks should be no higher than 100 mm (4 in.)

8.3.13 Pile soil along the outside of the outer ring to a height of at least 30 cm (12 in.) This soil places an overburden pressure on the grout that will prevent it from being pushed out of the trench when the rings are filled with water.

8.4 *Filling the Rings*:

8.4.1 Fill two buckets with water and place one on each back corner of the inner ring. The buckets are placed on the inner ring to counteract the uplift force that acts on the ring as it is being filled. Make sure that the buckets are placed on the edge of the ring, not in the center as this may overstress the ring and cause it to crack. Do not to spill any water around the inner ring as this will make it difficult to check for leaks in the seal.

8.4.2 Place an empty bucket upside down on the ground near the top port on the inner ring. Place a second bucket on the first bucket. Fill the second bucket with water. Cut a length of the flexible tubing long enough to reach from the top bucket to the top port on the inner ring. Siphon the water from the bucket to the inner ring. Allow the siphoning to continue until the depth of the water in the inner ring is approximately 25 mm (1 in.). Avoid spilling any water around the inner ring during this filling process as this will make it difficult to check for leaks. Any other suitable method for adding the required volume of water to the inner ring may also be used.

8.4.3 Let the water stand in the inner ring for at least 30 min. Check for leaks in the inner ring seal and repair any that are found.

8.4.4 Start filling the outer ring slowly so as not to scour the soil and muddy the water. Direct the water so that it hits a splashboard first. Fill the outer ring until the water level is approximately 100 mm (4 in.) above the top of the inner ring. While the rings are being filled, use a board or shovel handle to gently tap the inner ring to dislodge air bubbles that are trapped inside. Continue tapping on the inner ring until bubbles cease to emerge from the top port.

8.4.5 Remove the buckets from the top of the inner ring.

8.5 *Installation of Fittings and Tubing*:

8.5.1 Wrap the threads of the two barbed fittings with TFE-fluorocarbon tape.

8.5.2 Saturate the fittings and connect them to the inner ring. Screw one of the barbed fittings into the top port and the other barbed fitting into one of the lower ports. Use caution when screwing the fittings into the ports as the threads in fiberglass inner rings can be easily damaged.

8.5.3 Cut two lengths of the clear flexible tubing, one 900-mm (3-ft) piece and one 1800-mm (6-ft) piece.

8.5.4 Saturate the tubing by placing it under water. Be sure to remove all air bubbles.

8.5.5 Connect one end of the 1.8-m (6-ft) piece to the fitting in the top port and seal the other end with a plug fitting. Do not let air into the tube during this process. This tube is the flush tube.

8.5.6 Connect the end of the 900-mm (3-ft) piece to the barbed fitting in the lower port. Prop the open end of this tube on the cinder block platform. Water is being drawn into this tube so be sure not to allow the open end of the tube to float to the surface and draw in air or sink to the bottom and draw in mud. This tube is the inlet tube.

8.6 *Covering the Rings*:

8.6.1 Cover the rings with either a tarp or plywood. The purpose of the cover is to minimize evaporation, minimize temperature changes, and inhibit the growth of algae.

8.6.2 Provide a means in the cover that makes it convenient to access the front of the inner ring to connect and disconnect the measurement bag.

8.7 *Maintaining the Water Level*:

8.7.1 Place a mark indicating the water elevation on the inside wall of the outer ring near the cinder blocks.

8.7.2 Observe the water level within the outer ring during the test and refill the ring to this mark before the water level drops more than 25 mm (1 in.) below the mark. Record the date, time, and the amount of water added.

8.8 *Purging the Inner Ring*—During the test, air may accumulate beneath the inner ring. This air may introduce error in flow measurements and consequently should be purged on a regular basis as follows.

8.8.1 Disconnect bag, if one is present, from end of inlet tube.

8.8.2 Lift the plugged end of the flush tube out of outer ring and below the water level in the outer ring so that water can be siphoned out of inner ring.

8.8.3 Remove plug from end of flush tube. Water and air if present will start to flow out of inner ring. If air completely fills the tube, the syphon will be lost. If this happens, saturate the tube and restart the siphon.

8.8.4 Allow water to flow from end of tube until air ceases to emerge from inner ring. Replace plug in end of flush tube and place tube back into outer ring. Note the approximate volume of purged air. Volume can be determined by multiplying the flow area of the flush tube by the height of the air bubbles which flow out of the tube.

8.8.5 Wait at least 30 min before taking any flow measurements.

8.8.6 Purge the inner ring on a weekly basis until no significant amount of air is found.

8.9 *Measurements*:

8.9.1 Attach the shut-off valve to the flexible bag and fill the bag with water. Remove all air bubbles from the bag. Use water that has been degassed or allow the bag to sit overnight so that the water can degas. If left to sit overnight, remove any air bubbles. Do not overfill the bag so that the water inside is under pressure.

8.9.2 Dry the outside of the bag and record its weight to the nearest gram.

8.9.3 With the shut-off valve closed, attach the bag to the open end of the inlet tube connected to the inner ring. Be sure not to trap any air bubbles in the inlet tubing or in the valve when attaching the bag. Lay the bag down on the cinder block platform.

8.9.4 Record the time, date, temperature of the water in the outer ring, and the depth of the water in the outer ring, and then carefully open the shut-off valve on the bag. Check that the inlet tube is not pinched and that the bag is arranged in such a manner that water can flow freely from it into the inner ring.

8.9.5 Sometime before the bag empties, close the shut-off valve, disconnect the bag from the inlet tube, and record the date, time, temperature of the water in the outer ring and the depth of the water in the outer ring. Be sure to prop the open end of the inlet hose as pointed out in 8.5.6. Do not leave the bag on long enough to empty as this will create a suction in the inner ring and cause leaks in the grout seal.

8.9.6 Dry the bag and record the weight of it to the nearest gram.

8.9.7 Refill the bag and repeat 8.9.2-8.9.6 until the infiltration rate (see Section 9) becomes steady or drops below a predetermined value.

NOTE 3—The reading times are governed primarily by the length of time the bag can remain connected to the inner ring without emptying. This length of time can only be determined through experience. Initially, flow rates will be high and the bag may need to be disconnected after several hours. As the test progresses, the flow rate will slow and the length of time it takes the bag to empty may increase to several days or weeks.

A second important factor that governs when readings should be made is the temperature of the water. In order to minimize the effects of temperature changes on the measured flow rate, the bag should be disconnected from the inner ring when the water is at the same temperature (within ±2°C) as when the bag was connected. More consistent readings are usually obtained if readings are made between 7 am and 9 am.

NOTE 4—It is not necessary to have the bag connected to the inner ring continuously. Flow only needs to be measured over timed intervals so that a plot of infiltration rate versus time can be constructed. The infiltration rate is not influenced by whether or not the bag is connected to the inlet tube. If the flow rate is high, it is more convenient to connect the bag to the inner ring for several hours a day and leave the inlet tube open in the outer ring for the remainder of the time.

NOTE 5—When connecting or disconnecting the bag from the inner ring, do not raise the bag above the level of the water in the outer ring with the shut-off valve open. This would cause an uplift force to act on the inner ring and could cause it to rise out of the trench.

8.10 *Ending Test*:

8.10.1 Remove the fittings and tubing from the inner ring.

8.10.2 Drain water from rings.

8.10.3 Excavate the grout from around the rings and pull the rings out of the ground.

8.10.4 Excavate a narrow trench in the area encompassed by the inner ring and take moisture content samples every 25 mm (1 in.) to a depth of 150 mm (6 in.) below the observed wetting front. An alternative to this is to push a thin-walled sampling tube into the soil, extrude the soil, and slice it every 25 mm (1 in.) for moisture content samples.

9. Calculation

9.1 Calculate the infiltration rate for each timed interval as follows:

$$I\,(\mathrm{m/s}) = \frac{Q}{tA} \times 10^{-6} \qquad (1)$$

where:

Q = volume of flow, mL,
= $W_1 - W_2$
W_1 = initial weight of bag, g,
W_2 = final weight of bag, g,

t = time of flow, s = $t_2 - t_1$,
t_1 = time shut-off valve on bag was opened,
t_2 = time shut-off valve was closed, and
A = area of inner ring, m^2.

9.2 Calculate the amount of flow which resulted from any temperature fluctuations for each timed interval (see Note 6). If the flow due to temperature fluctuations is greater than 20 % of the total flow measured, then correct the flow used to calculate the infiltration rate by this amount.

NOTE 6—Expansion and contraction of the inner ring due to temperature changes will cause water to flow into or out of the measurement bag. The inner ring should be calibrated to determine if the flow resulting from temperature change is significant compared to flow due to infiltration. Calibration can be performed by sealing the inner ring to the bottom of a small plastic pool. Fill the pool and ring with water and allow the temperature to reach equilibrium. Connect a measurement bag to the inner ring and add ice to the pool water to lower the temperature several degrees. Allow the temperature to reach equilibrium and remove the bag. Determine the weight loss/gain and convert it to a volume of water. Divide this volume of water by the change in temperature to obtain a calibration factor for temperature changes.

9.3 Note the volume of air expelled from the weekly purging of the inner ring. Compare this volume of air with the volume of infiltration that occurred during the time the air collected in the inner ring. If this volume is significant, (that is, 20 % of that used to determine infiltration in 9.1,) then adjust the infiltration rates in 9.1 to account for it.

Page __of __

DATA FORM FOR SDRI TEST

Project: ____________
Inner ring info: ____________
Outer ring info: ____________
Liner thickness (m): ____________

$I = \frac{Q}{A\,t} \times 10^{-6}$

I = infiltration (m/sec)
Q - quantity of flow (mL)
t = interval of time (sec)
A = area of inner ring (m2) ________

Date (on / off)	Initial time (sec)	Final Time (sec)	t Interval of Time (sec)	Initial Wt of Bag (grams)	Final Wt. of Bag (grams)	Q Quan. of Flow (mL)	I Infiltration (m/sec)	Temp (C) (on / off)	Water Depth (m) (on / off)

NOTES:

FIG. 4 Data Sheet For Infiltration Test Using A Double-Ring Infiltrometer With A Sealed Inner Ring

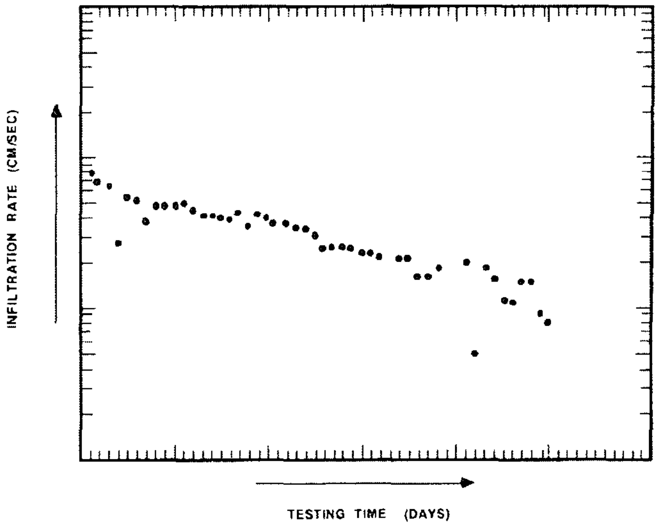


FIG. 5 Infiltration Rate Versus Time On A Semi-log Plot

10. Report

10.1 Report the following information:

10.1.1 A data sheet such as the one shown in Fig. 4,

10.1.2 A semi-log plot of infiltration versus time such as that shown in Fig. 5,

10.2 Additional optional information that can be presented in the report includes the following,

10.2.1 Thickness of layer tested,

10.2.2 A description of material beneath the layer tested,

10.2.3 Total and dry density of the layer tested,

10.2.4 Initial moisture content of the layer tested,

10.2.5 Initial degree of saturation,

10.2.6 Moisture contents of samples taken after termination of test,

10.2.7 Estimate of the depth to the saturation front.

11. Precision and Bias

11.1 *Precision*—Due to the nature of the soil or rock materials tested by this test method, it is either not feasible or too costly at this time to produce multiple specimens which have uniform physical properties. Any variation observed in the data is just as likely to be due to specimen variation as to operator or laboratory testing variation. Subcommittee D18.04 welcomes proposals that would allow for development of a valid precision statement.

11.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

12. Keywords

12.1 double ring infiltration; in-place infiltration; soil moisture infiltrometer

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the 1990(1997) edition.

(1) Requirement to follow Practice D 6026 added to Section 1.
(2) Standard note regarding quality of test results add to Section 5.
(3) Added Practices D 3740 and D 6026to Section 2.

NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

BILL RICHARDSON
Governor
Joanna Prukop
Cabinet Secretary

Mark E. Fesmire, P.E.
Director
Oil Conservation Division

July 22, 2004

Mr. Mitchel Johnson
Loco Hills GSF, LLC
158 Deer Creek Drive
Aledo,Texas 76008

Re: Loco Hills Gas Storage Facility
UL L Section 22-Township 17 South-Range 29 East
NMPM Eddy County, New Mexico

Dear Mr. Johnson:

The New Mexico Oil Conservation Division (OCD) has deemed that the Loco Hills Gas Storage Facility is subject to Oil Conservation Division rules and regulations pursuant to New Mexico Oil and Gas Act as defined in NMSA 70-2-12-(13). The facility was previously permitted under the Water Quality Control Commission regulations parts 20.6.2.3000 and 20.6.2.5000.

The OCD is hereby notifying Loco Hills GSF, LLC that the facility will now be permitted under rule 701.H for the storage wells, rule 50 for the surface impoundments, and rule 19 for the abatement of water. OCD's intent is to amend the original order by rolling over your existing permits conditions into the new amended order.

In addition, OCD has reviewed your request to modify the permit to include a single lined clay brine pond designed to have seepage. **OCD hereby denies your request for the following reasons:**

1. Rule 50 requires all ponds to be double lined with leak detection unless an exemption is granted where the operator demonstrates that the proposed design will not endanger fresh water, public health or the environment. Groundwater underlying the site has already been contaminated from previous operations and the underlying geology of the site has not proven to be an adequate barrier for protection of groundwater. OCD can not allow the operation to continue to add contaminants to the groundwater. OCD believes the previously approved double

Oil Conservation Division * 1220 South St. Francis Drive * Santa Fe, New Mexico 87505
Phone: (505) 476-3440 * Fax (505) 476-3462 * http://www.emnrd.state.nm.us

liner system with leak detection will provide an early warning of any leakage problems and prevent further contamination of groundwater.

2. The clay liner was originally constructed as the foundation for a double lined system and was not designed as a primary liner for the containment of water. In addition, the pond does not meet OCD's pit guidelines.

If you have any questions, please contact Wayne Price of my staff at (505-476-3487) or E-mail wprice@state.nm.us. On behalf of the staff of the OCD, I wish to thank you and your staff for your cooperation during this review process.

Sincerely,

Roger C. Anderson
Environmental Bureau Chief

RCA/lwp

Price, Wayne

From: Price, Wayne
Sent: Thursday, July 22, 2004 5:05 PM
To: mitchel Johnson-son (E-mail)
Cc: Randall Hicks (E-mail); Randall Hicks (E-mail 2)
Subject: Loco Hills GSF

Letter requiring Double liner ...

Letter went today

Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

Price, Wayne

From: Price, Wayne
Sent: Thursday, July 22, 2004 2:44 PM
To: 'Mitchel Johnson'; Price, Wayne
Cc: r@rthicksconsult.com
Subject: RE: Thank you for visting site

Dear Mitchel:

Randy Hicks is in the office and I just gave him a copy of the order. He said he would get you a copy. We are short handed and I'am really behind in my work, I will not have the time to search the file any time soon. You could have Randy search it if you wish!

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
Sent: Thursday, July 22, 2004 9:59 AM
To: wprice@state.nm.us
Cc: r@rthicksconsult.com
Subject: Thank you for visting site

Wayne,

Thank you for taking time to visit our site.

1. Could you please send me a copy of the original permit that you referenced yesterday?

2. I'm sorry I don't remeber which date either end of last week or on Monday of this week, you said you thought you had copies of tests of our supply wells. Could you please send me a copy of all test results you have on our supply wells?

Thank you,

Mitchel Johnson
Loco Hills GSF
office: 817-441-6568
cell: 817-371-7933

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Thursday, July 22, 2004 10:19 PM
To: 'Olson, William'
Cc: 'Price, Wayne'; 'Mitchel Johnson'; wcarr@hollandhart.com
Subject: RE: Pit Guidelines

Bill

Clearly I need some help here. I am looking for the Below Grade Tank and Pit Guidelines (I think)

Below is what is on your web site. Can you point me to what I seek?

As you know, we maintain that the updated hydrogeologic characterization (in DRAFT form in Wayne's office) will address all NMOCD concerns regarding the suitability of the site for an exemption from the double liner requirement. We are confident that the post construction testing of the liner will show that the seepage rate from this pond will not cause impairment of fresh water. Because there is only DRAFT guidance for pits on my computer, I am still trying to find what is currently in effect so we can be sure we are addressing all of NMOCD's issues as we prepare our petition for an exemption from the Rule.

I find it so unfortunate that NMOCD decided to change the rules on us after Loco Hills was clearly told in a meeting that "If you owned the land, the permeability of the clay meets our guidelines and this clay liner can be an approvable Discharge Plan". As I understood Roger in that December meeting, he was referring to the Pit Guildelines. Then, just a few days after we described how we could comply with the WQCC Regulations (less than ½ acre foot of seepage per year), NMOCD moved us to the new Pit Rule. Had we all understood that NMOCD had been improperly regulating the facility for the past decade and that we should have been under the pit rule, we could have moved toward approval of this pit under the old rule last November. Because NMOCD notified us of administration of the site under the new pit rule AFTER the deadline for grandfathering under the old pit rule, the moving of the finish line for this project is even more frustrating. Our frustration increases when we remember that Loco Hills GSF brought the existing ground water contamination to the attention to NMOCD with a plan to voluntarily abate the contamination caused by others, then this voluntary action is used as part of the rationale for denying the clay lined pond. And now I cannot even find the current guidelines! I would bet I am simply looking in the wrong place – help me out on this one.

Back

Thanks for your help

Randy

-----Original Message-----
From: Olson, William [mailto:WOLSON@state.nm.us]
Sent: Thursday, July 22, 2004 12:52 PM
To: 'Randall Hicks'
Subject: RE: Pit Guidelines

Randy,

The guidelines that were in effect in November of 2003 are listed on the OCD web site http://www.emnrd.state.nm.us/ocd/ under "Publications", then under "Environmental Handbook". You can copy them off of the web page.

If you have any questions please let me know.

Sincerely,

William C. Olson
Hydrologist
New Mexico Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505
(505) 476-3491

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Monday, July 19, 2004 12:31 PM
To: wolson@state.nm.us
Cc: 'Price, Wayne'; 'Mitchel Johnson'
Subject: Pit Guildelines
Bill

Could you or Wayne please email or fax me a copy of the Pit Guidelines that were in effect in November of 2003? Evidently I replaced by e-copy of the old guidelines with the new DRAFT of March 2004.

Thank

Randy Hicks
505-266-5004 - office
505-238-9515 – cell
fax – 266 0745

New clay lined pond-looking south- Infiltration devices in pond.

Standing on north side of new pond looking west down state Hwy 82- new groundwater piezometers P2

Same as above-new monitors were dry at time of visit.

Standing on the east bank looking west.

Standing on the east bank looking northwest

Standing on the east bank looking northeast

Standing on the east bank looking east- new groundwater piezometers P1-background shows mound where old pit area and farther in background is existing double lined pond with leak detection.

Southeast corner of existing pond. Monitor well #MW-1.

Same position as above except looking southeast into Bear Grass Draw.

Old collapsed water well located west of Gas storage well #3 and Northeast of new pond.

Monitor well located in Bear Grass Draw BGD-MW1.

Water supply well #SW-2 (background) and old unidentified well in foreground.

Same position as above looking northwest up Bear Grass Draw.

Looking south Bear Grass Draw.

Bear Grass Draw nested monitor wells.

Picture of soil sample collected for re-testing by Pettigrew Assoc. Located on north side of pond bottom.

Infiltration Devices

Apron where pond was partially filled for infiltration test. Large recent rain filled the bottom with about one foot of water.

Wayne Price reading water level.

Randy Hicks-Hicks Consultant taking a measurement from infiltration device.

Debra Hicks with Pettigrew collecting sample from pond bottom from west side.

Same as above

Picture of above. Clay soils were noted to be predominant in this picture.

Same as above

Picture of soil sample collected for re-testing by Pettigrew Assoc. Located in southeast corner about one foot above bottom of pond.

Picture of rocks taken on west sidewall of pond.

Same as above- Observed sand and silt in this sample.

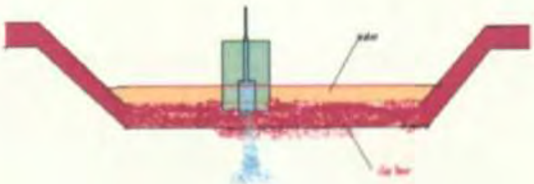
Same as above looking up wall. Rocks of this size were noted through out the sidewalls.

Same as above- Observed sand and silt in this sample

Picture of soil sample collected for re-testing by Pettigrew Assoc. Located on north side of pond sidewall approximately half way up.

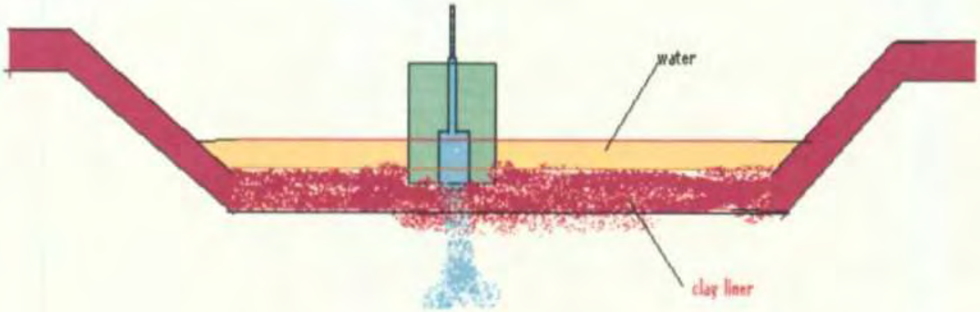
Picture of area where soil sample collected for re-testing by Pettigrew Assoc. Located on north side of pond sidewall approximately half way up. Noted dry clayey soils with some silt, caliche fines and gypsum roses.

Loco Hills GSF Infiltration device consists of a 55 gal drum top and bottom open. Inside is a container open on the bottom and sealed up to the top pipett used to measure fluid loss. The drum and inner container is bedded in the clay liner. The drum and inside device is is filled with water. Any fluid loss is considered to have leaked thru the clay liner. The pond bottom was soaked with water in order to obtain saturated conditions.



OCD sketch of observed field set up on July 21,04 by Wayne Price

Loco Hills GSF-Infiltration device consists of a 55 gal drum top and bottom open. Inside is a container open on the bottom and sealed up to the top pipett used to measure fluid loss. The drum and inner container is bedded in the clay liner. The drum and inside device is is filled with water. Any fluid loss is considered to have leaked thru the clay liner. The pond bottom was soaked with water in order to obtain saturated conditions.



OCD sketch of observed field set-up on July 21,04
by Wayne Price

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Monday, July 19, 2004 12:29 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'; 'Jeremy Baker'
Subject: Loco Hills

Wayne

I attach the double-ring infiltrometer protocol that we plan to use for the Loco Hills clay liner.

We will be modifying this protocol only slightly and we invite you to witness our work this Wednesday.

Jeremy Baker of Pettigrew will be on site at 9:30 am, as will I. We plan to set up 2 of the 3 infiltrometers on Tuesday afternoon. We plan to show you the field protocol for the 3rd test site on Wednesday.

I hope you can make it.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Designation: D 3385 – 94

AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
Reprinted from the Annual Book of ASTM Standards. Copyright ASTM

Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer[1]

This standard is issued under the fixed designation D 3385; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method describes a procedure for field measurement of the rate of infiltration of liquid (typically water) into soils using double-ring infiltrometer.

1.2 Soils should be regarded as natural occurring fine or coarse-grained soils or processed materials or mixtures of natural soils and processed materials, or other porous materials, and which are basically insoluble and are in accordance with requirements of 1.5.

1.3 This test method is particularly applicable to relatively uniform fine-grained soils, with an absence of very plastic (fat) clays and gravel-size particles and with moderate to low resistance to ring penetration.

1.4 This test method may be conducted at the ground surface or at given depths in pits, and on bare soil or with vegetation in place, depending on the conditions for which infiltration rates are desired. However, this test method cannot be conducted where the test surface is below the ground water table or perched water table.

1.5 This test method is difficult to use or the resultant data may be unreliable, or both, in very pervious or impervious soils (soils with a hydraulic conductivity greater than about 10^{-2} cm/s or less than about 1×10^{-6} cm/s) or in dry or stiff soils that most likely will fracture when the rings are installed. For soils with hydraulic conductivity less than 1×10^{-6} cm/s refer to Test Method D 5093.

1.6 This test method cannot be used directly to determine the hydraulic conductivity (coefficient of permeability) of the soil (see 5.2).

1.7 The values stated in SI units are to be regarded as the standard.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 2216 Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 5093 Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer With a Sealed Inner Ring[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *incremental infiltration velocity*—the quantity of flow per unit area over an increment of time. It has the same units as the infiltration rate.

3.1.2 *infiltration*—the downward entry of liquid into the soil.

3.1.3 *infiltration rate*—a selected rate, based on measured incremental infiltration velocities, at which liquid can enter the soil under specified conditions, including the presence of an excess of liquid. It has the dimensions of velocity (that is, $cm^3 cm^{-2} h^{-1} = cm\ h^{-1}$).

3.1.4 *infiltrometer*—a device for measuring the rate of entry of liquid into a porous body, for example, water into soil.

3.1.5 For definitions of other terms used in this test method, refer to Terminology D 653.

4. Summary of Test Method

4.1 The double-ring infiltrometer method consists of driving two open cylinders, one inside the other, into the ground, partially filling the rings with water or other liquid, and then maintaining the liquid at a constant level. The volume of liquid added to the inner ring, to maintain the liquid level constant is the measure of the volume of liquid that infiltrates the soil. The volume infiltrated during timed intervals is converted to an

---

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.04 on Hydrologic Properties of Soil and Rock.

Current edition approved Sept. 15, 1994. Published November 1994. Originally published as D 3385 – 75. Last previous edition D 3385 – 88.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

incremental infiltration velocity, usually expressed in centimetre per hour or inch per hour and plotted versus elapsed time. The maximum-steady state or average incremental infiltration velocity, depending on the purpose/application of the test is equivalent to the infiltration rate.

5. Significance and Use

5.1 This test method is useful for field measurement of the infiltration rate of soils. Infiltration rates have application to such studies as liquid waste disposal, evaluation of potential septic-tank disposal fields, leaching and drainage efficiencies, irrigation requirements, water spreading and recharge, and canal or reservoir leakage, among other applications.

5.2 Although the units of infiltration rate and hydraulic conductivity of soils are similar, there is a distinct difference between these two quantities. They cannot be directly related unless the hydraulic boundary conditions are known, such as hydraulic gradient and the extent of lateral flow of water, or can be reliably estimated.

5.3 The purpose of the outer ring is to promote one-dimensional, vertical flow beneath the inner ring.

5.4 Many factors affect the infiltration rate, for example the soil structure, soil layering, condition of the soil surface, degree of saturation of the soil, chemical and physical nature of the soil and of the applied liquid, head of the applied liquid, temperature of the liquid, and diameter and depth of embedment of rings.[3] Thus, tests made at the same site are not likely to give identical results and the rate measured by the test method described in this standard is primarily for comparative use.

5.5 Some aspects of the test, such as the length of time the tests should be conducted and the head of liquid to be applied, must depend upon the experience of the user, the purpose for testing, and the kind of information that is sought.

6. Apparatus

6.1 *Infiltrometer Rings*—Cylinders approximately 500 mm (20 in.) high and having diameters of about 300 and 600 mm (12 and 24 in.). Larger cylinders may be used, providing the ratio of the outer to inner cylinders is about two. Cylinders can be made of 3-mm (⅛-in.), hard-alloy, aluminum sheet or other material sufficiently strong to withstand hard driving, with the bottom edge bevelled (see Fig. 1). The bevelled edges shall be kept sharp. Stainless steel or strong plastic rings may have to be used when working with corrosive fluids.

6.2 *Driving Caps*—Disks of 13-mm (½-in.) thick hard-alloy aluminum with centering pins around the edge, or preferably having a recessed groove about 5 mm (0.2 in.) deep with a width about 1 mm (0.05 in.) wider than the thickness of the ring. The diameters of the disks should be slightly larger than those of the infiltrometer rings.

6.3 *Driving Equipment*—A 5.5-kg (12-lb) mall or sledge and a 600 or 900-mm (2 or 3-ft) length of wood approximately 50 by 100 mm or 100 by 100 mm (2 by 4 in. or 4 by 4 in.), or a jack and reaction of suitable size.

[3] Discussion of factors affecting infiltration rate is contained in the following reference: Johnson, A. I., *A Field Method for Measurement of Infiltration*, U.S. Geological Survey Water-Supply Paper 1544-F, 1963, pp. 4–9.

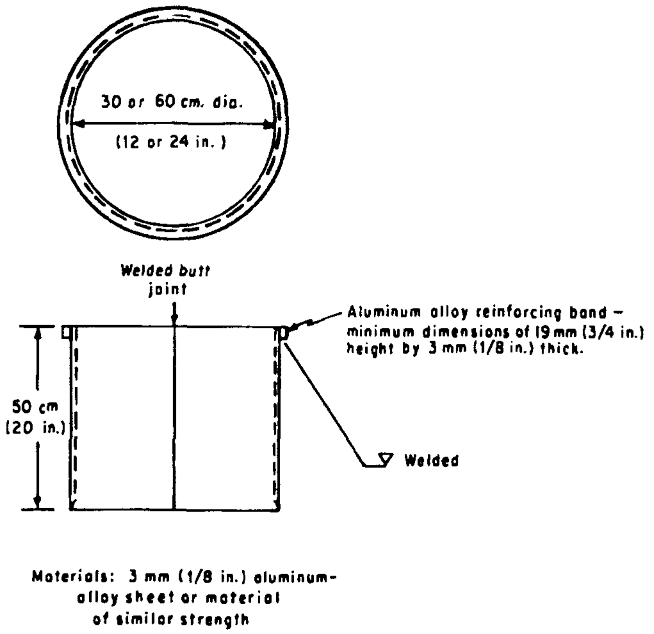


FIG. 1 Infiltrometer Construction

6.4 *Depth Gage*—A hook gage, steel tape or rule, or length of steel or plastic rod pointed on one end, for use in measuring and controlling the depth of liquid (head) in the infiltrometer ring, when either a graduated Mariotte tube or automatic flow control system is not used.

6.5 *Splash Guard*—Several pieces of rubber sheet or burlap 150 mm (6 in.) square.

6.6 *Rule or Tape*—Two-metre (6-ft) steel tape or 300-mm (1-ft) steel rule.

6.7 *Tamp*—Any device that is basically rigid, has a handle not less than 550 mm (22 in.) in length, and has a tamping foot with an area ranging from 650 to 4000 mm^2 (1 to 6 in.^{2}) and a maximum dimension of 150 mm (6 in.).

6.8 *Shovels*—One long-handled shovel and one trenching spade.

6.9 *Liquid Containers*:

6.9.1 One 200-L (55-gal) barrel for the main liquid supply, along with a length of rubber hose to siphon liquid from the barrel to fill the calibrated head tanks (see 6.9.3).

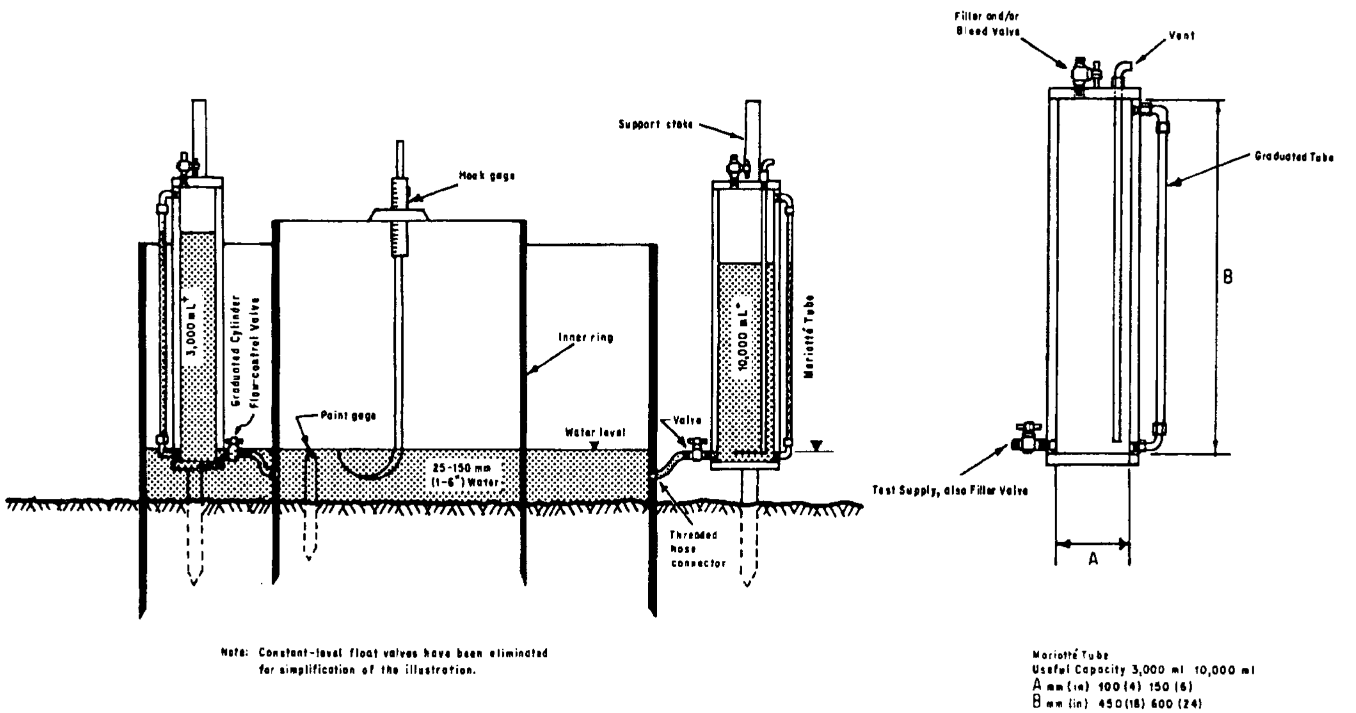
6.9.2 A 13-L (12-qt) pail for initial filling of the infiltrometers.

6.9.3 Two calibrated head tanks for measurement of liquid flow during the test. These may be either graduated cylinders or Mariotte tubes having a minimum volume capacity of about 3000 mL (see Note 1 and Note 2 and Fig. 2).

NOTE 1—It is useful to have one head tank with a capacity of three times that of the other because the area of the annular space between the rings is about three times that of the inner ring.

NOTE 2—In many cases, the volume capacity of these calibrated head tanks must be significantly larger than 3000 mL, especially if the test has to continue overnight. Capacities of about 50 L (13 gal) would not be uncommon.

6.10 *Liquid Supply*—Water, or preferably, liquid of the same quality and temperature as that involved in the problem



NOTE 1—Constant-level float valves have been eliminated for simplification of the illustration

FIG. 2 Ring Installation and Mariotte Tube Details

being examined. The liquid used must be chemically compatible with the infiltrometer rings and other equipment used to contain the liquid.

NOTE 3—To obtain maximum infiltration rates, the liquid should be free from suspended solids and the temperature of the liquid should be higher than the soil temperature. This will tend to avoid reduction of infiltration from blockage of voids by particles or gases coming out of solution.

6.11 *Watch or Stopwatch*—A stopwatch would only be required for high infiltration rates.

6.12 *Level*—A carpenter's level or bull's-eye (round) level.

6.13 *Thermometer*—With accuracy of 0.5°C and capable of measuring ground temperature.

6.14 *Rubber Hammer (mallet).*

6.15 *pH Paper*, in 0.5 increments.

6.16 *Recording Materials*—Record books and graph paper, or special forms with graph section (see Fig. 3 and Fig. 4).

6.17 *Hand Auger*—Orchard-type (barrel-type) auger with 75-mm (3-in.) diameter, 225-mm (9-in.) long barrel and a rubber-headed tire hammer for knocking sample out of the auger. This apparatus is optional.

6.18 *Float Valves*—Two constant level float valves (carburetors or bob-float types) with support stands. This apparatus is optional.

6.19 *Covers and Dummy Tests Set-Up*—For long-term tests in which evaporation of fluid from the infiltration rings and unsealed reservoirs can occur (see 8.2.1).

7. Calibration

7.1 *Rings*:

7.1.1 Determine the area of each ring and the annular space between rings before initial use and before reuse after anything has occurred, including repairs, which may affect the test results significantly.

7.1.2 Determine the area using a measuring technique that will provide an overall accuracy of 1 %.

7.1.3 The area of the annular space between rings is equal to the internal area of the 600-mm (24-in.) ring minus the external area of the 300-mm (12-in.) ring.

7.2 *Liquid Containers*—For each graduated cylinder or graduated Mariotte tube, establish the relationship between the change in elevation of liquid (fluid) level and change in volume of fluid. This relationship shall have an overall accuracy of 1 %.

8. Procedure

8.1 *Test Site*:

8.1.1 Establish the soil strata to be tested from the soil profile determined by the classification of soil samples from an adjacent auger hole.

NOTE 4—For the test results to be valid for soils below the test zone, the soil directly below the test zone must have equal or greater flow rates than the test zone.

8.1.2 The test requires an area of approximately 3 by 3 m (10 by 10 ft) accessible by a truck.

8.1.3 The test site should be nearly level, or a level surface should be prepared.

8.1.4 The test may be set up in a pit if infiltration rates are desired at depth rather than at the surface.

8.2 *Technical Precautions*:

8.2.1 For long-term tests, avoid unattended sites where interference with test equipment is possible, such as sites near children or in pastures with livestock. Also, evaporation of

NOTICE: This standard has either been superceded and replaced by a new version or discontinued. Contact ASTM International (www.astm.org) for the latest information.

Project Identification NRTS — Constants: Area (cm^2), Depth of Liquid (cm), Liquid Containers No., Vol/ΔH (cm^3/cm)

Test Location IDAHO - Lost River Alluvium — Inner Ring: 707, 4.0, 1, 78.54

Liquid Used: River water pH = 8.0 — Annular Space: 2106, 4.1, 2, 176.70

Tested by IJA CWJ Liquid level maintained using: ☐ Flow valve; ☐ Float valve; ☒ Mariotte tube

Depth to water table: 5.2 (m) Penetration of rings: Inner: 7.5 (cm); Outer: 17.5 (cm)

Trial No.		Date 1982	Time hr:min	Elapsed Time Δ (total) min	Flow Readings Inner Ring Reading cm	Inner Ring Flow cm^3	Annular Space Reading cm	Annular Space Flow cm^3	Liquid Temp °C	Incr. Infilt. Rate Inner cm/h	Incr. Infilt. Rate Annular cm/h	Ground temp. = 14°C @ depth of 30 (cm) Remarks: Weather Conditions, etc.
1	S	10/14	10:00	15	3.0	114	2.2	389	15	0.64	0.74	Cloudy, slight wind
	E	"	10:15	(15)	4.45		4.4		"			
2	S	"	10:15	15	4.45	212	4.4	795	15	1.2	1.5	
	E	"	10:30	(30)	7.15		8.9		"			
3	S	"	10:30	15	7.15	263	8.9	848	15	1.5	1.6	
	E	"	10:45	(45)	10.5		13.7		"			
4	S	"	10:45	15	10.5	306	13.7	945	15	1.7	1.8	
	E	"	11:00	(60)	14.4		19.05		15.5			
5	S	"	11:00	30	14.4	758	19.05	2324	15.5	2.1	2.2	
	E	"	11:30	(90)	24.05		32.2		16			
6	S	"	11:30	30	24.05	848	32.2	2580	16	2.4	2.45	
	E	"	12:00	(120)	34.85		46.8		16.5			
7	S	"	12:10	60	3.5	1944	2.2	5902	16.5	2.75	2.8	Refilled tubes
	E	"	13:10	(180)	28.25		35.6		17			
8	S	"	13:20	60	2.4	1877	3.2	5690	17.5	2.65	2.7	" "
	E	"	14:20	(240)	26.3		35.4		"			
9	S	"	14:30	60	4.3	1696	4.7	5054	17.5	2.4	2.4	" "
	E	"	15:30	(300)	25.9		33.3		18			
10	S	"	15:40	60	2.2	1586	4.5	4842	18	2.2	2.3	" "
	E	"	16:40	(360)	22.4		31.9		"			Cloudy, slight wind

FIG. 3 Data Form for Infiltration Test with Sample Data

fluid from the rings and unsealed reservoirs can lead to errors in the measured infiltration rate. Therefore, in such tests, completely cover the top of the rings and unsealed reservoirs with a relatively airtight material, but vented to the atmosphere through a small hole or tube. In addition, make measurements to verify that the rate of evaporation in a similar test configuration (without any infiltration into the soil) is less than 20% of the infiltration rate being measured.

8.2.2 Make provisions to protect the test apparatus and fluid from direct sunlight and temperature variations that are large enough to affect the slow measurements significantly, especially for test durations greater than a few hours or those using a Mariotte tube. The expansion or contraction of the air in the Mariotte tube above the water due to temperature changes may cause changes in the rate of flow of the liquid from the tube which will result in a fluctuating water level in the infiltrometer rings.

8.3 *Driving Infiltration Rings with a Sledge*:

NOTE 5—Driving rings with a jack is preferred; see 8.4.

8.3.1 Place the driving cap on the outer ring and center it thereon. Place the wood block (see 6.3) on the driving cap.

8.3.2 Drive the outer ring into the soil with blows of a heavy sledge on the wood block to a depth that will (*a*) prevent the test fluid from leaking to the ground surface surrounding the ring, and (*b*) be deeper than the depth to which the inner ring will be driven. A depth of about 150 mm (6 in.) is usually adequate. Use blows of medium force to prevent fracturing of the soil surface. Move the wood block around the edge of the driving cap every one or two blows so that the ring will penetrate the soil uniformly. A second person standing on the wood block and driving cap will usually facilitate driving the ring, and reduce vibrations and disturbance.

8.3.3 Center the smaller ring inside the larger ring and drive to a depth that will prevent leakage of the test fluid to the ground surface surrounding the ring, using the same technique as in 8.3.2. A depth of between about 50 and 100 mm (2 and 4 in.) is usually adequate.

8.4 *Driving Infiltration Rings with Jacks*:

8.4.1 Use a heavy jack under the back end of a truck to drive rings as an alternative to the sledge method (see 8.3).

8.4.2 Center the wood block across the driving cap of the ring. Center a jack on the wood block. Place the top of the jack

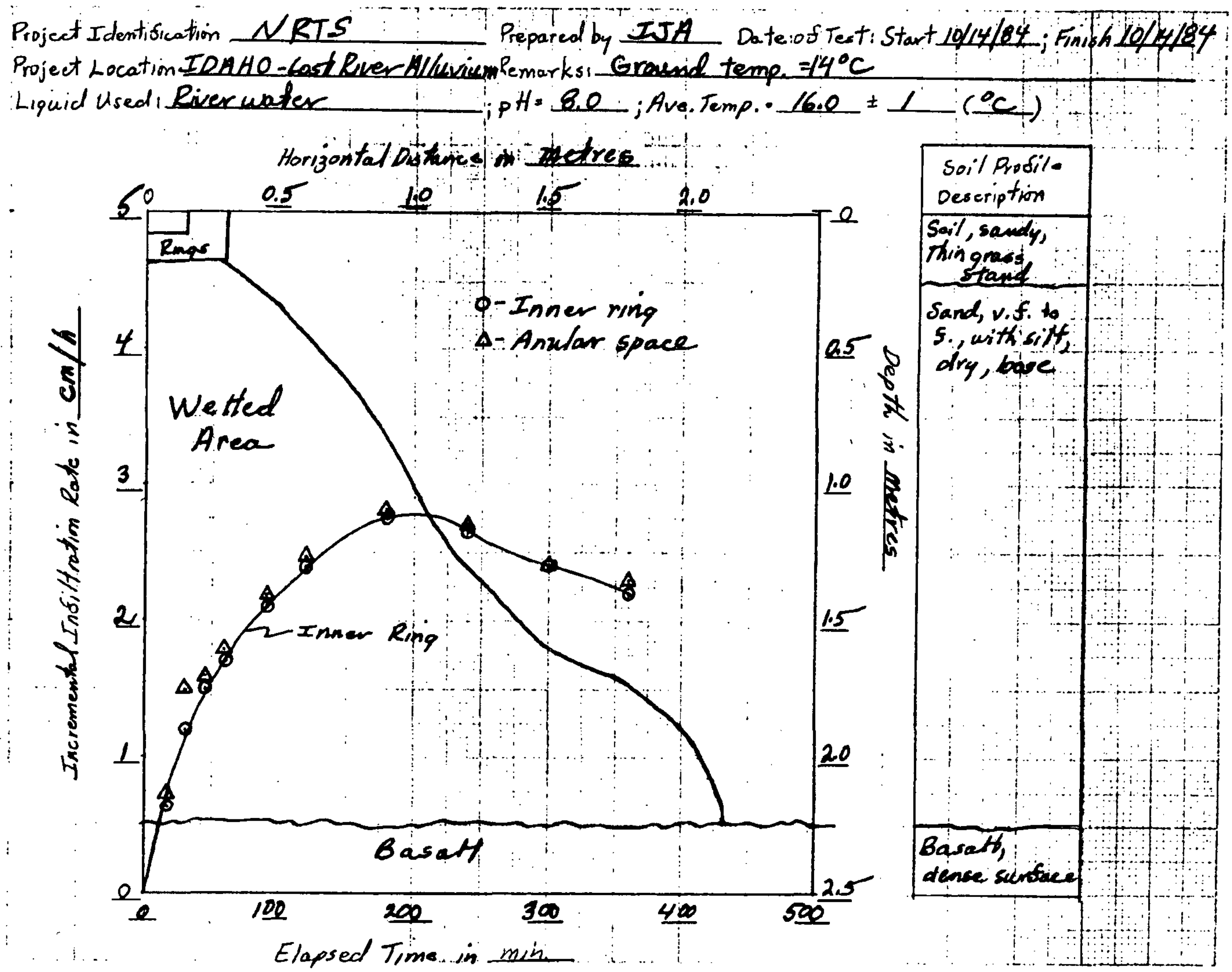


FIG. 4 Report Form for Infiltration Test With Sample Data

and the assembled items vertically under the previously positioned end of a truck body and apply force to the ring by means of the jack and truck reaction. Also, tamp near the edges or near the center of the ring with the rubber mallet, as slight tamping and vibrations will reduce hang-ups and tilting of the ring.

8.4.3 Add additional weight to the truck if needed to develop sufficient force to drive the ring.

8.4.4 Check the rings with the level, correcting the attitude of the rings to be vertical, as needed.

8.5 *Tamping Disturbed Soil*:

8.5.1 If the surface of the soil surrounding the wall of the ring(s) is excessively disturbed (signs of extensive cracking, excessive heave, and the like), reset the ring(s) using a technique that will minimize such disturbance.

8.5.2 If the surface of the soil surrounding the wall of the ring(s) is only slightly disturbed, tamp the disturbed soil adjacent to the inside and outside wall of the ring(s) until the soil is as firm as it was prior to disturbance.

8.6 *Maintaining Liquid Level*:

8.6.1 There are basically three ways to maintain a constant head (liquid level) within the inner ring and annular space between the two rings: manually controlling the flow of liquid, the use of constant-level float valves, or the use of a Mariotte tube.

8.6.2 When manually controlling the flow of liquid, a depth gage is required to assist the investigator visually in maintaining a constant head. Use a depth gage such as a steel tape or rule for soils having a relatively high permeability; for soils having a relatively low permeability use a hook gage or simple point gage.

8.6.3 Install the depth gages, constant-level valves, or Mariotte tubes as shown in Fig. 2, and in such a manner that the reference head will be at least 25 mm (1 in.) and not greater than 150 mm (6 in.). Select the head on the basis of the permeability of the soil, the higher heads being required for lower permeability soils. Locate the depth gages near the center of the center ring and midway between the two rings.

8.6.4 Cover the soil surface within the center ring and between the two rings with splash guards (150-mm (6-in.) square pieces of burlap or rubber sheet) to prevent erosion of the soil when the initial liquid supply is poured into the rings.

8.6.5 Use a pail to fill both rings with liquid to the same desired depth in each ring. Do not record this initial volume of liquid. Remove the splash guards.

8.6.6 Start flow of fluid from the graduated cylinders or Mariotte tubes. As soon as the fluid level becomes basically constant, determine the fluid depth in the inner ring and in the annular space to the nearest 2 mm (1⁄16 in.) using a ruler or tape measure. Record these depths. If the depths between the inner ring and annular space varies more than 5 mm (1⁄4 in.), raise the depth gage, constant-level float valve, or Mariotte tube having the shallowest depth.

8.6.7 Maintain the liquid level at the selected head in both the inner ring and annular space between rings as near as possible throughout the test, to prevent flow of fluid from one ring to the other.

NOTE 6—This most likely will require either a continuing adjustment of the flow control valve on the graduated cylinder, or the use of constant-level float valves. A rapid change in temperature may eliminate use of the Mariotte tube.

8.7 *Measurements*:

8.7.1 Record the ground temperature at a depth of about 300 mm (12 in.), or at the mid-depth of the test zone.

8.7.2 Determine and record the volume of liquid that is added to maintain a constant head in the inner ring and annular space during each timing interval by measuring the change in elevation of liquid level in the appropriate graduated cylinder or Mariotte tube. Also, record the temperature of the liquid within the inner ring.

8.7.3 For average soils, record the volume of liquid used at intervals of 15 min for the first hour, 30 min for the second hour, and 60 min during the remainder of a period of at least 6 h, or until after a relatively constant rate is obtained.

8.7.4 The appropriate schedule of readings may be determined only through experience. For high-permeability materials, readings may be more frequent, while for low-permeability materials, the reading interval may be 24 h or more. In any event, the volume of liquid used in any one reading interval should not be less than approximately 25 cm^3.

8.7.5 Place the driving cap or some other covering over the rings during the intervals between liquid measurements to minimize evaporation (see 8.2.1).

8.7.6 Upon completion of the test, remove the rings from the soil, assisted by light hammering on the sides with a rubber hammer.

9. Calculations

9.1 Convert the volume of liquid used during each measured time interval into an incremental infiltration velocity for both the inner ring and annular space using the following equations:

9.1.1 For the inner ring calculate as follows:

$$V_{IR} = \Delta V_{IR}/(A_{IR} \cdot \Delta t) \qquad (1)$$

where:

V_{IR} = inner ring incremental infiltration velocity, cm/h,
ΔV_{IR} = volume of liquid used during time interval to maintain constant head in the inner ring, cm^3,
A_{IR} = internal area of inner ring, cm^2, and
Δt = time interval, h.

9.1.2 For the annular space between rings calculate as follows:

$$V_A = \Delta V_A/(A_A \cdot \Delta t) \qquad (2)$$

where:

V_A = annular space incremental infiltration velocity, cm/h,
ΔV_A = volume of liquid used during time interval to maintain constant head in the annular space between the rings, cm^3, and
A_A = area of annular space between the rings, cm^2.

10. Report

10.1 Report the following information in the report or field records, or both:

10.1.1 Location of test site.

10.1.2 Dates of test, start and finish.

10.1.3 Weather conditions, start to finish.

10.1.4 Name(s) of technician(s).

10.1.5 Description of test site, including boring profile, see 10.1.11.

10.1.6 Type of liquid used in the test, along with the liquid's pH. If available, a full analysis of the liquid also should be recorded.

10.1.7 Areas of rings and the annular space between rings.

10.1.8 Volume constants for graduated cylinders or Mariotte tubes.

10.1.9 Depth of liquid in inner ring and annular space.

10.1.10 Record of ground and liquid temperatures, incremental volume measurements, and incremental infiltration velocities (inner ring and annular space) versus elapsed time. The rate of the inner ring should be the value used if the rates for inner ring and annular space differ. The difference in rates is due to divergent flow.

10.1.11 If available, depth to the water table and a description of the soils found between the rings and the water table, or to a depth of about 1 m (3 ft).

10.1.12 A plot of the incremental infiltration rate versus total elapsed time (see Fig. 4).

10.2 An example field records form is given in Fig. 3.

10.3 See Appendix X1 for information on the determination of the moisture pattern.

11. Precision and Bias

11.1 No statement on precision and bias can be made due to the variability in soils tested and in the types of liquids that might be used in this test method. Because of the many factors related to the soils, as well as the liquids that may affect the results, the recorded infiltration rate should be considered only as an index value.

12. Keywords

12.1 coefficient of permeability; hydraulic conductivity; infiltration rate; infiltrometer; in-situ testing; Mariotte tube

APPENDIX

(Nonmandatory Information)

X1. DETERMINATION OF MOISTURE PATTERN

X1.1 Although not considered a required part of the test method, the determination of the moisture pattern in the moistened soil beneath the infiltration rings commonly provides information useful in interpreting the movement of liquid through the soil profile. For example, horizontal liquid movement may be caused by lower-permeability layers and will be identified by a lateral spreading of the wetted zone. Thus, the exploration of the soil moisture pattern below an infiltration test in an unfamiliar area may identify subsurface conditions that may have affected the test and later applications of the data.

X1.2 If the investigator wishes to make such a study, dig a trench so that one wall of the trench passes along the center line of the former position of the rings. Orient the trench so that the other wall is illuminated by the sun, if the day is sunny. If feasible, dig the trench large enough to include all of the newly moistened area. Collect samples from the shaded wall of the trench for determination of water content. If preferred, an auger, such as the orchard barrel type, may be used to determine the approximate outline of the moistened area below the rings and to collect samples for water content.

X1.3 Plot the visibly moistened area on graph paper or on the cross-section part of the report form (see Fig. 4). If samples were collected and water contents were determined, contours of water content also can be plotted on the graph.

PETTIGREW and ASSOCIATES
1110 N. GRIMES
HOBBS, NEW MEXICO 88240
(505) 393-9827 voice
(505) 393-1543 fax

RECEIVED

JUL 1 9 2004

OIL CONSERVATION
DIVISION

Technical Response

To: Mr. Wayne Price - NMOCD

CC: Mitchel Johnson, Randall Hicks

From: Jeremy Baker, P.E./Debra P. Hicks, PE/LSI

Date: 07/16/04

Re: Loco Hills GSF Brine Pond

Please accept this document in response to the questions regarding the validity of the testing performed on the clay material lining the pond on the above referenced project. The red fat clay with sand material is classified in accordance with the Unified Soil Classification System as a CH.

During the excavation of the pond, the different material types were separated into stockpiles of sand, caliche, and clay. A representative sample of the clay liner material was taken in accordance with ASTM D 75 from the stockpile for laboratory testing including a moisture density curve, Atterberg limits and the hydraulic conductivity of saturated materials. A low content of gypsum[1] was observed in the sample materials during laboratory testing. The hydraulic conductivity (permeability) test was performed by our subconsultant, AMEC in their Albuquerque laboratory.

Liquid Limit	57	ASTM D 4318
Plasticity Index	40	ASTM D 4318
Moisture Density Curve	100.5 lb./cu. Ft. @ 24.7%	ASTM D 698
Hydraulic Conductivity	1.72×10^{-8} cm/s	ASTM D 5084

The measurement of conductivity, also referred as the coefficient of permeability, provides a means for determining hydraulic conductivity at a controlled level of effective stress. The hydraulic conductivity varies with the varying void ratio. The required hydraulic conductivity in accordance with Section IID is no greater than 1×10^{-7} cm per second. The clay material used for the liner meets this requirement. The test was performed at 95% of the maximum dry density to represent field conditions.

[1] Gypsum is one of the more common minerals in our sedimentary environments. It is generally formed as surface water evaporates from basins, the dissolved materials become more concentrated, normally by limestone deposition, until gypsum is formed.

The clay liner was installed in accordance with NMOCD *Interim Pit and Below-Grade Tank Guidelines* Section IID that was published at the time of construction (2003). During construction of the liner, field moisture and density tests were taken in accordance with ASTM D 2922 on the clay liner material for the full two foot thickness. When a failed test (one) occurred (on top of the berm), the contractor took corrective measures by re-processing and recompacting the material. Field density and moisture tests were measured against the laboratory moisture density curve. The specified compaction was 95% of the laboratory density and moisture control was held near optimum. Generally, it is difficult to achieve specified compaction on fat clays if the material is not processed (mixed) correctly. This includes having the correct amount of moisture in the material. Non-uniformity of the clay liner was not observed during the construction of the liner.

Concern has been expressed that the gypsum content of the clay liner could be detrimental to the mechanics of the clay material. This concern would have been evident through the laboratory test for hydraulic conductivity. This test is run in a saturated state, should there have been significant reaction of the gypsum, the test would not have met the regulated rate of conductivity.

In review of the NMOCD *Interim Pit and Below-Grade Tank Guidelines* dated May 28, 2004 and in specific Section II Disposal and Storage Pits paragraph 2 Clay Liners, construction requirements as itemized in (a) through (i) have been met.

Should you have any questions regarding this response, please do not hesitate to contact our office.

JEREMY BAKER
NEW MEXICO
16207
LICENSED PROFESSIONAL ENGINEER

Jeremy Baker

Jeremy Baker, PE

DEBRA P. HICKS
NEW MEXICO
10671
REGISTERED PROFESSIONAL ENGINEER

Debra P. Hicks

Debra P. Hicks, PE/LSI

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Friday, July 16, 2004 3:17 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'; wcarr@hollandhart.com; 'Jeremy Baker'
Subject: Loco Hills Testing Next Week

Wayne

Why don't you and Bill Olson come down get a real tour of the site with the geologists and engineers that have been working it for the past few months?

Here is a letter explaining what we plan to do next week.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

July 16, 2004

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E

Dear Wayne:

We plan to address all of the technical and regulatory concerns that currently prevent NMOCD from approving use of the Loco Hills GSF clay-lined pond. In a recent conversation, you, Roger and I identified three technical issues:

1. The presence of gypsum in the clay liner and its possible effect on the ability of the clay liner meet the appropriate compaction to attain a permeability of 1 x 10-7 cm/sec or less,
2. The thickness of the liner potentially being less than 2 feet thick, and
3. The nature of the underlying strata and hydrogeologic setting being unsuitable for accepting a clay-lined storage lagoon.

While Pettigrew and Associates have submitted information regarding the gypsum in the liner, the most direct method of determining the seepage rate of the liner is through the post-construction permeability testing. We plan to follow the methodology for permeability testing outlined in the NMOCD DRAFT Pit Guidelines of March 16, 2004. We assume that NMOCD will employ these guidelines for approval of and exemption to Rule 50 because these guidelines relating to clay liners were in effect at the time the pond was constructed. These guidelines were also in effect during the time we were creating a demonstration of "no threat to human health or the environment" under the WQCC Discharge Plan requirements.

In addition to collecting two samples for laboratory testing of permeability, we plan to perform three in-situ tests following the double-ring infiltrometer method (ASTM D-3385). We are saturating a small portion of the pond bottom with ground water to prepare for this post-construction testing. We invite you or any NMOCD staff to observe the field protocol.

We assume that if this extensive post-construction testing demonstrates a hydraulic conductivity of 1×10^{-7} or less, technical issues #1 will be behind us.

We are collecting information from Pettigrew and the construction contractor to provide verification that the liner is a minimum of 2-feet thick. We hope this information regarding the liner thickness will prove satisfactory to NMOCD.

We are completing a final submission that presents the results of our recent hydrogeologic investigation. Our analysis demonstrates that a small volume of seepage from the clay-lined pond will not cause a threat to human health, the environment, or fresh water. Moreover, the proposed ground water extraction program, which is an integral part of the proposed program, will result in material benefit to the environment.

Because Pettigrew and Hicks Consultants will be at the site next week (Tuesday-Thursday), we would like to resolve any additional outstanding issues. I will contact you on Tuesday morning to discuss any final testing or evaluation that you believe we should undertake before submission of our petition. Once again, I thank you and all of NMOCD for your attention to this matter.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T. Hicks

Randall Hicks
Principal

Copy:
Mitchell Johnson, Loco Hills GSF
Jeremy Baker, Pettigrew and Associates
William Carr, Holland and Hart

Price, Wayne

From: Jeremy Baker [jeremyb@nmpcs.com]
Sent: Thursday, July 15, 2004 4:45 PM
To: Mitchel Johnson; Randall Hicks; Wayne Price
Cc: Debra P. Hicks
Subject: Loco Hills Technical Response

Technical Response.doc

Wayne, please send me your mailing address and we will send out an origional signed and stamped document. Thanks.

Jeremy Baker, P.E.
Pettigrew & Associates, P.A.
ph. (505) 393-9827 ext. 25

PETTIGREW and ASSOCIATES
1110 N. GRIMES
HOBBS, NEW MEXICO 88240
(505) 393-9827 voice
(505) 393-1543 fax

Technical Response

To: Mr. Wayne Price - NMOCD

CC: Mitchel Johnson, Randall Hicks

From: Jeremy Baker, P.E./Debra P. Hicks, PE/LSI

Date: 7/16/2004

Re: Loco Hills GSF Brine Pond

Please accept this document in response to the questions regarding the validity of the testing performed on the clay material lining the pond on the above referenced project. The red fat clay with sand material is classified in accordance with the Unified Soil Classification System as a CH.

During the excavation of the pond, the different material types were separated into stockpiles of sand, caliche, and clay. A representative sample of the clay liner material was taken in accordance with ASTM D 75 from the stockpile for laboratory testing including a moisture density curve, Atterberg limits and the hydraulic conductivity of saturated materials. A low content of gypsum[1] was observed in the sample materials during laboratory testing. The hydraulic conductivity (permeability) test was performed by our subconsultant, AMEC in their Albuquerque laboratory.

Liquid Limit	57	ASTM D 4318
Plasticity Index	40	ASTM D 4318
Moisture Density Curve	100.5 lb./cu. Ft. @ 24.7%	ASTM D 698
Hydraulic Conductivity	1.72×10^{-8} cm/s	ASTM D 5084

The measurement of conductivity, also referred as the coefficient of permeability, provides a means for determining hydraulic conductivity at a controlled level of effective stress. The hydraulic conductivity varies with the varying void ratio. The required hydraulic conductivity in accordance with Section IID is no greater than 1×10^{-7} cm per second. The clay material used for the liner meets this requirement. The test was performed at 95% of the maximum dry density to represent field conditions.

[1] Gypsum is one of the more common minerals in our sedimentary environments. It is generally formed as surface water evaporates from basins, the dissolved materials become more concentrated, normally by limestone deposition, until gypsum is formed.

The clay liner was installed in accordance with NMOCD *Interim Pit and Below-Grade Tank Guidelines* Section IID that was published at the time of construction (2003). During construction of the liner, field moisture and density tests were taken in accordance with ASTM D 2922 on the clay liner material for the full two foot thickness. When a failed test (one) occurred (on top of the berm), the contractor took corrective measures by re-processing and recompacting the material. Field density and moisture tests were measured against the laboratory moisture density curve. The specified compaction was 95% of the laboratory density and moisture control was held near optimum. Generally, it is difficult to achieve specified compaction on fat clays if the material is not processed (mixed) correctly. This includes having the correct amount of moisture in the material. Non-uniformity of the clay liner was not observed during the construction of the liner.

Concern has been expressed that the gypsum content of the clay liner could be detrimental to the mechanics of the clay material. This concern would have been evident through the laboratory test for hydraulic conductivity. This test is run in a saturated state, should there have been significant reaction of the gypsum, the test would not have met the regulated rate of conductivity.

In review of the NMOCD *Interim Pit and Below-Grade Tank Guidelines* dated May 28, 2004 and in specific Section II Disposal and Storage Pits paragraph 2 Clay Liners, construction requirements as itemized in (a) through (i) have been met.

Should you have any questions regarding this response, please do not hesitate to contact our office.

Jeremy Baker, PE

Debra P. Hicks, PE/LSI

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Monday, July 12, 2004 11:25 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'; wcarr@hollandhart.com; 'Jeremy Baker'
Subject: tuesday meeting

Wayne

We remain busy pulling together the hydrogeologic data for the site. So a meeting on Tuesday would prove useless.

Thus far, our working hypothesis is that the seepage from the unlined pond used in the 1950s-60s caused impairment of ground water. The on-site supply well created a conduit that allowed the migration of brine seepage from the pond to a near-surface caliche bed, then into the ground water zone. This hypothesis is preliminary, but has yet to be discounted by data.

The well in Bear Grass Draw appears to be impacted by historic brine seepage, but we do not have analyses back yet.

There is no fresh water beneath the proposed clay-lined pond – of that we are certain.

We also asked Jeremy Baker of Pettigrew to speak with you regarding the gypsum in the liner.

I have some very good ideas about a testing program to measure the seepage rate from the pond in the event that your conversations with Jeremy do not assuage your concerns about the integrity of the clay liner. The testing requires

1. the transfer of sufficient brine to fill the clay lined pond to a depth of 2 feet, more or less.
2. Then installation of several falling head permeameters (6-12 inch diameter) at various locations around the pond bottom.
3. Measure the seepage rate over several days/weeks
4. Move the permeameters to other locations as desired by NMOCD.

This would be very similar to a double-ring infiltration test with the outer "ring" being the entire pond. We can have the results of this program in a few weeks and determine if the permeability of the clay liner is satisfactory. These in-situ tests may provide NMOCD with better data to base a decision regarding the liner – if such a decision is absolutely required.

From November to March, the brine would be re-injected into the caverns as product is removed. If we can empty the existing pond, we may be able to effect a repair of the synthetic liner before next Spring.

Please delay any conclusions regarding the liner or the site hydrogeology until you see our next edition of the permit application and speak with Jeremy. To us, the hydrogeologic data appear quite favorable.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Price, Wayne

From: Price, Wayne
Sent: Friday, July 09, 2004 2:59 PM
To: Fesmire, Mark; Anderson, Roger
Cc: Wrotenbery, Lori; Gum, Tim; Olson, William
Subject: FW: Loco Hills - request to transfer brine to the clay lined pond for a permeability test.

I am recommending that OCD deny Loco Hills GSF request to transfer any fluids to the new clay lined pond for the following reasons:

1. Soil samples collected by Mike Stubblefield from the bore hole logs show only a thin layer of actual red bed clay underlying the site ranging in depth from 14 feet below grade to approximately 20-30 feet below grade.

2. The new clay liner is only two feet thick and has been observed by Bill Olson that the liner contains visible impurities.

3. The previous ponds have leaked thru the same underlying red bed and caused groundwater contamination.

4. Due to the fact that the new pond will leak as has been pointed out by Loco Hills GSF, there is no reason to believe the underlying red bed will stop this leakage.

5. The fresh water wells in Bear Grass Draw has been contaminated from past operations due to the close proximately to the draw. Loco Hills GSF is assuming that the one recovery well will stop all migration. They have not submitted any pump test and do not have sufficient monitor wells to prove this point. What if their experiment doesn't work, they did not address that situation or made any commitments for clean-up.

6. The infiltration test procedure has not been submitted for our approval. How will rain events be compensated for, will evaporation be estimated or actual pan evaporation be used. Brine water evaporation has a completely different rate than rain water. The head pressure vs infiltration calculation curves have not been submitted. The measurement procedure was not defined and the accuracy of measuring such a large pond may be in question. If the system does leak, then we have actually added to the groundwater contamination. There is no plan of action for that scenario.

7. Bear Grass Draw does contain protectable waters and should be protected from further degradation.

8. New Rule 50 requires a double lined system with leak detection. The new pond is clay singled lined.

Please let me know what you think so I can let Randy know.

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Thursday, July 08, 2004 8:32 AM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'; wcarr@hollandhart.com; 'David Hamilton'
Subject: Loco Hills - request to transfer brine to the clay lined pond for a permeability test.

Wayne

We are amending the existing submission to NMOCD that is in the form of a Discharge Permit Application. We are updating the submission to tell you:

1. We found no ground water in the piezometer drilled several feet north of the center of the clay lined pond. As you and I suspected, there is no ground water in that portion of the site. Ground water appears to be restricted to the Bear Grass Draw area.
2. We will be asking for permission to install a second, smaller pond in the future.
3. We will be obtaining additional information from the engineers to address the concern of gypsum in the clay liner.

With respect to #3, above, we would like to resurrect our request to transfer brine on a temporary basis to the clay lined pond. We will be asking NMOCD for some quick turn-around for a review of this request as our existing pond is full and nobody is purchasing or even taking any brine for drilling. According to NMOGA, the new pit rule has caused the loss of several rigs from NM and the drilling activity is down. The lack of activity is causing Loco Hills GSF some hardship with respect to excess brine.

Please expect our revision to the Loco Hills submission on Monday next week and a formal request to transfer some fluid to the clay lined pond. Part of the request to transfer fluid will be monitoring the seepage from the pond, as we outlined earlier. If we can get permission for a 2 million gallon transfer, that would be great. We hope to have permission to use the pond soon after a hearing on the exemption.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Thursday, July 08, 2004 8:32 AM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'; wcarr@hollandhart.com; 'David Hamilton'
Subject: Loco Hills - request to transfer brine to the clay lined pond for a permeability test.

Bull Shit

Wayne

We are amending the existing submission to NMOCD that is in the form of a Discharge Permit Application. We are updating the submission to tell you:

1. We found no ground water in the piezometer drilled several feet north of the center of the clay lined pond. As you and I suspected, there is no ground water in that portion of the site. Ground water appears to be restricted to the Bear Grass Draw area.
2. We will be asking for permission to install a second, smaller pond in the future.
3. We will be obtaining additional information from the engineers to address the concern of gypsum in the clay liner.

With respect to #3, above, we would like to resurrect our request to transfer brine on a temporary basis to the clay lined pond. We will be asking NMOCD for some quick turn-around for a review of this request as our existing pond is full and nobody is purchasing or even taking any brine for drilling. According to NMOGA, the new pit rule has caused the loss of several rigs from NM and the drilling activity is down. The lack of activity is causing Loco Hills GSF some hardship with respect to excess brine.

Please expect our revision to the Loco Hills submission on Monday next week and a formal request to transfer some fluid to the clay lined pond. Part of the request to transfer fluid will be monitoring the seepage from the pond, as we outlined earlier. If we can get permission for a 2 million gallon transfer, that would be great. We hope to have permission to use the pond soon after a hearing on the exemption.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Tuesday, June 22, 2004 2:02 PM
To: 'Price, Wayne'
Cc: 'mitchel Johnson-son (E-mail)'; david@rthicksconsult.com
Subject: Modify Workplan

Wayne

I attach a DRAFT well log for the first seepage detection piezometer. Our work during the past few days provide the following data:

1. If present, the Dockum Group is very thin and restricted to the near surface.
2. Ground water at the site is under confined conditions in what we believe to be the Rustler Formation.
3. Preliminary data suggest that the TDS of ground water at the seepage detection well is about the same as what we see in supply well #1, which is adjacent to the existing pond.
4. Recent analysis shows that the monitor well has a TDS of 91,400 mg/L which is much more than the what we see in the supply wells (#1 is 48,200 and #2 is 64,800 mg/L)

At this time, we believe that one seepage detection well on the east side of the proposed clay-lined pond and one seepage detection well on the north side will provide sufficient data for preparing an exemption request. Therefore, we are modifying our work plan to eliminate the proposed third seepage detection well.

We expect to provide a request for an exemption from the new Pit Rule soon after July 4th. Do you have a format for such a request?

Again, thanks for your help on this interesting site.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Monday, June 21, 2004 9:15 AM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'
Subject: Loco Hills

Wayne

We drilled the seepage detection well on the east side of the pond and hit water at 90 feet on Friday. We plan to measure water levels again today and grab a sample of this water – which looks to be fresh (low TDS) at first glance.

We drill the arroyo well today.

I plan to fax to you a lithologic log and analysis from the seepage detection well today. I would like to discuss these results and determine if a need exists to drill additional seepage detection wells. The preliminary report on the lithology shows clay and anhydrite/gypsum with little to no porous horizons. We did install 2 piezometers in the best looking horizons in the vadose zone for seepage detection.

If the preliminary lithologic profile is correct AND if the deep ground water is fresh, we may wish to re-think up gradient wells.

I will fax you the data and call you soon thereafter.

THIS IS GOOD NEWS FOR APPROVING A CLAY-LINED IMPOUNDMENT. We can monitor any seepage via the piezometer and the lithology is very favorable.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

1. Name and Address of Landowner

As of August 1, 2004, the land upon which Loco Hills GSF resides is leased from and owned by:

Regional Office
State of New Mexico,
Commission of Public Land
Jim Carr
1004 Piasano
Carlsbad, NM 88220

Phone: 505.885.1323

Main Office
State of New Mexico,
Commission of Public Land
Joseph Lopez
310 Old Santa Fe Trail
PO Box 1148
Santa Fe, NM 87504

Phone: 505.827.4003

The owners of Loco Hills GSF are currently completing a land transfer with the State Land Office. At the time of Best Management Practices Plan approval, the 40 acres upon which the facility resides and land adjoining the facility to the east will be owned by:

Loco Hills GSF
Attention: Mitchell Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Plate 1 is a map showing the land status after the above-referenced transaction. Adjacent to the 40-acre parcel currently owned by the State of New Mexico is a parcel Loco Hills GSF is currently acquiring from Bogle Farms.

2. Description of Types and Quantities of Fluids at the Facility

Table 1 outlines the fluid storage locations at the facility, their capacity, and the types of fluids kept. See Appendix A for a map showing the locations of these ponds and tanks.

DRAFT

SEE FILE
FOR COPY OF
THIS DOCUMENT

PICKED-UP IN
FIELD

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Monday, June 14, 2004 9:24 AM
To: 'Price, Wayne'
Subject: FW: Loco Hills

price letter june 11 04.pdf

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Monday, June 14, 2004 6:41 AM
To: 'Price, Wayne'
Subject: FW: Loco Hills

This did not go through the first time

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Monday, June 14, 2004 6:34 AM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'; david@rthicksconsult.com; 'Stubblefield, Mike'
Subject: Loco Hills

Wayne

Today, Dave Hamilton of my staff will stake the locations of the three seepage detection wells and the proposed Bear Grass Draw Monitoring well.
On Wednesday or Thursday we should be drilling the first of the seepage detection wells. Then, we let this eastern-most seepage detection piezometer location stabilize while we drill the Bear Grass Draw well/piezometer.

If as we all suspect, the eastern seepage detection boring shows some water (brine or fresh), then we complete the other two seepage detection wells in the same manner. If the eastern seepage detection boring is dry, we need to do some quick thinking and decide how much value any additional holes will have. We can talk about this potential situation on Thursday when we have the lithologic log of the eastern hole in front of us.

Thanks for your help on this project. I have copied Mike Stubblefield on this message to provide for 48-hour notification of our drilling activities.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

This email has been scanned by the MessageLabs Email Security System.
For more information please visit http://www.messagelabs.com/email

This email has been scanned by the MessageLabs Email Security System.
For more information please visit http://www.messagelabs.com/email

R. T. Hicks Consultants, Ltd.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

June 11, 2004

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E

Dear Wayne:

First and foremost, we appreciate your meeting with us to discuss the project. We are pleased to understand that NMOCD supports our basic concept of identifying a cost-effective method of containing the brine at the surface that will allow Loco Hills GSF to focus their resources on accelerating their voluntary ground water remediation effort. The meeting with the Director and staff proved very useful to us and has resulted in this modified approach that does not involve long-term testing of the seepage rate in the impoundment.

Second, Loco Hills GSF will begin selling brine for use as drilling fluid. Because the 2 million gallon pond currently approved for use under the existing Discharge Permit is nearing capacity, we cannot continue pumping high-TDS ground water. As you know, during the summer months brine from the caverns is generated at the surface due to injection of propane and this action limits our ability to pump ground water. Brine sales and the proposed characterization program obviate the need for any transfer of fluid from the existing pond to the clay-lined impoundment.

WHAT? Since when

Third, we propose a hydrogeologic characterization program that will provide much or all of the data required for NMOCD to rule on the acceptability of a clay-lined impoundment at this unique site. As described herein, three of the proposed; borings will serve as part of a seepage detection program for the clay-lined pond. All of the four proposed borings/wells will help determine the extent of ground water impairment caused by others.

Finally, our technical evaluation of the past few weeks identified a need to construct a 1-2 million gallon impoundment to replace the existing 2 million gallon impoundment. We plan to present construction and operational details for this second impoundment after completion of the proposed characterization program.

Ground Water Characterization Program

A. Loco Hills GSF will begin quarterly monitoring of ground water at the site. Next month, we plan to submit the results of the first monitoring event. It will be interesting to see if the recent rains in the area combined with the increased use of water supply well #1 (adjacent ~~to the~~ lined pond) has created a decrease in the TDS ~~of~~ water supply well #2 (north of the highway).

BACH WALLS

B. On June 17, we will drill three seepage detection wells (see attached map). A geologist from Hicks Consultants will oversee the drilling and completion of the well. Because we believe that two or more of these borings may not intercept shallow ground water, we will employ the following drilling protocol. We will drill the first 20-40 feet with air rotary and log the cuttings. We will attempt to collect our first core sample at 10 feet below the base of the clay-lined impoundment to provide depth specific lithology and texture. We will then collect core samples every 10-20 feet to total depth. At depths of 40, 60, 80 and 100 feet, we will allow the borehole to stand open for 20-30 minutes then check the boring for any water accumulation. The total depth of this seepage detection well shall be 20 feet below the elevation of ground water observed in monitoring well #1 or the static water level in water supply well #1 (north of the highway). We will record our observations of the boring process.

C. In these three boreholes, we will construct a seepage detection system by installing three or four 1-inch piezometers in the borehole. We anticipate the deepest piezometer will be at total depth, the next piezometer will be placed between 75 and 95 feet, depending upon the hydrogeologic conditions of the depth interval. Other piezometers will be placed a various depths within more permeable units identified by the site geologist.

D. Next, we will drill a 2-inch monitoring well and piezometer in Bear Grass Draw (see attached map). In this boring, we will complete a monitoring well in accordance with NMOCD guidelines and industry standards. In this same borehole, we will construct a 1-inch piezometer open in the aquifer 20 feet below the bottom of the monitoring well screen. We anticipate the monitoring well will be screened from 5 feet above the water table (about 80 feet deep) to 15 feet below the water table. The piezometer will be employed to measure chloride concentrations at a discrete point 30 feet below the top of the water table.

E. We will allow the seepage detection piezometers and monitoring well cluster to stabilize for 2-3 weeks, then measure water levels in each piezometer and obtain samples in those that contain water.

F. After this short period, Hicks Consultants will prepare a brief letter report to NMOCD. We will interpret the results. This report may provide recommendations for further inquiry or call for the approval of the proposed clay-lined impoundment in the form of an application for an exemption to Rule 50.

Proposed 2-Million Gallon Clay-Lined Pond

Pumping ground water into the large clay-lined pond is a principal component of this integrated brine storage and ground water remedy. However, the extraction of ground water will cause dilution of the produced brine in the impoundment. Loco Hills GSF requires injection of fully saturated brine to prevent unwanted enlargement of the storage caverns. Drilling fluid requirements also call for saturated brine (10 pound weight). Adding salt to the large pond to adjust the weight of the brine is not economic. A smaller pond of 1-2 million gallons to permit adjustment of the brine weight prior to injection or sale is appropriate. Loco Hills GSF will submit plans and specifications for this smaller pond after completion of the characterization program.

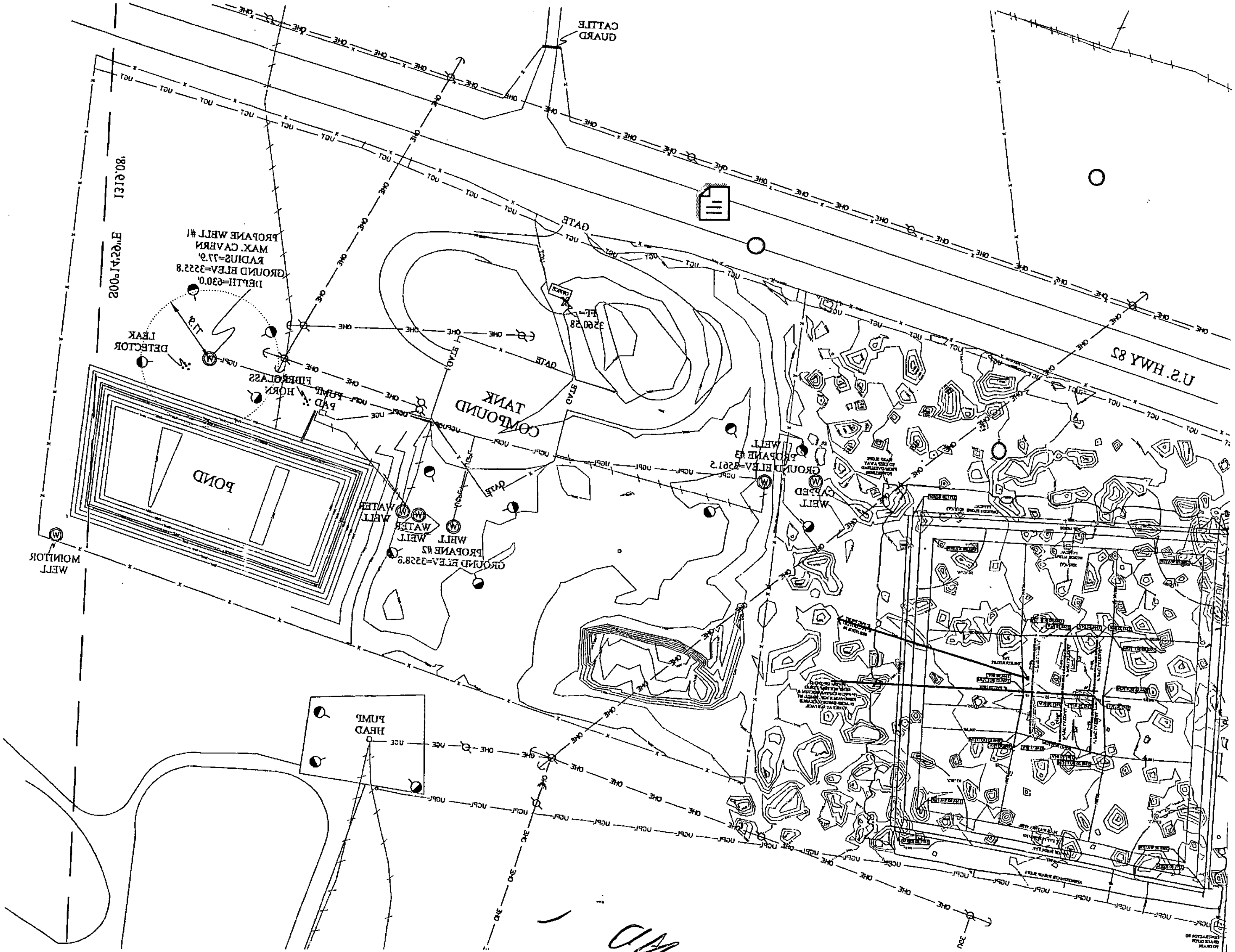
Thanks again for your attention to this important issue.

Sincerely,
R.T. Hicks Consultants, Ltd.

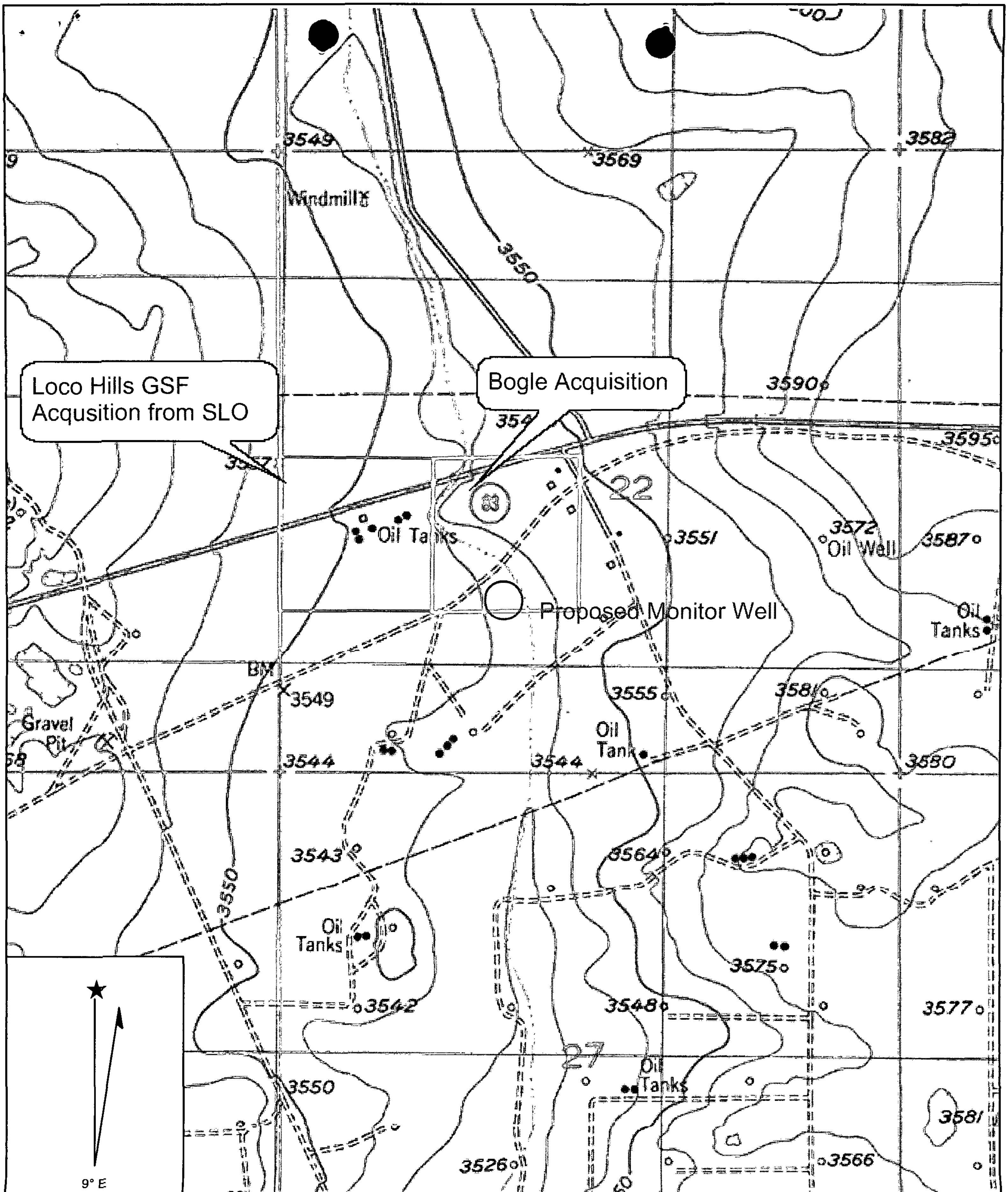
Randall T Hicks

Randall Hicks
Principal

Copy: Mitchell Johnson

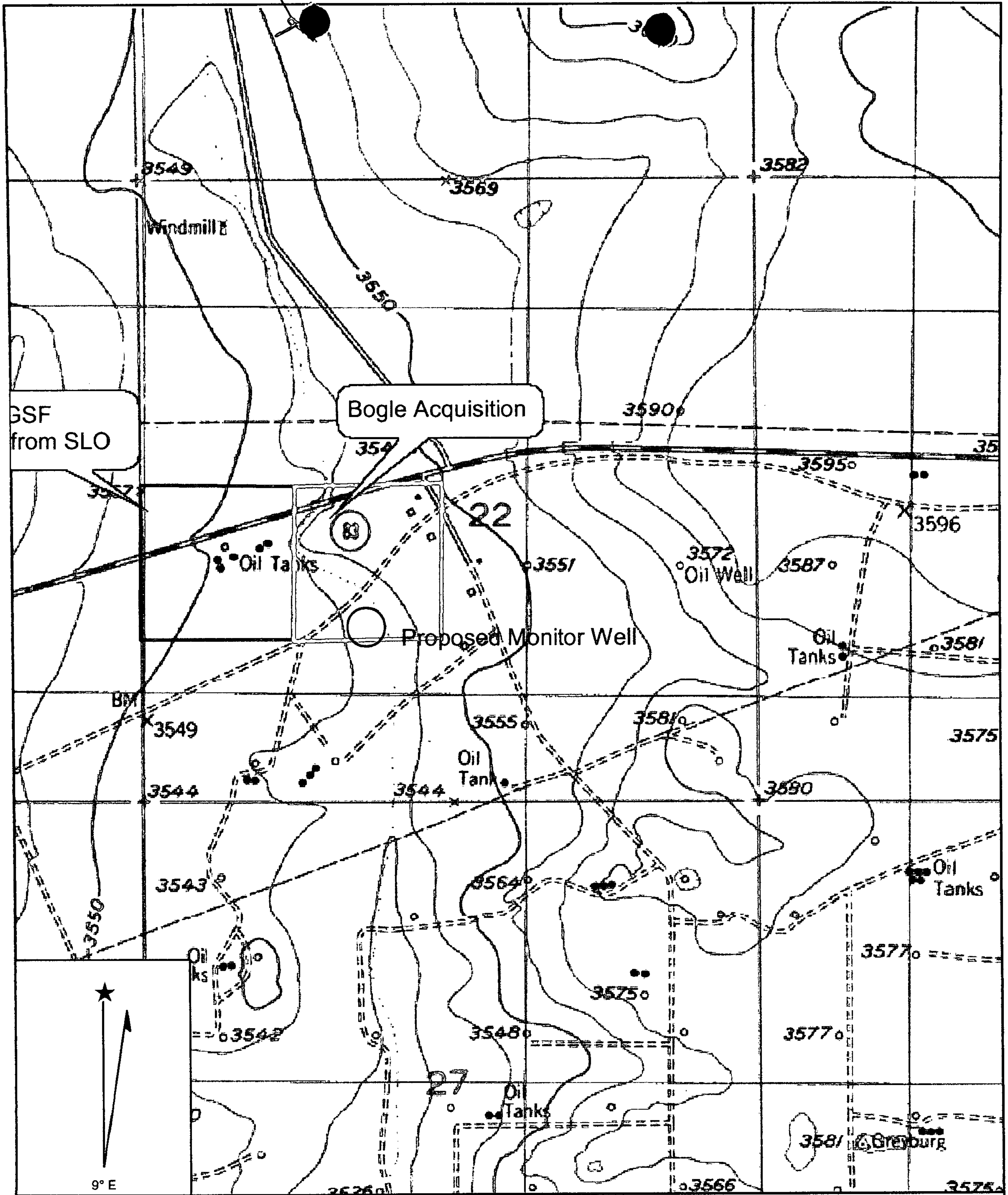


CATTLE GUARD
U.S. HWY 82
GATE
TANK COMPOUND
PROPANE WELL #1
MAX. CAVERN
RADIUS=77.9'
GROUND ELEV=3555.8
DEPTH=630.0'
71.9'
LEAK DETECTOR
FIBERGLASS HORN
PUMP PAD
POND
WATER WELL
WATER WELL
WELL
PROPANE #2
GROUND ELEV=3558.6
WELL
PROPANE #3
GROUND ELEV=3561.5
CAPPED WELL
MONITOR WELL
PUMP HEAD
500°14'59"E
1316.08'
FF=3560.58
CAN'T READ !



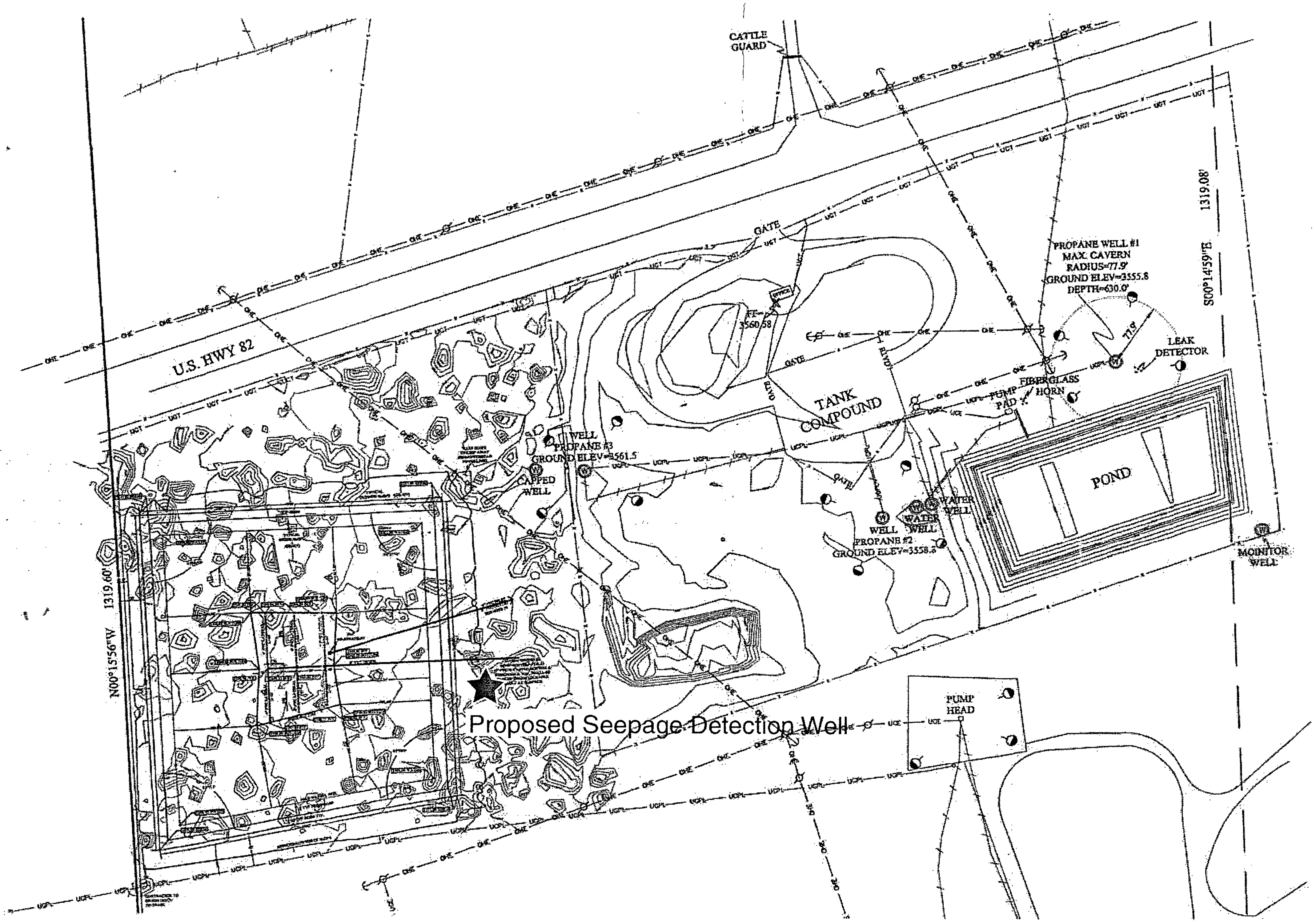
Name: RED LAKE SE
Date: 6/11/2004
Scale: 1 inch equals 1000 feet

Location: 032.8168023° N 104.0645094° W
Caption: Proposed Monitoring Well

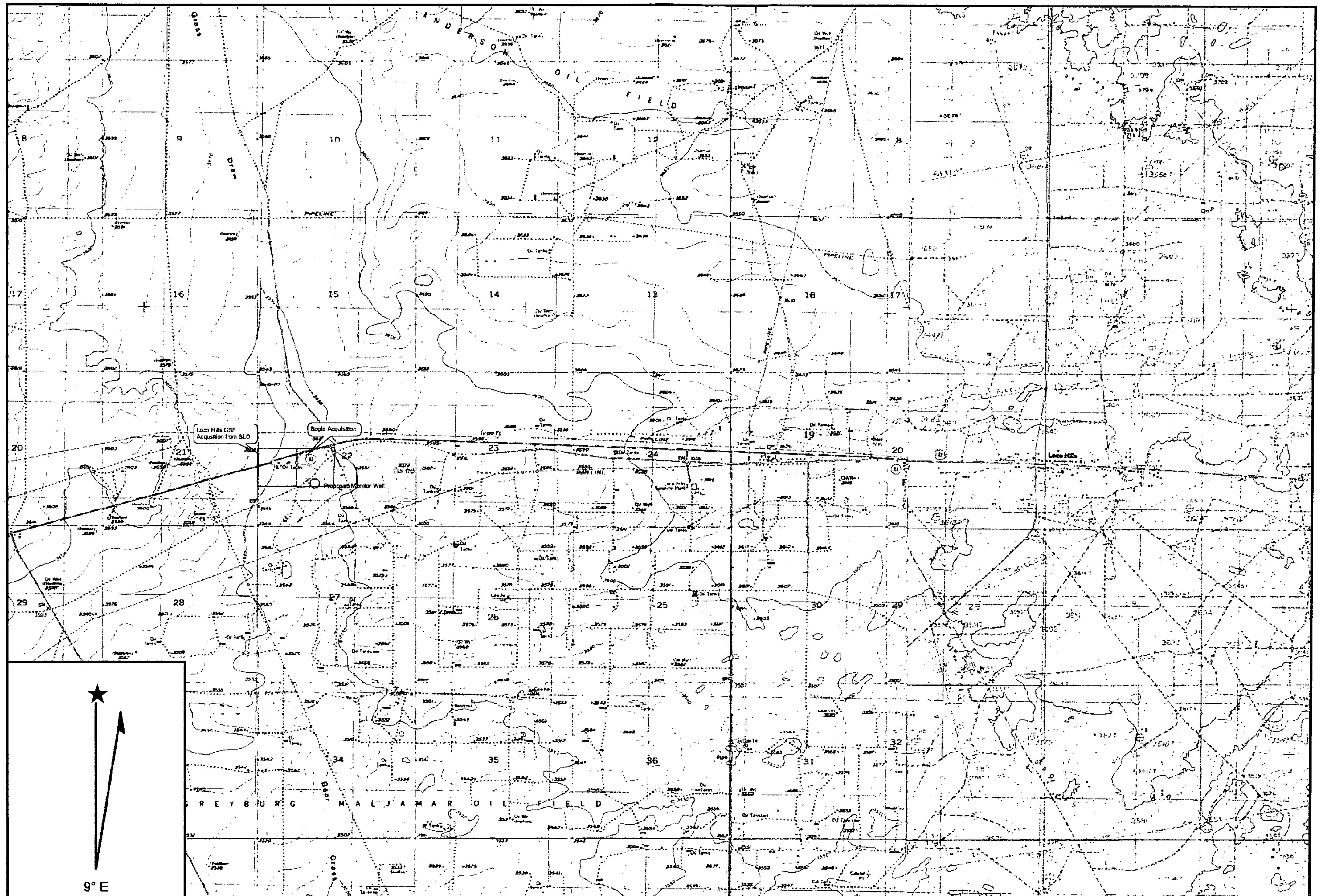


Name: RED LAKE SE
Date: 5/11/2004
Scale: 1 inch equals 1000 feet

Location: 032.8174199° N 104.0605926° W
Caption: Plate 1: Parcel Map



R.T. Hicks Consultants, Ltd. 901 Rio Grande Blvd. NW, Suite F-142 Albuquerque, NM 87104 505.266.5004 Fax: 505.266.0745	Loco Hills Discharge Permit	Appendix A
	Proposed Seepage Detection Well	May 2004



Name: RED LAKE SE
Date: 5/11/2004
Scale: 1 inch equals 4000 feet

Location: 032.8197289° N 104.0271399° W
Caption: Plate 2: Location Map

BILL RICHARDSON
Governor
Joanna Prukop
Cabinet Secretary

Lori Wrotenbery
Director
Oil Conservation Division

Memorandum of Meeting or Conversation

Telephone ____
Personal ___X___
E-Mail ______

Time: 10:30 am
Date: June 09, 2004

Originating Party: Loco Hills GSF- Mitchell Johnson, Randy Hicks

Other Parties: Mark Fesmire, Roger Anderson, Bill Olson, Lori Wrotenbury, Wayne price

Subject: Loco Hills Gas Storage System Single Clay Lined Pond

Discussion:

OCD notified Loco Hills that their facility would be covered under the Oil and Gas Act and OCD Rule 50

Conclusions or Agreements:

Loco Hills indicated they might submit a plan to investigate the hydrology of the area to determine if a single lined pond may be feasible. OCD agreed to review the technical data but no promises were given as to the future decision on this matter.

Signed: ___ Wayne Price ______________________

CC:

OCD/Loco Hills GSF Meeting 6/9/04

attendees - Bill Olson - NMOCD
Roger Anderson - "
Lori Wrotenbery - "
Mark Fesmire - "
Wayne Price - "
Randy Hicks - Hicks + Assoc.
Mitchell Johnson - Loco Hills GSF

- New issues for plan, see handout # 1 + 2
  - contingency plan
  - move MW to arroyo
  - want to use entire clay pond capacity

2' clay liner sufficient?

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

Meeting Agenda, June 9, 2004

Loco Hills GSF Permit Application for a Clay-Lined Brine Storage Impoundment

Goal: Develop a Permit for Loco Hills GSF that:

- follows appropriate statues, rules or regulations, and
- creates a reasonable relationship between the net environmental benefit of the plan and the cost of implementing the environmental controls.

Facts:

1. Bear Grass Draw, which is within the proposed facility boundaries, is a losing stream. The ground water system is about 85 feet below the Draw and generally exhibits a TDS of about 2500 ppm. Any ground water that is "fresh water" in Bear Grass Draw must be protected under any set of Laws or Regulations.
2. Practices by previous owners have impaired water quality beneath the facility to the extent that ground water exceeds 100,000 ppm TDS in the monitoring well drilled by Loco Hills GSF. In water supply well #1 (in Bear Grass Draw), ground water TDS exceeds 60,000 ppm.
3. Loco Hills GSF has commenced a ground water extraction program that will, over time, remove the impaired ground water beneath the site (for beneficial use). The extraction program will also mitigate any further migration of this poor-quality water into the ground water system beneath Bear Grass Draw.
4. Ground water extraction must cease now because the current pond is at capacity.
5. The clay-rich Dockum Group redbeds underlie the proposed clay-lined lagoon. The contractor excavated then compacted these natural clays to create an average hydraulic conductivity of 1.7×10^{-8} cm/sec (95% proctor density).
6. Most of the pond liner exhibits a proctor density of more than 100%.
7. The New Mexico Water Quality Control Commission Regulations allow seepage from impoundments into ground water.

Conclusions

A. The Oil and Gas Act and NMOCD Rules regulate discharges from the Loco Hills GSF facility, not the WQCC Regulations.

B. Loco Hills GSF has worked diligently with NMOCD in an attempt to create an approvable plan that provides the greatest environmental benefit, and will not endanger fresh water, public health or the environment. Loco Hills GSF volunteered to characterize and address the existing impairment of ground water quality caused by others.

C. The ground water beneath and adjacent to the Loco Hills GSF facility is not "fresh water".

D. The calculated seepage rate from the proposed clay-lined impoundment is about 40 gallons per day (1.7 x 10^{-8} cm/sec) but may be 4 gallons per day or lower. The proposed seepage testing program will provide a good estimate of the seepage rate for the entire impoundment.

E. Seepage from the clay-lined pond will not directly enter fresh water.

F. The calculated 40 gallons/day of seepage from the pond will not endanger fresh water beneath Bear Grass Draw. The flux of ground water flowing beneath Bear Grass Draw will be orders of magnitude greater than the calculated seepage rate from the clay-lined impoundment. A monitoring well, a supply well or any other measuring device could not detect the effect of the pond seepage. The proposed ground water extraction program combines with natural dilution to demonstrate that the seepage will not affect fresh water. Data from the proposed monitoring well in Bear Grass Draw will allow us to test this conclusion.

G. The estimated ground water extraction rate proposed by Loco Hills GSF will be more than 230,000 gallons per year.

H. After five years of operation, the facility should extract more than 1.1 million gallons while less than 7,000 – 70,000 gallons seep through the clay liner.

I. At this site, there is no reasonable relationship between the benefit of reducing the seepage rate via a synthetic liner and the cost of that liner. When the synthetic liner fails (in 5, 10 or 20 years) Loco Hills GSF or their successor will face an additional large expense to repair the liner. The proposed testing program will prove or disprove this conclusion.

J. If the seepage from the pond cannot endanger fresh water, public health or the environment, then NMOCD can approve an exemption for the clay-lined pond. Such an approval will allow Loco Hills GSF to focus the limited resources on their voluntary ground water remediation program.

K. Loco Hills GSF has given notice to the surface owner of record where the impoundment is to be located and will give notice to such other persons as the division may direct and Loco Hills GSF will obtain written waivers from all persons to whom notice is required unless no objection is received by the division within 30 days of the time notice is given. Therefore, a hearing on this matter is not necessarily required by Rule 50.

L. Under the WQCC Regulations, which regulated the site since the 1980s, the proposed clay-lined pond would be approved by NMOCD.

M. Filling the pond as part of the permitting evaluation will allow a long-term test of the seepage rate, which will provide more accurate values. This test will also permit continued and enhanced ground water extraction.

N. Loco Hills GSF is in the process of acquiring the State Land upon which the facility lies and the adjacent private property in Bear Grass Draw. This will materially reduce the liability profile of the State Land Office, Loco Hills GSF, and the previous operators.

O. In the unlikely event that the proposed testing program (seepage testing and monitor well installation) finds that brine seepage will endanger fresh water, public health or the environment, Loco Hills GSF stands ready to install a synthetic liner over the clay liner. Between these two liners Loco Hills GSF will install a leak detection system. We have developed a DRAFT operational plan to remove the stored water in the clay-lined lagoon and successfully install a leak detection system.

We respectfully request that NMOCD allow a long-term testing program as outlined in the attached DRAFT proposal. NMOCD may wish to recommend changes to this DRAFT proposal or place restrictions on the testing program as appropriate.

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

Date

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E

Dear Wayne:

First and foremost, we appreciate your meeting with us to discuss the project. In anticipation of NMOCD approval of brine storage in the clay-lined pond, Loco Hills GSF has begun quarterly monitoring of ground water at the site. Next month, we plan to submit the results of the first monitoring event. It will be interesting to see if the recent rains in the area combined with the increased use of water supply well #1 (adjacent to the lined pond) has created a decrease in the TDS of water supply well #2 (north of the highway).

Second, we request permission to conduct a long-term infiltration/seepage test of the existing clay-lined pond. Before NMOCD approval of permanent use of the pond, a 60-90 day examination of the seepage rate appears prudent. More importantly, the 2 million gallon pond currently approved for use under the existing Discharge Permit is nearing capacity. Therefore, we cannot continue pumping high-TDS ground water during the summer months, because brine from the caverns is generated at the surface due to injection of propane. As you are aware, a ground water extraction program is the method we propose to mitigate the ground water impairment caused by others.

Third, we propose an iterative ground water characterization program that will result in an acceptable seepage detection program for the clay-lined pond and determine the extent of ground water impairment caused by others.

Finally, creation of this testing program identified a need to construct a 1-2 million gallon clay-lined impoundment to replace the existing 2 million gallon impoundment. We plan to present construction and operational details for this second clay-lined impoundment after completion of the proposed testing program.

Proposed Pond Integrity Testing Program

1. Transfer all of the fluid in the existing 2 million gallon impoundment to the clay-lined pond. This transfer should require about 5-7 days.

2. Measure the depth of the fluid in the clay-lined pond with a staff gauge on a weekly basis. Collect water samples for chloride and specific conductance analysis on a weekly basis. Because we have a good survey of the completed pond, we can use the depth of fluid to calculate the volume of water that is lost to seepage and evaporation on a weekly basis. We can calculate the volume of water lost to evaporation through examination of the chloride concentration.
3. During the testing program outlined above, Loco Hills GSF will pump ground water from supply well #1 (adjacent to the 2 million gallon pond) on a continuous basis into the 2 million gallon impoundment. Loco Hills GSF staff will monitor the volume of water pumped as outlined in previous submissions to NMOCD,
4. During the testing program Loco Hills GSF will also discharge brine into the 2 million gallon impoundment as propane storage needs dictate.
5. When ground water and brine extraction cause the 2 million gallon impoundment to reach capacity, Loco Hills GSF will transfer the fluid to the clay-lined pond and repeat the testing process outlined above. The purpose of this second transfer of fluid is not only to test the sides of the impoundment but to understand if a higher head in the pond causes more seepage on the bottom of the impoundment. This transfer also permits continuation of the aggressive ground water extraction program that we believe will mitigate the ground water quality impairment caused by others.
6. Repeat steps 3-5 if possible until the clay-lined impoundment contains 8 million gallons.
7. In October, we anticipate that brine will be injected into the caverns to remove propane and the process outlined above is reversed. We will transfer the stored ground water and brine to the 2 million gallon impoundment in large batches (e.g. 1 million gallons), add salt as required to create saturated brine, and then inject the brine from the 2 million gallon impoundment into the caverns. By March of 2005, all of the brine extracted from the caverns will be returned to the caverns and the volume of water remaining in the clay-lined pond should be approximately equal to the volume of ground water extracted as a result of the proposed ground water remedy.
8. In early November, we will submit a report that provides an opinion on the integrity of the clay-lined impoundment. The report will also include ground water quality data and an opinion on the efficacy of the proposed remedy to address the impairment caused by others.

Ground Water Characterization Program

A. In June or early July, we will drill a seepage detection well as outlined in our previous correspondence at the location due east of the clay-lined pond. A geologist from Hicks Consultants will oversee the drilling and completion of the well. Because we believe that this boring may not intercept shallow ground water, we will employ the following drilling protocol. We will drill the first 20-40 feet with air rotary and log the cuttings. We will attempt to collect our first core sample at 40 feet to provide depth specific lithology and texture. We will then collect core samples every 10 feet to total depth. At depths of 40, 60, 80 and 100 feet, we will allow the borehole to stand open for 20-30 minutes then check the boring for any water accumulation. The total depth of this seepage detection well shall be 110 feet, which is 20 feet below the elevation of ground water observed in monitoring well #1. We will record our observations of the boring process.

B. In this borehole, we will construct a seepage detection system by installing three or four 1-inch piezometers in the borehole. We anticipate the deepest piezometer will be at total depth (110 feet), the next piezometer will be placed between 75 and 95 feet, depending upon the hydrogeologic conditions of the depth interval. Other piezometers will be placed a various depths.
C. Next, we will drill a 2-inch monitoring well and piezometer in Bear Grass Draw as proposed in our most recent submission. In this boring, we will complete a monitoring well in accordance with NMOCD guidelines and industry standards. In this same borehole, we will construct a 1-inch piezometer open in the aquifer 20 feet below the bottom of the monitoring well screen. We anticipate the monitoring well will be screened from 5 feet above the water table (about 80 feet deep) to 10-15 feet below the water table. The piezometer will be employed to measure chloride concentrations at a discrete point 30 feet below the top of the water table.
D. We will allow the seepage detection piezometer and monitoring well cluster to stabilize for 2-3 weeks, then measure water levels in each piezometer and obtain samples.
E. During the aggressive ground water extraction program described in item 3 above, Loco Hills GSF will measure the static water level in the monitoring wells and the northern supply well on a weekly basis. Staff will also determine the static and pumping water level in the main water supply well. Twice per month, Loco Hills GSF will obtain samples from all wells for determination of specific conductance and chloride.
F. After two months of ground water extraction and monitoring, Hicks Consultants will prepare a brief letter report to NMOCD. We will interpret the effect of the pumping strategy and provide recommendations for further inquiry.

Proposed 2-Million Gallon Clay-Lined Pond

Pumping ground water into the large clay-lined pond will cause dilution of the produced brine. Loco Hills GSF requires injection of fully saturated brine to prevent unwanted enlargement of the storage caverns. Adding salt to the large pond to adjust the weight of the brine is not economic. A smaller pond of 1-2 million gallons to permit adjustment of the brine weight prior to injection is appropriate. Loco Hills GSF will submit plans and specifications for this smaller pond after completion of the seepage testing program.

Loco Hills GSF would like to begin transferring brine and ground water to the clay lined lagoon as soon as possible. A hydrogeologist from Hicks Consultants will set up the monitoring programs next week, while visiting the site.

Proposed Post Testing Contingency Plan

Loco Hills GSF understands that the proposed investigation may show that a synthetic liner with leak detection overlying the existing clay liner may be the only fluid containment system that NMOCD can approve. Such a double-liner system can be installed at the site in early spring, when the pond will be empty. If testing shows a double-lined impoundment is necessary, beginning no later than November, we will transfer water from the clay-lined pond into the existing synthetic-lined impoundment, adjust the weight of the brine then either inject the brine to produce gas or sell the brine for drilling fluid. By March, the clay lined lagoon will be free of standing fluids and Loco Hills GSF will retain a contractor to install the liner and leak detection system.

Thanks again for your attention to this important issue.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall Hicks
Principal

Copy: Mitchell Johnson

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

DRAFT

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E

Dear Wayne:

First and foremost, we appreciate your meeting with us to discuss the project. In anticipation of NMOCD approval of brine storage in the clay-lined pond, Loco Hills GSF has begun quarterly monitoring of ground water at the site. Next month, we plan to submit the results of the first monitoring event. It will be interesting to see if the recent rains in the area combined with the increased use of water supply well #1 (adjacent to the lined pond) has created a decrease in the TDS of water supply well #2 (north of the highway).

Second, we request permission to conduct a long-term infiltration/seepage test of the existing clay-lined pond. Before NMOCD approval of permanent use of the pond, a 60-90 day examination of the seepage rate appears prudent. More importantly, the 2 million gallon pond currently approved for use under the existing Discharge Permit is nearing capacity. Therefore, we cannot continue pumping high-TDS ground water during the summer months, because brine from the caverns is generated at the surface due to injection of propane. As you are aware, a ground water extraction program is the method we propose to mitigate the ground water impairment caused by others.

Third, we propose an iterative ground water characterization program that will result in an acceptable seepage detection program for the clay-lined pond and determine the extent of ground water impairment caused by others.

Finally, creation of this testing program identified a need to construct a 1-2 million gallon clay-lined impoundment to replace the existing 2 million gallon impoundment. We plan to present construction and operational details for this second clay-lined impoundment after completion of the proposed testing program.

Proposed Pond Integrity Testing Program

1. Transfer all of the fluid in the existing 2 million gallon impoundment to the clay-lined pond. This transfer should require about 5-7 days.

2. Measure the depth of the fluid in the clay-lined pond with a staff gauge on a weekly basis. Collect water samples for chloride analysis on a weekly basis. Because we have a good survey of the completed pond, we can use the depth of fluid to calculate the volume of water that is lost to seepage and evaporation on a weekly basis. We can calculate the volume of water lost to evaporation through examination of the chloride concentration.
3. During the testing program outlined above, Loco Hills GSF will pump ground water from supply well #1 (adjacent to the 2 million gallon pond) on a continuous basis into the 2 million gallon impoundment. Loco Hills GSF staff will monitor the volume of water pumped as outlined in previous submissions to NMOCD,
4. During the testing program Loco Hills GSF will also discharge brine into the 2 million gallon impoundment as propane storage needs dictate.
5. When ground water and brine extraction cause the 2 million gallon impoundment to reach capacity, Loco Hills GSF will transfer the fluid to the clay-lined pond and repeat the testing process outlined above. The purpose of this second transfer of fluid is not only to test the sides of the impoundment but to understand if a higher head in the pond causes more seepage on the bottom of the impoundment. This transfer also permits continuation of the aggressive ground water extraction program that we believe will mitigate the ground water quality impairment caused by others.
6. Repeat steps 3-5 if possible until the clay-lined impoundment contains 8 million gallons.
7. In October, we anticipate that brine will be injected into the caverns to remove propane and the process outlined above is reversed. We will transfer the stored ground water and brine to the 2 million gallon impoundment in large batches (e.g. 1 million gallons), add salt as required to create saturated brine, and then inject the brine from the 2 million gallon impoundment into the caverns. By March of 2005, all of the brine extracted from the caverns will be returned to the caverns and the volume of water remaining in the clay-lined pond should be approximately equal to the volume of ground water extracted as a result of the proposed ground water remedy.
8. In early December, we will submit a report that provides an opinion on the integrity of the clay-lined impoundment. The report will also include ground water quality data and an opinion on the efficacy of the proposed remedy to address the impairment caused by others.

Ground Water Characterization Program

A. In June or early July, we will drill a seepage detection well as outlined in our previous correspondence at the location due east of the clay-lined pond. A geologist from Hicks Consultants will oversee the drilling and completion of the well. Because we believe that this boring may not intercept shallow ground water, we will employ the following drilling protocol. We will drill the first 20-40 feet with air rotary and log the cuttings. We will attempt to collect our first core sample at 40 feet to provide depth specific lithology and texture. We will then collect core samples every 10 feet to total depth. At depths of 40, 60, 80 and 100 feet, we will allow the borehole to stand open for 20-30 minutes then check the boring for any water accumulation. The total depth of this seepage detection well shall be 110 feet, which is 20 feet below the elevation of ground water observed in monitoring well #1. We will record our observations of the boring process.

B. In this borehole, we will construct a seepage detection system by installing three or four 1-inch piezometers in the borehole. We anticipate the deepest piezometer will be at total depth (110 feet), the next piezometer will be placed between 75 and 95 feet, depending upon the hydrogeologic conditions of the depth interval. Other piezometers will be placed a various depths.
C. We will allow the seepage detection piezometer to stabilize for 2-3 weeks, then measure water levels in each piezometer and obtain samples.
D. During the aggressive ground water extraction program described in item 3 above, Loco Hills GSF will measure the static water level in the monitoring well and the northern supply well on a weekly basis. Staff will also determine the static and pumping water level in the main water supply well. Twice per month, Loco Hills GSF will obtain samples from all wells for determination of specific conductance.
E. After two months of ground water extraction and monitoring, Hicks Consultants will prepare a brief letter report to NMOCD. We will interpret the effect of the pumping strategy and provide recommendations for further inquiry.

Proposed 2-Million Gallon Clay-Lined Pond

Pumping ground water into the large clay-lined pond will cause dilution of the produced brine. Loco Hills GSF requires injection of fully saturated brine to prevent unwanted enlargement of the storage caverns. Adding salt to the large pond to adjust the weight of the brine is not economic. A smaller pond of 1-2 million gallons to permit adjustment of the brine weight prior to injection is appropriate. Loco Hills GSF will submit plans and specifications for this smaller pond after completion of the seepage testing program.

Loco Hills GSF would like to begin transferring brine and ground water to the clay lined lagoon as soon as possible. A hydrogeologist from Hicks Consultants will set up the monitoring programs next week, while visiting the site.

Loco Hills GSF understands that the proposed investigation may show that a synthetic liner with leak detection overlying the existing clay liner may be the only fluid containment system that NMOCD can approve. Such a double-liner system can be installed at the site in spring, when the pond will be nearly empty.

Thanks again for your attention to this important issue.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall Hicks
Principal

Copy: Mitchell Johnson

NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

BILL RICHARDSON
Governor
Joanna Prukop
Cabinet Secretary

Lori Wrotenbery
Director
Oil Conservation Division

Memorandum of Meeting or Conversation

Telephone ____
Personal __X____
E-Mail ______

Time: 1 pm
Date: 6/3/04

Originating Party: OCD- WPrice, RAnderson, LWrotenbury, BOlson,

Other Parties: Mitch Johnson, Randy Hicks

Subject: Loco Hills GSF GW-019
Discussion: Permit Modification

Conclusions or Agreements:

1. OCD will make a legal determination which regulatory path that will be required, either NM Water Quality Act (WQCC) or Oil and Gas Act and notify Loco Hills GSF.

2. Loco Hills GSF indicated they want to submit a new request for OCD approval to temporarily store brine water in the new single clay lined pond in order to perform a leak test and install monitor wells to determine local hydrology and investigate possible groundwater contamination. OCD verbally agreed that we would consider such a request but would have to make an internal decision if such a plan could be approved.

3. Loco Hills GSF indicated if approval is granted, then depending upon the results of the investigation and leakage test, Loco Hills would then propose a major modification of the discharge plan and issue public notice. OCD's pointed out that final approval would be contingent upon Loco Hills properly demonstrating that local groundwater and Bear Grass Draw will be protected in the foreseeable future and the possibility this case may go to a hearing.

Signed:_______ Wayne Price ______________________________

CC:

Oil Conservation Division * 1220 South St. Francis Drive * Santa Fe, New Mexico 87505
Phone: (505) 476-3440 * Fax (505) 476-3462 * http://www.emnrd.state.nm.us

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Tuesday, June 01, 2004 4:02 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'
Subject: RE: loco hills

Wayne

Mitchell plans to drive to Santa Fe for the meeting. He plans to leave tomorrow morning. I want to be sure that the agenda of the meeting will be productive and worthy his long drive from Ft. Worth. Here is what I believe we should:

1. Discussion and decision regarding an appropriate and approvable pond monitoring and reporting system
2. Discussion regarding the probable NMOCD conditions of approval for the clay lined impoundment and ground water extraction system discharge permit
3. Discussion of the need for a 120-day approval to discharge without an approved plan
4. Publication of public notice for proposed discharge plan modification

We need to move this project forward. The land will be in the possession of Loco Hills GSF by mid-August. We are jumping that hurdle. We know we need to jump the monitoring program hurdle. Is there anything else that we are not considering that can delay approval of a clay-lined pond at this site?

Thanks
\
Randy

-----Original Message-----
From: Price, Wayne [mailto:WPrice@state.nm.us]
Sent: Tuesday, June 01, 2004 3:28 PM
To: 'Randall Hicks'
Subject: RE: loco hills

Meeting set up for 1pm Thursday.

> -----Original Message-----
> **From:** Randall Hicks [mailto:R@rthicksconsult.com]
> **Sent:** Tuesday, June 01, 2004 3:17 PM
> **To:** 'Price, Wayne'
> **Subject:** loco hills
> Wayne

Got caught in a conference call – I will call you when I get off of this!

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

This email has been scanned by the MessageLabs Email Security System.
For more information please visit http://www.messagelabs.com/email

---

Price, Wayne

From: Price, Wayne
Sent: Tuesday, June 01, 2004 1:13 PM
To: 'Randall Hicks'; Price, Wayne
Cc: 'Mitchel Johnson'
Subject: RE: Loco Hills GSF- We can meet on Thursday

Randy we are set for this Thursday 1:00 PM

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Monday, May 31, 2004 6:11 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'
Subject: Loco Hills GSF- We can meet on Thursday

Wayne

Please review the attached letter that responds to your recent email. We are ready to meet this Thursday to resolve outstanding technical and regulatory issues.

The attached letter clearly shows that the WQCC Regulations establish a protocol for NMOCD to approve this plan. I will call you on Tuesday to discuss the possibility of meeting this Thursday.

Thanks for your efforts on this permit application.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

May 12, 2004

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E
Discharge Plan Modification and Request to Discharge for 120 Days without an Approved Plan

Dear Wayne:

First and foremost, we appreciate your rapid review of our May 12, 2004 Discharge Permit modification and request to discharge for 120 days without an approved permit. In anticipation of NMOCD approval of the permit, Loco Hills GSF has begun the proposed quarterly monitoring of ground water at the site. Next month, we plan to submit the results of the first monitoring event. It will be interesting to see if the recent rains in the area combined with the increased use of water supply well #1 (adjacent to the lined pond) has created a decrease in the TDS of water supply well #2 (north of the highway).

Second, we would be pleased to meet with NMOCD to finalize the permit conditions and to outline what is required to obtain permission to discharge without an approved plan (beginning August 1, 2004). We fully understand that NMOCD cannot approve this proposed permit without developing a suitable plan to monitor the discharge and to close the facility.

However, I was a little confused by your e-mail; specifically your comment "*The issue of allowing brine pond seepage into the underlying groundwater is an issue that requires higher authority's input.*" I also am not certain why we would need attorneys present for the meeting.

I ask you to refer to the Water Quality Control Commission Regulations to aid in following my discussion. According to my reading of these regulations, the NMOCD cannot disapprove a permit application solely on the basis of the small volume of seepage. Below, I present Section 20.6.2.3109.C of the Regulations (italics) and my comments regarding these regulations.

C. Provided that the other requirements of this Part are met and the proposed discharge plan, modification or renewal demonstrates that neither a hazard to public health nor undue risk to property will result, the secretary ***shall*** (emphasis added by Hicks) *approve the proposed discharge plan, modification or renewal if the following requirements are met:*

The discharge permit application calculates a very small seepage rate from the clay-lined impoundment, it proposes a ground water extraction program, and calls for the transfer of property from State and private ownership to Loco Hills GSF. Because of these actions, the proposed plan will cause neither a hazard to public health nor an undue risk to property. We have had no indication from NMOCD that our actions would cause a hazard to public health. We understood from our December meeting that the fact that Loco Hills GSF did not own the property did cause a permit approval problem. We understand that Loco Hills GSF will own the property by mid-August, after completion of the land transfer with the State Land Office. Acquisition of the property by Loco Hills GSF will eliminate the outstanding issue of undue risk to property.

(1) ground water that has a TDS concentration of 10,000 mg/l or less will not be affected by the discharge, ***or*** (emphasis added by Hicks)

Below the site, ground water has a TDS concentration in excess of 10,000 mg/l. This high TDS was caused by past actions on the State Lease. The release of brine from past owners of the facility has affected ground water with a TDS concentration of less than 10,000 mg/l. The discharge permit application calls for a ground water extraction program that will mitigate the effect of these past actions and capture any leakage from the impoundment. The ground water extraction program, which is an integral part of the permit, will prevent any impact to water with a TDS concentration of 10,000 mg/l or less. NMOCD could approve the proposed discharge permit based upon this portion of the regulations. Seepage from the clay-lined impoundment into this ground water is really not the problem. The differential pressure head caused by this seepage in the absence of a ground water extraction program would be a problem. Our proposal calls for ground water extraction to mitigate any minor problem caused by seepage.

(2) the person proposing to discharge demonstrates that approval of the proposed discharge plan, modification or renewal will not result in either concentrations in excess of the standards of Section 20.6.2.3103 NMAC or the presence of any toxic pollutant at any place of withdrawal of water for present or reasonably foreseeable future use, except for contaminants in the water diverted as provided in Subsection D of Section 3109 NMAC, ***or*** (emphasis added by Hicks)

Loco Hills GSF went forward with the land transfer with the SLO to allow the NMOCD to approve the permit for a clay-lined pond under this portion of the regulations. By purchasing the property, we understood that the "place of reasonably foreseeable future use" becomes the down-gradient property line. With some permanent restrictive covenants on the property, our understanding is certainly true. Rather than implement such covenants to permit approval under this section, NMOCD should examine the discharge permit and approve the plan under a different section of the Regulations.

(3) the proposed discharge plan conforms to either Subsection a or b below and Subsection c below.

(b) Discharges from industrial, mining or manufacturing operations.

We understand that the Loco Hills GSF facility is a discharge from an industrial facility and falls under this provision of the Regulations.

(i) the discharger has demonstrated that the amount of effluent that enters the subsurface from a surface impoundment will not exceed 0.5 acre-feet per acre per year;

The calculated amount of brine that will enter the subsurface from the proposed clay-lined impoundment is 40 gallons per day or 14,600 gallons per year or 0.04 acre-feet per year. We used conservative assumptions in our calculations of seepage rate. Provided that NMOCD concurs with us that the proposed site activities prevent a hazard to public health and an undue risk to property, then NMOCD can (must) approve the discharge permit under this section of the Regulations. Because we have no nitrogen in the brine, sections C.3.b.i and C.3.b.ii do not apply to this discharge permit application.

The regulations state that NMOCD **shall** approve a discharge permit application that calls for less than 0.5 acre-feet per year of seepage from a clay-lined impoundment provided that the discharger demonstrates that approval of the permit will not cause a hazard to public health or an undue risk to property. We believe that the proposed permit application makes such a demonstration. If our submissions have not clearly made this demonstration, please identify where we fall short.

We clearly understand that transfer of the property from the State Land Office to Loco Hills GSF will be a requirement of discharge permit approval (to eliminate the "undue risk to property" requirement of the Regulations). We understand that we need to work with NMOCD to create an appropriate monitoring and reporting plan. We also understand that NMOCD may have some additional technical issues that we must resolve. However, we do not believe that we need attorneys to debate an issue regarding seepage from a lined lagoon that is clearly spelled out in the Regulations.

We are prepared to meet with NMOCD on Thursday of this week, June 3, to resolve any outstanding technical issues. We respectfully request that NMOCD permit the publication of a notice for this proposed modification as soon possible. We request that NMOCD consider our request to discharge for 120 days without an approved plan (beginning August 1, 2004) in the event that the discharge permit cannot be approved (with conditions) by August 1, 2004.

Thanks again for your attention to this important issue.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall Hicks
Principal

Copy: Mitchell Johnson

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Monday, May 31, 2004 6:11 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'
Subject: Loco Hills GSF- We can meet on Thursday

Wayne

Please review the attached letter that responds to your recent email. We are ready to meet this Thursday to resolve outstanding technical and regulatory issues.

The attached letter clearly shows that the WQCC Regulations establish a protocol for NMOCD to approve this plan. I will call you on Tuesday to discuss the possibility of meeting this Thursday.

Thanks for your efforts on this permit application.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Price, Wayne

From: Price, Wayne

Sent: Thursday, May 27, 2004 2:45 PM

To: 'Katie Lee'; Price, Wayne

Cc: Mitch Johnson; Wrotenbery, Lori; Anderson, Roger; Olson, William; MacQuesten, Gail

Subject: RE: Loco Hills Modified Discharge Plan

Dear Mr. Hicks and Johnson:

I am going to require another technical meeting concerning this design. The issue of allowing brine pond seepage into the underlying groundwater is an issue that requires higher authority's input. I will attempt to have Roger Anderson, Bill Olson, Lori Wrotenbury and one of our attorneys attend. Please let me know dates that are convenient to you.

-----Original Message-----
From: Katie Lee [mailto:katie@rthicksconsult.com]
Sent: Wednesday, May 12, 2004 2:51 PM
To: Wayne Price
Cc: Mitch Johnson
Subject: Loco Hills Modified Discharge Plan

Hello Mr. Price:

R.T. Hicks Consultants is pleased to submit a modified Discharge Plan for Loco Hills GSF. Attached, please find a transmittal letter, the modified Discharge Plan, and Plates 1 & 2. In subsequent e-mails, I will e-mail to you the Appendices A-F by pieces so as not to send anything too large at any one time. These Appendices are the same with the exception of a minor change to Appendix A. If you have any questions or concerns, please let me know.

Best regards,

Katie
R.T. Hicks Consultants, Ltd.
505.266.5004

Price, Wayne

From: Katie Lee [katie@rthicksconsult.com]
Sent: Wednesday, May 12, 2004 2:51 PM
To: Wayne Price
Cc: Mitch Johnson
Subject: Loco Hills Modified Discharge Plan

Hello Mr. Price:

R.T. Hicks Consultants is pleased to submit a modified Discharge Plan for Loco Hills GSF. Attached, please find a transmittal letter, the modified Discharge Plan, and Plates 1 & 2. In subsequent e-mails, I will e-mail to you the Appendices A-F by pieces so as not to send anything too large at any one time. These Appendices are the same with the exception of a minor change to Appendix A. If you have any questions or concerns, please let me know.

Best regards,

Katie
R.T. Hicks Consultants, Ltd.
505.266.5004

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

May 12, 2004

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E
Discharge Plan Modification and Request to Discharge for 120 Days without an Approved Plan

Dear Wayne:

On behalf of Loco Hills GSF, Hicks Consultants is pleased to submit this major modification to the previously-approved discharge permit. As before, for clarity, you will see commitments Loco Hills GSF is proposing to make upon approval of this Discharge Plan highlighted in yellow. We anticipate several conditions in your approval letter for this plan. One such condition is our providing NMOCD with documentation of the land acquisition described in the permit application. The State Land Office plans to exchange the land on which the facility resides with some Loco Hills GSF land of comparable value. Loco Hills GSF is also completing an acquisition of 40 acres due east of the facility. We cannot control the velocity of the SLO in exchanging this land with Loco Hills GSF. However, we can supply NMOCD with documentation from the SLO that the exchange is nearly complete. We ask that NMOCD consider approval of the plan prior to final acquisition of the property from the SLO.

As you know, the acquisition of these two parcels by Loco Hills GSF creates a win-win situation – Loco Hills can now move forward with the ground water restoration project without any encumbrances by the surface landowners. We would like to initiate the ground water extraction program as soon as possible. Therefore, we respectfully request permission to discharge to the clay-lined lagoon without an approved discharge plan for a period not to exceed 120 days. We understand that NMOCD may wish to wait until the end of the public comment period before issuing any such approval. We also understand that NMOCD may wish to closely examine the engineering specifications of the clay-lined pond. We are pleased to address any questions or concerns.

We remain confident that the calculated 40-gallon/day seepage rate from the proposed clay-lined pond will not cause ground water to exceed WQCC Standards at a place of reasonable foreseeable future use. The permit application provides for monitoring of the pond seepage. We understand that NMOCD will look closely at the proposed monitoring plan and may offer suggestions for modification. We commit to working through the details of the monitoring plan during the 120-day period of discharging without an approved plan.

Finally, we understand that the 120-day period is finite. We must obtain an approved discharge plan by the end of that time-frame or the regulations provide for serious consequences. We are motivated not by fear of violation, but by our needs to expand the business and restore ground water quality.

We are sure you will have some questions or comments regarding this plan. We hope that we have provided NMOCD with sufficient detail to permit publication of a notice as soon as possible. If you need additional information, please contact me.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T. Hicks

Randall Hicks
Principal

Copy: Mitchell Johnson

IV Name and Address of Landowner

As of May 10, 2004, the land upon which Loco Hills GSF resides is leased from and owned by:

Regional Office
State of New Mexico,
Commission of Public Land
Jim Carr
1004 Piasano
Carlsbad, NM 88220

Phone: 505.885.1323

Main Office
State of New Mexico,
Commission of Public Land
Jerry King
310 Old Santa Fe Trail
PO Box 1148
Santa Fe, NM 87504

Phone: 505.827.5760

The owners of Loco Hills GSF are currently completing a land transfer with the State Land Office. At the time of discharge permit approval, which we hope is within 120 days from June 1, 2004, the 40 acres upon which the facility resides and land adjoining the facility to the east will be owned by:

Loco Hills GSF
Attention: Mitchell Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Plate 1 is a map showing the land status after the above-referenced transaction. Adjacent to the 40-acre parcel currently owned by the State of New Mexico is a triangular parcel which Loco Hills GSF is currently acquiring from Bogle Farms.

V Description of Types and Quantities of Fluids at the Facility

The table below outlines the fluid storage locations at the facility, their capacity, and the types of fluids kept. See Appendix A for a map showing the locations of these ponds and tanks.

Table 1: Surface Fluid Storage at Loco Hills GSF

Type of Storage	Maximum Capacity	Stored Liquid	Location
Pond #1	2 million gallons	10 lb. Brine	SE Corner of facility
Pond #2	7-11 million gallons	10 lb. Brine	Western portion of facility
Above ground storage steel tank #1	30,000 gallons	Propane or Butane	Tank Area
#2	30,000 gallons	Propane or Butane	Tank Area
#3	18,000 gallons	Propane or Butane	Tank Area
#4	18,000 gallons	Propane or Butane	Tank Area

VI Description of Fluid Management Facilities and Solid Disposal Facilities

Loco Hills GSF proposes to manage brine in two surface impoundments and three subsurface salt caverns that will also store liquid propane or butane. Currently, Loco Hills GSF moves the brine from Pond #1 to the subsurface storage caverns to displace the product to the surface and permit loading of product to customers. During the spring and summer, when demand for propane and butane is low, we inject propane or butane to cavern storage, which results in brine production into the storage ponds.

After NMOCD approval of the mechanical integrity of each injection well/cavern, we plan to employ all three salt caverns for storage of propane and butane. *For the ease of review, we have highlighted all commitments Loco Hills GSF proposes to make upon approval of this plan in yellow.*

As the table below shows, the total capacity for subsurface storage is 8.75 million gallons.

Table 2: Subsurface Fluid Storage at Loco Hills GSF

Cavern #1	2.75 MM gallons	Served by injection well 1
Cavern #2	3 MM gallons	Served by injection well 2
Cavern #3	3 MM gallons	Served by injection well 3

Because these caverns will never contain 100% product (0% brine), we propose to provide sufficient surface storage for less than 9 million gallons of brine (Table 1). Refer to the map in Appendix A for the locations of these caverns. We plan to manage our surface storage to permit the working brine level in Pond #2 to remain at or below the level of the adjacent natural ground surface (3,561 asl) throughout most of the year. Maintaining the fluid level in Pond #2 below the natural ground surface will allow us to preserve the structural integrity of the pond berm in the absence of a synthetic liner. In essence, the berm of Pond #2 will not be employed to hold brine on a routine basis but will divert storm water run-on. Maintaining the maximum working level of Pond #2 at 7 million gallons for most of the year creates a normal pond storage capacity of 9 million gallons (when both ponds are employed for storage). As described below, we plan to maintain Pond #1 below 20-30% of capacity for most of the year. In both ponds we will maintain a freeboard of 3 feet (vertical) so that no overtopping of brine occurs.

In the summer, brine levels in Pond #2 may rise above ground level. When this occurs, we propose to transfer fluid to Pond #1 where we also store brine. When the brine level in Pond #2 falls more than 3-6 feet below ground level, as it may when sales of propane and butane call for injection of brine, we will transfer excess brine from Pond #1 to Pond #2.

We know that allowing the clay liner of Pond #2 to dry can cause desiccation cracks and thereby compromise the low permeability of the liner. We will attempt to minimize fluid level fluctuations in Pond #2. If inspection of the clay liner shows desiccation and possible loss of integrity, we will install a sprinkler or watering system slightly above the high water mark. When necessary, we will apply water to the clay to maintain the moisture content and the low permeability. Fortunately, low pond levels are expected during the winter when evaporation and solar gain is lowest. Loco

Hills GSF will generally employ ground water for this sprinkling program.

We know the primary liner of Pond 1 is compromised and Loco Hills GSF routinely pumps fluid in the leak detection system back into Pond #1. Loco Hills GSF plans to employ the leak detection well to capture fluid released from the primary liner of Pond #1. After approval of this Discharge Permit, Loco Hills GSF will begin to employ Pond #2 as the primary method of fluid management, as described above. As soon as possible, Loco Hills GSF will empty Pond #1 and attempt to repair the primary liner. If the leak cannot be found and/or repaired, we anticipate that this pond will remain only partially full and any leakage from the primary liner may be captured. Loco Hills GSF may elect to abandon the use of this pond. Until the pond is repaired or abandoned, Loco Hills GSF will continue to monitor the leak detection monitor well for brine storage pond #1 weekly.

If we elect to abandon Pond #1, the brine level in Pond 2 could be higher than ground level at the end of summer, when propane and butane cavern storage is greatest. Loco Hills GSF will manage the brine level in the ponds through brine sales, thereby minimizing the time that the brine level in Pond 2 is higher than the adjacent ground surface.

Ground water extraction is a critical element of the discharge plan. As described in Section IX ground water extraction is the proposed remedy to address potential ground water impairment caused by the actions of past owners. Ground water extraction is also necessary to control the slow percolation of brine from the clay-lined Pond #2. As shown below, the measured permeability of the liner (See Appendix B) allows the 100 meter by 100 meter pond to release only 40 gallons per day. Loco Hills GSF will export sufficient brine through sales to control this seepage and to mitigate any impairment of ground water quality caused by the past actions of others.

Table 3: Clay Liner Seepage Calculations

Saturated Hydraulic Conductivity		Pond Surface Area	Hydraulic Gradient	Seepage Rate	
cm/sec	m/day	m2	m/m	liters	gallons
1.72E-08	1.49E-05	10000	1	1.49E+02	40

HOW CAN SEEPAGE BE CONTROLLED IF NOT HYDRAULIC CONNECTED!!!

This discharge plan application expects slow percolation of brine from the clay-lined pond into the subsurface and Section IX of this submission explains how Loco Hills GSF will protect water quality from this planned seepage.

As Table 1 shows, Loco Hills GSF manages propane and butane in the above ground storage tanks, pending sale or storage. All drums containing materials other than fresh water will be stored on an impermeable pad with curbing. All empty drums will be stored on their sides with the bungs in place and lined up on a horizontal plane. Chemicals in other containers such as sacks or buckets will also be stored on an impermeable pad with curbing. All process and maintenance areas that show evidence that leaks or spills are reaching the ground surface will be either paved and curbed or have some type of spill collection device incorporated into the design. All above ground storage tanks that contain fluids other than fresh water are bermed to contain a volume of one-third the total volume of the largest tank. All new or modifications to existing facilities will place tanks on an impermeable pad within a berm. All above ground saddle tanks will have impermeable pad and curb type containment unless they contain fresh water or fluids that are gases at atmospheric temperature and pressure. All tanks, drums, and other containers will be clearly labeled to identify their contents and other emergency information if the tank were to rupture, spill, or ignite. All systems designed for spill collection/prevention, and leak detection will be inspected weekly to ensure proper operation and to prevent overtopping or system failure. All spills and releases will be reported according to OCD Rule 116 and WQCC 1203 to the OCD Artesia District office.

Periodically, Loco Hills GSF creates solid waste. Wind-blown dust and sand enters surface storage ponds and must be removed to maintain the capacity of the ponds. On-site disposal of pond sediment poses no threat to ground water because the quality of the underlying ground water is so poor that seepage of any leachate caused by disposal would not cause a measurable impact. Nevertheless, Loco Hills GSF wishes to maintain the surface at its productive capacity and to eliminate any eyesore caused by stored pond sediment. We propose the following to address any sediment removed from ponds:

Compact the pond sediment in an area of the site that is already disturbed by past activities. Cover the sediment with 1-2 feet of loose caliche and/or available coarse-grained material. Cover the loose caliche with 3-5 feet of Dockum Group clay and grade the surface to blend with the landscape. Cover the clay with 1-3 feet of topsoil and seed with native grasses. We propose this same restoration protocol for eventual pond abandonment. We employed this restoration protocol for the pond sediment waste pile that was stored over the former unlined brine pond, which was retired in the 1980s.

The loose caliche will reduce any upward capillary rise of salt. The clay will act as a reservoir for soil moisture and enhance the ability of vegetation growth on the topsoil.

Any other solid waste material will be shipped to an appropriate commercial or municipal landfill. Loco Hills GSF will comply with all applicable solid waste regulations and NMOCD Rules regarding solid waste.

VII Description of Underground Facilities

Loco Hills GSF has completed a sonar examination of cavern number one (Propane Well 1) and the complete report is on file at the New Mexico Oil Conservation Division. A summary of the findings of this report is included in Appendix C. Caverns two and three are suspected to be slightly larger than one, and will undergo sonar inspection prior to discharge plan renewal in 2005.

The maximum operating injection and/or test pressure at each well head will not be such that the fracture pressure of the injection formation will not be exceeded. An annual open hole cavern pressure test equal to one and one-half times the normal operating pressure (not to exceed formation fracture pressure) or 300 psi, whichever is greater, for four hours. At least once every five years and during well work-overs the cavern formation will be isolated from the casing/tubing annuals and the casing pressure tested at 300 psig for 30 minutes. All pressure tests will be conducted with the approval of and a witness from the OCD.

The basic engineering designs of the propane wells are outlined in Table 4 below. Brine water will be injected and withdrawn through the tubing and gas products and will be injected and withdrawn trough the casing/tubing annulus. Deviations may occur once a month for up to 24 hours due to maintenance.

Table 4. Propane Well Characteristics.

Well #	Depth of Casing (ft)	Total Depth of Tubing (ft)	Total Depth of Well (ft)	Casing Diameter (in)	Tubing Diameter (in)
1	525	630	640	4	2 3/8
2	507	624	unknown	5.5	2.875
3	500	617	unknown	5.5	2.875

VIII Contingency Plan for Spill Reporting and Clean-up

A SPCC plan and a SWPP plan will be completed within 120 days of Discharge Plan approval. Loco Hills GSF will adhere to all spill reporting requirements outlined in OCD Rules.

IX Hydrogeological Demonstration that Activities Will Not Adversely Impact Fresh Water

Site Hydrogeology

Plate 2 shows that the Loco Hills GSF lies adjacent to Bear Grass Draw, about 2 miles west of Loco Hills, New Mexico. Bear Grass Draw is mapped as an ephemeral drainage with "headwaters" about 4 miles north of the Loco Hills GSF. Bear Grass Draw drains to a closed basin about 9 miles south of the facility. Our field inspection found neither a developed channel for this drainage nor evidence of water flow within the recent past. We performed our first inspection on October 8, 2003, during a 2-day precipitation event that caused flooding north of Artesia. We performed a second, more exhaustive inspection of Bear Grass Draw on November 3, 2003 and found no evidence of an active watercourse.

One windmill, now abandoned, lies within Bear Grass Draw north of the facility (see Plate 2). Adjacent to this abandoned windmill is a new water supply well with a submersible pump. A second windmill exists within the Draw about 4.5 miles south of the facility. Examination of the records at the Office of the State Engineer and our reconnaissance identified no water wells within several miles of the facility, except for the active well north of the facility and the four wells located on the facility.

Our observations and driller's logs show that alluvium within Bear Grass Draw is thin or non-existent. Although the driller's log of the on-site monitoring well describes the Dockum Group Red Beds as chiefly red clay, thin permeable units yield water to wells. At the site, the depth to water in the monitoring well is about 80 feet (Table 5). Comparison of the observed water levels in the wells and the lithology described by the driller suggest that confined ground water exists within a thin limestone unit at a depth of about 90 feet (see log for monitoring well in Appendix D).

The water level in supply well #2 is a little puzzling, especially in light of the water level in the nearby monitoring well. Presumably Pecos Valley Pump obtained the water level of 36 feet after pulling the pump and it would represent a static condition. The water level for Well 1 was obtained during periodic pumping and may not represent a static level. Perhaps the high water level in well #2 is a relict of past leakage from unlined storage ponds.

Table 5: Depth to Water in On-site and Nearby Wells

Water Supply Well 1, North of Highway	86.58 feet depth to water	Measured by Hicks, October 8, 2003
Water Supply Well 2, Adjacent to brine pond	36 feet depth to water	Measured by Pecos Valley Pump, Inc, 2002
Monitoring well, adjacent to brine pond	83 feet depth to water	Measured by Driller, May 2, 2003
Older supply well	Casing collapsed	

We did not attempt to determine the ground water flow direction because we cannot be certain that these wells with measured water levels draw ground water from the same hydrostratigraphic units. We assume that, in general, ground water in the Dockum Group in the area flows south – consistent with topography and dip.

Below the Dockum Group and the underlying Dewey Lake Redbeds is the Salado Formation. Near the site, oil well logs show that the top of the Salado Formation lies between 200 and 300 feet below land surface. Ground water with a total dissolved solids (TDS) concentration below 10,000 mg/L does not exist within or below the Salado Formation.

Ground water with a TDS below 10,000 mg/L does not exist beneath the facility. Appendix E presents chemical analyses of three wells at the facility. The TDS of water supply well #1 (north of Highway 83) is 67,950 mg/L. Because the total cations and anions approach 80,000 mg/L, we believe the TDS, which is probably calculated via conductance, is lower than the actual value. The chemistry of water well #2 and the monitoring wells are very similar. All water beneath the facility exceeds 10,000 mg/L TDS. North and south of the facility, at the wells described above, ground water quality meets WQCC standards and is acceptable for stock (see analyses in Appendix F).

The high TDS value for ground water beneath the facility is not surprising because a previous owner used an earthen pit to store brine for many years. Perhaps years of brine seepage into the Dockum Group sediments has created a localized zone of saline ground water. At this time, we do not know the extent of this saline ground water. We propose to install a down gradient monitoring well within Bear Grass Draw to define the down gradient limit of ground water that was probably impaired by past seepage and to help monitor the results of our proposed discharge permit. Plate 2 shows the proposed location of this monitoring well. We will install this well immediately after conditional approval of this discharge permit.

Appendix A shows the location of a proposed monitoring well (seepage detection well) adjacent to the clay-lined impoundment. We will install this well immediately after conditional approval of this discharge permit. This well will be used to monitor the effect of any seepage from the clay-lined impoundment on the underlying ground water. At this proposed location, we believe ground water may be non-existent; it may be greater than 10,000 mg/L TDS due to the activities of past owners, or it could be acceptable for use. If this well is dry, we plan no additional wells for seepage detection as this well will detect seepage. If this well exhibits brine, we will drill an additional well up gradient (due west) to act as a "background" monitoring well. If this well encounters fresh water, the well will serve as a seepage detection well and other monitoring wells may not be necessary.

Proposed Seepage Capture and Ground Water Restoration Program

As outlined in Section VI, Loco Hills GSF plans to control the very small amount of seepage from the clay-lined impoundment and mitigate the impacts to ground water caused by past owners of the facilities through a ground water extraction program. Initially, Loco Hills GSF will extract a substantial volume of ground water to make brine in pond #1. The brine is required for injection into the caverns during this winter. In the spring and summer, when brine is produced from the caverns, Loco Hills will sell brine if necessary to maintain a ground water extraction program and to manage the brine levels in the storage ponds.

This withdrawal of ground water will cause overall ground water quality improvement. Although seepage control requires export of 1 barrel per day, we anticipate that Loco Hills GSF will be able to extract an minimum of 226,800 gallons/year (100 barrels/week) of brine from the facility for use at the Loco Hills GSF facility or in oil field drilling. The water rights for the facility limit the amount of ground water use to 3 acre-feet (978,000 gallons). This ground water withdrawal program will capture any seepage and remediate the seepage due to past activities over time. We propose to employ well #2 as the principal water withdrawal well because this well is located closest to the former unlined storage pit used by past owners of the facility. This well may be most effective in capturing past seepage. After well #1 begins to show a decrease in the TDS, we plan to limit use of Well #1 because its distance from the former unlined pond (the probable center of mass of subsurface brine) to prevent exacerbating off-site migration of any subsurface brine due to past pond seepage.

Monitoring and Reporting Program

Measuring the improvement of ground water quality caused by the proposed water exportation remedy is important. We propose a ground water monitoring program that consists of quarterly measurements of specific conductance and chloride from the two on-site water supply wells, the existing monitoring well and the proposed monitoring wells. We propose to obtain non-pumping water levels from the monitoring wells and Well #1 during these quarterly monitoring events. We also plan to obtain pumping and non-pumping water levels from Well #2 at this same time.

We will also monitor the volume of water pumped from each well and the volume of brine exported from the facility. Because the high TDS of ground water causes failure of flow meters, we plan to monitor the volume of pumped water by simply measuring the flow rate from each well every month then multiplying the flow rate by the amount of time each well was operating.

We will monitor the stage height in each impoundment on a weekly basis. We will monitor the volume of water pumped from the leak detection system in Pond #1.

We anticipate that, over time, Well #1 will begin to show a decrease in conductance and chloride. If the down gradient monitoring well exhibits a TDS higher than the 2000 ppm background, we anticipate that the ground water pumping program will also cause water quality in this well to improve over time.

During the first year of operation under this discharge plan, Loco Hills GSF plans to collect ground water elevation data on a monthly basis, assemble monthly brine sales data, and provide reports to NMOCD semi-annually. After the first year of operation, we plan to submit reports annually.

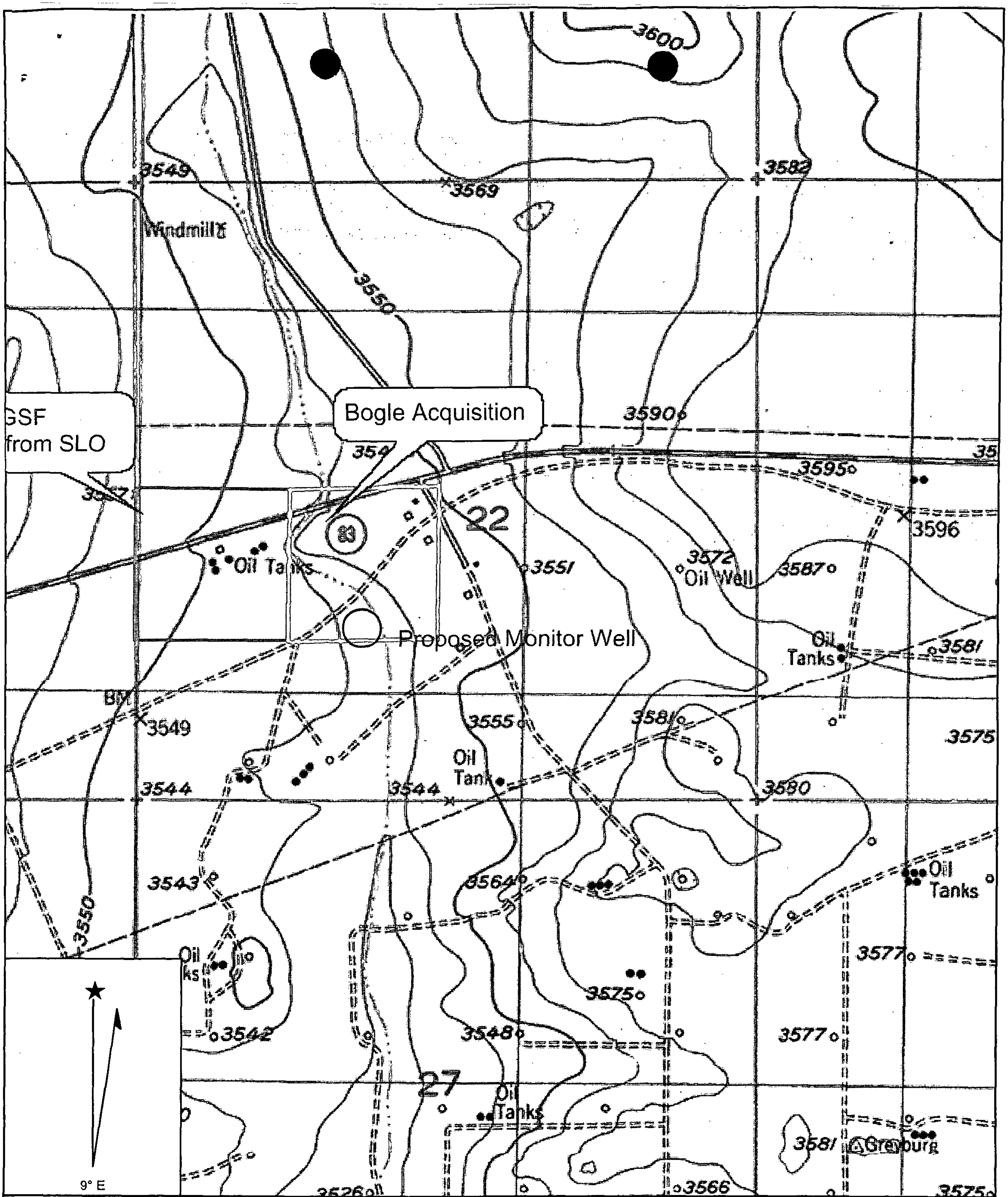
Contingency Plan

We anticipate that the proposed ground water extraction program described herein will cause improvement of water quality (lower TDS) in water supply well #1, the existing monitoring well and the proposed down gradient monitoring well. We also anticipate that the proposed seepage monitoring well (due east of the clay lined pond) will:

1. Not detect seepage if the well is dry,
2. show improvement of water quality if the well encounters brine, or
3. not show a degradation in water quality due to pond seepage, if the well encounters relatively fresh water.

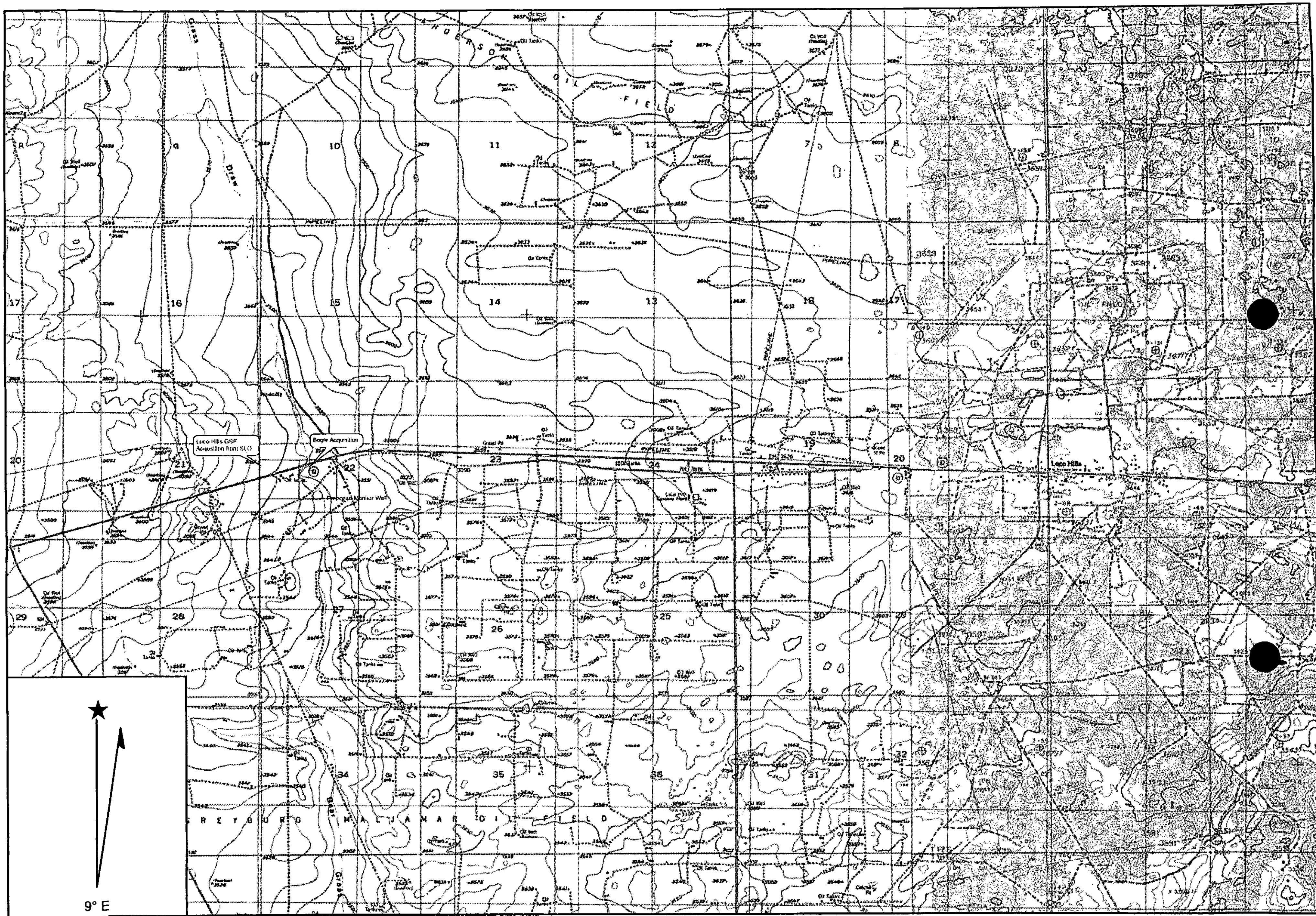
If Water Supply Well #1, the existing monitoring well, or the proposed down gradient monitoring well in Bear Grass Draw do not show water quality improvement after one year, Loco Hills GSF will increase the ground water pumping.

If the seepage detection well(s) suggest unacceptable seepage from the clay-lined pond, Loco Hills GSF will meet with NMOCD to determine the best course of action. One alternative is to increase the ground water pumping program. Another alternative is inspection and repair of the liner. A final alternative is installation of a synthetic liner and leak detection system.



Name: RED LAKE SE
Date: 5/11/2004
Scale: 1 inch equals 1000 feet

Location: 032.8174199° N 104.0605926° W
Caption: Plate 1: Parcel Map



Name: RED LAKE SE
Date: 5/11/2004
Scale: 1 inch equals 4000 feet

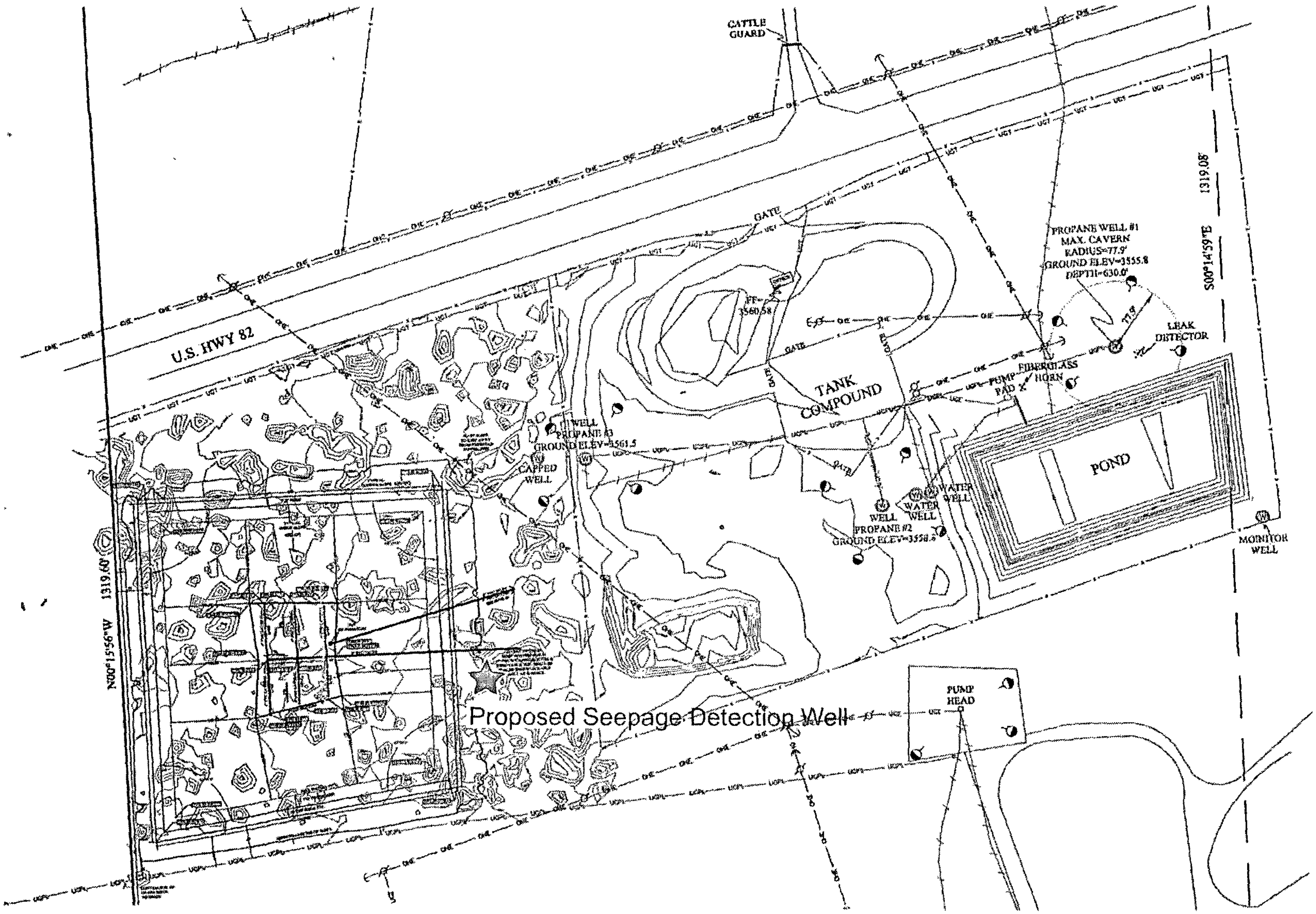
Location: 032.8197289° N 104.0271399° W
Caption: Plate 2: Location Map

Price, Wayne

From: Katie Lee [katie@rthicksconsult.com]
Sent: Wednesday, May 12, 2004 2:51 PM
To: Wayne Price
Subject: Loco Hills Appendices A-B

Katie
R.T. Hicks Consultants, Ltd.

APPENDIX A



R.T. Hicks Consultants, Ltd. 901 Rio Grande Blvd. NW, Suite F-142 Albuquerque, NM 87104 505.266.5004 Fax: 505.266.0745	Loco Hill[illegible]mit	Appendix A
	[illegible]tion Well	May 2004

APPENDIX B

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

PETTIGREW ENGINEERS SURVEYORS

PETTIGREW and ASSOCIATES
1110 N. GRIMES
HOBBS, NEW MEXICO 88240
(505) 393-9827

7 December, 2003

Loco Hills GSF, Ltd.
158 Deer Creek Dr.
Aledo, TX 76008

ATTN: Mr. Mitchel Johnson

RE: Construction Observations for Clay Lined Pond at Loco Hills GSF

Dear Mr. Johnson:

During construction of the above referenced pond, Pettigrew & Associates, P.A. was contracted to perform engineering services such as materials testing, site inspection, and consulting. The pond was constructed by Big D Construction out of Midland, Texas.

This firm observed good construction practices during all site visits. These construction practices directly relate to achieving good compaction, permeability, and durability of the clay liner. Lifts were kept to less than six (6) inches, the clay material was well processed, and therefore compacted easily.

The clay liner basically begins on the outside of the pond at existing ground level, extends over the berm, down the inner slope of the pond, across the bottom, back up the inner slope, over the berm and back to existing ground. Pettigrew & Associates was not on site until the berms were nearly completed, but we were able to test density on the top two feet of fill for most of the site. The bottom of the pond was scraped, scarified, and recompacted, and tested for compaction for a depth of two feet.

A total of thirty-nine (39) densities were taken on the clay liner. Densities were taken on the top of the berm, inner side slopes, and bottom of the pond. All densities inside pond were at least 95% of maximum density of an ASTM D698 standard proctor. One density on top of the berm was 93.4%, so the area was recompacted. All other densities were above 95% on the berm.

Based on the results of compaction and the good construction practices used by the contractor, the permeability of the clay material in the pond liner should approximate the permeability as tested in the laboratory. This liner should perform as required for brine water storage for both the short term as well as the long term.

Sincerely,

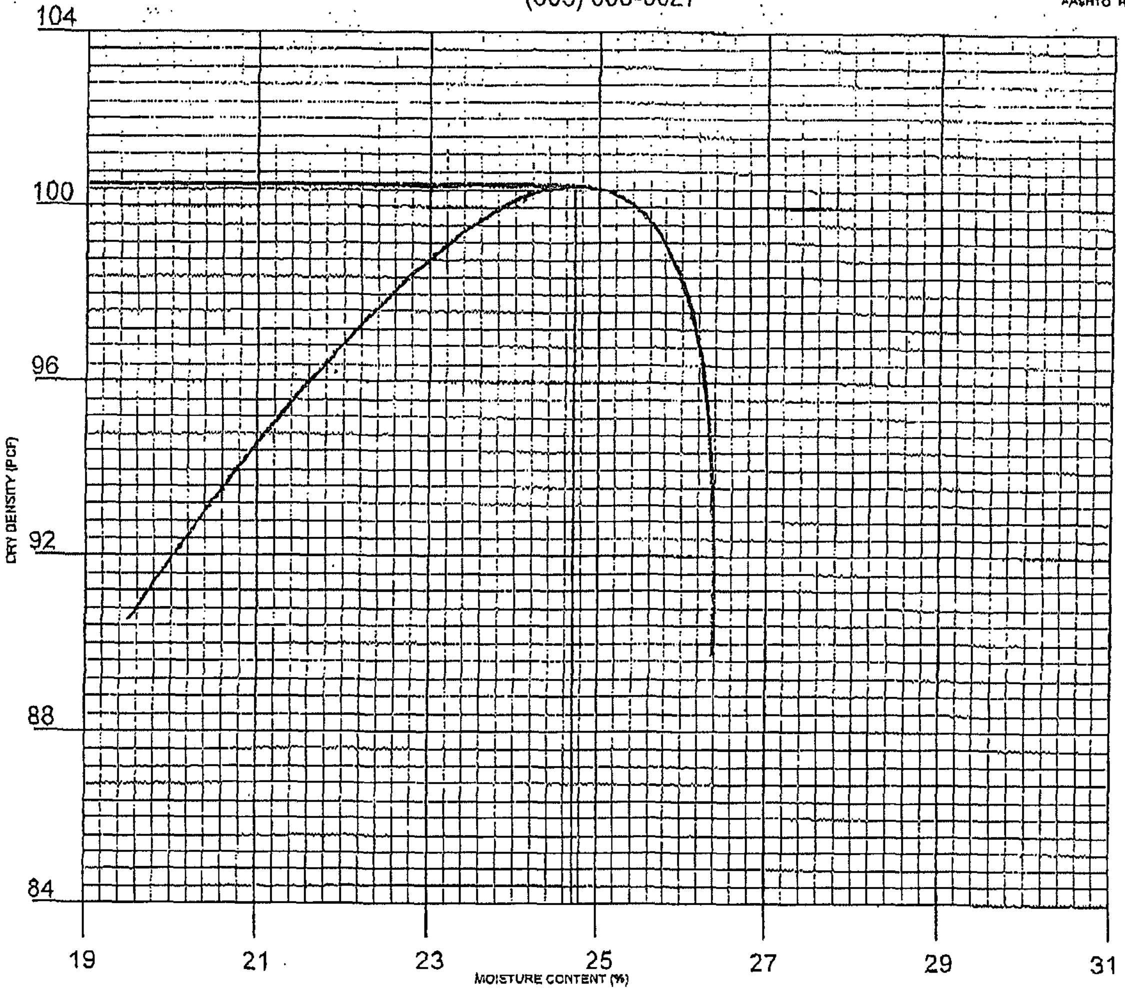
PETTIGREW & ASSOCIATES, P.A.

Jeremy Baker

Jeremy Baker, P.E.

JEREMY BAKER
NEW MEXICO
16207
LICENSED PROFESSIONAL ENGINEER
12-7-03

PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES ST.
HOBBS, NM 88240
(505) 393-9827



CLIENT: Loco Hills GSF PROJECT: Loco Hills Brine Pond

SAMPLE LOCATION: Pond

SOIL DESCRIPTION: Red Fat Clay with Sand

SOIL CLASSIFICATION: CH TEST METHOD: ASTM: D 698

ATTERBERG: LL 57 PI 40 Sampled & Delivered 10/20/03

DATE: 10/22/03 LAB NO. 03 6504-6508

DRY WEIGHT LB/CU. FT. 100.5 MOISTURE CONTENT % 24.7

SIEVE ANALYSIS - % PASSING						
#4	#10	#40	#80	#200		ASTM: D 5084-Permeability: 1.72E -08
99	99	97	91	81.5		95.8% Compaction - 24.2% Moisture

PETTIGREW and ASSOCIATES

COPIES: Loco Hills GSF

BY: S.E.T.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M HICKS, III, P.E./P.S.

To:	Loco Hills GSF Mitchel Johnson 158 Deer Creek Drive Aledo, Texas 76008	Material:	Red Fat Clay with Sand
		Test Method:	ASTM: D 2922
Project:	Loco Hills Brine Pond		
Date of Test:	October 20, 2003	Depth:	Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-1	Top of N. Birm - 30' W. of the NE Corner	102.1	19.0	
SG-2	Top of N. Birm - 100' W. of the NE Corner	97.7	18.3	
SG-3	Top of N. Birm - 100' E. of the NW Corner	106.1	18.4	
SG-4	Top of N. Birm - 40' E. of the NW Corner	93.4	18.6	
SG-5	Top of E. Birm - 50' S. of the NE Corner	97.2	18.6	
SG-6	Top of E. Birm - 120' S. of the NE Corner	100.8	19.6	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6482-6487 & 6502-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: [signature]

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To: Loco Hills GSF
Mitchel Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Material: Red Fat Clay with Sand

Test Method: ASTM: D 2922

Project: Loco Hills Brine Pond

Date of Test: October 20, 2003

Depth: Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-13	S. Slope - 10' From Top Edge of Slope - 40' E. of the SW Corner	106.1	16.1	
SG-14	S. Slope - 22' From Top Edge of Slope - 90' E. of the SW Corner	102.9	16.7	
SG-15	S. Slope - 30' From Top Edge of Slope - 75' W. of the SE Corner	101.4	16.4	
SG-16	S. Slope - 35' From Top Edge of Slope - 30' W. of the SE Corner	104.3	17.0	
SG-17	Top of W. Birm - 50' N. of the SW Corner	105.1	16.1	
SG-18	Top of W. Birm - 125' N. of the SW Corner	106.2	17.2	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6494-6499 & 6502-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: S.E.T.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To:	Loco Hills GSF Mitchel Johnson 158 Deer Creek Drive Aledo, Texas 76008	Material:	Red Fat Clay with Sand
		Test Method:	ASTM: D 2922
Project:	Loco Hills Brine Pond		
Date of Test:	October 20, 2003	Depth:	Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-7	Top of E. Birm - 100' N. of the SE Corner	100.4	19.9	
SG-8	Top of E. Birm - 40' N. of the SE Corner	105.0	21.2	
SG-9	Top of S. Birm - 45' W. of the SE Corner	105.4	19.6	
SG-10	Top of S. Birm - 100' W. of the SE Corner	103.0	25.6	
SG-11	Top of S. Birm - 100' E. of the SW Corner	105.0	22.0	
SG-12	Top of S. Birm - 50' E. of the SW Corner	104.2	20.8	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6487-6493 & 6502-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES.

BY: [signature] S.E.T.

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6499-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: [signature] S.E.T.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

AASHTO R18

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To: Loco Hills GSF
Mitchel Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Material: Red Fat Clay with Sand

Test Method: ASTM: D 2922

Project: Loco Hills Brine Pond

Date of Test: October 31, 2003

Depth: Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-21	Bottom of Pond - 20' S. & 20' W. of the NE Corner	106.0	14.6	
SG-22	Bottom of Pond - 30' N. & 15' E. of the SW Corner	97.5	14.2	
SG-23	Pond Slope - 20' N of the SE Corner - 15' Above Bottom of Pond	106.0	14.2	
SG-24	Pond Slope - 50' E. of the NW Corner - 10' Above Bottom of Pond	102.9	16.3	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6613-6616 & 6620-6621

Copies To: Loco Hills GSF ✓

PETTIGREW and ASSOCIATES

BY: [signature] E.T.

Price, Wayne

From: Katie Lee [katie@rthicksconsult.com]
Sent: Wednesday, May 12, 2004 2:51 PM
To: Wayne Price
Subject: Loco Hills Appendices C-D

Katie
R.T. Hicks Consultants, Ltd.

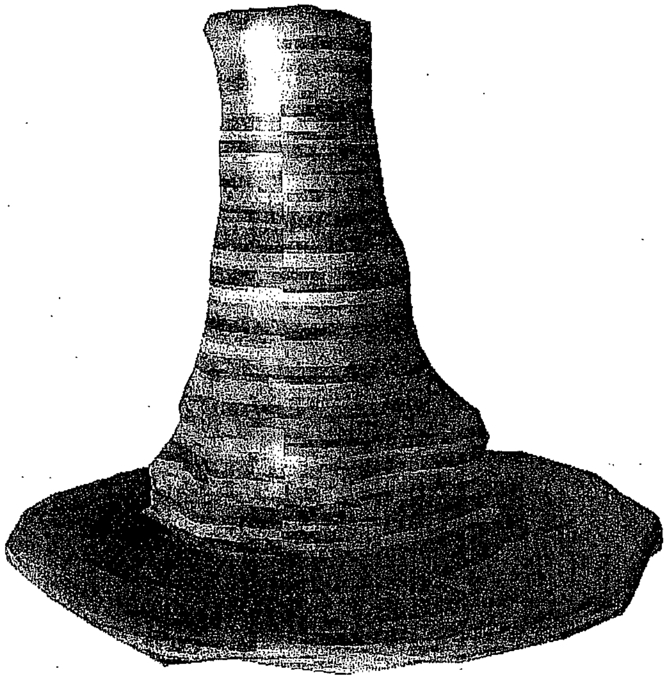
APPENDIX C

ECHO - LOG

Propane Well #1

1st. Survey

04/21/2003 033020



SOCON Cavity Control, Inc.
4070 Washington Blvd. Texas 77705, USA
Phone (409) 840-5554+5557 Fax (409) 840-4424
e-mail: lawrence@socon.com

Summary of results

Well details

All depths are given as:	**MD**
Datum level for all depths:	**surface**
Shoe of the cemented 13 3/8"-casing:	525.0 ft
Shoe of the - casing during the surveying:	525.0 ft
Reference depth for ECHO-LOG:	**525.0 ft**
Depth correction:	+12.0 ft

Details of survey equipment

Measuring vehicle used:	L 110
Tools used:	Echo tool BSE 17, BSE 17 Fibre-gyro-compass

General details

Number of runs:	1
Measured horizontal sections:	19
Measured tilted sections:	20
Lowest survey depth:	643.0 ft

Maximum and minimum dimensions with ref. to the measuring axis

Reference direction:	**magnetic north**

Determination out of 36 vertical sections derived from horizontally and tilted measured data at 5 degree intervals:

minimum radius:	0.0 ft
depth:	650.1 ft
direction:	0°
maximum radius:	77.9 ft
depth:	630.0 ft
direction:	60°
highest point of cavern:	522.2 ft
horizontal distance:	8.1 ft
direction:	345°
lowest point of cavern:	651.4 ft
horizontal distance:	5.4 ft
direction:	75°
lowest point in the measuring axis:	650.2 ft

Determination out of 37 horizontal sections in the depths between 192.3 m and 259 m at 5/15 degree intervals:

maximum radius:	77.9 ft
depth:	630.0 ft
direction:	60°
maximum diameter:	138.2 ft
depth:	625.0 ft
direction:	85 - 265°

Volume

volume:	65,456 bbls.
depth range:	525.0 ft <--> 650.0 ft

Interpretation

Supposing a rectilinear propagation of ultrasonic waves all recorded echo travel times were converted into distances by using the subsequent speeds of sound:

1798.0 m/s (5899.0 ft/s) to 1798.0 m/s (5899.0 ft/s) in brine (measured)

In the case of recording several echoes along one trace of echo signals, the representative echo signal was selected according to the level of amplitude, transmission time, density of measured points and the shape of the cavern.

Horizontal sections

19 horizontal sections at following measured depths are included as graphical plots in this report:

525.0 ft	530.0 ft	540.0 ft	550.0 ft	560.0 ft	570.0 ft	580.0 ft
590.0 ft	595.0 ft	600.0 ft	605.0 ft	610.0 ft	615.0 ft	620.0 ft
625.0 ft	630.0 ft	635.0 ft	640.0 ft	643.0 ft		

The following 4 sections are constructed:

644.0 ft	646.0 ft	648.0 ft	650.0 ft

Tilted sections

20 sections recorded with tilted echo-transducer at following measured depths are presented in the vertical sections:

12 sections of these with upwards-tilted echo-transducer:

Depth / Tilting Angle

540.0 / 54	540.0 / 60	540.0 / 66	540.0 / 72	540.0 / 78	540.0 / 84
640.0 / 9	640.0 / 12	640.0 / 15	640.0 / 17	640.0 / 21	640.0 / 24

8 sections of these with downwards-tilted echo-transducer:

Depth / Tilting Angle

600.0 / 6	600.0 / 12	600.0 / 18	600.0 / 24	600.0 / 30	600.0 / 36
600.0 / 42	600.0 / 48				

Vertical sections

The shape of the cavern was determined by interpretation of all horizontally and tilted measured data and is presented by 36 vertical sections in this report.

Maximum plots (top view)

The maximum plot presents the largest extension of the cavern in a top view. The first picture shows the areas of all horizontal sections and the area resulting out of the vertical sections (hatched). The resulting total area is shown in the second picture (cross hatching) together with the largest single area.

In both pictures the total centre of gravity of the cavern is shown with its distance and its direction referring to the measuring axis.
The total centre of gravity is derived out of the envelope, which is the connection line of the largest cavern extension in every direction

Perspective views

Several perspective drawings are included in this report to give a quick review of detailed relations.

Pockets in the cavern wall

Pockets in the cavern wall, which have been identified by the tilted echo-transducer, were transferred from the vertical sections to the respective horizontal sections.
The resulting additional areas have been added to the calculated areas.

LOG - Data

You will find the graphic representations of the following LOG data at the end of this report:

Parameter	from	to
CCL:	589'	498'
Temperature:	500'	640'
Pressure:	500'	640'
Speed of sound:	500'	640'

Volume list

Depth (ft)	Radius (ft)	Area (ft²)	Depth range (ft) from	to	Volume (bbls.) partial	total
525.0	16.1	813	525.0	527.5	362	362
530.0	15.3	733	527.5	535.0	979	1340
540.0	14.2	630	535.0	545.0	1122	2462
550.0	15.6	767	545.0	555.0	1366	3828
560.0	16.6	865	555.0	565.0	1540	5368
570.0	20.1	1269	565.0	575.0	2260	7628
580.0	20.7	1343	575.0	585.0	2392	10021
590.0	23.7	1765	585.0	592.5	2357	12378
595.0	26.0	2125	592.5	597.5	1892	14270
600.0	30.4	2906	597.5	602.5	2588	16858
605.0	31.0	3023	602.5	607.5	2692	19549
610.0	29.7	2778	607.5	612.5	2474	22023
615.0	36.3	4147	612.5	617.5	3693	25717
620.0	41.7	5451	617.5	622.5	4854	30571
625.0	68.0	14511	622.5	627.5	12922	43493
630.0	61.9	12028	627.5	632.5	10711	54204
635.0	51.1	8196	632.5	637.5	7299	61502
640.0	35.1	3868	637.5	641.5	2756	64258
643.0	24.8	1929	641.5	643.5	687	64945
644.0	18.4	1060	643.5	645.0	283	65228
646.0	11.4	409	645.0	647.0	146	65374
648.0	7.8	190	647.0	649.0	68	65442
650.0	5.0	78	649.0	650.0	14	65456

APPENDIX D

Loco Hills G55

Drill 5-1-03
Rate

0-2 2 ← Sand: Rd, Ambr, VFN GRN
4 -
6 - ← Gravel, Sand, Clay, (Gravel 1/8"-1/4")
8 -
10 -
2 1
4 1 ← Clay: Rd, VRY SNDY Water → 24
6 1
8 -
20 -
2 -
4 1
6 -
8 -
30 - Clay: AA, Sme FN Gravel
2 1
4 1
6 1-
8 2
40 2
2 2-
4 1
6 1
8 1
50 1
2 1
4 1
6 1-
8 1-
60 1
2 1-
4 1-
6 2
8 2- ← 67' Conglomerate: Gry, Dkgry, Mott, Lmy
70 2-
2 2
4 2
6 2- ← Clay: Rd, SLty
8 1-
80 1-

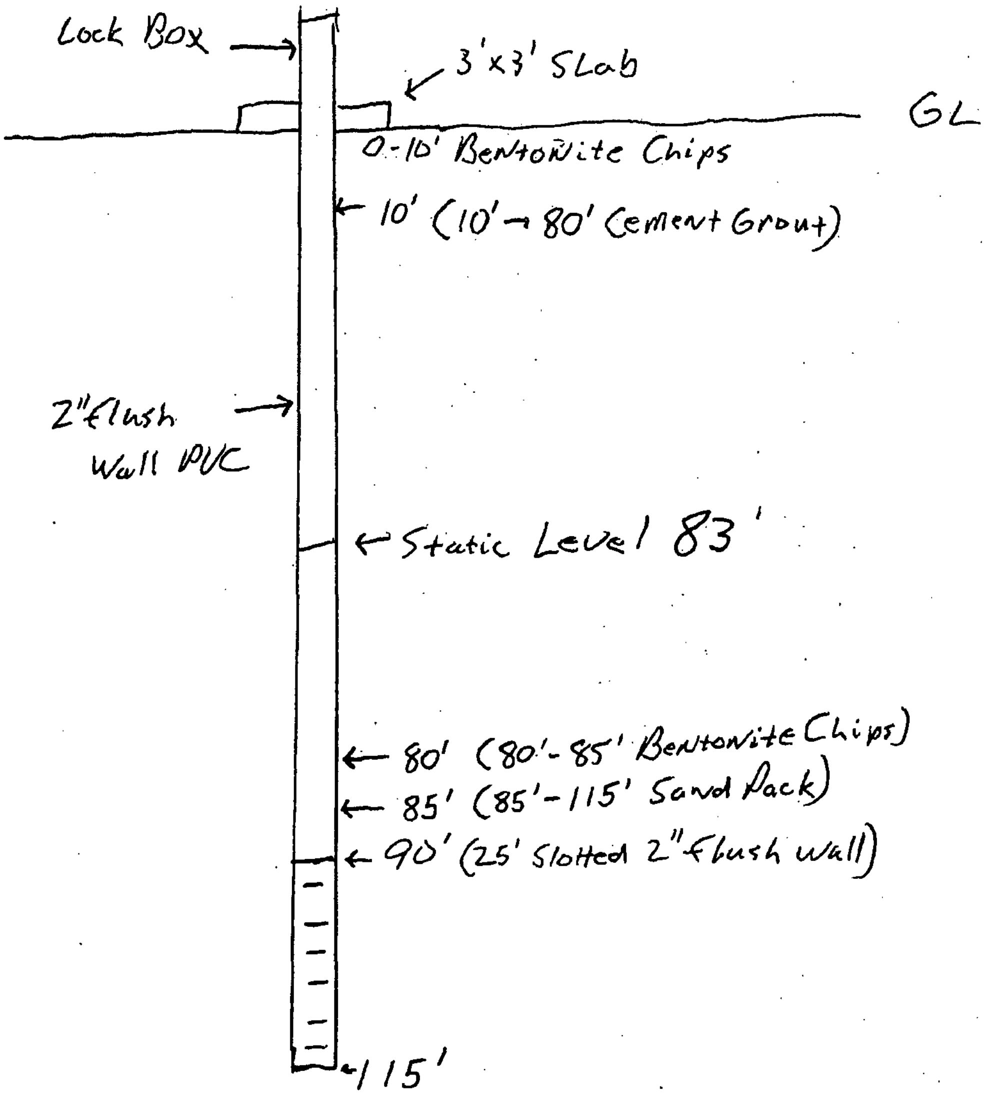
80-2 1
4 1-
6 1-
8 3 ← Rd Clay: Vry Stky
90 3
2 4 ← 5/2/03 Lost Some Fluid in Pit; Limestone: Off WHT-Lt GRY, VFN-Micxn, Sme Chlky, Sme Fractured
4 14
6 8
8 12
100 27
2 17
4 10
6 12
8 13
110 8 ← 109' Change to clay
2 20 ← Clay: BLu Gry, Smth
4 13
6 12 Clay: Rd, SLty-Smth
8
120

Hole Size: 6"

Casing Size 2"

5/5/03

Loco Hills GSF



Static Level 83'

APPENDIX E

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 05/28/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Na (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Conductivity (μS/cm)	T-Alkalinity ($mgCaCO_3/L$)
ANALYSIS DATE:		05/06/03	05/27/03	05/27/03	05/27/03	05/27/03	05/27/03
H7683-1	WATER WELL #1	27648	1074	994	151	99987	92
H7683-2	WATER WELL #2	24982	1785	685	104	100531	166
Quality Control		NR	56	59	5.17	1322	NR
True Value QC		NR	50	50	5.00	1413	NR
% Recovery		NR	112	118	103	93.6	NR
Relative Percent Difference		NR	0	0	1.0	0.7	NR
METHODS:			SM3500-Ca-D	3500-Mg E	8049	120.1	310.1

LAB NUMBER	SAMPLE ID	Cl^- (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	pH (s.u.)	TDS (mg/L)
ANALYSIS DATE:		05/27/03	05/27/03	05/27/03	05/27/03	05/27/03	05/28/03
H7683-1	WATER WELL #1	45986	2123	0	112	7.04	67950
H7683-2	WATER WELL #2	42987	971	0	202	7.00	69220
Quality Control		1050	53.65	NR	996	7.01	NR
True Value QC		1000	50.00	NR	1000	7.00	NR
% Recovery		105	107	NR	99.6	100	NR
Relative Percent Difference		0	1.5	NR	0	2.1	12.1
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1	160.1

67,950
69,220

Amy Hill
Chemist

5/28/03
Date

H7683

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 05/27/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Br^- (mg/L)	F^- (mg/L)	NO_3/NO_2 (mg/L)	PO_4 (mg/L)
ANALYSIS DATE		05/27/03	05/27/03	05/23/03	05/27/03
H7683-1	WATER WELL #1	4.39	2.36	2.35	0.20
H7683-2	WATER WELL #2	3.88	2.52	1.92	0.05
Quality Control		3.00	1.27	2.98	0.51
True Value QC		3.00	1.00	3.00	0.50
% Recovery		100	127	99.2	101
Relative Percent Difference		5.7	3.2	2.0	0
METHODS: Std. Methods		4500-Br^-B	4500-F^-D	353.3*	4500-P E

EPA 600/4-79-020

Amy Hill
Chemist

5/27/03
Date

H7683a

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 06/02/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

TOTAL METALS

LAB NUMBER	SAMPLE ID	Al (ppm)	Co (ppm)	Cu (ppm)	Fe (ppm)
ANALYSIS DATE:		05/29/03	05/29/03	05/29/03	05/29/03
H7683-1	WATER WELL #1	<1	0.312	<0.5	3.922
H7683-2	WATER WELL #2	<1	0.345	<0.5	2.057
Quality Control		5.003	0.998	5.108	5.031
True Value QC		5.000	1.000	5.000	5.000
% Recovery		100	99.8	102	101
Relative Percent Difference		1.6	1.2	0.3	2.0
METHODS: EPA 600/04-79-020		202.1	219.1	220.1	236.1

LAB NUMBER	SAMPLE ID	Mn (ppm)	Mo (ppm)	Ni (ppm)	Zn (ppm)
ANALYSIS DATE:		05/29/03	05/29/03	05/29/03	05/29/03
H7683-1	WATER WELL #1	<0.01	<1	0.224	<0.5
H7683-2	WATER WELL #2	0.416	<1	0.319	<0.5
Quality Control		0.914	3.001	5.144	0.497
True Value QC		1.000	3.000	5.000	0.500
% Recovery		91.4	100.0	103.0	99.4
Relative Percent Difference		2.3	0.6	0.2	0.7
METHODS: EPA 600/04-79-020		243.1	246.1	249.1	289.1

Amy Hill
Chemist

6/2/03
Date

H7683m2

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 06/02/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

RCRA METALS

LAB NUMBER	SAMPLE ID	As ppm	Ag ppm	Ba ppm	Cd ppm	Cr ppm	Pb ppm	Hg ppm	Se ppm
ANALYSIS DATE:		05/29/03	05/29/03	05/29/03	05/29/03	05/29/03	05/29/03	06/02/03	05/30/03
H7683-1	WATER WELL 1	<0.05	0.32	<0.5	<0.01	0.063	1.011	<0.002	<0.01
H7683-2	WATER WELL 2	<0.05	0.162	<0.5	<0.01	0.073	0.988	<0.002	<0.01
Quality Control		0.053	4.916	24.44	0.972	4.880	5.164	0.00980	0.051
True Value QC		0.050	5.000	25.00	1.000	5.000	5.000	0.01000	0.050
% Recovery		106.0	98.3	97.8	97.2	97.6	103	98.0	102
Relative Percent Difference		1.4	1.0	1.5	1.3	0.3	5.6	2.0	3.2
METHODS: EPA 600/4-79-020		206.2	272.1	208.1	213.1	218.1	239.1	245.1	270.2

Amy Hill
Chemist

6/2/03
Date

H7683m

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/07/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER SAMPLE ID	Na (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Conductivity (uS/cm)	T-Alkalinity ($mgCaCO_3/L$)
ANALYSIS DATE:	05/06/03	05/06/03	05/06/03	05/06/03	05/06/03	05/06/03
H7634-1 MONITOR WELL	43525	3069	1142	193	145615	140
Quality Control	NR	43	55	5.22	1322	NR
True Value QC	NR	50	50	5.00	1413	NR
% Recovery	NR	86	110	104	93.6	NR
Relative Percent Difference	NR	0	0	2.6	0.7	NR
METHODS:		SM3500-Ca-D	3500-Mg E	8049	120.1	310.1

	Cl^- (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	pH (s.u.)	TDS (mg/L)
ANALYSIS DATE:	05/06/03	05/06/03	05/06/03	05/06/03	05/06/03	05/06/03
H7634-1 MONITOR WELL	74977	1438	0	171	7.24	118200
Quality Control	1050	54.39	NR	1068	6.95	NR
True Value QC	1000	50.00	NR	1000	7.00	NR
% Recovery	105	109	NR	107	99.3	NR
Relative Percent Difference	2.0	0.7	NR	7.7	0.6	12.1
METHODS:	SM4500-Cl-B	375.4	310.1	310.1	150.1	160.1

Amy Hill
Chemist

5/7/03
Date

H7634C

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/06/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Br^- (mg/L)	F^- (mg/L)	NO_3/NO_2 (mg/L)	PO_4 (mg/L)
ANALYSIS DATE		05/06/03	05/06/03	05/06/03	05/06/03
H7634-1	MONITOR WELL	12.2	1.14	5.51	0.34
Quality Control		2.83	0.95	2.98	0.51
True Value QC		3.00	1.00	3.00	0.50
% Recovery		94.5	95.0	99.2	101
Relative Percent Difference		1.0	3.0	2.0	0
METHODS: Std. Methods		4500-Br⁻B	4500-F⁻D	353.3*	4500-P E

EPA 600/4-79-020

Amy Hill
Chemist

5/6/03
Date

H7634a

CARDINAL
LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/15/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

RCRA METALS

LAB NUMBER	SAMPLE ID	As ppm	Ag ppm	Ba ppm	Cd ppm	Cr ppm	Pb ppm	Hg ppm	Se ppm
ANALYSIS DATE:		05/13/03	05/13/03	05/08/03	05/13/03	05/13/03	05/13/03	05/13/03	05/08/03
H7634-1	MONITOR WELL	<0.08	<0.04	<0.5	<0.005	<0.04	<0.04	<0.001	<0.05
Quality Control		0.950	0.470	0.950	0.475	0.480	0.475	0.00104	0.051
True Value QC		1.000	0.500	1.000	0.500	0.500	0.500	0.00100	0.050
% Recovery		95.0	94.0	95.0	95.0	96.0	95.0	104	102
Relative Percent Difference		2.1	1.7	0.4	0	1.1	0	9.0	3.2
METHODS: EPA 600/4-79-020*		200.7	200.7	200.7	200.7	200.7	200.7	245.1*	270.2*

Amy Hill
Chemist

5/15/03
Date

H7634m

CARDINAL
LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/15/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

TOTAL METALS

LAB NUMBER SAMPLE ID	Al (ppm)	Co (ppm)	Cu (ppm)	Fe (ppm)
ANALYSIS DATE:	05/13/03	05/13/03	05/08/03	05/08/03
H7634-1 MONITOR WELL	<0.2	<0.04	<0.5	<1
Quality Control	0.960	0.970	5.110	5.223
True Value QC	1.000	1.000	5.000	5.000
% Recovery	96.0	97.0	102	104
Relative Percent Difference	0.4	0	0.4	0.4
METHODS: EPA 600/04-79-020	200.7	200.7	220.1	236.1

	Mn (ppm)	Mo (ppm)	Ni (ppm)	Zn (ppm)
ANALYSIS DATE:	05/13/03	05/13/03	05/13/03	05/08/03
H7634-1 MONITOR WELL	0.33	<0.1	<0.04	2.45
Quality Control	0.475	0.485	0.480	0.499
True Value QC	0.500	0.500	0.500	0.500
% Recovery	95.0	97.0	96.0	99.8
Relative Percent Difference	0.2	0.8	0.4	0.8
METHODS: EPA 600/04-79-020	200.7	200.7	200.7	289.1

Amy Hill
Chemist

5/15/03
Date

H7634m2

APPENDIX F

CARDINAL LABORATORIES

PHONE (325) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: MITCHEL JOHNSON
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 10/17/03
Reporting Date: 10/20/03
Project Number: NOT GIVEN
Project Name: NOT GIVEN
Project Location: NOT GIVEN

Sampling Date: 10/17/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: GP
Analyzed By: AH

LAB NUMBER	SAMPLE ID	TDS (mg/L)	Cl (mg/L)
ANALYSIS DATE:		10/20/03	10/20/03
H8096-1	NORTH WINDMILL	2411	88
H8096-2	WINDMILL 210	2471	104
Quality Control		NR	960
True Value QC		NR	1000
% Recovery		NR	96.0
Relative Percent Difference		12.1	8.3
METHODS: EPA 600/4-79-02		160.1	4500-ClB*

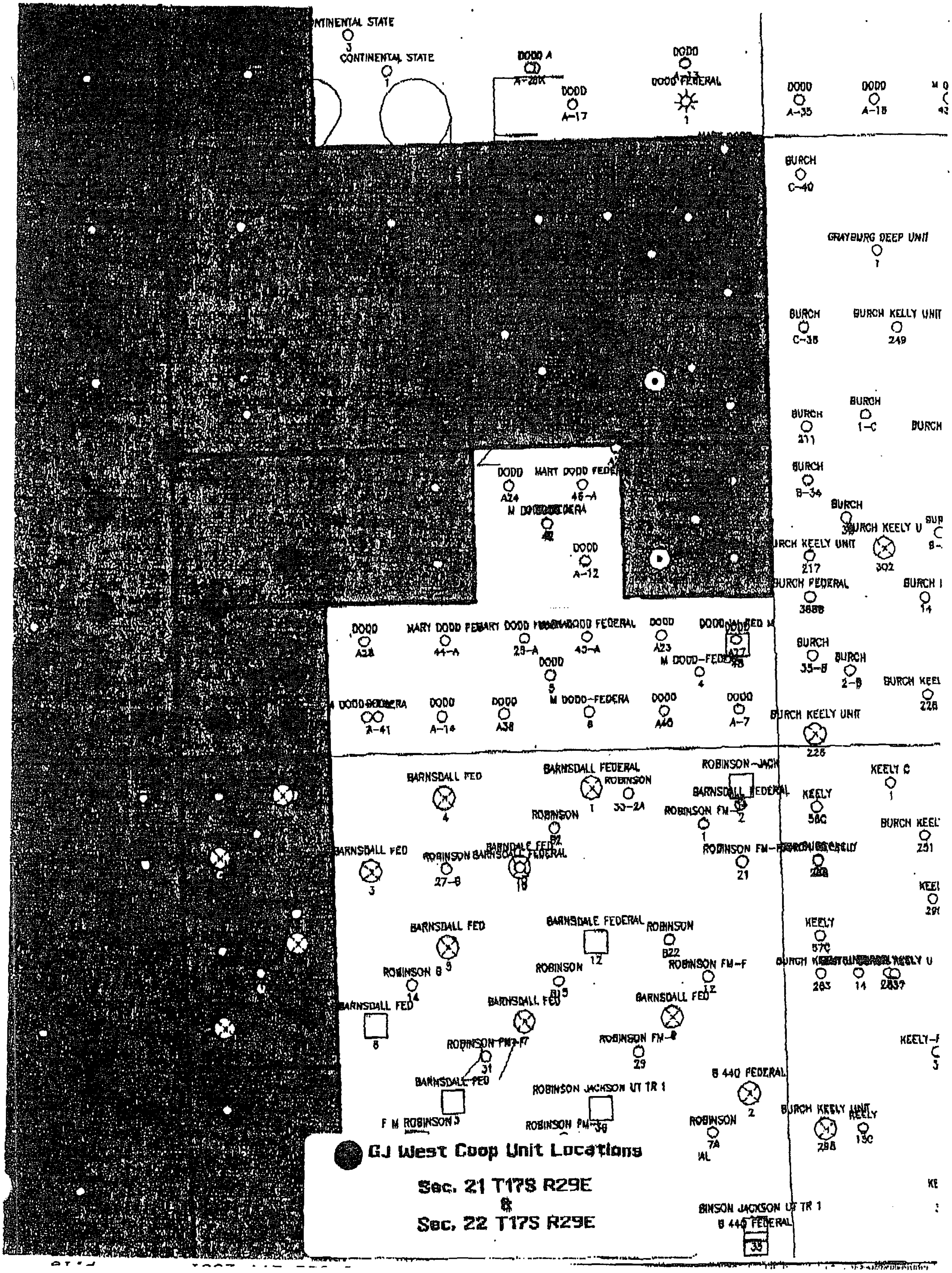
*Std. Methods

Amy Hill
Chemist

10/20/03
Date

H8096

PLEASE NOTE: Liability and Damages. Cardinal's liability and client's exclusive remedy for any claim arising, whether based in contract or tort, shall be limited to the amount paid by client for analyses. All claims, including those for negligence and any other cause whatsoever shall be deemed waived unless made in writing and received by Cardinal within thirty (30) days after completion of the applicable service. In no event shall Cardinal be liable for incidental or consequential damages, including, without limitation, business interruptions, loss of use, or loss of profits incurred by client, its subsidiaries, affiliates or successors arising out of or related to the performance of services hereunder by Cardinal, regardless of whether such claim is based upon any of the above-stated reasons or otherwise.



GJ West Coop Unit Locations
Sec. 21 T17S R29E
&
Sec. 22 T17S R29E
CONTINENTAL STATE
DODD A
DODD
DODD FEDERAL
A-17
A-35
A-18
BURCH
C-40
GRAYBURG DEEP UNIT
BURCH KELLY UNIT
249
MARY DODD FEDERAL
A-12
BURCH FEDERAL
BARNSDALL FED
BARNSDALL FEDERAL
ROBINSON
ROBINSON-JACKSON
KEELY C
KEELY
F M ROBINSON
ROBINSON JACKSON UT TR 1
B 440 FEDERAL

GJ West Coop Unit Locations		
Well #	T Salt	B Salt
24	245'	645'
25	242'	640'
26	242'	632'
28	265'	745'
29	288'	688'
63	310'	830'
70	175'	650'
71	195'	660'
78	240'	625'

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Thursday, March 04, 2004 12:51 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'
Subject: RE: Loco Hills

Wayne

Thanks for getting back to me. I understand about re-opening the pit rule. I will contact Pettigrew and be sure you get the drawings.

Although the NNOCC may open up the pit rule, they are certainly not opening up the WQCC Regulations. I referenced the Pit Rule because our pond exceeds the permeability criteria of NMOCD associated with pits and I thought that the Environmental Bureau may use this criteria as a benchmark for approving or disapproving clay-lined ponds. This site is under the WQCC, so whatever NMOCC does with respect to the pit rule need not affect us directly.

In any event, what I am asking is this:

In your opinion, based upon the information that you now have, with the understanding that your opinion may change when you are presented with more data, assuming that Loco Hills acquires the existing State Land Office property (40 acres), assuming that Loco Hills GSF acquires some property adjacent to the State Land in Bear Grass Draw, and (add any other weasel words here)...what will NMOCD require to approve a clay-lined pond for the Loco Hills GSF Brine pond?

Our December submission calls for a pump-back system to capture much more than the calculated volume of seepage from the clay liner. This pump-back is an important element of the discharge plan modification request and should help in demonstrating that the clay-lined pond will not cause ground water to exceed the WQCC Standards at a place of reasonably foreseeable future use – IF WE ACQUIRE THE PROPERTY.

Acquisition of the land as described above moves the "place of reasonable foreseeable future use" to perhaps 500 feet down gradient of the proposed clay-lined pond – not immediately adjacent to the pond. The WQCC Regulations specifically allow natural processes (such as dilution and dispersion) to mitigate any seepage that may escape the pump-back system.

Do we need two monitoring wells next to (immediately down gradient and other up gradient from) the clay-lined pond to augment the proposed monitoring of the two pumping wells? We discussed this probable requirement at our meeting with you all. I think, if we can acquire the State land and some adjacent land, then we become more interested in the impact that the seepage may have on the water in Bear Grass Draw, not the water immediately beneath the proposed clay-lined impoundment. I am interested in your thinking about this concept.

Think about this a little and discuss it with your peers. Let us know what we may need to do for approval of a clay lined pond provided that we acquire the land from the SLO and from the neighbor.

I am gone Friday and back in the office on Tuesday. I will contact you upon my return.

-----Original Message-----
From: Price, Wayne [mailto:WPrice@state.nm.us]
Sent: Thursday, March 04, 2004 10:12 AM
To: 'Randall Hicks'
Cc: mitchel Johnson-son (E-mail)
Subject: RE: Loco Hills

To the best of my knowledge we have not received the plans. Also please note there is some talk about opening the new pit rule back up. At this point and time I can not guarantee that it will or will not impact this project.

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Wednesday, March 03, 2004 2:43 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'
Subject: Loco Hills
Wayne

I wanted to check on our request for a minor modification to the approved discharge plan – have you received the leak detection schematic from Pettigrew? That should be all that you need to approve that modification.

As I indicated in my voice mail, the State Land Office is interested in a land swap with Loco Hills and we have started the paperwork to do so. We are also speaking with the adjacent landowner to discuss acquisition of land that may be affected by seepage caused by past operators.

If the land acquisition program outlined above is successful, NMOCD would have more flexibility in approving a clay-lined lagoon that meets the NMOCD guidance. If successful in acquiring the state land and some of the down gradient property, would NMOCD re-consider our previously-submitted request for a modification of the approved discharge plan?

Perhaps NMOCD would be willing to approve the discharge plan modification request submitted in December with a Condition of Approval that Loco Hills GSF provide documentation of land ownership of the current state lease and an agreement with the adjacent property owner regarding placement of a well on this adjacent property (see our December submission).

However, if the land acquisition program fails, we still need an NMOCD approval for a double-lined synthetic and clay lagoon. I am in Chicago on Friday and Monday. I will call you upon my return.

As always – thanks for your help.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

This email has been scanned by the MessageLabs Email Security System.
For more information please visit http://www.messagelabs.com/email

---

Price, Wayne

From: Price, Wayne
Sent: Thursday, March 04, 2004 10:12 AM
To: 'Randall Hicks'
Cc: mitchel Johnson-son (E-mail)
Subject: RE: Loco Hills

To the best of my knowledge we have not received the plans. Also please note there is some talk about opening the new pit rule back up. At this point and time I can not guarantee that it will or will not impact this project.

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Wednesday, March 03, 2004 2:43 PM
To: 'Price, Wayne'
Cc: 'Mitchel Johnson'
Subject: Loco Hills

Wayne

I wanted to check on our request for a minor modification to the approved discharge plan – have you received the leak detection schematic from Pettigrew? That should be all that you need to approve that modification.

As I indicated in my voice mail, the State Land Office is interested in a land swap with Loco Hills and we have started the paperwork to do so. We are also speaking with the adjacent landowner to discuss acquisition of land that may be affected by seepage caused by past operators.

If the land acquisition program outlined above is successful, NMOCD would have more flexibility in approving a clay-lined lagoon that meets the NMOCD guidance. If successful in acquiring the state land and some of the down gradient property, would NMOCD re-consider our previously-submitted request for a modification of the approved discharge plan?

Perhaps NMOCD would be willing to approve the discharge plan modification request submitted in December with a Condition of Approval that Loco Hills GSF provide documentation of land ownership of the current state lease and an agreement with the adjacent property owner regarding placement of a well on this adjacent property (see our December submission).

However, if the land acquisition program fails, we still need an NMOCD approval for a double-lined synthetic and clay lagoon. I am in Chicago on Friday and Monday. I will call you upon my return.

As always – thanks for your help.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

February 12, 2004

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail

RE: Loco Hills GSF, Discharge Plan
NW SW Section 22 Township 17S Range 29E

Dear Wayne:

Loco Hills GSF proposes a minor modification to their previously approved discharge plan. Information submitted to NMOCD on December 16, 2003, demonstrates that the clay-liner for the new pond meets NMOCD criteria for surface impoundments. We now propose to employ the existing clay liner as a secondary liner for the pond. Loco Hills GSF will install a synthetic liner over the clay lined impoundment to act as the primary liner. Between the primary liner (synthetic) and secondary liner (clay) Loco Hills GSF will install a leak detection device. Separately, Pettigrew and Associates will provide NMOCD with the design details of the leak detection device.

We also propose to implement a brine sales program discussed in our December 16, 2003 submittal. Sales of brine will require more ground water pumping, which is our proposed remedy to the impairment of ground water quality caused by past lessees. As discussed in our December 16 submittal, we will monitor ground water withdrawals and brine sales.

At this time, we propose only these two minor modifications to the approved discharge plan:

1. replacement of the secondary line (originally proposed as synthetic) with the existing clay liner, and
2. a brine sales program.

We plan to continue to pursue acquisition of the 40-acre tract now from the State of New Mexico. We believe that such an acquisition is in the best interest of the State and Loco Hills GSF. If the land ownership status changes, NMOCD should expect a work plan from Loco Hills GSF that outlines an investigative program that might demonstrate that a clay-lined pond is most appropriate for this unique site.

We will notify NMOCD 10 days before the planned date of the installation of the synthetic liner. It is possible that weather (e.g. wind) may delay the installation until late Spring or early Summer.

If you have any questions concerning this communication, please contact me or Mitchel Johnson.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T Hicks

Randall Hicks
Principal

Copy: Mitchell Johnson

Loco Hills GSF

To
New Mexico OCD
Attention Wayne, Price

Submit 3 Copies To Appropriate District Office
District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Rd., Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy, Minerals and Natural Resources

OIL CONSERVATION DIVISION
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-103
Revised March 25, 1999

WELL API NO. 30-15-06192

5. Indicate Type of Lease: STATE ☑ FEE ☐

6. State Oil & Gas Lease No. BL 635

7. Lease Name or Unit Agreement Name: Leonard

8. Well No.

9. Pool name or Wildcat

SUNDRY NOTICES AND REPORTS ON WELLS
(DO NOT USE THIS FORM FOR PROPOSALS TO DRILL OR TO DEEPEN OR PLUG BACK TO A DIFFERENT RESERVOIR. USE "APPLICATION FOR PERMIT" (FORM C-101) FOR SUCH PROPOSALS.)

1. Type of Well: Oil Well ☐ Gas Well ☑ Other Salt dome storage

2. Name of Operator: Loco Hills GSF LTD

3. Address of Operator: 158 Deer Creek Drive Aledo, Texas 76008

4. Well Location

Unit Letter L : 2069 feet from the South line and 1193 feet from the West line

Section 22 Township 17S Range 29E NMPM County Eddy

10. Elevation (Show whether DR, RKB, RT, GR, etc.) GR

11. Check Appropriate Box to Indicate Nature of Notice, Report or Other Data

NOTICE OF INTENTION TO:				SUBSEQUENT REPORT OF:			
PERFORM REMEDIAL WORK	☐	PLUG AND ABANDON	☐	REMEDIAL WORK	☐	ALTERING CASING	☐
TEMPORARILY ABANDON	☐	CHANGE PLANS	☐	COMMENCE DRILLING OPNS.	☐	PLUG AND ABANDONMENT	☐
PULL OR ALTER CASING	☑	MULTIPLE COMPLETION	☐	CASING TEST AND CEMENT JOB	☐		
OTHER:			☐	OTHER:			☐

12. Describe proposed or completed operations. (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work). SEE RULE 1103. For Multiple Completions: Attach wellbore diagram of proposed completion or recompilation.

Set composite bridge plug at 523'. Run 523' 4" FL 95 J-55-10# inside 5½ casing. (.779" clearance between 5½ I.D. and 4" O.D.)

Circulate cement from plug to surface. Inside 4" run run 2⅞" FL 95 J-55 tubing to 633'

When completed do MIT casing test. Not less than 300# for 30 minutes and open cavern test (Nitrogen) 4hr at 300# (OCD will be notified prior to start and before test.) Estimated start date 15-February and March 1st 2004

Estimated Pressure 4" 240# 2⅞" tubing 50-80# Frac Pressure of well 390 390

I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNATURE John B Smith TITLE Terminal Operator DATE 02/03/04

Type or print name John B. Smith Telephone No. (505)-677-2331

(This space for State use)

APPPROVED BY ____________ TITLE ____________ DATE ____________
Conditions of approval, if any:

TRANSACTION REPORT

FEB-04-2004 WED 08:18 AM

FOR:

RECEIVE

DATE	START	SENDER	RX TIME	PAGES	TYPE	NOTE	M#	DP
FEB-04	08:16 AM	1 505 677 2331	1'32"	2	RECEIVE	OK		

Price, Wayne

From: Price, Wayne
Sent: Wednesday, February 11, 2004 4:01 PM
To: Gum, Tim; Stubblefield, Mike
Cc: mitchel Johnson-son (E-mail)
Subject: Loco Hills GSF well workover API 30-15-061921

Dear Tim and Mike:

I have received a copy of the C-103. I understand that Loco Hills has been working with you guys on this issue. If it looks ok with you please go ahead and process.

Thanks for the help!

Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Monday, January 12, 2004 3:24 PM
To: jlopez@slo.state.nm.us
Cc: 'Price, Wayne'; 'Mitchel Johnson'
Subject: Proposal to acquire subject property

Mr. Lopez

Thank you for taking the time to speak with us last Friday. As promised, here is the proposal to acquire the property now leased to Loco Hills GSF. I believe we included sufficient background information to present to your colleagues. Wayne Price of NMOCD may be able to fill in some additional details.

As always, time is of the essence and we are available to help you in any way. Since I am out of the office for most of this week, you may wish to address any comments/questions to Mitchell Johnson of Loco Hills GSF.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

January 10, 2004

Joseph Lopez
New Mexico State Land Office
PO Box 1148
Santa Fe, New Mexico 87504
Via Email

RE: Loco Hills GSF, State Land Lease;
NW SW Section 22 Township 17S Range 29E

Dear Mr. Lopez:

Loco Hills GSF, Ltd., the current lessee of the above-referenced parcel, desires to acquire this 40-acre parcel through an exchange of like property. Because of certain language in the Water Quality Act, ownership of this parcel by Loco Hills GSF will create significant flexibility in obtaining an environmental permit for a clay-lined brine storage pond in lieu of the previously approved double plastic liner system. We have conducted a study of the environmental setting of the parcel. Additionally, the earth work contractor did an excellent job of installing a compacted clay liner in the proposed brine storage pond (the storage pond is built but empty). Our evaluation allows us to conclude that the activities now proposed for the site, which include a compacted clay liner for the storage pond, protect ground water quality and the environment as a whole better than the currently-approved plan that calls for a double plastic liner system.

We urge you to speak with Mr. Wayne Price and Mr. Roger Anderson regarding this issue. For the reasons outlined below, we believe that our proposal to acquire the property through exchange creates a situation where the State, Loco Hills GSF and the environment will benefit.

Background

- Before the 1980s, a previous lessee operated an unlined brine storage pond on the property.
- Seepage from this unlined pond caused local degradation of ground water quality.
- As a result of regulations promulgated in the 1980s, the previous lessee retired the unlined pond and installed a plastic-lined brine storage pond.
- The lifespan of a plastic-lined pond is generally less than 20 years and the existing pond has lost integrity. Loco Hills GSF currently captures leakage from this existing pond.
- In the course of conducting environmental research to support the replacement of the existing pond with a new storage pond, Hicks Consultants recently discovered the magnitude of the existing ground

water quality degradation. The ground water beneath the property exhibits a salinity of about 100,000 parts per million. Ocean water salinity is about 30,000 parts per million.

- We have not discovered the full extent of ground water degradation caused by previous lessees. We have discovered that the effects of past brine seepage affects 20-50% of the State land and may extend onto adjacent private property.
- Because of this discovery, Loco Hills GSF voluntarily proposed to implement a ground water quality restoration program. Loco Hills GSF plans to fund a large portion of this program through the cost savings associated with employing a clay-lined storage pond rather than the previously-approved double plastic liner system.
- Over the lifespan of any storage pond (plastic-lined or clay-lined), leakage will occur.
- Extensive testing of the newly-installed clay liner demonstrates that this proposed 7,000,000 gallon clay-lined pond will release between two quarts and 40 gallons per day to the subsurface. This small volume of seepage might encounter ground water.
- The New Mexico Oil Conservation Division can allow this small volume of seepage provided we demonstrate that this seepage will not cause unacceptable impairment of ground water quality "at a place of reasonably foreseeable future use".
- If Loco Hills GSF owned the subject property, a "place of reasonably foreseeable future use" is the property line adjacent to Bear Grass Draw. Hicks Consultants concludes that this small volume of seepage from the proposed clay-lined pond (which would be captured by Loco Hills GSF) will not degrade ground water at a place of reasonably foreseeable future use.
- Because of the current lease conditions with the State of New Mexico, a "place of reasonably foreseeable future use" of ground water is the edge of the proposed storage pond – not the edge of the lease. Hicks Consultants and NMOCD believe that the law and regulations do not allow any pond seepage, despite the provision in our proposal to capture this small volume of seepage in recovery wells.
- At this site, we firmly believe that the proposed clay-lined storage pond system provides the same degree of environmental protection as the previously-approved plastic liner system. Because of the unusual hydrogeologic conditions at the site, we believe the clay-lined system may provide more net environmental benefit than the previously-approved plastic-lining system.
- Permission to employ a clay liner at the site will create a cost savings for Loco Hills GSF. Loco Hills GSF plans to employ much of this cost savings in the proposed program to mitigate the degradation of ground water quality caused by past lessees. Without this cost-savings, restoration of

ground water quality and mitigation of the attendant liability will continue, albeit over a longer time span.

- Loco Hills GSF has modified its processes to begin the restoration of ground water quality caused by others. Continued operation of the gas storage facility is required for this ground water restoration process.

Proposal

1. Loco Hills GSF will work with the New Mexico State Land Office to identify a parcel in the area that is capable of generating lease income for the State of New Mexico.
2. Loco Hills GSF will acquire the identified property then exchange this parcel for the 40-acre tract currently leased to Loco Hills GSF.
3. Loco Hills will proceed with the proposed ground water restoration program to mitigate the environmental impairment and attendant liability caused by past lessees.

Loco Hills GSF and the State Land Office could sign a new lease agreement that might create the conditions necessary to allow NMOCD to approve a clay-lined storage pond. Due to the existing ground water quality impairment, we believe such an agreement would be relatively complicated – especially if the documented impairment has migrated to adjacent private property. We believe a simple exchange of property is in the best interest of the State of New Mexico and Loco Hills GSF.

Please contact Mitchell Johnson of Loco Hills GSF if you have any questions or comments regarding this proposal. You may also wish to meet with the NMOCD environmental professionals to discuss the environmental and permitting situation at the site. We would like to stress that continued operation of the facility is essential for our ongoing ground water restoration program. We hope to enhance this restoration system with the savings realized from eliminating the regulatory need for a synthetic pond liner. We thank you for your prompt attention to this matter.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T Hicks

Randall Hicks
Principal

Copy: Mitchell Johnson, Loco Hills GSF
Wayne Price, NMOCD

Price, Wayne

From: Price, Wayne
Sent: Monday, January 12, 2004 1:42 PM
To: Price, Wayne; 'mitchel_lhgsf@hotmail.com'
Cc: 'Randall Hicks (E-mail)'; Gum, Tim; Stubblefield, Mike
Subject: RE: Loco Hills Gas Storage system storage pond

Corrected change "unlined to single clay lined"

-----Original Message-----
From: Price, Wayne
Sent: Monday, January 12, 2004 1:38 PM
To: 'mitchel_lhgsf@hotmail.com'
Cc: Randall Hicks (E-mail); Gum, Tim; Stubblefield, Mike
Subject: Loco Hills Gas Storage system storage pond

Pursuant to our meeting on Jan 9, 2004, the OCD has determined that Loco Hills GSF shall provide additional information to justify the use of an ***unlined*** pond. Loco Hills must prove that existing protectable groundwater will be protected in the foreseeable future and demonstrate that groundwater contamination will be abated.

In addition, gas storage well #1 at the present time does not have mechanical integrity and may not be used until the system is properly repaired and approved by OCD.

Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

Price, Wayne

From: Price, Wayne
Sent: Monday, January 05, 2004 1:47 PM
To: 'Mitchel Johnson'
Subject: RE: Loco Hills GSF

Dear Mitchel:

Item #1. I discussed the single clay liner issue with the OCD Environmental Bureau Chief and he indicated that GSF will have to demonstrate that the current contamination did not come from the site and any new contamination would have to be contained on-site. OCD recommends that GSF proceed with the double lined system as proposed.

Item#2. I recommend that you contact our district office concerning this issue.

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
Sent: Monday, January 05, 2004 9:05 AM
To: wprice@state.nm.us
Subject: Loco Hills GSF

Wayne,
Happy New Year! Hope you were able to take some time off.

1. I wanted to see if you had any status updates to our Discharge Plan.

2. We are wanting to do something with the well for our Cavern 1. Do you have any suggestions for us to get it to pass the pressure test? Mr. Hicks suggested that we may drill a second hole for the tubing into the cavern and put new casing inside the original in the original hole. Is this an approvable option?

Thanks for any updates.

Mitchel Johnson
Loco Hills GSF
office: 817-441-6568
cell: 817-371-7933

August 17, 2004

Best Management Practices Plan

LOCO HILLS GAS STORAGE FACILITY
LOCO HILLS, NEW MEXICO

Prepared for:

Loco Hills GSF, Ltd.
158 Deer Creed Drive
Aledo, Texas 76008

R.T. HICKS CONSULTANTS, LTD.
901 RIO GRANDE BLVD. NW, SUITE F-142, ALBUQUERQUE, NM 87104

TABLES

PLATES

APPENDICES

1. Name and Address of Landowner

As of August 1, 2004, the land upon which Loco Hills Gas Storage Facility (Loco Hills GSF) resides is leased from and owned by:

Regional Office
State of New Mexico,
Commission of Public Land
Jim Carr
1004 Piasano
Carlsbad, NM 88220

Phone: 505.885.1323

Main Office
State of New Mexico,
Commission of Public Land
Joseph Lopez
310 Old Santa Fe Trail
PO Box 1148
Santa Fe, NM 87504

Phone: 505.827.4003

The owners of Loco Hills GSF are currently completing a land transfer with the State Land Office. As a condition of approval for this Best Management Practices Plan and exemption from Rule 50, the 40 acres upon which the facility resides and land adjoining the facility to the east will be owned by:

Loco Hills GSF
Attention: Mitchell Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Plate 1 is a map showing the land status after the above-referenced transaction. Adjacent to the 40-acre parcel currently owned by the State of New Mexico is a parcel Loco Hills GSF is currently acquiring from Bogle Farms.

2. Description of Types and Quantities of Fluids at the Facility

Table 1 outlines the fluid storage locations at the facility, their capacity, and the types of fluids kept. See Appendix A for a map showing the locations of these ponds and tanks.

1. Name and Address of Landowner

As of August 1, 2004, the land upon which Loco Hills Gas Storage Facility (Loco Hills GSF) resides is leased from and owned by:

Regional Office
State of New Mexico,
Commission of Public Land
Jim Carr
1004 Piasano
Carlsbad, NM 88220

Phone: 505.885.1323

Main Office
State of New Mexico,
Commission of Public Land
Joseph Lopez
310 Old Santa Fe Trail
PO Box 1148
Santa Fe, NM 87504

Phone: 505.827.4003

The owners of Loco Hills GSF are currently completing a land transfer with the State Land Office. As a condition of approval for this Best Management Practices Plan and exemption from Rule 50, the 40 acres upon which the facility resides and land adjoining the facility to the east will be owned by:

Loco Hills GSF
Attention: Mitchell Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Plate 1 is a map showing the land status after the above-referenced transaction. Adjacent to the 40-acre parcel currently owned by the State of New Mexico is a parcel Loco Hills GSF is currently acquiring from Bogle Farms.

2. Description of Types and Quantities of Fluids at the Facility

Table 1 outlines the fluid storage locations at the facility, their capacity, and the types of fluids kept. See Appendix A for a map showing the locations of these ponds and tanks.

Table 1: Surface Fluid Storage at Loco Hills GSF

Type of Storage	Maximum Capacity	Stored Liquid	Location
Pond #1	2 million gallons	10 lb. Brine	SE Corner of facility
Pond #2 (proposed)	7-11 million gallons	10 lb. Brine	Western portion of facility
Above ground storage steel tank #1	30,000 gallons	Propane or Butane	Tank Area
#2	30,000 gallons	Propane or Butane	Tank Area
#3	18,000 gallons	Propane or Butane	Tank Area
#4	18,000 gallons	Propane or Butane	Tank Area

.

3. Description of Fluid Management Facilities and Solid Disposal Facilities

Loco Hills GSF proposes to manage brine in two surface impoundments and three subsurface salt caverns that will also store liquid propane or butane. Appendix B includes a letter and supporting reports from Pettigrew & Associates, P.A. regarding the construction of pond #1. In Appendix C of this submission, Loco Hills GSF has provided the sonic inspection of cavern number one (Propane Well #1). Plans and specifications for the other propane storage wells were submitted separately to NMOCD. Loco Hills GSF will provide NMOCD a complete set of engineering drawings and specifications for the proposed clay-lined pond #2 after approval of this Best Management Practices Plan and NMOCD approval of the required exemption from Rule 50. [Note: we have highlighted all commitments made by Loco Hills GSF to ease review of this document]

Currently, Loco Hills GSF moves the brine from Pond #1 to the subsurface storage caverns to displace the product to the surface and permit loading of the product to customers. During the spring and summer, when demand for propane and butane is low, staff inject propane or butane to cavern storage, which results in brine production into the storage ponds.

After NMOCD approval of the mechanical integrity of each injection well/cavern and approval of this plan with the exemption from Rule 50, we plan to employ all three salt caverns for storage of propane and butane. As Table 2 shows, the total capacity for subsurface storage is 8.75 million gallons.

Table 2: Subsurface Fluid Storage at Loco Hills GSF

Cavern #1	2.75 MM gallons	Served by injection well 1
Cavern #2	3 MM gallons	Served by injection well 2
Cavern #3	3 MM gallons	Served by injection well 3

Because these caverns will never contain 100% product (0% brine), we propose to provide sufficient surface storage for less than 9 million gallons of brine (Table 1). Refer to the map in Appendix A for the locations of these caverns.

We plan to manage our surface storage to permit the working brine level in proposed Pond #2 to remain at or below the level of the adjacent natural ground surface (3,561 asl) throughout most of the year. Maintaining the fluid level in Pond #2 below the natural ground surface will allow us to preserve the structural integrity of the pond berm in the absence of a synthetic liner. In essence, the berm of Pond #2 will not be employed to hold brine on a routine basis but will divert storm water run-on. Maintaining the maximum working level of Pond #2 at 7 million gallons for most of the year creates a normal pond storage capacity of 9 million gallons (when both ponds are employed for storage). As described below, we plan to maintain Pond #1 below 20-30% of capacity for most of the year until this pond is repaired or replaced. In both ponds we will maintain a freeboard of 3 feet (vertical) so that no overtopping of brine occurs.

In the summer, brine levels in Pond #2 may rise above ground level. When this occurs, we propose to transfer fluid to Pond #1 where we also store brine. When the brine level in Pond #2 falls more than 3-6 feet below ground level, as it may when sales of propane and butane call for injection of brine, we will transfer excess brine from Pond #1 to Pond #2.

We know that allowing the clay liner of Pond #2 to dry can cause desiccation cracks and thereby compromise the low permeability of the liner. We will attempt to minimize fluid level fluctuations in Pond #2. If inspection of the clay liner shows desiccation and possible loss of integrity, we will install a sprinkler or watering system slightly above the high water mark. When necessary, we will apply water to the clay to maintain the moisture content and the low permeability. Fortunately, low pond levels are expected during the winter when evaporation and solar gain is lowest. Loco Hills GSF will generally employ ground water for this sprinkling program.

We also know that intense precipitation can cause erosion of the clay liner. We propose installation of a geotextile material between the top of the berm to the working fluid level of the pond. We will provide the specifications for this material with the plans and specifications for the pond.

Later in this plan, we describe the proposed pond seepage monitoring and ground water monitoring program.

We know the primary liner of Pond #1 is compromised and Loco Hills GSF routinely pumps fluid from the leak detection system back into Pond #1. Loco Hills GSF plans to employ the leak detection well to capture fluid released from the primary liner of Pond #1. After approval of this Best Management Practices Plan, Loco Hills GSF will begin to employ Pond #2 as the primary method of fluid management, as described above. As soon as possible, Loco Hills GSF will empty Pond #1 and attempt to repair the primary liner. If the leak cannot be found and/or repaired, we anticipate that this pond will remain only partially full and any leakage from the primary liner may be captured. Loco Hills GSF may elect to abandon the use of this pond and replace it with another. Until the pond is repaired or replaced, Loco Hills GSF will continue to monitor the leak detection monitor well for brine storage Pond #1 weekly.

If we elect to replace (rather than repair) Pond #1, the brine level in Pond #2 could be higher than ground level at the end of summer, when propane and butane cavern storage is greatest. This condition will cease after construction and approval of a replacement pond for Pond #1. Loco Hills GSF will manage the brine level in the ponds through brine sales, thereby minimizing the time that the brine level in Pond #2 is higher than the adjacent ground surface.

Ground water extraction is a critical element of the Best Management Practices Plan. As described in the Stage I/II Abatement Plan, ground water extraction is the proposed remedy to address potential ground water impairment caused by the actions of past owners. Ground water extraction is also necessary to control the slow percolation of brine from the clay-lined Pond #2. As shown in Appendix B, the measured permeability of the liner material ranges from 2 E-8 cm/sec to 1 E-5 cm/sec. A permeability of 2 E-8 cm/sec allows the 100 meter by 100 meter pond to release as little as 40 gallons per day. The plans and specifications scheduled for submission after approval of this BMP and the exemption of the pond from Rule 50 will show that the addition of bentonite to the native clay material will create a permeability of 1 E-7 or less. We propose post-construction permeability testing using a ring infiltrometer to show that the final liner performance exceeds the 1×10^{-7} cm/sec minimum permeability required by NMOCD guidance. As described in a later section, we will continually monitor the seepage rate of the clay liner. Upon approval of this BMP and the requested exemption from Rule 50, Loco Hills GSF will retain Pettigrew and Associates to create the specifications required to improve the existing clay liner such that it meets a permeability of 1 E-7 or less. We anticipate that the permeability of the liner will decrease with time as the bentonite placed in the liner expands due to contact with brine and reduces the pore space within the liner.

This Best Management Practices Plan expects slow percolation of brine from the clay-lined pond into the subsurface and a later section of this submission explains how Loco Hills GSF will protect water quality from this anticipated seepage.

As Table 1 shows, Loco Hills GSF manages propane and butane in the above ground storage tanks, pending sale or storage. All drums containing materials other than fresh water will be stored on an impermeable pad with curbing. All empty drums will be stored on their sides with the bungs in place and lined up on a horizontal plane. Chemicals in other containers such as sacks or buckets will also be stored on an impermeable pad with curbing. All process and maintenance areas that show evidence that leaks or spills are reaching the ground surface will be either paved and curbed or have some type of spill collection device incorporated into the design. All above ground storage tanks that contain fluids other than fresh water are bermed to contain a volume of one-third the total volume of the largest tank. All new additions or modifications to existing facilities will place tanks on an impermeable pad within a berm. All above ground saddle tanks will have impermeable pad and curb type containment unless they contain fresh water or fluids that are gases at atmospheric temperature and pressure. All tanks, drums, and other containers will be clearly labeled to identify their contents and other emergency information if the tank were to rupture, spill, or ignite. All systems designed for spill collection/prevention, and leak detection will be inspected weekly to ensure proper operation and to prevent overtopping or system failure. All spills and releases will be reported according to OCD Rule 116 and WQCC 1203 to the OCD Artesia District office.

Periodically, Loco Hills GSF creates solid waste. Wind-blown dust and sand enters surface storage ponds and must be removed to maintain the capacity of the ponds. On-site disposal of pond sediment poses no threat to ground water because the quality of the underlying ground water is so poor that seepage of any leachate caused by disposal would not cause a measurable impact. Nevertheless, Loco Hills GSF wishes to maintain the surface at its productive capacity and to eliminate any eyesore caused by stored pond sediment. We propose to do the following to address any sediment removed from ponds:

- Compact the pond sediment in an area of the site that is already disturbed by past activities.
- Cover the sediment with 1-2 feet of loose caliche and/or available coarse-grained material.
- Cover the loose caliche with 3-5 feet of Dockum Group clay and grade the surface to blend with the landscape.
- Cover the clay with 1-3 feet of topsoil and seed with native grasses.

We propose this same restoration protocol for eventual pond abandonment. We employed this restoration protocol for the pond sediment waste pile that was stored over the former unlined brine pond, which was retired in the 1980s, with no observed adverse affects.

The loose caliche will reduce any upward capillary rise of salt. The clay will act as a reservoir for soil moisture and enhance the ability of vegetation growth on the topsoil.

Any other solid waste material will be shipped to an appropriate commercial or municipal landfill. Loco Hills GSF will comply with all applicable solid waste regulations and NMOCD Rules regarding solid waste.

4. Description of Underground Facilities

Loco Hills GSF has completed a sonar examination of cavern number one (Propane Well 1) and the complete report is on file at the New Mexico Oil Conservation Division. A summary of the findings of this report is included in Appendix C.

The basic engineering designs of the propane wells are outlined in Table 3 below. Brine water will be injected and withdrawn through the tubing and gas products and will be injected and withdrawn trough the casing/tubing annulus. Deviations may occur once a month for up to 24 hours due to maintenance.

Table 3. Propane Well Characteristics.

Well #	Depth of Casing (ft)	Total Depth of Tubing (ft)	Total Depth of Well (ft)	Casing Diameter (in)	Tubing Diameter (in)
1	525	619	640	5.5	2 7/8
2	507	624	unknown	5.5	2.875
3	500	617	unknown	5.5	2.875

Appendix D contains well logs for Monitoring Wells on the site.

5. Contingency Plan for Spill Reporting and Clean-up

A SPCC plan and a SWPP plan will be completed after NMOCD approval of this Best Management Practices Plan and the exemption of the clay lined pond from Rule 50. Loco Hills GSF will adhere to all spill reporting requirements outlined in OCD Rules.

6. Hydrogeological Demonstration that Activities Will Not Endanger Fresh Water, Public Health or the Environment

We refer the reader to the Stage I/II Abatement Plan for a complete description of the environmental setting of the facility. The Abatement Plan also describes the location of existing monitoring wells and piezometers referenced in the following section. Table 4 (attached) shows the depth to water and the elevation of potentiometric surface at the end of this document. Appendix E presents analytical results from Monitoring Wells and Appendix F shows the location of Monitoring Wells near the facility.

As part of this BMP, Loco Hills commits to plug the two abandoned water wells at the site. A driller licensed in the State of New Mexico will develop the plugging and abandonment protocol with Hicks Consultants. We will submit the plan for plugging and abandonment after approval of this BMP and the exemption from Rule 50.

Proposed Seepage Capture Program

As outlined in this Best Management Practices Plan, Loco Hills GSF plans to control the very small amount of seepage from the clay-lined impoundment while they mitigate the impacts to ground water caused by past owners of the facilities through a ground water extraction program. In the spring and summer, when brine is produced from the caverns, Loco Hills will sell brine as necessary to maintain a ground water extraction program from Water Supply Well #2 and to manage the brine levels in the storage ponds. In the fall and winter, when brine is injected into the caverns, Loco Hills GSF typically pumps ground water to make brine. Loco Hills GSF now employs Water Supply Well #1 only when absolutely necessary. Before 2003, Loco Hills GSF and past owners of the facility used Water Supply Well #1 as their primary water source.

The withdrawal of ground water from Water Supply Well #2 has already caused overall ground water quality improvement and is capable of capturing the small seepage predicted from the clay-lined pond. Preliminary data suggest that this water quality improvement is evident since Loco Hills GSF changed the pumping schedule as described above. As Table 5 (attached at the end of this document) shows, chloride concentrations in up gradient supply well #1 have decreased from 46000 ppm to 33000 ppm. At

MW-1, which is cross gradient from the pumping well (supply well #2), chloride concentrations have decreased from 75,000 to 59,000 ppm. These water quality data show that pumping Supply Well #2 affects the ground water system at MW-1 and Supply Well #1

The effect of pumping Supply Well #2 is more pronounced in Plate 6 of the Stage I/II Abatement Plan. Plate 6, which is included in this BMP, is a potentiometric surface map using data after pumping of Supply Well #2 for 2 days. The pumping water level in SW-2 is 102 feet just before the pump begins a 12-minute pumping cycle (after 15 minutes of no pumping) and is 104 feet at the end of the pumping cycle. To create Plate 6, we used the average of these two measurements for SW-2. We used the water levels in nearby wells obtained at the end of the 2-day pumping period. Clearly the cone of depression caused by pumping Supply Well #2 will capture any seepage from the proposed clay-lined pond.

The data from the pumping program used to create Plate 6 of the Stage I/II Abatement Plan also show that ground water does not exist below much of Pond #2. We know from drilling P-2, north of Pond #2, that ground water does not exist on the north side of the pond. This water level response in P-1 allows us to conclude that a boundary exists to the west of P-1. This boundary is a "no-flow" boundary due to the pinch-out of the water bearing zone below Pond #2.

Seepage control for a clay pond with a liner permeability of 2×10^{-8} cm/sec requires export of 1 barrel per day. We anticipate that Loco Hills GSF will be able to extract about 226,800 gallons/year (100 barrels/week) of brine from the facility for use at the Loco Hills GSF facility or in oil field drilling. The water rights for the facility limit the amount of ground water use to 3 acre-feet (978,000 gallons). This ground water withdrawal program will capture any seepage from the clay-lined pond and remediate the existing ground water impairment caused by past activities. We propose to continue to employ Well #2 as the principal water withdrawal well because this well is located closest to the former unlined storage pit used by past owners of the facility. This well will be most effective in restoring ground water impairment caused by others.

Seepage from the clay-lined pond might be so minor that measurement devices now readily available could not detect the impact of such seepage on ground water quality. Additionally, we are uncertain if any seepage from the proposed clay-lined pond could overcome the pressure head in the confined aquifer and actually enter ground water. Nevertheless, we have designed the seepage capture program and closure plan under the assumption that the all of the seepage from the liner will eventually reach ground water. Therefore, we understand that NMOCD may desire implementation of Alternative Abatement Standards for the ground water zone beneath the clay-lined pond and between the clay-lined pond and Supply Well #2 during the period of facility operation. As described in the closure plan, we propose to restore all ground water at the site to a condition acceptable under Rule 19.

If required by NMOCD, we offer this BMP and the Stage I/II Abatement Plan as a petition for temporary Alternative Abatement Standards. We hypothesize that the TDS and chloride concentration in P-1 might approach 200,000 and 100,000 mg/L respectively before ground water restoration is complete. We are unsure of the regulatory protocol to petition for such temporary Alternative Abatement Standards.

Monitoring and Reporting Program

After NMOCD approval of this BMP and exemption to Rule 50, Loco Hills GSF will construct additional monitoring devices. In addition to the existing well and piezometer network described in the State I/II Abatement Plan, Loco Hills GSF proposes to construct two additional seepage detection piezometers: one on the west side and one on the south side of the proposed clay-lined pond. The design of these additional piezometers are the same as P-1 and P-2 (see Stage I/II Abatement Plan).

Eight shallow seepage detection piezometers are planned to monitor any seepage from Pond #2 into near surface caliche layer (see Stage I/II Abatement Plan for a description of this caliche layer). Although the exact placement of these eight shallow devices will be determined in the field, we anticipate two seepage detection devices on each side of the pond. We will employ the same basic design as P-1 and P-2 for these seepage detection devices, except the total depth will be the base of the caliche horizon (about 20 feet) and only one piezometer will monitor seepage into the caliche horizon. Loco Hills GSF will collect data from these seepage detection piezometers on a monthly basis.

Measuring the improvement of ground water quality caused by the proposed water exportation remedy is important. We propose a ground water monitoring program that consists of quarterly measurements of specific conductance and chloride from the two on-site water supply wells, the two existing monitoring wells, P-1 and other monitoring wells drilled in response to NMOCD conditions for approval of this BMP and exemption to Rule 50. We propose to obtain non-pumping water levels from the monitoring wells, piezometers and supply wells during these quarterly monitoring events. We also plan to obtain pumping water levels from during each quarter.

We will also monitor the volume of water pumped from each well and the volume of brine exported from the facility. Because the high TDS of ground water causes failure of flow meters, we plan to monitor the volume of pumped water by simply measuring the flow rate from each well every month then multiplying the flow rate by the amount of time each well was operating.

We will monitor the stage height in each impoundment on a weekly basis. We will monitor the volume of water pumped from the leak detection system in Pond #1.

During the first year of operation under this Best Management Practices Plan, Loco Hills GSF plans to collect ground water elevation data on a monthly basis, assemble monthly brine sales data, and provide reports to NMOCD semi-annually. After the first year of operation, we plan to submit reports annually.

Monitoring the seepage rate from the clay lined pond is also important. We anticipate that the seepage rate will decrease over time. Appendix G shows the design and operation of the proposed seepage rate measurement device, which is essentially a pan lysimeter. We will report the monthly seepage rate to NMOCD with the scheduled submissions.

Contingency Plan

We anticipate that the proposed ground water extraction program described herein will continue to cause improvement of water quality (lower TDS) at the site and will capture any seepage from the clay-lined pond.

If the seepage detection well(s) or other devices suggest that seepage from the clay-lined pond will cause impairment of fresh water or a threat to human health and the environment, then Loco Hills GSF will meet with NMOCD to determine the best course of action. One alternative is to increase the ground water pumping program to capture any seepage in excess of predicted rates. Another alternative is inspection and repair of the clay liner to reduce the amount of seepage. A final alternative is installation of a synthetic liner and leak detection system for Pond #2. In the absence of an agreement between NMOCD and Loco Hills GSF on an approach to protect fresh water from unexpected seepage, we will abide by any hearing order issued by the NMOCD on this matter.

Because Loco Hills GSF can operate their facility in a way that permits the drainage and repair of Pond #2, these contingency plans are viable.

Closure Plan

The Loco Hills gas storage facility will cease operation when gas or liquid storage is no longer required in salt caverns, which we believe will occur within 50-250 years. During this long period of operation, ground water pumping will not only remedy the ground water impairment caused by past operators, but will also capture all seepage from the clay-lined lagoon.

At closure, the facility owner will empty the caverns of stored product by filling the caverns with brine. Any brine remaining at the surface will be sold or otherwise removed from the site.

At the end of operations, a small volume of brine seepage might reside in the pore space of the unsaturated zone (between the bottom of the clay liner and the uppermost ground water zone). This residual fluid could move downward via unsaturated flow. Because unsaturated flow is extremely slow, we conclude that the rate of brine movement into ground water after closure of the facility will not cause contamination of fresh water.

TABLES

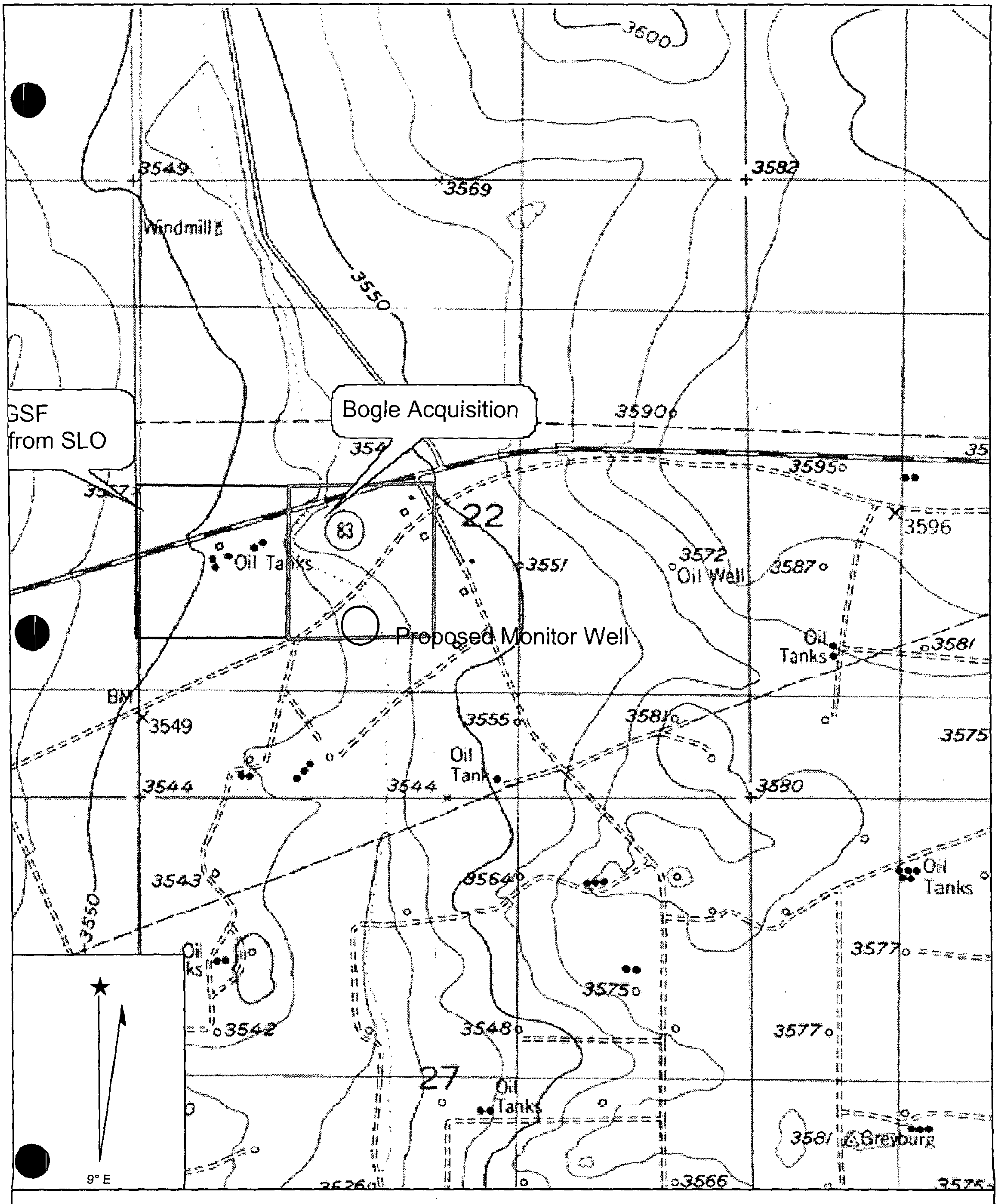
Table 4. Depth to Water and Elevation of Potentiometric Surface, Loco Hills GSF in ft.

	Supply Well 1 N. of High. 82	Supply Well 2 W. of lined Brine Pit	Monitoring Well 1 S.E. corner of lined Brine Pit	Bear Grass Draw Monitoring Well 1	Bear Grass Draw Piez. 1 129 ft.	Piez. 1-1 100 ft. E. of new Clay Pit	Piez. 1-2 88 ft. E. of new Clay Pit
Pecos V. Pump., 2002		36 3511.3					
Driller 5/2/2003			83 3465.9				
R. T. Hicks 10/8/2003	86.58 3462.7						
R. T. Hicks 6/25/2004	77.1 3472.2	81.3 3465.95	83.72 3465.18	78.48 3464.64	102.59 3440.51	86.64 3467.51	86.76 3467.59

Table 5. Chloride Concentrations in Wells at Loco Hills GSF in mg./l.

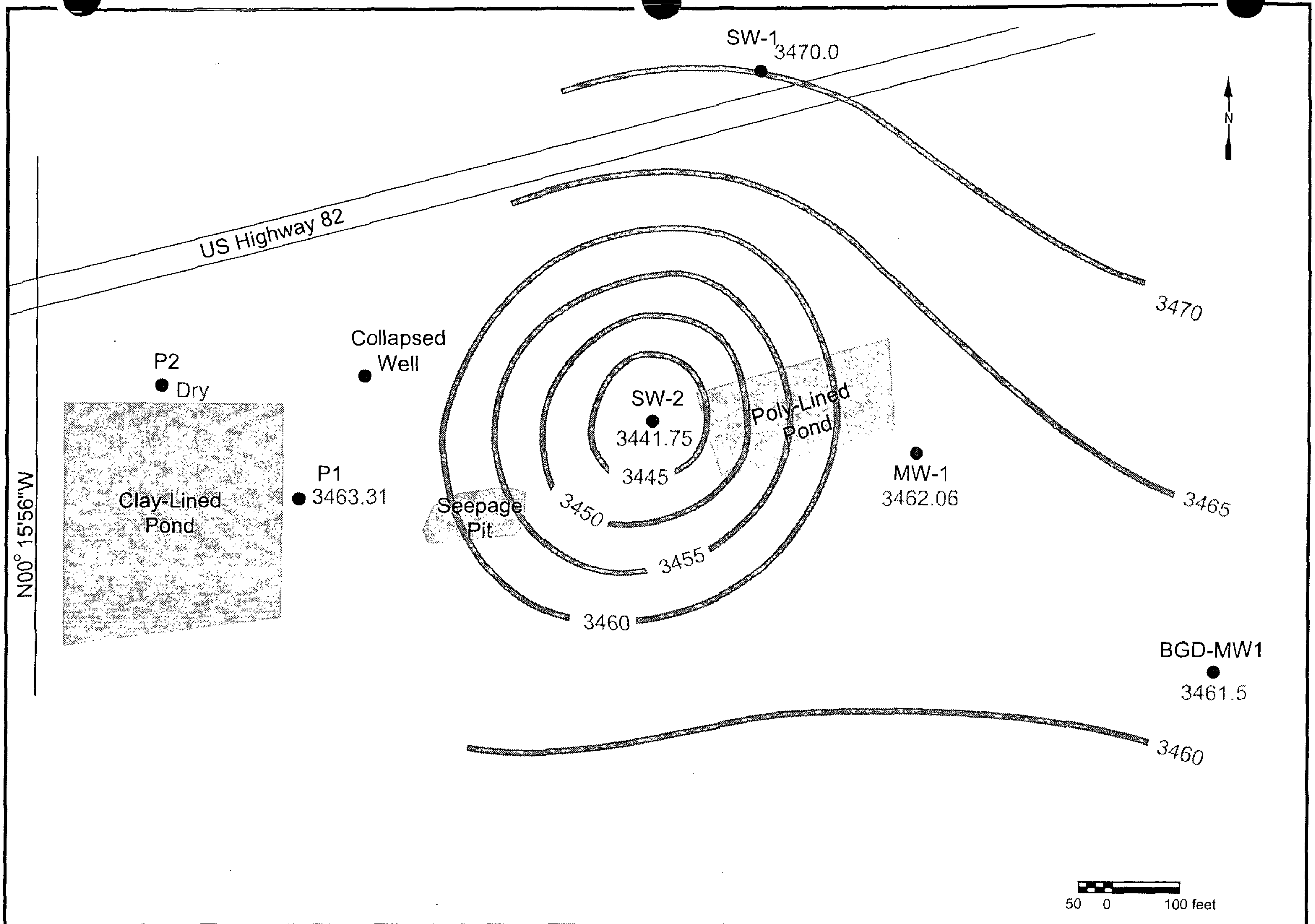
	Supply Well 1 N. of High. 82	Supply Well 2 W. of lined Brine Pit	Monitoring Well 1 S.E. corner of lined Brine Pit	Bear Grass Draw Monitoring Well 1	Bear Grass Draw Piez. 1 129 ft.	Piez. 1-1 100 ft. E. of new Clay Pit	Piez. 1-2 88 ft. E. of new Clay Pit
Cardinal Labs 5/28/2003	45988	42987	74977				
Cardinal Labs 6/12/2004	32990	42987	58982				
R. T. Hicks 6/25/2004			52984	16622	18540	22298	22549
LH GSF 7/14/2004	19619	20927	40588	11497	28258	15329	24559

PLATES



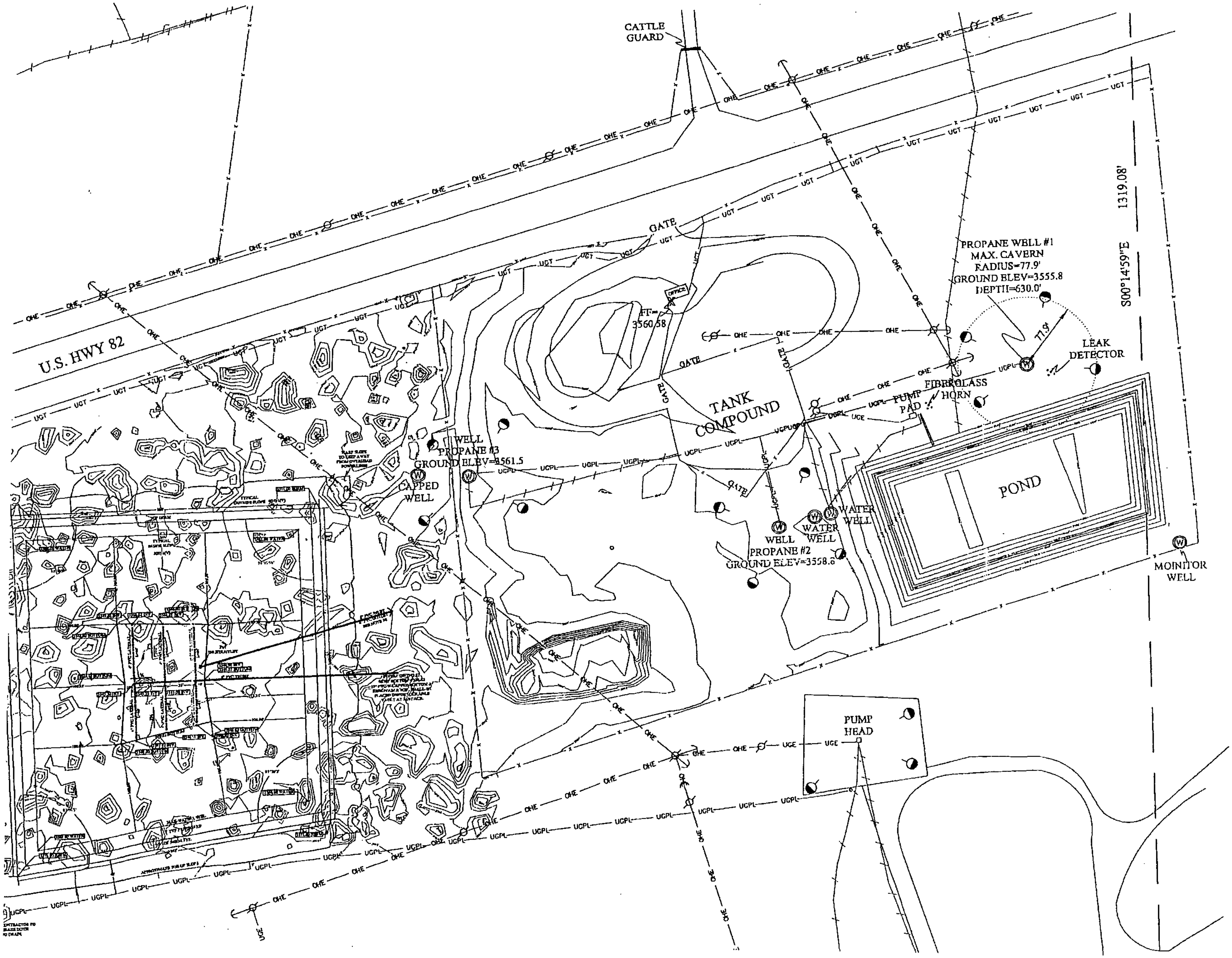
Name: RED LAKE SE
Date: 5/11/2004
Scale: 1 inch equals 1000 feet

Location: 032.8174199° N 104.0605926° W
Caption: Plate 1: Parcel Map



R.T. HICKS CONSULTANTS, LTD. 901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87104 505.266.5004 Fax: 505.246.1818	Loco Hills GSF	Plate 6
	Potentiometric Surface Map, August 17, 2004	August, 2004

APPENDIX A



CATTLE GUARD
U.S. HWY 82
GATE
FF=3560.58
OFFICE
TANK COMPOUND
WELL PROPANE #3 GROUND ELEV=3561.5
CAPPED WELL
WELL PROPANE #2 GROUND ELEV=3558.8
WATER WELL
WATER WELL
PROPANE WELL #1 MAX. CAVERN RADIUS=77.9' GROUND ELEV=3555.8 DEPTH=630.0'
77.9'
LEAK DETECTOR
FIBERGLASS HORN
PUMP PAD
POND
MONITOR WELL
1319.08'
S00°14'59"E
PUMP HEAD

APPENDIX B

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III , P.E./P.S.

PETTIGREW and ASSOCIATES
1110 N. GRIMES
HOBBS, NEW MEXICO 88240
(505) 393-9827

7 December, 2003

Loco Hills GSF, Ltd.
158 Deer Creek Dr.
Aledo, TX 76008

ATTN: Mr. Mitchel Johnson

RE: Construction Observations for Clay Lined Pond at Loco Hills GSF

Dear Mr. Johnson:

During construction of the above referenced pond, Pettigrew & Associates, P.A. was contracted to perform engineering services such as materials testing, site inspection, and consulting. The pond was constructed by Big D Construction out of Midland, Texas.

This firm observed good construction practices during all site visits. These construction practices directly relate to achieving good compaction, permeability, and durability of the clay liner. Lifts were kept to less than six (6) inches, the clay material was well processed, and therefore compacted easily.

The clay liner basically begins on the outside of the pond at existing ground level, extends over the berm, down the inner slope of the pond, across the bottom, back up the inner slope, over the berm and back to existing ground. Pettigrew & Associates was not on site until the berms were nearly completed, but we were able to test density on the top two feet of fill for most of the site. The bottom of the pond was scraped, scarified, and recompacted, and tested for compaction for a depth of two feet.

A total of thirty-nine (39) densities were taken on the clay liner. Densities were taken on the top of the berm, inner side slopes, and bottom of the pond. All densities inside pond were at least 95% of maximum density of an ASTM D698 standard proctor. One density on top of the berm was 93.4%, so the area was recompacted. All other densities were above 95% on the berm.

Based on the results of compaction and the good construction practices used by the contractor, the permeability of the clay material in the pond liner should approximate the permeability as tested in the laboratory. This liner should perform as required for brine water storage for both the short term as well as the long term.

Sincerely,

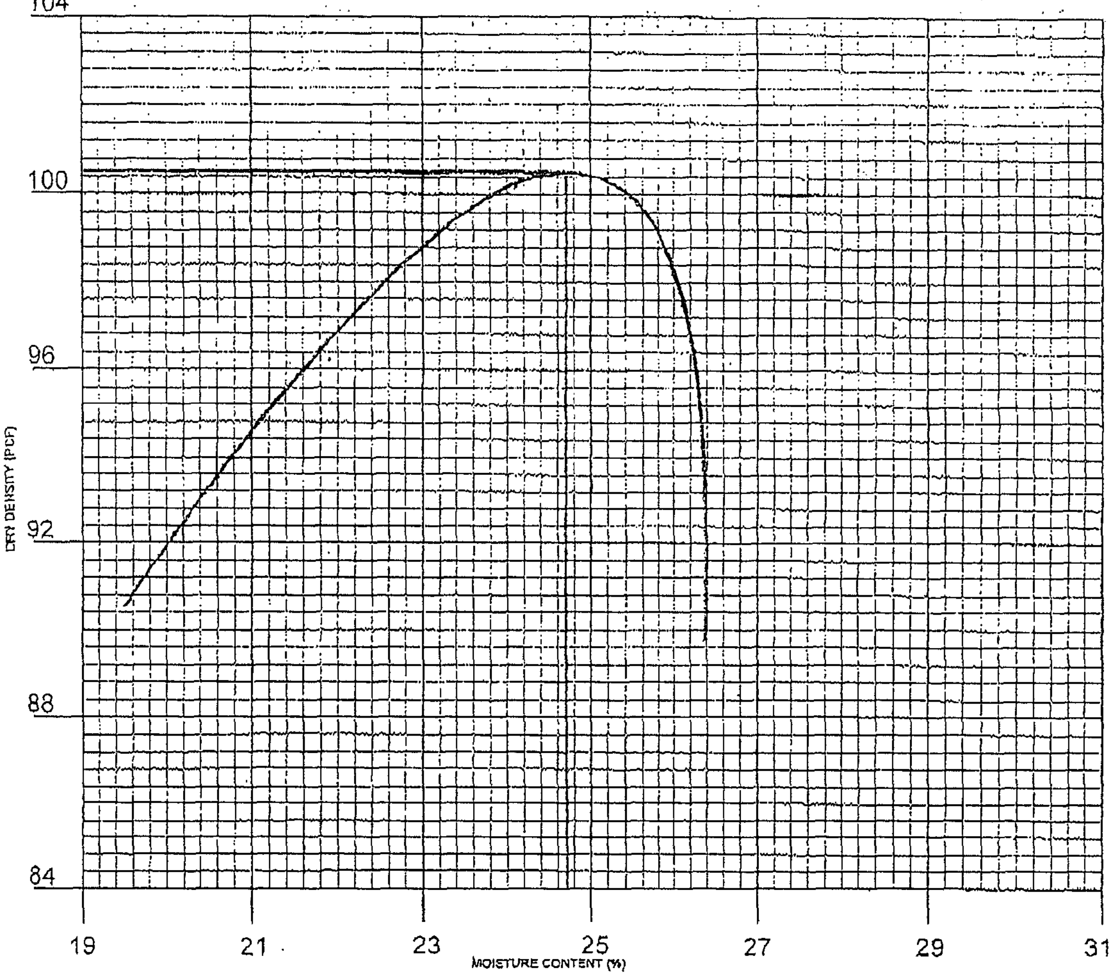
PETTIGREW & ASSOCIATES, P.A.

Jeremy Baker

Jeremy Baker, P.E.

JEREMY BAKER
NEW MEXICO
16207
12-7-03
LICENSED PROFESSIONAL ENGINEER

PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES ST.
HOBBS, NM 88240
(505) 393-9827



CLIENT: Loco Hills GSF PROJECT: Loco Hills Brine Pond

SAMPLE LOCATION: Pond

SOIL DESCRIPTION: Red Fat Clay with Sand

SOIL CLASSIFICATION: CH TEST METHOD: ASTM: D 698

ATTERBERG: LL 57 PI 40 Sampled & Delivered 10/20/03

DATE: 10/22/03 LAB NO. 03 6504-6508

DRY WEIGHT LB/CU. FT. 100.5 MOISTURE CONTENT % 24.7

SIEVE ANALYSIS - % PASSING						
#4	#10	#40	#80	#200		ASTM: D 5084-Permeability: 1.72E -08 95.8% Compaction - 24.2% Moisture
99	99	97	91	81.5		

PETTIGREW and ASSOCIATES

COPIES: Loco Hills GSF

BY: S.E.T.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

AASHTO R18
DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To: Loco Hills GSF
Mitchel Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Material: Red Fat Clay with Sand

Test Method: ASTM: D 2922

Project: Loco Hills Brine Pond

Date of Test: October 20, 2003

Depth: Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-1	Top of N. Birm - 30' W. of the NE Corner	102.1	19.0	
SG-2	Top of N. Birm - 100' W. of the NE Corner	97.7	18.3	
SG-3	Top of N. Birm - 100' E. of the NW Corner	106.1	18.4	
SG-4	Top of N. Birm - 40' E. of the NW Corner	93.4	18.6	
SG-5	Top of E. Birm - 50' S. of the NE Corner	97.2	18.6	
SG-6	Top of E. Birm - 120' S. of the NE Corner	100.8	19.6	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6482-6487 & 6502-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: [signature] P.E.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To: Loco Hills GSF
Mitchel Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Material: Red Fat Clay with Sand

Test Method: ASTM: D 2922

Project: Loco Hills Brine Pond

Date of Test: October 20, 2003

Depth: Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-13	S. Slope - 10' From Top Edge of Slope - 40' E. of the SW Corner	106.1	16.1	
SG-14	S. Slope - 22' From Top Edge of Slope - 90' E. of the SW Corner	102.9	16.7	
SG-15	S. Slope - 30' From Top Edge of Slope - 75' W. of the SE Corner	101.4	16.4	
SG-16	S. Slope - 35' From Top Edge of Slope - 30' W. of the SE Corner	104.3	17.0	
SG-17	Top of W. Birm - 50' N. of the SW Corner	105.1	16.1	
SG-18	Top of W. Birm - 125' N. of the SW Corner	106.2	17.2	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6494-6499 & 6502-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: S.E.T.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To:	Loco Hills GSF Mitchel Johnson 158 Deer Creek Drive Aledo, Texas 76008	Material:	Red Fat Clay with Sand
		Test Method:	ASTM: D 2922
Project:	Loco Hills Brine Pond		
Date of Test:	October 20, 2003	Depth:	Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-7	Top of E. Birm - 100' N. of the SE Corner	100.4	19.9	
SG-8	Top of E. Birm - 40' N. of the SE Corner	105.0	21.2	
SG-9	Top of S. Birm - 45' W. of the SE Corner	105.4	19.6	
SG-10	Top of S. Birm - 100' W. of the SE Corner	103.0	25.6	
SG-11	Top of S. Birm - 100' E. of the SW Corner	105.0	22.0	
SG-12	Top of S. Birm - 50' E. of the SW Corner	104.2	20.8	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6487-6493 & 6502-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES.

BY: Glen Reccord

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6499-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: Glen Reccord

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

AASHTO R18

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS. III, P.E./P.S.

To: Loco Hills GSF
Mitchel Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Material: Red Fat Clay with Sand

Test Method: ASTM: D 2922

Project: Loco Hills Brine Pond

Date of Test: October 31, 2003

Depth: Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-21	Bottom of Pond - 20' S. & 20' W. of the NE Corner	106.0	14.6	
SG-22	Bottom of Pond - 30' N. & 15' E. of the SW Corner	97.5	14.2	
SG-23	Pond Slope - 20' N of the SE Corner - 15' Above Bottom of Pond	106.0	14.2	
SG-24	Pond Slope - 50' E. of the NW Corner - 10' Above Bottom of Pond	102.9	16.3	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6613-6616 & 6620-6621

Copies To: Loco Hills GSF ✓

PETTIGREW and ASSOCIATES

BY: [signature] E.T.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To: Loco Hills GSF
Mitchel Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Material: Red Fat Clay with Sand

Test Method: ASTM: D 2922

Project: Loco Hills Brine Pond

Date of Test: October 31, 2003

Depth: Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-25	Pond Slope - 30' S. of the NW Corner - 30' Above Bottom of Pond	101.9	16.8	
SG-26	Pond Slope - 50' W. of the SE Corner - 15' Above Bottom of Pond	108.0	16.9	
SG-27	N. Birm - 60' E. of the NW Corner	102.0	17.6	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6617-6621

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: [signature] E.I.T.

LABORATORY TEST REPORT

PETTIGREW and ASSOCIATES, P.A.

1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To: Loco Hills GSF
Mitchel Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Material: Red Fat Clay with Sand

Test Method: ASTM: D 2922

Project: Loco Hills Brine Pond

Date of Test: November 6, 2003

Depth: 1' Below Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-28	Bottom of Pond - 7' W. & 35' N. of the SE Corner	102.1	15.6	
SG-29	Bottom of Pond - 100' N. & 50' W. of the SE Corner	96.3	18.8	
SG-30	Bottom of Pond - 25' S. & 40' W. of the NE Corner	103.2	21.2	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6758-6760

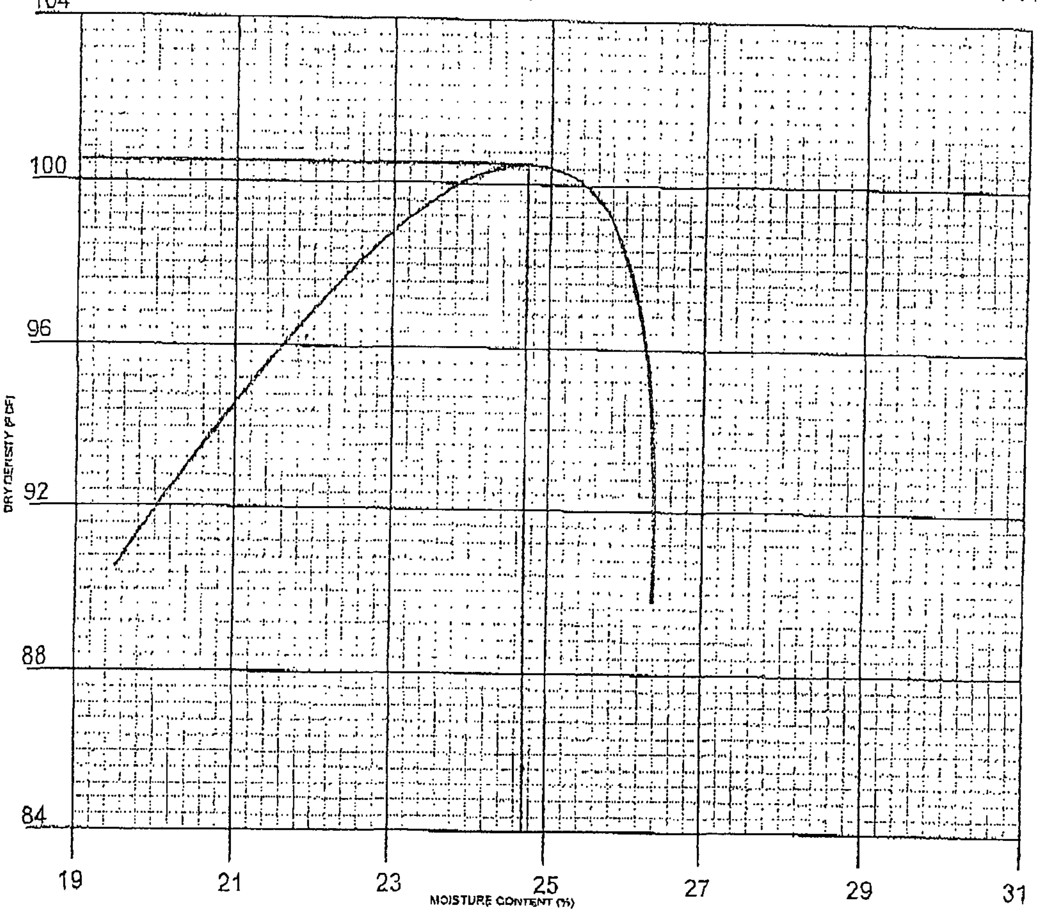
Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: [signature] S.E.T

PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES ST.
HOBBS, NM 88240
(505) 393-9827

AASHTO R18



CLIENT: Loco Hills GSF PROJECT: Loco Hills Brine Pond

SAMPLE LOCATION: Pond

SOIL DESCRIPTION: Red Fat Clay with Sand

SOIL CLASSIFICATION: CH TEST METHOD: ASTM: D 698

ATTERBERG: LL 57 PI 40 Sampled & Delivered 10/20/03

DATE: 10/22/03 LAB NO. 03 6504-6508

DRY WEIGHT LB/CU. FT. 100.5 MOISTURE CONTENT % 24.7

SIEVE ANALYSIS - % PASSING						
#4	#10	#40	#80	#200		ASTM: D 5084-Permeability: 1.72E -08 95.8% Compaction - 24.2% Moisture
99	99	97	91	81.5		

PETTIGREW and ASSOCIATES

COPIES: Loco Hills GSF

BY: [signature]

amec

PROJECT:	LOCO HILLS GSF PROJ# 2003.1016	JOB NO:	2-110-000075
LOCATION:	BRINE POND	WORK ORDER NO:	10
MATERIAL:	RED SANDY LEAN CLAY	LAB NO:	13
SAMPLE SOURCE:	BRINE POND	DATE SAMPLED:	10/23/03
SAMPLE PREP:	REMOLDED TO 95% MAX DRY DENSITY AND OPT. MOISTURE		
TARGET:	MAX DRY DENSITY D698A 100.5 pcf @ 24.7% OPT. MOISTURE		

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER (ASTM 5084-90)
"CV" METHOD C

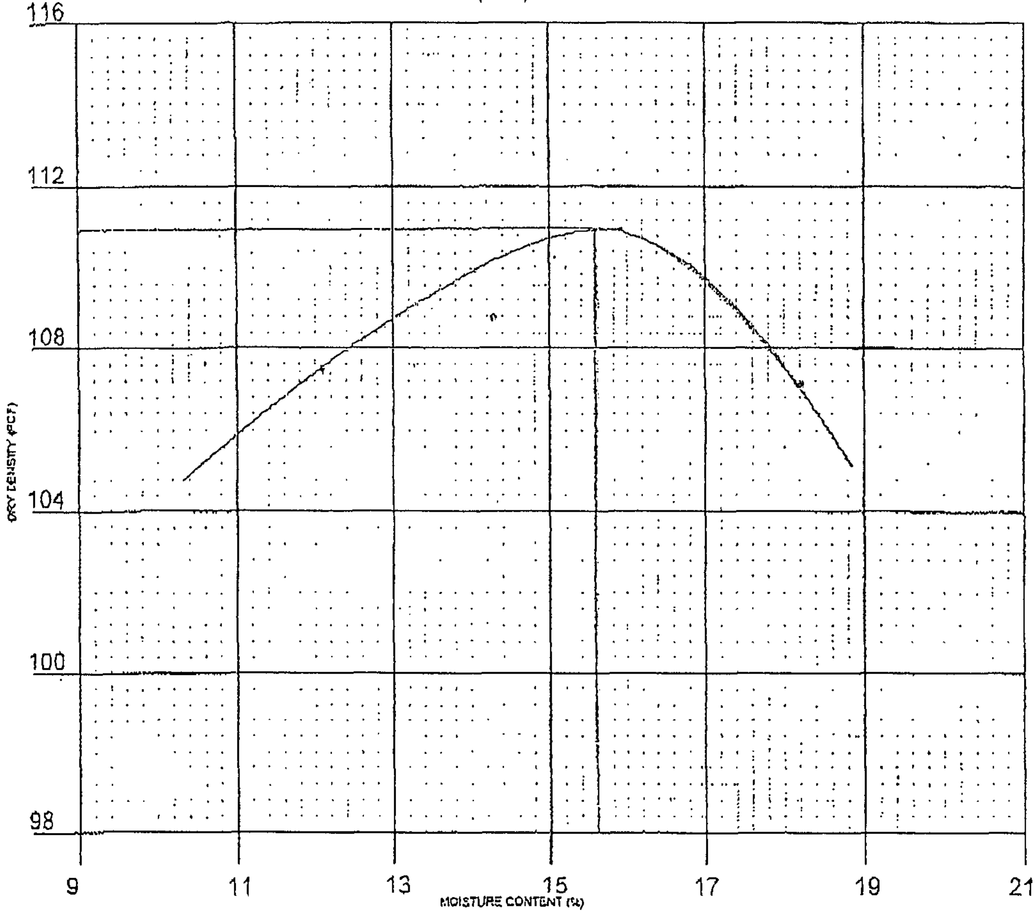
AVERAGE PERMEABILITY		1.72E-08 cm/sec	
INITIAL LENGTH OF SPECIMEN		7.15 cm	
INITIAL DIAMETER OF SPECIMEN		7.15 cm	
INITIAL WATER CONTENT		24.2 %	
INITIAL DRY UNIT WEIGHT		95.8 pcf	
INITIAL VOLUME		17.52 cu.in	
PERMEANT LIQUID		BOTTLED WATER	
MAGNITUDE OF TOTAL BACK PRESSURE		64.3 psi	
EFFECTIVE CONSOLIDATION STRESS		5 psi	
RANGE OF HYDRAULIC GRADIENT USED	14.4	to	12.2
FINAL LENGTH OF SPECIMEN		7.28 cm	
FINAL DIAMETER OF SPECIMEN		7.24 cm	
FINAL WATER CONTENT		29.6 %	
FINAL DRY UNIT WEIGHT		92.0 pcf	
FINAL VOLUME		18.24 cu.in	
DEGREE OF SATURATION (BEFORE AND AFTER TEST)	88%	and	98%
SPECIFIC GRAVITY USED IN CALCULATIONS OF SATURATION		2.651	

TIME INTERVAL sec	K cm/sec	K ft/yr.
1495	1.97E-08	0.02
1944	1.48E-08	0.02
2348	1.63E-08	0.02
2716	1.82E-08	0.02

03-650

REVIEWED BY

PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES ST.
HOBBS, NM 88240
(505) 393-9827



CLIENT: Big D Construction PROJECT: Loco Hills GSF Inc. Brine Water Pond

SAMPLE LOCATION: Bottom of Pond

SOIL DESCRIPTION: Reddish Tan Caliche

SOIL CLASSIFICATION: ____ TEST METHOD: ASTM: D 698

ATTERBERG: LL ____ PI ____ Delivered 10/9/03

DATE: 10/10/03 LAB NO. 03 6272

DRY WEIGHT LB/CU. FT. 111.0 MOISTURE CONTENT % 15.6

SIEVE ANALYSIS - % PASSING									

PETTIGREW and ASSOCIATES

COPIES: Big D Construction

BY: S.E.T.

APPENDIX C

Submit 3 Copies To Appropriate District Office
District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Rd., Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy, Minerals and Natural Resources

OIL CONSERVATION DIVISION
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-103
Revised March 25, 1999

RECEIVED
APR 12 2004
Oil Conservation Division
1220 S. Saint Francis Dr.
Santa Fe, NM 87505

WELL API NO. 30-15-06192
5. Indicate Type of Lease: STATE ☑ FEE ☐
6. State Oil & Gas Lease No. BL-635

SUNDRY NOTICES AND REPORTS ON WELLS
(DO NOT USE THIS FORM FOR PROPOSALS TO DRILL OR TO DEEPEN OR PLUG BACK TO A DIFFERENT RESERVOIR. USE "APPLICATION FOR PERMIT" (FORM C-101) FOR SUCH PROPOSALS.)

7. Lease Name or Unit Agreement Name: Leonard

1. Type of Well:
Oil Well ☐ Gas Well ☑ Other Salt Dome Storage

2. Name of Operator: Loco Hills GSF LTD

8. Well No. Leonard State #2

3. Address of Operator: 158 Deer Creek Drive Aledo, Texas 76008

9. Pool name or Wildcat

4. Well Location
Unit Letter L : 2069 feet from the South line and 1193 feet from the West line
Section 22 Township 12S Range 29E NMPM County Eddy

10. Elevation (Show whether DR, RKB, RT, GR, etc.)

11. Check Appropriate Box to Indicate Nature of Notice, Report or Other Data

NOTICE OF INTENTION TO:		SUBSEQUENT REPORT OF:	
PERFORM REMEDIAL WORK ☐	PLUG AND ABANDON ☐	REMEDIAL WORK ☐	ALTERING CASING ☑
TEMPORARILY ABANDON ☐	CHANGE PLANS ☐	COMMENCE DRILLING OPNS. ☐	PLUG AND ABANDONMENT ☐
PULL OR ALTER CASING ☐	MULTIPLE COMPLETION ☐	CASING TEST AND CEMENT JOB ☐	
OTHER:	☐	OTHER:	☐

12. **Describe proposed or completed operations.** (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work). SEE RULE 1103. For Multiple Completions: Attach wellbore diagram of proposed completion or recompilation. Set CIBP at 517', spotted 15 sacks of cement on top of plug. Dressed cement to 514'. Ran 4' FL4S to 514', pumped 35 sacks cement between 5½' and 4' circulated to surface. 9 Bbls circulated to pit. Let set 36 hrs.
Drilled out to 514'. Ran C.B.L + MIT on casing (510# for 30 min) CBL + chart included.
Open hole test (Nitrogen) waived by Wayne Price - E-mail March 31, 2004. Drilled out C.I.B.P.
Ran 2⅜" FL4S 5.55 to 630' Nippled up Well Head March 26, 2004

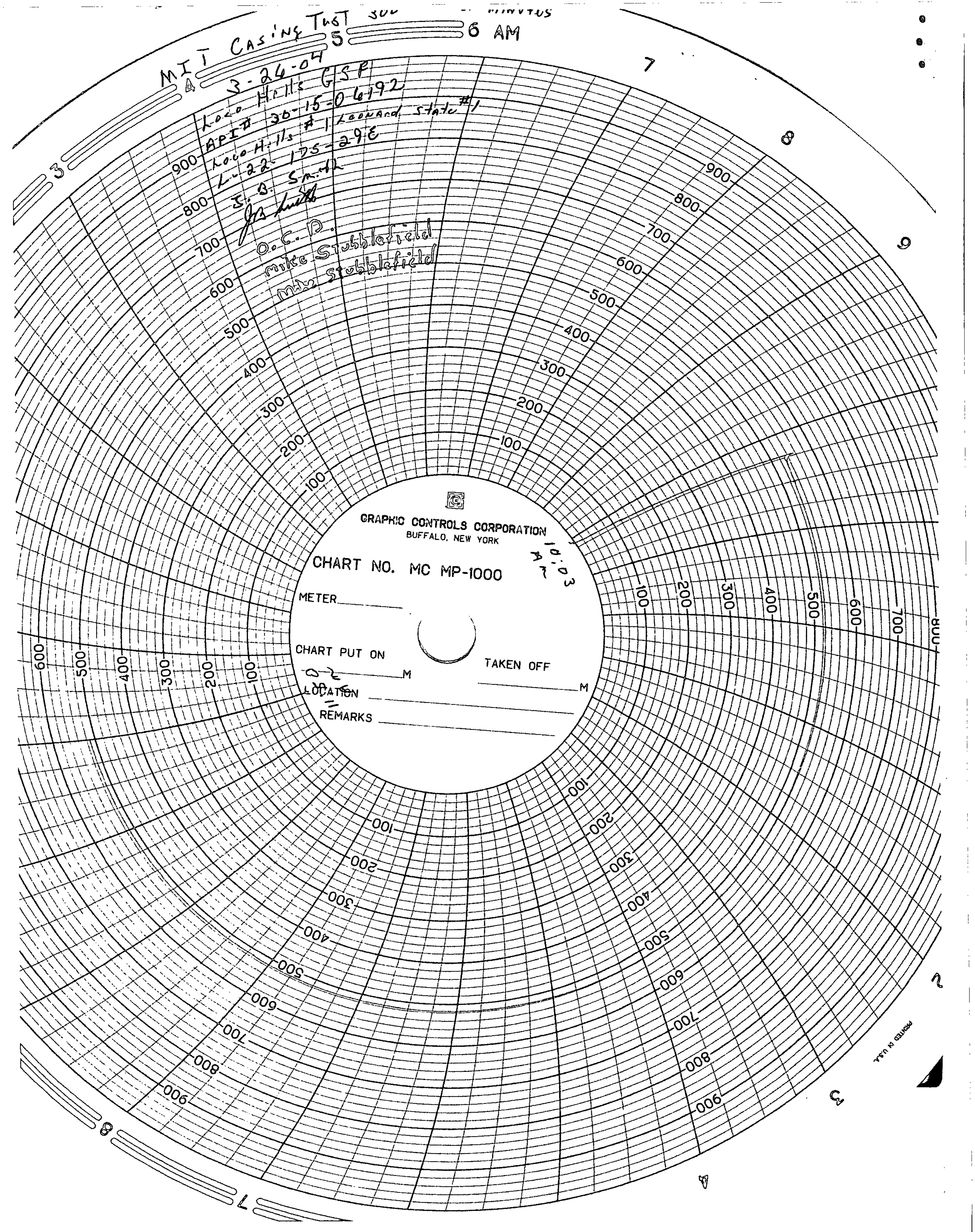
I hereby certify that the information above is true and complete to the best of my knowledge and belief.

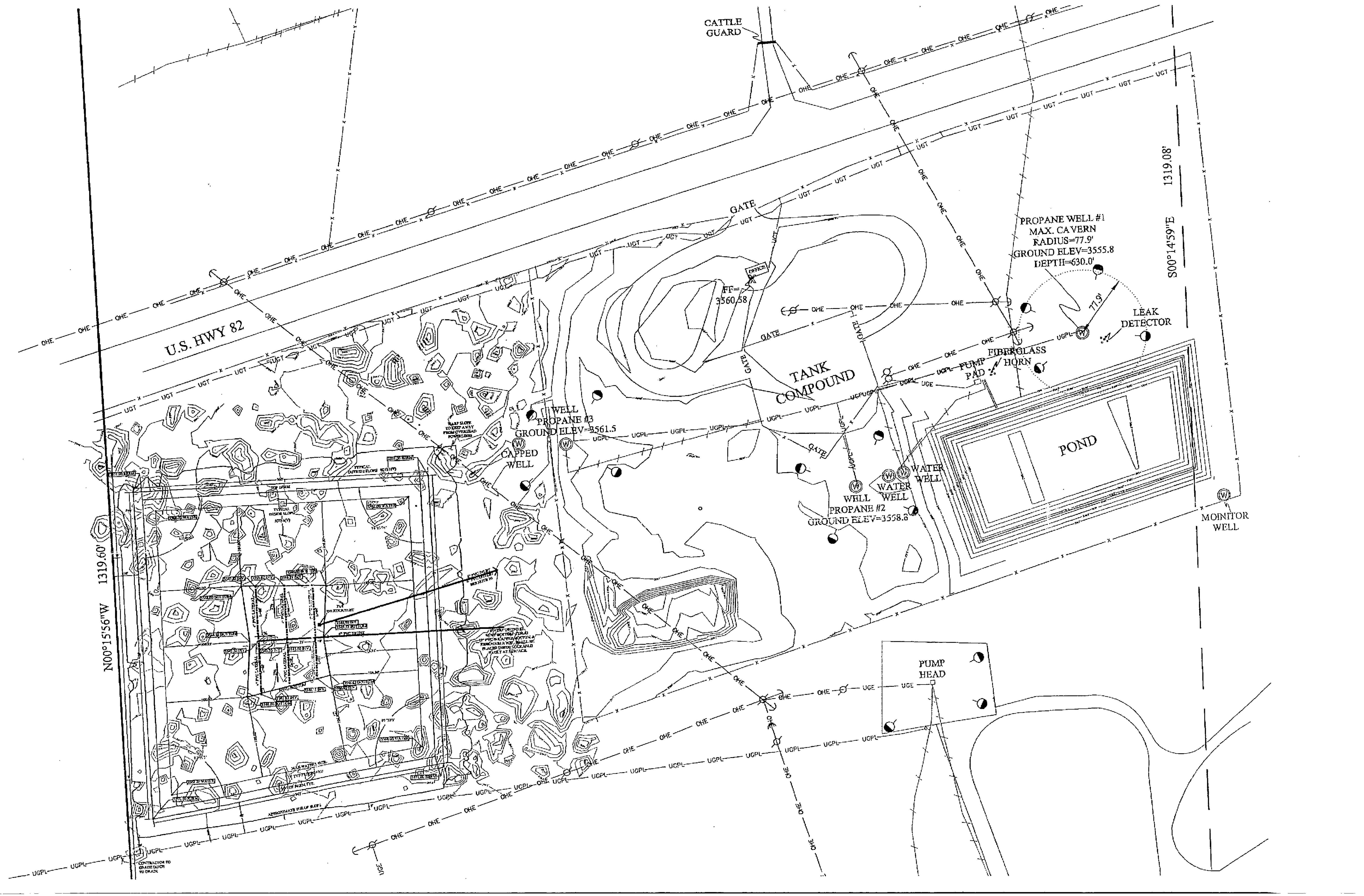
SIGNATURE John B Smith TITLE Terminal Operator DATE 4/6/04

Type or print name John B Smith Telephone No. (505) 677-2331

(This space for State use)

APPPROVED BY ____________ TITLE ____________ DATE ____________
Conditions of approval, if any:


MIT Casing Test
3-24-04
Loco Hills GSF
API# 30-15-06192
Loco Hills #1 Leonard State #1
L-22 17S-29E
J. B. Smith
O.C.D.
Mike Stubblefield
6 AM
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
CHART NO. MC MP-1000
10:03 AM
METER
CHART PUT ON
M
TAKEN OFF
M
LOCATION
REMARKS
PRINTED IN U.S.A.



CATTLE GUARD
U.S. HWY 82
GATE
FF=3560.58
TANK COMPOUND
PROPANE WELL #1
MAX. CAVERN
RADIUS=77.9'
GROUND ELEV=3555.8
DEPTH=630.0'
77.9'
LEAK DETECTOR
FIBERGLASS HORN
PUMP PAD
WELL PROPANE #3
GROUND ELEV=3561.5
CAPPED WELL
WATER WELL
WATER WELL
WELL PROPANE #2
GROUND ELEV=3558.8
POND
MOINITOR WELL
PUMP HEAD
1319.08'
S00°14'59"E
1319.60'
N00°15'56"W

ECHO - LOG

Propane Well #1

1st. Survey

04/21/2003 033020

SOCON Cavity Control, Inc.
4070 Washington Blvd. Texas 77705, USA
Phone (409) 840-5554+5557 Fax (409) 840-4424
e-mail: lawrence@socon.com

Results of the Cavern Survey

by means of Echo-Sounding

in the cavern

Propane Well #1

Date: 04/21/2003

033020

Customer: Loco Hills GSF

Loco Hills, New Mexico

Responsible for the survey:

Surveyor :	R. Lawrence
Leadership :	J.B. Smith
Interpreter :	R. Lawrence

Contents

Summary of results

Well details

All depths are given as:	**MD**
Datum level for all depths:	**surface**
Shoe of the cemented 13 3/8"-casing:	525.0 ft
Shoe of the - casing during the surveying:	525.0 ft
Reference depth for ECHO-LOG:	**525.0 ft**
Depth correction:	+12.0 ft

Details of survey equipment

Measuring vehicle used:	L 110
Tools used:	Echo tool BSE 17, BSE 17 Fibre-gyro-compass

General details

Number of runs:	1
Measured horizontal sections:	19
Measured tilted sections:	20
Lowest survey depth:	643.0 ft

Maximum and minimum dimensions with ref. to the measuring axis

Reference direction: **magnetic north**

Determination out of 36 vertical sections derived from horizontally and tilted measured data at 5 degree intervals:

minimum radius:	0.0 ft
depth:	650.1 ft
direction:	0°
maximum radius:	77.9 ft
depth:	630.0 ft
direction:	60°
highest point of cavern:	522.2 ft
horizontal distance:	8.1 ft
direction:	345°
lowest point of cavern:	651.4 ft
horizontal distance:	5.4 ft
direction:	75°
lowest point in the measuring axis:	650.2 ft

Determination out of 37 horizontal sections in the depths between 192.3 m and 259 m at 5/15 degree intervals:

maximum radius:	77.9 ft
depth:	630.0 ft
direction:	60°
maximum diameter:	138.2 ft
depth:	625.0 ft
direction:	85 - 265°

Volume

volume:	65,456 bbls.
depth range:	525.0 ft <--> 650.0 ft

Interpretation

Supposing a rectilinear propagation of ultrasonic waves all recorded echo travel times were converted into distances by using the subsequent speeds of sound:

1798.0 m/s (5899.0 ft/s) to 1798.0 m/s (5899.0 ft/s) in brine (measured)

In the case of recording several echoes along one trace of echo signals, the representative echo signal was selected according to the level of amplitude, transmission time, density of measured points and the shape of the cavern.

Horizontal sections

19 horizontal sections at following measured depths are included as graphical plots in this report:

525.0 ft	530.0 ft	540.0 ft	550.0 ft	560.0 ft	570.0 ft	580.0 ft
590.0 ft	595.0 ft	600.0 ft	605.0 ft	610.0 ft	615.0 ft	620.0 ft
625.0 ft	630.0 ft	635.0 ft	640.0 ft	643.0 ft		

The following 4 sections are constructed:

644.0 ft	646.0 ft	648.0 ft	650.0 ft

Tilted sections

20 sections recorded with tilted echo-transducer at following measured depths are presented in the vertical sections:

12 sections of these with upwards-tilted echo-transducer:

Depth / Tilting Angle

540.0 / 54	540.0 / 60	540.0 / 66	540.0 / 72	540.0 / 78	540.0 / 84
640.0 / 9	640.0 / 12	640.0 / 15	640.0 / 17	640.0 / 21	640.0 / 24

8 sections of these with downwards-tilted echo-transducer:

Depth / Tilting Angle

600.0 / 6	600.0 / 12	600.0 / 18	600.0 / 24	600.0 / 30	600.0 / 36
600.0 / 42	600.0 / 48				

Vertical sections

The shape of the cavern was determined by interpretation of all horizontally and tilted measured data and is presented by 36 vertical sections in this report.

Maximum plots (top view)

The maximum plot presents the largest extension of the cavern in a top view. The first picture shows the areas of all horizontal sections and the area resulting out of the vertical sections (hatched). The resulting total area is shown in the second picture (cross hatching) together with the largest single area.

In both pictures the total centre of gravity of the cavern is shown with its distance and its direction referring to the measuring axis.
The total centre of gravity is derived out of the envelope, which is the connection line of the largest cavern extension in every direction

Perspective views

Several perspective drawings are included in this report to give a quick review of detailed relations.

Pockets in the cavern wall

Pockets in the cavern wall, which have been identified by the tilted echo-transducer, were transferred from the vertical sections to the respective horizontal sections.
The resulting additional areas have been added to the calculated areas.

LOG - Data

You will find the graphic representations of the following LOG data at the end of this report:

Parameter	from	to
CCL:	589’	498’
Temperature:	500’	640’
Pressure:	500’	640’
Speed of sound:	500’	640’

LEGEND

■	Measured point recorded with horizontal adjusted ultrasonic transducer
○	Measured point recorded with tilted or vertical orientated ultrasonic transducer
▲	Interpolated point derived from the vertical sections
—	Connection line between two measured points in order to calculate the volume
- -	Assumed connection line (in areas which are not sufficiently covered by measured points)
N	Magnetic north determined with compass inside the tool (magnetic compass in areas without tubings) (fibre gyro compass in areas with tubings)
(N)	Assumed north direction (for sections in magnetic disturbed surroundings without fibre gyro compass)
a	Longest extension in section (without considering of hidden leached pockets)
b	Longest extension in section perpendicular to a (without considering of hidden leached pockets)
a/b	Ratio of longest extensions in section which are perpendicular to each other
(xx m²)	Area in actual section resulting from hidden leached pockets
r~	Average radius

Volume list

Depth (ft)	Radius (ft)	Area (ft^2)	Depth range (ft) from	to	Volume (bbls.) partial	total
525.0	16.1	813	525.0	527.5	362	362
530.0	15.3	733	527.5	535.0	979	1340
540.0	14.2	630	535.0	545.0	1122	2462
550.0	15.6	767	545.0	555.0	1366	3828
560.0	16.6	865	555.0	565.0	1540	5368
570.0	20.1	1269	565.0	575.0	2260	7628
580.0	20.7	1343	575.0	585.0	2392	10021
590.0	23.7	1765	585.0	592.5	2357	12378
595.0	26.0	2125	592.5	597.5	1892	14270
600.0	30.4	2906	597.5	602.5	2588	16858
605.0	31.0	3023	602.5	607.5	2692	19549
610.0	29.7	2778	607.5	612.5	2474	22023
615.0	36.3	4147	612.5	617.5	3693	25717
620.0	41.7	5451	617.5	622.5	4854	30571
625.0	68.0	14511	622.5	627.5	12922	43493
630.0	61.9	12028	627.5	632.5	10711	54204
635.0	51.1	8196	632.5	637.5	7299	61502
640.0	35.1	3868	637.5	641.5	2756	64258
643.0	24.8	1929	641.5	643.5	687	64945
644.0	18.4	1060	643.5	645.0	283	65228
646.0	11.4	409	645.0	647.0	146	65374
648.0	7.8	190	647.0	649.0	68	65442
650.0	5.0	78	649.0	650.0	14	65456

Propane Well #1 --> 0° <--

Propane Well #1 --> 60° <--

Propane Well #1 --> 120° <--

Propane Well #1 --> 180° <--

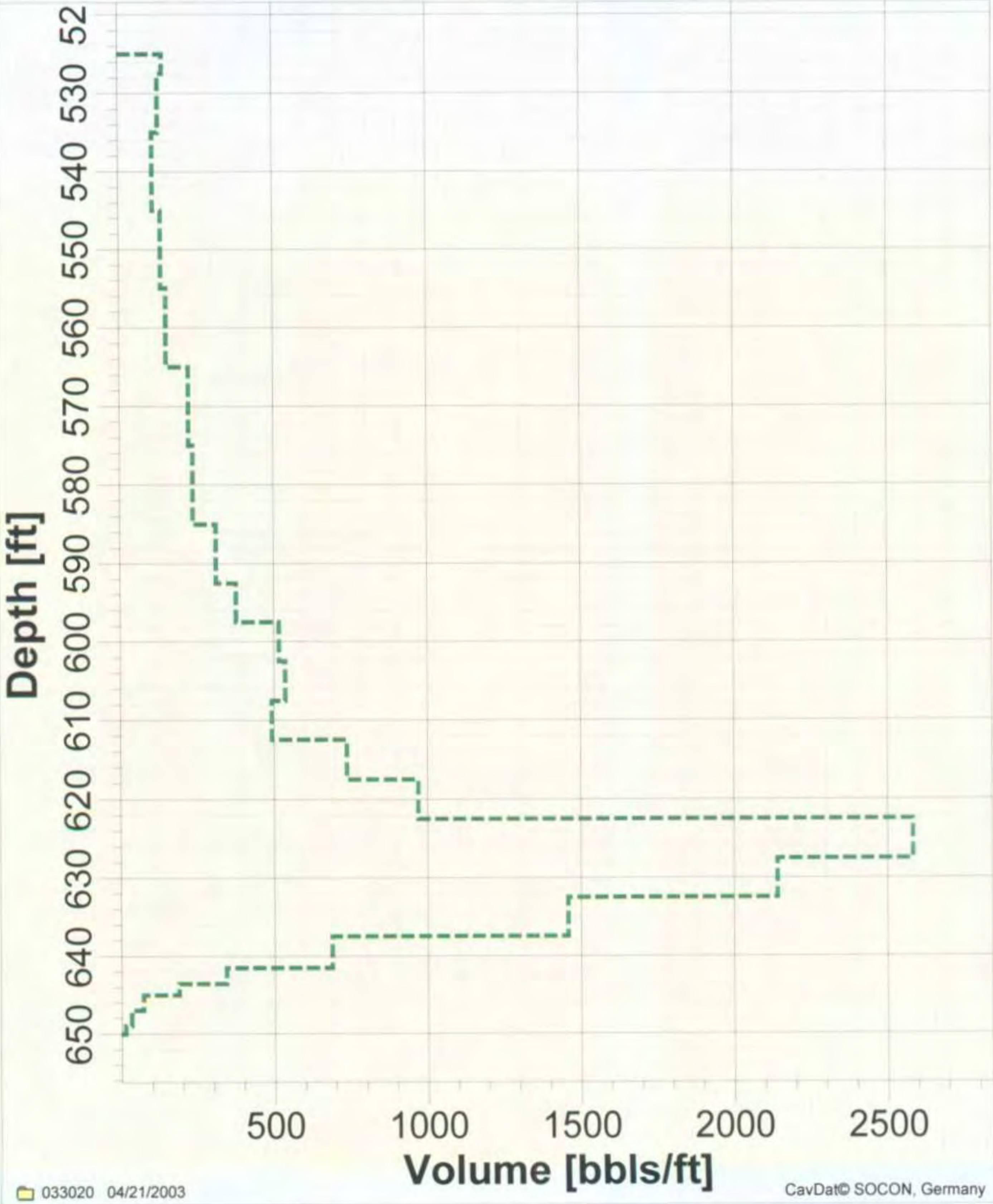
Propane Well #1 --> 240° <--

Propane Well #1 --> 300° <--

SOCON Cavity Control, Inc.

SOCON

Propane Well #1 **PARTIAL VOLUME** **04/21/2003**



033020 04/21/2003

CavDat© SOCON, Germany

Partial volume

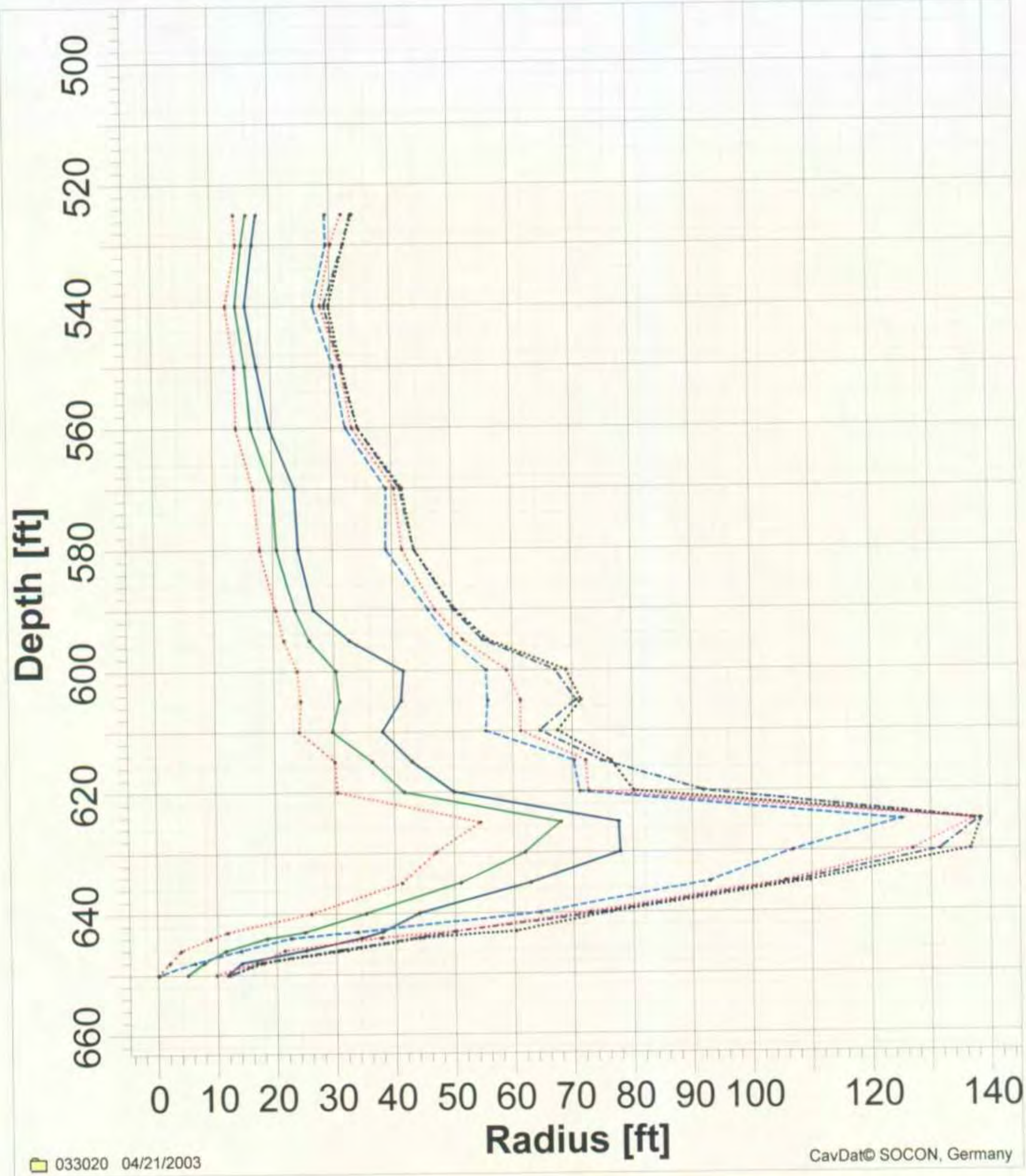
Job-No.: 033020, Name: Propane Well #1, Date: 04/21/2003

depth [ft]	volume [bbls]	depth [ft]	volume [bbls]	depth [ft]	volume [bbls]	depth [ft]	volume [bbls]	depth [ft]	volume [bbls]
525	0	526	145	527	289	528	427	529	558
530	688	531	818	532	949	533	1079	534	1210
535	1340	536	1453	537	1565	538	1677	539	1789
540	1901	541	2013	542	2125	543	2238	544	2350
545	2462	546	2599	547	2735	548	2872	549	3008
550	3145	551	3282	552	3418	553	3555	554	3691
555	3828	556	3982	557	4136	558	4290	559	4444
560	4598	561	4752	562	4906	563	5060	564	5214
565	5368	566	5594	567	5820	568	6046	569	6272
570	6498	571	6724	572	6950	573	7176	574	7402
575	7628	576	7867	577	8107	578	8346	579	8585
580	8824	581	9064	582	9303	583	9542	584	9781
585	10021	586	10335	587	10649	588	10963	589	11278
590	11592	591	11906	592	12221	593	12567	594	12945
595	13324	596	13702	597	14081	598	14529	599	15046
600	15564	601	16081	602	16599	603	17127	604	17665
605	18204	606	18742	607	19280	608	19797	609	20292
610	20786	611	21281	612	21776	613	22393	614	23131
615	23870	616	24609	617	25347	618	26202	619	27173
620	28144	621	29114	622	30085	623	31863	624	34447
625	37032	626	39616	627	42200	628	44564	629	46706
630	48848	631	50990	632	53133	633	54933	634	56393
635	57853	636	59313	637	60772	638	61847	639	62536
640	63225	641	63913	642	64430	643	64773	644	65040
645	65228	646	65301	647	65374	648	65408	649	65442

SOCON Cavity Control, Inc.

SOCON

Propane Well #1 **RADII / DIAMETERS** **04/21/2003**



033020 04/21/2003

CavDat© SOCON, Germany

Average radius
Minimum radius
Maximum radius
Minimum diameter
Maximum diameter
Largest extension
Largest perpendicular extension

SOCON Cavity Control, Inc.

SOCON

Table of radii and diameters

Cavity: Propane Well #1 033020 04/21/2003

Depth	Radius [MIN]		Radius [MAX]		Diameter [MIN]		[MAX]	
[ft]	[ft]	[°]	[ft]	[°]	[ft]	[°]	[ft]	[°]
525.0	14.0	5	17.8	290	29.4	5 <-> 185	33.7	110 <-> 290
530.0	14.3	187	17.1	64	29.5	5 <-> 185	32.4	64 <-> 244
540.0	12.4	230	15.8	90	27.2	150 <-> 330	29.1	105 <-> 285
550.0	13.9	220	17.6	70	30.5	95 <-> 275	31.7	75 <-> 255
560.0	14.0	250	19.7	40	32.5	26 <-> 206	34.5	40 <-> 220
570.0	16.8	235	23.8	64	39.2	124 <-> 304	41.5	155 <-> 335
580.0	17.8	230	24.3	60	39.0	90 <-> 270	43.7	105 <-> 285
590.0	20.4	290	26.7	95	46.0	40 <-> 220	50.2	135 <-> 315
595.0	21.7	260	32.7	110	49.8	175 <-> 355	55.1	110 <-> 290
600.0	23.9	255	41.8	110	55.7	60 <-> 240	67.2	110 <-> 290
605.0	24.4	274	41.3	110	55.9	65 <-> 245	70.7	165 <-> 345
610.0	24.2	237	38.1	105	55.5	5 <-> 185	64.6	110 <-> 290
615.0	30.1	280	43.1	50	70.3	135 <-> 315	74.8	55 <-> 235
620.0	30.5	270	50.1	105	71.2	90 <-> 270	91.9	45 <-> 225
625.0	54.4	214	77.7	85	125.2	34 <-> 214	138.2	85 <-> 265
630.0	46.9	215	77.9	60	106.8	35 <-> 215	131.6	95 <-> 275
635.0	41.2	235	62.8	69	92.9	30 <-> 210	107.4	126 <-> 306
640.0	25.9	265	44.0	89	64.5	115 <-> 295	75.1	164 <-> 344
643.0	11.7	255	37.9	95	33.6	174 <-> 354	50.2	95 <-> 275
644.0	8.9	323	34.3	75	22.4	150 <-> 330	44.0	75 <-> 255
646.0	3.9	315	24.9	75	14.0	135 <-> 315	30.6	75 <-> 255
648.0	2.0	315	14.1	75	6.2	135 <-> 315	17.4	90 <-> 270
650.0	0.1	315	11.7	90	0.3	135 <-> 315	12.1	90 <-> 270

SOCON Cavity Control, Inc.

Table of radii in N-E-S-W-NE-SE-SW-NW presentation

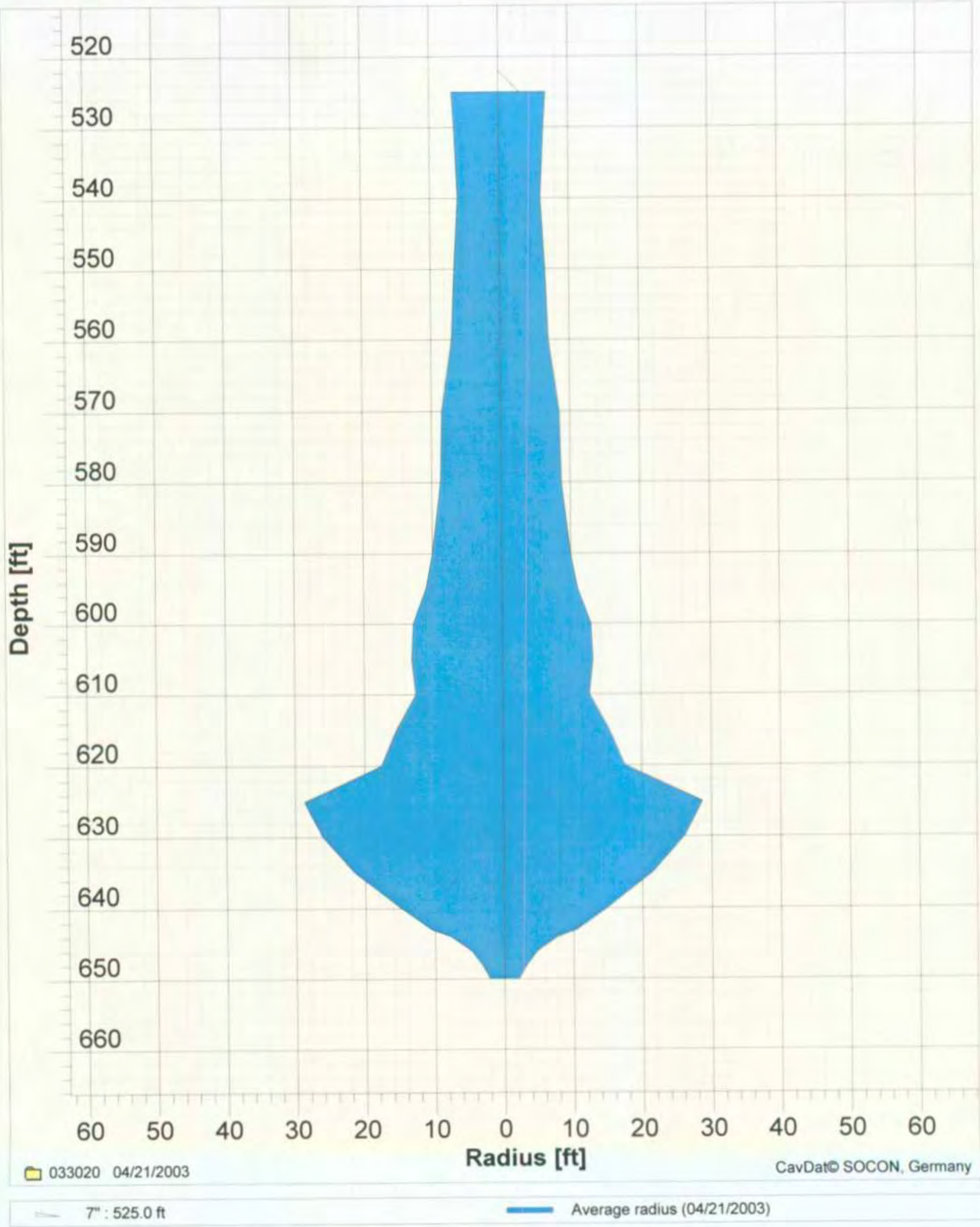
Cavity: Propane Well #1 033020 04/21/2003

Depth [ft]	<R> [ft]	N [ft]	E [ft]	S [ft]	W [ft]	NE [ft]	SE [ft]	SW [ft]	NW [ft]
525.0	16.1	14.3	15.7	15.3	17.2	15.8	15.9	16.3	17.1
530.0	15.3	15.1	16.2	14.6	14.6	16.5	15.3	14.5	15.0
540.0	14.2	14.6	15.8	13.3	13.3	15.0	13.9	12.7	14.6
550.0	15.6	16.1	17.3	14.5	14.0	17.2	15.9	14.3	14.9
560.0	16.6	17.5	18.5	15.6	14.6	18.2	17.1	14.7	15.4
570.0	20.1	21.5	22.3	18.7	17.1	22.9	20.9	17.1	18.7
580.0	20.7	21.3	21.2	19.5	17.8	22.8	22.0	18.5	18.7
590.0	23.7	24.3	26.3	22.6	20.8	25.8	26.2	21.4	24.0
595.0	26.0	26.4	29.8	23.7	23.7	29.1	27.7	22.3	23.7
600.0	30.4	33.8	37.3	27.7	25.4	35.2	29.1	25.2	28.7
605.0	31.0	29.7	35.3	27.8	24.5	33.5	32.5	25.2	28.6
610.0	29.7	29.5	31.9	27.0	24.5	32.2	29.4	26.3	28.3
615.0	36.3	37.7	39.8	34.5	32.1	42.6	36.9	31.2	33.4
620.0	41.7	43.5	40.7	46.3	30.5	44.8	46.2	47.1	34.5
625.0	68.0	67.9	76.1	66.8	60.4	73.7	72.4	59.7	63.1
630.0	61.9	57.5	77.5	59.0	53.2	68.1	72.8	49.5	54.1
635.0	51.1	51.7	55.6	49.6	47.9	58.3	55.2	41.4	49.2
640.0	35.1	34.9	43.6	35.5	28.7	42.2	39.0	28.3	30.3
643.0	24.8	18.5	36.6	16.8	12.3	33.9	31.8	12.9	12.8
644.0	18.4	12.4	32.5	12.2	10.6	25.9	21.9	11.0	9.0
646.0	11.4	6.8	16.9	7.6	7.2	17.0	10.1	7.2	3.9
648.0	7.8	3.4	13.6	4.7	3.8	12.8	4.3	3.6	2.0
650.0	5.0	0.1	11.7	0.2	0.4	8.8	0.2	0.3	0.1

SOCON Cavity Control, Inc.

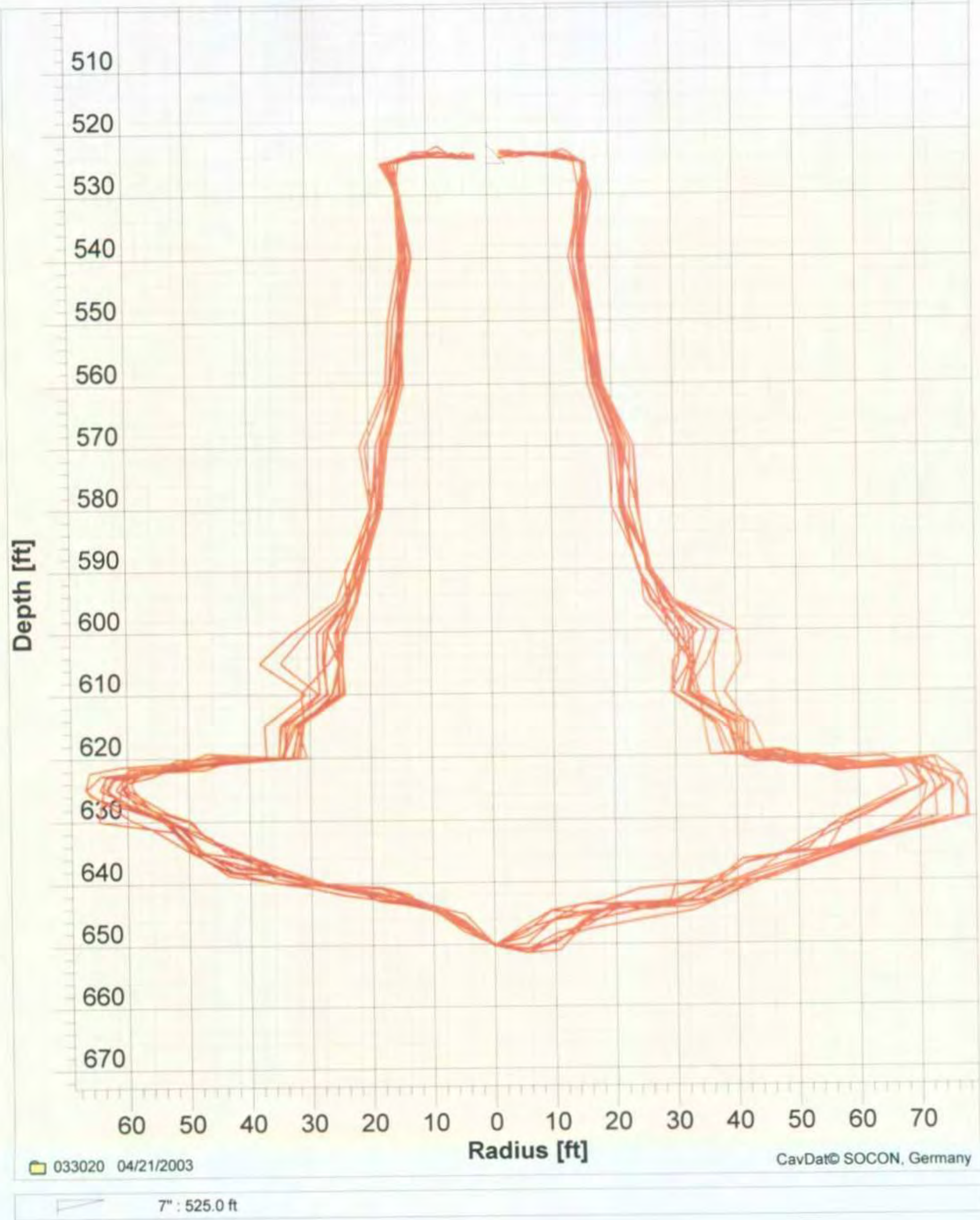
SOCON

Propane Well #1	AVERAGE RADIUS	04/21/2003



SOCON Cavity Control, Inc.

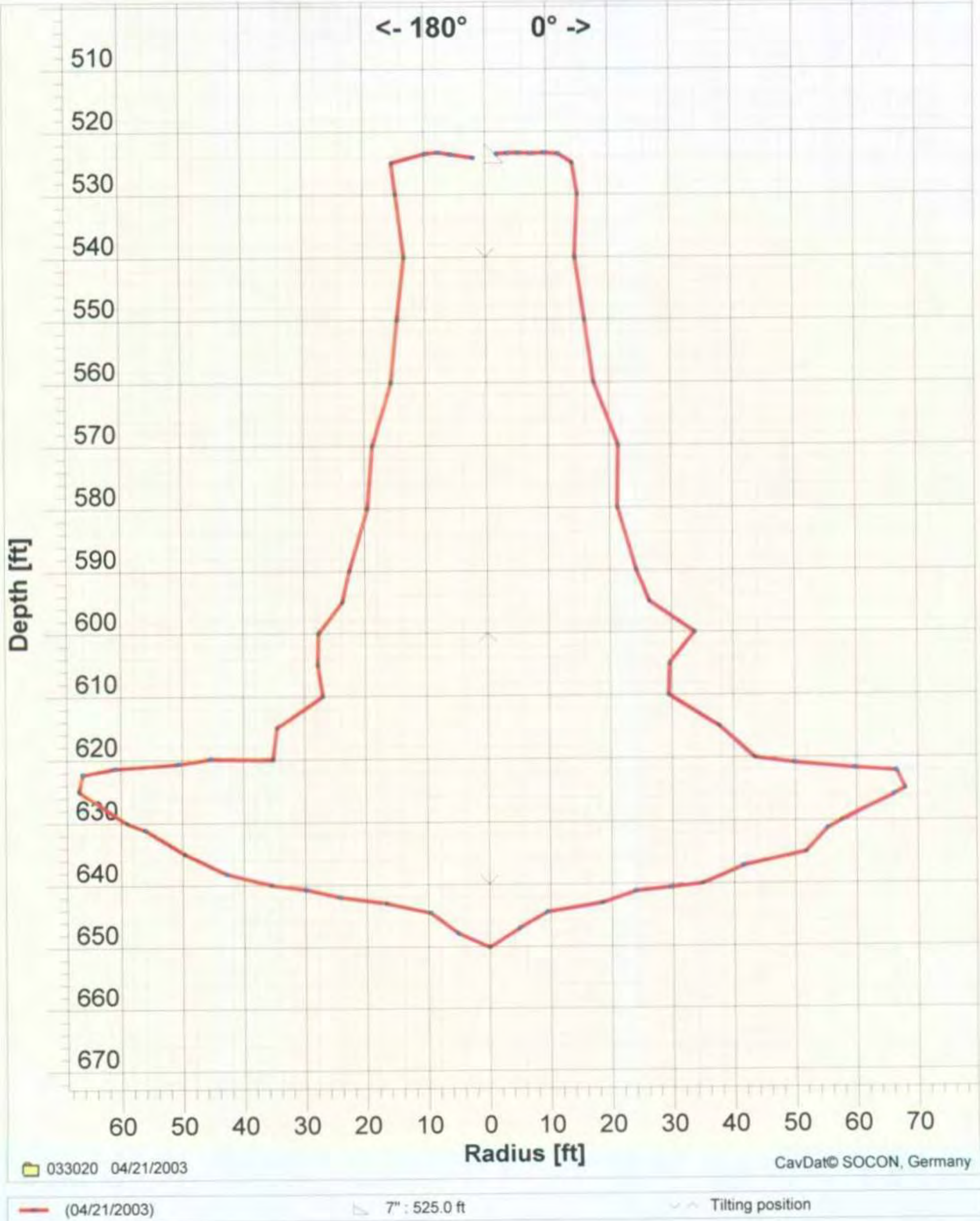
Propane Well #1 **MAXPLOT** **04/21/2003**



SOCON Cavity Control, Inc.

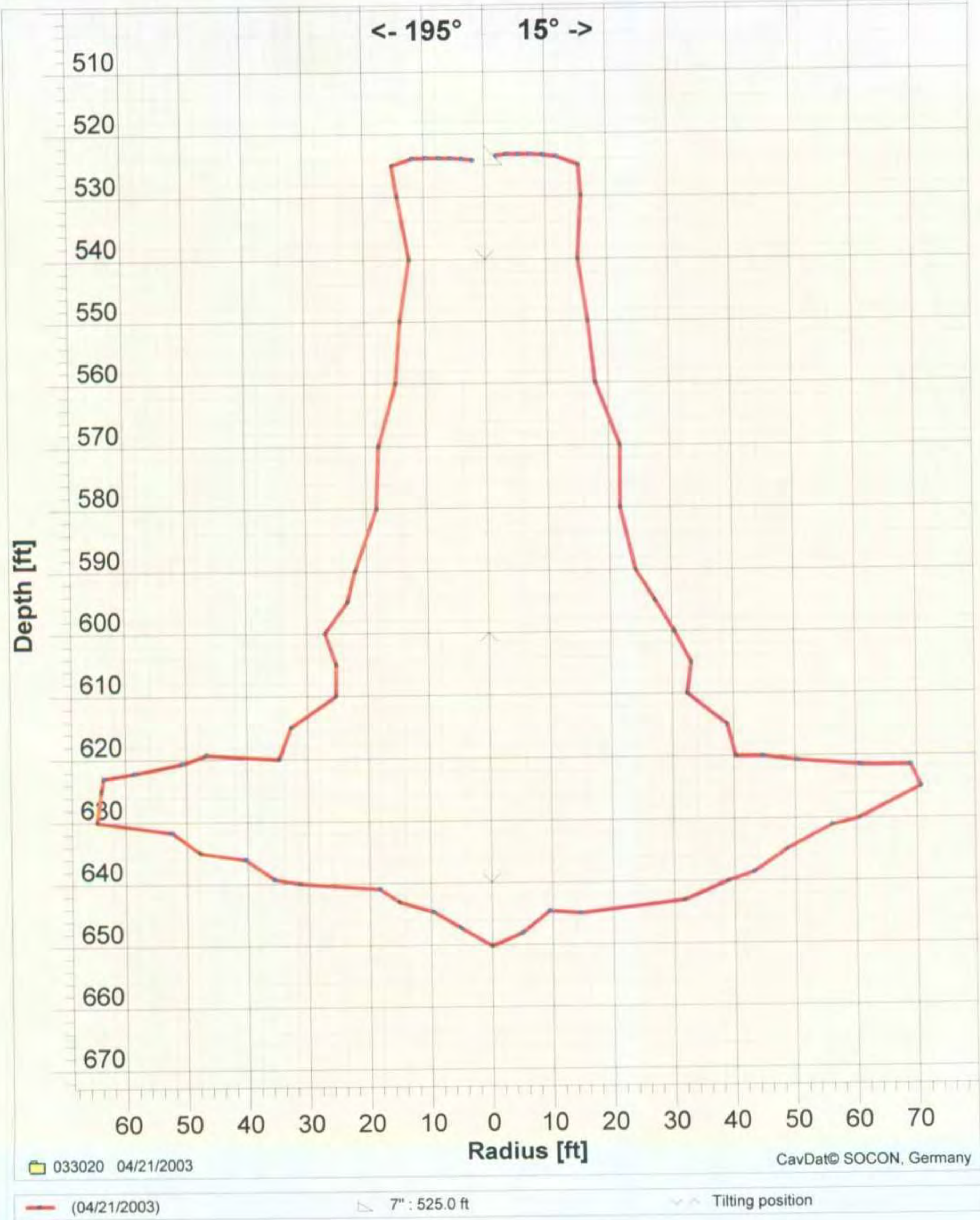
SOCON

Propane Well #1 **04/21/2003**

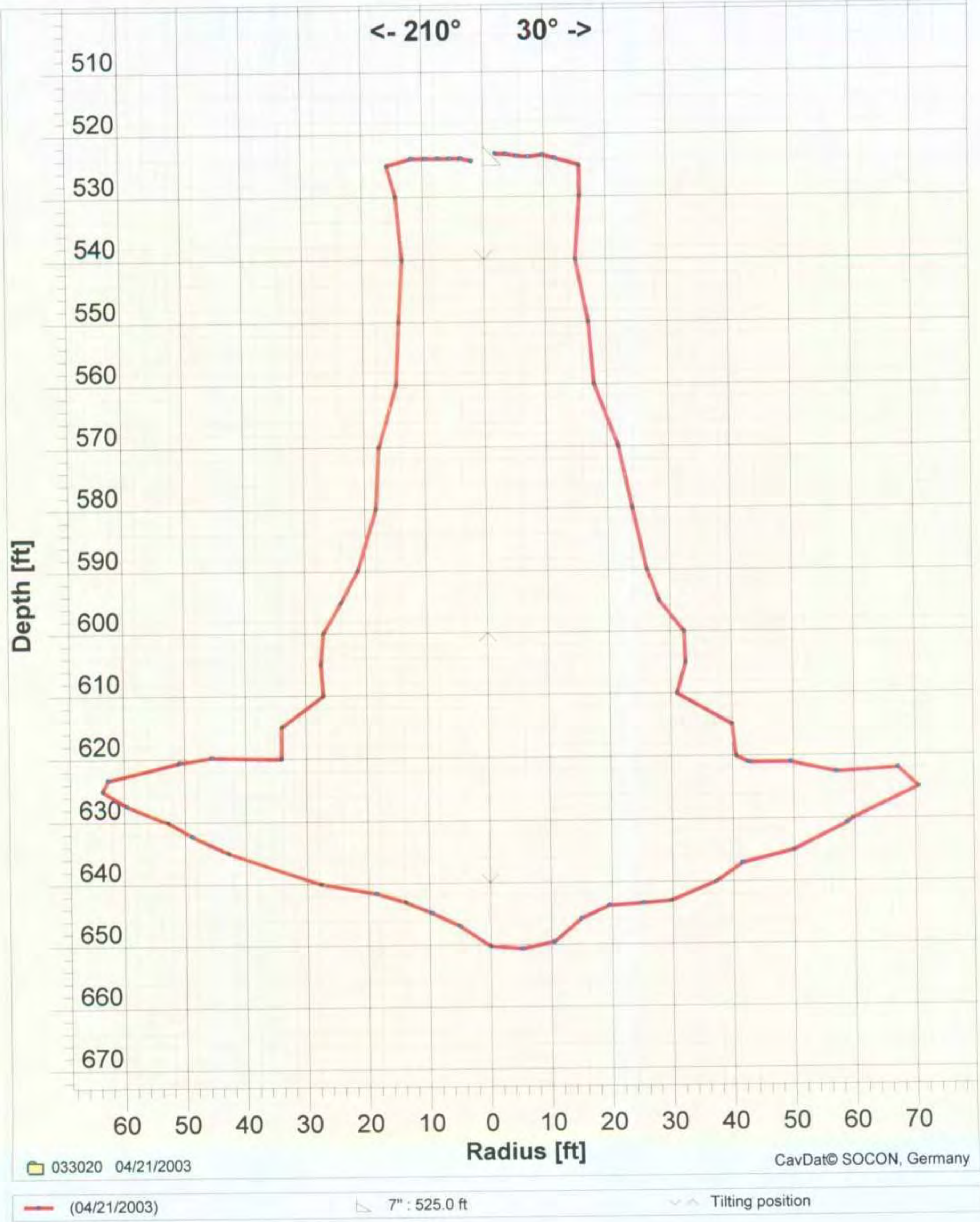


SOCON Cavity Control, Inc.

Propane Well #1 **04/21/2003**



Propane Well #1 **04/21/2003**

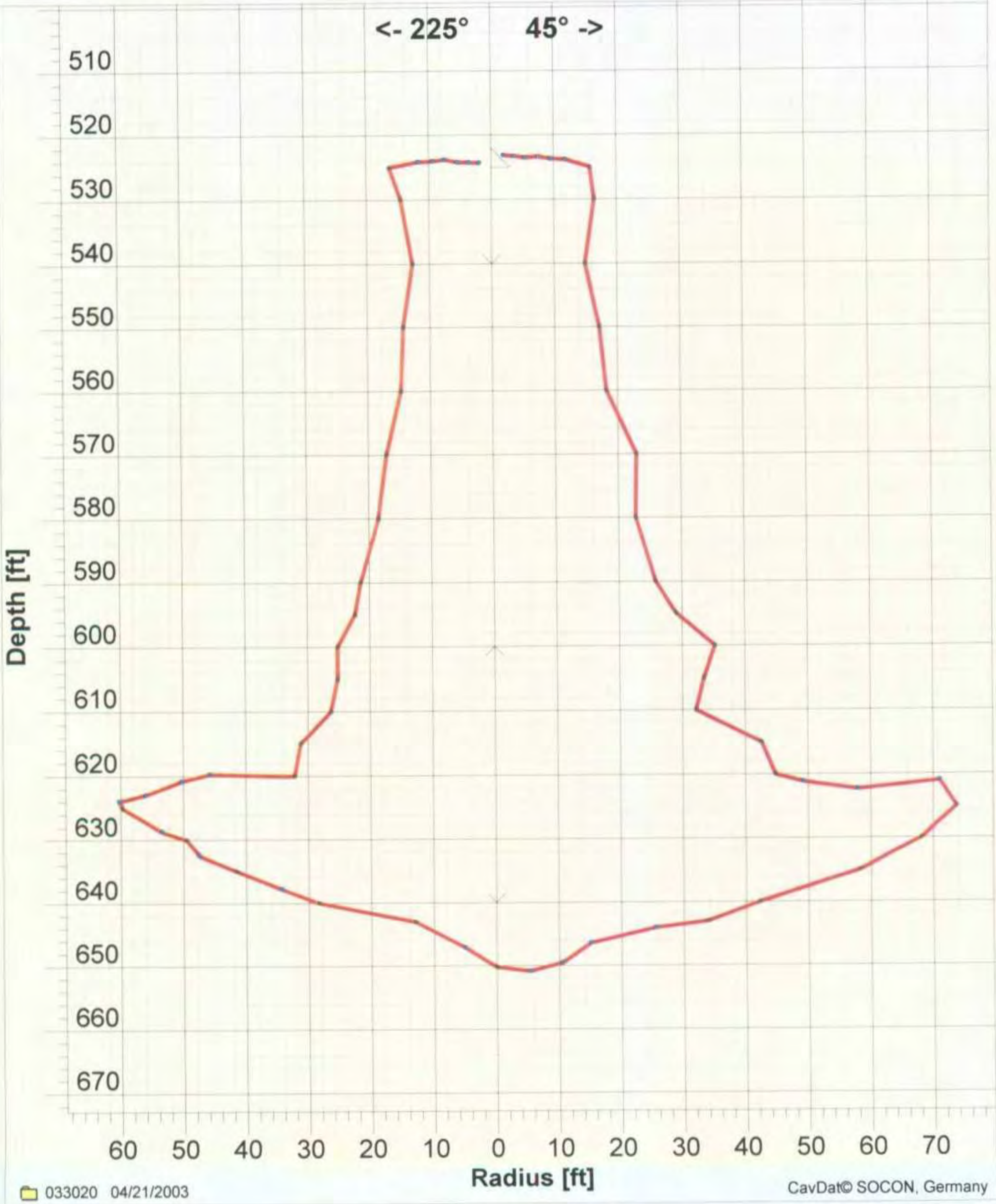


SOCON Cavity Control, Inc.

SOCON

Propane Well #1

04/21/2003



033020 04/21/2003

CavDat© SOCON, Germany

(04/21/2003)

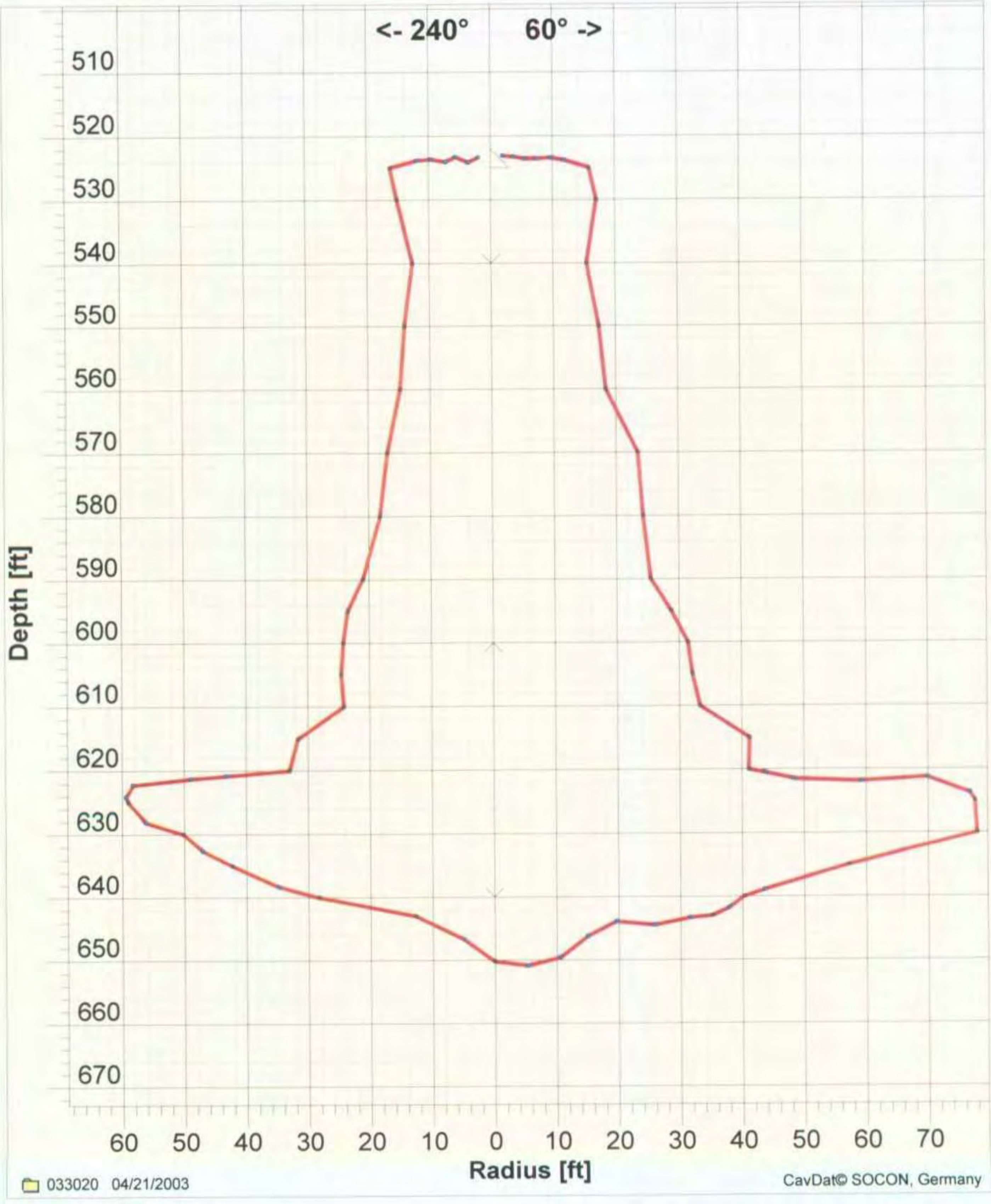
7" : 525.0 ft

Tilting position

SOCON Cavity Control, Inc.

SOCON

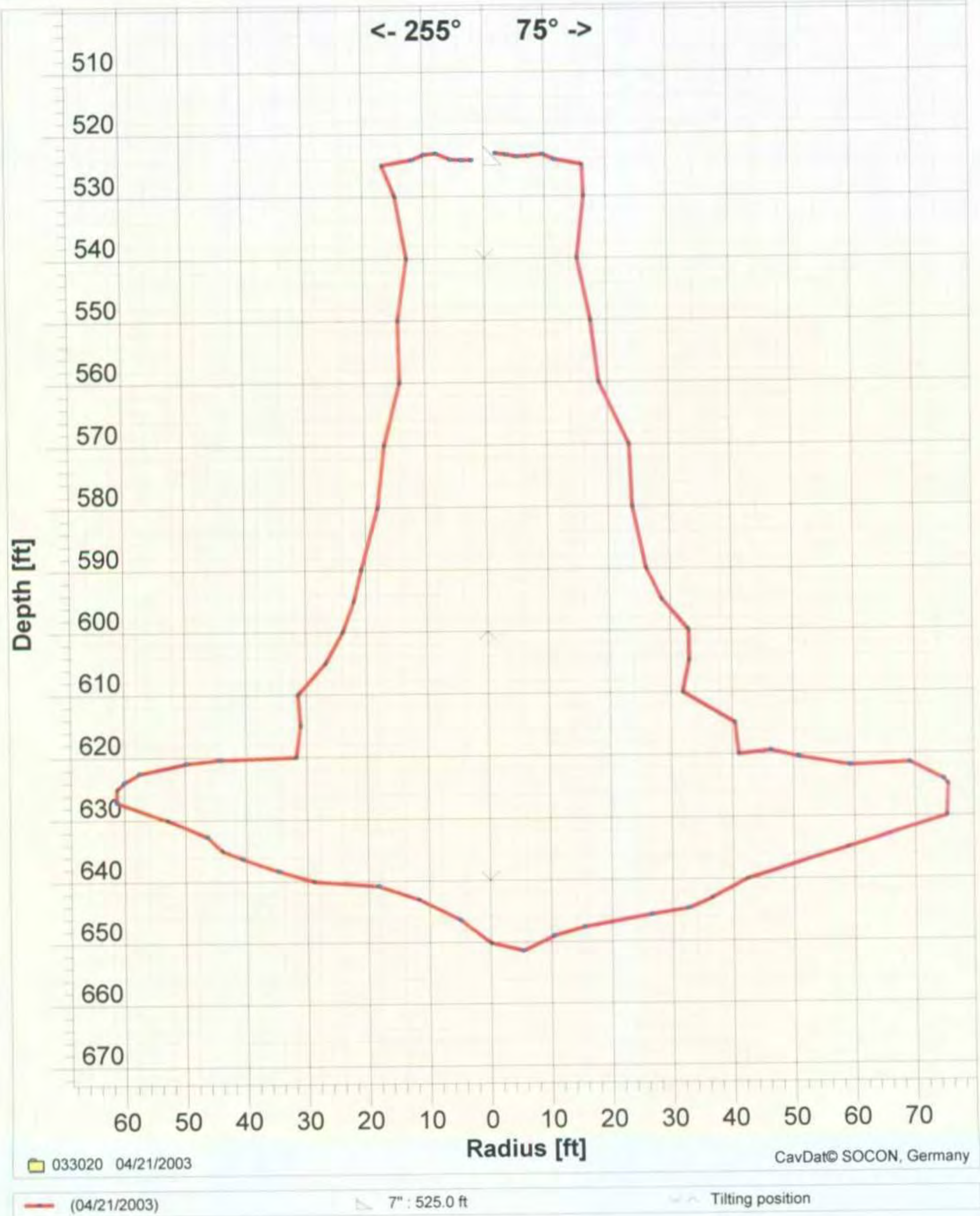
Propane Well #1 04/21/2003



(04/21/2003) 7" : 525.0 ft Tilting position

SOCON Cavity Control, Inc.

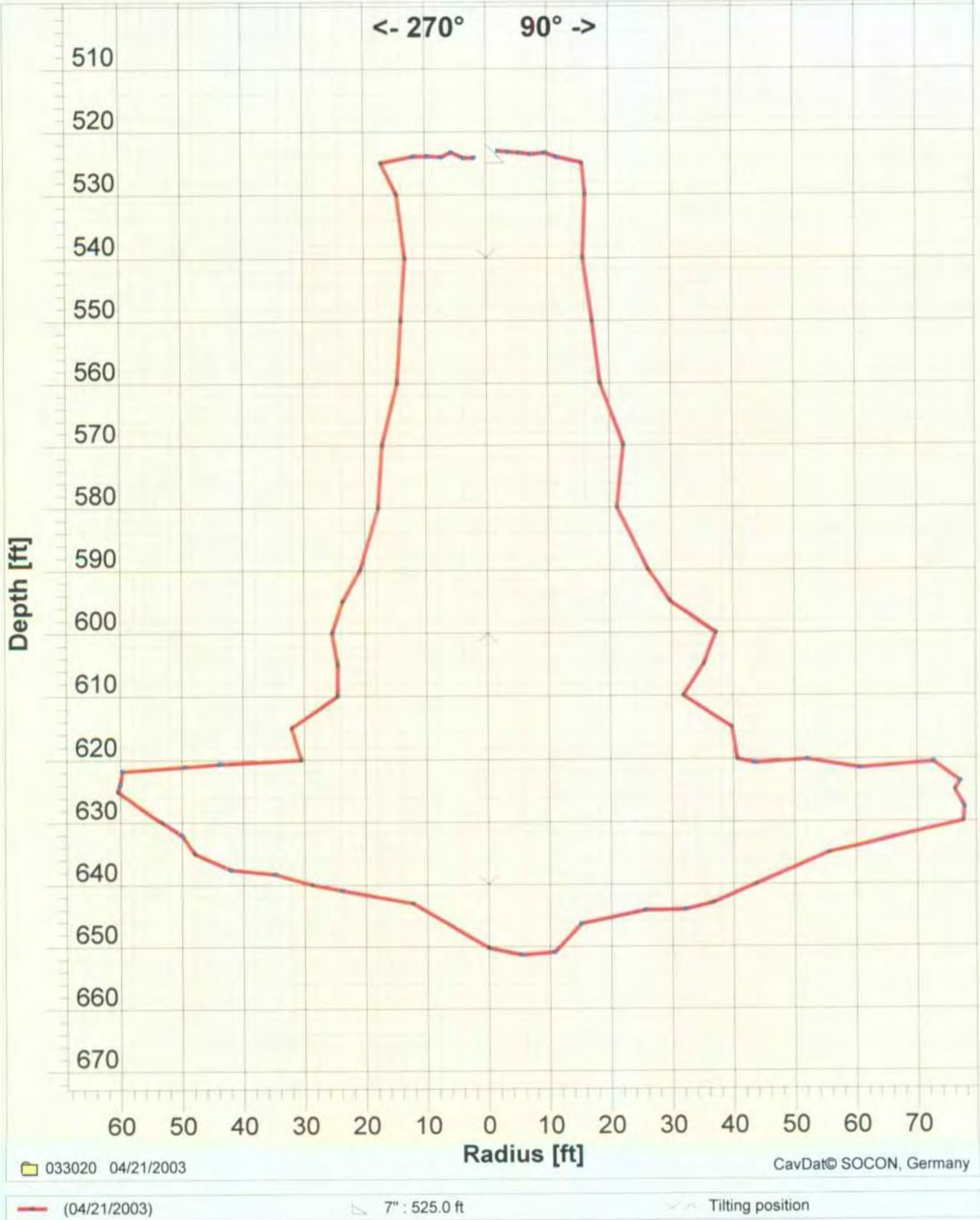
Propane Well #1 04/21/2003



SOCON Cavity Control, Inc.

SOCON

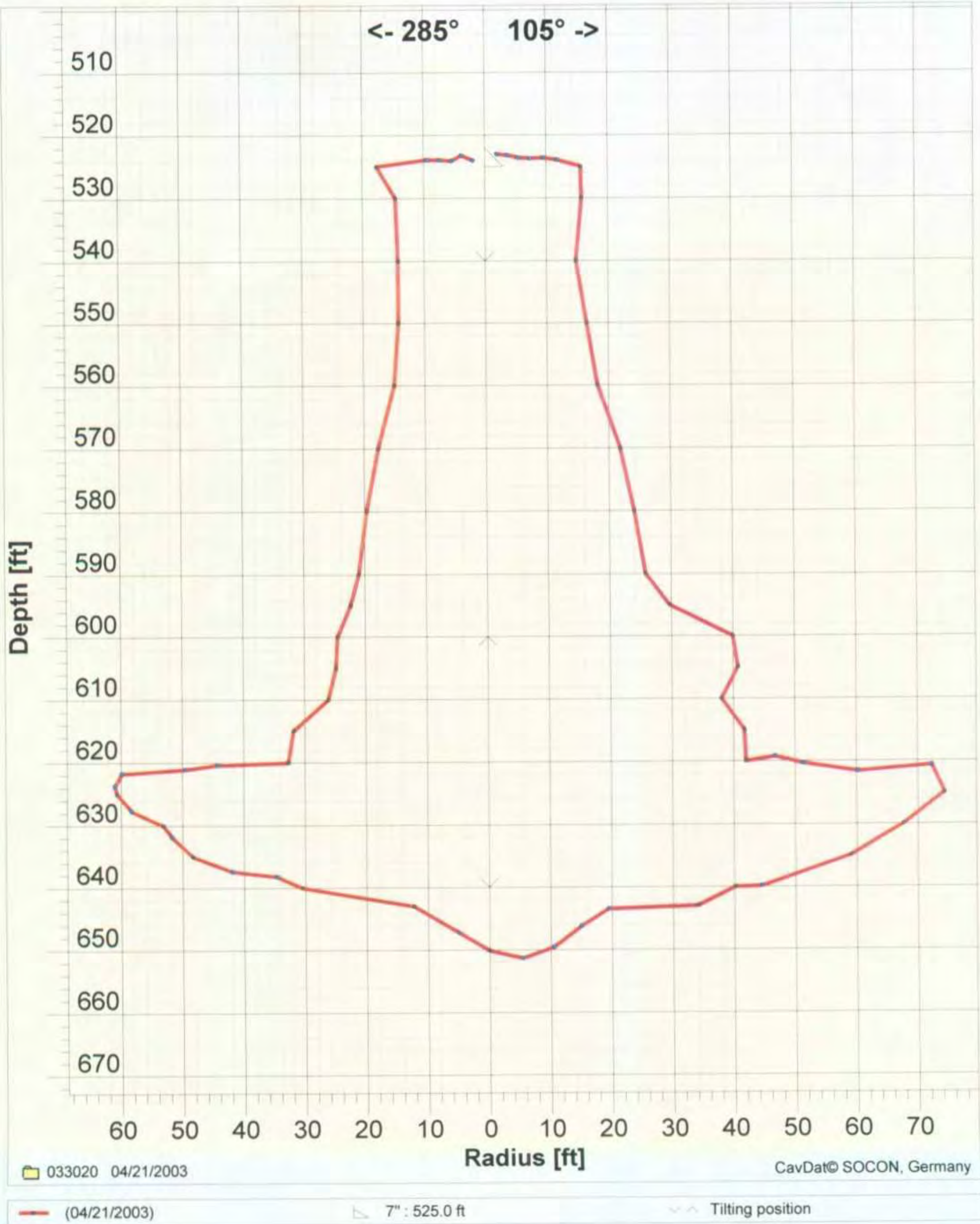
Propane Well #1 04/21/2003



SOCON Cavity Control, Inc.

SOCON

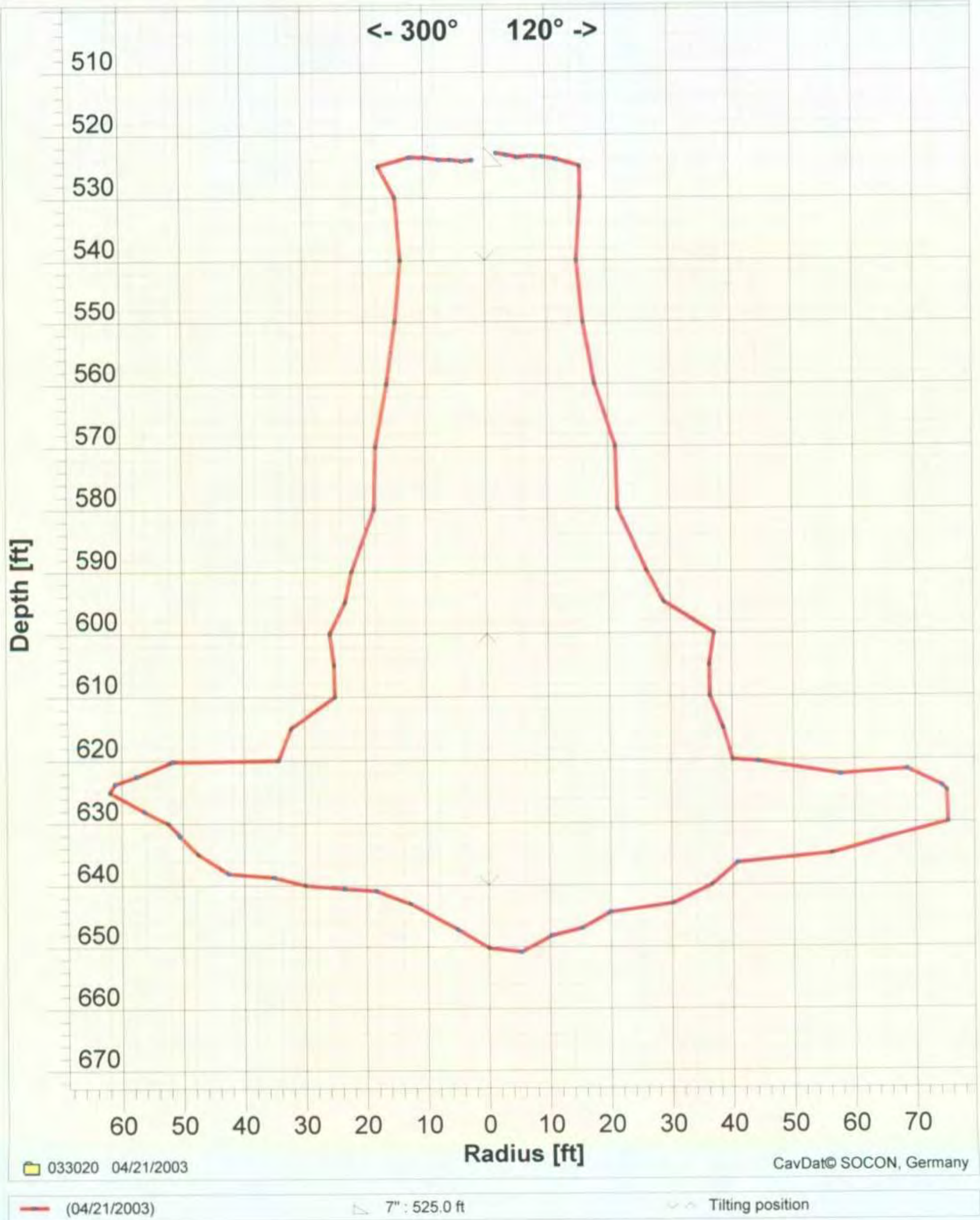
Propane Well #1 **04/21/2003**



SOCON Cavity Control, Inc.

SOCON

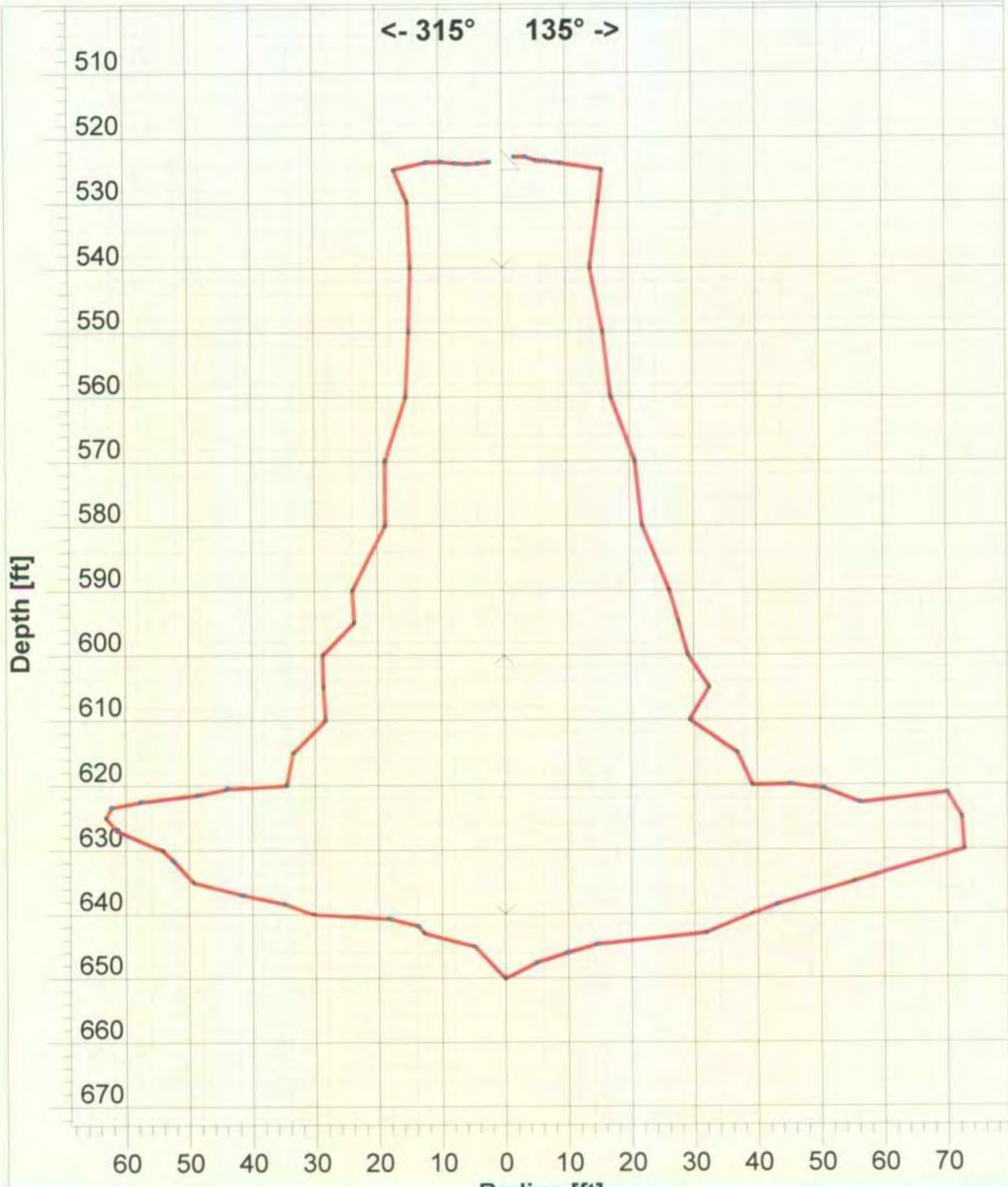
Propane Well #1 04/21/2003



SOCON Cavity Control, Inc.

SOCON

Propane Well #1 04/21/2003



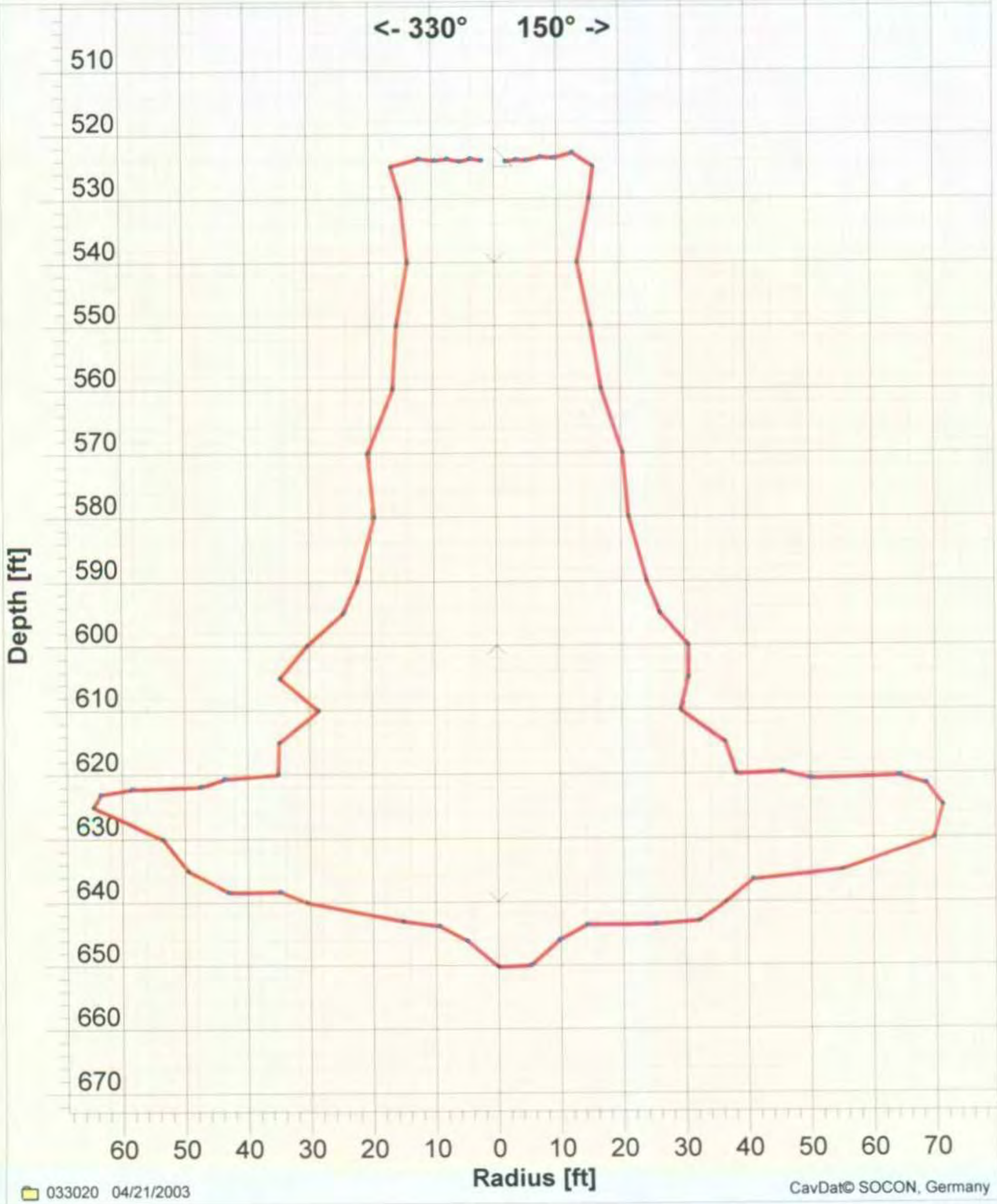
033020 04/21/2003

CavDat© SOCON, Germany

(04/21/2003) 7" : 525.0 ft Tilting position

SOCON Cavity Control, Inc.

Propane Well #1 **04/21/2003**



033020 04/21/2003

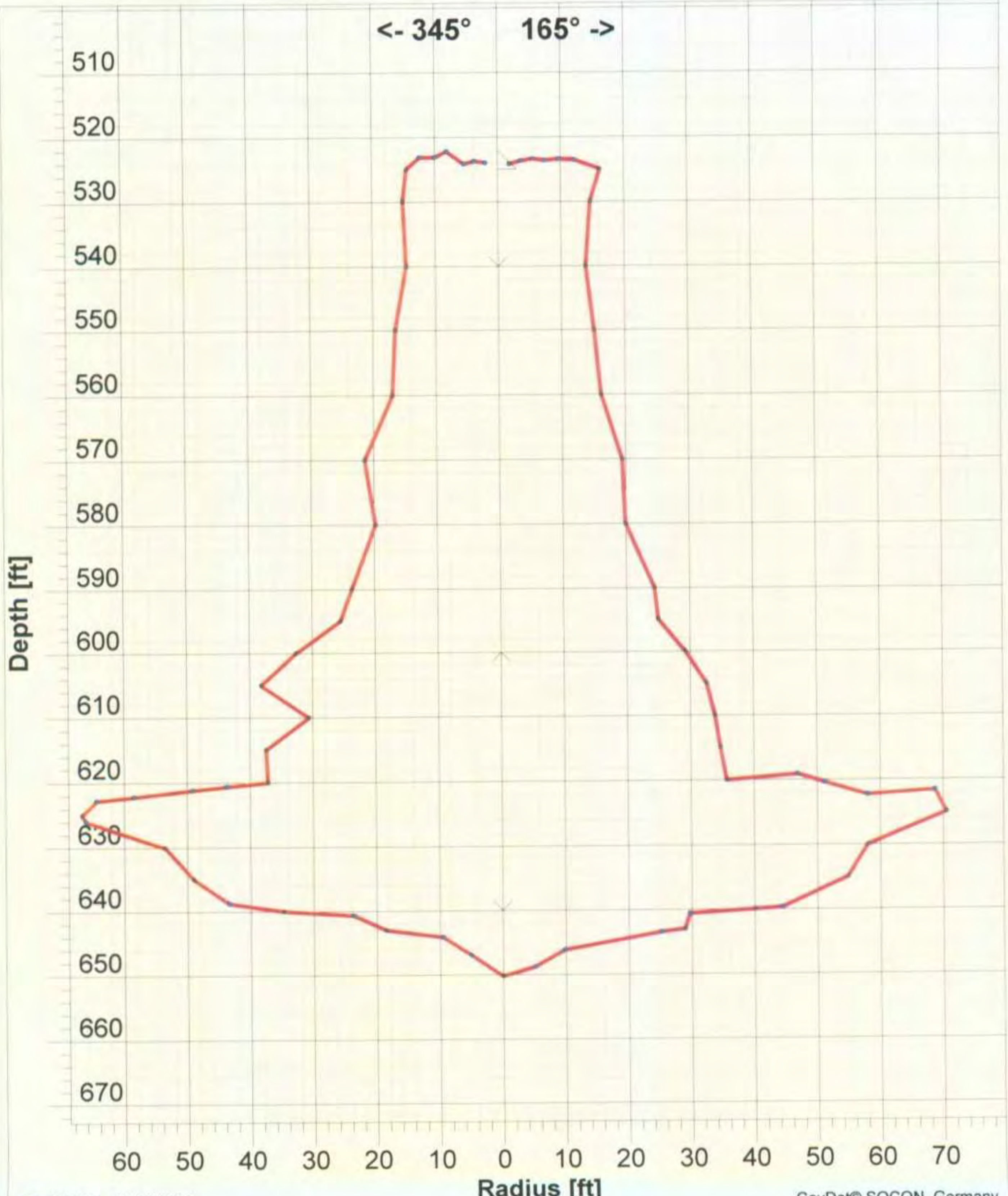
CavDat© SOCON, Germany

(04/21/2003) 7" : 525.0 ft Tilting position

SOCON Cavity Control, Inc.

SOCON

Propane Well #1 **04/21/2003**



033020 04/21/2003

CavDat© SOCON, Germany

(04/21/2003) 7" : 525.0 ft Tilting position

HORIZONTAL SECTIONS

Cavern: Propane Well #1 Report No.: 033020

Utilized speed of sound: 1798.0 m/s (5899.0 ft/s)

Measuring date: 04/21/2003 Scale: 1 :100

Horizontal sections measured at following depths:

525.0 ft	530.0 ft	540.0 ft	550.0 ft	560.0 ft	570.0 ft	580.0 ft
590.0 ft	595.0 ft	600.0 ft	605.0 ft	610.0 ft	615.0 ft	620.0 ft
625.0 ft	630.0 ft	635.0 ft	640.0 ft	643.0 ft		

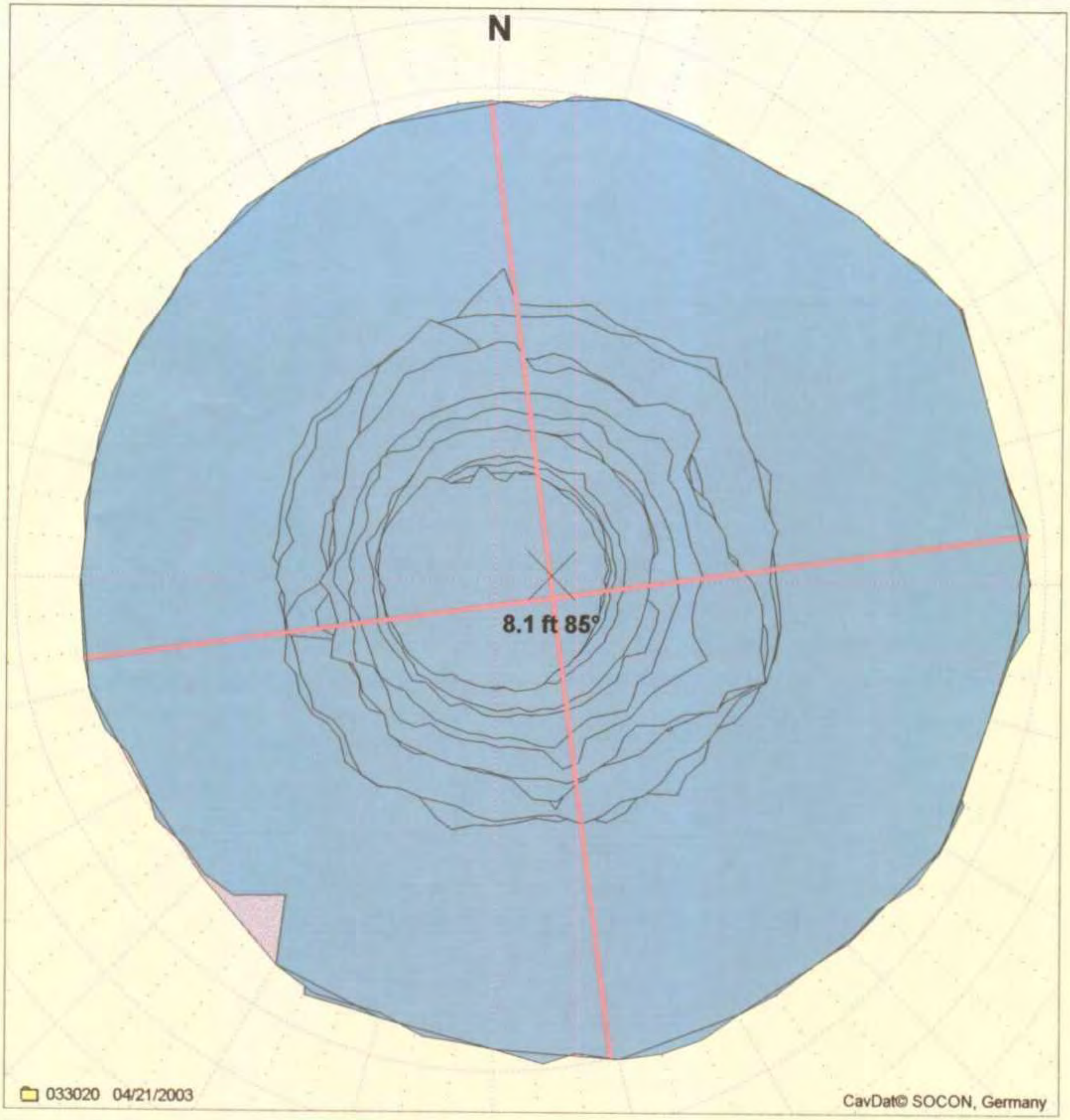
The following 4 sections are constructed:

644.0 ft	646.0 ft	648.0 ft	650.0 ft

SOCON Cavity Control, Inc.

SOCON

Propane Well #1 **MAXPLOT** **04/21/2003**



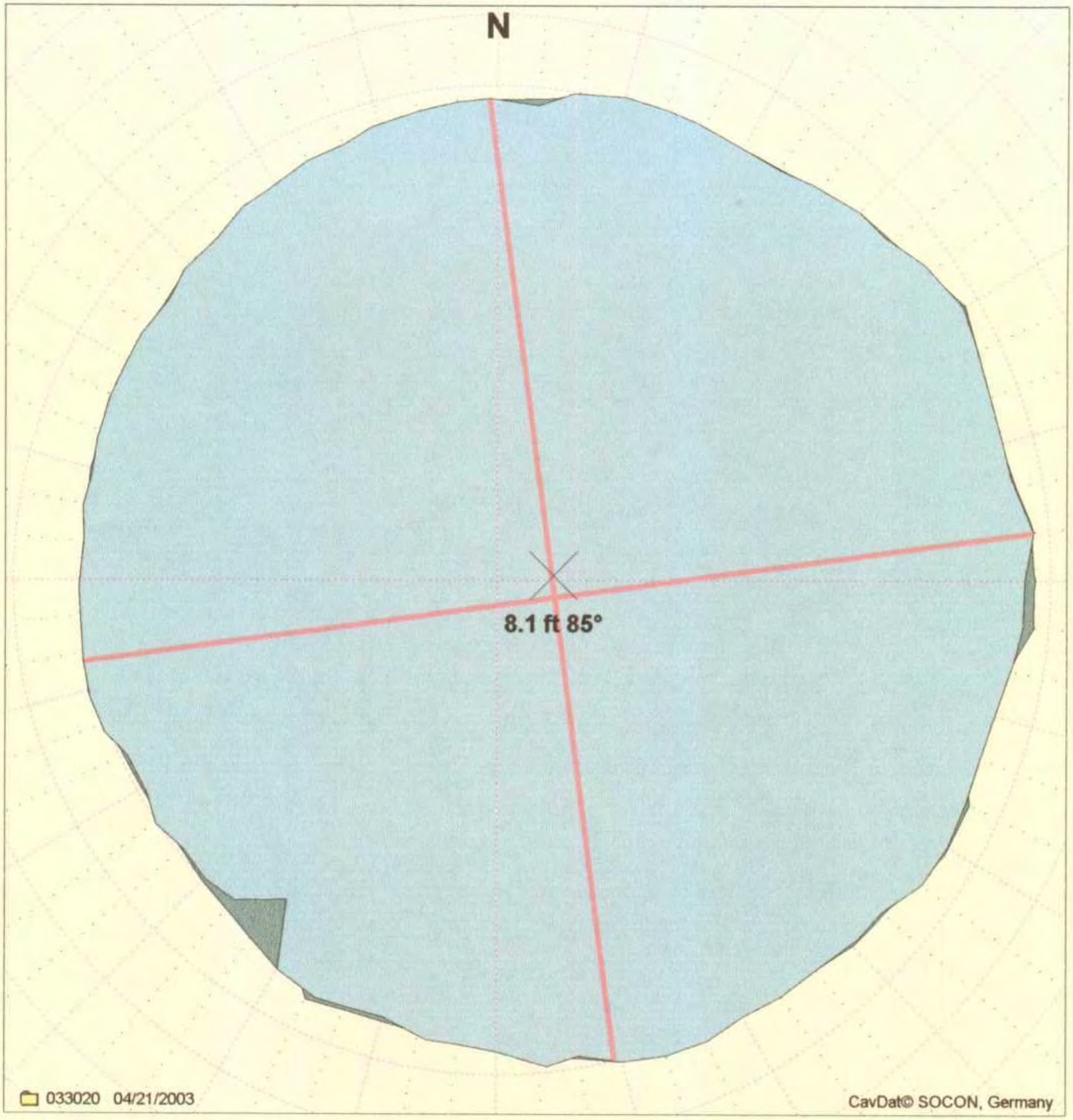
Vertical maximum plot | Horizontal sections | a/b
Center of gravity

d_{max}: 138.2 ft 85° <--> 265° r_{min}: 59.3 ft -> 239° r~: 0.0 ft r_{max}: 77.9 ft -> 60°

a/b = 1.008 a = 138.53 ft (84°-259°) b = 137.38 ft (165°-359°)

Area from vertical sections: 14454 ft², Area from horizontal and vertical sections: 14595 ft²

Propane Well #1 **MAXPLOT** **04/21/2003**



a/b — Center of gravity — Horizontal/vertical maximum plot — Largest single area

d_{max}: 138.2 ft 85° <--> 265° r_{min}: 59.3 ft -> 239° r~: 0.0 ft r_{max}: 77.9 ft -> 60°

a/b = 1.008 a = 138.53 ft (84°-259°) b = 137.38 ft (165°-359°)

Largest single area: 14511 ft² in depth: 625.0 ft, Area from horizontal and vertical sections: 14595 ft²

Table of radii

Cavity: Propane Well #1 33020 4/21/2003

Depth: 525.0 ft

[°]	Radii in [ft]									
0	14.3	14.1	14.3	15.2	15.5	15.5	15.8	15.9	15.8	15.8
30	15.8	15.7	15.6	15.5	15.6	15.8	15.9	15.8	15.7	15.7
60	15.9	15.7	15.7	15.8	16.0	16.2	16.1	16.1	16.3	16.0
90	15.7	15.9	15.9	15.4	15.5	15.6	15.7	15.8	15.7	15.6
120	15.6	15.8	15.8	15.9	15.9	15.9	16.0	15.9	15.7	15.7
150	15.9	16.2	16.4	16.4	16.3	16.2	16.1	15.9	15.5	15.3
180	15.3	15.4	15.4	15.4	15.3	15.3	15.2	15.1	15.0	15.3
210	15.9	16.2	16.3	16.3	16.3	16.3	16.4	16.5	16.4	16.3
240	16.2	16.2	16.3	16.5	16.7	16.7	16.7	16.7	16.4	16.6
270	17.2	17.2	17.3	17.3	17.4	17.7	17.7	17.8	17.6	17.5
300	17.4	17.3	17.3	17.2	17.1	17.1	17.1	17.3	17.5	17.1
330	16.5	15.5	14.9	14.7	14.4	14.5	15.3	16.2	15.9	14.9

Depth: 530.0 ft

[°]	Radii in [ft]									
0	15.1	15.2	15.2	15.3	15.5	15.9	15.9	15.9	15.7	15.7
30	15.8	15.8	15.9	16.3	16.4	16.5	16.5	16.5	16.7	16.8
60	17.0	17.1	17.0	16.8	16.6	16.4	16.6	16.6	16.7	16.5
90	16.2	16.0	15.8	15.8	15.8	15.7	15.6	15.6	15.6	15.7
120	15.7	15.5	15.4	15.4	15.3	15.3	15.3	15.3	15.3	15.3
150	15.2	15.0	14.9	14.9	14.8	14.7	14.8	14.9	14.9	14.8
180	14.6	14.4	14.3	14.3	14.3	14.4	14.4	14.4	14.4	14.4
210	14.4	14.4	14.4	14.5	14.5	14.5	14.5	14.5	14.7	14.9
240	15.2	15.2	15.2	15.0	14.8	14.6	14.7	14.6	14.6	14.6
270	14.6	14.5	14.5	14.6	14.6	14.6	14.6	14.6	14.6	14.6
300	14.7	14.6	14.7	14.9	14.9	15.0	14.9	14.9	14.8	14.9
330	14.9	15.1	15.1	15.1	15.1	15.1	15.1	15.2	15.2	15.1

Depth: 540.0 ft

[°]	Radii in [ft]									
0	14.6	14.9	15.0	15.0	15.1	15.3	14.9	14.8	14.9	14.9
30	15.0	15.2	15.3	15.3	15.1	15.0	15.2	15.2	15.2	15.3
60	15.4	15.1	14.9	14.6	14.8	15.3	15.1	15.2	15.3	15.5
90	15.8	15.4	15.0	14.8	14.8	14.8	14.6	14.6	14.7	14.8
120	15.0	14.7	14.5	14.6	14.3	13.9	14.2	14.4	14.0	13.6
150	13.3	13.5	13.7	13.7	13.8	13.9	13.5	13.3	13.5	13.4
180	13.3	13.1	13.0	13.1	12.9	12.5	13.0	13.3	13.3	13.4
210	13.5	13.2	13.1	13.3	13.0	12.7	12.5	12.5	12.7	12.7
240	12.7	12.6	12.7	13.0	13.0	12.8	13.0	13.1	13.3	13.2
270	13.3	13.7	13.7	13.6	13.8	14.3	14.1	14.0	13.7	13.7
300	13.9	14.0	14.0	14.1	14.3	14.6	14.4	14.1	13.8	13.8
330	13.9	14.5	14.9	15.0	14.8	14.6	14.2	14.1	14.4	14.5

Table of radii

Cavity: Propane Well #1 33020 4/21/2003

Depth: 550.0 ft

[°]	Radii in [ft]									
0	16.1	16.3	16.6	16.9	16.9	16.8	16.8	16.9	17.2	17.2
30	17.1	17.2	17.2	17.1	17.1	17.2	17.1	17.1	17.3	17.3
60	17.3	17.3	17.3	17.5	17.5	17.3	17.3	17.3	17.5	17.3
90	17.3	16.8	16.6	16.7	16.6	16.5	16.6	16.6	16.5	16.3
120	16.0	16.0	16.0	16.0	15.9	15.9	15.9	15.9	15.7	15.5
150	15.3	15.3	15.3	15.2	15.2	15.2	15.1	14.9	14.8	14.6
180	14.5	14.5	14.4	14.4	14.3	14.1	14.1	14.1	14.1	14.1
210	14.1	14.1	14.0	13.9	14.0	14.3	14.1	14.0	13.9	13.9
240	14.0	14.0	14.0	14.1	14.2	14.3	14.3	14.3	14.1	14.0
270	14.0	14.0	14.0	14.2	14.2	14.3	14.3	14.3	14.5	14.7
300	14.7	14.7	14.8	14.9	14.9	14.9	14.9	15.0	15.5	15.7
330	15.7	15.9	16.1	16.1	16.3	16.4	16.4	16.4	16.3	16.2

Depth: 560.0 ft

[°]	Radii in [ft]									
0	17.5	17.4	17.5	17.7	17.8	17.9	18.0	18.0	17.9	17.9
30	17.9	18.2	18.7	19.4	19.1	18.2	18.4	18.5	18.6	18.6
60	18.4	18.4	18.5	18.8	18.7	18.6	18.7	18.8	18.8	18.7
90	18.5	18.5	18.3	18.0	18.0	18.2	18.1	18.0	17.9	17.9
120	17.9	17.6	17.5	17.4	17.3	17.1	17.1	17.1	16.9	17.0
150	17.0	16.5	16.1	16.0	16.1	16.2	15.7	15.4	15.4	15.5
180	15.6	15.4	15.3	15.3	15.1	14.9	14.7	14.6	14.6	14.6
210	14.6	14.4	14.4	14.7	14.8	14.7	14.6	14.5	14.5	14.7
240	14.8	14.7	14.5	14.1	14.1	14.1	14.2	14.3	14.4	14.5
270	14.6	14.5	14.5	14.6	14.8	15.0	15.0	15.1	15.3	15.7
300	16.2	15.9	15.6	15.5	15.4	15.4	15.8	16.1	16.4	16.4
330	16.4	16.5	16.6	16.7	16.8	17.0	17.1	17.1	17.2	17.3

Depth: 570.0 ft

[°]	Radii in [ft]									
0	21.5	21.7	21.7	21.6	21.6	21.8	21.9	22.0	22.2	22.0
30	21.8	22.0	22.2	22.6	22.7	22.9	22.8	22.9	23.1	23.3
60	23.5	23.7	23.7	23.6	23.6	23.5	23.3	23.1	22.6	22.4
90	22.3	22.2	22.1	22.0	21.9	21.8	21.7	21.6	21.4	21.3
120	21.2	21.0	20.9	20.9	20.9	20.9	20.9	20.8	20.4	20.3
150	20.3	20.3	20.1	19.6	19.5	19.5	18.8	18.5	18.6	18.6
180	18.7	18.4	18.2	18.1	18.0	17.9	17.8	17.8	17.7	17.6
210	17.6	17.4	17.4	17.7	17.5	17.1	17.0	17.0	16.8	16.8
240	16.9	17.0	17.0	16.9	16.9	16.8	16.8	16.9	17.0	17.0
270	17.1	17.5	17.7	17.8	17.7	17.7	17.7	17.8	17.9	18.0
300	18.1	18.2	18.3	18.5	18.6	18.7	18.9	19.2	19.6	20.1
330	20.5	20.9	21.2	21.2	21.3	21.4	21.4	21.4	21.3	21.4

Table of radii

Cavity: Propane Well #1 33020 4/21/2003

Depth: 580.0 ft

[°]	Radii in [ft]									
0	21.3	21.0	20.9	21.3	21.5	21.8	21.9	22.1	22.4	23.1
30	24.0	23.6	23.5	23.4	23.0	22.8	23.2	23.6	24.0	24.2
60	24.3	24.0	23.9	23.9	23.9	23.9	23.8	23.3	22.2	21.5
90	21.2	21.2	21.7	23.4	24.0	24.1	23.9	23.8	23.9	22.9
120	21.5	21.8	22.2	22.6	22.3	22.0	21.9	21.8	21.7	21.5
150	21.2	21.0	20.7	20.5	20.2	19.9	19.6	19.4	19.6	19.5
180	19.5	19.4	19.2	18.8	18.5	18.3	18.8	19.1	18.8	18.5
210	18.2	18.0	18.1	18.7	18.7	18.5	18.1	17.8	18.0	18.1
240	18.2	18.3	18.4	18.4	18.2	17.9	17.9	17.9	18.0	17.9
270	17.8	18.0	18.3	18.8	19.2	19.6	19.1	18.8	18.7	18.6
300	18.4	18.8	19.1	19.4	19.0	18.7	19.0	19.2	19.3	19.4
330	19.5	19.6	19.8	19.7	19.6	19.8	20.1	20.2	20.3	20.6

Depth: 590.0 ft

[°]	Radii in [ft]									
0	24.3	24.1	24.0	23.9	24.0	24.2	24.2	24.4	25.1	25.7
30	26.3	26.4	26.3	25.5	25.5	25.8	25.9	26.0	26.0	25.8
60	25.5	25.6	25.8	25.9	26.0	26.1	26.1	26.1	26.0	26.1
90	26.3	26.5	26.6	26.2	26.0	25.8	25.8	25.7	25.7	25.9
120	26.2	25.5	25.3	25.9	26.3	26.2	25.4	24.7	24.1	23.9
150	24.1	24.3	24.7	25.2	25.0	24.5	23.7	23.0	22.6	22.5
180	22.6	22.3	22.2	22.2	22.1	22.0	21.9	21.9	21.8	21.5
210	21.3	21.2	21.1	20.8	21.0	21.4	21.7	21.8	21.5	21.3
240	21.0	20.8	20.7	20.7	20.7	20.8	21.1	21.4	21.5	21.2
270	20.8	21.2	21.5	21.5	21.2	21.0	20.6	20.4	20.6	21.2
300	22.2	22.4	22.5	22.5	23.0	24.0	23.8	23.2	22.5	22.2
330	22.3	22.9	23.4	23.8	23.7	23.6	23.3	23.4	23.9	24.0

Depth: 595.0 ft

[°]	Radii in [ft]									
0	26.4	26.5	26.7	26.8	27.0	27.3	27.5	27.5	27.5	27.8
30	28.2	28.3	28.4	28.4	28.6	29.1	30.3	31.3	31.1	30.1
60	28.7	29.0	29.0	29.0	28.7	28.6	28.6	28.8	29.2	29.7
90	29.8	29.3	29.0	29.0	29.2	29.7	31.4	32.2	31.0	29.9
120	29.0	28.2	27.8	27.6	27.6	27.7	27.1	26.7	26.5	26.3
150	26.1	27.6	28.6	28.6	26.8	25.0	24.6	24.2	23.9	23.8
180	23.7	23.3	23.2	23.3	23.2	23.2	23.1	22.9	22.6	23.2
210	24.1	24.3	24.3	23.9	23.1	22.3	22.1	21.9	21.9	22.5
240	23.5	23.1	22.7	22.1	21.9	22.0	21.8	21.9	22.5	23.2
270	23.7	23.6	23.3	22.6	22.3	22.4	22.4	22.5	22.8	23.0
300	23.2	23.3	23.5	23.9	23.8	23.7	24.1	24.4	24.5	24.6
330	24.6	25.1	25.3	25.4	25.4	25.5	25.7	25.9	26.0	26.1

SOCON Cavity Control, Inc.

Table of radii

Cavity: Propane Well #1 33020 4/21/2003

Depth: 600.0 ft

[°]	Radii in [ft]									
0	33.8	33.8	32.5	30.8	30.3	30.4	31.5	31.9	32.0	32.1
30	32.3	32.2	32.0	31.8	33.6	35.2	36.0	36.4	36.0	33.9
60	31.4	31.3	31.3	31.2	32.0	33.0	33.6	33.8	33.9	35.5
90	37.3	38.1	38.9	39.3	39.5	40.0	41.0	40.7	38.0	37.1
120	37.2	34.7	33.0	32.1	30.7	29.1	29.0	29.3	30.2	30.5
150	30.6	30.7	30.8	30.8	30.1	29.2	28.9	28.6	28.4	28.0
180	27.7	27.3	27.1	27.1	27.1	27.0	26.9	26.9	26.8	26.9
210	27.0	27.0	26.7	25.6	25.2	25.2	25.2	25.1	24.5	24.3
240	24.2	25.5	26.2	25.5	24.7	23.9	24.0	24.1	24.3	25.0
270	25.4	24.6	24.1	23.9	24.1	24.5	25.1	25.5	25.8	25.8
300	25.8	26.4	27.1	28.0	28.4	28.7	28.7	28.8	29.1	29.7
330	30.4	31.3	32.0	31.9	32.2	32.6	32.5	32.5	32.6	33.0

Depth: 605.0 ft

[°]	Radii in [ft]									
0	29.7	30.9	31.5	31.8	32.5	33.2	33.2	32.9	32.5	32.4
30	32.5	32.3	32.2	32.2	32.7	33.5	34.9	35.8	35.2	33.8
60	32.1	31.6	31.6	32.5	32.9	33.0	32.5	32.8	34.5	35.2
90	35.3	36.5	37.9	39.4	40.3	40.8	41.1	40.7	39.1	37.6
120	36.3	35.1	34.0	33.0	32.6	32.5	32.4	32.1	31.6	31.1
150	30.6	30.5	30.7	31.5	32.3	32.6	32.0	31.0	29.2	28.3
180	27.8	27.6	27.4	27.2	26.3	25.2	25.9	26.7	27.3	27.5
210	27.5	26.8	26.1	25.4	25.2	25.2	25.2	25.0	24.6	24.5
240	24.6	24.5	24.5	24.5	25.3	26.8	26.7	26.2	24.9	24.5
270	24.5	24.4	24.5	24.7	24.8	24.8	24.9	25.4	26.1	25.8
300	25.1	25.2	25.4	25.6	27.1	28.6	29.9	31.2	32.3	33.4
330	34.7	35.1	35.6	36.1	37.1	38.2	36.8	35.4	34.0	32.1

Depth: 610.0 ft

[°]	Radii in [ft]									
0	29.5	29.6	29.8	30.2	31.2	32.5	33.0	32.3	31.0	31.0
30	31.0	31.1	31.5	32.1	32.1	32.2	32.1	32.5	33.3	33.5
60	33.3	33.0	32.7	32.0	31.9	32.0	32.8	33.1	33.1	32.6
90	31.9	31.8	32.5	34.9	36.7	38.1	38.1	38.0	37.9	37.5
120	36.4	34.3	33.1	33.1	31.5	29.4	29.1	28.9	29.0	29.0
150	29.3	30.4	31.2	31.2	32.2	33.9	29.4	27.1	27.2	27.2
180	27.0	26.2	25.7	25.4	25.3	25.2	25.4	25.4	25.3	25.9
210	27.1	27.1	26.6	25.5	25.6	26.3	26.0	25.5	24.5	24.2
240	24.2	24.2	24.4	25.0	27.3	31.4	31.2	30.6	29.2	26.9
270	24.5	24.7	25.1	25.8	26.0	26.1	26.3	26.2	25.2	24.9
300	25.0	25.3	25.4	25.5	26.5	28.3	28.0	27.9	27.9	28.2
330	28.5	29.4	30.1	30.2	30.3	30.6	29.7	29.2	29.3	29.3

Table of radii

Cavity: Propane Well #1 33020 4/21/2003

Depth: 615.0 ft

[°]				Radii in [ft]						
0	37.7	37.6	37.6	37.9	38.4	39.0	38.9	38.8	38.8	39.3
30	40.0	39.9	40.0	40.6	41.5	42.6	42.8	42.9	42.5	41.9
60	41.3	41.3	41.2	41.0	40.7	40.5	41.0	41.1	40.3	40.0
90	39.8	40.3	40.9	41.5	41.7	41.8	41.8	41.3	39.6	38.9
120	38.6	38.5	38.4	38.2	37.3	36.9	37.2	37.5	37.4	37.0
150	36.4	36.8	37.0	37.0	36.0	34.7	34.3	34.2	34.2	34.3
180	34.5	34.1	33.7	33.0	32.8	32.7	32.8	32.8	32.8	33.3
210	34.0	34.0	33.7	33.0	32.1	31.2	31.1	31.4	32.1	32.0
240	31.6	31.6	31.3	31.0	30.9	31.0	31.2	31.3	31.0	31.4
270	32.1	31.8	31.3	30.3	30.7	31.8	31.8	31.9	32.3	32.4
300	32.3	32.3	32.7	33.8	33.9	33.4	33.5	34.1	34.9	34.9
330	34.9	35.3	35.7	35.7	36.5	37.4	37.5	37.6	37.6	37.6

Depth: 620.0 ft

[°]				Radii in [ft]						
0	43.5	40.8	39.3	39.4	39.8	40.3	41.1	41.0	40.5	40.4
30	40.6	41.2	41.7	41.9	43.0	44.8	43.5	42.2	40.9	41.0
60	41.1	41.2	41.6	42.6	45.6	49.1	43.6	40.6	40.4	40.5
90	40.7	41.1	41.5	41.9	45.6	50.1	43.3	41.3	41.1	40.7
120	40.1	38.4	38.4	39.3	42.0	46.2	41.6	39.1	37.4	40.3
150	46.9	41.2	37.6	36.1	40.2	50.1	39.4	34.5	34.7	38.6
180	46.3	38.9	35.3	36.0	35.7	34.7	33.5	32.8	32.8	37.4
210	47.2	36.6	34.0	34.0	38.3	47.1	36.7	32.2	33.0	32.9
240	33.0	32.5	32.4	33.0	32.2	31.7	31.5	31.4	31.7	31.2
270	30.5	31.7	32.6	32.4	32.4	32.7	32.9	33.2	33.3	33.8
300	34.3	34.2	34.4	34.9	34.8	34.5	34.5	34.5	34.6	34.8
330	35.0	34.9	35.1	35.9	36.5	37.1	37.2	37.8	39.6	41.5

Depth: 625.0 ft

[°]				Radii in [ft]						
0	67.9	67.5	67.9	69.7	70.1	70.7	70.7	70.7	70.8	70.6
30	70.5	70.7	71.1	72.1	72.8	73.7	73.9	74.7	76.1	76.7
60	77.6	76.9	76.2	75.8	75.5	75.4	75.4	76.1	77.2	77.0
90	76.1	76.1	75.9	75.4	74.8	74.4	74.2	74.2	74.5	74.8
120	75.1	74.9	74.4	73.1	72.6	72.4	71.9	71.7	71.7	71.4
150	71.2	71.6	71.8	71.6	71.1	70.5	69.1	68.5	69.2	67.9
180	66.8	66.3	65.9	65.9	64.8	63.9	64.0	64.3	64.6	64.0
210	63.5	56.4	55.8	58.2	59.3	59.7	59.4	59.4	60.0	59.6
240	59.0	59.0	59.4	60.8	61.0	61.2	61.1	60.8	60.6	60.5
270	60.4	60.2	60.2	60.7	60.7	60.7	61.1	61.4	61.7	61.8
300	61.9	62.1	62.1	62.0	62.5	63.1	63.1	63.4	64.1	64.4
330	64.6	65.0	65.4	65.5	66.0	66.7	67.0	67.4	67.7	68.0

Table of radii

Cavity: Propane Well #1 33020 4/21/2003

Depth: 630.0 ft

[°]	Radii in [ft]									
0	57.5	60.5	62.9	63.4	62.2	60.5	59.7	59.3	59.3	59.4
30	59.6	59.7	60.7	63.5	65.6	68.1	71.6	71.9	65.6	68.7
60	77.9	76.8	75.9	75.3	75.1	75.2	75.6	76.3	77.4	77.4
90	77.5	77.6	77.1	75.3	70.8	67.6	68.8	71.1	74.1	75.2
120	75.3	74.7	73.9	73.1	72.8	72.8	71.6	70.9	71.0	71.1
150	69.8	66.0	63.0	60.8	59.2	58.0	58.0	58.1	58.4	58.6
180	59.0	58.9	60.0	63.6	64.8	64.6	64.6	64.8	65.2	59.6
210	52.7	49.0	47.0	47.6	48.4	49.5	49.5	49.5	49.0	49.3
240	50.1	52.3	53.7	52.9	52.7	52.8	50.8	49.6	49.6	51.0
270	53.2	53.5	53.5	52.5	52.6	53.1	53.1	53.3	53.7	53.1
300	52.4	52.9	52.9	52.8	53.4	54.1	54.3	54.0	53.4	53.4
330	53.5	53.6	53.7	53.7	53.6	53.5	53.6	54.3	55.4	56.6

Depth: 635.0 ft

[°]	Radii in [ft]									
0	51.7	50.0	48.4	48.4	48.5	48.5	49.9	50.2	49.9	49.8
30	50.0	50.5	51.6	53.9	56.3	58.3	59.3	59.4	57.6	57.1
60	57.1	57.4	58.9	62.8	60.4	58.9	58.8	58.4	57.2	56.2
90	55.6	55.4	55.6	56.5	58.1	59.1	58.4	58.0	58.1	57.1
120	56.3	56.9	57.3	57.0	56.1	55.2	54.7	54.4	54.5	54.8
150	55.1	54.9	54.8	54.8	54.8	54.8	53.1	51.5	49.9	49.7
180	49.6	48.9	48.3	47.8	47.6	47.7	45.8	45.1	45.1	44.1
210	42.9	42.7	42.3	41.7	41.4	41.4	41.5	41.6	41.2	41.5
240	42.2	41.9	41.9	42.1	42.8	43.9	45.1	46.0	46.0	47.2
270	47.9	46.3	45.6	46.6	47.4	48.3	47.9	47.7	47.8	47.6
300	47.5	48.7	50.1	50.2	49.8	49.2	50.6	50.7	50.1	49.7
330	49.5	49.0	48.8	48.8	48.9	49.0	49.0	49.8	51.2	51.6

Depth: 640.0 ft

[°]	Radii in [ft]									
0	34.9	35.6	36.4	37.6	38.3	38.9	38.1	37.9	38.1	37.6
30	37.1	38.0	38.9	39.3	40.5	42.2	43.1	43.3	42.1	41.1
60	40.2	39.9	40.0	40.9	41.5	42.3	43.1	43.4	42.8	43.2
90	43.6	42.5	41.7	41.2	41.2	40.2	37.3	35.3	34.2	34.9
120	36.6	37.5	38.1	38.0	38.4	39.0	38.6	38.0	37.3	36.8
150	36.4	37.7	39.0	40.1	40.3	40.1	37.9	36.6	36.8	36.2
180	35.5	35.6	35.2	33.7	32.5	31.4	32.2	32.5	31.5	29.7
210	27.7	26.7	26.4	26.3	27.3	28.3	28.1	28.1	28.5	28.5
240	28.3	28.3	28.5	29.0	29.3	28.9	27.7	26.8	26.1	26.9
270	28.7	29.0	29.3	29.5	29.9	30.5	29.6	29.4	30.8	30.3
300	30.0	28.6	28.9	30.1	30.4	30.3	30.5	30.4	29.5	30.0
330	30.5	31.2	32.0	32.7	34.0	34.8	34.2	33.9	33.7	34.2

Table of radii

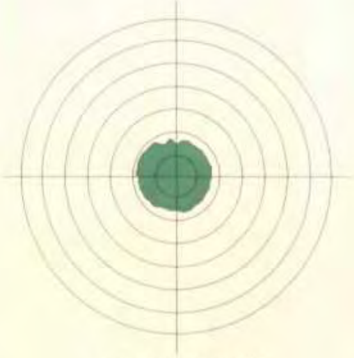
Cavity: Propane Well #1 33020 4/21/2003

Depth: 643.0 ft

[°]					Radii in [ft]					
0	18.5	18.3	19.7	25.6	29.6	31.7	30.3	29.6	30.4	30.0
30	29.7	32.3	33.2	33.1	33.5	33.9	34.5	34.3	33.7	34.1
60	35.2	36.0	36.6	36.6	36.5	36.6	36.4	36.5	37.1	37.3
90	36.6	37.3	37.6	37.1	35.5	34.1	32.6	31.1	29.6	29.8
120	30.2	31.1	31.8	32.0	31.9	31.8	33.0	33.6	32.6	32.2
150	32.2	32.3	31.7	29.8	29.1	28.9	29.0	24.1	16.0	16.4
180	16.8	16.7	16.3	15.4	15.1	15.1	14.8	14.8	15.4	14.8
210	13.8	14.0	14.0	13.8	13.4	12.9	13.4	13.4	13.3	13.0
240	12.7	12.8	12.7	12.5	12.1	11.7	12.0	12.4	12.7	12.5
270	12.3	12.3	12.5	12.7	12.5	12.3	12.4	12.6	12.7	12.8
300	12.8	12.8	12.8	12.8	12.8	12.8	13.0	13.4	13.9	14.5
330	15.2	15.1	15.5	16.2	17.3	18.5	17.7	17.5	17.6	17.9

Horizontal slices 1 - 12

Cavity: Propane Well #1 Report number: 033020 Date: 04/21/2003

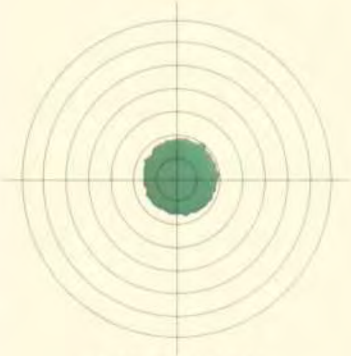


525.0 ft / 813 ft²

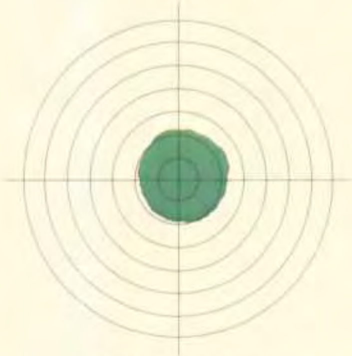
530.0 ft / 733 ft²

540.0 ft / 630 ft²

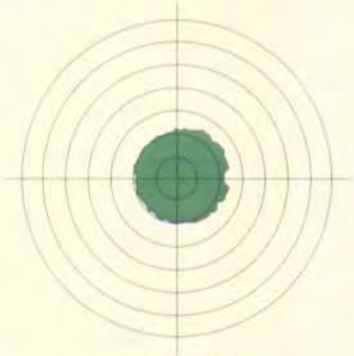
550.0 ft / 767 ft²



560.0 ft / 865 ft²

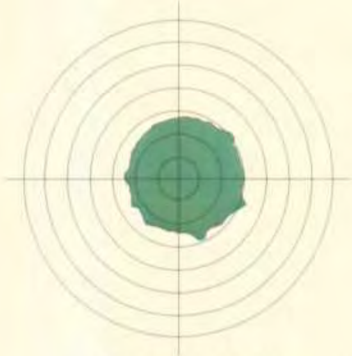


570.0 ft / 1269 ft²



580.0 ft / 1343 ft²

590.0 ft / 1765 ft²



595.0 ft / 2125 ft²

600.0 ft / 2906 ft²

605.0 ft / 3023 ft²

610.0 ft / 2778 ft²

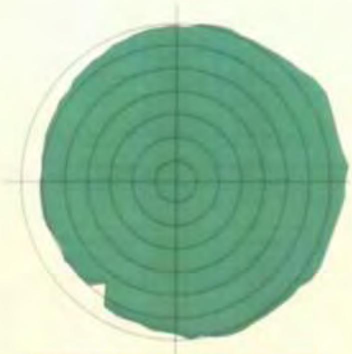
1 circle equals 10 ft

Horizontal slices 13 - 23

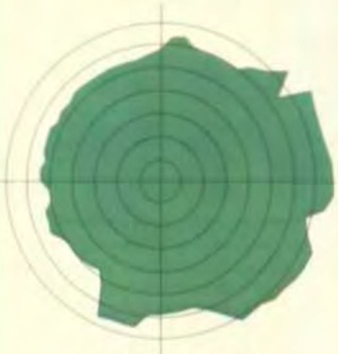
Cavity: Propane Well #1   Report number: 033020   Date: 04/21/2003

615.0 ft / 4147 ft^2

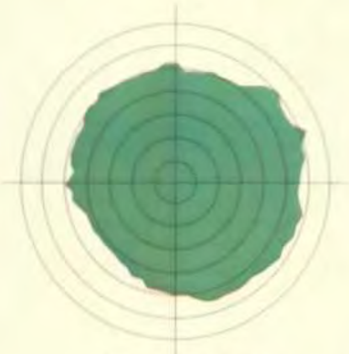
620.0 ft / 4354 ft^2



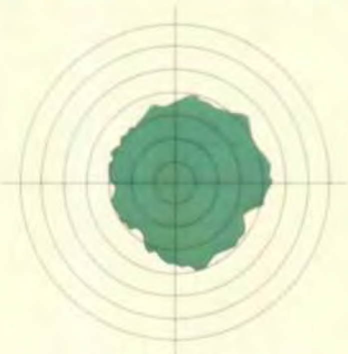
625.0 ft / 14511 ft^2 (max)



630.0 ft / 12028 ft^2



635.0 ft / 8196 ft^2



640.0 ft / 3868 ft^2

643.0 ft / 1929 ft^2

644.0 ft / 1010 ft^2

646.0 ft / 409 ft^2

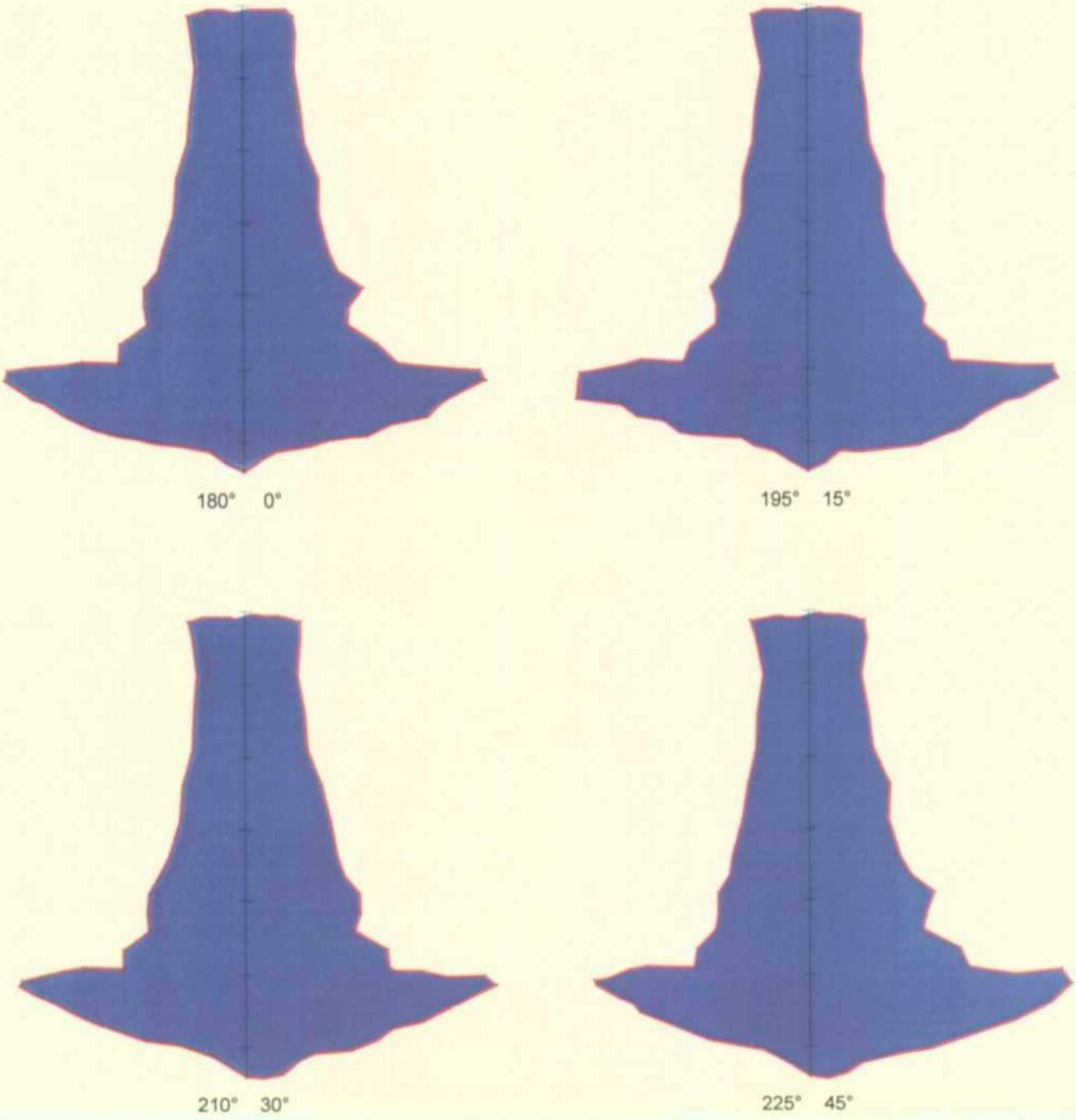
648.0 ft / 190 ft^2

650.0 ft / 78 ft^2

1 circle equals 10 ft

Vertical slices 1 - 4

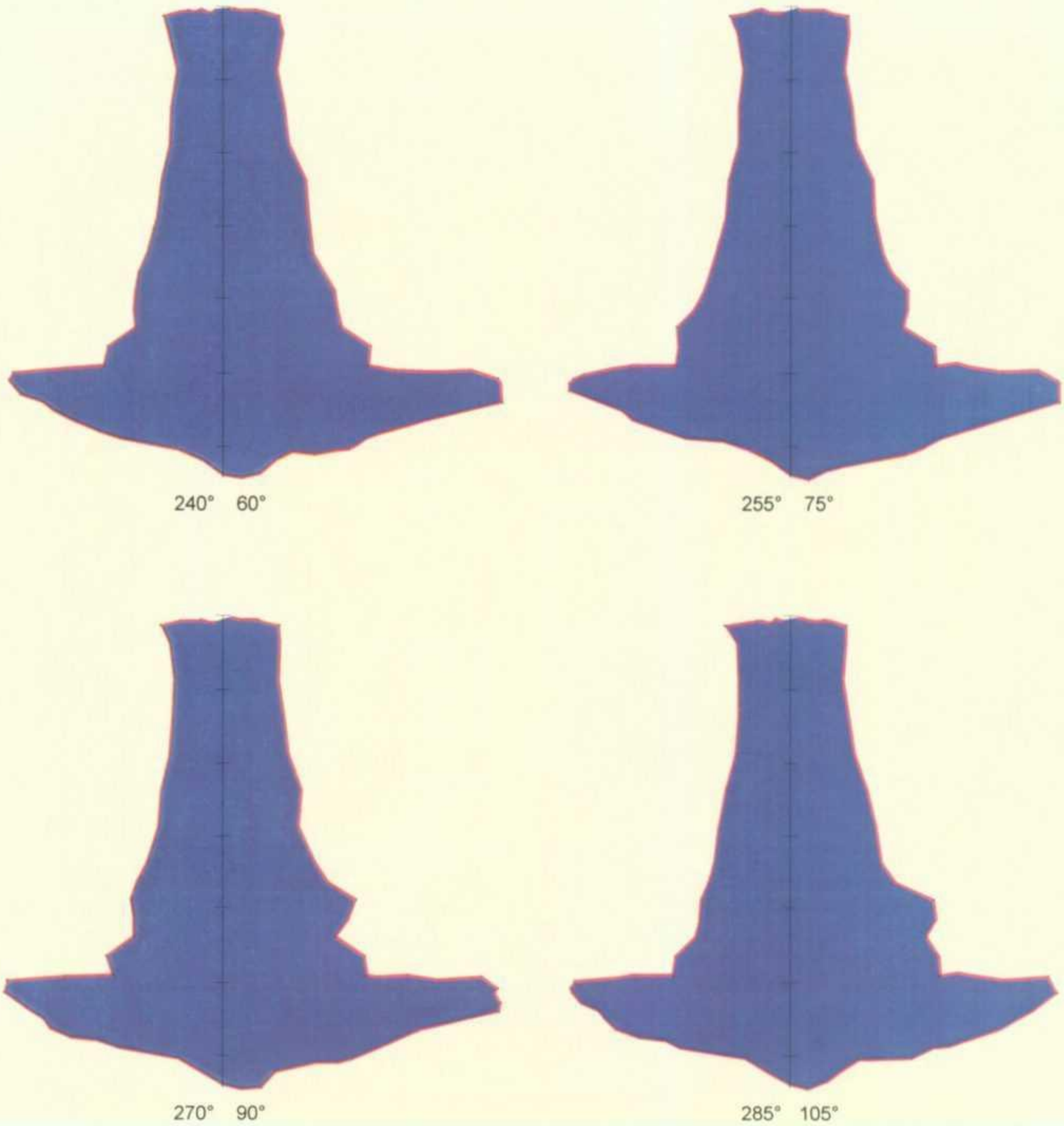
Cavity: Propane Well #1 Report number: 033020 Date: 04/21/2003



Range from 522 ft to 651 ft, step 20 ft

Vertical slices 5 - 8

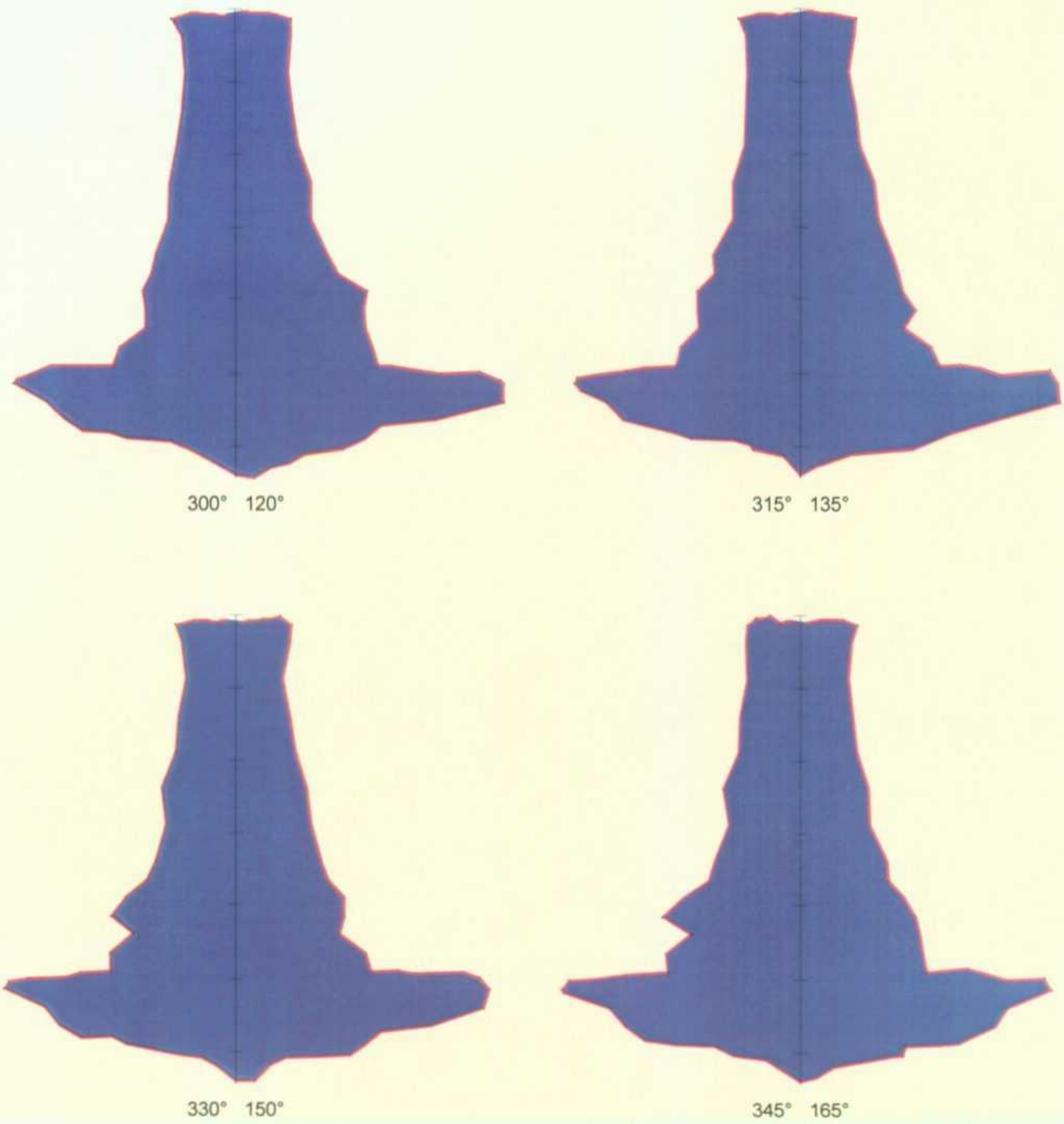
Cavity: Propane Well #1   Report number: 033020   Date: 04/21/2003



Range from 522 ft to 651 ft, step 20 ft

Vertical slices 9 - 12

Cavity: Propane Well #1 Report number: 033020 Date: 04/21/2003



Range from 522 ft to 651 ft, step 20 ft

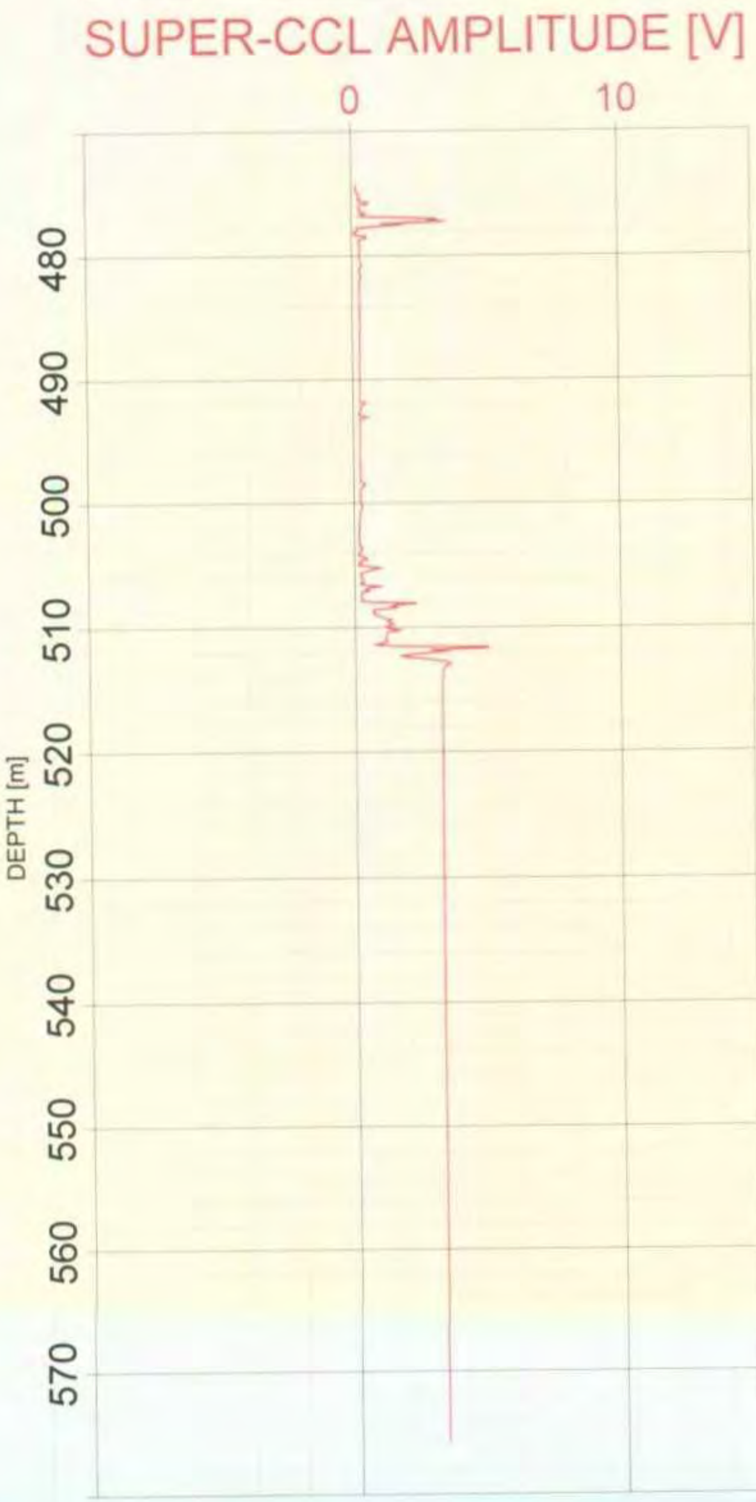
SOCON Cavity Control, Inc.

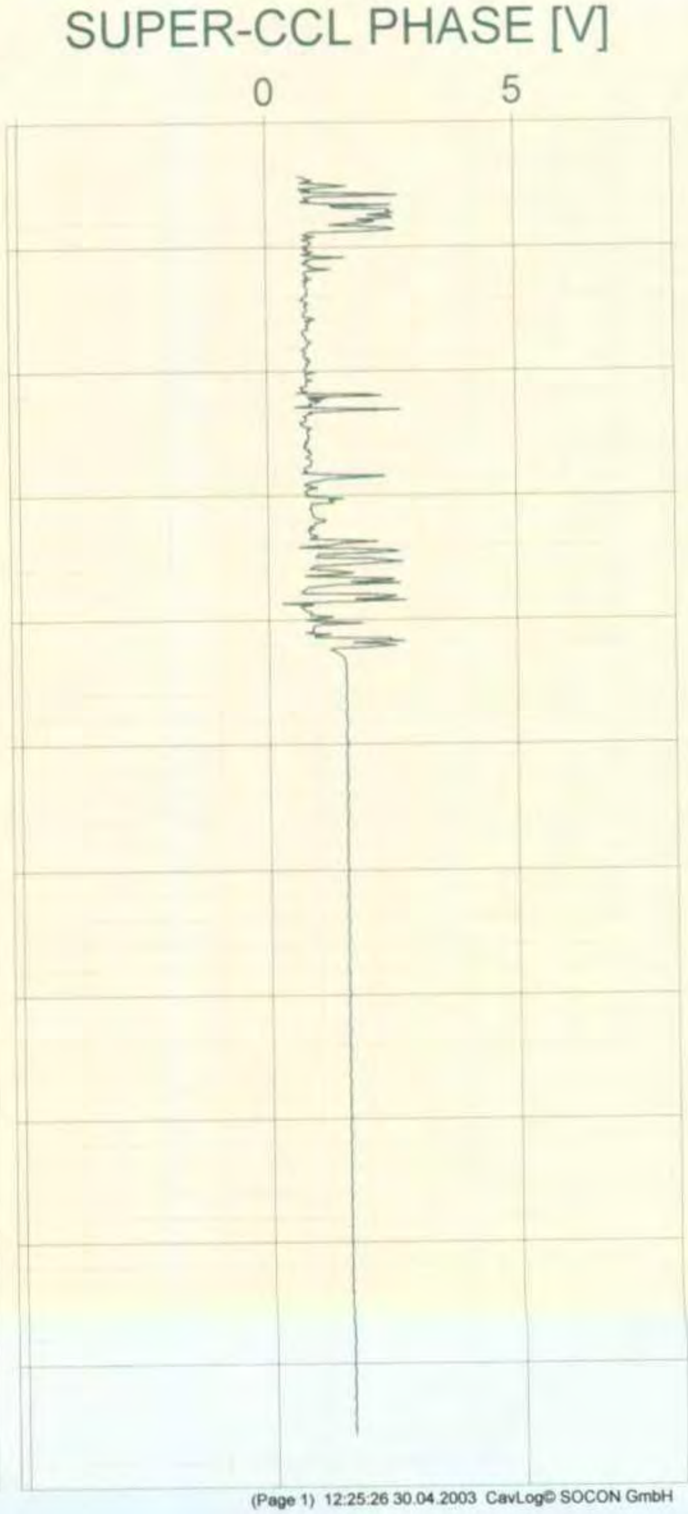
SOCON

BSE-COMBI-LOG

Cavity:	Propane Well #1
Job number:	033020
Date:	21.04.2003
LOG file:	020_0001.LOG
LOG name:	SUPER-CCL AMPLITUDE
Minimum:	0.095 V
Maximum:	4.999 V
Survey tool:	BSE (NORMAL)
Reference:	ECHOWANDLER H1-H2
Depth offset:	-12.082 m
Start depth:	474.273 m
End depth:	575.792 m
Depth step:	0.100 m

Cavity:	Propane Well #1
Job number:	033020
Date:	21.04.2003
LOG file:	020_0001.LOG
LOG name:	SUPER-CCL PHASE
Minimum:	0.284 V
Maximum:	2.780 V
Survey tool:	BSE (NORMAL)
Reference:	ECHOWANDLER H1-H2
Depth offset:	-12.082 m
Start depth:	474.273 m
End depth:	575.792 m
Depth step:	0.100 m





SOCON Cavity Control, Inc.

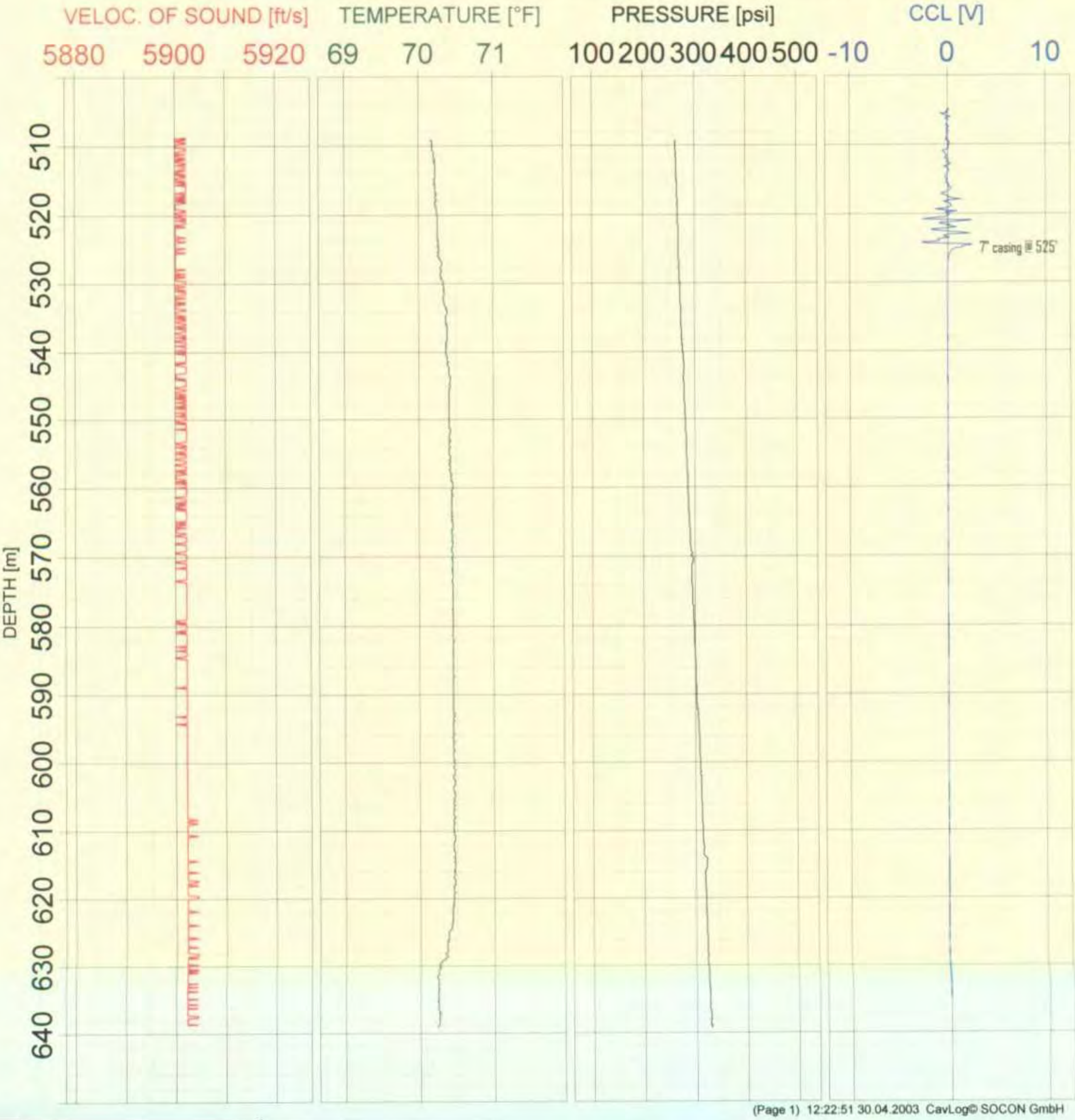
BSE-COMBI-LOG

Cavity:	Propane Well #1
Job number:	033020
Date:	21.04.2003
LOG file:	020_0002.LOG
LOG name:	VELOC. OF SOUND
Minimum:	5900.174 ft/s
Maximum:	5904.350 ft/s
Survey tool:	BSE (NORMAL)
Reference:	ECHOWANDLER H1-H2
Depth offset:	-8.227 m
Start depth:	508.742 m
End depth:	638.748 m
Depth step:	0.100 m

Cavity:	Propane Well #1
Job number:	033020
Date:	21.04.2003
LOG file:	020_0002.LOG
LOG name:	TEMPERATURE
Minimum:	70.170 °F
Maximum:	70.480 °F
Survey tool:	BSE (NORMAL)
Reference:	ECHOWANDLER H1-H2
Depth offset:	-7.849 m
Start depth:	509.120 m
End depth:	639.126 m
Depth step:	0.100 m

Cavity:	Propane Well #1
Job number:	033020
Date:	21.04.2003
LOG file:	020_0002.LOG
LOG name:	PRESSURE
Minimum:	262.500 psi
Maximum:	330.600 psi
Survey tool:	BSE (NORMAL)
Reference:	ECHOWANDLER H1-H2
Depth offset:	-7.669 m
Start depth:	509.300 m
End depth:	639.306 m
Depth step:	0.100 m

Cavity:	Propane Well #1
Job number:	033020
Date:	21.04.2003
LOG file:	020_0002.LOG
LOG name:	CCL
Minimum:	-2.500 V
Maximum:	2.499 V
Survey tool:	BSE (NORMAL)
Reference:	ECHOWANDLER H1-H2
Depth offset:	-12.082 m
Start depth:	504.887 m
End depth:	634.893 m
Depth step:	0.100 m



Document ID: EDF-ER-278
Revision ID: 2
Effective Date: 06/18/04

Engineering Design File

PROJECT NO. 23350

Liner/Leachate Compatibility Study

Idaho National Engineering
and Environmental Laboratory

Form 412.14
10/9/2003
Rev. 05

ENGINEERING DESIGN FILE

EDF No.: EDF-ER-278 EDF Rev. No.: 2 Project File No.: 23350

1. Title: Liner/Leachate Compatibility Study
2. Index Codes:
   Building/Type ______ SSC ID ______ Site Area ______
3. NPH Performance Category: ______ or ☐ N/A
4. EDF Safety Category: ______ or ☐ N/A SCC Safety Category: ______ or ☐ N/A
5. Summary:

This study evaluates the compatibility of the liner materials with the leachate generated by the waste disposed in the INEEL CERCLA Disposal Facility. The liner system is composed of both natural and synthetic materials including compacted clay, geosynthetic clay liner, high-density polyethylene, and polypropylene products. This study will determine whether these materials are compatible with the leachate, based on experience at similar landfills and published literature.

6. Review (R) and Approval (A) and Acceptance (Ac) Signatures:
   (See instructions for definitions of terms and significance of signatures.)

	R/A	Typed Name/Organization	Signature	Date
Independent Peer Reviewer (if applicable)		Pat Gibson	Pat Gibson	6/15/04
Document Owner		W. Mahlon Heileson	WM Heileson	6/15/04
Requestor		Mike Edgett	S. M. Edgett	6/16/04
Doc. Control	Ac	Juana Cruz	Juana Cruz	6/18/04
7. Distribution: (Name and Mail Stop)				

8. Does document contain sensitive unclassified information? ☐ Yes ☒ No
   If Yes, what category:
9. Can document be externally distributed? ☒ Yes ☐ No
10. Uniform File Code: 6102 Disposition Authority: ENV1-h-1
    Record Retention Period: See LST-9
11. For QA Records Classification Only: ☒ Lifetime ☐ Nonpermanent ☐ Permanent
    Item and activity to which the QA Record apply:
12. NRC related? ☐ Yes ☒ No
13. Registered Professional Engineer's Stamp (if required)

ABSTRACT

This study evaluates the compatibility of the liner materials with the leachate generated by the waste disposed in the INEEL CERCLA Disposal Facility. The liner system is composed of both natural and synthetic materials including compacted clay, geosynthetic clay liner, high-density polyethylene, and polypropylene products. This study will determine whether these materials are compatible with the leachate, based on experience at similar landfills and published literature.

This page intentionally left blank.

CONTENTS

TABLES

ACRONYMS

ASTM	American Society for Testing and Material
CCL	compacted clay liner
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CETCO	Colloid Environmental Technologies Company American
EDF	engineering design file
EPA	Environmental Protection Agency
GCL	geosynthetic clay liner
HDPE	high-density polyethylene
ICDF	INEEL CERCLA Disposal Facility
INEEL	Idaho National Engineering and Environmental Laboratory
LERF	Liquid Effluent Retention Facility
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
SBL	soil bentonite liner
TCE	trichloroethylene
TSCA	Toxic Substances Control Act
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WAC	Waste Acceptance Criteria

This page intentionally left blank.

Liner/Leachate Compatibility Study

1. INTRODUCTION

1.1 Purpose

The purpose of this study is to demonstrate that the liner materials proposed for the INEEL CERCLA Disposal Facility (ICDF) landfill and evaporation pond are chemically compatible with the leachate. Certain materials deteriorate over time when exposed to chemicals that may be contained in hazardous leachate. It is important to anticipate the type and quality of the leachate that the landfill will generate and select compatible liner materials. Data collected from other similar low-level radioactive mixed waste and hazardous waste sites was used to determine the allowable concentration of leachate constituents that could be in contact with the ICDF landfill and evaporation pond liner components.

1.2 ICDF Liner System

The ICDF landfill and evaporation pond liners are a double composite system compliant with the substantive requirements of the Resource Conservation and Recovery Act (RCRA) Subtitle C and the Toxic Substances Control Act (TSCA) polychlorinated biphenyl (PCB) landfill and surface impoundment design, consisting of leachate collection/detection systems, a 3-ft-thick soil bentonite liner (SBL) (landfill only), and flexible membrane liners. The specific liner materials are listed below:

- High-density polyethylene (HDPE) geomembranes
- Geosynthetic clay liner (GCL) consisting of a thin layer of bentonite sandwiched between two synthetic geotextiles
- Geocomposite consisting of a HDPE geonet and geotextile
- Compacted clay soil with a bentonite admix (soil bentonite layer [SBL]) to decrease permeability.

The evaporation pond liner also includes an additional sacrificial geomembrane for UV protection.

In general, the liner system consists of two types of materials. The geomembranes, geotextiles, and geonets are manufactured from polymeric materials made from synthetic polymers. HDPE products have a high crystallinity that increases the chemical resistance of the polymer. The second type of material is soil comprised mainly of clay-sized particles, also crystalline in nature. As part of this study, no information was found with respect to the degradation of the geotextile materials. It was determined that even if the geotextile materials used in the liner system degraded, that it would not negatively impact the containment qualities of the landfill. Therefore, the degradation of geotextile was not considered as part of this study.

1.3 Mechanisms of Liner System Deterioration

Specific mechanisms of deterioration of the liner system components that might be encountered based on the waste inventory are chemical, radioactive, and oxidation degradation. Degradation involves a change in the physical properties of the liner material that could increase the permeability of the material or reduce the material's strength or ductility.

Polymeric chain scission or bond breaking within the polymer structure of HDPE results in degradation. Chemical degradation for HDPE products is a concern for leachates containing high concentrations of organic solvents or other highly reactive chemicals. High radiation doses also have the potential to cause chain scission in polymers. Oxidation occurs when free radicals and oxygen are present and results in chain scission. Oxidation processes are slowed considerably in liquid environments and antioxidant formulations are added to most HDPE products (Koerner 1998). Oxidation is also significantly reduced when the liner system is buried. As discussed herein, these processes are not expected to occur based on the ICDF leachate quality.

HDPE geomembranes can deteriorate from contact with certain leachates, resulting in a decrease of elongation at failure, an increase in modulus of elasticity, a decrease in the stress at failure, and a loss of ductility. Similarly, the permeability of a SBL and GCL can increase or decrease due to certain constituents in the leachate. This study is intended to establish individual leachate constituent concentration limits that will not adversely impact the liner system components. A summary of the properties for the HDPE, SBL, and GCL liner materials and the effects that could result from exposure to an aggressive leachate are summarized in Table 1. Notably, aggressive leachate in the ICDF landfill or waste liquid in the evaporation pond are not anticipated during their service life.

Table 1. Potential effects of aggressive leachate on liner materials.

Liner Material	Property	Typical Value	Possible Effect of Leachate
60 mil Textured HDPE	Thickness	> 60 mils	Decrease
	Melt Index	< 1.0 g/10 min	Increase or Decrease
	Strength at yield	> 120 lb/in.	Increase or Decrease
	Strength at break	> 75 lb/in.	Increase or Decrease
	Elongation at yield	> 12%	Increase or Decrease
	Elongation at break	> 100%	Increase or Decrease
	Tear Resistance	> 42 lb	Increase or Decrease
	Puncture Resistance	> 80 lb	Increase or Decrease
	Environmental Stress Crack	> 200 hours	Increase or Decrease
SBL	Permeability	< 10^{-7} cm/sec	Increase or Decrease
GCL	Permeability	< 10^{-7} cm/sec	Increase or Decrease

Sodium bentonite is the primary clay mineral in SBLs and GCLs that results in a low permeability and high swell potential. Exposure of sodium bentonite to liquids containing concentrated salts (such as brines), or divalent cation concentrations (such as Ca^{++} and Mg^{++}), reduces the swelling potential and increases its permeability. Concentrated organic solutions (such as hydrocarbons) and strong acids and bases can break down the soil, which also increases permeability. The physical mechanism that causes these changes is a reduction of the thickness or absorption capacity of the diffuse double layer of water molecules surrounding the clay minerals. This results in an effective decrease in the volume of the clay since the water molecules are not attracted to the clay particles.

1.4 ICDF Leachate Concentrations

Soluble contaminants leached from the waste will come in contact with the landfill and evaporation pond bottom liner system during the operation period (15 years) and minimum post closure period (30 years). The natural soil bentonite liner system may be in contact with soluble contaminants as long as contaminants are present in the landfill. The synthetic liner system components may be in contact with soluble contaminants until they naturally degrade or become ineffective. Leachate is generated from water added to the waste for dust control and compaction purposes. Natural precipitation events also contribute to leachate production. In reality, as the landfill nears the end of its operational life, concentrations of contaminants will decrease with time as the leachable waste mass is reduced. During the post-closure period, a robust landfill cover will significantly reduce infiltration, and the corresponding volume of leachate.

An inventory of constituents and associated site-specific concentrations anticipated in the waste are published in the INEEL CERCLA Disposal Facility Design Inventory (EDF-ER-264). The expected chemical make-up of the leachate was determined based on modeling described in the leachate/contaminant reduction time study (EDF-ER-274).

Two hydrogeologic models were used to simulate leachate generation during the operational period (15 years) and post-closure period (30 years) of the ICDF landfill and evaporation pond. The post-closure period includes the waste-filled landfill having a cover to reduce infiltration and the generation of leachate. The models applied partitioning coefficients to the waste design inventory mass to determine a liquid concentration for each constituent, and resulting leachate concentration.

In addition to the hydrogeologic models, a geochemical evaluation was performed for the operational period to evaluate natural geochemical reactions that could potentially generate constituents harmful to the liner system materials in the landfill or evaporation pond other than by the soluble waste constituents alone. It also was used to determine the general composition of the leachate including pH. The geochemical evaluation consisted of determining the chemistry make-up of the leachate based on the constituents in the waste soil and the geochemical reactions between the atmospheric gases (i.e., O_2, CO_2, etc.), infiltrating water, and natural occurring minerals in the soil.

The maximum and average leachate concentrations determined from the operational 15-year and post-closure 30-year hydrogeologic models were compared to determine the worst-case leachate concentrations due to the contaminants in the waste soil. Based on the comparison, the highest concentration of contaminates would occur during the operational period since contaminant transport tends to be dominated by drainage and diffusion, driven by the infiltration rate, which is expected to be small once the landfill is covered (EDF-ER-279).

Based on the geochemistry evaluation, the modeled leachate composition will be a brackish water with a pH of 8.0 (EDF-ER-274). Some of the constituents in the leachate had higher concentrations than determined by the hydrogeologic model due to the added effects of geochemical reactions. These mainly included sodium and sulfate having concentrations of approximately 8,000 and 20,000 mg/L, respectively. Brackish solutions containing high-concentration divalent cation concentrations such as calcium and magnesium can increase the permeability of the SBL and GCL liner materials as discussed in Section 1.3. The predicted divalent cation (calcium, magnesium, manganese, and barium) total concentration is approximately 400 mg/L. Higher concentrations are predicted from the 15-year hydrogeologic model of approximately 4,000 mg/L due to more conservative assumptions than the geochemical model. In either case, the divalent cation concentration is less than the maximum allowable concentration of 35,000 mg/L for the SBL and GCL described in Section 3.

Based on the 15-year hydrogeologic model, the maximum leachate concentration occurs during the first year of operation. The maximum and average concentrations for organics, inorganics, and radionuclides are provided in Table 2. These concentrations are considered conservative since they were determined assuming that the entire landfill is filled with waste instantaneously and has a constant moisture content of 6% by dry weight for all 15 years of operation.

Table 2. Maximum and average concentrations of leachate constituents by chemical category.

Chemical Category	Maximum Concentration	Average Concentration
Organics	70 mg/L	10 mg/L
Inorganics	18,400 mg/L	17,100 mg/L
Radionuclides	1 mg/L (0.00002 Ci/l)	1 mg/L (0.00001 Ci/l)

The resulting constituents determined from the leachate/contaminant reduction time study are provided in Appendix A. The organic constituents and expected concentrations are provided in Table A-1. The inorganic constituents and expected concentrations are provided in Table A-2. The expected radionuclides and activity concentrations are provided in Table A-3.

1.5 Absorbed Dose In Geomembrane

Studies performed on polymer materials like HDPE show that their properties begin to change after absorbing ionizing radiation between 1,000,000 to 10,000,000 rads (Koerner et al. 1990). The HDPE geomembrane lining the bottom of the landfill and evaporation pond will absorb ionizing radiation energy from the leachate generated in the landfill and combination of leachate and other waste liquids in the evaporation pond. Energy will be absorbed during the operational life of the landfill and evaporation pond as long as there are liquids with ionizing radionuclides in contact with the geomembranes.

The absorbed dose in the geomembrane was determined by multiplying the dose rate by an absorption duration. Conservatively, the absorption duration was assumed that the leachate was in contact continuously with the liner for the entire 15-year landfill operational life. In reality, leachate will be in contact with the landfill geomembrane intermittently depending on climatological and waste moisture content conditions. The absorption duration in the evaporation pond will be shortlived, due to evaporation and dilution from make-up water.

A design absorption rate was calculated for each of the radionuclides listed in Appendix A, Table A-3. Exceptions included Krypton (Kr-85 and Kr-81), which is a gaseous element, and radionuclides that are not in the leachate. The design absorption rate is dependent upon the physical properties of the absorbing material and how the energy from the source is deposited into the material. The physical properties of the HDPE geomembrane needed to determine the absorption rate are provided in Table 3.

Table 3. Physical properties of geomembranes.

Parameter	Value	Units
HDPE density	0.94	g/cm^3
Geomembrane thickness	1.5	mm
Unit surface area	1	cm^2

The amount of energy was based on the depth of leachate on the landfill liner and depth of liquids in the evaporation pond. The maximum depth of leachate was estimated as 4 cm across the floor of the landfill, assuming both Cell 1 and Cell 2 are in operation (EDF-ER-269). In the sump area of the landfill, the maximum leachate head would be approximately 30.5 cm. If the volume of leachate 4 cm deep over the area of the landfill (Cell 1 and Cell 2) was placed in the evaporation pond, the depth of leachate in the evaporation pond would be approximately 36 cm. Using these depths, the activity concentration, and the geomembrane proprieties, the design absorption rate was computed for each radionuclide. The computation is provided in Appendix B. The design absorption rates are listed in Table A-4, provided in Appendix A.

The design absorbed dose to the geomembrane is approximately 0.09 and 0.8 rads per hour, for the landfill and evaporation pond, respectively. Assuming the leachate concentration and composition remains constant, the total doses over the 15-year operation life are conservatively estimated to be 12,000 and 100,000 rads for the landfill and evaporation pond, respectively. The total dose for the landfill for 1,000 years is estimated to be 800,000 rads. This assumes that all the energy from the leachate will be absorbed in the geomembranes. In reality, only small fractions of alpha and beta particles will penetrate the geomembrane material. Notably, the upper sacrificial geomembrane lining the evaporation ponds will absorb the majority of the ionizing radiation with little dose to the underlying primary geomembrane. Based on radiation absorbed dose, the mechanical properties of the HDPE liner are not expected to be degraded below acceptable levels.

2. EXISTING STUDIES OF LINER/LEACHATE COMPATIBILITY

2.1 EPA Method 9090

In 1992, EPA published Method 9090, 'Compatibility Tests for Wastes and Membrane Liners,' to set the standard that liners must meet to be protective of human health and the environment. This test has been used throughout the industry to demonstrate that liners are compatible with numerous leachate compositions from municipal and hazardous waste landfills, and surface impoundments. The results of these studies have been documented and are readily available. The manufacturers of the liners now supply limitations of the products based on these tests. The results are commonly accepted as reliable and complete. Since the ICDF leachate contains no unusual or excessive constituents, the industry results for these liners is sufficient to demonstrate compatibility.

The compatibility of GCL and SBL materials are usually demonstrated by permeating the material with leachate to determine its permeability. Method 9090 consists of immersing small sample specimens of a liner material in leachate and periodically measuring changes in the physical properties. The specimens are removed after 30, 60, 90, and 120 days, then tested to determine changes to the physical dimensions and mechanical properties. Acceptance criteria for defining compatibility tend to vary. Compatibility has been defined as geomembrane properties remaining above the minimum suggested property value or an allowable small percentage of change in properties (e.g., less than 15%) to maintain the integrity of the liner.

GCL and SBL are tested for compatibility by permeating the material with a leachate solution to determine effects on the hydraulic performance of the material. Typically, solutions with high concentrations of contaminants or pure products are allowed to permeate a sample under confining pressure to determine the saturated permeability of the material using ASTM methods such as ASTM D5084. A saturated permeability exceeding 1×10^{-7} cm/sec would indicate incompatibility.

The HDPE geomembrane and GCL materials planned for the ICDF are considered to be the most chemically inert liner materials commercially available for waste disposal facilities. Numerous studies using EPA Method 9090 and permeability tests, among other testing procedures, have been performed for waste disposal facilities and in the laboratory providing a good understanding of the compatibility behavior of these liner materials.

2.2 Published Studies

2.2.1 Comparison with Other Geomembrane 9090 Compatibility Studies

Relevant compatibility studies have been performed at DOE's Hanford facility near Richland, Washington. These projects include the Liquid Effluent Retention Facility (LERF), W-025 landfill, and the Grout Facility. Other relevant studies include the Kettleman Hills landfill located in northern California. The results of these published studies indicate that a HDPE geomembrane will function well as a liner beneath the landfill waste or liquid waste in the evaporation pond. The published geomembrane compatibility studies for the Hanford facility are listed in Section 6 Bibliography of this report.

A comparison between the anticipated ICDF landfill leachate and that used in compatibility tests for other facilities is summarized in Table 4.

Table 4. EPA test method 9090 compatibility studies comparison.

Compatibility Study[a]	Type of Material Tested	General Composition of Leachate	9090[b] Test Concentrations or Radiation Exposure that Demonstrated Compatibility in Each Study	ICDF[c] Leachate Concentration/ Absorbed Radiation
Hanford LERF	60-mil smooth HDPE from four manufacturers	Organics	16.25 mg/L	70 mg/L
Hanford W-025 Landfill	60-mil smooth HDPE	Inorganics	204,210 mg/L	18,400[g] mg/L
		Organic Leachate and Radiation Exposure	50,000 rads	12,000 rads (landfill) 100,000 rads (evaporation pond)
		pH	9.2	8.0
Hanford Grout Facility	60-mil smooth HDPE	Inorganics	368,336 mg/L	18,400 mg/L
		Organic Leachate and Radiation[e] Exposure	37,000,000 rads	
		Organic Leachate and Radiation[f] Exposure	16,000,000 rads	12,000 rads (landfill) 100,000 rads (evaporation pond)
		pH	>14	8.0
Kettleman Hills Landfills	60-mil smooth HDPE	Organics	93,040 mg/L	70 mg/L
		Inorganics	250,000 mg/L	18,400 mg/L
		pH	>12	8.0
Unidentified Landfill Study	Textured HDPE	Organics	154 mg/L	70 mg/L

a. Detailed compatibility test information is provided in *Evaluation of Liner/Leachate Chemical Compatibility for the Environmental Restoration Disposal Facility report* (USACE 1995).

b. EPA Test Method 9090 "Compatibility Test for Wastes and Membrane Liners" (EPA 1992).

Values reported represent values at which the test was run, showing no unacceptable effects. They do not represent an allowable limit.

Values based on the "Leachate/Contaminate Reduction Time Study" (EDF-ER-274).

e. A slight reduction in strength and elasticity of the HDPE liner occurred at the highest doses used in the testing.

f. No measurable changes in the HDPE liner material properties were observed after the testing.

g. Reported as total inorganics.

HDPE is chemically resistant to inorganic salt solutions and can be incompatible with some organic solutions at high concentrations (i.e., pure products). Actual compatibility tests from other landfills show that HDPE is chemically resistant to much higher concentrations of organics in the leachate than what is expected in the ICDF leachate. The organic concentration in the Kettlemen Hills Landfill leachate is almost four orders of magnitude higher than what is expected in the ICDF landfill leachate. The use of general categories of chemicals rather than individual constituents has been accepted by the EPA for the Environmental Restoration Disposal Facility at Hanford and provide a worst-case scenario due to possible synergistic effects of mixed compounds.

The EPA Method 9090 tests performed on HDPE geomembrane liner planned for the Grout Facility included high temperatures and doses of large amounts of radiation. The leachate solution temperature was increased to 194°F, which is significantly above the standard test temperatures of 73° and 122°F required in Method 9090. Additionally, the samples were irradiated at doses up to 37,000,000 rads prior to the testing, significantly decreasing the strength and elasticity (i.e., greater than 25%) of the geomembrane specimens (USACE 1995). Geomembrane samples tested for the W-025 facility did not produce measurable changes in the HDPE liner properties when irradiated for 120 days with a total dose of 50,000 rads. HDPE geomembranes are manufactured with additives to improve ductility and durability such as carbon black and antioxidants. The literature also indicates that these additives allow higher doses than standard HDPE material alone (Kircher and Bowman 1964). The literature indicates that thin films (i.e., 0.002 in.) of different types of HDPE material alone can become brittle when irradiated at doses between 4,400,000 and 78,000,000 rads. Studies performed using polymer materials show that properties typically begin to change at a total radiation dose of between 1,000,000 and 10,000,000 rads (Koerner et al. 1990).

The landfill and evaporation pond HDPE geomembrane liners are expected to receive a dose from the leachate of 12,000 and 100,000 rads, respectively. This is a conservatively high dose since it assumes that concentrations of radionuclides are constant in the leachate over the 15-year operational life of the landfill. Even though conservatively high, the total dose is below the dose found in other studies (i.e., 1,000,000 rads) that may affect the properties of the geomembrane.

2.2.2 Geosynthetic Clay and Soil Bentonite Liners

Based on review of the published studies listed in Section 6 (Bibliography), SBL and GCL perform well unless exposed to high concentrations of divalent cations, very acidic or basic solutions, or solutions with a low dielectric constant (such as gasoline). The leachate expected at the ICDF will have a pH of 8, slightly above neutral. The studies further demonstrate that, when confined, as is the case in the ICDF landfill, or pre-hydrated, SBLs and GCLs will perform well when exposed to high divalent cation concentrations.

Several studies were found that evaluated the impact of SBL permeability with various organic and inorganic materials. The majority of them used very concentrated compounds, which is not the typical composition of landfill leachates and when compared with ICDF leachate exceeded concentrations by as much as an order of magnitude. One study was found that addressed the issue of when leachate constituent concentrations impact SBL permeability. For this study, four different types of organic compounds were used as permeants. They included methanol, acetic acid, heptane, and trichloroethylene (TCE). The results indicate that soil permeability was not affected by methanol until a concentration of 80% by volume was used. The acetic acid actually reduced the soil permeability due to dissolution and reprecipitation of the soil. Heptane and TCE had no effect on permeability when used up to their solubility limit in water. However, when used in pure form, they increased the soil permeability significantly (250 to 1,000 times). In addition to the concentration of the permeant used, changes in hydraulic permeability are also governed by the mineralogy of the soil (Borders 1986). Although only low concentrations of TCE are predicted in the ICDF leachate, the study demonstrates that high concentrations of organic constituents are required to affect permeability.

No studies were identified that considered the long-term effects of radiation on the physical properties of the SBL or GCL materials. Since long-term studies cannot be conducted, conservative radiation limitations have been employed. Low-permeability soils have been used at multiple DOE facilities containing radioactive waste. The only potential adverse reaction that could occur with the SBL or GCL would be high heat that could dry out these materials, however, it is anticipated that the radioactive material placed in the ICDF will not generate any thermal gradients across the liner system.

The concentration of organic material is expected to be approximately 70 mg/L. This is significantly below the concentration of a highly concentrated solution so it will not increase the permeability of the SBL and GCL. The amount of radioactivity will be low in the ICDF landfill waste and will not generate a significant amount of heat that can desiccate the compacted clay. Additionally, the operations layer will provide a 3-ft buffer between the liner system and waste.

2.3 Manufacturers' Data

2.3.1 HDPE Geomembrane

The manufacturers of the geosynthetic products proposed for the ICDF landfill have published maximum allowable concentrations of various chemical compounds that can contact the HDPE geomembrane without adversely affecting its performance. The most recent recommended maximum concentrations of chemicals were obtained from the manufacturer. A list of the manufacturers' maximum allowable concentrations for specific leachate constituents on HDPE material is provided in Appendix C. In addition, the effects of radiation exposure with respect to the geomembrane physical properties are also presented.

2.3.2 Geosynthetic Clay and SBLs

The GCL underlying the geomembrane in the ICDF landfill and evaporation pond liner consists of processed sodium bentonite clay sandwiched between two geotextile fabrics. The SBL underlying the geosynthetic liners also consists of 5% by weight of processed bentonite amendment. Sodium bentonite is an ore comprised mainly of the montmorillonite clay mineral with broad, flat, negatively charged platelets that attract water hydrating the bentonite. The swelling provides the ability to seal around penetrations, giving the GCL its self-healing properties. A GCL product with Volclay® type sodium bentonite manufactured by CETCO will be installed in the landfill and evaporation pond.

The GCL manufacturer allows the use of GCL with few restrictions on maximum chemical concentrations. The manufacturer does recommend that treated bentonite should be used when directly exposed to liquids with high concentration of salts (divalent cations) such as in seawater (CETCO 2001). The concentration of salts in typical seawater is on the order of 35,000 mg/L (USGS 1989). The ICDF total inorganic leachate concentration is on the order of 17,000 mg/L, approximately 2 times lower than that of seawater. The same compatibility limitation is found in the literature as described in Section 2.1.2. The bentonite added to the soil for the bentonite liner will have the same limitation, however, to a lesser extend since only a small percentage (i.e., 5%) is comprised of bentonite. Based on this assessment, the exposed salts in the brackish leachate will be compatible with the GCL and SBL underlying the geomembrane. Notably, this assumes that the overlying HDPE geomembranes must leak before leachate can come in contact with the GCL or SBL.

3. WASTE ACCEPTANCE CRITERIA

3.1 Landfill

Individual constituents in the ICDF landfill design inventory were evaluated to determine maximum allowable ICDF landfill waste concentrations, that if placed in the landfill would generate leachate compatible with the liner system. Many of the individual design inventory constituents have not been included in the composition of leachate used for published compatibility studies. However, the constituents used in the published studies are in similar chemical groups as the constituents in the ICDF design inventory and therefore, would react similarly with the liner materials. Moreover, the use of general chemical categories rather than individual constituents provide a worst-case scenario due to possible synergistic effects of mixed compounds.

Table 5 provides the recommended maximum concentration of chemical categories that, if in the landfill leachate, may be incompatible with the polymeric or earthen material comprised of the ICDF landfill and evaporation pond liner systems. These limits are based on review of the published liner compatibility studies and manufacturers' recommendations. The maximum allowable concentration for HDPE geomembrane, GCL, and SBL were compared to determine the highest acceptable value. The lowest of all three values was selected as the suggested maximum concentration. The concentrations based on the design inventory of waste constituents are also provided in Table 5. Where available, the recommended maximum allowable concentration with regard to liner compatibility for individual constituents is provided in Tables D-1, D-2, and D-3 in Appendix D for specific organic, inorganic, and radionuclide constituents, respectively.

Table 5. Maximum allowable concentrations in leachate by chemical category.

Chemical Category	Compatible Concentration for HDPE	Compatible Concentration for GCL and Clay	Suggested ICDF Maximum Concentration or Value	Design Inventory Concentration Dose or Value
Organics	500,000[a] mg/L	500,000[b] mg/L	500,000 mg/L	70 mg/L
Acids and Bases	750,000[a] mg/L	500,000[b] mg/L	500,000 mg/L	0[d] mg/L
Inorganic	500,000[a] mg/L	500,000[b] mg/L	500,000 mg/L	17,100 mg/L
Dissolved Salts	No Limit	35,000 mg/L	35,000 mg/L	8,000 mg/L[c]
Strong Oxidizers	1,000 mg/L	No limit	1,000 mg/L	0 [d] mg/L
Radionuclides	1,000,000[b] rads	No limit	1,000,000 rads	12,000 rads (15 yr) 800,000 rads (1000 yr)
pH	0.5 - 13.0[a]	0.5 - 13.0	0.5 - 13.0	8.0

a. Based on the manufacturers' maximum concentration of the list of constituents tested by the manufacturers. The manufacturrs' recommendations are provided in Appendix C.

b. Based on reported literature values.

c. Based on the maximum sodium concentration determined in the Geochemical Evaluation.

d. Strong acids, bases, or oxidizing compounds were not reported in the design inventory.

The concentration and exposure limits in Table 5 provide Waste Acceptance Criteria (WAC) for chemical categories. These values can be used as a general guide to determine WAC if individual constituents in the leachate are lower than the limits provided in Appendix D.

The maximum allowable activity concentration of individual radionuclides was determined based on a maximum allowable dose of 1,000,000 rads. The calculated values are provided in Table C-3 in Appendix C. Based on radiation absorbed dose, the mechanical properties of the HDPE liner are not expected to be degraded below acceptable levels.

3.2 Evaporation Pond

The evaporation pond liner system will be comprised of HDPE geomembrane and GCL similar to the landfill liner system underlying a sacrificial geomembrane. The evaporation pond will contain leachate from the landfill and waste liquids from other CERCLA investigations (i.e., well purge water) or remediation tasks. Organics and inorganics in the leachate compatible with the landfill liner will also be compatible with the evaporation pond liner materials since they will be comprised of the same material. Leachate in the evaporation pond from the landfill will also have less concentration of contaminants than when originally in the landfill due to added make-up water, and precipitation.

The maximum allowable concentration of an individual radionuclide and WAC design ratios for the evaporation pond liner is provided in Appendix E. The maximum concentration was developed in the same manner as the landfill maximum allowable concentration assuming a maximum absorption dose of 1,000,000 rads. The allowable concentrations are less than in the landfill due to a greater depth of liquid in the evaporation pond resulting in a higher dose rate.

Waste liquids from other sources in the evaporation pond should not exceed the maximum allowable concentrations of liquids by chemical category in Table 5. The recommended maximum allowable concentrations with regard to liner compatibility for individual constituents are provided in Table D-4 of Appendix D.

4. CONCLUSIONS

An extensive literature review was performed to evaluate the compatibility of the ICDF landfill and evaporation pond liner materials with the expected leachate composition. Compatibility tests performed at similar sites have shown that HDPE geomembranes can be exposed to high doses of radiation without damage and are compatible with leachate from hazardous waste landfills. Liner manufacturers have also performed compatibility tests using numerous organic and inorganic chemicals, usually in a pure solution, to determine maximum allowable limits. Based on review of literature, the expected leachate concentrations will have no effect on the performance of the ICDF liner system based on the available literature.

The maximum recommended concentration of chemical categories was provided to supply the WACs regarding liner compatibility. General chemical categories rather than individual constituents provide a worst-case scenario due to possible synergistic effects of mixed compounds. However, to provide numerical WAC, individual constituents in the ICDF design inventory were evaluated to determine maximum allowable ICDF landfill waste soil concentrations with regard to liner compatibility. The maximum allowable ICDF landfill waste concentrations are provided in Appendix D.

Samples of 60-mil-thick HDPE geomembrane were irradiated with a total radiation dose of 16,000,000 and 37,000,000 rads for the Hanford Grout facility. The dose rate was 740,000 rads per hour for a total time of 50 hours. These doses showed decreases in the liner's break strength and break elongation due to radiation-induced cross-linking for the polymer chains, decreasing the plasticity of the liner. At the Hanford project W-025 landfill, the HDPE liner showed only a slight reduction in mechanical properties including tensile strength and elasticity after it was irradiated to 50,000 rads for

120 days while submerged in leachate. The literature indicates that the mechanical properties of polymeric materials begin to change at approximately 1,000,000 rads. The geomembrane can accommodate a slight reduction in its strength properties without creating defects that result in leaks since the actual properties are more robust than the design properties (i.e., thickness). Therefore, a maximum radiation dose of 1,000,000 rads for the landfill and evaporation pond liner system during their respective service life is recommended.

The manufacturer for the ICDF geomembrane recommends that leachate have a pH between 0.5 and 13 pH units. Recommended manufacturers' limits for strong oxidizers are 1,000 to 500,000 mg/L and metals, salts, and nutrients of 500,000 mg/L. The permeability of the bentonite used in the GCL and SBL may increase if permeated with leachate having a salt ion concentration. Therefore, a maximum inorganic salt concentration of 35,000 mg/L is recommended as a conservative upper limit. These limits are far above the concentrations expected in the leachate from the ICDF landfill and waste liquids in the evaporation pond. They will be used to determine the maximum allowable concentrations in the waste soil and liquids that if placed in the ICDF landfill or evaporation would not cause significant degradation of the liner system.

5. REFERENCES

ASTM D5084, 1998 (2001), "Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter," American Society for Testing and Materials, Reapproved 2001.

Borders, J. J., Jr., and D. D. Daniel, 1996, "Hydraulic Conductivity of Compacted Clay to Dilute Organic Chemicals," *Journal of Geotechnical Engineering*, Vol. 113, No. 112, pp. 1432-1447.

CETCO, 2001, *Bentomat / Claymax Technical Manual*, GCL Manufacturer's publication, Colloid Environmental Technologies Company, Arlington Heights, Illinois.

EDF-ER-264, 2001, "INEEL CERCLA Disposal Facility Design Inventory," Rev. A, Environmental Restoration Program, Idaho National Engineering and Environmental Laboratory, March 2001.

EDF-ER-269, 2002, "Leachate Generation Study," Rev. 1, Environmental Restoration Program, Idaho National Engineering and Environmental Laboratory, May 2002.

EDF-ER-274, 2002, "Leachate/Contamination Reduction Time," Rev. 1, Environmental Restoration Program, Idaho National Engineering and Environmental Laboratory, May 2002.

EDF-ER-279, 2002, "Hydrologic Modeling of Final Cover," Rev. 2, Environmental Restoration Program, Idaho National Engineering and Environmental Laboratory, May 2002.

EPA, 1992, "SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Method 9090, " *Compatibility Test for Wastes and Membrane Liners,"* U.S. Environmental Protection Agency, Office of Solid Waste Management, Washington, D.C.

Kircher, J. F. and R. E. Bowman, 1964, *Effects of Radiation on Material and Components,* Reinhold Publishing Corporation, New York, New York.

Koerner, R. M., 1998, *Designing with Geosynthetics*, Fourth Edition, Prentice Hall, Upper Saddle River, New Jersey.

Koerner, R. M., Y. H. Halse, and A. E. Lord, Jr., 1990, "Long-Term Durability and Aging of Geomembranes," ASTM Special Publication No. 26, *Waste Containment,* American Society of Engineers, New York, New York.

USACE, 1995, *Evaluation of Liner/Leachate Chemical Compatibility For the Environmental Restoration Disposal Facility,* U.S. Army Corps of Engineers, Walla Walla, Washington.

USGS, 1989, *Study and Interpretation of the Chemical Characteristics of Natural Water,* Water-Supply Paper 2254, U.S. Geological Survey, Department of the Interior, Washington, D.C.

6. BIBLIOGRAPHY

6.1 HDPE Geomembrane Leachate Compatibility Studies

Casbon, M. A., 1995, Evaluation of Linear/Leachate Chemical Compatability for the Environmental Restoration Disposal Facility, Bechtel Hanford, Inc., Richland, Washington.

DOE-RL, 1994, Source Inventory Development Engineering Study for the Environmental Restoration Disposal Facility, DOE/RL/12074-29, Rev. 0, Walla Walla, Washington.

Farnsworth, R. K. and C. R. Hymas, 1989, The Compatibility of Various Polymeric Liner and Pipe Materials with Simulated Double-Shell Slurry Feed at 90° C, Hanford Grout Technology Program, Pacific Northwest Laboratory, Richland, Washington.

Koerner, R. M., Y. H. Halse, and A. E. Lord, Jr., 1990, "Long-Term Durability and Aging of Geomembranes," ASTM Special Publication No. 26, Waste Containment, American Society of Engineers, New York, New York.

6.2 Clay Liner and GCL Leachate Compatibility Studies

Acar, Y. B., A. Hamidon, S.D. Field, and L. Scott, 1985, "The Effect of Organic Fluids on Hydraulic Conductivity of Compacted Kaolinite," *Hydraulic Barriers in Soil and Rock, ASTM STP 874,* A. I. Johnson, R. K. Frobel, N.J. Cavalli, and C. B. Pettersson, Eds., American Society for Testing and Materials, Philadelphia, Pennsylvania, pp. 171-187.

Anderson, D. C., W. Crawley, and J.D. Zabcik, 1985, "Effects of Various Liquids on Clay Soil: Bentonite Slurry Mixtures," *Hydraulic Barriers in Soil and Rock, ASTM STP 874,* A. I Johnson, R. K. Frobel, N. J. Cavalli, and C. B. Pettersson, Eds., American Society for Testing and Materials, Philadelphia, Pennsylvania, pp. 93-103.

Broderick, Gregory P. and David E. Daniel, 1990, "Stabilizing Compacted Clay Against Chemical Attack," *Journal of Geotechnical Engineering,* Vol. 116, No. 10, pp. 1549 – 1567.

Eklund, A.G., 1985, "A Laboratory Comparison of the Effects of Water and Waste Leachate on the Performance of Soil Liners," *Hydraulic Barriers in Soil and Rock, ASTM STP 874,* A. I. Johnson, R. K. Frobel, N. J. Cavalli, and C. B. Pettersson, Eds., American Society for Testing and Materials, Philadelphia, Pennsylvania, pp. 188-202.

Finno, Richard J. and William R. Schubert, 1986, "Clay Liner Compatibility in Waste Disposal Practice," *Journal of Environmental Engineering,* Vol. 112, No. 6, pp. 1070 – 1083.

This page intentionally left blank.

Appendix A

Expected Leachate Design Concentrations and Absorbed Radiation Dose

This page intentionally left blank.

Table A-1. Predicted organic concentrations in leachate.

Constituent[a]	Maximum Leachate Concentration[b] (mg/L)	Average Leachate Concentration (mg/L)	Constituent[a]	Maximum Leachate Concentration[b] (mg/L)	Average Leachate Concentration (mg/L)
1,1,1-Trichloroethane	0.0609	0.0073	Acenaphthene	0.0399	0.0028
1,1,2,2-Tetrachloroethane	0.0002	0.0000	Acenaphthylene	0.3366	0.0230
1,1,2-Trichloroethane	0.0013	0.0002	Acetone	6.2674	0.3917
1,1-Dichloroethane	0.0105	0.0009	Acetonitrile	0.0002	0.0000
1,1-Dichloroethene	0.0004	0.0000	Acrolein	0.0001	0.0000
1,2,4-Trichlorobenzene	0.0113	0.0010	Acrylonitrile	0.0000	0.0000
1,2-Dichlorobenzene	0.0734	0.0046	Anthracene	0.0083	0.0013
1,2-Dichloroethane	0.0001	0.0000	Aramite	0.0000	0.0000
1,2-Dichloroethene (total)	0.0003	0.0000	Aroclor-1016	0.0000	0.0000
1,3-Dichlorobenzene	0.0071	0.0006	Aroclor-1254	0.0002	0.0000
1,4-Dichlorobenzene	5.1303	0.4578	Aroclor-1260	0.0087	0.0005
1,4-Dioxane	0.0000	0.0000	Aroclor-1268	0.2891	0.0181
2,4,5-Trichlorophenol	0.0441	0.0114	Benzene	1.3491	0.1685
2,4,6-Trichlorophenol	0.0427	0.0109	Benzidine	0.0000	0.0000
2,4-Dichlorophenol	0.0371	0.0023	Benzo(a)anthracene	0.0001	0.0000
2,4-Dimethylphenol	0.3041	0.0190	Benzo(a)pyrene	0.0000	0.0000
2,4-Dinitrophenol	0.1705	0.0173	Benzo(b)fluoranthene	0.0000	0.0000
2,4-Dinitrotoluene	0.0488	0.0041	Benzo(g,h,i)perylene	0.0000	0.0000
2,6-Dinitrotoluene	0.2903	0.0242	Benzo(k)fluoranthene	0.3024	0.1623
2-Butanone	0.0063	0.0004	Benzoic acid	0.1162	0.0073
2-Chloronaphthalene	0.0108	0.0007	Bis(2-Chloroethoxy)methane	0.0455	0.0444
2-Chlorophenol	0.1867	0.0208	bis(2-Chloroethyl)ether	0.0535	0.0048
2-Hexanone	0.0001	0.0001	bis(2-Chloroisopropyl)ether	0.0000	0.0000

Table A-1. (continued).

Constituent[a]	Maximum Leachate Concentration[b] (mg/L)	Average Leachate Concentration (mg/L)	Constituent[a]	Maximum Leachate Concentration[b] (mg/L)	Average Leachate Concentration (mg/L)
2-Methylnaphthalene	1.7772	1.7403	bis(2-Ethylhexyl)phthalate	0.5714	0.0497
2-Methylphenol	0.2014	0.0126	Butane,1,1,3,4-Tetrachloro-	0.0001	0.0000
2-Nitroaniline	0.1728	0.1663	Butylbenzylphthalate	0.0080	0.0005
2-Nitrophenol	0.0098	0.0006	Carbazole	0.1856	0.1793
3,3'-Dichlorobenzidine	0.1896	0.0168	Carbon Disulfide	0.0734	0.0046
3-Methyl Butanal	0.0022	0.0021	Chlorobenzene	0.0679	0.0062
3-Nitroaniline	0.0165	0.0165	Chloroethane	0.0000	0.0000
4,6-Dinitro-2-methylphenol	0.0010	0.0001	Chloromethane	0.0000	0.0000
4-Bromophenyl-phenylether	0.0615	0.0595	Chrysene	4.4199	1.4812
4-Chloro-3-methylphenol	0.0810	0.0789	Decane, 3,4-Dimethyl	0.0004	0.0004
4-Chloroaniline	0.0052	0.0052	Diacetone alcohol	0.0005	0.0000
4-Chlorophenyl-phenylether	0.0288	0.0284	Dibenz(a,h)anthracene	0.0006	0.0002
4-Methyl-2-Pentanone	0.1131	0.0071	Dibenzofuran	0.4156	0.0260
4-Methylphenol	0.3766	0.0235	Diethylphthalate	0.1897	0.0120
4-Nitroaniline	0.1728	0.1663	Dimethyl Disulfide	0.0127	0.0124
4-Nitrophenol	0.0029	0.0002	Dimethylphthalate	0.0001	0.0000
Di-n-butylphthalate	0.0000	0.0000	N-Nitroso-di-n-propylamine	0.0035	0.0003
Di-n-octylphthalate	0.4370	0.0370	N-Nitrosodiphenylamine	0.1896	0.0119
Eicosane	0.0472	0.0029	Octane,2,3,7-Trimethyl	0.0027	0.0024
Ethyl cyanide	0.0000	0.0000	o-Toluenesulfonamide	0.0033	0.0033
Ethylbenzene	0.0705	0.0050	Pentachlorophenol	0.0046	0.0010
Famphur	0.0000	0.0000	Phenanthrene	8.8500	0.8023
Fluoranthene	0.0221	0.0039	Phenol	0.1370	0.0086
Fluorene	3.0594	0.2043	Phenol,2,6-Bis(1,1-Dimethyl)	0.0674	0.0042

Table A-1. (continued).

Constituent[a]	Maximum Leachate Concentration[b] (mg/L)	Average Leachate Concentration (mg/L)	Constituent[a]	Maximum Leachate Concentration[b] (mg/L)	Average Leachate Concentration (mg/L)
Heptadecane, 2,6,10,15-Tetra	0.0000	0.0000	p-Toluenesulfonamide	0.0000	0.0000
Hexachlorobenzene	0.0001	0.0000	Pyrene	3.2501	1.4592
Hexachlorobutadiene	0.0000	0.0000	RDX	0.0000	0.0000
Hexachlorocyclopentadiene	0.0025	0.0002	Styrene	0.0000	0.0000
Hexachloroethane	0.0000	0.0000	Tetrachloroethene	0.0235	0.0039
Indeno(1,2,3-cd)pyrene	0.1585	0.0524	Toluene	16.3666	1.0229
Isobutyl alcohol	0.0001	0.0000	Tributylphosphate	1.2292	0.1704
Isophorone	0.1829	0.0114	Trichloroethene	1.1526	0.3027
Isopropyl Alcohol/2-propanol	0.0000	0.0000	Trinitrotoluene	0.0000	0.0000
Kepone	0.2511	0.0704	Undecane,4,6-Dimethyl-	0.0003	0.0003
Mesityl oxide	1.2939	0.0809	Xylene (ortho)	0.0071	0.0006
Methyl Acetate	0.0057	0.0053	Xylene (total)	6.2805	0.5293
Methylene Chloride	0.0165	0.0010			
Naphthalene	1.9193	0.1398	Total Organics	69.5426	10.4515
Nitrobenzene	0.0948	0.0082			

a. Constituents based on the design Inventory (EDF-ER-264)
b. Peak and average concentrations during the 15 year active life of the landfill assuming the entire mass is placed in the landfill (EDF-ER-274)

Table A-2. Expected peak inorganic concentrations in leachate.

Constituent[a]	Maximum Leachate Concentration (mg/L)[b]	Average Leachate Concentration (mg/L)[b]
Aluminum	28.3029	28.3022
Antimony	0.1165	0.1164
Arsenic	1.8470	1.8434
Barium	3.5848	3.5843
Beryllium	0.0011	0.0011
Boron	36.4728	36.4292
Cadmium	0.5917	0.5911
Calcium	4035.0217	4030.1943
Chloride	31.1061	28.1653
Chromium	1.3691	1.3689
Cobalt	0.5999	0.5996
Copper	1.4906	1.4902
Cyanide	4.0932	3.8059
Dysprosium	0.2472	0.2472
Fluoride	64.4341	58.3424
Iron	46.5528	46.5516
Lead	0.5753	0.5753
Magnesium	883.9838	882.9262
Manganese	4.1300	4.1295
Mercury	49.7230	48.1710
Molybdenum	1.0117	1.0111
Nickel	0.1964	0.1964
Nitrate	65.4429	59.2558
Nitrate/Nitrite-N	3.6979	3.3483
Nitrite	0.1414	0.1281
Phosphorus	19.2492	19.2261
Potassium	74.8819	74.8518
Selenium	0.2084	0.2080
Silver	0.1092	0.1092
Sodium	2.7716	2.7714
Strontium	1.5094	1.5087
Sulfate	342.1180	309.7736
Sulfide	12641.8391	11446.6606
Terbium	2.3867	2.3866
Thallium	0.0037	0.0037
Vanadium	3.5063	3.5028
Ytterbium	0.8124	0.8123
Zinc	12.9486	12.9437
Zirconium	0.1151	0.1151
Total Inorganic Concentration	18367.1936	17116.2485

a. Constituents based on the design Inventory (2001 EDF-264)

b. Peak and average concentrations during the 15 year active life of the landfill assuming the entire mass is placed in the landfill (EDF-ER-274)

Table A-3. Expected peak rationuclides concentrations in leachate.

Constituent[a]	Maximum Leachate Concentration (pCi/L)[b]	Average Leachate Concentration (pCi/L)[b]	Constituent[a]	Maximum Leachate Concentration (pCi/L)[b]	Average Leachate Concentration (pCi/L)[b]
Ac225	1.1E-07	7.1E-09	Cm241	3.2E-81	2.0E-82
Ac227	4.5E-05	3.6E-05	Cm242	1.3E-17	1.1E-18
Ac228	3.4E-10	2.1E-11	Cm243	8.9E-07	7.4E-07
Ag106	0.0E+00	0.0E+00	Cm244	4.5E-04	3.4E-04
Ag108	4.1E-08	2.6E-09	Cm245	2.0E-08	2.0E-08
Ag108m	8.9E+00	8.5E+00	Cm246	4.5E-10	4.5E-10
Ag109m	5.5E-11	3.4E-12	Cm247	1.6E-16	1.6E-16
Ag110	5.7E-10	3.6E-11	Cm248	4.9E-17	4.9E-17
Ag110m	6.2E-08	6.0E-09	Cm250	1.4E-25	1.4E-25
Ag111	0.0E+00	0.0E+00	Co57	3.7E-01	3.8E-02
Am241	7.0E+01	6.9E+01	Co58	5.8E-15	3.8E-16
Am242	1.3E-04	8.3E-06	Co60	1.9E+04	8.6E+03
Am242m	1.3E-04	1.3E-04	Cr51	7.7E-53	4.8E-54
Am243	9.8E-04	9.8E-04	Cs132	0.0E+00	0.0E+00
Am245	0.0E+00	0.0E+00	Cs134	2.2E+01	4.9E+00
Am246	4.1E-25	2.5E-26	Cs135	7.2E-02	7.2E-02
At217	8.5E-04	5.3E-05	Cs136	0.0E+00	0.0E+00
Ba136m	0.0E+00	0.0E+00	Cs137	4.9E+04	4.1E+04
Ba137m	4.6E+05	2.9E+04	Er169	0.0E+00	0.0E+00
Ba140	0.0E+00	0.0E+00	Eu150	5.1E-08	3.2E-09
Be10	4.6E-06	4.6E-06	Eu152	2.8E+03	2.0E+03
Bi210	1.1E-05	6.8E-07	Eu154	2.4E+03	1.4E+03
Bi211	1.8E-04	1.1E-05	Eu155	5.2E+02	2.2E+02

Table A-3. (continued).

Constituent[a]	Maximum Leachate Concentration (pCi/L)[b]	Average Leachate Concentration (pCi/L)[b]	Constituent[a]	Maximum Leachate Concentration (pCi/L)[b]	Average Leachate Concentration (pCi/L)[b]
Bi212	5.5E-03	3.5E-04	Eu156	0.0E+00	0.0E+00
Bi213	0.0E+00	0.0E+00	Fe59	2.0E-34	1.3E-35
Bi214	5.6E-05	3.5E-06	Fr221	1.0E-07	6.4E-09
Bk249	5.4E-22	6.2E-23	Fr223	5.6E-07	3.5E-08
Bk250	1.9E-26	1.2E-27	Gd152	1.1E-13	1.1E-13
C14	9.1E-03	9.1E-03	Gd153	8.4E-11	8.1E-12
Cd109	8.1E-10	1.2E-10	H3	8.3E+05	5.2E+05
Cd113m	2.7E+02	1.9E+02	Hf181	1.7E-36	1.1E-37
Cd115m	7.0E-52	4.4E-53	Ho166m	1.1E-05	6.7E-07
Ce141	3.6E-71	2.3E-72	I129	2.2E+04	2.0E+04
Ce142	0.0E+00	0.0E+00	I131	0.0E+00	0.0E+00
Ce144	3.6E-03	3.8E-04	In114	4.8E-54	3.0E-55
Cf249	8.1E-16	8.0E-16	In114m	5.1E-54	3.2E-55
Cf250	4.1E-16	2.9E-16	In115	1.5E-11	1.5E-11
Cf251	1.9E-18	1.9E-18	In115m	0.0E+00	0.0E+00
Cf252	4.4E-20	1.2E-20	K40	1.3E+02	1.3E+02
Kr81[c]	0.0E+00	8.0E-05	Po216	3.7E-03	2.3E-04
Kr85[c]	0.0E+00	1.1E+07	Po218	3.7E-05	2.3E-06
La138	0.0E+00	0.0E+00	Pr143	0.0E+00	0.0E+00
La140	2.2E-105	1.4E-106	Pr144	7.4E-03	4.6E-04
Mn54	3.9E-07	4.3E-08	Pr144m	1.1E-04	6.6E-06
Nb92	6.3E-18	6.3E-18	Pu236	3.9E-05	1.1E-05
Nb93m	1.3E-01	9.5E-02	Pu237	8.6E-58	5.4E-59
Nb94	8.8E-05	8.8E-05	Pu238	1.7E+03	1.6E+03

Table A-3. (continued).

Constituent[a]	Maximum Leachate Concentration (pCi/L)[b]	Average Leachate Concentration (pCi/L)[b]	Constituent[a]	Maximum Leachate Concentration (pCi/L)[b]	Average Leachate Concentration (pCi/L)[b]
Nb95	4.8E-32	3.0E-33	Pu239	4.8E+01	4.8E+01
Nb95m	1.8E-34	1.1E-35	Pu240	1.1E+01	1.1E+01
Nd144	1.4E-09	1.4E-09	Pu241	4.6E+02	3.3E+02
Nd147	0.0E+00	0.0E+00	Pu242	1.7E-03	1.7E-03
Np235	8.4E-09	1.1E-09	Pu243	4.6E-15	2.9E-16
Np236	8.6E-06	8.6E-06	Pu244	1.8E-10	1.8E-10
Np237	8.0E+01	8.0E+01	Pu246	9.9E-25	6.2E-26
Np238	2.7E-05	1.7E-06	Ra222	1.2E-115	7.3E-117
Np239	4.1E-02	2.6E-03	Ra223	2.0E-04	1.3E-05
Np240	3.5E-12	2.2E-13	Ra224	5.5E-03	3.5E-04
Np240m	3.1E-09	2.0E-10	Ra225	5.1E-07	3.2E-08
Pa231	1.3E-04	1.3E-04	Ra226	4.7E+00	4.7E+00
Pa233	7.9E-02	4.9E-03	Ra228	1.5E-09	7.2E-10
Pa234	5.0E-06	3.1E-07	Rb86	0.0E+00	0.0E+00
Pa234m	3.1E-03	1.9E-04	Rb87	2.0E-04	2.0E-04
Pb209	4.8E-07	3.0E-08	Rh102	5.7E-04	1.6E-04
Pb210	1.1E-05	8.7E-06	Rh103m	5.4E-57	3.4E-58
Pb211	1.8E-04	1.1E-05	Rh106	2.2E-01	1.4E-02
Pb212	5.5E-03	3.5E-04	Rn218	2.1E-112	1.3E-113
Pb214	5.6E-05	3.5E-06	Rn219	3.4E-01	2.1E-02
Pd107	1.1E-01	1.1E-01	Rn220	9.2E+00	5.8E-01
Pm146	2.4E-02	1.1E-02	Rn222	1.0E-01	6.5E-03
Pm147	1.6E+03	4.2E+02	Ru103	3.6E-28	2.3E-29
Pm148	1.7E-58	1.0E-59	Ru106	2.2E-01	2.8E-02

Table A-3. (continued).

Constituent[a]	Maximum Leachate Concentration (pCi/L)[b]	Average Leachate Concentration (pCi/L)[b]	Constituent[a]	Maximum Leachate Concentration (pCi/L)[b]	Average Leachate Concentration (pCi/L)[b]
Pm148m	3.4E-57	2.1E-58	Sb124	4.1E-39	2.6E-40
Po210	6.8E-06	5.0E-07	Sb125	1.9E+02	5.1E+01
Po211	4.6E-09	2.9E-10	Sb126	4.1E-01	2.6E-02
Po212	2.2E-03	1.4E-04	Sb126m	2.9E+00	1.8E-01
Po213	2.9E-07	1.8E-08	Sc46	9.2E-20	6.0E-21
Po214	3.7E-05	2.3E-06	Se79	4.1E+01	4.1E+01
Po215	1.2E-04	7.6E-06	Sm146	1.8E-09	1.8E-09
Sm147	1.7E-05	1.7E-05	Th231	1.6E+00	1.0E-01
Sm148	4.2E-12	4.2E-12	Th232	1.6E+00	1.6E+00
Sm149	2.1E-11	2.1E-11	Th234	1.7E-02	1.1E-03
Sm151	1.4E+03	1.3E+03	Tl207	1.8E-04	1.1E-05
Sn117m	0.0E+00	0.0E+00	Tl208	2.0E-03	1.2E-04
Sn119m	1.1E-06	1.2E-07	Tl209	1.1E-08	6.6E-10
Sn121m	2.1E-01	1.9E-01	Tm170	2.7E-25	1.9E-26
Sn123	6.5E-16	4.7E-17	Tm171	6.6E-12	1.4E-12
Sn125	0.0E+00	0.0E+00	U230	0.0E+00	0.0E+00
Sn126	1.1E+00	1.1E+00	U232	8.8E-02	8.2E-02
Sr89	5.0E-42	3.1E-43	U233	4.2E-03	4.2E-03
Sr90	1.9E+06	1.6E+06	U234	9.9E+02	9.9E+02
Tb160	1.3E-33	8.5E-35	U235	1.8E+01	1.8E+01
Tb161	0.0E+00	0.0E+00	U236	3.3E+01	3.3E+01
Tc98	6.8E-04	6.6E-04	U237	0.0E+00	0.0E+00
Tc99	2.2E+04	2.2E+04	U238	3.2E+02	3.2E+02
Te123	3.6E-14	3.6E-14	U240	4.2E-09	2.6E-10

Table A-3. (continued).

Constituent[a]	Maximum Leachate Concentration (pCi/L)[b]	Average Leachate Concentration (pCi/L)[b]	Constituent[a]	Maximum Leachate Concentration (pCi/L)[b]	Average Leachate Concentration (pCi/L)[b]
Te123m	2.4E-22	1.7E-23	Xe127	2.6E-68	1.6E-69
Te125m	1.8E+01	1.1E+00	Xe129m	0.0E+00	0.0E+00
Te127	7.5E-19	4.7E-20	Xe131m	4.5E-108	2.8E-109
Te127m	7.6E-19	5.3E-20	Xe133	0.0E+00	0.0E+00
Te129	5.4E-70	3.4E-71	Y90	1.3E+05	8.4E+03
Te129m	8.6E-70	5.4E-71	Y91	2.4E-36	1.5E-37
Th226	2.2E-116	1.4E-117	Zn65	1.7E-07	1.6E-08
Th227	1.8E-04	1.1E-05	Zr93	1.4E+00	1.4E+00
Th228	3.3E-01	6.7E-02	Zr95	4.9E-25	3.1E-26
Th229	5.1E-07	5.1E-07		2.3E+07	1.4E+07
Th230	1.7E+00	1.7E+00			

a. Constituents based on the design Inventory (2001 EDF-264)
b. Peak and average concentrations during the 15 year active life of the landfill assuming the entire mass is placed in the landfill (EDF-ER-274)
c. Constituents Kr-81 and Kr-85 are gaseous elements, so are not part of the leachate.

Table A-4. Radionuclide design absorption rate.

Constituent[a]	Landfill Design Absorption Rate Rads/Hour[b]	Evaporation Pond Design Absorption Rate Rads/Hour[b]	Constituent[a]	Landfill Design Absorption Rate Rads/Hour[b]	Evaporation Pond Design Absorption Rate Rads/Hour[b]
Ac225	3.95E-14	3.55E-13	Cm250	1.07E-32	9.61E-32
Ac227	2.15E-13	1.94E-12	Co57	3.13E-09	2.82E-08
Ac228	2.73E-17	2.46E-16	Co58	3.40E-22	3.06E-21
Ag106	1.53E-15	1.38E-14	Co60	2.98E-03	2.68E-02
Ag108	8.63E-07	7.77E-06	Cr51	1.65E-61	1.48E-60
Ag108m	0.00E+0	0.00E+0	Cs132	0.00E+0	0.00E+0
Ag109m	2.83E-19	2.54E-18	Cs134	2.29E-06	2.06E-05
Ag110	4.15E-17	3.73E-16	Cs135	2.40E-10	2.16E-09
Ag110m	1.03E-14	9.26E-14	Cs136	0.00E+0	0.00E+0
Ag111	0.00E+0	0.00E+0	Cs137	4.96E-04	4.47E-03
Am241	2.31E-05	2.08E-04	Er169	0.00E+0	0.00E+0
Am242	1.52E-12	1.37E-11	Eu150	8.84E-16	7.96E-15
Am242m	5.19E-13	4.67E-12	Eu152	2.16E-04	1.94E-03
Am243	3.13E-10	2.81E-09	Eu154	2.19E-04	1.97E-03
Am245	0.00E+0	0.00E+0	Eu155	3.78E-06	3.40E-05
Am246	3.07E-32	2.76E-31	Eu156	0.00E+0	0.00E+0
At217	3.59E-10	3.23E-09	Fe-59	1.59E-41	1.43E-40
Ba136m	0.00E+0	0.00E+0	Fr221	3.90E-14	3.51E-13
Ba137m	1.82E-02	1.64E-01	Fr223	1.46E-14	1.31E-13
Ba140	0.00E+0	0.00E+0	Gd152	1.45E-20	1.30E-19
Be10	5.50E-14	4.95E-13	Gd153	7.60E-19	6.84E-18
Bi210	2.53E-13	2.27E-12	H3	2.79E-04	2.52E-03
Bi211	7.19E-11	6.47E-10	Hf181	7.62E-44	6.85E-43
Bi212	9.29E-10	8.36E-09	Ho166m	1.12E-12	1.01E-11
Bi213	0.00E+0	0.00E+0	I129	1.02E-04	9.15E-04
Bi214	7.20E-12	6.48E-11	I131	0.00E+0	0.00E+0
Bk249	1.06E-30	9.53E-30	In114	2.31E-61	2.08E-60
Bk250	1.36E-33	1.22E-32	In114m	7.21E-62	6.49E-61
C14	2.68E-11	2.41E-10	In115	1.34E-19	1.21E-18
Cd109	9.48E-19	8.54E-18	In115m	0.00E+0	0.00E+0
Cd113m	2.95E-06	2.65E-05	K40	4.62E-06	4.16E-05
Cd115m	2.62E-59	2.36E-58	Kr81	0.00E+0	0.00E+0
Ce141	5.30E-79	4.77E-78	Kr85	0.00E+0	0.00E+0

Table A-4. (continued).

Constituent[a]	Landfill Design Absorption Rate Rads/Hour[b]	Evaporation Pond Design Absorption Rate Rads/Hour[b]	Constituent[a]	Landfill Design Absorption Rate Rads/Hour[b]	Evaporation Pond Design Absorption Rate Rads/Hour[b]
Ce142	0.00E+0	0.00E+0	La138	3.74E-112	3.37E-111
Ce144	2.40E-11	2.16E-10	La140	0.00E+0	0.00E+0
Cf249	2.98E-22	2.69E-21	Mn54	1.93E-14	1.73E-13
Cf250	1.48E-22	1.33E-21	Nb92	5.70E-25	5.13E-24
Cf251	6.60E-25	5.94E-24	Nb93m	2.43E-10	2.19E-09
Cf252	2.70E-29	2.43E-28	Nb94	9.04E-12	8.13E-11
Cm241	3.30E-89	2.97E-88	Nb95	2.31E-39	2.08E-38
Cm242	4.91E-24	4.42E-23	Nb95m	2.70E-42	2.43E-41
Cm243	3.22E-13	2.90E-12	Nd144	1.54E-16	1.39E-15
Cm244	1.56E-10	1.40E-09	Nd147	0.00E+0	0.00E+0
Cm245	6.57E-15	5.92E-14	Np235	4.92E-18	4.43E-17
Cm246	1.43E-16	1.29E-15	Np236	1.75E-13	1.57E-12
Cm247	5.02E-23	4.52E-22	Np237	2.30E-05	2.07E-04
Cm248	1.35E-23	1.22E-22	Np238	1.30E-12	1.17E-11
Np239	1.02E-09	9.22E-09	Rh103m	1.26E-65	1.13E-64
Np240	3.29E-19	2.96E-18	Rh106	2.10E-08	1.89E-07
Np240m	1.78E-16	1.60E-15	Rn218	8.91E-119	8.02E-118
Pa231	4.12E-11	3.71E-10	Rn219	1.37E-07	1.24E-06
Pa233	1.93E-09	1.74E-08	Rn220	3.45E-06	3.10E-05
Pa234	7.31E-13	6.58E-12	Rn222	3.38E-08	3.04E-07
Pa234m	1.55E-10	1.39E-09	Ru103	1.20E-35	1.08E-34
Pb209	5.70E-15	5.13E-14	Ru106	5.17E-10	4.65E-09
Pb210	2.53E-14	2.27E-13	Sb124	5.54E-46	4.99E-45
Pb211	5.50E-12	4.95E-11	Sb125	5.84E-06	5.26E-05
Pb212	1.06E-10	9.51E-10	Sb126	7.48E-08	6.73E-07
Pb214	1.80E-12	1.62E-11	Sb126m	3.79E-07	3.41E-06
Pd107	2.19E-10	1.97E-09	Sc46	1.16E-26	1.04E-25
Pm146	1.23E-09	1.10E-08	Se79	1.27E-07	1.14E-06
Pm147	5.86E-06	5.28E-05	Sm146	2.67E-16	2.40E-15
Pm148	1.28E-65	1.15E-64	Sm147	2.29E-12	2.06E-11
Pm148m	4.40E-64	3.96E-63	Sm148	4.98E-19	4.48E-18
Po210	2.14E-12	1.92E-11	Sm149	0.00E+00	0.00E+00
Po211	2.02E-15	1.82E-14	Sm151	1.66E-06	1.49E-05
Po212	1.14E-09	1.03E-08	Sn117m	0.00E+0	0.00E+0

Table A-4. (continued).

Constituent[a]	Landfill Design Absorption Rate Rads/Hour[b]	Evaporation Pond Design Absorption Rate Rads/Hour[b]	Constituent[a]	Landfill Design Absorption Rate Rads/Hour[b]	Evaporation Pond Design Absorption Rate Rads/Hour[b]
Po213	1.44E-13	1.30E-12	Sn119m	5.91E-15	5.32E-14
Po214	1.71E-11	1.54E-10	Sn121m	3.74E-11	3.36E-10
Po215	5.36E-11	4.83E-10	Sn123	2.03E-23	1.83E-22
Po216	1.49E-09	1.34E-08	Sn125	0.00E+0	0.00E+0
Po218	1.34E-11	1.20E-10	Sn126	2.42E-08	2.18E-07
Pr143	0.00E+0	0.00E+0	Sr89	1.72E-49	1.55E-48
Pr144	5.64E-10	5.08E-09	Sr90	6.16E-02	5.55E-01
Pr144m	7.44E-14	6.70E-13	Tb160	1.07E-40	9.59E-40
Pu236	1.36E-11	1.22E-10	Tb161	6.13E-11	5.52E-10
Pu237	3.20E-66	2.88E-65	Tc 98	1.11E-04	1.00E-03
Pu238	5.45E-04	4.91E-03	Tc99	3.67E-23	3.31E-22
Pu239	1.46E-05	1.31E-04	Te123	3.45E-30	3.10E-29
Pu240	3.29E-06	2.96E-05	Te123m	1.72E-07	1.55E-06
Pu241	1.42E-07	1.28E-06	Te125m	1.01E-26	9.13E-26
Pu242	5.03E-10	4.53E-09	Te127	4.11E-27	3.69E-26
Pu243	5.30E-23	4.77E-22	Te127m	1.94E-77	1.74E-76
Pu244	4.97E-17	4.47E-16	Te129	1.57E-77	1.42E-76
Pu246	9.07E-33	8.17E-32	Te129m	0.00E+0	0.00E+0
Ra222	4.56E-122	4.10E-121	Th226	8.21E-123	7.39E-122
Ra223	7.11E-11	6.40E-10	Th227	6.54E-11	5.89E-10
Ra224	1.87E-09	1.68E-08	Th228	1.06E-07	9.54E-07
Ra225	3.63E-15	3.27E-14	Th229	1.54E-13	1.39E-12
Ra226	1.35E-06	1.21E-05	Th230	4.84E-07	4.36E-06
Ra228	1.05E-18	9.43E-18	Th231	1.71E-08	1.54E-07
Rb86	0.00E+0	0.00E+0	Th232	3.72E-07	3.35E-06
Rb87	9.50E-13	8.55E-12	Th234	6.78E-11	6.10E-10
Rh102	2.71E-12	2.44E-11	Tl207	5.38E-12	4.84E-11
Tl208	4.66E-10	4.20E-09			
Tl209	2.48E-15	2.24E-14			
Tm170	5.29E-33	4.76E-32			
Tm171	1.04E-20	9.33E-20			
U230	0.00E+0	0.00E+0			
U232	2.80E-08	2.52E-07			
U233	1.21E-09	1.09E-08			

Table A-4. (continued).

Constituent[a]	Landfill Design Absorption Rate Rads/Hour[b]	Evaporation Pond Design Absorption Rate Rads/Hour[b]	Constituent[a]	Landfill Design Absorption Rate Rads/Hour[b]	Evaporation Pond Design Absorption Rate Rads/Hour[b]
U234	2.83E-04	2.54E-03			
U235	4.95E-06	4.46E-05			
U236	8.94E-06	8.05E-05			
U237	0.00E+0	0.00E+0			
U238	8.06E-05	7.25E-04			
U240	3.99E-17	3.59E-16			
Xe127	4.85E-76	4.36E-75			
Xe129m	0.00E+0	0.00E+0			
Xe131m	4.33E-116	3.90E-115			
Xe133	0.00E+0	0.00E+0			
Y90	7.76E-03	6.99E-02			
Y91	8.79E-44	7.91E-43			
Zn65	5.88E-15	5.29E-14			
Zr93	1.66E-09	1.49E-08			
Zr95	2.47E-32	2.22E-31			
Total Design Absorption Rate	9.30E-02 rads/hr	8.37E-01 rads/hr			
Total Design Absorption	1.22E+04 rads	1.10E+05 rads			

a. Constituents based on the design Inventory (EDF-ER-264)
b. Based on average concentrations during the 15 year active life of the landfill assuming the entire mass is placed in the landfill (EDF-ER-274)

This page intentionally left blank.

Appendix B

Geomembrane Dose Calculations

This page intentionally left blank.

Appendix B-1

Geomembrane Dose in the Landfill

This page intentionally left blank.

ENGINEERING DESIGN FILE

MONTGOMERY WATSON HARZA
Description: Radiation dosage to ICDF liner resulting from leachate exposure
Project #: 2470178
Prepared by: J. Thompson
Date: 10/6/01
Checked by: B. Adams/J. Pellicer
Date: 12/7/01

VARIABLES

Liner Thickness =	60 mils
Liner density =	0.94 g/cm^3
Depth of leachate =	4 cm

CONVERSIONS

pCi/Ci =	1.00E+12
cm^3/l =	1000
cm/mil =	2.54E-03
(dis/s)/Ci =	3.70E+10
sec/hr =	3600
g/kg =	1.00E+03
eV/Mev =	1.00E+06
J/eV =	1.60E-19
rad =	0.01 J/kg
rad/Gy =	100

Hand Calculation for Calculating Dose for Ac225

	1.14e-7pCi x	liter x	Ci x	4cm3	= 4.56e-22 Ci	
	liter	1000cm3	1e12pCi			
	4.56e-22 Ci x	3.7e10 dis x	3600 sec x	5.832 MeV x	1e6 eV	= 0.3542 eV
		Ci sec	hour	dis	MeV	hour
Liner Mass:	60 mil x	in x	2.54 cm x	0.94 g x	kg	= 1.432e-4 kg
		1000 mil	in	cm3	1000 g	
0.3542 eV x	1.6e-19 J x	1 x	rad kg	= 3.95e-14 rad		
hour	eV	1.432e-4 kg	0.01 J	hr		

Constituent	ICDF Average Activity Concentration (pCi/L)	ICDF Average Activity Concentration (Ci/cm^3)	Disintegration Energy from Alpha Radiation (MeV/dis)[a]	Disintegration Energy from Beta Radiation (MeV/dis)[a]	Disintegration Energy from Gamma Radiation (MeV/dis)[a]	Disintegration Energy from Electron Radiation (MeV/dis)[a]	Total Disintegration Energy (MeV/dis)[b]	ICDF Liner Radiation Dose (Rads/hr)
Ac225	1.14E-07	1.14E-22	5.794750712		0.015675725	0.021753375	5.832179811	3.95E-14
Ac227	4.54E-05	4.54E-20	0.067076762	0.009519	0.000269356	0.002766609	0.079631727	2.15E-13
Ac228	3.38E-10	3.38E-25		0.365039719	0.926920369	0.064207018	1.356167107	2.73E-17
Ag108	4.10E-08	4.10E-23		0.609441	0.017742571	0.000104798	0.627288369	1.53E-15
Ag108m	8.88E+00	8.88E-15			1.619571716	0.014175304	1.63374702	8.63E-07
Ag109m	5.46E-11	5.46E-26			0.011251468	0.075708836	0.086960304	2.83E-19
Ag110	5.75E-10	5.74855E-25		1.181485222	0.030569692	1.49286E-05	1.212069842	4.15E-17
Ag110m	6.16E-08	6.15802E-23		0.065497652	2.740392268	0.002891351	2.808781272	1.03E-14
Am241	7.01E+01	7.00857E-14	5.4776265		0.028100691	0.029402026	5.535129217	2.31E-05
Am242	1.33E-04	1.33277E-19		0.159206	0.01777726	0.014518168	0.191501428	1.52E-12
Am242m	1.33E-04	1.32877E-19	0.02491305		0.004697851	0.036045937	0.065656838	5.19E-13
Am243	9.82E-04	9.8225E-19	5.26454376		0.058325807	0.025255628	5.348125195	3.13E-10
Am246	4.06E-25	4.06494E-40		0.2600814	0.979943558	0.029091734	1.269116692	3.07E-32
At217	8.54E-04	8.53567E-19	7.065707158				7.065707158	3.59E-10
Ba137m	4.62E+05	4.61732E-10			0.597793455	0.063669106	0.661462561	1.82E-02
Be 10	4.57E-06	4.56737E-21		0.2025			0.2025	5.50E-14
Bi210	1.09E-05	1.09161E-20		0.389			0.389	2.53E-13
Bi211	1.83E-04	1.82992E-19	6.549152819	0.000476658	0.047468126	0.009283362	6.606380966	7.19E-11
Bi212	5.53E-03	5.52598E-18	2.173446631	0.459769426	0.184126961	0.008766847	2.826109865	9.29E-10
Bi214	5.62E-05	5.61657E-20		0.631854371	1.509899923	0.011891859	2.153646154	7.20E-12
Bk249	5.39E-22	5.39325E-37		0.03299967			0.03299967	1.06E-30
Bk250	1.94E-26	1.93749E-41		0.26636366	0.886746664	0.02698613	1.180096454	1.36E-33
C 14	9.11E-03	9.1119E-18		0.04947			0.04947	2.68E-11
Cd109	8.11E-10	8.11386E-25			0.014910997	0.004730612	0.019641609	9.48E-19
Cd113m	2.67E+02	2.67401E-13		0.185357358			0.185357358	2.95E-06
Cd115m	7.02E-52	7.01999E-67		0.606227346	0.021898515		0.62812586	2.62E-59
Ce141	3.61E-71	3.60929E-86		0.1446745	0.076850362	0.025152933	0.246677795	5.30E-79
Ce144	3.61E-03	3.61187E-18		0.0832751	0.019274755	0.009263998	0.111813852	2.40E-11
Cf249	8.09E-16	8.08594E-31	5.832326913		0.331949482	0.037464582	6.201740977	2.98E-22
Cf250	4.13E-16	4.13182E-31	6.019605686		0.001194765	0.004455842	6.025256294	1.48E-22
Cf251	1.87E-18	1.86599E-33	5.6630136		0.121953755	0.159025305	5.94399266	6.60E-25
Cf252	4.40E-20	4.39839E-35			0.006078129	0.004222783	0.010300912	2.70E-29
Cm241	3.24E-81	3.24048E-96	0.0592	0.112			0.1712	3.30E-89
Cm242	1.35E-17	1.34831E-32	6.104058752		0.00886198	0.007548684	6.120469416	4.91E-24

ENGINEERING DESIGN FILE

Constituent	ICDF Average Activity Concentration (pCi/L)	ICDF Average Activity Concentration (Ci/cm^3)	Disintegration Energy from Alpha Radiation (MeV/dis)[a]	Disintegration Energy from Beta Radiation (MeV/dis)[a]	Disintegration Energy from Gamma Radiation (MeV/dis)[a]	Disintegration Energy from Electron Radiation (MeV/dis)[a]	Total Disintegration Energy (MeV/dis)[b]	ICDF Liner Radiation Dose (Rads/hr)
Cm248	4.88E-17	4.88339E-32	4.652098978		0.001053916	0.004771581	4.657924475	1.35E-23
Cm250	1.38E-25	1.3823E-40	1.2975	0.00126			1.29876	1.07E-32
Co-57	3.67E-01	3.67011E-16			0.125116492	0.018266873	0.143383365	3.13E-09
Co-58	5.84E-15	5.84275E-30			0.97577339	0.003554852	0.979328243	3.40E-22
Co-60	1.92E+04	1.92228E-11		0.09579	2.505813093		2.601603093	2.98E-03
Cr-51	7.66E-53	7.66009E-68			0.032581687	0.003609603	0.036191289	1.65E-61
Cs-134	2.24E+01	2.24236E-14		0.156843574	1.555088123	0.005168308	1.717100005	2.29E-06
Cs135	7.16E-02	7.16176E-17		0.0563			0.0563	2.40E-10
Cs137	4.89E+04	4.88614E-11		0.1707536			0.1707536	4.96E-04
Eu150	5.09E-08	5.08758E-23		0.292			0.292	8.84E-16
Eu152	2.85E+03	2.84526E-12		0.083686791	1.152309414	0.040284747	1.276280952	2.16E-04
Eu154	2.41E+03	2.41379E-12		0.225199121	1.253240971	0.04847077	1.526910861	2.19E-04
Eu155	5.19E+02	5.18807E-13		0.04544052	0.060584231	0.016346264	0.122371015	3.78E-06
Fe-59	2.05E-34	2.0497E-49		0.117452592	1.188458138		1.30591073	1.59E-41
Fr221	1.02E-07	1.02416E-22	6.35419518		0.030918345	0.009345796	6.394459322	3.90E-14
Fr223	5.65E-07	5.64646E-22		0.341682282	0.054245778	0.038798691	0.434726751	1.46E-14
Gd152	1.13E-13	1.13275E-28	2.1496				2.1496	1.45E-20
Gd153	8.38E-11	8.38004E-26			0.110492119	0.041857881	0.15235	7.60E-19
H 3	8.26E+05	8.26041E-10		0.005685			0.005685	2.79E-04
Hf-181	1.73E-36	1.73311E-51		0.118616	0.544135316	0.075669588	0.738420904	7.62E-44
Ho166m	1.08E-05	1.07982E-20		0.040363706	1.59696433	0.103964407	1.741292443	1.12E-12
I129	2.16E+04	2.16334E-11		0.0409	0.024638767	0.013400713	0.078939479	1.02E-04
In114	4.83E-54	4.83478E-69		0.771593317	0.031986443	4.73967E-05	0.803627157	2.31E-61
In114m	5.06E-54	5.06252E-69			0.097219841	0.142167093	0.239386934	7.21E-62
In115	1.48E-11	1.48146E-26		0.152			0.152	1.34E-19
K-40	1.27E+02	1.27291E-13		0.454278782	0.155895094	0.00019193	0.610365806	4.62E-06
La140	2.21E-105	2.2065E-120		0.527461627	2.316273704	0.005168104	2.848903435	3.74E-112
Mn-54	3.86E-07	3.85666E-22			0.83600515	0.003819757	0.839824907	1.93E-14
Nb92	6.34E-18	6.34129E-33			1.503376922	0.006587855	1.509964777	5.70E-25
Nb93m	1.35E-01	1.34956E-16			0.001949851	0.02830264	0.030252491	2.43E-10
Nb94	8.83E-05	8.82572E-20		0.1458	1.573752035	0.001108272	1.720660307	9.04E-12
Nb95	4.80E-32	4.79764E-47		0.04343358	0.764449657	0.000960441	0.808843679	2.31E-39
Nb95m	1.84E-34	1.83993E-49		0.024094426	0.066299718	0.156400746	0.24679489	2.70E-42
Nd144	1.36E-09	1.3614E-24	1.9				1.9	1.54E-16
Np235	8.43E-09	8.43464E-24			0.006849299	0.00295462	0.009803919	4.92E-18
Np236	8.60E-06	8.60333E-21		0.007895	0.144249657	0.188908994	0.341053651	1.75E-13
Np237	7.98E+01	7.97825E-14	4.759362826		0.032973835	0.062385374	4.854722034	2.30E-05
Np238	2.70E-05	2.70471E-20		0.224714208	0.554083268	0.029658953	0.808456429	1.30E-12
Np239	4.14E-02	4.14422E-17		0.115125998	0.172110902	0.128163122	0.415400022	1.02E-09
Np240	3.46E-12	3.46382E-27		0.241	1.16312137	0.190279619	1.594400989	3.29E-19
Np240m	3.15E-09	3.14893E-24		0.590015065	0.333687187	0.025194589	0.948896841	1.78E-16
Pa231	1.27E-04	1.26888E-19	5.380806428		0.037179164	0.035516603	5.453502195	4.12E-11
Pa233	7.92E-02	7.91815E-17		0.0585556	0.217583236	0.133362528	0.409501364	1.93E-09
Pa234	4.98E-06	4.98489E-21		0.22297083	1.966021292	0.2744944	2.463486522	7.31E-13
Pa234m	3.11E-03	3.11453E-18		0.820374363	0.011413333	0.003045741	0.834833438	1.55E-10
Pb209	4.85E-07	4.84656E-22		0.1976			0.1976	5.70E-15
Pb210	1.09E-05	1.09161E-20		0.00651402	0.004510364	0.027874272	0.038898656	2.53E-14
Pb211	1.83E-04	1.82992E-19		0.452909635	0.050904428	0.001625278	0.505439341	5.50E-12
Pb212	5.53E-03	5.52598E-18		0.09961888	0.14811816	0.073508769	0.321245808	1.06E-10
Pb214	5.62E-05	5.61657E-20		0.2195445	0.249218235	0.069709256	0.538471991	1.80E-12
Pd107	1.11E-01	1.11124E-16		0.033101			0.033101	2.19E-10
Pm146	2.42E-02	2.42035E-17		0.0895829	0.753108251	0.008140193	0.850831344	1.23E-09
Pm147	1.59E+03	1.58971E-12		0.061957827	3.51654E-06		0.061961344	5.86E-06
Pm148	1.66E-58	1.65511E-73		0.72568641	0.574309603	0.000924896	1.30092091	1.28E-65
Pm148m	3.43E-57	3.42833E-72		0.1454396	1.991307208	0.01855489	2.155301698	4.40E-64
Po210	6.77E-06	6.7654E-21	5.304496719		8.8341E-06		5.304505553	2.14E-12
Po211	4.56E-09	4.5606E-24	7.442553252		0.007761102		7.450314354	2.02E-15
Po212	2.19E-03	2.18667E-18	8.7849				8.7849	1.14E-09
Po213	2.89E-07	2.89342E-22	8.3769694		0.000030381		8.376999781	1.44E-13
Po214	3.75E-05	3.74513E-20	7.686985013		8.29192E-05		7.687067933	1.71E-11
Po215	1.22E-04	1.22019E-19	7.386157912		0.000149158		7.38630707	5.36E-11
Po216	3.68E-03	3.68473E-18	6.77847216		1.44882E-05		6.778486648	1.49E-09
Po218	3.75E-05	3.74513E-20	6.001296466				6.001296466	1.34E-11
Pr144	7.38E-03	7.38075E-18		1.207181838	0.031914881	0.044921056	1.284017776	5.64E-10
Pr144m	1.06E-04	1.05542E-19			0.01184728		0.01184728	7.44E-14
Pu236	3.95E-05	3.94781E-20	5.759246369		0.001823624	0.010642416	5.771712409	1.36E-11
Pu237	8.64E-58	8.63987E-73			0.053631643	0.00860943	0.062241073	3.20E-66

Constituent	ICDF Average Activity Concentration (pCi/L)	ICDF Average Activity Concentration (Ci/cm^3)	Disintegration Energy from Alpha Radiation (MeV/dis)[a]	Disintegration Energy from Beta Radiation (MeV/dis)[a]	Disintegration Energy from Gamma Radiation (MeV/dis)[a]	Disintegration Energy from Electron Radiation (MeV/dis)[a]	Total Disintegration Energy (MeV/dis)[b]	ICDF Liner Radiation Dose (Rads/hr)
Pu238	1.67E+03	1.66644E-12	5.487135213		0.001600358	0.008259555	5.496995126	5.45E-04
Pu239	4.76E+01	4.75673E-14	5.147993305		0.000654063	0.004879569	5.153526936	1.46E-05
Pu240	1.07E+01	1.07109E-14	5.15442817		0.001526154	0.008332035	5.164286359	3.29E-06
Pu241	4.56E+02	4.56263E-13		0.005229895			0.005229895	1.42E-07
Pu242	1.72E-03	1.71827E-18	4.914950908		0.001267029	0.006838836	4.923056772	5.03E-10
Pu243	4.56E-15	4.56263E-30		0.160416257	0.024856596	0.009931485	0.195204338	5.30E-23
Pu244	1.82E-10	1.81534E-25	4.59129767		0.001091163	0.00576354	4.598152374	4.97E-17
Pu246	9.87E-25	9.86952E-40		0.054192	0.100325541		0.154517541	9.07E-33
Ra222	1.17E-115	1.1686E-130	6.543645859		0.009191111	0.000710852	6.553547823	4.56E-122
Ra223	2.02E-04	2.02468E-19	5.693111445		0.135359242	0.070979646	5.899450334	7.11E-11
Ra224	5.53E-03	5.52598E-18	5.674903074		0.010016186	0.002181394	5.687100654	1.87E-09
Ra225	5.12E-07	5.11833E-22		0.09364	0.014401901	0.011183962	0.119225863	3.63E-15
Ra226	4.73E+00	4.73487E-15	4.779486739		0.006748	0.003450946	4.789685685	1.35E-06
Ra228	1.52E-09	1.52191E-24		0.0099	6.67E-09	0.001668	0.011568007	1.05E-18
Rb87	2.02E-04	2.02493E-19		0.0788			0.0788	9.50E-13
Rh102	5.71E-04	5.71027E-19		0.0798			0.0798	2.71E-12
Rh103m	5.43E-57	5.42777E-72			0.001719179	0.03714169	0.038860869	1.26E-65
Rh106	2.18E-01	2.18418E-16		1.412048767	0.207318974		1.61936774	2.10E-08
Rn218	2.10E-112	2.0999E-127	7.13224054		0.000755544		7.132996084	8.91E-119
Rn219	3.38E-01	3.3765E-16	6.768687931		0.057349406	0.006215139	6.832252476	1.37E-07
Rn220	9.22E+00	9.2155E-15	6.287774939		0.000522244		6.288297183	3.45E-06
Rn222	1.03E-01	1.03486E-16	5.48922225		0.00038912		5.48961137	3.38E-08
Ru103	3.65E-28	3.64513E-43		0.06754106	0.483836014	0.00219364	0.553570714	1.20E-35
Ru106	2.21E-01	2.20509E-16		0.039401			0.039401	5.17E-10
Sb124	4.14E-39	4.14237E-54		0.377755372	1.868890831	0.002369455	2.249015659	5.54E-46
Sb125	1.85E+02	1.85236E-13		0.08644006	0.432562126	0.011201711	0.530203897	5.84E-06
Sb126	4.12E-01	4.11874E-16		0.2904498	2.753144672	0.008852224	3.052446696	7.48E-08
Sb126m	2.94E+00	2.94195E-15		0.5821	1.572598561	0.010281928	2.164980488	3.79E-07
Sc-46	9.18E-20	9.1778E-35		0.112016432	2.009462055		2.121478487	1.16E-26
Se 79	4.08E+01	4.08468E-14		0.0522			0.0522	1.27E-07
Sm146	1.77E-09	1.77335E-24	2.53				2.53	2.67E-16
Sm147	1.71E-05	1.7098E-20	2.2476				2.2476	2.29E-12
Sm148	4.20E-12	4.20258E-27	1.99				1.99	4.98E-19
Sm149	2.13E-11	2.13338E-26	0	0			0	0.00E+00
Sm151	1.41E+03	1.40601E-12		0.019629664	1.26002E-05	0.000142779	0.019785044	1.66E-06
Sn119m	1.14E-06	1.14041E-21			0.011398832	0.075702053	0.087100885	5.91E-15
Sn121m	2.07E-01	2.06532E-16		0.00304			0.00304	3.74E-11
Sn123	6.47E-16	6.4725E-31		0.520527904	0.006892023		0.527419926	2.03E-23
Sn126	1.13E+00	1.1334E-15		0.2501	0.056584693	0.051902929	0.358587622	2.42E-08
Sr89	4.96E-42	4.96364E-57		0.58294069	0.000136365		0.583077055	1.72E-49
Sr90	1.90E+06	1.8965E-09		0.546			0.546	6.16E-02
Tb160	1.32E-33	1.32325E-48		0.225914897	1.081655763	0.045293923	1.352864583	1.07E-40
Tc 98	6.80E-04	6.79832E-19		0.118	1.394806477	0.002533816	1.515340293	6.13E-11
Tc 99	2.21E+04	2.21364E-11		0.084600002	5.3616E-07		0.084600538	1.11E-04
Te123	3.62E-14	3.61635E-29			0.013085863	0.003979538	0.017065401	3.67E-23
Te123m	2.36E-22	2.35653E-37			0.147968536	0.097813431	0.245781966	3.45E-30
Te125m	1.81E+01	1.81252E-14			0.035029212	0.1243697	0.159398912	1.72E-07
Te127	7.48E-19	7.48362E-34		0.222944359	0.004837938		0.227782297	1.01E-26
Te127m	7.60E-19	7.59597E-34		0.004605048	0.01122391	0.074989512	0.090818471	4.11E-27
Te129	5.40E-70	5.39691E-85		0.524547312	0.057653871	0.021254015	0.603455198	1.94E-77
Te129m	8.57E-70	8.56757E-85		0.211896011	0.039439344	0.057284	0.308619356	1.57E-77
Th226	2.18E-116	2.1787E-131	6.30769684		0.008516701	0.019601821	6.335815362	8.21E-123
Th227	1.82E-04	1.81633E-19	5.90223546		0.109621209	0.038621827	6.050478496	6.54E-11
Th228	3.29E-01	3.2872E-16	5.39930015		0.003074111	0.019010262	5.421384523	1.06E-07
Th229	5.12E-07	5.11833E-22	4.862233245		0.094769364	0.099685142	5.056687752	1.54E-13
Th230	1.73E+00	1.73379E-15	4.67678788		0.001405096	0.012883269	4.691076245	4.84E-07
Th231	1.61E+00	1.60797E-15		0.080038999	0.023548831	0.074878474	0.178466304	1.71E-08
Th232	1.56E+00	1.55721E-15	4.00455		0.001196619	0.010883174	4.016629793	3.72E-07
Th234	1.71E-02	1.71215E-17		0.0433679	0.009067919	0.014136614	0.066572433	6.78E-11
Tl207	1.83E-04	1.82539E-19		0.4932555	0.002169023		0.495424523	5.38E-12
Tl208	1.98E-03	1.97939E-18		0.554863585	3.369590402	0.034133866	3.958587853	4.66E-10
Tl209	1.05E-08	1.05084E-23		1.8248	2.117940734	0.028724369	3.971465102	2.48E-15
Tm170	2.66E-25	2.65672E-40		0.315252	0.005426825	0.014066319	0.334745144	5.29E-33
Tm171	6.64E-12	6.64218E-27		0.0248128	0.000683304	0.000721114	0.026217219	1.04E-20
U232	8.83E-02	8.8251E-17	5.306496425		0.001781837	0.014381205	5.322659468	2.80E-08
U233	4.23E-03	4.22558E-18	4.813433579		0.000718117	0.003004358	4.817156054	1.21E-09
U234	9.95E+02	9.94693E-13	4.763028496		0.001476859	0.011293806	4.775799161	2.83E-04

ENGINEERING DESIGN FILE

Constituent	ICDF Average Activity Concentration (pCi/L)	ICDF Average Activity Concentration (Ci/cm^3)	Disintegration Energy from Alpha Radiation (MeV/dis)[a]	Disintegration Energy from Beta Radiation (MeV/dis)[a]	Disintegration Energy from Gamma Radiation (MeV/dis)[a]	Disintegration Energy from Electron Radiation (MeV/dis)[a]	Total Disintegration Energy (MeV/dis)[b]	ICDF Liner Radiation Dose (Rads/hr)
U235	1.82E+01	1.81903E-14	4.378449		0.153592927	0.041995511	4.574037438	4.95E-06
U236	3.34E+01	3.33559E-14	4.4925232		0.001373011	0.009564051	4.503460262	8.94E-06
U238	3.22E+02	3.22148E-13	4.1940197		0.001212454	0.008504387	4.203736541	8.06E-05
U240	4.19E-09	4.18818E-24		0.125	0.006717716	0.028465325	0.160183041	3.99E-17
Xe127	2.63E-68	2.63427E-83			0.278982226	0.030144757	0.309126983	4.85E-76
Xe131m	4.49E-108	4.4853E-123			0.02009925	0.142249615	0.162348865	4.33E-116
Y90	1.35E+05	1.34525E-10		0.93471862		0.035127416	0.969846036	7.76E-03
Y91	2.44E-36	2.43696E-51		0.6022883	0.0036147		0.605903	8.79E-44
Zn65	1.68E-07	1.67979E-22			0.583769699	0.004560562	0.588330261	5.88E-15
Zr93	1.43E+00	1.4275E-15		0.0195			0.0195	1.66E-09
Zr95	4.87E-25	4.87454E-40		0.116123	0.73494917		0.85107217	2.47E-32
Total Absorbed Dose Rate in Rads/Hour								**9.30E-02**
Total Absorbed Dose For 15 year Operational Life in Rads								**1.22E+04**

References:

a. Disintigration energy based on the total energy reported in the following sources:

Computer software: Radiation Decay Version 3.5 developed by Professor Charles Hacker, Griffith Univeristy, Gold Coast, ustraila

Handbook of Health Physics and Radiological Health, 3rd Edition, edited by Bernard Shleien, Lester A. Slaback Jr., and Brian Kent Birky, Baltimore, Maryland, 1998

National Nuclear Data Center web site, Decay in the MIRD format, www:nndc.bnl.gov/nnbc/formmird.html

b. Total disintigration energy is the sum of alpha, beta, gamma, and electron energies.

This page intentionally left blank.

Appendix B-2

Geomembrane Dose in the Evaporation Pond

This page intentionally left blank.

ENGINEERING DESIGN FILE

MONTGOMERY WATSON HARZA
Description: Radiation dosage to ICDF evaporation ponds liner resulting from leachate exposure
Project #: 2470178
Prepared by: J. Thompson
Date: 10/6/01
Checked by: B. Adams/J. Pellicer
Date: 12-7-01

VARIABLES

Liner Thickness =	60	mils
Liner density =	0.94	g/cm^3
Depth of leachate =	36	cm

CONVERSIONS

pCi/Ci =	1.00E+12
cm^3/l =	1000
cm/mil =	2.54E-03
(dis/s)/Ci =	3.70E+10
sec/hr =	3600
g/kg =	1.00E+03
eV/Mev =	1.00E+06
J/eV =	1.60E-19
rad/Gy =	100

Constituent	ICDF Average Activity Concentration (pCi/L)	ICDF Average Activity Concentration (Ci/cm^3)	Disintegration Energy from Alpha Radiation (MeV/dis)[a]	Disintegration Energy from Beta Radiation (MeV/dis)[a]	Disintegration Energy from Gamma Radiation (MeV/dis)[a]	Disintegration Energy from Electron Radiation (MeV/dis)[a]	Total Disintegration Energy (MeV/dis)[b]	ICDF Liner Radiation Dose (Rads/hr)
Ac225	1.1E-07	1.14E-22	5.794750712		0.015675725	0.021753375	5.832179811	3.55E-13
Ac227	4.5E-05	4.54E-20	0.067076762	0.009519	0.000269356	0.002766609	0.079631727	1.94E-12
Ac228	3.4E-10	3.38E-25		0.365039719	0.926920369	0.064207018	1.356167107	2.46E-16
Ag108	4.1E-08	4.10E-23		0.609441	0.017742571	0.000104798	0.627288369	1.38E-14
Ag108m	8.9E+00	8.88E-15			1.619571716	0.014175304	1.63374702	7.77E-06
Ag109m	5.5E-11	5.46E-26			0.011251468	0.075708836	0.086960304	2.54E-18
Ag110	5.7E-10	5.74855E-25		1.181485222	0.030569692	1.49286E-05	1.212069842	3.73E-16
Ag110m	6.2E-08	6.15802E-23		0.065497652	2.740392268	0.002891351	2.808781272	9.26E-14
Am241	7.0E+01	7.00857E-14	5.4776265		0.028100691	0.029402026	5.535129217	2.08E-04
Am242	1.3E-04	1.33277E-19		0.159206	0.01777726	0.014518168	0.191501428	1.37E-11
Am242m	1.3E-04	1.32877E-19	0.02491305		0.004697851	0.036045937	0.065656838	4.67E-12
Am243	9.8E-04	9.8225E-19	5.26454376		0.058325807	0.025255628	5.348125195	2.81E-09
Am246	4.1E-25	4.06494E-40		0.2600814	0.979943558	0.029091734	1.269116692	2.76E-31
At217	8.5E-04	8.53567E-19	7.065707158				7.065707158	3.23E-09
Ba137m	4.6E+05	4.61732E-10			0.597793455	0.063669106	0.661462561	1.64E-01
Be 10	4.6E-06	4.56737E-21		0.2025			0.2025	4.95E-13
Bi210	1.1E-05	1.09161E-20		0.389			0.389	2.27E-12
Bi211	1.8E-04	1.82992E-19	6.549152819	0.000476658	0.047468126	0.009283362	6.606380966	6.47E-10
Bi214	5.6E-05	5.61657E-20		0.631854371	1.509899923	0.011891859	2.153646154	6.48E-11
Bk249	5.4E-22	5.39325E-37		0.03299967			0.03299967	9.53E-30
Bk250	1.9E-26	1.93749E-41		0.26636366	0.886746664	0.02698613	1.180096454	1.22E-32
Cd109	8.1E-10	8.11386E-25			0.014910997	0.004730612	0.019641609	8.54E-18
Cd113m	2.7E+02	2.67401E-13		0.185357358			0.185357358	2.65E-05
Ce141	3.6E-71	3.60929E-86		0.1446745	0.076850362	0.025152933	0.246677795	4.77E-78
Ce144	3.6E-03	3.61187E-18		0.0832751	0.019274755	0.009263998	0.111813852	2.16E-10
Cf249	8.1E-16	8.08594E-31	5.832326913		0.331949482	0.037464582	6.201740977	2.69E-21
Cf250	4.1E-16	4.13182E-31	6.019605686		0.001194765	0.004455842	6.025256294	1.33E-21
Cf251	1.9E-18	1.86599E-33	5.6630136		0.121953755	0.159025305	5.94399266	5.94E-24
Cm241	3.2E-81	3.24048E-96	0.0592	0.112			0.1712	2.97E-88
Cm242	1.3E-17	1.34831E-32	6.104058752		0.00886198	0.007548684	6.120469416	4.42E-23
Cm243	8.9E-07	8.883E-22	5.834234959		0.132613797	0.122747969	6.089596726	2.90E-12
Cm244	4.5E-04	4.50948E-19	5.796499747		0.001490051	0.006438553	5.804428351	1.40E-09
Cm245	2.0E-08	2.00547E-23	5.360616241		0.076920127	0.069851389	5.507387757	5.92E-14
Cm246	4.5E-10	4.47549E-25	5.37557179		0.001325463	0.006093795	5.382991049	1.29E-15
Cm247	1.6E-16	1.59758E-31	4.946722		0.317367237	0.014739412	5.278828648	4.52E-22
Cm248	4.9E-17	4.88339E-32	4.652098978		0.001053916	0.004771581	4.657924475	1.22E-22
Co-57	3.7E-01	3.67011E-16			0.125116492	0.018266873	0.143383365	2.82E-08
Co-58	5.8E-15	5.84275E-30			0.97577339	0.003554852	0.979328243	3.06E-21
Co-60	1.9E+04	1.92228E-11		0.09579	2.505813093		2.601603093	2.68E-02
Cr-51	7.7E-53	7.66009E-68			0.032581687	0.003609603	0.036191289	1.48E-60
Cs-134	2.2E+01	2.24236E-14		0.156843574	1.555088123	0.005168308	1.717100005	2.06E-05
Cs135	7.2E-02	7.16176E-17		0.0563			0.0563	2.16E-09
Cs137	4.9E+04	4.88614E-11		0.1707536			0.1707536	4.47E-03
Eu150	5.1E-08	5.08758E-23		0.292			0.292	7.96E-15
Eu152	2.8E+03	2.84526E-12		0.083686791	1.152309414	0.040284747	1.276280952	1.94E-03
Eu154	2.4E+03	2.41379E-12		0.225199121	1.253240971	0.04847077	1.526910861	1.97E-03
Eu155	5.2E+02	5.18807E-13		0.04544052	0.060584231	0.016346264	0.122371015	3.40E-05
Fe-59	2.0E-34	2.0497E-49		0.117452592	1.188458138		1.30591073	1.43E-40
Fr221	1.0E-07	1.02416E-22	6.35419518		0.030918345	0.009345796	6.394459322	3.51E-13

Constituent	ICDF Average Activity Concentration (pCi/L)	ICDF Average Activity Concentration (Ci/cm^3)	Disintegration Energy from Alpha Radiation (MeV/dis)[a]	Disintegration Energy from Beta Radiation (MeV/dis)[a]	Disintegration Energy from Gamma Radiation (MeV/dis)[a]	Disintegration Energy from Electron Radiation (MeV/dis)[a]	Total Disintegration Energy (MeV/dis)[b]	ICDF Liner Radiation Dose (Rads/hr)
In114m	5.1E-54	5.06252E-69			0.097219841	0.142167093	0.239386934	6.49E-61
In115	1.5E-11	1.48146E-26		0.152			0.152	1.21E-18
K-40	1.3E+02	1.27291E-13		0.454278782	0.155895094	0.00019193	0.610365806	4.16E-05
La140	2.2E-105	2.2065E-120		0.527461627	2.316273704	0.005168104	2.848903435	3.37E-111
Mn-54	3.9E-07	3.85666E-22			0.83600515	0.003819757	0.839824907	1.73E-13
Nb92	6.3E-18	6.34129E-33			1.503376922	0.006587855	1.509964777	5.13E-24
Nb93m	1.3E-01	1.34956E-16			0.001949851	0.02830264	0.030252491	2.19E-09
Nb94	8.8E-05	8.82572E-20		0.1458	1.573752035	0.001108272	1.720660307	8.13E-11
Nb95m	1.8E-34	1.83993E-49		0.024094426	0.066299718	0.156400746	0.24679489	2.43E-41
Nd144	1.4E-09	1.3614E-24	1.9				1.9	1.39E-15
Np236	8.6E-06	8.60333E-21		0.007895	0.144249657	0.188908994	0.341053651	1.57E-12
Np239	4.1E-02	4.14422E-17		0.115125998	0.172110902	0.128163122	0.415400022	9.22E-09
Np240m	3.1E-09	3.14893E-24		0.590015065	0.333687187	0.025194589	0.948896841	1.60E-15
Pa231	1.3E-04	1.26888E-19	5.380806428		0.037179164	0.035516603	5.453502195	3.71E-10
Pa233	7.9E-02	7.91815E-17		0.0585556	0.217583236	0.133362528	0.409501364	1.74E-08
Pa234	5.0E-06	4.98489E-21		0.22297083	1.966021292	0.2744944	2.463486522	6.58E-12
Pa234m	3.1E-03	3.11453E-18		0.820374363	0.011413333	0.003045741	0.834833438	1.39E-09
Pb209	4.8E-07	4.84656E-22		0.1976			0.1976	5.13E-14
Pb210	1.1E-05	1.09161E-20		0.00651402	0.004510364	0.027874272	0.038898656	2.27E-13
Pb212	5.5E-03	5.52598E-18		0.09961888	0.14811816	0.073508769	0.321245808	9.51E-10
Pb214	5.6E-05	5.61657E-20		0.2195445	0.249218235	0.069709256	0.538471991	1.62E-11
Pd107	1.1E-01	1.11124E-16		0.033101			0.033101	1.97E-09
Pm146	2.4E-02	2.42035E-17		0.0895829	0.753108251	0.008140193	0.850831344	1.10E-08
Pm147	1.6E+03	1.58971E-12		0.061957827	3.51654E-06		0.061961344	5.28E-05
Pm148	1.7E-58	1.65511E-73		0.72568641	0.574309603	0.000924896	1.30092091	1.15E-64
Pm148m	3.4E-57	3.42833E-72		0.1454396	1.991307208	0.01855489	2.155301698	3.96E-63
Po210	6.8E-06	6.7654E-21	5.304496719		8.8341E-06		5.304505553	1.92E-11
Po211	4.6E-09	4.5606E-24	7.442553252		0.007761102		7.450314354	1.82E-14
Po212	2.2E-03	2.18667E-18	8.7849				8.7849	1.03E-08
Po213	2.9E-07	2.89342E-22	8.3769694		0.000030381		8.376999781	1.30E-12
Po214	3.7E-05	3.74513E-20	7.686985013		8.29192E-05		7.687067933	1.54E-10
Po215	1.2E-04	1.22019E-19	7.386157912		0.000149158		7.38630707	4.83E-10
Po216	3.7E-03	3.68473E-18	6.77847216		1.44882E-05		6.778486648	1.34E-08
Po218	3.7E-05	3.74513E-20	6.001296466				6.001296466	1.20E-10
Pr144	7.4E-03	7.38075E-18		1.207181838	0.031914881	0.044921056	1.284017776	5.08E-09
Pr144m	1.1E-04	1.05542E-19			0.01184728		0.01184728	6.70E-13
Pu236	3.9E-05	3.94781E-20	5.759246369		0.001823624	0.010642416	5.771712409	1.22E-10
Pu237	8.6E-58	8.63987E-73			0.053631643	0.00860943	0.062241073	2.88E-65
Pu238	1.7E+03	1.66644E-12	5.487135213		0.001600358	0.008259555	5.496995126	4.91E-03
Pu239	4.8E+01	4.75673E-14	5.147993305		0.000654063	0.004879569	5.153526936	1.31E-04
Pu240	1.1E+01	1.07109E-14	5.15442817		0.001526154	0.008332035	5.164286359	2.96E-05
Pu241	4.6E+02	4.56263E-13		0.005229895			0.005229895	1.28E-06
Pu242	1.7E-03	1.71827E-18	4.914950908		0.001267029	0.006838836	4.923056772	4.53E-09
Pu243	4.6E-15	4.56263E-30		0.160416257	0.024856596	0.009931485	0.195204338	4.77E-22
Pu244	1.8E-10	1.81534E-25	4.59129767		0.001091163	0.00576354	4.598152374	4.47E-16
Pu246	9.9E-25	9.86952E-40		0.054192	0.100325541		0.154517541	8.17E-32
Ra222	1.2E-115	1.1686E-130	6.543645859		0.009191111	0.000710852	6.553547823	4.10E-121
Ra224	5.5E-03	5.52598E-18	5.674903074		0.010016186	0.002181394	5.687100654	1.68E-08
Ra225	5.1E-07	5.11833E-22		0.09364	0.014401901	0.011183962	0.119225863	3.27E-14
Ra226	4.7E+00	4.73487E-15	4.779486739		0.006748	0.003450946	4.789685685	1.21E-05
Ra228	1.5E-09	1.52191E-24		0.0099	6.67E-09	0.001668	0.011568007	9.43E-18
Rb87	2.0E-04	2.02493E-19		0.0788			0.0788	8.55E-12
Rh102	5.7E-04	5.71027E-19		0.0798			0.0798	2.44E-11
Rh103m	5.4E-57	5.42777E-72			0.001719179	0.03714169	0.038860869	1.13E-64
Rh106	2.2E-01	2.18418E-16		1.412048767	0.207318974		1.61936774	1.89E-07
Rn218	2.1E-112	2.0999E-127	7.13224054		0.000755544		7.132996084	8.02E-118
Rn219	3.4E-01	3.3765E-16	6.768687931		0.057349406	0.006215139	6.832252476	1.24E-06
Rn220	9.2E+00	9.2155E-15	6.287774939		0.000522244		6.288297183	3.10E-05
Rn222	1.0E-01	1.03486E-16	5.48922225		0.00038912		5.48961137	3.04E-07
Ru103	3.6E-28	3.64513E-43		0.06754106	0.483836014	0.00219364	0.553570714	1.08E-34
Ru106	2.2E-01	2.20509E-16		0.039401			0.039401	4.65E-09
Sb124	4.1E-39	4.14237E-54		0.377755372	1.868890831	0.002369455	2.249015659	4.99E-45
Sb125	1.9E+02	1.85236E-13		0.08644006	0.432562126	0.011201711	0.530203897	5.26E-05
Sb126	4.1E-01	4.11874E-16		0.2904498	2.753144672	0.008852224	3.052446696	6.73E-07
Sc-46	9.2E-20	9.1778E-35		0.112016432	2.009462055		2.121478487	1.04E-25
Se 79	4.1E+01	4.08468E-14		0.0522			0.0522	1.14E-06
Sm146	1.8E-09	1.77335E-24	2.53				2.53	2.40E-15
Sm147	1.7E-05	1.7098E-20	2.2476				2.2476	2.06E-11
Sm148	4.2E-12	4.20258E-27	1.99				1.99	4.48E-18

Constituent	ICDF Average Activity Concentration (pCi/L)	ICDF Average Activity Concentration (Ci/cm^3)	Disintegration Energy from Alpha Radiation (MeV/dis)[a]	Disintegration Energy from Beta Radiation (MeV/dis)[a]	Disintegration Energy from Gamma Radiation (MeV/dis)[a]	Disintegration Energy from Electron Radiation (MeV/dis)[a]	Total Disintegration Energy (MeV/dis)[b]	ICDF Liner Radiation Dose (Rads/hr)
Sm151	1.4E+03	1.40601E-12		0.019629664	1.26002E-05	0.000142779	0.019785044	1.49E-05
Sn119m	1.1E-06	1.14041E-21			0.011398832	0.075702053	0.087100885	5.32E-14
Sn121m	2.1E-01	2.06532E-16		0.00304			0.00304	3.36E-10
Sn123	6.5E-16	6.4725E-31		0.520527904	0.006892023		0.527419926	1.83E-22
Sn126	1.1E+00	1.1334E-15		0.2501	0.056584693	0.051902929	0.358587622	2.18E-07
Sr89	5.0E-42	4.96364E-57		0.58294069	0.000136365		0.583077055	1.55E-48
Sr90	1.9E+06	1.8965E-09		0.546			0.546	5.55E-01
Tb160	1.3E-33	1.32325E-48		0.225914897	1.081655763	0.045293923	1.352864583	9.59E-40
Tc 98	6.8E-04	6.79832E-19		0.118	1.394806477	0.002533816	1.515340293	5.52E-10
Tc 99	2.2E+04	2.21364E-11		0.084600002	5.3616E-07		0.084600538	1.00E-03
Te123	3.6E-14	3.61635E-29			0.013085863	0.003979538	0.017065401	3.31E-22
Te123m	2.4E-22	2.35653E-37			0.147968536	0.097813431	0.245781966	3.10E-29
Te125m	1.8E+01	1.81252E-14			0.035029212	0.1243697	0.159398912	1.55E-06
Te127m	7.6E-19	7.59597E-34		0.004605048	0.01122391	0.074989512	0.090818471	3.69E-26
Te129	5.4E-70	5.39691E-85		0.524547312	0.057653871	0.021254015	0.603455198	1.74E-76
Te129m	8.6E-70	8.56757E-85		0.211896011	0.039439344	0.057284	0.308619356	1.42E-76
Th226	2.2E-116	2.1787E-131	6.30769684		0.008516701	0.019601821	6.335815362	7.39E-122
Th227	1.8E-04	1.81633E-19	5.90223546		0.109621209	0.038621827	6.050478496	5.89E-10
Th228	3.3E-01	3.2872E-16	5.39930015		0.003074111	0.019010262	5.421384523	9.54E-07
Th229	5.1E-07	5.11833E-22	4.862233245		0.094769364	0.099685142	5.056687752	1.39E-12
Th230	1.7E+00	1.73379E-15	4.67678788		0.001405096	0.012883269	4.691076245	4.36E-06
Th231	1.6E+00	1.60797E-15		0.080038999	0.023548831	0.074878474	0.178466304	1.54E-07
Th232	1.6E+00	1.55721E-15	4.00455		0.001196619	0.010883174	4.016629793	3.35E-06
Th234	1.7E-02	1.71215E-17		0.0433679	0.009067919	0.014136614	0.066572433	6.10E-10
Tl207	1.8E-04	1.82539E-19		0.4932555	0.002169023		0.495424523	4.84E-11
Tl208	2.0E-03	1.97939E-18		0.554863585	3.369590402	0.034133866	3.958587853	4.20E-09
Tl209	1.1E-08	1.05084E-23		1.8248	2.117940734	0.028724369	3.971465102	2.24E-14
Tm170	2.7E-25	2.65672E-40		0.315252	0.005426825	0.014066319	0.334745144	4.76E-32
Tm171	6.6E-12	6.64218E-27		0.0248128	0.000683304	0.000721114	0.026217219	9.33E-20
U232	8.8E-02	8.8251E-17	5.306496425		0.001781837	0.014381205	5.322659468	2.52E-07
U233	4.2E-03	4.22558E-18	4.813433579		0.000718117	0.003004358	4.817156054	1.09E-08
U234	9.9E+02	9.94693E-13	4.763028496		0.001476859	0.011293806	4.775799161	2.54E-03
U235	1.8E+01	1.81903E-14	4.378449		0.153592927	0.041995511	4.574037438	4.46E-05
U236	3.3E+01	3.33559E-14	4.4925232		0.001373011	0.009564051	4.503460262	8.05E-05
U238	3.2E+02	3.22148E-13	4.1940197		0.001212454	0.008504387	4.203736541	7.25E-04
U240	4.2E-09	4.18818E-24		0.125	0.006717716	0.028465325	0.160183041	3.59E-16
Xe127	2.6E-68	2.63427E-83			0.278982226	0.030144757	0.309126983	4.36E-75
Xe131m	4.5E-108	4.4853E-123			0.02009925	0.142249615	0.162348865	3.90E-115
Y90	1.3E+05	1.34525E-10		0.93471862		0.035127416	0.969846036	6.99E-02
Zn65	1.7E-07	1.67979E-22			0.583769699	0.004560562	0.588330261	5.29E-14
Zr93	1.4E+00	1.4275E-15		0.0195			0.0195	1.49E-08
Zr95	4.9E-25	4.87454E-40		0.116123	0.73494917		0.85107217	2.22E-31
Total Absorbed Dose Rate in Rads/Hour								**8.36E-01**
Total Absorbed Dose For 15 year Operational Life in Rads								**1.10E+05**

References:

a. Disintigration energy based on the total energy reported in the following sources:

Computer software: Radiation Decay Version 3.5 developed by Professor Charles Hacker, Griffith Univeristy, Gold Coast, ustraila

Handbook of Health Physics and Radiological Health, 3rd Edition, edited by Bernard Shleien, Lester A. Slaback Jr., and Brian Kent Birky, Baltimore, Maryland, 1998

National Nuclear Data Center web site, Decay in the MIRD format, www:nndc.bnl.gov/nnbc/formmird.html

b. Total disintigration energy is the sum of alpha, beta, gamma, and electron energies.

This page intentionally left blank.

Appendix B-3

Maximum Allowable Geomembrane Dose Calculation for the Landfill

This page intentionally left blank.

MONTGOMERY WATSON HARZA

Description: Back calculation of maximum allowable concentration for each distinct Parameter. for the landfill liner

Project #: 2470178

Prepared by: B.G. Adams

Date: 12/5/01

Checked by: J. Pellicer

Date: 12/7/01

VARIABLES

Liner Thickness =	60	mils
Liner density =	0.94	g/cm^3
Depth of leachate =	4	cm

CONVERSIONS

pCi/Ci =	1.00E+12
cm^3/l =	1000
cm/mil =	2.54E-03
(dis/s)/Ci =	3.70E+10
sec/hr =	3600
g/kg =	1.00E+03
eV/Mev =	1.00E+06
J/eV =	1.60E-19
rad/Gy =	100

15 yr Dose =	1.0E+06
Daily Dose =	1.8E+02
Dose Rad/hr =	7.6E+00

Constituent	ICDF Maximum Allowable Activity Concentration (pCi/L)	ICDF Maximum Allowable Activity Concentration (Ci/cm^3)	Disintegration Energy (MeV/dis)	ICDF Liner Absorbed Dose (Rads/hr)
Ac225	2.2E+07	2.19282E-08	5.832179811	7.61E+00
Ac227	1.6E+09	1.60601E-06	0.079631727	7.61E+00
Ac228	9.4E+07	9.43018E-08	1.356167107	7.61E+00
Ag108	2.0E+08	2.03876E-07	0.627288369	7.61E+00
Ag108m	7.8E+07	7.82796E-08	1.63374702	7.61E+00
Ag109m	1.5E+09	1.47066E-06	0.086960304	7.61E+00
Ag110	1.1E+08	1.05513E-07	1.212069842	7.61E+00
Ag110m	4.6E+07	4.55319E-08	2.808781272	7.61E+00
Am241	2.3E+07	2.3105E-08	5.535129217	7.61E+00
Am242	6.7E+08	6.67823E-07	0.191501428	7.61E+00
Am242m	1.9E+09	1.94784E-06	0.065656838	7.61E+00
Am243	2.4E+07	2.39129E-08	5.348125195	7.61E+00
Am246	1.0E+08	1.0077E-07	1.269116692	7.61E+00
At217	1.8E+07	1.81E-08	7.065707158	7.61E+00
Ba137m	1.9E+08	1.93343E-07	0.661462561	7.61E+00
Be 10	6.3E+08	6.31551E-07	0.2025	7.61E+00
Bi210	3.3E+08	3.28764E-07	0.389	7.61E+00
Bi211	1.9E+07	1.93584E-08	6.606380966	7.61E+00
Bi214	5.9E+07	5.93826E-08	2.153646154	7.61E+00
Bk249	3.9E+09	3.87546E-06	0.03299967	7.61E+00
Bk250	1.1E+08	1.08372E-07	1.180096454	7.61E+00
Cd109	6.5E+09	6.51113E-06	0.019641609	7.61E+00
Cd113m	6.9E+08	6.89959E-07	0.185357358	7.61E+00
Ce141	5.2E+08	5.18446E-07	0.246677795	7.61E+00
Ce144	1.1E+09	1.14377E-06	0.111813852	7.61E+00
Cf249	2.1E+07	2.06215E-08	6.201740977	7.61E+00

Constituent	ICDF Maximum Allowable Activity Concentration (pCi/L)	ICDF Maximum Allowable Activity Concentration (Ci/cm^3)	Disintegration Energy (MeV/dis)	ICDF Liner Absorbed Dose (Rads/hr)
Cf250	2.1E+07	2.12255E-08	6.025256294	7.61E+00
Cf251	2.2E+07	2.15157E-08	5.94399266	7.61E+00
Cm241	7.5E+08	7.47015E-07	0.1712	7.61E+00
Cm242	2.1E+07	2.08953E-08	6.120469416	7.61E+00
Cm243	2.1E+07	2.10012E-08	6.089596726	7.61E+00
Cm244	2.2E+07	2.2033E-08	5.804428351	7.61E+00
Cm245	2.3E+07	2.32214E-08	5.507387757	7.61E+00
Cm246	2.4E+07	2.3758E-08	5.382991049	7.61E+00
Cm247	2.4E+07	2.42268E-08	5.278828648	7.61E+00
Cm248	2.7E+07	2.74562E-08	4.657924475	7.61E+00
Co-57	8.9E+08	8.91938E-07	0.143383365	7.61E+00
Co-58	1.3E+08	1.30589E-07	0.979328243	7.61E+00
Co-60	4.9E+07	4.91578E-08	2.601603093	7.61E+00
Cr-51	3.5E+09	3.5337E-06	0.036191289	7.61E+00
Cs-134	7.4E+07	7.44797E-08	1.717100005	7.61E+00
Cs135	2.3E+09	2.27156E-06	0.0563	7.61E+00
Cs137	7.5E+08	7.48968E-07	0.1707536	7.61E+00
Eu150	4.4E+08	4.37976E-07	0.292	7.61E+00
Eu152	1.0E+08	1.00204E-07	1.276280952	7.61E+00
Eu154	8.4E+07	8.37567E-08	1.526910861	7.61E+00
Eu155	1.0E+09	1.04509E-06	0.122371015	7.61E+00
Fe-59	9.8E+07	9.79309E-08	1.30591073	7.61E+00
Fr221	2.0E+07	2E-08	6.394459322	7.61E+00
Fr223	2.9E+08	2.94183E-07	0.434726751	7.61E+00
Gd153	8.4E+08	8.39442E-07	0.15235	7.61E+00
H 3	2.2E+10	2.24959E-05	0.005685	7.61E+00
Ho166m	7.3E+07	7.34449E-08	1.741292443	7.61E+00
In114	1.6E+08	1.5914E-07	0.803627157	7.61E+00
In114m	5.3E+08	5.34236E-07	0.239386934	7.61E+00
In115	8.4E+08	8.41375E-07	0.152	7.61E+00
K-40	2.1E+08	2.09528E-07	0.610365806	7.61E+00
La140	4.5E+07	4.48906E-08	2.848903435	7.61E+00
Mn-54	1.5E+08	1.52281E-07	0.839824907	7.61E+00
Nb92	8.5E+07	8.46967E-08	1.509964777	7.61E+00
Nb93m	4.2E+09	4.22739E-06	0.030252491	7.61E+00
Nb94	7.4E+07	7.43255E-08	1.720660307	7.61E+00
Nb95m	5.2E+08	5.182E-07	0.24679489	7.61E+00
Nd144	6.7E+07	6.731E-08	1.9	7.61E+00
Np236	3.7E+08	3.74982E-07	0.341053651	7.61E+00
Np239	3.1E+08	3.0787E-07	0.415400022	7.61E+00
Np240m	1.3E+08	1.34777E-07	0.948896841	7.61E+00

Constituent	ICDF Maximum Allowable Activity Concentration (pCi/L)	ICDF Maximum Allowable Activity Concentration (Ci/cm^3)	Disintegration Energy (MeV/dis)	ICDF Liner Absorbed Dose (Rads/hr)
Pa231	2.3E+07	2.34508E-08	5.453502195	7.61E+00
Pa233	3.1E+08	3.12304E-07	0.409501364	7.61E+00
Pa234	5.2E+07	5.19138E-08	2.463486522	7.61E+00
Pa234m	1.5E+08	1.53191E-07	0.834833438	7.61E+00
Pb209	6.5E+08	6.47212E-07	0.1976	7.61E+00
Pb210	3.3E+09	3.28775E-06	0.038898656	7.61E+00
Pb212	4.0E+08	3.98103E-07	0.321245808	7.61E+00
Pb214	2.4E+08	2.37504E-07	0.538471991	7.61E+00
Pd107	3.9E+09	3.8636E-06	0.033101	7.61E+00
Pm146	1.5E+08	1.50311E-07	0.850831344	7.61E+00
Pm147	2.1E+09	2.06401E-06	0.061961344	7.61E+00
Pm148	9.8E+07	9.83065E-08	1.30092091	7.61E+00
Pm148m	5.9E+07	5.93369E-08	2.155301698	7.61E+00
Po210	2.4E+07	2.41095E-08	5.304505553	7.61E+00
Po211	1.7E+07	1.71656E-08	7.450314354	7.61E+00
Po212	1.5E+07	1.45578E-08	8.7849	7.61E+00
Po213	1.5E+07	1.52667E-08	8.376999781	7.61E+00
Po214	1.7E+07	1.66369E-08	7.687067933	7.61E+00
Po215	1.7E+07	1.73143E-08	7.38630707	7.61E+00
Po216	1.9E+07	1.88669E-08	6.778486648	7.61E+00
Po218	2.1E+07	2.13102E-08	6.001296466	7.61E+00
Pr144	1.0E+08	9.96007E-08	1.284017776	7.61E+00
Pr144m	1.1E+10	1.07948E-05	0.01184728	7.61E+00
Pu236	2.2E+07	2.21579E-08	5.771712409	7.61E+00
Pu237	2.1E+09	2.05474E-06	0.062241073	7.61E+00
Pu238	2.3E+07	2.32653E-08	5.496995126	7.61E+00
Pu239	2.5E+07	2.48158E-08	5.153526936	7.61E+00
Pu240	2.5E+07	2.47641E-08	5.164286359	7.61E+00
Pu241	2.4E+10	2.44535E-05	0.005229895	7.61E+00
Pu242	2.6E+07	2.59776E-08	4.923056772	7.61E+00
Pu243	6.6E+08	6.55155E-07	0.195204338	7.61E+00
Pu244	2.8E+07	2.78131E-08	4.598152374	7.61E+00
Pu246	8.3E+08	8.27667E-07	0.154517541	7.61E+00
Ra222	2.0E+07	1.95145E-08	6.553547823	7.61E+00
Ra224	2.2E+07	2.24876E-08	5.687100654	7.61E+00
Ra225	1.1E+09	1.07266E-06	0.119225863	7.61E+00
Ra226	2.7E+07	2.67009E-08	4.789685685	7.61E+00
Ra228	1.1E+10	1.10554E-05	0.011568007	7.61E+00
Rb87	1.6E+09	1.62296E-06	0.0788	7.61E+00
Rh102	1.6E+09	1.60262E-06	0.0798	7.61E+00
Rh103m	3.3E+09	3.29095E-06	0.038860869	7.61E+00

Constituent	ICDF Maximum Allowable Activity Concentration (pCi/L)	ICDF Maximum Allowable Activity Concentration (Ci/cm^3)	Disintegration Energy (MeV/dis)	ICDF Liner Absorbed Dose (Rads/hr)
Rh106	7.9E+07	7.89747E-08	1.61936774	7.61E+00
Rn218	1.8E+07	1.79292E-08	7.132996084	7.61E+00
Rn219	1.9E+07	1.87184E-08	6.832252476	7.61E+00
Rn220	2.0E+07	2.03376E-08	6.288297183	7.61E+00
Rn222	2.3E+07	2.32966E-08	5.48961137	7.61E+00
Ru103	2.3E+08	2.31026E-07	0.553570714	7.61E+00
Ru106	3.2E+09	3.24583E-06	0.039401	7.61E+00
Sb124	5.7E+07	5.68644E-08	2.249015659	7.61E+00
Sb125	2.4E+08	2.41207E-07	0.530203897	7.61E+00
Sb126	4.2E+07	4.18972E-08	3.052446696	7.61E+00
Sc-46	6.0E+07	6.0283E-08	2.121478487	7.61E+00
Se 79	2.4E+09	2.44998E-06	0.0522	7.61E+00
Sm146	5.1E+07	5.0549E-08	2.53	7.61E+00
Sm147	5.7E+07	5.69003E-08	2.2476	7.61E+00
Sm148	6.4E+07	6.42658E-08	1.99	7.61E+00
Sm151	6.5E+09	6.46392E-06	0.019785044	7.61E+00
Sn119m	6.5E+09	6.46392E-06	0.019785044	7.61E+00
Sn121m	1.5E+09	1.46829E-06	0.087100885	7.61E+00
Sn123	4.2E+10	4.20688E-05	0.00304	7.61E+00
Sn126	2.4E+08	2.4248E-07	0.527419926	7.61E+00
Sr89	3.6E+08	3.56646E-07	0.358587622	7.61E+00
Sr90	2.2E+08	2.19335E-07	0.583077055	7.61E+00
Tb160	2.3E+08	2.34229E-07	0.546	7.61E+00
Tc 98	9.5E+07	9.4532E-08	1.352864583	7.61E+00
Tc 99	8.4E+07	8.43962E-08	1.515340293	7.61E+00
Te123	1.5E+09	1.51168E-06	0.084600538	7.61E+00
Te123m	7.5E+09	7.49405E-06	0.017065401	7.61E+00
Te127	8.0E+08	8.02321E-07	0.159398912	7.61E+00
Te127m	1.4E+09	1.40818E-06	0.090818471	7.61E+00
Te129	1.4E+09	1.40818E-06	0.090818471	7.61E+00
Th226	4.1E+08	4.14391E-07	0.308619356	7.61E+00
Th227	2.0E+07	2.01851E-08	6.335815362	7.61E+00
Th228	2.1E+07	2.1137E-08	6.050478496	7.61E+00
Th229	2.4E+07	2.35897E-08	5.421384523	7.61E+00
Th230	2.5E+07	2.52911E-08	5.056687752	7.61E+00
Th231	2.7E+07	2.72622E-08	4.691076245	7.61E+00
Th232	7.2E+08	7.166E-07	0.178466304	7.61E+00
Th234	3.2E+07	3.18399E-08	4.016629793	7.61E+00
Tl207	1.9E+09	1.92105E-06	0.066572433	7.61E+00
Tl208	2.6E+08	2.5814E-07	0.495424523	7.61E+00
Tl209	3.2E+07	3.23067E-08	3.958587853	7.61E+00

Constituent	ICDF Maximum Allowable Activity Concentration (pCi/L)	ICDF Maximum Allowable Activity Concentration (Ci/cm^3)	Disintegration Energy (MeV/dis)	ICDF Liner Absorbed Dose (Rads/hr)
Tm170	3.2E+07	3.2202E-08	3.971465102	7.61E+00
Tm171	3.8E+08	3.82049E-07	0.334745144	7.61E+00
U232	4.9E+09	4.87805E-06	0.026217219	7.61E+00
U233	2.4E+07	2.40273E-08	5.322659468	7.61E+00
U234	2.7E+07	2.65487E-08	4.817156054	7.61E+00
U235	2.7E+07	2.67786E-08	4.775799161	7.61E+00
U236	2.8E+07	2.79598E-08	4.574037438	7.61E+00
U238	2.8E+07	2.83979E-08	4.503460262	7.61E+00
U240	3.0E+07	3.04227E-08	4.203736541	7.61E+00
Xe127	8.0E+08	7.98393E-07	0.160183041	7.61E+00
Xe131m	4.1E+08	4.1371E-07	0.309126983	7.61E+00
Y90	7.9E+08	7.87742E-07	0.162348865	7.61E+00
Zn65	1.3E+08	1.31865E-07	0.969846036	7.61E+00
Zr93	2.2E+08	2.17376E-07	0.588330261	7.61E+00
Zr95	6.6E+09	6.55841E-06	0.0195	7.61E+00

This page intentionally left blank.

Appendix B-4

Geomembrane Maximum Allowable Dose in the Evaporation Pond

This page intentionally left blank.

MONTGOMERY WATSON HARZA

Description: Back calculation of maximum allowable concentration for each distinct Parameter for the evaporation ponds

Project #: 2470178

Prepared by: B.G. Adams

Date: 12/5/01

Checked by: J. Pellicer

Date: 12/7/01

VARIABLES

Liner Thickness =	60	mils
Liner density =	0.94	g/cm^3
Depth of leachate =	36	cm

CONVERSIONS

pCi/Ci =	1.00E+12
cm^3/l =	1000
cm/mil =	2.54E-03
(dis/s)/Ci =	3.70E+10
sec/hr =	3600
g/kg =	1.00E+03
eV/Mev =	1.00E+06
J/eV =	1.60E-19
rad/Gy =	100

15 yr Dose =	1,000,000
Daily Dose =	182.6484018
Dose Rad/hr =	7.610350076

Constituent	ICDF Maximum Activity Concentration (pCi/l)	ICDF Maximum Activity Concentration (Ci/cm^3)	Dissintegration Energy (MeV/dis)	ICDF Liner Radiation Dose (Rads/hr)
Ac225	2.4E+06	2.43646E-09	5.832179811	7.61E+00
Ac227	1.8E+08	1.78445E-07	0.079631727	7.61E+00
Ac228	1.0E+07	1.0478E-08	1.356167107	7.61E+00
Ag108	2.3E+07	2.26529E-08	0.627288369	7.61E+00
Ag108m	8.7E+06	8.69773E-09	1.63374702	7.61E+00
Ag109m	1.6E+08	1.63407E-07	0.086960304	7.61E+00
Ag110	1.2E+07	1.17237E-08	1.212069842	7.61E+00
Ag110m	5.1E+06	5.05909E-09	2.808781272	7.61E+00
Am241	2.6E+06	2.56722E-09	5.535129217	7.61E+00
Am242	7.4E+07	7.42025E-08	0.191501428	7.61E+00
Am242m	2.2E+08	2.16427E-07	0.065656838	7.61E+00
Am243	2.7E+06	2.65699E-09	5.348125195	7.61E+00
Am246	1.1E+07	1.11967E-08	1.269116692	7.61E+00
At217	2.0E+06	2.01111E-09	7.065707158	7.61E+00
Ba137m	2.1E+07	2.14825E-08	0.661462561	7.61E+00
Be 10	7.0E+07	7.01723E-08	0.2025	7.61E+00
Bi210	3.7E+07	3.65293E-08	0.389	7.61E+00
Bi211	2.2E+06	2.15093E-09	6.606380966	7.61E+00
Bi214	6.6E+06	6.59806E-09	2.153646154	7.61E+00
Bk249	4.3E+08	4.30607E-07	0.03299967	7.61E+00
Bk250	1.2E+07	1.20413E-08	1.180096454	7.61E+00
Cd109	7.2E+08	7.23459E-07	0.019641609	7.61E+00
Cd113m	7.7E+07	7.66621E-08	0.185357358	7.61E+00
Ce141	5.8E+07	5.76051E-08	0.246677795	7.61E+00
Ce144	1.3E+08	1.27085E-07	0.111813852	7.61E+00
Cf249	2.3E+06	2.29127E-09	6.201740977	7.61E+00

Constituent	ICDF Maximum Activity Concentration (pCi/l)	ICDF Maximum Activity Concentration (Ci/cm^3)	Dissintegration Energy (MeV/dis)	ICDF Liner Radiation Dose (Rads/hr)
Cf250	2.4E+06	2.35839E-09	6.025256294	7.61E+00
Cf251	2.4E+06	2.39063E-09	5.94399266	7.61E+00
Cm241	8.3E+07	8.30017E-08	0.1712	7.61E+00
Cm242	2.3E+06	2.3217E-09	6.120469416	7.61E+00
Cm243	2.3E+06	2.33347E-09	6.089596726	7.61E+00
Cm244	2.4E+06	2.44811E-09	5.804428351	7.61E+00
Cm245	2.6E+06	2.58015E-09	5.507387757	7.61E+00
Cm246	2.6E+06	2.63978E-09	5.382991049	7.61E+00
Cm247	2.7E+06	2.69186E-09	5.278828648	7.61E+00
Cm248	3.1E+06	3.05069E-09	4.657924475	7.61E+00
Co-57	9.9E+07	9.91042E-08	0.143383365	7.61E+00
Co-58	1.5E+07	1.45098E-08	0.979328243	7.61E+00
Co-60	5.5E+06	5.46197E-09	2.601603093	7.61E+00
Cr-51	3.9E+08	3.92633E-07	0.036191289	7.61E+00
Cs-134	8.3E+06	8.27552E-09	1.717100005	7.61E+00
Cs135	2.5E+08	2.52396E-07	0.0563	7.61E+00
Cs137	8.3E+07	8.32187E-08	0.1707536	7.61E+00
Eu150	4.9E+07	4.8664E-08	0.292	7.61E+00
Eu152	1.1E+07	1.11338E-08	1.276280952	7.61E+00
Eu154	9.3E+06	9.3063E-09	1.526910861	7.61E+00
Eu155	1.2E+08	1.16121E-07	0.122371015	7.61E+00
Fe-59	1.1E+07	1.08812E-08	1.30591073	7.61E+00
Fr221	2.2E+06	2.22222E-09	6.394459322	7.61E+00
Fr223	3.3E+07	3.26869E-08	0.434726751	7.61E+00
Gd153	9.3E+07	9.32714E-08	0.15235	7.61E+00
H 3	2.5E+09	2.49954E-06	0.005685	7.61E+00
Ho166m	8.2E+06	8.16054E-09	1.741292443	7.61E+00
In114	1.8E+07	1.76822E-08	0.803627157	7.61E+00
In114m	5.9E+07	5.93595E-08	0.239386934	7.61E+00
In115	9.3E+07	9.34861E-08	0.152	7.61E+00
K-40	2.3E+07	2.32809E-08	0.610365806	7.61E+00
La140	5.0E+06	4.98785E-09	2.848903435	7.61E+00
Mn-54	1.7E+07	1.69201E-08	0.839824907	7.61E+00
Nb92	9.4E+06	9.41074E-09	1.509964777	7.61E+00
Nb93m	4.7E+08	4.6971E-07	0.030252491	7.61E+00
Nb94	8.3E+06	8.25839E-09	1.720660307	7.61E+00
Nb95m	5.8E+07	5.75777E-08	0.24679489	7.61E+00
Nd144	7.5E+06	7.47889E-09	1.9	7.61E+00
Np236	4.2E+07	4.16647E-08	0.341053651	7.61E+00
Np239	3.4E+07	3.42077E-08	0.415400022	7.61E+00
Np240m	1.5E+07	1.49752E-08	0.948896841	7.61E+00

Constituent	ICDF Maximum Activity Concentration (pCi/l)	ICDF Maximum Activity Concentration (Ci/cm^3)	Dissintegration Energy (MeV/dis)	ICDF Liner Radiation Dose (Rads/hr)
Pa231	2.6E+06	2.60565E-09	5.453502195	7.61E+00
Pa233	3.5E+07	3.47005E-08	0.409501364	7.61E+00
Pa234	5.8E+06	5.7682E-09	2.463486522	7.61E+00
Pa234m	1.7E+07	1.70212E-08	0.834833438	7.61E+00
Pb209	7.2E+07	7.19124E-08	0.1976	7.61E+00
Pb210	3.7E+08	3.65305E-07	0.038898656	7.61E+00
Pb212	4.4E+07	4.42337E-08	0.321245808	7.61E+00
Pb214	2.6E+07	2.63893E-08	0.538471991	7.61E+00
Pd107	4.3E+08	4.29289E-07	0.033101	7.61E+00
Pm146	1.7E+07	1.67012E-08	0.850831344	7.61E+00
Pm147	2.3E+08	2.29335E-07	0.061961344	7.61E+00
Pm148	1.1E+07	1.09229E-08	1.30092091	7.61E+00
Pm148m	6.6E+06	6.59299E-09	2.155301698	7.61E+00
Po210	2.7E+06	2.67883E-09	5.304505553	7.61E+00
Po211	1.9E+06	1.90729E-09	7.450314354	7.61E+00
Po212	1.6E+06	1.61754E-09	8.7849	7.61E+00
Po213	1.7E+06	1.6963E-09	8.376999781	7.61E+00
Po214	1.8E+06	1.84855E-09	7.687067933	7.61E+00
Po215	1.9E+06	1.92382E-09	7.38630707	7.61E+00
Po216	2.1E+06	2.09632E-09	6.778486648	7.61E+00
Po218	2.4E+06	2.3678E-09	6.001296466	7.61E+00
Pr144	1.1E+07	1.10667E-08	1.284017776	7.61E+00
Pr144m	1.2E+09	1.19942E-06	0.01184728	7.61E+00
Pu236	2.5E+06	2.46199E-09	5.771712409	7.61E+00
Pu237	2.3E+08	2.28304E-07	0.062241073	7.61E+00
Pu238	2.6E+06	2.58503E-09	5.496995126	7.61E+00
Pu239	2.8E+06	2.75731E-09	5.153526936	7.61E+00
Pu240	2.8E+06	2.75157E-09	5.164286359	7.61E+00
Pu241	2.7E+09	2.71705E-06	0.005229895	7.61E+00
Pu242	2.9E+06	2.8864E-09	4.923056772	7.61E+00
Pu243	7.3E+07	7.2795E-08	0.195204338	7.61E+00
Pu244	3.1E+06	3.09035E-09	4.598152374	7.61E+00
Pu246	9.2E+07	9.1963E-08	0.154517541	7.61E+00
Ra222	2.2E+06	2.16827E-09	6.553547823	7.61E+00
Ra224	2.5E+06	2.49862E-09	5.687100654	7.61E+00
Ra225	1.2E+08	1.19185E-07	0.119225863	7.61E+00
Ra226	3.0E+06	2.96677E-09	4.789685685	7.61E+00
Ra228	1.2E+09	1.22838E-06	0.011568007	7.61E+00
Rb87	1.8E+08	1.80329E-07	0.0788	7.61E+00
Rh102	1.8E+08	1.78069E-07	0.0798	7.61E+00
Rh103m	3.7E+08	3.65661E-07	0.038860869	7.61E+00

Constituent	ICDF Maximum Activity Concentration (pCi/l)	ICDF Maximum Activity Concentration (Ci/cm^3)	Dissintegration Energy (MeV/dis)	ICDF Liner Radiation Dose (Rads/hr)
Rh106	8.8E+06	8.77496E-09	1.61936774	7.61E+00
Rn218	2.0E+06	1.99213E-09	7.132996084	7.61E+00
Rn219	2.1E+06	2.07983E-09	6.832252476	7.61E+00
Rn220	2.3E+06	2.25974E-09	6.288297183	7.61E+00
Rn222	2.6E+06	2.58851E-09	5.48961137	7.61E+00
Ru103	2.6E+07	2.56695E-08	0.553570714	7.61E+00
Ru106	3.6E+08	3.60648E-07	0.039401	7.61E+00
Sb124	6.3E+06	6.31827E-09	2.249015659	7.61E+00
Sb125	2.7E+07	2.68008E-08	0.530203897	7.61E+00
Sb126	4.7E+06	4.65525E-09	3.052446696	7.61E+00
Sc-46	6.7E+06	6.69811E-09	2.121478487	7.61E+00
Se 79	2.7E+08	2.7222E-07	0.0522	7.61E+00
Sm146	5.6E+06	5.61656E-09	2.53	7.61E+00
Sm147	6.3E+06	6.32225E-09	2.2476	7.61E+00
Sm148	7.1E+06	7.14065E-09	1.99	7.61E+00
Sm151	7.2E+08	7.18214E-07	0.019785044	7.61E+00
Sn119m	7.2E+08	7.18214E-07	0.019785044	7.61E+00
Sn121m	1.6E+08	1.63143E-07	0.087100885	7.61E+00
Sn123	4.7E+09	4.67431E-06	0.00304	7.61E+00
Sn126	2.7E+07	2.69423E-08	0.527419926	7.61E+00
Sr89	4.0E+07	3.96274E-08	0.358587622	7.61E+00
Sr90	2.4E+07	2.43705E-08	0.583077055	7.61E+00
Tb160	2.6E+07	2.60254E-08	0.546	7.61E+00
Tc 98	1.1E+07	1.05036E-08	1.352864583	7.61E+00
Tc 99	9.4E+06	9.37736E-09	1.515340293	7.61E+00
Te123	1.7E+08	1.67965E-07	0.084600538	7.61E+00
Te123m	8.3E+08	8.32673E-07	0.017065401	7.61E+00
Te127	8.9E+07	8.91467E-08	0.159398912	7.61E+00
Te127m	6.2E+07	6.23836E-08	0.227782297	7.61E+00
Te129	1.6E+08	1.56465E-07	0.090818471	7.61E+00
Th226	4.6E+07	4.60434E-08	0.308619356	7.61E+00
Th227	2.2E+06	2.24279E-09	6.335815362	7.61E+00
Th228	2.3E+06	2.34856E-09	6.050478496	7.61E+00
Th229	2.6E+06	2.62108E-09	5.421384523	7.61E+00
Th230	2.8E+06	2.81012E-09	5.056687752	7.61E+00
Th231	3.0E+06	3.02913E-09	4.691076245	7.61E+00
Th232	8.0E+07	7.96223E-08	0.178466304	7.61E+00
Th234	3.5E+06	3.53776E-09	4.016629793	7.61E+00
Tl207	2.1E+08	2.1345E-07	0.066572433	7.61E+00
Tl208	2.9E+07	2.86823E-08	0.495424523	7.61E+00
Tl209	3.6E+06	3.58964E-09	3.958587853	7.61E+00

Constituent	ICDF Maximum Activity Concentration (pCi/l)	ICDF Maximum Activity Concentration (Ci/cm^3)	Dissintegration Energy (MeV/dis)	ICDF Liner Radiation Dose (Rads/hr)
Tm170	3.6E+06	3.578E-09	3.971465102	7.61E+00
Tm171	4.2E+07	4.24499E-08	0.334745144	7.61E+00
U232	5.4E+08	5.42006E-07	0.026217219	7.61E+00
U233	2.7E+06	2.6697E-09	5.322659468	7.61E+00
U234	2.9E+06	2.94985E-09	4.817156054	7.61E+00
U235	3.0E+06	2.9754E-09	4.775799161	7.61E+00
U236	3.1E+06	3.10664E-09	4.574037438	7.61E+00
U238	3.2E+06	3.15533E-09	4.503460262	7.61E+00
U240	3.4E+06	3.3803E-09	4.203736541	7.61E+00
Xe127	8.9E+07	8.87103E-08	0.160183041	7.61E+00
Xe131m	4.6E+07	4.59678E-08	0.309126983	7.61E+00
Y90	8.8E+07	8.75269E-08	0.162348865	7.61E+00
Zn65	2.3E+07	2.34524E-08	0.605903	7.61E+00
Zr93	2.4E+07	2.41529E-08	0.588330261	7.61E+00
Zr95	7.3E+08	7.28712E-07	0.0195	7.61E+00

This page intentionally left blank.

Appendix C

Manufacturers Maximum Constituent Concentration Data for HDPE Geomembrane

This page intentionally left blank.

HDPE Liner Manufacturer's Compatibility Data

LINER COMPATIBILITY

1. **Identify the manufacturer and the type of liner that will be used in the landfill which will contain the form R wastes.**

   MANUFACTURER: GSE Lining Technology, Inc.
   LINER TYPE: *60 mil HDPE*

2. **Describe how the following types of chemicals will affect the liner to be used to contain the form R waste:**

   aromatic halogenated hydrocarbons - SEE ATTACHED SHEET

   aliphatic halogenated hydrocarbons - SEE ATTACHED SHEET

   aromatic hydrocarbons - SEE ATTACHED SHEET

   aliphatic hydrocarbons - SEE ATTACHED SHEET

   volatile and semi-volatile organics - SEE ATTACHED SHEET

   oil and grease - SEE ATTACHED SHEET

   strong oxidizers - GENERALLY NO SIGNIFICANT EFFECT

   acids - GENERALLY NO SIGNIFICANT EFFECT

   bases - GENERALLY NO SIGNIFICANT EFFECT

   dissolved metals, salts and nutrients - GENERALLY NO EFFECT

3. **Give an acceptable compatibility limit for each of the compounds on the following pages and certificate liner manufacturer:**

Signature of Liner Manufacturer:

____

Matthew W. Adams
Technical Support Chemist

____

Date

Aromatic Halogenated Hydrocarbons

Aromatic Halogenated Hydrocarbons tend to be absorbed into polyethylene over long periods of time where they may function as a plasticizer. As a result, the polyethylene may swell and become softer and more elastic. These effects are generally reversible if the exposure is terminated.

Since polyethylene consists of a range of molecular weight molecules and somewhat different branching arrangements, some lower density polyethylenes may contain fractions that are extractable. Some types of chemical stabilizers and processing aids may also be extractable.

These above noted effects increase with increasing temperature. Softening, swelling and increased elasticity may rapidly reduce the usefulness of polyethylene as a structural component such as for use as a pressure pipe. Generally, these effects do not seriously affect the performance of polyethylene as a containment membrane.

GSE HyperFlex® polyethylene geomembranes are manufactured from a narrow molecular weight range resin designed to minimize the possibility of extractable fractions and maximize the resistance to stress cracking.

Aliphatic Halogenated Hydrocarbons

Similar effects as for Aromatic Halogenated Hydrocarbons but generally less severe. Some materials have little or no effect.

Aromatic Hydrocarbons

Again similar to Aromatic Halogenated Hydrocarbons but generally less severe. Many materials have no significant effect.

Aliphatic Hydrocarbons

Again similar, but with further reductions of general severity. Most materials have no significant effect.

Volatile and Semivolatile Organics

These are mostly covered by the previously noted comments about hydrocarbons.

Oil and Grease

Mineral, vegetable and animal oils, fats or grease generally have no significant effect.

Strong Oxidizers - Generally no significant effect.

Acids - Generally no significant effect.

Dissolved Metals, Salts and Nutrients - Generally no effect.

FORM R
LINER COMPATABILITY

PARAMETER CLASSIFICATION	PARAMETER	MANUFACTURER'S LINER/LEACHATE LIMIT mg/l
Aromatic Halogenated Hydrocarbons	polychlorinated biphenyl	(2000)
	aldrin	(2000)
	dichlorobenzene	(2000)
	hexachlorobenzene	(2000)
	pentachlorobenzene	(2000)
	trichlorobenzene	(2000)
	tetrachlorobenzene	(2000)
	2-chloronaphthalene	(2000)
	chloronaphthalene	(2000)
	chlorobenzene	(2000)
	4,4-DDT	(2000)
	4,4-DDE	(2000)
	4,4-DDD	(2000)
Aliphatic Halogenated Hydrocarbons	bromoform	(2000)
	carbon tetrachloride	(2000)
	chlorodibromomethane	(2000)
	chloroethane	(2000)
	chloroform	(2000)
	dichlorobromomethane	(2000)
	dichlorodifluoromethane	(2000)
	dichloroethane	(2000)
	dichloropropane	(2000)
	dichloroethene	(2000)
	ethylene chloride	(2000)
	ethylene dichloride	(2000)
	hexachloroethane	(2000)
	methyl bromide	(2000)
	methyl chloride	(2000)
	methylene chloride	(2000)
	tetrachloroethane	(2000)
	tetrachloroethene	(2000)
	trichloroethane	(2000)
	trichloroethene	(2000)
	trichlorofluoromethane	(2000)
	vinyl chloride	(2000)

TEMPERATURE 70 °F

FORM R
LINER COMPATABILITY

PARAMETER CLASSIFICATION	PARAMETER	MANUFACTURER'S LINER/LEACHATE LIMIT mg/l
Aromatic Hydrocarbons	acenapthene	(2000)
	acenaphthylene	(2000)
	anthracene	(2000)
	benzene	(2000)
	benzo(a)anthracene	(2000)
	benzo(a)pyrene	(2000)
	benzo(g,h,i)perylene	(2000)
	benzo(k)fluoranthene	(2000)
	3,4-benzoflouranthene	(2000)
	chrysene	(2000)
	dibenzo(a,h)anthracene	(2000)
	ethyl benzene	(2000)
	flouranthene	(2000)
	flourene	(2000)
	ideno(1,2,3,c,d)pyrene	(2000)
	naphthalene	(2000)
	phenanthrene	(2000)
	pyrene	(2000)
	styrene	(5000)
	toluene	(5000)
	xylene	(5000)
Aliphatic Hydrocarbons	heptane	(500,000)
	hexane	(500,000)
	octane	(500,000)

TEMPERATURE 70 °F

FORM R
LINER COMPATABILITY

PARAMETER CLASSIFICATION	PARAMETER	MANUFACTURER'S LINER/LEACHATE LIMIT mg/l
Volatile & Semivolatile Organics	acrolein	(200,000)
	acrylonitrile	(200,000)
	acetone	(200,000)
	amyl acetate	(200,000)
	benzidine	(200,000)
	butyl alcohol	(500,000)
	bis(2-chloroethoxy)methane	(2,000)
	bis(2-chloroethosy)ether	(2,000)
	bis(2-chloroisopropy)ether	(2,000)
	bis(2-etylhexyl)pththalate	(2,000)
	4-bromophenyl phenyl ether	(2,000)
	butyl benzyl phthalate	(200,000)
	cresol	(100,000)
	chlordane	(2,000)
	alpha-BHC	(2,000)
	beta-BHC	(2,000)
	gamma-BHC	(2,000)
	delta-BHC	(2,000)
	dieldrin	(2,000)
	dichlorobenzidine	(2,000)
	diethyl phthalate	(100,000)
	dibutyl phthalate	(100,000)
	dimethyl phthalate	(100,000)
	isobutyl alchohol	(500,000)
	isopropyl alcohol	(500,000)
	methyl alcohol	(500,000)
	2-chloroethyl vinyl ether	(2,000)
	2-chlorophenol	(2,000)
	dichlorophenol	(2,000)
	dimethyl phenol	(2,000)
	dinitro-o-cresol	(2,000)
	dinitrophenol	(2,000)
	dinitrotoluene	(2,000)
	diphenylhydrazine	(2,000)
	ethyl acetate	(100,000)
	ethyl ether	(2,000)
	ethyl glycol	(500,000)
	endosulfan	(2,000)
	endrin	(2,000)
	formaldehyde	(200,000)
	heptachlor	(2,000)
	hexachlorocyclopentadiene	(2,000)
	hexachlorobutadiene	(2,000)
	isophorone	(2,000)
	methyl ethyl ketone	(200,000)
	TEMPERATURE 70 °F	

FORM R
LINER COMPATABILITY

PARAMETER CLASSIFICATION	PARAMETER	MANUFACTURER'S LINER/LEACHATE LIMIT mg/l
Volatile & Semivolotile Organics (cont.)	methyl isobutyl ketone	(500,000)
	nitrophenol	(100,000)
	N-nitrosodimethylamine	(100,000)
	N-nitrosodi-n-propylamine	(100,000)
	nitrobenzene	(100,000)
	pentachlorophenol	(100,000)
	phenol	(100,000)
	pyridine	(100,000)
	toxaphene	(100,000)
	trichlorophenol	(100,000)
	2,4,5-TP(silvex)	(?)

TEMPERATURE 70 °F

FORM R
LINER COMPATABILITY

PARAMETER CLASSIFICATION	PARAMETER	MANUFACTURER'S LINER/LEACHATE LIMIT mg/l
Acids & Bases	acetic acid	(500,000)
	chromic acid	(100,000)
	citric acid	(500,000)
	hydrobromic acid	(100,000)
	hydrochloric acid	(350,000)
	hydrocyanic acid	(100,000)
	hydrofluoric acid	(750,000)
	nitric acid	(500,000)
	picric acid	(500,000)
	phosphoric acid	(500,000)
	perchloric acid	(500,000)
	sulfuric acid	(500,000)
	potassium hydroxide	(500,000)
	sodium hydroxide	(500,000)
Products & Various Substances	antifreeze	(500,000)
	asphalt	(500,000)
	cresols	(100,000)
	crude oil	(500,000)
	diesel fuel	(500,000)
	fatty acids	(500,000)
	freon	(500,000)
	fuel oil	(500,000)
	gasoline	(500,000)
	hydraulic oil	(500,000)
	kerosene	(500,000)
	lacquers	(500,000)
	lubricating oil	(500,000)
	mineral spirits	(500,000)
	naphtha	(500,000)
	paraffin	(500,000)
	transformer oil	(500,000)
Miscellaneous	pH	(0.5-13.0 pH unit)
	strong oxidizers*	(1000-500,000)
	metals, salts, nutrients	(500,000)

*potassium permaganate, potassium dichromate, chlorine, peroxides

TEMPERATURE 70 °F

GSE®

Chemical Resistance

For environmental lining solutions...the world comes to GSE.®

GSE is the world's leading supplier of high quality, polyethylene geomembranes. GSE polyethylene geomembranes are resistant to a great number and combinations of chemicals. Note that the effect of chemicals on any material is influenced by a number of variable factors such as temperature, concentration, exposed area and duration. Many tests have been performed that use geomembranes and certain specific chemical mixtures. Naturally, however, every mixture of chemicals cannot be tested for, and various criteria may be used to judge performance. Reported performance ratings may not apply to all applications of a given material in the same chemical. Therefore, these ratings are offered as a guide only.

Abbreviations

S = Satisfactory
L = Limited application possible
U = Unsatisfactory
— = Not tested

Concentration

sat. sol. = Saturated aqueous solution, prepared at 20°C (68°F)
sol. = aqueous solution with concentration above 10% but below saturation level
dil. sol. = diluted aqueous solution with concentration below 10%
cust. conc. = customary service concentration

Medium	Concentration	Resistance at: 20 °C (68 °F)	Resistance at: 60 °C (140 °F)
A			
Acetic acid	100%	S	L
Acetic acid	10%	S	S
Acetic acid anhydride	100%	S	L
Acetone	100%	L	L
Adipic acid	sat. sol.	S	S
Allyl alcohol	96%	S	S
Aluminum chloride	sat. sol.	S	S
Aluminum fluoride	sat. sol.	S	S
Aluminum sulfate	sat. sol.	S	S
Alum	sol.	S	S
Ammonia, aqueous	dil. sol.	S	S
Ammonia, gaseous dry	100%	S	S
Ammonia, liquid	100%	S	S
Ammonium chloride	sat. sol.	S	S
Ammonium fluoride	sol.	S	S
Ammonium nitrate	sat. sol.	S	S
Ammonium sulfate	sat. sol.	S	S
Ammonium sulfide	sol.	S	S
Amyl acetate	100%	S	L
Amyl alcohol	100%	S	L
Aniline	100%	S	L
Antimony trichloride	90%	S	S
Arsenic acid	sat. sol.	S	S
Aqua regia	HCl-HNO33/1	U	U
B			
Barium carbonate	sat. sol.	S	S
Barium chloride	sat. sol.	S	S
Barium hydroxide	sat. sol.	S	S
Barium sulfate	sat. sol.	S	S
Barium sulfide	sol.	S	S
Benzaldehyde	100%	S	L
Benzene	—	L	L
Benzoic acid	sat. sol.	S	S
Beer	—	S	S
Borax (sodium tetraborate)	sat. sol.	S	S
Boric acid	sat. sol.	S	S
Bromine, gaseous dry	100%	U	U
Bromine, liquid	100%	U	U
Butane, gaseous	100%	S	S
1-Butanol	100%	S	S
Butyric acid	100%	S	L
C			
Calcium carbonate	sat. sol.	S	S
Calcium chlorate	sat. sol.	S	S
Calcium chloride	sat. sol.	S	S
Calcium nitrate	sat. sol.	S	S
Calcium sulfate	sat. sol.	S	S
Calcium sulfide	dil. sol.	L	L
Carbon dioxide, gaseous dry	100%	S	S
Carbon disulfide	100%	L	U
Carbon monoxide	100%	S	S
Chloracetic acid	sol.	S	S
Carbon tetrachloride	100%	L	U
Chlorine, aqueous solution	sat. sol.	L	U
Chlorine, gaseous dry	100%	L	U
Chloroform	100%	U	U
Chromic acid	20%	S	L
Chromic acid	50%	S	L
Citric acid	sat. sol.	S	S
Copper chloride	sat. sol.	S	S
Copper nitrate	sat. sol.	S	S
Copper sulfate	sat. sol.	S	S
Cresylic acid	sat. sol.	L	—
Cyclohexanol	100%	S	S
Cyclohexanone	100%	S	L
D			
Decahydronaphthalene	100%	S	L
Dextrine	sol.	S	S
Diethyl ether	100%	L	—
Dioctylphthalate	100%	S	L
Dioxane	100%	S	S
E			
Ethanediol	100%	S	S
Ethanol	40%	S	L
Ethyl acetate	100%	S	U
Ethylene trichloride	100%	U	U
F			
Ferric chloride	sat. sol.	S	S
Ferric nitrate	sol.	S	S
Ferric sulfate	sat. sol.	S	S
Ferrous chloride	sat. sol.	S	S
Ferrous sulfate	sat. sol.	S	S
Fluorine, gaseous	100%	U	U
Fluorosilicic acid	40%	S	S
Formaldehyde	40%	S	S
Formic acid	50%	S	S
Formic acid	98-100%	S	S
Furfuryl alcohol	100%	S	L
G			
Gasoline	—	S	L
Glacial acetic acid	96%	S	L
Glucose	sat. sol.	S	S
Glycerine	100%	S	S
Glycol	sol.	S	S
H			
Heptane	100%	S	U
Hydrobromic acid	50%	S	S

(CONTINUED ON OTHER SIDE)

(S) Satisfactory: *Liner material is resistant to the given reagent at the given concentration and temperature. No mechanical or chemical degradation is observed.*
(L) Limited Application Possible: *Liner material may reflect some attack. Factors such as concentration, pressure and temperature directly affect liner performance against the given media. Application, however, is possible under less severe conditions, e.g. lower concentration, secondary containment, additional liner protections, etc.*
(U) Unsatisfactory: *Liner material is not resistant to the given reagent at the given concentration and temperature. Mechanical and/or chemical degradation is observed.*
(–) Not tested

Medium	Concentration	Resistance at: °C (68 °F)	60 °C (140 °F)
Hydrobromic acid	100%	S	S
Hydrochloric acid	10%	S	S
Hydrochloric acid	35%	S	S
Hydrocyanic acid	10%	S	S
Hydrofluoric acid	4%	S	S
Hydrofluoric acid	60%	S	L
Hydrogen	100%	S	S
Hydrogen peroxide	30%	S	L
Hydrogen peroxide	90%	S	U
Hydrogen sulfide, gaseous	100%	S	S
L			
Lactic acid	100%	S	S
Lead acetate	sat. sol.	S	—
M			
Magnesium carbonate	sat. sol.	S	S
Magnesium chloride	sat. sol.	S	S
Magnesium hydroxide	sat. sol.	S	S
Magnesium nitrate	sat. sol.	S	S
Maleic acid	sat. sol.	S	S
Mercuric chloride	sat. sol.	S	S
Mercuric cyanide	sat. sol.	S	S
Mercuric nitrate	sol.	S	S
Mercury	100%	S	S
Methanol	100%	S	S
Methylene chloride	100%	L	—
Milk	—	S	S
Molasses	—	S	S
N			
Nickel chloride	sat. sol.	S	S
Nickel nitrate	sat. sol.	S	S
Nickel sulfate	sat. sol.	S	S
Nicotinic acid	dil. sol.	S	—
Nitric acid	25%	S	S
Nitric acid	50%	S	U
Nitric acid	75%	U	U
Nitric acid	100%	U	U
O			
Oils and Grease	—	S	L
Oleic acid	100%	S	L
Orthophosphoric acid	50%	S	S
Orthophosphoric acid	95%	S	L
Oxalic acid	sat. sol.	S	S
Oxygen	100%	S	L
Ozone	100%	L	U
P			
Petroleum (kerosene)	—	S	L
Phenol	sol.	S	S
Phosphorus trichloride	100%	S	L
Photographic developer	cust. conc.	S	S
Picric acid	sat. sol.	S	—
Potassium bicarbonate	sat. sol.	S	S
Potassium bisulfide	sol.	S	S
Potassium bromate	sat. sol.	S	S
Potassium bromide	sat. sol.	S	S
Potassium carbonate	sat. sol.	S	S
Potassium chlorate	sat. sol.	S	S
Potassium chloride	sat. sol.	S	S
Potassium chromate	sat. sol.	S	S
Potassium cyanide	sol.	S	S
Potassium dichromate	sat. sol.	S	S
Potassium ferricyanide	sat. sol.	S	S
Potassium ferrocyanide	sat. sol.	S	S
Potassium fluoride	sat. sol.	S	S
Potassium hydroxide	10%	S	S
Potassium hydroxide	sol.	S	S
Potassium hypochlorite	sol.	S	L
Potassium nitrate	sat. sol.	S	S
Potassium orthophosphate	sat. sol.	S	S
Potassium perchlorate	sat. sol.	S	S

Medium	Concentration	Resistance at: 20 °C (68 °F)	60 °C (140 °F)
Potassium permanganate	20%	S	S
Potassium persulfate	sat. sol.	S	S
Potassium sulfate	sat. sol.	S	S
Potassium sulfite	sol.	S	S
Propionic acid	50%	S	S
Propionic acid	100%	S	L
Pyridine	100%	S	L
Q			
Quinol (Hydroquinone)	sat. sol.	S	S
S			
Salicylic acid	sat. sol.	S	S
Silver acetate	sat. sol.	S	S
Silver cyanide	sat. sol.	S	S
Silver nitrate	sat. sol.	S	S
Sodium benzoate	sat. sol.	S	S
Sodium bicarbonate	sat. sol.	S	S
Sodium biphosphate	sat. sol.	S	S
Sodium bisulfite	sol.	S	S
Sodium bromide	sat. sol.	S	S
Sodium carbonate	sat. sol.	S	S
Sodium chlorate	sat. sol.	S	S
Sodium chloride	sat. sol.	S	S
Sodium cyanide	sat. sol.	S	S
Sodium ferricyanide	sat. sol.	S	S
Sodium ferrocyanide	sat. sol.	S	S
Sodium fluoride	sat. sol.	S	S
Sodium hydroxide	40%	S	S
Sodium hydroxide	sat. sol.	S	S
Sodium hypochlorite	15% active chlorine	S	S
Sodium nitrate	sat. sol.	S	S
Sodium nitrite	sat. sol.	S	S
Sodium orthophosphate	sat. sol.	S	S
Sodium sulfate	sat. sol.	S	S
Sodium sulfide	sat. sol.	S	S
Sulfur dioxide, dry	100%	S	S
Sulfur trioxide	100%	U	U
Sulfuric acid	10%	S	S
Sulfuric acid	50%	S	S
Sulfuric acid	98%	S	U
Sulfuric acid	fuming	U	U
Sulfurous acid	30%	S	S
T			
Tannic acid	sol.	S	S
Tartaric acid	sol.	S	S
Thionyl chloride	100%	L	U
Toluene	100%	L	U
Triethylamine	sol.	S	L
U			
Urea	sol.	S	S
Urine	—	S	S
W			
Water	—	S	S
Wine vinegar	—	S	S
Wines and liquors	—	S	S
X			
Xylenes	100%	L	U
Y			
Yeast	sol.	S	S
Z			
Zinc carbonate	sat. sol.	S	S
Zinc chloride	sat. sol.	S	S
Zinc (II) chloride	sat. sol.	S	S
Zinc (IV) chloride	sat. sol.	S	S
Zinc oxide	sat. sol.	S	S
Zinc sulfate	sat. sol.	S	S

Specific immersion testing should be undertaken to ascertain the suitability of chemicals not listed above with reference to special requirements.

GSE Lining Technology, Inc.
Corporate Headquarters
19103 Gundle Road
Houston, Texas 77073
USA
800-435-2008, 281-443-8564
FAX: 281-875-6010

GSE Lining Technology GmbH
European Headquarters
Buxtehuder Straße 112
D-21073 Hamburg
Germany
49-40-767-420
FAX: 49-40-767-42-33

Sales/Installation Offices
Australia
Egypt
Singapore
United Kingdom

Represented by:

Marlex

POLYETHYLENE

TECHNICAL SERVICE MEMORANDUM

TSM-243
September, 1994

Engineering Properties of Marlex Resins

INTRODUCTION

It is sometimes necessary to have information about high density polyethylene (HDPE) that does not normally appear on the typical resin data sheet. This Technical Service Memorandum supplies data on many of the infrequently published physical, chemical and electrical properties of our Marlex resins. In this Memorandum, we will briefly discuss many of these test procedures and provide available information concerning particular resin properties as well as comparing Marlex HDPE to other resin types.

CONTENTS

Deformation of Plastics Under Load (ASTM D621)

Method A: Rigid Plastics – A 1/2 in *(12.7 mm)* cubical specimen is maintained under a constant compressive force of 500 pounds *(227 kg)* between the parallel plates of a device manufactured by the Luster Jordan Company. The whole assembly is enclosed in a constant temperature oven at 122°F *(50°C)*. The change in thickness is observed over a period of 24 hours and reported as follows:

POLYETHYLENE MATERIAL	ORIGINAL HEIGHT, in *(cm)*	DEFORMED HEIGHT, in *(cm)*	DEFORMATION, PERCENT	TIME ELAPSED, HOURS	PRESSURE, psi *(MPa)*	TEMPERATURE, °F *(°C)*
High Density	0.506 *(1.27)*	0.465 *(1.18)*	8.1	22	2000 *(13.8)*	122 *(50)*
Low Density	0.509 *(1.30)*	0.425 *(1.08)*	16.5	24	2000 *(13.8)*	122 *(50)*

Method B: Non-Rigid Plastics – Method B is essentially the same as Method A except that (1) the test specimen is in the shape of a cylinder 1.129 in *(28.7 mm)* in diameter and 0.250 in *(6.4 mm)* thick having the two flat surfaces parallel; (2) the pressure is 100 psi *(0.69 MPa)*; and (3) the test period is 3 hours. The results of testing by Method B are as follows:

POLYETHYLENE MATERIAL	ORIGINAL HEIGHT, in *(cm)*	DEFORMED HEIGHT, in *(cm)*	DEFORMATION, PERCENT	TIME ELAPSED, HOURS	PRESSURE, psi *(MPa)*	TEMPERATURE, °F *(°C)*
High Density	0.483 *(1.23)*	0.483 *(1.23)*	0	3	100 *(0.69)*	122 *(50)*
Low Density	0.498 *(1.26)*	0.496 *(1.25)*	.5	3	100 *(0.69)*	122 *(50)*

Irradiation – Effects on Properties of HDPE of Gamma and Beta Irradiation

Data indicate that polymer crosslinking occurs with beta or gamma irradiation accompanied by an increase in density, tensile strength and hardness and by a decrease in solubility. Irradiation of Marlex high density polyethylene also increases resistance to environmental stress cracking.

TYPICAL PROPERTIES	TEMPERATURE, °F *(°C)*	BETA IRRADIATION DOSAGE (MEGARADS) 0	5	10	15	50
Tensile Strength, psi *(MPa)*	82 *(28)*	4110 *(28.3)*	4217 *(29.1)*	4293 *(30)*	4400 *(30.3)*	4560 *(31.4)*
	200 *(93)*	1303 *(8.98)*	1567 *(10.8)*	1640 *(11.3)*	1120 *(7.7)*	1477 *(10.8)*
	270 *(132)*	–	180 *(1.2)*	212 *(1.46)*	455 *(3.13)*	745 *(5.13)*
Elongation, %	82 *(28)*	20	18	22	20	20
	200 *(93)*	167	375	520	505	133
	270 *(132)*	–	510	445	385	110
Hardness, Shore D		64	67	67	68	70
Density, g/cm³		0.96	0.96	0.96	0.96	0.96
Solubility, Tetralin, 266°F *(130°C)*		Soluble	Insoluble	Insoluble	Insoluble	Insoluble
Color		White	White	Ivory	Ivory	Tan

TYPICAL PROPERTIES	TEMPERATURE, °F *(°C)*	GAMMA IRRADIATION DOSAGE (MEGARADS) 0	1	10	100
Tensile Strength, psi *(MPa)*	82 *(28)*	5840 *(40.2)**	7007 *(51.7)*	7120 *(49.1)*	8360 *(57.6)*
Elongation, %	82 *(28)*	13	15	15	1
Hardness, Shore D		64	68	70	70
Density, g/cm³		0.952	0.955	0.955	0.967
Solubility, Tetralin 266°F *(130°C)*		Soluble	Insoluble	Insoluble	Insoluble

*Measured by different laboratories.

Marlex
POLYETHYLENE

TABLE 9

Effect of Gamma and Beta Irradiation of Marlex HDPE on Environmental Stress Cracking in IGEPAL CO-630 at 122°F (50°C)

TYPE OF IRRADIATION DOSAGE, RADS	F_{50} VALUES, h GAMMA	BETA
None	20	20
1 x 10^6	20	-
3 x 10^6	24	-
6 x 10^6	110	40
1 x 10^7	700	350
3 x 10^7	350	350
1 x 10^8	1	-

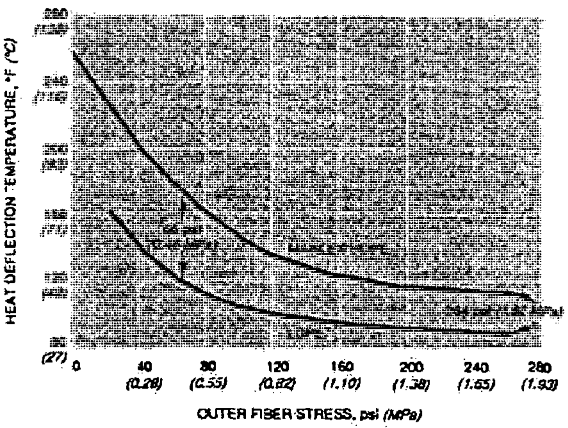
Heat Deflection Temperature (ASTM D648)

This test is primarily intended to determine the temperature at which an arbitrary deformation occurs when specimens are subjected to a specific fiber stress. It is used to indicate the behavior of plastic material at elevated temperatures in applications which are similar to the test procedure. Although this test is designed for more rigid materials such as polystyrene, unplasticized vinyl polymers and nylon, it is especially useful in comparing Marlex HDPE with other polyethylenes.

Injection molded bars 5 in. *(127 mm)* long, 0.5 in. *(12.7 mm)* wide and 0.25 in. *(6.4 mm)* thick are supported along the 0.25 in. edge between two points 4 in. *(100 mm)* apart. Weight is applied at the center of the span to impose a fiber stress of 66 psi *(0.46 MPa)*. The bars are immersed in silicone oil and the bath temperature increased at a rate of 3.6°F *(2°C)* per minute. The bath temperature at the instant the specimen deflects (bends) 0.010 in. *(0.254 mm)* is the heat deflection temperature. In a more stringent test which was originally designed for thermosetting resins, a heavier weight is used to impose a 264 psi *(1.8 MPa)* fiber stress. Therefore, care should be taken to designate the load involved when interpreting heat deflection data. Figure 6 compares the heat deflection temperature of a typical Marlex high density polyethylene with low density polyethylene at various loadings.

FIGURE 6

Effect of Loading on Heat Deflection Temperature

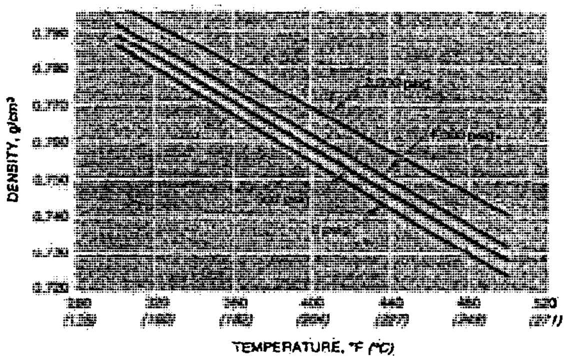


Melt Density

The density of molten Marlex HDPE differs from its density in the solid form. Unlike the solid density, which covers a broad range depending upon resin morphology, the density of all Marlex HDPEs in the melted state is about the same at a given temperature and pressure. The melt density may be useful in the design of extruders and other molding equipment.

FIGURE 7

Melt Density vs. Temperature at Indicated Pressures for Marlex HDPE



Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Thursday, October 09, 2003 1:52 PM
To: 'Price, Wayne'
Cc: Mitchel_lhgsf@hotmail.com
Subject: Loco Hills GSF

Wayne

HELP!

The dirt is flying down at Loco Hills as they construct the new brine pond. The attached letter provides my opinions regarding the hydrogeology of the site – as well as some opinions regarding the regulatory framework in which you could approve this plan. We can wait on creating the appropriate regulatory/permit vehicle – but we need your opinion on two things PRONTO:

1. If Loco Hills shows that the native clay at the site can be compacted to form an acceptable low-permeability barrier, would you permit such a constructed liner at this site without direct leak detection? Look at the hydrogeology; I think you will see that a clay liner provides more than adequate protection of human health and the environment. I would bet that they can create a clay liner with permeability much better than 1 x 10E-6 cm/sec.
2. The proposed plan for the pond sediment pile remedy also needs your attention. Given the nature of what lies beneath the site, I believe the proposed solution works fine.

Please contact me if you have any questions regarding the site and what I have put together here. Let's get a conference call if we need to. The heavy equipment to implement the soil pile remedy is going away soon. I have convinced Loco Hills GSF to try to stop the purchase of the liner until we hear from you regarding the clay liner. Again, they need an answer regarding the clay in order to save unnecessary costs (if you agree with the clay liner, that is).

We apologize that things are happening so fast – TAKE YOUR TIME (an hour or so) to read the letter and understand the hydrogeology. Tell us what we need to provide in order to help you make a decision on this. We do not think that expensive HYDRUS modeling is required for this dirt/salt pile. Nothing will make the underlying water worse than it is. The proposed plan can make the water IMPROVE!

Take a look and give me a call if you need to. Thanks a million.

Randy Hicks
505-266-5004 - office

505-238-9515 - cell

Price, Wayne

From: Katie Lee [katie@rthicksconsult.com]
Sent: Tuesday, December 16, 2003 2:25 PM
To: Wayne Price
Subject: Loco Hills Discharge Plan

Mr. Price:

Attached, please find the Discharge Plan & Plates we've been working on for Loco Hills. Relevant appendices will follow in subsequent e-mails.

Katie
R.T. Hicks Consultants, Ltd.

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

December 16, 2003

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

RE: Loco Hills GSF, Discharge Plan Modification;
NW SW Section 22 Township 17S Range 29E

Dear Wayne:

On behalf of Loco Hills GSF, Ltd., we are pleased to submit this amendment to the request for discharge plan application for the above-referenced facility (dated 7/22/03). In this discharge plan application, we address the conditions of approval listed in the NMOCD letter of April 12, 2000, we address issues raised in email correspondence between NMOCD and Loco Hills GSF, Ltd., and we include salient portions of our recent letters to NMOCD. The attached files place all of the various pieces of the discharge plan application in one electronic submission.

As stated in recent communications with your office, we believe that the unique hydrogeologic characteristics of the site and the proposed ground water extraction program will effectively prevent any expansion of the existing body of poor-quality water underlying the site. Unlike past operators of the facility, who may have caused the observed zone of poor-quality ground water, Loco Hills GSF is implementing a wide variety of environmental protocols that will result in an improvement of the land surface and ground water quality.

We stand ready to address any questions or comments of NMOCD. Please direct any communication to Mitchell Johnson of Loco Hills GSF with a copy to R@rthicksconsult.com. We look forward to NMOCD approval of this plan and implementation of the commitments presented herein.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T. Hicks

Randall Hicks
Principal

Copy: Mitchell Johnson, Loco Hills GSF

IV Name and Address of Landowner

The land is leased from the State of New Mexico.

Regional Office
State of New Mexico,
Commission of Public Land
Jim Carr
1004 Piasano
Carlsbad, NM 88220

Phone: 505.885.1323

Main Office
State of New Mexico,
Commission of Public Land
Joseph Lopez
310 Old Santa Fe Trail
PO Box 1148
Santa Fe, NM 87504

Phone: 505.827.4003

V Description of Types and Quantities of Fluids at the Facility

The table below outlines the fluid storage locations at the facility, their capacity, and the types of fluids kept. See Appendix A for a map showing the locations of these ponds and tanks.

Table 1: Surface Fluid Storage at Loco Hills GSF

Type of Storage	Maximum Capacity	Stored Liquid	Location
Pond #1	2 million gallons	10 lb. Brine	SE Corner of facility
Pond #2	7-11 million gallons	10 lb. Brine	Western portion of facility
Above ground storage steel tank #1	30,000 gallons	Propane or Butane	Tank Area
#2	30,000 gallons	Propane or Butane	Tank Area
#3	18,000 gallons	Propane or Butane	Tank Area
#4	18,000 gallons	Propane or Butane	Tank Area

VI Description of Fluid Management Facilities and Solid Disposal Facilities

Loco Hills GSF proposes to manage brine in two surface impoundments and three subsurface salt caverns that will also store liquid propane or butane. Currently, we move the brine from Pond #1 to the subsurface storage caverns to displace the product to the surface and permit loading of product to customers. During the spring and summer, when demand for propane and butane is low, we inject propane or butane to cavern storage, which results in brine production into the storage ponds.

After NMOCD approval of the mechanical integrity of each injection well/cavern, we plan to employ all three salt caverns for storage of propane and butane. As the table below shows, the total capacity for subsurface storage is 8.75 million gallons.

Table 2: Subsurface Fluid Storage at Loco Hills GSF

Cavern #1	2.75 MM gallons	Served by injection well 1
Cavern #2	3 MM gallons	Served by injection well 2
Cavern #3	3 MM gallons	Served by injection well 3

Because these caverns will never contain 100% product (0% brine), we propose to provide sufficient surface storage for less than 9 million gallons of brine (Table 1). Refer to the map in Appendix A for the locations of these caverns. We plan to manage our surface storage to permit the working brine level in Pond #2 to remain at or below the level of the adjacent natural ground surface (3,561 asl) throughout most of the year. Maintaining the fluid level in Pond #2 below the natural ground surface will allow us to preserve the structural integrity of the pond berm in the absence of a synthetic liner. In essence, the berm of Pond #2 will not be employed to hold brine on a routine basis but will divert storm water run-on. Maintaining the maximum working level of Pond #2 at 7 million gallons for most of the year creates a normal pond storage capacity of 9 million gallons (when both ponds are employed for storage). As described below, we plan to maintain Pond #1 below 20-30% of capacity for most of the year. In both ponds we will maintain a freeboard of 3 feet (vertical) so that no overtopping of brine occurs.

In the summer, brine levels in Pond #2 may rise above ground level. When this occurs, we propose to transfer fluid to Pond #1 where we store brine. When the brine level in Pond #2 falls more than 3-6 feet below ground level, as it may when sales of propane and butane call for injection of brine, we will transfer excess brine from Pond #1 to Pond #2.

We know that allowing the clay liner of Pond #2 to dry can cause desiccation cracks and thereby compromise the low permeability of the liner. We will attempt to minimize fluid level fluctuations in Pond #2. If inspection of the clay liner shows desiccation and possible loss of integrity, we will install a sprinkler or watering system slightly above the high water mark. When necessary, we will apply water to the clay to maintain the moisture content and the low permeability. Fortunately, low pond levels are expected during the winter when evaporation and solar gain is lowest. Loco Hills GSF will generally employ ground water for this sprinkling program.

We know the primary liner of Pond 1 is compromised and Loco Hills GSF routinely pumps fluid in the leak detection system back into Pond #1. Loco Hills GSF plans to employ the leak detection well to capture fluid released from the primary liner of Pond #1. After approval of this Discharge Permit, Loco Hills GSF will begin to employ Pond #2 as the primary method of fluid management, as described above. As soon as possible, Loco Hills GSF will empty Pond #1 and attempt to repair the primary liner. If the leak cannot be found and/or repaired, we anticipate that this pond will remain only partially full and any leakage from the primary liner may be captured. Loco Hills GSF may elect to abandon the use of this pond. Until the pond is repaired or abandoned, Loco Hills GSF will continue to monitor the leak detection monitor well for brine storage pond #1 weekly.

If we elect to abandon Pond #1, the brine level in Pond 2 could be higher than ground level at the end of summer, when propane and butane cavern storage is greatest. Loco Hills GSF will manage the brine level in the ponds through brine sales, thereby minimizing the time that the brine level in Pond 2 is higher than the adjacent ground surface.

Ground water extraction is a critical element of the discharge plan. As described in Section IX ground water extraction is the proposed remedy to address potential ground water impairment caused by the actions of past owners. Ground water extraction is also necessary to control the slow percolation of brine from the clay-lined Pond #2. As shown below, the measured permeability of the liner (See Appendix B) allows the 100 meter by 100 meter pond to release only 40 gallons per day. Loco Hills GSF will export sufficient brine through sales to control this seepage and to mitigate any impairment of ground water quality caused by the past actions of others.

Table 3: Clay Liner Seepage Calculations

Permeability		Pond Surface Area	Hydraulic Gradient	Seepage Rate	
cm/sec	m/day	m2	m/m	liters	gallons
1.72E-08	1.49E-05	10000	1	1.49E+02	40

This discharge plan application expects slow percolation of brine from the clay-lined pond into the subsurface and Section IX of this submission explains how Loco Hills GSF will protect water quality from this planned seepage.

As Table 1 shows, Loco Hills GSF manages propane and butane in the above ground storage tanks, pending sale or storage. All drums containing materials other than fresh water will be stored on an impermeable pad with curbing. All empty drums will be stored on their sides with the bungs in place and lined up on a horizontal plane. Chemicals in other containers such as sacks or buckets will also be stored on an impermeable pad with curbing. All process and maintenance areas that show evidence that leaks or spills are reaching the ground surface will be either paved and curbed or have some type of spill collection device incorporated into the design. All above ground storage tanks that contain fluids other than fresh water are bermed to contain a volume of one-third the total volume of the largest tank. All new or modifications to existing facilities will place tanks on an impermeable pad within a berm. All above ground saddle tanks will have impermeable pad and curb type containment unless they contain fresh water or fluids that are gases at atmospheric temperature and pressure. All tanks, drums, and other containers will be clearly labeled to identify their contents and other emergency information if the tank were to rupture, spill, or ignite. All systems designed for spill collection/prevention, and leak detection will be inspected weekly to ensure proper operation and to prevent overtopping or system failure. All spills and releases will be reported according to OCD Rule 116 and WQCC 1203 to the OCD Artesia District office.

Periodically, Loco Hills GSF creates solid waste. Wind-blown dust and sand enters surface storage ponds and must be removed to maintain the capacity of the ponds. On-site disposal of pond sediment poses no threat to ground water because the quality of the underlying ground water is so poor that seepage of any leachate caused by disposal would not cause a measurable impact. Nevertheless, Loco Hills GSF wishes to maintain the surface at its productive capacity and to eliminate any eyesore caused by stored pond sediment. We propose the following to address any sediment removed from ponds:

Compact the pond sediment in an area of the site that is already disturbed by past activities. Cover the sediment with 1-2 feet of loose caliche and/or available coarse-grained material. Cover the loose caliche with 3-5 feet of Dockum Group clay and grade the surface to blend with the landscape. Cover the clay with 1-3 feet of topsoil and seed with native grasses. We propose this same restoration protocol for eventual pond abandonment. We employed this restoration protocol for the pond sediment waste pile that was stored over the former unlined brine pond, which was retired in the 1980s.

The loose caliche will reduce any upward capillary rise of salt. The clay will act as a reservoir for soil moisture and enhance the ability of vegetation growth on the topsoil.

Any other solid waste material will be shipped to an appropriate commercial or municipal landfill. Loco Hills GSF will comply with all applicable solid waste regulations and NMOCD Rules regarding solid waste.

VII Description of Underground Facilities

Loco Hills GSF has completed a sonar examination of cavern number one (Propane Well 1) and the complete report is on file at the New Mexico Oil Conservation Division. A summary of the findings of this report is included in Appendix C. Caverns two and three are suspected to be slightly larger than one, and will undergo sonar inspection prior to discharge plan renewal in 2005.

The maximum operating injection and/or test pressure at each well head will not be such that the fracture pressure of the injection formation will not be exceeded. An annual open hole cavern pressure test equal to one and one-half times the normal operating pressure (not to exceed formation fracture pressure) or 300 psi, whichever is greater, for four hours. At least once every five years and during well work overs the cavern formation will be isolated from the casing/tubing annuals and the casing pressure tested at 300 psig for 30 minutes. All pressure tests will be conducted with the approval of and a witness from the OCD.

The basic engineering designs of the propane wells are outlined in Table 4 below. Brine water will be injected and withdrawn through the tubing and gas products and will be injected and withdrawn trough the casing/tubing annulus. Deviations may occur once a month for up to 24 hours due to maintenance.

Table 4. Propane Well Characteristics.

Well #	Depth of Casing (ft)	Total Depth of Tubing (ft)	Total Depth of Well (ft)	Casing Diameter (in)	Tubing Diameter (in)
1	525	619	640	5.5	2 7/8
2	507	624	unknown	5.5	2.875
3	500	617	unknown	5.5	2.875

VIII Contingency Plan for Spill Reporting and Clean-up

A SPCC plan and a SWPP plan will be completed within 120 days of Discharge Plan approval. Loco Hills GSF will adhere to all spill reporting requirements outlined in OCD Rules.

IX Hydrogeological Demonstration that Activities Will Not Adversely Impact Fresh Water

Site Hydrogeology

Plate 1 shows that the Loco Hills GSF lies adjacent to Bear Grass Draw, about 2 miles west of Loco Hills, New Mexico. Bear Grass Draw is mapped as an ephemeral drainage with "headwaters" about 4 miles north of the Loco Hills GSF. Bear Grass Draw drains to a closed basin about 9 miles south of the facility. Our field inspection found neither a developed channel for this drainage nor evidence of water flow within the recent past. We performed our inspection on October 8, 2003, during a 2-day precipitation event that caused flooding north of Artesia. We performed a second, more exhaustive inspection of Bear Grass Draw on November 3, 2003 and found no evidence of an active watercourse.

One windmill, now abandoned, lies within Bear Grass Draw north of the facility (see Plate 1). Adjacent to this abandoned windmill is a new water supply well with a submersible pump. A second windmill exists within the Draw about 4.5 miles south of the facility. Examination of the records at the Office of the State Engineer and our reconnaissance identified no water wells within several miles of the facility, except for the active well north of the facility and the four wells located on the facility.

Our observations and driller's logs show that alluvium within Bear Grass Draw is thin or non-existent. Although the driller's log of the on-site monitoring well describes the Dockum Group Red Beds as chiefly red clay, thin permeable units yield water to wells. At the site, the depth to water in the monitoring well is about 80 feet (Table 5). Comparison of the observed water levels in the wells and the lithology described by the driller suggest that confined ground water exists within a thin limestone unit at a depth of about 90 feet (see log for monitoring well in Appendix D).

The water level in supply well #2 is a little puzzling, especially in light of the water level in the nearby monitoring well. Presumably Pecos Valley Pump obtained the water level of 36 feet after pulling the pump and it would represent a static condition. The water level for Well 1 was obtained during periodic pumping and may not represent a static level. Perhaps the high water level in well #2 is a relict of past leakage from unlined storage ponds.

Table 5: Depth to Water in On-site and Nearby Wells

Water Supply Well 1, North of Highway	86.58 feet depth to water	Measured by Hicks, October 8, 2003
Water Supply Well 2, Adjacent to brine pond	36 feet depth to water	Measured by Pecos Valley Pump, Inc, 2002
Monitoring well, adjacent to brine	83 feet depth to water	Measured by Driller, May 2, 2003

pond		
Older supply well	Casing collapsed	

We did not attempt to determine the ground water flow direction because we cannot be certain that these wells with measured water levels draw ground water from the same hydrostratigraphic units. We assume that, in general, ground water in the Dockum Group in the area flows south – consistent with topography and dip.

Below the Dockum Group and the underlying Dewey Lake Redbeds is the Salado Formation. Near the site, oil well logs show that the top of the Salado Formation lies between 200 and 300 feet below land surface. Ground water with a total dissolved solids (TDS) concentration below 10,000 mg/L does not exist within or below the Salado Formation.

Ground water with a TDS below 10,000 mg/L does not exist beneath the facility. Appendix E presents chemical analyses of three wells at the facility. The TDS of water supply well #1 (north of Highway 83) is 67,950 mg/L. Because the total cations and anions approach 80,000 mg/L, we believe the TDS, which is probably calculated via conductance, is lower than the actual value. The chemistry of water well #2 and the monitoring wells are very similar. All water beneath the facility exceeds 10,000 mg/L TDS. North and south of the facility, at the wells described above, ground water quality meets WQCC standards and is acceptable for stock (see analyses in Appendix F).

The high TDS value for ground water beneath the facility is not surprising because a previous owner used an earthen pit to store brine for many years. Perhaps years of brine seepage into the Dockum Group sediments has created a localized zone of saline ground water. At this time, we do not know the extent of this saline ground water. We propose to install a down gradient monitoring well within Bear Grass Draw to define the down gradient limit of ground water that was probably impaired by past seepage and to help monitor the results of our proposed discharge permit. Plate 2 shows the proposed location of this monitoring well.

Proposed Seepage Capture and Ground Water Restoration Program

As outlined in Section VI, Loco Hills GSF plans to control the very small amount of seepage from the clay-lined impoundment and mitigate the impacts to ground water caused by past owners of the facilities through a ground water extraction program. Initially, Loco Hills GSF will extract a substantial volume of ground water to make brine in pond #1. The brine is required for injection into the caverns during this winter (2003-2004). In the spring and summer, when brine is produced from the caverns, Loco Hills will sell brine if necessary to maintain a ground water extraction program and to manage the brine levels in the storage ponds..

This withdrawal of ground water will cause overall ground water quality improvement. Although seepage control requires export of 1 barrel per day, we anticipate that Loco Hills GSF will be able to extract an minimum of 226,800 gallons/year (100 barrels/week) of brine from the facility for use at the Loco Hills GSF facility or in oil field drilling. The water rights for the facility limit the amount of ground water use to 3 acre-feet (978,000 gallons). This ground water withdrawal program will capture any seepage and remediate the seepage due to past activities over time. We propose to employ well #2 as the principal water withdrawal well because this well is located closest to the former unlined storage pit used by past owners of the facility. This well may be most effective in capturing past seepage. After well #1 begins to show a decrease in the TDS, we plan to limit use of Well #1 because its distance from the former unlined pond (the probably center of mass of subsurface brine) to prevent exacerbating off-site migration of any subsurface brine due to past pond seepage.

Monitoring and Reporting Program

Measuring the improvement of ground water quality caused by the proposed water exportation remedy is important. We propose a ground water monitoring program that consists of quarterly measurements of specific conductance and chloride from the three on-site wells and the off-site and the down gradient monitoring well. We propose to obtain non-pumping water levels from the two monitoring wells and Well #1 during these quarterly monitoring events. We also plan to obtain pumping and non-pumping water levels from Well #2 at this same time.

We will also monitor the volume of water pumped from each well and the volume of brine exported from the facility. Because the high TDS of ground water causes failure of flow meters, we plan to monitor the volume of pumped water by simply measuring the flow rate from each well every month then multiplying the flow rate by the amount of time each well was operating.

We will monitor the stage height in each impoundment on a weekly basis. We will monitor the volume of water pumped from the leak detection system in Pond #1.

We anticipate that, over time, Well #1 will begin to show a decrease in conductance and chloride. If the off-site monitoring well exhibits a TDS higher than the 2000 ppm background, we anticipate that the ground water pumping program will also cause water quality in this well to improve over time.

During the first year of operation under this discharge plan, Loco Hills GSF plans to collect ground water elevation data on a monthly basis, assemble monthly brine sales data, and provide reports to NMOCD semi-annually. After the first year of operation, we plan to submit reports annually.

Appendix G summarizes the required future submissions under this discharge plan.

X. Additional Submissions

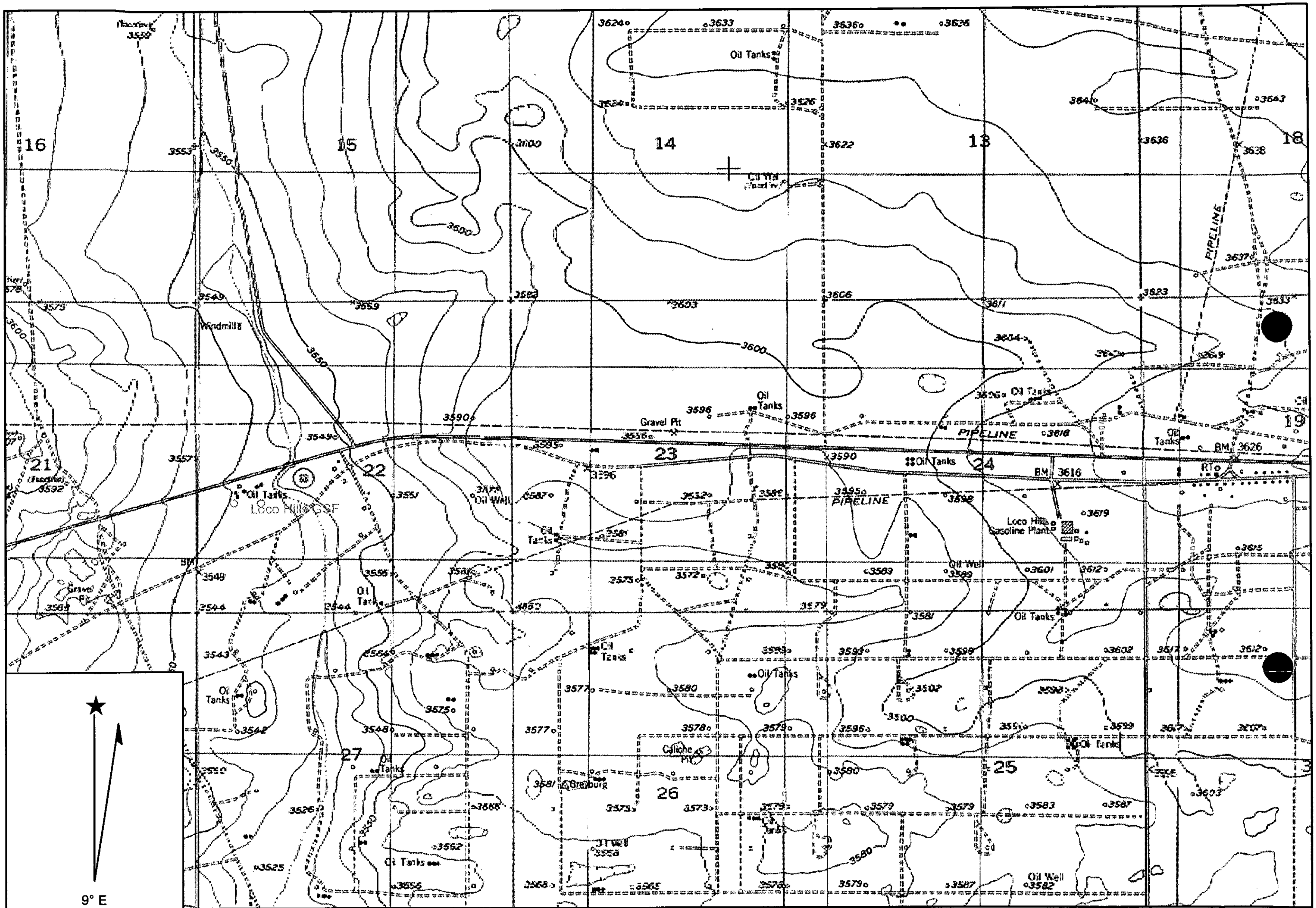
B. Plan for Fluid Containment for Brine Pump

Clay will be laid to catch and retain any possible leaks from the brine pump.

C. Documentation of Line Repair

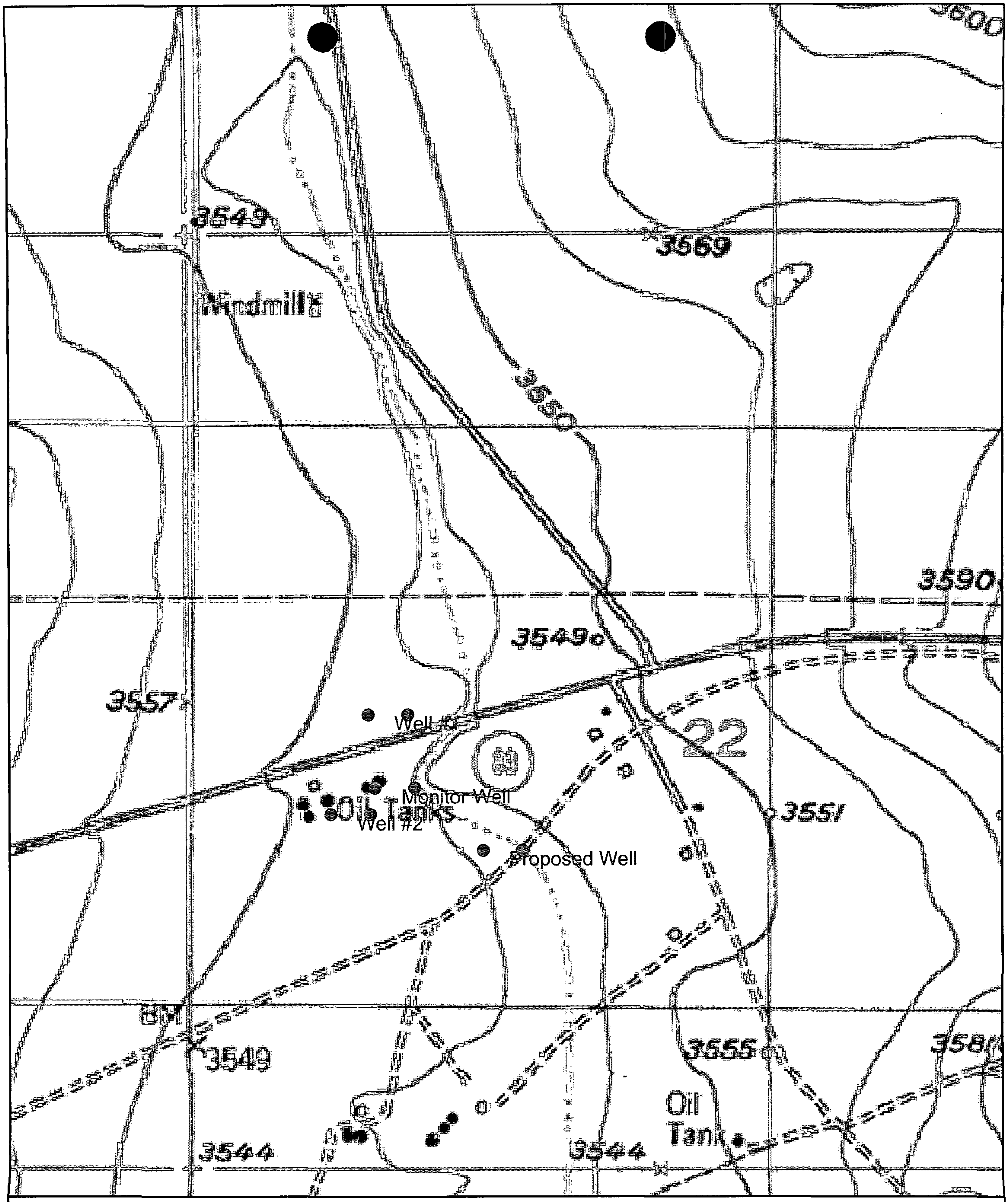
This will be submitted.

PLATES



Name: RED LAKE SE
Date: 10/7/2003
Scale: 1 inch equals 2000 feet

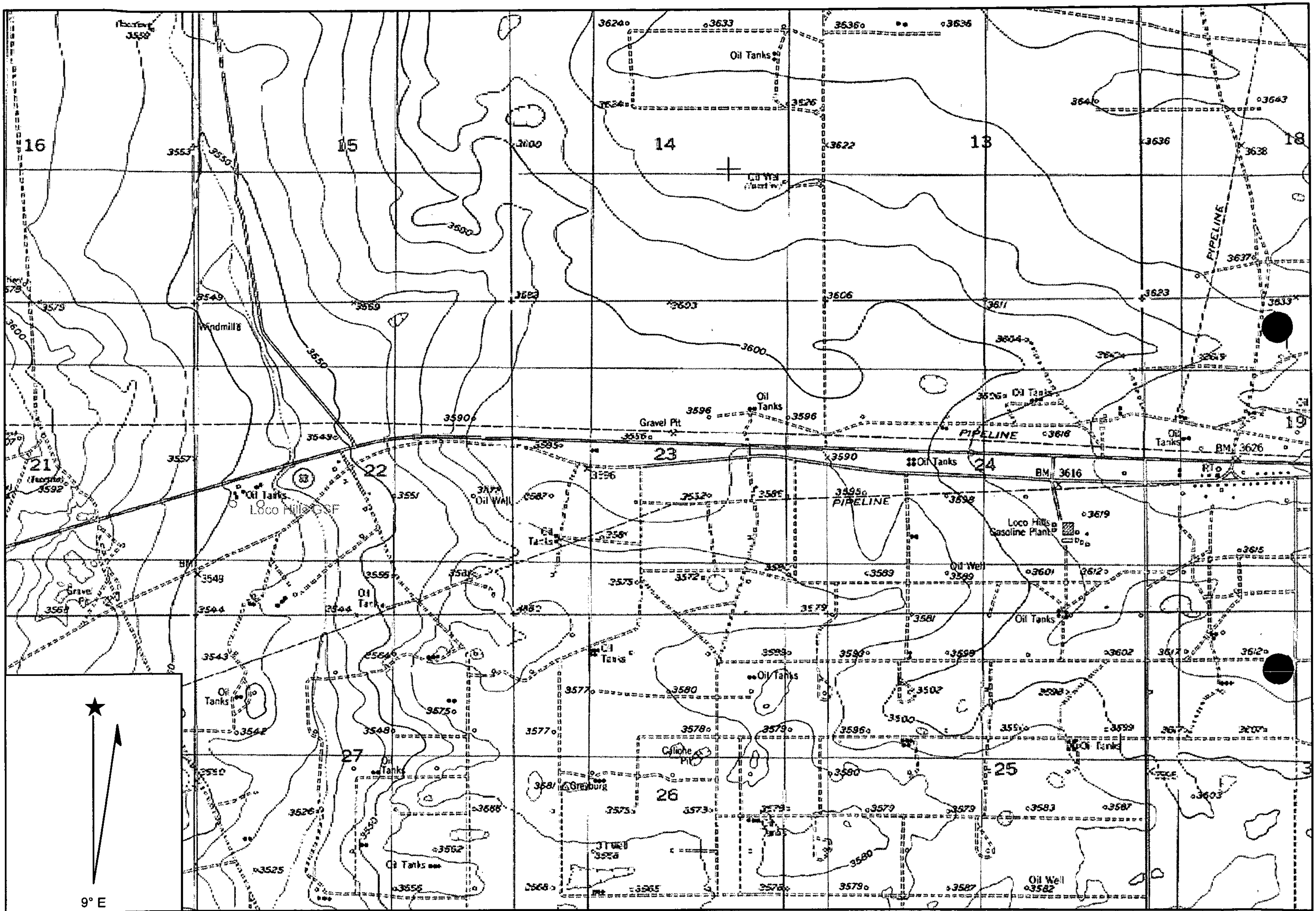
Location: 032° 49' 11.3" N 104° 02' 44.1" W
Caption: Plate 1: Location Map Loco Hills GSF



Name: RED LAKE SE
Date: 11/25/2003
Scale: 1 inch equals 666 feet

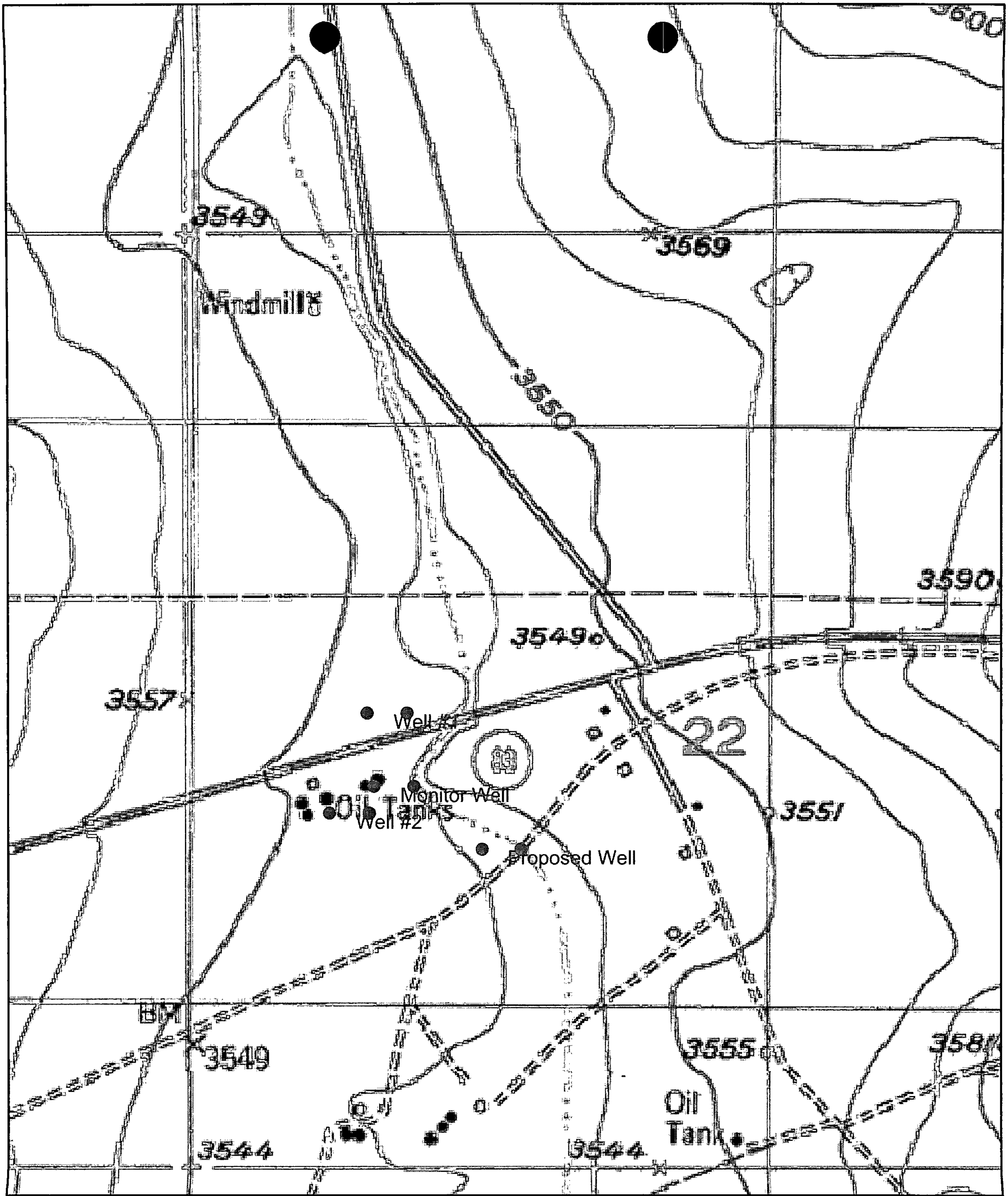
Location: 032° 49' 17.4" N 104° 03' 53.4" W
Caption: Plate 2: Location of Proposed Monitoring Well

PLATES



Name: RED LAKE SE
Date: 10/7/2003
Scale: 1 inch equals 2000 feet

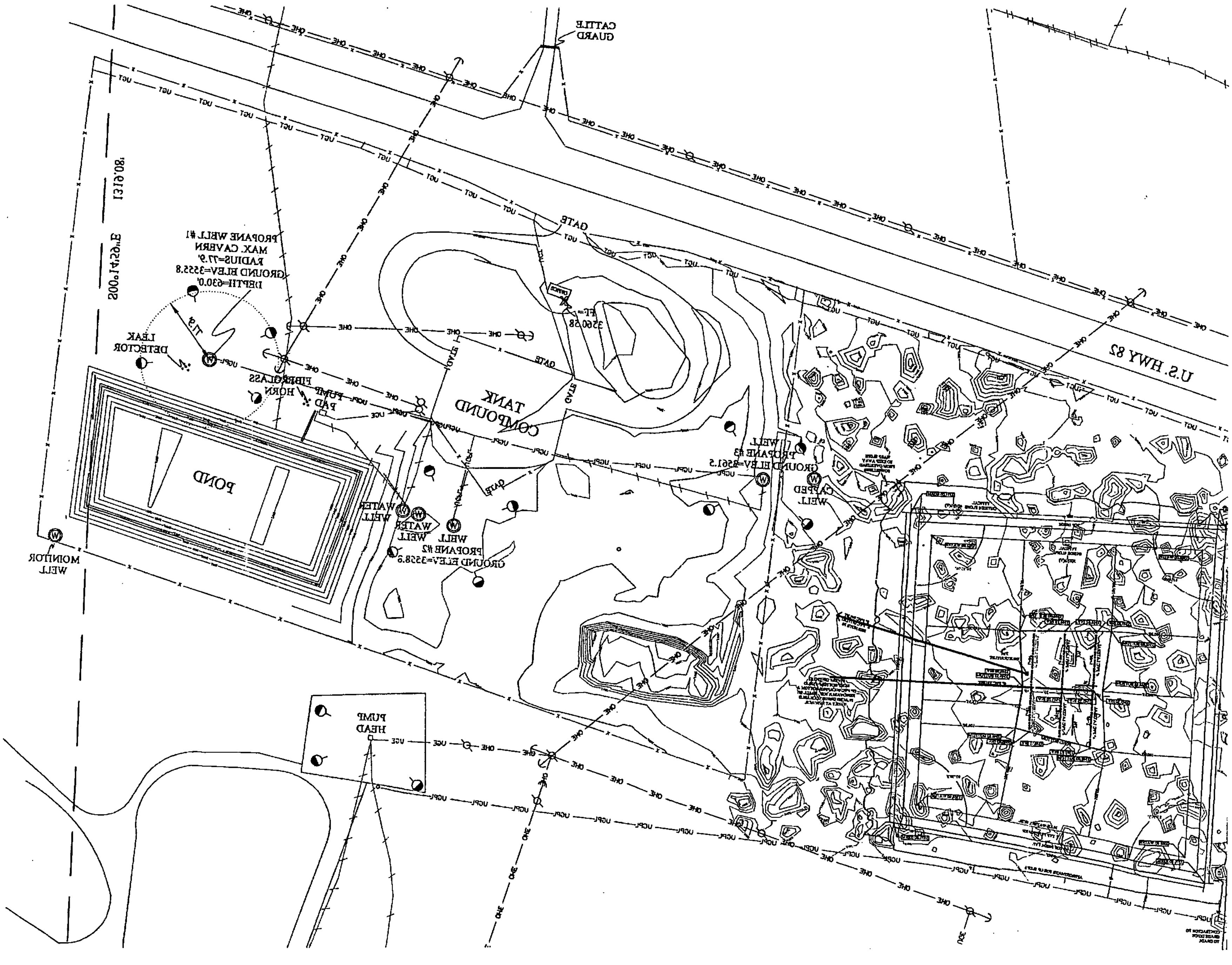
Location: 032° 49' 11.3" N 104° 02' 44.1" W
Caption: Plate 1: Location Map Loco Hills GSF



Name: RED LAKE SE
Date: 11/25/2003
Scale: 1 inch equals 666 feet

Location: 032° 49' 17.4" N 104° 03' 53.4" W
Caption: Plate 2: Location of Proposed Monitoring Well

APPENDIX A


CATTLE GUARD
U.S. HWY 82
GATE
TANK COMPOUND
PROPANE WELL #1
MAX. CAVERN
RADIUS=77.9'
GROUND ELEV=3555.8
DEPTH=630.0'
77.9'
LEAK DETECTOR
FIBERGLASS HORN
PUMP PAD
POND
WATER WELL
WATER WELL
WELL
PROPANE #2
GROUND ELEV=3558.6
WELL
PROPANE #3
GROUND ELEV=3561.5
CAPPED WELL
MONITOR WELL
PUMP HEAD
FF=3560.58
S00°14'55"E
1319.08'

APPENDIX B

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

PETTIGREW and ASSOCIATES
1110 N. GRIMES
HOBBS, NEW MEXICO 88240
(505) 393-9827

7 December, 2003

Loco Hills GSF, Ltd.
158 Deer Creek Dr.
Aledo, TX 76008

ATTN: Mr. Mitchel Johnson

RE: Construction Observations for Clay Lined Pond at Loco Hills GSF

Dear Mr. Johnson:

During construction of the above referenced pond, Pettigrew & Associates, P.A. was contracted to perform engineering services such as materials testing, site inspection, and consulting. The pond was constructed by Big D Construction out of Midland, Texas.

This firm observed good construction practices during all site visits. These construction practices directly relate to achieving good compaction, permeability, and durability of the clay liner. Lifts were kept to less than six (6) inches, the clay material was well processed, and therefore compacted easily.

The clay liner basically begins on the outside of the pond at existing ground level, extends over the berm, down the inner slope of the pond, across the bottom, back up the inner slope, over the berm and back to existing ground. Pettigrew & Associates was not on site until the berms were nearly completed, but we were able to test density on the top two feet of fill for most of the site. The bottom of the pond was scraped, scarified, and recompacted, and tested for compaction for a depth of two feet.

A total of thirty-nine (39) densities were taken on the clay liner. Densities were taken on the top of the berm, inner side slopes, and bottom of the pond. All densities inside pond were at least 95% of maximum density of an ASTM D698 standard proctor. One density on top of the berm was 93.4%, so the area was recompacted. All other densities were above 95% on the berm.

Based on the results of compaction and the good construction practices used by the contractor, the permeability of the clay material in the pond liner should approximate the permeability as tested in the laboratory. This liner should perform as required for brine water storage for both the short term as well as the long term.

Sincerely,

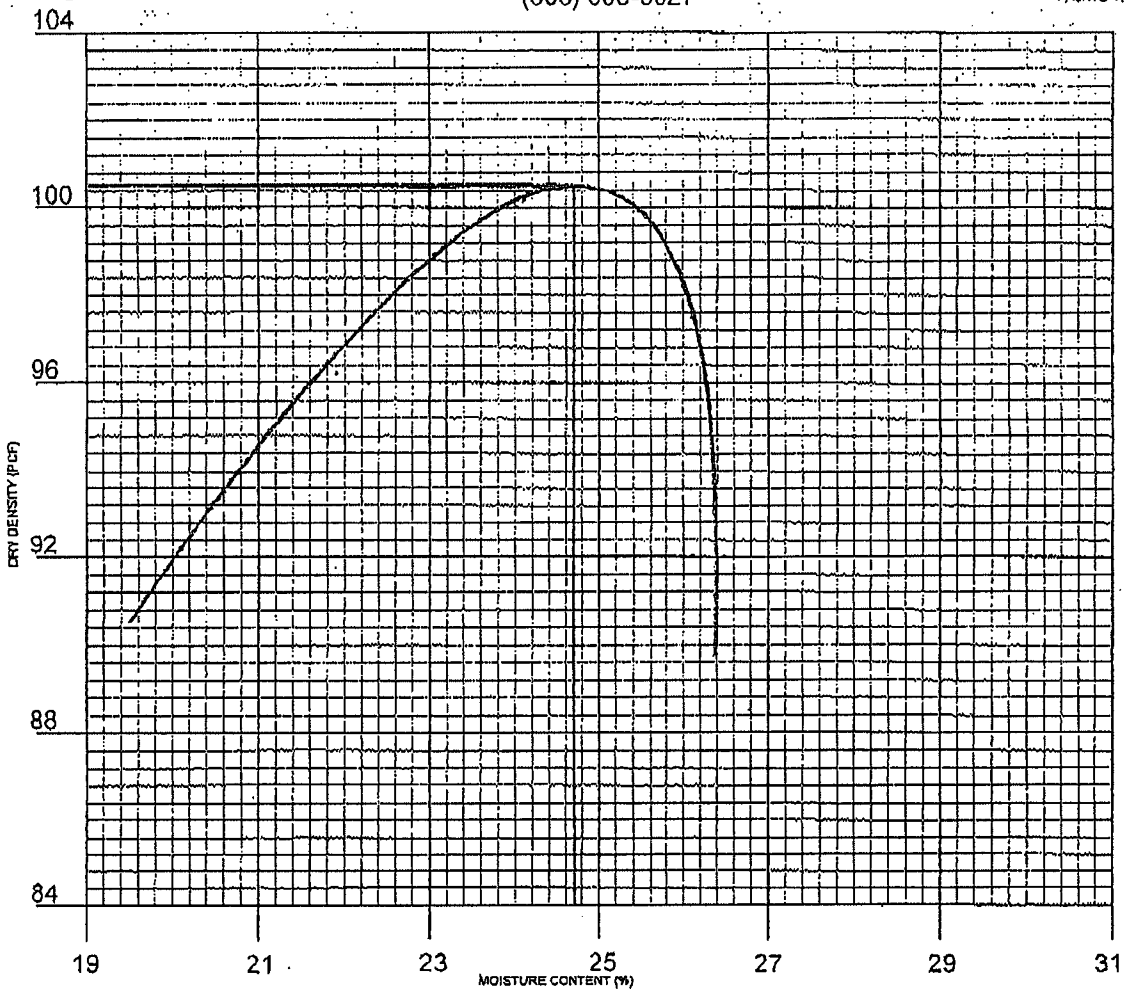
PETTIGREW & ASSOCIATES, P.A.

Jeremy Baker

Jeremy Baker, P.E.

JEREMY BAKER
NEW MEXICO
16207
12-7-03
LICENSED PROFESSIONAL ENGINEER

PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES ST.
HOBBS, NM 88240
(505) 393-9827



CLIENT: Loco Hills GSF PROJECT: Loco Hills Brine Pond

SAMPLE LOCATION: Pond

SOIL DESCRIPTION: Red Fat Clay with Sand

SOIL CLASSIFICATION: CH TEST METHOD: ASTM: D 698

ATTERBERG: LL 57 PI 40 Sampled & Delivered 10/20/03

DATE: 10/22/03 LAB NO. 03 6504-6508

DRY WEIGHT LB/CU. FT. 100.5 MOISTURE CONTENT % 24.7

SIEVE ANALYSIS - % PASSING						
#4	#10	#40	#80	#200		ASTM: D 5084-Permeability: 1.72E -08 95.8% Compaction - 24.2% Moisture
99	99	97	91	81.5		

PETTIGREW and ASSOCIATES

COPIES: Loco Hills GSF

BY: S.E.T.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

AASHTO R18
DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M HICKS, III, P.E./P.S.

To: Loco Hills GSF
Mitchel Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Material: Red Fat Clay with Sand

Test Method: ASTM: D 2922

Project: Loco Hills Brine Pond

Date of Test: October 20, 2003

Depth: Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-1	Top of N. Birm - 30' W. of the NE Corner	102.1	19.0	
SG-2	Top of N. Birm - 100' W. of the NE Corner	97.7	18.3	
SG-3	Top of N. Birm - 100' E. of the NW Corner	106.1	18.4	
SG-4	Top of N. Birm - 40' E. of the NW Corner	93.4	18.6	
SG-5	Top of E. Birm - 50' S. of the NE Corner	97.2	18.6	
SG-6	Top of E. Birm - 120' S. of the NE Corner	100.8	19.6	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6482-6487 & 6502-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: [signature] P.S.E.T.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

AASHTO R18
DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To: Loco Hills GSF
Mitchel Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Material: Red Fat Clay with Sand

Test Method: ASTM: D 2922

Project: Loco Hills Brine Pond

Date of Test: October 20, 2003

Depth: Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-13	S. Slope - 10' From Top Edge of Slope - 40' E. of the SW Corner	106.1	16.1	
SG-14	S. Slope - 22' From Top Edge of Slope - 90' E. of the SW Corner	102.9	16.7	
SG-15	S. Slope - 30' From Top Edge of Slope - 75' W. of the SE Corner	101.4	16.4	
SG-16	S. Slope - 35' From Top Edge of Slope - 30' W. of the SE Comer	104.3	17.0	
SG-17	Top of W. Birm - 50' N. of the SW Corner	105.1	16.1	
SG-18	Top of W. Birm - 125' N. of the SW Comer	106.2	17.2	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6494-6499 & 6502-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: S.E.T.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To:	Loco Hills GSF Mitchel Johnson 158 Deer Creek Drive Aledo, Texas 76008	Material:	Red Fat Clay with Sand
		Test Method:	ASTM: D 2922
Project:	Loco Hills Brine Pond		
Date of Test:	October 20, 2003	Depth:	Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-7	Top of E. Birm - 100' N. of the SE Corner	100.4	19.9	
SG-8	Top of E. Birm - 40' N. of the SE Corner	105.0	21.2	
SG-9	Top of S. Birm - 45' W. of the SE Corner	105.4	19.6	
SG-10	Top of S. Birm - 100' W. of the SE Corner	103.0	25.6	
SG-11	Top of S. Birm - 100' E. of the SW Corner	105.0	22.0	
SG-12	Top of S. Birm - 50' E. of the SW Corner	104.2	20.8	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6487-6493 & 6502-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES.

BY: [signature] SET.

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6499-6503

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: [signature] SET.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To:	Loco Hills GSF Mitchel Johnson 158 Deer Creek Drive Aledo, Texas 76008	Material:	Red Fat Clay with Sand
		Test Method:	ASTM: D 2922
Project:	Loco Hills Brine Pond		
Date of Test:	October 31, 2003	Depth:	Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-21	Bottom of Pond - 20' S. & 20' W. of the NE Corner	106.0	14.6	
SG-22	Bottom of Pond - 30' N. & 15' E. of the SW Corner	97.5	14.2	
SG-23	Pond Slope - 20' N of the SE Corner - 15' Above Bottom of Pond	106.0	14.2	
SG-24	Pond Slope - 50' E. of the NW Corner - 10' Above Bottom of Pond	102.9	16.3	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6613-6616 & 6620-6621

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: [signature] S.E.T.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To:	Loco Hills GSF Mitchel Johnson 158 Deer Creek Drive Aledo, Texas 76008	Material:	Red Fat Clay with Sand
		Test Method:	ASTM: D 2922
Project:	Loco Hills Brine Pond		
Date of Test:	October 31, 2003	Depth:	Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-25	Pond Slope - 30' S. of the NW Corner - 30' Above Bottom of Pond	101.9	16.8	
SG-26	Pond Slope - 50' W. of the SE Corner - 15' Above Bottom of Pond	108.0	16.9	
SG-27	N. Birm - 60' E. of the NW Corner	102.0	17.6	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

Lab No.: 03 6617-6621

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: [signature] E.I.T.

LABORATORY TEST REPORT
PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES
HOBBS, NM 88240
(505) 393-9827

DEBRA P. HICKS, P.E./L.S.I.
WILLIAM M. HICKS, III, P.E./P.S.

To: Loco Hills GSF
Mitchel Johnson
158 Deer Creek Drive
Aledo, Texas 76008

Material: Red Fat Clay with Sand

Test Method: ASTM: D 2922

Project: Loco Hills Brine Pond

Date of Test: November 6, 2003

Depth: 1' Below Finished Subgrade

Test No.	Location	Dry Density % Maximum	% Moisture	Depth
SG-28	Bottom of Pond - 7' W. & 35' N. of the SE Corner	102.1	15.6	
SG-29	Bottom of Pond - 100' N. & 50' W. of the SE Corner	96.3	18.8	
SG-30	Bottom of Pond - 25' S. & 40' W. of the NE Corner	103.2	21.2	

Control Density: 100.5
ASTM: D 698

Optimum Moisture: 24.7%

Required Compaction:

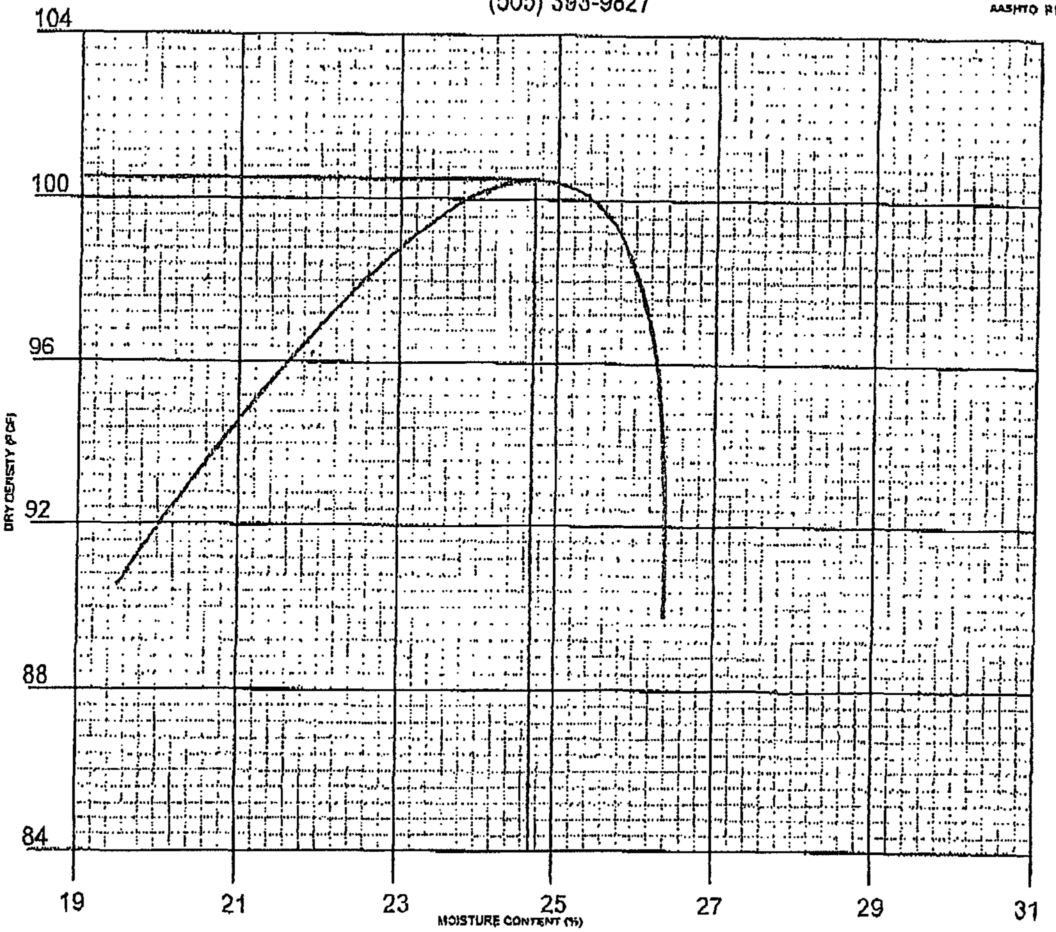
Lab No.: 03 6758-6760

Copies To: Loco Hills GSF

PETTIGREW and ASSOCIATES

BY: S.E.T

PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES ST.
HOBBS, NM 88240
(505) 393-9827



CLIENT: Loco Hills GSF PROJECT: Loco Hills Brine Pond

SAMPLE LOCATION: Pond

SOIL DESCRIPTION: Red Fat Clay with Sand

SOIL CLASSIFICATION: CH TEST METHOD: ASTM: D 698

ATTERBERG: LL 57 PI 40 Sampled & Delivered 10/20/03

DATE: 10/22/03 LAB NO. 03 6504-6508

DRY WEIGHT LB/CU. FT. 100.5 MOISTURE CONTENT % 24.7

SIEVE ANALYSIS - % PASSING						
#4	#10	#40	#80	#200		ASTM: D 5084-Permeability: 1.72E -08
99	99	97	91	81.5		95.8% Compaction - 24.2% Moisture

PETTIGREW and ASSOCIATES

COPIES: Loco Hills GSF

BY: S.E.T.

amec

PROJECT:	LOCO HILLS GSF PROJ# 2003.1016	JOB NO:	2-110-000075
LOCATION:	BRINE POND	WORK ORDER NO:	10
MATERIAL:	RED SANDY LEAN CLAY	LAB NO:	13
SAMPLE SOURCE:	BRINE POND	DATE SAMPLED:	10/23/03
SAMPLE PREP:	REMOLDED TO 95% MAX DRY DENSITY AND OPT. MOISTURE		
TARGET:	MAX DRY DENSITY D698A 100.5 pcf @ 24.7% OPT. MOISTURE		

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER (ASTM 5084-90) "CV" METHOD C

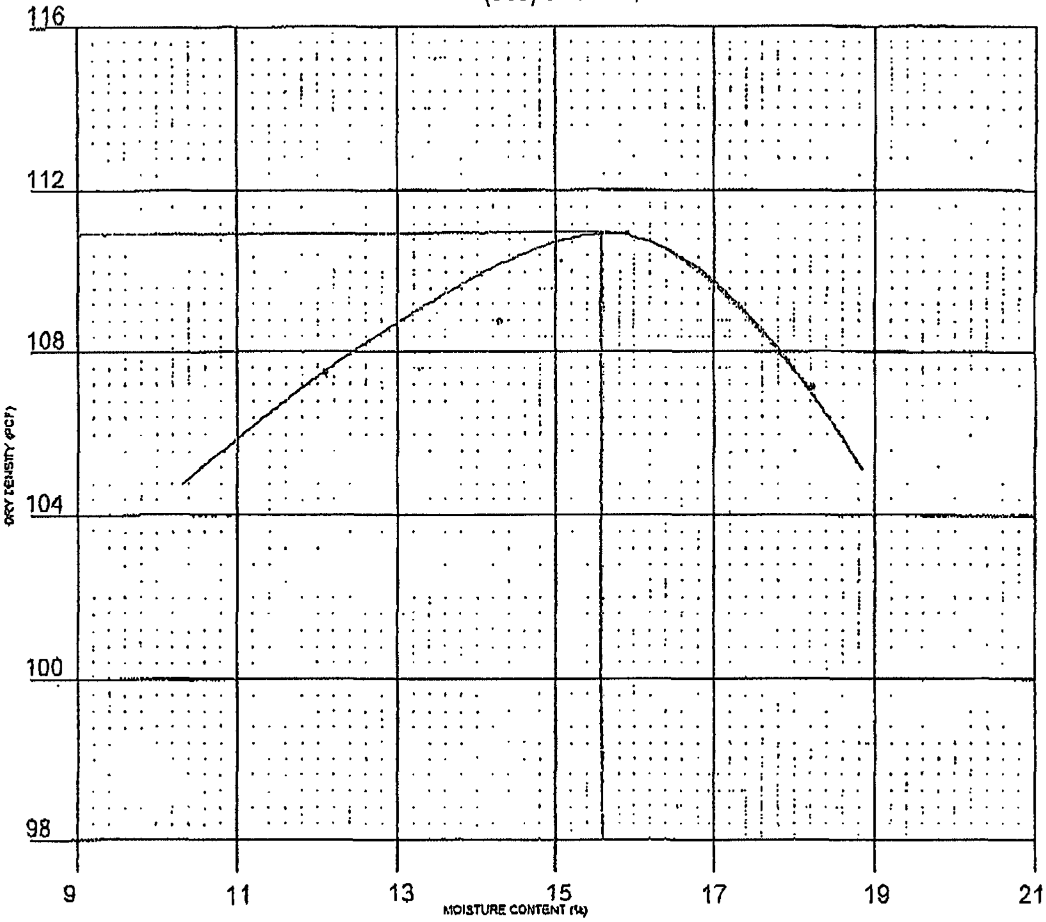
AVERAGE PERMEABILITY		1.72E-08 cm/sec	
INITIAL LENGTH OF SPECIMEN		7.15 cm	
INITIAL DIAMETER OF SPECIMEN		7.15 cm	
INITIAL WATER CONTENT		24.2 %	
INITIAL DRY UNIT WEIGHT		95.8 pcf	
INITIAL VOLUME		17.52 cu.in	
PERMEANT LIQUID		BOTTLED WATER	
MAGNITUDE OF TOTAL BACK PRESSURE		84.3 psi	
EFFECTIVE CONSOLIDATION STRESS		5 psi	
RANGE OF HYDRAULIC GRADIENT USED	14.4	to	12.2
FINAL LENGTH OF SPECIMEN		7.26 cm	
FINAL DIAMETER OF SPECIMEN		7.24 cm	
FINAL WATER CONTENT		29.5 %	
FINAL DRY UNIT WEIGHT		92.0 pcf	
FINAL VOLUME		18.24 cu.in	
DEGREE OF SATURATION (BEFORE AND AFTER TEST)	88%	and	98%
SPECIFIC GRAVITY USED IN CALCULATIONS OF SATURATION		2.651	

TIME INTERVAL sec	K cm/sec	K ft/yr.
1495	1.97E-08	0.02
1944	1.46E-08	0.02
2345	1.63E-08	0.02
2716	1.82E-08	0.02

03-650

REVIEWED BY [signature]

PETTIGREW and ASSOCIATES, P.A.
1110 N. GRIMES ST,
HOBBS, NM 88240
(505) 393-9827



CLIENT: Big D Construction PROJECT: Loco Hills GSF Inc. Brine Water Pond

SAMPLE LOCATION: Bottom of Pond

SOIL DESCRIPTION: Reddish Tan Caliche

SOIL CLASSIFICATION: ______ TEST METHOD: ASTM: D 698

ATTERBERG: LL ____ PI ____ Delivered 10/9/03

DATE: 10/10/03 LAB NO. 03 6272

DRY WEIGHT LB/CU. FT. 111.0 MOISTURE CONTENT % 15.6

SIEVE ANALYSIS - % PASSING									

PETTIGREW and ASSOCIATES

COPIES: Big D Construction

BY: S.E.T.

APPENDIX C

ECHO - LOG

Propane Well #1

1st. Survey

04/21/2003 033020

SOCON Cavity Control, Inc.
4070 Washington Blvd. Texas 77705, USA
Phone (409) 840-5554+5557 Fax (409) 840-4424
e-mail: lawrence@socon.com

Summary of results

Well details

All depths are given as:	**MD**
Datum level for all depths:	**surface**
Shoe of the cemented 13 3/8"-casing:	525.0 ft
Shoe of the - casing during the surveying:	525.0 ft
Reference depth for ECHO-LOG:	**525.0 ft**
Depth correction:	+12.0 ft

Details of survey equipment

Measuring vehicle used:	L 110
Tools used:	Echo tool BSE 17, BSE 17 Fibre-gyro-compass

General details

Number of runs:	1
Measured horizontal sections:	19
Measured tilted sections:	20
Lowest survey depth:	643.0 ft

Maximum and minimum dimensions with ref. to the measuring axis

Reference direction: **magnetic north**

Determination out of 36 vertical sections derived from horizontally and tilted measured data at 5 degree intervals:

minimum radius:	0.0 ft
depth:	650.1 ft
direction:	0°
maximum radius:	77.9 ft
depth:	630.0 ft
direction:	60°
highest point of cavern:	522.2 ft
horizontal distance:	8.1 ft
direction:	345°
lowest point of cavern:	651.4 ft
horizontal distance:	5.4 ft
direction:	75°
lowest point in the measuring axis:	650.2 ft

Determination out of 37 horizontal sections in the depths between 192.3 m and 259 m at 5/15 degree intervals:

maximum radius:	77.9 ft
depth:	630.0 ft
direction:	60°
maximum diameter:	138.2 ft
depth:	625.0 ft
direction:	85 - 265°

Volume

volume:	65,456 bbls.
depth range:	525.0 ft <--> 650.0 ft

Interpretation

Supposing a rectilinear propagation of ultrasonic waves all recorded echo travel times were converted into distances by using the subsequent speeds of sound:

1798.0 m/s (5899.0 ft/s) to 1798.0 m/s (5899.0 ft/s) in brine (measured)

In the case of recording several echoes along one trace of echo signals, the representative echo signal was selected according to the level of amplitude, transmission time, density of measured points and the shape of the cavern.

Horizontal sections

19 horizontal sections at following measured depths are included as graphical plots in this report:

525.0 ft	530.0 ft	540.0 ft	550.0 ft	560.0 ft	570.0 ft	580.0 ft
590.0 ft	595.0 ft	600.0 ft	605.0 ft	610.0 ft	615.0 ft	620.0 ft
625.0 ft	630.0 ft	635.0 ft	640.0 ft	643.0 ft		

The following 4 sections are constructed:

644.0 ft	646.0 ft	648.0 ft	650.0 ft

Tilted sections

20 sections recorded with tilted echo-transducer at following measured depths are presented in the vertical sections:

12 sections of these with upwards-tilted echo-transducer:

Depth / Tilting Angle

540.0 / 54	540.0 / 60	540.0 / 66	540.0 / 72	540.0 / 78	540.0 / 84
640.0 / 9	640.0 / 12	640.0 / 15	640.0 / 17	640.0 / 21	640.0 / 24

8 sections of these with downwards-tilted echo-transducer:

Depth / Tilting Angle

600.0 / 6	600.0 / 12	600.0 / 18	600.0 / 24	600.0 / 30	600.0 / 36
600.0 / 42	600.0 / 48				

Vertical sections

The shape of the cavern was determined by interpretation of all horizontally and tilted measured data and is presented by 36 vertical sections in this report.

Maximum plots (top view)

The maximum plot presents the largest extension of the cavern in a top view. The first picture shows the areas of all horizontal sections and the area resulting out of the vertical sections (hatched). The resulting total area is shown in the second picture (cross hatching) together with the largest single area.

In both pictures the total centre of gravity of the cavern is shown with its distance and its direction referring to the measuring axis.
The total centre of gravity is derived out of the envelope, which is the connection line of the largest cavern extension in every direction

Perspective views

Several perspective drawings are included in this report to give a quick review of detailed relations.

Pockets in the cavern wall

Pockets in the cavern wall, which have been identified by the tilted echo-transducer, were transferred from the vertical sections to the respective horizontal sections.
The resulting additional areas have been added to the calculated areas.

LOG - Data

You will find the graphic representations of the following LOG data at the end of this report:

Parameter	from	to
CCL:	589'	498'
Temperature:	500'	640'
Pressure:	500'	640'
Speed of sound:	500'	640'

Volume list

Depth (ft)	Radius (ft)	Area (ft²)	Depth range (ft) from	to	Volume (bbls.) partial	total
525.0	16.1	813	525.0	527.5	362	362
530.0	15.3	733	527.5	535.0	979	1340
540.0	14.2	630	535.0	545.0	1122	2462
550.0	15.6	767	545.0	555.0	1366	3828
560.0	16.6	865	555.0	565.0	1540	5368
570.0	20.1	1269	565.0	575.0	2260	7628
580.0	20.7	1343	575.0	585.0	2392	10021
590.0	23.7	1765	585.0	592.5	2357	12378
595.0	26.0	2125	592.5	597.5	1892	14270
600.0	30.4	2906	597.5	602.5	2588	16858
605.0	31.0	3023	602.5	607.5	2692	19549
610.0	29.7	2778	607.5	612.5	2474	22023
615.0	36.3	4147	612.5	617.5	3693	25717
620.0	41.7	5451	617.5	622.5	4854	30571
625.0	68.0	14511	622.5	627.5	12922	43493
630.0	61.9	12028	627.5	632.5	10711	54204
635.0	51.1	8196	632.5	637.5	7299	61502
640.0	35.1	3868	637.5	641.5	2756	64258
643.0	24.8	1929	641.5	643.5	687	64945
644.0	18.4	1060	643.5	645.0	283	65228
646.0	11.4	409	645.0	647.0	146	65374
648.0	7.8	190	647.0	649.0	68	65442
650.0	5.0	78	649.0	650.0	14	65456

APPENDIX D

Loco Hills G55

Drill Rate 5-1-03

0-2 2 Sand: Rd, Ambr, VFN GRN
4 - ← Gravel, Sand, Clay, (Gravel 1/8"-1/4")
6 -
8 -
10 -
2 1
4 1 ← Clay: Rd, VRY SNDY Water →
6 1
8 -
20 -
2 -
4 1
6 -
8 -
30 - Clay: AA, Sme FN Gravel
2 1
4 1
6 1-
8 2
40 2
2 2-
4 1
6 1
8 1
50 1
2 1
4 1
6 1-
8 1-
60 1
2 1-
4 1-
6 2
8 2- ← 67' Conglomerate: Gry, Dkgry, Mott, Lmy
70 2-
2 2
4 2
6 2- ← Clay: Rd, SLty
8 1-
80 1-

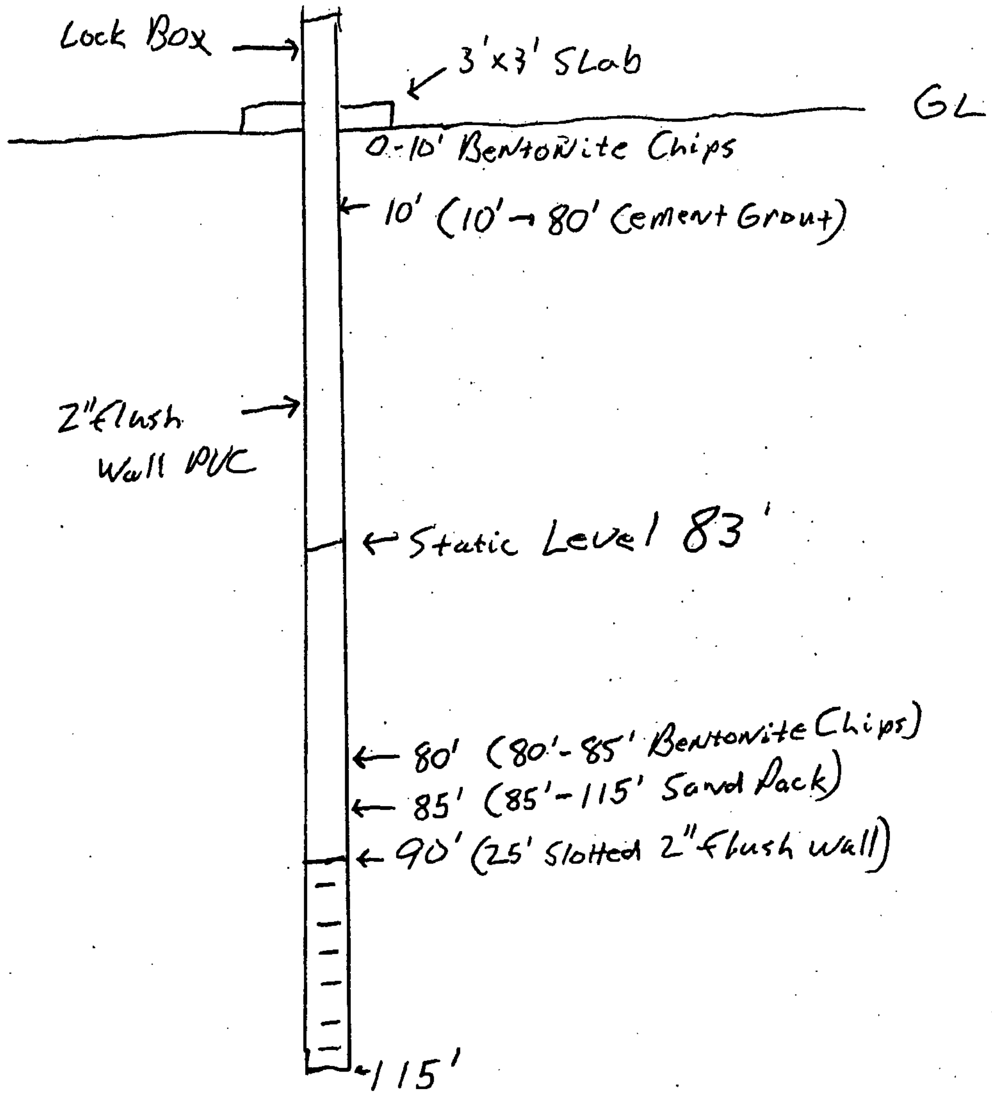
80-2 1
4 1-
6 1-
8 3 ← Rd Clay: Vry Stky
90 3
2 4 ← 5/2/03 Lost Some Fluid in Pit; Limestone: Off WHT-Lt GRY, VFN-Micxn, Sme Chlky, Sme Fractured
4 14
6 8
8 12
100 27
2 19
4 10
6 12
8 13
110 8 ← 109' Change to clay
2 20 ← Clay; BLu Gry, Smth
4 13
6 12 Clay: Rd, SLty-Smth
8
120

Hole Size: 6"

Casing Size 2"

5/5/03

Loco Hills GSF



Static Level 83'

APPENDIX E

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 05/28/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Na (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Conductivity (uS/cm)	T-Alkalinity ($mgCaCO_3/L$)
ANALYSIS DATE:		05/06/03	05/27/03	05/27/03	05/27/03	05/27/03	05/27/03
H7683-1	WATER WELL #1	27648	1074	994	151	99987	92
H7683-2	WATER WELL #2	24982	1785	685	104	100531	166
Quality Control		NR	56	59	5.17	1322	NR
True Value QC		NR	50	50	5.00	1413	NR
% Recovery		NR	112	118	103	93.6	NR
Relative Percent Difference		NR	0	0	1.0	0.7	NR
METHODS:			SM3500-Ca-D	3500-Mg E	8049	120.1	310.1

LAB NUMBER	SAMPLE ID	Cl^- (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	pH (s.u.)	TDS (mg/L)
ANALYSIS DATE:		05/27/03	05/27/03	05/27/03	05/27/03	05/27/03	05/28/03
H7683-1	WATER WELL #1	45986	2123	0	112	7.04	67950
H7683-2	WATER WELL #2	42987	971	0	202	7.00	69220
Quality Control		1050	53.65	NR	996	7.01	NR
True Value QC		1000	50.00	NR	1000	7.00	NR
% Recovery		105	107	NR	99.6	100	NR
Relative Percent Difference		0	1.5	NR	0	2.1	12.1
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1	160.1

67,950
69,220

Amy Hill
Chemist

5/28/03
Date

H7683C

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 05/27/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Br^- (mg/L)	F^- (mg/L)	NO_3/NO_2 (mg/L)	PO_4 (mg/L)
ANALYSIS DATE		05/27/03	05/27/03	05/23/03	05/27/03
H7683-1	WATER WELL #1	4.39	2.36	2.35	0.20
H7683-2	WATER WELL #2	3.88	2.52	1.92	0.05
Quality Control		3.00	1.27	2.98	0.51
True Value QC		3.00	1.00	3.00	0.50
% Recovery		100	127	99.2	101
Relative Percent Difference		5.7	3.2	2.0	0

METHODS: Std. Methods	$4500\text{-}Br^-B$	$4500\text{-}F^-D$	353.3*	4500-P E

EPA 600/4-79-020

Amy Hill
Chemist

5/27/03
Date

H7683a

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 06/02/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

TOTAL METALS

LAB NUMBER	SAMPLE ID	Al (ppm)	Co (ppm)	Cu (ppm)	Fe (ppm)
ANALYSIS DATE:		05/29/03	05/29/03	05/29/03	05/29/03
H7683-1	WATER WELL #1	<1	0.312	<0.5	3.922
H7683-2	WATER WELL #2	<1	0.345	<0.5	2.057
Quality Control		5.003	0.998	5.108	5.031
True Value QC		5.000	1.000	5.000	5.000
% Recovery		100	99.8	102	101
Relative Percent Difference		1.6	1.2	0.3	2.0
METHODS: EPA 600/04-79-020		202.1	219.1	220.1	236.1

		Mn (ppm)	Mo (ppm)	Ni (ppm)	Zn (ppm)
ANALYSIS DATE:		05/29/03	05/29/03	05/29/03	05/29/03
H7683-1	WATER WELL #1	<0.01	<1	0.224	<0.5
H7683-2	WATER WELL #2	0.416	<1	0.319	<0.5
Quality Control		0.914	3.001	5.144	0.497
True Value QC		1.000	3.000	5.000	0.500
% Recovery		91.4	100.0	103.0	99.4
Relative Percent Difference		2.3	0.6	0.2	0.7
METHODS: EPA 600/04-79-020		243.1	246.1	249.1	289.1

Amy Hill
Chemist

6/2/03
Date

H7683m2

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 06/02/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

RCRA METALS

LAB NUMBER	SAMPLE ID	As ppm	Ag ppm	Ba ppm	Cd ppm	Cr ppm	Pb ppm	Hg ppm	Se ppm
ANALYSIS DATE:		05/29/03	05/29/03	05/29/03	05/29/03	05/29/03	05/29/03	06/02/03	05/30/03
H7683-1	WATER WELL 1	<0.05	0.32	<0.5	<0.01	0.063	1.011	<0.002	<0.01
H7683-2	WATER WELL 2	<0.05	0.162	<0.5	<0.01	0.073	0.988	<0.002	<0.01
Quality Control		0.053	4.916	24.44	0.972	4.880	5.164	0.00980	0.051
True Value QC		0.050	5.000	25.00	1.000	5.000	5.000	0.01000	0.050
% Recovery		106.0	98.3	97.8	97.2	97.6	103	98.0	102
Relative Percent Difference		1.4	1.0	1.5	1.3	0.3	5.6	2.0	3.2
METHODS: EPA 600/4-79-020		206.2	272.1	208.1	213.1	218.1	239.1	245.1	270.2

Amy Hill
Chemist

6/2/03
Date

H7683m

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/07/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Na (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Conductivity (uS/cm)	T-Alkalinity ($mgCaCO_3/L$)
ANALYSIS DATE:		05/06/03	05/06/03	05/06/03	05/06/03	05/06/03	05/06/03
H7634-1	MONITOR WELL	43525	3069	1142	193	145615	140
Quality Control		NR	43	55	5.22	1322	NR
True Value QC		NR	50	50	5.00	1413	NR
% Recovery		NR	86	110	104	93.6	NR
Relative Percent Difference		NR	0	0	2.6	0.7	NR
METHODS:			SM3500-Ca-D	3500-Mg E	8049	120.1	310.1

LAB NUMBER	SAMPLE ID	Cl^- (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	pH (s.u.)	TDS (mg/L)
ANALYSIS DATE:		05/06/03	05/06/03	05/06/03	05/06/03	05/06/03	05/06/03
H7634-1	MONITOR WELL	74977	1438	0	171	7.24	118200
Quality Control		1050	54.39	NR	1068	6.95	NR
True Value QC		1000	50.00	NR	1000	7.00	NR
% Recovery		105	109	NR	107	99.3	NR
Relative Percent Difference		2.0	0.7	NR	7.7	0.6	12.1
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1	160.1

Amy Hill
Chemist

5/7/03
Date

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/06/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Br^- (mg/L)	F^- (mg/L)	NO_3/NO_2 (mg/L)	PO_4 (mg/L)
ANALYSIS DATE		05/06/03	05/06/03	05/06/03	05/06/03
H7634-1	MONITOR WELL	12.2	1.14	5.51	0.34
Quality Control		2.83	0.95	2.98	0.51
True Value QC		3.00	1.00	3.00	0.50
% Recovery		94.5	95.0	99.2	101
Relative Percent Difference		1.0	3.0	2.0	0
METHODS: Std. Methods		4500-Br^-B	4500-F^-D	353.3*	4500-P E

EPA 600/4-79-020

Amy Hill
Chemist

5/6/03
Date

H7634a

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/15/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

RCRA METALS

LAB NUMBER	SAMPLE ID	As ppm	Ag ppm	Ba ppm	Cd ppm	Cr ppm	Pb ppm	Hg ppm	Se ppm
ANALYSIS DATE:		05/13/03	05/13/03	05/08/03	05/13/03	05/13/03	05/13/03	05/13/03	05/08/03
H7634-1	MONITOR WELL	<0.08	<0.04	<0.5	<0.005	<0.04	<0.04	<0.001	<0.05
Quality Control		0.950	0.470	0.950	0.475	0.480	0.475	0.00104	0.051
True Value QC		1.000	0.500	1.000	0.500	0.500	0.500	0.00100	0.050
% Recovery		95.0	94.0	95.0	95.0	96.0	95.0	104	102
Relative Percent Difference		2.1	1.7	0.4	0	1.1	0	9.0	3.2
METHODS: EPA 600/4-79-020*		200.7	200.7	200.7	200.7	200.7	200.7	245.1*	270.2*

Amy Hill
Chemist

5/15/03
Date

H7634m

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/15/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

TOTAL METALS

LAB NUMBER	SAMPLE ID	Al (ppm)	Co (ppm)	Cu (ppm)	Fe (ppm)
ANALYSIS DATE:		05/13/03	05/13/03	05/08/03	05/08/03
H7634-1	MONITOR WELL	<0.2	<0.04	<0.5	<1
Quality Control		0.960	0.970	5.110	5.223
True Value QC		1.000	1.000	5.000	5.000
% Recovery		96.0	97.0	102	104
Relative Percent Difference		0.4	0	0.4	0.4
METHODS: EPA 600/04-79-020		200.7	200.7	220.1	236.1

LAB NUMBER	SAMPLE ID	Mn (ppm)	Mo (ppm)	Ni (ppm)	Zn (ppm)
ANALYSIS DATE:		05/13/03	05/13/03	05/13/03	05/08/03
H7634-1	MONITOR WELL	0.33	<0.1	<0.04	2.45
Quality Control		0.475	0.485	0.480	0.499
True Value QC		0.500	0.500	0.500	0.500
% Recovery		95.0	97.0	96.0	99.8
Relative Percent Difference		0.2	0.8	0.4	0.8
METHODS: EPA 600/04-79-020		200.7	200.7	200.7	289.1

Amy Hill
Chemist

5/15/03
Date

H7634m2

APPENDIX F

CARDINAL LABORATORIES

PHONE (325) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: MITCHEL JOHNSON
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 10/17/03
Reporting Date: 10/20/03
Project Number: NOT GIVEN
Project Name: NOT GIVEN
Project Location: NOT GIVEN

Sampling Date: 10/17/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: GP
Analyzed By: AH

LAB NUMBER	SAMPLE ID	TDS (mg/L)	Cl (mg/L)
ANALYSIS DATE:		10/20/03	10/20/03
H8096-1	NORTH WINDMILL	2411	88
H8096-2	WINDMILL 210	2471	104
Quality Control		NR	960
True Value QC		NR	1000
% Recovery		NR	96.0
Relative Percent Difference		12.1	8.3

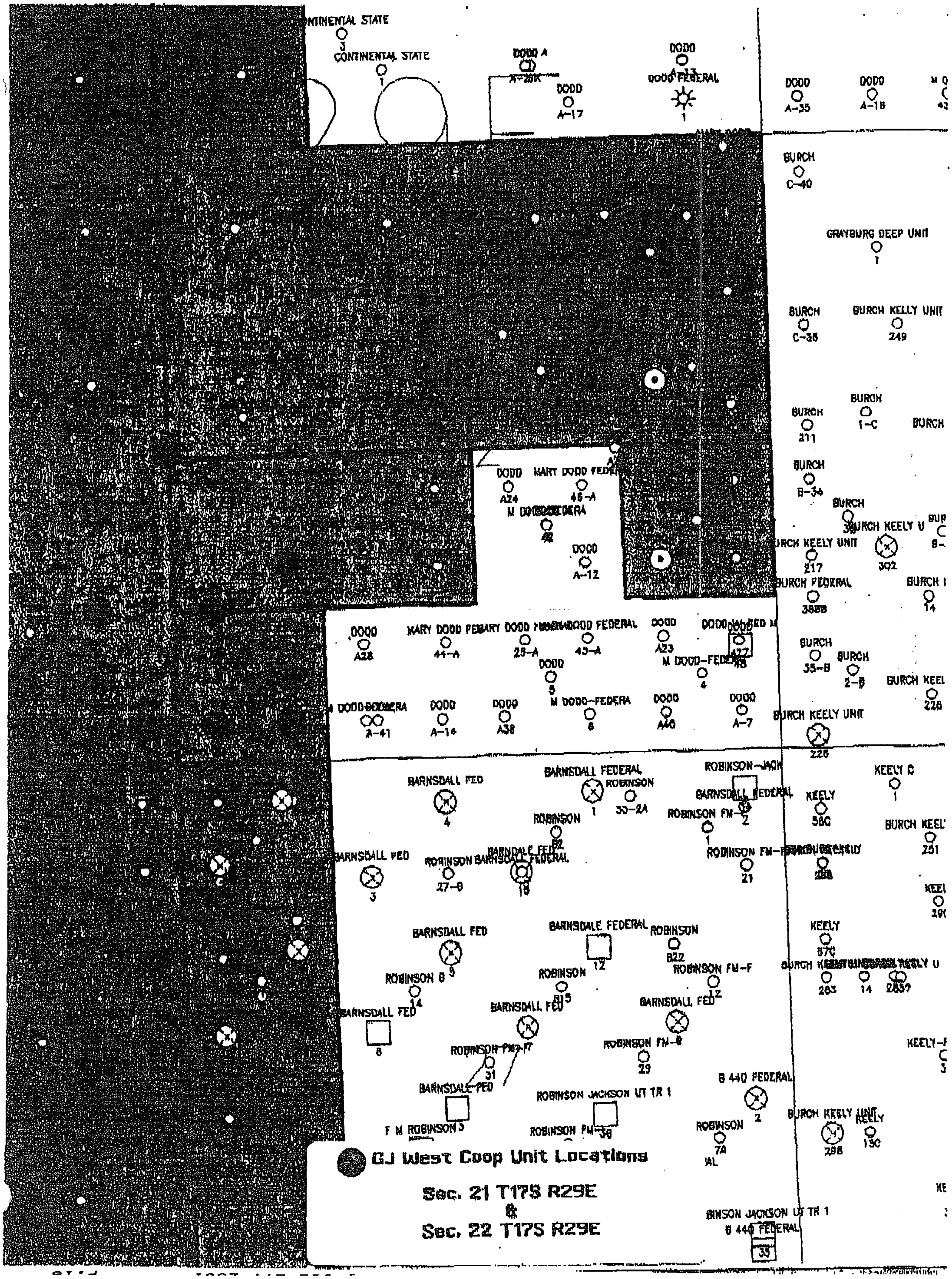
METHODS: EPA 600/4-79-02		160.1	4500-ClB*

*Std. Methods

Amy Hill
Chemist

10/20/03
Date

H8096


GJ West Coop Unit Locations
Sec. 21 T17S R29E
&
Sec. 22 T17S R29E
CONTINENTAL STATE
DODD A
DODD
DODD FEDERAL
DODD
A-17
DODD
A-35
DODD
A-18
BURCH
C-40
GRAYBURG DEEP UNIT
1
BURCH
C-38
BURCH KELLY UNIT
249
BURCH
211
BURCH
1-C
BURCH
BURCH
B-34
BURCH
DODD
A24
MARY DODD FEDER
46-A
DODD
A-12
BURCH KEELY UNIT
217
302
BURCH FEDERAL
388B
BURCH
14
DODD
A28
MARY DODD FED
44-A
DODD
A23
BURCH
35-B
BURCH
2-B
DODD
A-14
DODD
A38
M DODD-FEDERA
DODD
A40
DODD
A-7
BURCH KEELY UNIT
226
BARNSDALL FED
4
BARNSDALL FEDERAL
ROBINSON
33-2A
ROBINSON-JACK
KEELY C
1
KEELY
58C
ROBINSON
B2
BURCH KEEL
251
BARNSDALL FED
3
ROBINSON
27-B
ROBINSON FM
21
BARNSDALL FED
BARNSDALE FEDERAL
12
ROBINSON
B22
KEELY
57C
ROBINSON B
14
ROBINSON
B15
ROBINSON FM-F
12
283
14
BARNSDALL FED
8
BARNSDALL FED
ROBINSON FM-B
29
KEELY
B 440 FEDERAL
2
BARNSDALE FED
ROBINSON JACKSON UT TR 1
F M ROBINSON
ROBINSON FM
ROBINSON
7A
BURCH KEELY UNIT
298
KEELY
13C
B 440 FEDERAL
35

GJ West Coop Unit Locations		
Well #	T Salt	B Salt
24	245'	645'
25	242'	640'
26	242'	632'
28	265'	745'
29	288'	688'
63	310'	830'
70	175'	650'
71	195'	660'
78	240'	625'

Price, Wayne

From: Price, Wayne
Sent: Friday, October 10, 2003 11:02 AM
To: 'Randall Hicks'; Price, Wayne
Cc: Mitchel_lhgsf@hotmail.com
Subject: RE: Loco Hills GSF

OCD has reviewed your request and hereby approves item #2. Item #1 would have to be reviewed and approved by the OCD technical staff and would require public notice which could take 30-60 days. OCD considers Bear Grass Draw as a protectable water course and the groundwater lying beneath it. There is past evidence i.e. windmills that support this claim.

Please let OCD know your intentions before preceding.

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Thursday, October 09, 2003 1:52 PM
To: 'Price, Wayne'
Cc: Mitchel_lhgsf@hotmail.com
Subject: Loco Hills GSF

Wayne

HELP!

The dirt is flying down at Loco Hills as they construct the new brine pond. The attached letter provides my opinions regarding the hydrogeology of the site – as well as some opinions regarding the regulatory framework in which you could approve this plan. We can wait on creating the appropriate regulatory/permit vehicle – but we need your opinion on two things PRONTO:

1. **If Loco Hills shows that the native clay at the site can be compacted to form an acceptable low-permeability barrier, would you permit such a constructed liner at this site without direct leak detection? Look at the hydrogeology; I think you will see that a clay liner provides more than adequate protection of human health and the environment. I would bet that they can create a clay liner with permeability much better than 1 x 10E-6 cm/sec.**
2. **The proposed plan for the pond sediment pile remedy also needs your attention. Given the nature of what lies beneath the site, I believe the proposed solution works fine.**

Please contact me if you have any questions regarding the site and what I have put together here. Let's get a conference call if we need to. The heavy equipment to implement the soil pile remedy is going away soon. I have convinced Loco Hills GSF to try to stop the purchase of the liner until we hear from you regarding the clay liner.

Again, they need an answer regarding the clay in order to save unnecessary costs (if you agree with the clay liner, that is).

We apologize that things are happening so fast – TAKE YOUR TIME (an hour or so) to read the letter and understand the hydrogeology. Tell us what we need to provide in order to help you make a decision on this. We do not think that expensive HYDRUS modeling is required for this dirt/salt pile. Nothing will make the underlying water worse than it is. The proposed plan can make the water IMPROVE!

Take a look and give me a call if you need to. Thanks a million.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

October 9, 2003

Wayne Price

RE: Loco Hills GSF, DP-XXX
NW SW Section 22 Township 17S Range 29E
32.818 Lat, 104.068 Long

Dear Wayne:

Loco Hills GSF, Ltd. retained R.T. Hicks Consultants, Ltd. to perform an environmental assessment of the above-referenced facility. The assessment included an evaluation of material removed from a brine pond and development of a plan to minimize any environmental risk posed by this chloride-rich pond sediment. In the course of our investigation, we also assessed the regulatory compliance of the site and made recommendations for design changes to the new brine pond.

Site Hydrogeology

Plate 1 shows that the Loco Hills GSF lies adjacent to Bear Grass Draw, about 2 miles west of Loco Hills, New Mexico. Bear Grass Draw is mapped as an ephemeral drainage with "headwaters" about 4 miles north of the Loco Hills GSF. Bear Grass Draw drains to a closed basin about 9 miles south of the facility. Our field inspection found neither a developed channel for this drainage nor evidence of water flow within the recent past. We performed our inspection on October 8, 2003, during a 2-day precipitation event that caused flooding north of Artesia.

One windmill, now abandoned, lies within Bear Grass Draw north of the facility (see Plate 1) and a second windmill exists within the Draw about 4.5 miles south of the facility. Examination of the records at the Office of the State Engineer and our reconnaissance identified no water wells within several miles of the facility, except for the windmill north of the facility and the four wells located on the facility.

Available well records for (Appendix A) show that ground water sometimes exists within the Dockum Group Red Beds. Our observations and driller's logs show that alluvium within Bear Grass Draw is thin or non-existent. Although the driller's log of the on-site monitoring well describes the Dockum Group Red Beds as chiefly red clay, thin permeable units yield water to wells. At the site, the depth to water in the monitoring well is about 80 feet (Table 1). Comparison of the observed water levels in the wells and the lithology described by the driller suggest that confined ground water exists within a thin limestone unit at a depth of about 90 feet (see log for monitoring well in Appendix A). We did not attempt to determine the ground water flow direction because we cannot be certain that these wells with measured water levels draw ground water from the same hydrostratigraphic units.

The water level in supply well #2 is a little puzzling, especially in light of the water level in the nearby monitoring well. Presumably Pecos Valley Pump obtained the water level of 36 feet after pulling the pump and it would represent a static condition. The water level for Well 1 was obtained during periodic pumping and may not represent a static level.

Water Supply Well 1, North of Highway	86.58 feet depth to water	Measured by Hicks, October 8, 2003
Water Supply Well 2, Adjacent to brine pond	36 feet depth to water	Measured by Pecos Valley Pump, Inc, 2002
Monitoring well, adjacent to brine pond	83 feet depth to water	Measured by Driller, May 2, 2003
Older supply well	Casing collapsed	

Separately, we will forward to you a letter from Mack Energy that describes the geologic column underlying the Loco Hills GSF. We know that the Dockum Group crops out at the facility and forms the bottom of the new brine pond excavation. The letter from Mack Energy will identify the depth of the base of the Dockum Group, which is also the top of the Dewey Lake Formation. The letter will also document the top of the Salado Formation, which lies below the Dewey Lake, and is the salt formation in which Loco Hills GSF, Ltd. stores the gas (propane). The brine injection/withdrawal wells at the facility, which are within the Salado, are only 500 feet deep. Ground water with a total dissolved solids (TDS) concentration below 10,000 mg/L does not exist within or below the Salado Formation.

Ground water with a TDS below 10,000 mg/L does not exist beneath the facility either. Appendix B presents chemical analyses of three wells at the facility. The TDS of water supply well #1 (north of Highway 83) is 67,950 mg/L. Because the total cations and anions approach 80,000 mg/L, we believe the TDS, which is probably calculated via conductance, is lower than the actual value. The chemistry of water well #2 and the monitoring wells are very similar. All water beneath the facility exceeds 10,000 mg/L TDS.

The high TDS value for ground water in this area is not surprising. We have identified four possible causes for this observed TDS:

1. TDS is naturally elevated due to the proximity of ground water to the thick salt deposits of the Salado. Upward leakage of saline ground water over geologic time could have affected the water quality within the Dockum Group.

2. Surface discharges of produced water from nearby oil wells during the 1920s-1960s may have seeped into the permeable units of the Dockum Group at or near the recharge area to the west of the facility.
3. Seepage from brine pond leakage before Loco Hills GSF acquired the property may have caused elevated TDS in the Dockum Group.
4. Releases from oil well casing have occurred in the past at or near the site and migrated into the water-bearing units of the Dockum Group.

However, hypothesis #3 is improbable if water in the wells originates in a confined water-bearing zone. The fluid dynamics of moving brine from the ground surface into a pressurized unit defy the laws of gravity.

We know that lack of integrity associated with the brine injection/withdrawal wells cannot cause the observed high TDS. Loco Hills GSF injects brine into the salt cavern through injection tubing. Propane then flows through the tubing/well casing annulus to the surface. A failure in the well casing would cause propane, not brine, to flow into the subsurface. We saw no evidence of any propane leakage at the facility.

Finally, we do not believe that any activities of the Loco Hills Gas Storage Facility will cause migration of documented saline ground water to a place where ground water may be employed as a water supply in the reasonable foreseeable future. The thick clay of the Dockum Group that separates the brine ponds from any ground water minimizes or eliminates any brine flux to ground water. Natural migration of this saline ground water may occur.

Recommended Disposition of Stored Pond Sediment
The chloride-rich pond sediment poses no threat to ground water quality at the site for three reasons:

- Ground water beneath the site is about 80,000 mg/L TDS and is so poor it is not afforded protection under New Mexico statute or regulation
- Ground water is probably confined and any release from the ground surface at the facility cannot enter ground water
- In the absence of confined conditions, the 80-90 feet of Dockum Group clay create an adequate barrier to any seepage from the surface to ground water

Although the pond sediment poses no threat to ground water, Loco Hills GSF wishes to return the surface to its productive capacity and to eliminate the eyesore of the stored sediment. We propose the following:

A. Compact the pond sediment in place

B. If possible, cover the sediment with 1-2 feet of loose caliche and/or available coarse-grained material
C. Cover the loose caliche with 3-5 feet of Dockum Group clay and grade the surface to blend with the landscape
D. Cover the clay with 1-3 feet of topsoil and seed with native grasses

The loose caliche will reduce any upward capillary rise of salt. The clay will act as a reservoir for soil moisture and enhance the ability of vegetation growth on the topsoil.

Recommended Regulatory Approach
The New Mexico Water Quality Control Commission Regulations affords protection to ground water that exhibits a TDS less than 10,000 mg/L. The citation below illustrates this interpretation of the regulations:

20.6.2.3101 PURPOSE:
A. The purpose of Sections 20.6.2.3000 through 20.6.2.3114 NMAC controlling discharges onto or below the surface of the ground is to protect all ground water of the state of New Mexico which has an existing concentration of 10,000 mg/l or less TDS, for present and potential future use as domestic and agricultural water supply,

Therefore, we conclude that the permitting and standards section of the Water Quality Control Regulations do not apply to the site. We recommend that Loco Hills GSF terminate the WQCC Discharge Plan for the facility.

We believe the Oil and Gas Act and NMOCD Rules provide environmental regulation for the facility. We recommend that Loco Hills Gas Storage Facility operate in a manner consistent with NMOCD Rules. Because of the nature of the facility, we are unsure what type of permit, if any, NMOCD would choose to issue for the brine ponds and facility operation. Regardless of the type of permit or approval issued by the NMOCD, Loco Hills GSF, Ltd. should operate the facility in a manner that is consistent with "Best Management Practices". This letter outlines such practices.

Recommended Pond Design
Because ground water beneath the site cannot be employed as a domestic or agricultural water supply in the present or reasonably foreseeable future, operational reasons, not environmental concerns, create a need for preventing seepage from the pond. Loco Hills GSF needs to retain brine in their ponds to move propane in and out of the subsurface storage cavern. The clay of the Dockum Group can create a suitable low-permeability liner if compacted. If NMOCD approves of a compacted clay liner for the pond, Loco Hills GSF will retain a geotechnical engineering firm to conduct geotechnical testing of the native clay that forms the bottom of the pond excavation. The geotechnical testing will use brine to measure permeability and determine the seepage from a 2-foot thick clay layer compacted to 95% of proctor density. We believe that such testing will show a

vertical hydraulic conductivity of less than 1 x 10E-7 cm/sec. This rate of seepage is acceptable for operational purposes.

A clay liner for this new pond may be substantially better than a synthetic liner because it facilitates pond clean-out. Degradation by UV radiation, rodents, or punctures is also much less likely with clay than with a synthetic liner.

We understand that the existing pond releases about 30 gallons per day from the primary liner into the leak detection system. The secondary liner obviously retains the brine released from the primary liner. We recommend that this pond remain in service "as is". The leakage and recovery of brine poses no operational problems.

Recommended Action to Mitigate Effects of Saline Ground Water
As discussed, we believe that it is possible but not probable that past activities of the Loco Hills Gas Storage Facility have caused the observed elevated TDS of ground water. Because of this possibility, we propose that Loco Hills GSF, Ltd. voluntarily expand their business to include limited brine sales for oil and gas drilling activity. This business expansion would cause additional removal of saline ground water by the two existing wells. At a minimum, such withdrawals will minimize any down gradient (southern) migration of this saline ground water, regardless of its origin.

Because poor-quality ground water exists beneath the site, Loco Hills GSF, LLC should voluntarily notify landowners adjacent to the facility that high TDS water exists beneath the facility. This notification might include a copy of this letter and advice to use caution when developing water supplies in this area.

Conclusions

- The high TDS of ground water beneath the facility is a result of natural conditions or man-made conditions that occurred before Loco Hills GSF, Ltd. acquired the property.
- Determining the cause of the high TDS is not warranted.
- The high TDS of ground water and other natural conditions beneath the site eliminates any environmental rationale for minimizing seepage from the brine storage ponds.
- The thick clay of the Dockum Group that exists between the ground surface and ground water act as an effective barrier to pond seepage.
- Any minimal pond seepage will not cause the existing saline ground water to migrate a material distance from the facility.
- Employing the native clay to create a low-permeability liner for the new brine pond may provide more operational flexibility
- Maintaining the existing lined pond "as is" creates no threat to human health or the environment and is acceptable from an operational standpoint.

- The WQCC Regulations do not apply to this site.
- The Oil and Gas Act and NMOCD Rules apply to this site.

If you have any questions concerning this communication, please contact me at our Albuquerque address and telephone number.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T. Hicks

Randall Hicks
Principal

Copy: Loco Hills GSF, Ltd.

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 05/28/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB.NUMBER	SAMPLE ID	Na (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Conductivity (u S/cm)	T-Alkalinity ($mgCaCO_3/L$)
ANALYSIS DATE:		05/06/03	05/27/03	05/27/03	05/27/03	05/27/03	05/27/03
H7683-1	WATER WELL #1	27648	1074	994	151	99987	92
H7683-2	WATER WELL #2	24982	1785	685	104	100531	166
Quality Control		NR	56	59	5.17	1322	NR
True Value QC		NR	50	50	5.00	1413	NR
% Recovery		NR	112	118	103	93.6	NR
Relative Percent Difference		NR	0	0	1.0	0.7	NR
METHODS:		SM3500-Ca-D		3500-Mg E	8049	120.1	310.1

LAB.NUMBER	SAMPLE ID	Cl^- (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	pH (s.u.)	TDS (mg/L)	
ANALYSIS DATE:		05/27/03	05/27/03	05/27/03	05/27/03	05/27/03	05/28/03	
H7683-1	WATER WELL #1	45986	2123	0	112	7.04	67950	67,950
H7683-2	WATER WELL #2	42987	971	0	202	7.00	69220	69,220
Quality Control		1050	53.65	NR	996	7.01	NR	
True Value QC		1000	50.00	NR	1000	7.00	NR	
% Recovery		105	107	NR	99.6	100	NR	
Relative Percent Difference		0	1.5	NR	0	2.1	12.1	
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1	160.1	

Amy Hill
Chemist

5/28/03
Date

H7683C

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 05/27/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Br^- (mg/L)	F^- (mg/L)	NO_3/NO_2 (mg/L)	PO_4 (mg/L)
ANALYSIS DATE		05/27/03	05/27/03	05/23/03	05/27/03
H7683-1	WATER WELL #1	4.39	2.36	2.35	0.20
H7683-2	WATER WELL #2	3.88	2.52	1.92	0.05
Quality Control		3.00	1.27	2.98	0.51
True Value QC		3.00	1.00	3.00	0.50
% Recovery		100	127	99.2	101
Relative Percent Difference		5.7	3.2	2.0	0

METHODS: Std. Methods	$4500\text{-}Br^-B$	$4500\text{-}F^-D$	353.3*	4500-P E

EPA 600/4-79-020

Amy Hill
Chemist

5/27/03
Date

H7683

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 06/02/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

TOTAL METALS

LAB NUMBER SAMPLE ID	Al (ppm)	Co (ppm)	Cu (ppm)	Fe (ppm)
ANALYSIS DATE:	05/29/03	05/29/03	05/29/03	05/29/03
H7683-1 WATER WELL #1	<1	0.312	<0.5	3.922
H7683-2 WATER WELL #2	<1	0.345	<0.5	2.057
Quality Control	5.003	0.998	5.108	5.031
True Value QC	5.000	1.000	5.000	5.000
% Recovery	100	99.8	102	101
Relative Percent Difference	1.6	1.2	0.3	2.0
METHODS: EPA 600/04-79-020	202.1	219.1	220.1	236.1

	Mn (ppm)	Mo (ppm)	Ni (ppm)	Zn (ppm)
ANALYSIS DATE:	05/29/03	05/29/03	05/29/03	05/29/03
H7683-1 WATER WELL #1	<0.01	<1	0.224	<0.5
H7683-2 WATER WELL #2	0.416	<1	0.319	<0.5
Quality Control	0.914	3.001	5.144	0.497
True Value QC	1.000	3.000	5.000	0.500
% Recovery	91.4	100.0	103.0	99.4
Relative Percent Difference	2.3	0.6	0.2	0.7
METHODS: EPA 600/04-79-020	243.1	246.1	249.1	289.1

Amy Hill
Chemist

6/2/03
Date

H7683m2

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 06/02/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

RCRA METALS

LAB NUMBER	SAMPLE ID	As ppm	Ag ppm	Ba ppm	Cd ppm	Cr ppm	Pb ppm	Hg ppm	Se ppm
ANALYSIS DATE:		05/29/03	05/29/03	05/29/03	05/29/03	05/29/03	05/29/03	06/02/03	05/30/03
H7683-1	WATER WELL 1	<0.05	0.32	<0.5	<0.01	0.063	1.011	<0.002	<0.01
H7683-2	WATER WELL 2	<0.05	0.162	<0.5	<0.01	0.073	0.988	<0.002	<0.01
Quality Control		0.053	4.916	24.44	0.972	4.880	5.164	0.00980	0.051
True Value QC		0.050	5.000	25.00	1.000	5.000	5.000	0.01000	0.050
% Recovery		106.0	98.3	97.8	97.2	97.6	103	98.0	102
Relative Percent Difference		1.4	1.0	1.5	1.3	0.3	5.6	2.0	3.2
METHODS: EPA 600/4-79-020		206.2	272.1	208.1	213.1	218.1	239.1	245.1	270.2

Amy Hill
Chemist

6/2/03
Date

H7683m

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/07/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Na (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Conductivity (μS/cm)	T-Alkalinity ($mgCaCO_3/L$)
ANALYSIS DATE:		05/06/03	05/06/03	05/06/03	05/06/03	05/06/03	05/06/03
H7634-1	MONITOR WELL	43525	3069	1142	193	145615	140
Quality Control		NR	43	55	5.22	1322	NR
True Value QC		NR	50	50	5.00	1413	NR
% Recovery		NR	86	110	104	93.6	NR
Relative Percent Difference		NR	0	0	2.6	0.7	NR
METHODS:			SM3500-Ca-D	3500-Mg E	8049	120.1	310.1

LAB NUMBER	SAMPLE ID	Cl^- (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	pH (s.u.)	TDS (mg/L)
ANALYSIS DATE:		05/06/03	05/06/03	05/06/03	05/06/03	05/06/03	05/06/03
H7634-1	MONITOR WELL	74977	1438	0	171	7.24	118200
Quality Control		1050	54.39	NR	1068	6.95	NR
True Value QC		1000	50.00	NR	1000	7.00	NR
% Recovery		105	109	NR	107	99.3	NR
Relative Percent Difference		2.0	0.7	NR	7.7	0.6	12.1
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1	160.1

Amy Hill
Chemist

5/7/03
Date

H7634

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/06/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER SAMPLE ID	Br^- (mg/L)	F^- (mg/L)	NO_3/NO_2 (mg/L)	PO_4 (mg/L)
ANALYSIS DATE	05/06/03	05/06/03	05/06/03	05/06/03
H7634-1 MONITOR WELL	12.2	1.14	5.51	0.34
Quality Control	2.83	0.95	2.98	0.51
True Value QC	3.00	1.00	3.00	0.50
% Recovery	94.5	95.0	99.2	101
Relative Percent Difference	1.0	3.0	2.0	0

METHODS: Std. Methods	4500-Br⁻B	4500-F⁻D	353.3*	4500-P E

EPA 600/4-79-020

Amy Hill
Chemist

5/6/03
Date

H7634

CARDINAL
LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/15/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

RCRA METALS

LAB NUMBER SAMPLE ID	As ppm	Ag ppm	Ba ppm	Cd ppm	Cr ppm	Pb ppm	Hg ppm	Se ppm
ANALYSIS DATE:	05/13/03	05/13/03	05/08/03	05/13/03	05/13/03	05/13/03	05/13/03	05/08/03
H7634-1 MONITOR WELL	<0.08	<0.04	<0.5	<0.005	<0.04	<0.04	<0.001	<0.05
Quality Control	0.950	0.470	0.950	0.475	0.480	0.475	0.00104	0.051
True Value QC	1.000	0.500	1.000	0.500	0.500	0.500	0.00100	0.050
% Recovery	95.0	94.0	95.0	95.0	96.0	95.0	104	102
Relative Percent Difference	2.1	1.7	0.4	0	1.1	0	9.0	3.2

METHODS: EPA 600/4-79-020*	200.7	200.7	200.7	200.7	200.7	200.7	245.1*	270.2*

Amy Hill
Chemist

5/15/03
Date

H7634m

CARDINAL
LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/15/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

TOTAL METALS

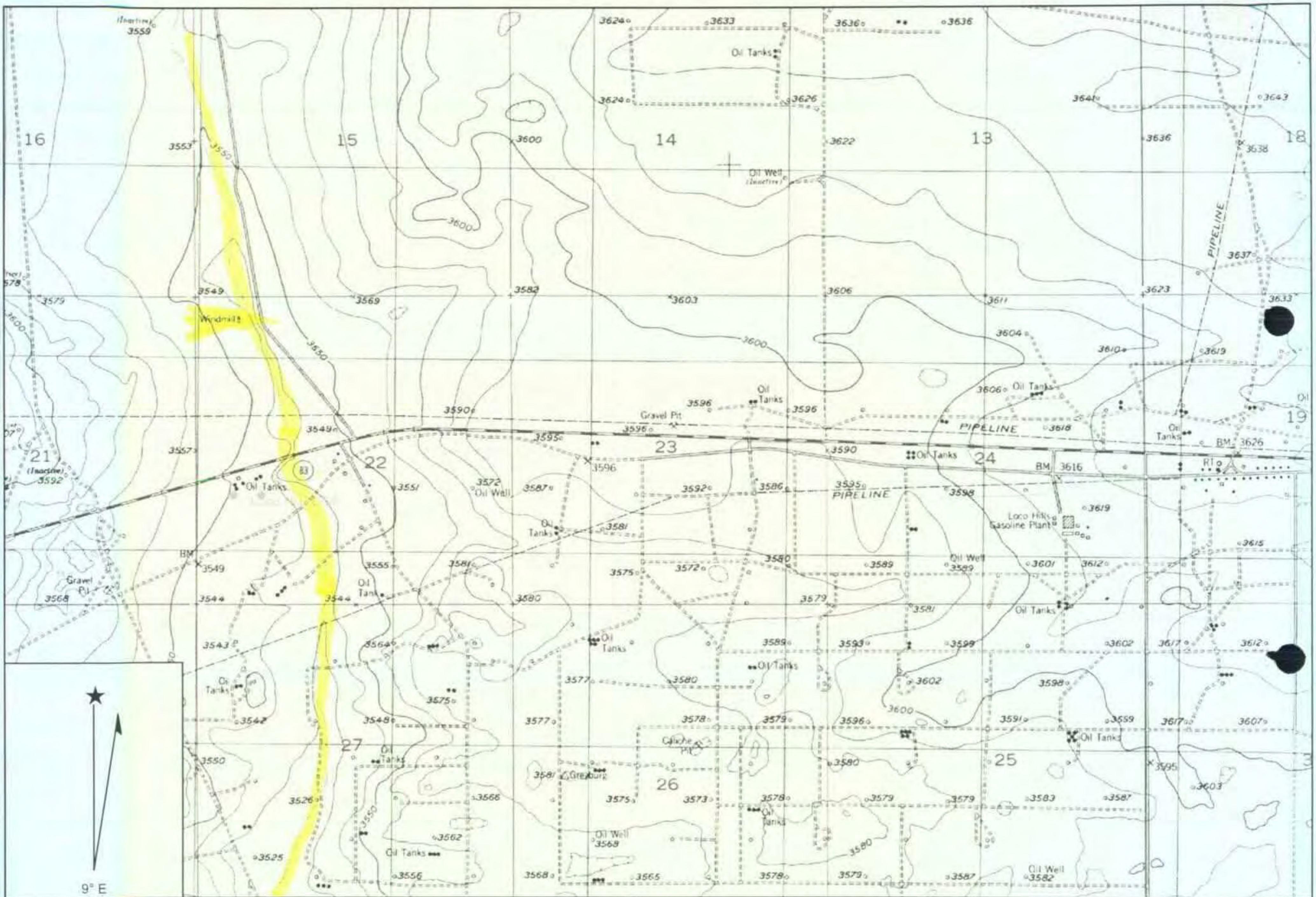
LAB NUMBER SAMPLE ID	Al (ppm)	Co (ppm)	Cu (ppm)	Fe (ppm)
ANALYSIS DATE:	05/13/03	05/13/03	05/08/03	05/08/03
H7634-1 MONITOR WELL	<0.2	<0.04	<0.5	<1
Quality Control	0.960	0.970	5.110	5.223
True Value QC	1.000	1.000	5.000	5.000
% Recovery	96.0	97.0	102	104
Relative Percent Difference	0.4	0	0.4	0.4
METHODS: EPA 600/04-79-020	200.7	200.7	220.1	236.1

	Mn (ppm)	Mo (ppm)	Ni (ppm)	Zn (ppm)
ANALYSIS DATE:	05/13/03	05/13/03	05/13/03	05/08/03
H7634-1 MONITOR WELL	0.33	<0.1	<0.04	2.45
Quality Control	0.475	0.485	0.480	0.499
True Value QC	0.500	0.500	0.500	0.500
% Recovery	95.0	97.0	96.0	99.8
Relative Percent Difference	0.2	0.8	0.4	0.8
METHODS: EPA 600/04-79-020	200.7	200.7	200.7	289.1

Amy Hill
Chemist

5/15/03
Date

H7634m2



Name: RED LAKE SE
Date: 10/7/2003
Scale: 1 inch equals 2000 feet

Location: 032° 49' 11.3" N 104° 02' 44.1" W
Caption: Plate 1: Location Map Loco Hills GSF

Wheeler, Andrea

From: Vicky_Maciaszek@oxy.com
Sent: Thursday, October 09, 2003 12:30 PM
To: AWHEELER@state.nm.us
Cc: Lyndy_Chu@oxy.com
Subject: RE: oxyusawtp1007.doc

Andrea: The oil transporter is Navajo Refining, Oil Transporter OGRID 15694. Lyndy is in training but she will try to respond as soon as she is able with your questions. Thanks for your patience.

-----Original Message-----
From: Wheeler, Andrea [mailto:AWHEELER@state.nm.us]
Sent: Wednesday, October 08, 2003 1:25 PM
To: Maciaszek, Vicky
Cc: Stewart, David; Chu, Lyndy
Subject: RE: oxyusawtp1007.doc

The Transporter OGRID for POD 2033810 in Pool # 19190 Property # 27936 a volume of 165 transported, did not get picked up on the txt file. Please let me know what the Transporter OGRID code should be and I can fix it. I hope that this helps. Thanks!

Andrea Wheeler
OCD
1220 S. Saint Francis Dr.
Santa Fe, NM 87505
(505) 476-3482 (v)
(505) 476-3462 (f)
email address: awheeler@state.nm.us

-----Original Message-----
From: Vicky_Maciaszek@oxy.com [mailto:Vicky_Maciaszek@oxy.com]
Sent: Wednesday, October 08, 2003 6:54 AM
To: AWHEELER@state.nm.us
Cc: David_Stewart@oxy.com; Lyndy_Chu@oxy.com
Subject: FW: oxyusawtp1007.doc

Andrea: Please gives us more info. Thanks.
-----Original Message-----
From: Stewart, David
Sent: Wednesday, October 08, 2003 7:52 AM
To: Maciaszek, Vicky
Cc: Chu, Lyndy
Subject: RE: oxyusawtp1007.doc

I don't have any idea, you might check with the NMOCD.

-----Original Message-----
From: Maciaszek, Vicky
Sent: Wednesday, 10 08, 2003 06:59
To: Stewart, David

Loco Hills GSS

Drill Rate 5-1-03

0-2 2 ← Sand: Rd, Ambr, VFN GRN
4 -
6 - Gravel, Sand, Clay,
8 - (Gravel 1/8" - 1/4")
10 -
2 1
4 1 ← Clay: Rd, VRY SNDY Water →
6 1
8 -
20 -
2 -
4 1
6 -
8 -
30 - Clay: AA, Sme FN Gravel
2 1
4 1
6 1-
8 2
40 2
2 2-
4 1
6 1
8 1
50 1
2 1
4 1
6 1-
8 1-
60 1
2 1-
4 1-
6 2
8 2- ← 67' Conglomerate: Gry, Dkgry, Mott, Lmy
70 2-
2 2
4 2
6 2- ← Clay: Rd, SLty
8 1-
80 1-

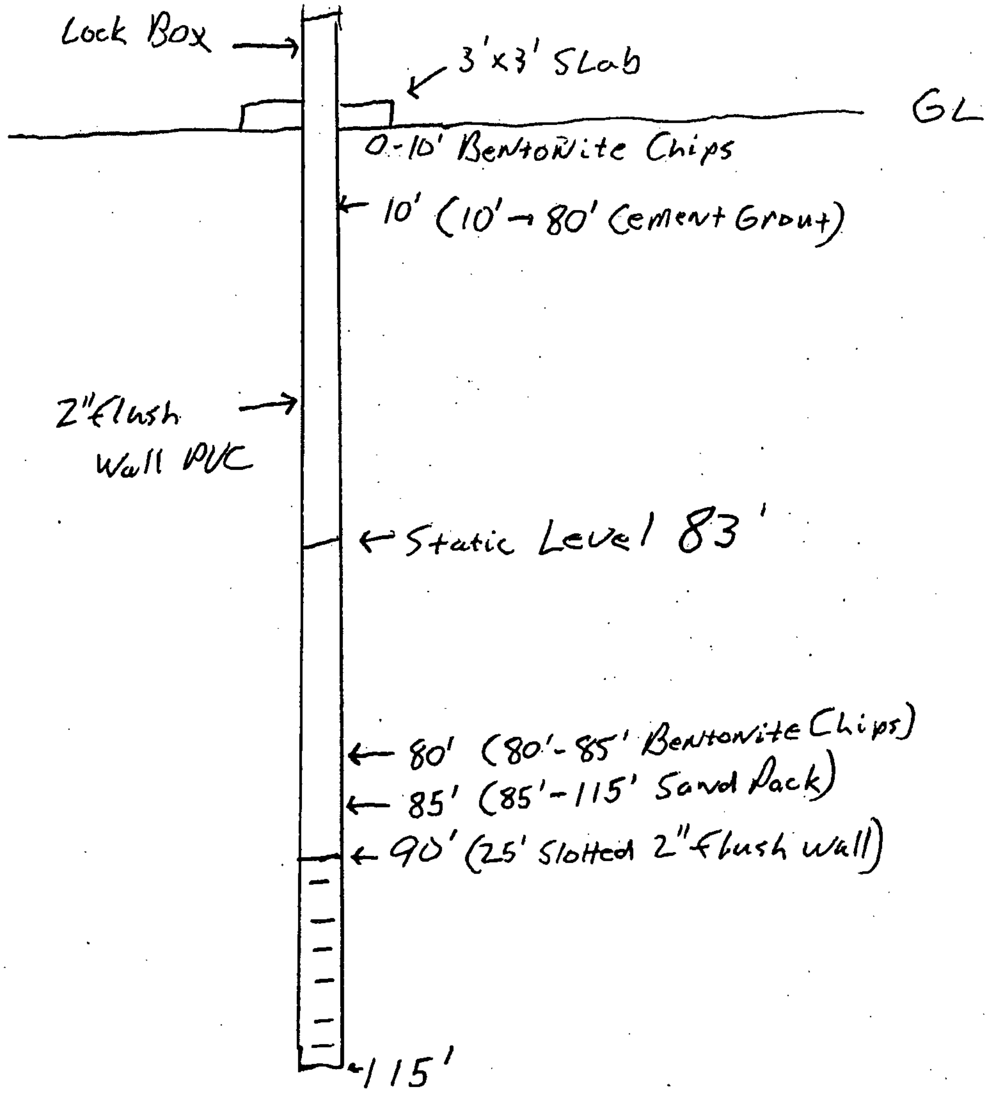
80-2 1
4 1-
6 1-
8 3 ← Rd Clay: Vry Stky
90 3
2 4 ← 5/2/03 Lost Some Fluid in
4 14 Pit; Limestone: Off WHT-
6 8 Lt GRY, VFN - Micxn, Sme
8 12 Chlky, Sme Fractured
100 27
2 19
4 10
6 12
8 13
110 8 ← 109' Change to clay
2 20 ← Clay: BLu Gry, Smth
4 13
6 12 Clay: Rd, SLty - Smth
8
120

Hole Size: 6"

Casing Size 2"

Loco Hills GSF

5/5/03



Static Level 83'

sed June 1972

E ENGINEER OFFICE

FIELD ENGR. LOG

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well New Mexico Chemical Company Owner's Well No. ____
Street or Post Office Address P.O. Box 423
City and State Artesia, New Mexico 88210

Well was drilled under Permit No. RA-6837 and is located in the:

a. ____ ¼ SE ¼ SE ¼ SW ¼ of Section 9 Township 17-S Range 29E N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in ____ County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Yucca Drilling Co., Inc. License No. WD-763

Address P.O. Box 798 Artesia, New Mexico 88210

Drilling Began 9-1-81 Completed 9-4-81 Type tools Rotary Size of hole 9 3/4 in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 325 ft.

Completed well is [x] shallow [ ] artesian. Depth to water upon completion of well 220 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
260	280	20	Gravel & Sand	5
295	310	15	Gravel	10

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
6	160 psi		0	325	325		225	325

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				
0	325	9 3/4	7		mud

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

____
State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received September 11, 1981

Quad ____ FWL ____ FSL ____

File No. RA-6837 Use Comm. Location No. 17S.29.9.34444

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	10	10	Top
10	65	55	Gravel
65	125	60	Clay & Gravel
125	140	15	Gravel
140	220	80	Clay & Gravel
220	290	70	Clay, Sand & Gravel
290	310	20	Gravel
310	315	5	Gravel, Sand & Clay
315	320	5	Sand
320	325	5	Clay

Section 7. REMARKS AND ADDITIONAL INFORMATION

STATE ENGINEER
ROSWELL, NM
SEP 11 9 AM '81

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Clifton L. [signature]

Driller

INSTRUCTIONS: This for[m sho]uld be executed in triplicate, preferably typewritten, and submitted [to th]e appropriate district office of the State Engineer. All s[ec]tions, except Section 5, shall be answered as completely and accurate[ly a]s possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section [5] need be completed.

Revised June 1972

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well ______ Owner's Well No. ______
Street or Post Office Address ______
City and State ______

Well was drilled under Permit No. ______ and is located in the:

a. ____ ¼ ____ ¼ ____ ¼ ____ ¼ of Section ______ Township ______ Range ______ N.M.P.M.

b. Tract No. ______ of Map No. ______ of the ______

c. Lot No. ______ of Block No. ______ of the ______
Subdivision, recorded in ______ County.

d. X= ______ feet, Y= ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.

(B) Drilling Contractor L. Scarborough, Lamesa, Texas License No. ______

Address ______

Drilling Began ______ Completed ______ Type tools ______ Size of hole ______ in.

Elevation of land surface or ______ at well is ______ ft. Total depth of well ______ ft.

Completed well is ☐ shallow ☐ artesian. Depth to water upon completion of well ______ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				

Section 5. PLUGGING RECORD

Plugging Contractor ______
Address ______
Plugging Method ______
Date Well Plugged ______
Plugging approved by:

______
State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ______ FWL ______ FSL ______

File No. ______ Use Test Location No. 17.30.19.412224

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered	POROSITY
0	10	10	75% red siliceous sandstone; some white calcareous sandstone; 25% red loose sand	None
10	20	10	20% caliche; 80% clay, firm, red-brown	None
20	30	10	100% Sand; reddish, medium-coarse, loose to cemented with clay	Slight
30	40	10	70% as above, 30% sandy firm clay	None
40	50	10	20% Caliche; 60% Sand; medium-coarse, loose to slightly argillaceous; 20% Clay, red	Slight
50	60	10	100% Clay, red, firm, some sand	None
60	90	30	100% Sand, loose, red, fine-medium-coarse, subround	Good
90	100	10	70% Sand; 30% Gravel	
100	130	30	40% Sand, fine-medium-coarse, loose, 60% Clay	
			Total Depth: 130' abd. hole. Hole too large, no circulation or control.	
			Driller's Log:	
0	11	11	Caliche	
11	65	54	Clay with sand streaks	
65	130	65	Sand with some clay	
			Top of Triassic: 11'	

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

L. Scarborough, Lamesa, Texas

Driller

INSTRUCTIONS: This form be executed in triplicate, preferably typewritten, and submitted t ppropriate district office of the State Engineer. All se. ..s, except Section 5, shall be answered as completely and accurately possible when any well is drilled, repaired or deepened. W: n this form is used as a plugging record, only Section 1(a) and Section 5 and be completed

Revised June 1972

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well ______ Owner's Well No. ______
Street or Post Office Address ______
City and State ______

Well was drilled under Permit No. ______ and is located in the:

a. ______ ¼ ______ ¼ ______ ¼ ______ ¼ of Section ______ Township ______ Range ______ N.M.P.M.

b. Tract No. ______ of Map No. ______ of the ______

c. Lot No. ______ of Block No. ______ of the ______
Subdivision, recorded in ______ County.

d. X= ______ feet, Y= ______ feet, N.M. Coordinate System ______ Zone in the ______ Grant.

(B) Drilling Contractor L. Scarborough, Lamesa Texas License No. ______

Address ______

Drilling Began ______ Completed ______ Type tools ______ Size of hole ______ in.

Elevation of land surface or ______ at well is ______ ft. Total depth of well ______ ft.

Completed well is ☐ shallow ☐ artesian. Depth to water upon completion of well ______ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				

Section 5. PLUGGING RECORD

Plugging Contractor ______
Address ______
Plugging Method ______
Date Well Plugged ______
Plugging approved by:

______
State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ______ FWL ______ FSL ______

File No. ______ Use Test Location No. 17.30.21.112331

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	10	10	80% sand; pink-red, medium to coarse grain, quartzitic, round to subround, loose; 20% Caliche; Red-white, calcareous sandstone. Porosity: Good
10	20	10	As above. Porosity: Good
20	30	10	100% Sand, fine-medium coarse, reddish loose, subround, quartzitic. Porosity: Good
30	40	10	70% Siltstone; pinkish, very fine sand and silt; 20% Red clay with sand; 10% Caliche; sandstone, trace gravels and calcareous sand. Porosity: Fair
40	50	10	75% Silty clay and sandy clay, pink to red; 25% Clay, Reddish. Porosity: None
50	80	30	100% Sand; fine-medium-coarse, reddish, loose, subround to round, quartzitic. Porosity: Good
80	90	10	90% Siltstone; pinkish, argillaceous and sandy; 10% Clay Dry hole drilling started to inject some water to keep hole from slumping. Porosity: None
90	100	10	70% Sandstone and silt; pink-red, slightly argillaceous; 30% Clay, reddish with sand. Porosity: Slight
100	150	50	100% Clay; reddish brown, slightly sandy, few hard streaks sandstone. Porosity: None
			Total Depth: 150' Jet from total depth, no fluid; wait 3 minutes, jet again, no fluid.
			Top of Triassic: 9'
			DRILLERS:
0	9	9	Caliche
9	100	91	Sandy Clay and sand
100	150	50	Heavy clay with sand streaks
			Drillers water from Caprock Water Co., Loco Hills. Checked chlorides 30 ppm.

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

L. Scarborough, Lamesa, Texas

Driller

INSTRUCTIONS: This form be executed in triplicate, preferably typewritten, and submitted t ppropriate district office of the State Engineer. All se. .s, except Section 5, shall be answered as completely and accurately . possible when any well is drilled, repaired or deepened. Wl n this form is used as a plugging record, only Section 1(a) and Section 5 eed be completed.

Loco Hills G55

Drill Rate 5-1-03

0-2 2 Sand: Rd, Ambr, VFN Grn
4 - ← Gravel, Sand, Clay, (Gravel 1/8" - 1/4")
6 -
8 -
10 -
2 1
4 1 ← Clay: Rd, VRY SNDY Water →
6 1
8 -
20 -
2 -
4 1
6 -
8 -
30 - Clay: AA, Sme FN Gravel
2 1
4 1
6 1-
8 2
40 2
2 2-
4 1
6 1
8 1
50 1
2 1
4 1
6 1-
8 1-
60 1
2 1-
4 1-
6 2
8 2- ← 67' Conglomerate: Gry, Dkgry, Mott, Lmy
70 2-
2 2
4 2
6 2- ← Clay: Rd, SLty
8 1-
80 1-

80-2 1
4 1-
6 1-
8 3 ← Rd Clay: Vry Stky
90 3
2 4 ← 5/2/03 Lost Some Fluid in Pit; Limestone: Off WHT - Lt GRY, VFN - Micxn, Sme Chlky, Sme Fractured
4 14
6 8
8 12
100 27
2 17
4 10
6 12
8 13
110 8 ← 109' Change to Clay
2 20 ← Clay; BLu Gry, Smth
4 13
6 12 Clay: Rd, SLty - Smth
8
120

Hole Size: 6"

Casing Size 2"

Price, Wayne

From: Mitchel Johnson [mitchel_lhgsf@hotmail.com]
Sent: Wednesday, September 24, 2003 7:16 AM
To: WPrice@state.nm.us
Subject: RE: Loco Hills GSF dirt pile

Wayne,
I'm very sorry to hear that you had a death in the family.

I spoke with Jim Carr and he said they would prefer to see us do the land farming (mixing the dirt pile with the dirt we are taking out for the pond.) He said that he did not need anything from me just a statement from OCD as to which way to go.

Thanks,
Mitchel Johnson
Loco Hills GSF

>From: "Price, Wayne" <WPrice@state.nm.us>
>To: 'Mitchel Johnson' <mitchel_lhgsf@hotmail.com>
>Subject: RE: Loco Hills GSF dirt pile
>Date: Wed, 17 Sep 2003 13:41:11 -0600
>
>Dear Mitch! Usually it would be BLM land (federal) or State LAND (NM). We
>would like to see concurrence on this issue.
>
>-----Original Message-----
>From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
>Sent: Tuesday, September 16, 2003 2:27 PM
>To: WPrice@state.nm.us
>Subject: RE: Loco Hills GSF dirt pile
>
>
>Wayne,
>Yes, this is State BLM land. Do I need to get approval through them?
>
>Thanks,
>Mitchel
>
>
> >From: "Price, Wayne" <WPrice@state.nm.us>
> >To: 'Mitchel Johnson' <mitchel_lhgsf@hotmail.com>
> >Subject: RE: Loco Hills GSF dirt pile
> >Date: Mon, 15 Sep 2003 08:35:06 -0600
> >
> >Mitch, who is the property owner, if it is state land that may be an
>issue!
> >
> >-----Original Message-----
> >From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
> >Sent: Friday, September 12, 2003 4:13 PM
> >To: wprice@state.nm.us
> >Cc: MStubblefield@state.nm.us
> >Subject: Loco Hills GSF dirt pile
> >
> >
> >Wayne,
> >As you know the previous ownership left a pile of dirt that we have to
> >dispose of an ecological friendly manner. When the crew is out to build
> >the
> >
> >new brine pond may we bury this approximate 2500-3000 yards of dirt

>encased
> >in liner. I know we have discussed this option before, but I wanted to
> >make
> >
> >sure it was approved.
> >
> >Thanks,
> >Mitchel Johnson
> >Loco Hills GSF
> >817-441-6568
> >
> >____
> >Get 10MB of e-mail storage! Sign up for Hotmail Extra Storage.
> >http://join.msn.com/?PAGE=features/es
>
>____
>Try MSN Messenger 6.0 with integrated webcam functionality!
>http://www.msnmessenger-download.com/tracking/reach_webcam

____
Add MSN 8 Internet Software to your existing Internet access and enjoy
patented spam protection and more. Sign up now!
http://join.msn.com/?page=dept/byoa

Price, Wayne

From: Mitchel Johnson [mitchel_lhgsf@hotmail.com]
Sent: Friday, September 12, 2003 4:13 PM
To: wprice@state.nm.us
Cc: MStubblefield@state.nm.us
Subject: Loco Hills GSF dirt pile

Wayne,
As you know the previous ownership left a pile of dirt that we have to dispose of an ecological friendly manner. When the crew is out to build the new brine pond may we bury this approximate 2500-3000 yards of dirt encased in liner. I know we have discussed this option before, but I wanted to make sure it was approved.

Thanks,
Mitchel Johnson
Loco Hills GSF
817-441-6568

Price, Wayne

From: Mitchel Johnson [mitchel_lhgsf@hotmail.com]
Sent: Friday, August 29, 2003 6:41 AM
To: wprice@state.nm.us
Cc: MStubblefield@state.nm.us
Subject: Loco Hills GSF Pond Status

Wayne,

It has been a while since I've updated you on our pond situation. We are in the process of narrowing the bids down. At your suggestion we have been looking into the possibility of going over the top with the inlet/outlet and this is the way we are currently leaning towards. One of the companies want to do the pond with a 3:1 ratio for the slope instead of a 5:1 as designed. Would NM OCD have a problem with that? You should have received a copy of the notification that the owners of the land bordering our lease have been notified. The notification posting has been up for approximately 30 days. Jim Carr, NM Business Lease, has visited the site and there seem to be no issues there. One of the companies will have a crew available in 3 weeks, please let me know the things you still need (besides a final decision how we are going to do the inlet/outlet) so that if we did decide to use that company we would be ready to go then.

Thank you,
Mitchel Johnson

NOTICE OF PUBLICATION STATE OF NEW MEXICO ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT OIL CONSERVATION DIVISION

Notice is hereby given that pursuant to New Mexico Water Quality Control Commission Regulations, the following discharge plan application(s) have been submitted to the Director of the Oil Conservation Division, 1220 South St. Francis Drive, Santa Fe, New Mexico 87505, Telephone (505) 476-3440:

(GW-275)-Unichem (a Division of BJ Services Company), Mr. Robert E. Barr, 1215 Basin Road, Farmington, New Mexico 87401, has submitted a Discharge Plan Renewal Application for their Farmington Service Facility located in the NE/4 NE/4, Section 23, Township 29 North, Range 13 West, NMPM, San Juan County, New Mexico. Any potential discharge at the facility will be stored in a closed top receptacle prior to transport off-site to an OCD approved disposal facility. Groundwater most likely to be affected by a spill, leak, or accidental discharge to the surface is at a depth of approximately 15 feet with a total dissolved solids concentration of approximately 675 mg/L. The discharge plan addresses how spills, leaks, and other accidental discharges to the surface will be managed.

(BW-025) Paul Prather, P.O. Box 7169, Eunice, New Mexico 88231, has submitted a discharge plan renewal application for the CSI Brine Sales Station located in the NE/4 NE/4 of Section 20, Township 25 South, Range 37 East, NMPM, Lea County, New Mexico. Fresh water from the City of Jal is injected into the Salado Formation at an approximate depth of 1,150 feet and brine water is extracted with an average total dissolved solids concentration of 350,000 mg/l. The brine water is stored in four 1,000 barrel above ground closed top tanks. The plan includes a chemical storage dock and a below grade concrete pit for temporary storage of exempt oilfield waste. Ground water most likely to be affected in the event of an accidental discharge is at a depth of approximately 40 feet with a total dissolved solids concentration of approximately 875 mg/l. The discharge plan addresses how spills, leaks, and other accidental discharges to the surface will be managed.

(UIC-CL1-008) - Navajo Refining Company, Darrell Moore, (505) 748-3311, P.O. Box 159, Artesia, New Mexico, 88211, has submitted a discharge plan renewal application for their Class I non-hazardous disposal wells for disposal of non-hazardous fluids generated at the Artesia and Lovington refineries. The non-hazardous fluids will be transported to the injection wells by pipeline. The wells named "Navajo WDW-1 and WDW-2" are located approximately 11 miles southeast of Artesia, New Mexico found in section 31 (660 FSL-2310 FEL), Township 17 South, Range 28 East and Section 12 (1980 FNL-660 FWL, Township 18 South, Range 27 East, respectively, NMPM, Eddy County, New Mexico. The proposed injection zone will be the lower Wolfcamp Formation and the Cisco and Canyon Formations between 7,270 feet and 8894 feet. The total dissolved solids concentration of the injection zone ranges from 13,000 mg/l to 119,909 mg/l. The proposed maximum injection rate into the wells will be 500 gallons per minute with a maximum injection pressure of 1490 psi (WDW-1) and 1454 psi (WDW-2). The total dissolved solids concentration of the injection fluid is expected to range from 1000-5000 mg/l. Ground water most likely to be affected in the event of an accidental discharge is at a depth of approximately 100 feet below ground level with a total dissolved solids concentration ranging from approximately 100 mg/l to 1,535 mg/l. The discharge plan addresses how spills, leaks, and other accidental discharges to the surface will be managed.

UIC-CLI-005 (GW-130) - Key Energy Services, Inc., Mr. Mike Talovich, P.O. Box 900, Farmington, New Mexico, 87499 has submitted a discharge plan renewal application for their permitted Class I disposal well located in Unit Letter E, Section 2, Township 29 North, Range 12 West, NMPM, San Juan County, New Mexico. Approximately 2,000 barrels per day of non-hazardous oil field liquid waste are disposed of by injection into the Point Lookout Formation at a depth from 4,380 to 4,480 feet. The total dissolved solids concentration of the injection water is approximately 24,000 mg/l. The total dissolved solids concentration of the formation fluids is approximately 14,000 mg/l. The discharge plan addresses construction, operation and monitoring of the well and associated surface facilities and provides a contingency plan in the event of accidental spills, leaks and other accidental discharges to the ground surface. Ground water most likely to be affected by any accidental discharge is at a depth from 78 to 90 feet and has a total dissolved solids concentration of approximately 450 mg/l.

(GW-019) – Loco Hills GSF has purchased the Amerigas Gas Corporation's Loco Hills L.P. Gas underground salt cavern storage facility located in NW/4 SW/4 of Section 22, Township 17 South, Range 29 East, NMPM, Eddy County, New Mexico. Loco Hills GSF has submitted a discharge plan modification to construct a new 186,540 barrel double lined storage pond with leak detection to store brine water. Groundwater most likely to be affected by an accidental discharge is at a depth of 80-90 feet with a total dissolved solids concentration of 0-10,000 mg/l. The discharge plan addresses how spill, leaks, and other accidental discharges to the surface will be managed.

Any interested person may obtain further information from the Oil Conservation Division and may submit written comments to the Director of the Oil Conservation Division at the address given above. The discharge permit application and draft discharge permit may be viewed at the above address between 8:00 a.m. and 4:00 p.m., Monday through Friday. The draft discharge permit may also be viewed at OCD's web site http://www.emnrd.state.nm.us/ocd/. Prior to ruling on any proposed discharge permit or its modification, the Director of the Oil Conservation Division shall allow at least thirty (30) days after the date of publication of this notice during which comments may be submitted and any interested person may request a public hearing. Requests for a public hearing shall set forth the reasons why a hearing should be held. A hearing will be held if the Director determines there is significant public interest.

If no public hearing is held, the Director will approve or disapprove the proposed permit based on information available. If a public hearing is held, the director will approve or disapprove the proposed permit based on information in the permit and information submitted at the hearing.

GIVEN under the Seal of New Mexico Oil Conservation Commission at Santa Fe, New Mexico, on this 24th day of June 2003.

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

SEAL
LORI WROTENBERY,
Director

Legal #73788

Pub. August 1, 2003

THE SANTA FE
NEW MEXICAN
Founded 1849

RECEIVED

AUG 0 5 2003

OIL CONSERVATION
DIVISION

Ed Martin
NM OIL CONSERVATION D
1220 ST. FRANCIS DR
ATT MARY ANAYA
SANTA FE NM 87505

ALTERNATE ACCOUNT: 56689	
AD NUMBER: 00019826 ACCOUNT: 00002212	
LEGAL NO: 73788	P.O. #: 04.199.050340
333 LINES 1 TIME(S)	227.92
AFFIDAVIT:	5.25
TAX:	15.59
TOTAL:	248.76

AFFIDAVIT OF PUBLICATION

STATE OF NEW MEXICO
COUNTY OF SANTA FE

I, K. Voorhees, being first duly sworn declare and say that I am Legal Advertising Representative of THE SANTA FE NEW MEXICAN, a daily newspaper published in the English language, and having a general circulation in the Counties of Santa Fe and Los Alamos, State of New Mexico and being a newspaper duly qualified to publish legal notices and advertisements under the provisions of Chapter 167 on Session Laws of 1937; that the publication # 73788 a copy of which is hereto attached was published in said newspaper 1 day(s) between 08/01/2003 and 08/01/2003 and that the notice was published in the newspaper proper and not in any supplement; the first date of publication being on the 1st day of August, 2003 and that the undersigned has personal knowledge of the matter and things set forth in this affidavit.

/S/ K. Voorhees
LEGAL ADVERTISEMENT REPRESENTATIVE

Subscribed and sworn to before me on this 1st day of August, 2003

Notary Laura E. Harding

Commission Expires: 11/23/03

OK Wayne Price 8/27/03

Price, Wayne

From: Price, Wayne
Sent: Thursday, July 24, 2003 11:01 AM
To: mitchel Johnson-son (E-mail)
Subject: Public Notice

Dear Mitchel:

Please find attached a copy of the public notice that OCD will be issuing. Please note under the WQCC public notice regulations you are required to issue public notice and provide proof to OCD. Please find attached a copy of the public notice regs and a flow chart to assist you.

PUBNOT.DOC   Public Notice Reg's..doc   PN Flow Chart.doc

Also please note the plat seems to have the SE corner marked wrong. it is showing NE.

Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

56689

LEGALS

rict 1)
E OF WORK:
dway Rehabilitation
ITRACT TIME: 120
king Days
GOAL: The ap-
ed FY 2003 State
Goal on Federally
sted projects is es-
shed at 8.36%. At
time NMSHTD will
t the State DBE on
erally-assisted pro-
through race neu-
measures. There is
DBE project goal es-
shed for this project.
ENSES: (GA-1 Or
98)

(2)
P-043-1(17)304 - CN
3912R

MINI: US 54, Jct
237, Tucumcari for
0 miles
JNTY: Quay (District

PE OF WORK:
dway Reconstruc-

NTRACT TIME: To
completed by No-
nber 30, 2003
E GOAL:
approved FY 2003
te DBE Goal on Fed-
lly assisted projects
established at 8.36%.
this time NMSHTD
meet the State DBE
Federally-assisted
jects through race
itral measures.
ere is no DBE project
l established for this
ject.
ENSES: (GA-1 Or
-98)

(3)
PM-TPE-0017(8)02 -
CN 0853

RMINI: NM 17, Vil-
e of Chama MP
78 to 1.689 for 0.610
es
UNTY: Rio Arriba
istrict 5)
PE OF WORK:
adway Reconstruc-
n, Lighting

LEGALS

New Mexico Department of Transportation
Santa Fe, New Mexico

Legal #73750

Pub. July 25; August 1, 8, 15, 2003

NOTICE is hereby given that on July 7, 2003, Harmony Hammond, 5618 State Highway 41, Galisteo, New Mexico 87540, filed Application No. E-24383-B into RG-51167-Enlg. with the **STATE ENGINEER** for Permit to Change Place Use or Purpose of Use of Underground Waters within the Rio Grande Underground Water Basin.

On April 2, 1991, Application No. RG-24383-B into RG-51167 for Permit to Change Location of Well was granted by the State Engineer to divert 2.1 acre feet of water per annum from well No. RG-51167 in the NW1/4 SW1/4 SW1/4 of Section 36, Township 14 North, Range 9 East, NMPM, for the irrigation of 0.70 acres of land located within Tract A-2 of Plat of Survey for H. Peter Gould and Priscilla Hoback and located at a point in the NW1/4 and NE1/4 SW1/4 SW1/4 of said Section 36, and partially within E.W. Eaton Grant. Well RG-51167 is also permitted in accordance with 72-12-1 NMSA.

The applicant proposes to change place of use from said 0.70 acres of land located within said Tract A-2 to 3.493 acres of land being all of said Tract A-2 and to change the purpose of use from flood irrigation to drip irrigation. The applicant states, I want "to en-

LEGALS

INVITATION FOR BID – ADDENDUM

OWNER: New Mexico School for the Deaf, 1060 Cerrillos Road, Santa Fe, New Mexico 87503

PROJECT: Re roof, Re stucco and Miscellaneous Infrastructure at the New Mexico School for the Deaf

BID OPENING: The bid opening of 2:00 p.m., (local time), Wednesday, July 30, 2003 (07/30/2003) is hereby changed to 2:00 p.m., (local time) on Wednesday, August 6, 2003 (08/06/2003). At such date and time, all bids received will be opened and read aloud. Bids received after the time indicated will be returned unopened.

All other facts and circumstances related to the previous invitation for bid announcement remain unchanged.

Legal #73793
Pub. August 1, 4, 5, 6, 2003

NOTICE OF PUBLICATION STATE OF NEW MEXICO ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT OIL CONSERVATION DIVISION

Notice is hereby given that pursuant to New Mexico Water Quality Control Commission Regulations, the following discharge plan application(s) have been submitted to the Director of the Oil Conservation Division, 1220 South St. Francis Drive, Santa Fe, New Mexico

LEGALS

Wolfcamp Formation and the Cisco and Canyon Formations between 7,270 feet and 8894 feet. The total dissolved solids concentration of the injection zone ranges from 13,000 mg/l to 119,909 mg/l. The proposed maximum injection rate into the wells will be 500 gallons per minute with a maximum injection pressure of 1490 psi (WDW-1) and 1454 psi (WDW-2). The total dissolved solids concentration of the injection fluid is expected to range from 1000-5000 mg/l. Ground water most likely to be affected in the event of an accidental discharge is at a depth of approximately 100 feet below ground level with a total dissolved solids concentration ranging from approximately 100 mg/l to 1,535 mg/l. The discharge plan addresses how spills, leaks, and other accidental discharges to the surface will be managed.

UIC-CLI-005 (GW-130) - Key Energy Services, Inc., Mr. Mike Talovich, P.O. Box 900, Farmington, New Mexico, 87499 has submitted a discharge plan renewal application for their permitted Class I disposal well located in Unit Letter E, Section 2, Township 29 North, Range 12 West, NMPM, San Juan County, New Mexico. Approximately 2,000 barrels per day of non-hazardous oil field liquid waste are disposed of by injection into the Point Lookout Formation at a depth from 4,380 to 4,480 feet. The total dissolved solids concentration of the injection water is approximately 24,000 mg/l. The total dis-

LEGALS

MEXICO
OIL CONSERVATION DIVISION

SEAL
LORI WROTENBERY, Director

Legal #73788

Pub. August 1, 2003

Notice of Availability

The U.S. Army Corps of Engineers, Albuquerque District, has completed the Draft Findings of No Significant Impact and Environmental Assessment (DFONSI/EA) entitled "Relocation of the Al Black Recreation Area at the Cochiti Dam Outlet Works to Peña Blanca, Sandoval County, New Mexico." The proposed project entails closing public access to the Al Black Recreation Area at Cochiti Dam on New Mexico Highway 22, removing all recreation facilities, and restoring the site to natural conditions. The proposed work at Peña Blanca (NM) on the Rio Grande involves construction of public recreation facilities that include an access road, parking lot, and a vault toilet and floating fishing pier with universal accessibility.

The DFONSI/EA is electronically available for viewing and copying at the Albuquerque District website (under "Environmental Assessment and FONSI" at:

http://www.spa.usace.army.mil

or a hard copy will be sent upon written request to the following address:

U.S. Army Corps of Engineers

LEGALS

NEW MEXICO STATE TRANSPORTATION COMMISSION NOTICE OF SPECIAL MEETING AUGUST 6, 2003 IN SANTA FE, EW MEXICO

The New Mexico State Transportation Commission will hold a special meeting at 9:00 a.m. on Wednesday August 6, 2003, at the New Mexico Department of Transportation, 1120 Cerrillos Road, Santa Fe, New Mexico, in Training Rooms 1 and 2.

The agenda for the special meeting will be a training workshop for staff of the New Mexico Department of Transportation and others to make presentations to the Commission on the Commission and Department's finances, revenues, budget, potential bonding program, project funding, Gov. Richardson's investment program, federal funding process, statewide transportation improvement plan process, contracting and procurement, construction contracting, and related subject matter. In addition, the Commission will act on setting a new schedule for its regular meetings. If time permits, the Commission may also take part in a "Park and Ride" training trip to Espanola and lunch. No action will be taken during this outing.
Pursuant to the American with Disabilities Act of 1990, unless compelling reasons dictate otherwise, meetings and hearings conducted by the Commission will be held in accessible buildings. Given reasonable notice, interpreters and

LEGALS

Invitation for Proposals

Engineers are invited to submit a sealed proposal to Picuris Pueblo at P.O. Box 127, Penasco, NM 87553 no later than August 4, 2003. Picuris will be requesting funding for a proposed waste water system project from USDA Rural Utilities Service and the Agreement for Engineering Services and design policies of that agency shall be utilized on this project. For a copy of the full proposal packet contact Lyra Barron at (505)587-2519.
Legal #73776
Pub. July 30; August 1. 2003

Santa Fe Indian School New Mexico Tribal Coalition Request for Proposals for Data Management and Communications Specialist

Santa Fe Indian School, located at 1501 Cerrillos Road, Santa Fe, New Mexico, 87502, is accepting bids for a Data Management and Communications Specialist. Under the supervision of the NMTC Project Directors, the contractor will be responsible the following services: Graphic Design – newsletters, website development, promotional materials, forms, and reports to be used in data collection and presentations; Database Design - design, manipulation, and programming of NMTC school database with report customization and conversion to charts and tables; and, Data Management – data migration and follow-up formats to be

TERMINI: NM 48, NM 532 to NM 37 for 6.580 km
COUNTY: Lincoln (District 2)
TYPE OF WORK: Roadway Reconstruction, Bridge Replacement
CONTRACT TIME: To be completed by May 20, 2005 (See Notice To Contractors)
DBE GOAL: The approved FY 2003 State DBE Goal on Federally assisted projects is established at 8.36%. At this time NMSHTD will meet the State DBE on Federally-assisted projects through race neutral measures. There is no DBE project goal established for this project.
LICENSES: (GA-1 Or GA-98) & (GF-2 Or GF-98)

A Pre-Bid Conference (MANDATORY) for CN 1245 will be held on August 7, 2003 at 1:00 PM at the Ruidoso Convention Center 111 Sierra Blanca Drive, Ruidoso, New Mexico. For additional information regarding the Pre-Bid Conference contact Rick Padilla at 505.827.0388

Project Field Reviews with David Dawson, Project Manager, New Mexico Department of Transportation (MANDATORY) for CN 1245 will be held on August 4, 5 & 6, 2003. Contractors must schedule a day and time with the Ruidoso Project Office at 505.257.8424. The Ruidoso Project Office is located at 100 Cree Meadows, Ruidoso, New Mexico. For additional information regarding the Project Field Reviews contact David Dawson at 505.257-8424.

(5)
BR-O-0154(1)01 - CN 2065

TERMINI: NM 154, MP 1.0 for 0.012 miles
COUNTY: Dona Ana (District 1)
TYPE OF WORK: Bridge Replacement
CONTRACT TIME: 30 Working Days
DBE GOAL: The approved FY 2003 State DBE Goal on Federally assisted projects is established at 8.36%. At this time NMSHTD will meet the State DBE on Federally-assisted projects through race neutral measures. There is no DBE project goal established for this project.
LICENSES: (GA-1 Or GA-98) & (GF-2 Or GF-98)
Advertisement Dates: July 25, August 1, 8 & 15, 2003

Rhonda G. Faught, Secretary

cant located within the Village of Galisteo, Santa Fe County, New Mexico.

Any person, firm or corporation or other entity having standing to file objections or protests shall do so in writing (legible, signed, and include the writer's complete name and mailing address). The objection to the approval of the application: (1) if impairment, you must specifically identify your water rights; and/or (2) if public welfare or conservation of water within the state of New Mexico, you must show you will be substantially effected. The written protest must be filed, in triplicate, with the State Engineer, 121 Tijeras NE Suite 2000, Albuquerque, NM 87102, within ten (10) days after the date of the last publication of this Notice. Facsimiles (faxes) will be accepted as a valid protest as long as the hard copy is sent within the 24-hour period. Protests can be faxed to (505)764-3892. If no valid protest or objection is filed, the State Engineer will evaluate the application in accordance with Sections 72-2-16, 72-5-6, 72-6-5, and 72-12-3.
Legal #73792
Pub. August 1, 8, 15, 2003

Notice of Invitation to Bid

The Alternative Fuels Vehicle Network (AFVN) will accept sealed bids from qualified respondents to provide equipment hardware and installation for one (1) to five (5) ethanol (E-85) public fueling stations. Equipment bids will include a dispenser and a 10,000 gallon E-85 tank with the option of installation both above and below ground at the public site. Dispenser will have universal card access capability. Bids shall provide a separate equipment list and cost and a separate installation (estimated) cost. Stations will be installed in and around the communities of Albuquerque, Los Alamos and Santa Fe. Bids will be accepted until 5:00 pm local time on Friday, August 8, 2003. Bids received after this time will not be accepted. All bids must be submitted in a sealed envelope. Specific questions regarding the bid can be made to AFVN at 505-856-8585. Bids will be submitted to AFVN, 11621 San Antonio NE, Albuquerque, NM, 87122.
Legal #73761
Pub. July 29, 30, 31; August 4, 2003

closed top receptacle prior to transport off-site to an OCD approved disposal facility. Groundwater most likely to be affected by a spill, leak, or accidental discharge to the surface is at a depth of approximately 15 feet with a total dissolved solids concentration of approximately 675 mg/L. The discharge plan addresses how spills, leaks, and other accidental discharges to the surface will be managed.

(BW-025) Paul Prather, P.O. Box 7169, Eunice, New Mexico 88231, has submitted a discharge plan renewal application for the CSI Brine Sales Station located in the NE/4 NE/4 of Section 20, Township 25 South, Range 37 East, NMPM, Lea County, New Mexico. Fresh water from the City of Jal is injected into the Salado Formation at an approximate depth of 1,150 feet and brine water is extracted with an average total dissolved solids concentration of 350,000 mg/l. The brine water is stored in four 1,000 barrel above ground closed top tanks. The plan includes a chemical storage dock and a below grade concrete pit for temporary storage of exempt oilfield waste. Ground water most likely to be affected in the event of an accidental discharge is at a depth of approximately 40 feet with a total dissolved solids concentration of approximately 875 mg/l. The discharge plan addresses how spills, leaks, and other accidental discharges to the surface will be managed.

(UIC-CL1-008) - Navajo Refining Company, Darrell Moore, (505) 748-3311, P.O. Box 159, Artesia, New Mexico, 88211, has submitted a discharge plan renewal application for their Class I non-hazardous disposal wells for disposal of non-hazardous fluids generated at the Artesia and Lovington refineries. The non-hazardous fluids will be transported to the injection wells by pipeline. The wells named "Navajo WDW-1 and WDW-2" are located approximately 11 miles southeast of Artesia, New Mexico found in section 31 (660 FSL-2310 FEL), Township 17 South, Range 28 East and Section 12 (1980 FNL-660 FWL, Township 18 South, Range 27 East, respectively, NMPM, Eddy County, New Mexico. The proposed injection zone will be the lower

has a total dissolved solids concentration of approximately 450 mg/l.

(GW-019) - Loco Hills GSF has purchased the Amerigas Gas Corporation's Loco Hills L.P. Gas underground salt cavern storage facility located in NW/4 SW/4 of Section 22, Township 17 South, Range 29 East, NMPM, Eddy County, New Mexico. Loco Hills GSF has submitted a discharge plan modification to construct a new 186,540 barrel double lined storage pond with leak detection to store brine water. Groundwater most likely to be affected by an accidental discharge is at a depth of 80-90 feet with a total dissolved solids concentration of 0-10,000 mg/l. The discharge plan addresses how spill, leaks, and other accidental discharges to the surface will be managed.

Any interested person may obtain further information from the Oil Conservation Division and may submit written comments to the Director of the Oil Conservation Division at the address given above. The discharge permit application and draft discharge permit may be viewed at the above address between 8:00 a.m. and 4:00 p.m., Monday through Friday. The draft discharge permit may also be viewed at OCD's web site http://www.emnrd.state.nm.us/ocd/. Prior to ruling on any proposed discharge permit or its modification, the Director of the Oil Conservation Division shall allow at least thirty (30) days after the date of publication of this notice during which comments may be submitted and any interested person may request a public hearing. Requests for a public hearing shall set forth the reasons why a hearing should be held. A hearing will be held if the Director determines there is significant public interest.

If no public hearing is held, the Director will approve or disapprove the proposed permit based on information available. If a public hearing is held, the director will approve or disapprove the proposed permit based on information in the permit and information submitted at the hearing.

GIVEN under the Seal of New Mexico Oil Conservation Commission at Santa Fe, New Mexico, on this 24th day of June 2003.

STATE OF NEW

ernest.w.jahnke@usace.army.mil.

A public meeting on this proposal will be held on Thursday, August 28, 2003, from 6:30 to 8:30 PM at the Rio Rancho High School Performing Arts Center, 301 Loma Colorado, NE, Rio Rancho, NM.
Legal #73740
Pub. August 1, 2003

NOTIFICATION OF DISPOSITION OF COLLATERAL

NOTICE OF PUBLIC SALE

NAME OF DEBTOR: ALL ONE TRIBE, INC.

CREDITOR: FIRST STATE BANK N.M.: P.O. Box 3686 Albuquerque, N.M. 87190 Attention: Ms. Cynthia Richards, phone 241-7677

DEBT: Debt owed to First State Bank by ALL ONE TRIBE, INC. May 8, 2000 Promissory Note; Original Principal Amount $183,000.00; Loan #327336

DESCRIPTION OF COLLATERAL TO BE SOLD:

All inventory, accounts, equipment, general intangibles, fixtures and furniture of the Debtor.

NOTICE OF SALE: Pursuant to N.M. Stat. Ann. # 55-9-610 (1978), the interest of First State Bank in the above-described Collateral will be offered for sale at a public auction, as follows:
Day: Saturday
Date: August 2, 2003
Time: 9:00 a.m.
Place of Sale: 1219 E. Gusdorf Road, Taos, New Mexico 87571

The collateral will be sold to the highest qualified bidder, however, the Bank reserves the right to reject any bid that it does not consider acceptable, and the Bank reserves the right to take any other action necessary to sell the subject Collateral in a commercially reasonable manner.

DISCLAIMER: The interest of First State Bank in the above-described Collateral will be sold "as is," without warranty, express or implied. There will be no warranty relating to title, possession, quiet enjoyment, or the like in this disposition.

FIRST STATE BANK

By Cynthia Richards
Assistant Vice President
Legal #73760
Pub. July 28, 29, 30, 31; August 1, 2003

SOFTWARE TO RUN THE COUNTY FINANCE, TREASURER, ASSESSOR, SOLID WASTE AND CLERK'S OFFICES

General:
The County of San Miguel is requesting proposals for software to run the County's Finance, Payroll, Treasurer, Assessor, Solid Waste and Clerk's offices. The software should be designed to interface with all modules and run the daily operations of the said offices and meet all federal and state requirements. All interested firms submitting proposals must submit to the County Manager's office a firm proposal of their respective software. The bidder must identify the hardware requirements, outside licenses (i.e., compiler licenses, etc.) and any other cost the county will have to incur in order to operate the proposed software.

Request for Proposals may be obtained from the County Manager's office at 500 West National Avenue, Suite 100, Las Vegas, New Mexico. Proposals must be delivered to the County Manager's office at 500 West National Avenue, Suite 100, Las Vegas New Mexico by 3:00 p.m. on or before August 13, 2003. The envelope containing the proposal shall be labeled **"PROPOSALS FOR SOFTWARE TO RUN THE COUNTY FINANCE, TREASURER, ASSESSOR, SOLID WASTE AND CLERK'S OFFICES** on the lower left hand corner. It shall be the responsibility of the Bidders to see that its proposal is delivered to the County Manager by the date set above. If the delivery of the proposal by whatever means is delayed beyond the opening time and date set, the proposal will not be opened nor considered. The Bidders shall provide five (5) copies of its proposal.

The County shall open sealed proposals on August 14, 2003. The Proposals will be opened at 10:00 a.m. in the County Manager's Office, 500 West National Avenue, Suite 100, Las Vegas New Mexico, 87701

/s/MELINDA GONZALES, FINANCE DIVISION SUPERVISOR

/s/Les Montoya, County Manager

Legal #73794

Pub. August 1, 2003

pm on
August
Please
989-6340 f
mation. S
dian Scho
the right to
any propos
an EEO E
Indian Pref
cies.

Legal #7377

Pub. July 3
1, 2003

STATE OF NEW MEXIC
C

IN THE P
COU

IN THE MAT
OF THE EST
OF KATHER
BROWNLIE, Deceased.

PR

NOTIC
CRED

Ruby Auburg
appointed
Representati
Estate of K
Brownlie, de
persons hav
against this
required to p
claims wit
months after
the first pub
this Notice or
will be forev
Claims must
sented either
sonal Rep
c/o Worcester
P.C., Attentio
P. Worcester,
fice Box 17
Fe, New
87504-1717,
with the Prob
of Santa Fe
New Mexico.

DATED: 7-16-

RUBY

WORCESTER
McKAY, P.C.

By: Robert P. V
Post Office Bo
Santa Fe, Ne
87504-1717
(505)820-2244

Attorneys for
Representative

Legal #73748

Pub. July 25;
August 1, 2003

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

RECEIVED
JUL 2 4 2003
OIL CONSERVATION DIVISION

State of New Mexico
Energy, Minerals and Natural Resources Department

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Revised June 10, 2003

Submit Original
Plus 1 Copy
to Santa Fe
1 Copy to Appropriate
District Office

DISCHARGE PLAN APPLICATION FOR BRINE EXTRACTION FACILITES

(Refer to the OCD Guidelines for assistance in completing the application)

☐ New ☐ Renewal X Modification

I. Facility Name: Loco Hills GSF. Ltd.

II. Operator: Loco Hills GSF, Ltd.

Address: 158 Deer Creek Drive, Aledo, TX 76008

Contact Person: Mitchel Johnson Phone: 817-441-6568

III. Location: *State Lease: BL-635, NW ¼ SW ¼ of Section 22, Township 17 South, Range 29 East*
Submit large scale topographic map showing exact location. (one has recently been filed)

IV. Attach the name and address of the landowner of the facility site.
See existing Discharge Plan

V. Attach a description of the types and quantities of fluids at the facility.
See existing Discharge Plan

VI. Attach a description of all fluid transfer and storage and fluid and solid disposal facilities.
See existing Discharge Plan

VII. Attach a description of underground facilities (i.e. brine extraction well).
See existing Discharge Plan

VIII. Attach a contingency plan for reporting and clean-up of spills or releases.
See existing Discharge Plan

IX. Attach geological/hydrological evidence demonstrating that brine extraction operations will not adversely impact fresh water.
See existing Discharge Plan

X. Attach such other information as is necessary to demonstrate compliance with any other OCD rules, regulations and/or orders.
This is a request to modify the current Discharge Plan to include the building of a new brine pond with an approximate capacity of 7 million gallons.

XI. CERTIFICATION:

I hereby certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

Name: Mitchel Johnson Title: Operations Manager

Signature: [signature] Date: 7/22/03

E-mail Address: mitchel_lhgsf@hotmail.com

NOTICE OF PUBLICATION

STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION

Notice is hereby given that pursuant to New Mexico Water Quality Control Commission Regulations, the following discharge permit application(s) has been submitted to the Director of the Oil Conservation Division, 1220 S. Saint Francis Drive, Santa Fe, New Mexico 87505, Telephone (505) 476-3440:

> **(GW-019) – Loco Hills GSF has purchased the Amerigas Gas Corporation's Loco Hills L.P. Gas underground salt cavern storage facility located in** NW/4 SW/4 of Section 22, Township 17 South, Range 29 East, NMPM, Eddy County, New Mexico. **Loco Hills GSF has submitted a discharge plan modification to construct a new 186,540 barrel double lined storage pond with leak detection to store brine water. Groundwater most likely to be affected by an accidental discharge is at a depth of 80-90 feet with a total dissolved solids concentration of** 0-10,000 mg/l. **The discharge plan addresses how spill, leaks, and other accidental discharges to the surface will be managed.**

Any interested person may obtain further information from the Oil Conservation Division and may submit written comments to the Director of the Oil Conservation Division at the address given above. The discharge permit application and draft discharge permit may be viewed at the above address between 8:00 a.m. and 4:00 p.m., Monday through Friday. The draft discharge permit may also be viewed at OCD's web site http://www.emnrd.state.nm.us/ocd/. Prior to ruling on any proposed discharge permit or its modification, the Director of the Oil Conservation Division shall allow at least thirty (30) days after the date of publication of this notice during which comments may be submitted and a public hearing may be requested by any interested person. Requests for a public hearing shall set forth the reasons why a hearing should be held. A hearing will be held if the Director determines there is significant public interest.

If no public hearing is held, the Director will approve or disapprove the proposed permit based on information available. If a public hearing is held, the director will approve or disapprove the proposed permit based on information in the permit and information submitted at the hearing.

GIVEN under the Seal of New Mexico Oil Conservation Commission at Santa Fe, New Mexico, on this 24th day of June 2003.

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

S E A L

LORI WROTENBERY, Director

Price, Wayne

From: Price, Wayne
Sent: Monday, July 21, 2003 11:06 AM
To: 'Mitchel Johnson'
Subject: RE: Modification BW-019

You are hereby approved to sell brine for a period not to exceed 6 months.

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
Sent: Monday, July 21, 2003 10:56 AM
To: WPrice@state.nm.us
Subject: RE: Modification BW-019

This would be temporary. It would come straight out of the pond. We would not be washing the caverns to get the brine. This would, also, help our situation until the new brine pond was built.

>From: "Price, Wayne" <WPrice@state.nm.us>
>To: 'Mitchel Johnson' <mitchel_lhgsf@hotmail.com>
>Subject: RE: Modification BW-019
>Date: Mon, 21 Jul 2003 10:23:59 -0600
>
>Selling of brine water is not in your permit. If this is just a temporary
>situation then I can give you permission. Long term I think might be a
>problem because it will enlarge your caverns.
>
>-----Original Message-----
>From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
>Sent: Monday, July 21, 2003 10:11 AM
>To: WPrice@state.nm.us
>Subject: RE: Modification BW-019
>
>
>Wayne,
>We are researching this issue and I will get back to you. Wayne, I have
>yet
>
>to find anyone with a brine pond where the intlet and outlet go over the
>top
>
>of the pond. I am being told that "over the top" is the way the ponds used
>to be constructed, however everyone got away from that due to the pumps
>ability to stay primed, and that today's standard is to go through the
>bottom of the pond. If you know of any ponds that are "going over the top"
>please inform me so that I may contact them to see how it is working. I
>have several pump companies looking at the type of pump it would take. Any
>input you would have would be greatly appreciated.
>
>Also, I have a customer that is wanting to buy some of our brine. Is there
>any paperwork that we would have to fill out with NM OCD to be able to sell
>brine?
>
>Thank you,
>Mitchel Johnson
>Loco Hills GSF
>
>
> >From: "Price, Wayne" <WPrice@state.nm.us>

> >To: 'Mitchel Johnson' <mitchel_lhgsf@hotmail.com>
> >Subject: RE: Modification BW-019
> >Date: Mon, 21 Jul 2003 10:00:48 -0600
> >
> >Thanks for the info, but as we discussed OCD is concerned about the
>design
> >of the inlet-outlet pipe being installed without secondary containment.
> >Please address this issue.
> >
> >-----Original Message-----
> >From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
> >Sent: Thursday, July 17, 2003 12:35 PM
> >To: WPrice@state.nm.us
> >Subject: RE: Modification BW-019
> >
> >
> >Wayne,
> >
> >The BL is NW 1/4 SW 1/4 of Section 22, Township 17 South, Range 29 East,
> >N.M.P.M., Eddy County, New Mexico.
> >
> >The lab results for total dissolved solids concentration from our water
> >wells for this pond are:
> >Well 1: 67,950 mg/l
> >Well 2: 69,220 mg/l
> >
> >Yes, there is a second liner planned for this pond. The current plan is
> >using a primary liner 60 mil polypropylene, and the secondary liner is 36
> >mil polypropylene.
> >
> >The details on the liner under current consideration is at
>www.gseworld.com
> >under Products, GSE HD. I will put a copy of the literature in with the
> >check and form I'm sending to you.
> >
> >If you have any more questions, please don't hesitate to contact us. We
> >welcome your input.
> >
> >Thank you,
> >Mitchel Johnson
> >Loco Hills GSF
> >
> > >From: "Price, Wayne" <WPrice@state.nm.us>
> > >To: "Price, Wayne" <WPrice@state.nm.us>, "'mitchel Johnson-son
>(E-mail)'"
> > ><mitchel_lhgsf@hotmail.com>
> > >Subject: RE: Modification BW-019
> > >Date: Thu, 17 Jul 2003 08:55:34 -0600
> > >
> > >This one has the attachment <<PUBNOT.DOC>>
> > >
> > > > > -----Original Message-----
> > > > From: Price, Wayne
> > > > Sent: Wednesday, July 16, 2003 4:44 PM
> > > > To: mitchel Johnson-son (E-mail)
> > > > Subject: Modification BW-019
> > > >
> > > > Dear Mitchel:
> > > >
> > > > Please find attach a draft public notice. Please note the items
> > > > highlighted, I need the correct legal description and TDS of
> > >groundwater.
> > > >
> > > > Also please provide me with the technical info for the liners and
> > > > installation specs. Will the pipes located under the pond have

> > >secondary
> > > > containment?
> > > >
> > > > << OLE Object: Microsoft Word Document >>
> > > >
> > > > Sincerely:
> > > > << OLE Object: Picture (Metafile) >>
> > > > Wayne Price
> > > > New Mexico Oil Conservation Division
> > > > 1220 S. Saint Francis Drive
> > > > Santa Fe, NM 87505
> > > > 505-476-3487
> > > > fax: 505-476-3462
> > > > E-mail: WPRICE@state.nm.us
> > > >
> > > >
> > > >
> > > >
> > ><< PUBNOT.DOC >>
> >
> >____

>
>____

____

Price, Wayne

From: Price, Wayne
Sent: Monday, July 21, 2003 10:24 AM
To: 'Mitchel Johnson'
Subject: RE: Modification BW-019

Selling of brine water is not in your permit. If this is just a temporary situation then I can give you permission. Long term I think might be a problem because it will enlarge your caverns.

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
Sent: Monday, July 21, 2003 10:11 AM
To: WPrice@state.nm.us
Subject: RE: Modification BW-019

Wayne,
We are researching this issue and I will get back to you. Wayne, I have yet to find anyone with a brine pond where the intlet and outlet go over the top of the pond. I am being told that "over the top" is the way the ponds used to be constructed, however everyone got away from that due to the pumps ability to stay primed, and that today's standard is to go through the bottom of the pond. If you know of any ponds that are "going over the top" please inform me so that I may contact them to see how it is working. I have several pump companies looking at the type of pump it would take. Any input you would have would be greatly appreciated.

Also, I have a customer that is wanting to buy some of our brine. Is there any paperwork that we would have to fill out with NM OCD to be able to sell brine?

Thank you,
Mitchel Johnson
Loco Hills GSF

>From: "Price, Wayne" <WPrice@state.nm.us>
>To: 'Mitchel Johnson' <mitchel_lhgsf@hotmail.com>
>Subject: RE: Modification BW-019
>Date: Mon, 21 Jul 2003 10:00:48 -0600
>
>Thanks for the info, but as we discussed OCD is concerned about the design
>of the inlet-outlet pipe being installed without secondary containment.
>Please address this issue.
>
>-----Original Message-----
>From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
>Sent: Thursday, July 17, 2003 12:35 PM
>To: WPrice@state.nm.us
>Subject: RE: Modification BW-019
>
>
>Wayne,
>
>The BL is NW 1/4 SW 1/4 of Section 22, Township 17 South, Range 29 East,
>N.M.P.M., Eddy County, New Mexico.
>
>The lab results for total dissolved solids concentration from our water
>wells for this pond are:
>Well 1: 67,950 mg/l

>Well 2: 69,220 mg/l
>
>Yes, there is a second liner planned for this pond. The current plan is
>using a primary liner 60 mil polypropylene, and the secondary liner is 36
>mil polypropylene.
>
>The details on the liner under current consideration is at www.gseworld.com
>under Products, GSE HD. I will put a copy of the literature in with the
>check and form I'm sending to you.
>
>If you have any more questions, please don't hesitate to contact us. We
>welcome your input.
>
>Thank you,
>Mitchel Johnson
>Loco Hills GSF
>
> >From: "Price, Wayne" <WPrice@state.nm.us>
> >To: "Price, Wayne" <WPrice@state.nm.us>, "'mitchel Johnson-son (E-mail)'"
> ><mitchel_lhgsf@hotmail.com>
> >Subject: RE: Modification BW-019
> >Date: Thu, 17 Jul 2003 08:55:34 -0600
> >
> >This one has the attachment <<PUBNOT.DOC>>
> >
> > > -----Original Message-----
> > > From: Price, Wayne
> > > Sent: Wednesday, July 16, 2003 4:44 PM
> > > To: mitchel Johnson-son (E-mail)
> > > Subject: Modification BW-019
> > >
> > > Dear Mitchel:
> > >
> > > Please find attach a draft public notice. Please note the items
> > > highlighted, I need the correct legal description and TDS of
> >groundwater.
> > >
> > > Also please provide me with the technical info for the liners and
> > > installation specs. Will the pipes located under the pond have
> >secondary
> > > containment?
> > >
> > > << OLE Object: Microsoft Word Document >>
> > >
> > > Sincerely:
> > > << OLE Object: Picture (Metafile) >>
> > > Wayne Price
> > > New Mexico Oil Conservation Division
> > > 1220 S. Saint Francis Drive
> > > Santa Fe, NM 87505
> > > 505-476-3487
> > > fax: 505-476-3462
> > > E-mail: WPRICE@state.nm.us
> > >
> > >
> > >
> > >
> ><< PUBNOT.DOC >>
>
>
>Tired of spam? Get advanced junk mail protection with MSN 8.
>http://join.msn.com/?page=features/junkmail

Price, Wayne

From: Price, Wayne
Sent: Monday, July 21, 2003 10:01 AM
To: 'Mitchel Johnson'
Subject: RE: Modification BW-019

Thanks for the info, but as we discussed OCD is concerned about the design of the inlet-outlet pipe being installed without secondary containment. Please address this issue.

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
Sent: Thursday, July 17, 2003 12:35 PM
To: WPrice@state.nm.us
Subject: RE: Modification BW-019

Wayne,

The BL is NW 1/4 SW 1/4 of Section 22, Township 17 South, Range 29 East, N.M.P.M., Eddy County, New Mexico.

The lab results for total dissolved solids concentration from our water wells for this pond are:
Well 1: 67,950 mg/l
Well 2: 69,220 mg/l

Yes, there is a second liner planned for this pond. The current plan is using a primary liner 60 mil polypropylene, and the secondary liner is 36 mil polypropylene.

The details on the liner under current consideration is at www.gseworld.com under Products, GSE HD. I will put a copy of the literature in with the check and form I'm sending to you.

If you have any more questions, please don't hesitate to contact us. We welcome your input.

Thank you,
Mitchel Johnson
Loco Hills GSF

>From: "Price, Wayne" <WPrice@state.nm.us>
>To: "Price, Wayne" <WPrice@state.nm.us>, "'mitchel Johnson-son (E-mail)'"
><mitchel_lhgsf@hotmail.com>
>Subject: RE: Modification BW-019
>Date: Thu, 17 Jul 2003 08:55:34 -0600
>
>This one has the attachment <<PUBNOT.DOC>>
>
> > -----Original Message-----
> > From: Price, Wayne
> > Sent: Wednesday, July 16, 2003 4:44 PM
> > To: mitchel Johnson-son (E-mail)
> > Subject: Modification BW-019
> >
> > Dear Mitchel:
> >
> > Please find attach a draft public notice. Please note the items
> > highlighted, I need the correct legal description and TDS of
>groundwater.
> >

> > Also please provide me with the technical info for the liners and
> > installation specs. Will the pipes located under the pond have
>secondary
> > containment?
> >
> > << OLE Object: Microsoft Word Document >>
> >
> > Sincerely:
> > << OLE Object: Picture (Metafile) >>
> > Wayne Price
> > New Mexico Oil Conservation Division
> > 1220 S. Saint Francis Drive
> > Santa Fe, NM 87505
> > 505-476-3487
> > fax: 505-476-3462
> > E-mail: WPRICE@state.nm.us
> >
> >
> >
> >
><< PUBNOT.DOC >>

Price, Wayne

From: Price, Wayne
Sent: Thursday, July 17, 2003 1:16 PM
To: 'Mitchel Johnson'
Subject: RE: Modification BW-019

Dear Mitchel: Will your new pond have inlet-outlet pipes below the pond, if so will these have secondary containment?

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
Sent: Thursday, July 17, 2003 12:35 PM
To: WPrice@state.nm.us
Subject: RE: Modification BW-019

Wayne,

The BL is NW 1/4 SW 1/4 of Section 22, Township 17 South, Range 29 East, N.M.P.M., Eddy County, New Mexico.

The lab results for total dissolved solids concentration from our water wells for this pond are:
Well 1: 67,950 mg/l
Well 2: 69,220 mg/l

Yes, there is a second liner planned for this pond. The current plan is using a primary liner 60 mil polypropylene, and the secondary liner is 36 mil polypropylene.

The details on the liner under current consideration is at www.gseworld.com under Products, GSE HD. I will put a copy of the literature in with the check and form I'm sending to you.

If you have any more questions, please don't hesitate to contact us. We welcome your input.

Thank you,
Mitchel Johnson
Loco Hills GSF

>From: "Price, Wayne" <WPrice@state.nm.us>
>To: "Price, Wayne" <WPrice@state.nm.us>, "'mitchel Johnson-son (E-mail)'"
><mitchel_lhgsf@hotmail.com>
>Subject: RE: Modification BW-019
>Date: Thu, 17 Jul 2003 08:55:34 -0600
>
>This one has the attachment <<PUBNOT.DOC>>
>
> > -----Original Message-----
> > From: Price, Wayne
> > Sent: Wednesday, July 16, 2003 4:44 PM
> > To: mitchel Johnson-son (E-mail)
> > Subject: Modification BW-019
> >
> > Dear Mitchel:
> >
> > Please find attach a draft public notice. Please note the items
> > highlighted, I need the correct legal description and TDS of
>groundwater.
> >

> > Also please provide me [illegible]n the technical info for the [illegible]rs and
> > installation specs. Will the pipes located under the pond have
>secondary
> > containment?
> >
> > << OLE Object: Microsoft Word Document >>
> >
> > Sincerely:
> > << OLE Object: Picture (Metafile) >>
> > Wayne Price
> > New Mexico Oil Conservation Division
> > 1220 S. Saint Francis Drive
> > Santa Fe, NM 87505
> > 505-476-3487
> > fax: 505-476-3462
> > E-mail: WPRICE@state.nm.us
> >
> >
> >
> >
><< PUBNOT.DOC >>

Price, Wayne

From: Mitchel Johnson [mitchel_lhgsf@hotmail.com]
Sent: Thursday, July 17, 2003 12:35 PM
To: WPrice@state.nm.us
Subject: RE: Modification BW-019

Wayne,

The BL is NW 1/4 SW 1/4 of Section 22, Township 17 South, Range 29 East, N.M.P.M., Eddy County, New Mexico.

The lab results for total dissolved solids concentration from our water wells for this pond are:
Well 1: 67,950 mg/l
Well 2: 69,220 mg/l

Yes, there is a second liner planned for this pond. The current plan is using a primary liner 60 mil polypropylene, and the secondary liner is 36 mil polypropylene.

The details on the liner under current consideration is at www.gseworld.com under Products, GSE HD. I will put a copy of the literature in with the check and form I'm sending to you.

If you have any more questions, please don't hesitate to contact us. We welcome your input.

Thank you,
Mitchel Johnson
Loco Hills GSF

>From: "Price, Wayne" <WPrice@state.nm.us>
>To: "Price, Wayne" <WPrice@state.nm.us>, "'mitchel Johnson-son (E-mail)'"
><mitchel_lhgsf@hotmail.com>
>Subject: RE: Modification BW-019
>Date: Thu, 17 Jul 2003 08:55:34 -0600
>
>This one has the attachment <<PUBNOT.DOC>>
>
> > -----Original Message-----
> > From: Price, Wayne
> > Sent: Wednesday, July 16, 2003 4:44 PM
> > To: mitchel Johnson-son (E-mail)
> > Subject: Modification BW-019
> >
> > Dear Mitchel:
> >
> > Please find attach a draft public notice. Please note the items
> > highlighted, I need the correct legal description and TDS of
>groundwater.
> >
> > Also please provide me with the technical info for the liners and
> > installation specs. Will the pipes located under the pond have
>secondary
> > containment?
> >
> > << OLE Object: Microsoft Word Document >>
> >
> > Sincerely:
> > << OLE Object: Picture (Metafile) >>
> > Wayne Price

> > New.Mexico Oil Conservation Division
> > 1220 S. Saint Francis Drive
> > Santa Fe, NM 87505
> > 505-476-3487
> > fax: 505-476-3462
> > E-mail: WPRICE@state.nm.us
> >
> >
> >
> >
><< PUBNOT.DOC >>

From:	Price, Wayne
Sent:	Wednesday, July 16, 2003 2:06 PM
To:	'mitchel_lhgsf@hotmail.com'
Cc:	Stubblefield, Mike; Carr, Jim
Subject:	Loco Hills GSF LP gas storage GW-019-Modification Installation of new brine storage pond
Contacts:	mitchel Johnson-son

Dear Mitchel:

Please submit the modification application from with $100 filing fee. OCD will issue public notice today and will wait 30 days for comments. I have attached the new Public Regulations and flow chart for your review. Once you have completed your part of the public notice then provide the OCD proof of notice. At that time we should have completed our technical review for approval process.

Pursuant to our telephone conversation I think you should have a minimum of 20 foot setback from the west property line. If this causes a safety or operational problem please let me know as soon as possible. You may begin preliminary work before permit approval at your own risk, since permit conditions may be changed due to public input.

PN Flow Chart.doc

Public Notice Reg's..doc

Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

Tracking:

Recipient	Read
'mitchel_lhgsf@hotmail.com'	
Stubblefield, Mike	
Carr, Jim	Read: 7/16/2003 2:10 PM

Loco Hills GSF

158 Deer Creek Drive
Aledo, TX 76008

RECEIVED

JUL 09 2003

OIL CONSERVATION
DIVISION

July 7, 2003

New Mexico Oil Conservation District
Wayne Price
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

Dear Mr. Price:

Enclosed is a copy of the survey you required before approving the new brine pond we intend to construct. Please contact me if you have any questions at 817-441-6568.

Sincerely,

Mitchel Johnson

Mitchel Johnson
Loco Hills GSF

Tracking:	Recipient	Read
	'Mitchel Johnson'	
	Stubblefield, Mike	Read: 5/15/2003 3:35 PM

Attention: WAYNE PRICE

FROM: MITCHEL JOHNSON

LOCO HILLS GSF

505-677-2331 OFFICE

940-367-0660 CELL

C-103

Submit 3 Copies To Appropriate District Office
District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Ave., Artesia, NM 88210
District III
1000 Rio Brazos Rd., Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy, Minerals and Natural Resources

OIL CONSERVATION DIVISION
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-103
Revised June 10, 2003

WELL API NO. 30-015-06192
5. Indicate Type of Lease STATE ☑ FEE ☐
6. State Oil & Gas Lease No. BL-635
7. Lease Name or Unit Agreement Name Leonard
8. Well Number #1
9. OGRID Number
10. Pool name or Wildcat

SUNDRY NOTICES AND REPORTS ON WELLS

(DO NOT USE THIS FORM FOR PROPOSALS TO DRILL OR TO DEEPEN OR PLUG BACK TO A DIFFERENT RESERVOIR. USE "APPLICATION FOR PERMIT" (FORM C-101) FOR SUCH PROPOSALS.)

1. Type of Well: Oil Well ☐ Gas Well ☑ Other Salt Dome Storage
2. Name of Operator Loco Hills GSF
3. Address of Operator 158 Deer Creek Drive Aledo, Texas 76008
4. Well Location

Unit Letter L : 2065 feet from the South line and 1193 feet from the West line

Section 22 Township 17S Range 29E NMPM County Eddy

11. Elevation (Show whether DR, RKB, RT, GR, etc.) GR

12. Check Appropriate Box to Indicate Nature of Notice, Report or Other Data

NOTICE OF INTENTION TO:		SUBSEQUENT REPORT OF:	
PERFORM REMEDIAL WORK ☒	PLUG AND ABANDON ☐	REMEDIAL WORK ☐	ALTERING CASING ☐
TEMPORARILY ABANDON ☐	CHANGE PLANS ☐	COMMENCE DRILLING OPNS. ☐	PLUG AND ABANDONMENT ☐
PULL OR ALTER CASING ☐	MULTIPLE COMPLETION ☐	CASING TEST AND CEMENT JOB ☐	
OTHER: ☐		OTHER: ☐	

13. Describe proposed or completed operations. (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work). SEE RULE 1103. For Multiple Completions: Attach wellbore diagram of proposed completion or recompletion.

Run cement bond log. If void exists in cement perforate casing + squeeze cement to fill void. If needed circulate cement from plug to surface. Let set and drill out. Perform MIT casing test (300 psi for 30 minutes) If passes then do open hole cavern test. (Nitrogen test not to exceed 300 psi.) for 4 hours

CBL 6/26/03 9:00 AM

other ASAP after C.B.L

I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNATURE John B Smith TITLE Technical Operator DATE 6/25/03

Type or print name John B. Smith E-mail address: Telephone No. (505) 677-2331

(This space for State use)

APPPROVED BY ____ TITLE ____ DATE ____

Conditions of approval, if any:

Wayne Price
New Mexico Oil Conservation Division

J. R. Smith
Loco Hills GSF
June 16, 2003

Mr. Wayne Price:

Amended co C-103 followin. Mr Stubbfield came by concerning open hole cavern testpressure. Test pressure will not exceed 300 psi, per your conversation with Mr Stubbfield early this morning.

JB Smith
Loco Hills GSF

Submit 3 Copies To Appropriate District Office
District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Rd., Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy, Minerals and Natural Resources

OIL CONSERVATION DIVISION
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-103
Revised March 25, 1999

WELL API NO. (30-015) 06192

5. Indicate Type of Lease
STATE ☒ FEE ☐

6. State Oil & Gas Lease No. BL-635

7. Lease Name or Unit Agreement Name: Leonard

8. Well No. 1

9. Pool name or Wildcat

SUNDRY NOTICES AND REPORTS ON WELLS

(DO NOT USE THIS FORM FOR PROPOSALS TO DRILL OR TO DEEPEN OR PLUG BACK TO A DIFFERENT RESERVOIR. USE "APPLICATION FOR PERMIT" (FORM C-101) FOR SUCH PROPOSALS.)

1. Type of Well:
Oil Well ☐ Gas Well ☐ Other Salt Brine Storage

2. Name of Operator
John B. Smith

3. Address of Operator
158 Deer Creek Drive Aledo, Texas 76008

4. Well Location

Unit Letter L : 2069 feet from the South line and 1193 feet from the West line

Section 22 Township 17S Range 29E NMPM County Eddy

10. Elevation (Show whether DR, RKB, RT, GR, etc.)
GR

11. Check Appropriate Box to Indicate Nature of Notice, Report or Other Data

NOTICE OF INTENTION TO:				SUBSEQUENT REPORT OF:			
PERFORM REMEDIAL WORK	☐	PLUG AND ABANDON	☒	REMEDIAL WORK	☐	ALTERING CASING	☐
TEMPORARILY ABANDON	☐	CHANGE PLANS	☐	COMMENCE DRILLING OPNS.	☐	PLUG AND ABANDONMENT	☐
PULL OR ALTER CASING	☐	MULTIPLE COMPLETION	☐	CASING TEST AND CEMENT JOB	☐		
OTHER:			☐	OTHER:			☐

12. Describe proposed or completed operations. (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work). SEE RULE 1103. For Multiple Completions: Attach wellbore diagram of proposed completion or recompilation.

If M.I.T. test fails will pour + squeeze cement, above plug, under pressure

If no loss of cement circulate cement to surface and abandon.

Estimated start date June 23 2003

* Previous set CIBP @ 515' with 5 sx cement on Top of CIBP. 6/16/03 11:15AM. MikeS.

I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNATURE John B Smith TITLE Terminal Operator DATE 6/14/03

Type or print name John B. Smith Telephone No. 505-677-2331

(This space for State use)

APPPROVED BY Mike Stubblefield TITLE Environ. Eng. Spec. DATE 6/16/2003.

Conditions of approval, if any:

* Perforate 5½" casing @ 475'. Squeeze cement under Packer with 25 sx cement. Leaving 6/16/03. M.S. 11:15AM

* Notify N.M.O.C.D. to witness. 100' cement Plug inside + outside 5½" csg. TAG Toc. Circulate cmt to surface

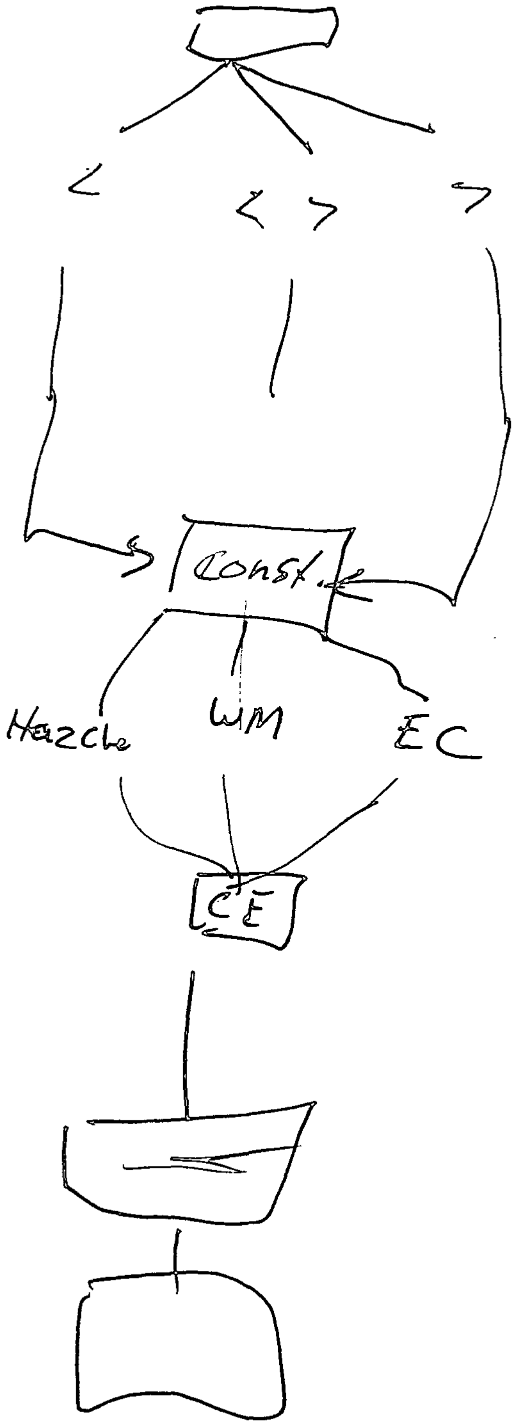
TRANSACTION REPORT

JUN-16-2003 MON 12:14 PM

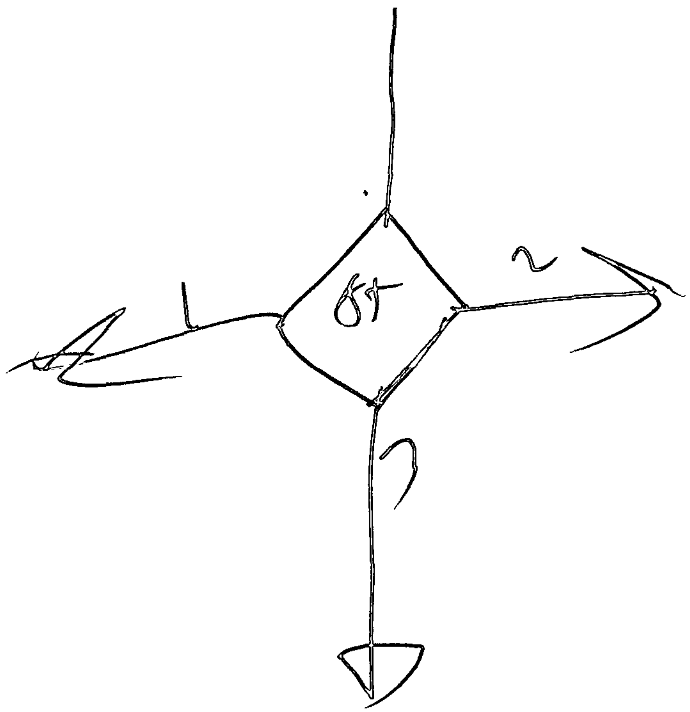
FOR:

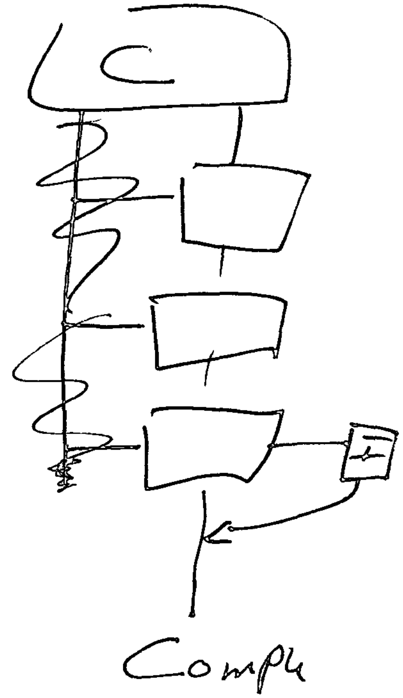
RECEIVE

DATE	START	SENDER	RX TIME	PAGES	TYPE	NOTE	M#	DP
JUN-16	12:12 PM	1 505 677 2331	1'58"	3	RECEIVE	OK		



Const.
Hazcle
WM
EC
CE





Comple

Wayne Price
New Mexico Oil Conversation Division

J. R. Smith
Loco Hills GSF
June 16, 2003

Submit 3 Copies To Appropriate District Office
District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Rd., Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy, Minerals and Natural Resources

OIL CONSERVATION DIVISION
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-103
Revised March 25, 1999

WELL API NO. (30-015) 06192

5. Indicate Type of Lease
STATE ☑ FEE ☐

6. State Oil & Gas Lease No. BL-635

SUNDRY NOTICES AND REPORTS ON WELLS
(DO NOT USE THIS FORM FOR PROPOSALS TO DRILL OR TO DEEPEN OR PLUG BACK TO A DIFFERENT RESERVOIR. USE "APPLICATION FOR PERMIT" (FORM C-101) FOR SUCH PROPOSALS.)

1. Type of Well:
Oil Well ☐ Gas Well ☐ Other Salt Dome Storage

7. Lease Name or Unit Agreement Name: Leonard

2. Name of Operator
John B Smith

8. Well No. 1

3. Address of Operator
150 Deer Creek Drive Aledo Texas 76008

9. Pool name or Wildcat

4. Well Location

Unit Letter L : 2069 feet from the South line and 1193 feet from the West line

Section 22 Township 17S Range 29E NMPM County Eddy

10. Elevation (Show whether DR, RKB, RT, GR, etc.)
GR

11. Check Appropriate Box to Indicate Nature of Notice, Report or Other Data

NOTICE OF INTENTION TO:

PERFORM REMEDIAL WORK ☐ PLUG AND ABANDON ☒
TEMPORARILY ABANDON ☐ CHANGE PLANS ☐
PULL OR ALTER CASING ☐ MULTIPLE COMPLETION ☐
OTHER: ☐

SUBSEQUENT REPORT OF:

REMEDIAL WORK ☐ ALTERING CASING ☐
COMMENCE DRILLING OPNS. ☐ PLUG AND ABANDONMENT ☐
CASING TEST AND CEMENT JOB ☐
OTHER: ☐

12. Describe proposed or completed operations. (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work). SEE RULE 1103. For Multiple Completions: Attach wellbore diagram of proposed completion or recompilation.

If M.I.T. test fails will pour + squeeze cement, above plug, under pressure

If no loss of cement circulate cement to surface and abandon.

Estimated start date June 23 2003

I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNATURE John B Smith TITLE Terminal Operator DATE 6/14/03

Type or print name John B. Smith Telephone No. 505.677.2331

(This space for State use)

APPPROVED BY Mike Stubblefield TITLE Environ. Eng. Spec. DATE 6/16/2003

Conditions of approval, if any:

* Perforate 5½" casing @ 475'. Squeeze cement under Packer with 25 sx cement.
* Notify N.M.O.C.D. to witness

Submit 3 Copies To Appropriate District Office
District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Rd., Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy, Minerals and Natural Resources

OIL CONSERVATION DIVISION
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-103
Revised March 25, 1999

WELL API NO. 30-015-06192	
5. Indicate Type of Lease	STATE ☒ FEE ☐
6. State Oil & Gas Lease No.	BL-635
7. Lease Name or Unit Agreement Name:	
8. Well No.	1
9. Pool name or Wildcat	

SUNDRY NOTICES AND REPORTS ON WELLS

(DO NOT USE THIS FORM FOR PROPOSALS TO DRILL OR TO DEEPEN OR PLUG BACK TO A DIFFERENT RESERVOIR. USE "APPLICATION FOR PERMIT" (FORM C-101) FOR SUCH PROPOSALS.)

1. Type of Well:
Oil Well ☐ Gas Well ☐ Other Salt Dome Storage Leased

2. Name of Operator
John B Smith

3. Address of Operator
158 Deer Creek Drive Aledo Texas 76008

4. Well Location

Unit Letter L : 2069 feet from the South line and 1193 feet from the West line

Section 22 Township 17S Range 29E NMPM County Eddy

10. Elevation (Show whether DR, RKB, RT, GR, etc.)
GR

11. Check Appropriate Box to Indicate Nature of Notice, Report or Other Data

NOTICE OF INTENTION TO:				SUBSEQUENT REPORT OF:			
PERFORM REMEDIAL WORK	☒	PLUG AND ABANDON	☐	REMEDIAL WORK	☐	ALTERING CASING	☐
TEMPORARILY ABANDON	☐	CHANGE PLANS	☐	COMMENCE DRILLING OPNS.	☐	PLUG AND ABANDONMENT	☐
PULL OR ALTER CASING	☐	MULTIPLE COMPLETION	☐	CASING TEST AND CEMENT JOB	☐		
OTHER:			☐	OTHER:			☐

12. Describe proposed or completed operations. (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work). SEE RULE 1103. For Multiple Completions: Attach wellbore diagram of proposed completion or recompilation.

Run cast iron bridge plug at 515'. Cement above Bridge plug class C cement (5 sack mix); let set and run MIT casing test (300# psi for 30 minutes). If passes open hole cavern test (Nitrogen) 1½ times working pressure for 4 hours

Estimated start date June 23 2003

I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNATURE John B Smith TITLE Terminal operator DATE June 3 2003

Type or print name John B Smith Telephone No. 505-677-2331

(This space for State use)

APPPROVED BY [signature] TITLE Environ. Eng. Spec DATE 6/16/2003

Conditions of approval, if any:

Wayne Price
New Mexico OCD

Loco Hills GSF

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 06/02/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

TOTAL METALS

LAB NUMBER	SAMPLE ID	Al (ppm)	Co (ppm)	Cu (ppm)	Fe (ppm)
ANALYSIS DATE:		05/29/03	05/29/03	05/29/03	05/29/03
H7683-1	WATER WELL #1	<1	0.312	<0.5	3.922
H7683-2	WATER WELL #2	<1	0.345	<0.5	2.057
Quality Control		5.003	0.998	5.108	5.031
True Value QC		5.000	1.000	5.000	5.000
% Recovery		100	99.8	102	101
Relative Percent Difference		1.6	1.2	0.3	2.0
METHODS: EPA 600/04-79-020		202.1	219.1	220.1	236.1

LAB NUMBER	SAMPLE ID	Mn (ppm)	Mo (ppm)	Ni (ppm)	Zn (ppm)
ANALYSIS DATE:		05/29/03	05/29/03	05/29/03	05/29/03
H7683-1	WATER WELL #1	<0.01	<1	0.224	<0.5
H7683-2	WATER WELL #2	0.416	<1	0.319	<0.5
Quality Control		0.914	3.001	5.144	0.497
True Value QC		1.000	3.000	5.000	0.500
% Recovery		91.4	100.0	103.0	99.4
Relative Percent Difference		2.3	0.6	0.2	0.7
METHODS: EPA 600/04-79-020		243.1	246.1	249.1	289.1

Amy Hill
Chemist

6/2/03
Date

H7683m2

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 05/28/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Na (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Conductivity (u S/cm)	T-Alkalinity ($mgCaCO_3/L$)
ANALYSIS DATE:		05/08/03	05/27/03	05/27/03	05/27/03	05/27/03	05/27/03
H7683-1	WATER WELL #1	27648	1074	994	151	99987	92
H7683-2	WATER WELL #2	24982	1786	686	104	100531	166
Quality Control		NR	56	59	5.17	1322	NR
True Value QC		NR	50	50	5.00	1413	NR
% Recovery		NR	112	118	103	93.6	NR
Relative Percent Difference		NR	0	0	1.0	0.7	NR
METHODS:			SM3500-Ca-D	3500-Mg E	8049	120.1	310.1

LAB NUMBER	SAMPLE ID	Cl^- (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	pH (s.u.)	TDS (mg/L)
ANALYSIS DATE:		05/27/03	05/27/03	05/27/03	05/27/03	05/27/03	05/28/03
H7683-1	WATER WELL #1	45986	2123	0	112	7.04	67950
H7683-2	WATER WELL #2	42987	971	0	202	7.00	69220
Quality Control		1050	53.65	NR	996	7.01	NR
True Value QC		1000	50.00	NR	1000	7.00	NR
% Recovery		105	107	NR	99.6	100	NR
Relative Percent Difference		0	1.5	NR	0	2.1	12.1
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1	160.1

Amy Hill
Chemist

5/28/03
Date

H7683

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 06/02/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

RCRA METALS

LAB NUMBER	SAMPLE ID	As ppm	Ag ppm	Ba ppm	Cd ppm	Cr ppm	Pb ppm	Hg ppm	Se ppm
ANALYSIS DATE:		05/29/03	05/29/03	05/29/03	05/29/03	05/29/03	05/29/03	06/02/03	05/30/03
H7683-1	WATER WELL 1	<0.05	0.32	<0.5	<0.01	0.063	1.011	<0.002	<0.01
H7683-2	WATER WELL 2	<0.05	0.162	<0.5	<0.01	0.073	0.988	<0.002	<0.01
Quality Control		0.053	4.916	24.44	0.972	4.880	5.164	0.00980	0.051
True Value QC		0.050	5.000	25.00	1.000	5.000	5.000	0.01000	0.050
% Recovery		106.0	98.3	97.8	97.2	97.6	103	98.0	102
Relative Percent Difference		1.4	1.0	1.5	1.3	0.3	5.6	2.0	3.2
METHODS: EPA 600/4-79-020		206.2	272.1	208.1	213.1	218.1	239.1	245.1	270.2

Amy Hill
Chemist

6/2/03
Date

H7683m

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/23/03
Reporting Date: 05/27/03
Project Number: NOT GIVEN
Project Name: WATER WELLS #1 & #2
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/23/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Br^- (mg/L)	F^- (mg/L)	NO_3/NO_2 (mg/L)	PO_4 (mg/L)
ANALYSIS DATE		05/27/03	05/27/03	05/23/03	05/27/03
H7683-1	WATER WELL #1	4.39	2.36	2.35	0.20
H7683-2	WATER WELL #2	3.88	2.52	1.92	0.05
Quality Control		3.00	1.27	2.98	0.51
True Value QC		3.00	1.00	3.00	0.50
% Recovery		100	127	99.2	101
Relative Percent Difference		5.7	3.2	2.0	0

METHODS: Std. Methods	4500-Br⁻B	4500-F⁻D	353.3*	4500-P E

EPA 600/4-79-020

Amy Hill
Chemist

5/27/03
Date

H7683a

JUN-04-2001 01:56 PM LOCO HILLS GSF 1 505 677 2331 P.06

CARDINAL LABORATORIES, INC.

2111 Beechwood, Abilene, TX 79603 101 East Marland, Hobbs, NM 88240

(915) 673-7001 Fax (915) 673-7020 (505) 393-2326 Fax (505) 393-2476

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Page ___ of ___

Company Name:	Loco Hills GSF
Project Manager:	J. B. Smith
Address:	P.O Box 37 (MM 127.5 Lovington Hwy)
City:	Loco Hills
State:	N. Mex
Zip:	88255
Phone #:	505-677-2331
Fax #:	(505) 677-2331
Project #:	
Project Owner:	Loco Hills GSF
Project Name:	Water Well #1 Water Well #2
Project Location:	MM 127.5 Lovington Hwy
Sampler Name:	J. B. Smith

BILL TO

P.O. #:	
Company:	Loco Hills GSF
Attn:	Mitchell Johnson
Address:	158 Deer Creek Dr
City:	Aledo
State:	TX
Zip:	76008
Phone #:	817-441-6568
Fax #:	817-441-5880

ANALYSIS REQUEST

Lab I.D. (FOR LAB USE ONLY)	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	MATRIX: GROUNDWATER	WASTEWATER	SOIL	CRUDE OIL	SLUDGE	OTHER:	PRESERV: ACID/BASE	ICE/COOL	OTHER:	SAMPLING: DATE	TIME	Cations/Anions	Br, NO3/NO2, F, PO4	WQCC Metals
H7683-1	Water Well 1												5/23/03		✓	✓	✓
-2	Water Well 2												↓		✓	✓	✓

Sampler Relinquished:	Date:	Received By:
	Time:	
Relinquished By: J. B. Smith	Date: 5/23/03 Time: 1:00	Received By: (Lab Staff) Amy Hill
Delivered By: (Circle One) Sampler - UPS - Bus - Other:	Sample Condition Cool Intact ☐ Yes ☐ Yes ☐ No ☐ No	CHECKED BY: (Initials)

Phone Result: ☐ Yes ☐ No Add'l Phone #:
Fax Result: ☐ Yes ☐ No Add'l Fax #:
REMARKS:

† Cardinal cannot accept verbal changes. Please fax written changes to 505-393-2476.

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131A
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

MONTHLY GAS STORAGE REPORT

Loco Hills GSF LTD (Company) 15 Deer Creek Drive Aledo Texas 76008 (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year May 2003

WELL NAME AND NUMBER	LOCATION UNIT SEC. TWP. RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (MCF)	WITHDRAWAL (MCF)
Loco Hills G.S. F Well #1 API # 06192	L 22 17S 29E	390 #	0	0

TOTALS

TOTAL CAPACITY (MMCF) 106

BEGINNING STORAGE (MMCF) 0

NET CHANGE (MMCF) 0

ENDING STORAGE (MMCF) 0

CALCULATED RESERVOIR PRESSURE @ END OF MONTH 115.5 #

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature John B. Smith

Printed Name & Title John B Smith Terminal Operator

Date ____________ Telephone No (505)-677-2331

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131A
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

MONTHLY GAS STORAGE REPORT

Loco Hills GSF LTD (Company) 158 Bear Creek Drive Aledo Texas 76008 (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year May, 2003

WELL NAME AND NUMBER	LOCATION UNIT SEC. TWP. RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (MCF)	WITHDRAWAL (MCF)
Loco Hills G.S.F. Well #2	L 22 17S 29E	379.5#	46,510	

TOTALS

TOTAL CAPACITY (MMCF) 102.3

BEGINNING STORAGE (MMCF) 41.1

NET CHANGE (MMCF) + 5.41

ENDING STORAGE (MMCF) 46.510

CALCULATED RESERVOIR PRESSURE @ END OF MONTH 1111.5#

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature John B. Smith

Printed Name & Title John B. Smith Technical Agent

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-131A
Revised March 17, 1999

Submit one copy to Santa Fe and one copy to appropriate District Office postmarked by 24th day of succeeding month. See Rule 1131.

MONTHLY GAS STORAGE REPORT

Loco Hills GSF LTD (Company) 158 Deer Creek Drive Aledo Texas 76008 (Address)

NAME OF STORAGE PROJECT Loco Hills GSF COUNTY Eddy Month/Year May, 2003

WELL NAME AND NUMBER	LOCATION UNIT	SEC.	TWP.	RANGE	MAXIMUM INJECTION PRESSURE	INJECTION (MCF)	WITHDRAWAL (MCF)
Loco Hills GSF Well #3 API # 06194	L	22	17S	29E	378#	16,100,421	166,849

TOTALS

TOTAL CAPACITY (MMCF) 109.3

BEGINNING STORAGE (MMCF) 0

NET CHANGE (MMCF) -.167

ENDING STORAGE (MMCF) 15.933

CALCULATED RESERVOIR PRESSURE @ END OF MONTH 110#

I hereby certify that this report is true and complete to the best of my knowledge and belief.

Signature [signature]

Printed Name & Title John B. Smith

P.01

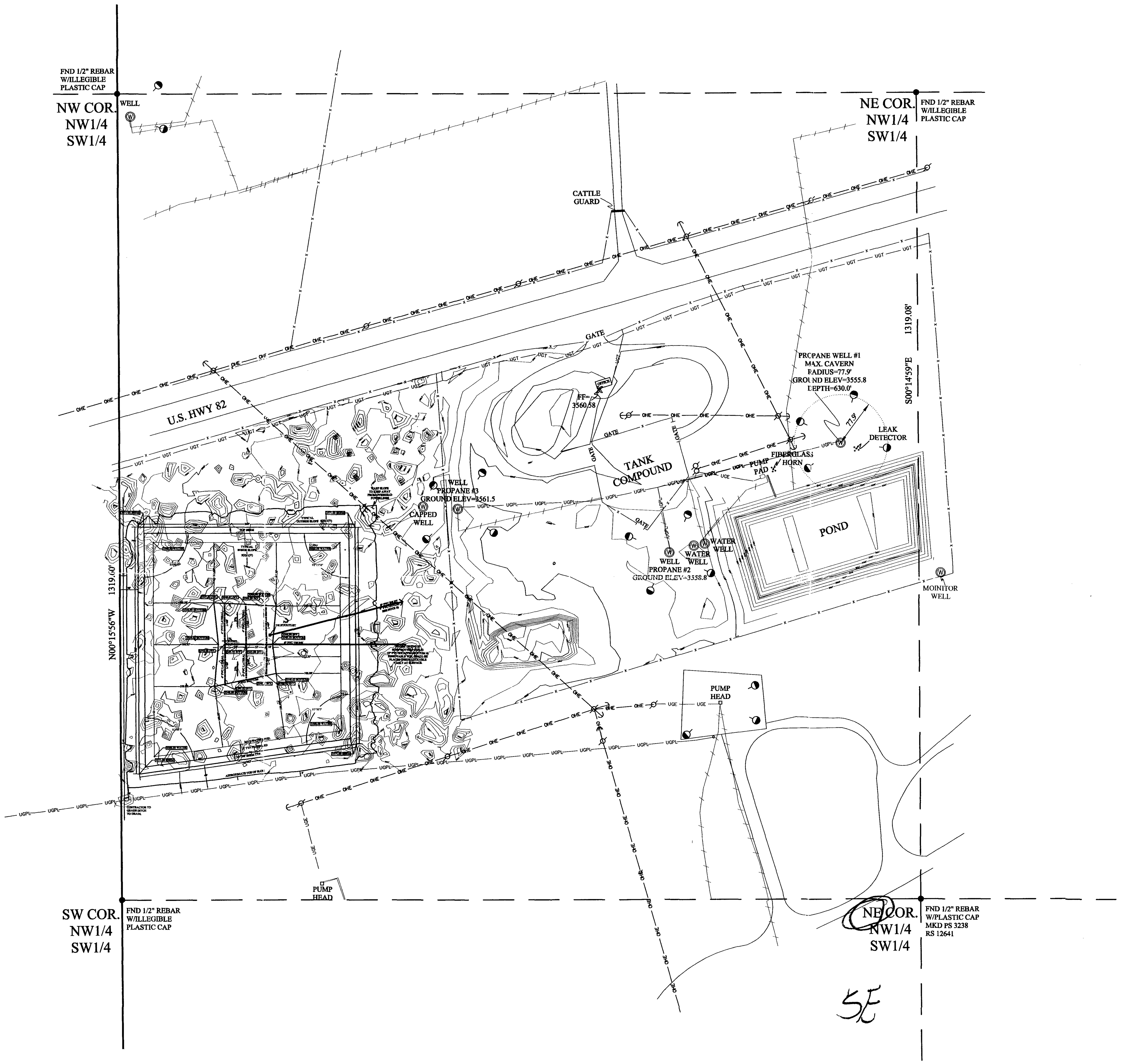
TRANSACTION REPORT

JUN-04-2003 WED 02:00 PM

FOR:

RECEIVE

DATE	START	SENDER	RX TIME	PAGES	TYPE	NOTE	M#	DP
JUN-04	01:54 PM	1 505 677 2331	5'54"	9	RECEIVE	OK		



CERTIFICATE OF SURVEY-

"I, Daniel R. Muth, New Mexico Professional Surveyor, hereby certify that this Topographic Survey Plat was prepared from an actual ground survey performed by me or under my supervision, that this survey is true and correct to the best of my knowledge and belief, that this Topographic Survey Plat and the field survey upon which it is based meet the Minimum Standards for Surveying in New Mexico.

Daniel R. Muth NMPS# 13239

DANIEL R. MUTH NEW MEXICO 13239 REGISTERED PROFESSIONAL SURVEYOR

6/26/03
Date

LEGEND	
	ANCHOR
	POWER POLE
	GUY WIRE
	WELL
	PUMP HEAD
	VENT PIPE
OHE	OVERHEAD ELECTRIC
	ABOVEGROUND FAS-LINE
UGT	UNDERGROUND ELECTRIC
UGT	UNDERGROUND TELEPHONE
UGPL	UNDERGROUND PIPELINE
x x	4 STRAND BARB WIRE

SCALE 1" = 100'
0' 50' 100' 200'

NORTH

NOTE: Information hereon pertaining to land boundary data is for graphic use only. Boundaries have not been created and are not a matter of record. This topographic map is not intended to create any such record, or represent any such record. Tracts shown hereon are for informational purposes only and they do not exist as a matter of record as of the date of this survey.

NEW MEXICO STATE LAND OFFICE
BUSINESS LEASE No. BL-635

PETTIGREW AND ASSOCIATES
1110 N. GRIMES HOBBS, N.M. 88240
(505) 393-9827

PLAT OF TOPOGRAPHIC SURVEY FOR
LOCO HILLS GSF
LOCO HILLS, NEW MEXICO

REV	DATE	DESCRIPTION
1	06/26/2003	ADDED MORE TOPO
0	03/11/2003	FINAL PLAT
00	03/06/2003	PRELIMINARY PLAT
	03/05/2003-03/06/2003	DATE OF SURVEY

PROJECT#	2003.1016	DRN BY:	A. Garcia
DWG	\AutoCAD Loco Hills GSF\dwg\Loco Hills GSF.dwg		
BOOK#		SHEET	1 of 1

\\Server\Public\Data Files\2003.1016\AutoCAD Loco Hills GSF\dwg\Loco Hills GSFR2.dwg, 06/26/2003 09:14:56 PM, Fuzzy

Price, Wayne

From: Price, Wayne
Sent: Thursday, May 15, 2003 3:15 PM
To: 'Mitchel Johnson'
Cc: Stubblefield, Mike
Subject: Loco Hills GSF LTD GW-019 (C-103 for state #1 API 30-015-06192) and Brine pond proposal

The OCD is in receipt of the fax containing the C-103 for repair of the above referenced well, the analytical results from the Monitor Well. In addition OCD is in receipt of the drawing for the proposed Brine pond. In order for OCD to continue its review for this project please provide the following information:

Well:

1. Please provide a schematic of the well bore as will be completed. Please show well bore details, cement depths, pipe size, location, etc.
2. Provide calculations showing that the new piping design i.e. casing will not cause excessive back pressure that may exceed the frac pressure calculated at the shoe of the casing or the roof of the cavern. Please use .65 psi/ft as a conservative frac pressure gradient in your calculations.
3. If approved, then a Casing MIT hydrostatic pressure test shall be performed for 30 minutes. In addition, an additional OCD approved open hole nitrogen test shall be performed for 4 hours with no bleed-off allowed.
4. Provide to OCD the results of the recent sonar test including any conclusions or recommendations.

Brine Pond:

1. Provide calculations showing that the new brine pond will be of sufficient size to contain the replacement volume of the caverns.
2. Provide a scaled site plot plan showing all significant features, equipment, wells, etc. Include the estimated radius of each cavern on this drawing.
3. Provide a detail written explanation addressing how the old brine pond will be closed and the on-site stock-pile of salt contaminated dirt.

Groundwater Investigation:

The monitor well analytical results indicate groundwater contamination. Loco Hills GSF LTD shall commit to a groundwater investigation study.

Well C-103 Approval and Testing Procedure:

Once the OCD Environmental Bureau approves of the plan then Loco Hills GSF LTD shall submit C-103 to OCD Artesia District for final approval. OCD must witness testing and any other work as required by the District office.

Sincerely:

Wayne Price

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

Price, Wayne

From: Price, Wayne
Sent: Tuesday, June 03, 2003 11:23 AM
To: 'Mitchel Johnson'; Price, Wayne
Cc: Stubblefield, Mike
Subject: RE: Loco Hills GSF LTD GW-019 (C-103 for state #1 API 30-015-06192) and Brine pond proposal

Dear Mitchel:

OCD hereby approves of an additional well test as described below. Please submit a C-103 to the OCD Artesia district office for their approval and provide a copy of the final C-103 with pressure chart.

Please provide all of the information requested in my E-mail dated May 15, 2003. Please note it appears that the existing brine pond may be leaking and must be repaired or removed from service. Please provide a schedule for OCD approval to perform this check.

Please note OCD does not have a detailed specification for pond construction. However, we do have some generic guidelines that may be found at the following web link.
http://www.emnrd.state.nm.us/ocd/ Publications/environmental handbook/tab4a

OCD will require a surveyed plot plan as previously requested before we approve this project.

If you are not familiar on how to conduct a groundwater investigation it might save you time and money to hire a consultant, however it is not a requirement. Groundwater investigations are conducted to determine if groundwater has actually been impacted by past operations and if so what is the extent and how will it be cleaned-up. It usually requires additional monitoring wells and possibly recovery wells. In your case the recovered water may be used as process water.

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_lhgsf@hotmail.com]
Sent: Wednesday, May 28, 2003 7:39 AM
To: WPrice@state.nm.us
Cc: MStubblefield@state.nm.us
Subject: Re: Loco Hills GSF LTD GW-019 (C-103 for state #1 API 30-015-06192) and Brine pond proposal

Wayne,

I believe that you already have received most of the answers from previous emails from the conversations you had with J.B. Smith, however some new developments have happened that I wanted to make you aware of.

Regarding Well 1: we received the engineering back for the proposed new casing, and there will not be enough room to squeeze cement between the old casing and the new. We would like to get OCD approval to plug the bottom of Well 1 and have the pressure test the casing again. The engineers believe this would be a better test than the previous test we completed using the inflatible liner. I have mailed you a copy of the sonar for Well 1.

Regarding the new Brine Pond: it is not our intention to put the existing brine pond out of service. We plan to operate it in conjunction with the new brine pond. The combined ponds will have us a capacity of approximately 10.2 million gallons of brine. Cavern 1 has been sonared at a capacity of 2.75 million gallons, and it is believed that caverns 2 & 3 are approximately 3 million gallons each for an approximate total of 8.75 million gallons. However, I still need the OCD specifications for the new

pond so that I can get them to the people bidding on the job. Regarding
your request for the scaled site plot, we would like to know if we could do
the drawing instead of an outside survey crew. We've spent a huge amount of
money on the survey so far, and they are telling me they would need to come
back out to fullfill your request. They did not get the location of the
other equipment if it did not have to do with the new pond. We could use a
GPS for this purpose so that is will be as accurate as possible.

Regarding the ground water investigation: What does the entail? JB has
sent the water samples to the lab, but we have not received the results yet.

Please feel free to contact me if you have any questions.

Thank you,
Mitchel Johnson
Office: 817-441-6568
Cell: 940-367-0660

>From: "Price, Wayne" <WPrice@state.nm.us>
>To: 'Mitchel Johnson' <mitchel_lhgsf@hotmail.com>
>CC: "Stubblefield, Mike" <MStubblefield@state.nm.us>
>Subject: Loco Hills GSF LTD GW-019 (C-103 for state #1 API
>30-015-06192) and Brine pond proposal
>Date: Thu, 15 May 2003 15:14:34 -0600
>
>The OCD is in receipt of the fax containing the C-103 for repair of the
>above referenced well, the analytical results from the Monitor Well. In
>addition OCD is in receipt of the drawing for the proposed Brine pond. In
>order for OCD to continue its review for this project please provide the
>following information:
>
>Well:
>
>1. Please provide a schematic of the well bore as will be completed.
>Please show well bore details, cement depths, pipe size, location, etc.
>2. Provide calculations showing that the new piping design i.e. casing
>will not cause excessive back pressure that may exceed the frac pressure
>calculated at the shoe of the casing or the roof of the cavern. Please
>use
>.65 psi/ft as a conservative frac pressure gradient in your calculations.
>3. If approved, then a Casing MIT hydrostatic pressure test shall be
>performed for 30 minutes. In addition, an additional OCD approved open
>hole
>nitrogen test shall be performed for 4 hours with no bleed-off
>allowed.
>4. Provide to OCD the results of the recent sonar test including any
>conclusions or recommendations.
>
>Brine Pond:
>
>1. Provide calculations showing that the new brine pond will be of
>sufficient size to contain the replacement volume of the caverns.
>2. Provide a scaled site plot plan showing all significant features,
>equipment, wells, etc. Include the estimated radius of each cavern on this
>drawing.
>3. Provide a detail written explanation addressing how the old brine
>pond will be closed and the on-site stock-pile of salt contaminated dirt.
>
>
>Groundwater Investigation:
>
>The monitor well analytical results indicate groundwater contamination.
>Loco Hills GSF LTD shall commit to a groundwater investigation study.
>

>
>Well C-103 Approval and Testing Procedure:
>
>Once the OCD Environmental Bureau approves of the plan then Loco Hills GSF
>LTD shall submit C-103 to OCD Artesia District for final approval. OCD
>must
>witness testing and any other work as required by the District office.
>
>Sincerely:
> <<...OLE_Obj...>>
>Wayne Price
>New Mexico Oil Conservation Division
>1220 S. Saint Francis Drive
>Santa Fe, NM 87505
>505-476-3487
>fax: 505-476-3462
>E-mail: WPRICE@state.nm.us
>
>
>
>

Tracking:	**Recipient**	**Read**
	'Mitchel Johnson'	
	Price, Wayne	Read: 6/3/2003 11:23 AM
	Stubblefield, Mike	

Loco Hills GSF
158 Deer Creek Drive
Aledo, Texas 76008

5/22/03

New Mexico OCD
Wayne Price
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

Dear Mr. Price:

Enclosed is a copy of the sonar from Well 1 per your request.

If you have any questions, please contact me at 817-441-6568.

Thank you,

Mitchel Johnson

Price, Wayne

From: Price, Wayne
Sent: Monday, February 24, 2003 4:17 PM
To: 'Mitchel Johnson'; Price, Wayne
Cc: mstufflefield@state.nm.us
Subject: RE: Request O.C.D. approval for a groundwater monitor well at Loco Hills G.S.F.

OCD hereby approves of drilling a monitor well in the location as indicated below. The monitoring well installation and subsequent soil and ground water monitoring and sampling shall fulfill the requirements as set out below:

1. A Soil sample from every 20 foot interval from the surface to total depth and at the top of the water table during the drilling of the monitor well. Each soil sample shall be sampled and analyzed for EPA general chemistry (Chlorides).

2. The monitor well shall be completed as follows:

   a. At least 20 feet of well screen shall be placed across the water table interface with at least 5 feet of well screen above the water table.

   b. An appropriately sized gravel pack shall be set in the annulus around the well screen from the bottom of the hole to 2-3 feet above the top of the well screen.

   c. A 2-3 foot bentonite plug shall be placed above the gravel pack.

   d. The remainder of the hole shall be grouted to the surface with a cement grout containing 3-5% bentonite.

   e. A concrete pad and locking well cover shall be placed around the well casing at the surface.

3. The monitoring well shall be developed after construction by pumping, surging, bailing, or a combination of these methods after construction. Development of each well shall continue until the water is as free of sediment as practicable with respect to the composition of the subsurface materials within the screened interval. The removal rate and amount of ground water removed shall be recorded during well development. The pH, electrical conductance and temperature of the water shall be monitored during development. The monitoring wells shall be considered satisfactorily developed when the water is free of sediment, the pH, conductivity and temperature values do not vary by more than 10 percent for at least three measurements, and at least five borehole volumes of water have been removed from the well

4. No less than 24 hours after the well is developed, ground water from monitor well shall be purged, sampled and analyzed for concentrations of total dissolved solids (TDS), major cations and anions and dissolved WQCC metals using EPA methods.

5. Notify the OCD Santa Fe office and the OCD District office at least 72 hours in advance of all scheduled activities such that the OCD has the opportunity to witness the events and/or split samples during OCD's normal business hours.

-----Original Message-----
From: Mitchel Johnson [mailto:mitchel_sacenergy@hotmail.com]
Sent: Monday, February 17, 2003 10:07 AM
To: wprice@state.nm.us
Cc: mstufflefield@state.nm.us

Subject: Request O.C.D. approval for a groundwater monitor well at Loco Hills G.S.F.

Dear Mr. Price:

I would like to intoduce myself: I am Mitchel Johnson, son of Mitch Johnson. I have recently joined Loco Hills G.S.F., and I look forward to working with you to resolve some of the issues at our Loco Hills Gas Storage Facility.

It has come to my attention that we need to request O.C.D. approval for a groundwater monitor well. Upon O.C.D. approval Loco Hills G.S.F. will drill a ground water monitor well 35 feet from the south east corner of the brine storage pond.

Loco Hills G.S.F. has a water well 108 feet north of U.S. 82. We believe this would be an appropriate up-gradient monitoring point.

Please feel free to contact me with any issues you have with Loco Hills G.S.F.

Sincerely,

Mitchel Johnson
Loco Hills G.S.F.
817-441-6868
fax: 817-441-5880
email: mitchel_sacenergy@hotmail.com (corrected address)

Tracking:	**Recipient**	**Read**
	'Mitchel Johnson'	
	Price, Wayne	Read: 2/24/2003 4:17 PM
	mstufflefield@state.nm.us	

NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

Bill Richardson
Governor
Joanna Prukop
Cabinet Secretary

Lori Wrotenbery
Director
Oil Conservation Division

February 20, 2003

Mr. Louis Sneed
Weatherford National Bank
101 N. Main Street
P.O. Box 259
Weatherford, TX 76086

Re: $5,000 Letter of Credit No. 4001
Loco Hills GSF, Ltd., Customer
Weatherford National Bank, Issuer

Dear Mr. Sneed:

The New Mexico Oil Conservation Division hereby approves the above-captioned Letter of Credit No. 4001 which will expire on **February 7, 2004.**

Sincerely,

David K. Brooks

DAVID K. BROOKS
Assistant General Counsel

DKB/dp

cc: Oil Conservation Division - Artesia, NM

Attn: Bobby Johnson
Loco Hills GSF, Ltd.
158 Deer Creek
Aledo, TX 76008

NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

Bill Richardson
Governor
Joanna Prukop
Cabinet Secretary

Lori Wrotenbery
Director
Oil Conservation Division

February 20, 2003

Mr. Louis Sneed
Weatherford National Bank
101 N. Main Street
P.O. Box 259
Weatherford, TX 76086

Re: $5,000 Letter of Credit No. 4101
Loco Hills GSF, Ltd., Customer
Weatherford National Bank, Issuer

Dear Mr. Sneed:

The New Mexico Oil Conservation Division hereby approves the above-captioned Letter of Credit No. 4101 which will expire on **February 7, 2004**.

Sincerely,

David K. Brooks

DAVID K. BROOKS
Assistant General Counsel

DKB/dp

cc: Oil Conservation Division - Artesia, NM

Attn: Bobby Johnson
Loco Hills GSF, Ltd.
158 Deer Creek
Aledo, TX 76008

Price, Wayne

From: Price, Wayne
Sent: Friday, February 07, 2003 3:08 PM
To: JB Smith (E-mail)
Cc: Stubblefield, Mike
Subject: Letter to Mitch Johnson and MW requirement

Dear Mr. Smith:

Please find enclosed a letter sent to Mr. Johnson concerning bonding of the other two wells on site and discharge plan conditions sign-off requirement. Please forward this to Mr. Johnson. The other issue is the pond leak detection which still has water in it indicating the pond liner is leaking. This was observed the other day when I was in SE NM. and during the last formal inspection this problem was also noted. Therefore please perform the following action items:

Propose for OCD approval a groundwater monitor well location that will be located in close proximity and down-gradient of the on-site brine storage pond and an appropriate up-gradient monitoring point. At the time of approval OCD will inform you of the MW construction, developing and sampling requirements.

January 28.doc

Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

Tracking:

Recipient	Read
JB Smith (E-mail)	
Stubblefield, Mike	Read: 2/7/2003 3:55 PM

NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

BILL RICHARDSON
Governor
Joanna Prukop
Cabinet Secretary

Lori Wrotenbery
Director
Oil Conservation Division

January 28, 2003

CERTIFIED MAIL
RETURN RECEIPT NO. 3929 9758

Mr. Mitch Johnson
Loco Hills GSF, LLC
12705 E. Lovington HWY
Lovington, NM 88255

Re: Loco Hills Gas Storage Facility
OCD Discharge Plan GW-019

Dear Mr. Johnson:

The New Mexico Oil Conservation Division (OCD) has reviewed the Discharge Plan file and has determined that Loco Hills GSF, LLC is deficient in the transfer of ownership for your facility in following areas:

1. Only one of the three wells on-site is presently bonded. Please contact Ms. Dorothy Phillips OCD Santa Fe at 505-476-3461 to make immediate arrangements to provide sufficient bonding for the other two wells API 30-015-06192 and API 30-015-06193. In addition, please contact Carmon Reno in the OCD Artesia office at 505-748-1283 to complete the change of ownership for these wells.

2. Loco Hills GSF, LLC needs to provide the OCD a letter stating that it will comply with the terms and conditions of the discharge plan item # 23. (Transfer of Discharge Plan). OCD never received an original letter concerning this matter.

Please complete these action items by April 1, 2003. If you have any questions please do not hesitate to contact me at 505-476-3487 or E-mail WPRICE@state.nm.us.

Sincerely,

Wayne Price

Wayne Price- Engineer

cc: OCD Artesia Office
Dorothy Phillips- OCD SF

NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

BILL RICHARDSON
Governor
Joanna Prukop
Cabinet Secretary

January 28, 2003

Lori Wrotenbery
Director
Oil Conservation Division

CERTIFIED MAIL
RETURN RECEIPT NO. 3929 9758

Mr. Mitch Johnson
Loco Hills GSF, LLC
12705 E. Lovington HWY
Lovington, NM 88255

SENT VIA E-MAIL OCD HAS NO BUDGET FOR POSTAGE! [initials]

Re: Loco Hills Gas Storage Facility
OCD Discharge Plan GW-019

Dear Mr. Johnson:

The New Mexico Oil Conservation Division (OCD) has reviewed the Discharge Plan file and has determined that Loco Hills GSF, LLC is deficient in the transfer of ownership for your facility in following areas:

1. Only one of the three wells on-site is presently bonded. Please contact Ms. Dorothy Phillips OCD Santa Fe at 505-476-3461 to make immediate arrangements to provide sufficient bonding for the other two wells API 30-015-06192 and API 30-015-06193. In addition, please contact Carmon Reno in the OCD Artesia office at 505-748-1283 to complete the change of ownership for these wells.

2. Loco Hills GSF, LLC needs to provide the OCD a letter stating that it will comply with the terms and conditions of the discharge plan item # 23. (Transfer of Discharge Plan). OCD never received an original letter concerning this matter.

Please complete these action items by April 1, 2003. If you have any questions please do not hesitate to contact me at 505-476-3487 or E-mail WPRICE@state.nm.us.

Sincerely,

Wayne Price

Wayne Price- Engineer

cc: OCD Artesia Office
Dorothy Phillips- OCD SF

Price, Wayne

From:	Phillips, Dorothy
Sent:	Tuesday, January 28, 2003 2:42 PM
To:	Price, Wayne
Subject:	RE: Change of ownership Ameri-gas to Loco Hills GSF (limited partnership)

Wayne, they are registered as a operator OGRID 214766 but they only have a $5,000 Letter of Credit for the one-well 30-015-6194. I have no other bonding for them.

-----Original Message-----

From:	Price, Wayne
Sent:	Tuesday, January 28, 2003 2:14 PM
To:	Phillips, Dorothy
Cc:	Reno, Carmen
Subject:	Change of ownership Ameri-gas to Loco Hills GSF (limited partnership)

Dorothy: Did Loco Hills GSF ever get registered in NM and did they obtain bonding for the following three wells and did the change of ownership go through?
Do you have a name and address for this company?

30-015-06192
30-015-06193
30-015-06194

Sincerely:
<< OLE Object: Picture (Metafile) >>

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

Price, Wayne

From:	Price, Wayne
Sent:	Tuesday, January 28, 2003 2:14 PM
To:	Phillips, Dorothy
Cc:	Reno, Carmen
Subject:	Change of ownership Ameri-gas to Loco Hills GSF (limited partnership)

Dorothy: Did Loco Hills GSF ever get registered in NM and did they obtain bonding for the following three wells and did the change of ownership go through?
Do you have a name and address for this company?

30-015-06192
30-015-06193
30-015-06194

Sincerely:

Wayne Price

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

GW-19

Submit 3 Copies To Appropriate District Office
District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 87210
District III
1000 Rio Brazos Rd., Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy, Minerals and Natural Resources

OIL CONSERVATION DIVISION
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-103
Revised March 25, 1999

WELL API NO. 06192

5. Indicate Type of Lease
STATE ☒ FEE ☐

6. State Oil & Gas Lease No. BL-635

SUNDRY NOTICES AND REPORTS ON WELLS

(DO NOT USE THIS FORM FOR PROPOSALS TO DRILL OR TO DEEPEN OR PLUG BACK TO A DIFFERENT RESERVOIR. USE "APPLICATION FOR PERMIT" (FORM C-101) FOR SUCH PROPOSALS.)

1. Type of Well:
Oil Well ☐ Gas Well ☐ Other Salt Dome Storage

7. Lease Name or Unit Agreement Name: Loco Hills GSF

2. Name of Operator
John B. Smith (505-677-2331)

8. Well No. 1

3. Address of Operator
P.O. Box 37 Loco Hills, New Mexico 88255

9. Pool name or Wildcat

4. Well Location

Unit Letter L : 2069.5 feet from the South line and 1193 feet from the west line

Section 22 Township 19S Range ~~29~~-29E NMPM County Eddy

10. Elevation (Show whether DR, RKB, RT, GR, etc.)
GR

11. Check Appropriate Box to Indicate Nature of Notice, Report or Other Data

NOTICE OF INTENTION TO:		SUBSEQUENT REPORT OF:	
PERFORM REMEDIAL WORK ☒	PLUG AND ABANDON ☐	REMEDIAL WORK ☒	ALTERING CASING ☐
TEMPORARILY ABANDON ☐	CHANGE PLANS ☐	COMMENCE DRILLING OPNS. ☐	PLUG AND ABANDONMENT ☐
PULL OR ALTER CASING ☐	MULTIPLE COMPLETION ☐	CASING TEST AND CEMENT JOB ☐	
OTHER: ☐		OTHER: ☐	

12. Describe proposed or completed operations. (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work). SEE RULE 1103. For Multiple Completions: Attach wellbore diagram of proposed completion or recompilation.

Remove and Replace Tubing
Well #1 1/16/03

Tubing Replaced
open hole casing Test
Test method Nitrogen
MIT after tubing replacement
1/24/03
chart recording submitted
by Mike Stubblefield 1/27/03

I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNATURE John B. Smith TITLE Terminal Operator DATE 1/28/03

Type or print name John B. Smith Telephone No. 505-677-2331

(This space for State use)

APPPROVED BY ________ TITLE ________ DATE ________
Conditions of approval, if any:

Attention

Wayne Price

New Mexico O.C.D.

From

Loco Hills GSF

CARDINAL LABORATORIES
PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/13/03
Reporting Date: 05/16/03
Project Owner: LOCO HILLS GSF
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/01/03
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: BC
Analyzed By: HM

LAB NUMBER	SAMPLE ID	Na (mg/Kg)	Ca (mg/Kg)	Mg (mg/Kg)	K (mg/Kg)	Conductivity (uS/cm)	T-Alkalinity ($mgCaCO_3/Kg$)
ANALYSIS DATE:		05/15/03	05/15/03	05/15/03	05/13/03	05/14/03	05/15/03
H7655-1	0-10	1517	1730	118	22	10095	100
H7655-2	10-20	483	1869	118	60	15587	100
H7655-3	20-30	3861	937	61	55	15418	120
Quality Control		NR	43	55	5.22	1322	NR
True Value QC		NR	50	50	5.00	1413	NR
% Recovery		NR	86	110	104	93.6	NR
Relative Percent Difference		NR	0	0	2.6	0.7	NR
METHODS:			SM3500-Ca-D	3500-Mg E	8049	120.1	310.1

LAB NUMBER	SAMPLE ID	Cl^- (mg/Kg)	SO_4 (mg/Kg)	CO_3 (mg/Kg)	HCO_3 (mg/Kg)	pH (s.u.)
ANALYSIS DATE:		05/15/03	05/15/03	05/15/03	05/15/03	05/14/03
H7655-1	0-10	624	5872	0	122	7.74
H7655-2	10-20	896	4684	0	122	7.75
H7655-3	20-30	1264	5632	0	146	7.86
Quality Control		1050	54.39	NR	1068	6.92
True Value QC		1000	50.00	NR	1000	7.00
% Recovery		105	109	NR	107	98.9
Relative Percent Difference		2.0	0.7	NR	7.7	0.4
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1

Note: Analyses performed on 1:4 w:v aqueous extracts.

Amy Hill
Chemist

5/16/03
Date

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/13/03
Reporting Date: 05/16/03
Project Owner: LOCO HILLS GSF
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/01/03
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: BC
Analyzed By: HM

LAB NUMBER	SAMPLE ID	Na (mg/Kg)	Ca (mg/Kg)	Mg (mg/Kg)	K (mg/Kg)	Conductivity (u S/cm)	T-Alkalinity ($mgCaCO_3$/Kg)
ANALYSIS DATE:		05/15/03	05/15/03	05/15/03	05/13/03	05/14/03	05/15/03
H7655-4	30-40	3466	39	20	20	17656	320
H7655-5	40-50	1505	33	17	17	10095	220
H7655-6	50-60	3607	28	17	22	10264	220
Quality Control		NR	43	55	5.22	1322	NR
True Value QC		NR	50	50	5.00	1413	NR
% Recovery		NR	86	110	104	93.6	NR
Relative Percent Difference		NR	0	0	2.6	0.7	NR
METHODS:			SM3500-Ca-D	3500-Mg E	8049	120.1	310.1

LAB NUMBER	SAMPLE ID	Cl^- (mg/Kg)	SO_4 (mg/Kg)	CO_3 (mg/Kg)	HCO_3 (mg/Kg)	pH (s.u.)
ANALYSIS DATE:		05/15/03	05/15/03	05/15/03	05/15/03	05/14/03
H7655-4	30-40	4479	1068	48	293	8.64
H7655-5	40-50	1855	588	48	171	8.74
H7655-6	50-60	1983	4796	48	171	8.83
Quality Control		1050	54.39	NR	1068	6.92
True Value QC		1000	50.00	NR	1000	7.00
% Recovery		105	109	NR	107	98.9
Relative Percent Difference		2.0	0.7	NR	7.7	0.4
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1

Note: Analyses performed on 1:4 w:v aqueous extracts.

Amy Hill
Chemist

5/16/03
Date

MAY-16-2001 01:43 PM LOCO HILLS GSF 1 505 677 2331 P.04

05/16/2003 12:29 50[redacted]2476 CARDINAL LAB H[redacted] PAGE 03

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/13/03
Reporting Date: 05/16/03
Project Owner: LOCO HILLS GSF
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/01/03
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: BC
Analyzed By: HM

LAB NUMBER	SAMPLE ID	Na (mg/Kg)	Ca (mg/Kg)	Mg (mg/Kg)	K (mg/Kg)	Conductivity (μS/cm)	T-Alkalinity ($mgCaCO_3/Kg$)
ANALYSIS DATE:		05/15/03	05/15/03	05/15/03	05/13/03	05/14/03	05/15/03
H7655-7	60-70	987	46	20	10	5791	120
H7655-8	70-80	1422	17	27	9.0	8351	200
H7655-9	80-90	1601	60	3.4	13	9293	200
Quality Control		NR	43	55	5.22	1322	NR
True Value QC		NR	50	50	5.00	1413	NR
% Recovery		NR	86	110	104	93.6	NR
Relative Percent Difference		NR	0	0	2.6	0.7	NR
METHODS:			SM3500-Ca-D	3500-Mg E	8049	120.1	310.1

LAB NUMBER	SAMPLE ID	Cl^- (mg/Kg)	SO_4 (mg/Kg)	CO_3 (mg/Kg)	HCO_3 (mg/Kg)	pH (s.u.)
ANALYSIS DATE:		05/15/03	05/15/03	05/15/03	05/15/03	05/14/03
H7655-7	60-70	880	892	24	98	8.47
H7655-8	70-80	1759	556	46	146	8.88
H7655-9	80-90	1951	680	0	244	7.65
Quality Control		1050	54.39	NR	1068	6.92
True Value QC		1000	50.00	NR	1000	7.00
% Recovery		105	109	NR	107	98.9
Relative Percent Difference		2.0	0.7	NR	7.7	0.4
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1

Note: Analyses performed on 1:4 w:v aqueous extracts.

Amy Hill
Chemist

5/16/03
Date

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 677-2331

Receiving Date: 05/13/03
Reporting Date: 05/16/03
Project Owner: LOCO HILLS GSF
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/01/03
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: BC
Analyzed By: HM

LAB NUMBER	SAMPLE ID	Na (mg/Kg)	Ca (mg/Kg)	Mg (mg/Kg)	K (mg/Kg)	Conductivity (uS/cm)	T-Alkalinity ($mgCaCO_3/Kg$)
ANALYSIS DATE:		05/15/03	05/15/03	05/15/03	05/13/03	05/14/03	05/15/03
H7655-10	90-100	654	112	27	11	4682	100
H7655-11	100-115	83	960	115	39	10082	100
Quality Control		NR	43	55	5.22	1322	NR
True Value QC		NR	50	50	5.00	1413	NR
% Recovery		NR	86	110	104	93.6	NR
Relative Percent Difference		NR	0	0	2.6	0.7	NR
METHODS:			SM3500-Ca-D	3500-Mg E	8049	120.1	310.1

LAB NUMBER	SAMPLE ID	Cl^- (mg/Kg)	SO_4 (mg/Kg)	CO_3 (mg/Kg)	HCO_3 (mg/Kg)	pH (s.u.)
ANALYSIS DATE:		05/15/03	05/15/03	05/15/03	05/15/03	05/14/03
H7655-10	90-100	640	792	0	122	7.76
H7655-11	100-115	548	1736	0	122	7.44
Quality Control		1050	54.39	NR	1068	6.92
True Value QC		1000	50.00	NR	1000	7.00
% Recovery		105	109	NR	107	98.9
Relative Percent Difference		2.0	0.7	NR	7.7	0.4
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1

Note: Analyses performed on 1:4 w:v aqueous extracts.

Amy Hill
Chemist

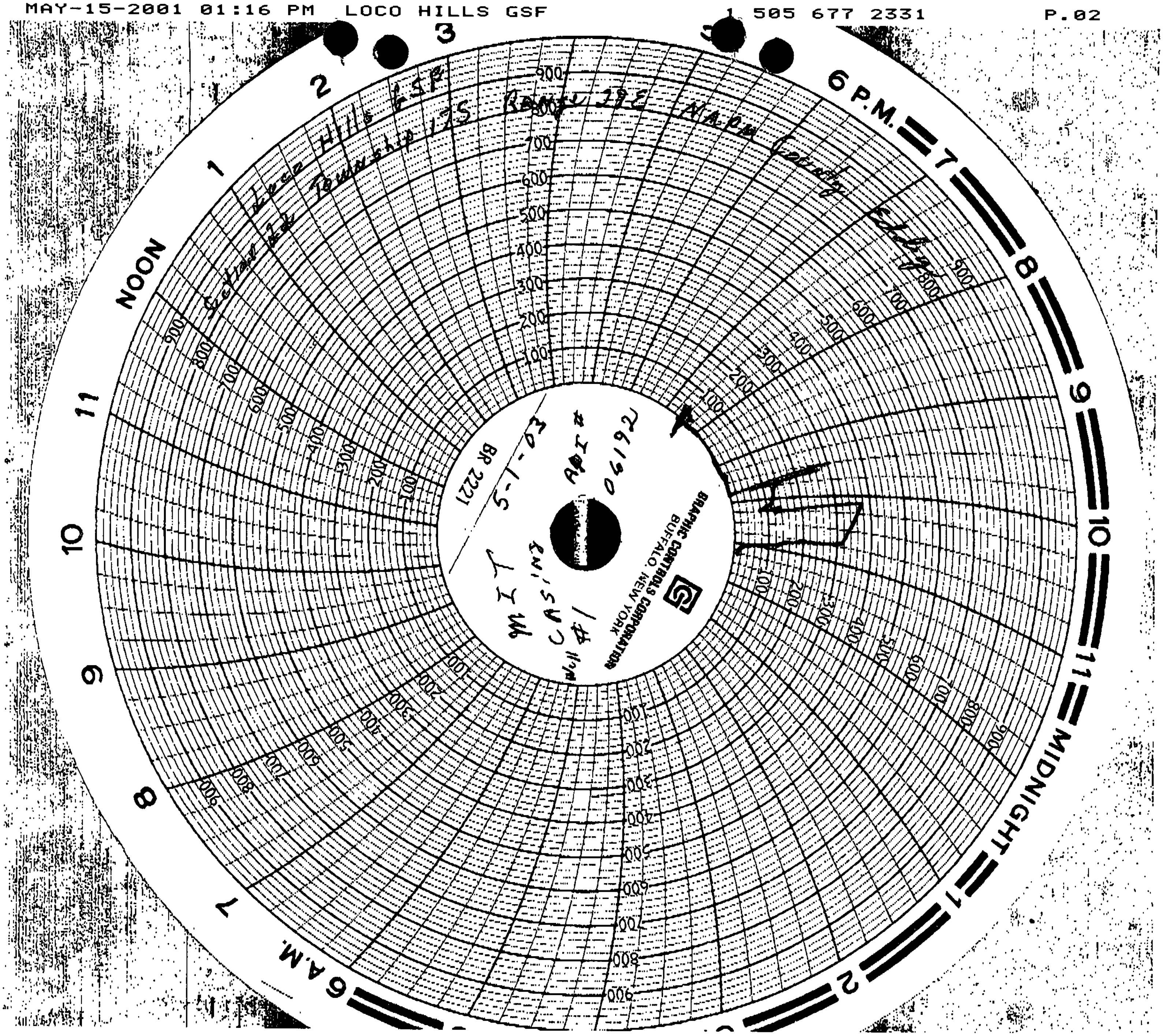
5/16/03
Date

Attention

Wayne Price
New Mexico O.C.D.

From

Loco Hills GSF


Loco Hills GSF
Township 17S
BR 2221
5-1-03
API #
MIT
CASING
Well #1
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
NOON
6 P.M.
MIDNIGHT
6 A.M.

Submit 3 Copies To Appropriate District Office
District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Rd., Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy, Minerals and Natural Resources

OIL CONSERVATION DIVISION
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-103
Revised March 25, 1999

WELL API NO.	30-015-06192
5. Indicate Type of Lease	STATE ☒ FEE ☐
6. State Oil & Gas Lease No.	B6 635
7. Lease Name or Unit Agreement Name:	Loco Hills GSF LTD
8. Well No.	1
9. Pool name or Wildcat	

SUNDRY NOTICES AND REPORTS ON WELLS
(DO NOT USE THIS FORM FOR PROPOSALS TO DRILL OR TO DEEPEN OR PLUG BACK TO A DIFFERENT RESERVOIR. USE "APPLICATION FOR PERMIT" (FORM C-101) FOR SUCH PROPOSALS.)

1. Type of Well: Oil Well ☐ Gas Well ☐ Other Salt Dome Injection (storage)
2. Name of Operator: Loco Hills GSF LTD
3. Address of Operator: 158 Deer Creek Drive Aledo, Texas 76008
4. Well Location

Unit Letter L : 2069 feet from the South line and 1193 feet from the West line

Section 22 Township 17S Range 29E NMPM County Eddy

10. Elevation (Show whether DR, RKB, RT, GR, etc.) GR

11. Check Appropriate Box to Indicate Nature of Notice, Report or Other Data

NOTICE OF INTENTION TO:				SUBSEQUENT REPORT OF:			
PERFORM REMEDIAL WORK	☐	PLUG AND ABANDON	☐	REMEDIAL WORK	☐	ALTERING CASING	☐
TEMPORARILY ABANDON	☐	CHANGE PLANS	☐	COMMENCE DRILLING OPNS.	☐	PLUG AND ABANDONMENT	☐
PULL OR ALTER CASING	☒	MULTIPLE COMPLETION	☐	CASING TEST AND CEMENT JOB	☐		
OTHER:			☐	OTHER:			☐

12. **Describe proposed or completed operations.** (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work). SEE RULE 1103. For Multiple Completions: Attach wellbore diagram of proposed completion or recompilation.

Run 10.5# J55 4½ FL-4S casing 525' inside 5½" casing. 5½" cast iron bridge plug will be run and cement circulated between 5½" casing and new casing. After completion, MIT Test and open hole cavern test will follow.
Estimated start date June 3, 2003

I hereby certify that the information above is true and complete to the best of my knowledge and belief.

SIGNATURE John B Smith TITLE Terminal Operator DATE 5/15/03

Type or print name John B Smith Telephone No. (505) 677-2331

(This space for State use)

APPROVED BY ______ TITLE ______ DATE ______
Conditions of approval, if any:

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

CARDINAL LABORATORIES, INC.
2111 Beechwood, Abilene, TX 79603 (915) 673-7001 Fax (915) 673-7020
101 East Marland, Hobbs, NM 88240 (505) 393-2326 Fax (505) 393-2476

Page ____ of ____

Company Name:	LOCO Hills GSF
Project Manager:	J. B. Smith
Address:	P.O. Box 37
City:	Loco Hills
State:	NM
Zip:	88255
Phone #:	505-677-2331
Fax #:	505-622-9807
Project #:	
Project Owner:	695-2331
Project Name:	
Project Location:	
Sampler Name:	

BILL TO

P.O. #:	
Company:	LOCO Hills GSF
Attn:	Mitchell Johnson
Address:	158 Deer Creek Dr.
City:	Aledo
State:	Tx
Zip:	76008
Phone #:	817-441-6568
Fax #:	817-441-5880

ANALYSIS REQUEST

Lab I.D.	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	GROUNDWATER	WASTEWATER	SOIL	CRUDE OIL	SLUDGE	OTHER:	ACID/BASE:	ICE / COOL	OTHER:	DATE	TIME	Cations Anions	NO3/NO2, F, Br, PO4	WQCC metals
H7634-1	Groundwater	G	3	✓									5/5/03		✓	✓	✓

Sampler Relinquished:	Date: Time:	Received By:	
Relinquished By:	Date: 5/6/03 Time: 4:15	Received By: (Lab Staff) Amy Hill	
Delivered By: (Circle One) Sampler - UPS - Bus - Other:		Sample Condition Cool ☑ Yes ☐ No Intact ☑ Yes ☐ No	CHECKED BY: (Initials)

Phone Result: ☐ Yes ☐ No Add'l Phone #:
Fax Result: ☐ Yes ☐ No Add'l Fax #:
REMARKS:

† Cardinal cannot accept verbal changes. Please fax written changes to 505-393-2476

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/06/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Br^- (mg/L)	F^- (mg/L)	NO_3/NO_2 (mg/L)	PO_4 (mg/L)
ANALYSIS DATE		05/06/03	05/06/03	05/06/03	05/06/03
H7634-1	MONITOR WELL	12.2	1.14	5.61	0.34
Quality Control		2.83	0.95	2.98	0.51
True Value QC		3.00	1.00	3.00	0.50
% Recovery		94.3	95.0	99.2	101
Relative Percent Difference		1.0	3.0	2.0	0
METHODS: Std. Methods		4500-Br B	4500-F D	353.3*	4500-P E

EPA 600/4-79-020

Amy Hill
Chemist

5/6/03
Date

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 623-9607

Receiving Date: 05/06/03
Reporting Date: 05/07/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Na (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Conductivity (uS/cm)	T-Alkalinity (mgCaCO$_3$/L)
ANALYSIS DATE:		05/06/03	05/06/03	05/06/03	05/06/03	05/06/03	05/06/03
H7634-1	MONITOR WELL	43626	3060	1142	193	146815	140
Quality Control		NR	43	55	5.22	1322	NR
True Value QC		NR	50	50	5.00	1413	NR
% Recovery		NR	86	110	104	93.6	NR
Relative Percent Difference		NR	0	0	2.6	0.7	NR
METHODS:			SM3500-Ca-D	3500-Mg E	8049	120.1	310.1

LAB NUMBER	SAMPLE ID	Cl$^-$ (mg/L)	SO$_4$ (mg/L)	CO$_3$ (mg/L)	HCO$_3$ (mg/L)	pH (s.u.)	TDS (mg/L)
ANALYSIS DATE:		05/06/03	05/06/03	05/06/03	05/06/03	05/06/03	05/06/03
H7634-1	MONITOR WELL	74977	1488	0	171	7.24	118200
Quality Control		1050	54.39	NR	1069	6.95	NR
True Value QC		1000	50.00	NR	1000	7.00	NR
% Recovery		105	109	NR	107	99.3	NR
Relative Percent Difference		2.0	0.7	NR	7.7	0.8	12.1
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1	160.1

Amy Hill
Chemist

5/7/03
Date

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/15/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

TOTAL METALS

LAB NUMBER	SAMPLE ID	Al (ppm)	Co (ppm)	Cu (ppm)	Fe (ppm)
ANALYSIS DATE:		05/13/03	05/13/03	05/08/03	05/08/03
H7634-1	MONITOR WELL	<0.2	<0.04	<0.5	<1
Quality Control		0.980	0.970	5.110	5.223
True Value QC		1.000	1.000	5.000	5.000
% Recovery		98.0	97.0	102	104
Relative Percent Difference		0.4	0	0.4	0.4
METHODS: EPA 600/04-79-020		200.7	200.7	220.1	236.1

LAB NUMBER	SAMPLE ID	Mn (ppm)	Mo (ppm)	Ni (ppm)	Zn (ppm)
ANALYSIS DATE:		05/13/03	05/13/03	05/13/03	05/08/03
H7634-1	MONITOR WELL	0.33	<0.1	<0.04	2.45
Quality Control		0.475	0.485	0.480	0.499
True Value QC		0.500	0.500	0.500	0.500
% Recovery		95.0	97.0	96.0	99.8
Relative Percent Difference		0.2	0.8	0.4	0.8
METHODS: EPA 600/04-79-020		200.7	200.7	200.7	289.1

Amy Hill
Chemist

5/15/03
Date

H7634m2

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
LOCO HILLS GSF
ATTN: J.B. SMITH
P.O. BOX 37
LOCO HILLS, NM 88255
FAX TO: (505) 622-9807

Receiving Date: 05/05/03
Reporting Date: 05/15/03
Project Number: NOT GIVEN
Project Name: MONITOR WELL
Project Location: MM 127.5 LOVINGTON HWY

Sampling Date: 05/05/03
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

RCRA METALS

LAB NUMBER	SAMPLE ID	As ppm	Ag ppm	Ba ppm	Cd ppm	Cr ppm	Pb ppm	Hg ppm	Se ppm
ANALYSIS DATE:		05/13/03	05/13/03	05/06/03	05/13/03	05/13/03	05/13/03	05/13/03	05/08/03
H7634-1	MONITOR WELL	<0.08	<0.04	<0.5	<0.005	<0.04	<0.04	<0.001	<0.05
Quality Control		0.950	0.470	0.950	0.475	0.480	0.475	0.00104	0.061
True Value QC		1.000	0.500	1.000	0.500	0.500	0.500	0.00100	0.060
% Recovery		95.0	94.0	95.0	95.0	96.0	95.0	104	102
Relative Percent Difference		2.1	1.7	0.4	0	1.1	0	9.0	3.2
METHODS: EPA 600/4-79-020*		200.7	200.7	200.7	200.7	200.7	200.7	245.1*	270.2*

Amy Hill
Chemist

5/15/03
Date

H7634m

Loco Hills GSF

Drill Rate 5-1-03

0-2 2 Sand: Rd, Ambr, VFN GRN
4 - ← Gravel, Sand, Clay,
6 - (Gravel 1/4" - 1/8")
8 -
10 -
2 1
4 1 ← Clay: Rd, VRY SNDY Water
6 1
8 -
20 -
2 -
4 1
6 -
8 -
30 - Clay AA, sme FN Gravel
2 1
4 1
6 1-
8 2
40 2
2 2-
4 1
6 1
8 1
50 1
2 1
4 1
6 1-
8 1-
60 1
2 1-
4 1-
6 2
8 2- ← 67' Conglomerate: Gry, Dkgry, Mott, Lmy
70 2-
2 2
4 2
6 2- ← Clay: Rd, SLty
8 1-
80 1-

80-2 1
4 1-
6 1-
8 3 ← Rd Clay: Vry Stky
90 3
2 4 ← 5/2/03 Lost Some fluid in Pit; Limestone: CRE WHT - Lt GRY, VFN - MiCXN, Sme CHLKY, Sme Fractured
4 4
6 8
8 12
100 27
2 17
4 10
6 12
8 13
110 8 ← 109' Change to clay
2 20 ← Clay: BLu Gry, Smth
4 13
6 12 Clay: Rd, SLty - Smth
8
120

Hole Size: 6"

Casing Size 2"

P.01

TRANSACTION REPORT

MAY-15-2003 THU 01:23 PM

FOR:

RECEIVE

DATE	START	SENDER	RX TIME	PAGES	TYPE	NOTE	M#	DP
MAY-15	01:16 PM	1 505 677 2331	7'00"	10	RECEIVE	OK		

LETTER OF TRANSMITTAL

PETTIGREW and ASSOCIATES, PA
1110 N. Grimes
Hobbs, NM 88240
505-393-9827 Phone
505-393-1543 Fax

DATE April 28, 2003

TO: Oil Conservation Division
Environmental Bureau
1220 South Street Francis Drive
Santa Fe, NM 87505

ATTENTION: Wayne Price

RE: Loco Hills GSF, LTD Proposed New Brine Pond

WE ARE SENDING YOU:

☐ **ATTACHED** ☐ **FORWARDED SEPERATELY VIA** ____________________

☐ Shop Drawings ☐ Prints ☐ Mylar ☐ Samples
☐ Copy of Letter ☒ Plans ☐ Original Documents ☐ Diskettes
☐ Specifications ☐ Other____________________

QUANTITY	IDENT. NO.	DATE	DESCRIPTION
1		4/28/03	Loco Hills GSF, LTD Proposed New Brine Pond

THESE ARE TRANSMITTED as checked

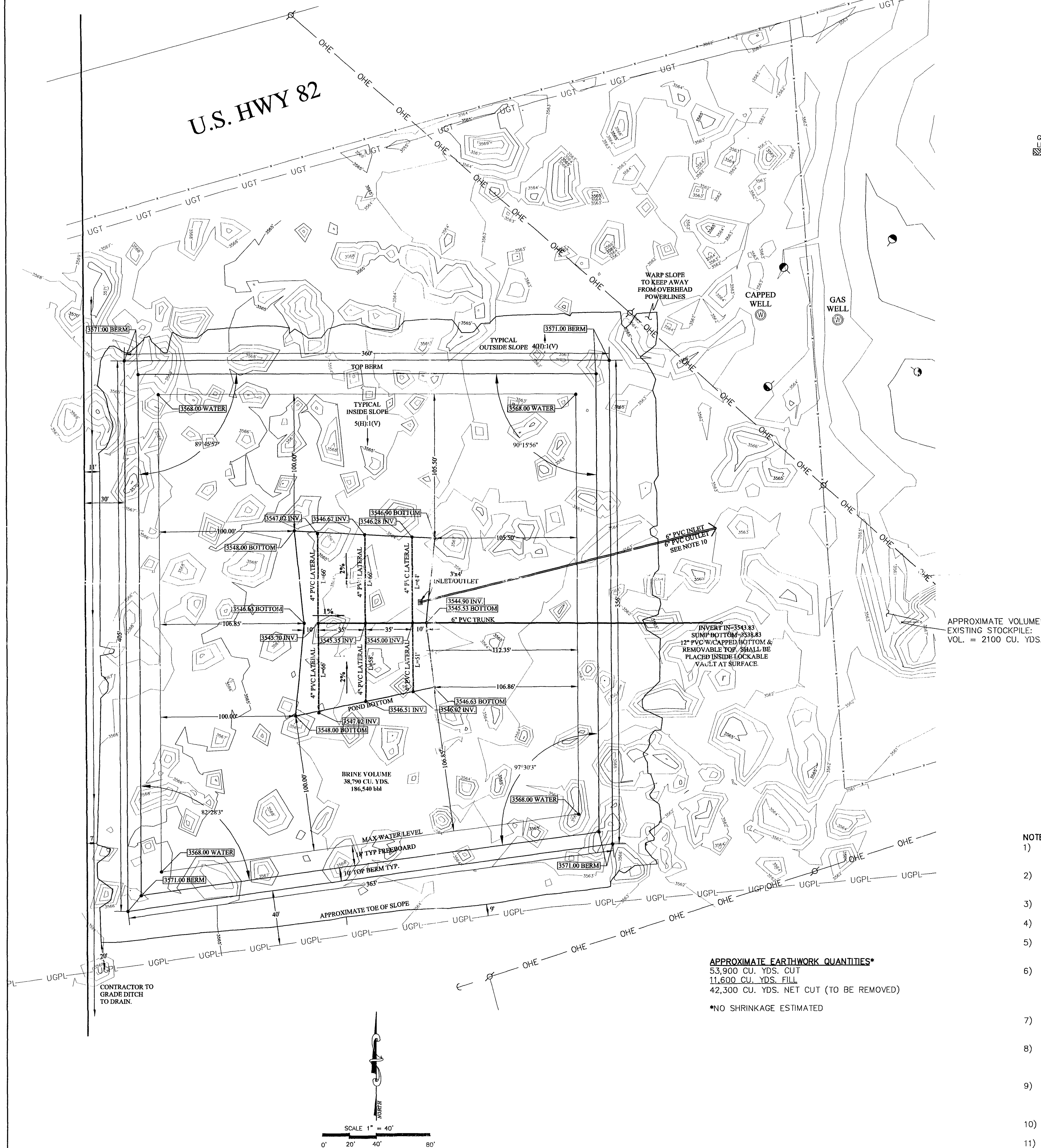
☐ For Approval ☐ Approved Resubmit______Copies for Approval
☒ For Your Use ☐ Approved as Noted Submit ______Copies for Distribution
☐ As Requested ☐ Returned for Corrections Return______Corrected Prints
☐ For Review and Comment ☐ Other ____________________

REMARKS

This is sent to you as requested by Mitchel Johnson

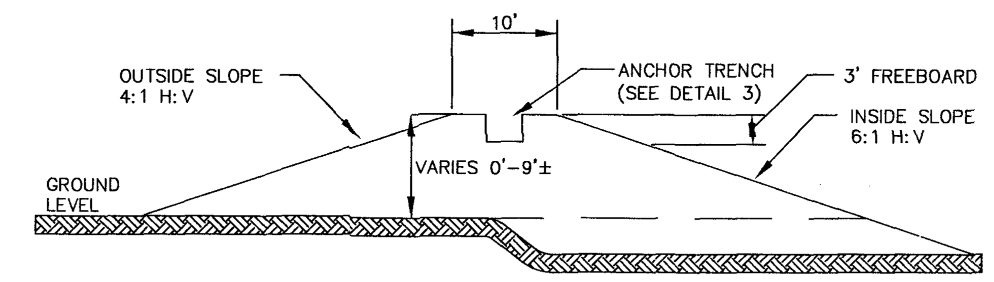
Copies:

Signed By: Jeremy Baker
Reply To: Jeremy Baker, EI

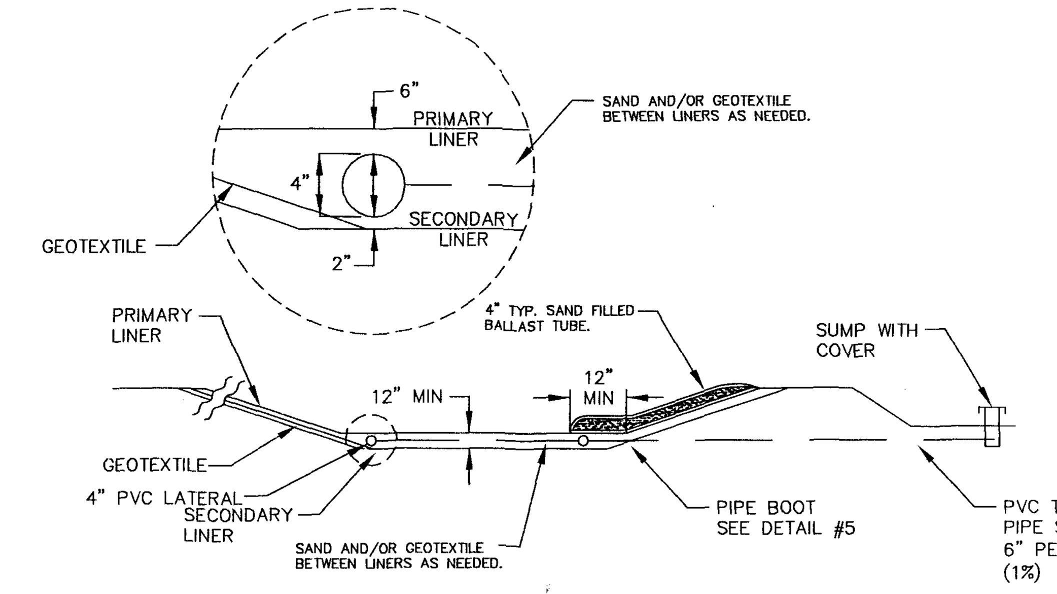


APPROXIMATE EARTHWORK QUANTITIES*
53,900 CU. YDS. CUT
11,600 CU. YDS. FILL
42,300 CU. YDS. NET CUT (TO BE REMOVED)

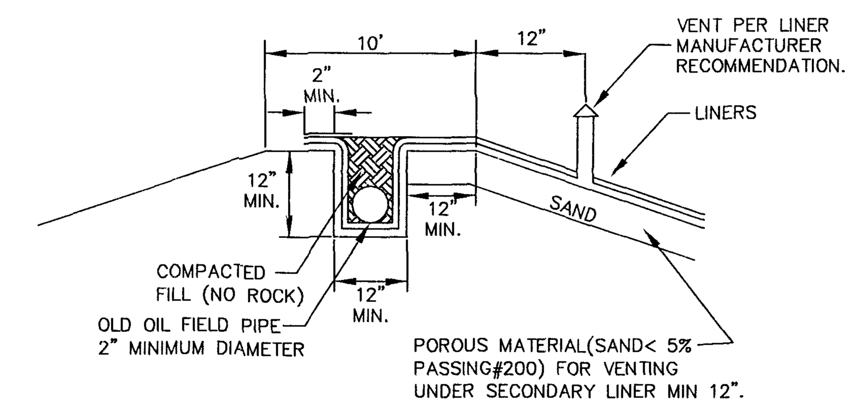
*NO SHRINKAGE ESTIMATED



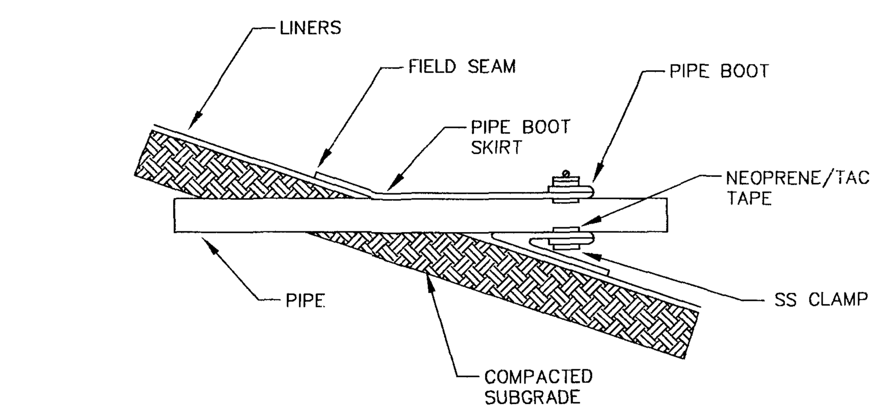
DETAIL #1
PIT CONSTRUCTION
N.T.S



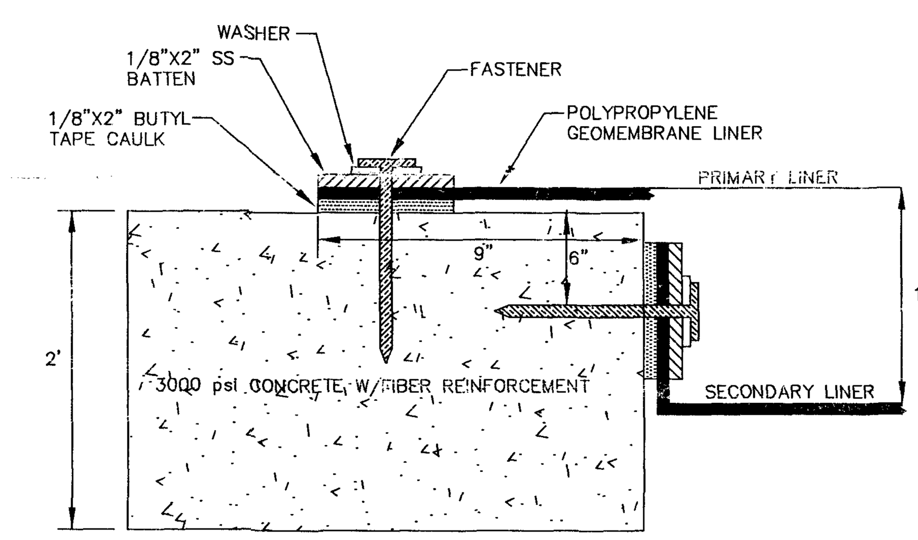
DETAIL #2
LEAK DETECTION &
BALLAST TUBE
N.T.S



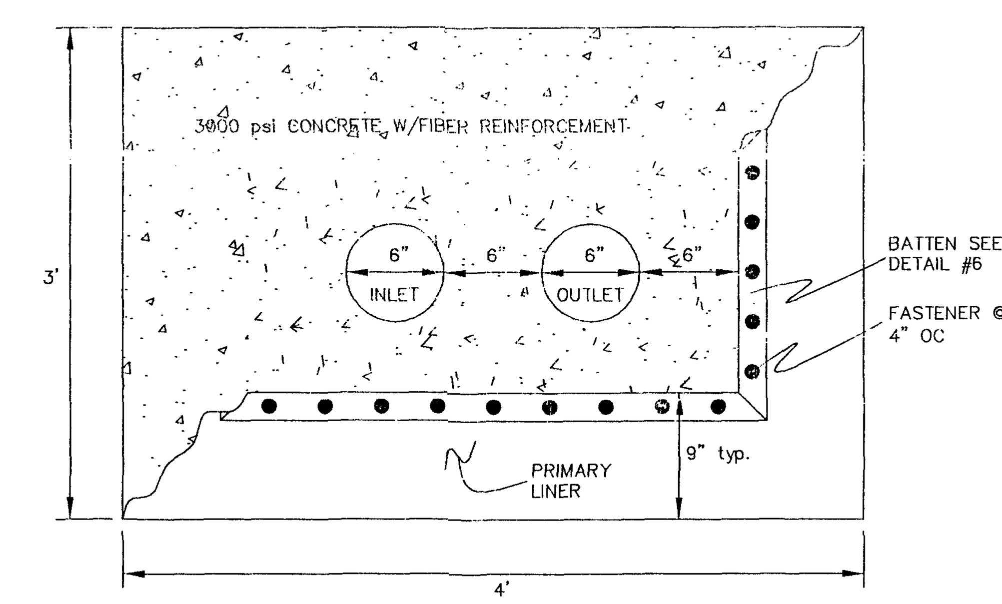
DETAIL #3
ANCHOR TRENCH
N.T.S



DETAIL #4
PIPE BOOT
N.T.S



DETAIL #5
BATTEN
N.T.S



DETAIL #6
CONCRETE
INLET/OUTLET
DETAIL–PLANVIEW
N.T.S

NOTES:

1) INSTALL VENTS AT 50' INTERVALS AROUND PERIMETER OF POND.
2) INSTALL BALLAST TUBE AT 50' INTERVALS AROUND PERIMETER OF POND BETWEEN VENTS AND IN CORNERS.
3) PRIMARY LINER–60 MIL POLYPROPYLENE.
4) SECONDARY LINER–36 MIL POLYPROPYLENE.
5) FABRIC UNDERLAY–8 lb. NONWOVEN GEOTEXTILE OR AS PER MANUFACTURERS RECOMMENDATION.
6) PVC PIPE UNDER DRAIN SYSTEM–
   a) LATERAL–4" PVC SDR–41 W/ (2) 3/8" ø HOLES AT 180° AT 5" O.C. SOLVENT WELD ALL JOINTS.
   b) TRUNK–4" PVC SDR–26 SOLVENT WELD ALL JOINTS.
7) ANCHOR TRENCH BACKFILL MATERIAL SHALL HAVE A PI OF 4 MIN TO 12 MAX.
8) ALL MATERIALS SHALL BE COMPACTED TO A MINIMUM OF 95% ASTM D–698 AT +4% TO –2% OPTIMUM MOISTURE.
9) DETAILS SHOWN FOR REFERENCE ONLY. INSTALL LINER, BALLAST TUBES, BOOTS, VENTS, ETC. AS PER LINER MANUFACTURER'S RECOMMENDATION.
10) PIPING BEYOND BY OWNER.
11) CONTRACTOR SHALL VERIFY QUANTITY ESTIMATES. NO PRICE ADJUSTMENTS WILL BE MADE BASED ON EARTHWORK QUANTITIES.

WILLIAM M. HICKS III
NEW MEXICO
10682
REGISTERED PROFESSIONAL SURVEYOR
April 21, 2003

LEGEND

Symbol	Description
◑	ANCHOR
ø	POWER POLE
⟵	GUY WIRE
Ⓦ	WELL
□	PUMP HEAD
○	VENT PIPE
—— OHE ——	OVERHEAD ELECTRIC
—/—/—	ABOVEGROUND FAS-LINE
—— UGT ——	UNDERGROUND TELEPHONE
—— UGPL ——	UNDERGROUND PIPELINE
—x—x—	4 STRAND BARB WIRE

PROPOSED NEW BRINE POND
ALTERNATIVE NO.2
SITE LAYOUT & DETAILS
LOCO HILLS GSF, LTD.
BUSINESS LEASE No. BL-635

PETTIGREW AND ASSOCIATES
1110 N. GRIMES HOBBS, N.M. 88240
(505) 393-9827

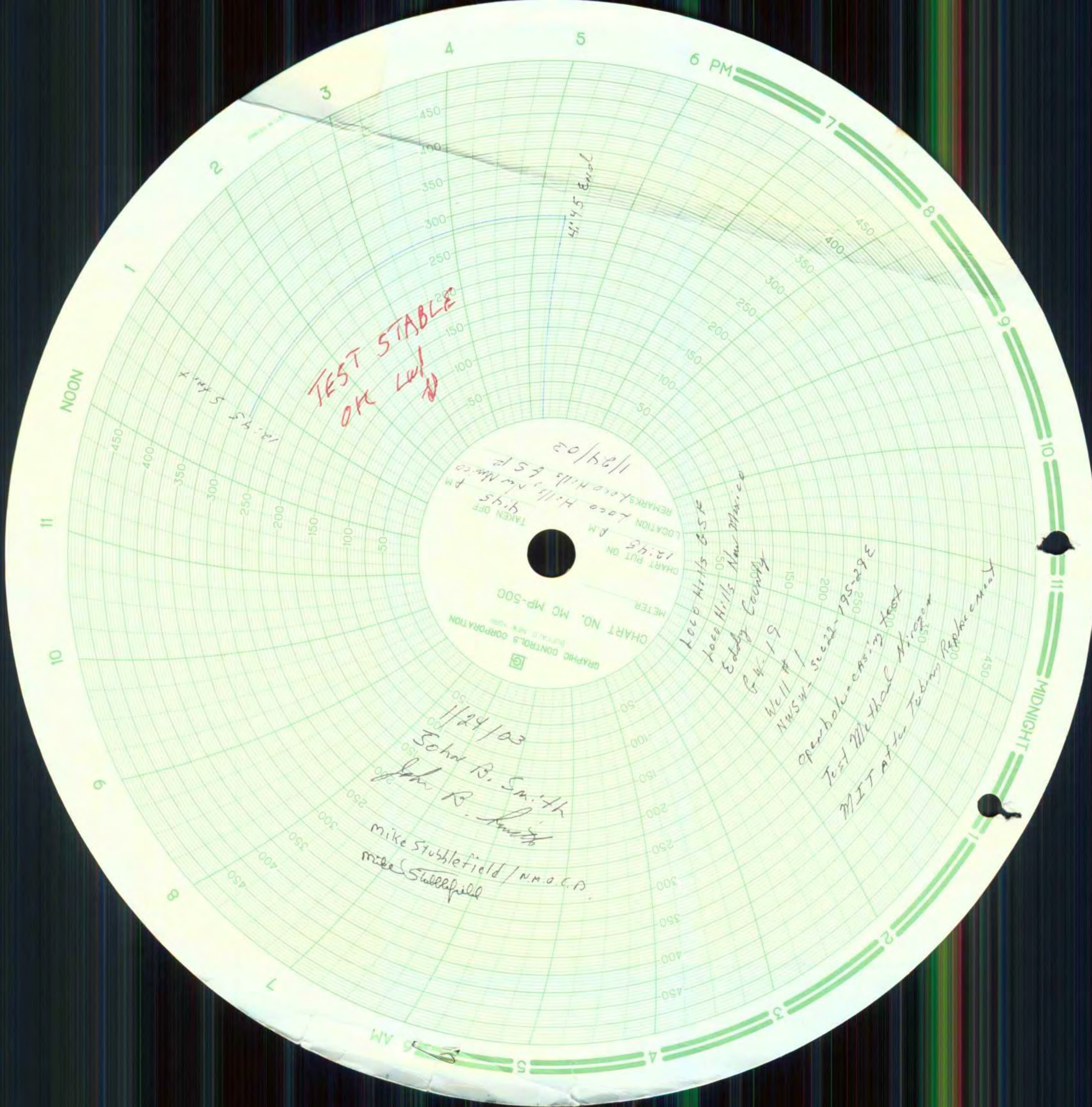
PLAT OF TOPOGRAPHIC SURVEY FOR
LOCO HILLS GSF, LTD.
LOCO HILLS, NEW MEXICO

REV	DATE	DESCRIPTION
0	04/21/2003	FINAL PLAT
00	03/14/2003	PRELIMINARY PLAT
X	03-05-2003-03-06-2003	DATE OF SURVEY

PROJECT# 2003.1016 | DRN BY A. Garcia
DWG AutoCAD Loco Hills GSF dwg Loco Hills GSF.dwg

Server\Public\Data Files\2003.1016\AutoCAD Loco Hills GSF\dwg\Loco Hills GSF.dwg, 04/21/2003 12:08:08 PM, Fuzzy


NOT STABLE
LWP
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
CHART NO. MC MP-1000-S
METER
10:25 AM
TAKEN OFF
2:37 PM
CHART PUT ON
LOCATION Loco Hills N. Mex
REMARKS Loco Hills GSF
1-23-03
Start 10:25 A.M.
1/23/03
John B. Spruill
Mike Stubblefield / O.C.D.
Nitrogen inj. @ 220.
Loco Hills GSF
Loco Hills New Mexico
NWSW - Sec22 - 19S - 29E
Eddy County
GW-19
Well #1
Operating Pressure 1420
Open Hole Test - Casing - test Method Nitrogen
MIT After Tubing Replacement
SATURDAY
SUNDAY
MONDAY
TUESDAY
WEDNESDAY
THURSDAY
FRIDAY


GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
CHART NO. MC MP-500
METER
CHART PUT ON 12:45 A.M
LOCATION Loco Hills New Mexico
TAKEN OFF 4:45 P.M
REMARKS Loco Hills GSU
1/24/03
TEST STABLE
OK
4:45 End
12:45 Start
Loco Hills GSU
Loco Hills New Mexico
Eddy County
G-W-19
Well #1
NWSW-Sec22-19S-29E
openhole casing test
Test Method Nitrogen
MIT after Tubing Replacement
1/24/03
John B. Smith
Mike Stubblefield / N.M.O.C.D.
6 PM
MIDNIGHT
6 AM
NOON

AmeriGas®

America's Propane Company

FACSIMILE NUMBER: (610) 992-3258

PLEASE DELIVER THE FOLLOWING PAGE(S) TO:

NAME	Wayne Price, Engineer Dwight Heard, Esq. Mitch Johnson
COMPANY	New Mexico Energy, Minerals and Natural Resources Department – Oil Conversation Division Heard & Wright, P.C. Loco Hills GSF, LTD.
FACSIMILE NUMBER	(505) 476 – 3462 (817) 732 – 0967 (817) 441 – 5880
FROM	Matthew A. Woodward
TOTAL NUMBER OF PAGES (INCLUDING COVER PAGE)	8
DATE	July 8, 2002

If you do not receive all the pages, please call back as soon as possible, (610) 337 – 1000 extension 7737. Thank, you, Gloria

MESSAGE:

Per my conversation with Mitch Johnson, attached please find a copy of the Discharge Plan GW-109 Renewal Application as executed by Loco Hills GSF. LTD. Please call me at (610) 337–1000, ext. 7737 with any questions.

April 12, 2000

CERTIFIED MAIL
RETURN RECEIPT NO. 5051 5895

William S. Stagg
Columbia Propane
P.O. Box 35800
Richmond, Virginia 23235-08000

Re: Columbia Propane Loco Hills Gas Storage Facility
Discharge Plan GW-019 Renewal Application

Dear Mr. Stagg:

The groundwater discharge plan renewal application for the Columbia Propane Loco Hills Gas Storage Facility BW-019 operated by Columbia Propane located in the NW/4 SE/4, Section 22, Township 17 South, Range 29 East, NMPM, Eddy County, New Mexico is hereby approved under the conditions contained in the enclosed attachment. Enclosed are two copies of the conditions of approval. **Please sign and return one copy to the New Mexico Oil Conservation Division (OCD) Santa Fe Office within ten working days of receipt of this letter.**

The original discharge plan was approved on February 27, 1985 and subsequently renewed on January 03, 1990 and July 20, 1995 with an expiration date of February 27, 2000. The discharge plan renewal application, including attachments, dated February 17, 2000 submitted pursuant to Section 5101.B.3. of the New Mexico Water Quality Control Commission (WQCC) Regulations also include. all earlier applications and all conditions later placed on those approvals. The discharge plan renewal application was submitted pursuant to Section 5101.B.3. of the New Mexico Water Quality Control Commission (WQCC) Regulations. The discharge plan is renewed pursuant to Section 5101.A. and 3109.C. Please note Section 3109.G., which provides for possible future amendment of the plan. Please be advised that approval of this plan does not relieve Columbia Propane of liability should operations result in pollution of surface or ground waters, or the environment.

Please be advised that all exposed pits, including lined pits and open top tanks (exceeding 16 feet in diameter) shall be screened, netted, or otherwise rendered nonhazardous to wildlife including migratory birds.

Please note that Section 3104. of the regulations requires that "when a plan has been approved, discharges must be consistent with the terms and conditions of the plan." Pursuant to Section 3107.C., Columbia Propane is required to notify the Director of any facility expansion,

William S. Stagg
02/05/02
Page 2

production increase, or process modification that would result in any change in the discharge of water quality or volume.

Pursuant to Section 3109.H.4., this approval is for a period of five years. **This approval will expire February 27, 2005** and an application for renewal should be submitted in ample time before that date. Pursuant to Section 5101.F. of the regulations, if a discharger submits a discharge plan renewal application at least 120 days before the discharge plan expires and is in compliance with the approved plan, then the existing discharge plan will not expire until the application for renewal has been approved or disapproved. It should be noted that all discharge plan facilities will be required to submit plans for, or the results of, an underground drainage testing program as a requirement for discharge plan renewal.

The discharge plan application for the Columbia Propane Loco Hills Gas Storage Facility is subject to the WQCC Regulation 3114. Every billable facility submitting a discharge plan will be assessed a fee equal to the filing fee of $50 plus a renewal fee of $690.00 for Class III Gas Well Injection Storage Systems. The OCD has not received the $690.00 flat fee. The flat fee of $690.00 may be paid in a single payment due on the date of the discharge plan approval or in five equal installments over the expected duration of the discharge plan. Installment payments shall be remitted yearly, with the first installment due on the date of the discharge plan approval and subsequent installments due on this date of each calendar year.

Please make all checks payable to: **NMED-Water Quality Management** and addressed to the OCD Santa Fe Office.

If you have any questions, please contact Wayne Price of my staff at (505-827-7155). On behalf of the staff of the OCD, I wish to thank you and your staff for your cooperation during this discharge plan review.

Sincerely,

Roger C. Anderson
Environmental Bureau Chief
RCA/lwp
Attachment-1
xc: OCD Artesia Office

William S. Stagg
02/05/02
Page 3

ATTACHMENT TO THE DISCHARGE PLAN BW-019 APPROVAL
Columbia Propane Loco Hills Gas Storage Facility (BW-019)
DISCHARGE PLAN APPROVAL CONDITIONS
April 12, 2000

1. Payment of Discharge Plan Fees: The $50.00 filing fee has been received by OCD. The $690.00 flat fee shall be submitted upon receipt of this approval. The required flat fee may be paid in a single payment due at the time of approval, or in equal annual installments over the duration of the plan, with the first payment due upon receipt of this approval.

2. Commitments: Columbia Propane will abide by all commitments submitted in the discharge plan renewal application dated February 17, 2000 and these conditions of approval.

3. Brine Storage Pond: A minimum freeboard will be maintained in the pond so that no overtopping of brine occurs. Any repairs or modifications to the pond liner must receive prior OCD approval. If the pond liner is replaced or a new pond is constructed, a double synthetic liner with leak detection will be incorporated into the design. The outside walls of the levees will be maintained in such a manner to prevent erosion and be inspected monthly and after any substantial rainfall. Inspection records shall be maintained by Columbia Propane. Leaks shall be reported pursuant to Item 21. (Spill Reporting) of these conditions.

4. Leak Detection Monitor Well: The leak detection monitor well for the brine storage pond must be inspected for fluids monthly. Records will be maintained to include quantity of fluid measured, conductivity and chlorides of fluid, date of inspection, and name of inspector. Any fluids found must be reported to the NMOCD Santa Fe office and the appropriate District office within 48 hours of discovery.

5. Production Method: Brine water will be injected and withdrawn through the tubing and gas products shall be injected and withdrawn through the casing/tubing annulus. Deviations will be allowed for maintenance reasons once a month for up to 24 hours.

6. Maximum Injection Pressure: The maximum operating injection and/or test pressure at the well head will be such that the fracture pressure of the injection formation will not be exceeded.

7. Mechanical Integrity Testing: Columbia Propane will conduct an annual open hole cavern pressure test equal to one and one-half tim s the normal operating pressure (not to exceed formation fracture pressure) or 300 psi, whichever is greater, for four hours. At least once every five years and during well work overs the cavern formation will be isolated from the casing/tubing annuals and the casing pressure tested at 300 psig for 30 minutes. All pressure test must be witnessed and approved by OCD.

8. Capacity and Cavity Configuration: A test will be conducted to determine the size and configuration of the mined cavities prior to discharge plan renewal (February 27, 2005). The method and time of testing will be approved by the OCD prior to performing the test.

   Columbia Propane will provide to the OCD the calculated size of the cavities and demonstrate the stability of the salt formation cavities from collapse and/or subsidence. Please include this information in the first annual report due on July 31, 2000.

9. Operation Reports: Monthly operation reports shall be submitted on OCD C-131A forms and Annual operation reports shall be submitted on OCD C-131B forms in the annual report due on July 31, 2000.

10. Analysis of Injection Fluid and Brine: Provide an analysis of the injection fluid and produced brine with each annual report. Analysis will be for General Chemistry (Method 40 CFR 136.3) using EPA methods.

11. Drum Storage: All drums containing materials other than fresh water must be stored on an impermeable pad with curbing. All empty drums should be stored on their sides with the bungs in place and lined up on a horizontal plane. Chemicals in other containers such as sacks or buckets must also be stored on an impermeable pad with curbing.

12. Process Areas: All process and maintenance areas which show evidence that leaks and spills are reaching the ground surface must be either paved and curbed or have some type of spill collection device incorporated into the design.

13. Above Ground Tanks: All above ground tanks which contain fluids other than fresh water must be bermed to contain a volume of one-third more than the total volume of the largest tank or of all interconnected tanks. All new facilities or modifications to existing facilities must place the tank on an impermeable type pad within the berm.

14. Above Ground Saddle Tanks: Above ground saddle tanks must have impermeable pad and curb type containment unless they contain fresh water or fluids that are gases at atmospheric temperature and pressure.

15. Labeling: All tanks, drums, and other containers should be clearly labeled to identify their contents and other emergency information necessary if the tank were to rupture, spill, or ignite.

16. Below Grade Tanks/Sumps: All below grade tanks, sumps, and pits must be approved by the OCD prior to installation or upon modification and must incorporate secondary containment and leak-detection into the design. All pre-existing sumps and below-grade tanks must be tested to demonstrate their mechanical integrity no later than June 01, 2000 and every year from tested date, thereafter. Permittees may propose various methods for testing such as pressure testing to 3 pounds per square inch above normal operating pressure and/or visual inspection of cleaned out tanks and/or sumps, or other OCD approved methods. The OCD will be notified at least 72 hours prior to all testing. The test results will be submitted to OCD in the annual report due on July 31, of each year.

17. Underground Process/Wastewater Lines: All underground process/wastewater pipelines must be tested to demonstrate their mechanical integrity no later than June 01, 2000 and every 5 years, from tested date, thereafter. Permittees may propose various methods for testing such as pressure testing to 3 pounds per square inch above normal operating pressure or other means acceptable to the OCD. The OCD will be notified at least 72 hours prior to all testing. The test results will be submitted to OCD in the annual report due on July 31, 2000.

18. Class V Wells: No Class V wells that inject non-hazardous industrial wastes or a mixture of industrial wastes and domestic wastes will be approved for construction and/or operation unless it can be demonstrated that groundwater will not be impacted in the reasonably foreseeable future. Leach fields and other wastewater disposal systems at OCD regulated facilities which inject non-hazardous fluid into or above an underground source of drinking water are considered Class V injection wells under the EPA UIC program. Class V wells that inject domestic waste only must be permitted by the New Mexico Environment Department.

19. Well Work Over Operations: OCD approval will be obtained from the Director prior to performing remedial work, pressure test or any other Work over. Approval will be requested on OCD Form C-103 "Sundry Notices and Reports on Wells" (OCD Rule 1103.A.) with appropriate copies sent to the OCD Artesia District Office.

20. Housekeeping: All systems designed for spill collection/prevention, and leak detection will be inspected daily to ensure proper operation and to prevent overtopping or system failure.

21. Spill Reporting: All spills/releases shall be reported pursuant to OCD Rule 116. and WQCC 1203. to the OCD Artesia District Office.

22. Waste Disposal: All wastes will be disposed of at an OCD approved facility. Only oilfield exempt wastes shall be disposed of down Class II injection wells. Non-exempt oilfield wastes that are non-hazardous may be disposed of at an OCD approved facility upon proper waste determination per 40 CFR Part 261.

23. Transfer of Discharge Plan: The OCD will be notified prior to any transfer of ownership, control, or possession of a facility with an approved discharge plan. A written commitment to comply with the terms and conditions of the previously approved discharge plan must be submitted by the purchaser and approved by the OCD prior to transfer.

24. Closure: The OCD will be notified when operations of the facility are discontinued for a period in excess of six months. Prior to closure of the facility a closure plan will be submitted for approval by the Director. Closure and waste disposal will be in accordance with the statutes, rules and regulations in effect at the time of closure.

25. OCD Inspections: Additional requirements may be placed on the facility based upon results from OCD inspections. As a result of NMOCD's recent inspection of the facility conducted on January 24, 2000 the following additional conditions will be required:

    A. Columbia Propane shall collect groundwater samples from the three fresh water supply wells. The water shall be tested for general water chemistry method 40 CFR 136.3. Total heavy metals using the ICAP scan (EPA method 6010/ICPMS) and Mercury using Cold Vapor (EPA method 7470).

       Columbia Propane will notify the OCD Santa Fe office and the OCD District office at least 48 hours in advance of all scheduled activities such that the OCD has the opportunity to witness the events and/or split samples during OCD's normal business hours.

    B. Columbia Propane shall submit a plan for OCD approval to address the large salt pile being stored on site without proper containment.

    C. Columbia Propane shall submit a plan for OCD approval to address closing the old unlined pit area.

    D. Columbia Propane shall submit a plan for OCD approval to investigate and determine if the pond liner is leaking. The leak detectors were observed to be full of water.

    E. Columbia Propane shall submit a plan for OCD approval to investigate and determine the status of the old abandoned well located on site.

William S. Stagg
02/05/02
Page 7

F. Columbia Propane shall submit a plan for OCD approval to investigate and determine the status of the old salt cavern which is no longer used.

G. Columbia Propane shall submit plans for OCD approval to install containment around the brine pump. This inspection and previous inspections reveal brine water releases from this pump onto the ground surface.

H. Columbia Propane shall repair the leaking lines that were noted during the inspection and provide verification.

I. Columbia Propane shall submit for OCD approval a storm water run-off plan.

J. Columbia Propane shall provide well signs pursuant to OCD rule 103 (19 NMAC 15.C.103) and a sign at the site entrance with the following minimum information: Company name, facility name, emergency telephone number, and OCD discharge plan number.

<u>Columbia Propane shall provide to the OCD all of the above requested information listed in Item 25. By July 31, 2000.</u>

26. <u>Certification:</u> Columbia Propane by the officer whose signature appears below, accepts this permit and agrees to comply with all terms and conditions contained herein. Columbia Propane further acknowledges that these conditions and requirements of this permit may be changed administratively by the Division for good cause shown as necessary to protect fresh water, human health and the environment.

Conditions accepted by:

LOCO HILLS GSF, LTD.
By: LHPS GP, L.L.C., Its General Partner
Company Representative (print name)

By: ______________________
Company Representative - Sign

Title: V. Managing Partner

AmeriGas®

America's Propane Company

FACSIMILE NUMBER: (610) 992-3258

PLEASE DELIVER THE FOLLOWING PAGE(S) TO:

NAME	Wayne Price, Engineer Dwight Heard, Esq. Mitch Johnson
COMPANY	New Mexico Energy, Minerals and Natural Resources Department – Oil Conversation Division Heard & Wright, P.C. Loco Hills GSF, LTD.
FACSIMILE NUMBER	(505) 476 – 3462 (817) 732 – 0967 (817) 441 – 5880
FROM	Matthew A. Woodward
TOTAL NUMBER OF PAGES (INCLUDING COVER PAGE)	8
DATE	July 8, 2002

If you do not receive all the pages, please call back as soon as possible, (610) 337 – 1000 extension 7737. Thank, you, Gloria

MESSAGE:

Per my conversation with Mitch Johnson, attached please find a copy of the Discharge Plan GW-109 Renewal Application as executed by Loco Hills GSF. LTD. Please call me at (610) 337–1000, ext. 7737 with any questions.

William S. Stagg
02/05/02
Page 2

production increase, or process modification that would result in any change in the discharge of water quality or volume.

Pursuant to Section 3109.H.4., this approval is for a period of five years. **This approval will expire February 27, 2005** and an application for renewal should be submitted in ample time before that date. Pursuant to Section 5101.F. of the regulations, if a discharger submits a discharge plan renewal application at least 120 days before the discharge plan expires and is in compliance with the approved plan, then the existing discharge plan will not expire until the application for renewal has been approved or disapproved. It should be noted that all discharge plan facilities will be required to submit plans for, or the results of, an underground drainage testing program as a requirement for discharge plan renewal.

The discharge plan application for the Columbia Propane Loco Hills Gas Storage Facility is subject to the WQCC Regulation 3114. Every billable facility submitting a discharge plan will be assessed a fee equal to the filing fee of $50 plus a renewal fee of $690.00 for Class III Gas Well Injection Storage Systems. The OCD has not received the $690.00 flat fee. The flat fee of $690.00 may be paid in a single payment due on the date of the discharge plan approval or in five equal installments over the expected duration of the discharge plan. Installment payments shall be remitted yearly, with the first installment due on the date of the discharge plan approval and subsequent installments due on this date of each calendar year.

Please make all checks payable to: **NMED-Water Quality Management** and addressed to the OCD Santa Fe Office.

If you have any questions, please contact Wayne Price of my staff at (505-827-7155). On behalf of the staff of the OCD, I wish to thank you and your staff for your cooperation during this discharge plan review.

Sincerely,

Roger C. Anderson
Environmental Bureau Chief
RCA/lwp
Attachment-1
xc: OCD Artesia Office

William S. Stagg
02/05/02
Page 3

ATTACHMENT TO THE DISCHARGE PLAN BW-019 APPROVAL
Columbia Propane Loco Hills Gas Storage Facility (BW-019)
DISCHARGE PLAN APPROVAL CONDITIONS
April 12, 2000

1. Payment of Discharge Plan Fees: The $50.00 filing fee has been received by OCD. The $690.00 flat fee shall be submitted upon receipt of this approval. The required flat fee may be paid in a single payment due at the time of approval, or in equal annual installments over the duration of the plan, with the first payment due upon receipt of this approval.

2. Commitments: Columbia Propane will abide by all commitments submitted in the discharge plan renewal application dated February 17, 2000 and these conditions of approval.

3. Brine Storage Pond: A minimum freeboard will be maintained in the pond so that no overtopping of brine occurs. Any repairs or modifications to the pond liner must receive prior OCD approval. If the pond liner is replaced or a new pond is constructed, a double synthetic liner with leak detection will be incorporated into the design. The outside walls of the levees will be maintained in such a manner to prevent erosion and be inspected monthly and after any substantial rainfall. Inspection records shall be maintained by Columbia Propane. Leaks shall be reported pursuant to Item 21. (Spill Reporting) of these conditions.

4. Leak Detection Monitor Well: The leak detection monitor well for the brine storage pond must be inspected for fluids monthly. Records will be maintained to include quantity of fluid measured, conductivity and chlorides of fluid, date of inspection, and name of inspector. Any fluids found must be reported to the NMOCD Santa Fe office and the appropriate District office within 48 hours of discovery.

5. Production Method: Brine water will be injected and withdrawn through the tubing and gas products shall be injected and withdrawn through the casing/tubing annulus. Deviations will be allowed for maintenance reasons once a month for up to 24 hours.

6. Maximum Injection Pressure: The maximum operating injection and/or test pressure at the well head will be such that the fracture pressure of the injection formation will not be exceeded.

7. Mechanical Integrity Testing: Columbia Propane will conduct an annual open hole cavern pressure test equal to one and one-half tim s the normal operating pressure (not to exceed formation fracture pressure) or 300 psi, whichever is greater, for four hours. At least once every five years and during well work overs the cavern formation will be isolated from the casing/tubing annuals and the casing pressure tested at 300 psi, for 30 minutes. All pressure test must be witnessed and approved by OCD.

8. Capacity and Cavity Configuration: A test will be conducted to determine the size and configuration of the mined cavities prior to discharge plan renewal (February 27, 2005). The method and time of testing will be approved by the OCD prior to performing the test.

   Columbia Propane will provide to the OCD the calculated size of the cavities and demonstrate the stability of the salt formation cavities from collapse and/or subsidence. Please include this information in the first annual report due on July 31, 2000.

9. Operation Reports: Monthly operation reports shall be submitted on OCD C-131A forms and Annual operation reports shall be submitted on OCD C-131B forms in the annual report due on July 31, 2000.

10. Analysis of Injection Fluid and Brine: Provide an analysis of the injection fluid and produced brine with each annual report. Analysis will be for General Chemistry (Method 40 CFR 136.3) using EPA methods.

11. Drum Storage: All drums containing materials other than fresh water must be stored on an impermeable pad with curbing. All empty drums should be stored on their sides with the bungs in place and lined up on a horizontal plane. Chemicals in other containers such as sacks or buckets must also be stored on an impermeable pad with curbing.

12. Process Areas: All process and maintenance areas which show evidence that leaks and spills are reaching the ground surface must be either paved and curbed or have some type of spill collection device incorporated into the design.

13. Above Ground Tanks: All above ground tanks which contain fluids other than fresh water must be bermed to contain a volume of one-third more than the total volume of the largest tank or of all interconnected tanks. All new facilities or modifications to existing facilities must place the tank on an impermeable type pad within the berm.

14. Above Ground Saddle Tanks: Above ground saddle tanks must have impermeable pad and curb type containment unless they contain fresh water or fluids that are gases at atmospheric temperature and pressure.

15. Labeling: All tanks, drums, and other containers should be clearly labeled to identify their contents and other emergency information necessary if the tank were to rupture, spill, or ignite.

16. Below Grade Tanks/Sumps: All below grade tanks, sumps, and pits must be approved by the OCD prior to installation or upon modification and must incorporate secondary containment and leak-detection into the design. All pre-existing sumps and below-grade tanks must be tested to demonstrate their mechanical integrity no later than June 01, 2000 and every year from tested date, thereafter. Permittees may propose various methods for testing such as pressure testing to 3 pounds per square inch above normal operating pressure and/or visual inspection of cleaned out tanks and/or sumps, or other OCD approved methods. The OCD will be notified at least 72 hours prior to all testing. The test results will be submitted to OCD in the annual report due on July 31, of each year.

17. Underground Process/Wastewater Lines: All underground process/wastewater pipelines must be tested to demonstrate their mechanical integrity no later than June 01, 2000 and every 5 years, from tested date, thereafter. Permittees may propose various methods for testing such as pressure testing to 3 pounds per square inch above normal operating pressure or other means acceptable to the OCD. The OCD will be notified at least 72 hours prior to all testing. The test results will be submitted to OCD in the annual report due on July 31, 2000.

18. Class V Wells: No Class V wells that inject non-hazardous industrial wastes or a mixture of industrial wastes and domestic wastes will be approved for construction and/or operation unless it can be demonstrated that groundwater will not be impacted in the reasonably foreseeable future. Leach fields and other wastewater disposal systems at OCD regulated facilities which inject non-hazardous fluid into or above an underground source of drinking water are considered Class V injection wells under the EPA UIC program. Class V wells that inject domestic waste only must be permitted by the New Mexico Environment Department.

19. Well Work Over Operations: OCD approval will be obtained from the Director prior to performing remedial work, pressure test or any other Work over. Approval will be requested on OCD Form C-103 "Sundry Notices and Reports on Wells" (OCD Rule 1103.A.) with appropriate copies sent to the OCD Artesia District Office.

20. Housekeeping: All systems designed for spill collection/prevention, and leak detection will be inspected daily to ensure proper operation and to prevent overtopping or system failure.

21. Spill Reporting: All spills/releases shall be reported pursuant to OCD Rule 116. and WQCC 1203. to the OCD Artesia District Office.

22. Waste Disposal: All wastes will be disposed of at an OCD approved facility. Only oilfield exempt wastes shall be disposed of down Class II injection wells. Non-exempt oilfield wastes that are non-hazardous may be disposed of at an OCD approved facility upon proper waste determination per 40 CFR Part 261.

23. Transfer of Discharge Plan: The OCD will be notified prior to any transfer of ownership, control, or possession of a facility with an approved discharge plan. A written commitment to comply with the terms and conditions of the previously approved discharge plan must be submitted by the purchaser and approved by the OCD prior to transfer.

24. Closure: The OCD will be notified when operations of the facility are discontinued for a period in excess of six months. Prior to closure of the facility a closure plan will be submitted for approval by the Director. Closure and waste disposal will be in accordance with the statutes, rules and regulations in effect at the time of closure.

25. OCD Inspections: Additional requirements may be placed on the facility based upon results from OCD inspections. As a result of NMOCD's recent inspection of the facility conducted on January 24, 2000 the following additional conditions will be required:

A. Columbia Propane shall collect groundwater samples from the three fresh water supply wells. The water shall be tested for general water chemistry method 40 CFR 136.3. Total heavy metals using the ICAP scan (EPA method 6010/ICPMS) and Mercury using Cold Vapor (EPA method 7470).

   Columbia Propane will notify the OCD Santa Fe office and the OCD District office at least 48 hours in advance of all scheduled activities such that the OCD has the opportunity to witness the events and/or split samples during OCD's normal business hours.

B. Columbia Propane shall submit a plan for OCD approval to address the large salt pile being stored on site without proper containment.

C. Columbia Propane shall submit a plan for OCD approval to address closing the old unlined pit area.

D. Columbia Propane shall submit a plan for OCD approval to investigate and determine if the pond liner is leaking. The leak detectors were observed to be full of water.

E. Columbia Propane shall submit a plan for OCD approval to investigate and determine the status of the old abandoned well located on site.

William S. Stagg
02/05/02
Page 7

F. Columbia Propane shall submit a plan for OCD approval to investigate and determine the status of the old salt cavern which is no longer used.

G. Columbia Propane shall submit plans for OCD approval to install containment around the brine pump. This inspection and previous inspections reveal brine water releases from this pump onto the ground surface.

H. Columbia Propane shall repair the leaking lines that were noted during the inspection and provide verification.

I. Columbia Propane shall submit for OCD approval a storm water run-off plan.

J. Columbia Propane shall provide well signs pursuant to OCD rule 103 (19 NMAC 15.C.103) and a sign at the site entrance with the following minimum information: Company name, facility name, emergency telephone number, and OCD discharge plan number.

Columbia Propane shall provide to the OCD all of the above requested information listed in item 25. By July 31, 2002.

26. Certification: Columbia Propane by the officer whose signature appears below, accepts this permit and agrees to comply with all terms and conditions contained herein. Columbia Propane further acknowledges that these conditions and requirements of this permit may be changed administratively by the Division for good cause shown as necessary to protect fresh water, human health and the environment.

Conditions accepted by:

LOCO HILLS GSF, LTD.
By: LHPS GP, L.L.C., Its General Partner
Company Representative (print name)

By: [signature]
Company Representative - Sign
Title: V. Managing Partner

Price, Wayne

From: Price, Wayne
Sent: Wednesday, June 26, 2002 2:11 PM
To: 'woodwardm@ugicorp.com'
Cc: Phillips, Dorothy; Reno, Carmen; Stubblefield, Mike
Subject: AmeriGas Loco Hills, NM Gas Storage Facility permitted by OCD Discharge Plan GW-019

Dear Mr. Woodward: 610-337-1000

The OCD is in receipt of your letter dated June 10, 2002 concerning the sale of AmeriGas facility to Loco Hills GSF Ltd. Please note limited partnerships are registered by the NM Secretary of State (505-827-3600). OCD contacted this agency and as of to date they are not registered. Therefore in order for OCD to process the change of ownership please provide the following information:

1. Detail information on Loco Hills GSF Ltd.

2. Pursuant to the current discharge plan condition # 23.

   Transfer of Discharge Plan: The OCD will be notified prior to any transfer of ownership, control, or possession of a facility with an approved discharge plan. A written commitment to comply with the terms and conditions of the previously approved discharge plan must be submitted **by the purchaser** and approved by the OCD prior to transfer.

3. The new purchaser must provide well bonding before transfer may occur. Call OCD Dorothy Phillips 505-476-3461.

Sincerely:

Wayne Price

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

AmeriGas®

America's Propane Company

June 10, 2002

RECEIVED
JUN 11 2002
Environmental Bureau
Oil Conservation Division

__Via Facsimile and Federal Express__

Mr. Wayne Price
New Mexico Energy, Minerals and
Natural Resources Department
Oil Conversation Division
1220 South St. Francis Drive
Santa Fe, NM 87505

RE: Loco Hill Gas Storage Facility OCD's; Discharge Plan GW-019 (the "Discharge Plan") Eddy County, New Mexico

Dear Mr. Price:

Please be advised that AmeriGas Eagle Propane, L.P. has entered into an agreement to sell its Loco Hills liquefied propane and butane gas storage facility in Eddy County, New Mexico, including its rights and obligations under the Discharge Plan, to Loco Hills GSF Ltd. (the "Sale"). In furtherance of that sale, Loco Hills GSF Ltd. has executed the attached Discharge Plan relating to said facility and it has agreed to satisfy and otherwise comply with the terms and conditions of said Discharge Plan from and after the closing of said Sale.

Please evidence the ODC's approval of the assignment and assumption of said Discharge Plan by signing the enclosed duplicate original of this letter where indicated below and faxing a copy of the fully executed letter to me at (610) 992-3258 and returning the original fully executed letter to me using the enclosed, postage-paid envelope. Note also that neither the approval requested herein nor the assignment and assumption referenced herein will be of any force or effect in the event the Sale is not consummated. Lastly, AmeriGas and Loco Hills GSF Ltd. desire to consummate the Sale as soon as practicable, so your prompt attention to this request would be greatly appreciated.

P.O. Box 965, Valley Forge, PA 19482 (610) 337-7000

Should you require additional information or if you have any questions regarding this matter, please feel free to contact me at (610) 337 – 1000, ext. 3377.

AmeriGas Eagle Propane, L.P.

Matthew A. Woodward
As Counsel for AmeriGas Eagle Propane, L.P.

Attachment
MAW\gl

cc: Roger C. Anderson, Environmental Bureau Chief
Tim Gum, District Supervisor

ACKNOWLEDGED AND AGREED TO:

NEW MEXICO ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT OIL CONVERSATION DIVISION

____
Name: ________________________
Title: ________________________

Date: ________________

AmeriGas®
America's Propane Company

DUPLICATE ORIGINAL

June 10, 2002

__*Via Facsimile and Federal Express*__

Mr. Wayne Price
New Mexico Energy, Minerals and
Natural Resources Department
Oil Conversation Division
1220 South St. Francis Drive
Santa Fe, NM 87505

RE: Loco Hill Gas Storage Facility OCD's; Discharge Plan GW-019 (the "Discharge Plan") Eddy County, New Mexico

Dear Mr. Price:

Please be advised that AmeriGas Eagle Propane, L.P. has entered into an agreement to sell its Loco Hills liquefied propane and butane gas storage facility in Eddy County, New Mexico, including its rights and obligations under the Discharge Plan, to Loco Hills GSF Ltd. (the "Sale"). In furtherance of that sale, Loco Hills GSF Ltd. has executed the attached Discharge Plan relating to said facility and it has agreed to satisfy and otherwise comply with the terms and conditions of said Discharge Plan from and after the closing of said Sale.

Please evidence the ODC's approval of the assignment and assumption of said Discharge Plan by signing the enclosed duplicate original of this letter where indicated below and faxing a copy of the fully executed letter to me at (610) 992-3258 and returning the original fully executed letter to me using the enclosed, postage-paid envelope. Note also that neither the approval requested herein nor the assignment and assumption referenced herein will be of any force or effect in the event the Sale is not consummated. Lastly, AmeriGas and Loco Hills GSF Ltd. desire to consummate the Sale as soon as practicable, so your prompt attention to this request would be greatly appreciated.

Should you require additional information or if you have any questions regarding this matter, please feel free to contact me at (610) 337 – 1000, ext. 3377.

AmeriGas Eagle Propane, L.P.

Matthew A. Woodward

Matthew A. Woodward
As Counsel for AmeriGas Eagle Propane, L.P.

Attachment
MAW\gl

cc: Roger C. Anderson, Environmental Bureau Chief
Tim Gum, District Supervisor

ACKNOWLEDGED AND AGREED TO:

NEW MEXICO ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT OIL CONVERSATION DIVISION

____
Name: ________________________
Title: ________________________

Date: ________________

Price, Wayne

From: Price, Wayne
Sent: Tuesday, April 02, 2002 2:29 PM
To: 'Amgasaz@aol.com'
Cc: Stubblefield, Mike
Subject: RE: Pressure Test Loco Hills

OCD hereby approves of the pressure test conducted on 3/26/02 for AmeriGas GW-19 Well #1.

-----Original Message-----
From: Amgasaz@aol.com [mailto:Amgasaz@aol.com]
Sent: Monday, April 01, 2002 3:41 PM
To: WPrice@state.nm.us
Subject: Pressure Test Loco Hills

Mr. Price, was just wondering if you received the test results that were conducted
on March 26th. I looked at the charts and they looked good to me.

We are just waiting for you approval to put the Cavern into use.

Thank You,

Gary Powdrill-Phoenix

Tracking:

Recipient	Read
'Amgasaz@aol.com'	
Stubblefield, Mike	Read: 4/2/2002 3:41 PM

William S. Stagg
02/05/02
Page 3

ATTACHMENT TO THE DISCHARGE PLAN BW-019 APPROVAL
Columbia Propane Loco Hills Gas Storage Facility (BW-019)
DISCHARGE PLAN APPROVAL CONDITIONS
April 12, 2000

1. Payment of Discharge Plan Fees: The $50.00 filing fee has been received by OCD. The $690.00 flat fee shall be submitted upon receipt of this approval. The required flat fee may be paid in a single payment due at the time of approval, or in equal annual installments over the duration of the plan, with the first payment due upon receipt of this approval.

2. Commitments: Columbia Propane will abide by all commitments submitted in the discharge plan renewal application dated February 17, 2000 and these conditions of approval.

3. Brine Storage Pond: A minimum freeboard will be maintained in the pond so that no overtopping of brine occurs. Any repairs or modifications to the pond liner must receive prior OCD approval. If the pond liner is replaced or a new pond is constructed, a double synthetic liner with leak detection will be incorporated into the design. The outside walls of the levees will be maintained in such a manner to prevent erosion and be inspected monthly and after any substantial rainfall. Inspection records shall be maintained by Columbia Propane. Leaks shall be reported pursuant to Item 21. (Spill Reporting) of these conditions.

4. Leak Detection Monitor Well: The leak detection monitor well for the brine storage pond must be inspected for fluids monthly. Records will be maintained to include quantity of fluid measured, conductivity and chlorides of fluid, date of inspection, and name of inspector. Any fluids found must be reported to the NMOCD Santa Fe office and the appropriate District office within 48 hours of discovery.

5. Production Method: Brine water will be injected and withdrawn through the tubing and gas products shall be injected and withdrawn through the casing/tubing annulus. Deviations will be allowed for maintenance reasons once a month for up to 24 hours.

6. Maximum Injection Pressure: The maximum operating injection and/or test pressure at the well head will be such that the fracture pressure of the injection formation will not be exceeded.

7. Mechanical Integrity Testing: Columbia Propane will conduct an annual open hole cavern pressure test equal to one and one-half times the normal operating pressure (not to exceed formation fracture pressure) or 300 psi, whichever is greater, for four hours. At least once every five years and during well work overs the cavern formation will be isolated from the casing/tubing annuals and the casing pressure tested at 300 psig for 30 minutes. All pressure test must be witnessed and approved by OCD.

8. Capacity and Cavity Configuration; A test will be conducted to determine the size and configuration of the mined cavities prior to discharge plan renewal (February 27, 2005). The method and time of testing will be approved by the OCD prior to performing the test.

   Columbia Propane will provide to the OCD the calculated size of the cavities and demonstrate the stability of the salt formation cavities from collapse and/or subsidence. Please include this information in the first annual report due on July 31, 2000.

9. Operation Reports: Monthly operation reports shall be submitted on OCD C-131A forms and Annual operation reports shall be submitted on OCD C-131B forms in the annual report due on July 31, 2000.

10. Analysis of Injection Fluid and Brine: Provide an analysis of the injection fluid and produced brine with each annual report. Analysis will be for General Chemistry (Method 40 CFR 136.3) using EPA methods.

11. Drum Storage: All drums containing materials other than fresh water must be stored on an impermeable pad with curbing. All empty drums should be stored on their sides with the bungs in place and lined up on a horizontal plane. Chemicals in other containers such as sacks or buckets must also be stored on an impermeable pad with curbing.

12. Process Areas: All process and maintenance areas which show evidence that leaks and spills are reaching the ground surface must be either paved and curbed or have some type of spill collection device incorporated into the design.

13. Above Ground Tanks: All above ground tanks which contain fluids other than fresh water must be bermed to contain a volume of one-third more than the total volume of the largest tank or of all interconnected tanks. All new facilities or modifications to existing facilities must place the tank on an impermeable type pad within the berm.

14. Above Ground Saddle Tanks: Above ground saddle tanks must have impermeable pad and curb type containment unless they contain fresh water or fluids that are gases at atmospheric temperature and pressure.

15. Labeling: All tanks, drums, and other containers should be clearly labeled to identify their contents and other emergency information necessary if the tank were to rupture, spill, or ignite.

16. Below Grade Tanks/Sumps: All below grade tanks, sumps, and pits must be approved by the OCD prior to installation or upon modification and must incorporate secondary containment and leak-detection into the design. All pre-existing sumps and below-grade tanks must be tested to demonstrate their mechanical integrity no later than **June 01, 2000** and every year from tested date, thereafter. Permittees may propose various methods for testing such as pressure testing to 3 pounds per square inch above normal operating pressure and/or visual inspection of cleaned out tanks and/or sumps, or other OCD approved methods. The OCD will be notified at least 72 hours prior to all testing. The test results will be submitted to OCD in the annual report due on July 31, of each year.

17. Underground Process/Wastewater Lines: All underground process/wastewater pipelines must be tested to demonstrate their mechanical integrity no later than **June 01, 2000** and every 5 years, from tested date, thereafter. Permittees may propose various methods for testing such as pressure testing to 3 pounds per square inch above normal operating pressure or other means acceptable to the OCD. The OCD will be notified at least 72 hours prior to all testing. The test results will be submitted to OCD in the annual report due on July 31, 2000.

18. Class V Wells: No Class V wells that inject non-hazardous industrial wastes or a mixture of industrial wastes and domestic wastes will be approved for construction and/or operation unless it can be demonstrated that groundwater will not be impacted in the reasonably foreseeable future. Leach fields and other wastewater disposal systems at OCD regulated facilities which inject non-hazardous fluid into or above an underground source of drinking water are considered Class V injection wells under the EPA UIC program. Class V wells that inject domestic waste only must be permitted by the New Mexico Environment Department.

19. Well Work Over Operations: OCD approval will be obtained from the Director prior to performing remedial work, pressure test or any other Work over. Approval will be requested on OCD Form C-103 "Sundry Notices and Reports on Wells" (OCD Rule 1103.A.) with appropriate copies sent to the OCD Artesia District Office.

20. Housekeeping: All systems designed for spill collection/prevention, and leak detection will be inspected daily to ensure proper operation and to prevent overtopping or system failure.

21. Spill Reporting: All spills/releases shall be reported pursuant to OCD Rule 116. and WQCC 1203. to the OCD Artesia District Office.

22. Waste Disposal: All wastes will be disposed of at an OCD approved facility. Only oilfield exempt wastes shall be disposed of down Class II injection wells. Non-exempt oilfield wastes that are non-hazardous may be disposed of at an OCD approved facility upon proper waste determination per 40 CFR Part 261.

23. Transfer of Discharge Plan: The OCD will be notified prior to any transfer of ownership, control, or possession of a facility with an approved discharge plan. A written commitment to comply with the terms and conditions of the previously approved discharge plan must be submitted by the purchaser and approved by the OCD prior to transfer.

24. Closure: The OCD will be notified when operations of the facility are discontinued for a period in excess of six months. Prior to closure of the facility a closure plan will be submitted for approval by the Director. Closure and waste disposal will be in accordance with the statutes, rules and regulations in effect at the time of closure.

25. OCD Inspections: Additional requirements may be placed on the facility based upon results from OCD inspections. As a result of NMOCD's recent inspection of the facility conducted on January 24, 2000 the following additional conditions will be required:

A. Columbia Propane shall collect groundwater samples from the three fresh water supply wells. The water shall be tested for general water chemistry method 40 CFR 136.3. Total heavy metals using the ICAP scan (EPA method 6010/ICPMS) and Mercury using Cold Vapor (EPA method 7470).

Columbia Propane will notify the OCD Santa Fe office and the OCD District office at least 48 hours in advance of all scheduled activities such that the OCD has the opportunity to witness the events and/or split samples during OCD's normal business hours.

B. Columbia Propane shall submit a plan for OCD approval to address the large salt pile being stored on site without proper containment.

C. Columbia Propane shall submit a plan for OCD approval to address closing the old unlined pit area.

D. Columbia Propane shall submit a plan for OCD approval to investigate and determine if the pond liner is leaking. The leak detectors were observed to be full of water.

E. Columbia Propane shall submit a plan for OCD approval to investigate and determine the status of the old abandoned well located on site.

William S. Stagg
02/05/02
Page 7

F. Columbia Propane shall submit a plan for OCD approval to investigate and determine the status of the old salt cavern which is no longer used.

G. Columbia Propane shall submit plans for OCD approval to install containment around the brine pump. This inspection and previous inspections reveal brine water releases from this pump onto the ground surface.

H. Columbia Propane shall repair the leaking lines that were noted during the inspection and provide verification.

I. Columbia Propane shall submit for OCD approval a storm water run-off plan.

J. Columbia Propane shall provide well signs pursuant to OCD rule 103 (19 NMAC 15.C.103) and a sign at the site entrance with the following minimum information: Company name, facility name, emergency telephone number, and OCD discharge plan number.

<u>Columbia Propane shall provide to the OCD all of the above requested information listed in Item 25. By July 31, 2002.</u>

26. <u>Certification:</u> Columbia Propane by the officer whose signature appears below, accepts this permit and agrees to comply with all terms and conditions contained herein. Columbia Propane further acknowledges that these conditions and requirements of this permit may be changed administratively by the Division for good cause shown as necessary to protect fresh water, human health and the environment.

Conditions accepted by:

LOCO HILLS GSF, LTD.
By: LHPS GP, L.L.C., Its General Partner
Company Representative (print name)

By: Mitch Johnson
Company Representative - Sign

Title: Managing Partner

ATTN: WAYNE PRICE

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-104B
March 19, 2001

Submit 1 copy of the final affected wells list along with 1 copy of this form per number of wells on that list to appropriate District Office

Change of Operator Name

OGRID: 186724
Effective Date: August 21, 2001

Previous Operator Name and Information:

Name: Columbia Propane, L.P.
Address: 10710 Midlothian Turnpike
Address: Suite 200
City, State, Zip: Richmond, VA 23235

New Operator Name and Information:

New Name: AmeriGas Eagle Propane, L.P.
Address: 460 North Gulph Road
Address:
City, State, Zip: King of Prussia, PA 19406

I hereby certify that* the rules of the Oil Conservation Division have been complied with and that the information given on this form and the attached list of wells is true and complete to the best of my knowledge and belief.

Signature: Robert H. Knauss

Printed name: Robert H. Knauss

Title: Vice President - Law of AmeriGas Eagle Holdings, Inc., the general partner of AmeriGas Eagle Propane, L.P.

Date: April 8, 2002 Phone: (610) 337 - 1000, ext. 3393

* , upon the filing and approval of this Form C-104B,

APR 2002
RECEIVED
OCD - ARTESIA

NMOCD Approval

Signature: Tim W. Gum

Printed Name:

District: District Supervisor

Date: APR 22 2002

PAGE 1

MAR 29, 2002

WELLS INVOLVED IN NAME CHANGE
FINAL LIST WITH C104B

OPERATOR: 186724 COLUMBIA PROPANE LP

OCD DISTRICT: ARTESIA

OPERATOR INITIALS RHK

PROPERTY	WELL NAME	ULSTR	OCD UNIT LTR	API
29495	LEONARD #001	L-22-17S-29E	L	30-015-06192
	LEONARD #002	L22-17S-29E	L	30-015-06193
	LEONARD #003	L22-17S-29E	L	30-015-06194

1

RECEIVED
APR 2002
OCD - ARTESIA

Price, Wayne

From: Price, Wayne
Sent: Tuesday, April 02, 2002 2:29 PM
To: 'Amgasaz@aol.com'
Cc: Stubblefield, Mike
Subject: RE: Pressure Test Loco Hills

OCD hereby approves of the pressure test conducted on 3/26/02 for AmeriGas GW-19 Well #1.

-----Original Message-----
From: Amgasaz@aol.com [mailto:Amgasaz@aol.com]
Sent: Monday, April 01, 2002 3:41 PM
To: WPrice@state.nm.us
Subject: Pressure Test Loco Hills

Mr. Price, was just wondering if you received the test results that were conducted
on March 26th. I looked at the charts and they looked good to me.

We are just waiting for you approval to put the Cavern into use.

Thank You,

Gary Powdrill-Phoenix

RECEIVED

APR 0 1 2002

Environmental Bureau
Oil Conservation Division

Wildcat Measurement

Calibration Certificate

Pressure Recorder

Serial Number: 265-6213

Pressure Range 0-500# **p.s.i. accuracy +/-** 0.2 **% Full Scale** ________ **p.s.i.** ________

Increasing Pressure			Decreasing Pressure		
Applied Pressure	*Indicated Pressure*	*Difference*	*Applied Pressure*	*Indicated Pressure*	*Difference*
0.0#	0.0#	0.0#	400#	400#	0.0#
50#	50#	0.0#	300#	300#	0.0#
150#	150#	0.0#	200#	200#	0.0#
250#	250#	0.0#	100#	100#	0.0#
350#	350#	0.0#	0.0#	0.0#	0.0#
500#	500#	0.0#			

Calibrated By: DCT **Gauge** **Deadweight** ________

This Is To Certify That This Recorder Has Been Inspected And Tested.

Remarks ________

Date Of Calibration 03/11/2002 **Inspector** [signature]

Price, Wayne

From: Price, Wayne
Sent: Thursday, March 21, 2002 1:42 PM
To: 'Amgasaz@aol.com'; Price, Wayne
Cc: Walth@amerigas.com; Morant@pbworld.com; Stubblefield, Mike
Subject: RE: Loco Hills Cavern #1 Pressure Test

Dear Mr. Powdrill:

The OCD hereby approves of your request to test well #1. Please notify the OCD District office so they may witness. The other aspects of the plan will be discussed at a latter date. OCD understands that AmeriGas is in need of WEll #1 and this is the reason we are expediting your testing request.

Once the OCD approves of the test then AmeriGas may resume operations in well #1.

Please be advised that NMOCD approval of this test does not relieve Amerigas of liability should their operations pose a threat to ground water, surface water, human health or the environment, or cause damage to the well system. In addition, NMOCD approval does not relieve Amerigas of responsibility for compliance with any other federal, state, or local laws and/or regulations.

-----Original Message-----
From: Amgasaz@aol.com [mailto:Amgasaz@aol.com]
Sent: Thursday, March 21, 2002 1:19 PM
To: WPrice@state.nm.us
Cc: Walth@amerigas.com; Morant@pbworld.com
Subject: Loco Hills Cavern #1 Pressure Test

Wayne, I am attaching a revised letter outlining the pressure test and addressing the items you sent with the approval.

There are a few areas we need clarification concerning your request.

We would to expedite this test and we do appreciate your cooperation.

1. We never received the procedure for calculating the frac pressure as you mentioned to Tim Moran. Without that info we have used the industry "Rule of Thumb" of 1 psi/ft.

2. You mentioned a modification to the GW-019 Storage System Discharge Plan. We assume that it just applies to Well #1.
   a. In our first letter we proposed to test the well at it's current pressure, which is now approximately 180 psig or 0.863 psi/ft gradient. IN the modification you want an annual "open to formation" test. We do not recommend this gradient every year. It is still on the high side. The annual test should be limited to a 0.8 psi/ft. This pressure is still higher than the maximum operating pressure gradients.

3. We do agree and will comply with a casing pressure test be conducted every 5 years.

4. These test procedures and acceptance criteria will be in accordance with the guidelines from the OCD. The testing time will be 4 hours with a criteria is +/- 1% of starting pressure. With the pressure recorded at time of test or 180 psig the pressure drop cannot exceed 1.8 psi in four hours.

Thank You,

Gary Powdrill
Regional Logistics Manager-Phoenix

Tracking:

Recipient	Read
'Amgasaz@aol.com'	
Price, Wayne	Read: 3/21/2002 1:42 PM
Walth@amerigas.com	
Morant@pbworld.com	
Stubblefield, Mike	Read: 3/22/2002 8:46 AM

Price, Wayne

From: Amgasaz@aol.com
Sent: Thursday, March 21, 2002 1:19 PM
To: WPrice@state.nm.us
Cc: Walth@amerigas.com; Morant@pbworld.com
Subject: Loco Hills Cavern #1 Pressure Test

PBKBB #2.doc

Wayne, I am attaching a revised letter outlining the pressure test and addressing the items you sent with the approval.

There are a few areas we need clarification concerning your request.

We would to expedite this test and we do appreciate your cooperation.

1. We never received the procedure for calculating the frac pressure as you mentioned to Tim Moran. Without that info we have used the industry "Rule of Thumb" of 1 psi/ft.

2. You mentioned a modification to the GW-019 Storage System Discharge Plan. We assume that it just applies to Well #1.
   a. In our first letter we proposed to test the well at it's current pressure, which is now approximately 180 psig or 0.863 psi/ft gradient. IN the modification you want an annual "open to formation" test. We do not recommend this gradient every year. It is still on the high side. The annual test should be limited to a 0.8 psi/ft. This pressure is still higher than the maximum operating pressure gradients.

3. We do agree and will comply with a casing pressure test be conducted every 5 years.

4. These test procedures and acceptance criteria will be in accordance with the guidelines from the OCD. The testing time will be 4 hours with a criteria is +/- 1% of starting pressure. With the pressure recorded at time of test or 180 psig the pressure drop cannot exceed 1.8 psi in four hours.

Thank You,
Gary Powdrill
Regional Logistics Manager-Phoenix

March 19, 2002

Mr. Wayne Price
New Mexico Energy, Minerals and Natural Resources Department
Oil Conservation Division
1220 S. St. Francis Drive
Sante Fe, New Mexico 87505

Re: AmeriGas Loco Hills Facility
Well #1
Gas Storage System Discharge Plan GW-019
Eddy County, New Mexico

Dear Mr. Price:

AmeriGas respectfully submits for OCD approval a discharge plan modification for our Loco Hills Well #1. The proposed modification includes the following two items for the Plan Approval Conditions. (Reference your March 11, 2002 letter.)

Item #6. Maximum Injection Pressure
The cavern system fracture pressure is defined as the pressure that is required to fracture the geological formation or lift the overburden formations. Experimental evidence and operating history have shown that this fracture pressure is contingent upon the specific site geological conditions, including but not limited to the weight of the overburden. In the absence of specific site data an industry guideline for fracture pressure gradient of 1.0 psi/ft has been used. Assuming this fracture gradient for the Loco Hills #1, the fracture pressure at the 7" cemented production casing shoe, set at a depth of 525 feet, would be 525 psig. The surface pressure required to impose this fracture pressure at the casing shoe is dependent upon the fluid in the well. The following table presents the estimated surface fracture pressures for propane, butane and brine along with the maximum allowable product injection pressures. Note: The Loco Hills Well #1 may be placed in either propane or butane storage service.

ESTIMATED FRACTURE PRESSURES FOR LOCO HILLS WELL #1

	Propane	n-Butane	Brine
Est. Frac. Pressure gradient	1.0 psi/ft	1.0 psi/ft	1.0 psi/ft
Est. Frac. Pressure @ Casing shoe (525 feet)	525 psig	525 psig	525 psig
Assumed Specific Gravity	0.507	0.584	1.20
Est. Frac. Wellhead Pressure	410 psig	392 psig	252 psig
Max. Allowable Inj. Pressure	180 psig	100 psig	

Mr. Wayne Price
April 19, 2002

Item #7. Mechanical Integrity Testing

An annual open to formation pressure test will be conducted on Loco Hills Well #1. The initial test will be a brine full hydrostatic pressure test to a gradient of 0.86 psi/ft. (The well is currently pressured to this gradient.) Subsequent annual tests will be conducted to a 0.8 psi/ft gradient.

The following table lists maximum wellhead pressures, casing shoe pressures and pressure gradients for propane and butane storage and the proposed brine hydrostatic tests:

	Propane	n-Butane	Initial Brine Test	Annual Brine Test
Assumed Specific Gravity	0.507	0.584	1.20	1.20
Max. Wellhead Pressure	180 psig	100 psig	180 psig	147 psig
Casing shoe pressure @ 525 feet	295 psig	233 psig	453 psig	420 psig
Max. Pressure gradient	0.562 psi/ft	0.443 psi/ft	0.863 psi/ft	0.80 psi/ft

As shown, both initial and annual brine hydrotest pressure gradients are considerably greater than either the propane or the butane storage gradients.

In addition, at least once every five years and during well workovers the cavern will be isolated from the casing/tubing annulus and the casing pressure tested at 300 psig for 30 minutes.

Cavern testing procedures and acceptance criteria will be in accordance with OCD Brine Well Testing Technical Guidance.

If you have any questions or comments regarding this request for discharge plan modification, please call or e-mail me at 623-935-2661 or amgasaz@aol.com.

Sincerely,

Gary Powdrill

March 18, 2002

To: Carmen Reno-OCD Artesia

From: Wayne Price-OCD Environmental Bureau WP

Re: AmeriGas Gas Storage System

Please find enclosed a C-104 for change of ownership. There are three wells. Please do not approve until Dorothy gets new bonds approved. After your approval please copy me.

Thanks!!

AmeriGas®

America's Propane Company

March 11, 2002

RECEIVED
MAR 18 2002
Environmental Bureau
Oil Conservation Division

<u>Via Facsimile and</u>
<u>Certified Mail, Returned Receipt</u>

Mr. Wayne Price – Engineer
New Mexico Energy, Minerals and
Natural Resources Department
Oil Conversation Division
1220 South St. Francis Drive
Santa Fe, NM 87505

RE: Loco Hill Gas Storage Facility; Form C-104A
Eddy County, New Mexico

Dear Mr. Price:

In response to your letter dated February 5, 2002, I am enclosing the completed (Form C-104A) Change of Operator. Please send me a copy of the same (together with the New OGRID) once it is approved by the OCD. The Bond Certificate and related information will be forwarded to you as soon as it is available.

Should you need any additional information, please feel free to contact me.

AmeriGas Eagle Propane, L.P.

By: AmeriGas Eagle Holdings, Inc.
its general partner

By: Robert H. Knauss
Name: Robert H. Knauss
Title: Vice President – Law

Enclosure

cc: G. Powdrill
T. Jackal
P. Monaco
M. White
M. Woodward

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-104A
March 19, 2001

Submit 1 copy of the final affected wells list along with 1 copy of this form per number of wells on that list to appropriate District Office

Change of Operator

Previous Operator Information:		New Operator Information:	
		Effective Date:	
OGRID:	186724	New Ogrid:	
Name:	Columbia Propane, L.P. (now know as	New Name:	AmeriGas Eagle Propane, L.P.
Address:	AmeriGas Eagle Propane, L.P.)	Address:	460 North Gulph Road
Address:	460 North Gulph Road	Address:	
City, State, Zip:	King of Prussia, PA 19406	City, State, Zip:	King of Prussia, PA 19406

I hereby certify that* the rules of the Oil Conservation Division have been complied with and that the information on this form and the attached list of wells is true and complete to the best of my knowledge and belief.

New Operator Signature: Robert H. Knauss

Printed name: Robert H. Knauss

Title: Vice President-Law of AmeriGas Eagle Holdings, Inc.
the general partner of AmeriGas Eagle Propane, L.P.

Date: March 11, 2002 Phone: (610) 337-1000, ext. 3393

*, upon the filing and approval of this Form C-104A,

Previous operator complete below:

Previous Operator: Columbia Propane, L.P. (now known as AmeriGas Eagle Propane, L.P.)

Previous OGRID: 186724

Signature: Robert H. Knauss

Printed Name: Robert H. Knauss
Vice President-Law of AmeriGas Eagle Holdings, Inc.,
the general partner of AmeriGas Eagle Propane, L.P.

NMOCD Approval

Signature:

Printed Name:

District:

Date:

RECEIVED

MAR 1 8 2002

Environmental Bureau
Oil Conservation Division

WELLS INVOLVED IN OPERATOR CHANGE
FINAL LIST WITH C-104A

MAR 18, 2002

This is a final list of wells being transferred. If all bonding requirements are satisfied, submit this list to the OCD District with your C-104A.

PREVIOUS OPERATOR: 186724 COLUMBIA PROPANE LP

NEW OPERATOR: ____________

OCD DISTRICT: ARTESIA

PROPERTY	WELL NAME	ULSTR	OCD UNIT LTR	API	WELL TYPE	POOL ID	POOL NAME	LAST PROD/INJ
29495	LEONARD #001	L-22-17S-29E	L	30-015-06192	M			
	LEONARD #002	L-22-17S-29E	L	30-015-06193	M			
	LEONARD #003	L-22-17S-29E	L	30-015-06194	M			

AmeriGas®

America's Propane Company

FACSIMILE NUMBER: (610) 992-3258

PLEASE DELIVER THE FOLLOWING PAGE(S) TO:

NAME	Wayne Price, Engineer
COMPANY	New Mexico Energy, Minerals and Natural Resources Department – Oil Conversation Division
FACSIMILE NUMBER	(505) 476 – 3462
FROM	Robert H. Knauss
TOTAL NUMBER OF PAGES (INCLUDING COVER PAGE)	3
DATE	March 11, 2002

If you do not receive all the pages, please call back as soon as possible, (610) 337 – 1000 extension 7737. Thank, you, Gloria

MESSAGE:

AmeriGas®

America's Propane Company

March 11, 2002

Via Facsimile and
Certified Mail, Returned Receipt

Mr. Wayne Price – Engineer
New Mexico Energy, Minerals and
Natural Resources Department
Oil Conversation Division
1220 South St. Francis Drive
Santa Fe, NM 87505

RE: Loco Hill Gas Storage Facility; Form C-104A
Eddy County, New Mexico

Dear Mr. Price:

In response to your letter dated February 5, 2002, I am enclosing the completed (Form C-104A) Change of Operator. Please send me a copy of the same (together with the New OGRID) once it is approved by the OCD. The Bond Certificate and related information will be forwarded to you as soon as it is available.

Should you need any additional information, please feel free to contact me.

AmeriGas Eagle Propane, L.P.

By: AmeriGas Eagle Holdings, Inc.
its general partner

By: Robert H. Knauss
Name: Robert H. Knauss
Title: Vice President – Law

Enclosure.

cc: G. Powdrill
T. Jackal
P. Monaco
M. White
M. Woodward

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-104A
March 19, 2001

Submit 1 copy of the final affected wells list along with 1 copy of this form per number of wells on that list to appropriate District Office

Change of Operator

Previous Operator Information:

OGRID: 186724
Name: Columbia Propane, L.P. (now know as
Address: AmeriGas Eagle Propane, L.P.)
Address: 460 North Gulph Road
City, State, Zip: King of Prussia, PA 19406

New Operator Information:

Effective Date:
New Ogrid:
New Name: AmeriGas Eagle Propane, L.P.
Address: 460 North Gulph Road
Address:
City, State, Zip: King of Prussia, PA 19406

I hereby certify that* the rules of the Oil Conservation Division have been complied with and that the information on this form and the attached list of wells is true and complete to the best of my knowledge and belief.

New Operator Signature: Robert H. Knauss

Printed name: Robert H. Knauss

Title: Vice President-Law of AmeriGas Eagle Holdings, Inc.
the general partner of AmeriGas Eagle Propane, L.P.

Date: March 11, 2002 Phone: (610) 337-1000, ext. 3393

*, upon the filing and approval of this Form C-104A,

Previous operator complete below:

Previous Operator: Columbia Propane, L.P. (now known as AmeriGas Eagle Propane, L.P.)

Previous OGRID: 186724

Signature: Robert H. Knauss

Printed Name: Robert H. Knauss
Vice President-Law of AmeriGas Eagle Holdings, Inc.,
the general partner of AmeriGas Eagle Propane, L.P.

NMOCD Approval

Signature:

Printed Name:

District:

Date:

Price, Wayne

From: Price, Wayne
Sent: Monday, March 11, 2002 1:52 PM
To: 'Amgasaz@aol.com'
Cc: Stubblefield, Mike; 'morant@pbworld.com'
Subject: RE: Pressure Test,

March02 Test.doc   Test Guidence
ocument amended.

Dear Mr. Powdrill:

Please find enclosed the approval letter with conditions and a Brine Well Testing Technical Guidance for reference.

-----Original Message-----
From: Amgasaz@aol.com [mailto:Amgasaz@aol.com]
Sent: Monday, March 11, 2002 9:02 AM
To: WPrice@state.nm.us
Subject: Re: Pressure Test,

Wayne, I will try and send it again, Thanks

NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

GARY E. JOHNSON
Governor
Betty Rivera
Cabinet Secretary

Lori Wrotenbery
Director
Oil Conservation Division

March 11, 2002

<u>CERTIFIED MAIL</u>
<u>RETURN RECEIPT NO. 5357 7140</u>

Mr. Gary Powdrill
AmeriGas Propane
14702 W. Olive Ave.
Waddell Arizona 85355

Re: AmeriGas Loco Hills Facility
Gas Storage System Discharge Plan GW-019
Eddy County, New Mexico

Dear Mr. Powdrill:

The OCD has reviewed the letter dated March 06, 2002 Well Test procedure which was received via E-mail on March 11, 2002 and hereby approves of the plan with the following conditions:

AmeriGas will submit for OCD approval a discharge plan modification that incorporates the following items into the Discharge Plan Approval Conditions:

<u>Item # 6. Maximum Injection Pressure:</u> The maximum operating injection and/or test pressure at the well head will be such that the fracture pressure of the injection formation will not be exceeded. Provide to OCD the system fracture pressure calculated at the bottom casing shoe, fracture pressure gradient (psi/ft) for the system, and the maximum surface injection pressure that will not cause new fractures or propagate existing fractures.

<u>Item # 7. Mechanical Integrity Testing:</u> Conduct an annual open to formation pressure test by pressuring up the formation with fluids to one and one-half times the normal operating pressure or 300 psig whichever is greater for four hours. However, no operator may exceed surface injection or test pressures that may cause formation fracturing (see item 6 above) or system failures. Systems requiring test pressures less than 300 psig or methods that use testing media other than fluids, i.e. gas, must be approved by OCD prior to testing. Brine supply wells operating with isolation packers will have to pressure test both the cavern formation and casing/tubing annuals.

At least once every five years and during well work-overs the cavern formation will be isolated from the casing/tubing annuals and the casing pressure tested at 300 psig for 30 minutes. All pressure tests must be witnessed by OCD.

Please be advised that NMOCD approval of this plan does not relieve AmeriGas of liability should their operations pose a threat to ground water, surface water, human health or the environment. In addition, NMOCD approval does not relieve AmeriGas of responsibility for compliance with any other federal, state, or local laws and/or regulations.

Also, please find attached a Brine Well Testing Technical Guidance document to assist you in the well test. If you have any questions please do not hesitate to contact me at 505-476-3487 or E-mail WPRICE@state.nm.us.

Sincerely,

Wayne Price

Electronic Signature

Wayne Price- Engineer

cc: OCD Artesia Office

attachments-1

Brine Well Testing Technical Guidance

1) The cavern and all piping must be filled, pressured up and stabilized for a period of at least 24 hours prior to testing. If this test requires a packer then casing/tubing annulus must be loaded with inert fluid 24 hours prior to testing.

2) Have manpower and equipment available for pressure test. Wellhead shall be prepared for test and all valves and gauges should be in good working order.

3) Pumps, tanks, external lines etc. must be isolated from the wellhead during test.

4) A continuous recording pressure device with a **8 or 12-hour clock** shall be installed on the casing/tubing annulus. The pressure range shall not be greater than 500 psig. The operator must provide proof that the pressure-recording device has been calibrated within the past 6 months. **Note: Wells with packer installed: If this test requires both the casing/tubing annulus and cavern to be tested then two recording devices must be supplied or one recording device with two pins.**

5) A minimum of one pressure gauge shall be installed on the casing/tubing annulus.

6) OCD must witness the beginning of test (putting chart on) and ending of test (removing chart). At the end of test operator may be required to bleed-off well pressure to demonstrate recorder and gauge response.

7) The Operator will supply the following information on the pressure chart:

   A. Company Name, Well Name, API #, Legal Location.
   B. Test Procedure (1) Casing + Formation (2) Casing Test Only (3) Both (4) Other
   C. Testing Media: Water, Gas, Oil, Etc.
   D. Date, time started and ending.
   E. Name (printed) and signature of company representative and OCD Inspector

8) **TEST ACCEPTANCE:** The OCD will use the following criteria in determining if a well has passed the Mechanical Integrity Test:

   A. **Passes** if Zero Bleed-Off during the test.
   B. **Passes** if Final Test Pressure is within ± 1% of Starting Pressure, if approved by the OCD inspector.
   C. **Fails** if any Final Test Pressure is greater than ± 1% of Starting Pressure. Operators must investigate for leaks and demonstrate that mechanical integrity of the well(s) by ensuring there are no leaks in the tubing, casing, or packer, and injected/produced fluids are confined within the piping and injection zones. Wells shall not resume operations until approved by OCD.

Note: OCD recognizes that different operations, well designs, formation characteristics and field conditions may cause variations in the above procedures. If operator wishes to make or anticipate changes please notify the OCD for approval. All operators are responsible to notify OCD of any procedure that may cause harm to the well system or formation. Please be advised that OCD approval does not relieve any operator of liability should operations result in pollution of surface water, groundwater, or the environment.

Also note: This document is intended to provide technical guidance to operators on technical means to achieve compliance with the rules and regulations of the Oil Conservation Division and the Oil and Gas Act. The test procedures set forth are not regulations or policies and therefore other methods may exist to achieve compliance with the rules and regulations and the Oil and Gas Act.

Price, Wayne

From: Amgasaz@aol.com
Sent: Monday, March 11, 2002 9:02 AM
To: WPrice@state.nm.us
Subject: Re: Pressure Test,

PBKBB Letter.doc

Wayne, I will try and send it again, Thanks

March 6, 2002
Mr. Wayne Price
New Mexico Energy, Minerals and Natural Resources Department
Oil Conservation Division
1220 S. St. Francis Drive
Sante Fe, New Mexico 87505

Re: AmeriGas Propane
Loco Hills Well #1
Well Test

Dear Mr. Price:

Our Loco Hills Well #1 has been out of service for some time, and we would like to re-activate it for butane storage. Before doing so we must conduct an integrity test of the well and cavern.

An initial test was conducted by Mr. Buster McDaniel on February 11, 2002 and witnessed by Mr. Mike Stubblefield, OCD. During the four-hour brine hydrostatic pressure test the wellhead pressure dropped approximately 20 psi. We understand the OCD does not consider this pressure drop acceptable for the test. The pressure decline could have been caused by cavern stabilization factors, e.g. salt dissolution by dilute brine injected or temperature stabilization, or a slight high-pressure leakage or a combination of factors. Since the test, pressure has been maintained on the well and it appears to have stabilized at approximately 190 psig.

In order to expedite the cavern test and take advantage of the cavern's current pressurized condition, we propose to conduct a second four-hour hydrostatic test at the current pressure level. Test gauges and circular chart pressure recorders will be connected to both the annulus and tubing sides of the wellhead. Wellhead valves will be isolated from the surface lines to eliminate potential valve leakage. Gauge pressure will be recorded at the start of the test and hourly thereafter. At the end of the test, brine will be released from the well and the chart recorder monitored to verify the test pressure and subsequent pressure decline. All gauge test pressures will be recorded on the circular chart and AmeriGas' site superintendent and OCD's witness will sign the chart.

In our opinion, a successful brine hydrostatic test at the current wellhead pressure of 190 psig will demonstrate cavern mechanical integrity required for hydrocarbon storage. The test pressure gradient will be considerably greater than the maximum operating pressure gradient for either propane or butane storage. This is demonstrated as follows:

From facility operating records and well records for Well #1 -

- 7" cemented production casing set @ 525 feet.
- 2-7/8" brine tubing set @ 654 feet.
- Maximum wellhead operating pressure for Propane storage = 180 psig.
- Maximum wellhead operating pressure for Butane storage = 100 psig.

The following table lists casing shoe pressures and pressure gradients for propane and butane storage and the proposed brine hydrostatic test:

	Propane	n-Butane	Brine Test
Assumed Specific Gravity	0.507	0.584	1.20
Max. Wellhead Pressure	180 psig	100 psig	190 psig
Casing shoe pressure @ 525 feet	295 psig	233 psig	463 psig
Max. Pressure gradient	0.562 psi/ft	0.443 psi/ft	0.882 psi/ft

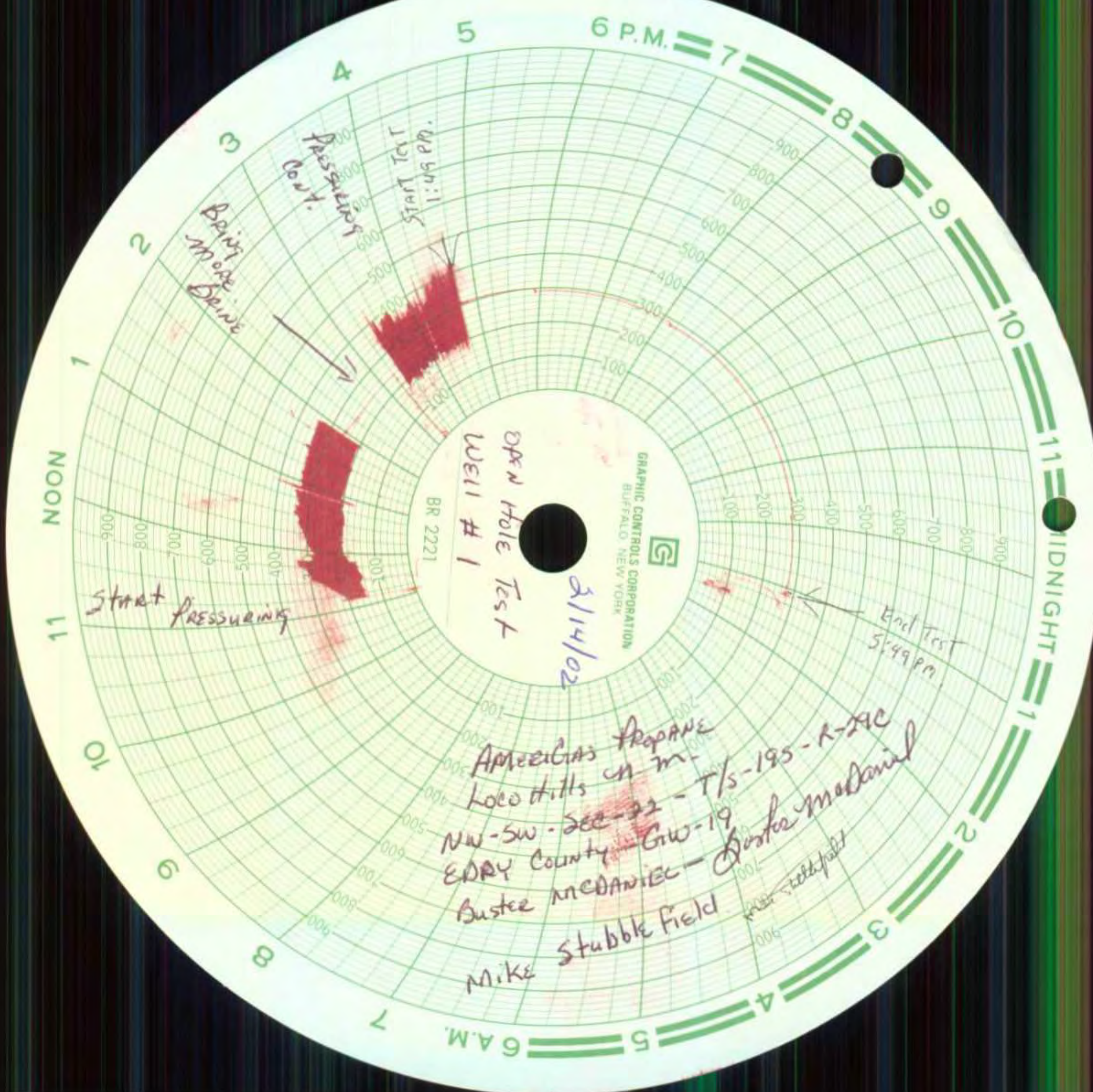
As shown, the brine hydrotest pressure gradient is considerably greater than either the propane or the butane storage gradients.

Mr. Price, we have located a pressure chart in Artesia from Wildcat Measurment Services which will be calibrated from 0-500 lbs prior to the test. We would like to propose the test be conducted on Tuesday March 12, 2002. The operator will contact the OCD local representative, Mr. Stubblefield upon your approval and coordinate the start times.

If you have any questions or comments regarding this proposed test procedure, please call or e-mail me at 623-935-2661 or amgasaz@aol.com. You can also contact our cavern consultant Tim Moran, PB-KBB at 281-589-5823 or morant@pbworld.com.

Sincerely,

Gary Powdrill
Regional Logistics Manager-Western Region


GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
BR 2221
Open Hole Test
Well # 1
2/14/02
Start Pressuring
Bring more Brine
Pressuring Cont.
Start Test
End Test
5:49 pm
AmeriGas Propane
Loco Hills N.M.
NW-SW-Sec-32-T/S-19S-R-29E
Eddy County - GW-19
Buster McDaniel
Mike Stubblefield

D & L Motors & Instrument Service, Inc.
P.O. Box 1621
Lovington, NM 88260
(505) 396-3716 FAX (505) 396-6812

May 15, 2002

Certification of Pressure Recorder Test:

Serial #: 665427

This Pressure Recorder was tested at midrange for accuracy and verified within +5% and –5% for 1000# Pressure Element.

Felix Aguirres, Technician

AmeriGas®
America's Propane Company

RECEIVED
FEB 26 2002
Environmental Bureau
Oil Conservation Division

February 25, 2002

__Via Facsimile and FedEx Mail__

Mr. Wayne Price – Engineer
New Mexico Energy, Minerals and
Natural Resources Department
Oil Conversation Division
1220 South St. Francis Drive
Santa Fe, NM 87505

RE: Loco Hill Gas Storage Facility; Discharge Plan GW-019
Eddy County, New Mexico

Dear Mr. Price:

We are in receipt of your letter dated February 5, 2002, addressed to Gary Powdrill of this office. As you may be aware, Columbia Propane, L.P. changed its name to AmeriGas Eagle Propane, L.P. For your records, I am attaching an original certified copy evidencing this name change, as certified by the Secretary of State of the State of Delaware, Columbia Propane's jurisdiction of formation. As evidenced by the attached, Columbia Propane has not changed its legal existence and it is still managed by the same legal entity as its general partner (i.e., AmeriGas Eagle Holdings, Inc. formerly known as CP Holdings, Inc.; I am also attaching an original certified copy evidencing this general partner's name change for your records).

In response to your request for a written commitment to comply with the terms and conditions of the previously approved discharge plan referenced above, I am attaching the original certification and acceptance of such terms and conditions which has been executed by an authorized officer of AmeriGas Eagle Holdings, Inc., as the general partner of AmeriGas Eagle Propane, L.P. In addition, AmeriGas Eagle Propane will continue to review and consider the most effective and efficient alternatives to address the issues raised in the discharge plan.

P.O. Box 965, Valley Forge, PA 19482 (610) 337-7000

In response to your second request, please note that we are working with Dorothy Phillips of your office to obtain the necessary OGRID codes and to procure the requested replacement bonds. Once that information is available, we will submit the completed Form C-104A and new bonds to your attention for approval.

We appreciate in advance the OCD's understanding in connection with this matter and we look forward to working with the OCD on the issues outlined in the discharge plan.

AmeriGas Eagle Propane, L.P.

By: AmeriGas Eagle Holdings, Inc.
its general partner

By: Robert H. Knauss
Name: Robert H. Knauss
Title: Vice President – Law

cc: G. Powdrill
T. Jackal
P. Monaco
M. White
M. Woodward

F. Columbia Propane shall submit a plan for OCD approval to investigate and determine the status of the old salt cavern which is no longer used.

G. Columbia Propane shall submit plans for OCD approval to install containment around the brine pump. This inspection and previous inspections reveal brine water releases from this pump onto the ground surface.

H. Columbia Propane shall repair the leaking lines that were noted during the inspection and provide verification.

I. Columbia Propane shall submit for OCD approval a storm water run-off plan.

J. Columbia Propane shall provide well signs pursuant to OCD rule 103 (19 NMAC 15.C.103) and a sign at the site entrance with the following minimum information; Company name, facility name, emergency telephone number, and OCD discharge plan number.

Columbia Propane shall provide to the OCD all of the above requested information listed in Item 25. By July 31, 2000.

26. Certification: **Columbia Propane** by the officer whose signature appears below, accepts this permit and agrees to comply with all terms and conditions contained herein. **Columbia Propane** further acknowledges that these conditions and requirements of this permit may be changed administratively by the Division for good cause shown as necessary to protect fresh water, human health and the environment.

Conditions accepted by: AmeriGas Eagle Propane, L.P. (f/k/a Columbia Propane, L.P.)
By: AmeriGas Eagle Holdings, Inc.
its General Partner

Robert H. Knauss
Company Representative- print name

Robert H. Knauss Date 2/25/02
Company Representative- Sign

Title Vice President - Law

Delaware

The First State

I, HARRIET SMITH WINDSOR, SECRETARY OF STATE OF THE STATE OF DELAWARE, DO HEREBY CERTIFY THE ATTACHED IS A TRUE AND CORRECT COPY OF THE CERTIFICATE OF AMENDMENT OF "COLUMBIA PROPANE, L.P.", CHANGING ITS NAME FROM "COLUMBIA PROPANE, L.P." TO "AMERIGAS EAGLE PROPANE, L.P.", FILED IN THIS OFFICE ON THE TWENTY-SECOND DAY OF AUGUST, A.D. 2001, AT 2:01 O'CLOCK P.M.

Harriet Smith Windsor

Harriet Smith Windsor, Secretary of State

2603211 8100

020119777

AUTHENTICATION: 1628408

DATE: 02-22-02

STATE OF DELAWARE
SECRETARY OF STATE
DIVISION OF CORPORATIONS
FILED 02:01 PM 08/22/2001
010414388 - 2603211

CERTIFICATE OF AMENDMENT

OF

CERTIFICATE OF LIMITED PARTNERSHIP

OF

COLUMBIA PROPANE, L.P.

It is hereby certified that:

1. The name of the partnership (hereinafter called the "Partnership") is Columbia Propane, L.P.

2. The Certificate of Limited Partnership of the Partnership is hereby amended by striking Paragraph 1 in its entirety and substituting in lieu thereof the following new Paragraph:

"The name of the limited partnership is AmeriGas Eagle Propane, L.P."

3. The Amendment of the Certificate of Limited Partnership herein certified has been duly adopted in accordance with the provisions of Sections 17-202 and 17-405 of the Delaware Revised Uniform Limited Partnership Act, as amended.

Dated as of August 22, 2001

COLUMBIA PROPANE, L.P.

By: CP Holdings, Inc., its General Partner

Eugene V.N. Bissell

Name: Eugene V.N. Bissell
Title: President

CONSENT TO USE OF NAME

AmeriGas Eagle Propane, Inc., a corporation organized under the laws of the State of Delaware, hereby consents to the change of name of Columbia Propane, L.P., a limited partnership existing in the State of Delaware, to AmeriGas Eagle Propane, L.P.

IN WITNESS WHEREOF, the said AmeriGas Eagle Propane, Inc. has caused this consent to be executed by its President this 21st day of August, 2001.

AmeriGas Eagle Propane, Inc.

By: ____________________

Name: Eugene V.N. Bissell

Title: President

Delaware

The First State

I, HARRIET SMITH WINDSOR, SECRETARY OF STATE OF THE STATE OF DELAWARE, DO HEREBY CERTIFY THE ATTACHED IS A TRUE AND CORRECT COPY OF THE CERTIFICATE OF AMENDMENT OF "CP HOLDINGS, INC.", CHANGING ITS NAME FROM "CP HOLDINGS, INC." TO "AMERIGAS EAGLE HOLDINGS, INC.", FILED IN THIS OFFICE ON THE TWENTY-SECOND DAY OF AUGUST, A.D. 2001, AT 1 O'CLOCK P.M.

SECRETARY'S OFFICE DELAWARE

Harriet Smith Windsor

Harriet Smith Windsor, Secretary of State

3018524 8100

020119769

AUTHENTICATION: 1628400

DATE: 02-22-02

STATE OF DELAWARE
SECRETARY OF STATE
DIVISION OF CORPORATIONS
FILED 01:00 PM 08/22/2001
010414403 – 3018524

CERTIFICATE OF AMENDMENT

OF

CERTIFICATE OF INCORPORATION

OF

CP HOLDINGS, INC.

It is hereby certified that:

1. The name of the corporation (hereinafter called the "Company") is CP Holdings, Inc.

2. The Certificate of Incorporation of the Company is hereby amended by striking Article 1 in its entirety and substituting in lieu thereof the following new Article:

"The name of the corporation is AmeriGas Eagle Holdings, Inc."

3. The Amendment of the Certificate of Incorporation herein certified has been duly adopted in accordance with the provisions of Sections 228 and 242 of the Delaware General Corporation Law, as amended.

Dated as of August 22, 2001

CP HOLDINGS, INC.

By: [signature]
Name: Eugene V.N. Bissell
Title: President

NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

GARY E. JOHNSON
Governor
Carol Leach
Acting Cabinet Secretary

Lori Wrotenbery
Director
Oil Conservation Division

February 05, 2002

CERTIFIED MAIL
RETURN RECEIPT NO. 5357 7249

Mr. Gary Powdrill
AmeriGas Propane
14702 W. Olive Ave.
Waddell Arizona 85355

Re: AmeriGas Loco Hills Facility
Gas Storage System Discharge Plan GW-019
Eddy County, New Mexico

Dear Mr. Powdrill:

The New Mexico Oil Conservation Division (OCD) understands that AmeriGas is the new operator of the Columbia Propane Loco Hills Gas Storage Facility discharge plan GW-019 located in the NW/4 SE/4 Section 22, Township 17 South, Range 29 East, NMPM, Eddy County, New Mexico. Pursuant to the New Mexico Water Quality Control Commission and Oil Conservation Division Regulations AmeriGas is hereby required to perform the following actions by February 25, 2002.

1. A written commitment to comply with the terms and conditions of the previously approved discharge plan pursuant to item 23.of the discharge plan (copy enclosed).

2. Provide proper bonding pursuant to OCD Rule 19 NMAC 15.3.101. and an approved change of ownership OCD form C-104 for the three wells.

If you have any questions please do not hesitate to contact me at 505-476-3487 or E-mail WPRICE@state.nm.us.

Sincerely,

Wayne Price- Engineer

cc: OCD Artesia Office

Attachments-1

From: Amgasaz@aol.com
Sent: Monday, February 04, 2002 2:06 PM
To: WPrice@state.nm.us
Subject: Fwd: AmeriGas, Loco Hills Facility

\meriGas, Loco Hills Facility

Company Information

Cooperate Amerigas Propane
P.O. Box 965
Valley Forge, PA 19482
610-337-7000

Houston 13105 Northwest Freeway
Suite 500
Houston Texas 77040
Anita Walth, Manager of Terminals
281-552-4019

Phoenix AmeriGas Terminal
14702 W. Olive Ave.
Waddell Arizona 85355
623-935-2661
Gary Powdrill- Regional Logistics Manager
Cell 602-359-0323

Phone 623-935-2661
Cell 602-359-0323

Price, Wayne

From: Price, Wayne
Sent: Monday, February 04, 2002 2:36 PM
To: 'Amgasaz@aol.com'; Walth@AmeriGas.com
Cc: Gum, Tim; Stubblefield, Mike
Subject: RE: AmeriGas, Loco Hills Facility

Your request is hereby approved subject to the following condition(s):

1. The net volume of product pumped out of cavern #2 shall be metered (in gallons).

2. The net volume of product from Navajo shall be metered (in gallons) into Cavern #1.

3. The total net volume of product pumped back into cavern #2 shall be metered (in gallons.)

4. The transfer shall be completed by February 28, 2002.

5. A complete report shall be attached to a OCD form C-103 and submitted to the district office and copy to this office.

Please be advised that NMOCD approval of this plan does not relieve AmeriGas of liability should their operations pose a threat to ground water, surface water, human health or the environment. In addition, NMOCD approval does not relieve AmeriGas of responsibility for compliance with any other federal, state, or local laws and/or regulations.

Wayne Price
OCD Environmental Bureau

-----Original Message-----
From: Amgasaz@aol.com [mailto:Amgasaz@aol.com]
Sent: Monday, February 04, 2002 1:56 PM
To: Walth@AmeriGas.com
Subject: AmeriGas, Loco Hills Facility

Mr. Price,

We have a valve stem leaking on our #2 Cavern (Butane Storage) and we need to replace the packing to ensure Cavern #2 remains leak free. The leakage at this time is very minimal and the cavern inventory is very low.

We figure there is approximately 80-100,000 gals (2000 bbls) in inventory. Our proposal is to transfer the product from Cavern#2 into Cavern #1 (which is not being used at this time. The integrity tests were ran on Cavern #1 on 4/20/2000 and witnessed by Mr. Mike Stubblefield of the OCD. The transfer should be completed by Feb 13th or 14th. We will then replace the packing and start transferring the product back into Cavern #2. Navajo refining will be bringing Butane into the facility on February 5. The actual transfer time back out of the Cavern will be dependent upon how much product we receive from Navajo.

This will only be a temporary situation that will allow us the get the packing replaced.

Your cooperation is greatly appreciated.

Gary Powdrill
Regional Logistics Manager, Phoenix

Price, Wayne

From: Phillips, Dorothy
Sent: Monday, July 16, 2001 4:20 PM
To: Price, Wayne
Subject: NATIONAL PROPANE LP

GW-019

Hello! do you remember the 3 one-well bonds you took on National Propane LP. You said you were going to work with them. The surety on the three bonds is with Amwest which has gone bankrupt and the surety is now liquidated. We will have to ask for new bonding from the operator. Our attorney, David Brooks is sending a letter to all the other operators we have that are insured by Amwest. Do you want to bring me the bonds so he can write them too? Let me know. Thanks

GAVE DORTHY BOND FILES!!

W.P.

Columbia Propane

C. David Watson
Associate General Counsel

PO Box 35800
Richmond, VA 23235-0800

Shipping:
10710 Midlothian Turnpike
Suite 200
Richmond, VA 23235

804 594 1726
804 594 1736 Fax

GW-19

November 17, 2000

Mr. Roger C. Anderson
Environmental Bureau Chief
Oil Conservation Division
2040 S. Pacheco St.
Santa Fe, NM 87505

Dear Mr. Anderson,

We are in receipt of the April 12, 2000 letter from the New Mexico Oil Conservation Division ("OCD"). This reply is intended to be the beginning of Columbia Propane's compliance.

The first 24 items appear to be a general list of Bureau requirements for facilities such as ours and not particular to our facility. We have posted these at our facility as guides for the future. We will comply with those applicable to our operation, as described below. Also included are items 25 A through J as items specific to our operation. We will also comply with these items, as described below.

1. Payment of Discharge Plan Fees:
   Columbia agrees with the fee structure and will comply.

2. Commitments:
   Columbia Propane will abide by all applicable commitments submitted in the discharge plan renewal application dated February 17, 2000 and these conditions of approval.

3. Brine storage Pond:
   a. A minimum freeboard will be maintained.
   b. OCD will be pre-notified for approval of any repairs, modifications or replacements.
   c. The levees will be maintained leak free to prevent erosion and be inspected monthly and after any substantial rainfall and a written inspection report retained.

4. Leak Detection Monitor Wells (Two):
   a. The monitor wells will be inspected monthly and an inspection report retained.
   b. Quantity change will be noted and substantial increases will be tested for contents and the OCD notified.

5. Production Method:
   Your described methods are agreed with and are being followed.

6. Maximum Injection Pressure:
   Columbia agrees with the requirement. Normal injection pressure is 30/50 psig open end, well below fracture pressure.

7. Mechanical Integrity Testing:
   Columbia agrees to conduct annual open hole cavern testing. The last test appears to have been done in 1993 and we were not aware of the requirement for annual testing.

8. Capacity and Cavity Configuration :
   Columbia agrees to provide the required test and information application to OCD prior to the February 27, 2005 discharge plan renewal. Columbia will provide the calculated cavities size. The method of stability testing is unknown and we request information on the compliance of this item.

9. Operation Reports:
   Columbia will comply. Please supply the necessary OCD C-131A and OCD C-131 forms or a source, for our use.

10. Analysis of Injection Fluid and Brine:
    Columbia will comply. If possible, please provide a list of approved contractors that provide this service.

11. Drum Storage:
    Columbia will comply.

12. Process Areas:
    Columbia will comply.

13. Above Ground Tanks:
    We do not believe this requirement is currently applicable. Columbia has no containers on site that require this protection and agrees to provide same if new installations are considered.

14. Above Ground Saddle Tanks:
    We do not believe this requirement is currently applicable. Columbia has no saddle tanks on site that require this protection and agrees to provide same if new installations are considered.

15. Labeling:
    Columbia will comply.

16. Below Grade Tanks /Sumps:
    We do not believe this requirement is currently applicable. Columbia has no below grade tanks/sumps on site that require this protection and agrees to provide same if new installations are considered.

17. Underground Process /Wastewater Lines:
    Columbia does not have any underground waste water lines. Records cannot be found concerning the last test of the process (Brine) lines. A testing plan and schedule will be prepared and presented to OCD for approval.

18. Class V Wells:
    Not applicable. Columbia has no Class V Wells on site that require this protection and agrees to provide same if new installations are considered.

19. Well Work Over Operations:
Columbia will comply.

20. Housekeeping:
Columbia will create and maintain a daily survey sheet meeting this requirement.

21. Spill Reporting:
Columbia will comply.

22. Waste Disposal:
Columbia will comply.

23. Transfer of Discharge Plan:
Columbia will comply.

24. Closure:
Columbia will comply.

25. OCD Inspections: (1-24-00)

A. Columbia will cause the three make-up wells to be tested for the quantities indicated.

B. Columbia will notify OCD at least 48 hours prior to the samples being taken.

C. Columbia will provide OCD with a permanent containment plan addressing the large earth pile.

D1. Columbia will create and provide OCD plans and timing relative to the closing and dispossession of the old temporary holding pond.

D2. Columbia's routine inspections reveal no leakage from the brine pond.

E. Columbia will create and provide OCD a plan for closing and sealing the abandoned well.

F. Columbia has tested and verified the integrity of well 1, and intends to keep it ready for service.

G. Columbia will provide OCD with the plans for a containment curb on the brine pump and the compressor stand.

H. Columbia has repaired all known leaking brine control lines. Columbia routinely inspects such for leaks.

I. Columbia will reestablish the normal rain water run off grades disturbed by installation of temporary pads for well testing.

J. Columbia has provided and installed the required information signs on the noted areas.

If you have any questions about the foregoing, please let me know.

Columbia apologies for the delay in responding to OCD's letter. Columbia Propane is committed to working with the OCD and meeting its requirements. The plans and notification for your items 25 A through J are being prepared and will be submitted for notice and permit where required.

Best regards,

C. David Watson

Cc: Marty Wood

Columbia Propane℠

RECEIVED

JUN - 5 2000

Marty Woods
Vice President
Supply and Wholesale
10710 Midlothian TPike
Suite 200
Richmond, VA 23235
Tel: 804-594-1763
Fax: 804-594-1340

Mr. Roger Anderson
Environmental Bureau Chief
New Mexico Energy, Minerals & Natural Resources Dept.
Oil Conservation Division
2040 South Pacheco
Santa Fe, NM 87505

May 30, 2000

Via Fax and Mail

Re: Loco Hills Gas Storage Facility

Mr. Anderson,

Per discussions with Mr. Wayne Price, I submit for your determination a recap of the events surrounding our Loco Hills storage well testing and our evidence to support our belief that well 3 possesses mechanical integrity.

Last month Columbia performed a hydrostatic test of wells 1, 2 and 3 at the subject facility. Wells 1 and 2 sealed easily with mechanical plugs and presented no problems completing the test. Well 3 was challenging in that the contractor attempted to achieve pressure with mechanical plugs. The plugs did not seal properly so we brought in pneumatic plugs, which sealed immediately on the first attempt. Mr. Mike Stubblefield of the OCD witnessed the test and indicated that it passed. As a consequence of Mr. Stubblefield's determination, we reset the stringer, sealed the wells and discharged all of the contractors.

We were ready to resume operations on well 3 when we were surprised to get a call from your office a couple of days later stating that well 3 was a marginal failure. Had Mr. Stubblefield expressed any doubt about the test, we would have spent the additional hour to immediately reset and re-inflate the pneumatic plug to retest. A retest at that point would have only cost a few hundred dollars. Bringing the contractors back would cost over ten thousand dollars, which is uneconomic, given the limited returns associated with storing gas in eastern New Mexico.

We are certain that well 3 is our best well, in terms of its operating "personality" as well as its performance with respect to historical product loss control. As you know, each well has unique characteristics with respect to an operator's ability to put product down hole, pull product up, and manage its overall operation. To substantiate our belief, I submit for you a recap of our well 3 inventory records for the past three years. I apologize for the delay we have had putting this package together; we just moved our corporate offices, so records had to be pulled from remote archives.

The summary schedule indicates that we bottomed the cavern in April 1997 and again in February of 2000. Bottoming is very significant, in that it is the only way to definitively determine actual physical inventory levels. As the schedule shows, in the past three years, we have experienced a cumulative inventory *gain* of 2,229 gallons. This gain is determined before factoring in the usual shrink calculation. The measurement of this activity is not subject to meter calibration error, as the receipts and disbursements are calculated from weigh scales.

Columbia recognizes our duty as corporate citizens to conduct our business in a safe, environmentally responsible manner. Additionally, given the extremely high natural gas liquids prices, we have a powerful economic incentive to utilize the best assets and tools we have to ensure we do not experience product loss, whose cost we bare. Considering the foregoing, Columbia would like to return well 3 to service. Well 3's good service has ensured the security of energy supply for residents of New Mexico for many years.

Respectfully, Columbia requests that the State grant approval to resume operation on well 3. We are certain, based on our careful inventory control process, that the apparent marginal failure was the result of a poorly positioned or improperly inflated pneumatic plug.

Sincerely,

Marty Woods

Marty Woods

LOCO HILLS
#3 STORAGE INVENTORY
6/1/97 TO 3/1/00

Date	Gross Receipt Gallons	Gross Sales	Surface Butane Inventory
5/1/97	498,774	0	0
6/1/97	453,100	0	0
7/1/97	125,224	0	0
8/1/97	0	0	0
9/1/97	66,554	0	0
10/1/97	387,902	0	0
11/1/97	0	0	31,094
12/1/97	0	(413,793)	33,118
1/1/98	238,814	(318,544)	33,120
2/1/98	0	(485,863)	18,400
3/1/98	0	0	18,400
4/1/98	183,287	0	0
5/1/98	271,855	0	0
6/1/98	16,480	0	0
7/1/98	0	0	0
8/1/98	0	(99,485)	18,400
9/1/98	0	0	35,326
10/1/98	0	(55,823)	28,518
11/1/98	0	(28,365)	8,832
12/1/98	0	(523,253)	8,832
1/1/99	0	(248,592)	18,400
2/1/99	0	(29,808)	23,232
3/1/99	0	0	0
4/1/99	201,598	0	0
5/1/99	273,871	0	0
6/1/99	100,310	0	0
7/1/99	0	0	0
8/1/99	0	0	0
9/1/99	0	0	0
10/1/99	0	0	0
11/1/99	0	0	0
12/1/99	0	(227,303)	7,360
1/1/00	0	(289,386)	33,118
2/1/00	0	(48,665)	33,118
3/1/00	0	0	51,118
4/1/00	0	0	0
5/1/00	0	0	0
	2,817,769	(2,768,880)	51,118

Beginning Balance 5/1/97	0
Total Gross Recipts	2,817,769
Total Gross Sales	2,768,880
Ending Surface Inventory	51,118
Net Gain	2,229

ATTN Jerry Smith

LOCO HILLS NORMAL BUTANE CAVERN RECAP

BARRELS	2000	1999	1998	1997	
OPENING INVENTORY	8312	8995	26671	0	
DELIVERIES INTO CAVERN	4824	685,198 16314	979,394 18557	36502	— 1,533,084
DELIVERIES OUT OF CAVERN	8054	507,570 12085	1,522,626 36253	9832	- 412,944
SALES OUT OF CAVERN	304	162,918 3879	0	0	
ENDING INVENTORY	4824	349,104 8312	377,790 8995	26671	1,120,182
(GAIN) or LOSS	-46	1033 43,386	-20 -840	-1	-42

A 2% SHRINKAGE FACTOR HAS BEEN APPLIED TO THE DELIVERIES INTO THE CAVERN.

	NATIONAL PROPANE - LOCO	HILLS, NM UNDERGROUND ST	ORAGE			
JUNE 1997	NAVAJO - BUTANE	B/L	GALLONS		SHRINK @ 2%	NET GALLONS
		OPENING BALANCE	498,774		(9,975)	488,799
REC'D FROM	DATE				0	0
NAVAJO	60197	970528	8,982		(180)	8,802
NAVAJO	60197	970592	9,023		(180)	8,843
NAVAJO	60197	970720	8,940		(179)	8,761
NAVAJO	60197	970880	8,912		(178)	8,734
NAVAJO	60197	971136	8,772		(175)	8,597
NAVAJO	60297	971296	8,952		(179)	8,773
NAVAJO	60297	971584	8,924		(178)	8,746
NAVAJO	60397	972832	8,846		(177)	8,669
NAVAJO	60397	972896	8,883		(178)	8,705
NAVAJO	60397	973152	8,862		(177)	8,685
NAVAJO	60397	973280	8,776		(176)	8,600
NAVAJO	60397	973440	8,838		(177)	8,661
NAVAJO	60497	974112	8,879		(178)	8,701
NAVAJO	60497	974208	8,821		(176)	8,645
NAVAJO	60497	974304	8,842		(177)	8,665
NAVAJO	60497	974464	8,858		(177)	8,681
NAVAJO	60497	974688	8,813		(176)	8,637
NAVAJO	60597	975008	8,887		(178)	8,709
NAVAJO	60597	975264	8,973		(179)	8,794
NAVAJO	60597	975424	8,842		(177)	8,665
NAVAJO	60597	975712	8,735		(175)	8,560
NAVAJO	60597	975840	8,809		(176)	8,633
NAVAJO	60597	975936	8,834		(177)	8,657
NAVAJO	60697	976096	8,879		(178)	8,701
NAVAJO	60997	978112	8,982		(180)	8,802
NAVAJO	60997	978528	8,908		(178)	8,730
NAVAJO	60997	978880	8,797		(176)	8,621
NAVAJO	61697	986208	8,834		(177)	8,657
NAVAJO	61697	986368	8,862		(177)	8,685
NAVAJO	61697	986592	8,825		(177)	8,649
NAVAJO	61697	986848	8,858		(177)	8,681
NAVAJO	61697	986976	8,809		(176)	8,633
NAVAJO	61797	987232	8,879		(178)	8,701
NAVAJO	61797	987296	8,887		(178)	8,709
NAVAJO	61797	987392	8,875		(178)	8,698
NAVAJO	61797	987456	9,179		(184)	8,995
NAVAJO	61797	987744	9,211		(184)	9,027
NAVAJO	61897	988352	9,183		(184)	8,999
NAVAJO	61897	988512	9,294		(186)	9,108
NAVAJO	61897	988640	9,146		(183)	8,963
NAVAJO	61897	988960	9,084		(182)	8,902
NAVAJO	61897	989120	9,129		(183)	8,946
NAVAJO	61997	989376	9,269		(185)	9,084
NAVAJO	61997	990048	9,170		(183)	8,987
NAVAJO	62097	990784	9,363		(187)	9,176
NAVAJO	62397	992512	9,220		(184)	9,036
NAVAJO	62397	992672	9,170		(183)	8,987
NAVAJO	62397	992736	7,963		(159)	7,804
NAVAJO	62697	995744	8,074		(161)	7,913
NAVAJO	62697	996096	8,111		(162)	7,949
NAVAJO	62697	996192	8,136		(163)	7,973
NAVAJO					0	0
NAVAJO					0	0
NAVAJO					0	0
NAVAJO					0	0
					0	0
	**************************************		453,100			
		ENDING BALANCE	951,874		(19,037)	932,837
============	====================	============================	===========	========	==========	============

JULY 1997	**LOCO HILLS**	B/L	GALLONS		SHRINK @ 2%	NET GALLONS
	NAVAJO - BUTANE	OPENING BALANCE	951,874		(19,037)	932,837
REC'D FROM	DATE					
NAVAJO	7/1/97	1000554	8,185		(164)	8,021
NAVAJO	7/1/97	1000768	8,423		(168)	8,255
NAVAJO	7/1/97	1000896	7,540		(151)	7,389
NAVAJO	7/2/97	1888	8,230		(165)	8,065
NAVAJO	7/2/97	2016	8,230		(165)	8,065
NAVAJO	7/2/97	2112	8,300		(166)	8,134
NAVAJO	7/8/97	5120	8,004		(160)	7,844
NAVAJO	7/8/97	5696	8,550		(171)	8,379
NAVAJO	7/8/97	5920	8,324		(166)	8,158
NAVAJO	7/10/97	7776	3,010		(60)	2,950
NAVAJO	7/16/97	10843	8,131		(163)	7,968
NAVAJO	7/16/97	10881	8,227		(165)	8,062
NAVAJO	7/16/97	10919	8,255		(165)	8,090
NAVAJO	7/23/97	12352	7,930		(159)	7,771
NAVAJO	7/23/97	12361	7,889		(158)	7,731
NAVAJO	7/23/97	12372	7,996		(160)	7,836
	**************************************					
		ENDING BALANCE IN GALLONS	1,077,098		(21,542)	1,055,556
		ENDING BALANCE IN BARRELS	25,645		(513)	25,132

==============	========================	==========================	============	=========	============	==============	============	=============	============			
AUGUST 1997	LOCO HILLS	B/L	GALLONS		SHRINK @ 2%	NET GALLONS						
	NAVAJO - BUTANE	OPENING BALANCE	1,077,098		(21,542)	1,055,556						
REC'D FROM	DATE											
NAVAJO			0		0	0						
NAVAJO			0		0	0						
NAVAJO			0		0	0						
NAVAJO			0		0	0						
NAVAJO			0		0	0						
NAVAJO			0		0	0						
NAVAJO			0		0	0						
	************************************	MONTH RECEIPTS	0		0	0						
		ENDING BALANCE IN GALLONS	1,077,098	1077098	(21,542)	1,055,556	-21542	1055556				
		ENDING BALANCE IN BARRELS	25,645		(513)	25,132						
==============	========================	==========================	============	=========	============	==============	============	=============	============			
	IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH 800/653-1550 EXT 141											

SEPTEMBER 1997	**LOCO HILLS**	B/L	GALLONS		SHRINK @ 2%	NET GALLONS							
	NAVAJO - BUTANE	OPENING BALANCE	1,077,098		(21,542)	1,055,556							
REC'D FROM	DATE												
NAVAJO	9/19/97	24236	8,756		(175)	8,581							
NAVAJO	9/19/97	24246	8,456		(169)	8,287							
NAVAJO	9/19/97	24258	8,493		(170)	8,323							
NAVAJO	9/19/97	24266	8,103		(162)	7,941							
NAVAJO	9/19/97	24341	8,119		(162)	7,957							
NAVAJO	9/22/97	24709	8,287		(166)	8,121							
NAVAJO	9/22/97	24716	8,172		(163)	8,009							
NAVAJO	9/22/97	24720	8,168		(163)	8,005							
		MONTH RECEIPTS	66,554		(1,331)	65,223							
		ENDING BALANCE IN GALLONS	1,143,652	1077098	(22,873)	1,120,779	-21542	1055556					
		ENDING BALANCE IN BARRELS	27,230		(545)	26,685							
	IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH 800/653-1550 EXT 141												

OCTOBER 1997	LOCO HILLS	B/L	GALLONS		SHRINK @ 2%	NET GALLONS
	NAVAJO - BUTANE	OPENING BALANCE	1,143,652		(22,873)	1,120,779
REC'D FROM	DATE					
NAVAJO	10/6/97	25842	9,129		(183)	8,946
NAVAJO	10/6/97	25843	8,772		(175)	8,597
NAVAJO	10/6/97	25876	9,068		(181)	8,887
NAVAJO	10/6/97	25877	9,211		(184)	9,027
NAVAJO	10/6/97	25878	8,858		(177)	8,681
NAVAJO	10/6/97	25913	8,883		(178)	8,705
NAVAJO	10/7/97	25958	8,825		(177)	8,649
NAVAJO	10/7/97	25968	8,871		(177)	8,694
NAVAJO	10/7/97	26007	8,862		(177)	8,685
NAVAJO	10/8/97	26107	8,916		(178)	8,738
NAVAJO	10/8/97	26143	8,854		(177)	8,677
NAVAJO	10/8/97	26156	8,690		(174)	8,516
NAVAJO	10/8/97	26259	8,908		(178)	8,730
NAVAJO	10/10/97	26457	9,055		(181)	8,874
NAVAJO	10/10/97	26458	9,253		(185)	9,068
NAVAJO	10/10/97	26464	9,195		(184)	9,011
NAVAJO	10/10/97	26466	8,842		(177)	8,665
NAVAJO	10/10/97	26467	9,265		(185)	9,080
NAVAJO	10/10/97	26468	8,940		(179)	8,761
NAVAJO	10/10/97	26469	9,195		(184)	9,011
NAVAJO	10/10/97	26470	8,797		(176)	8,621
NAVAJO	10/10/97	26471	9,302		(186)	9,116
NAVAJO	10/10/97	26474	8,789		(176)	8,613
NAVAJO	10/10/97	26478	9,314		(186)	9,128
NAVAJO	10/10/97	26511	8,842		(177)	8,665
NAVAJO	10/11/97	26513	9,175		(184)	8,992
NAVAJO	10/11/97	26514	8,805		(176)	8,629
NAVAJO	10/11/97	26515	9,257		(185)	9,072
NAVAJO	10/11/97	26580	8,834		(177)	8,657
NAVAJO	10/11/97	26581	9,277		(186)	9,091
NAVAJO	10/11/97	26582	8,875		(178)	8,698
NAVAJO	10/11/97	26583	9,285		(186)	9,099
NAVAJO	10/11/97	26584	8,965		(179)	8,786
NAVAJO	10/16/97	26788	8,879		(178)	8,701
NAVAJO	10/16/97	26789	9,216		(184)	9,032
NAVAJO	10/16/97	26792	8,936		(179)	8,757
NAVAJO	10/16/97	26794	9,413		(188)	9,225
NAVAJO	10/16/97	26797	8,850		(177)	8,673
NAVAJO	10/16/97	26800	9,368		(187)	9,181
NAVAJO	10/16/97	26801	8,903		(178)	8,725
NAVAJO	10/16/97	26804	9,376		(188)	9,188
NAVAJO	10/16/97	26805	8,932		(179)	8,753
NAVAJO	10/16/97	26810	8,920		(178)	8,742
	**	MONTH RECEIPTS	387,902		(7,758)	380,144
		ENDING BALANCE IN GALLONS	1,531,554		(30,631)	1,500,923
		ENDING BALANCE IN BARRELS	36,466		(729)	35,736

NOVEMBER 1997	LOCO HILLS	B/L	GALLONS		SHRINK @ 2%	NET GALLONS				
	NAVAJO - BUTANE	OPENING BALANCE	1,531,554		(30,631)	1,500,923				
REC'D FROM	DATE									
					0	0				
	************************************	MONTH RECEIPTS	0		0	0				
		ENDING BALANCE IN GALLON	1,531,554		(30,631)	1,500,923				
		ENDING BALANCE IN BARREL	36,466		(729)	35,738				

DECEMBER 1997	LOCO HILLS	B/L	GALLONS		SHRINK @ 2%	NET GALLONS
	NAVAJO - BUTANE	OPENING BALANCE	1,531,554		(30,631)	1,500,923
REC'D FROM	DATE					
NAVAJO	12/8/97	32728	(9,010)			(9,010)
NAVAJO	12/8/97	32765	(9,068)			(9,068)
NAVAJO	12/8/97	32771	(8,969)			(8,969)
NAVAJO	12/8/97	32840	(9,018)			(9,018)
NAVAJO	12/8/97	32845	(9,097)			(9,097)
NAVAJO	12/9/97	32921	(8,961)			(8,961)
NAVAJO	12/9/97	33120	(8,973)			(8,973)
NAVAJO	12/9/97	33154	(9,039)			(9,039)
NAVAJO	12/9/97	33224	(9,031)			(9,031)
NAVAJO	12/13/97	34296	(9,224)			(9,224)
NAVAJO	12/13/97	34333	(9,105)			(9,105)
NAVAJO	12/13/97	34368	(9,216)			(9,216)
NAVAJO	12/13/97	34469	(9,298)			(9,298)
NAVAJO	12/15/97	34477	(9,298)			(9,298)
NAVAJO	12/15/97	34514	(9,199)			(9,199)
NAVAJO	12/15/97	34518	(9,121)			(9,121)
NAVAJO	12/15/97	34554	(9,179)			(9,179)
NAVAJO	12/15/97	34558	(9,240)			(9,240)
NAVAJO	12/15/97	34600	(9,203)			(9,203)
NAVAJO	12/15/97	34607	(9,064)			(9,064)
NAVAJO	12/15/97	34610	(8,936)			(8,936)
NAVAJO	12/20/97	35884	(8,871)			(8,871)
NAVAJO	12/20/97	35887	(9,446)			(9,446)
NAVAJO	12/20/97	35990	(9,240)			(9,240)
NAVAJO	12/20/97	35993	(9,294)			(9,294)
NAVAJO	12/22/97	35997	(9,331)			(9,331)
NAVAJO	12/22/97	36000	(9,294)			(9,294)
NAVAJO	12/22/97	36006	(9,343)			(9,343)
NAVAJO	12/23/97	36617	(9,265)			(9,265)
NAVAJO	12/23/97	36750	(9,359)			(9,359)
NAVAJO	12/27/97	37067	(9,236)			(9,236)
NAVAJO	12/27/97	37100	(9,076)			(9,076)
NAVAJO	12/27/97	37167	(9,273)			(9,273)
NAVAJO	12/27/97	37202	(9,273)			(9,273)
NAVAJO	12/27/97	37203	(9,248)			(9,248)
NAVAJO	12/28/97	37243	(9,314)			(9,314)
NAVAJO	12/28/97	37247	(9,191)			(9,191)
NAVAJO	12/28/97	37251	(9,253)			(9,253)
NAVAJO	12/28/97	37380	(9,269)			(9,269)
NAVAJO	12/29/97	37382	(9,105)			(9,105)
NAVAJO	12/29/97	37418	(9,298)			(9,298)
NAVAJO	12/29/97	37554	(9,220)			(9,220)
NAVAJO	12/29/97	37486	(9,257)			(9,257)
NAVAJO	12/29/97	37692	(9,840)			(9,840)
NAVAJO	12/30/97	37727	(9,248)			(9,248)
	**	MONTH RECEIPTS	(413,793)		0	(413,793)
		ENDING BALANCE IN GALLONS	1,117,761		(30,631)	1,087,130
		ENDING BALANCE IN BARRELS	26,613		(729)	25,884

IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH 800/653-1550 EXT 141

JANUARY 1998	LOCO HILLS	B/L	GALLONS		SHRINK @ 2%	NET GALLONS			
	NAVAJO - BUTANE	OPENING BALANCE	1,117,761		(30,631)	1,087,130			
REC'D FROM	DATE								
NAVAJO	1/5/98	38322	(9,232)			(9,232)			
NAVAJO	1/5/98	38328	(9,372)			(9,372)			
NAVAJO	1/5/98	38331	(9,363)			(9,363)			
NAVAJO	1/5/98	38335	(9,331)			(9,331)			
NAVAJO	1/5/98	38373	(9,236)			(9,236)			
NAVAJO	1/5/98	38407	(9,273)			(9,273)			
NAVAJO	1/5/98	38445	(9,302)			(9,302)			
NAVAJO	1/5/98	38448	(9,339)			(9,339)			
NAVAJO	1/5/98	38548	(9,298)			(9,298)			
NAVAJO	1/12/98	39833	9,244		(185)	9,059			
NAVAJO	1/12/98	39835	9,322		(186)	9,136			
NAVAJO	1/12/98	39839	9,474		(189)	9,285			
NAVAJO	1/12/98	39840	9,483		(190)	9,293			
NAVAJO	1/12/98	39844	9,290		(186)	9,104			
NAVAJO	1/12/98	39846	9,405		(188)	9,217			
NAVAJO	1/12/98	39882	9,302		(186)	9,116			
NAVAJO	1/13/98	39938	9,150		(183)	8,967			
NAVAJO	1/13/98	39992	9,265		(185)	9,080			
NAVAJO	1/13/98	40059	9,105		(182)	8,923			
NAVAJO	1/13/98	40135	9,191		(184)	9,007			
NAVAJO	1/13/98	40205	9,257		(185)	9,072			
NAVAJO	1/13/98	40210	9,285		(186)	9,099			
NAVAJO	1/13/98	40213	9,092		(182)	8,910			
NAVAJO	1/13/98	40215	9,170		(183)	8,987			
NAVAJO	1/13/98	40101	9,088		(182)	8,906			
NAVAJO	1/13/98	40226	9,179		(184)	8,995			
NAVAJO	1/13/98	40219	9,199		(184)	9,015			
NAVAJO	1/13/98	40228	9,105		(182)	8,923			
NAVAJO	1/14/98	40303	8,977		(180)	8,797			
NAVAJO	1/14/98	40309	8,768		(175)	8,593			
NAVAJO	1/14/98	40378	8,571		(171)	8,400			
NAVAJO	1/16/98	41058	9,269		(185)	9,084			
NAVAJO	1/19/98	41291	9,224		(184)	9,040			
NAVAJO	1/19/98	41327	9,224		(184)	9,040			
NAVAJO	1/19/98	41328	9,175		(184)	8,992			
NAVAJO	1/21/98	41755	(9,220)			(9,220)			
NAVAJO	1/22/98	41824	(9,359)			(9,359)			
NAVAJO	1/22/98	41831	(9,335)			(9,335)			
NAVAJO	1/22/98	41901	(9,290)			(9,290)			
NAVAJO	1/22/98	42033	(9,347)			(9,347)			
NAVAJO	1/22/98	42134	(9,421)			(9,421)			
NAVAJO	1/22/98	42278	(9,388)			(9,388)			
NAVAJO	1/23/98	42281	(9,437)			(9,437)			
NAVAJO	1/23/98	42289	(9,318)			(9,318)			
NAVAJO	1/23/98	42296	(9,450)			(9,450)			
NAVAJO	1/26/98	42571	(9,372)			(9,372)			
NAVAJO	1/26/98	42577	(9,351)			(9,351)			
NAVAJO	1/26/98	42650	(9,347)			(9,347)			
NAVAJO	1/26/98	42655	(9,405)			(9,405)			
NAVAJO	1/26/98	42693	(9,421)			(9,421)			
NAVAJO	1/28/98	42967	(9,425)			(9,425)			
NAVAJO	1/28/98	43166	(9,322)			(9,322)			
NAVAJO	1/28/98	43429	(9,400)			(9,400)			
NAVAJO	1/28/98	43533	(9,429)			(9,429)			
NAVAJO	1/28/98	43568	(9,499)			(9,499)			
NAVAJO	1/29/98	43686	(9,405)			(9,405)			
NAVAJO	1/29/98	43692	(9,524)			(9,524)			
NAVAJO	1/29/98	43764	(9,511)			(9,511)			
NAVAJO	1/29/98	43768	(9,409)			(9,409)			
NAVAJO	1/30/98	43777	(9,413)			(9,413)			
		In	238813						
		Out.							
	**************************************	MONTH RECEIPTS	(79,730)		(4,776)	(84,506)			
		ENDING BALANCE IN GALLONS	1,038,031		(35,407)	1,002,624			
		ENDING BALANCE IN BARRELS	24,715		(843)	23,872			

FEBRUARY 1998	LOCO HILLS	B/L	GALLONS		SHRINK @ 2%	NET GALLONS			
	NAVAJO - BUTANE	OPENING BALANCE	1,038,031		(35,407)	1,002,624			
REC'D FROM	DATE								
						0			
NAVAJO	2/2/98	44433	(9,405)			(9,405)			
NAVAJO	2/2/98	44471	(9,425)			(9,425)			
NAVAJO	2/2/98	44477	(9,400)			(9,400)			
NAVAJO	2/2/98	44481	(9,380)			(9,380)			
NAVAJO	2/2/98	44591	(9,614)			(9,614)			
NAVAJO	2/5/98	44842	(9,018)			(9,018)			
NAVAJO	2/5/98	44851	(9,133)			(9,133)			
NAVAJO	2/5/98	44861	(9,355)			(9,355)			
NAVAJO	2/5/98	44867	(9,589)			(9,589)			
NAVAJO	2/5/98	44873	(9,552)			(9,552)			
NAVAJO	2/6/98	44916	(9,491)			(9,491)			
NAVAJO	2/6/98	45020	(9,544)			(9,544)			
NAVAJO	2/6/98	45156	(9,536)			(9,536)			
NAVAJO	2/6/98	45259	(9,569)			(9,569)			
NAVAJO	2/6/98	45388	(9,520)			(9,520)			
NAVAJO	2/9/98	45916	(9,487)			(9,487)			
NAVAJO	2/9/98	45927	(9,281)			(9,281)			
NAVAJO	2/9/98	45997	(9,651)			(9,651)			
NAVAJO	2/9/98	46068	(9,454)			(9,454)			
NAVAJO	2/9/98	46172	(9,515)			(9,515)			
NAVAJO	2/12/98	46586	(9,634)			(9,634)			
NAVAJO	2/12/98	46590	(9,388)			(9,388)			
NAVAJO	2/12/98	46660	(9,454)			(9,454)			
NAVAJO	2/12/98	46730	(9,470)			(9,470)			
NAVAJO	2/12/98	46897	(9,405)			(9,405)			
NAVAJO	2/12/98	46997	(9,528)			(9,528)			
NAVAJO	2/13/98	47006	(9,437)			(9,437)			
NAVAJO	2/13/98	47013	(9,421)			(9,421)			
NAVAJO	2/13/98	47023	(9,392)			(9,392)			
NAVAJO	2/13/98	47034	(9,413)			(9,413)			
NAVAJO	2/16/98	47418	(9,425)			(9,425)			
NAVAJO	2/16/98	47426	(8,908)			(8,908)			
NAVAJO	2/16/98	47432	(9,552)			(9,552)			
NAVAJO	2/16/98	47471	(9,462)			(9,462)			
NAVAJO	2/16/98	47603	(9,684)			(9,684)			
NAVAJO	2/19/98	48216	(9,429)			(9,429)			
NAVAJO	2/19/98	48321	(9,548)			(9,548)			
NAVAJO	2/19/98	48332	(9,524)			(9,524)			
NAVAJO	2/19/98	48340	(9,212)			(9,212)			
NAVAJO	2/19/98	48415	(8,694)			(8,694)			
NAVAJO	2/19/98	48598	(4,411)			(4,411)			
NAVAJO	2/19/98	48603	(9,495)			(9,495)			
NAVAJO	2/19/98	48606	(9,634)			(9,634)			
NAVAJO	2/19/98	48610	(9,655)			(9,655)			
NAVAJO	2/19/98	48613	(9,626)			(9,626)			
NAVAJO	2/19/98	48616	(9,610)			(9,610)			
NAVAJO	2/23/98	48673	(9,474)			(9,474)			
NAVAJO	2/23/98	48676	(8,337)			(8,337)			
NAVAJO	2/23/98	48709	(9,704)			(9,704)			
NAVAJO	2/23/98	48714	(9,749)			(9,749)			
NAVAJO	2/23/98	48882	(9,688)			(9,688)			
NAVAJO	2/26/98	49537	(9,581)			(9,581)			
	**	MONTH RECEIPTS	(485,863)		0	(485,863)			
		ENDING BALANCE IN GALLONS	552,168		(35,407)	516,761			
		ENDING BALANCE IN BARRELS	13,147		(843)	12,304			

MARCH 1998	**LOCO HILLS**	B/L	GALLONS		SHRINK @ 2%	NET GALLONS
	NAVAJO - BUTANE	OPENING BALANCE	552,168		(35,407)	516,761
REC'D FROM	DATE					
						0
						0
						0
						0
	**	MONTH RECEIPTS	0		0	0
		ENDING BALANCE IN GALLONS	552,168		(35,407)	516,761
		ENDING BALANCE IN BARRELS	13,147		(843)	12,304
FAX TO DAVID BLAIR	@ 505-746-6155					
	IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH 800/653-1550 EXT 141					

APRIL 1998
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE	RECEIVED FROM	B / L	GALLONS	SHRINK @ 2%	NET GALLONS
APRIL 1998	BEGINNING BALANCE		516,761		516,761
				0	0
04/27/98	Navajo	55654	8,842	(177)	8,665
04/27/98	Navajo	68693	9,138	(183)	8,955
04/27/98	Navajo	55765	9,027	(181)	8,846
04/27/98	Navajo	55770	9,154	(183)	8,971
04/27/98	Navajo	55840	9,203	(184)	9,019
04/28/98	Navajo	55882	9,269	(185)	9,084
04/28/98	Navajo	55883	9,261	(185)	9,076
04/28/98	Navajo	55891	9,236	(185)	9,051
04/28/98	Navajo	55898	9,232	(185)	9,047
04/28/98	Navajo	55901	9,199	(184)	9,015
04/29/98	Navajo	55940	9,101	(182)	8,919
04/29/98	Navajo	55942	9,639	(193)	9,446
04/29/98	Navajo	55957	9,146	(183)	8,963
04/29/98	Navajo	55967	9,109	(182)	8,927
04/29/98	Navajo	55977	8,932	(179)	8,753
04/30/98	Navajo	55985	9,183	(184)	8,999
04/30/98	Navajo	55988	9,294	(186)	9,108
04/30/98	Navajo	56031	9,199	(184)	9,015
04/30/98	Navajo	56075	9,088	(182)	8,906
04/30/98	Navajo	56082	9,035	(181)	8,854
	NET IN / OUT		183,287	(3,666)	179,621
APRIL 1998	**ENDING BALANCE IN GALS**		700,048	(3,666)	696,382
	ENDING BALANCE IN BARRELS		16,668	(87)	16,581

*** * * IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH @ 800-653-1550, EXT. 141.**

* * * CORRECTED COPY * * *

Dave,

Please note that this is a corrected copy for April 1998. The balance brought forward into the new year was the gross gallons, not the net gallons, from the 1997 - 1998 contract year. Also the shrink was previously figured at the wrong rate.

MAY 1998
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE	RECEIVED FROM	B / L	ALLONS	SHRINK @ 2%	NET GALLONS
MAY 1998	BEGINNING BALANCE		735,455	(39,073)	696,382
05/04/98	NAVAJO	56337	8,908	(178)	8,730
05/04/98	NAVAJO	56440	8,957	(179)	8,778
05/04/98	NAVAJO	56448	8,953	(179)	8,774
05/05/98	NAVAJO	56531	9,142	(183)	8,959
05/05/98	NAVAJO	56604	9,741	(195)	9,546
05/06/98	NAVAJO	56689	9,023	(180)	8,843
05/06/98	NAVAJO	56701	9,047	(181)	8,866
05/06/98	NAVAJO	56741	9,014	(180)	8,834
05/06/98	NAVAJO	56841	8,982	(180)	8,802
05/07/98	NAVAJO	56882	8,990	(180)	8,810
05/12/98	NAVAJO	57907	9,109	(182)	8,927
05/12/98	NAVAJO	57915	9,072	(181)	8,891
05/12/98	NAVAJO	57954	9,072	(181)	8,891
05/12/98	NAVAJO	58122	9,018	(180)	8,838
05/12/98	NAVAJO	58193	9,101	(182)	8,919
05/12/98	NAVAJO	58199	9,495	(190)	9,305
05/13/98	NAVAJO	58245	9,101	(182)	8,919
05/13/98	NAVAJO	58378	9,055	(181)	8,874
05/13/98	NAVAJO	58481	9,043	(181)	8,862
05/13/98	NAVAJO	58649	8,871	(177)	8,694
05/19/98	NAVAJO	59305	8,986	(180)	8,806
05/20/98	NAVAJO	59575	9,039	(181)	8,858
05/20/98	NAVAJO	59586	9,064	(181)	8,883
05/20/98	NAVAJO	59598	8,891	(178)	8,713
05/20/98	NAVAJO	59614	8,945	(179)	8,766
05/20/98	NAVAJO	59632	9,068	(181)	8,887
05/20/98	NAVAJO	59622	8,973	(179)	8,794
05/21/98	NAVAJO	59835	9,117	(182)	8,935
05/21/98	NAVAJO	59939	9,076	(182)	8,894
05/21/98	NAVAJO	60049	9,002	(180)	8,822
	NET IN / OUT		271,855	(5,437)	266,418
MAY 1998	ENDING BALANCE IN		*1,007,310*	*(44,510)*	*962,800*
	ENDING BALANCE IN BARRELS		23,984	(1,060)	22,924

* * * IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH @ 800-653-1550,

JUNE 1998
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE	RECEIVED FROM	B / L	GALLONS	SHRINK @ 2%	NET GALLONS
JUNE 1998	BEGINNING BALANCE		1,007,310	(44,510)	962,800
06/01/98	NAVAJO	62746	8,657	(173)	8,484
06/01/98	NAVAJO	62377	7,823	(156)	7,667
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
	NET IN / OUT		16,480	(330)	16,150
JUNE 1998	ENDING BALANCE IN		1,023,790	(44,840)	978,950
	ENDING BALANCE IN BARRELS		24,376	(1,068)	23,308

* * * IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH @ 800-653-1550, E

JULY 1998
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE	RECEIVED FROM	B / L	GALLONS	SHRINK @ 2%	NET GALLONS
JULY 1998	BEGINNING BALANCE		1,023,790	(44,840)	978,950
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
				0	0
	NET IN / OUT		0	0	0
JULY 1998	ENDING BALANCE IN GALS		1,023,790	(44,840)	978,950
	ENDING BALANCE IN BARRELS		24,376	(1,068)	23,308

August 1998
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE	RECEIVED FROM	B / L	GALLONS	SHRINK @ 2%	NET GALLONS
August 1998	BEGINNING BALANCE		1,023,790	(44,840)	978,950
08/06/98	NAVAJO	74782	(9,326)		(9,326)
08/06/98	NAVAJO	74851	(9,318)		(9,318)
08/06/98	NAVAJO	75140	(10,086)		(10,086)
08/06/98	NAVAJO	75181	(9,277)		(9,277)
08/13/98	NAVAJO	77677	(9,405)		(9,405)
08/13/98	NAVAJO	77733	(9,216)		(9,216)
08/13/98	NAVAJO	77769	(9,285)		(9,285)
08/13/98	NAVAJO	77775	(5,869)		(5,869)
08/18/98	NAVAJO	78293	(9,441)		(9,441)
08/18/98	NAVAJO	78300	(9,018)		(9,018)
08/19/98	NAVAJO	78312	(9,244)		(9,244)
	NET IN / OUT		(99,485)	0	(99,485)
August 1998	ENDING BALANCE IN GALS		924,305	(44,840)	879,465
	ENDING BALANCE IN BARRELS		22,007	(1,068)	20,940

*** IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH @ 800-653-1550,

SEPTEMBER 1998
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE	RECEIVED FROM	B / L	GALLONS	SHRINK @ 2%	NET GALLONS
SEPTEMBER 1998	BEGINNING BALANCE				879,465
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NET IN / OUT		0	0	0
SEPTEMBER 1998	ENDING BALANCE IN GALS		0	0	879,465
	ENDING BALANCE IN BARRELS		0	0	20,940

OCTOBER 1998
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE	RECEIVED FROM	B / L	GALLONS	SHRINK @ 2%	NET GALLONS
OCTOBER 1998	BEGINNING BALANCE				879,465
10/15/98	NAVAJO	87893	0		(9,220)
10/15/98	NAVAJO	87897	0		(9,232)
10/15/98	NAVAJO	87900	0		(9,363)
10/21/98	NAVAJO	88694	0		(9,347)
10/22/98	NAVAJO	88768	0		(9,425)
10/22/98	NAVAJO	88775	0		(9,236)
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NET IN / OUT		0	0	(55,823)
OCTOBER 1998	ENDING BALANCE IN GALS		0	0	823,642
	ENDING BALANCE IN BARRELS		0	0	19,611

NOVEMBER
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE	RECEIVED FROM	B / L	GALLONS	SHRINK @ 2%	NET GALLONS
NOVEMBER	BEGINNING BALANCE				823,642
11/30/98	NAVAJO	94543	0		(9,441)
11/30/98	NAVAJO	94611	0		(9,450)
11/30/98	NAVAJO	94616	0		(9,474)
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NET IN / OUT		0	0	(28,365)
NOVEMBER	ENDING BALANCE IN GALS		0	0	795,277
	ENDING BALANCE IN BARRELS		0	0	18,935

* * * IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH @ 800-653-1550, EXT

DECEMBER 1998
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
DECEMBER 1998	BEGINNING BALANCE				795,277
2	NAVAJO	95603	0		(9,380)
2	NAVAJO	95037	0		(9,610)
2	NAVAJO	95171	0		(9,524)
2	NAVAJO	95205	0		(9,532)
3	NAVAJO	95278	0		(9,417)
3	NAVAJO	95378	0		(9,392)
3	NAVAJO	95383	0		(9,474)
3	NAVAJO	95385	0		(9,433)
3	NAVAJO	95423	0		(9,487)
4	NAVAJO	95605	0		(9,470)
4	NAVAJO	95640	0		(9,446)
4	NAVAJO	95541	0		(9,409)
7	NAVAJO	95909	0		(9,495)
7	NAVAJO	95945	0		(9,433)
7	NAVAJO	95949	0		(9,437)
7	NAVAJO	95951	0		(9,474)
7	NAVAJO	95986	0		(9,532)
18	NAVAJO	96160	0		(9,474)
18	NAVAJO	96197	0		(9,634)
19	NAVAJO	96270	0		(9,659)
19	NAVAJO	96277	0		(9,700)
19	NAVAJO	96312	0		(9,643)
19	NAVAJO	96315	0		(9,659)
19	NAVAJO	96354	0		(9,589)
10	NAVAJO	96455	0		(9,634)
10	NAVAJO	96462	0		(9,606)
10	NAVAJO	96466	0		(9,659)
10	NAVAJO	96564	0		(9,655)
13	NAVAJO	97153	0		(9,548)
14	NAVAJO	97159	0		(9,782)
14	NAVAJO	97163	0		(9,729)
14	NAVAJO	97204	0		(9,610)
14	NAVAJO	97208	0		(9,561)
15	NAVAJO	97329	0		(9,532)
16	NAVAJO	97354	0		(9,515)
16	NAVAJO	97362	0		(9,458)
16	NAVAJO	97366	0		(9,577)
16	NAVAJO	97501	0		(9,585)
17	NAVAJO	97538	0		(9,520)
22	NAVAJO	98290	0		(9,339)
22	NAVAJO	98294	0		(9,573)
22	NAVAJO	98297	0		(9,433)
23	NAVAJO	98340	0		(9,495)
24	NAVAJO	98546	0		(9,257)
24	NAVAJO	98549	0		(9,478)
28	NAVAJO	98727	0		(9,297)
28	NAVAJO	98733	0		(9,565)
28	NAVAJO	98767	0		(9,589)
29	NAVAJO	98912	0		(9,183)
29	NAVAJO	98916	0		(9,462)
29	NAVAJO	98917	0		(9,384)
30	NAVAJO	99002	0		(9,490)
30	NAVAJO	99041	0		(9,564)
31	NAVAJO	99220	0		(9,441)
31	NAVAJO	99226	0		(9,429)
	NAVAJO		0		0
	NET IN / OUT		0	0	(523,253)
DECEMBER 1998	ENDING BALANCE IN GALS		0	0	272,024
	ENDING BALANCE IN BARRELS		0	0	6,477

*** IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH @ 800-653-1550, EX

JANUARY 1999
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
JANUARY 1999	BEGINNING BALANCE				272,024
3	NAVAJO	99511	0		(9,474)
3	NAVAJO	99514	0		(9,569)
3	NAVAJO	99579	0		(9,626)
4	NAVAJO	99685	0		(9,413)
4	NAVAJO	99688	0		(9,495)
5	NAVAJO	99690	0		(9,561)
6	NAVAJO	99740	0		(9,441)
8	NAVAJO	100054	0		(9,725)
8	NAVAJO	100089	0		(9,770)
14	NAVAJO	101135	0		(9,384)
14	NAVAJO	101176	0		(9,663)
14	NAVAJO	101178	0		(9,585)
16	NAVAJO	101522	0		(9,647)
16	NAVAJO	101556	0		(9,491)
16	NAVAJO	101560	0		(9,598)
17	NAVAJO	101562	0		(9,433)
17	NAVAJO	101565	0		(9,446)
17	NAVAJO	101636	0		(9,507)
17	NAVAJO	101640	0		(9,844)
17	NAVAJO	101645	0		(9,873)
17	NAVAJO	101648	0		(9,922)
18	NAVAJO	101660	0		(9,425)
18	NAVAJO	101701	0		(9,133)
26	NAVAJO	103468	0		(9,441)
26	NAVAJO	103506	0		(9,598)
26	NAVAJO	103514	0		(9,528)
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NAVAJO		0		0
	NET IN / OUT		0	0	(248,592)
JANUARY 1999	ENDING BALANCE IN GALS		0	0	23,432
	ENDING BALANCE IN BARRELS		0	0	558

*** IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH @ 800-653-1550, EXT. 141.

FEBRUARY 1999
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
FEBRUARY 1999	BEGINNING BALANCE				23,432
02/04/99	NAVAJO		(9,947)		(9,947)
02/04/99	NAVAJO		(10,103)		(10,103)
02/04/99	NAVAJO		(9,758)		(9,758)
			0		0
			0		0
			0		0
	NET IN / OUT		(29,808)	0	(29,808)
FEBRUARY 1999	ENDING BALANCE IN GALS		(29,808)	0	(6,376)
	ENDING BALANCE IN BARRELS		(710)	0	(152)

*** IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH @ 800-653-1550, EXT. 141.

LOCO HILLS UNDERGROUND STORAGE # B301

MONTH OF March - 1999 Butane Hole #3

A.	OPENING INVENTORY.........		
	HOLE # 1	0	
	HOLE # 2	0	
	HOLE # 3	0	
	ABOVE GROUND.	0	
	TOTAL OPENING INVENTORY		0
B.	RECEIVED DURING MONTH.........(SEE ATTACHED FORM).		0
C.	TOTAL TO ACCOUNT FOR		0
D.	DEDUCTIONS FOR THE MONTH: (SEE ATTACH LIST)		
	1 SALES TO NATIONAL PROPANE PLANTS	0	
	2 SALES TO WHOLESALE ACCOUNTS	0	
	3 OTHER DEDUCTIONS	0	
E.	TOTAL DEDUCTIONS......................(1.tru.3.		0
F.	CLOSING INVENTORY ....(C - E)...		0
G.	PHYSICAL INVENTORY : HOLE # 1	0	
	HOLE # 2	0	
	HOLE # 3	0	
	ABOVE GROUND.	0	
	PHYSICAL INVENTORY TOTAL		0
I.	DIFFERENCE:.........(between G & F)...............		0
J.	YEAR TO DATE TO BE ACCOUNTED FOR..................		0.
K.	YEAR TO DATE DIFFERENCE		0

L. EXPLAIN DIFFERENCES : ____________________

April-99

LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE				0
04/09/99		114472	9,589	(192)	9,397
04/09/99		114550	9,598	(192)	9,406
04/09/99		114648	9,630	(193)	9,437
04/15/99		115231	9,721	(194)	9,527
04/15/99		115243	9,741	(195)	9,546
04/15/99		115246	9,836	(197)	9,639
04/19/99		115773	9,799	(196)	9,603
04/19/99		115776	9,717	(194)	9,523
04/19/99		115810	9,536	(191)	9,345
04/19/99		115883	9,733	(195)	9,538
04/20/99		115925	9,565	(191)	9,374
04/20/99		115932	9,639	(193)	9,446
04/20/99		115935	9,495	(190)	9,305
04/20/99		115938	9,495	(190)	9,305
04/20/99		116100	9,429	(189)	9,240
04/21/99		116339	9,520	(190)	9,330
04/26/99		117812	9,585	(192)	9,393
04/26/99		117855	9,552	(191)	9,361
04/26/99		117866	9,433	(189)	9,244
04/27/99		117868	9,433	(189)	9,244
04/27/99		117967	9,552	(191)	9,361
			0		0
	NET IN / OUT		201,598	(4,032)	197,566
04/01/99	ENDING BALANCE IN		201,598	(4,032)	197,566
	ENDING BALANCE IN BARR		4,800	(96)	4,704

*** IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH @ 800-653-1550, EXT. 141.

D. Blair

May-99
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE		201,598	(4,032)	197,566
05/04/99		119446	9,281	(186)	9,095
05/04/99		119449	9,495	(190)	9,305
05/04/99		119483	9,474	(189)	9,285
05/05/99		119627	9,548	(191)	9,357
05/05/99		119632	9,561	(191)	9,370
05/11/99		120369	9,667	(193)	9,474
05/11/99		120407	9,503	(190)	9,313
05/11/99		120416	9,511	(190)	9,321
05/12/99		120522	9,561	(191)	9,370
05/12/99		120623	9,700	(194)	9,506
05/12/99		120698	9,491	(190)	9,301
05/13/99		120929	9,499	(190)	9,309
05/13/99		121096	9,392	(188)	9,204
05/18/99		121557	9,634	(193)	9,441
05/18/99		121657	9,437	(189)	9,248
05/18/99		121701	9,392	(188)	9,204
05/18/99		121740	9,437	(189)	9,248
05/19/99		121894	9,170	(183)	8,987
05/19/99		121968	9,101	(182)	8,919
05/19/99		122103	8,780	(176)	8,604
05/20/99		122318	8,912	(178)	8,734
05/26/99		123339	9,569	(191)	9,378
05/26/99		123346	9,618	(192)	9,426
05/26/99		123353	9,495	(190)	9,305
05/26/99		123423	9,446	(189)	9,257
05/26/99		123430	9,503	(190)	9,313
05/27/99		123444	9,655	(193)	9,462
05/27/99		123550	9,532	(191)	9,341
05/27/99		123656	9,507	(190)	9,317
This Month	NET IN / OUT		273,871	(5,477)	268,394
YTD	ENDING BALANCE IN		475,469	(9,509)	465,960
ENDING BALANCE IN BARRELS			11,321	(226)	11,094

* * * IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH @ 800-653-1550, EXT. 141.

June-99

LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE		475,469	(9,509)	465,960
06/01/99		124294	9,552	(191)	9,361
06/01/99		124367	9,380	(188)	9,192
06/01/99		124372	9,355	(187)	9,168
06/01/99		124438	9,351	(187)	9,164
06/02/99		124510	9,417	(188)	9,229
06/02/99		124618	9,437	(189)	9,248
06/02/99		124717	9,392	(188)	9,204
06/02/99		124850	9,437	(189)	9,248
06/08/99		125731	8,283	(166)	8,117
06/08/99		125770	8,283	(166)	8,117
06/08/99		125776	8,423	(168)	8,255
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
This Month	NET IN / OUT		100,310	(2,006)	98,304
YTD	ENDING BALANCE IN		575,779	(11,516)	564,263
ENDING BALANCE IN BARRELS			13,709	(274)	13,435

* * * IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH @ 800-653-1550, EXT. 141.

LOCO HILLS UNDERGROUND STORAGE #3 INVENTORY
Jul-99

Date	Beginning Balance	Receipt BOL #	Gallons	Shrink 2%	Net Gallons	Dispersements	Ending Balance
7/1/99	564,264	0	0	0	0	0	564,264

NO ACTIVITY

August-99
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE		575,779	(11,516)	564,263
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
This Month	NET IN / OUT		0	0	0
YTD	ENDING BALANCE IN		575,779	(11,516)	564,263
ENDING BALANCE IN BARRELS			13,709	(274)	13,435

IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH at 800/653-1550 Ext 141

September-99

LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE		575,779	(11,516)	564,263
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
This Month	NET IN / OUT		0	0	0
YTD	ENDING BALANCE IN		575,779	(11,516)	564,263
ENDING BALANCE IN BARRELS			13,709	(274)	13,435

IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH at 800/653-1550 Ext 141

October-99

LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE		575,779	(11,516)	564,263
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
This Month	NET IN / OUT		0	0	0
YTD	ENDING BALANCE IN		575,779	(11,516)	564,263
ENDING BALANCE IN BARRELS			13,709	(274)	13,435

IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH at 800/653-1550 Ext 141

November-99

LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE		575,779	(11,516)	564,263
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
		0	0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
This Month	NET IN / OUT		0	0	0
YTD	ENDING BALANCE IN		575,779	(11,516)	564,263
ENDING BALANCE IN BARRELS			13,709	(274)	13,435

IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH at 800/653-1550 Ext 141

December-99
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE		575,779	(11,516)	564,263
12/13/99		162611	0	0	(9,847)
12/13/99		162615	0	0	(9,818)
12/13/99		162620	0	0	(9,663)
12/13/99		162622	0	0	(9,778)
12/13/99		162623	0	0	(9,737)
12/13/99		162626	0	0	(9,614)
12/14/99		162699	0	0	(9,749)
12/14/99		162738	0	0	(9,692)
12/14/99		162868	0	0	(9,667)
12/18/99		163546	0	0	(9,992)
12/18/99		163547	0	0	(10,045)
12/18/99		163549	0	0	(9,910)
12/18/99		163554	0	0	(9,943)
12/18/99		163622	0	0	(9,828)
12/18/99		163655	0	0	(9,979)
12/21/99		163940	0	0	(10,074)
12/21/99		163944	0	0	(9,975)
12/21/99		163980	0	0	(10,082)
12/21/99		163983	0	0	(10,041)
12/22/99		164317	0	0	(9,934)
12/22/99		164382	0	0	(9,988)
12/29/99		165314	0	0	(9,955)
12/29/99		165349	0	0	(9,992)
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
This Month	NET IN / OUT		0	0	(227,303)
YTD	ENDING BALANCE IN		575,779	(11,516)	336,960
ENDING BALANCE IN BARRELS			13,709	(274)	8,023

IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH at 800/653-1550 Ext 141

January-00
LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE		336,960		336,960
01/04/00		165888	0	0	(9,926)
01/04/00		165956	0	0	(9,975)
01/05/00		166023	0	0	(10,119)
01/05/00		166065	0	0	(10,049)
01/05/00		166203	0	0	(9,914)
01/05/00		166273	0	0	(9,943)
01/10/00		167275	0	0	(9,963)
01/10/00		167277	0	0	(10,082)
01/10/00		167310	0	0	(8,234)
01/10/00		167396	0	0	(9,848)
01/11/00		167349	0	0	(10,041)
01/11/00		167352	0	0	(8,222)
01/11/00		167419	0	0	(8,965)
01/17/00		168608	0	0	(9,943)
01/17/00		168616	0	0	(9,573)
01/17/00		168623	0	0	(9,713)
01/18/00		168694	0	0	(6,189)
01/20/00		169190	0	0	(9,901)
01/20/00		169195	0	0	(9,754)
01/20/00		169196	0	0	(10,103)
01/21/00		169233	0	0	(9,963)
01/21/00		169235	0	0	(9,951)
01/21/00		169242	0	0	(9,922)
01/21/00		169345	0	0	(9,770)
01/21/00		169414	0	0	(9,910)
01/24/00		169731	0	0	(9,795)
01/26/00		170110	0	0	(9,848)
01/27/00		170246	0	0	(10,012)
01/27/00		170254	0	0	(9,914)
01/24/00		169800			($9,844.00)
This Month	NET IN / OUT		0	0	(289,386)
YTD	ENDING BALANCE IN		336,960	0	47,574
ENDING BALANCE IN BARRELS			8,023	0	1,133

IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH at 800/653-1550 Ext 141

February-00

LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE				47,574
02/05/00		171622	0	0	(9,897)
02/05/00		171623	0	0	(9,409)
02/05/00		171856	0	0	(9,918)
02/05/00		171889	0	0	(9,552)
02/05/00		171891	0	0	(9,889)
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
This Month	NET IN / OUT		0	0	(48,665)
YTD	ENDING BALANCE IN		0	0	(1,091)
ENDING BALANCE IN BARRELS			0	0	(26)

IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH at 800/653-1550 Ext 141

March-00

LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE				(1,091)
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
This Month	NET IN / OUT		0	0	0
YTD	ENDING BALANCE IN		0	0	(1,091)
ENDING BALANCE IN BARRELS			0	0	(26)

IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH at 800/653-1550 Ext 141

April-00

LOCO HILLS - NAVAJO-BUTANE

FAX TO DAVID BLAIR
505-746-6155 or 505-748-9077

DATE		B / L	GALLONS	SHRINK @ 2%	NET GALLONS
	BEGINNING BALANCE				0
04/19/00		182377	9,240	(185)	9,055
04/19/00		182384	8,891	(178)	8,713
04/19/00		182396	9,088	(182)	8,906
04/20/00		182704	9,268	(185)	9,083
04/20/00		182715	9,112	(182)	8,930
04/20/00		182784	9,138	(183)	8,955
04/20/00		182851	9,175	(184)	8,992
04/21/00		182954	9,084	(182)	8,902
04/21/00		182961	9,310	(186)	9,124
04/21/00		182966	9,253	(185)	9,068
04/26/00		183448	9,237	(185)	9,052
04/26/00		183457	9,240	(185)	9,055
04/26/00		183560	9,269	(185)	9,084
04/26/00		183630	9,236	(185)	9,051
04/26/00		183763	9,175	(184)	8,992
04/26/00		183767	9,187	(184)	9,003
04/27/00		183902	9,248	(185)	9,063
04/27/00		183908	9,253	(185)	9,068
04/27/00		183911	9,228	(185)	9,043
04/27/00		183916	9,216	(184)	9,032
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
This Month	NET IN / OUT		183,848	(3,677)	180,171
YTD	ENDING BALANCE IN		183,848	(3,677)	180,171
ENDING BALANCE IN BARRELS			4,377	(88)	4,290

IF THERE ARE ANY DIFFERENCES, PLEASE ADVISE JERRY SMITH at 800/653-1550 Ext 141

April-00
LOCO HILLS - BUTANE

DATE		B / L	GALLONS	SHRINK @ 2%	NET ALLONS
	BEGINNING BALANCE				0
04/01/00	Recovered Shrink		0	0	51,118
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
			0	0	0
This Month NET	IN / OUT		0	0	51,118
YTD	ENDING BALANCE		#VALUE!	0	51,118
ENDING BALANCE IN BARRELS			#VALUE!	0	1,217

NEW MEXICO ENERGY, MINERALS and
NATURAL RESOURCES DEPARTMENT

GARY E. JOHNSON
Governor
Jennifer A. Salisbury
Cabinet Secretary

Lori Wrotenbery
Director
Oil Conservation Division

June 6, 2000

Mr. Marty Woods-Vice President
Columbia Propane
10710 Midlothian Tpike
Suite 200
Richmond, VA 23235

CERTIFIED MAIL
RETURN RECIEPT REQ: 5051 5666

Re: Loco Hills Gas Storage Facility

Dear Mr. Woods:

The New Mexico Oil Conservation Division (NMOCD) is in receipt of Columbia Propane's letter dated May 30, 2000 requesting permission to resume operations on storage well #3. Your request is hereby approved subject to the following condition:

- Columbia Propane will perform a hydrostatic mechanical integrity test on the well#3 casing/tubing annulus which will be isolated from the salt cavern. The test will be performed at the end of this years gas storage season and be witnessed and approved by OCD.

Please be advised that NMOCD approval of this site does not relieve Columbia Propane of liability should their operations pose a threat to ground water, surface water, human health or the environment. In addition, NMOCD approval does not relieve Columbia Propane of responsibility for compliance with any other federal, state, or local laws and/or regulations.

If you have any questions, please contact Wayne Price of my staff at (505-827-7155). On behalf of the staff of the OCD, I wish to thank you and your staff for your cooperation during this review process.

Sincerely,

Roger C. Anderson
Environmental Bureau Chief
RCA/lwp

xc: OCD Artesia Office

Oil Conservation Division * 2040 South Pacheco Street * Santa Fe, New Mexico 87505
Phone: (505) 827-7131 * Fax (505) 827-8177 * http://www.emnrd.state.nm.us

The Santa Fe New Mexican

Since 1849 We Read You

MAR 15 2000

OIL CONSERVATION DIVISION

NM OIL CONSERVATION DIVISION
ATTN: DONNA DOMINGUEZ
2040 S. PACHECO ST.
SANTA FE, NM 87505

AD NUMBER: 136832 ACCOUNT: 56689
LEGAL NO: 67031 P.O.#: 00199000278
193 LINES 1 time(s) at $ 85.07
AFFIDAVITS: 5.25
TAX: 5.65
TOTAL: 95.97

NOTICE OF PUBLICATION

STATE OF NEW MEXICO ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT OIL CONSERVATION DIVISION

Notice is hereby given that pursuant to New Mexico Water Quality Control Commission Regulations, the following discharge plan application has been submitted to the Director of the Oil Conservation Division, 2040 South Pacheco, Santa Fe, New Mexico 87505, Telephone (505) 827-7131:

(GW-19) - Columbia Propane, William S. Stagg, P.O. Box 35800, Richmond, Virginia, 23235-08000, has submitted an application for renewal of its previously approved discharge plan for its Loco Hills brine discharge facility located in the NW/4 SE/4, Section 22, Township 17 South, Range 29 East, NMPM, Eddy County, New Mexico. Columbia Propane proposes continuation of brine discharges to an existing 2.44 million gallon plastic-lined storage pond. The brine discharge is the result of propane injection to three salt domes. The brine storage pond contains a secondary plastic liner and a leak detection system. The brine is reinjected to the salt domes when propane extraction is desired. Ground water most likely to be affected in the event of an accidental discharge is at a depth of approximately 75 feet with a total dissolved solids concentration ranging from 0 mg/l to 10,000 mg/l. The discharge plan addresses how spills, leaks, and other accidental discharges to the surface will be managed.

Any interested person may obtain further information from the Oil Conservation Division and may submit written comments to the Director of the Oil Conservation Division at the address given above. The discharge plan application may be viewed at the above address between 8:00 a.m. and 4:00 p.m., Monday through Friday. Prior to ruling on any proposed discharge plan or its modification, the Director of the Oil Conservation Division shall allow at least thirty (30) days after the date of publication of this notice during which comments may be submitted to him and a public hearing may be requested by any interested person. Requests for a public hearing shall set forth the reasons why a hearing should be held. A hearing will be held if the Director determines there is significant public interest.

If no public hearing is held, the Director will approve or disapprove the proposed plan based on information available. If a public hearing is held, the director will approve or disapprove the proposed plan based on information in the plan and information submitted at the hearing.

GIVEN under the Seal of New Mexico Oil Conservation Commission at Santa Fe, New Mexico, on this Third (3rd) day of March, 2000.

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION
LORI WROTENBERY,
Director

Legal #67031
Pub. March 10, 2000

AFFIDAVIT OF PUBLICATION

STATE OF NEW MEXICO
COUNTY OF SANTA FE
I, B Perner being first duly sworn declare and say that I am Legal Advertising Representative of THE SANTA FE NEW MEXICAN, a daily newspaper published in the English language, and having a general circulation in the Counties of Santa Fe and Los Alamos, State of New Mexico and being a Newspaper duly qualified to publish legal notices and advertisements under the provisions of Chapter 167 on Session Laws of 1937; that the publication #67031 a copy of which is hereto attached was published in said newspaper 1 day(s) between 03/10/2000 and 03/10/2000 and that the notice was published in the newspaper proper and not in any supplement; the first publication being on the 10 day of March, 2000 and that the undersigned has personal knowledge of the matter and things set forth in this affidavit.

/S/ Betsy Perner
LEGAL ADVERTISEMENT REPRESENTATIVE

Subscribed and sworn to before me on this 9 day of March A.D., 2000

Notary Candace R. Dunton

Commission Expires 11/16/2003

OK Wayne Price
3/28/00

Affidavit of Publication

NO. 16883

STATE OF NEW MEXICO

County of Eddy:

Gary D. Scott being duly sworn, says: That he is the **Publisher** of The Artesia Daily Press, a daily newspaper of general circulation, published in English at Artesia, said county and county and state, and that the here to attached

Legal Notice

was published in a regular and entire issue of the said Artesia Daily Press, a daily newspaper duly qualified for that purpose within the meaning of Chapter 167 of the 1937 Session Laws of the state of New Mexico for 1 consecutive weeks/days on the same day as follows:

First Publication	March 14 2000
Second Publication	
Third Publication	
Fourth Publication	

Gary D Scott

Subscribed and sworn to before me this

17 day of March 2000

Barbara Ann Beans

Notary Public, Eddy County, New Mexico

My Commission expires September 23, 2003

Copy of Publication:

LEGAL NOTIC

NOTICE OF PUBLICATI
STATE OF NEW MEXIC
ENERGY, MINERALS AN
NATURAL RESOURCE
DEPARTMENT
OIL CONSERVATION DI
SION

Notice is hereby given that suant to New Mexico Quality Control Commi Regulations, the following charge plan application has submitted to the Director Oil Conservation Division, South Pacheco, Santa Fe, Mexico 87505, Telephone 827-7131.

(GW-19) - Columbia Pr William S. Stagg, P.O. 35800, Richmond, Vi 23235-08000, has submit application for renewal previously approved dis plan for its Loco Hills bri

Eireen Carson and Eileen Richardson, both of Artesia; grandchildren Richard Harden, Kiana Harden and Bret Harden, all of Artesia; and several nieces and nephews.

He was preceded in death by his mother, Betty Sue Harper in 1964 and stepmother Ruthe Marshall

Divorced pare

Dear Ann Landers: My brother went through a nasty divorce with a woman who has nothing in her heart but revenge. While they were in the midst of getting a divorce, she attacked him with a screwdriver as he was trying to call the police. She grabbed the phone, and beat him with it. He had her arrested for assault, and the whole thing turned very ugly.

cc: Mary

OIL CONSERVATION DIVISION
2040 South Pacheco Street
Santa Fe, New Mexico 87505
(505) 827-7131

April 25, 2000

CERTIFIED MAIL
RETURN RECEIPT NO. 5051 4706

William S. Stagg
Columbia Propane
9200 Arboretun Parkway Suite 140
Richmond, Virginia 23236

Re: Columbia Propane Loco Hills Gas Storage Facility
Discharge Plan GW-019 Mechanical Integrity Test of Wells.

Dear Mr. Stagg:

The New Mexico Oil Conservation Division (NMOCD) received the pressure test charts for the three wells for the above captioned facility. In order for OCD Environmental Bureau to approve the results of the Mechanical Integrity Test, Columbia Propane shall supply the following additional information:

1. Please provide a copy of the calibration records for the chart recorders used.

2. The chart for well #1 did not have the discharge plan number, date of test, type of test, recorder chart speed and pressure calibration range. Please provide.

3. The chart for well #2 did not have the type of test, recorder chart speed, pressure calibration range, normal operating pressure, and the pressure appeared to be only 46 psig. Please provide the information requested and an explanation of why the well was only pressured to 46 psig.

4. The chart for well #3 indicates the well failed the pressure test. Please schedule with OCD to re-test. Columbia will not operate the well #3 system until OCD issues approval.

If you require any further information or assistance please do not hesitate to write or call me at (505-827-7155).

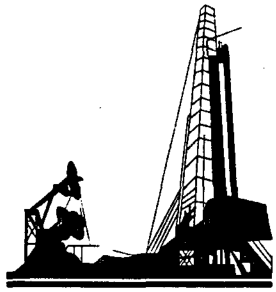
Sincerely Yours,

Wayne Price

Wayne Price-Pet. Engr. Spec.
Environmental Bureau

cc: OCD Artesia Office.
attachments-copy of pressure charts

OIL CONSERVATION DIVISION



2040 South Pacheco
Santa Fe, NM 87505
(505) 827-7133
Fax: (505) 827-8177

(PLEASE DELIVER THIS FAX)

To: BILL STAGG - Columbia

From: OCD

Date: 4/25/00 ≈ 11:45 AM

Number of Pages (Includes Cover Sheet) 3

Message:

If you have any trouble receiving this, please call:
(505) 827-7133

OIL CONSERVATION DIVISION

2040 South Pacheco
Santa Fe, NM 87505
(505) 827-7133
Fax: (505) 827-8177

(PLEASE DELIVER THIS FAX)

TEL: 804-594-1364

To: MR. BILL STAGG - COLUMBIA FAX ~~804-269-1736~~

From: OCD

Date: 4/25/00 9:08 AM

Number of Pages (Includes Cover Sheet) 2

Message:

FAX 505-677-2331

If you have any trouble receiving this, please call:
(505) 827-7133

OIL CONSERVATION DIVISION

2040 South Pacheco
Santa Fe, NM 87505
(505) 827-7133
Fax: (505) 827-8177

(PLEASE DELIVER THIS FAX)

505-677-2331

To: BUSTER McDANIEL - COLUMBIA

From: OCD

Date: 4/25/00

Number of Pages (Includes Cover Sheet) 2

Message:

If you have any trouble receiving this, please call:
(505) 827-7133

NEW MEXICO ENERGY, MINERALS
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION
2040 South Pacheco Street
Santa Fe, New Mexico 87505
(505) 827-7131

~~Price, Wayne~~

From: Price, Wayne
Sent: Tuesday, April 25, 2000 8:57 AM
To: 'wstagg@ceg.com'
Cc: Anderson, Roger; Gum, Tim; Stubblefield, Mike
Subject: Columbia well #3 test

Dear Bill:

The OCD Environmental Bureau received a copy of the MIT for well number #3. The chart shows a starting pressure of 360 psig and a ending pressure of 340 psig or a net of 20 psig loss. The Environmental Staff has reviewed this procedure and considers this well to have failed the Mechanical Integrity Test.

Please determine where the well failed. This system cannot be used until Columbia demonstrates to the OCD the integrity of the well is sound.

~~FAX: 804-267-1736~~

FAX: 505-677-2331

BUSTER McDANIEL – 4/25/00 9:10 AM
CALLED, BUSTER INDICATED THEY HAVE NOT STARTED USING WELL #3. INFORMED HIM TO RE-TEST, BEFORE USING WELL #3.

4/25/00: 9:20 AM CALLED BILL STAGG – COLUMBIA
804-594-1364 LEFT MESSAGE TO SHUT DOWN OR DO NOT START-UP WELL #3 SYSTEM.

4/25/00 9:48 AM CALL BILL STAGG – LEFT MESSAGE!

OIL CONSERVATION DIVISION
2040 South Pacheco Street
Santa Fe, New Mexico 87505
(505) 827-7131

Price, Wayne

From: Price, Wayne
Sent: Tuesday, April 25, 2000 8:57 AM
To: 'wstagg@ceg.com'
Cc: Anderson, Roger; Gum, Tim; Stubblefield, Mike
Subject: Columbia well #3 test

Dear Bill:

The OCD Environmental Bureau received a copy of the MIT for well number #3. The chart shows a starting pressure of 360 psig and a ending pressure of 340 psig or a net of 20 psig loss. The Environmental Staff has reviewed this procedure and considers this well to have failed the Mechanical Integrity Test.

Please determine where the well failed. This system cannot be used until Columbia demonstrates to the OCD the integrity of the well is sound.

OIL CONSERVATION DIVISION
2040 South Pacheco Street
Santa Fe, New Mexico 87505
(505) 827-7131

April 25, 2000

CERTIFIED MAIL
RETURN RECEIPT NO. 5051 4706

William S. Stagg
Columbia Propane
9200 Arboretun Parkway Suite 140
Richmond, Virginia 23236

Re: Columbia Propane Loco Hills Gas Storage Facility
Discharge Plan GW-019 Mechanical Integrity Test of Wells.

Dear Mr. Stagg:

The New Mexico Oil Conservation Division (NMOCD) received the pressure test charts for the three wells for the above captioned facility. In order for OCD Environmental Bureau to approve the results of the Mechanical Integrity Test, Columbia Propane shall supply the following additional information:

1. Please provide a copy of the calibration records for the chart recorders used.

2. The chart for well #1 did not have the discharge plan number, date of test, type of test, recorder chart speed and pressure calibration range. Please provide.

3. The chart for well #2 did not have the type of test, recorder chart speed, pressure calibration range, normal operating pressure, and the pressure appeared to be only 46 psig. Please provide the information requested and an explanation of why the well was only pressured to 46 psig.

4. The chart for well #3 indicates the well failed the pressure test. Please schedule with OCD to re-test. Columbia will not operate the well #3 system until OCD issues approval.

If you require any further information or assistance please do not hesitate to write or call me at (505-827-7155).

Sincerely Yours,

Wayne Price

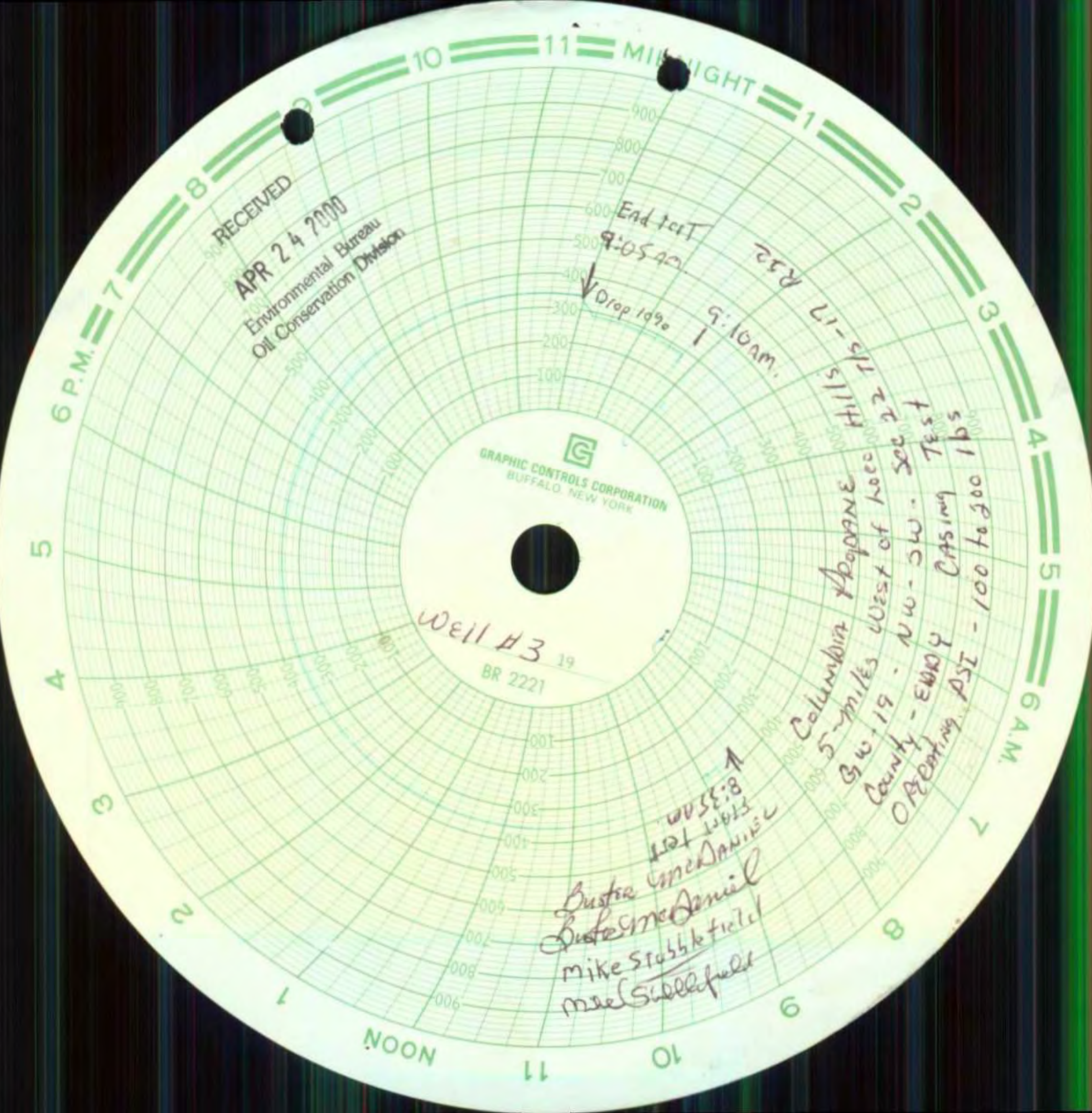
Wayne Price-Pet. Engr. Spec.
Environmental Bureau

cc: OCD Artesia Office.
attachments-copy of pressure charts


NOON
6 PM
MIDNIGHT
6 AM
Start time 1:00 pm
— Stop time 5:00 pm.
CHART NO. MC MP-500
GRAPHIC CONTROLS CORPORATION
CHART PUT ON 1:00 P M
TAKEN OFF 5:00 P M
LOCATION Loco Hills N.M.
REMARKS AmeriGas L.P.
METER Hole #1
RECEIVED
APR 0 1 2002
Environmental Bureau
Oil Conservation Division
James McDaniel
Mike Stubblefield
3/26/02
AmeriGas L.P.
Loco Hills, N.M.
NW - SW - Sec - 22 - T/S - 19S - R - 29E
Eddy County
GW-19.
Well #1
Operating Pressure 120 P.S.I
Open Hole Test.


RECEIVED
APR 24 2000
Environmental Bureau
Oil Conservation Division
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
BR 2221
MIDNIGHT
NOON
6 P.M.
6 A.M.
Well #1
Start test.
5:31 pm.
6:05PM. End test.
↓ 30% drop in PSI
6:10 pm.
Eddy
-17 -R-29
Columbia Propane
GW-19 - NW - SW - SEC - 22 - T-17s-17
5-miles west / Loco Hills
Normal operating PRES. 100 to 200 lbs
Dustin McDaniel
Mike Stubblefield


RECEIVED
APR 24 2001
Environmental Bureau
Oil Conservation Division
TEJAS Instruments, Inc.
BR-4638
B0-100-8
SIGNED WELL #2
PRINTED IN U.S.A.
DAY
NIGHT
Start Test
1325PM
2:25PM 20
End Test
2:40PM
4/18/00
NW-SW-SEC 32
T/S-19 - R29
County Eddy
Columbia Propane
CW-19
Buster McDaniel
NMOCD, Mike Stubblefield


RECEIVED
APR 2 4 2000
Environmental Bureau
Oil Conservation Division
End test
9:05 AM
Drop 10%
9:10am.
T17 R32
Columbia Apache Hills
5-miles West of Loco Hills
GW. 19 - NW - SW - Sec 22
County - Eddy Casing Test
Operating PSI - 100 to 200 lbs
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
Well #3 19
BR 2221
Start test
8:35AM
McDaniel
Buster McDaniel
Buster McDaniel
Mike Stubblefield
Mike Stubblefield
MIDNIGHT
6 A.M.
NOON
6 P.M.

NEW MEXICO ENERGY, MINERALS
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION
2040 South Pacheco Street
Santa Fe, New Mexico 87505
(505) 827-7131

March 23, 2000

CERTIFIED MAIL
RETURN RECEIPT NO. 50514652

Mr. William S. Stagg
Columbia Propane
P.O. Box 35800
Richmond, Virginia 23235-08000

Re: Discharge Plan GW-19
Mechanical Integrity Testing of Brine Supply Wells

Dear : Mr. Stagg:

The Underground Injection Control Program of the Federal Safe Drinking Water Act requires that operators demonstrate mechanical integrity of all injection wells by ensuring there are no leaks in the tubing, casing, or packer, and injected/produced fluids are confined within the piping and injection zones.

The Oil Conservation Division (OCD) requires operators of brine supply wells to perform the following mechanical integrity test:

1. At least once every five years isolate the cavern formation from the casing/tubing annuals and hydrostatic fluid pressure test the casing at 300 psig for 30 minutes. New brine wells and wells being worked over will have to be tested in this manner before operations begin.

2. Annually perform an open hole cavern formation pressure test by pressuring up the formation one and one-half times the normal operating pressure (not to exceed formation fracture pressure) or 300 psig whichever is greater for four hours. Brine supply wells operating with packers will have to pressure both the cavern formation and casing/tubing annuals.

OCD has reviewed the Columbia discharge plan file and it appears the last mechanical integrity test was performed in 1995. Therefore, Columbia will be required to test the three on-site wells as described in item #1. above. Please find enclosed an OCD Test Procedure for your future reference. All test must be witnessed by the New Mexico Oil Conservation Division. Please notify this office and the local OCD District office 72 hours in advance so the OCD may witness the testing during OCD's normal business hours. Operators will be responsible for providing equipment and shall bear all costs incurred.

If you require any further information or assistance please do not hesitate to write or call me at (505-827-7155).

Sincerely Yours,

Wayne Price

Wayne Price-Pet. Engr. Spec.
Environmental Bureau

cc: OCD District Offices
attachments- Brine Well Testing Procedure Guidance Document

<u>Brine Well Testing Procedure Guidance Document</u>

1) The cavern and all piping must be filled, pressured up and stabilized for a period of at least 24 hours prior to testing. If this test requires a packer then casing/tubing annulus must be loaded with inert fluid 24 hours prior to testing.

2) Have manpower and equipment available for pressure test. Well head shall be prepared for test and all valves and gauges should be in good working order.

3) Pressure devices i.e pumps, truck pumps, etc. must be isolated from the well head before and during test.

4) A continuous recording pressure chart with an 8 hour clock shall be installed on the casing/tubing annulus. The pressure range shall not be greater than 1,000 psig. The operator must provide proof that the recording device has been calibrated within the past 6 months. **Note: Wells with packer installed: If this test requires both the casing/tubing annulus and cavern to be tested then two recording devices must be supplied or one recording device with two pins.**

5) A minimum of one pressure gage shall be installed in the system.

6) OCD must witness the beginning of test (putting chart on) and ending of test (removing chart). At the end of test operator shall bleed-off pressure by 10% to demonstrate recorder response.

7) The following information shall be place on the chart:

    1. Date, time test started, time stop.
    2. Company name, Discharge Plan #, well name and number, legal location UL, section, township, range and county.
    3. Type of Test; Open hole, Casing Test, or Both.
    4. Printed name and signature of company representative and OCD representative.
    5. Chart and Recorder information.
    6. Normal operating pressure.

Note: **NMOCD recognizes that different operations, well constructions and field conditions may cause variations in the above procedures. If operator wishes to make or anticipate changes please notify the OCD for approval.**

NOTICE OF PUBLICATION

STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION

Notice is hereby given that pursuant to New Mexico Water Quality Control Commission Regulations, the following discharge plan application has been submitted to the Director of the Oil Conservation Division, 2040 South Pacheco, Santa Fe, New Mexico 87505, Telephone (505) 827-7131:

(GW-19) - Columbia Propane , William S. Stagg, P.O. Box 35800, Richmond, Virginia, 23235-08000, has submitted an application for renewal of its previously approved discharge plan for its Loco Hills brine discharge facility located in the NW/4 SE/4, Section 22, Township 17 South, Range 29 East, NMPM, Eddy County, New Mexico. Columbia Propane proposes continuation of brine discharges to an existing 2.44 million gallon plastic-lined storage pond. The brine discharge is the result of propane injection to three salt domes. The brine storage pond contains a secondary plastic liner and a leak detection system. The brine is reinjected to the salt domes when propane extraction is desired. Ground water most likely to be affected in the event of an accidental discharge is at a depth of approximately 75 feet with a total dissolved solids concentration ranging from 0 mg/l to 10,000 mg/l. The discharge plan addresses how spills, leaks, and other accidental discharges to the surface will be managed.

Any interested person may obtain further information from the Oil Conservation Division and may submit written comments to the Director of the Oil Conservation Division at the address given above. The discharge plan application may be viewed at the above address between 8:00 a.m. and 4:00 p.m., Monday through Friday. Prior to ruling on any proposed discharge plan or its modification, the Director of the Oil Conservation Division shall allow at least thirty (30) days after the date of publication of this notice during which comments may be submitted to him and a public hearing may be requested by any interested person. Requests for a public hearing shall set forth the reasons why a hearing should be held. A hearing will be held if the Director determines there is significant public interest.

If no public hearing is held, the Director will approve or disapprove the proposed plan based on information available. If a public hearing is held, the director will approve or disapprove the proposed plan based on information in the plan and information submitted at the hearing.

GIVEN under the Seal of New Mexico Oil Conservation Commission at Santa Fe, New Mexico, on this Third (3rd) day of March, 2000.

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

Will Olson

for LORI WROTENBERY, Director

SEAL

Columbia Propane℠

PO Box 35800
Richmond, VA 23235-0800

Shipping:
9200 Arboretum Parkway
Suite 140
Richmond, VA 23236-3489

804 330 4266
http://www.columbiapropane.com

RECEIVED
FEB 28 2000
OIL CONSERVATION DIVISION

February 17, 2000

Re: GW-19 Discharge Plan

Mr. Wayne Price
State of New Mexico
Energy, Minerals and Natural Resources Department
Oil Conservation Division
2040 South Pacheco
Santa Fe, NM 87505

Dear Mr. Price,

Enclosed is the application for the renewal of Discharge Plan GW-19 for our Loco Hills facility. There have been no changes since the last discharge plan approval except for the change of ownership. All of the required information should already be in your files. However, if you should require any additional information please do not hesitate to contact me at (804) 327-1364. Thank you for all of your help during this renewal process.

Sincerely,

William S. Stagg

District I
1625 N. French Dr., Hobbs, NM 88240
District II
811 South First, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
2040 South Pacheco, Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
2040 South Pacheco
Santa Fe, NM 87505

Revised March 17, 1999

Submit Original
Plus 1 Copy
to Santa Fe
1 Copy to Appropriate
District Office

DISCHARGE PLAN APPLICATION FOR SERVICE COMPANIES,GAS PLANTS. REFINERIES, COMPRESSOR, AND CRUDE OIL PUMP STATIONS

(Refer to the OCD Guidelines for assistance in completing the application)

☐ New ☑ Renewal ☐ Modification

1. Type: LOCO HILLS BRINE DISCHARGE FACILITY

2. Operator: COLUMBIA PROPANE CORPORATION

   Address: PO BOX 35800; RICHMOND, VA 23235

   Contact Person: BILL STAGG Phone: (804) 327-1364

3. Location: NW /4 SE /4 Section 22 Township 17 SOUTH Range 29 EAST
   Submit large scale topographic map showing exact location.

4. Attach the name, telephone number and address of the landowner of the facility site. SAME AS #2

5. Attach the description of the facility with a diagram indicating location of fences, pits, dikes and tanks on the facility.

6. Attach a description of all materials stored or used at the facility.

7. Attach a description of present sources of effluent and waste solids. Average quality and daily volume of waste water must be included.

8. Attach a description of current liquid and solid waste collection/treatment/disposal procedures.

9. Attach a description of proposed modifications to existing collection/treatment/disposal systems.

10. Attach a routine inspection and maintenance plan to ensure permit compliance.

11. Attach a contingency plan for reporting and clean-up of spills or releases.

12. Attach geological/hydrological information for the facility. Depth to and quality of ground water must be included.

13. Attach a facility closure plan, and other information as is necessary to demonstrate compliance with any other OCD rules, regulations and/or orders.

14. CERTIFICATIONI hereby certify that the information submitted with this application is true and correct to the best of my knowledge and belief.

Name: BILL STAGG Title: OPERATIONS ENGINEER

Signature: William S. Stagg Date: 17 FEB 00

VENDOR NO. 054349 CHECK DATE:2/18/00 NO. [redacted]

VOUCHER NO.	INVOICE NO.	INV. DATE	DESCRIPTION	INVOICE AMOUNT	NET PAY
00000000000010314	STMT2/17/00	2/17/00	RENEWAL FEE FOR L	$50.00	$50.00
			TOTALS:	$50.00	$50.00

ACKNOWLEDGEMENT OF RECEIPT OF CHECK/CASH

I hereby acknowledge receipt of check No. [redacted] dated 2/18/00,

or cash received on ______________ in the amount of $ 50.00

from Columbia Propane LP

for Loco Hills Facility GW-19

(Facility Name) (DP No.)

Submitted by: Wayne Price Date: 2/28/00

Submitted to ASD by: [signature] Date: 2/28/00

Received in ASD by: ______________ Date: ______

Filing Fee ✓ New Facility ____ Renewal ____

Modification ____ Other ______________ (specify)

Organization Code 521.07 Applicable FY 2000

To be deposited in the Water Quality Management Fund.

Full Payment ____ or Annual Increment ____

THIS CHECK IS VOID WITHOUT A BLUE BACKGROUND AND AN ARTIFICIAL WATERMARK ON THE BACK - HOLD AT ANGLE TO VIEW

Columbia Propane LP
9200 Arboretum Pkwy, Suite 140
P. O. Box 35800
Richmond, VA 23235

PNC Bank, National Association
Jeannette, PA

60-162/433 NO. [redacted]

VENDOR NO. 054349

DATE	AMOUNT
2/18/00	$**********50.00

PAY Fifty And No/100 Dollars

TO THE ORDER OF NMED - WATER QUALITY MNGMT.

[signature]
AUTHORIZED SIGNATURE(S)

GW-19

SIGNATURE HAS A COLORED BACKGROUND • BORDER CONTAINS MICROPRINTING

[redacted]

NEW MEXICO ENERGY, MINERALS
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION
2040 South Pacheco Street
Santa Fe, New Mexico 87505
(505) 827-7131

February 3, 2000

Martha B. Card
Columbia Propane Corporation
P.O. Box 35800
Richmond, VA 23235-800

Re: GW-19 Propane Underground Storage System

Dear Ms. Card:

On January 24, 2000 the New Mexico Oil Conservation Division (NMOCD) conducted a discharge plan site inspection for the above captioned facility. Please note this discharge plan is due to expire on February 27, 2000.

If you require any further information or assistance please do not hesitate to write or call me at (505-827-7155).

Sincerely Yours,

Wayne Price

Wayne Price-Pet. Engr. Spec.
Environmental Bureau

cc: OCD Artesia office

attachments-1

OCD ENVIRONMENTAL BUREAU

SITE INSPECTION SHEET

DATE: 1/24/2000 Time: 3:30 PM

Type of Facility: Refinery ☐ Gas Plant ☐ Compressor St. ☐ Brine St. ☐ OilField Service Co. ☐
Surface Waste Mgt. Facility ☐ E&P Site ☐ Crude Oil Pump Station ☐
Other ☑ GAS STORAGE (SALT CAVERNS)

Discharge Plan: No ☐ Yes ☑ DP# GW-19

FACILITY NAME: LOCO HILLS UNDERGROUND STORAGE

PHYSICAL LOCATION: ≈ 3-5 mi WEST LOCO HILLS NM

Legal: QRT NW QRT SW Sec 22 TS 17S R 29E County LEA

OWNER/OPERATOR (NAME) COLUMBIA PROPANE CORPORATION

Contact Person: MARTHA B. CARD Tele:# 804-327-1384

MAILING ADDRESS: P.O BOX 35800 9200 ARBORETUM PARKWAY SUITE 140 ~~RICHARD~~ RICHMOND State VA ZIP 23235-0800

Owner/Operator Rep's: ON-SITE BUSTER McDANIEL

OCD INSPECTORS: PRICE, FORD, ANDERSON + STUBBLEFIELD

1. **Drum Storage:** All drums containing materials other than fresh water must be stored on an impermeable pad with curbing. All empty drums will be stored on their sides with the bungs in and lined up on a horizontal plane. Chemicals in other containers such as sacks or buckets will also be stored on an impermeable pad and curb type containment.

SOLVENT DRUM NEEDS CONTAINMENT - MSDS ATTACHED

2. **Process Areas:** All process and maintenance areas which show evidence that leaks and spills are reaching the ground surface must be either paved and curbed or have some type of spill collection device incorporated into the design.

BRINE TRANSFER PUMP LEAKING - NEEDS CONTAINMENT

3. **Above Ground Tanks:** All above ground tanks which contain fluids other than fresh water must be bermed to contain a volume of one-third more than the total volume of the largest tank or of all interconnected tanks. All new tanks or existing tanks that undergo a major modification, as determined by the Division, must be placed within an impermeable bermed enclosure.

NA

4. **Above Ground Saddle Tanks:** Above ground saddle tanks must have impermeable pad and curb type containment unless they contain fresh water or fluids that are gases at atmospheric temperature and pressure.

NA - NGL's

5. **Labeling:** All tanks, drums and containers will be clearly labeled to identify their contents and other emergency notification information.

DRUMS NEED LABELS, WELLS NEED SIGNS, NO SIGN VISABLE FROM OR AT ENTERANCE GATE.

6. **Below Grade Tanks/Sumps:** All below grade tanks, sumps, and pits must be approved by the OCD prior to installation or upon modification and must incorporate secondary containment and leak-detection into the design. All pre-existing sumps and below-grade tanks must demonstrate integrity on an annual basis. Integrity tests include pressure testing to 3 pounds per square inch above normal operating pressure and/or visual inspection of cleaned out tanks and/or sumps, or other OCD approved methods. The OCD will be notified at least 72 hours prior to all testing.

2 BRINE POND LEAK DETECTION HAS WATER IN IT!

7. **Underground Process/Wastewater Lines:** All underground process/wastewater pipelines must be tested to demonstrate their mechanical integrity at present and then every 5 years thereafter, or prior to discharge plan renewal. The permittee may propose various methods for testing such as pressure testing to 3 pounds per square inch above normal operating pressure or other means acceptable to the OCD. The OCD will be notified at least 72 hours prior to all testing.

ALL LINES NEED TESTING

8. **Onsite/Offsite Waste Disposal and Storage Practices:** Are all wastes properly characterized and disposed of correctly? Does the facility have an EPA hazardous waste number? _______ Yes _________ No

ARE ALL WASTE CHARACTERIZED AND DISPOSED OF PROPERLY? YES ☐ NO ☒ IF NO DETAIL BELOW.

SOLVENT WASTE + SALT PILE

9. <u>Class V Wells:</u> Leach fields and other wastewater disposal systems at OCD regulated facilities which inject non-hazardous fluid into or above an underground source of drinking water are considered Class V injection wells under the EPA UIC program. All Class V wells that inject non-hazardous industrial wastes or a mixture of industrial wastes and domestic wastes will be closed unless it can be demonstrated that groundwater will not be impacted in the reasonably foreseeable future. Closure of Class V wells must be in accordance with a plan approved by the Division's Santa Fe Office. The OCD allows industry to submit closure plans which are protective of human health, the environment and groundwater as defined by the WQCC, and are cost effective. Class V wells that inject domestic waste only must be permitted by the New Mexico Environment Department.

ANY CLASS V WELLS NO ☐ YES ☐ IF YES DESCRIBE BELOW ! Undetermined ☑

SEPTIC LEECH FIELD FROM MAINTENANCE BLDG.

10. <u>Housekeeping:</u> All systems designed for spill collection/prevention will be inspected weekly and after each storm event to ensure proper operation and to prevent overtopping or system failure. A record of inspections will be retained on site for a period of five years.

FAIR

11. <u>Spill Reporting:</u> All spills/releases will be reported pursuant to OCD Rule 116 and WQCC 1203 to the proper OCD District Office.

2 ACTIVE DISCHARGES - PIPE NEAR #(1) PRODUCTION WELL, VALVE LEAKING ON #3 PRODUCTION WELL

12. <u>Does the facility have any other potential environmental concerns/issues?</u>

- #1 PRODUCTION WELL & CAVERN HAS LOST INTEGRITY
- #2 & 3 PRODUCTION WELLS NEED CASING MIT'S.
- LARGE SALT PILE LEECHING SALT ONTO THE GROUND.

13. <u>Does the facility have any other environmental permits - i.e. SPCC, Stormwater Plan, etc.?</u>

14. ANY WATER WELLS ON SITE ? NO ☐ YES ☑ IF YES, HOW IS IT BEING USED ?

THREE MAKE-UP WELLS

Miscellaneous Comments:

ABANDON WELL BORE FOUND ON SITE.
ALL THREE CAVERNS NEED CAVITY SURVEY, MIT'S & SUBSIDENCE STUDY.
ABANDON OLD UNLINED PIT REQUIRES CLOSURE.

Number of Photos taken at this site: 12
attachments- MSDS - & PHOTO'S

CUSTOMER: V0247461 ORDER # : 01600
BATCH #: 982180163 STICKER #: 982181535
ZONE # : N
BARCODE NUMBER: 900016613 0001
PRODUCT NAME : SAF-SOL 20/20

MATERIAL SAFETY DATA SHEET: SAF-SOL 20/20 PAGE : 1

(000000-000000- -0657) | DATE OF ISSUE 04/03/98 | SUPERSEDES 09/04/97 |

SECTION I - GENERAL INFORMATION

CHEMICAL NAME & SYNONYMS N/A	TRADE NAME & SYNONYMS SAF-SOL 20/20
CHEMICAL FAMILY : CHLORINATED HYDROCARBON BLEND	FORMULA X <--MIXTURE

MANUFACTURE'S NAME:
CERTIFIED LABS, DIV. OF NCH CORP.

ADDRESS (NUMBER, STREET, CITY, STATE & ZIP CODE)
BOX 152170
IRVING, TEXAS
75015

PREPARED BY:	PRODUCT CODE NUMBER	EMERGENCY TELEPHONE NUMBER
B MALKEY/CHEMIST	0657	972-438-1381

SECTION II - HAZARDOUS INGREDIENTS

THE HAZARDS PRESENTED BELOW ARE THOSE OF THE INDIVIDUAL COMPONENTS

CHEMICAL NAME (INGREDIENTS) :

METHYLENE CHLORIDE HAZARD----->CARC. 4 STEL(TWA)*->N/E	TLV--->50 PPM 1. CAS#-->75-09-2	PEL--->25 PPM 2.
PERCHLOROETHYLENE HAZARD----->CARC. 4 STEL(TWA)*->N/E	TLV--->50 PPM 1. CAS#-->127-18-4	PEL--->25 PPM 2.
MEDIUM ALIPHATIC SOLVENT NAPHTHA HAZARD----->IRRITANT STEL(TWA)*->N/E	TLV--->5MG/M3 $1. CAS#-->64742-88-7	PEL--->5MG/M3 $2.
$ DENOTES OIL MIST VALUE HAZARD----> STEL(TWA)*->	TLV---> CAS#-->	PEL--->

SECTION III - PHYSICAL DATA

BOILING PT. (F)	154	SPEC. GRAVITY (H2O=1)	1.053
VAPOR PR. (MM HG)	116	COLOR	COLORLESS-LT YELLOW
VAPOR DENSITY	3.1	ODOR	ETHER-LIKE
PH. @ 100%	N/A	CLARITY	TRANSPARENT
% VOLATILE BY VOL	100	EVAPORATION RATE * (BU A/C = 1)	14
H2O SOLUBILITY	NEGLIGIBLE		
VISCOSITY	NON-VISCOUS		

SECTION IV - FIRE AND EXPLOSION HAZARD

FLASH POINT: >200 F SETAFLASH	FLAMMABLE LIMITS SOLVENT NAPHTHA	0.7% LEL	6% UEL

EXTINGUISHING MEDIA "ALCOHOL"
X <--FOAM <--FOAM X <--CO2 X <--DRY CHEMICAL X <--WATER SPRAY <--OTHER

SPECIAL FIRE FIGHTING PROCEDURES
FIREFIGHTERS SHOULD WEAR A SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE GEAR. COOL FIRE-EXPOSED CONTAINERS WITH WATER SPRAY TO PREVENT BURSTING.

UNUSUAL FIRE AND EXPLOSION HAZARDS
PHOSGENE GAS AND OTHER TOXIC COMPOUNDS CAN BE GENERATED VIA THERMAL DEGRADATION. CONCENTRATED VAPORS CAN IGNITE BY INTENSE IGNITION SOURCE.

NFPA HAZARD RATING (0=INSIGNIFICANT:1=SLIGHT:2=MODERATE:3=HIGH:4=EXTREME):
2 <--HEALTH 1 <--FLAMMABILITY 0 <--REACTIVITY <--SPECIAL

SECTION V - HEALTH HAZARD DATA

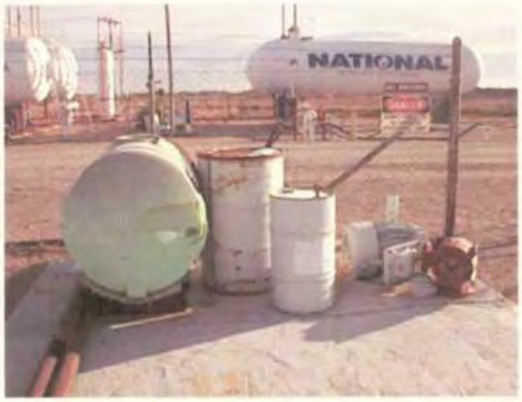
THRESHOLD LIMIT VALUE:

NOT ESTABLISHED FOR PRODUCT MIXTURE. SEE SECTION II.

Pictures Taken by Wayne Price 1/24/2000
Columbia Cavern propane & Butane storage system. 3-5 miles west of Loco Hills, NM
Discharge Plan BW-19

#1 Columbia Gas Cavern Storage System 1/24/00 (Old National)

#4 Brine Storage Pond-looking SE



#2 Solvent drum & Mercaptan

#5 Productin well #1 out of service. Leaking pipe in background.

#3 Brine transfer pump

#6 Production #1 –Pond Leak detection in background.

#7 Old abanodon well- Background shows water supply well and brine pond- looking east.

#8 Salt waste pile located on west side of property.

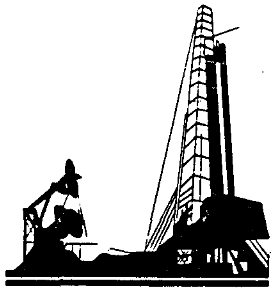
#9 salt leeching from waste pile.

#10. Old un-lined brine pit area located between salt pile and brine pond.

#11 Prodstion well #3 located on the west side of property.

#12 Office & Shop building 50 feet from building looking south.

OIL CONSERVATION DIVISION



2040 South Pacheco
Santa Fe, NM 87505
(505) 827-7133
Fax: (505) 827-8177

(PLEASE DELIVER THIS FAX)

To: MARTHA CARD FAX 804-327-1380

From: OCD

Date: 1/18/2000

Number of Pages (Includes Cover Sheet) 9

Message:

**If you have any trouble receiving this, please call:
(505) 827-7133**

Price, Wayne

From: Price, Wayne
Sent: Friday, January 07, 2000 12:26 PM
To: 'CPC908@aol.com'
Subject: RE: Information requested from Columbia Propane

attached is a copy of the Discharge Plan permit with conditions!

Natgw19.app   Natgw19.pub

Once we received the discharge plan application and the $50.00 filing fee we will process and issue public notice. I have included the last public notice, please change public notice to fit Columbia and send back. NMOCD will need to inspect facility and witness pressure test (mechanical Integrity Test) on well casing. Please make arrangements with us before Feb 27, 2000 to perform the above.

From: CPC908@aol.com[SMTP:CPC908@aol.com]
Sent: Friday, January 07, 2000 11:12 AM
To: Price, Wayne
Subject: Information requested from Columbia Propane

Hi Wayne,
I really appreciate you looking out for me. The information you requested follows:

Martha B. Card
Manager, Supply & Distribution
Columbia Propane Corporation
PO Box 35800
9200 Arboretum Parkway
Suite 140
Richmond, VA 23235-0800
(804)327-1384
(800)955-9101
(804)327-1380 fax
(804)334-3075 Mobile

E-mail address MBCARD@aol.com

I will e-mail you the onsite information Monday. Have a great week-end.

Thanks,
Martha Card

NEW MEXICO ENERGY, MINERALS
& NATURAL RESOURCES DEPARTMENT

Jennifer A. Salisbury
CABINET SECRETARY

Oil Conservation Div.
Environmental Bureau
2040 S. Pacheco
Santa Fe, NM 87505

Memorandum of Meeting or Conversation

Telephone __X__
Personal ____

Time: 3:45 PM
Date: January 5, 2000

Originating Party: **Wayne Price-OCD**

Other Parties: **Columbia Propane (old National Propane) Martha Card 804-327-1384.**

GW-019

Subject:

DP re-newal notice- left message Plan expires Fen 27, 2000

Discussion:

Left message
Conclusions or Agreements:

Signed: Wayne Price

CC:

Price, Wayne

From: CPC908@aol.com[SMTP:CPC908@aol.com]
Sent: Friday, January 07, 2000 11:12 AM
To: Price, Wayne
Subject: Information requested from Columbia Propane

Hi Wayne,
I really appreciate you looking out for me. The information you requested follows:

Martha B. Card
Manager, Supply & Distribution
Columbia Propane Corporation
PO Box 35800
9200 Arboretum Parkway
Suite 140
Richmond, VA 23235-0800
(804)327-1384
(800)955-9101
(804)327-1380 fax
(804)334-3075 Mobile

E-mail address MBCARD@aol.com

I will e-mail you the onsite information Monday. Have a great week-end.

Thanks,
Martha Card

State of New Mexico
Energy, Minerals and Natural Resources Department
OIL CONSERVATION DIVISION
P.O. Box 2088
Santa Fe, NM 87501

DISCHARGE PLAN APPLICATION FOR BRINE EXTRACTION FACILITIES

(Refer to OCD Guidelines for assistance in completing the application.)

☐ NEW ☐ RENEWAL

I. FACILITY NAME: ______________________________

II. OPERATOR: ______________________________

ADDRESS: ______________________________

CONTACT PERSON: ______________________ PHONE: __________

III. LOCATION: ____/4 ____/4 Section _____ Township _________ Range _________

Submit large scale topographic map showing exact location.

IV. Attach the name and address of the landowner of the facility site.

V. Attach a description of the types and quantities of fluids at the facility.

VI. Attach a description of all fluid transfer and storage and fluid and solid disposal facilities.

VII. Attach a description of underground facilities (i.e. brine extraction well).

VIII. Attach a contingency plan for reporting and clean-up of spills or releases.

IX. Attach geological/hydrological evidence demonstrating that brine extraction operations will not adversely impact fresh water.

X. Attach such other information as is necessary to demonstrate compliance with any other OCD rules, regulations and/or orders.

XI. CERTIFICATION

I hereby certify under penalty of law that I have personnaly examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

Name: ______________________ Title: ______________________

Signature: ______________________ Date: ______________________

DISTRIBUTION: Original and one copy to Santa Fe with one copy to appropriate Division District Office.

NOTICE OF PUBLICATION

STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION

Notice is hereby given that pursuant to the New Mexico Water Quality Control Commission Regulations, the following discharge plan applications have been submitted to the Director of the Oil Conservation Division, 2040 South Pacheco, Santa Fe, New Mexico 87505, Telephone (505) 827-7131:

(GW-19) - National Propane Corporation, Robert W. Berry, P.O. Box 2067, Cedar Rapids, Iowa 52406-2067, has submitted an application for renewal of its previously approved discharge plan for its Loco Hills brine discharge facility located in the NW/4 SE/4, Section 22, Township 17 South, Range 29 East, NMPM, Eddy County, New Mexico. National Propane proposes continuation of brine discharges to an existing 2.44 million gallon plastic-lined storage pond. The brine discharge is the result of propane injection to three salt domes. The brine storage pond contains a secondary plastic liner and a leak detection system. The brine is reinjected to the salt domes when propane extraction is desired. Ground water most likely to be affected in the event of an accidental discharge is at a depth of approximately 75 feet with a total dissolved solids concentration of approximately 10,000 mg/l. The discharge plan addresses how spills, leaks, and other accidental discharges to the surface will be managed.

(GW-199) - Champion Technologies, Inc., Joe Schornick, P.O. Box 450499, Houston, Texas 77245-0499, has submitted a discharge plan application for its Hobbs oilfield chemical distribution site located in the NE/4 SE/4, Section 15, Township 19 South, Range 38 East, NMPM, Lea County, New Mexico. All wastes generated will be stored in closed top above ground storage tanks prior to offsite disposal or recycling at an OCD approved site. Ground water most likely to be affected in the event of an accidental discharge is at a depth of approximately 44 feet with a total dissolved solids concentration of approximately 1,036 mg/l. The discharge plan addresses how spills, leaks, and other accidental discharges to the surface will be managed.

(GW-199-1) - Champion Technologies, Inc., Joe Schornick, P.O. Box 450499, Houston, Texas 77245-0499, has submitted a discharge plan application for its Farmington oilfield chemical distribution site located in Section 12, Township 29 North, Range 13 West, NMPM, San Juan County, New Mexico. All wastes generated will be stored in closed top above ground storage tanks prior to offsite disposal or recycling at an OCD approved site. Ground water most likely to be affected in the event of an accidental discharge is at a depth of approximately 59 feet with a total dissolved solids concentration of

OIL CONSERVATION DIVISION

July 20, 1995

CERTIFIED MAIL
RETURN RECEIPT NO. Z-765-962-741

Mr. Robert Berry
National Propane Corporation
1101 2nd Avenue SE
P.O. Box 2067
Cedar Rapids, IA 52406-2067

RE: Discharge Plan Renewal GW-19
Loco Hills Underground Storage
Eddy County, New Mexico

Dear Mr. Berry:

The discharge plan renewal GW-19 for the National Propane Corporation Loco Hills Underground Storage located in the NW/4 SW/4 of Section 22, Township 17 South, Range 29 East, NMPM, Eddy County, New Mexico, **is hereby approved** under the conditions contained in the enclosed attachment. The renewal application consists of the original discharge plan as approved February 27, 1985, the renewal dated January 3, 1990, and the renewal request dated May 18, 1995.

The discharge plan renewal was submitted pursuant to Section 3-106 of the New Mexico Water Quality Control Commission (WQCC) Regulations. It is approved pursuant to Section 3-109.A. Please note Sections 3-109.E and 3-109.F. which provide for possible future amendments or modifications of the plan. Please be advised the approval of this plan does not relieve you of liability should your operation result in pollution of surface water, ground water, or the environment.

Please be advised that all exposed pits, including lined pits and open tanks (tanks exceeding 16 feet in diameter), shall be screened, netted, or otherwise rendered nonhazardous to wildlife including migratory birds.

Please note that Section 3-104 of the regulations require "When a facility has been approved, discharges must be consistent with the terms and conditions of the plan." Pursuant to Section 3-107.C. you are required to notify the Director of any facility expansion, production increase, or process modification that would result in any change in the discharge of water quality or volume.

Pursuant to Section 3-109.G.4., this plan is for a period of five (5) years. This approval will expire on February 27, 2000, and you should submit an application for renewal six months before this date. It should be noted that all discharge plan facilities will be required to submit plans for, or the results of, an underground drainage testing program as a requirement for discharge plan renewal.

The discharge plan application for the National Propane Corporation Loco Hills Underground Storage is subject to WQCC Regulation 3-114 discharge plan fee. Every billable facility submitting a discharge plan will be assessed a fee equal to the filing fee of fifty (50) dollars plus one-half of the flat fee, or six-hundred and ninety dollars ($690.00) for underground storage projects. The New Mexico Oil Conservation Division (OCD) has not received your filing fee or flat fee. The fifty (50) dollar filing fee is due upon receipt of this approval. The flat fee for an approved discharge plan may be paid in a single payment due at the time of approval, or in equal annual installments over the duration of the plan, with the first payment due upon receipt of this approval.

Please make all checks payable to: **NMED-Water Quality Management** and addressed to the OCD Santa Fe Office.

On behalf of the staff of the OCD, I wish to thank you and your staff for your cooperation during this discharge plan review.

Sincerely,

William J. LeMay
Director

WJL/mwa
Attachment

xc: Tim Gum, OCD Artesia Office
Ray Smith, OCD Artesia Office

ATTACHMENT TO THE DISCHARGE PLAN GW-19 RENEWAL
NATIONAL PROPANE CORPORATION
LOCO HILLS UNDERGROUND STORAGE
DISCHARGE PLAN REQUIREMENTS
(July 20, 1995)

1. Payment of Discharge Plan Fees: The fifty (50) dollar filing fee and the six-hundred ninety dollar ($690.00) flat fee shall be submitted upon receipt of this approval. The required flat fee may be paid in a single payment due at the time of approval, or in equal annual installments over the duration of the plan, with the first payment due upon receipt of this approval.

2. Drum Storage: All drums will be stored on pad and curb type containment.

3. Sump Inspection: All pre-existing single-lined sumps at this facility will be cleaned and visually inspected on an annual basis.

   Any new or rebuilt sumps or below-grade tanks will incorporate leak detection in their designs and will be approved by the OCD prior to installation.

4. Leak Detection: All leak detection systems will be visually inspected monthly. Inspection records will be kept on file for two years from the date of record. If fluids are found in the leak detection system the following steps will be taken:

   a. The operator will notify the OCD Santa Fe and Artesia offices within 24 hours of discovery.

   b. The fluids will be sampled and analyzed to determine the source.

   c. The fluids will be immediately and continuously removed from the sump. Such fluids may be returned to the pond.

   If a leak is determined to exist in the primary liner, the operator may be required to undertake the following contingency plan under the direction of the OCD:

   a. Introduction of fluids into the pond will cease.

   b. Fluids will be removed from the pond utilizing evaporation and transportation to another authorized facility until the fluid level is below the proven location of the leak in the liner.

5. Pond Levees: The outside walls of the levees will be maintained in such a manner to prevent erosion. They will be inspected monthly and after any substantial rainfall.

6. Berms: All tanks that contain materials other than freshwater will be bermed to contain one and one-third (1-1/3) the capacity of the largest tank within the berm or one and

one-third (1-1/3) the total capacity of all interconnected tanks.

7. Above Grade Tanks: All above ground tanks (saddle tanks) will be on impermeable pad and curb type containment.

8. Pressure Testing: All discharge plan facilities are required to pressure test all underground piping at the time of discharge plan renewal. All new underground piping shall be designed and installed to allow for isolation and pressure testing at 3 psi above normal operating pressure.

9. Spills: All spills and/or leaks will be reported to the OCD Santa Fe and Artesia District Offices pursuant to WQCC Rule 1-203 and OCD Rule 116.

10. Closure: The OCD will be notified when operations of the facility are discontinued for a period in excess of six months. Prior to closure of the facility a closure plan will be submitted for approval by the director. Closure and waste disposal will be in accordance with the statutes, rules and regulations in effect at the time of closure.

11. Mechanical Integrity Testing: An open hole pressure test equal to one and one-half of the normal operating pressure for four hours or 500 PSI for four hours, which ever is greater, will be conducted on the well annually. A pressure test to assure mechanical integrity of the casing to a minimum of 300 PSI for 30 minutes will be conducted prior to commencement of operations, at least once every five years, and during well work overs.

    Annual open hole testing will be performed within 60 days of the discharge plan approval anniversary commencing February 27, 1995. The five year testing will be conducted prior to renewal of the discharge plan. A pressure recorder shall be used and copies of the chart shall be submitted to the appropriate Division district office within 30 days following the test date. The operator shall notify the OCD at least 72 hours prior to testing in order that such tests may be witnessed.

Price, Wayne

From: Price, Wayne
Sent: Friday, January 07, 2000 12:26 PM
To: 'CPC908@aol.com'
Subject: RE: Information requested from Columbia Propane

attached is a copy of the Discharge Plan permit with conditions!

Natgw19.app   Natgw19.pub

Once we received the discharge plan application and the $50.00 filing fee we will process and issue public notice. I have included the last public notice, please change public notice to fit Columbia and send back. NMOCD will need to inspect facility and witness pressure test (mechanical Integrity Test) on well casing. Please make arrangements with us before Feb 27, 2000 to perform the above.

From: CPC908@aol.com[SMTP:CPC908@aol.com]
Sent: Friday, January 07, 2000 11:12 AM
To: Price, Wayne
Subject: Information requested from Columbia Propane

Hi Wayne,
I really appreciate you looking out for me. The information you requested follows:

Martha B. Card
Manager, Supply & Distribution
Columbia Propane Corporation
PO Box 35800
9200 Arboretum Parkway
Suite 140
Richmond, VA 23235-0800
(804)327-1384
(800)955-9101
(804)327-1380 fax
(804)334-3075 Mobile

E-mail address MBCARD@aol.com

I will e-mail you the onsite information Monday. Have a great week-end.

Thanks,
Martha Card

NEW MEXICO ENERGY, MINERALS
& NATURAL RESOURCES DEPARTMENT

Jennifer A. Salisbury
CABINET SECRETARY

Oil Conservation Div.
Environmental Bureau
2040 S. Pacheco
Santa Fe, NM 87505

Memorandum of Meeting or Conversation

Telephone __X__
Personal _____

Time: 3:45 PM
Date: January 5, 2000

Originating Party: Wayne Price-OCD

Other Parties: Columbia Propane (old National Propane) Martha Card 804-327-1384.

GW-019

Subject:

DP re-newal notice- left message Plan expires Fen 27, 2000

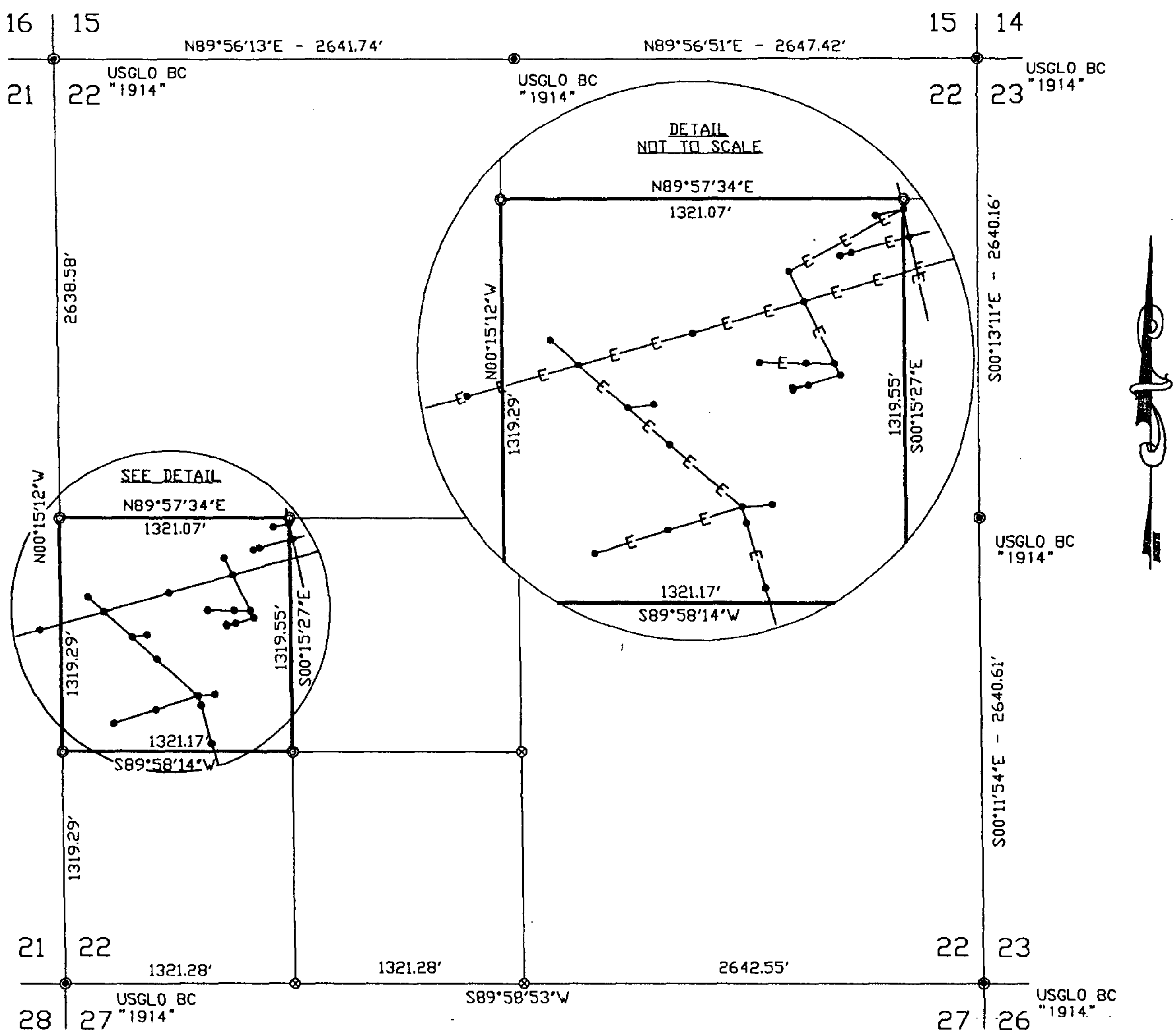
Discussion:

Left message
Conclusions or Agreements:

Signed: Wayne Price

CC:

SECTION 22, TOWNSHIP 17 SOUTH, RANGE 29 EAST, N.M.P.M.,
EDDY COUNTY, NEW MEXICO.



LEGAL DESCRIPTION

A TRACT OF LAND BEING THE NORTHWEST QUARTER OF THE SOUTHWEST QUARTER OF SECTION 22, TOWNSHIP 17 SOUTH, RANGE 29 EAST, N.M.P.M., EDDY COUNTY, NEW MEXICO AND BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

BEGINNING AT A 1/2" IRON ROD W/PVC CAP MKD. (PS 3239 PS 12641) SET FOR THE NORTHWEST CORNER OF SAID TRACT AND BEING THE WEST QUARTER CORNER OF SAID SECTION 22 WHICH LIES N00°15'12"W, 2638.58 FEET FROM A USGLO BRASS CAP FOUND FOR THE SOUTHWEST CORNER OF SAID SECTION 22; THENCE N89°57'34"E, 1321.07 FEET TO A 1/2" IRON ROD W/PVC CAP MKD.(PS 3239 PS 12641) SET FOR THE NORTHEAST CORNER OF SAID TRACT; THENCE S00°15'27"E, 1319.55 FEET TO A 1/2" IRON ROD W/PVC CAP MKD. (PS 3239 PS 12641) SET FOR THE SOUTHEAST CORNER OF SAID TRACT; THENCE S89°58'14"W, 1321.17 FEET TO A 1/2" IRON ROD W/PVC CAP MKD. (PS 3239 PS 12641) SET FOR THE SOUTHWEST CORNER OF SAID TRACT; THENCE N00°15'12"W, 1319.29 FEET TO THE POINT OF BEGINNING. SAID TRACT CONTAINING 40.016 ACRES OF LAND MORE OR LESS.

NOTE:
BEARINGS SHOWN HEREON ARE TRANSVERSE MERCATOR GRID AND CONFORM TO THE NEW MEXICO COORIDINATE SYSTEM "NEW MEXICO EAST ZONE", NORTH AMERICAN DATUM OF 1983. DISTANCES ARE SURFACE VALUES AND DO NOT REFLECT A GRID FACTOR ADJUSTMENT.

LEGEND

- DENOTES SET 1/2" IRON ROD W/PVC CAP MKD. (PS 3232 PS 12641) AND T-POST
- DENOTES FOUND MONUMENT AS NOTED
- DENOTES CALCULATED CORNERS
- DENOTES ELECTRIC POLES
- —E— DENOTES ELECTRIC LINE

1000 0 1000 2000 FEET

Scale: 1" = 1000'

I HEREBY CERTIFY THAT I DIRECTED AND AM RESPONSIBLE FOR THIS SURVEY, THAT THIS SURVEY IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF, AND THAT THIS SURVEY AND PLAT MEET THE MININUM STANDARDS FOR SURVEYING IN NEW MEXICO.

GARY G. EIDSON NEW MEXICO

5-1-98

RONALD J. EIDSON, N.M. L.S. No. 3239
GARY G. EIDSON N.M. P.S. No. 12641

JOHN W. WEST ENGINEERING COMPANY
CONSULTING ENGINEERS & SURVEYORS – HOBBS, NEW MEXICO

NATIONAL PROPANE			
THE NW/4 SW/4 OF SECTION 22, TOWNSHIP 17 SOUTH, RANGE 29 EAST, N.M.P.M., EDDY COUNTY, NEW MEXICO			
Survey Date: 4/23/98		Sheet 1 of 1 Sheets	
W.O. Number: 98-11-0640		Drawn By: D.McCARLEY	
Date: 4/29/98	NATIONAL	NATP0640	Scale: 1" = 1000'

STATE OF NEW MEXICO
OIL CONSERVATION DIVISION

MEMORANDUM OF MEETING OR CONVERSATION

☒ Telephone ☐ Personal	Time 3:00 PM	Date 4-28-98

Originating Party	Other Parties
MARK ASHLEY	JERRY SMITH - NATIONAL PROPANE

Subject: LOCO HILLS GAS STORAGE (PROPANE) - MIT

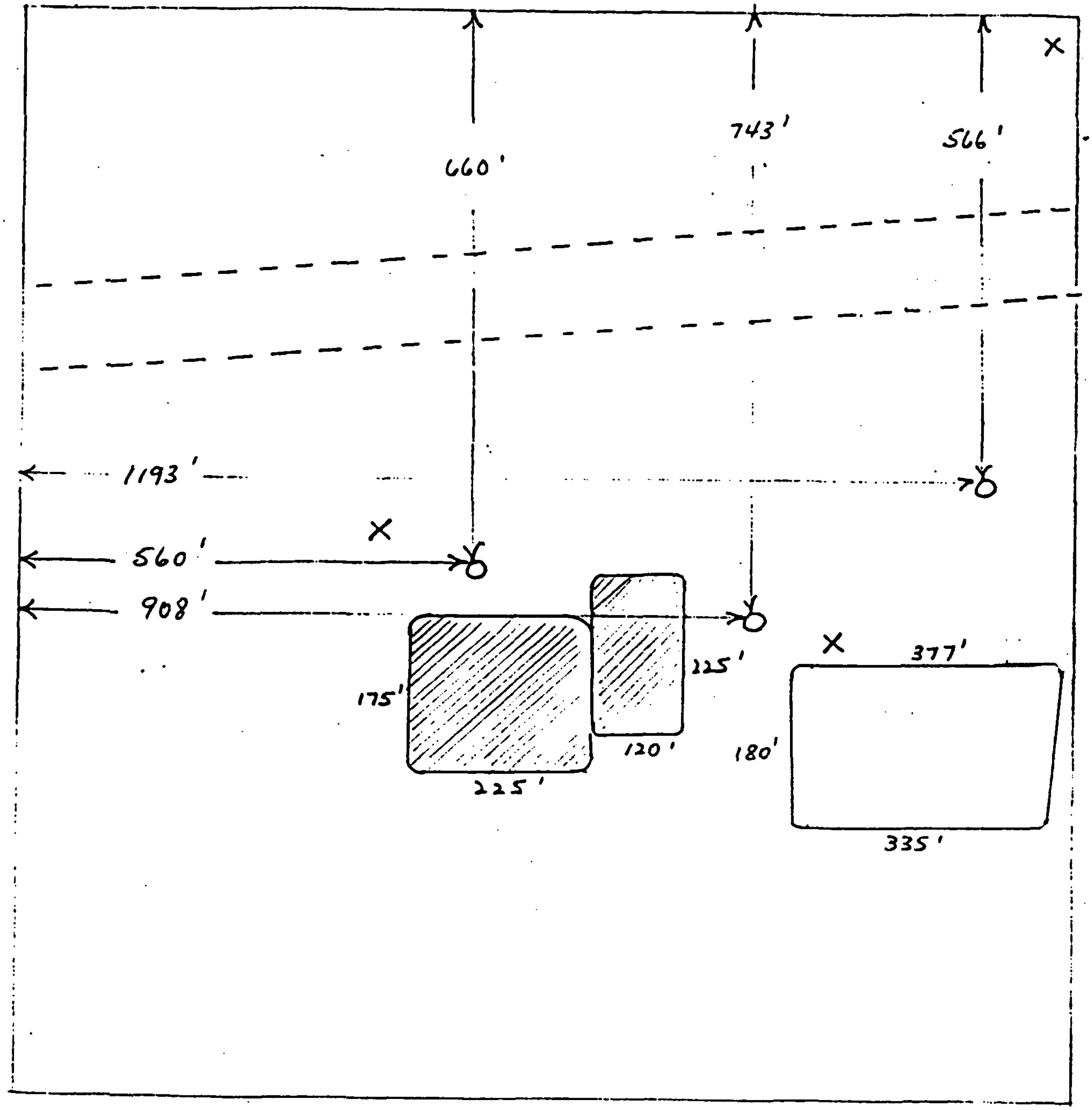
Discussion: I LET JERRY KNOW THAT THE LOCO HILL FACILITY NEED AN MIT AS SOON AS POSSIBLE.

Conclusions or Agreements: JERRY WOULD LIKE TO SET UP TESTING FOR FEB/MARCH OF EACH YEAR BECAUSE OF PRODUCT CONCERNS. WE SET UP TEST THIS YEAR AS SOON AS POSSIBLE.

Distribution

Signed Mark Ashley

LOCO HILLS - UNDERGROUND STORAGE
(Not to exact scale)
NW¼-SW¼ Sec. 22
1" equals approx.200'



U.S. 82 Highway Right of Way

Water Wells

Propane Storage Wells

Abandoned and filled-in former brine storage pond

New brine storage pond

NATIONAL
The Nation's Propane Company.

SUITE 1700 IES TOWER
200 1st STREET S.E.
CEDAR RAPIDS, IA 52401-1409
319/365-1550 EXT. 141
800/653-1550 X 141

FEBRUARY 3, 1998

STATE OF NEW MEXICO
ENERGY, MINERALS, AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION
2040 S. PACHECO
SANTA FE, N.M. 87505

ATT: MARK ASHLEY

RE: LOCO HILLS STORAGE FACILITY

DEAR MARK;

As per our telephone conversation of today, we are looking to do some upgrading of the Loco Hills facility which would include building new brine storage pond(s). Hopefully we will know more about this within the next sixty days.

At the time of the upgrade, we will take care of the excess salt/sand mixture now located on the back of the property and also fill or do whatever is necessary to fill the temporary pit on the east side.

We certainly appreciate your patience and working with us on this project.

Jerry Smith
Director of Supply & Distribution

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240
PHONE (505) 326-4669 • 115 S. COMMERCIAL AVE. • FARMINGTON, NM 87401

RECEIVED APR 24 1996

ANALYTICAL RESULTS FOR
CONTROLLED RECOVERY, INC.
ATTN: BUSTER MC DANIEL
P.O. BOX 369
HOBBS, NM 88241
FAX TO:

Receiving Date: 04/19/96
Reporting Date: 04/23/96
Project Number: NOT GIVEN
Project Name: WEST LOCO SALT CAVERN STORAGE
Project Location: NOT GIVEN

Sampling Date: 04/19/96
Sample Type: SOIL
Sample Condition: INTACT & COOL
Sample Received By: BC
Analyzed By: BC

LAB NUMBER SAMPLE ID	TPH (mg/L)	BENZENE (ppb)	TOLUENE (ppb)	ETHYLBENZENE (ppb)	TOTAL XYLENES (ppb)
ANALYSIS DATE:	4/23/96	4/22/96	4/22/96	4/22/96	4/22/96
H2501-1	105	<2.0	<2.0	<2.0	<6.0
Quality Control	415	94.5	93.5	92.2	275
True Value QC	425	100	100	100	300
% Accuracy	96.9	94.5	93.5	92.2	91.7
Relative Percent Difference	1.5	5.5	6.5	7.8	8.3

METHODS: TRPHC - EPA 600/7-79-020, 418.1; BTEX - EPA SW-846-8020

Burgess J. A. Cooke, Ph. D.

4/23/96
Date

TOTAL P.02

NATIONAL
The Nation's Propane Company.

National Propane Corporation
1101 2nd Avenue SE
PO Box 2067
Cedar Rapids, IA 52406-2067
Tel 319 365 1550
FAX 319 365 ~~3692~~ 0288

FEBRUARY 20, 1996

STATE OF NEW MEXICO
ENERGY, MINERALS, AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION
2040 S. PACHECO
SANTA FE, NM 87505

ATT: MARK ASHLEY

RE: LOCO HILLS TERMINAL, LOCATED IN EDDY COUNTY NEW MEXICO.

DEAR MARK:

WE ARE ENGAGING BELCHER CONSTRUCTION OF HOBBS, NEW MEXICO TO:

A: REMOVE SALT FROM EXISTING PIT AND STORE ON SITE.
B: ERECT TEMPORARY POND WHILE WORK IS BEING DONE. (6 MIL)
C: REPAIR AND PATCH EXISTING LINER AS NEEDED.

WE ARE ALSO CONSIDERING INSTALLING SOME SORT OF CIRCULATION SYSTEM TO HELP STOP BUILD UP OF SALT IN THE FUTURE.

IF THERE ARE ANY COMMENTS OR QUESTIONS, PLEASE ADVISE ME AT 800/653-1550 EXT 141.

SINCERELY,

Jerry Smith

JERRY SMITH
DIRECTOR OF SUPPLY
NATIONAL PROPANE CORP.