BW - 33

PERMIT APPLICATION 2011

Key® Energy Services

Key Energy Services
6 Desta Drive
Suite 4300
Midland, Texas 79705

Telephone: 432.620.0300
Facsimile: 432.571.7173
www.keyenergy.com

January 24, 2011

Mr. Glenn vonGonten
Acting Environmental Bureau Chief
Mr. Jim Griswold
Senior Hydrologist
1220 South St. Francis
Santa Fe, New Mexico 87505

Subject: ***Application for replacement brine well Near Carlsbad, NM***

Dear Mr. vonGonten and Mr. Griswold:

Key Energy Services, LLC is submitting to the Oil Conservation Division (OCD) an application for a new replacement brine well to be used in conjunction with Key Energy's existing water station previously permitted as BW-19, Carlsbad Fresh and Brine Water Station, located near Carlsbad, New Mexico.

Please find enclosed for your review and approval the following:

1. Signed brine well permit application form with one complete hard copy of the guidance document "Questions and Answers" and a flash drive with complete PDF version.
2. Copy of the "Public Notice" requirements pursuant to Water Quality Control Commission regulations (WQCC) 20.6.2.3108 NMAC that includes all of the basic elements of 3108.A and 3108.F.1-5, including the locations of signs, off-site notices and newspapers to be used.
3. A $100.00 check made out to the "New Mexico Water Quality Management Fund" for the required filing fee.

If OCD requires additional information concerning this application please do not hesitate to call me at 432-571-7536 or Wayne Price at 505-715-2809, or E-mail wayneprice77@earthlink.net.

Sincerely,

Daniel K. Gibson, P.G.
Corporate Environmental Director

cc: Mr. Harry Burgess-Carlsbad, NM City Administrator
Mr. Allen Sartin, Eddy County Manager
Mr. Danny Stafford, adjacent landowner
Mr. Will Brantley, adjacent landowner

Enclosures

Performance *is* Key

Key Energy Services

Application for New (replacement) Brine Well

Carlsbad, New Mexico

Submitted to:

New Mexico Oil Conservation Division

January 31, 2011

by:

Dan K. Gibson
Corporate Environmental Director

Key Energy Services, LLC.
6 Desta Drive
Suite 4300
Midland, Texas 79705

Table of Contents

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 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)

X New ☐ Renewal

I. Facility Name: *Key Energy Services LLC – Carlsbad Fresh and Brine Water Station*

II. Operator: *Key Energy Services LLC.*

Address: *6 Desta Drive Suite 4300 Midland, TX 79705* Local: *1609 E. Green St. Carlsbad NM 88221*
Contact Person: *Dan Gibson Corporate Environmental Director (Midland TX permit issues) 432-571-7536*
Carlsbad Yard Dispatcher-575-885-2053; Marcos Hernadez-Yard Mgr. cell # 575-706-0232
J.D.McCormack-Brine Well Supervisor-Cell # 575-706-0235

III. Location: Submit large scale topographic map showing exact location.- *Maps Located in attached report.*
Brine Well Location: SW/4 NW/4 UL E of Section 31 - Township 22 South - Range 27 East.
Existing Water Station Location: SE/4 NE/4 UL H of Section 36 - Township 22 South - Range 26 East.

IV. Attach the name and address of the landowner of the facility site.

*Brine Well Location -Key Energy Services LLC 6 Desta Drive Suite 4300 Midland, TX 79705****
Water Station- Danny Stafford 5501 Old Cavern Hwy. Carlsbad, NM 88220
*** contingent upon permit approval.

V. Attach a description of the types and quantities of fluids at the facility.
see attachments.

VI. Attach a description of all fluid transfer and storage and fluid and solid disposal facilities.
see attachments.

VII. Attach a description of underground facilities (i.e. brine extraction well).
There are no underground facilities, tanks or piping.

VIII. Attach a contingency plan for reporting and clean-up of spills or releases.
see attachments.

IX. Attach geological/hydrological evidence demonstrating that brine extraction operations will not adversely impact fresh water.
see attachments.

X. Attach such other information as is necessary to demonstrate compliance with any other OCD rules, regulations and/or orders.
see attachments.

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: Daniel K. Gibson Title: *Corporate Environmental Director*

Signature: ______________ Date: January 24, 2011

E-mail Address: *dgibson@keyenergy.com*

Appendix for Public Notices:

Includes:

1. Copy of public notice of the 2'x3' sign. *
2. Copy of off-site public notice.**
3. Copy of public notice letter to property owners within 1/3 mile of proposed site.
4. Copy of public notice letter to property owner of site.
5. Copy of public notice of 3"x4" newspaper display ad.***

Notes:

* The sign will be installed at the entrance to the current brine station just off highway 62-180. The sign will be located as close as possible to the highway. If the DOT will allow us we will install it on their ROW. If not then we can install in the easement ROW just off of the DOT property. The sign will be 3 ft wide x 2 ft tall and set approximately 4 ft off the ground level to the bottom of the sign.

** The off-site notice will be placed at City Hall as approved by the city or other locations as required.

*** The 3x4 inch display ad will be placed in the Carlsbad Current Argus Newspaper.

Public Notice

Legal notification for 2'x3' signage per Water Quality Control Commission Regulations 20.6.2.3.108.B.1 NMAC

Key Energy Services LLC, 6 Desta Drive Suite 4300 Midland, TX 79705, Dan Gibson Corporate Environmental Director, has filed an application with the New Mexico Oil Conservation Division (OCD) to install and operate a replacement class III brine well for its existing brine and fresh water station previously permitted by the OCD as BW-19.

The existing water station and replacement brine well is located approximately One-half mile behind this sign. A detail description and aerial photo is hereby attached below.

The New Mexico Oil Conservation Division (OCD) will accept comments and statements of interest regarding this application and will create a facility-specific mailing list for persons who wish to receive future notices. Interested persons may contact Jim Griswold, Oil Conservation Division (OCD) 505-476-3465 or by writing 1220 South Saint Francis, Santa Fe, New Mexico, 87505.

Para obtener más información sobre esta solicitud en espanol, sirvase comunicarse por favor:
New Mexico Energy, Minerals and Natural Resources Department (Depto. Del Energia, Minerals y Recursos Naturales de Nuevo México), Oil Conservation Division (Depto. Conservacio´n Del Petróleo), 1220 South St. Francis Drive, Santa Fe, New México (Contacto: Dorothy Phillips, 505-476-3461)

Will contain the 8.5 x 11 inch detail off-site notice laminated in plastic Page 1	Will contain the 8.5 x 11 inch detail off-site notice laminated in plastic Page 2	Will contain the 8.5 x 11 inch Aerial photo of the site area Laminated in plastic.

Key Energy Proposed Brine Well Site

(SW/4 NW/4 UL E of Section 31-Township 22 South-Range 27 East)

Access and property marked in Blue

Public Notice

Legal off-site notification per Water Quality Control Commission Regulations 20.6.2.3.108.B.1 NMAC

Key Energy Services LLC, 6 Desta Drive Suite 4300 Midland, TX 79705, Dan Gibson Corporate Environmental Director, has filed an application with the New Mexico Oil Conservation Division (OCD) to install and operate a replacement class III brine well for its existing brine and fresh water station previously permitted by the OCD as BW-19. This well site will be located approximately 3 miles southwest of Carlsbad, New Mexico, Eddy County, in the Carlsbad ET Zone, located east of the airport and US highway 62-180. The portion of the land is actually part of the east side of the Old Carlsbad Army Airbase, currently used for commercial and industrial activity.

An aerial photo has been attached in this notification for your review.

The existing water station is located in (SE/4 NE/4 UL H of Section 36 -Township 22 South- Range 26 East) on private land. The new replacement brine well will be located approximately 1000 feet east of the existing facility in (SW/4 NW/4 UL E of Section 31-Township 22 South-Range 27 East) on private land.

Brine water is used in the Oil and Gas industry to supply a "heavy pure sodium chloride" concentrated salt water (i.e. brine water) with a total dissolved solids concentration of approximately 320,000 mg/l and a density that is 20% higher than fresh water. Heavy brine water is essential in preventing blow-outs in high pressure gas wells and prevents loss of circulation when drilling through salt zones typically found in the Carlsbad area.

Fresh water will be injected deep into the Castile salt formation at a depth ranging from 1300 to 1500 feet below the surface to produce brine water. The Castile formation is the same deep stable formation found under the WIPP site. The formation is known to contain a pure "Sodium" salt that is preferred in the oil and gas drilling operations. Other salts typically found, in the potash area, playa lakes and salt-water aquifers, can interfere with the drilling mud programs, thus causing significant control problems and added cost.

The Castile formation contains thick continuous anhydrite rock layers, that act a lot like natural concrete beams, that overly the targeted salt section. These layers have been identified and geo-engineering calculations show they will provide a natural support and barrier for the cavern created as a result of solution mining. An engineering model that included safety factors was developed to verify the long-term stability of the site.

The brine well will be designed to produce approximately 12 million barrels of brine water over a 20-year life period. The anticipated cavern radius will be approximately 150 feet. The well has been located on private land to provide a minimum of 1000 feet separation from all significant features, such as houses, roads, utilities, pipelines, water supplies, buildings, schools, businesses, etc.

This site has no public water supplies that may be impacted, and ground water in this area is somewhat limited, with some dry holes being encountered while in other wells groundwater may be present, both in shallow lenses 30-60 feet deep and in deeper horizons i.e. 100-250 feet. The shallow groundwater in this area is typically not used for drinking water and when found is in very limited quantity. The deeper zone is considered usable as an irrigation water source, when sufficient quantities are found, with an average quality concentration of 1500-2000 mg/l of total dissolved solids.

This facility will be designed and permitted to have no intentional water contaminants discharged to the surface or subsurface for the protection of groundwater. The system will have concrete and synthetic liners to prevent any spills or leaks from reaching the ground surface. The brine well will have double-cemented casing and tubing pipes to protect groundwater.

Key Energy has determined that bulk mixing of purchased pure salt is neither, economically feasible or environmentally safe. The volumes required during drilling programs cannot be met other than using brine caverns that can safely store large volumes of brine water.

If you have any questions or concerns please do not hesitate to contact Key Energy at the address above or you may contact Wayne Price 505-715-2809 or E-mail wayneprice77@earthlink.net. Key welcomes your input.

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Public Notice Letter

Certified Mail:

Property Owner of Record:

Name:

Address:

City/County:

State:

Public Notice

Legal notification to property owner(s) of record within one-third mile per Water Quality Control Commission Regulations 20.6.2.3.108.B.2 NMAC

Key Energy Services LLC, 6 Desta Drive Suite 4300 Midland, TX 79705, Dan Gibson Corporate Environmental Director, has filed an application with the New Mexico Oil Conservation Division (OCD) to install and operate a replacement class III brine well for its existing brine and fresh water station previously permitted by the OCD as BW-19. This well site will be located approximately 3 miles southwest of Carlsbad, New Mexico, Eddy County, in the Carlsbad ET Zone, located east of the airport and US highway 62-180. The portion of the land is actually part of the east side of the Old Carlsbad Army Airbase, currently used for commercial and industrial activity.

The existing water station and replacement brine well may be located within one-third mile (i.e. 1760 ft) from your property boundary. An aerial photo has been attached in this notification for your review.

The existing water station is located in (SE/4 NE/4 UL H of Section 36 -Township 22 South- Range 26 East) on private land. The new replacement brine well will be located approximately 1000 feet east of the existing facility in (SW/4 NW/4 UL E of Section 31-Township 22 South-Range 27 East) on private land.

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The Castile formation contains thick continuous anhydrite rock layers, that act a lot like natural concrete beams, that overly the targeted salt section. These layers have been identified and geo-engineering calculations show they will provide a natural support and barrier for the cavern created as a result of solution mining. An engineering model that included safety factors was developed to verify the long-term stability of the site.

The brine well will be designed to produce approximately 12 million barrels of brine water over a 20-year life period. The anticipated cavern radius will be approximately 150 feet. The well has been located on private land to provide a minimum of 1000 feet separation from all significant features, such as houses, roads, utilities, pipelines, water supplies, buildings, schools, businesses, etc.

This site has no public water supplies that may be impacted, and ground water in this area is somewhat limited, with some dry holes being encountered while in other wells groundwater may be present, both in shallow lenses 30-60 feet deep and in deeper horizons i.e. 100-250 feet. The shallow groundwater in this area is typically not used for drinking water and when found is in very limited quantity. The deeper zone is considered usable as an irrigation water source, when sufficient quantities are found, with an average quality concentration of 1500-2000 mg/l of total dissolved solids.

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Public Notice Letter

Legal notification to property owner(s) of the site per Water Quality Control Commission Regulations 20.6.2.3.108.B.3 NMAC

Certified Mail Return Receipt Requested:

Property Owner of Record:

Name:

Address:

City/County:

State:

Public Notice

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Public Notice Display Ad

Legal notification for 3"x4" newspaper display add per Water Quality Control Commission Regulations 20.6.2.3.108.B.4 NMAC

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GUIDELINES FOR THE PREPARATION OF DISCHARGE PLANS AT BRINE EXTRACTION FACILITIES (Revised 5-91) - OIL CONSERVATION DIVISION 1220 SOUTH ST. FRANCIS DR. SANTA FE, NEW MEXICO 87505.

Introduction

The New Mexico Oil Conservation Division (OCD) regulates brine extraction activities and disposal of non-domestic wastes resulting from this industry pursuant to authority granted in the New Mexico Water Quality Act and the Oil and Gas Act. OCD administers, through delegation by the New Mexico Water Quality Control Commission (WQCC), all Water Quality Act regulations pertaining to surface and ground water except sewage. However, if the sewage is in a combined waste stream, the OCD will have jurisdiction.

Sections 3-104 and 3-106 of the WQCC Regulations stipulate that, unless otherwise provided for by the regulations, no person shall cause or allow effluent or leachate to discharge so that it may move directly or indirectly into the ground water unless such discharge is pursuant to a discharge plan approved by the director. Additionally, Section 5-101 requires in situ extraction wells, including those extracting brine, to have approved discharge plans prior to operation. The Oil and Gas Act (Section 70-2-12.B(22)) authorizes the OCD to regulate the disposition of non-domestic, non-hazardous wastes at oil field facilities to protect public health and the environment. The OCD has combined these requirements into one document, (a "discharge plan") that will provide protection to ground water, surface water and the environment through proper regulation of brine extraction facilities and associated transfer, storage, and disposal of materials at the facility.

A proposed discharge plan shall set forth in detail the methods or techniques the discharger proposes to use which will ensure compliance with WQCC regulations and the Oil and Gas Act. The proposed discharge plan must provide the technical staff and the director of the regulating agency (in this case, the OCD) with sufficient information about the operation to demonstrate that the discharger's activities will not cause state regulations or ground water standards (WQCC Section 3-103) to be violated.

In addition to meeting the Part 5 WQCC requirements for injection wells, the discharge plan must address surface facility operations including storage pits, tankage and loading areas. Inadvertent discharges of liquids (ie. leaks and spills, or any type of accidental discharge of contaminants) or improper disposal of waste solids still have a potential to cause ground water contamination or threaten public health and the environment.

For existing brine extraction facilities presently operating under an approved discharge plan, WQCC UIC regulation 5-101.G stipulates that the expiration date of the plan shall be extended provided the following conditions are met: (1) A discharge plan renewal application should be submitted to the OCD at least 180 days prior to plan expiration, and (2) the discharger is in compliance with the existing plan on the original date of expiration. The extension of the existing plan is effective until the OCD approves or disapproves the renewal application. The renewal application should follow the attached guidelines with emphasis on the items that are not included in the original plan.

After a discharge application plan has been received, the OCD must publish a public notice pursuant to Section 3-108 of the regulations, and allow 30 days for public comment before a discharge plan may be approved or otherwise resolved. If significant public interest is indicated, a public hearing will be held which will delay a decision on plan approval.

Once a plan has been approved, discharges must be consistent with the terms and conditions of the plan. Similarly, if there is any facility expansion or process change that would result in any significant modification of the approved discharge of water contaminants, the discharger is required to notify this agency, and have the modification approved prior to implementation.

Approval of a discharge plan application by OCD will not relieve the operator of the necessity to become familiar with other applicable state and federal regulations.

The review of a proposed discharge plan often requires several months depending on complexity. This includes time for requests to the discharger for additional information and clarification, in-house information gathering and analysis, and field investigations of the discharge site, and a public notice and comment period. Review time will, to a large extent, be dependent on the extent to which a facility has generally self-contained processes to prevent movement of fluids and leaching of solids from the work area into the environment.

For example, the review process will be expedited when effluent, process or other fluids are routed to tanks, or lined pits with under drains for leak detection, when accurate monitoring of fluid volumes and pressure and/or integrity testing is performed for leak detection in below grade or underground tanks, and when the possibility of accidental spills and leaks is addressed by adequate contingency plans (e.g. containment by curbing and drainage to properly constructed sumps). Other examples allowing faster review include recycling of waste oils, proper disposal of dried sludges to minimize potential ground water contamination, and closure of previously used ponds. A more rapid review of discharge plans for such facilities is possible because much less geologic and hydrologic study of the site is required in order to delineate impact.

Similarly, longer review times will be required for operators seeking to continue to use unlined ponds or to utilize other procedures that have a high probability of allowing infiltration and movement of effluent and leachate to the subsurface. For these instances large amounts of technical data generally will be required including: 1) detailed information on site hydrogeology, natural and current water quality, and movement of contaminants; 2) processes expected to occur in the vadose and saturated zones to attenuate constituents to meet WQCC standards at a place of present or reasonably foreseeable future use of ground water; and 3) monitoring of ground water (including post operational monitoring as necessary).

If an operator desires to change or modify effluent or solid waste disposal practices it is not necessary to have completed all such changes prior to plan approval. A commitment to make the changes together with submittal of proposed modification details and a timely completion schedule can be included in the plan. These become plan requirements after the plan is approved.

The following discharge plan application guidelines have been prepared for use by the discharger to aid in fulfilling the requirements of Sections 3-106, 3-107 and Part 5 (UIC) of the WQCC regulations and to expedite the review process by minimizing OCD requests for additional information. It sets up a logical sequence in which to present the information required in a discharge plan for this type of facility. It is suggested that you read the entire document before preparing your application. Not all information discussed in the guidelines may be applicable to your facility. However, all sections of the application form must be completed for new or renewal discharge plan applications.

If there are any questions on the preparation of a discharge plan, please contact OCD's Environmental Bureau (1220 South St. Francis Dr., Santa Fe, New Mexico 87505 or by telephone at (505) 476-3440).

DISCHARGE PLAN GUIDELINES – "Questions" and **Answers:**

I. Name of Facility- Provide complete name, Indicate whether this is a new or renewal application.

Answer: Key Energy Services LLC, Carlsbad Fresh and Brine Water Station, is an existing facility that was previously permitted under brine well permit BW-19 issued by the Oil Conservation Division. This is a **new application** that will include a replacement brine well, and the existing water station.

II. Name of Operator or Legally Responsible Party and Local Representative Include address and telephone number.

Answer:
Key Energy Services LLC.
Address: 6 Desta Drive Suite 4300 Midland, TX 79705
Local: 1609 E. Green St. Carlsbad NM 88221

Contact Persons:
Dan Gibson Corporate Environmental Manager (Midland TX permit issues) phone # 432-571-7536
Carlsbad Yard Dispatcher- Phone # 575-885-2053
Marcos Hernadez-Assistant Yard Manager Cell # 575-706-0232
JD McCormack- Brine Well Supervisor Cell # 575-706-0235

III. Location of Facility- Give a legal description of the location (i.e. 1/4. 1/4, Section, Township, Range) and county. Use state coordinates or latitude/longitude on unsurveyed land. Submit a large scale topographic map, facility site plan, or detailed aerial photograph for use in conjunction with the written material. It should depict the location of the injection well, storage tanks and/or ponds, process equipment, relevant objects, facility property boundaries, and other site information required in Sections V through IX below. If within an incorporated city, town or village provide a street location and map.

Answer: Key Energy Services LLC, 6 Desta Drive Suite 4400 Midland, TX 79705, Dan Gibson Corporate Environmental Director, has filed an application with the New Mexico Oil Conservation Division (OCD) to install and operate a replacement class III brine well for its existing brine and fresh water station previously permitted by the OCD as BW-19. This well site will be located approximately 3 miles southwest of Carlsbad, New Mexico, Eddy County, in the Carlsbad ET Zone, located east of the Carlsbad airport and US highway 62-180. The portion of the land is actually part of the east side of the Old Carlsbad Army Airbase, currently used for commercial and industrial activity.

The existing water station is located in (SE/4 NE/4 UL H of Section 36-Township 22 South-Range 26 East) on private land. The new replacement brine well will be located approximately 1100 feet east of the existing facility in (SW/4 NW/4 UL E of Section 31-Township 22 South-Range 27 East) on private land.

The following referenced material is enclosed in appendix section I-IV, found immediately behind this section IV: 1. Eddy County Map depicting Carlsbad City limits marked in yellow, and proposed brine well location. 2. BLM Surface Management Status Topographic Map 1:100,000 scale with elevation contours, roads, water features and section, township and range lines (NGVD-1929) USGS and location of proposed site. 3. An Aerial photo of the site. 4. Surveyed plats of the facility with purchase contract descriptions.

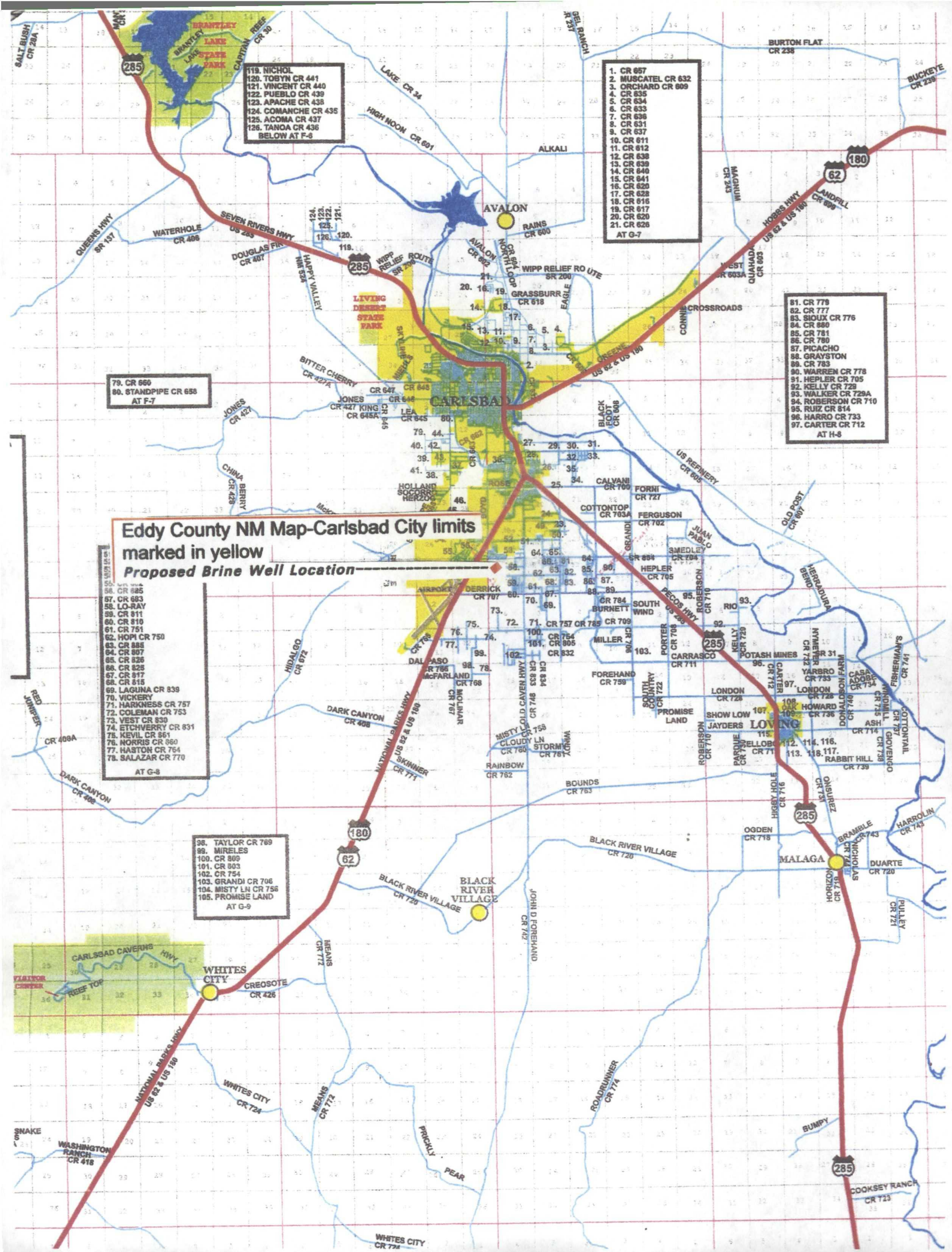
IV. Landowners-Attach the name and address of the landowner(s) of record of the facility site.

Answer:
Brine Well Location- Key Energy Services LLC, 6 Desta Drive Suite 4300 Midland, TX 79705
Water Station- Danny Stafford- 5501 Old Cavern Highway Carlsbad, NM 88220
Mineral Owner- Will Brantley- Merland Inc. P.O. 548 Carlsbad, NM 88220

Section I-IV. Appendix for Brine Well Application Guideline

Includes:

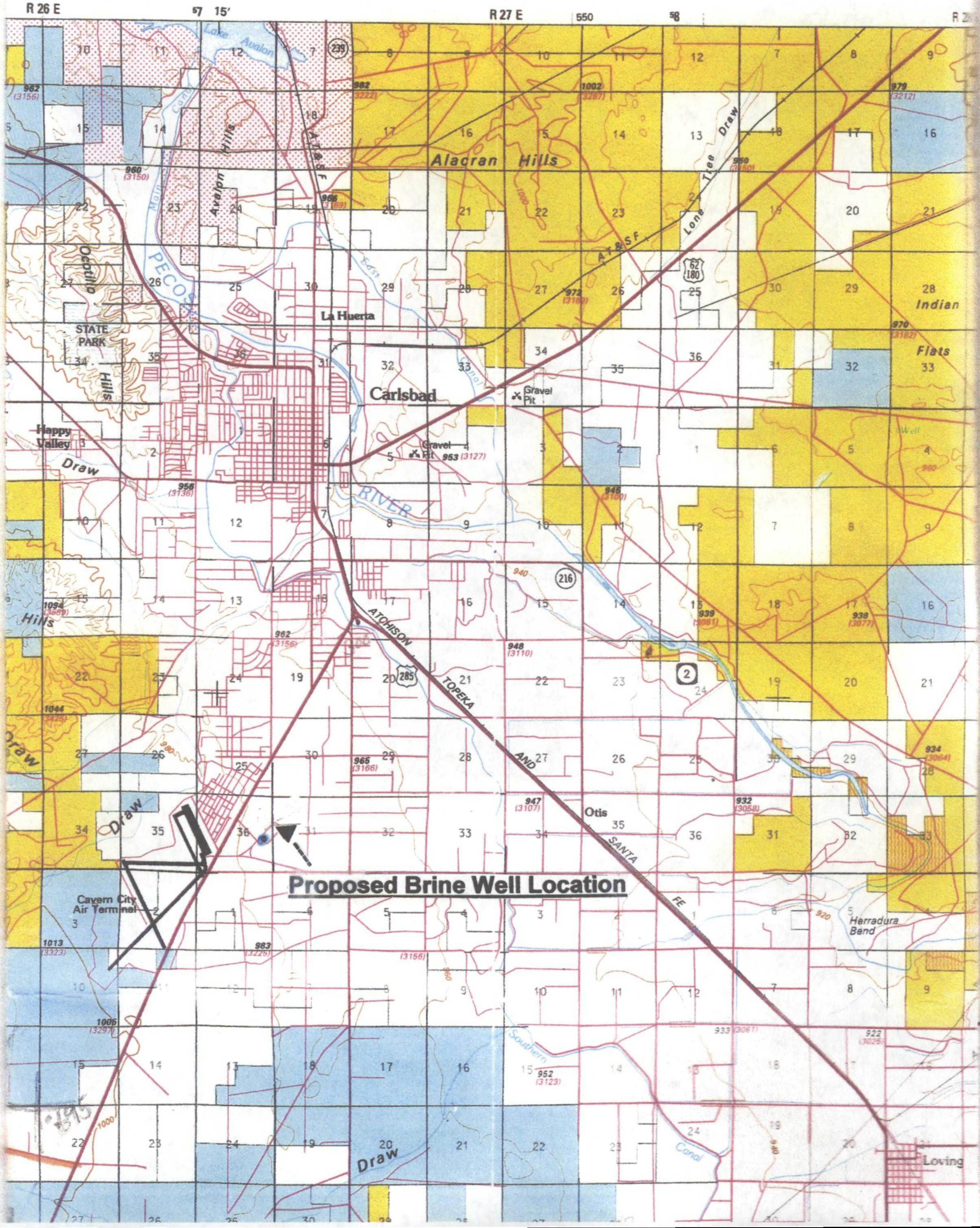
1. Eddy County Map depicting Carlsbad City limits marked in yellow, and proposed brine well location.
2. BLM Surface Management Status Topographic Map 1:100,000 scale with elevation contours, roads, water features and section, township and range lines (NGVD-1929) USGS and location of proposed site.
3. An Aerial photo of the site showing ¼ mile radius.
4. Surveyed plats of facility with purchase contract descriptions.



Eddy County NM Map-Carlsbad City limits marked in yellow
Proposed Brine Well Location
CARLSBAD
AVALON
LOVING
MALAGA
BLACK RIVER VILLAGE
WHITES CITY
LIVING DESERT STATE PARK
BRANTLEY LAKE STATE PARK
119. NICHOL
120. TOBYN CR 441
121. VINCENT CR 440
122. PUEBLO CR 439
123. APACHE CR 438
124. COMANCHE CR 435
125. ACOMA CR 437
126. TANOA CR 436
BELOW AT F-6
1. CR 657
2. MUSCATEL CR 632
3. ORCHARD CR 609
4. CR 635
5. CR 634
6. CR 633
7. CR 636
8. CR 631
9. CR 637
10. CR 611
11. CR 612
12. CR 638
13. CR 639
14. CR 640
15. CR 641
16. CR 620
17. CR 628
18. CR 616
19. CR 617
20. CR 620
21. CR 626
AT G-7
81. CR 779
82. CR 777
83. SIOUX CR 776
84. CR 880
85. CR 781
86. CR 780
87. PICACHO
88. GRAYSTON
89. CR 783
90. WARREN CR 778
91. HEPLER CR 705
92. KELLY CR 729
93. WALKER CR 729A
94. ROBERSON CR 710
95. RUIZ CR 814
96. HARRO CR 733
97. CARTER CR 712
AT H-8
79. CR 660
80. STANDPIPE CR 658
AT F-7
57. CR 683
58. LO-RAY
59. CR 811
60. CR 810
61. CR 751
62. HOPI CR 750
63. CR 885
64. CR 807
65. CR 826
66. CR 828
67. CR 817
68. CR 815
69. LAGUNA CR 839
70. VICKERY
71. HARKNESS CR 757
72. COLEMAN CR 753
73. VEST CR 830
74. ETCHVERRY CR 831
75. KEVIL CR 861
76. NORRIS CR 860
77. HASTON CR 764
78. SALAZAR CR 770
AT G-8
98. TAYLOR CR 769
99. MIRELES
100. CR 809
101. CR 803
102. CR 754
103. GRANDI CR 706
104. MISTY LN CR 756
105. PROMISE LAND
AT G-9

BLM Surface Management Status Topographic Map 1:100,000 scale with elevation contours, roads, water features and section, township and range lines (NGVD-1929) USGS and location of proposed site-------- ▲

30X6



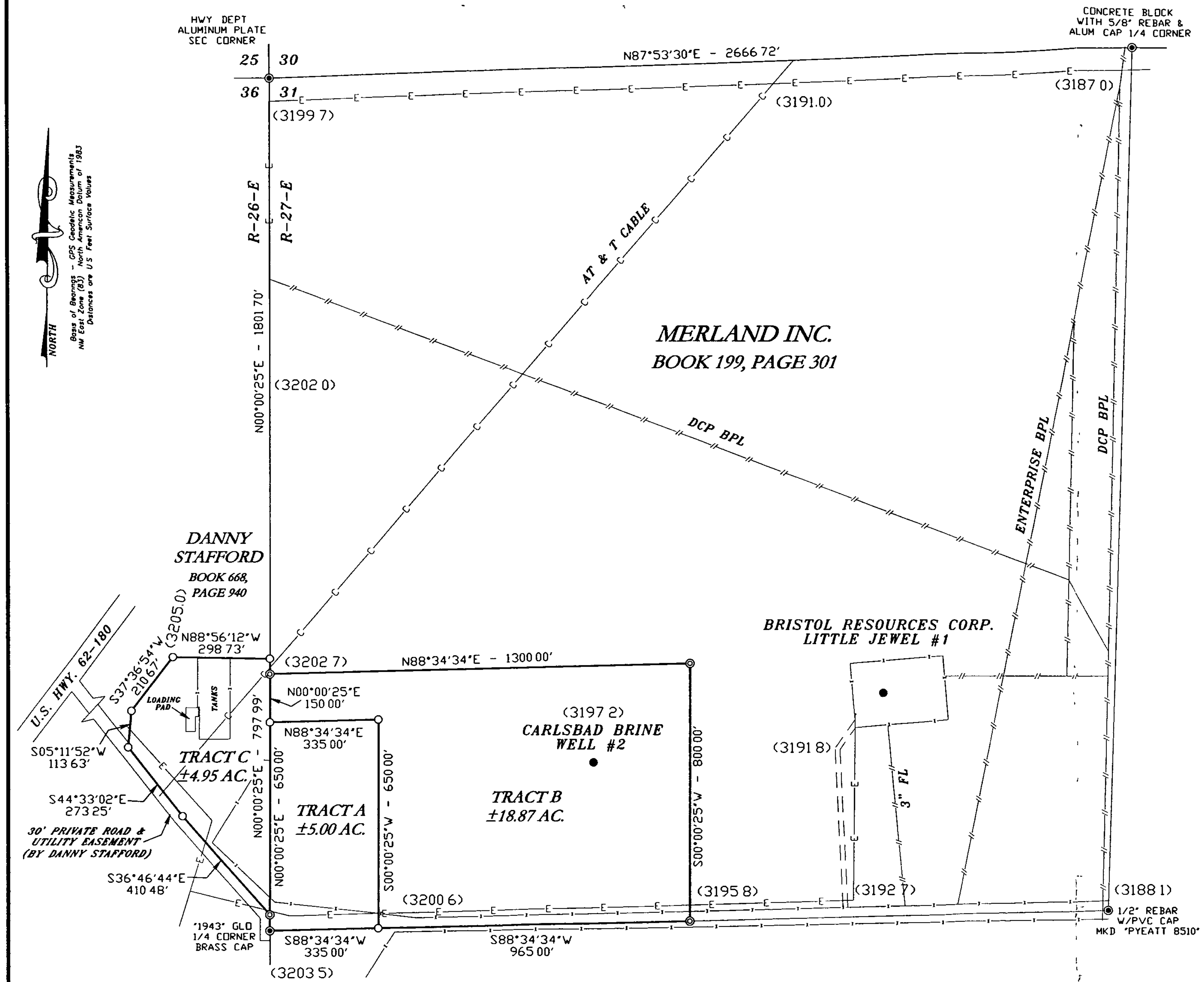
Key Energy Proposed Brine Well Location UL E Sec 31-Ts 22s-R27e
Approximately 3.5 miles SW of Carlsbad NM- Outer ETZ

Surveyed "PLATS" of the facility with purchase contract descriptions.

1. PLAT (Merland Inc. Land Division No. 1) A tract of land currently owned by Merland Inc., showing approximately 160.88 acres of land more or less, located in the NW/4 of Section 31-Ts 22s-R 27e NMPM in Eddy County, NM. Tract B (23.87 acres) shown on the plat is a parcel of land proposed to be sub-divided out of the 160.88 acres owned by Merland Inc. Key Energy LLC and Merland Inc., have a mutual agreement stipulating the transfer of ownership of Tract B from Merland Inc. to Key Energy. This transfer will commence upon Key Energy LLC receiving approval from all Federal, State, County, City or other entities, that require legal approval to construct and operate an oilfield Class III brine supply well as defined by the NMOCD and US EPA.
2. PLAT (Survey Plat of Three Tracts of Land) This plat provides a legal description of the proposed Key Energy LLC., brine water station and replacement brine well area. Tract A and Tract B comprises 23.87 acres of land that will be owned by Key Energy as described above. Tract C is 4.95 acres of land that is owned by Danny Stafford and currently leased to Key Energy. Tract C is the current location of the water station and tanks. This PLAT shows all existing significant features and utilities.
3. PLAT (Survey For A Private Road & Utility Easement). As required by local sub-division laws, an easement is required. This plat will be filed with the local authorities and a copy provided to the OCD for reference.
4. PLAT (Survey for Legal Description of Well Location). C-102

Note: Once Key Energy LLC is approved for the construction and operation of the brine well, all legal land transfer documents will be filed and copies provided to the NMOCD for the brine well file.

SURVEY PLAT OF THREE TRACTS OF LAND LOCATED IN LOTS 1 & 2 AND E1/2 NW1/4 SECTION 31, TOWNSHIP 22 SOUTH, RANGE 27 EAST AND SECTION 36, TOWNSHIP 22 SOUTH, RANGE 26 EAST, N.M.P.M., EDDY COUNTY, NEW MEXICO



LEGAL DESCRIPTION

THREE TRACTS OF LAND LOCATED IN LOTS 1 & 2 AND E1/2 NW1/4 SECTION 31, TOWNSHIP 22 SOUTH, RANGE 27 EAST AND SECTION 36, TOWNSHIP 22 SOUTH, RANGE 26 EAST, N M P M, EDDY COUNTY, NEW MEXICO AND BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS

TRACT A

BEGINNING AT A "1943" GLO 1/4 CORNER BRASS CAP BEING THE EAST QUARTER CORNER OF SAID SECTION 31 AND THE SOUTHWEST CORNER OF THIS TRACT, THENCE N00°00'25"E - 650 00 FEET ALONG THE WEST LINE OF SAID SECTION 31 TO A POINT BEING THE NORTHWEST CORNER OF THIS TRACT, THENCE N88°34'34"E - 335 00 FEET TO A POINT BEING THE NORTHEAST CORNER OF THIS TRACT, THENCE S00°00'25"W - 650 00 FEET TO A POINT BEING THE SOUTHEAST CORNER OF THIS TRACT, THENCE S88°34'34"W - 335 00 FEET TO THE POINT OF BEGINNING AND CONTAINING 5 00 ACRES OF LAND MORE OR LESS

TRACT B

BEGINNING AT A POINT ON THE WEST LINE OF SAID SECTION 31 WHICH LIES N00°00'25"E - 650 00 FEET FROM A "1943" GLO 1/4 CORNER BRASS CAP FOUND AS THE WEST QUARTER CORNER OF SAID SECTION 31, THENCE N00°00'25"E - 150 00 FEET ALONG THE WEST LINE OF SAID SECTION 31 TO A 1/2" REBAR W/PVC CAP MARKED "NM 15079 TX 5204" SET AS THE NORTHWEST CORNER OF THIS TRACT, THENCE N88°34'34"E - 1300 00 FEET TO A 1/2" REBAR W/PVC CAP MARKED "NM 15079 TX 5204" SET AS THE NORTHEAST CORNER OF THIS TRACT, THENCE S00°00'25"W - 800 00 FEET TO A 1/2" REBAR W/PVC CAP MARKED "NM 15079 TX 5204" SET AS THE SOUTHEAST CORNER OF THIS TRACT, THENCE S88°34'34"W - 965 00 FEET TO A POINT, THENCE N00°00'25"E - 650 00 FEET TO A POINT, THENCE S88°34'34"W - 335 00 FEET THE POINT OF BEGINNING AND CONTAINING 18 87 ACRES OF LAND MORE OR LESS.

TRACT C (LEASED FROM DANNY STAFFORD)

BEGINNING AT A 1/2" REBAR W/PVC CAP MARKED "NM 15079 TX 5204" SET ON THE EAST LINE OF SAID SECTION 36 WHICH LIES N00°00'25"E - 50 10 FEET FROM A "1943" GLO 1/4 CORNER BRASS CAP FOUND AS THE EAST QUARTER CORNER OF SAID SECTION 36; THENCE N00°00'25"E - 797 99 FEET ALONG THE EAST LINE OF SAID SECTION 36 TO A POINT BEING THE NORTHEAST CORNER OF THIS TRACT, THENCE N88°56'12"W - 298 73 FEET TO A POINT, THENCE S37°36'54"W - 210.67 FEET TO A POINT, THENCE S05°11'52"W - 113 63 FEET TO A POINT, THENCE S44°33'02"E - 273 25 FEET TO A POINT, THENCE S36°46'44"E - 410 48 FEET TO THE POINT OF BEGINNING AND CONTAINING 4 95 ACRES OF LAND MORE OR LESS.

400' 0 400' 800 FEET
SCALE 1"= 400'

Asel Surveying
P O BOX 393 - 310 W. TAYLOR
HOBBS, NEW MEXICO - 575-393-9146

SURVEYORS CERTIFICATE

I, TERRY J ASEL, NEW MEXICO REGISTERED PROFESSIONAL LAND SURVEYOR NO 15079, DO HEREBY CERTIFY THAT I CONDUCTED AND AM RESPONSIBLE FOR THIS SURVEY, THAT THIS SURVEY IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF, AND MEETS THE "MINIMIUM STANDARDS FOR SURVEYING IN NEW MEXICO" AS ADOPTED BY THE NEW MEXICO STATE BOARD OF REGISTRATION FOR PROFESSIONAL ENGINEERS AND SURVEYORS

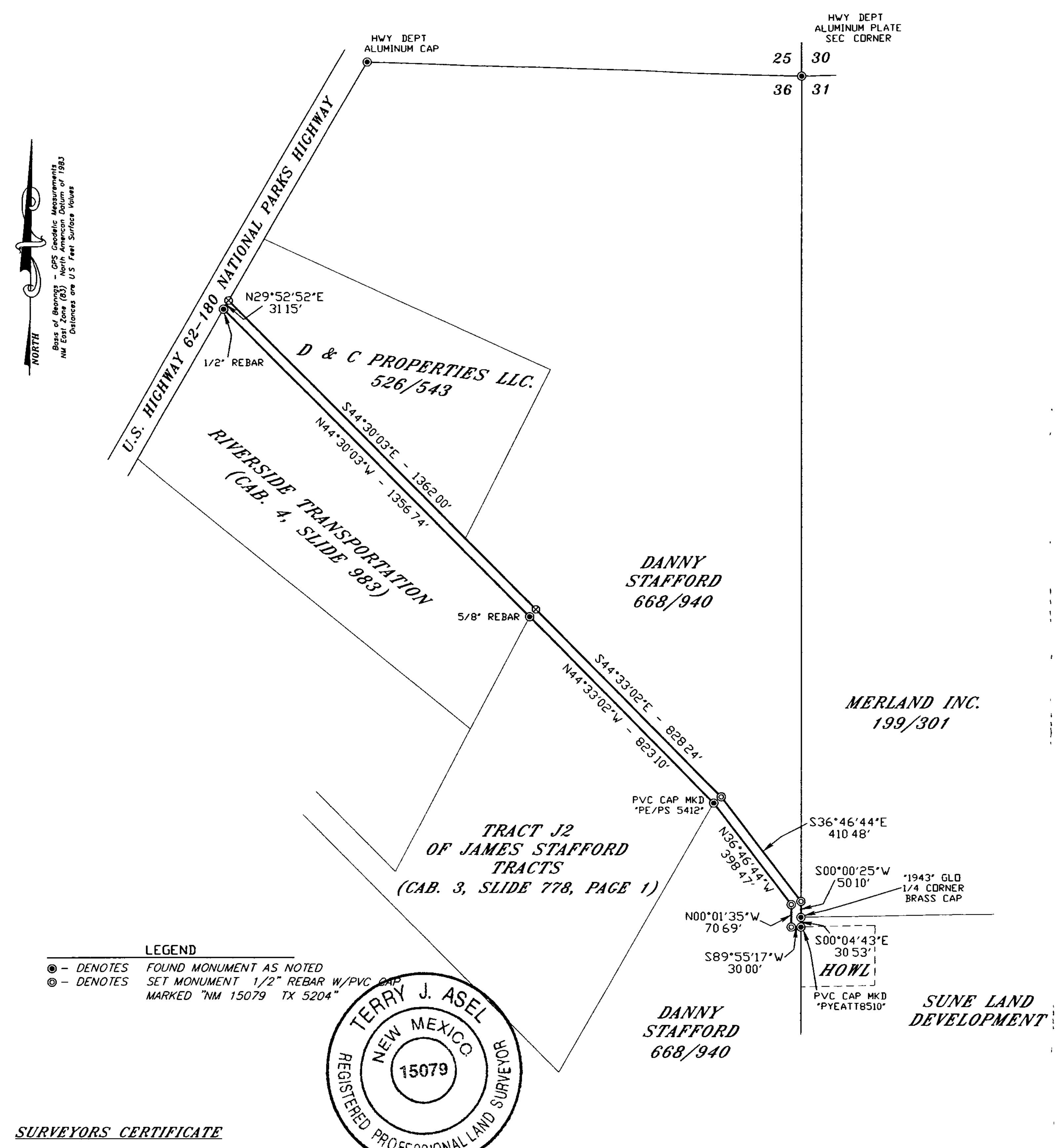
Terry J Asel
Terry J Asel N M R P S No 15079

1/18/2011
DATE

TERRY J. ASEL
NEW MEXICO
15079
REGISTERED PROFESSIONAL LAND SURVEYOR

LEGEND
◉ - DENOTES FOUND MONUMENT AS NOTED
◎ - DENOTES SET MONUMENT 1/2" REBAR W/PVC CAP MARKED "NM 15079 TX 5204"
(3203 5) - DENOTES GROUND ELEVATION

KEY ENERGY SERVICES LLC	Work Order #101216PS-b
Date Surveyed 12/16/2010	Surveyed by Terry Asel
DWG # 101216PS-b dwg	Drafted By: KA
Scale 1" = 400'	Sheet 1 of 1



SURVEY FOR A PRIVATE ROAD & UTILITY EASEMENT IN SECTION 36, TOWNSHIP 22 SOUTH, RANGE 26 EAST, N.M.P.M., EDDY COUNTY, NEW MEXICO

LEGAL DESCRIPTION

A PRIVATE ROAD & UTILITY EASEMENT IN SECTION 36, TOWNSHIP 22 SOUTH, RANGE 26 EAST, N M P.M , EDDY COUNTY, NEW MEXICO AND BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS

BEGINNING AT A "1943" GLO 1/4 CORNER BRASS CAP BEING THE EAST QUARTER CORNER OF SAID SECTION 36, THENCE S00°04'43"E – 30 53 FEET ALONG THE EAST LINE OF SAID SECTION 36 TO A PVC CAP MARKED "PYEATT8510" FOUND AS A CORNER OF THIS EASEMENT, THENCE S89°55'17"W – 30 00 FEET TO A 1/2" REBAR W/PVC CAP MARKED "NM 15079 TX 5204" SET AS A CORNER OF THIS EASEMENT, THENCE N00°01'35"W – 70 69 FEET TO A 1/2" REBAR W/PVC CAP MARKED "NM 15079 TX 5204" SET AS A CORNER OF THIS EASEMENT, THENCE N36°46'44"W – 398 47 FEET TO A PVC CAP MARKED "PE/PS 5412" FOUND AS A CORNER OF THIS EASEMENT, THENCE N44°33'02"W – 823.10 FEET TO A 5/8" REBAR FOUND AS A CORNER OF THIS EASEMENT, THENCE N44°30'03"W – 1356 74 FEET TO A 1/2" REBAR FOUND ON THE EAST RIGHT OF WAY LINE OF HIGHWAY 62-180 AND BEING A CORNER OF THIS EASEMENT, THENCE N29°52'52"E – 31.15 FEET ALONG THE EAST RIGHT OF WAY LINE OF HIGHWAY 62-180 AND BEING A CORNER OF THIS EASEMENT, THENCE S44°30'03"E – 1362 00 FEET TO A CORNER, THENCE S44°33'02"E – 828 24 FEET TO A 1/2" REBAR W/PVC CAP MARKED "NM 15079 TX 5204" SET AS A CORNER OF THIS EASEMENT, THENCE S36°46'44"E – 410 48 FEET TO A 1/2" REBAR W/PVC CAP MARKED "NM 15079 TX 5204" SET ON THE EAST LINE OF SAID SECTION 36 AND BEING A CORNER OF THIS EASEMENT, THENCE S00°00'25"W – 50 10 FEET ALONG THE EAST LINE OF SAID SECTION 36 TO THE POINT OF BEGINNING AND CONTAINING 1 84 ACRES OF LAND MORE OR LESS

OWNERS STATEMENT AND AFFIDAVIT

STATE OF NEW MEXICO)
COUNTY OF EDDY)

THE UNDERSIGNED BEING FIRST DULY SWORN ON OATH, STATE:

AS THE OWNERS AND PROPRIETORS, WE HAVE OF OUR OWN FREE WILL AND CONSENT CAUSED THIS PLAT WITH ITS TRACTS TO BE PLATTED.

SUBSCRIBED, SWORN TO AND ACKNOWLEDGED BEFORE ME THIS_____ DAY OF__________________, 2011 BY

____
DANNY STAFFORD

ACKNOWLEDGEMENT

STATE OF NEW MEXICO)
COUNTY OF EDDY)

THIS INSTRUMENT WAS ACKNOWLEDGED BEFORE ME ON THIS_____DAY OF______________, 2011 BY
____________________________________.

MY COMMISSION EXPIRES:__________________ ______________________________
NOTARY PUBLIC

SURVEYORS CERTIFICATE

I, TERRY J ASEL, NEW MEXICO REGISTERED PROFESSIONAL LAND SURVEYOR NO 15079, DO HEREBY CERTIFY THAT I CONDUCTED AND AM RESPONSIBLE FOR THIS SURVEY, THAT THIS SURVEY IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF, AND MEETS THE "MINIMUM STANDARDS FOR SURVEYING IN NEW MEXICO" AS ADOPTED BY THE NEW MEXICO STATE BOARD OF REGISTRATION FOR PROFESSIONAL ENGINEERS AND SURVEYORS

Terry J Asel

Terry J Asel N M R P S No 15079

1/18/2011
DATE

400' 0 400' 800 FEET
SCALE 1" = 400'

Asel Surveying
P O BOX 393 – 310 W TAYLOR
HOBBS, NEW MEXICO – 575-393-9146

DANNY STAFFORD	Work Order #110112PS
Date Surveyed 1/12/2011	Surveyed by Terry Asel
DWG # 110112PS dwg	Drafted By KA
Scale 1" = 400'	Sheet 1 of 1

INDEXING INF. FOR CO. CLERK
SEC. 36 *T.*22S *R.* 26E *N.M.P.M.*
SUBDIVISION: N/A
OWNER: DANNY STAFFORD
CITY: CARLSBAD
COUNTY: EDDY
STATE: NEW MEXICO
DATE: JANUARY 12, 2011
ACCESS: YES
AREA: ±1 84 ACRES

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 & Natural Resources Department
OIL CONSERVATION DIVISION
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-102
Revised October 12, 2005
Submit to Appropriate District Office
State Lease- 4 Copies
Fee Lease- 3 Copies

☐ AMENDED REPORT

WELL LOCATION AND ACREAGE DEDICATION PLAT

API Number	Pool Code	Pool Name

Property Code	Property Name	Well Number
	CARLSBAD BRINE	*2*
OGRID No.	**Operator Name**	**Elevation**
	KEY ENERGY SERVICES LLC.	*3197.2'*

Surface Location

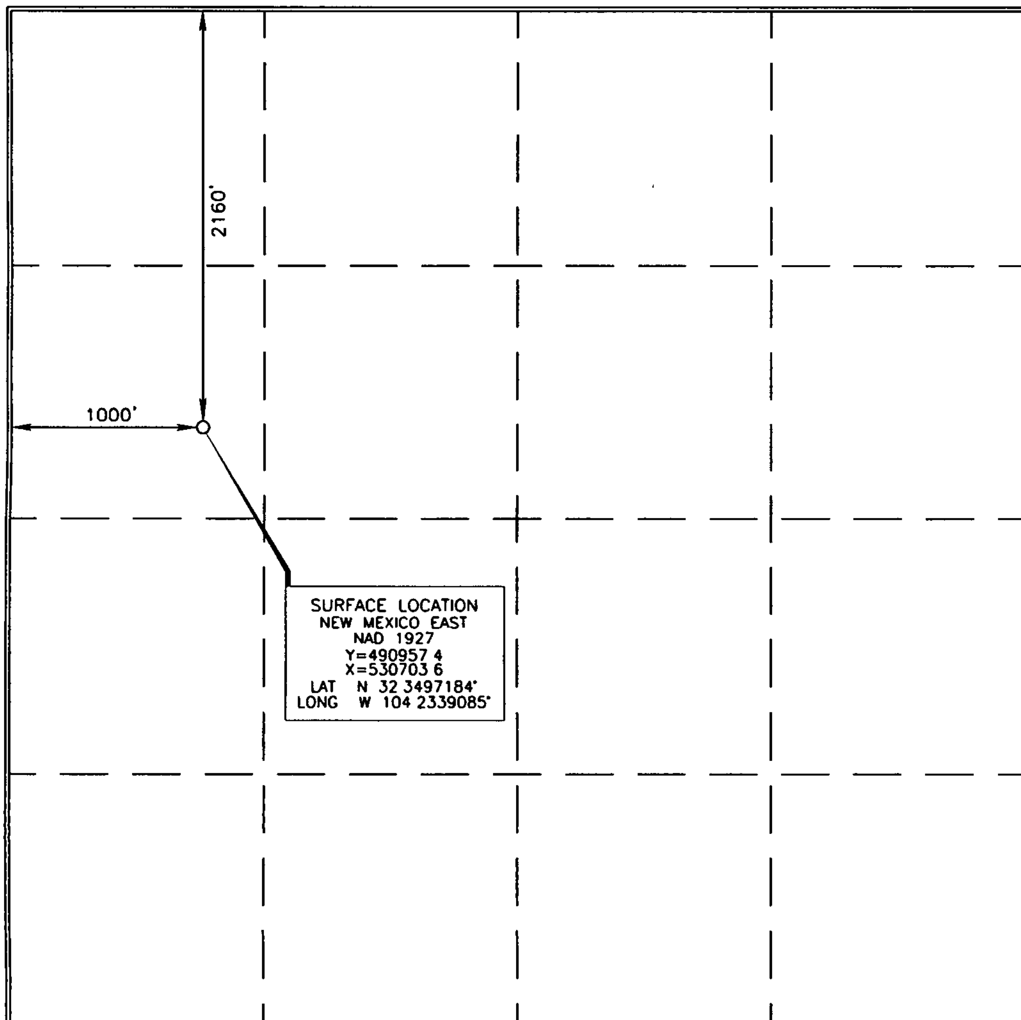
UL or lot no	Section	Township	Range	Lot Idn	Feet from the	North/South line	Feet from the	East/West line	County
E	31	22 SOUTH	27 EAST, N.M.P.M.		2160'	NORTH	1000'	WEST	EDDY

Bottom Hole Location If Different From Surface

UL or lot no	Section	Township	Range	Lot Idn	Feet from the	North/South line	Feet from the	East/West line	County

Dedicated Acres	Joint or Infill	Consolidation Code	Order No

No allowable will be assigned to this completion until all interests have been consolidated or a non-standard unit has been approved by the division.



OPERATOR CERTIFICATION

I hereby certify that the information contained herein is true and complete to the best of my knowledge and belief, and that this organization either owns a working interest or unleased mineral interest in the land including the proposed bottom hole location or has a right to drill this well at this location pursuant to a contract with an owner of such a mineral or working interest, or to a voluntary pooling agreement or a compulsory pooling order heretofore entered by the division

Signature Date

Printed Name

SURVEYOR CERTIFICATION

I hereby certify that the well location shown on this plat was plotted from field notes of actual surveys made by me or under my supervision, and that the same is true and correct to the best of my belief

DECEMBER 16, 2010
Date of Survey

Signature and Seal of Professional Surveyor

TERRY J. ASEL
NEW MEXICO
15079
REGISTERED PROFESSIONAL LAND SURVEYOR

Terry J. Asel 1/17/2011

Certificate Number 15079

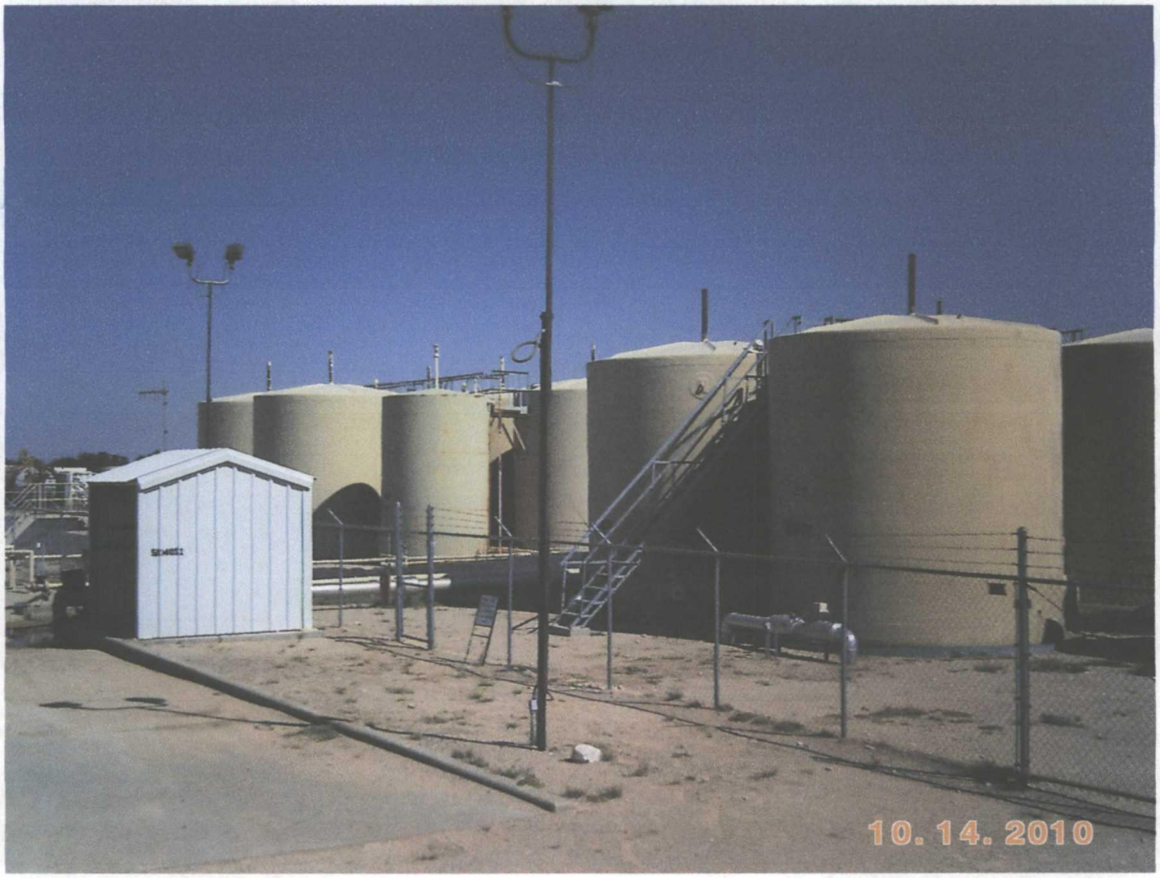
WO# 101216WL (KA)

V. Type and Quantities of Fluids Stored or Used at the Facility -List all fluids stored or used at the facility (e.g. High TDS salt water, hydrocarbons, etc.). Include source, average daily volume produced, estimated volume stored, location, and type of containers.

Answer: The existing water station constructed in 2005 can store approximately 2500 barrels of concentrated salt water (i.e. 10 lb/gal brine water) in five (5) above ground fiberglass tanks; and store 2000 barrels of fresh water in four (4) above ground fiberglass tanks; and store 210 barrels of rainwater-brine water mix, generated from rainfall events and deminimis drips from the concrete loading pad area in one (1) above ground fiberglass catch-tank.

There will also be a one (1) small 100-gallon plastic tank to store a chemical packer fluid to be located in the new brine well house.

Fresh water is obtained from the City of Carlsbad and brine water will be generated from a new brine well to be located approximately 1100 feet east of the storage tanks. The anticipated brine water production will have an estimated Instantaneous flow rate of 3-5 barrels per minute. Estimated monthly totals could vary from 0-50,000 barrels per month or 0-1,666 barrels per day depending upon on usage demand.



Key Carlsbad Water Station

VI. Transfer, Storage and Disposal of Fluids and Solids

VI.A.- Provide sufficient information to determine what water contaminants may be discharged to the surface and subsurface within the facility. Information desired includes whether tanks, piping, and pipelines are pressurized, above ground or buried. If fluids are drained to surface impoundments, skimmer pits, emergency pits, sumps, etc. for further transfer and processing, provide size and show if these units are lined or unlined. Provide fluid flow schematics with sufficient detail to show individual units.

Answer: The City of Carlsbad has a buried fresh water line that supplies the water station with fresh water. The fresh water line will have either an installed air-break, or approved check valve to prevent back flow into the city line.

There are four 500-barrel fresh water tanks that are manifold together with an automatic level control. Each tank has isolation valves for maintenance. The output of the tanks feed a fresh water load pump, which is control by the sales management system. Another output from the fresh water manifold goes underground directly to the brine well charge pump, located in the pump house, just south of the fresh water tanks.

The brine well charge pump will feed a 4-6 inch buried fresh water line going from the pump house to the brine well located approximately 1100 feet east of the pump house. The exposed portions of this line will be insulated for freeze protection.

The brine well will be located in a well house and will have a well head piping manifold with isolation valves, pressure gauges, and braden-head outlets. There will be a 4-6 " above ground pressured rated PE fast line from the well head to the brine well tanks inlet manifold. There will be isolation valves on both ends.

Optional Design: Key will entertain the idea of placing the brine well discharge piping between the well head and brine tanks in some form of secondary containment.

There are five 500-barrel brine water storage tanks connected to a common header that is connected to the suction side of an electric driven load pump. The load pump is controlled by an automatic sales management system. Trucks are loaded on a concrete loading pad. All tanks, headers, and pumps have manual isolation valves. The brine well charge pump will be cycled off and on, depending upon the level in the brine tanks. There is a fail-safe, hi-level shut-off with alarm.

As mentioned, there is a concrete loading pad with an integral sump and pump that removes fluids automatically. The water from this sump is automatically transferred to the above ground 210-barrel catch-tank. Key will coat this loading pad and sump with either a fiberglass or salt resistant epoxy coating for added protection.

Another 400-gallon sump is located inside the lined bermed brine water storage tank area to collect rainwater. This sump is a fiberglass tank with a pump and level control to automatically transfer collected water to the above ground 210-barrel catch tank.

A brine well piping schematic and facility-fluid flow diagrams are included in section VI appendix for reference. The water station will have the same basic configuration as the previously permitted site, with the exception that any underground lines containing other than fresh water, will be aboveground.

VI.A.1. *Tankage and Chemical Storage Areas - Storage tanks for fluids other than fresh water must be bermed to contain a volume one-third more than the largest tank. If tanks are interconnected, the berm must be designed to contain a volume one-third more than the total volume of the interconnected tanks.*

Chemical and drum storage areas must be paved, curbed and drained such than spills or leaks from drums are contained on the pads or in lined sumps.

Answer: The brine water tanks, catch-tank, and 400-gallon rainwater sump are located on an existing sand-gravel pad underlain by an impervious 60 mil HDPE black liner and bermed to sufficiently maintain one and one-third volume of the total interconnected tanks. The size of the bermed area is approximately 130 feet by 60 feet and 3 feet high. Based on these figures, the secondary containment can contain approximately 4,167 barrels of fluid. This facility has been previously approved by OCD under discharge permit BW-19. Enclosed in appendix VI is a recent photo of this area.

Optional Design: Key will entertain the idea of placing the brine well discharge piping between the well-head and brine tanks in some form of secondary containment.

As mentioned above, there will be one small chemical tank containing a well bore packer fluid. The tank will be located inside of the well house with secondary containment. Enclosed in appendix VI is a copy of the packer fluid MSDS.

VI.A.2. *Surface impoundments-Date built, use, type and volume of materials stored, area, volume, depth, slope of pond sides, sub-grade description, liner type and thickness, compatibility of liner and stored materials, installation methods, leak detection methods, freeboard, runoff/runon protection.*

Answer: There are no surface impoundments at this facility.

VI.A.3. *Leach fields-Type and volume of effluents, leach field area and design layout. If non-sewage or mixed flow from any process units or internal drains is, or has been, sent to the leach fields, include dates of use and disposition of septic tank sludges.*

Answer: There are no leach fields at this facility.

VI.A.4. *Solids disposal-Describe types, volumes, frequency and location of on-site solids dried disposal. Typical solids include sands, sludges, filters, containers, cans and drums.*

Answer: Routine domestic household type trash, or other similar non-domestic waste pursuant to 19.15.35.8 NMAC, generated from on-site activities, will be stored in common trash cans and/or bins that are supplied and picked up routinely by the local waste management trucking company and disposed of at a New Mexico Environment Department permitted solid waste transfer or disposal facility.

Liquid and solid waste generated from the clean-up of deminimis leaks, drips, spills of oilfield non-domestic waste, resulting from routine operations, will be stored in tanks, sealed drums, bins or other containers in a bermed secondary containment area for liquids, or for solids, on an impermeable pad and curd. This waste material may be stored up to 180 days before being, recycled, or disposed of off-site pursuant to section VI.C below.

The 180-day time period will not start until the on-site liquid volume exceeds 210 barrels, which is the volume of the sump (catch-tank), or when the solid waste container(s) are filled to capacity. Each container will be properly labeled with type of contents, RCRA classification, and dated.

Deminimis volumes of liquids contained in secondary containment devices or sumps, that do not interfere with normal operations, or has a minimal chance of being released to the environment, will be allowed to evaporate.

Non-contaminated liquids, i.e. rainwater, may be recycled, disposed of off-site (per section VI.C below), or discharged on site as irrigation water for native vegetation or wildlife. If discharged on site, Key will verify that the water is clean, clear, and contains chlorides no greater than 250 mg/l, TDS < 1000 mg/l and no oil sheen. Samples will be retained for one year. The events and results will be included in the annual report.

All other oilfield non-domestic liquid and solid waste generated as a result of unintentional releases of water contaminants to the ground will be reported and corrective actions taken pursuant to OCD Rule 19.15.29 NMAC. The events and results will be included in the annual report.

VI.B. For each of the transfer/storage/disposal methods listed above:

VI.B.1. Describe the existing and proposed measures to prevent or retard seepage such that ground water at any place of present or future use will meet the WQCC Standards of Section 3-103, and not contain any toxic pollutant as defined in Section 1-101.UU.

Answer: All tanks, drums, bins, etc., containing anything other than fresh water, will have impervious secondary containment or pad and curb, as described above, except for the loading pad sump. All unloading valves will have encapsulating containers to prevent miscellaneous drips, leaks or spills. All loading areas will have concrete loading ramps that are sloped to prevent brine water run-off.

The concrete loading pad will have a coated concrete sump to allow deminimis leaks, spills and rainwater to be collected and placed in an above ground tank with secondary containment.

All process piping, other than fresh water, will be above ground, unless install in an appropriate secondary containing device with leak detection.

VI.B.*2. Provide the location and design of site(s) and method(s) to be available for sampling, and for measurement or calculation of flow.*

Answer: Both brine and fresh water samples will be collected from the load lines. Fresh and brine water will be monitored in the pump house, located south of the fresh water tanks enclosed within the facility fence. Electronic accumulating flow meters with an accuracy of ±1% will be utilized.

A continuous pressure chart recorder will be installed and maintained. A minimum of two pressure gauges will be installed to verify recording pressures. The system will include a high-pressure cut-off relay and alarm for formation protection, except if the selected pump cannot exert sufficient pressure to cause harm.

VI.B.*3. Describe the monitoring system existing or proposed in the plan to detect leakage or failure of any discharge system. If ground water monitoring exists or is proposed, provide information on the number, location, design, and installation of monitoring wells.*

Answer: The water station has an automatic electronic sales management system with overflow shut-down systems incorporated in the design. The system tanks have low, normal and high-level control devices.

Groundwater monitoring is being proposed at this time. Key plans on installing a minimum of three groundwater monitoring wells. Once the permit is approved, key will submit details on the depths, locations, design and construction for OCD approval.

Subsidence monitoring is being proposed at this time. Key plans on installing a minimum of three subsidence monitors similar in installation and construction as the existing monitors currently installed on the former brine well BW-19. Key Energy will submit installation plans for OCD approval within one year after permit approval.

VI.C. Off-Site Disposal

If wastewaters, sludges, solids etc. are pumped or shipped off-site, indicate general composition (e.g. waste oils), method of shipment (e.g. pipeline, trucked), and final disposition (e.g. recycling plant, OCD-permitted or domestic landfill, Class II disposal well). Include name, address, and location of receiving facility. If receiving facility is a sanitary or modified domestic landfill show operator approval for disposal of the shipped wastes.

Answer: Routine domestic household type trash, or other similar non-domestic waste pursuant to 19.15.35.8, generated from on-site activities, will be stored in common trash cans and/or bins that are supplied and picked up routinely by the local waste management trucking company and disposed of at a New Mexico Environment Department Permitted Solid Waste Transfer or Disposal facility.

Waste generated on site will either be recycled or shipped off site by trucks owned or operated by Key Energy, or by other commercial trucking companies. Liquid waste from the sump catch-tank will either be recycled or shipped off-site to a class II SWD well permitted by OCD, or to an OCD permitted surface waste management facility.

Key is requesting that any commercial OCD solid waste management facility, permitted pursuant to 19.15.36 NMAC, be incorporated as an approved disposal site. In addition, Key is requesting that any New Mexico Environment Department commercial permitted facility be incorporated as an approved disposal site pursuant to 19.15.35.8 type waste. Key will have the responsible to ensure that all waste is properly stored, transported, classified, tested, manifested and the receiving facility is approved to take the waste type.

Key is also requesting that any Class II SWD type well permitted by the OCD for commercial disposal or any Class II well owned and operated by Key Energy, or another company by written agreement, be incorporated as an approved disposal site. Key will have the responsible to ensure that all waste is properly stored, transported, classified, tested, manifested and the receiving facility is approved to take the waste type.

All waste shipped off-site, will be summarized and reported in an annual report due March 31 of each year. The report will indicate general composition (e.g. brine water, soil contaminated with brine water, etc.), method of shipment (e.g. trucked), and final disposition (e.g. recycling plant, OCD-permitted or domestic landfill, Class II disposal well). The report will include the name, address, and location of receiving facility. All manifest, test results, etc. and any other pertinent information will be included in the report.

VI.D. Proposed Modifications

VI.D.1. If protection of ground water cannot be demonstrated pursuant to Section B.1. above, describe what modification (including closure) is proposed to meet the requirements of the Regulations. Describe in detail the proposed changes. Provide the information requested in A. and B. above for the proposed modified facility and a proposed time schedule for construction and completion. (Note: OCD has developed specific guidelines for lined surface impoundments that are available on request.)

Answer: This is a new application and no modifications are required or anticipated at this time. If permit conditions require modifications then they will be properly addressed after permit is issued within appropriate time lines

VI.D.2. For ponds, pits, leach fields, etc. where protection of ground water cannot be demonstrated, describe the proposed closure of such units so that existing fluids are removed, and emplacement of additional fluids and runoff/runon of precipitation are prevented. Provide a proposed time schedule for closure.

Answer: There are no ponds, pits, or leach fields at this site. There are no designed discharges to the surface or sub-surface that would impact ground or surface water.

VI.E. If the facility contains underground piping, the age and specification (i.e., wall thickness, fabrication material, etc.) of said piping should be submitted. Upon evaluation of such information, mechanical integrity testing of piping may be necessary as a condition for discharge plan approval. If such testing (e.g. hydrostatic tests) has already been conducted, details of the program should be submitted.

Answer: This facility will not contain any underground piping other than fresh water lines.

VI.F. Inspection, Maintenance and Reporting

VI.F.1. Describe proposed routine inspection procedures for surface impoundments and other transfer, storage, or disposal units including leak detection systems. Include frequency of inspection, how records are to be maintained and OCD notification in the event of leaks.

Answer: The facility will be inspected on a daily basis by drivers and supervisors. A safety supervisor will perform weekly inspections, with the results recorded on a log sheet. Deficiencies will be addressed and maintained on file for a minimum of five years. Inspection report forms will be developed and supplied in the annual report with a summary of corrective actions.

Releases will be reported and corrective actions taken pursuant to OCD Rule 19.15.29 NMAC and noted in the weekly and annual reports.

VI.F.2. If ground water monitoring is used to detect leakage or failure of the surface impoundments, leach fields, or other approved transfer/storage/disposal systems provide:

Answer: All groundwater, subsidence, level controls, flow controls, pressure charts, gauges, valves, electric monitors, housekeeping issues, leaks/spills, inoperative equipment, and any special observations will be incorporated in the inspection reports and reported in the annual reports.

VI.F.2.a. The frequency of sampling, and constituents to be analyzed.

Answer: As indicated in VI.B.3 above, Key Energy plans on installing a minimum of three groundwater monitoring wells and subsidence devices. Once the permit is approved, key will submit details on the depths, locations, design, construction, sample frequency and analysis for OCD approval.

VI.F.2.b. The proposed periodic reporting of the results of the monitoring and sampling.

Answer: Once Key and the agency agree on sampling points, analysis, and frequency, then the results will be included in an annual report submitted to the agency by March 31, of each year after operations began.

VI.F.2.c. The proposed actions and procedures (including OCD notification) to be undertaken by the discharger in the event of detecting leaks or failure of the discharge system.

Answer: Key understands special permit conditions may be imposed when monitoring indicates a problem.

VI.F.3. Discuss general procedures for containment of precipitation and runoff such that water in contact with process areas does not leave the facility, or is released only after testing for hazardous constituents. Include information on curbings, drainage, disposition, notification, etc.

Answer: The current water station system is currently designed to hold a large amount of rainfall. All brine water tanks are surrounded by an impermeable 3-foot high berm. The concrete loading pad can hold an approximate 4-inch rainfall before, overflowing. Key Energy will remove all fluids during or after significant rainfall events within one week. These fluids will be recycled or properly disposed of as indicated in sections VI.A.4 and VI.C above.

Special attention will be given to make sure no standing water from either leaks or spills, or rainfall events remain over the anticipated brine well cavern located approximately 1100 feet to the east. The system will be designed to allow normal sheet flow off of the site. A small berm will be located on the southeast side of the well to ensure that run-off from the brine well site will not enter into the small stock/wildlife pond located on Mr. Brantley's property.

Any leaks or spills of brine or fresh water around the wellhead will be routinely picked up and disposed of properly.

VI.F.4. Describe methods used to detect leaks and ensure integrity of above and below ground tanks, and piping. Discuss frequency of inspection and procedures to be undertaken if significant leaks are detected.

Answer: As mentioned in VI.F.1 above the system will be observed daily with routine inspections documented. Emergencies will be handled pursuant to a site-specific contingency plan included in section VIII below.

VI.F.5. Submit a general closure plan describing what actions are to be taken when the facility discontinues operations. These actions must include:

VI.F.5.a. Removal of all fluids, contaminants and equipment.

Answer: All products, equipment, and materials may be sold, recycled or disposed of in a legal manner; or left on site, if Key Energy adequately demonstrates it has a future beneficial use by remaining on-site, and will not be a threat to public health, fresh water or the environment.

Water contaminants remaining on site, which will cause surface or groundwater exceedence, or is a significant threat to public health or the environment, will be remediated to safe acceptable levels.

VI.F.5.b. Grading of facility to as close to the original contour as is practical.

Answer: The facility will be restored to its original contour that was found when permitted, unless it has a future beneficial use as is, and will not adversary impact the environment.

VI.F.5.c. Proper disposal of fluids, sludges and solids pursuant to rules and regulations in effect at the time of closure.

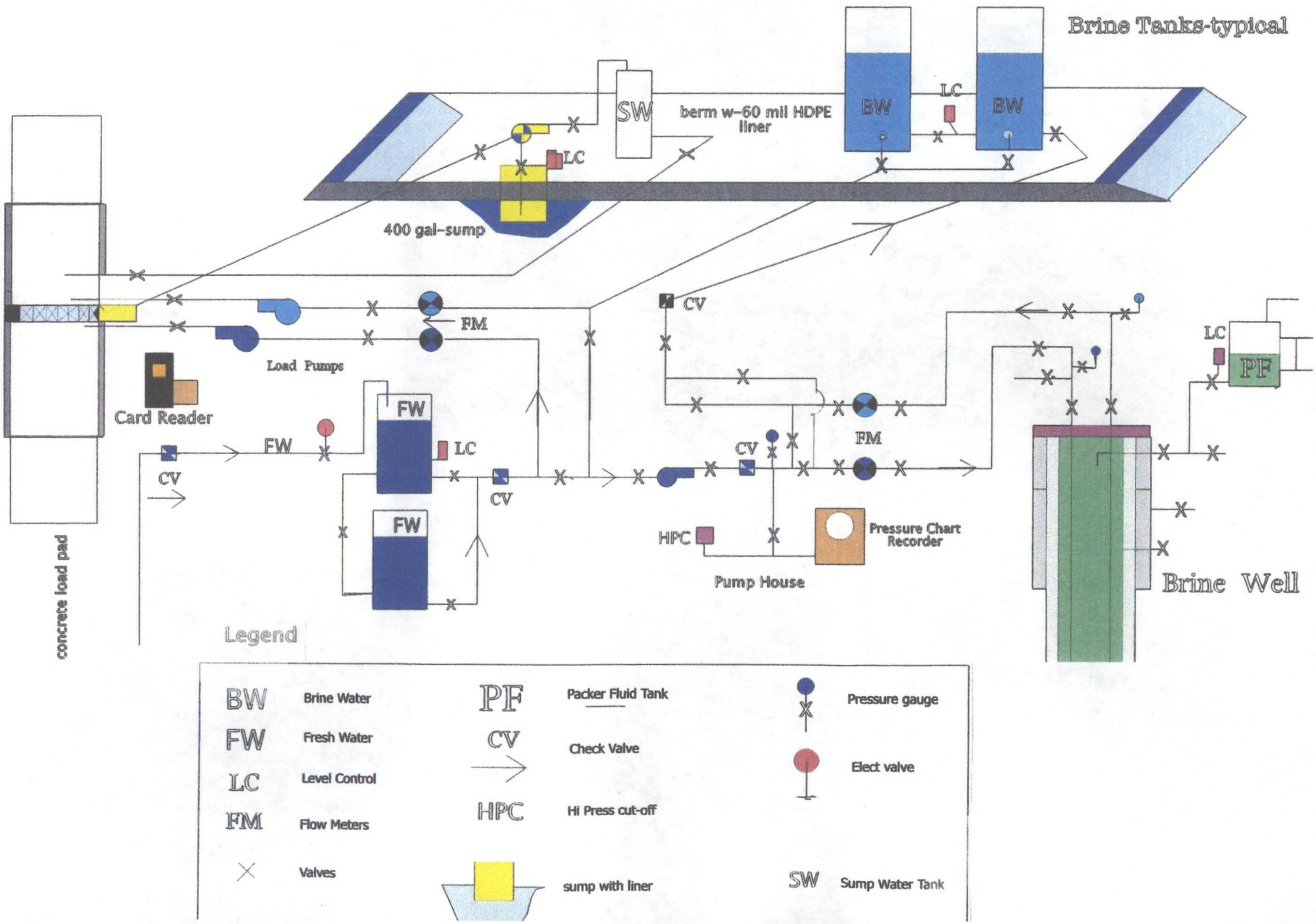
Answer: Inheritably waste-like materials, such as fluids, sludges, and solids, may be sold, recycled or disposed of in a legal manner; or left on site, if Key Energy adequately demonstrates it has a future beneficial use by remaining on-site, and will not be a threat to public health, fresh water or the environment.

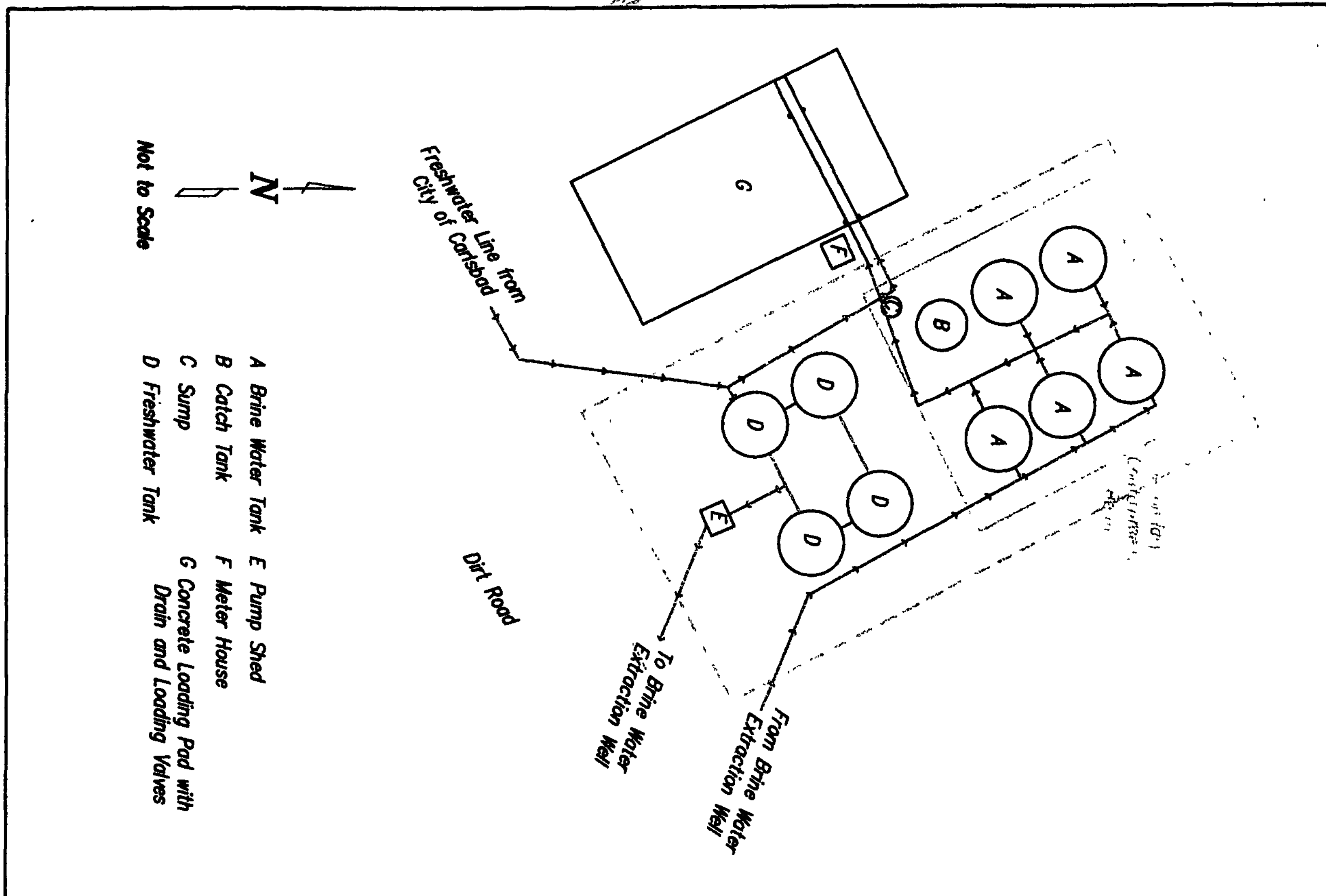
Section VI. Appendix for Brine Well Application Guideline
Includes:

1. Brine well piping schematic
2. Facility and Fluid Flow Diagram
3. Recent photo of the Key Energy brine water tank storage area.
4. Packer Fluid MSDS

Key Energy Brine Well Piping Schematic

Date: 12/22/10
Drawn By: LWP
New Carlsbad Replacement Brine well





Facility and Fluid Flow Diagram
Key Energy Discharge Plan BW-019
Carlsbad, New Mexico

Figure 2

Revisions
By: ______ Date: ______ Descr.: ______
By: ______ Date: ______ Descr.: ______

Drawn MLV
Checked DJE
Approved DJE

SMA

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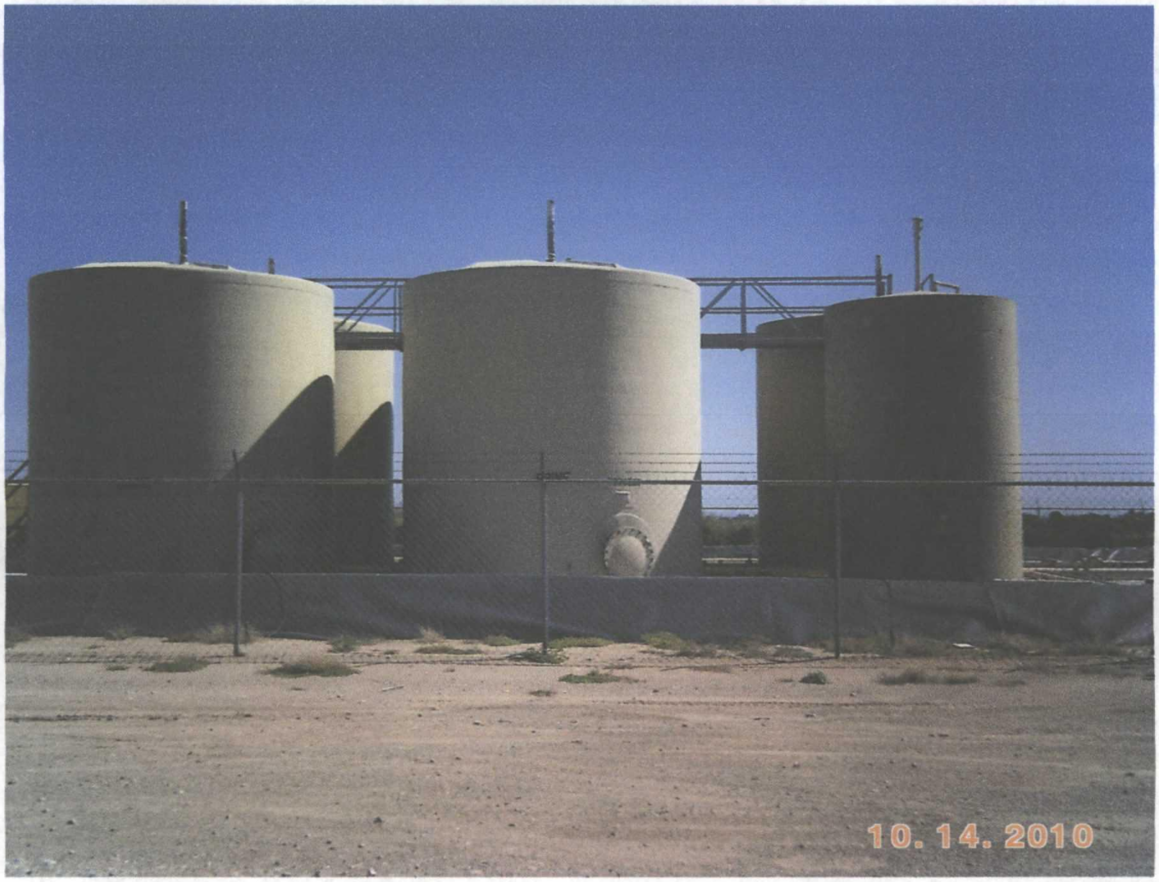
5317307
08-07

Key Energy Brine and Fresh Water Station.

Photo shows 5-500 barrel brine water tanks and 1-210 barrel sump (catch tank) inside bermed area. Battery is lined with 60 mil HDPE liner for secondary containment.



TECHNI-HIB™ 606 Corrosion Inhibitor

CHEMICAL PRODUCTS AND SERVICES

Product Information

Description

TECHNI-HIB 606 corrosion inhibitor is a water-soluble combination of a cationic filming corrosion inhibitor and sulfite-based oxygen scavenger.

Uses

TECHNI-HIB 606 corrosion inhibitor has been developed for use as a packer fluid inhibitor, hydrostatic test inhibitor and general purpose filming corrosion inhibitor for water injection systems, water disposal operations, power water pumping systems and high water/oil ratio producing oil wells where a small amount of oxygen is present.

Application

TECHNI-HIB 606 corrosion inhibitor can be injected continuously into a system at a rate of 60 to 120 ppm (1 to 2 quarts per 100 barrels of water). When used as a packer fluid inhibitor, 2500 to 5000 ppm (10 to 20 gallons per 100 barrels of water) is required. When used as a hydrostatic test fluid inhibitor, TECHNI-HIB 606 corrosion inhibitor injected at a rate of 500 to 3500 ppm is typically recommended dependent on conditions.

Technical Data

Specific Gravity @ 60°F	0.991 - 1.027
Pounds Per Gallon @ 60°F	8.26 - 8.56
Freeze Point	-5°F
Flash Point(TCC)	98°F
pH	6 - 6.5
Appearance	Dark Brown Liquid

SOLUBILITIES:

Fresh Water	Soluble
2% Brine	Soluble
15% Brine	Soluble
Crude Oil	Insoluble

Safety Precautions

WARNING! FLAMMABLE. Keep away from heat, sparks, and open flame. Keep container closed when not in use. Do not breathe vapors, use with adequate ventilation. Avoid contact with eyes, skin, and clothing.

References

TECHNI-HIB 606 corrosion inhibitor is available in 55-gallon drums and bulk quantities. Refer to Material Safety Data Sheet for additional information and first aid.

BJ CHEMICAL SERVICES
MATERIAL SAFETY DATA SHEET

Section: 01 PRODUCT IDENTIFICATION

BJ CHEMICAL SERVICES	Emergency Telephone	CHEMTREC (800)424-9300
707 N. LEECH	Previous Version Date	5/20/03
HOBBS, NM 88241-1499	Date Prepared	10/30/03
TELEPHONE:(575)393-7751	Version: 0000009	

Product Name: TECHNI-HIB 606
Trade Name: Packer Fluid Inhibitor
Chemical Description:
Combination oxygen scavenger/corrosion inhibitor

Section: 02 HAZARDOUS INGREDIENTS

Component Name	CAS#	% Range
methanol	000067-56-1	< 15%
isopropyl alcohol	000067-63-0	< 10%
ammonium bisulfite	010192-30-0	< 10%

Section: 03 PHYSICAL DATA

Freezing Point: - 5 Deg.F. pH: 6 - 6.5
Boiling Point, 760 mm Hg: approx. 200 Deg.F
Specific Gravity(H2O=1) : 1.009 Solubility in water: Soluble
Appearance and Odor: Dark brown liquid; pungent odor.

Section: 04 FIRE AND EXPLOSION HAZARD DATA

Flash Point (Test Method): 98 Deg.F TCC

Extinguishing Media

CO2, dry chemical, water spray or fog, or foam. Use water to keep containers cool. Isolate "fuel" supply from fire. Contain fire fighting liquids for proper disposal.

Special Fire Fighting Procedures

Do not enter confined fire space without proper personal protective equipment including NIOSH approved self-contained breathing apparatus with full facepiece operated in the positive pressure demand mode. Do not inject a solid stream of water or foam into hot, burning pools; this may cause splattering and increase fire intensity. Evacuate personnel to a safe area. Keep unnecessary people away.

Unusual Fire and Explosion Hazards

This material is volatile and readily gives off vapors that may travel along the ground or be moved by ventilation and ignited by pilot lights, other flames, sparks, heaters, smoking, electrical motors, static discharge, or other ignition sources at locations distant from material handling point. Never use welding or cutting torch on or near drum (even empty) because product (even just residue) can ignite explosively. Containers may explode from internal pressure if confined to fire. Keep containers cool. Keep unnecessary people away.

Section: 05 HEALTH HAZARD DATA

Effects of Overexposure

Eye Contact: causes moderate to severe conjunctival irritation, (including burning sensation, tearing, redness or swelling), corneal injury and iritis. Corneal injury may be marked, extensive, and if not promptly treated, may possibly lead to permanent impairment of vision.

Skin Contact: causes local redness, swelling and chemical burns. May cause immediate skin irritation, blistering and/or dermatitis in some individuals. Prolonged or widespread exposure may result in the absorption of potentially harmful amounts of material.

Inhalation: vapors are irritating and may cause excessive tear formation, intoxication, burning sensation of the nose and throat, coughing, wheezing, shortness of breath, nausea, vomiting, headache, dizziness, narcosis, unconsciousness, cardiac depression or coma. May also cause symptoms of lack of oxygen leading to collapse and possible death. Extremely high vapor concentrations may cause lung damage. Some Some individuals may develop asthma. Repeated exposure may cause liver and kidney injury.

Ingestion: may cause blindness, narcosis, nausea, vomiting, throat and abdominal pain, acidosis, diarrhea, dizziness, weakness, thirst, collapse and possible coma or death. The nature and severity of these signs and symptoms will be dependent on the amount swallowed.

Additional Information: methanol is a component of this product. It can be highly toxic, even lethal, in inhalation exposures, but most of the literature on methanol poisoning deals with accidental or intentional ingestions. There are three stages of toxicity from acute exposures (either by inhalation or ingestion) to methanol: (1) a rapid narcotic effect involving drowsiness or fatigue with mild irritation of the eyes and mucous membranes, (2) a latent period of 10-15 hours, followed by (3) more severe CNS effects including nausea, vomiting, dizziness, headache, failing eyesight, visual disturbances, metabolic acidosis, and deep respiration. The last stage is thought to be due to the formation of toxic metabolite(s) of methanol. Permanent toxic effects can be produce from a single exposure. The effects include damage to both central and motor nerves and blindness due to damage to the optic nerve. Other symptoms to exposure to methanol include roaring in the ears, insomnia, rapid eye movements, tremor, dizziness, loss of coordination, diluted pupils, itching of the skin, skin irritation, and dermatitis caused by removal of skin oils. As little as 15mL can cause blindness and 30-250mL can be fatal. Methanol can be absorbed through the skin in toxic amounts. Since it is eliminated slowly from the body, it can have cumulative toxic effects from daily exposures. Subacute ingestion of methanol has caused liver damage in laboratory animals. It has shown to be a teratogen and a fetotoxin in tests on laboratory animals. It has shown some genetic effects in laboratory tests.

Target Organs: eyes, skin, lungs, CNS, liver and kidneys.

Emergency and First Aid Procedures

SKIN

Wash with soap and water. Remove contaminated clothing and launder contaminated clothing before reuse. Get medical attention if redness or irritation develops.

EYES

Flush eyes immediately with large amounts of water for at least 15 minutes. Lift lower and upper lids occasionally. Get medical attention.

INHALATION

Remove victim to fresh air. Give artificial respiration if not breathing. If breathing is difficult, administer oxygen. Keep person warm, quiet and get medical attention.

INGESTION

Call a physician immediately. Give victim a glass of water. Do NOT induce vomiting unless instructed by a physician or poison control center. Never give anything by mouth to an unconscious person.

Section: 06 REACTIVITY DATA

Stable (Y=Yes/N=No): Y

Stability -- Conditions to Avoid

None known.

Incompatibility (Materials to Avoid)

Avoid contact with strong oxidizing agents, strong alkalies, and strong mineral acids.

Hazardous Decomposition Products

Smoke, carbon dioxide, carbon monoxide, oxides of nitrogen.

Hazardous Polymerization May Occur(Y=Yes/N=No): N

Hazardous Polymerization -- Conditions to Avoid

None

Section: 07 SPILL OR LEAK PROCEDURES

Steps to be Taken if Material is Released or Spilled
Eliminate sources of ignition. Persons not wearing suitable personal protective equipment should be excluded from area of spill until clean-up has been completed. Shut off source of spill if possible to do so without hazard. Prevent material from entering sewers or watercourses. Provide adequate ventilation. Contain spilled materials with sand or earth. Recover undamaged and minimally contaminated material for reuse or reclamation. Place all collected material and spill absorbents into DOT approved containers.
Advise authorities. If this product is an EPA hazardous substance (see Section 10), notify the U.S.EPA and/or the National Response Center. Additional notification pursuant to SARA Section 302/304 (40 CFR 355) may also be required.
Waste Disposal Method
Treatment, storage transportation and disposal must be in accordance with EPA or State regulations under authority of the Resource Conservation and Recovery Act (40 CFR 260-271)
If product requires disposal, ignitability (D001) would be applicable.

Section: 08 SPECIAL PROTECTIVE INFORMATION

Respiratory Protection
If workplace exposure limit(s) of product or any component is exceeded, an NIOSH/MSHA approved air supplied respirator is advised in absence of proper environmental control. OSHA regulations also permit other NIOSH/MSHA respirators (negative pressure organic vapor type) under specified conditions. Engineering or administrative controls should be implemented to reduce exposure.
Ventilation
The use of mechanical dilution ventilation is recommended whenever this product is used in confined spaces, is heated above ambient temperatures or is agitated. When applicable, sufficient local ventilation should be provided to maintain employee exposures below safe working limits (TWA's).
Protective Gloves
Neoprene, nitrile, polyvinyl alcohol (PVA), polyvinyl chloride (PVC)
Eye Protection
Chemical splash goggles or face shield in compliance with OSHA regulations is advised; however OSHA regulations also permits safety glasses under certain conditions. The use of contact lenses is not recommended.
Other Protective Equipment
Eye wash and safety shower

Section: 09 SPECIAL PRECAUTIONS

Precautions to be Taken in Handling and Storing
Avoid contact with eyes, skin or clothing. Avoid breathing vapors or mist. Keep away from heat, sparks, and open flames and never use a cutting torch on or near container (even empty) or explosion may result. Vapors may travel to areas away from the work site and ignite.
Other Precautions
Containers of this material may be hazardous when emptied. Since emptied containers retain product residues (vapor, liquid, and/or solid), all hazard precautions given in the data sheet must be observed. Do not transfer to improperly marked container. Do not use pressure to empty container. Do not cut, heat, weld, or expose containers to flame or other sources of ignition. Keep container closed. Use with adequate ventilation. Wash thoroughly after handling. Containers should be grounded and bonded to receiving container(s) when being emptied. Containers should not be washed out and used for other purposes.
FOR INDUSTRIAL USE ONLY

Section: 10 REGULATORY INFORMATION

Superfund Amendments and Reauthorization Act Of 1986(SARA) Title III
Section 302/304-Extremely Hazardous Substances (40 CFR 355)

SARA requires emergency planning based on Threshold Planning Quantities (TPQs) and release reporting based on Reportable Quantities (RQs) in 40 CFR 355 (used for SARA 302, 304, 311 and 312). These values are subject to change and the regulations should be consulted to verify current statutory requirements.

Components present in this product at a level which could require reporting under the statute are:

Component Name	RQ	TPQ	% Range
NONE			

Section 311/312 Chemical Inventory Reporting Requirements (40 CFR 370)

The Superfund Amendments and Reauthorization Act (SARA) may require submission of reports (chemical list, MSDS, Tier I & Tier II) to the State Emergency Response Commission, Local Emergency Response Committee and the local fire department. The SARA physical and health hazards related to this product are:

X Acute Health Hazard	Sudden Release of Pressure	X Fire
X Chronic Health Hazard	Reactive	

Section 313-List of Toxic Chemicals (40 CFR 372)

This product contains the following toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (40 CFR 372). This information should be included in all MSDSs that are copied and distributed for this material.

Component Name	CAS #	% Range
methanol	000067-56-1	< 15%

CERCLA, 40 CFR 261 AND 302

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) requires notification of the National Response Center 1-800-424-8802 of any release of a Hazardous Substances equal to or greater than the reportable quantities (RQs) listed in 40CFR 302.4. Values are given in pounds for the component and not the mixture, if applicable. (These values are subject to change and the regulations should be consulted to verify current statutory levels.)

Component Name	CAS #	CERCLA RQ
methanol	000067-56-1	5000
ammonium bisulfite	010192-30-0	5000

OSHA Exposure Limits

Component Name

methanol

TWA ppm: 200.0 TWA MG/M3: 260.0 STEL ppm: 250.0 STEL MG/M3: 325.0 Skin: X

isopropyl alcohol

TWA ppm: 400.0 TWA MG/M3: 980.0 STEL ppm: 500.0 STEL MG/M3: 1225.0

National Fire Protection Agency

2 Health	3 Fire
0 Reactive	Other

Department of Transportation Shipping Information

Proper Shipping Name: Flammable liquids, n.o.s.

Hazard Class: 3 Identification: UN1993

Packaging Group: PG III

Contains: methanol, isopropyl alcohol

Hazardous Substance RQ: 33333# Emergency Response Guide Number: 128

Labels: Flammable liquid

Toxic Substances Control Act (TSCA), 40 CFR 261

This product, or components if product is a mixture, is/are listed on the Toxic Substances Control Act (TSCA) inventory.

Section 10 information is to remain attached to the material safety data sheet for this product.

While BJ CHEMICAL SERVICES believes that the above data is correct, BJ CHEMICAL SERVICES expressly disclaims liability for any loss or injury arising out of the use of this information or the use of any materials designated.

END OF MSDS

VII. Brine Extraction Well(s)- In-situ brine extraction wells must meet the requirements of Part 5 of the Water Quality Control Commission Regulations in addition to other applicable requirements of WQCC and Oil Conservation Division Rules and Regulations.

Answer and Description for New Brine Well(s):

Brine Well, Cavern Development, Operation and Design Considerations:

The well bore will consist of two casing and tubing strings. A water protection casing string will be set at a depth of approximately 500 ft and cemented back to surface. An approximate 1250-foot long casing string will be installed where at least 50 feet will be cemented into the Castile Salt I Zone and cemented back to the surface.

There will a double tubing packer set to isolate the salt formation from the annulus. The first tubing string will be set approximately 200-300 feet below the casing shoe, maintaining at least 50 feet of salt at the bottom of the salt formation, where injection of fresh water occurs. The other tubing string will be set approximately 50 feet below the casing shoe. The cavern will be allowed to grow from the bottom up, creating an elongated conical cavern resembling a flask. A conceptual drawing is including in this section VII appendix for review.

The actual cavern configuration can be controlled by varying the depth of the tubing and adjusting flow rates. In addition, Key Energy has contracted PB Energy Storage Services, Inc., to assist us in developing the cavern properly and to model and make recommendations for innovative techniques to protect the roof salt zone. PB Energy has extensive experience in developing caverns for the US Strategic Petroleum Reserves.

The annulus will be filled with a protective packer fluid that will be monitored on a routine basis. Please see the attached C-101 form in section *VII.A.* appendix for details of the casing/tubing/packer/cement type, size, installation depths, location and formation details.

The lithology of the formation has been described in detail in the Geological Characterization Report in section IX Site Characteristics. The brine well has been selected to be located in UL E (1000 FWL & 2140 FNL) of Section 31, Township 21s, Range 27e. This zone provides approximately 500 feet of Surface/Rustler/Salado, 330 feet of the Anhydrite III-IV, 200 feet of Salt II, 150 feet of Anhydrite II, 350 feet of Salt I, and 300 feet of base consisting of Anhydrite I. A modified W-E cross-section showing the location of a brine well cavern in the proposed zone is included in this section VII appendix for review.

This geologic location provides for approximately 480 feet of anhydrite overlying the anticipated mined area. A Brine Well Roof Stability Steady State Model was developed to determine critical parameters such as maximum safe diameter.

Brine Well Roof Stability Calculations Using Beam Theory. (Steady-State Model)

A steady state model was developed to calculate the stress(s) developed in a cantilever beam that is uniformly loaded. The maximum compressive, tensional and shear stress can be assessed using the general flexure bending formulas found in Civil Engineering Text Books.

Several similar studies have been conducted by various organizations such as SMRI, DOE (WIPP), and National labs. Most of these studies used complex finite-difference time dependant models with multiple variables. The roof designs varied from using a cohesive circular plate, strongest of the roof designs, a uniform loaded beam supported on two ends, to a uniformly loaded cantilever beam which would be the weakest of the roof configurations. This later approach provided the most conservative results.

The idea of using a cantilever beam may well be the most representative when manmade or natural stress fractures are considered. Referring to the figure "Fractured Anhydrite Circular Plate Over Brine Cavern", which can be found in this section VII appendix, represents a stiff anhydrite that has very cohesive connection points to the anhydrite layers outside of the cavern. This diagram shows how fractures may actually reduce the plate into several independent cantilever beams supported at the connection points.

The starting formulas were $\sigma = My/I$ for maximum flexure stress at the outer most (i.e. upper and lower) fibers of the beam, which are in compression and tension. The maximum shear stress formula is $\tau = VQ/It$, which gives the maximum shear stress, generally found in the center of the beam. Stress units are in pounds per square inch (psi), the first moment (M) is in inch-lbs, with second moment (I) is in $inch^4$, and (y) is the distance measured from the center of the beam to the outer fibers. All units designated in feet measurements are converted to inches for unit consistency.

Pure bending, neglecting longitudinal shear, with no axial or torsion effects is simulated. The beam is considered a stiff anhydrite material of homogenous and isotropic properties. When more than one beam (anhydrite layer) is present above the salt zone, then the overall beam thickness is set to the combined thickness. Since compressive strength properties of concrete type materials i.e. anhydrite, are substantially larger than the tensile strength, the tensional properties is used to allow the most conservative results.

Slippage due to shearing between the anhydrite beds is neglected. It should be pointed out that some error could be introduced by using this assumption.

Physical properties of anhydrite were obtained from various references and handbooks. Average figures for these properties are used in the calculations. The geometry of the beam was selected to be a rectangle with the length of the beam being considerably longer than the width. For simplicity, the beam width will always be 1 foot (12 inches wide) to allow for uniform loading, and the length and height (i.e. thickness) are input variables.

The weight on the beam shall be the overburden of the earth material including the beam. The density of the rocks and soils were generally set at 100 lbs/ft^3. For example, If the rocks and soil on top of the beam weights 100 lbs/ft^3, and if the distance from the surface to the top of the salt is 1000 feet, then the total weight on 1 ft^2 would be 100,000 lbs.

The model equations include the counter hydrostatic forces generated by the well bore hydrostatic head on the cavern formation. These forces actually push upward and help support the roof beam. The model output actually provides stresses on the beam with and without these hydrostatic forces.

The density of the fluid can be varied in the model between using fresh water and brine-water. While artificial forces, such as pump pressures, would also aid in supporting the roof, it was not included, so that the true static conditions could be represented at closure.

Formula details are, M is the moment at where the beam is attached to the cavern wall, Y is the distance from the centroid of the beam to the outer edges, and (I) is the second moment of inertia for the beam looking at the end view. V is the maximum weight on the beam, Q the first moment of the beam, I the second moment, and t = thickness of which the shear force will be distributed across.

Mohr's circle, a very simple standard civil engineering technique, was used to verify the interaction between the maximum tensional stresses (σ) and resulting shear stresses (τ). A general rule of thumb allows the maximum shear stresses to be estimated as one half of the difference between the maximum and minimum normal stresses $\tau = (\sigma max - \sigma min)/2$.

Since the maximum tensile strength of the anhydrite is used as the limiting property, the maximum shear force would be one-half of the normal stresses and generally neglected. As previously stated, this assumption could cause error in the analysis.

This approach presents a very simple and friendly method to the problem, albeit with some acceptable error. The outer fibers of the anhydrite are in pure bending under tension and the shear forces are zero. Where the fibers in the center of the beam have zero compressive and tensional stresses, but has the maximum shear force. The actual maximum stresses and resultant angles becomes a complex tri-axial study beyond the scope of this presentation.

An Excel spreadsheet was used to handle the equation and various input variables were manually inputted. **The input variables are:**

Input #1 - The length (ft) of the beam, (i.e. radius of the cavern).

Input #2 - Thickness (ft) of the roof beam (i.e. thickness of the anhydrite layers).

Input #3 - Depth of the overburden, measured in feet from the surface to top of the salt.

Input #4 - Thickness (ft) of the salt zone of interest.

The following output results are:

Output #1 gives the maximum tensional stress in the beam near its support. A value of 1200 psi was selected to be the maximum allowable stress in the beam. Any output numbers above this threshold were deemed unsafe and the beam would fail.

Output #2 gives the maximum tensional stress in the beam near its support without the hydrostatic counter forces of the well bore.

Output #3 gives the D/H ratio of the system. This ratio has been used as recent guidance for determining if a cavern is deemed unsafe. Ratios greater than .66 have been linked to collapsed wells. A threshold of .50 has been suggested to be the limit for brine wells. (Griswold OCD). D is defined as the Diameter of the cavern, where H is the depth between the surface and top of the salt.

Output #4 provides the maximum surface static or test pressure (psig) allowed.

Output #5 shows the maximum diameter of the cavern.

Output #6 is the estimated amount of brine that could be produced out of cavern with the inputted configuration. The equation used a right cylinder reduced by 25% to more closely simulate a flask looking cavern. This figure is included in section VII. appendix for review.

Output #7 provides a recommended safety factory of 2:1 derived from dividing the allowed tensile strength (1200 psi) by output #2.

Output #8 provides a simple "Yes" or "No" recommendation for the system. A truth table was set up to evaluate the seven parameters mentioned above. In order for the system to receive a "YES" recommendation it must pass all seven parameters.

Proposed Key Brine Well Input Data:

The model was used to estimate the stresses in the proposed brine well with the following inputs:

Input #1- Estimated Cavern Radius = 150 ft or 300 ft diameter.

Input #2- Estimated 480 ft of anhydrite over the proposed salt zone.

Input #3- Estimated 1250 ft of overburden.

Input #4- Estimated 300 ft of salt

The Model Results for the proposed Key Brine well are:

Output #1- Maximum stress = 64 psi (1200 psi allowed) with cavern filled with brine water and 1250 feet of hydrostatic head.

Output #2- Maximum stress = 254 psi (1200 psi allowed) with cavern filled with brine, but no hydrostatic head.

Output #3- D/H = 0.24

Output #4- 288 psig

Output #5- 300 foot diameter

Output #6- Brine Production 13 million barrels

Output #7- 4.7 safety factor

Output #8- System Recommended "YES"

These results compare favorably with the Kansas brine well guidance, which limits brine wells to 300 feet in diameter. (ref Mike Cochron-KDEH)

<u>The results are included in the section VII. appendix for review.</u>

Brine Well Size, Life and D/H Ratio.

Brine well size and life are directly related. While the life will be quite variable depending upon production, the size of the cavern will be limited. As pointed out above, it appears that a roof diameter of 300 feet i.e. (radius of 150 feet) will provide for a very safe design in the designated Castile formation. The actual physical size of the cavern, in volume, will be dependent on how the cavern is developed over time, and how much vertical and horizontal distance is available in the salt zone.

The current formation is not limited in the horizontal direction, but will be limited in the vertical direction. While a lot of emphasis is placed on the diameter at the top of the cavern, several studies have shown that large diameters at the bottom of the cavern can also cause problems, albeit generally not as prolific. One such study was conducted by SMRI.

The maximum volume size calculation could be based on a right cylinder with a maximum diameter of 300 feet and an approximate depth of 250 feet. This configuration calculates a volume of approximately 18 million cubic feet. Using the "rule of thumb" conversion factor, for every barrel of brine water produced, it removes approximately one cubic foot of salt in the cavern. This configuration would produce approximately 18 million barrels of concentrated brine water during the life of the well.

The most conservative approach, would be to calculate the volume of an upright cone, where the base would be 300 feet and the top basically nil. The approach would yield a cavern with a volume of approximately 6 million cubic feet. Neither one of the configurations is realistic, as the actual configuration will look a lot like the conceptual wellbore drawing listed above.

A more realistic configuration will be that of an upright flask with the neck having a diameter of approximately 200 feet and the bottom a diameter of 300 feet, with the depth remaining the same at 250 feet. This calculates to a more realistic cavern volume of approximately 12.5 million cubic feet and will produce approximately 12.5 million barrels of brine water. The brine well cavern volume calculation results are included in the section VII. appendix for review.

Over a 20 or 30-year life span, this configuration will provide average production volumes of about 50,000 and 35,000 barrels/month respectfully. In comparison, the old Key Carlsbad brine well BW-19, produced approximately 6-7 millions barrels of brine water in a 32 year period.

A special note concerning bedded salts. Bedded salts with various layers between salts definitely can influence the configuration of any cavern. The Castile formation does have layered bedding planes, however, it has been noted that the salt zones of the Castile formation are more of a thick pure salt, versus bedding as commonly found in the Salado formation. This should allow the cavern to be developed in a more favorable configuration.

The Solution Mining Research Institute (SMRI), other state agencies, OCD work-group, along with various studies conducted during the permitting of the WIPP site, have concluded that failures, such as "catastrophic collapses", have a higher probability when the roof diameter of the cavern exceeds a certain value compared to the actual depth of the cavern.

This number is typically called D/H where "D" is the diameter of the cavity and "H" is the depth from surface to the casing shoe. Various reports seem to conclude that when a ratio of D/H reaches or exceeds .66 then the probability of collapse increases to a point where the well may be considered un-safe, thus closing procedures, such as proper plugging and abandonment, and possible long term subsidence monitoring should be instituted.

The proposed brine well will have a maximum diameter (D) of 300 feet and an (H) of 1250 feet.
This equates to a conservative D/H ratio of 0.24. The NMOCD (Griswold) has tentatively set a D/H of 0.5 as a possible guidance criterion.

Comparing the proposed D/H ratio of 0.24 to the 0.50 value mentioned above, it can be concluded that the brine well will meet and exceed the recommended safety value by two times.

History of Recent Brine Wells:

Two shallow brine wells have recently collapsed (JWS and Loco Hills) and a third well (I&W) is under heavy scrutiny. A fourth brine well operated by Key Energy was closed in an over abundance of precaution. The two wells that have collapsed were located on the backside of the Capitan reef where the Castile formation does not exist.

The lithogoly of the area of those collapsed wells basically consisted of wind blow sands overlying calichie, clastic red beds, and the Rustler formation that contains thin beds of anhydrite. The Salado is very shallow ranging from as shallow as 280 feet to 500 feet below the surface. The Salado has several stringers of clastic and anhydrite material embedded within.

The Third well, (I&W) is actually located within the city limits of Carlsbad, NM. According to the OCD and Carlsbad's consultant, the well was producing from the Rustler/Salado at a depth of about 300-500 feet. A viable reason the two wells may have collapsed, is the fact that both had large volumes of brine produced from them, and the top of the salt was mined out, exposing the overburden roof layer i.e. anhydrite. Both wells had the casing shoe set in or very near the support roof.

The reverse flow condition (fresh water pumped down the annulus) probably allowed fresh water to create a cavern with a long extended roof support. In addition, the roof support was being exposed to fresh water that most likely degraded its' structure properties, turning anhydrite to gypsum, a structurally weaker material.

Another contributing factor may have been that operating/test pressures exceeded the fracture pressure of both the salt and anhydrite at various stages during the life of the well. Both wells had started to experience typical problems of an overly large bedded salt brine well.

Using the Key beam stress model discussed above, and a fracture pressure model as will be discussed in section VII.C.2, simulations were ran for all four wells using known conditions. The model predicted failure in two of the three cases and the D/H ratios approached or exceeded the maximum level. <u>The results are included in the section VII. appendix for review.</u>

There is some *<u>anecdotal evidence</u>* that both wells may have experienced a triggering mechanism (the straw that broke the camels back per se). A few days before JWS collapsed, the area received a large rainfall, which may have lubricated joint fractures and substantially increased the overburden weight, the same scenario that causes mud slides. In the case of the Loco Hills collapse, a nearby drilling rig experienced a brine water flow, as reported by OCD (Gum), which may have been in hydrologic connection to the brine well. The reduction in formation pressure may have caused the overlying roof structures to fail beyond its structure limit.

Even though both collapse features were fairly remote, they both were located in proximately to surface features such as public roads, pipelines and power lines that involved emergency response actions from private, local, county and state agencies.

The I&W well is sited in close proximately to several important surface features that may adversely impact the public if collapse occurs. Basic siting and land control issues imposed when the permit was issued would have prevented this from being a highly sensitive topic to a much lower one.

Ironically, the model developed by Key Energy shows that the I&W well may exceed the structure limits of the roof support if the hydrostatic head is removed. This coincides with the recent activity at the site where the pressure was reduced, and the subsidence monitors indicated a relative large movement.

The current status of the fourth well, Key's P&A brine well BW-19, meets and exceeds the 2:1 safety factory for closure. <u>The results are included in the section VII appendix for review.</u>

Recommended Best Management Practices (BMP's) for future Brine Wells:

The following BMP's are recommendations for the agency to consider that will make all future brine wells inherently safer. Key Energy understands that certain WQCC requirements are still required and these BMP's are not intended to limit those requirements.

Site Control:

- A 900 foot set-back should be maintained from the well bore to any existing residences, public buildings, parks, public roads, schools, etc.
- A minimum amount of land area surrounding the brine well shall be fenced and in control of the operator at closure. An area that would provide twice the radius is recommended.

Geologic Setting:

- The operator shall provide logs of area wells demonstrating the geologic cross-section or conduct coring.
- A minimum of 500 feet of overburden shall exist over the first material (i.e. anhydrite layer) that acts as a roof beam over the salt mining zone. The beam, or combination of beam layers, shall have a sufficient thickness to resist exceeding the structural limits of the roof material, using a cantilever steady state design model as described above. The input parameters are; the maximum designed roof radius span, overburden depth and weight, beam thickness and pore pressure.
- The operator shall demonstrate that a 2:1 stress safety factor exist in the above calculation if the hydrostatic cavern pressure has been set to zero.
- The salt zone shall be sufficiently large enough so the injection fluid shall remain in the permitted interval.

Well Design:

- All brine wells shall have at a minimum, two steel casing strings cemented back to the surface, with the lower casing shoe set a minimum of 50 feet into the proposed salt zone.
- Single well configurations shall have two tubing strings with a double tubing packer installed to isolate the casing annulus from the salt mining formation.
- Tubing type and sizes shall be large enough to handle sonic survey tools.

Cavern Configuration and Maximum Size:

- The cavern shall not be developed from the top-down.
- The maximum size of the cavern shall be determined and listed in the permit.
- The D/H ratio shall not exceed 0.50
- The diameter of the cavern shall not exceed 300 feet (150 foot radius), unless approved by the permitting agency.

Operational Controls:

- The maximum dynamic or static pressure shall not cause fracturing of any part of the producing formation.
- The maximum fracture pressure gradient shall not exceed 0.75 psi/ft.
- The injection and production volumes have to be measured with calibrated flow meters with an accuracy of ± 1%.
- Pressure limiting devices shall be incorporated, unless the pump curve will not exceed limited pressures.

Monitoring:

- A minimum of three groundwater monitoring wells shall be installed and monitored on a routine basis.
- Injection and production water samples shall be collected and analyzed on a routine basis.
- A minimum of three subsidence monitors shall be installed and monitored on a routine basis.
- Annulus fluid levels shall be monitored on a routine basis.
- Well flows and pressures shall have continuous monitor devices.
- Sonar monitoring shall be conducted once every five years or every 3 million barrels of brine production.

Testing:

- The casing 5-year test should continue as part of the permit conditions.
- The annual pressure testing of the cavern formation should not be performed as conducted in the past. This pressure test has routinely cause exceedence of the fracture pressure of the formation, caused extreme flexing of the cavern and roof, and changed the hydrostatic head causing the overburden anhydrite layer to exceed its stress limits.

Closure:

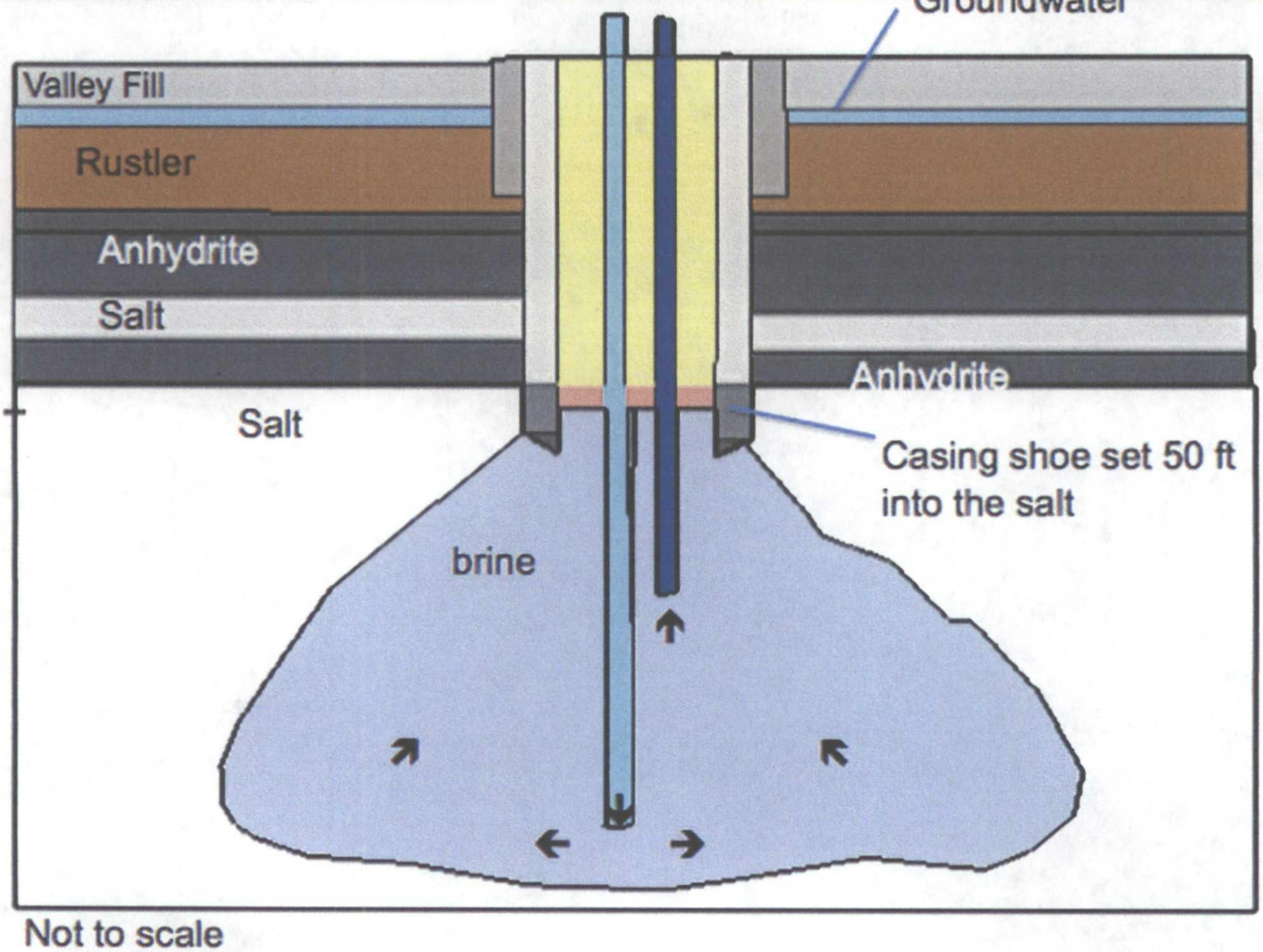
- A long-term closure plan should be negotiated with the permitting agency.

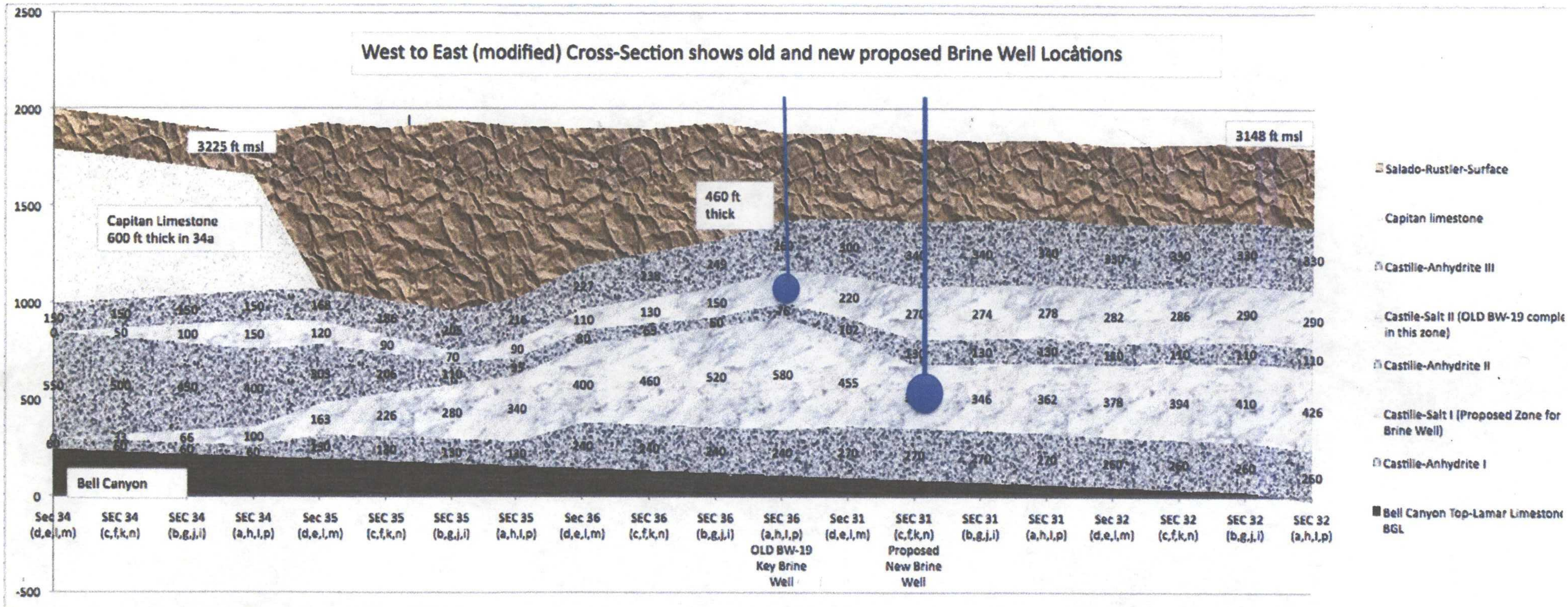
Section VII. Appendix for Brine Well Application Guideline

Includes:

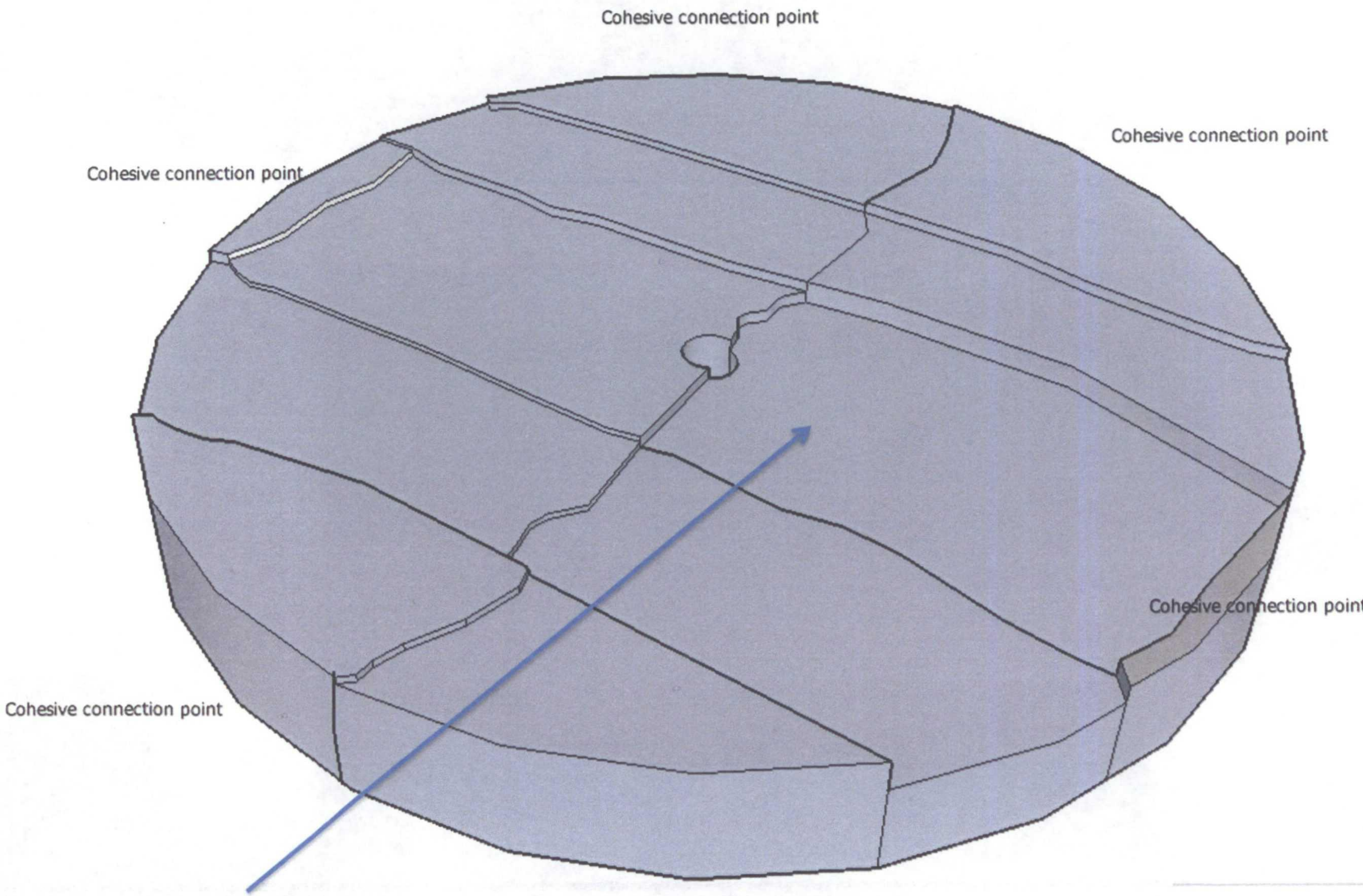
1. Conceptual Brine Well Drawing
2. Modified West-East Cross-Section showing locations of Old Brine BW-19 and the New Proposed Brine Well in the Castile Formation
3. Figure of the Fractured Anhydrite Circular Plate over Brine Cavern
4. Brine Well Cavern Volume Calculation
5. Results of Model for Key Proposed Brine Well
6. JWS Model Results
7. Loco Hills Model Results
8. I&W Model Results
9. Key P&A Model Results
10. Drawing of Cantilevel Beam Design

Double casing/tubing and packard design




West to East (modified) Cross-Section shows old and new proposed Brine Well Locations
2500
2000
1500
1000
500
0
-500
3225 ft msl
3148 ft msl
Capitan Limestone
600 ft thick in 34a
460 ft
thick
Bell Canyon
Sec 34 (d,e,l,m)
SEC 34 (c,f,k,n)
SEC 34 (b,g,j,i)
SEC 34 (a,h,I,p)
Sec 35 (d,e,l,m)
SEC 35 (c,f,k,n)
SEC 35 (b,g,j,i)
SEC 35 (a,h,I,p)
Sec 36 (d,e,l,m)
SEC 36 (c,f,k,n)
SEC 36 (b,g,j,i)
SEC 36 (a,h,I,p) OLD BW-19 Key Brine Well
Sec 31 (d,e,l,m)
SEC 31 (c,f,k,n) Proposed New Brine Well
SEC 31 (b,g,j,i)
SEC 31 (a,h,I,p)
Sec 32 (d,e,l,m)
SEC 32 (c,f,k,n)
SEC 32 (b,g,j,i)
SEC 32 (a,h,I,p)
Salado-Rustler-Surface
Capitan limestone
Castille-Anhydrite III
Castile-Salt II (OLD BW-19 comple in this zone)
Castille-Anhydrite II
Castile-Salt I (Proposed Zone for Brine Well)
Castille-Anhydrite I
Bell Canyon Top-Lamar Limestone BGL

Fractured Anhydrite Circular Plate Over Brine Cavern



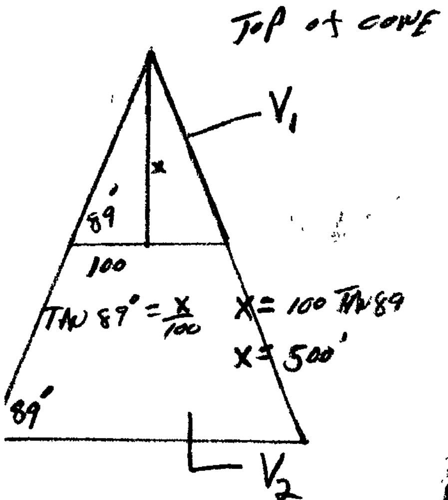
Each plate becomes an independent cantilever beam

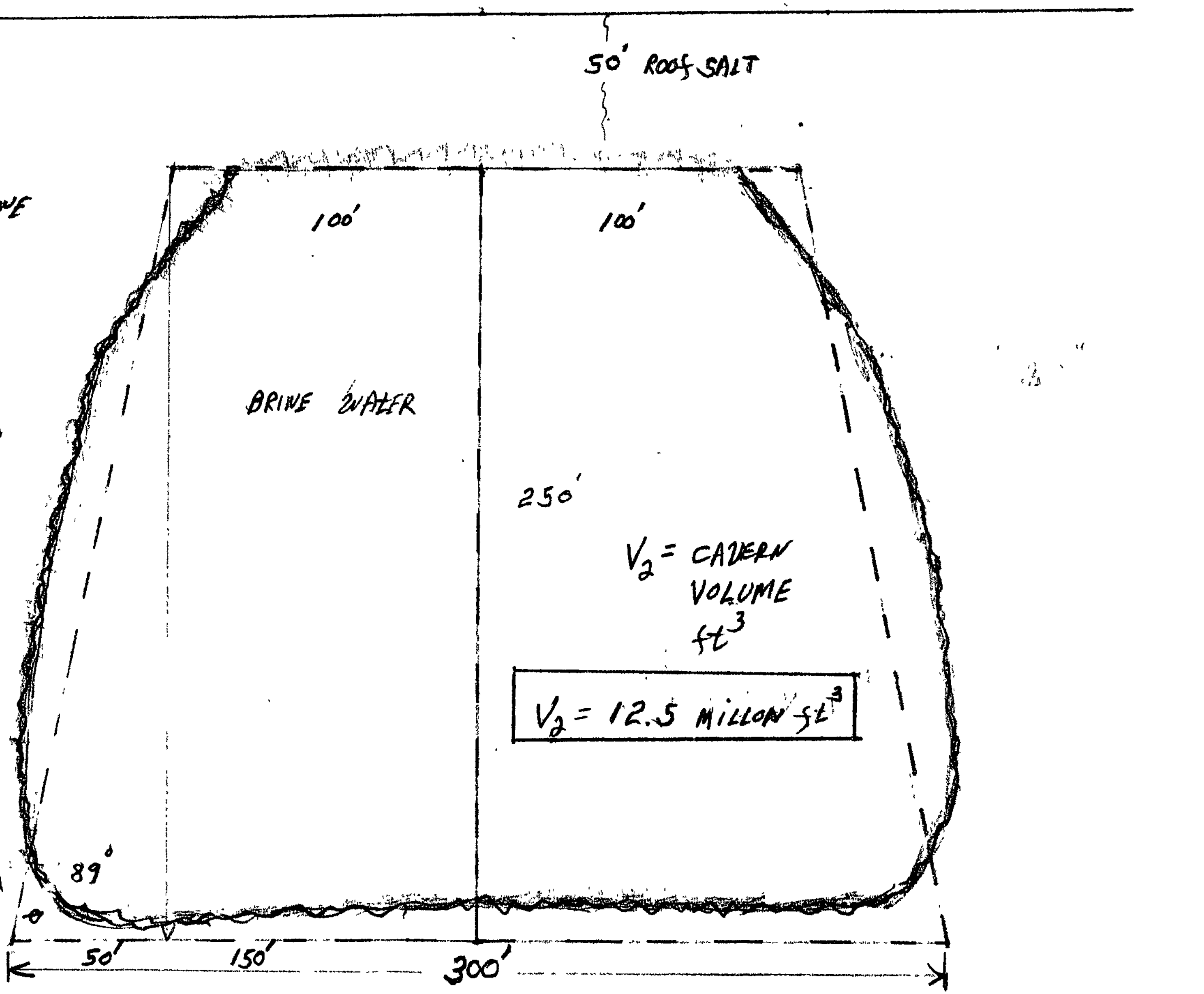
"ANHYDRITE"

CAVERN VOLUME CALCULATION

KEY CARLSBAD PROPOSED BRINE WELL UL E - SEC 31 - T21S - R27E

$TAN\,\theta = \frac{250}{50} = 5 = 89^\circ$





$$V_T - V_1 = V_2$$

$$V_T = \tfrac{1}{3}\pi r^2 \cdot H$$

$$V_1 = \tfrac{1}{3}\pi r^2 \cdot H$$

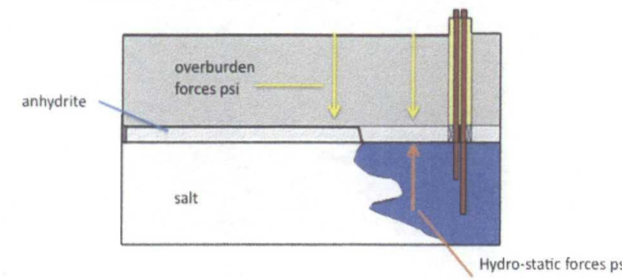
$$V_T = \tfrac{1}{3}\pi\, 150^2 \cdot 750 = 17.7\,M$$

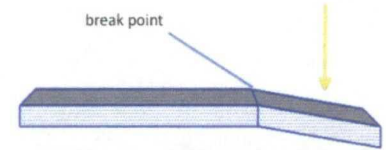
$$V_1 = \tfrac{1}{3}\pi\, 100^2 \cdot 500 = 5.2\,M$$

$$V_2 = 12.5\ MM\,ft^3$$

Brine Well Roof Stability Steady State Model-	Units	Key Proposed Brine Well			
Cantilever Beam design when Anhydrite separtes from Casing.		Inputs in green cells only			
σ = My/I (equation for flexure stress in a uniform loaded Cantilevel beam)	psi				
τ = VQ/It (equation for transverse shear stress in a uniform loaded Cantilevel beam)	psi				
σ = Normal Stress (tension or compression) psi	psi				
τ = Transverse Shear Stress psi	psi				
M = moment ft-lbs	ft-lbs	353250000	formula		
y = Distance of centroid to outer fibers inches	inches	2928	formula		
I = second monment of inertia beam inches^4	inches^4	2.00818E+11	formula		
w = Total uniform load of beam lbs/ft (Wob-Wc)	lbs/ft	31400	formula		
"-wc = counter uniform load generated by hydrostatic cavern pressure"	lbs/ft	93600	formula		
Wob = uniform load on beam from overburden lbs/ft (Wob-Wc)	lbs/ft	125000	formula		
Beam length in feet- Radius of Cavern	feet	150	Radius in (ft)		
Beam width in inches	inches	12	fixed		
Beam height in feet	feet	488	Anhydite Thickness (ft)		
V = Shear from total load at beam connection end	lbs		fixed		
Q = first moment of beam - end view center axis	inches		fixed		
t = thickness of beam or width in inches	inches		fixed		
P = Cavern hydrostatic pressure calculated directly below anhydrite or at casing shoe	psi	650	brine water		
Depth of casing shoe below ground surface	feet	1250	Depth to top of Salt (ft)		
Estimated thickness of Salt production zone	feet	300	Salt thickness (ft)		
Max Stress when the Cavern Pressure (psi) is maintained	>>>>>>>>	62	*Stable Roof*	Output #1	0
Max Stress when Cavern Pressure (psi) is not maintained	>>>>>>>>	246	*Stable Roof*	Output #2	0
Ratio of Cavern Diameter/Depth of Casing Shoe---(D/H <.50)	>>>>>>>>	0.24	*Within Limits*	Output #3	0
Max Surface Static or Test Pressure	>>>>>>>>	288	*PSIG*	Output #4	0
Max Cavern Diameter (Feet)	>>>>>>>>	300	*Feet*	Output #5	0
Estimated Brine Production Volume (Rgt cyclinder reduced by 25%)	>>>>>>>>	13	*Millon Barrels*	Output #6	0
Safety Factor (must be > 2.0)	>>>>>>>	4.9		Output #7	0
System Recommended	>>>>>>>	*Yes*	<<<<<<<<<<	Output #8	0
Check shear stress					
τ = VQ/It (equation for transverse shear stress in a uniform loaded Cantilevel beam)		402			
V = total load on beam (lbs) = depth ft x 100 lbs/ft2 x length ft		4710000			
Q (first monment) = AD = Cross section area(BxH) x distance to the centroid= 1/2*H		205756416			
I (second monment)= 1/12*base*height^3		2.00818E+11			
t (width of beam i.e. base) = 12 inches		12			
Hydrostatic		14040000			

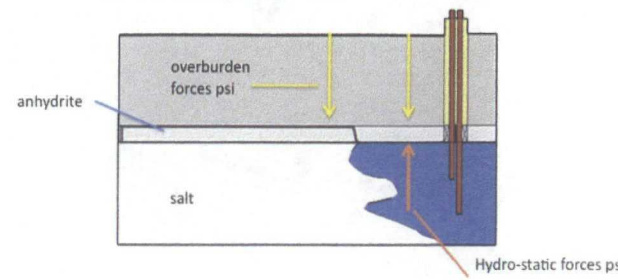
Cantilever Beam Design for Brine Wells

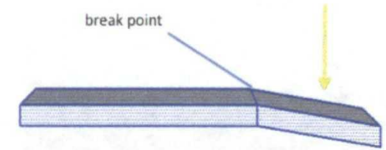




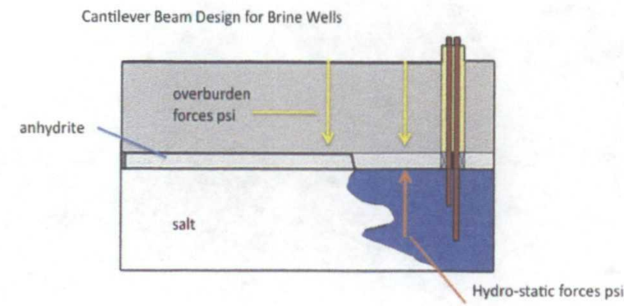
Brine Well Roof Stability Steady State Model-	Units		JWS Example	
Cantilever Beam design when Anhydrite separtes from Casing.		Inputs in green cells only		
σ = My/I (equation for flexure stress in a uniform loaded Cantilevel beam)	psi			
τ = VQ/It (equation for transverse shear stress in a uniform loaded Cantilevel beam)	psi			
σ = Normal Stress (tension or compression) psi	psi			
τ = Transverse Shear Stress psi	psi			
M = moment ft-lbs	ft-lbs	295441344	formula	
y = Distance of centroid to outer fibers inches	inches	600	formula	
I = second monment of inertia beam inches^4	inches^4	1728000000	formula	
w = Total uniform load of beam lbs/ft (Wob-Wc)	lbs/ft	12208.32	formula	
"-wc = counter uniform load generated by hydrostatic cavern pressure"	lbs/ft	36391.68	formula	
Wob = uniform load on beam from overburden lbs/ft (Wob-Wc)	lbs/ft	48600	formula	
Beam length in feet- Radius of Cavern	feet	220	Radius in (ft)	
Beam width in inches	inches	12	fixed	
Beam height in feet	feet	100	Anhydite Thickness (ft)	
V = Shear from total load at beam connection end	lbs		fixed	
Q = first moment of beam - end view center axis	inches		fixed	
t = thickness of beam or width in inches	inches		fixed	
P = Cavern hydrostatic pressure calculated directly below anhydrite or at casing shoe	psi	252.72	brine water	
Depth of casing shoe below ground surface	feet	486	Depth to top of Salt (ft)	
Estimated thickness of Salt production zone	feet	200	Salt thickness (ft)	
Max Stress when the Cavern Pressure (psi) is maintained	>>>>>>>>	1231	*Roof Fails*	Output #1 — 1
Max Stress when Cavern Pressure (psi) is not maintained	>>>>>>>>	4901	*Roof Fails*	Output #2 — 1
Ratio of Cavern Diameter/Depth of Casing Shoe---(D/H <.50)	>>>>>>>>	0.91	*Out of Limits*	Output #3 — 1
Max Surface Static or Test Pressure	>>>>>>>>	112	*PSIG*	Output #4 — 1
Max Cavern Diameter (Feet)	>>>>>>>>	440	*Feet*	Output #5 — 1
Estimated Brine Production Volume (Rgt cyclinder reduced by 25%)	>>>>>>>>	17	*Millon Barrels*	Output #6 — 1
Safety Factor (must be > 2.0)	>>>>>>>	0.2		Output #7 — 1
System Recommended	>>>>>>>	**NO**	<<<<<<<<<<	Output #8 — 7
Check shear stress				

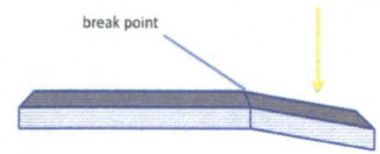
Cantilever Beam Design for Brine Wells





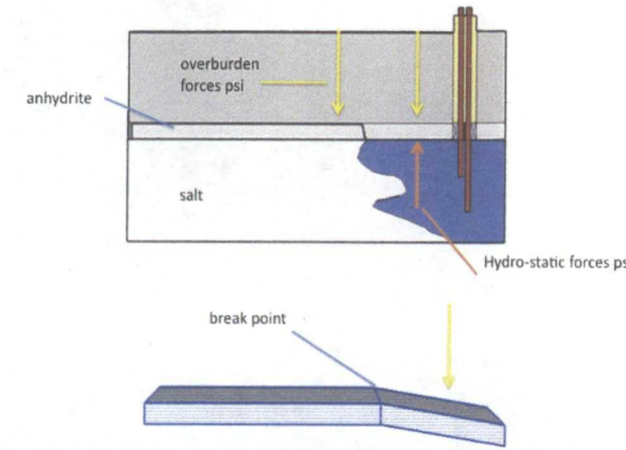
Brine Well Roof Stability Steady State Model- *Cantilever Beam design when Anhydrite separtes from Casing.*	Units	Loco Hills Example Inputs in green cells only			
σ = My/I (equation for flexure stress in a uniform loaded Cantilevel beam)	psi				
τ = VQ/It (equation for transverse shear stress in a uniform loaded Cantilevel beam)	psi				
σ = Normal Stress (tension or compression) psi	psi				
τ = Transverse Shear Stress psi	psi				
M = moment ft-lbs	ft-lbs	251200000	formula		
y = Distance of centroid to outer fibers inches	inches	540	formula		
I = second monment of inertia beam inches^4	inches^4	1259712000	formula		
w = Total uniform load of beam lbs/ft (Wob-Wc)	lbs/ft	12560	formula		
"-wc = counter uniform load generated by hydrostatic cavern pressure"	lbs/ft	37440	formula		
Wob = uniform load on beam from overburden lbs/ft (Wob-Wc)	lbs/ft	50000	formula		
Beam length in feet- Radius of Cavern	feet	200	Radius in (ft)		
Beam width in inches	inches	12	fixed		
Beam height in feet	feet	90	Anhydite Thickness (ft)		
V = Shear from total load at beam connection end	lbs		fixed		
Q = first moment of beam - end view center axis	inches		fixed		
t = thickness of beam or width in inches	inches		fixed		
P = Cavern hydrostatic pressure calculated directly below anhydrite or at casing shoe	psi	260	brine water		
Depth of casing shoe below ground surface	feet	500	Depth to top of Salt (ft)		
Estimated thickness of Salt production zone	feet	200	Salt thickness (ft)		
Max Stress when the Cavern Pressure (psi) is maintained	>>>>>>>>	1292	*Roof Fails*	Output #1	1
Max Stress when Cavern Pressure (psi) is not maintained	>>>>>>>>	5144	*Roof Fails*	Output #2	1
Ratio of Cavern Diameter/Depth of Casing Shoe---(D/H <.50)	>>>>>>>>	0.80	*Out of Limits*	Output #3	1
Max Surface Static or Test Pressure	>>>>>>>>	115	*PSIG*	Output #4	1
Max Cavern Diameter (Feet)	>>>>>>>>	400	*Feet*	Output #5	1
Estimated Brine Production Volume (Rgt cyclinder reduced by 25%)	>>>>>>>>	14	*Millon Barrels*	Output #6	0
Safety Factor (must be > 2.0)	>>>>>>>	0.2		Output #7	1
System Recommended	>>>>>>>	***NO***	<<<<<<<<<<	Output #8	6





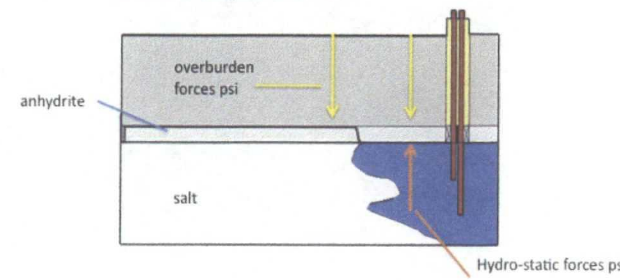
Brine Well Roof Stability Steady State Model-	Units		I&W Example		
Cantilever Beam design when Anhydrite separtes from Casing.		Inputs in green cells only			
σ = My/I (equation for flexure stress in a uniform loaded Cantilevel beam)	psi				
τ = VQ/It (equation for transverse shear stress in a uniform loaded Cantilevel beam)	psi				
σ = Normal Stress (tension or compression) psi	psi				
τ = Transverse Shear Stress psi	psi				
M = moment ft-lbs	ft-lbs	84780000	formula		
y = Distance of centroid to outer fibers Inches	inches	540	formula		
I = second monment of inertia beam inches^4	inches^4	1259712000	formula		
w = Total uniform load of beam lbs/ft (Wob-Wc)	lbs/ft	7536	formula		
"-wc = counter uniform load generated by hydrostatic cavern pressure"	lbs/ft	22464	formula		
Wob = uniform load on beam from overburden lbs/ft (Wob-Wc)	lbs/ft	30000	formula		
Beam length in feet- Radius of Cavern	feet	150	Radius in (ft)		
Beam width in inches	inches	12	fixed		
Beam height in feet	feet	90	Anhydite Thickness (ft)		
V = Shear from total load at beam connection end	lbs		fixed		
Q = first moment of beam - end view center axis	inches		fixed		
t = thickness of beam or width in inches	inches		fixed		
P = Cavern hydrostatic pressure calculated directly below anhydrite or at casing shoe	psi	156	brine water		
Depth of casing shoe below ground surface	feet	300	Depth to top of Salt (ft)		
Estimated thickness of Salt production zone	feet	200	Salt thickness (ft)		
Max Stress when the Cavern Pressure (psi) is maintained	>>>>>>>>	436	Stable Roof	Output #1	0
Max Stress when Cavern Pressure (psi) is not maintained	>>>>>>>>	1736	Roof Fails	Output #2	1
Ratio of Cavern Diameter/Depth of Casing Shoe---(D/H <.50)	>>>>>>>>	1.00	Out of Limits	Output #3	1
Max Surface Static or Test Pressure	>>>>>>>>	69	PSIG	Output #4	1
Max Cavern Diameter (Feet)	>>>>>>>>	300	Feet	Output #5	0
Estimated Brine Production Volume (Rgt cyclinder reduced by 25%)	>>>>>>>>	8	Millon Barrels	Output #6	0
Safety Factor (must be > 2.0)	>>>>>>>	0.7		Output #7	1
System Recommended	>>>>>>>	NO	<<<<<<<<<<	Output #8	4

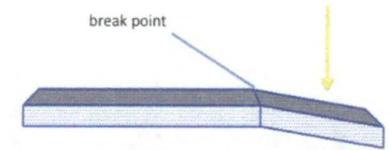
Cantilever Beam Design for Brine Wells



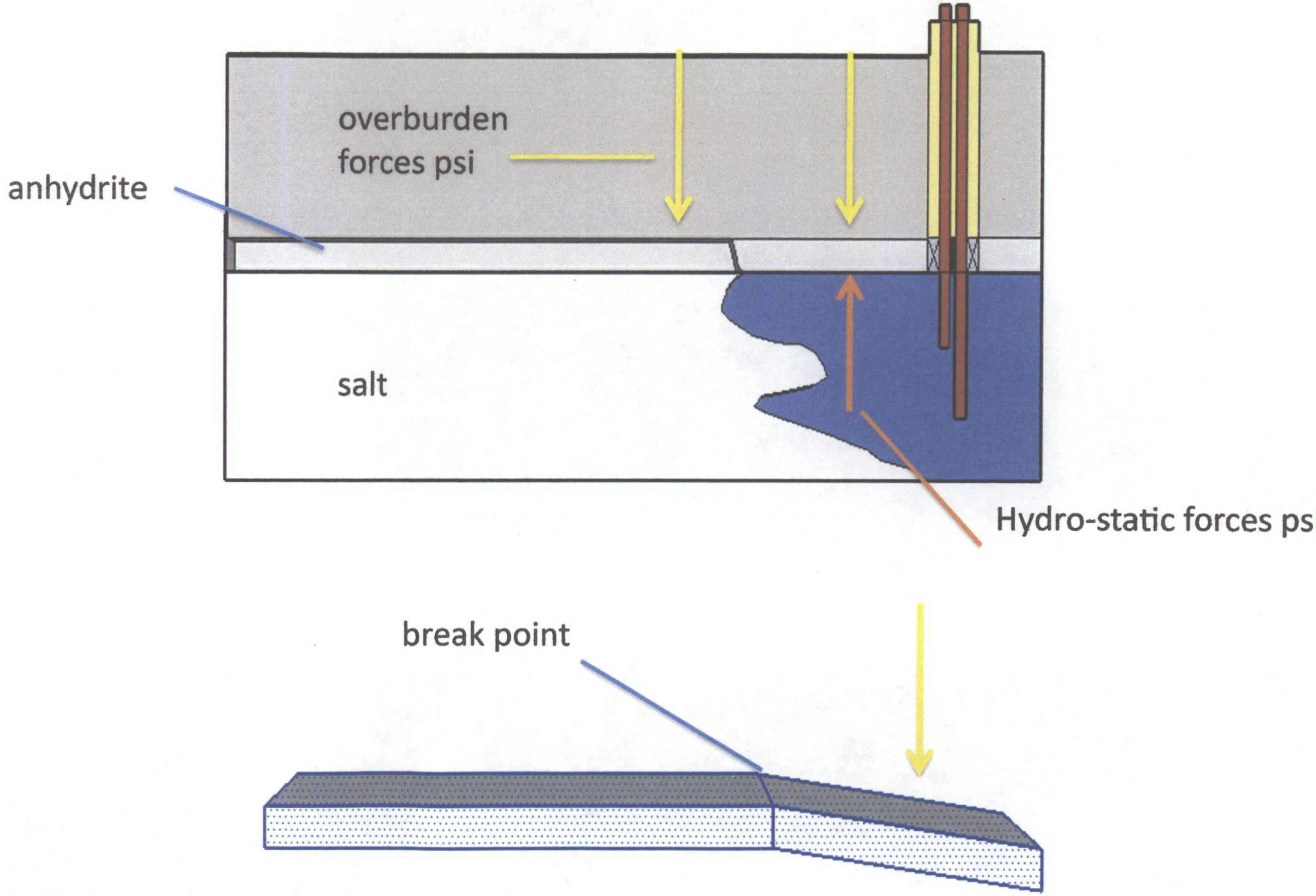
Brine Well Roof Stability Steady State Model- *Cantilever Beam design when Anhydrite separtes from Casing.*	Units	Old P&A BW-19 Brine Well Inputs in green cells only			
σ = My/I (equation for flexure stress in a uniform loaded Cantilevel beam)	psi				
τ = VQ/It (equation for transverse shear stress in a uniform loaded Cantilevel beam)	psi				
σ = Normal Stress (tension or compression) psi	psi				
τ = Transverse Shear Stress psi	psi				
M = moment ft-lbs	ft-lbs	220075315.2	formula		
y = Distance of centroid to outer fibers Inches	inches	1500	formula		
I = second monment of inertia beam Inches^4	inches^4	27000000000	formula		
w = Total uniform load of beam lbs/ft (Wob-Wc)	lbs/ft	18086.4	formula		
"-wc = counter uniform load generated by hydrostatic cavern pressure"	lbs/ft	53913.6	formula		
Wob = uniform load on beam from overburden lbs/ft (Wob-Wc)	lbs/ft	72000	formula		
Beam length in feet- Radius of Cavern	feet	156	Radius in (ft)		
Beam width in inches	inches	12	fixed		
Beam height in feet	feet	250	Anhydite Thickness (ft)		
V = Shear from total load at beam connection end	lbs		fixed		
Q = first moment of beam - end view center axis	inches		fixed		
t = thickness of beam or width in inches	inches		fixed		
P = Cavern hydrostatic pressure calculated directly below anhydrite or at casing shoe	psi	374.4	brine water		
Depth of casing shoe below ground surface	feet	720	Depth to top of Salt (ft)		
Estimated thickness of Salt production zone	feet	180	Salt thickness (ft)		
Max Stress when the Cavern Pressure (psi) is maintained	>>>>>>>>	147	*Stable Roof*	Output #1	0
Max Stress when Cavern Pressure (psi) is not maintained	>>>>>>>>	584	*Stable Roof*	Output #2	0
Ratio of Cavern Diameter/Depth of Casing Shoe---(D/H <.50)	>>>>>>>>	0.43	*Within Limits*	Output #3	0
Max Surface Static or Test Pressure	>>>>>>>>	166	*PSIG*	Output #4	1
Max Cavern Diameter (Feet)	>>>>>>>>	312	*Feet*	Output #5	1
Estimated Brine Production Volume (Rgt cyclinder reduced by 25%)	>>>>>>>>	7	*Millon Barrels*	Output #6	0
Safety Factor (must be > 2.0)	>>>>>>>	2.1		Output #7	0
System Recommended	>>>>>>>	*NO*	<<<<<<<<<<	Output #8	2
Check shear stress					
τ = VQ/It (equation for transverse shear stress in a uniform loaded Cantilevel beam)		470			
V = total load on beam (lbs) = depth ft x 100 lbs/ft2 x length ft		2821478.4			
Q (first monment) = AD = Cross section area(BxH) x distance to the centroid= 1/2*H		54000000			
I (second monment)= 1/12*base*height^3		27000000000			
t (width of beam i.e. base) = 12 inches		12			
Hydrostatic		8410521.6			

Cantilever Beam Design for Brine Wells





Cantilever Beam Design for Brine Wells



VII.A.1-4. Drilling, Deepening, or Plug Back Operations

Before drilling, deepening, or plug back operations, the operator of the well must file the following plans, specifications, and pertinent documents with the Oil Conservation Division 90 days prior to start-up of the planned operation.

VII.A.1.- Form C-101 "Application for Permit to Drill, Deepen, or Plug Back" (OCD Rule 1101).

Answer: The C-101 Application for Permit to Drill, Deepen, C-144 CLEZ, and C-102 well location and acreage dedication plat is included in this section VII.A.1-4 appendix.

VII.A.2.- A "Notice of Intent to Discharge" in accordance with WQCC regulation 1-201 (New facilities only).

Answer: The Notice of Intent was submitted on November 24, 2010. Copies of the Notice of Intent and OCD's response is included in this section VII.A.1-4 appendix.

Special Use Permits: Key Energy will obtain a special use permit from the Federal Aviation Administration (FAA) and issue a special NOTAM (Notice to Airmen) 60 days prior to drilling the well. Any other local, city, county, state, and federal permits will be obtained if required.

VII.A.3.- A map showing the number, name, and location of all producing oil and gas wells, injection wells, abandoned holes, surface bodies of water, watercourses, springs, mines, quarries, water wells, and other pertinent surface features within 1/4 mile from the wellbore(s).

Answer: *Information is provided in detail and contained in the* "GEOLOGICAL CHARACTERIZATION REPORT" included in section IX below:

VII.A.4.- Maps and cross-sections indicating the general vertical and lateral limits of all ground water having 10,000 mg/l or less TDS within one mile of the site. Show the position of such ground water within this area relative to the injection formation. Indicate the direction of water movement, where known, for each zone of ground water.

Answer: *Information is provided in detail and contained in the* "GEOLOGICAL CHARACTERIZATION REPORT" included in section IX below:

Section VII.A.1-4 Appendix for Brine Well Application Guideline

Includes:

1. C-101 form "Application for Permit to Drill, Deepen, or Plug Back", C-144 CLEZ and C-102 "Well Location and Acreage Dedicated Plat".
2. Copy of original Notice of Intent.
3. OCD's response letter to Notice of Intent.

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-101
June 16, 2008

Submit to appropriate District Office

☐ AMENDED REPORT

APPLICATION FOR PERMIT TO DRILL, RE-ENTER, DEEPEN, PLUGBACK, OR ADD A ZONE

[1] Operator Name and Address	[2] OGRID Number
Key Energy Services LLC 6 Desta Drive Suite 4000 Midland, TX 79705	19797 [3] API Number 30 -

[4] Property Code	[5] Property Name	[6] Well No
	Carlsbad Brine	#2

[9] Proposed Pool 1	[10] Proposed Pool 2

[7] Surface Location

UL or lot no	Section	Township	Range	Lot Idn	Feet from the	North/South line	Feet from the	East/West line	County
E	31	22S	27 E		2160'	North	1000'	West	Eddy

[8] Proposed Bottom Hole Location If Different From Surface

UL or lot no	Section	Township	Range	Lot Idn	Feet from the	North/South line	Feet from the	East/West line	County

Additional Well Information

[11] Work Type Code	[12] Well Type Code	[13] Cable/Rotary	[14] Lease Type Code	[15] Ground Level Elevation
N	I	R	P	3197.2'
[16] Multiple	[17] Proposed Depth	[18] Formation	[19] Contractor	[20] Spud Date
N	1510'	Castile-Salt I	Key Energy Service, Inc	August 2011

[21] Proposed Casing and Cement Program

Hole Size	Casing Size	Casing weight/foot	Setting Depth	Sacks of Cement	Estimated TOC
Driven	20"	78.6 #/ft	60'	Driven	
17-1/2"	13-3/8"	54.5 #/ft	500'	695	Circ to surf
12-1/4"	9-5/8"	47 #/ft	1290'	810	Circ to surf
8-1/4"	3-1/2"	9.3 #/ft	1510'	Tubing	
	3-1/2"	9.3 #/ft	1340'	Tubing	

[22] Describe the proposed program If this application is to DEEPEN or PLUG BACK, give the data on the present productive zone and proposed new productive zone Describe the blowout prevention program, if any Use additional sheets if necessary

SEE ATTACHED

[23] I hereby certify that the information given above is true and complete to the best of my knowledge and belief	OIL CONSERVATION DIVISION	
Signature Brian J. Luckianow	Approved by	
Printed name **Brian J Luckianow**	Title	
Title **Sr FMS Engineer**	Approval Date	Expiration Date
E-mail Address **bluckianow@keyenergy.com**		
Date **Jan 27, 2011** Phone: **713-654-4350**	Conditions of Approval Attached ☐	

State of New Mexico
Energy Minerals and Natural Resources
Oil Conservation Division
Form C-101 Attachment pg1

Operator: Key Energy Services, LLC
6 Desta Drive, Suite 4000
Midland, T. 79705

Property Name: Carlsbad Brine Well #2

22.) Describe the proposed program:

All activities of the design plan will be incompliance with the appropriate requirements of 19.15.17.9 NMAC

All drilling activities will be utilizing a closed loop system in compliance with the appropriate requirements of 19.15.17.9 NMAC

Drive ~ 60ft. of 20" STD .375" wall welded line pipe

Drill 17-1/2" hole to 500'

Condition hole to stabilize

Run deviation survey

Log 500' to surface, run Triple Combo log – Dual Induction Resistivity/Compensated Neutron Log/Litho-Density

Condition hole to run casing

Run ~500' of 13-3/8" 54.50 #/ft ST&C casing

Cement to surface with 695 sacks cement, twice annular volume

Wait on cement for 24 hours, notify NMOCD to witness test

Pressure test cement to 650 psi for 30 minutes

Run cement evaluation tool from TD to surface

Cut off conductor and surface casing and weld on 13-3/8" x 11" 5M slip-on casing head

Install 11" 5M BOP stack; double ram and annular preventer and choke assembly

Test BOP stack to 5000 psi

State of New Mexico
Energy Minerals and Natural Resources
Oil Conservation Division
Form C-101 Attachment pg 2

Operator: Key Energy Services, LLC
6 Desta Drive, Suite 4000
Midland, T. 79705

Property Name: Carlsbad Brine Well #2

Drill 12-1/4" hole with Automated Drilling System (ADS or similar) to ~ 1290' (or 50' into top of salt) to insure ~0 ° deviation

Run ~ 1290' of 9-5/8" 47 #/ft ST&C casing

Condition hole to stabilize

Log from 1290' to surface, run Triple Combo log – Dual Induction Resistivity/Compensated Neutron Log /Litho-Density

Run mechanical sidewall coring tool and sample

Condition hole to run casing

Cement to surface with 810 sacks cement, twice annular volume

Wait on cement 24 hours, notify NMOCD to witness test

Pressure test casing to 650 psi for 30 minutes

Run cement evaluation tool from TD to surface

Drill 8' hole to ~1510'

Clean hole and stabilize

Run dual completion packer 9-5/8" x 3-1/2"

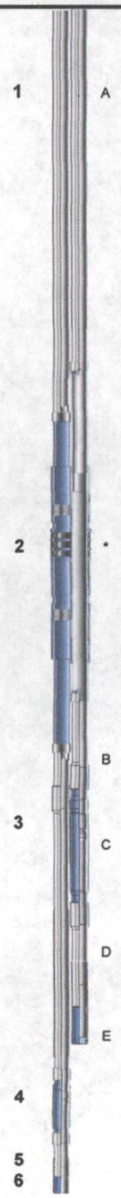
Run and set ~1510' of 3-1/2" 9.30 #/ft tubing

Run and set ~1340' of 3-1/2" 9.30 #/ft tubing

Test packer and fill annulus with inhibited packer fluid

Rig down and move off and clean location

Schlumberger



COMPANY	Key Energy Services, LLC
WELL NAME/#	Carlsbad Brine #2
Rig NAME	Key
FIELD	Carlsbad
COUNTY	Eddy
PARISH	----
STATE	NEW MEXICO
DATE :	19/Jan/2001
NEW W.O.	Old
PREPARED FOR:	Brian Luckianow

	CASING #1	CASING #2	LINER #1	TBG #1	TBG #2
SIZE	9.625	----	----	3 1/2	3 1/2
WEIGHT	47.00 lb/ft	----	----	9.30	9.30
GRADE	----	----	----	N-80	N-80
THREAD	-----	-----	-----	Eu 8rd	Eu 8rd
TOP	----	----	----	1300.00	1300.00
DEPTH	----	----	----	----	
COMPLETION PERFS					BHT ----
PREPARDED BY:	Todd Dupre				
OFFICE:	Houston, Texas				
PHONE :					

ITEM	DESCRIPTION	MAX O.D. INCHES	MIN. I.D. INCHES	LENGTH INCHES	DEPTH FROM	DEPTH TO
	ELEVATION			0.00	0.00	0.00
				0.00	0.00	0.00
					0.00	0.00
	Long String				0.00	0.00
1	3-1/2" 9.3# Eu 8rd Tubing			1200.00	0.00	1200.00
2	9-5/8" CS Ultra Dual Packer 3-1/2" x 3-1/2"			12.50	1200.00	1212.50
3	3-1/2" 9.3# Eu 8rd Tubing			100.00	1212.50	1312.50
4	3-1/2" MX Nipple 2.81" ID profile			1.00	1312.50	1313.50
5	3-1/2" 9.3# Eu 8rd Pup Joint			6.00	1313.50	1319.50
6	3-1/2" 9.3# Eu 8rd Wireline ReEntry Guide			0.50	1319.50	1320.00
	Short String Saleables: *End Of Long String*					*1320.00*
	Short String					
A	3-1/2" 9.3# Eu 8rd Tubing			1200.00	0.00	1200.00
•	9-5/8" CS Ultra Dual Packer 3-1/2" x 3-1/2"			12.50	1200.00	1212.50
B	3-1/2" 9.3# Eu 8rd Pup Joint			6.00	1212.50	1218.50
C	3-1/2" MX Nipple 2.81" ID profile			1.00	1218.50	1219.50
D	3-1/2" 9.3# Eu 8rd Pup Joint			6.00	1219.50	1225.50
E	3-1/2" 9.3# Eu 8rd Pump Out Plug/ ReEntry Guide			0.50	1225.50	1226.00
	End Of Short String					*1226.00*
					Quote Total	########

District I
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State of New Mexico
Energy Minerals and Natural Resources
Department
Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-144 CLEZ
July 21, 2008

For closed-loop systems *that only use above ground steel tanks or haul-off bins and propose to implement waste removal for closure*, submit to the appropriate NMOCD District Office.

Closed-Loop System Permit or Closure Plan Application

(that only use above ground steel tanks or haul-off bins and propose to implement waste removal for closure)

Type of action: ✓ **Permit** ☐ Closure

Instructions: Please submit one application (Form C-144 CLEZ) per individual closed-loop system request. For any application request other than for a closed-loop system that only use above ground steel tanks or haul-off bins and propose to implement waste removal for closure, please submit a Form C-144.

Please be advised that approval of this request does not relieve the operator of liability should operations result in pollution of surface water, ground water or the environment Nor does approval relieve the operator of its responsibility to comply with any other applicable governmental authority's rules, regulations or ordinances

1.

Operator: **Key Energy Services, LLC** OGRID #. **19797**

Address. **6 Desta Drive Suite 4000 Midland Tx 79705**

Facility or well name: **Carlsbad Brine Well #2**

API Number: ______ OCD Permit Number: ______

U/L or Qtr/Qtr **E** Section **31** Township **22S** Range **27E** County **Eddy County**

Center of Proposed Design: Latitude **N 32.34971184°** Longitude **W 104.2339085°** NAD: ✓ 1927 ☐ 1983

Surface Owner: ☐ Federal ☐ State ✓ Private ☐ Tribal Trust or Indian Allotment

2.

✓ **Closed-loop System:** Subsection H of 19.15.17.11 NMAC

Operation: ✓ Drilling a new well ☐ Workover or Drilling (Applies to activities which require prior approval of a permit or notice of intent) ☐ P&A

✓ Above Ground Steel Tanks or ✓ Haul-off Bins

3

Signs: Subsection C of 19 15 17.11 NMAC

✓ 12"x 24", 2" lettering, providing Operator's name, site location, and emergency telephone numbers

✓ Signed in compliance with 19 15.3.103 NMAC

4.

Closed-loop Systems Permit Application Attachment Checklist: Subsection B of 19 15.17.9 NMAC

Instructions: Each of the following items must be attached to the application. Please indicate, by a check mark in the box, that the documents are attached.

✓ Design Plan - based upon the appropriate requirements of 19.15.17.11 NMAC
✓ Operating and Maintenance Plan - based upon the appropriate requirements of 19 15.17.12 NMAC
✓ Closure Plan (Please complete Box 5) - based upon the appropriate requirements of Subsection C of 19 15 17.9 NMAC and 19 15.17 13 NMAC

☐ Previously Approved Design (attach copy of design) API Number: ______

☐ Previously Approved Operating and Maintenance Plan API Number: ______

5.

Waste Removal Closure For Closed-loop Systems That Utilize Above Ground Steel Tanks or Haul-off Bins Only: (19.15 17 13.D NMAC)

Instructions: Please indentify the facility or facilities for the disposal of liquids, drilling fluids and drill cuttings. Use attachment if more than two facilities are required.

Disposal Facility Name. **CRI** Disposal Facility Permit Number: **R9166**

Disposal Facility Name: ______ Disposal Facility Permit Number: ______

Will any of the proposed closed-loop system operations and associated activities occur on or in areas that *will not* be used for future service and operations?

☐ Yes (If yes, please provide the information below) ✓ No

Required for impacted areas which will not be used for future service and operations.

☐ Soil Backfill and Cover Design Specifications - - based upon the appropriate requirements of Subsection H of 19 15.17 13 NMAC
☐ Re-vegetation Plan - based upon the appropriate requirements of Subsection I of 19.15.17.13 NMAC
☐ Site Reclamation Plan - based upon the appropriate requirements of Subsection G of 19.15.17.13 NMAC

6.

Operator Application Certification:

I hereby certify that the information submitted with this application is true, accurate and complete to the best of my knowledge and belief

Name (Print): **Brian J. Luckianow** Title. **Sr. FMS Engineer**

Signature: Brian J. Luckianow Date: **Jan 28, 2011**

e-mail address: **bluckianow@keyenergy.com** Telephone: **713-654-4350**

7.

OCD Approval: ☐ Permit Application (including closure plan) ☐ Closure Plan (only)

OCD Representative Signature: ______________________ **Approval Date:** ______________

Title: ______________________ **OCD Permit Number:** ______________

8

Closure Report (required within 60 days of closure completion): Subsection K of 19 15.17.13 NMAC

Instructions: Operators are required to obtain an approved closure plan prior to implementing any closure activities and submitting the closure report. The closure report is required to be submitted to the division within 60 days of the completion of the closure activities. Please do not complete this section of the form until an approved closure plan has been obtained and the closure activities have been completed.

☐ **Closure Completion Date:** ______________

9

Closure Report Regarding Waste Removal Closure For Closed-loop Systems That Utilize Above Ground Steel Tanks or Haul-off Bins Only:

Instructions: Please indentify the facility or facilities for where the liquids, drilling fluids and drill cuttings were disposed. Use attachment if more than two facilities were utilized.

Disposal Facility Name: ______________ Disposal Facility Permit Number. ______________

Disposal Facility Name: ______________ Disposal Facility Permit Number. ______________

Were the closed-loop system operations and associated activities performed on or in areas that *will not* be used for future service and operations?

☐ Yes (If yes. please demonstrate compliance to the items below) ☐ No

Required for impacted areas which will not be used for future service and operations

☐ Site Reclamation (Photo Documentation)

☐ Soil Backfilling and Cover Installation

☐ Re-vegetation Application Rates and Seeding Technique

10

Operator Closure Certification:

I hereby certify that the information and attachments submitted with this closure report is true, accurate and complete to the best of my knowledge and belief I also certify that the closure complies with all applicable closure requirements and conditions specified in the approved closure plan.

Name (Print): ______________ Title: ______________

Signature: ______________ Date: ______________

e-mail address: ______________ Telephone. ______________

State of New Mexico
Energy Minerals and Natural Resources
Oil Conservation Division
Form C-144 CLEZ Attachment

Operator: Key Energy Services, LLC
6 Desta Drive, Suite 4000
Midland, T. 79705

Property Name: Carlsbad Brine Well #2

Closed-Loop Design Plan

All aspects of the Plan will comply with the appropriate requirements of 19.15.17.11 NMAC.

The Closed-Loop System will consist of one or more temporary above-ground tanks(s) suitable for holding the cuttings and fluids for rig operations and workover activities.

A frac tank will be used to store water

There will be no stock piling of any soil.

There will be no below grade tanks utilized.

There will be no pits dug; no fences are to be installed.

There will be no storage of open top containers requiring bird netting.

All signage will be installed according to the regulation.

The closed loop system will be supplied by either Controlled Recovery, Inc. or Key Energy Services, LLC. All waste material generated will be properly disposed of at Controlled Recovery, Inc.

State of New Mexico
Energy Minerals and Natural Resources
Oil Conservation Division
Form C-144 CLEZ Attachment

Operator: Key Energy Services, LLC
6 Desta Drive, Suite 4000
Midland, T. 79705

Property Name: Carlsbad Brine Well #2

Closed Loop Operating and Maintenance Plan

All aspects of the Plan will comply with the appropriate requirements of 19.15.17.12 NMAC.

The Closed-loop system will be operated and maintained to prevent the contamination of fresh water sources.

All solids and liquids will be disposed of at Controlled Recovery ,Inc.

No hazardous waste will be discharged or stored in the tank(s)

Key Energy Services, LLC is in the process of modeling the proposed wellbore configuration and leaching plan. This is to ensure that the design is safe and fully protective of the cavern integrity. When the model is completed Key intends to submit the Plan to the OCD for discussion. Key is employing outside consultants with PB Energy Services, Inc. to complete this important task.

State of New Mexico
Energy Minerals and Natural Resources
Oil Conservation Division
Form C-144 CLEZ Attachment

Operator: Key Energy Services, LLC
6 Desta Drive, Suite 4000
Midland, T. 79705

Property Name: Carlsbad Brine Well #2

Closed- Loop Closure Pan

All aspects of the Plan will comply with the appropriate requirements of Subsection C of 19.15.17.9 NMAC and 19.15.17.13 NMAC

All waste generated from the drilling and operating the facility will be taken to Controlled Recovery Inc. Permit #R9166

The drilling process will utilize a closed loop system all fluids will be contained in roll off bins and above grade steel tanks.

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 & Natural Resources Department
OIL CONSERVATION DIVISION
1220 South St Francis Dr
Santa Fe, NM 87505

Form C-102
Revised October 12, 2005
Submit to Appropriate District Office
State Lease- 4 Copies
Fee Lease- 3 Copies

☐ AMENDED REPORT

WELL LOCATION AND ACREAGE DEDICATION PLAT

API Number	Pool Code	Pool Name

Property Code	Property Name	Well Number
	CARLSBAD BRINE	*2*
OGRID No	**Operator Name**	**Elevation**
	KEY ENERGY SERVICES LLC	*3197 2'*

Surface Location

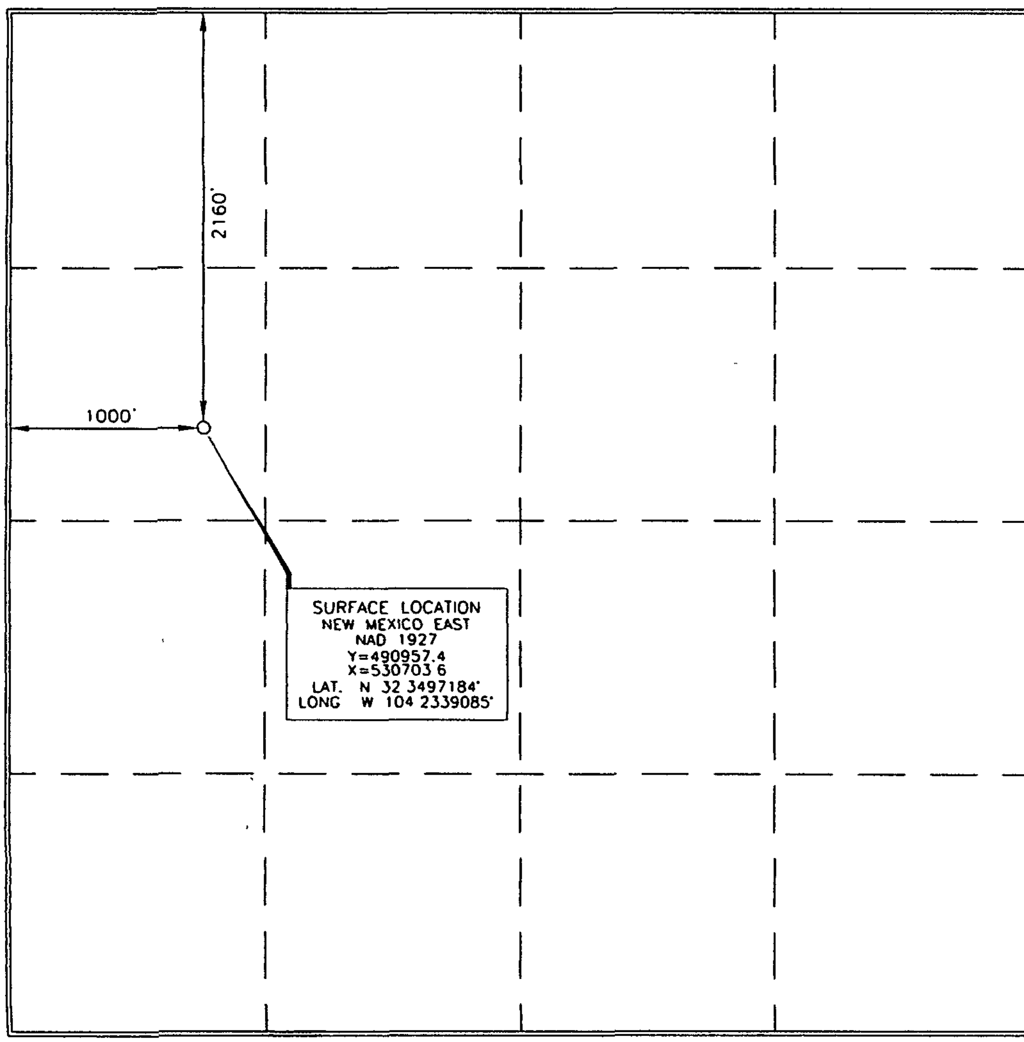
UL or lot no.	Section	Township	Range	Lot Idn	Feet from the	North/South line	Feet from the	East/West line	County
E	*31*	*22 SOUTH*	*27 EAST, N M P M*		*2160'*	*NORTH*	*1000'*	*WEST*	*EDDY*

Bottom Hole Location If Different From Surface

UL or lot no	Section	Township	Range	Lot Idn	Feet from the	North/South line	Feet from the	East/West line	County

Dedicated Acres	Joint or Infill	Consolidation Code	Order No

No allowable will be assigned to this completion until all interests have been consolidated or a non-standard unit has been approved by the division



OPERATOR CERTIFICATION

I hereby certify that the information contained herein is true and complete to the best of my knowledge and belief, and that this organization either owns a working interest or unleased mineral interest in the land including the proposed bottom hole location or has a right to drill this well at this location pursuant to a contract with an owner of such a mineral or working interest, or to a voluntary pooling agreement or a compulsory pooling order heretofore entered by the division

Signature Date

Printed Name

SURVEYOR CERTIFICATION

I hereby certify that the well location shown on this plat was plotted from field notes of actual surveys made by me or under my supervision, and that the same is true and correct to the best of my belief.

15079

DECEMBER 16, 2010

Date of Survey

Signature and Seal of Professional Surveyor

1/17/2011

Certificate Number 15079

WO# 101216WL (KA)

Key® Energy Services

Key Energy Services
6 Desta Drive
Suite 4300
Midland, Texas 79705

Telephone 432 620 0300
Facsimile 432 571 7173
www keyenergy com

November 23, 2010

Glenn vonGonten- Acting Environmental Bureau Chief
Jim Griswold- Senior Hydrologist
1220 South St. Francis
Santa Fe, New Mexico 87505

Subject: ***NOTICE OF INTENT TO DISCHARGE***
WQCC 20.6.2.1201 NMAC

Dear Mr. vonGonten and Griswold:

Key Energy Services LLC is notifying the New Mexico Oil Conservation Division of its intent to permit a new brine well to be located in Eddy County, New Mexico. Pursuant to the Water Quality Control Commission Regulations (WQCC) 20.6.2.1201.B and C. NMAC the following information is provided:

(1) The name of the person making the discharge;
Key Energy Services LLC,

(2) The address of the person making the discharge;
Corporate office: 6 Desta Drive Suite 4400 Midland, TX 79705
Local: 1609 E. Green St. Carlsbad NM 88221

(3) The location of the discharge;
Brine Well Location: SW/4 NW/4 UL E- Section 31 - Township 22 South - Range 27 East.
Existing Water Station Location: SE/4 NE/4 UL H Section 36 -Township 22 South- Range 26 East.

(4) An estimate of the concentration of water contaminants in the discharge; and
Injection Water: Fresh water from City of Carlsbad <500 mg/l TDS.
Produced Brine Water: approximately 300,000 mg/l TDS.

(5) The quantity of the discharge.
Estimated Instantaneous flow rate: 3-5 barrels per minute.
Estimated monthly totals: 0-50,000 barrels per month.

According to WQCC 20.6.2.1201.D; Based on information provided in this notice of intent, the department will notify the person proposing the discharge as to which of the following apply: (1) a discharge permit is required; (2) a discharge permit is not required; (3) the proposed injection well will be added to the department's underground injection well inventory; (4) the proposed injection activity or injection well is prohibited pursuant to 20.6.2.5004 NMAC.

If OCD requires additional information concerning this notice of intent please do not hesitate to call me at 432-571-7536 or Wayne Price at 505-715-2809, or E-mail wayneprice77@earthlink.net.

Sincerely,

Daniel K. Gibson, P.G.
Corporate Environmental Director

From: "Griswold, Jim, EMNRD" <Jim.Griswold@state.nm.us>
Subject: **New brine well in Carlsbad**
Date: December 14, 2010 1:20:45 PM MST
To: <dgibson@keyenergy.com>
Cc: "Molleur, Loren" <lmolleur@keyenergy.com>, wayne price <wayneprice77@earthlink.net>
1 Attachment, 56.9 KB

Dan,

Attached you will find a pdf file containing my letter dated today requesting Key submit a discharge plan for the proposed new brine well south of Carlsbad. Please print a copy for your files as no hardcopy will be mailed. Thanks.

Jim Griswold
Senior Hydrologist
Environmental Bureau
ENMRD/Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

direct: *505.476.3465*
email: *jim griswold@state nm us*

<<Permit ltr 12-14-10.pdf>>

New Mexico Energy, Minerals and Natural Resources Department

December 14, 2010

Daniel K. Gibson, P.G.
Corporate Environmental Director
Key Energy Services
6 Desta Drive, Suite 4300
Midland, Texas 79705

RE: Proposed Brine Well in Unit E of Section 31, Township 22 South, Range 27 East NMPM; Eddy County, New Mexico

Dan,

The Oil Conservation Division is in receipt of Key Energy's Notice of Intent to Discharge (dated 11/23/10) regarding possible installation of a brine well at the above-referenced location. New Mexico Water Quality Control Commission regulation 20.6.2 5101 B. states:

> "*Operation of a...Class III well must be pursuant to a discharge permit meeting the requirements of Sections 20.6.2.3000 through 20.6.2.3999 NMAC and Sections 20.6.2.5000 through 20.6.2.5299 NMAC.*"

A brine well injects fluids into the subsurface for the in situ extraction of salt and is thus considered a Class III well within the Underground Injection Control program. An approved discharge permit is therefore required for your proposed operation. Within 120 days of receipt of this notice, please submit a discharge plan in conformance with the provisions of 20.6.2.3106 C., 5000 through 5299 NMAC, and any other applicable requirements along with a filing fee of $100.00. Make any check payable to the "*Water Quality Management Fund.*" An *Application for Permit to Drill* (Form C-101) should also be filed at an appropriate date and, if approved, the well will be added to our underground injection inventory.

Respectfully,

J. Gl

Jim Griswold
Senior Hydrologist

VII.A.5-11- List all abandoned wells/shafts or other conduits in the area of review which penetrate the injection zone. Identify those which may provide a pathway for migration of contaminant through being Improperly sealed, completed or abandoned. Detail what corrective action will be taken prior to start up of operations to prevent any movement of contaminants into ground water of less than/equal to 10,000 mg/l TDS through such conduits due to the proposed injection activity (e.g. plugging open holes). Include completion and plugging records. If information becomes available after operations have begun, which indicates the presence of a conduit that will require plugging then the injection pressure will be limited to avoid movement of contaminants through such a conduit into protected groundwater.

VII.A.5- Answer: Oil & Gas Wells Area of Review (AOR)
An AOR review was conducted for the Key proposed brine well to be located in UL E (1000 FWL & 2140 FNL) of Section 31-Ts22S-R27E. Key used OCD records and field verification to confirm wells in the AOR.

Using OCD on-line downloads, a well status list was constructed listing all wells within adjacent quarter sections of the proposed site. The list shows API#, Operator well name, UL, Section, Township and Range, footages, Wells within ¼ mile, casing program status, casing/ cementing status, and corrective action required status. Copies of the downloads and status list are attached in this section VII.5-11 appendix.

There were 3 wells located within a ¼ miles radius of the brine well. Please refer to the ¼ mile AOR aerial photo attached in this section VII.5-11 appendix.

This list was formulated to provide a baseline for future AOR studies and to determine if corrective actions are required.

The Findings are as follows:

API # 30-015-21842: Key Energy Services City of Carlsbad #1, according to OCD records, is located 2420 FNL & 330 FEL of Section 36-Ts22s-R26e. It is shown to be located approximately *1100 ft* to the SE of the proposed well. The well was drilled and placed in production in August 1976 and operated up until time of closure in October of 2008. The well produced an estimated 6.5 million barrels of concentrated salt water (10 lb brine water) during the 32-year life of the well. The well file indicates this well was completed in the salt zone found about 715-900 feet below the surface. Well records are attached in this section VII.5-11 appendix for review.

The well begin to experience downhole problems and in an over abundance of precaution, Key chose to plug and abandoned the well in 2008. The plugging consisted of setting a bridge plug just above the casing shoe and filing the casing with cement to surface. The plugging was approved by OCD. The worst case final diameter of the cavern is estimated to be approximately 300 feet. Well reports are attached in the appendix for review.

Conclusions: The OCD reports indicate that the salt section was properly plugged off inside and outside of all casing strings. The salt section was in the Castile Salt II formation and appeared to start at about 715 ft below ground level and ends above 950 ft. Subsidence monitors have been installed.

Corrective actions: Continue subsidence monitoring and report results to OCD.

API # 30-015-20573: Oxy* USA Grace Carlsbad #1, according to OCD records, is located 1980 FSL & 660 FEL of UL I Section 36-Ts22s-R26e. It is shown to be located approximately *1900 ft* to the SW of the proposed brine well.

This well was drilled in 1973 with surface casing set at 382 feet bgl and cemented with 400 sacks. Intermediate casing was set at 5200 feet and cemented with 1050 sacks and 150 sacks class "c".

A long string was ran and set at 10735 feet and cemented with 335 sacks. The well is an active producer. The well reports are attached in the appendix for review.

Conclusions: The OCD reports indicate that the casing strings were properly sealed above and below the salt section. The anhydrite and salt sections appears to start at about 500 ft bgl and ends slightly above 1828 ft bgl.

Corrective actions: None recommended at this time.

*Note- Key Energy is the owner of this well as of OCT 27, 2010.

API # 30-015-20368: Chaparral Energy LLC, Little Jewel Com #1, according to OCD records, is shown to be located 1980 FNL & 1900 FWL of UL F Section 31-Ts22s-R27e which would be approximately *1000 ft* to the NE of the proposed brine well.

This well was drilled in 1971 with surface casing set at 373 feet bgl and cemented with 380 sacks. Intermediate casing was set at 2600 feet and cemented with 950 sacks. A long string was ran and set at 10708 feet and cemented with 1170 sacks in 2 stages. The well is an active producer. The well reports are attached in the appendix for review.

Conclusions: The OCD reports indicate that the casing strings were properly sealed above and below the salt section. The salt section appears to start at about 800 feet and ends slightly above 1600 ft bgl.

Corrective actions: None recommended at this time.

VII.A.6.- Maps and cross-sections detailing the geology and geologic structure of the local area.

Answer: *Information is provided in detail and contained in the* "GEOLOGICAL CHARACTERIZATION REPORT" included in section IX below:

VII.A.7.- A proposed formation testing program to obtain an analysis or description of fluids in the receiving formation.

Answer: Included in Section VII.C.4 below.

VII.A.8.- Schematic drawings of the surface and subsurface construction details.

Answer: Surface well schematics and subsurface construction details are included in the C-101 "Application for Permit to Drill" in Section VII.A.1 above.

VII.A.9.- The proposed drilling, evaluation, and testing, programs. Include logging procedures, coring program, and deviation checks.

Answer: Information included in the form C-101 "Application for Permit to Drill" in Section VII.A.1 above. The results after well completion will be provided in the form C-105 - well completion or recompletion report and log.

VII.A.10.- The proposed stimulation, injection, and operation procedures (Note WQCC 5-206 limitations).

<u>Answer:</u> There is no proposed stimulation at this time other than circulating fresh water down the deeper tubing and producing up the shallow tubing until the anticipated fluid density is produced. Reverse flow will occur occasionally for maintenance reasons.

VII.A.11.- A plan for plugging and abandonment of the well that meets the requirements of WQCC regulations section 5-209. A plugging bond pursuant to OCD Rule 101 is required prior to commencement of any new well drilling operations.

<u>Answer:</u> Key Energy proposes the following plugging procedure of the brine well. Remove the water from the well bore and a minimum of one foot from the formation, then set a cast iron bridge plug at 10 feet above the casing shoe and fill the well bore with a Class C high strength salt resistant cement. The model program demonstrates that hydrostatic head is not required to support the roof.

Over time the salt will creep and fill in the void without fracturing the formation. Subsidence and groundwater monitors will be monitored for a minimum of five years after closure, unless issues occur.

An option that Key would like OCD to consider is the filling in of the cavern with oilfield non-hazardous solid waste. Key understands OCD does not have current guidance on this issue and therefore would like to work with OCD in developing this procedure and possibly even a new rule.

<u>Answer: (Bonding)</u>

Key Energy proposes it be allowed to use its existing $50,000.00 blanket plugging bond to meet the initial bonding requirements for permitting of the well.

<u>Answer: (Financial Assurance per 20.6.2.3107.11 NMAC)</u>

Key Energy proposes that financial assurances be staged throughout the life of the permit. Key proposes that the financial assurance be changed ever five years when the permit is up for renewal. Due to the enormous expense in drilling this well, Key is proposing that the financial assurance be held to a reasonable figure starting off.

Key Energy is requesting the financial assurance to be built into a schedule included in the discharge permit conditions.

Section VII.A.5-11 Appendix for Brine Well Application Guideline

Includes:

1. Copy of OCD Down-load list Section 36
2. Copy of OCD Down-load list Section 31
3. Well Status List
4. ¼ mile AOR Photo
5. Key Old Brine Well (Truckers) City of Carlsbad well records- 2 pages
6. Corinne Grace-Carlsbad well well records-4 pages
7. Morris R. Antwell Little Jewel Com well records-2 pages

Well File Search - *Select API Number to View*

Please select the API Number you wish to view from the list below by clicking the radio button next to the API Number. Then click the "Continue" button to see the thumbnails for the API you selected. The search results are broken out by groups of 25 on each page. Switching pages can be done by clicking the "Next 25" or "Previous 25" links.

4 Records Found Displaying Screen 1 of 1

API Number	ULSTR	Footages	
3001510908	C -36-22S-26E	660 FNL & 1980 FWL	X
Well Name & Number: SALTY BILL SWD No. 001			
Operator: CORINNE GRACE			
3001520573	I -36-22S-26E	1980 FSL & 660 FEL	✓
Well Name & Number: GRACE CARLSBAD No. 001			
Operator: OXY USA INC			
3001520829	K -36-22S-26E	1980 FSL & 2164 FWL	X
Well Name & Number: AIRPORT GRACE No. 001			
Operator: BOLD ENERGY, L.P.			
3001521842	H -36-22S-26E	2420 FNL & 330 FEL	✓
Well Name & Number: CITY OF CARLSBAD No. 001			
Operator: KEY ENERGY SERVICES, LLC			

4 Records Found Displaying Screen 1 of 1

Continue Go Back

Well File Search - *Select API Number to View*

Please select the API Number you wish to view from the list below by clicking the radio button next to the API Number. Then click the "Continue" button to see the thumbnails for the API you selected. The search results are broken out by groups of 25 on each page. Switching pages can be done by clicking the "Next 25" or "Previous 25" links.

4 Records Found Displaying Screen 1 of 1

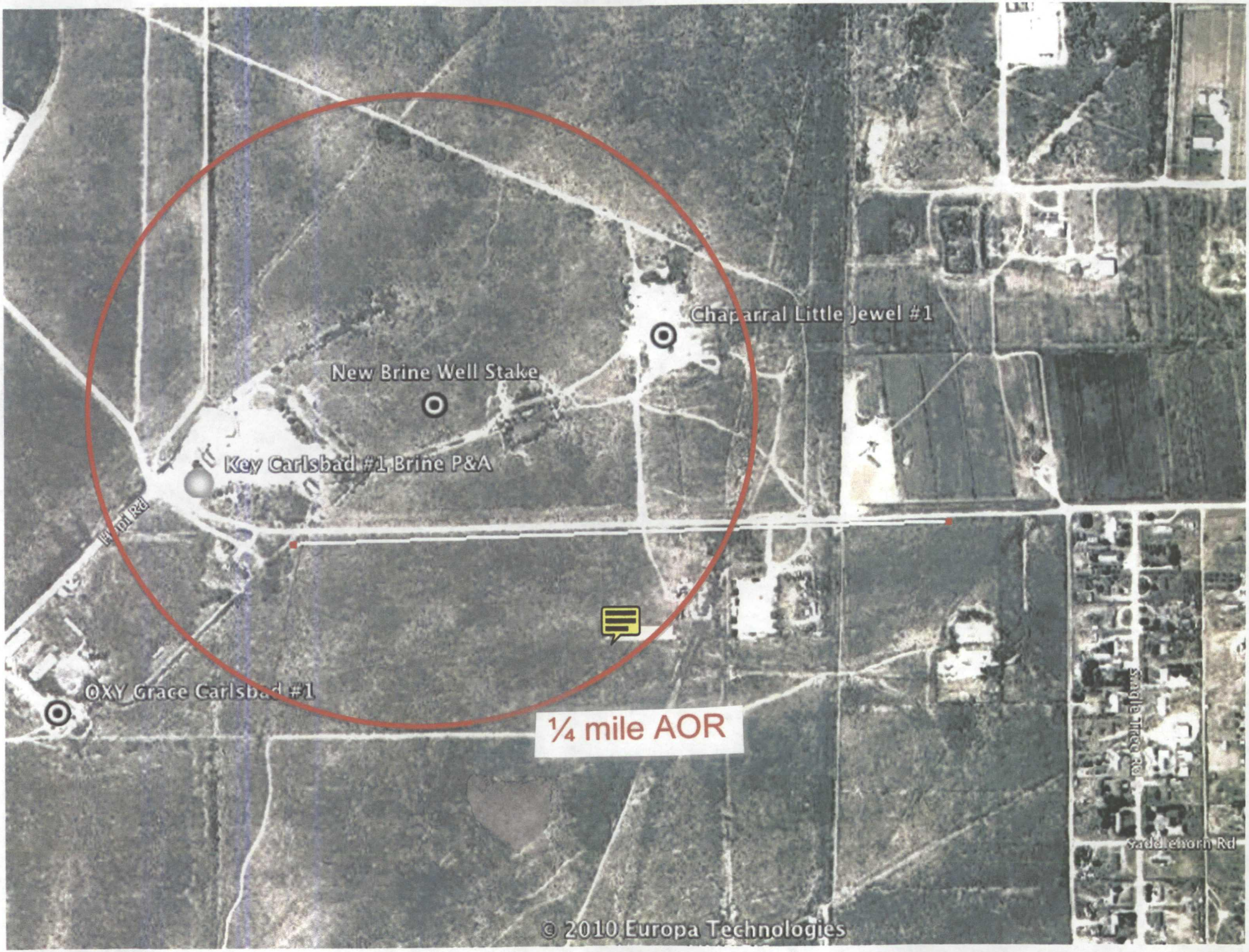
API Number	ULSTR	Footages	
3001520288	J -31-22S-27E	1980 FSL & 1980 FEL	No X
Well Name & Number: ALLEN No. 001			
Operator: SABRE OP INC			
3001520368	F -31-22S-27E	1980 FNL & 1900 FWL	✓
Well Name & Number: LITTLE JEWEL COM No. 001			
Operator: CHAPARRAL ENERGY LLC			
3001532795	H -31-22S-27E	1650 FNL & 990 FEL	No X
Well Name & Number: ALLEN COM No. 002			
Operator: CHI OPERATING INC			
3001533788	B -31-22S-27E	660 FNL & 1980 FEL	No X
Well Name & Number: ALLEN No. 003			
Operator: CHI OPERATING INC			

4 Records Found Displaying Screen 1 of 1

Continue Go Back

AOR Review--   Well Status List

API#	Well Name	UL	Section	Ts	Rg	Footage	Within 1/4 mi AOR * within 660 ft	Casing Program Checked	Cased/Cemented across salt section	Corrective Action Required
New Proposed Brine Well	*Key-City of Carlsbad #2*	F	31	22s	27e	1000 FWL & 2140 FNL	NA	Pending	Pending	NA
30-015-21842	*Key- City of Carlsbad #1*	*H*	*36*	*22s*	*26e*	*1340 FNL & 330 FWL*	*yes*	*yes*	*yes*	*Monitoring*
30-015-20573	Oxy USA Grace Carlsbad #1	*I*	*36*	*22s*	*26e*	*1980 FSL & 660 FEL*	*yes*	*yes*	*yes*	*NO*
30-015-20368	Chaparral little Jewel Com #1	F	31	22s	27e	1980 FNL & 1900 FWL	*yes*	*yes*	*yes*	*NO*



Chaparral Little Jewel #1
New Brine Well Stake
Key Carlsbad #1 Brine P&A
OXY Grace Carlsbad #1
¼ mile AOR
Saddlehorn Rd
© 2010 Europa Technologies

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FILE	1	✓
U.S.G.S.	2	
LAND OFFICE	1	
OPERATOR		

Bureau of Mines 1

Form C-105
Revised 1-1-65

RECEIVED

SEP 13 1976

O. C. C.
ARTESIA, OFFICE

NEW MEXICO OIL CONSERVATION COMMISSION

WELL COMPLETION OR RECOMPLETION REPORT AND LOG

5a. Indicate Type of Lease: State [X] Fee [ ]

5. State Oil & Gas Lease No.: Salt Mining #M19264

7. Unit Agreement Name:

8. Farm or Lease Name: City of Carlsbad

9. Well No.: 1

10. Field and Pool, or Wildcat: Wildcat

1a. TYPE OF WELL: OIL WELL [ ] GAS WELL [ ] DRY [ ] OTHER Brine Well

b. TYPE OF COMPLETION: NEW WELL [ ] WORK OVER [ ] DEEPEN [ ] PLUG BACK [ ] DIFF. RESVR. [ ] OTHER

2. Name of Operator: Truckers Water Company ✓

3. Address of Operator: P. O. Box 1499, Hobbs, New Mexico 88240

4. Location of Well: UNIT LETTER H LOCATED 2420 FEET FROM THE North LINE AND 330 FEET FROM THE East LINE OF SEC. 36 TWP. 22S RGE. 26E NMPM

12. County: Eddy

15. Date Spudded	16. Date T.D. Reached	17. Date Compl. (Ready to Prod.)	18. Elevations (DF, RKB, RT, GR, etc.)	19. Elev. Cashinghead
7-13-76	8-20-76	8-31-76		

20. Total Depth	21. Plug Back T.D.	22. If Multiple Compl., How Many	23. Intervals Drilled By	Rotary Tools	Cable Tools
930			→		X

24. Producing Interval(s), of this completion — Top, Bottom, Name: Salt - 710' Salt 930'

25. Was Directional Survey Made: No

26. Type Electric and Other Logs Run: None

27. Was Well Cored: No

28. CASING RECORD (Report all strings set in well)

CASING SIZE	WEIGHT LB./FT.	DEPTH SET	HOLE SIZE	CEMENTING RECORD	AMOUNT PULLED
8 5/8	32#	350'	13"	225 sx Class C	
5 1/2	14#	710'	7 7/8	150 sx Class C	

29. LINER RECORD

SIZE	TOP	BOTTOM	SACKS CEMENT	SCREEN

30. TUBING RECORD

SIZE	DEPTH SET	PACKER SET
2 3/8	926'	No

31. Perforation Record (Interval, size and number): Open hole 710 - 930

32. ACID, SHOT, FRACTURE, CEMENT SQUEEZE, ETC.

DEPTH INTERVAL	AMOUNT AND KIND MATERIAL USED

POSTED 10-2 + comp. 10-1-76

33. PRODUCTION

Date First Production	Production Method (Flowing, gas lift, pumping — Size and type pump)	Well Status (Prod. or Shut-in)
8-31	Circulating fresh water	Circulating

Date of Test	Hours Tested	Choke Size	Prod'n. For Test Period	Oil — Bbl.	Gas — MCF	Water — Bbl.	Gas—Oil Ratio

Flow Tubing Press.	Casing Pressure	Calculated 24-Hour Rate	Oil — Bbl.	Gas — MCF	Water — Bbl.	Oil Gravity — API (Corr.)

34. Disposition of Gas (Sold, used for fuel, vented, etc.)

Test Witnessed By

35. List of Attachments

36. *I hereby certify that the information shown on both sides of this form is true and complete to the best of my knowledge and belief.*

SIGNED R. Bailey TITLE Vice-President DATE 9-9-76

INSTRUCTIONS

This form is to be filed with the appropriate District Office of the Commission not later than 20 days after the completion of any newly-drilled or deepened well. It shall be accompanied by one copy of all electrical and radio-activity logs run on the well and a summary of all special tests conducted, including drill stem tests. All depths reported shall be measured depths. In the case of directionally drilled wells, true vertical depths shall also be reported. For multiple completions, Items 30 through 34 shall be reported for each zone. The form is to be filed in quintuplicate except on state land, where six copies are required. See Rule 1105.

INDICATE FORMATION TOPS IN CONFORMANCE WITH GEOGRAPHICAL SECTION OF STATE

Southeastern New Mexico		Northwestern New Mexico	
T. Anhy [redacted] 240	T. Canyon	T. Ojo Alamo	T. Penn. "B"
T. Salt [redacted] 715	T. Strawn	T. Kirtland-Fruitland	T. Penn. "C"
B. Salt	T. Atoka	T. Pictured Cliffs	T. Penn. "D"
T. Yates	T. Miss	T. Cliff House	T. Leadville
T. 7 Rivers	T. Devonian	T. Menefee	T. Madison
T. Queen	T. Silurian	T. Point Lookout	T. Elbert
T. Grayburg	T. Montoya	T. Mancos	T. McCracken
T. San Andres	T. Simpson	T. Gallup	T. Ignacio Qtzte
T. Glorieta	T. McKee	Base Greenhorn	T. Granite
T. Paddock	T. Ellenburger	T. Dakota	T.
T. Blinebry	T. Gr. Wash	T. Morrison	T.
T. Tubb	T. Granite	T. Todilto	T.
T. Drinkard	T. Delaware Sand	T. Entrada	T.
T. Abo	T. Bone Springs	T. Wingate	T.
T. Wolfcamp	T.	T. Chinle	T.
T. Penn.	T.	T. Permian	T.
T Cisco (Bough C)	T.	T. Penn. "A"	T.

FORMATION RECORD (Attach additional sheets if necessary)

From	To	Thickness in Feet	Formation	From	To	Thickness in Feet	Formation
0	210	210	Red bed and shale				
210	240	30	Anhydrite and shale				
240	715	475	Anhydrite				
715	TD	211	Salt				

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FILE	1	✓
U.S.G.S.	2	
LAND OFFICE		
OPERATOR		

Form C-105
Revised 1-1-65

NEW MEXICO OIL CONSERVATION COMMISSION
WELL COMPLETION OR RECOMPLETION REPORT AND LOG

RECEIVED
MAR 22 1973
O. C. C.
~~ARTESIA, OFFICE~~

5a. Indicate Type of Lease: State [X] Fee [ ]
5. State Oil & Gas Lease No. K-6290
7. Unit Agreement Name
8. Farm or Lease Name: Grace-Carlsbad
9. Well No.: 1
10. Field and Pool, or Wildcat: ~~Undes.~~ South Carlsbad

1a. TYPE OF WELL: OIL WELL [ ] GAS WELL [X] DRY [ ] OTHER

b. TYPE OF COMPLETION: NEW WELL [X] WORK OVER [ ] DEEPEN [ ] PLUG BACK [ ] DIFF. RESVR. [ ] OTHER

2. Name of Operator: Corinne Grace

3. Address of Operator: P O Box 1418, Carlsbad, New Mexico

4. Location of Well: UNIT LETTER I LOCATED 1980 FEET FROM THE South LINE AND 660 FEET FROM THE East LINE OF SEC. 36 TWP. 22S RGE. 26E NMPM

12. County: Eddy

15. Date Spudded	16. Date T.D. Reached	17. Date Compl. (Ready to Prod.)	18. Elevations (DF, RKB, RT, GR, etc.)	19. Elev. Cashinghead
2/11/72	4/2/72	5/4/72	3207.8	

20. Total Depth	21. Plug Back T.D.	22. If Multiple Compl., How Many	23. Intervals Drilled By — Rotary Tools	Cable Tools
11.875	11.764 KB	2	0-11,875	

24. Producing Interval(s), of this completion — Top, Bottom, Name: Morrow 86522

25. Was Directional Survey Made: Yes

26. Type Electric and Other Logs Run: Micro-Laterolog, Laterolog, Gamma Ray Neutron, BHC Acoustilog

27. Was Well Cored: No

28. CASING RECORD (Report all strings set in well)

CASING SIZE	WEIGHT LB./FT.	DEPTH SET	HOLE SIZE	CEMENTING RECORD	AMOUNT PULLED
13 3/8	48#	382	17	400 sks Class "H"	circl.
9 5/8	40# & 36#	5200	12 1/4	1050 sks & 150 sks Cl. "C"	
7	26# & 23#	10735	8 3/4	335 Class "H"	

29. LINER RECORD

SIZE	TOP	BOTTOM	SACKS CEMENT	SCREEN
4 1/2	10,634	11,875	200	

30. TUBING RECORD

SIZE	DEPTH SET	PACKER SET
2 3/8	10175	10169
2 3/8	11380	11380

31. Perforation Record (Interval, size and number)

11486-88 (8 shots)
11490-96 (24 shots)
11498-05 (21 shots)
11507-09 (8 shots)
11516-22 (18 shots)
11524-26 (8 shots)
11511-14 (12 shots)

32. ACID, SHOT, FRACTURE, CEMENT SQUEEZE, ETC.

DEPTH INTERVAL	AMOUNT AND KIND MATERIAL USED
None	None

33. PRODUCTION

Date First Production	Production Method (Flowing, gas lift, pumping — Size and type pump)	Well Status (Prod. or Shut-in)
	Flowing	Shut-In

Date of Test	Hours Tested	Choke Size	Prod'n. For Test Period	Oil — Bbl.	Gas — MCF	Water — Bbl.	Gas—Oil Ratio
7/7/72	4			0	* 8527	o	TSTM

Flow Tubing Press.	Casing Pressure	Calculated 24-Hour Rate	Oil — Bbl.	Gas — MCF	Water — Bbl.	Oil Gravity — API (Corr.)
1595.0	Pkr.		* From last	rate 4-point	test	

34. Disposition of Gas (Sold, used for fuel, vented, etc.): To be sold CAOF 14,105

Test Witnessed By

35. List of Attachments: Logs listed above

36. I hereby certify that the information shown on both sides of this form is true and complete to the best of my knowledge and belief.

SIGNED Juanita L. Jones TITLE Agent DATE March 22, 1973

Copy to SF

NEW MEXICO OIL CONSERVATION COMMISSION **RECEIVED** Form C-102

WELL LOCATION AND ACREAGE DEDICATION PLAT

MAR 30 1973

All distances must be from the outer boundaries of the Section

Operator		Lease		Well No.
CORINNE GRACE		GRACE-CARLSBAD, C. C.		1

Unit Letter	Section	Township	Range	County
I	36	23 SOUTH	26 EAST	ARTESIA, OFFICE. EDDY

Actual Footage Location of Well:
1980 feet from the SOUTH line and 660 feet from the EAST line

Ground Level Elev.	Producing Formation	Pool	Dedicated Acreage:
3207.8	STRAWN	~~Undes.~~ South Carlsbad Strawn	320 Acres

1. Outline the acreage dedicated to the subject well by colored pencil or hachure marks on the plat below.

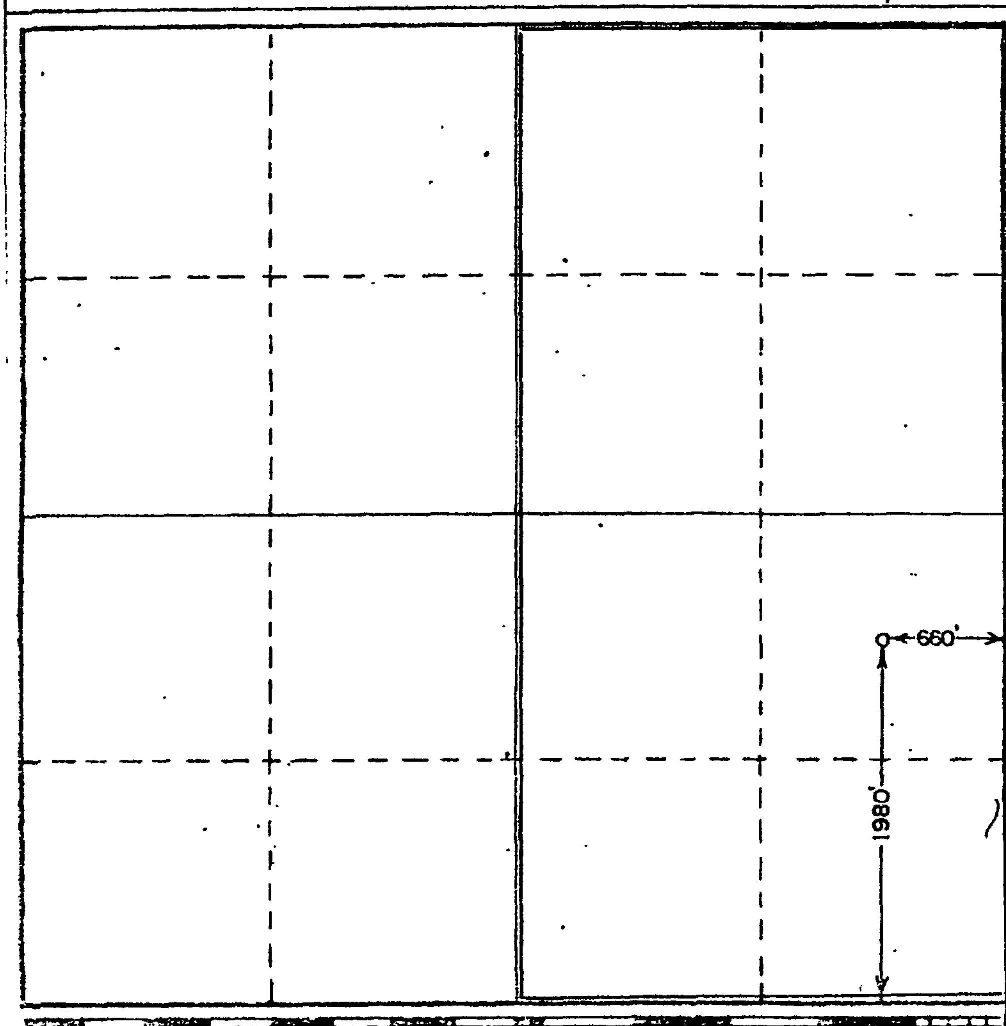
2. If more than one lease is dedicated to the well, outline each and identify the ownership thereof (both as to working interest and royalty).

3. If more than one lease of different ownership is dedicated to the well, have the interests of all owners been consolidated by communitization, unitization, force-pooling. etc?

☐ Yes ☐ No If answer is "yes," type of consolidation ______

If answer is "no," list the owners and tract descriptions which have actually been consolidated. (Use reverse side of this form if necessary.) ______

No allowable will be assigned to the well until all interests have been consolidated (by communitization, unitization, forced-pooling, or otherwise) or until a non-standard unit, eliminating such interests, has been approved by the Commission.



CERTIFICATION

I hereby certify that the information contained herein is true and complete to the best of my knowledge and belief.

Name: Donna Holler

Position: Agent

Company: Corinne Grace

Date: February 8, 1972

I hereby certify that the well location shown on this plat was plotted from field notes of actual surveys made by me or under my supervision, and that the same is true and correct to the best of my knowledge and belief.

Date Surveyed: FEBRUARY 7, 1972

Registered Professional Engineer and/or Land Surveyor: John W. West

Certificate No. 676

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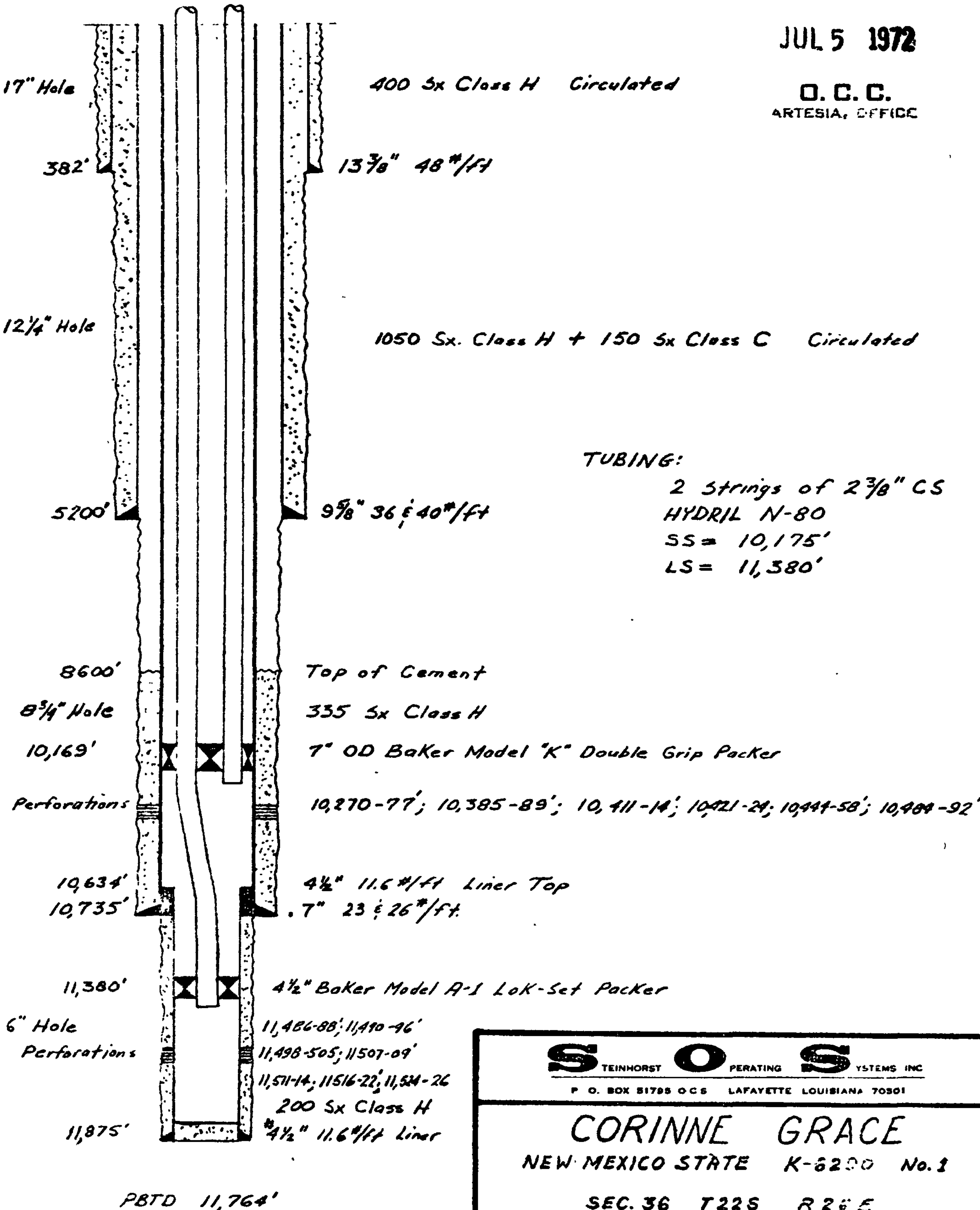
JUL 5 1972

O. C. C.
ARTESIA, OFFICE



STEINHORST **O**PERATING **S**YSTEMS INC
P. O. BOX 51795 O C S LAFAYETTE LOUISIANA 70501

CORINNE GRACE

NEW MEXICO STATE K-6200 No. 1

SEC. 36 T22S R 26 E

EDDY COUNTY NEW MEXICO

Date 4-8-72	Scale: NONE	Drwg No CG-1 Sheet 1 of 1

INSTRUCTIONS

This form is to be filed with the appropriate District Office of the Commission not later than 20 days after the completion of any newly-drilled or deepened well. It shall be accompanied by one copy of all electrical and radio-activity logs run on the well and a summary of all special tests conducted, including drill stem tests. All depths reported shall be measured depths. In the case of directionally drilled wells, true vertical depths shall also be reported. For multiple completions, Items 30 through 34 shall be reported for each zone. The form is to be filed in quintuplicate except on state land, where six copies are required. See Rule 1105.

INDICATE FORMATION TOPS IN CONFORMANCE WITH GEOGRAPHICAL SECTION OF STATE

Southeastern New Mexico		Northwestern New Mexico	
T. Anhy ______	T. Canyon ______	T. Ojo Alamo ______	T. Penn. "B" ______
T. Salt ______	T. Strawn ______	T. Kirtland-Fruitland ______	T. Penn. "C" ______
B. Salt ______	T. Atoka ______	T. Pictured Cliffs ______	T. Penn. "D" ______
T. Yates ______	T. Miss ______	T. Cliff House ______	T. Leadville ______
T. 7 Rivers ______	T. Devonian ______	T. Menefee ______	T. Madison ______
T. Queen ______	T. Silurian ______	T. Point Lookout ______	T. Elbert ______
T. Grayburg ______	T. Montoya ______	T. Mancos ______	T. McCracken ______
T. San Andres ______	T. Simpson ______	T. Gallup ______	T. Ignacio Qtzte ______
T. Glorieta ______	T. McKee ______	Base Greenhorn ______	T. Granite ______
T. Paddock ______	T. Ellenburger ______	T. Dakota ______	T. ______
T. Blinebry ______	T. Gr. Wash ______	T. Morrison ______	T. ______
T. Tubb ______	T. Granite ______	T. Todilto ______	T. ______
T. Drinkard ______	T. Delaware Sand ______	T. Entrada ______	T. ______
T. Abo ______	T. Bone Springs ______	T. Wingate ______	T. ______
T. Wolfcamp ______	T. ______	T. Chinle ______	T. ______
T. Penn. ______	T. ______	T. Permian ______	T. ______
T Cisco (Bough C) ______	T. ______	T. Penn. "A" ______	T. ______

FORMATION RECORD (Attach additional sheets if necessary)

From	To	Thickness in Feet	Formation	From	To	Thickness in Feet	Formation
0	500	500	Surface Sand & Shale				
500	1680	1180	Salt-Anhy.				
1680	2050	370	Lime & Sand				
2050	4100	2050	Sand				
4100	5200	1100	Lime, Sand, Shale	Lamar Lime			1828
5200	6280	1080	Lime and shale	Delaware Sand			1975
6280	6800	520	Sand & Shale	Bone Spring			5340
6800	7790	990	Lime and shale	1st Bone Spring Sand			6268
7790	8120	330	Sand and shale	2nd Bone Soring Sand			6803
8120	9030	910	Lime and shale	3rd Bone Spring Sand			8356
9030	9550	520	Shale and Lime	Wolfcamp			8740
9550	10257	707	Shale Sand & Lime	Cisco-Canyon			9945
10257	10850	610	Lime and shale	Strawn			10257
10850	11050	200	Limestone and shale	Atoka			10578
11050	11100	50	Shale & Lime	Morrow			11115
11100	11350	250	Lime and shale	Barnett			11820
11350	11420	70	Lime and shale				
11420	11875	455	Lime and shale				

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LAND OFFICE		
OPERATOR		

Form C-105
Revised 1-1-65

NEW MEXICO OIL CONSERVATION COMMISSION
WELL COMPLETION OR RECOMPLETION REPORT AND LOG

MA

O. C. C.
ARTESIA, OFFICE

5a. Indicate Type of Lease: State [ ] Fee [X]

5. State Oil & Gas Lease No. ------

1a. TYPE OF WELL: OIL WELL [ ] GAS WELL [X] DRY [ ] OTHER

b. TYPE OF COMPLETION: NEW WELL [X] WORK OVER [ ] DEEPEN [ ] PLUG BACK [ ] DIFF. RESVR. [ ] OTHER

7. Unit Agreement Name: ------

8. Farm or Lease Name: Little Jewel Com.

2. Name of Operator: Morris R. Antweil

9. Well No.: 1

3. Address of Operator: Box 2010, Hobbs, New Mexico 88240

10. Field and Pool, or Wildcat: South Carlsbad(Strawn)

4. Location of Well: UNIT LETTER E LOCATED 1980 FEET FROM THE North LINE AND 1900 FEET FROM THE West LINE OF SEC. 31 TWP. 22-S RGE. 27-E NMPM

12. County: Eddy

15. Date Spudded	16. Date T.D. Reached	17. Date Compl. (Ready to Prod.)	18. Elevations (DF, RKB, RT, GR, etc.)	19. Elev. Cashinghead
16 Jan 71	17 Mar 71	20 April 71	3189' GL	3189'

20. Total Depth	21. Plug Back T.D.	22. If Multiple Compl., How Many	23. Intervals Drilled By	Rotary Tools	Cable Tools
11,818'	11,786'	Two Zones	→	0-11,818'	----

24. Producing Interval(s), of this completion — Top, Bottom, Name: 10,362' -- 10,440' Strawn

25. Was Directional Survey Made: No

26. Type Electric and Other Logs Run: Gamma-Sonic, MLL, LL

27. Was Well Cored: No

28. CASING RECORD (Report all strings set in well)

CASING SIZE	WEIGHT LB./FT.	DEPTH SET	HOLE SIZE	CEMENTING RECORD	AMOUNT PULLED
13-3/8"	54#	373'	17-1/2"	380 sx.	----
9-5/8"	36#	2600'	12-1/4"	950 sx.	----
7	23,26,29#	10708'	8-3/4"	1170 sx - 2 stages	----
			6-1/8"		

29. LINER RECORD

SIZE	TOP	BOTTOM	SACKS CEMENT	SCREEN
4-1/2"	10,538'	11,818'	150 sx	--

30. TUBING RECORD

SIZE	DEPTH SET	PACKER SET
2-3/8"	10,452'	----
2-3/8"	11,393'	11,390'

31. Perforation Record (Interval, size and number)

10 holes @
10,362', 10,366', 10,371', 10,382'
10,391', 10,400', 10,403', 10,410'
10,375', and 10,440'.

32. ACID, SHOT, FRACTURE, CEMENT SQUEEZE, ETC.

DEPTH INTERVAL	AMOUNT AND KIND MATERIAL USED
10,362'-10,440'	4500 gals. acid

33. PRODUCTION

Date First Production	Production Method (Flowing, gas lift, pumping — Size and type pump)	Well Status (Prod. or Shut-in)
20 April 71	Flowing	Shut-In.

Date of Test	Hours Tested	Choke Size	Prod'n. For Test Period	Oil — Bbl.	Gas — MCF	Water — Bbl.	Gas—Oil Ratio
20 April 71	1 hr	17/64"	→				

Flow Tubing Press.	Casing Pressure	Calculated 24-Hour Rate	Oil — Bbl.	Gas — MCF	Water — Bbl.	Oil Gravity — API (Corr.)
3401 psi.	3762 psi	→	239	5758	---	58°

34. Disposition of Gas (Sold, used for fuel, vented, etc.): Test vented, connection pending

Test Witnessed By: Bill Kerley

35. List of Attachments: C-122, logs, DST summary, deviation record, packer leakage test.

36. *I hereby certify that the information shown on both sides of this form is true and complete to the best of my knowledge and belief.*

SIGNED R M Williams TITLE Agent DATE April 30, 1971

INSTRUCTIONS

... filed with the appropri... ... of the Commission not later than 20 days after the completion of any newly-dri... shall be accompanied by one copy of all electrical and radio-activity logs run on the well and a summary of all special tests ...ding drill stem tests. All depths reported shall be measured depths. In the case of directionally drilled wells, true vertical depths ... ...ered. For multip... complet..., Items 30 through 34 shall be reported for each zone. The form is to be filed in quintuplicate except on ... where six copies are required ... Rule 1105.

INDICATE FORMATION TOPS IN CONFORMANCE WITH GEOGRAPHICAL SECTION OF STATE

Southeastern New Mexico			Northwestern New Mexico	
T. ...	T. Canyon	T. Ojo Alamo	T. Penn. "B"
T. ...	T. Strawn 10,260	T. Kirtland-Fruitland	T. Penn. "C"
T. Sal...	T. Atoka 10,528	T. Pictured Cliffs	T. Penn. "D"
T. Yates	T. Miss	T. Cliff House	T. Leadville
T. ... Rivers	T. Devonian	T. Menefee	T. Madison
T. ...een	T. Silurian	T. Point Lookout	T. Elbert
T. ...rayburg	T. Montoya	T. Mancos	T. McCracken
T. ...an Andres	T. Simpson	T. Gallup	T. Ignacio Qtzte
T. ...lorieta	T. McKee	Base Greenhorn	T. Granite
T. ...addock	T. Ellenburger	T. Dakota	T.
T. ...inebry	T. Gr. Wash	T. Morrison	T.
T. ...	T. Granite	T. Todilto	T.
T. ...	T. Delaware Sand 1878	T. Entrada	T.
T. ...	T. Bone Springs 5250	T. Wingate	T.
T. ...	T. 3rd " " Sand 8365	T. Chinle	T.
T.	T. Morrow 11,080	T. Permian	T.
T. ... (... C)	T.	T. Penn. "A"	T.

FORMATION RECORD (Attach additional sheets if necessary)

From	To	Thickness in Feet	Formation	From	To	Thickness in Feet	Formation
0	1878	1878	Red Bed, Salt, Sand				
1878	5250	3372	Sand, Shale & Anhy.				
5250	10260	5010	Lime, Sand, Shale				
10260	10528	268	Lime				
10528	11818	1558	Lime, Sand & Shale.				

VII.B.- Workover Operations-Before performing remedial work, altering or pulling casing, plugging or abandonment, or any other workover, approval of OCD must be obtained. Approval should be requested on OCD Form C-103 "Sundry Notices and Reports on Wells" (OCD Rule 1103-A).

<u>Answer:</u> Key Energy acknowledges the requirement that any subsequent workovers after permit approval will be approved by OCD using the C-103 process. Key Energy will use the local districts guidance on when a C-103 requires submittal. In absent of OCD's guidance, Key will submit a C-103 for approval anytime the packer or tubing strings are unseated. Routine well-head piping maintenance or pressure testing will not be reported on a C-103 but a summary will be included in the annual report.

VII.C. Additional Information Required with Discharge Plan- In addition to all of the information required above in Part VII.A. (Drilling, Deepening, or Plug Back Operations), include the following with your discharge plan application.

VII.C.1. Provide evaluation, completion and well workover information. Include all logs, test results, completion reports and workover descriptions.

<u>Answer:</u> This information will be provided with the normal requirements of a C-103 and C-105 Sundry Notice and Well Completion reports respectfully, after well operations have been completed and will also be included in the annual reports.

VII.C.2. Provide the proposed maximum and average injection pressures and injection volume. If one well is to be used for injection and extraction, fresh water must be injected down the annulus and brine must be recovered up the tubing. Reverse flow will be allowed for up to once a month for 24 hours for clean out. If an alternative operating method is desired then a written request must be submitted to the OCD which describes the proposed operating procedures and how the mechanical integrity of the casing will be guaranteed.

<u>Answer:</u>

<u>Maximum Static, Dynamic and Average Injection Pressures and Estimated Flow Rates:</u>

The maximum pressure exerted on the formation will be limited to prevent formation fracturing. The emphasis will be to make sure the salt formation at or near the casing shoe will not be fractured under static or dynamic operating conditions.

Currently, the Oil Conservation Division does not have guidance concerning this issue. Therefore, Key Energy will use the Kansas guidance for maximum fracture gradient of 0.75 psi/ft. (per Mike Cochran-Kansas UIC Department).

In addition, Key used one of the noted fracture pressure calculation determinations by Willis, Kelly and Eaton. The Eaton equation provides the most conservative number for Fracture Gradients.

Key utilized the Eaton equation in an excel spreadsheet model to determine if these results are comparable to Kansas' 0.75 psi/ft rule of thumb fracture gradient.

The Eaton equation provided a conservative fracture gradient of 0.68 psi/ft when the Poisson ratio was set at the lower limit of 0.25 for Salt (WIPP site ref.) Other salt zones can have Poisson ratios of 0.37 on the high side, which gives a fracture gradient of 0.80 psi/ft. The average of 0.68 psi/ft and 0.80 psi/ft calculates to be 0.74 psi/ft. Therefore, Key Energy will use a 0.75 psi/ft fracture gradient for determining maximum pressures.

A very conservative depth of 1000 feet was used in the fracture calculation to determine the fracture pressure at that depth. In addition, the model also calculated the allowable static surface pressure (i.e. pump not running) and the maximum allowable injection pressure, taking into account friction pressure losses in the tubing.

The maximum allowable surface injection pressure was calculated to be 306 psig. The maximum static pressure was determined to be 226 psig. The flow rate will be between 3-5 bbl/min with an average injection pressure ranging from 100-300 psig. Depending on different criteria such as actual pump selection and speed control, piping design, and flow demand, the average injection pressure may be reduced for energy savings.

<u>The results of the model is in this section VII.B.-VII.C1-6 appendix.</u>

<u>Answer:</u> Key Energy understands OCD's position has changed on the issue of injecting fresh water down the annulus (i.e. reverse flow) since it causes a cavern to be formed at the top of the salt formation thus over time causes an inheritably unstable roof condition. Key Energy is planning on using a double tubing arrangement where the fresh water will be injected down the longer tubing string near the bottom of the formation. The shorter tubing string will be used to produce brine water out of the formation. The system will be designed to reverse the tubing flows for maintenance reasons.

VII.C.3. Submit a proposed mechanical integrity testing program. OCD requires a casing pressure test isolating the casing from the formation using either a bridge plug or packer prior to start of operation, and repeated at least once every five years or during well work over. In addition, OCD requires an open hole pressure test to 500 PSI for 4 hours on an annual basis.

<u>Answer:</u> All casing strings will be tested to a minimum of 350 psig for 30 minutes, 24 hours after cementing to surface. Thereafter, an annual casing pressure test shall be ran for 30 minutes at a minimum of 350 psig using a pressure chart recorder with a maximum of 500 lb range and 4 hour (complete revolution) chart. OCD will be notified in ample time so they may witness the test. The double tubing packer will not be unseated for this test.

A packer fluid will be maintained and monitored in the annulus and a summary will be reported in the annual report. Any annulus fluid "loss or gain" of more than 10% of the normal variation in the well bore volume will be investigated and reported to the OCD within one week of discovery. After consultation with OCD, corrective actions will be taken.

Key Energy **<u>does not agree</u>** with the current guidance of pressuring testing the formation to 500 psi for 4 hours. This pressure exceeds the formation fracture pressure and recommends OCD changes this guidance. Key Energy plans to maintain a minimum of 100 psig (surface pressure) at all times on the formation. Several SMRI and other reports have shown that sudden releases and inadvertent pressure surges during testing may be causing extensive damage in the formation. Therefore, Key is proposing that no annual formation test be performed per se.

Key intends to maintain a duel continuous pressure chart recorder on the formation and annulus. The pressure recorder will have a 30-day clock and all charts will be maintained for a minimum of 5 years. All charts will be submitted in an annual report due on March 31 of each year.

VII.C.4. Provide an analysis of the injection fluid and brine. Include location and design of site(s) and method(s) of sampling. Analysis will be for concentrations of Total Dissolved Solids, Sodium, Calcium, Potassium, Magnesium, Bromide, Carbonate/Bicarbonate, Chloride and Sulfate.

Answer: Fresh water and brine water samples will be collected at the load line area of the facility or taken directly from sample ports at the well-head. Key believes OCD's guidance does not adequately sample for all of the important parameters and hereby proposes to sample for the following constituents:

Key energy will sample for the following chemical constituents: All WQCC metals, general chemistry (major cations and anions), total dissolved solids (TDS), total suspended solids (TSS), density, Ph, with a cation/anion balance, volatile organics (8260B), total uranium, radium 226/228, and TPH (418.1) shall be taken as a baseline at the end of the first years operation and reported in the annual report.

At least four times during the first year of production, and then twice a year thereafter, all WQCC metals, general chemistry (major cations and anions), total dissolved solids (TDS), total suspended solids (TSS), density, Ph, with a cation/anion balance and TPH (418.1). All sample and analysis will be pursuant to EPA methods and reported in the annual report.

VII.C.5. Compare volumes of fresh water injected to volume of brine to detect underground losses and specify method by which volumes are determined. After approval, submittal of a quarterly report listing, by month, the volume of fluids injected and produced will be required.

Answer: Key Energy proposes to monitor both fresh water and brine water by installing individual flow meters on the inlet and outlet brine well lines. The meters will have totalizers and will be read and recorded monthly. These readings will be evaluated monthly to determine if they remain within a 10% tolerance, with the fresh water generally being greater that the brine water produced. Any monthly reading out of limits will be investigated and reported to OCD within 30 days. The results will be reported in the annual report.

VII.C.6. For renewal application for facilities in operation in excess of 15 years, provide information on the size and extent of the solution cavern and geologic/engineering data demonstrating that continued brine extraction will not cause surface subsidence of catastrophic collapse.

Answer: Key Energy believes this guidance is out dated and should require this information every year in the annual report. Key Energy proposes to provide an annual cavity size, D/H ratio, estimated radius, and configuration. Key also has developed a model to determine the roof stability and will provide the results of the model annually.

Key is designing its tubing strings to be oversized to accommodate the largest sonic tools and will survey the cavern at least once every five years or every 3 million barrels of brine production whichever comes first.

Once the permit is approved and the well completed and put in production, Key will install approved subsidence monitors within the first year. Key will include the information in each annual report.

The OCD guidance should be changed to provide for a certain life, volume, and radius depending upon on-site geo-technical information. Therefore, key Energy is committing to a 20-year life, or a 12.5 million barrel volume, or a limited radius of 150 feet. If Key has not reached the anticipated volume or radius in 20 years, then Key will petition the agency and provide technical evidence that operations may continue safely.

Section VII.B-VII.C1-6 Appendix for Brine Well Application Guideline

Includes:

1. Results of Injection Pressure Model Excel Spreadsheet
2. Friction Charts
3. Eaton Equation for Old Brine Well BW-19.

Maximum Injection Pressure Model

Pr (frac pressure gradient) = (S-Po)*(Y/(1-Y))+Po --------------------------------

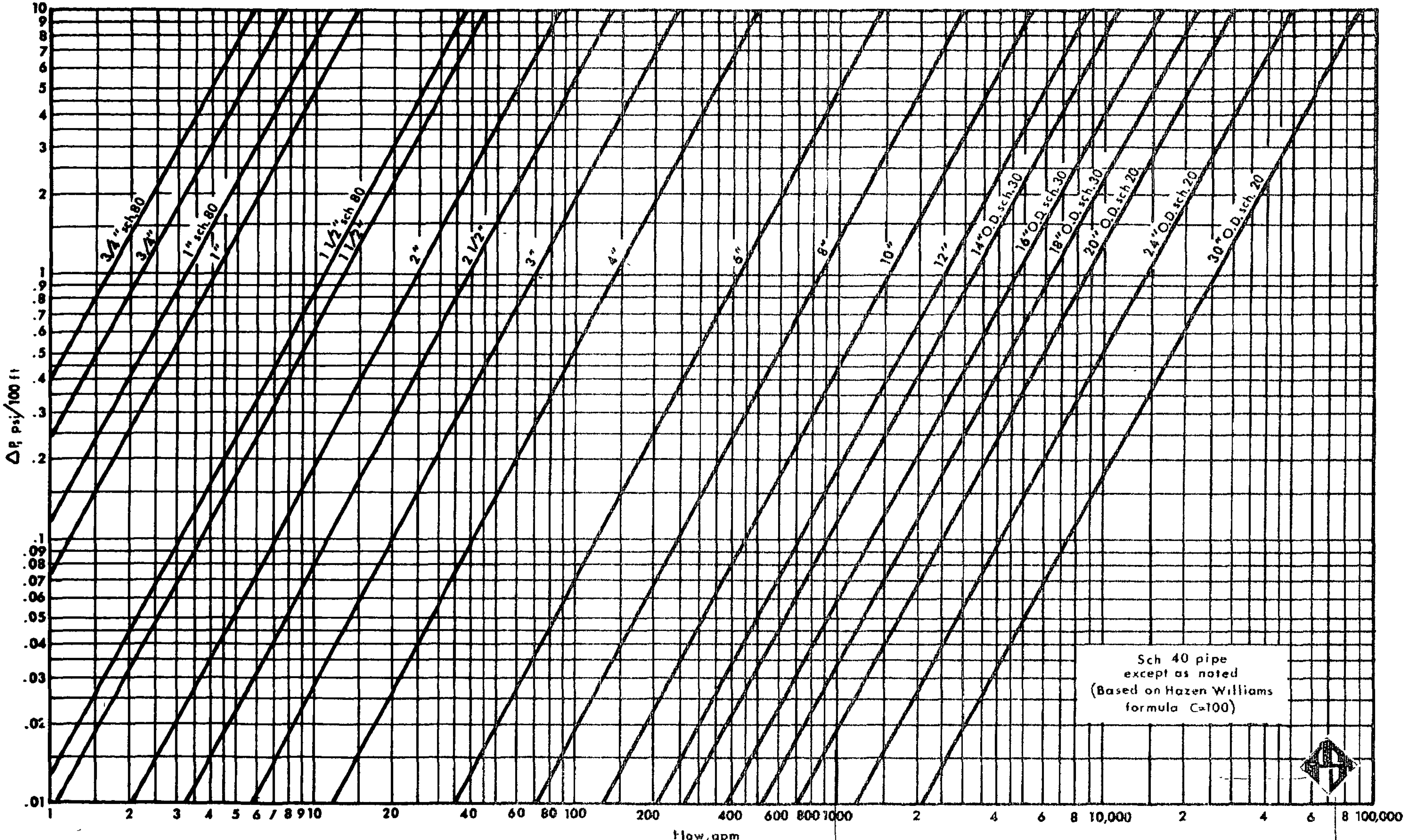
Overburden pressure gradient psi/ft	1	psi/ft	input
Pore pressure gradient	0.52	psi/ft	input
Brine water gradient	0.52	psi/ft	input
D = Depth to injection zone or casing shoe	1000	ft	input
Y = poissan's ratio	0.32		input
S (overburden pressure) = 1 psi/ft x depth to injection	1000	psi	formula
Po = pore pressure	520	psi	formula
Calculated Frac Gradient	0.745882353	psi/ft	formula
			formula
			formula
Frac Pressure at injection point	746	psi	formula
Maximum Static Surface Pessure	226	psi	formula
***Friction Loss	80	psi	input
Maximum Injection Pressure	306	psi	formula

*** See friction charts attached

3-4 bbls/min - 3" pipe- 3000 ft pipe

FIG. 10-11

Pressure drop for flowing water



The laboratory Poissan's ratio for salt is 0.25. Using the equation below, the potential downhole fracture pressure at the top of the perforations for the two wells is calculated.

$$P_f = (S - P_o)\ (Y / 1 - Y) + P_o$$

P_f = fracture pressure (psi) at injection face
S = overburden pressure
P_o = pore pressure
Y = Poissan's ratio = 0.25
Brine gradient = 0.52 psi/ft.

City of Carlsbad #1

Top of perfs= 710
S = 1.0 x 710
P_o = 0.46 x 710 = 327 psi
P_f = 455

Top Hole fracture pressure
= 455 psi – (710 x 0.52 psi/ft)
= 86 psi

Total hole fracture pressure
Friction loss = 62 psi

Maximum Injection Pressure
= 148 psi

State #1

Top of perfs = 1350
S = 1.0 x 1350
P_o = 0.46 x 1350
P_f = 864

Top Hole fracture pressure
= 864 psi – (1350 x 0.52)
= 162 psi

Total hole fracture pressure
Friction loss = 118

Maximum Injection Pressure
= 280 psi

Injection pressure at the surface on the City of Carlsbad #1 is 100 psi. Injection pressure at the surface on the State #1 is 220 #. Both wells are operating under the calculated maximum pressures.

VIII. Spill/Leak Prevention and Reporting Procedures (Contingency Plans)- *It is necessary to include in the discharge plan submittal a contingency plan that anticipates where any leaks or spills might occur. It must describe how the discharger proposes to guard against such accidents and detect them when they have occurred. The contingency plan also must describe the steps proposed to contain and remove the spilled substance or mitigate the damage caused by the discharge such that ground water is protected, or movement into surface waters is prevented. The discharger will be required to notify the OCD Director in the event of significant leaks and spills. This commitment and proposed notification threshold levels must be included in the contingency plan.*

VIII.A. Prevention- Describe how spills and leaks will be prevented at the facility. Include specifically how spillage/leakage will be prevented during truck loading and at major transfer points within the facility. Discuss general "housekeeping" procedures for areas not directly associated with the above major processes.

VIII.B. Containment and Cleanup-Describe procedures for containment and cleanup of major and minor spills at the facility. Include information as to whether areas are curbed, paved, and drained to sumps; final disposition of spill materials; etc.

VIII.C. Notification-Propose a schedule for OCD notification of spills. The OCD requires the discharger to notify the director within 48 hours of the detection or suspected detection of a spill, and provide subsequent reports as required.

VIII. (A-C) Answer: Please find enclosed in the appendix for this section VIII a site "Emergency Contingency Plan" that addresses this section.

Section VIII. Appendix for Brine Well Application Guideline

Includes:

"Emergency Contingency Plan"

Emergency Contingency Plan

Key Energy Carlsbad Brine & Fresh Water Station

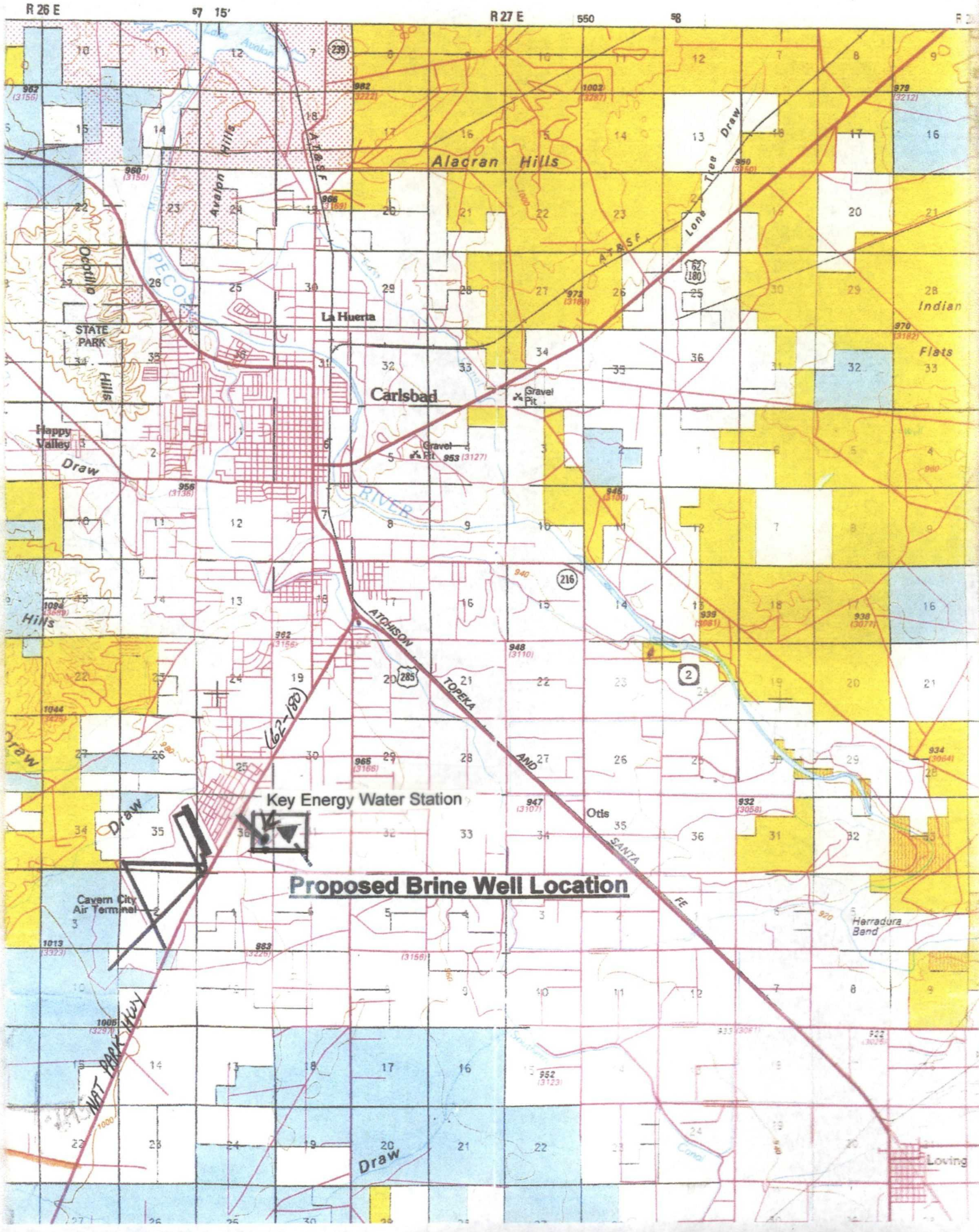
Location of Facility: Approximately 3 miles southwest of the intersection of US Highways 285 and (62-180) in Carlsbad, New Mexico, and ½ mile east of the Carlsbad airport off of the National Parks Highway US (62-180). Entrance just south of B&H Construction Company. <u>Latitude/Longitude:</u> *<u>Water Station</u>* - (N 32°-20.943' W 104°-14.269') *<u>Well Location-</u>* (N 32°-20.981' W 104°-14.081') See attached map for reference.	
Local Key Energy Response Personnel: Carlsbad Yard Office and Dispatcher.............575-885-2053 Marcos Hernadez-Yard Manager................... 575-706-0232 JD McCormack- Brine Well Supervisor..........575-706-0235 <u>Local Mailing Address:</u> Key Energy Services, LLC. 1609 E Green St. Carlsbad, NM 88221	***Remote Key Energy Response Personnel:*** Dan K. Gibson-Environmental Dir...........432-571-7536 office 432-638-6134 cell Louis Sanchez-Environmental Spec.........432-571-7382 office 432-230-7926 cell <u>Remote Mailing Address:</u> Key Energy Services, LLC. 6 Desta Drive. Suite 4300 Midland, Texas 79705
Emergency Response Agencies: Carlsbad Fire and Medical....................................911 Eddy County Sheriff Dept.................... ....575-887-7551 Carlsbad Fire Department...................................575-885-3125 Carlsbad Police department.................................575-885-2111 New Mexico State Police......................................575-392-5588	***Reporting Agencies:*** New Mexico Oil Conservation (Santa Fe).........505-476-3440 New Mexico Oil Conservation (Artesia).......... .575-748-1283 National Response Center...............................800-424-8802 EPA Region 6 Emergency Response................214-665-6428 Chemtrec...800-424-9300
Materials Stored or Transferred On Site: >Fresh Water & Brine Water- (Non-Hazardous)>>>>>>>>>>>>>>>>>>> >Packer Fluid- (Combustible)>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>> >Contaminated Soil- (Non-Hazardous)>>>>>>>>>>>>>>>>>>>>>>>>> >Common Trash- (Non-Hazardous)>>>>>>>>>>>>>>>>>>>>>>>>>>>>>	***General Location of anticipated Leaks/Spills:*** >Water station inside lined-bermed tank battery, concrete loading pad and lines between pump house and brine well. >Brine well house 1000 ft east of water station. >Sealed bins or drums at water station. >Trash bins at water station.
Prevention: >Brine water storage tanks have impermeable containment and level controls. >Packer Fluid tank in secondary containment device. >Waste containers on pad & curb. >Spills outside of containment areas will be contained with dirt berms.	***Containment and Clean-up Actions:*** >Incidental drips, leaks, and spills will be picked up routinely by on-site personnel and placed back into the system or in waste containers. >Any release of brine water over 5 bbls; or 1 bbl of chemical or 1 bbl of waste; that is discharged out of the secondary containment will be handled pursuant to the Emergency Procedures and Notification below.

Emergency Procedures and Notification:

Step 1. "***<u>Call Immediately</u>***" ---Key Energy "***Dispatch Telephone Number***" listed above for all uncontrolled releases outside of a containment area; or for any fire, break, leak or spill that has caused, or may cause, a life-threatening situation.
Step 2. "***<u>Call Immediately</u>***" ---One of the ***Emergency Response Agencies*** listed above if there is a life-threatening situation.
Step 3. Provide assistance to "First Responders" as directed and allowed by Key Energy Supervisor.
Step 4. Stop the release, only if you have been trained or have experience in the operations of the site, and only if it can be done in a safe manner.
Step 5. Key Energy will use all available resources in the area to stop, contain and mitigate the emergency situation.
Step 6. During "***Emergency Response Conditions***"--- fluids, contaminated soils; or waste-like materials may be contained, temporarily stored, picked up, recycled or disposed of off-site at an approved facility.
Step 7. Key Supervisor shall "***Notify the Reporting Agencies***" as appropriate, listed above.
Step 8. ***Incident Command System (ICS)*** --If the emergency is series enough to have the Local or State police initiate the incident command system (ICS), then Key Energy will take an active roll as directed by the incident commander.

BLM Surface Management Status Topographic Map 1:100,000 scale with elevation contours, roads, water features and section, township and range lines (NGVD-1929) USGS and location of proposed site-------- ▲

30X60



IX. Site Characteristics

IX.A. The following hydrologic/geologic information is required to be submitted with all discharge plan applications. Some information already may be included in this application or may be on file with OCD and can be provided to the applicant on request.

A.1. Provide the name, description, and location of any bodies of water, streams (indicate perennial or intermittent), or other watercourses (arroyos, canals, drains, etc.); and ground water discharges sites (seeps, springs, marshes, swamps) within one mile of the outside perimeter of the facility. For water wells, locate wells within one-quarter mile and specify use of water (e.g. public supply, domestic, stock, etc.).

A.2. Provide the depth to and total dissolved solids (TDS) concentration (in mg/l) of the ground water most likely to be affected by any discharge (planned or unplanned). Include the source of the information and how it was determined. Provide a recent water quality analysis of the ground water, if available, including name of analyzing laboratory and sample date.

A.3. Provide the following information and attach or reference source information as available (e.g. driller's logs): a. Soil type(s) (sand, clay, loam, caliche); b. Name of aquifer(s); c. Composition of aquifer material (e.g. alluvium, sandstone, basalt, etc.); and d. Depth to rock at base of alluvium (if available).

A.4. Provide information on: a. The flooding potential at the discharge site with respect to major precipitation and/or run-off events; and b. Flood protection measures (berms, channels, etc.), if applicable.

Answers: Information for items (A.1-A.4) above, is provided in detail and contained in the "GEOLOGICAL CHARACTERIZATION REPORT" included as part of section IX below:

IX.B. Additional Information

Provide any additional information necessary to demonstrate that approval of the discharge plan will not result in concentrations in excess of the standards of WQCC Section 3-103 or the presence of any toxic pollutant (Section 1-101.UU.) at any place of withdrawal of water for present or reasonably foreseeable future use. Depending on the method and location of discharge, detailed technical information on site hydrologic and geologic conditions may be required to be submitted for discharge plan evaluation. This material is most likely to be required for unlined surface impoundments and pits, and leach fields. Check with OCD before providing this information. However, if required it could include but not be limited to:

B.1. Stratigraphic information including formation and member names, thickness, lithologies, lateral extent, etc. B.2. Generalized maps and cross-sections; B.3. Potentiometric maps for aquifers potentially affected; B.4. Porosity, hydraulic conductivity, storactivity and other hydrologic parameters of the aquifer; B.5. Specific information on the water quality of the receiving aquifer; B.6. Information on expected alteration of contaminants due to sorption, precipitation or chemical reaction in the unsaturated zone, and expected reactions and/or dilution in the aquifer.

Answer to B.1-B.5: Included in the "GEOLOGICAL CHARACTERIZATION REPORT" below:

Answer to B.6: Key Energy does not anticipate an alteration of contaminants since salts generally have an extended bioavailability in the environment. For this reason every attempt will be made to prevent the release of contaminants, and in the case of releases, an appropriate response shall be conducted to minimize or eliminate this effect.

Answers for Section IX Site Characteristics:

GEOLOGICAL CHARACTERIZATION REPORT (GCR)
For a Proposed
KEY ENERGY CARLSBAD BRINE STATION
UL E Section 31-Ts 22S-R27E
EDDY COUNTY
CARLSBAD, NEW MEXICO

GCR Section I- Introduction:

Brines wells extract saturated salt-laden water (i.e. brine water) typically used in oilfield drilling operations to ensure the integrity of the bore hole when drilling in salt zones, and for conditioning certain drilling fluids to mitigate down-hole pressures, and in preventing well bore plugging during completion operations. Brine wells have been an integral part of the Oil and Gas industry for many years, especially in the Permian Basin of SE New Mexico and West Texas.

Key Energy LLC has contracted with ***Price-LLC*** a single member company to perform a preliminary feasibility study to determine if the current location of Key's existing brine facility would be a suitable location for a new replacement brine well. In addition, ***Dennis W. Powers, Ph.D.*** *Consulting Geologist, has been hired to perform a peer review of the site Geological Characterization Report (GCR).*

The current facility is located approximately three miles south of the intersection of US highways 285 and 180 located south of Carlsbad, NM and about three quarters of a mile east of US Highway 180 and the Carlsbad Airport. The existing site was actually located in the Carlsbad City limits in UL H of Section 36-Ts22S-R26E. A local Carlsbad City map is included in this GCR section I appendix for reference. The site was permitted by the New Mexico Oil Conservation Division and operated under permit BW-19 and had a state salt mining mineral lease # M19264.

The proposed site will be located approximately 1100 feet east of the existing site in UL E (1000 FWL & 2140 FNL) of Section 31-Ts 22S-R 27E, Eddy County, New Mexico in the outer Carlsbad ET zone. This area is actually part of the old Carlsbad Army Air Base industrial complex and is zoned for commercial and industrial use.

History of BW-19 Carlsbad Brine Well:

The site is currently not in operation at this time as the existing brine supply well was experiencing down-hole problems and subsequently was plugged and abandoned.

The well was drilled and placed in production in August 1976 and operated up until time of closure in October of 2008. The well produced an estimated 6.5 million barrels of concentrated salt water (10 lb brine water) during the 32-yearlife of the well. The well file indicates this well was completed in a salt zone found about 715-900 feet below the surface.

This well operated virtually trouble free for almost 25 years before experiencing any major issues. The well casing had developed a leak and the bedded salt layers had began to sluff off causing pinching of the tubing making reentry very difficult, especially the required sonar logging.

This phenomenon is quite common among older single brine well systems especially those completed in bedded salt formations such as the Salado. The problem is compounded when fresh water is injected down the casing annuals and brine is produced up the tubing. (I.e. reverse flow)

Originally brine wells were operated under "normal flow" conditions by injected fresh water down the tubing and producing brine up the casing annulus. Sometime ago the regulatory agencies changed their permit conditions that required operators to operate under "reverse flow" conditions. The idea was that if the casing developed a leak then only fresh water would be released, thus preventing groundwater contamination. The result of these actions actually began to cause severe damage to the cavern roof system, due to the fact that fresh water came into direct contact with the top salt and anhydrite layers, thus dissolving them to a point where the structure stability became unstable.

On July 02, 2008 Jim's Water Service brine well collapsed and on September 03, of the same year another brine well collapsed in the area causing the Oil Conservation Division to issue a temporary moratorium on new brine wells. During this time the agency requested that I&W brine well located just three miles to the north of Key's site be shut in for public protection. This Carlsbad area now has only one active "UIC Class III" brine well for the oil and gas drilling industry.

After Key plugged their Carlsbad well BW-19, they had contacted the agency about applying for a new brine well system in the same area. However, Key was confronted with the new moratorium, thus forgoing any plans at the time. Ironically, starting in about September of 2008 the world economy went into the worst recession of many decades and the price of oil plummeted virtually shutting down the drilling activity.

This lessened the strain on required brine, but as the economy recovers there will be a need for additional brine capacity. That time has arrived with the price of oil expected to rise substantially in the near future. The area has already begun to experience new drilling activity.

In October 09, Key personnel met with the OCD to determine a path forward for permitting a new brine well. Since Key has a first class BMP type brine station with secondary containment at the site, costing in the millions of dollars, locating a new well in the general vicinity makes logical sense.

The agency spelled out a number of criteria and concerns during the meeting and entered the minutes of the meeting in the BW-19 file. This document is included in this GCR section I appendix for reference. OCD pointed out in the memo that they would prefer a deeper well possibly in the Castile Formation. One of the criteria was *"Key will need to look at surrounding wells to create a cross-section of the hydrogeology across the area to determine if the Castile formation may be present beneath their facility."*

Since there is a high probability that new brines located on the back-side, i.e. north of the Capitan Reef, in a large area progressing north all the way to Roswell and east to the Caprock area, may be prohibited due to the unfavorable geology. Therefore, Key Energy feels it is paramount that Industry obtains a new brine well for up-coming activities in the area.

Presently, the Carlsbad location is the most favorable position to serve the industry to south, east, west and especially to the north since brine wells do not exist.

Siting Critera for New Brine Wells:

Any new brine well in New Mexico will certainly have to be properly sited, designed, completed, operated and closed in a manner that will be most protective of public health, safety and the environment. The following criterion should be addressed in any application for new brine wells.

Preliminary Site Selection:

➪The preliminary site selection will be based on demand of the product, required minerals, rights to develop, availability of personnel and services, transportation, accessibility, utilities, land jurisdiction, set-backs from populated areas, including any significant ecological effects and sociological impacts.

Geologic Criteria:

The geology of the site must permit a long-term safe operation and closure of the site. In order to accomplish this goal, the following geologic parameters should be met:

➪Regional Stability- While local stability of any site is a must, there is always a prerequisite that the regional geological stability exist.

➪Topography- must permit access for transportation; negate flooding potential, and erosion.

➪Depth of Salt Zone- The zone of interest must be sufficiently deep to ensure there is an adequate overburden structured layers (e.g. anhydrite) forming a stable roof, sufficient overburden thickness to prevent catastrophic collapse due to "stopping" (Wilson Report) and be at least 1000 feet BGL due to low fracture gradients in shallow wells. (SMRI; & WPrice)

➪Recent brine wells collapses in SE New Mexico have occurred at locations where the top of the salt was quite shallow, the casing shoe was not set deep enough in the salt, and there was only approximately 500 feet or less of overburden. Therefore, recommended "salt depth criteria" should be at a minimum depth of 1000 feet BGL.

➪Thickness of Salt- The salt must be sufficiently thick to ensure that at least 50 feet of cavern roof salt is available and provide enough salt to guarantee that the cavern over time is confined in the permitted zone.

➪Stratigraphy and Lithology- The area Stratigraphy and Lithology should be studied and identified by obtaining information from know accurate sources and local well logs. The anticipated zone of interest must demonstrate that is has sufficient roof support material and adequate vertical and lateral salts to be mined without encroaching upon other structure boundaries.

➪Fracture Gradients- Shallow brine wells generally have a fracture gradient of less than 1 psi/ft where the salt zones are less than 1000 feet BGL. Such wells are know to have gradients as low as .60 psi/ft. (ref SMRI) which can lead to continual fracturing of the formation during normal production or testing, causing extensive roof damage.

➪Geologic Disturbed Zones-Any area where the geologic features have been disturbed, either by man or nature, should be taken into account in the siting process. During the early siting stages of the WIPP site, a disturbed zone was found along the Capitan reef. See attached fig-1-1 in this GCR section I appendix. An arbitrary setback of six miles was established at that time. However, the actual setback of one mile would have been appropriate accordingly. (Ref Griswold) A one-mile criteria will be used to provide an adequate setback for siting of any new brine well and zone of interest from disturbed zones.

➪Karsts Regions, Dissolution, Sinkholes, and Brine Pockets - Brine wells are manmade dissolution cavities that are created in a matter of years. Sinkholes, karsts areas, brine pockets and other disturbed geologic features are generally natural occurring features which has taken thousands or millions of years in geologic time to develop.

Some of these natural occurring areas are quite stable, while other areas may be highly unstable and would certainly be reason for not placing a brine well in such an area. One example may be an area that has had rapid dissolution of the overlying overburden materials, possibly causing the natural roof support material to become plastic in nature and cause subsidence or collapse.

Other examples may include known karsts areas with sufficiently large void features that cause instability, or allows conduit flow of dissolution water that may eventually undermine an otherwise adequate roof support. In addition, many caves in the region are becoming an important sociological recreational value that should be protected.

Surface features, such as faults, sinkholes, dry stream beds, dissolution fronts, and others may also indicate an existing unstable area, or may be a collection point for fresh water that may infiltrate and cause rapid dissolution of natural occurring roof support material. It is important to address these natural occurring features both individually and on a combined basis because they can and generally be interrelated. Therefore, the siting criteria should take into account the long-term effects that such geologic features may have on any new brine well.

➩Brine Flows- Review of Neutron density logs, production practices, review of well files and inquires with the local regulatory agency should be conducted to determine if high pressure brine pockets have been encountered in the area.

<u>**Hydrologic Criteria:**</u>

➩Surface Water- Siting should take into consideration all surface waters such as watercourses, rivers, streams, lakes, playas, and springs that may be impacted from the current and future brine well operations.

➩Groundwater- Siting should take into consideration all groundwater sources such as natural springs, aquifers, municipal, domestic and industry wells and any other protectable water sources including possible pathways to these features.

➩Area of review- The area of review should be an area surrounding any Class III Brine well that is to be examined to identify possible fluid conduits that may allow pressured brine water to migrate to known oil and gas reservoirs, fresh water wells, watercourses or fractures that may penetrate the injection zone. A suitable distance should be determined by either regulatory requirements, or based upon a standard and known mathematical calculation using current engineering best practices to determine the area of review.

Computations should include site-specific parameters and injection time periods equal to the expected life and/or the physical size of the cavern to be developed.

Currently the State agency criteria requires identification of all surface/subsurface protectable water sources within one mile of the site; and a comprehensive review of all producing or abandoned oil and gas wells, injection wells, watercourses, water wells, and any significant features within 1/4 mile of the site.

Tectonic Criteria:

➪Seismic Activity Definition and Background- An earthquake (also known as a quake, tremor or temblor) is the result of a sudden release of energy in the Earth's crust that creates seismic waves. The seismicity or seismic activity of an area refers to the frequency, type and size of earthquakes experienced over a period of time. Earthquakes are measured with a seismometer; a device, which also records, is known as a *seismograph*. The moment magnitude (or the related and mostly obsolete Richter magnitude) of an earthquake is conventionally reported, with magnitude 3 or lower earthquakes being mostly imperceptible and magnitude 7 causing serious damage over large areas. Intensity of shaking is measured on the modified Mercalli scale. (Reference Wikipedia)

Brine wells create caverns with natural roof spans over the cavity and the structure integrity of that roof is extremely important to the stability of the cavern. The overlying anhydrite sections can act as a beam with determinate reactions much like a bridge. Therefore, some criteria must be set for maximum seismic activity that can occur with corresponding beam design criteria to ensure a suitable roof design.

Construction codes generally have safety factors build into the design of any system. Where little or no seismic activity is present, the normal safety factors can vary from 2:1, to 10:1 in areas of high seismic activity.

Therefore, an arbitrary recommended safety factor of 2:1 will be assigned to any brine well roof design that is located in an area that has less than 5 magnitude earthquakes. Anything over 5 but less than 7, would be assigned a safety factor of 3:1, and anything over 7 should have a safety factor of 5:1 or higher.

The impact of these recommendations would not necessarily preclude from a brine well being placed in a high seismic area, but would certainly require more stringent design requirements.

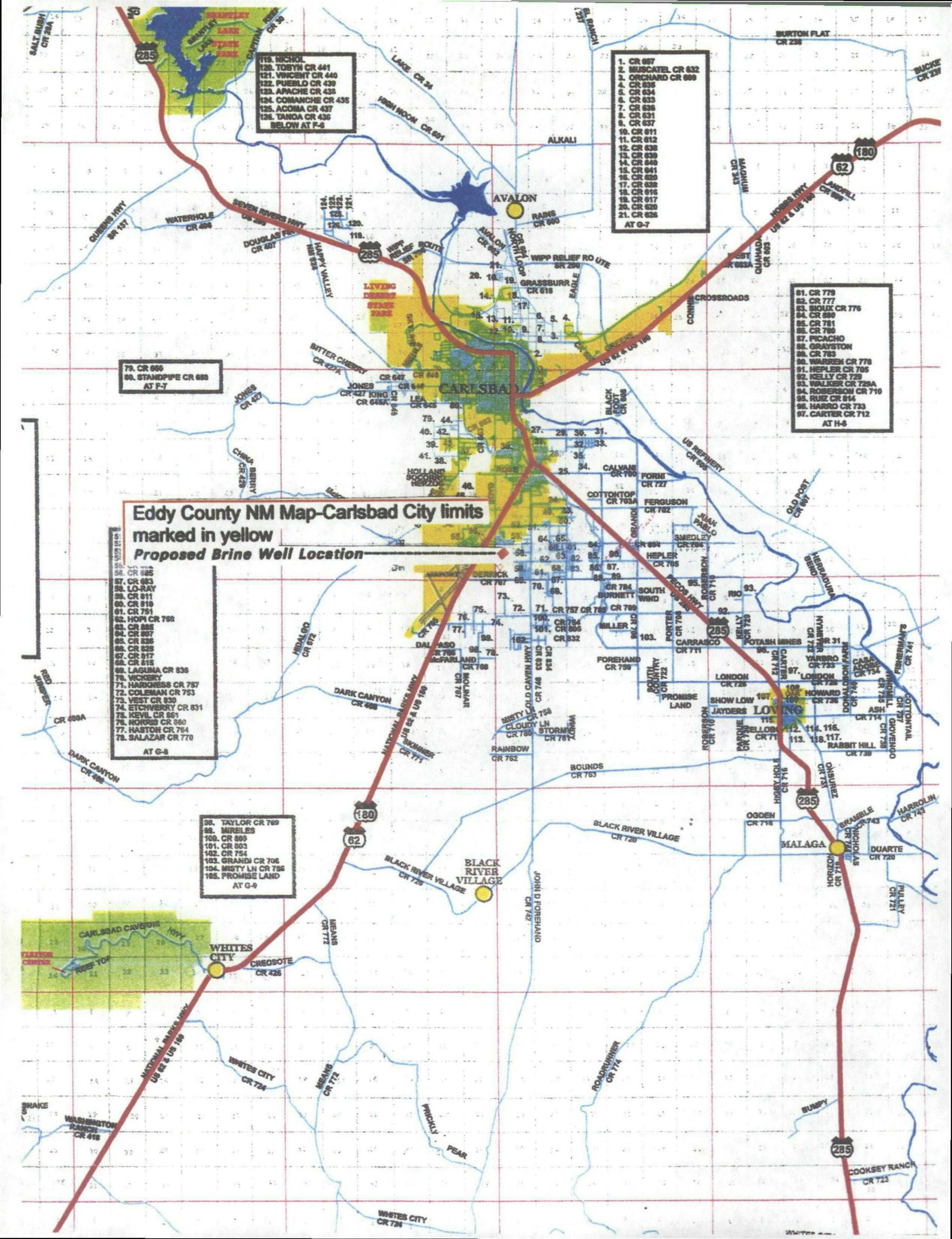
The actual impact of these conditions will require that certain overburden layers be thicker and continuous, and the span length most likely be reduced.

➪Faulting/Fracturing- As with the WIPP siting criteria, a study of known faults and fractures of formations surrounding the "salt zone of interest" should be conducted. While salt zones of the Permian and Delaware Basins have a creep component that generally heals fractures over time, major faults should be avoided and become a criterion for siting.

GCR Section I. Appendix

Includes:

1. Eddy County and Carlsbad City Limit Map with proposed brine well location.
2. E-mail of Minutes of Meeting between Key-OCD- 2 pages.
3. Fig. 1-1 WIPP Disturbed Zone Map with definitions- 2 pages.


Eddy County NM Map-Carlsbad City limits marked in yellow
Proposed Brine Well Location
CARLSBAD
AVALON
LOVING
MALAGA
BLACK RIVER VILLAGE
WHITES CITY
119. NICHOL
120. TOBYN CR 441
121. VINCENT CR 440
122. PUEBLO CR 439
123. APACHE CR 438
124. COMANCHE CR 435
125. ACOMA CR 437
126. TANOA CR 436
BELOW AT F-6
1. CR 657
2. MUSCATEL CR 632
3. ORCHARD CR 609
4. CR 635
5. CR 634
6. CR 633
7. CR 636
8. CR 631
9. CR 637
10. CR 611
11. CR 612
12. CR 638
13. CR 639
14. CR 640
15. CR 641
16. CR 620
17. CR 622
18. CR 616
19. CR 617
20. CR 620
21. CR 626
AT G-7
79. CR 660
80. STANDPIPE CR 658
AT F-7
81. CR 779
82. CR 777
83. SIOUX CR 776
84. CR 880
85. CR 781
86. CR 780
87. PICACHO
88. GRAYSTON
89. CR 783
90. WARREN CR 778
91. HEPLER CR 705
92. KELLY CR 720
93. WALKER CR 729A
94. ROBERSON CR 710
95. RUIZ CR 814
96. HARRO CR 733
97. CARTER CR 712
AT H-8
57. CR 683
58. LO-RAY
59. CR 811
60. CR 810
61. CR 751
62. HOPI CR 758
69. LAGUNA CR 839
70. VICKERY
71. HARKNESS CR 757
72. COLEMAN CR 753
73. VEST CR 830
74. ETCHVERRY CR 831
75. KEVIL CR 851
76. HORRIS CR 860
77. HASTON CR 764
78. SALAZAR CR 770
AT G-8
98. TAYLOR CR 769
99. MIRELES
100. CR 800
101. CR 803
102. CR 754
103. GRANDI CR 706
104. MISTY LN CR 756
105. PROMISE LAND
AT G-9

Chavez, Carl J, EMNRD

To: Chavez, Carl J, EMNRD
Cc: Chavez, Carl J, EMNRD
Subject: Key Energy Services, L.L.C. (BW-19) Meeting on New Class III Well Application for Facility GEN. CORRESPONDENCE

Date: 10-6-09 (9:30 a.m. – 10:30 a.m.)

Key Attendees:

Bob Patterson (Area Manager- Trucking Division)
Rex Alexander (Trucking Manager)
Dan Gibson (Corporate Environmental Manager)
H.C. Putman (Area Manager)

OCD Attendees:

Carl Chavez
Jim Griswold
Glenn von Gonten

Key had no plan to present, but wanted to listen to OCD thoughts on an application for a new Class III Well, since the OCD Moratorium on new applications ended back in June of 2009. Key has a modern facility at the location near its plugged and abandoned BW-019, and would prefer to drill another well at the facility.

- Trailer House nearby BW-019. OCD has siting and land ownership concerns..... set-backs from lease line, away from population centers, city limits,....
- OCD shows well log from nearby well with deeper salt formation (Castile Fm.) at about 1000 ft. bgl with a stronger anhydrite back would be preferred over shallow Salado Fm. w/ ledges type brine well. Key like idea of deeper well on same facility in order to use its modern facility nearby BW-019.
- OCD likes the single casing w/ 2 strings of tubing well construction, but would consider what Key proposes.
- Key will need to look at surrounding wells to create a cross-section of the hydrogeology across the area to determine if the Castile Fm. may be present beneath their facility. Key owns 30 acres of land on state mineral lease land. Key could buy a couple more acres from the landowner?
- There will probably be public comments associated with any new wells drilled at the facility. Be prepared... Key states that if well is deeper and can be placed at the facility, can use existing Key facility and depth coupled w/ well construction into Castile (if geology permits) may make a new well at the facility possible.....
- OCD mentions that there will be logging requirements, i.e., cement bond log at completion of cementing casing, and other logs. Would like upper 200 ft. logged, unlike oil and gas well logs that miss this zone.
- OCD mentions that Key will need to submit an OCD C-108 Form and the numberless brine well application forms with its submittal package. OCD mentions that WQCC Regulations 20.6.2 NMAC includes all of the info. needed for a new well application...... look there to see what OCD expects from Key for the new Class III Well.
- OCD mentions that new Class III wells will need to meter or track injection vs. production of brine. Key states that BW-28 is fully metered...
- OCD mentions that any new well at the facility will require a new well or permit application.
- Key is the first new well application, since the moratorium ended.....
- OCD mentions the "Closure Plan" requirements in Key's Discharge Plans and recommends that any subsidence monitoring, well monitoring, facility decommissioning, continued use of the facility, etc. should be submitted to the OCD in the form of a "Closure Plan" to address the discharge permit requirement. For example, at BW-19, the closure plan to focus on the PA's brine well, facility, subsidence monitoring, etc., but may also summarize how the facility will not be decommissioned, but used for the new well, but may satisfy the closure requirements for BW-019? Full or partial closure?
- Key mentioned that they were interested in using its plugged and abandoned Eunice Well for disposal into the salt cavern..... OCD mentioned that Key may want to take a look at the Brine Well Working Group comments from March of 2009 at "BW-999" under OCD Online to view the detailed discussion of the concerns under the "Talking Points" thumbnail as there were some issues identified related to this subject depending on the waste type, etc.

- Key will put an application package together and meet with the OCD again to make sure the package is acceptable and move forward with the submittal process. Ok.

END...........

Carl J. Chavez, CHMM
New Mexico Energy, Minerals & Natural Resources Dept.
Oil Conservation Division, Environmental Bureau
1220 South St. Francis Dr., Santa Fe, New Mexico 87505
Office: (505) 476-3490
Fax: (505) 476-3462
E-mail: CarlJ.Chavez@state.nm.us
Website: http://www.emnrd.state.nm.us/ocd/index.htm
(Pollution Prevention Guidance is under "Publications")

1.4 Definition of the Disturbed Zone

The evaporite beds are deformed around portions of the margin of the Delaware Basin and in some areas in the middle of the Basin. Deformation features in the northern part of the WIPP site have been lumped together under the term "Disturbed Zone" (DZ). The DZ is now delineated on the combined basis of structure exhibited in boreholes and by the chaotic seismic reflection data in the northern part of the site (see Figure 1-1).

- Structures on which the DZ is defined are thickened or thinned halite units of the Castile and anti- or synforms in anhydrite units of the Castile. Mesoscopic structures that are associated with the DZ are tight-to-open folding and boudinage of carbonate-anhydrite laminae. As suggested above, the DZ is based predominantly on Castile structures, whereas in the overlying Salado, deformation is nonexistent or weak; e.g., ERDA 6.
- The chaotic seismic reflection data, which is the other basis for delineating the DZ, is characterized by discontinuous reflectors and a blocky return pattern (see Sec 3.2).

The term "Disturbed Zone" has been used historically in different ways during the discussion of the WIPP. The historical usage is reviewed to help readers understand prior discussions.

The DZ was recognized on the basis of seismic reflection data; we began with a review of proprietary industry data. Hundreds of line-miles of seismic reflection data were made available in 1976 to G. J. Long and Associates (1976) for review of shallow (<4000-ft) reflectors in the northern Delaware Basin. Several seismic anomalies were identified in this review; one of the larger seismic anomalies was located 3 mi north of ERDA 9. At the time of the review, the extent and geologic character of the DZ were not recognized.

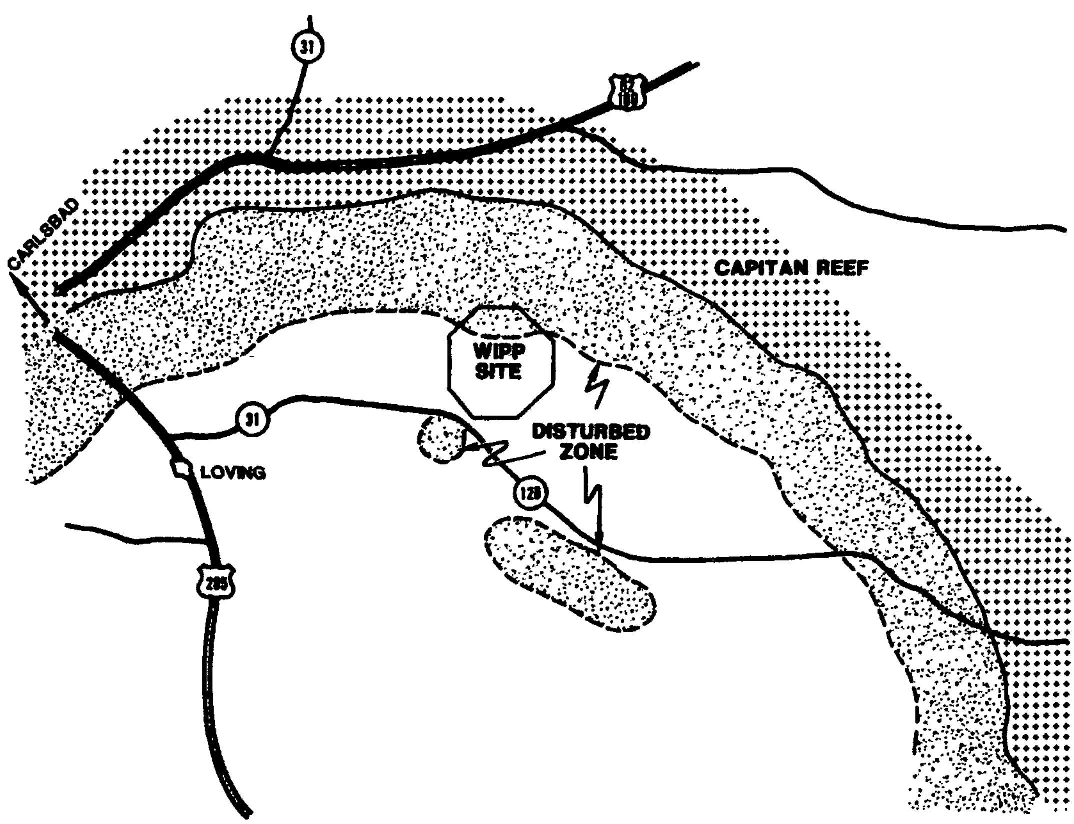


Figure 1-1. Areal Extent of the Disturbed Zone, Northern Delaware Basin

During the latter half of 1977, Sandia National Laboratories in Albuquerque (SNLA), assisted by G. J. Long and Associates, made a seismic reflection survey to obtain better shallow reflections and to cover the possible seismic anomalies identified earlier through data review. The survey, designated the 1977 X Geophysical Program, covered about 48 line-miles, including some offsite work. Full details of parameters and line locations for all SNLA seismic reflection data are contained in Hern et al (1979).

Preliminary interpretation of the 1977 X seismic reflection data revealed an area in the northern part of the WIPP study area where shallow reflectors were not easily interpreted. A rough outline of an area called the "highly disturbed zone" was inferred on the basis of limited data then available. The highly disturbed zone was reported in Powers et al (1978, Figure 4.4-6). The limited amount of seismic reflection data and lack of good reflectors prevented significant interpretation of the internal structure of the DZ. The anomaly 3 mi north of ERDA 9 was included in the DZ, and was investigated by drilling borehole WIPP 11 (SNLA and USGS, 1982).

In 1978 an additional small seismic reflection survey ("Y" series) was conducted by G. J. Long and Associates for SNLA (Hern et al, 1979). A more extensive survey was made by Bechtel for underground design and site evaluation (Bell and Murphy and Assoc., Inc., 1979; Dobrin, 1979). These data better define the boundary of the DZ and provide some indications of its internal structure.

By 1979 Sec 16, 17 of R31E, T22S were being interpreted as either an area of anomalous seismic data or an area of complex geologic structure. At that time borehole WIPP 13 bottomed at 1025 ft in the upper member of the Salado Formation. During 1980 the hole was deepened to the lowermost anhydrite of the Castile Formation to establish the origin of the seismic signals. The hole verified that the DZ was an area of complex geologic structures in the Castile and lowermost Salado Formations. Subsequent DZ investigations have included two high-resolution seismic experiments, the high-precision gravity survey, petrographic core analysis, development of tectonic models, and deepening of WIPP 12.

The seismic reflection data from 1978 are summarized in the WIPP Safety Analysis Report (SAR) (Department of Energy, 1980). The "zone of anomalous seismic reflection data" (Figures 2.7-23, 2.7-24, 2.7-30 of the SAR) is used to indicate portions of the seismic records generally regarded as uninterpretable by these investigators. This zone is equivalent in definition to the early highly deformed zone in that uninterpretable seismic records are the bases. More seismic data resulted in a somewhat different boundary to this zone.

The SAR also shows a "*line indicating steepening* of dip of Castile strata to the north" (Figures 2.7-23, 2.7-24, 2.7-30) based on Bell and Murphy and Associates, Inc. (1979). This line approximately coincides with the southern boundary of the DZ as defined in this report; the Castile structure as exhibited in the northern part of Zone II now is included in the DZ by us (Figure 1-1). Thus, the area where the Castile/lower Salado departs from generally parallel beds with slight dip is the DZ. For the present, we assume a common origin for these structures. Several evaporite structures in the Delaware Basin (Anderson and Powers, 1978) may have similar origins.

NOTE: The configuration of WIPP surface control zones has changed as a result of the cost-reduction program, the DOE resource management policy, and Bureau of Land Management land withdrawal actions (McGough, written communication, 1983). In this report, the older configuration boundaries have been used, in part to be consistent with previously published figures. Figure 1-2 is included to show the present configuration for comparison.

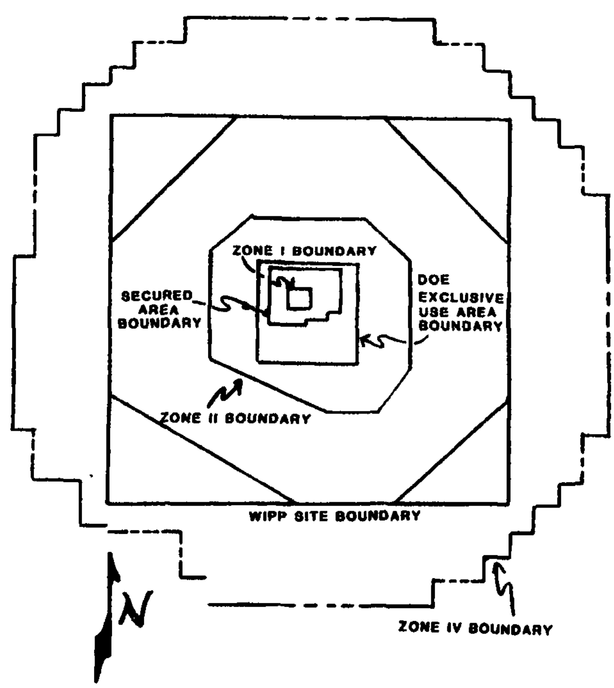


Figure 1-2. Present Configuration of Surface Control Zones at the WIPP Site

GCR Section II- Site Geology-Delaware Basin's Salado and Castile Formations:

The first step in this process was to obviously determine if the Castile Formation is below the site and if deeper salt horizons are present. Key has performed a geo-technical investigation for the area under the Key site and presents the findings in this report.

A "Key study area" was developed to include a South-North and West-East cross-section of the underlying geology to include at a minimum two miles either side of the current location of the BW-19 brine well (API # 30-015-21842), located in UL H section 36-Ts22s-R26e. Enclosed in this GCR section II appendix, is a copy of the local BLM topographic map depicting the top view of the sections to be included in the study.

This area is part of the Delaware Basin (see fig 1 included in this GCR section II appendix for reference) in southern New Mexico which is famous for holding large oil fields, potash reserves, the DOE Waste Isolation Pilot Plant (WIPP) and for exposing a fossilized reef (Capitan Reef). The Guadalupe Mountains National Park and Carlsbad Caverns National Park protect part of the basin. It is part of the larger Permian Basin, itself part of the Mid-Continent Oil Field.

The basin contains two significant salt units, the Salado and the Castile Formations. Shown in this GRC section II appendix, is fig 4. and fig. 2 respectfully, indicating the salt thickness at the proposed Key Energy Brine Well site. (ref: 1958 USGS report # 709 Hayes). As fig 4 shows the Salado salt thickness approaches zero in this area and the Castile salt thickness ranges from 200-400 feet thick and approaches zero to the west and north.

The Castile Formation has been divided into four anhydrite units designated with roman numerals separated by laminated halite. Anhydrite beds I, II, and III, and their overlying halite units (Salt I & II), can be traced widely over the Delaware Basin (Snider, 1966; Anderson and others, 1972), but near the Capitan Reef west and north of the study area the halite units pinch out and are laterally equivalent to anhydrite.

Anhydrite bed IV is a composite of multiple genetic units and, therefore, the stratigraphy and facies relationships are complex over much of the Delaware Basin as well as all of the area between the WIPP site westward to the Key site. It is therefore difficult to identify and correlate a contact between the Castile and the Salado Formations.

Below the Castile formation is the upper Guadalupian section, which is composed of the Bell Canyon Formation, capped by the Lamar limestone, a finely laminated, organic-rich, silty limestone deposited prior to evaporite precipitation. The Bell Canyon Formation is the deep-water basinal equivalent of the Seven Rivers, Yates, and Tansill Formations on the Platform (Garber and others, 1989). Because of its high gamma-ray-log response and sharp contact with overlying Castile Anhydrite I, this contact serves as an excellent stratigraphic marker. Shown in this GRC section II appendix, fig. 2-6 East-West Cross Section and Fig 4-3-2 site geologic column taken at the WIPP site, which is approximately 25 miles due east of the Key study area, identifies graphically the Castile layers. *Ref: (Deformation of Evaporites Near the Waste Isolation Pilot Plant (WIPP)-David J. Borns -Sandia National Laboratories) and GEOLOGICAL CHARACTERIZATION REPORT SOUTHEASTERN NEW MEXICO WASTE ISOLATION PILOT PLANT (WIPP) SITE, SAND78-1596.*

These layers start at the top of the Bell Canyon and progresses upward to the Salado. They are; Anhydrite I, Halite I, Anhydrite II, Halite II, Anhydrite III and generally Anhydrite IV and the bottom member of the Salado salt is not distinguishable, and not marked.

<u>Shown in this GRC section II appendix, Plate 4- west-east cross section C-C' stratigraphy</u> (Summers #37-1972) located approximately 12 miles south of the study area provides a good graphic view of the Bell Canyon formation. As noted in the referenced literature the Castile formation comfortable follows the Bell Canyon until it reaches the Capitan bank complex to the west where the Bell Canyon tucks under the Reef and the Castile transgresses into the reef. At the points of interface between Castile and the Reef, the Salt I &II sections generally pinch out into a thin wedge and are replace by anhydrite. This area may be commonly known and defined as a disturbed area by WIPP definition terms.

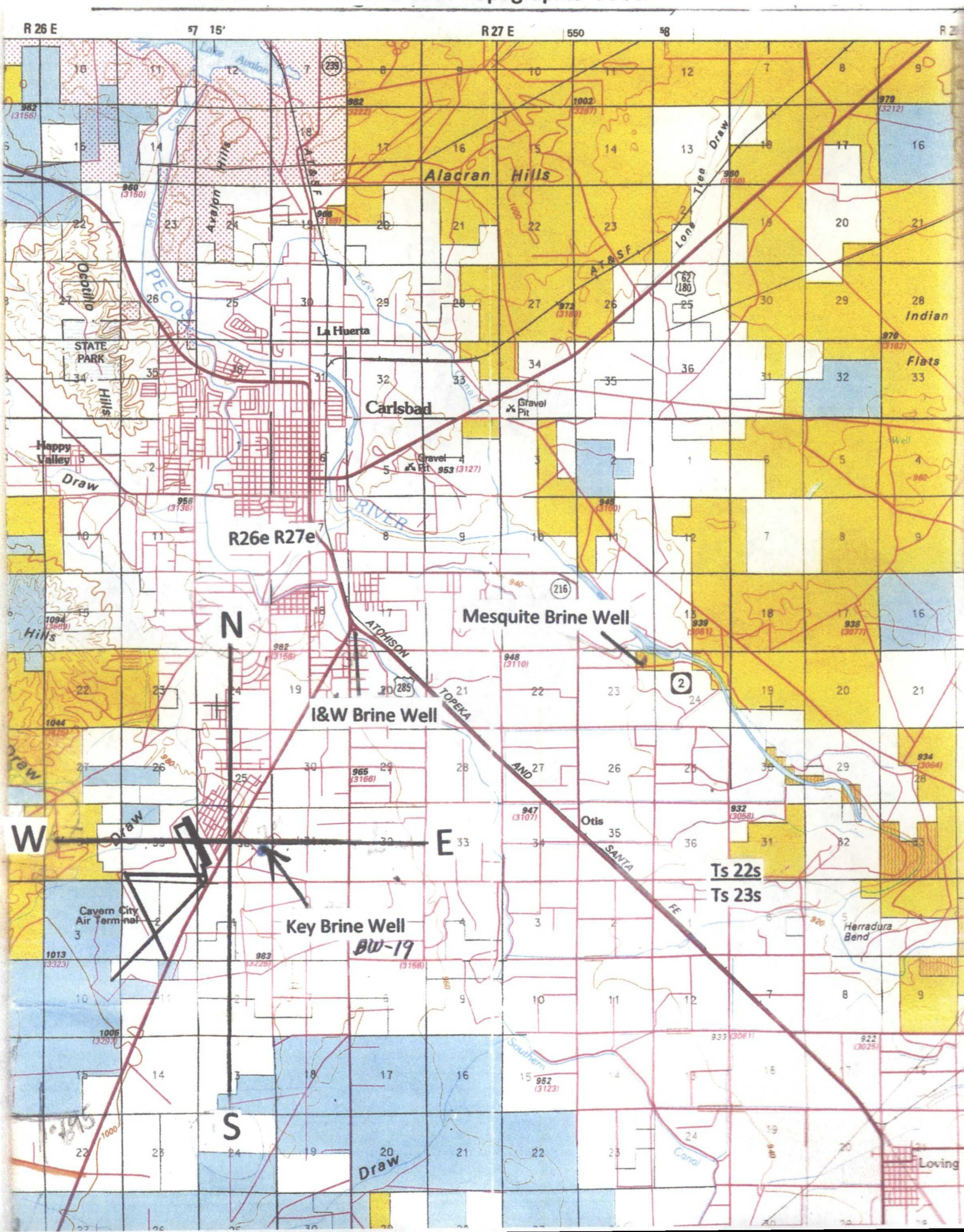
The Salado formation in the study area also wedges out and grades into the upper rustler formation and was though to have been removed by solution in these areas. Talking to various geologists who work in the area, the "*<u>rule of thumb</u>*", is the Salado generally does not extend westward much past the Pecos River. However, this doesn't preclude some salt being found in the Rustler formation, which overlies the Salado and Castile.

GCR Section II. Appendix

Includes:

1. Key Energy Study Area Graphic Cross-Section Locations BLM Carlsbad 1997 Topographic USGS.
2. Fig. 1 Index map showing outline of area underlain by salt and the Delaware Basin.
3. Fig. 4 Map showing Aggregate Thickness of Salt in the Salado Formation New Mexico and Texas. Red dot shows approximate location of proposed Key Energy brine well.
4. Fig. 2 Map of Delaware Basin, New Mexico and Texas, showing Aggregate Thickness of Salt in the Castile Formation. Red dot shows approximate location of proposed Key Energy brine well.
5. Figure 2-6. East-West Cross Section, WIPP Site.
6. Figure 4.3-2 Site Geologic Column.
7. Plate 4- Cross Section CC'-stratigraphy.

Key Energy Study Area
Graphic Cross-Section Locations "W-E" and "S-N"
BLM-Carlsbad BLM Carlsbad 1997 Topographic USGS.



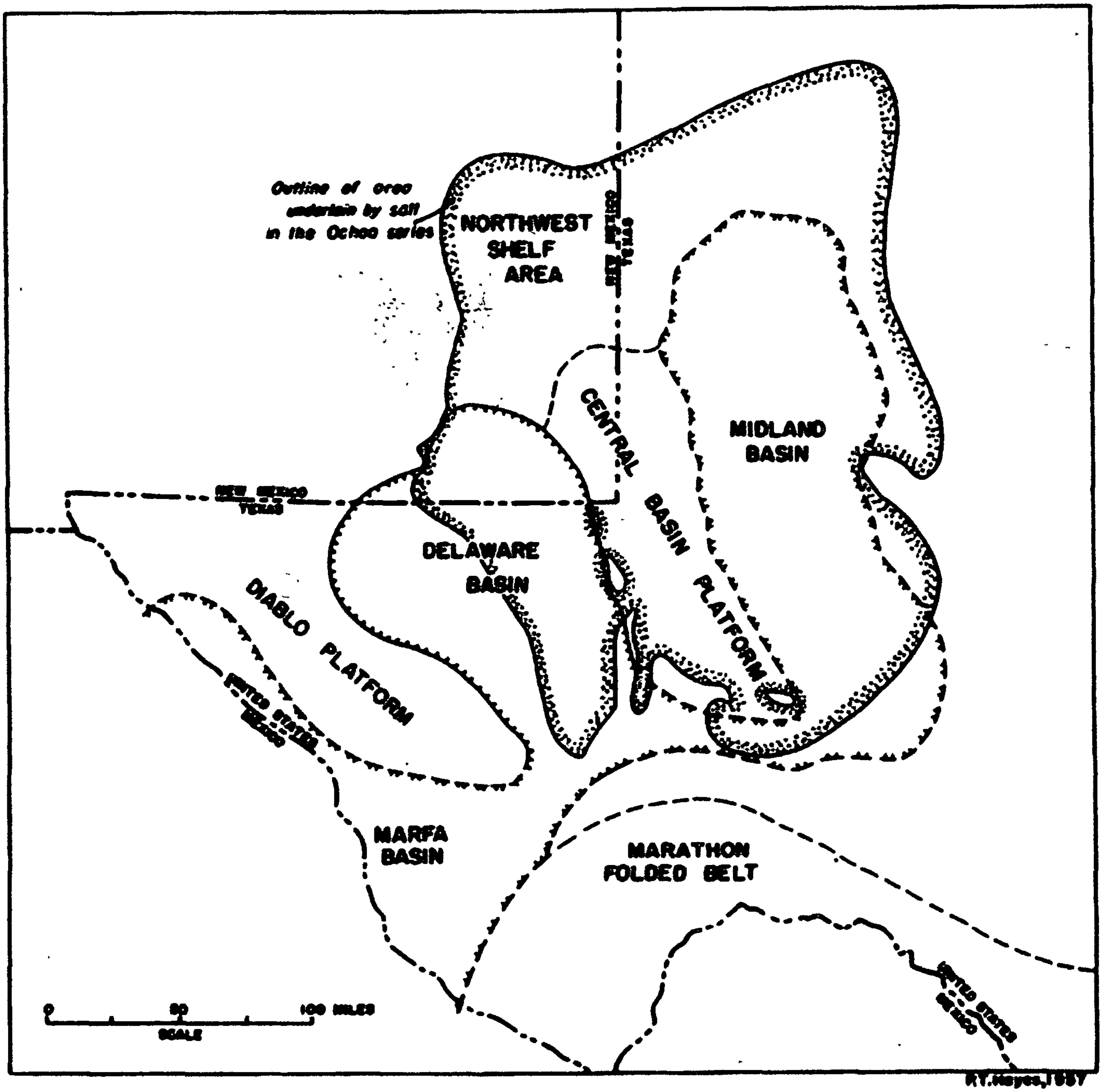


Fig. I. Index map showing outline of area underlain by salt in the Ochoa series in relation to late Permian basins and shelf areas. (Adapted from King, 1948).

TEI-709

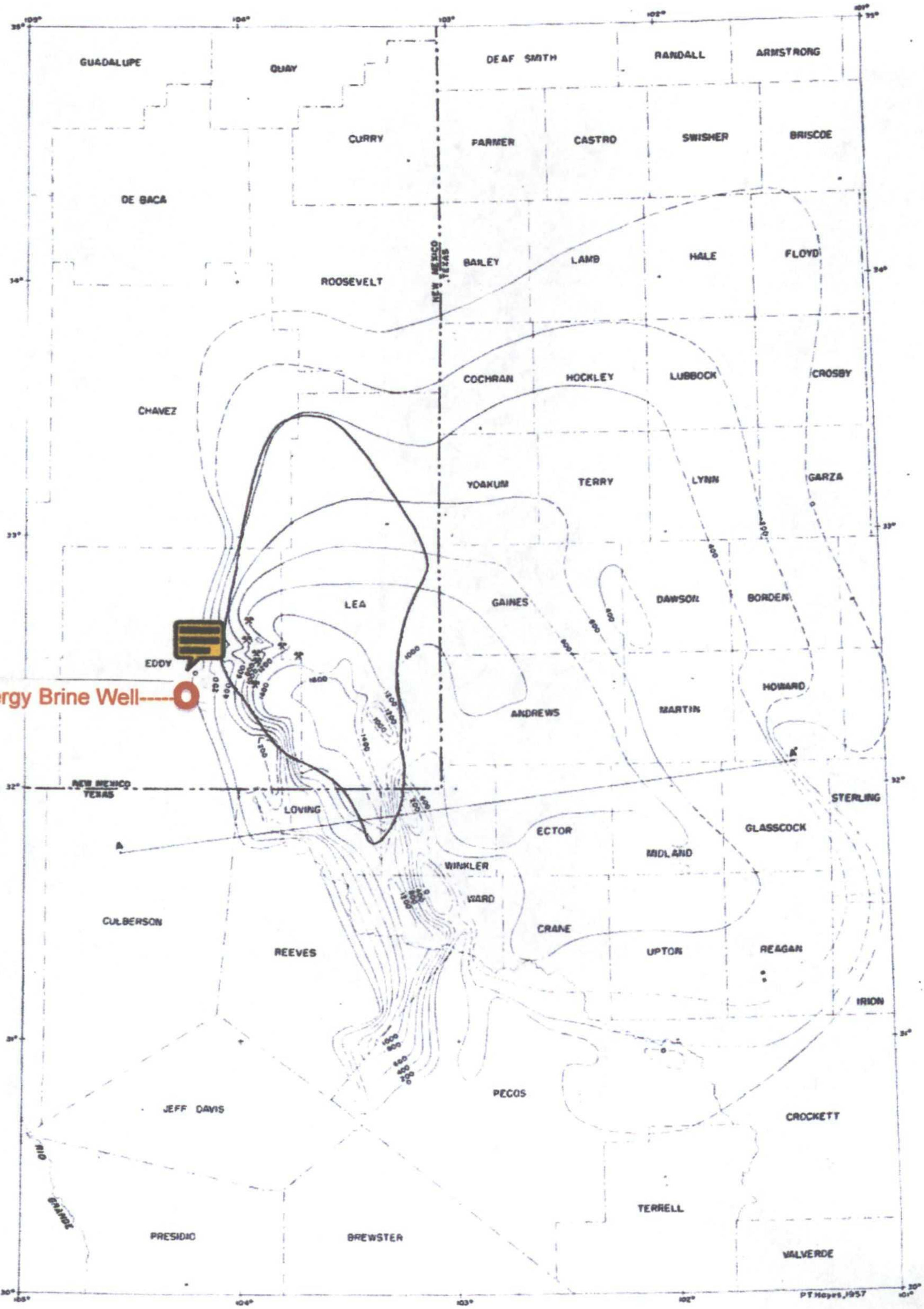


FIG. 4.--MAP SHOWING AGGREGATE THICKNESS OF SALT IN THE SALADO FORMATION NEW MEXICO AND TEXAS

400 Isopach interval 200 feet. Isopach lines dashed where less certain

Approximate outline of area of occurrence of soluble potassium minerals.

Potash mine

10 0 10 20 30 40 Miles

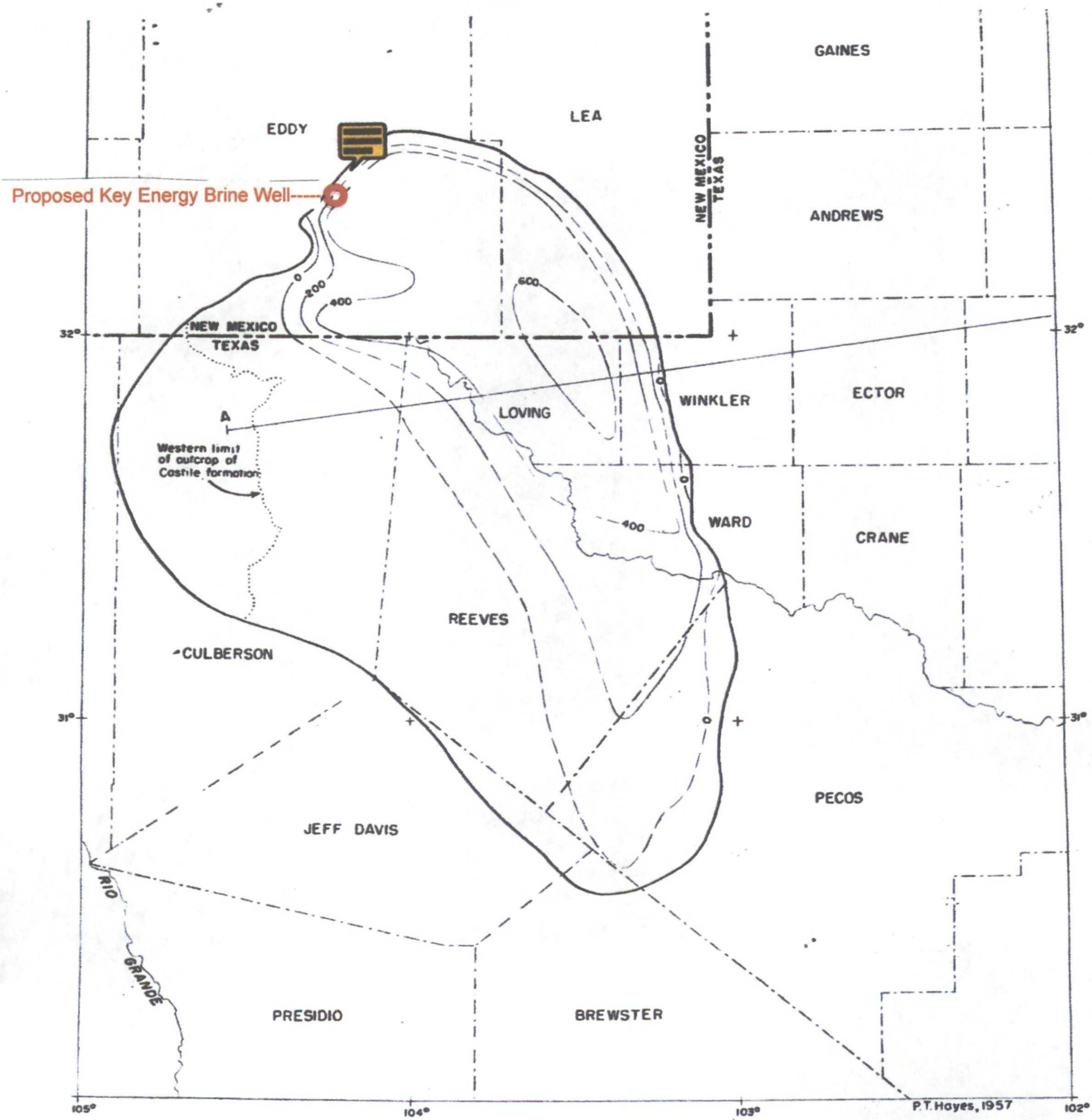


FIG. 2. MAP OF DELAWARE BASIN, NEW MEXICO AND TEXAS, SHOWING AGGREGATE THICKNESS OF SALT IN CASTILE FORMATION

400 Isopach interval 200 feet Isopach lines dashed where less certain.

Boundary of Delaware Basin during Castile deposition.

10 0 10 20 30 40 Miles

SCALE

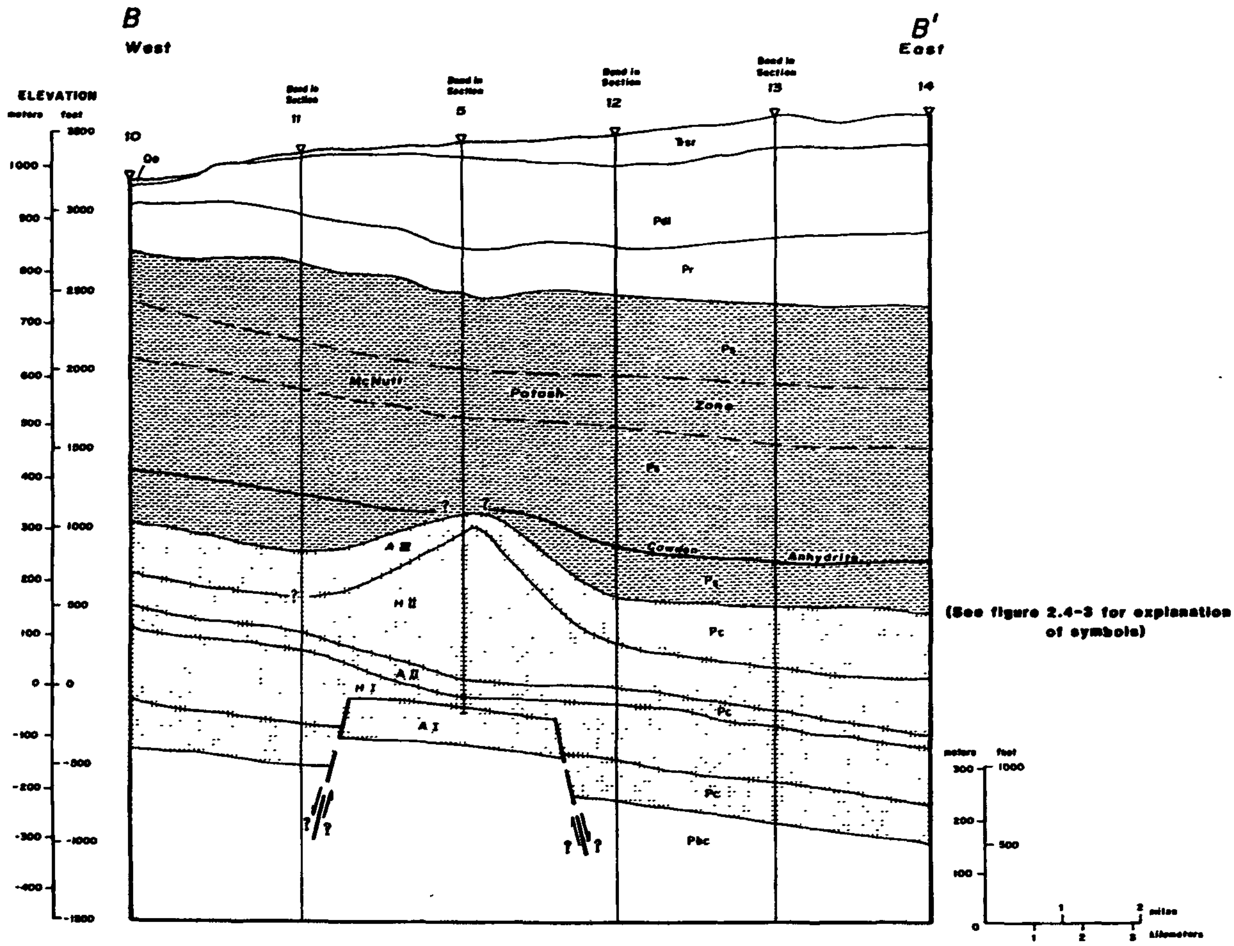
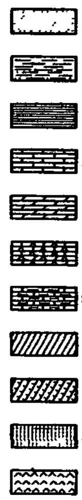


Figure 2-6. East-West Cross Section, WIPP Site

EXPLANATION

LITHOLOGIC SYMBOLS

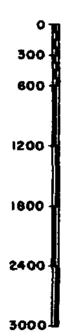


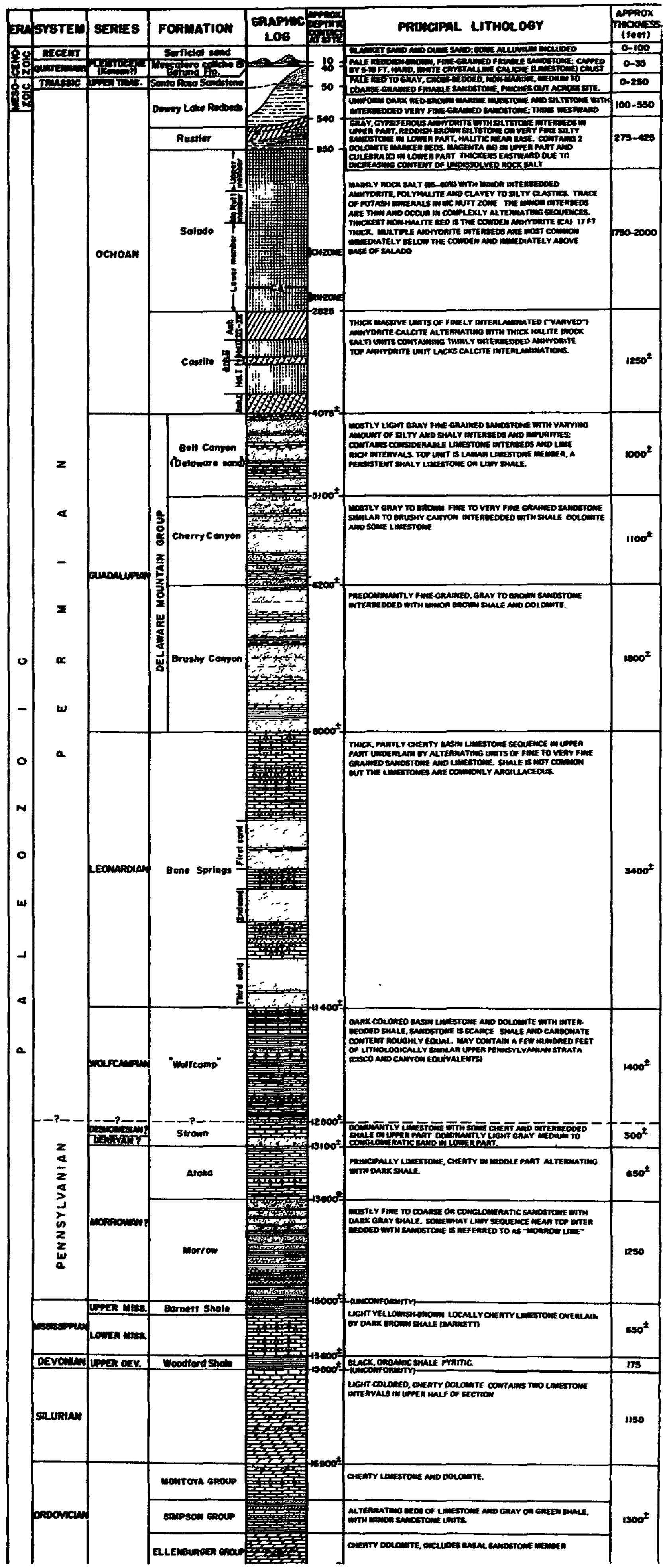
REFERENCES:

1 Anderson, 1978
2. Anderson, et al, 1972
3. Brokaw, et al, 1972
4 Foster, 1974
5. Griswold, 1977
6 Meyer, 1966
7 Sipes, Williamson and Aycock, 1976

NOTE:

For complete citations, refer to reference list for chapter 4





SITE GEOLOGIC COLUMN

FIGURE 4.3-2

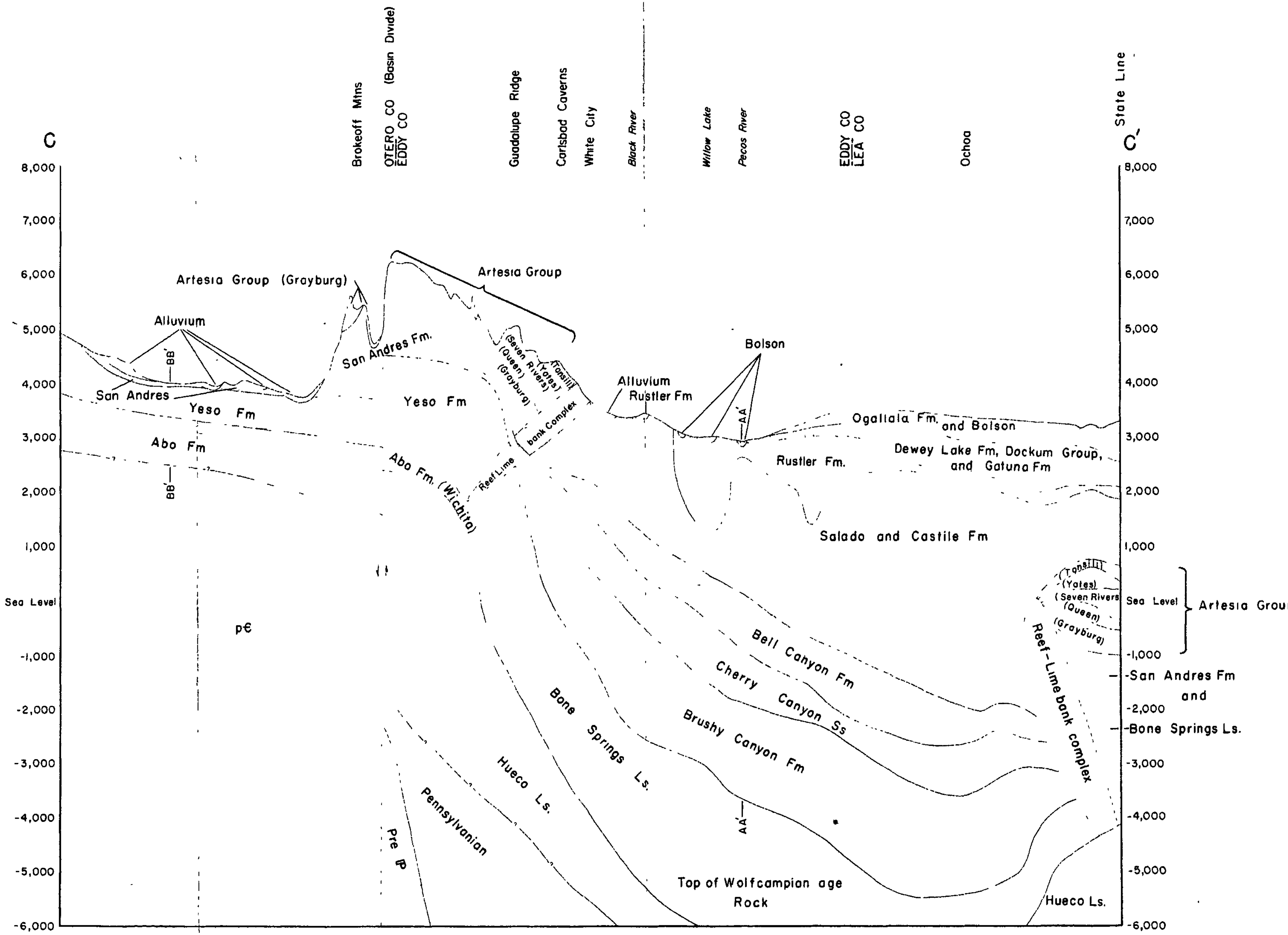


PLATE 4-Cross section C C'-stratigraphy

GCR Section III- Key Energy Study Area:

In order to obtain a representative graphic cross-section of the study area, well files and electric logs were downloaded from the Oil Conservation Division web-site "ON-Line" imaging site. These were TIFF files and downloads were quite time consuming. The study area consisted of drawing a "south to north" and "west to east" cross-section line through a minimum of at least two miles located on each side of Section 36, the section that the existing BW-19 well and brine station is currently located. See attached in this GCR III appendix, a BLM-Carlsbad 1997 Topographical USGS map showing the sections investigated. All of the downloaded files are listed in the appendix.

The methodology was to find both electric logs and mud logs (i.e. cuttings lithology, drilling reports or anticipated formation). Mud logs were generally self-describing using local geologic drilling nomenclature. The "Electric Logs", where available, were various types such as gamma ray, caliper, resistivity, SP, neutron porosity and density, and acoustical. These logs were basically selected on the basis of shallow depth and open hole. Most of the electric logs found started at about 300-400 feet after the water protection casing had already been set.

Very little information was gained from the electric logs from surface to where the first casing string was set. However, some of the wells were drilled by "cable tool" which provided good information from surface to depth of interest.

Almost all of the logs had a gamma ray component, which was quite helpful in identifying the top of the Bell Canyon Lamar limestone. As mention in the GCR section II above (Site Geology-Delaware Basin's Salado and Castile Formations) the Lamar limestone was an excellent marker and provided a great log signature. Indentifying log signatures were aided by typical industry log interpretation charts and from examples of Log Stratigraphic Picks for the Rustler, Salado, Castile and Bell Canyon found in the 1985 report "Regional Well-Log Correlation in the New Mexico Portion of the Delaware Basin."Ref (Burns &Shaffer Sandia National Laboratories). These charts and reference logs are included in this GCR Section III appendix.

There were two absolute markers, the top of the Bell Canyon and the surface elevation. Starting at the top of the "Bell Canyon" and progressing up-ward in the "Castile Formation", the approach was to identify and confirm the presence of the known units of the Castile formation (i.e. Anhydrite I, Halite I, Anhydrite II, Halite II, and Anhydrite III-IV).

Once these units were matched and identified on the various well logs, including some driller's reports where electric logs were missing, the top and bottom elevations were recorded on a raw data sheet. Anything above the Anhydrite III-IV section was lumped into the category of Salado, Rustler, and Surface i.e. valley fill. While most of the research indicated the Salado salt is probably missing in this area, it was concluded that the possibility may exist for its presence at a very shallow depth and would most likely be graded into the Rustler. Included in this GCR section III appendix, are the raw data sheets and a sketch of the south-north cross section and west-east cross-section. These sketches were drawn in reference to Zero Mean Sea Level (MSL).

A quality check was made using an Excel spreadsheet where the formation zones, location, elevation, medium zone thickness of each unit, and an accumulation of each zone thickness would actually match the depth of the formation. Please find in this GCR Section III appendix the chart showing this information.

The aforementioned various well logs were correlated by compiling them onto a large graphic sheet and the like units were connected by drawing a line to the next log providing a well log pictorial graphic cross-section of the study area. The "South to North and "West to East" correlated well logs are provided in this GCR Section III appendix. These correlated well logs were drawn in reference to below grade level depths in feet. Each log was matched to the adjacent log's exact depth. This approach provides a slight error in the charts because each well has a small surface elevation difference.

The other issue with matching well logs is the fact that in most cases there is up to a mile's difference between sites and some of the well logs were in off-setting units, i.e not in a straight line. This gives the appearance of an abrupt pictorial change in slope between logs. Where as in reality, if the scale could be stretched out, the formation would show more of a gradual slope.

In order to provide for a good pictorial cross section and compensate for some of the effects of off-center data from the well logs, an Excel spreadsheet was utilized and the data averaged over the study area in both directions. While this removed some of the actual variation in zone thickness, it provided a good picture of how the salt zones pinch out when approaching the Capitan reef bank complex. The opposite is true of the anhydrite layers, as they increase in thickness. These cross-sections depict more accurately the slopes across the Key Study Area. Please find in this GCR Section III appendix the Excel "South to North" and "West to East" (modified) cross sections for review.

Findings of Study Area:

The combination of electric and drilling logs provided a good representation of the stratigraphy in the study area. For the most part, the local study area generally follows the same geologic sequence as the Delaware basin region, except that the Salado formation, per se, in this area is missing. As quoted in many references, the general rule of thumb is that the Salado generally pinches out east of the Pecos River while the Castile underlies the area west of the Pecos River and transgresses into the Capitan Reef area.

Referring to the "South-North" and "West-East" cross section maps respectively, The top of the Bell Canyon, or base of the Castile Formation on the south end of the study area in section 13H-Ts23s-R26e was recorded at approximately 1347 feet above mean sea level (MSL) or approximately 1880 feet below ground level (BGL). The north end of the study area located in section 24J-Ts22s-R26e was recorded at approximately 1434 feet above mean sea level (MSL) or approximately 1740 feet below ground level (BGL).

The west end of the study area in section 34A-Ts22s-R26e was recorded at approximately 1575 feet above mean sea level (MSL) or approximately 1660 feet below ground level (BGL). The east end of the study area located in section 32J-Ts22s-R27e was recorded at approximately 1248 feet above mean sea level (MSL) or approximately 1900 feet below ground level (BGL).

The base of the Castile formation lies comfortable over the Bell Canyon formation and generally dips to the east and south. The easterly "BGL" gradient of the Bell Canyon/Castile is calculated to be approximately 240 feet over 4 miles that equates to about 60 feet/mile. The southerly "BGL" gradient is calculated to be approximately 140 feet over 5 miles that equates to about 28 feet per mile.

This compares with the regional dip of the Bell Canyon/Castile formation of approximately 80 feet per mile easterly and 30 feet per mile southerly. These values were taken and estimated from known reference maps.

Respectfully, the surface ground elevation ranges from 3227 feet above MSL on the south end to 3174 feet above MSL on the north end; 3235 feet above MSL on the west end to 3148 feet above MSL on the east end. The local surface gradient ranges from south to north and dips slightly by 53 feet over 5 miles. This is opposite of the regional gradient which dips from north to south along the Pecos River water shed.

The local surface gradient going from west to east dips 87 feet over 4 miles and aligns itself with the south-easterly gradient of the Pecos River water shed. East of the Pecos River the gradient is generally to the south and west.

The overlying Castile formation units mentioned above, Anhydrite I, Salt I, Anhydrite II, Salt II, Anhydrite III-IV all seem to be continuous in the study area but with varying thickness. For the most part the units get thicker going east and south. On the contrary, the salt units decrease in thickness going west and north, while the anhydrite units thicken.

The Castile Anhydrite I unit overlies the Bell Canyon throughout the study area. The thickness ranges from approximately 60 feet on the west end, 270 feet in Section 31F, and 260 feet on the east end. It has a medium thickness of approximately 240 feet across the study area west to east. The south to north thickness ranges from 240 feet to 280 feet, with a medium thickness of approximately 255 feet.

The Castile Salt I unit overlies the Anhydrite I unit throughout the study area. The thickness ranges from approximately 100 feet on the west end, 580 feet in Section 36I, and 410 feet on the east end with a medium thickness of approximately 330 feet across the study area west to east. The south to north thickness, ranges from 480 feet on the south end, 580 feet in Section 36I, and 300 feet on the north end, with a medium thickness of approximately 350 feet.

The Castile Anhydrite II unit overlies the Salt I unit throughout the study area. The thickness ranges from approximately 400 feet on the west end, 50 feet in Section 36I, and 110 feet on the east end. It has a medium thickness of approximately 110 feet across the study area west to east. The south to north thickness ranges from 260 feet on the south end, 50 feet in Section 36I, to 580 feet on the north end, with a medium thickness of approximately 205 feet.

The Castile Salt II unit overlies the Anhydrite II unit throughout the study area. The thickness ranges from approximately 150 feet on the west end to 290 feet on the east end with a medium thickness of approximately 170 feet across the study area west to east. The south to north thickness ranges from 280 feet on the south end to 50 feet on the north end, with a medium thickness of approximately 245 feet.

The Castile Anhydrite III-IV unit overlies the Salt II unit throughout the study area. The thickness ranges from approximately 150 feet on the west end to 330 feet on the east end. It has a medium thickness of approximately 260 feet across the study area west to east. The south to north thickness ranges from 320 feet on the south end to 80 feet on the north end, with a medium thickness of approximately 290 feet.

The geology overlying the Castile to surface in the study area consists of possible remnants of the Salado, overlain by the Rustler and Valley Fill. The west side of the study area includes the beginning of the Capitan Bank Complex. The Capitan limestone aquifer, which is overlain by the Carlsbad Limestone, is noted for its high quality groundwater. The City of Carlsbad obtains fresh water from this aquifer and their well field is located approximately 5 miles west of the study area, in Sheep Draw more or less starting in Sections 1 and 12 Ts23s-R25e on the west side of Hidalgo road.

The Rustler formation is known to contain groundwater of a lesser quality, but still protectable as a fresh water source. A complete detail of the region and local hydrogeology will be presented in the Hydrology section of this report.

Castile Salt Unit I is a "Zone of Interests:"

The Castile Salt Zone Unit I was investigated in detail in the Key study area to determine if the zone is continuous and has adequate size both vertically and laterally.

The "top" of the Castile Salt Zone Unit I, ranges from a depth of approximately 1500 feet BGL on the "west end" of the study area, decreasing in depth to 980 feet BGL, more or less in the "middle" of the study area Section 36I, and then increasing in depth to 1230 BGL on the "east end".

The "base" of the Castile Salt Zone Unit I, ranges from a depth of 1600 feet BGL on the "west end" of the study area, decreasing in depth to 1560 feet BGL, more or less in the "middle" of the study area Section 36I, and then increasing in depth to 1640 BGL on the "east end".

The "top" of the Castile Salt Zone Unit I, ranges from a depth of 1160 feet BGL on the "south end" of the study area, decreasing in depth to 980 feet BGL, slightly north of the "middle" of the study area Section 36-I, and then increasing in depth to 1160 feet BGL on the "north end".

The "base" of the Castile Salt Zone Unit I, ranges from a depth of 1640 feet BGL on the "south end" of the study area, decreasing in depth to 1360 feet BGL, north of the middle of the study area in Section 25G, and then increasing in depth to 1460 feet BGL on the "north end".

A Castile Salt I Isopach (thickness of salt) map was developed by hand drawing the estimated salt thickness contours lines for the zone of interest. The map plots the estimated Salt I unit thickness over the study area. The map is included in this GCR Section III Appendix.

The data points were taken from the logs mentioned above and where possible, a minimum of two points was used to draw thickness contours. However, there were contours based on single data points and for protocol reasons these contours would be inferred only for the study area.

It appears that the salt thickness for the Salt I unit increases to the south and east and decreases to the west and north. The same can also be said of the upper Salt II zone.

The very far northeastern part of the map probably indicates the decrease in salt thickness due to the Castile formation transgressing into the Capitan Reef Bank Complex. The associated Anhydrite units thicken in this area. The general consensus is that the salt units of the Castile pinch out and are no longer present past the reef area. The electronic and mud logs, for the most part, agree with and correlate with the general professional opinion for this area.

Proposed Brine Well Location:

All of Section 36 is located in the Carlsbad city limits, as was the existing Key Brine Well BW-19. One of the criteria and request from the agency was to attempt to have the well located outside of the city limits. Key Energy is contracted to obtain ownership of approximately 10-25 acres of adjacent land. The new brine well will be located in SW/4 NW/4 UL E of Section 31-Township 22 South-Range 27 East, approximately 1100 feet east of the existing facility. The new well is being plated to be located approximately 1000 FWL & 2140 FNL in UL E Section 31-Ts 22S-R27E. The C-101 Application for Permit to Drill, Deepen and C-102 well location and acreage dedication plat is included in section VII.A.1-4 appendix.

Included in this GCR section III appendix is a copy of the Excel West to East (modified) cross-section that includes the approximate location of the existing Key brine well permit BW-19 and the proposed replacement brine well location.

GCR Section III. Appendix for Brine Well Application Guideline

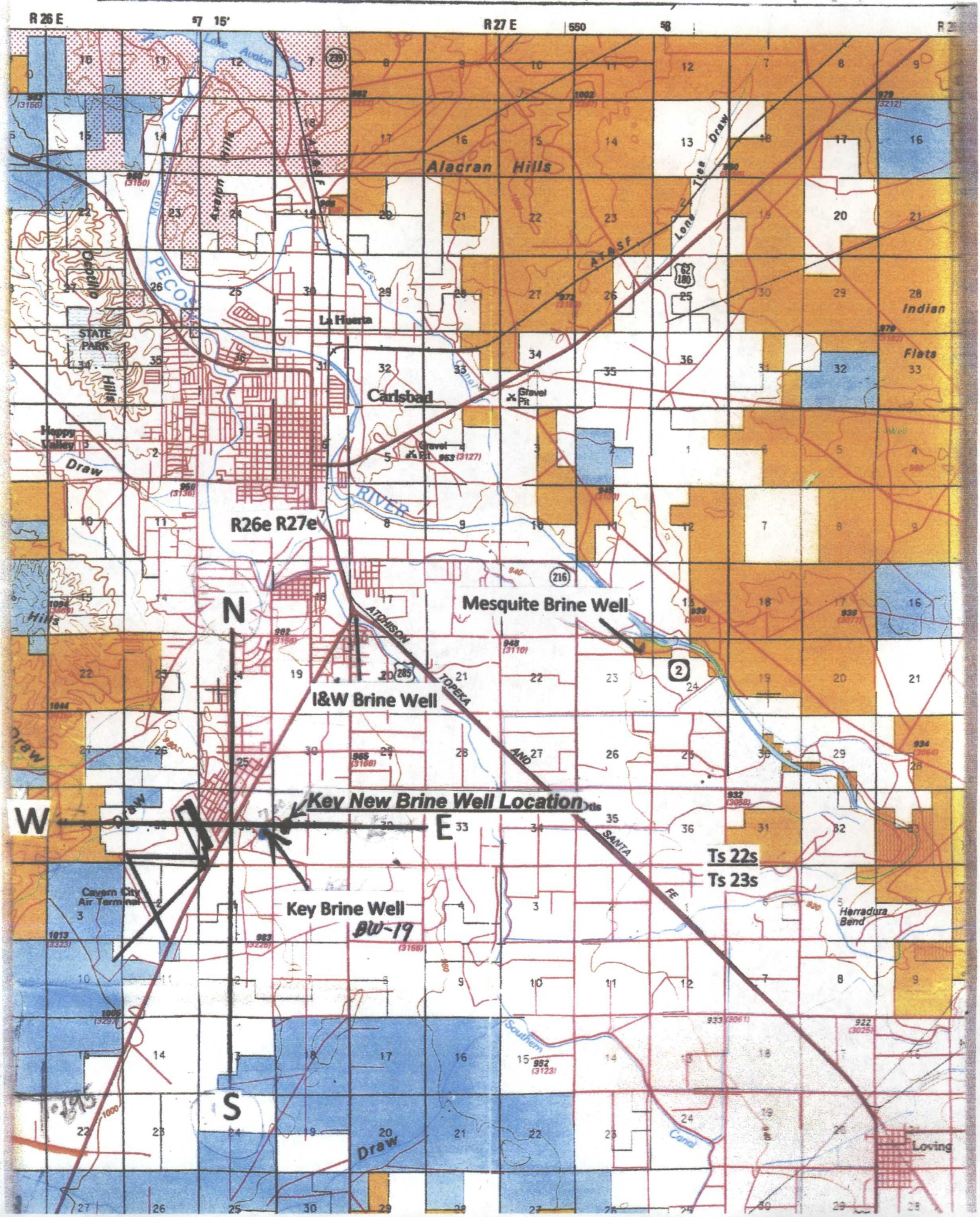
Includes:

1. BLM Surface Management Status Topographic Map 1:100,000 scale with elevation contours, roads, water features and section, township and range lines (NGVD-1929) USGS and location of proposed site.
2. List of all well files and logs downloaded and reviewed.
3. Typical Industry well Log interpretation charts, 2 pages.
4. Figures 27 and Fig. 29 examples of Log Stratigraphic Picks for the Rustler, Salado, Castile and Bell Canyon found in the 1985 report "Regional Well-Log Correlation in the New Mexico Portion of the Delaware Basin."Ref (Burns &Shaffer Sandia National Laboratories). 2-pages.
5. South-North Raw Data Sheet and Sketch. 2-pages.
6. West-East Raw Data Sheet and Sketch. 2-pages.
7. Formation Zone(s)-Location, Elevation, Medium Thickness and Total Depth Chart.
8. 8.5"x 11" South to North Cross-Section from Correlated Well Logs.
9. 8.5"x 11" West to East Cross-Section from Correlated Well Logs.
10. Excel South to North (modified) Cross-Sections.
11. Excel West to East (modified) Cross-Sections showing Brine Wells.
12. Castile Salt I Zone Isopach (salt thickness) map.
13. Large South to North Cross-Section from Correlated Well Logs.
14. Large West to East Cross-Section from Correlated Well Logs.

Key Energy Study Area

Graphic Cross-Section Locations "W-E" and "S-N"

BLM-Carlsbad BLM Carlsbad 1997 Topographic USGS.



2. List of all well files and logs downloaded and reviewed.

   The following well files and well logs were downloaded from the OCD web-site and reviewed.

   All well files and logs in sections 36,35,34 in Ts 22s-R26e.

   All well files and logs in sections 31,32,33 in Ts 22s-R27e.

   All well files and logs in sections 13,12,1 in Ts 23s-R26e.

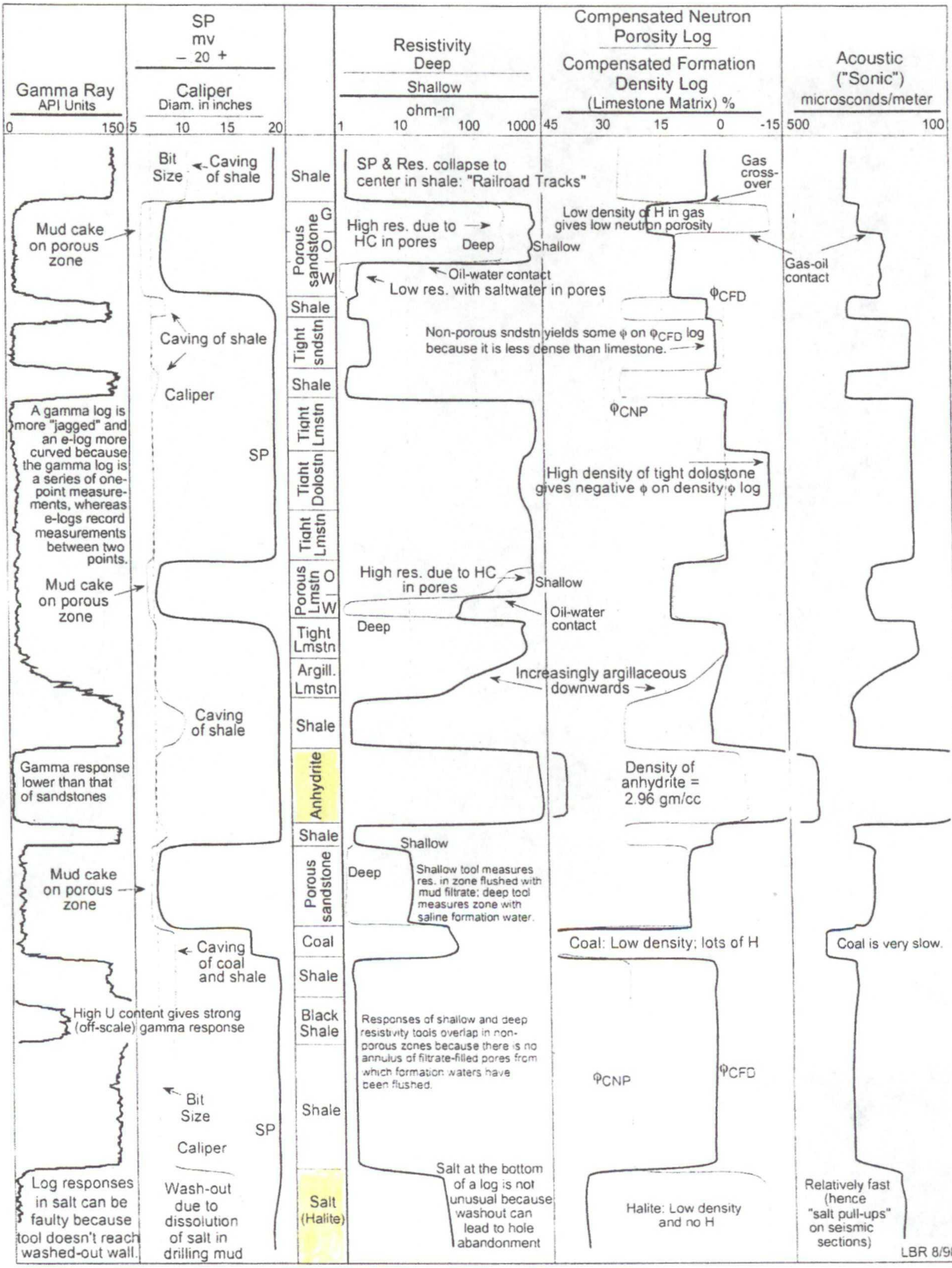
   All well files and logs in sections 25,24, in Ts 22s-R26e.

   Selected well files and logs in section 2, 11, in Ts 23s-R26e.

   Selected well files and logs in section 26,23, in Ts 22s-R26e.

   Selected well files and logs in section 5, in Ts 23s- R27e.

   Selected well files and logs in sections 30, 29, in Ts 22s-R27e.



Gamma Ray
API Units
0 150
SP
mv
– 20 +
Caliper
Diam. in inches
5 10 15 20
Resistivity
Deep
Shallow
ohm-m
1 10 100 1000
Compensated Neutron Porosity Log
Compensated Formation Density Log
(Limestone Matrix) %
45 30 15 0 -15
Acoustic
("Sonic")
microsconds/meter
500 100
Bit Size
Caving of shale
Shale
SP & Res. collapse to center in shale: "Railroad Tracks"
Gas cross-over
Mud cake on porous zone
Porous sandstone
G
O
W
High res. due to HC in pores
Deep
Shallow
Low density of H in gas gives low neutron porosity
Gas-oil contact
Oil-water contact
Low res. with saltwater in pores
φCFD
Shale
Caving of shale
Tight sndstn
Non-porous sndstn yields some φ on φCFD log because it is less dense than limestone.
Caliper
Shale
A gamma log is more "jagged" and an e-log more curved because the gamma log is a series of one-point measurements, whereas e-logs record measurements between two points.
φCNP
Tight Lmstn
SP
Tight Dolostn
High density of tight dolostone gives negative φ on density φ log
Tight Lmstn
Mud cake on porous zone
Porous Lmstn
High res. due to HC in pores
Shallow
Deep
Oil-water contact
Tight Lmstn
Argill. Lmstn
Increasingly argillaceous downwards
Caving of shale
Shale
Gamma response lower than that of sandstones
Anhydrite
Density of anhydrite = 2.96 gm/cc
Shale
Shallow
Mud cake on porous zone
Porous sandstone
Deep
Shallow tool measures res. in zone flushed with mud filtrate; deep tool measures zone with saline formation water.
Coal
Coal: Low density; lots of H
Coal is very slow.
Caving of coal and shale
Shale
High U content gives strong (off-scale) gamma response
Black Shale
Responses of shallow and deep resistivity tools overlap in non-porous zones because there is no annulus of filtrate-filled pores from which formation waters have been flushed.
φCNP
φCFD
Bit Size
Shale
SP
Caliper
Salt at the bottom of a log is not unusual because washout can lead to hole abandonment
Log responses in salt can be faulty because tool doesn't reach washed-out wall.
Wash-out due to dissolution of salt in drilling mud
Salt (Halite)
Halite: Low density and no H
Relatively fast (hence "salt pull-ups" on seismic sections)
LBR 8/98

Table 5-1 Sonic Velocity / Transit Time

	v_{ma}(ft/sec)	Δt_{ma}(μs/ft)	Δt_{ma}(μs/ft) (commonly used)
Sandstones	18,000-19,500	55.5-51.0	55.5 or 51.0
Limestones	21,000-23,000	47.6-43.5	47.5
Dolomites	23,000	43.5	43.5
Anhydrite	20,000	50.0	50.0
Salt	15,000	66.7	67.0
Casing (iron)	17,500	57.0	57.0

approximately:

SHEAR-WAVE PROPAGATION

Sandstone, t_{ma} ≈ 86 μs/ft
Limestone, t_{ma} ≈ 90 μs/ft
Dolomite, t_{ma} ≈ 76 μs/ft
Anhydrite, t_{ma} ≈ 100 μs/ft
Water, t_{ma} ≈ 350 μ/ft

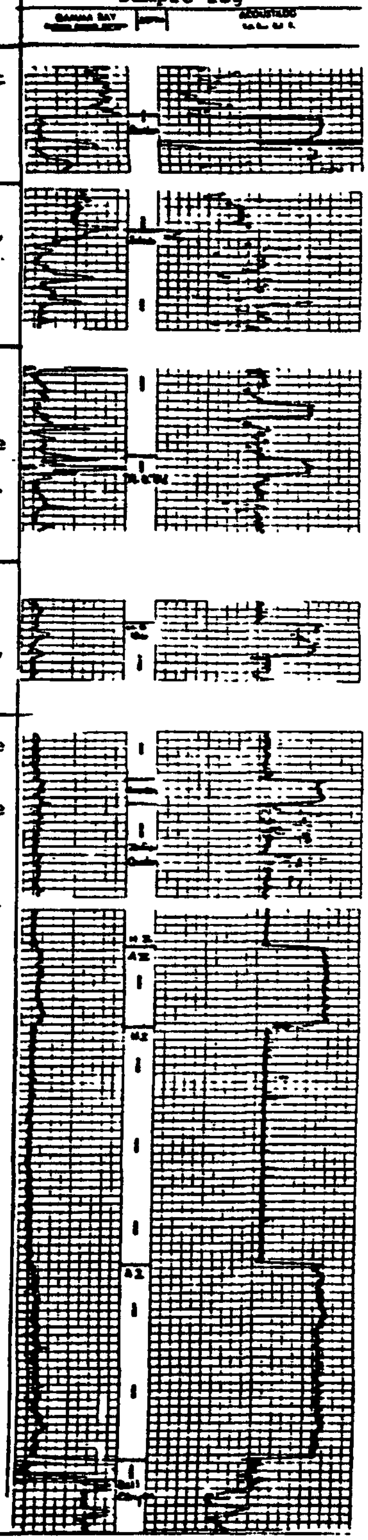
Red Beds - SST cemented w/ Ferric Anhydrite

Table 5-3 Density

Compound	Formula	Actual Density ρ_b	$\frac{2\Sigma Z\text{'s}}{\text{Mol. Wt.}}$	ρ_e	ρ_a (as seen by tool)
Quartz	SiO_2 SST	2.654	0.9985	2.650	2.648
Calcite	$CaCO_3$ LST	2.710	0.9991	2.708	2.710
Dolomite	$CaCO_3MgCO_3$ DOL	2.870	0.9977	2.863	2.876
Anhydrite	$CaSO_4$ ANHY	2.960	0.9990	2.957	2.977
Sylvite	KCl	1.984	0.9657	1.916	1.863
Halite	NaCl SALT	2.165	0.9581	2.074	2.032
Gypsum	$CaSO_4 2H_2O$ GYP	2.320	1.0222	2.372	2.351
Anthracite Coal		$\begin{Bmatrix}1.400\\1.800\end{Bmatrix}$	1.0300	$\begin{Bmatrix}1.442\\1.852\end{Bmatrix}$	$\begin{Bmatrix}1.355\\1.796\end{Bmatrix}$
Bituminous Coal		$\begin{Bmatrix}1.200\\1.500\end{Bmatrix}$	1.0600	$\begin{Bmatrix}1.272\\1.590\end{Bmatrix}$	$\begin{Bmatrix}1.173\\1.514\end{Bmatrix}$
Fresh Water	H_2O	1.000	1.1101	1.110	1.000
~~Salt Water~~ Brine	200,000 ppm	1.146	1.0797	1.237	1.135
Oil	$n(CH_2)$	0.850	1.1407	0.970	0.850
Methane	CH_4	ρ_{meth}	1.2470	1.247 ρ_{meth}	1.335 ρ_{meth}—0.188
Gas	$C_{1.1} H_{4.2}$	ρ_g	1.238	1.238 ρ_g	1.325 ρ_g—0.188

1,387-86

Stratigraphic Picks

Formation or Marker Bed	Basis for Stratigraphic Picks	Sample log*
Rustler Formation	The top of the Rustler is the 1st continuous anhydrite encountered--an increase on velocity, acoustic, or density logs is seen, and a decrease on gamma logs.	
Salado Formation	The top of the Salado registers as a sharp change from the Rustler, with an abrupt, brief increase on the gamma log and an abrupt, brief decrease in acoustic, velocity, or density logs.	
Marker Bed 124	Marker Bed 124 is the lower of two well-developed spikes; it frequently registers as a double spike itself on both gamma logs and acoustic, velocity, or density logs.	
Marker Bed 136	Marker Bed 136 generally is seen as a heavy spike with triple peaks or as a group of three spikes on acoustic, velocity, or density logs, and has a well-developed spike or spikes on the gamma log.	
Cowden Anhydrite Infracowden	The Cowden shows as a heavy spike on velocity, acoustic, or density logs, and is characterized by a small, sharp gamma peak at the base of the anhydrite.	
Castile Formation Halite-Anhydrite Sequence	The anhydrites show a regular, fairly high trace on acoustic, velocity, or density logs, and a small less regular trace on gamma logs. Halites have a regular, medium level trace, somewhat lower than anhydrites on acoustic, velocity, or density logs, and a decrease in the gamma logs as well.	
Bell Canyon Formation Delaware Mt. Group	The top of the Bell Canyon shows a sharp increase in gamma logs and a sharp decrease in acoustic, velocity, or density logs, followed by an irregular trace on the logs.	

*Sample log from Neil H. Wills Continental State No. 1, T25SR33E, S. 32, Gamma Ray and Acoustilog

Figure 27. Gamma-ray and acoustilog signatures for ideal well log from which the stratigraphic picks are unambiguous (Neil H. Wills Continental State #1, T25SR33E, S.32)

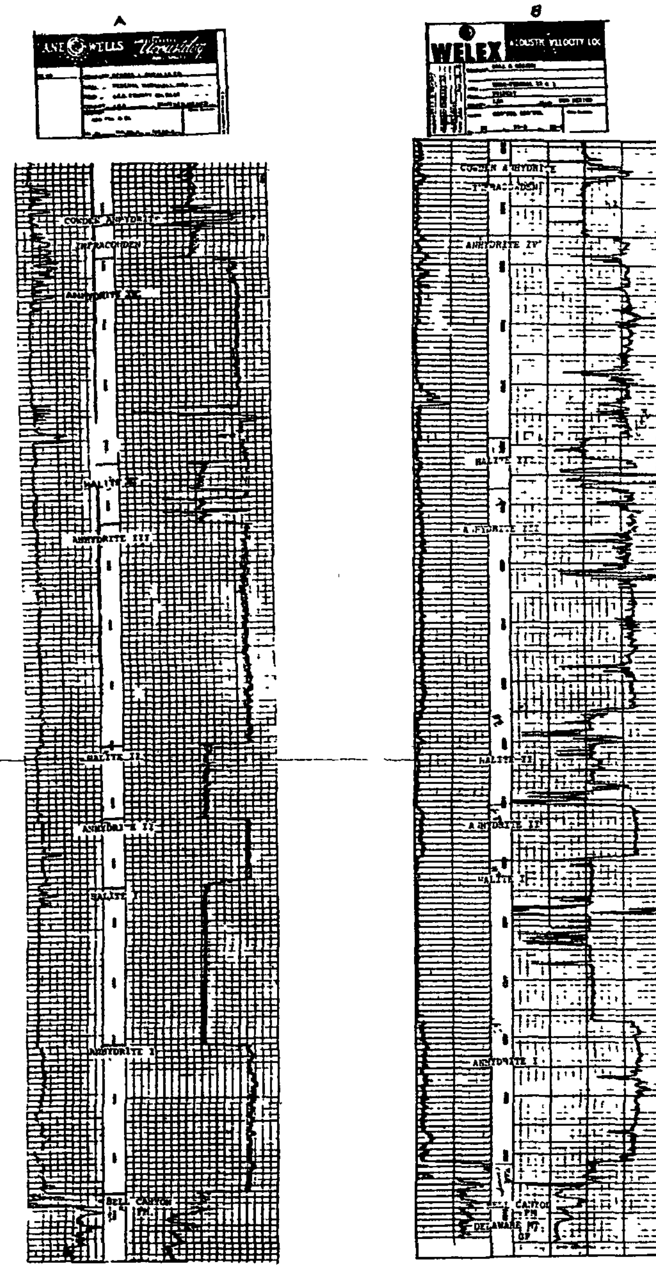


Figure 29. Comparison of ideal and nonideal logs of the lower Salado and Castile stratigraphy (Ideal log is on the left. Stratigraphy is more complicated in the right-hand log; e g , halite interfingers in AIII and anhydrite bed in HI)

S → N

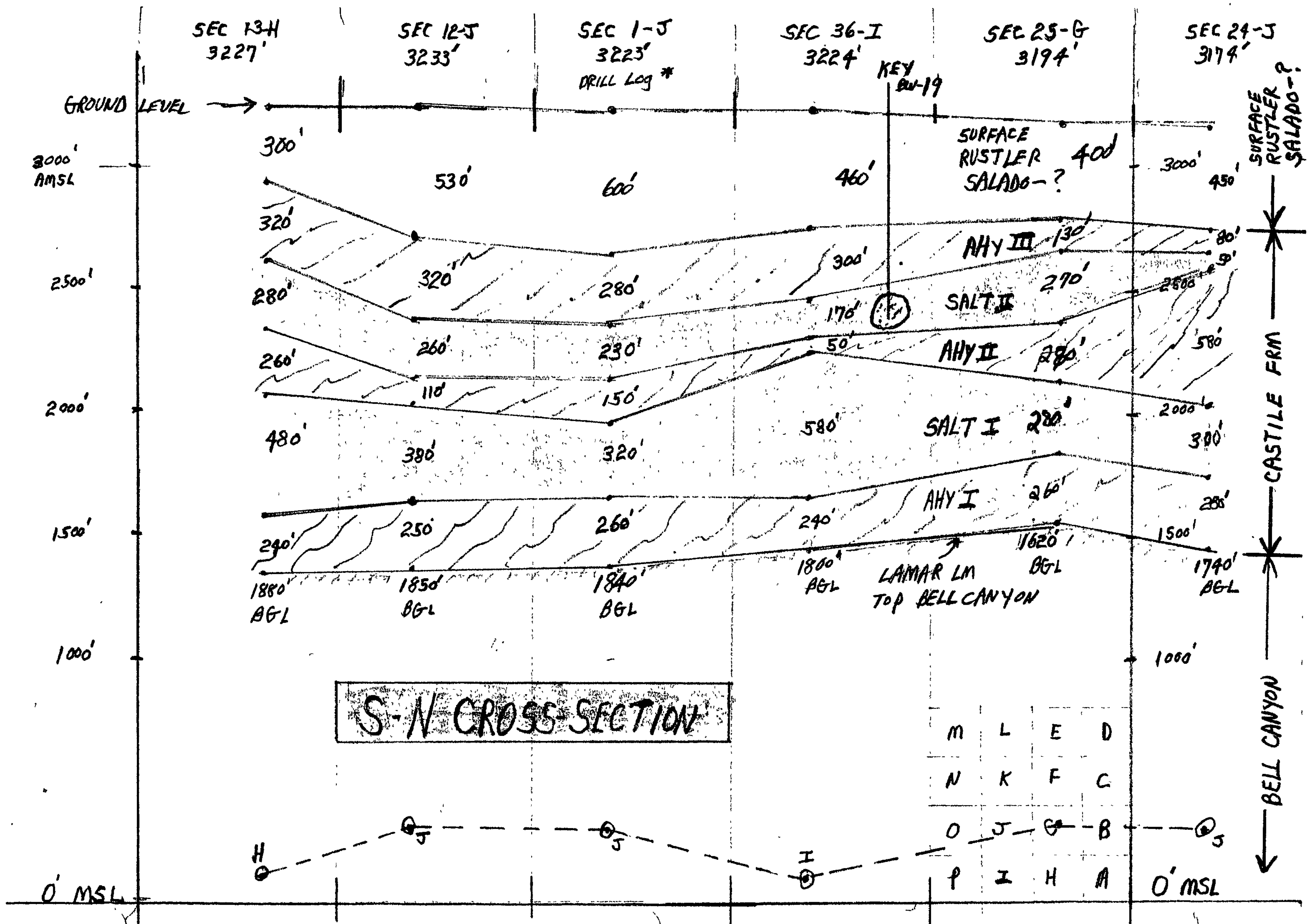
	13-H (3227)	12-J (3235)	1-J	36-I (3224)	25-G (3194)	24-J (3174)	
				CASTILE			
AHY III	300'	530'	600	480'	400'	450'	
	320	≈ 320'	AHY III 280'	300'	≈ 130'	≈ 80	
SALT II	620'	850' ~~880~~	880	760'	530'	530'	
THICKNESS →	280	≈ 260'	SALT II 130'	170' / 211'-H	≈ 270	≈ 50'	
AHY II	900'	1110'	1110'	930'	800'	580'	
	≈ 260'	≈ 110' ?	AHY II ? ≈ 150	50' ?	≈ 280'	≈ 580' ?	?
SALT I	1160'	1220'	1260'	1180'	1080'	1160'	
	≈ 480'	≈ 380	320'	≈ 380' ?	≈ 280'	300	
AHY I	1640'	1600'	1560'	1560'	1360'	1460'	TOP
	240'	≈ 250'	AHY I 260'	290'	≈ 260'	≈ 280'	THICKNESS
TOP LAMAR LM	1880'	1850'	1840'	1890'	1620'	1740'	BOLt

D.Log

BELL CANYON

S - N CROSS SECTION

RAW DATA FROM WELL LOGS

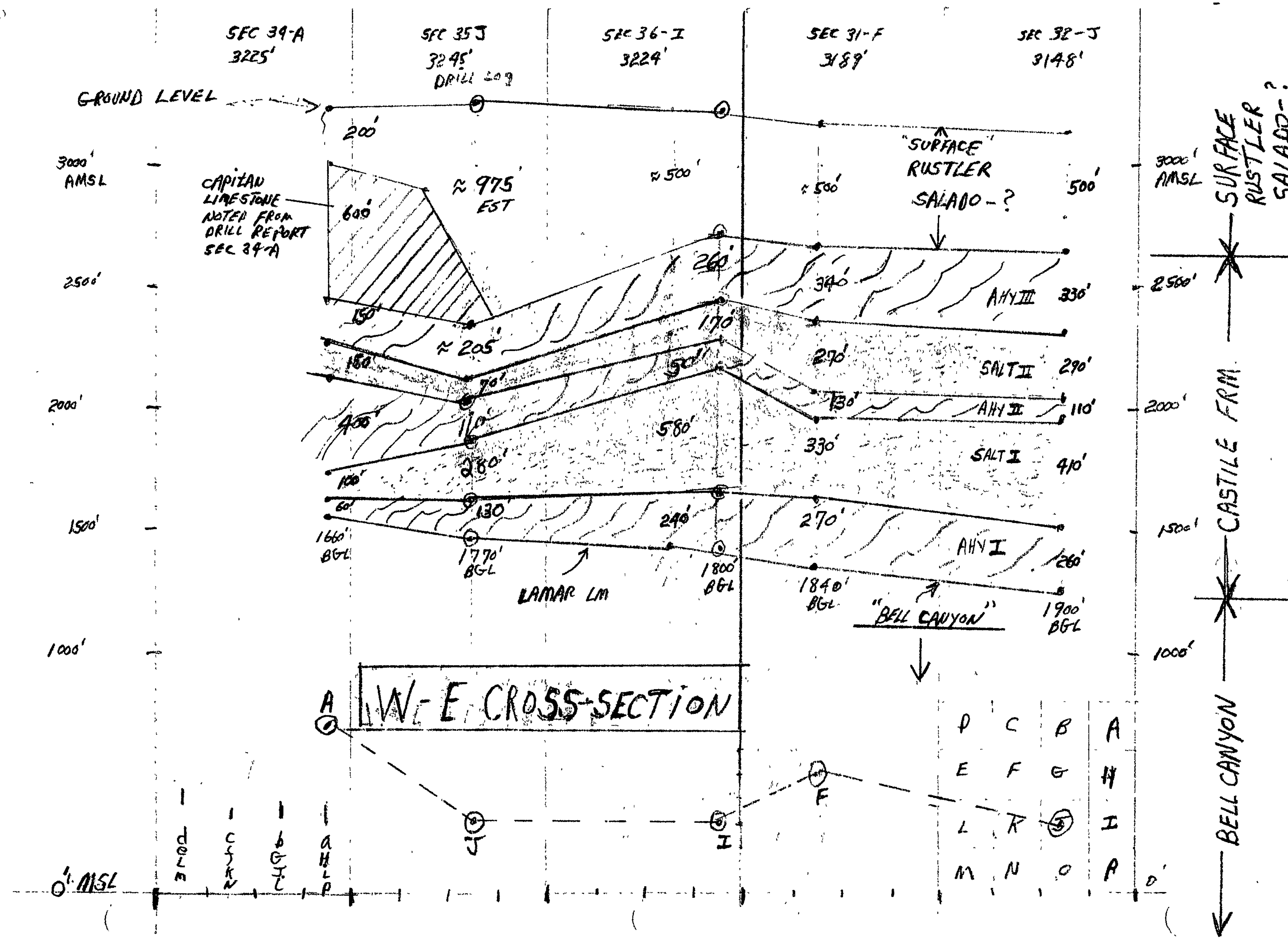


S-N CROSS SECTION

W → E

	34-A	35-J	36-I	31 F	32J	
ELEV →	3235'	3245 ML	3224	3189	3148	GROUND LEVEL
	3235	35-M-EL AERIAL				
(GALADO/RUSTLER)	CAPITAN LM		I	281'	350'	CASTILE
					≈150'	
AHY III	800	110' ?	≈500'	≈500' ?	500'	
	≈150'		≈260	≈340'	≈330'	– THICKNESS
SALT II	950'	1180'	– THE SALT 760'	840'	830'	BOT / TOP TYPICAL
	≈150'	70' ?	≈170'	≈270'	≈290'	
AHY II	1100'	1250'	930'	1110'	1120	RAW DATA FROM LOGS
	≈400'	≈110'	≈50' ?	≈130'	≈110'	
SALT I	1500'	1360'	980'	1240'	1230	W → E
	≈100'	≈280'	≈580'	≈330'	≈410'	
AHY I	1600'	1640'	1560'	1570'	1640'	
	≈60'	≈130'	≈290	≈270'	≈260'	
TOP LAMAR LM	1660'	1790	1800'	1840'	1900'	CASTILE
	BGL	BGL DL-J	BGL	BGL	BGL	BELL CANYON

BELOW GROUND DEPTH



SEC 34-A 3225'
SEC 35 J 3245' DRILL LOG
SEC 36-I 3224'
SEC 31-F 3189'
SEC 32-J 3148'
GROUND LEVEL
3000' AMSL
2500'
2000'
1500'
1000'
0' MSL
CAPITAN LIMESTONE NOTED FROM DRILL REPORT SEC 34-A
≈ 975' EST
"SURFACE" RUSTLER SALADO-?
AHY III
SALT II
AHY II
SALT I
AHY I
LAMAR LM
"BELL CANYON"
1660' BGL
1770' BGL
1800' BGL
1840' BGL
1900' BGL
W-E CROSS-SECTION
SURFACE RUSTLER SALADO-?
CASTILE FRM
BELL CANYON

Formation Zone(s)-Location, Elevation, Medium Thickness and Total Depth Chart

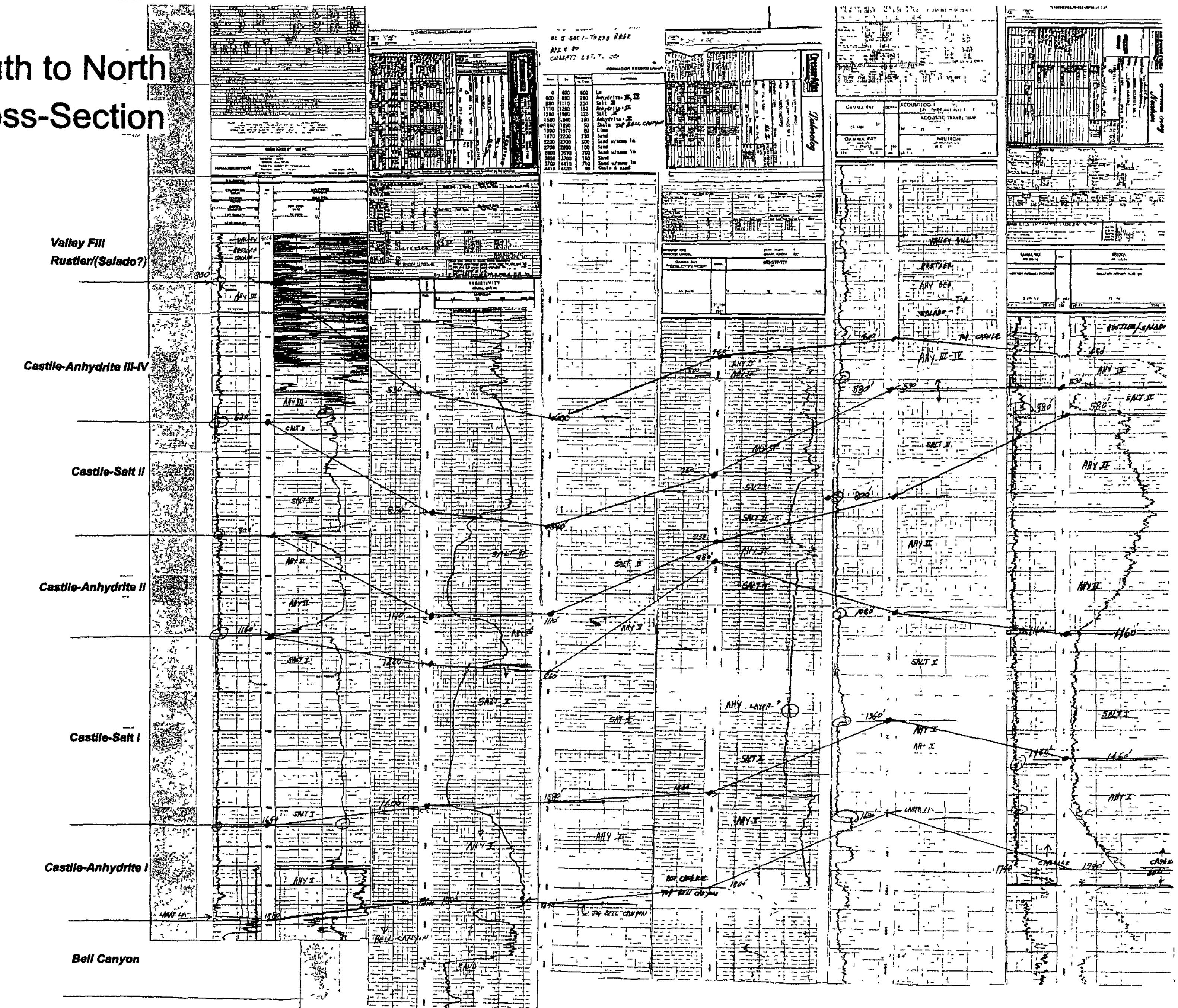
West-East Cross Section

Location	Elevation MSL	Ahy I	Salt I	Ahy II	Salt II	AhyIII	Rustler/Surface	Total Depth ft (BGL)	Above MSL ft
Sec 34 UL A- Ts22s-R26e	3235	60	100	400	150	150	800	1660	1575
Sec 35 UL J- Ts22s-R26e	3245	130	280	110	70	205	975	1770	1475
Sec 36 UL I- Ts22s-R26e	3224	240	580	50	170	260	500	1800	1424
Sec 31 UL F- Ts22s-R27e	3189	270	330	130	270	340	500	1840	1349
Sec 32 UL J- Ts22s-R27e	3148	260	410	110	290	330	500	1900	1248
Medium Thickness (ft)----------------------------------		240	330	110	170	260	500		

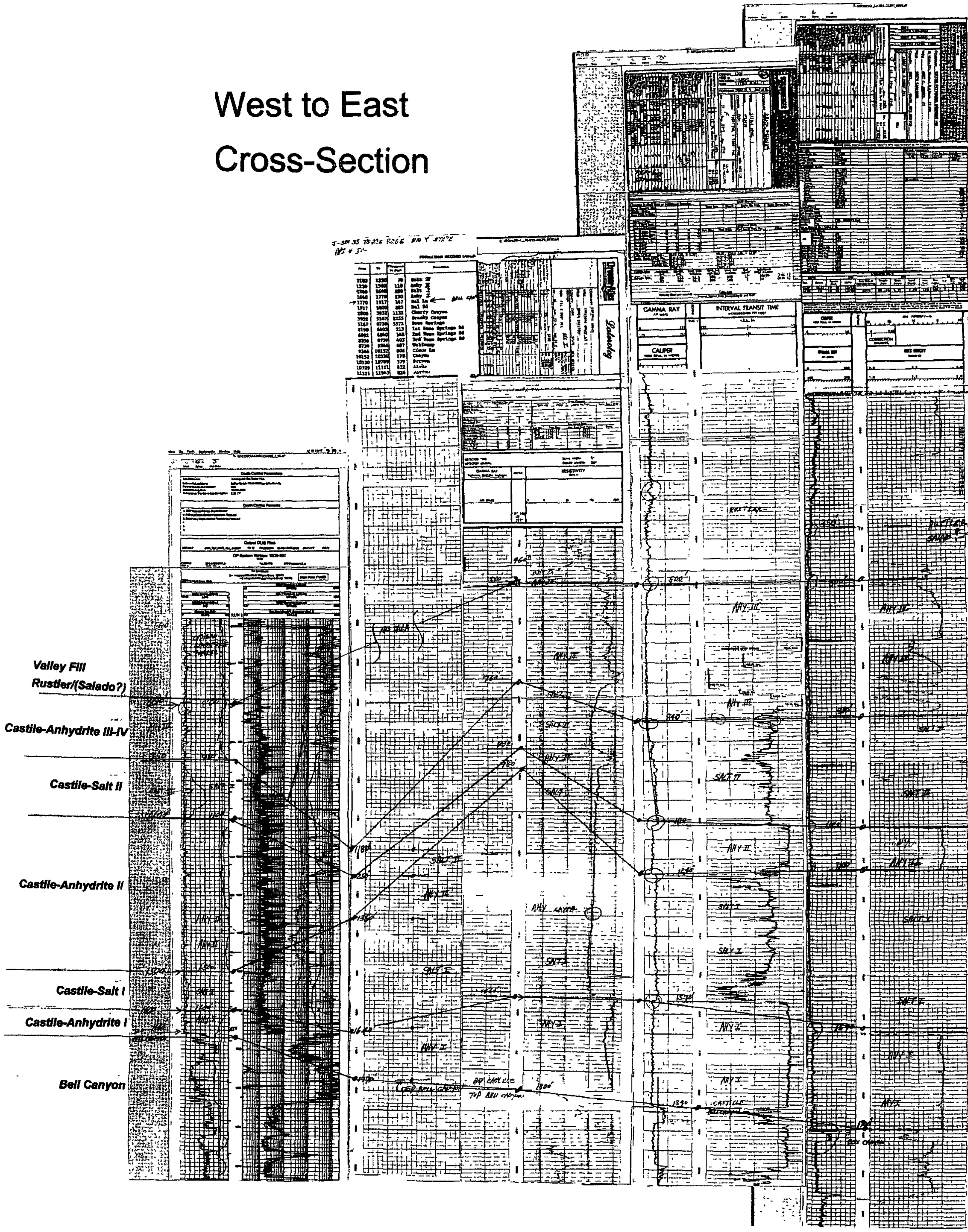
South-North Cross Section

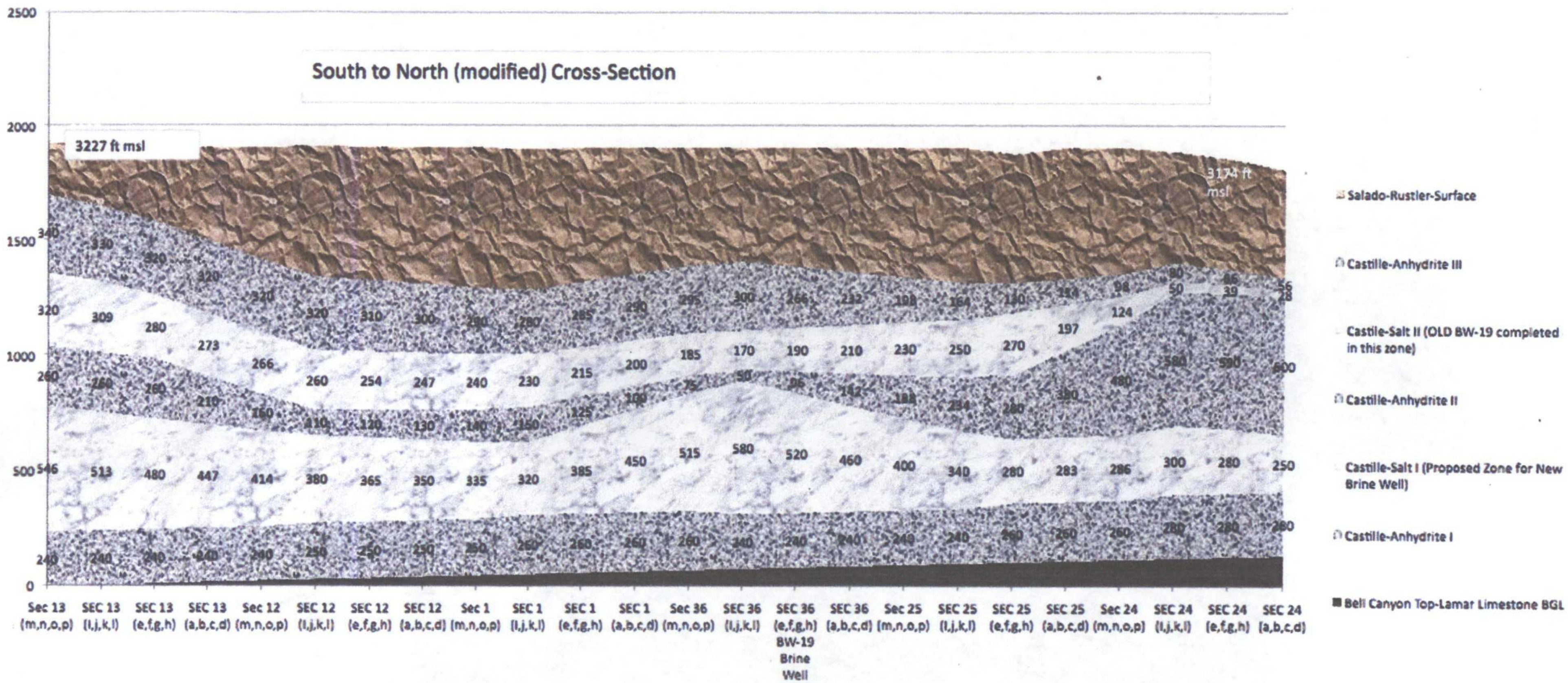
Location	Elevation MSL	Ahy I	Salt I	Ahy II	Salt II	AhyIII	Rustler/Surface	Total Depth ft (BGL)	Above MSL ft
Sec 13 UL H- Ts23s-R26e	3227	240	480	260	280	320	300	1880	1347
Sec 12 UL J- Ts23s-R26e	3233	250	380	110	260	320	530	1850	1383
Sec 01 UL J- Ts23s-R26e	3223	260	320	150	230	280	600	1840	1383
Sec 36 UL I- Ts22s-R26e	3224	240	580	50	170	300	460	1800	1424
Sec 25 UL G- Ts22s-R26e	3194	260	280	280	270	130	400	1620	1574
Sec 24 UL J- Ts22s-R26e	3174	280	300	580	50	80	450	1740	1434
Medium Thickness (ft)----------------------------------		255	350	205	245	290	455		

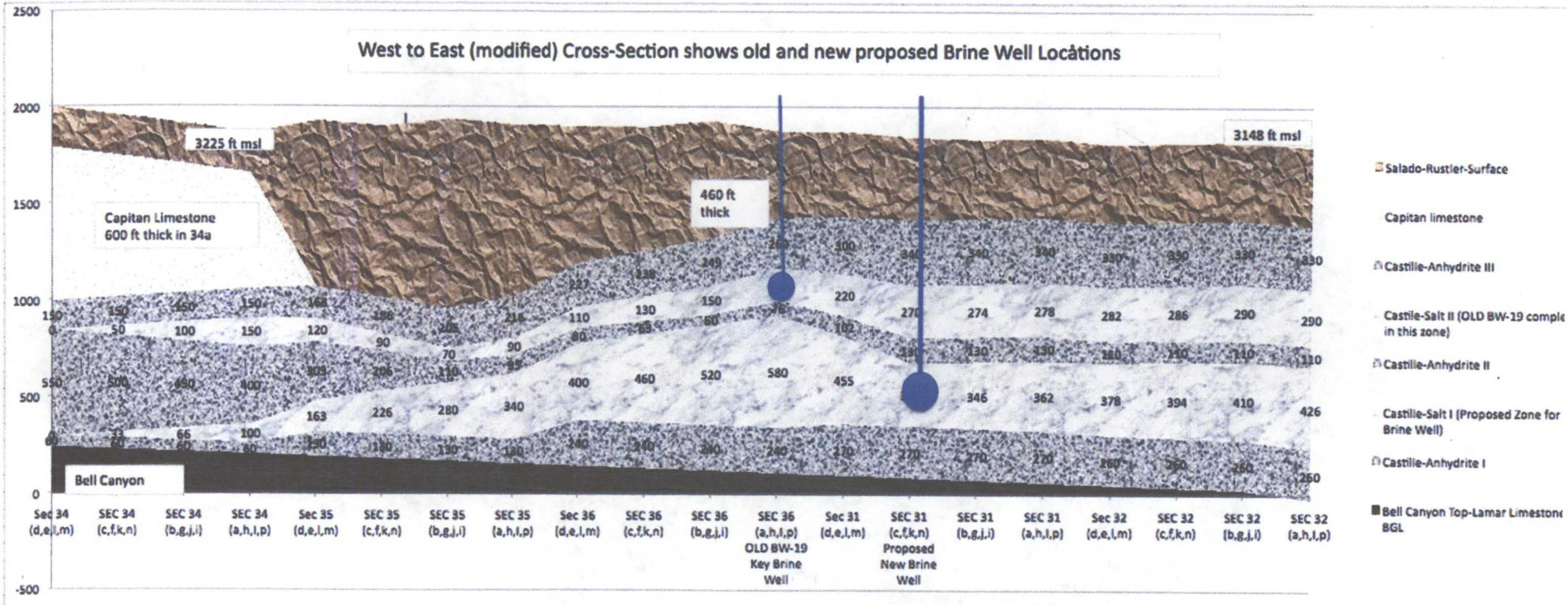
South to North Cross-Section



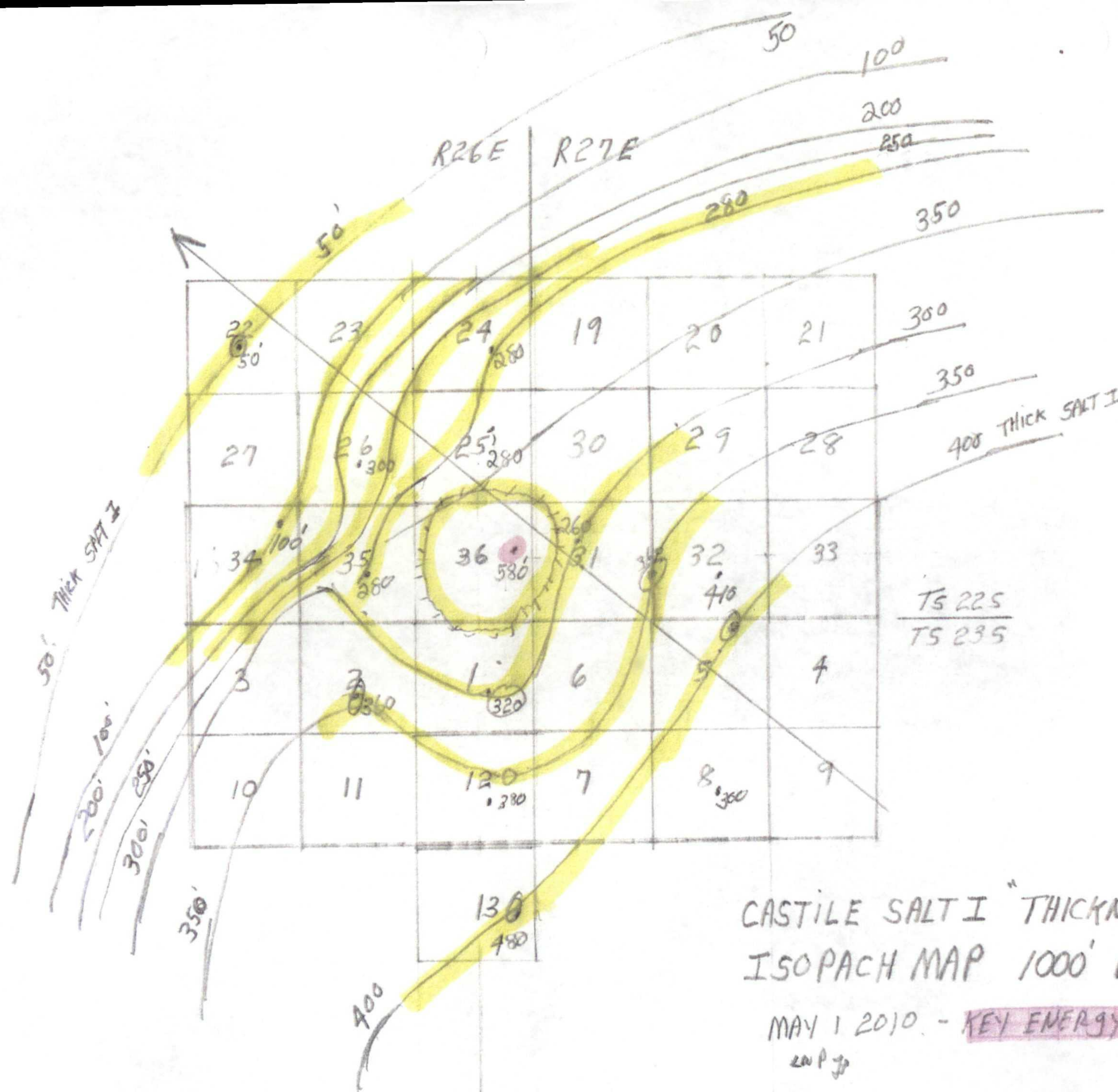
West to East Cross-Section




South to North (modified) Cross-Section
3227 ft msl
3174 ft msl
2500
2000
1500
1000
500
0
Salado-Rustler-Surface
Castile-Anhydrite III
Castile-Salt II (OLD BW-19 completed in this zone)
Castile-Anhydrite II
Castile-Salt I (Proposed Zone for New Brine Well)
Castile-Anhydrite I
Bell Canyon Top-Lamar Limestone BGL
Sec 13 (m,n,o,p)
SEC 13 (I,j,k,l)
SEC 13 (e,f,g,h)
SEC 13 (a,b,c,d)
Sec 12 (m,n,o,p)
SEC 12 (I,j,k,l)
SEC 12 (e,f,g,h)
SEC 12 (a,b,c,d)
Sec 1 (m,n,o,p)
SEC 1 (I,j,k,l)
SEC 1 (e,f,g,h)
SEC 1 (a,b,c,d)
Sec 36 (m,n,o,p)
SEC 36 (I,j,k,l)
SEC 36 (e,f,g,h) BW-19 Brine Well
SEC 36 (a,b,c,d)
Sec 25 (m,n,o,p)
SEC 25 (I,j,k,l)
SEC 25 (e,f,g,h)
SEC 25 (a,b,c,d)
Sec 24 (m,n,o,p)
SEC 24 (I,j,k,l)
SEC 24 (e,f,g,h)
SEC 24 (a,b,c,d)



West to East (modified) Cross-Section shows old and new proposed Brine Well Locâtions
3225 ft msl
3148 ft msl
460 ft thick
Capitan Limestone 600 ft thick in 34a
Bell Canyon
2500
2000
1500
1000
500
0
-500
Sec 34 (d,e,l,m)
SEC 34 (c,f,k,n)
SEC 34 (b,g,j,i)
SEC 34 (a,h,I,p)
Sec 35 (d,e,l,m)
SEC 35 (c,f,k,n)
SEC 35 (b,g,j,i)
SEC 35 (a,h,I,p)
Sec 36 (d,e,l,m)
SEC 36 (c,f,k,n)
SEC 36 (b,g,j,i)
SEC 36 (a,h,I,p) OLD BW-19 Key Brine Well
Sec 31 (d,e,l,m)
SEC 31 (c,f,k,n) Proposed New Brine Well
SEC 31 (b,g,j,i)
SEC 31 (a,h,I,p)
Sec 32 (d,e,l,m)
SEC 32 (c,f,k,n)
SEC 32 (b,g,j,i)
SEC 32 (a,h,I,p)
Salado-Rustler-Surface
Capitan limestone
Castile-Anhydrite III
Castile-Salt II (OLD BW-19 comple in this zone)
Castile-Anhydrite II
Castile-Salt I (Proposed Zone for Brine Well)
Castile-Anhydrite I
Bell Canyon Top-Lamar Limestone BGL



CASTILE SALT I "THICKNESS"
ISOPACH MAP 1000' DEEP
MAY 1 2010 - KEY ENERGY BW-19

GCR Section III.A- Seismic Findings:

In retrospect to areas like California, the Carlsbad NM area is not known for large seismic events. However, both the USGS and NM Tech geophysics department has tracked and recorded several minor events near the Carlsbad NM area. For the most part, the magnitude of these events is generally recorded in the 3-4 range on the Richter scale.

The largest magnitude seismic event near Carlsbad, NM was recorded and listed being from the Eunice NM area in January 1992, at an estimated magnitude of 5. (Ref NM TECH-GeoPhysics Website).

Since 2002 there have been 13 earthquakes with magnitudes generally less than 3.0 in southern New Mexico, which all occurred in the Dagger Draw area, located about 13 miles northwest of Carlsbad, NM. These earthquakes happen generally 1-2 times per year according to the report. (From USGS catalog). The cause of the events is actually unknown, however one press release (copy included below) connected it to possible oil and gas activity.

Press Release. 12/19/2005 4:00 pm MST: Earthquake near Carlsbad, New Mexico
"A minor earthquake occurred in southeast New Mexico on December 19, 2005 at 20:27:39 UTC (13:27:39 MST). The magnitude 3.8 earthquake was located at 32 degrees 38.29 minutes N and 104 degrees 36.26 minutes W, which is approximately 25 miles WNW of Carlsbad. The quake was felt in Roswell, Artesia and Carlsbad. We have received no reports of damage at this time. This earthquake is located near the Dagger Draw oil field. This area has been experiencing repeated seismicity since the late 1990's, most likely as a result of water injection practices associated with oil production. The USGS website for this earthquake can be found at http://earthquake.usgs.gov/eqinthenews/2005/usgva8/"

The USGS has a model that predicts earthquakes in any area of interest. The input to the model was for the Carlsbad zip code and for a magnitude greater than 5, for the next 100 years. Please find in this GCR III.A appendix a copy of the output of the model. The results indicate there is less than a 3-4% probability of have a seismic event larger that a 5 magnitude in the next 100 years.

These results show that seismic activity does occur in the study area, but at minor levels of magnitude. Therefore any beam design for the roof would employ a 2:1 safety factor.

GCR Section III.A Seismic Appendix

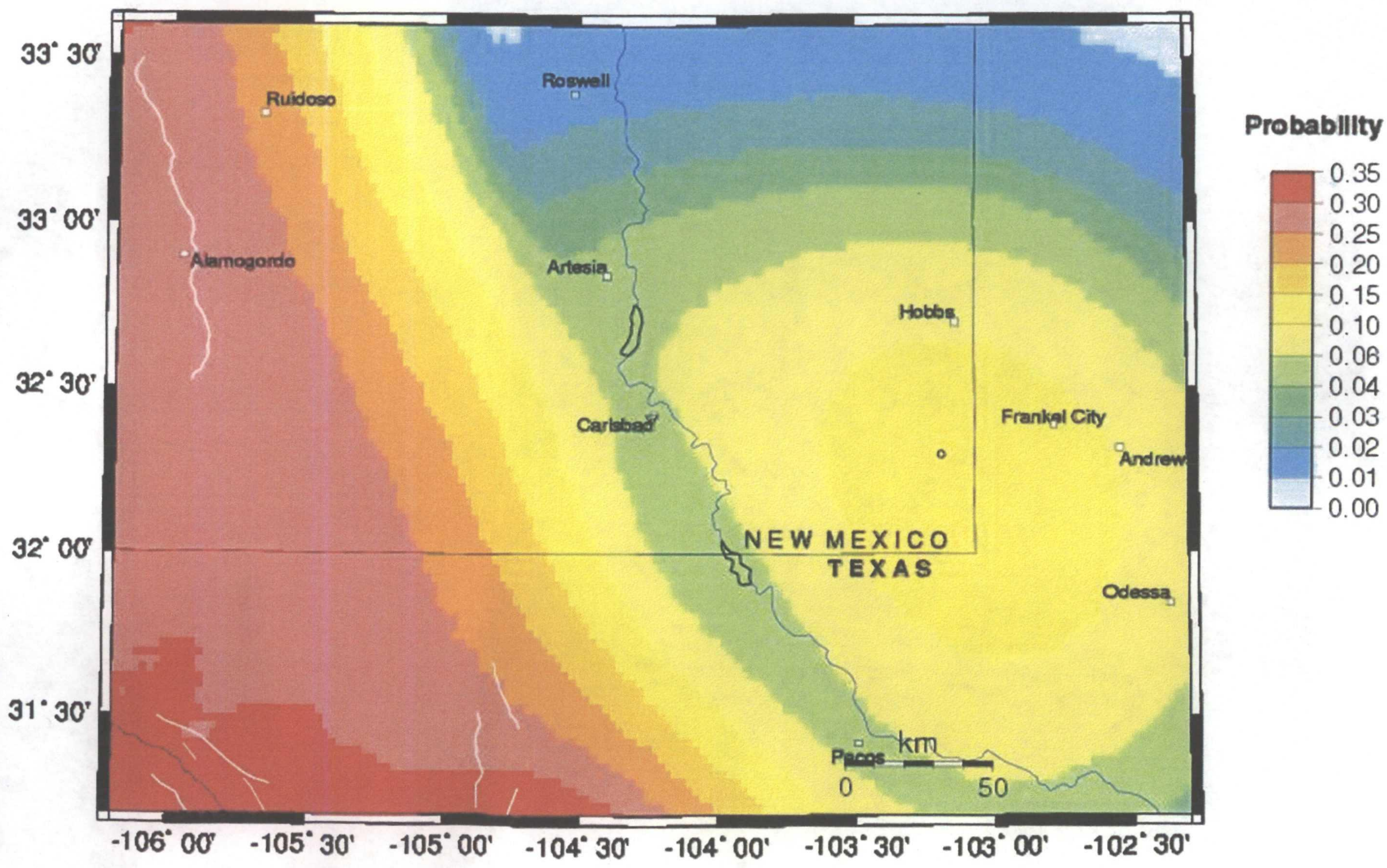
Includes:

1. Seismic Model Results for the Carlsbad, NM area.

Probability of earthquake with M $\geq$ 5.0 within 100 years & 50 km

U.S. Geological Survey PSHA Model

Site: CARLSBAD NM . .



GMT 2010 Sep 6 02:05:29 Earthquake probabilities from USGS OFR_02-420 PSHA. 50 km maximum horizontal distance. Site of interest: triangle. Fault traces are white; rivers blue. Epicenters M>=5.0 circles.

GCR Section III. B. Geologic Disturbed Zones-Findings:

During the early stages of the DOE WIPP site investigation, a geologic disturbed zone was found between the north side of WIPP and the Capitan reef. The concern of the disturbed zone near the WIPP site was mainly that the salt beds were thinning, and thickening of the anhydrite layers in the underlying formations. There was also a concern of the possibility of on-going dissolution of salts in this area, which could have infringed upon the depository including pressurized brine pockets.

In addition, a high angle debris field caused by the fore-reef ocean currents and wave action battering the Capitan Reef caused large fragments of the reef to break off and slide down the slope forming the fore-reef. The fore-reef is a debris fan consisting of lime mud and fossils that did not become highly cemented, as did the reef itself. Also, other deformities such as deep thrust fault blocks were discovered in the underlying Castile formation causing the Castile units to be non-continuous.

In an apparent abundance of pre-caution, a six-mile set back from the reef was imposed for the WIPP site. Please see Fig. 1-1 WIPP Disturbed Zone Map with definitions included in this GCR III.B section appendix.

As previously discussed in the GCR section III above, the base of the Castile salt zone I, the zone of interest, has a flat slope of about 1 deg across the study area and is continuous throughout. As previously noted, this unit does pinch out gong to the west into the Capitan bank complex. Also, the Rustler formation in this area, starting in Section 35, appears to have a very steep slope up-ward going west. This is most likely the beginning of the disturbed area of the Capitan fore-reef.

The existing Key Brine well BW-19 was located in Section 36, two miles east of the disturbed-area, and operated for many years without any major issues. Any new location will most likely be located east of the current brine well and will have more than three miles separation from the documented disturbed area.

Another very small disturbance area was noted at the southeast intersection of Derrick road and US Highway 62-180 located about one and one-half miles to the southwest of the Key Study Area. This site is noted on the Map of Geology of the Guadalupe Mountains-Carlsbad Regions (included in appendix) as Sedimentary Rocks Qd, (indicating a disturbed gravel affected by collapse). This area was mined several years ago most likely for the highway or the old Army Air Base. Some photos are included in this GCR III.B section appendix.

GCR Section III.B. Disturbed Areas Appendix

Includes:

1. Fig. 1-1 WIPP Disturbed Zone Map with definitions- 2 pages.
2. Geology Map of the Guadalupe Mountains-Carlsbad Region.
3. Photos of small gravel field disturbed area.

1.4 Definition of the Disturbed Zone

The evaporite beds are deformed around portions of the margin of the Delaware Basin and in some areas in the middle of the Basin. Deformation features in the northern part of the WIPP site have been lumped together under the term "Disturbed Zone" (DZ). The DZ is now delineated on the combined basis of structure exhibited in boreholes and by the chaotic seismic reflection data in the northern part of the site (see Figure 1-1).

- Structures on which the DZ is defined are thickened or thinned halite units of the Castile and anti- or synforms in anhydrite units of the Castile. Mesoscopic structures that are associated with the DZ are tight-to-open folding and boudinage of carbonate-anhydrite laminae. As suggested above, the DZ is based predominantly on Castile structures, whereas in the overlying Salado, deformation is nonexistent or weak; e.g., ERDA 6.
- The chaotic seismic reflection data, which is the other basis for delineating the DZ, is characterized by discontinuous reflectors and a blocky return pattern (see Sec 3.2).

The term "Disturbed Zone" has been used historically in different ways during the discussion of the WIPP. The historical usage is reviewed to help readers understand prior discussions.

The DZ was recognized on the basis of seismic reflection data; we began with a review of proprietary industry data. Hundreds of line-miles of seismic reflection data were made available in 1976 to G. J. Long and Associates (1976) for review of shallow (<4000-ft) reflectors in the northern Delaware Basin. Several seismic anomalies were identified in this review; one of the larger seismic anomalies was located 3 mi north of ERDA 9. At the time of the review, the extent and geologic character of the DZ were not recognized.

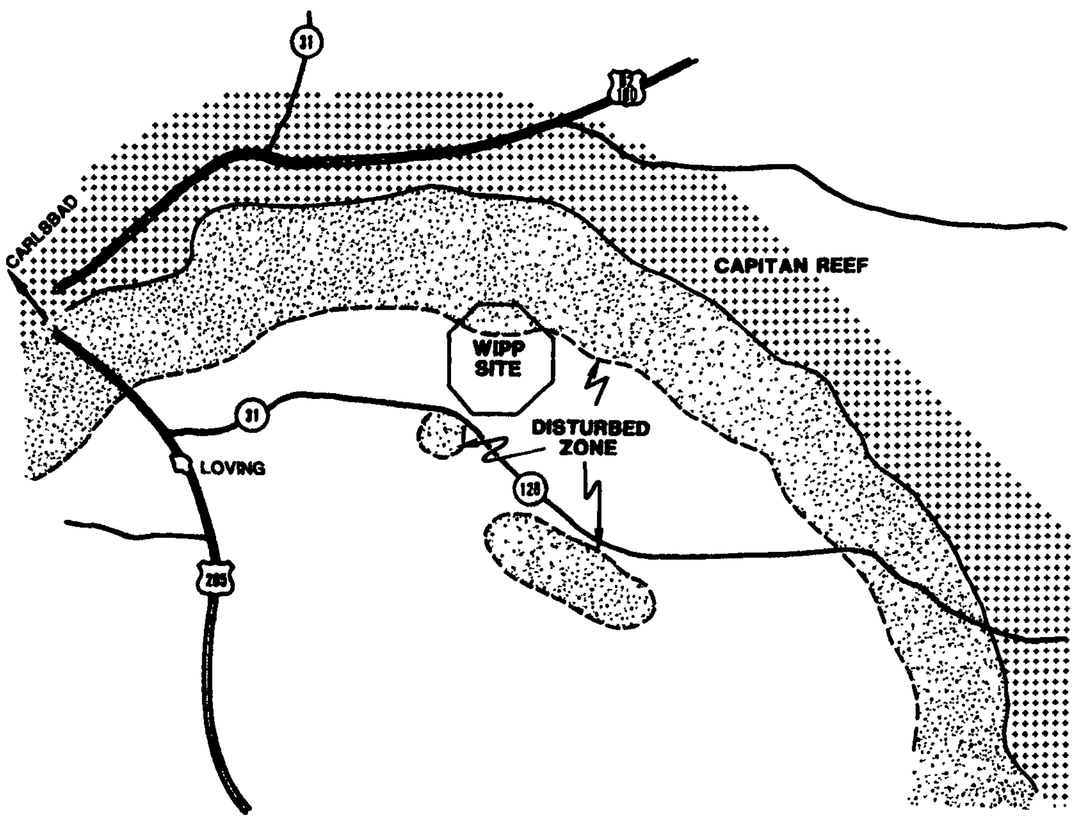


Figure 1-1. Areal Extent of the Disturbed Zone, Northern Delaware Basin

During the latter half of 1977, Sandia National Laboratories in Albuquerque (SNLA), assisted by G. J. Long and Associates, made a seismic reflection survey to obtain better shallow reflections and to cover the possible seismic anomalies identified earlier through data review. The survey, designated the 1977 X Geophysical Program, covered about 48 line-miles, including some offsite work. Full details of parameters and line locations for all SNLA seismic reflection data are contained in Hern et al (1979).

Preliminary interpretation of the 1977 X seismic reflection data revealed an area in the northern part of the WIPP study area where shallow reflectors were not easily interpreted. A rough outline of an area called the "highly disturbed zone" was inferred on the basis of limited data then available. The highly disturbed zone was reported in Powers et al (1978, Figure 4.4-6). The limited amount of seismic reflection data and lack of good reflectors prevented significant interpretation of the internal structure of the DZ. The anomaly 3 mi north of ERDA 9 was included in the DZ, and was investigated by drilling borehole WIPP 11 (SNLA and USGS, 1982).

In 1978 an additional small seismic reflection survey ("Y" series) was conducted by G. J. Long and Associates for SNLA (Hern et al, 1979). A more extensive survey was made by Bechtel for underground design and site evaluation (Bell and Murphy and Assoc., Inc., 1979; Dobrin, 1979). These data better define the boundary of the DZ and provide some indications of its internal structure.

By 1979 Sec 16, 17 of R31E, T22S were being interpreted as either an area of anomalous seismic data or an area of complex geologic structure. At that time borehole WIPP 13 bottomed at 1025 ft in the upper member of the Salado Formation. During 1980 the hole was deepened to the lowermost anhydrite of the Castile Formation to establish the origin of the seismic signals. The hole verified that the DZ was an area of complex geologic structures in the Castile and lowermost Salado Formations. Subsequent DZ investigations have included two high-resolution seismic experiments, the high-precision gravity survey, petrographic core analysis, development of tectonic models, and deepening of WIPP 12.

The seismic reflection data from 1978 are summarized in the WIPP Safety Analysis Report (SAR) (Department of Energy, 1980). The "zone of anomalous seismic reflection data" (Figures 2.7-23, 2.7-24, 2.7-30 of the SAR) is used to indicate portions of the seismic records generally regarded as uninterpretable by these investigators. This zone is equivalent in definition to the early highly deformed zone in that uninterpretable seismic records are the bases. More seismic data resulted in a somewhat different boundary to this zone.

The SAR also shows a "line indicating steepening of dip of Castile strata to the north" (Figures 2.7-23, 2.7-24, 2.7-30) based on Bell and Murphy and Associates, Inc. (1979). This line approximately coincides with the southern boundary of the DZ as defined in this report; the Castile structure as exhibited in the northern part of Zone II now is included in the DZ by us (Figure 1-1). Thus, the area where the Castile/lower Salado departs from generally parallel beds with slight dip is the DZ. For the present, we assume a common origin for these structures. Several evaporite structures in the Delaware Basin (Anderson and Powers, 1978) may have similar origins.

NOTE: The configuration of WIPP surface control zones has changed as a result of the cost-reduction program, the DOE resource management policy, and Bureau of Land Management land withdrawal actions (McGough, written communication, 1983). In this report, the older configuration boundaries have been used, in part to be consistent with previously published figures. Figure 1-2 is included to show the present configuration for comparison.

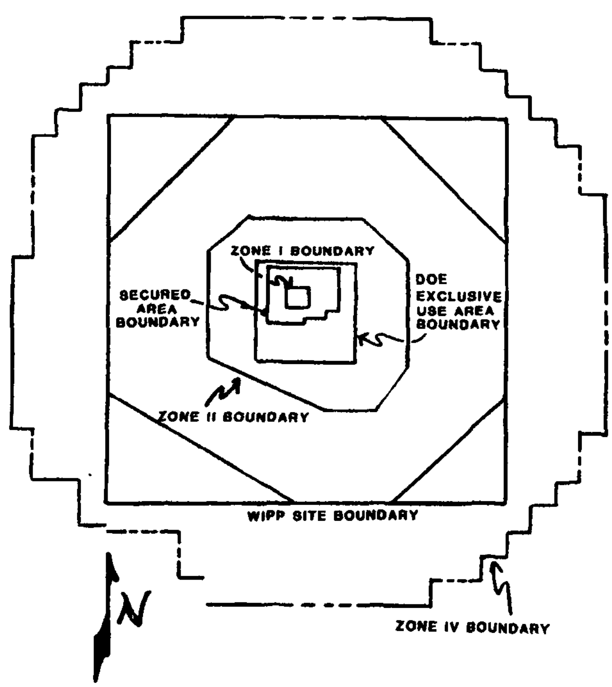
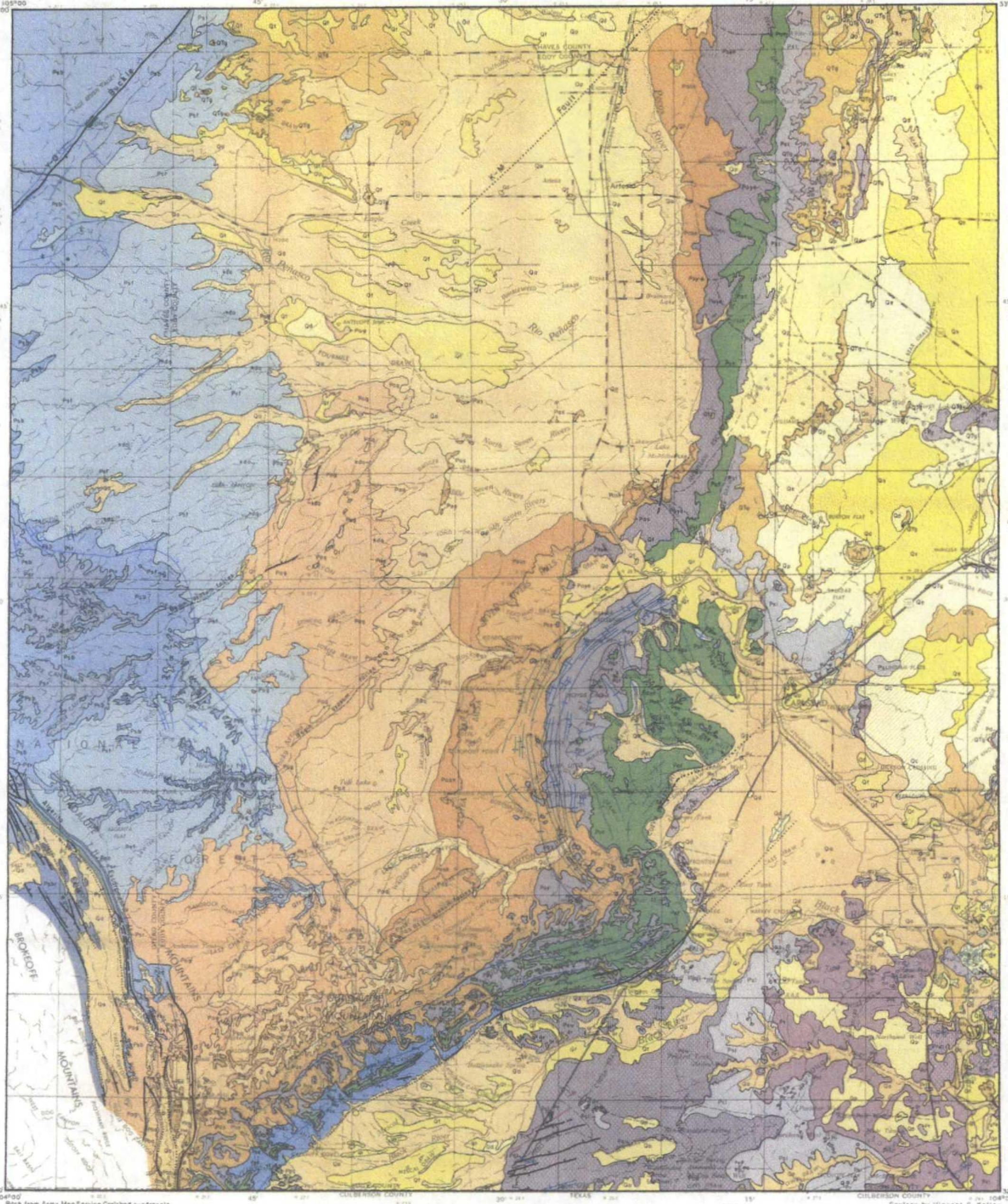


Figure 1-2. Present Configuration of Surface Control Zones at the WIPP Site



EXPLANATION

SEDIMENTARY ROCKS

TERTIARY QUATERNARY

Qa | Qs | Qe | Ql | Qd | QTt | Qt | Qp | Qc

Surficial Deposits

Gatuna Formation (QTg)

Red, tan, and buff sand, gravel, and mudstone

Cub Mountain Formation (Tkc)

CRETACEOUS

Mesaverde Group (Kmv)

Mancos Shale (Km)

Dakota Sandstone (Kd)

TRIASSIC

Chinle Formation (Trc)

Santa Rosa Formation (Trs)

PERMIAN

Dewey Lake Formation (Pd)

Rustler Formation (Pr, Pru, Prl)

Salado Formation (Psl)

Castile Formation (Pc, Pcu, Pcl)

Artesia Group

Tansill Formation (Pat)

Yates Formation (Pay, Paye)

Seven Rivers Formation (Pas, Pase)

Queen and Grayburg Formations (Paq, Pag, Paqg)

Capitan Limestone (Pcl)

Bell Canyon Formation (Pbc)

Goat Seep Formation (Pgs)

San Andres Formation (Psf, Psb, Psr, Psbr, Psg)

Yeso Formation (Py)

PRECAMBRIAN

Precambrian rocks, undivided

Granite, syenite, and gneiss

IGNEOUS ROCKS

TERTIARY

Sierra Blanca Volcanic Group (Tsb)

Dikes, sills, stocks, and laccoliths (Ti, Tis, Tig, Tir, Tim, Tid)

Contact

Dashed where approximately located; dotted where concealed

Key bed or zone within a formation

High-angle fault

Anticline

Showing trace of axial plane

Syncline

Showing trace of axial plane

Traces of anticlinal and synclinal bends

horizontal | vertical | inclined

Attitude of beds

Line of measured section

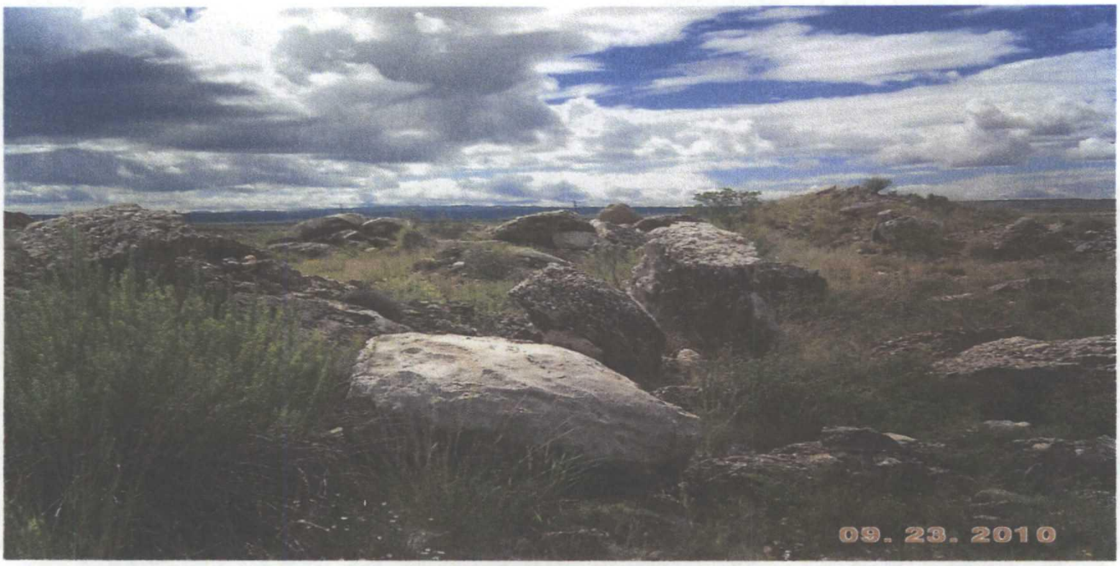
Tie leader

Lines of slump

Small salt piercements and related sinks

GEOLOGY OF THE GUADALUPE MOUNTAINS-CARLSBAD REGION

by Vincent C. Kelley, 1971



Gravel Field located 1 ½ miles Southwest of Proposed Site. SE Corner of Derrick Road and US HWY 62-180.

GCR III.C. Fault Study-Findings:

Although faulting is commonplace in the Rocky Mountains and in some adjacent areas in the Guadalupe Mountains, known faults that displace Permian salt-bearing rocks in the Western Interior of the United States are rare. (Bachman/Johnson-73-14-USGS)

Kelley (1971) has described two faults near the study area, named the Barrera and Carlsbad, fronting the reef escarpment 32 kilometers and 16 kilometers southwest of Carlsbad and having "late Tertiary with possible Quarternary movement." However, many other geologists who have investigated the area are not convinced that the linear features seen on aerial photos are actually faults. (Claiborne and Gera, 1974).

The Carlsbad feature is located approximately 4-5 miles due west of the study area. The Barrera feature is located approximately 10 miles southwest of the study area. Please find in this GCR III.C section appendix the "Tectonic Map of the Pecos Country, South Half" showing the location and general directional trend of the two faults marked in orange, and the location of the proposed brine well marked as a red dot. Neither fault is located in the salt zone of interest.

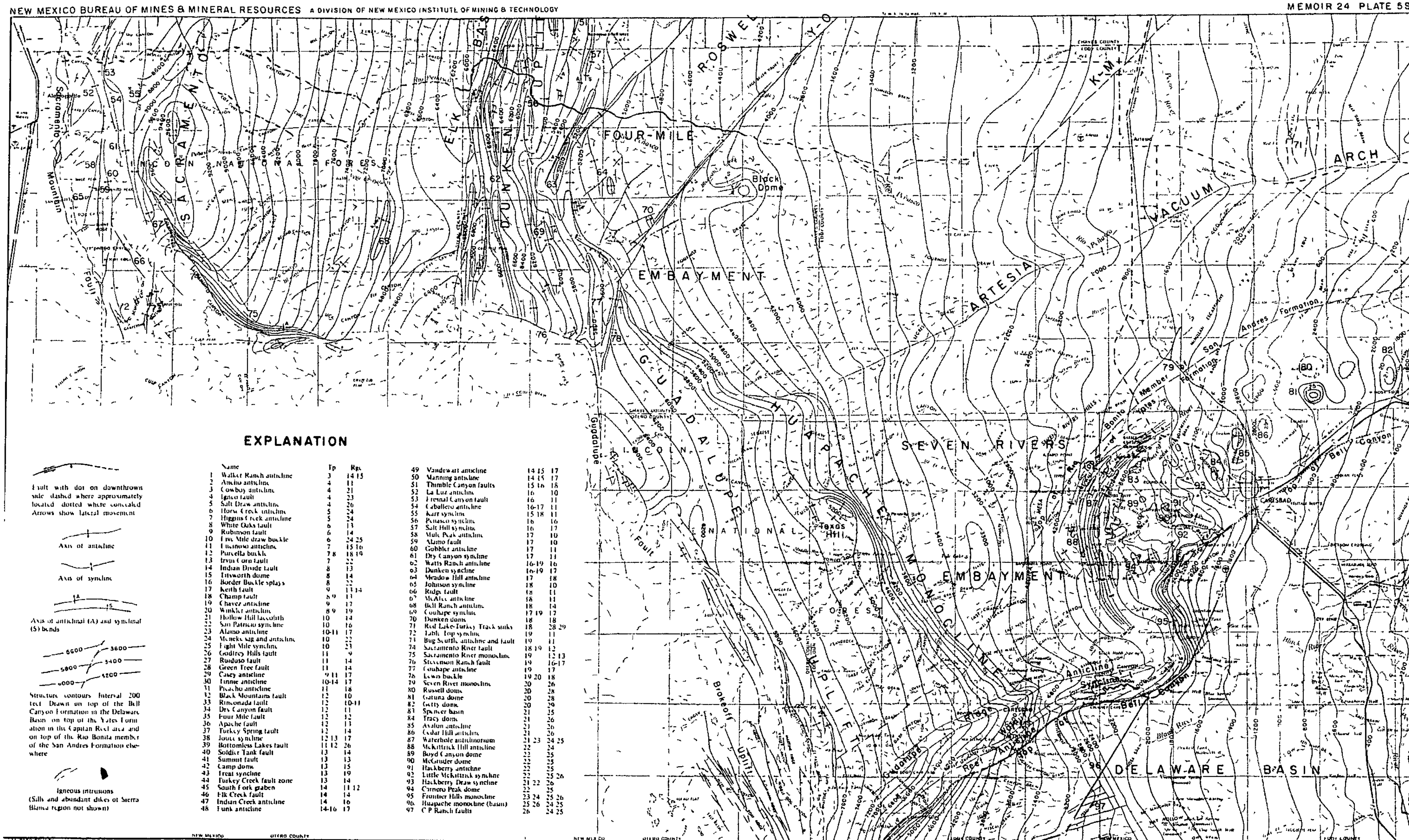
During the investigation of the WIPP site, a thrust block fault was discovered in the Castile formation. See figure 2.5 of the report Deformation of Evaporites Near the Waste Isolation Pilot Plant (WIPP) Sandia SAND82 –1069. This fault was located in the Castile Anhydrite I unit by interpretation of the geophysical logs. The relief of these units was noted as being in excess of a hundred feet.

The well and drilling log correlations in the study area did not reflect any discontinuous areas or faulting of this nature. There were some areas in the study zone that showed thinning and thickening of the Castile units. However, this variation in thickness seemed to be quite common in the Castile units throughout the basin.

GCR Section III.C. Faults Appendix

Includes:

1. Tectonic Map of the Pecos Country-South Half complete.
2. Tectonic Map of the Pecos Country-South Half showing faults marked in orange and the proposed brine well marked as red dot.
3. Figure 2-6. East-West Cross Section, WIPP Site.



EXPLANATION

Fault with dot on downthrown side dashed where approximately located dotted where concealed Arrows show lateral movement

Axis of anticline

Axis of syncline

Axis of anticlinal (A) and synclinal (S) bends

Structure contours Interval 200 feet Drawn on top of the Bell Canyon Formation in the Delaware Basin on top of the Yates Formation in the Capitan Reef area and on top of the Rio Bonita member of the San Andres Formation elsewhere

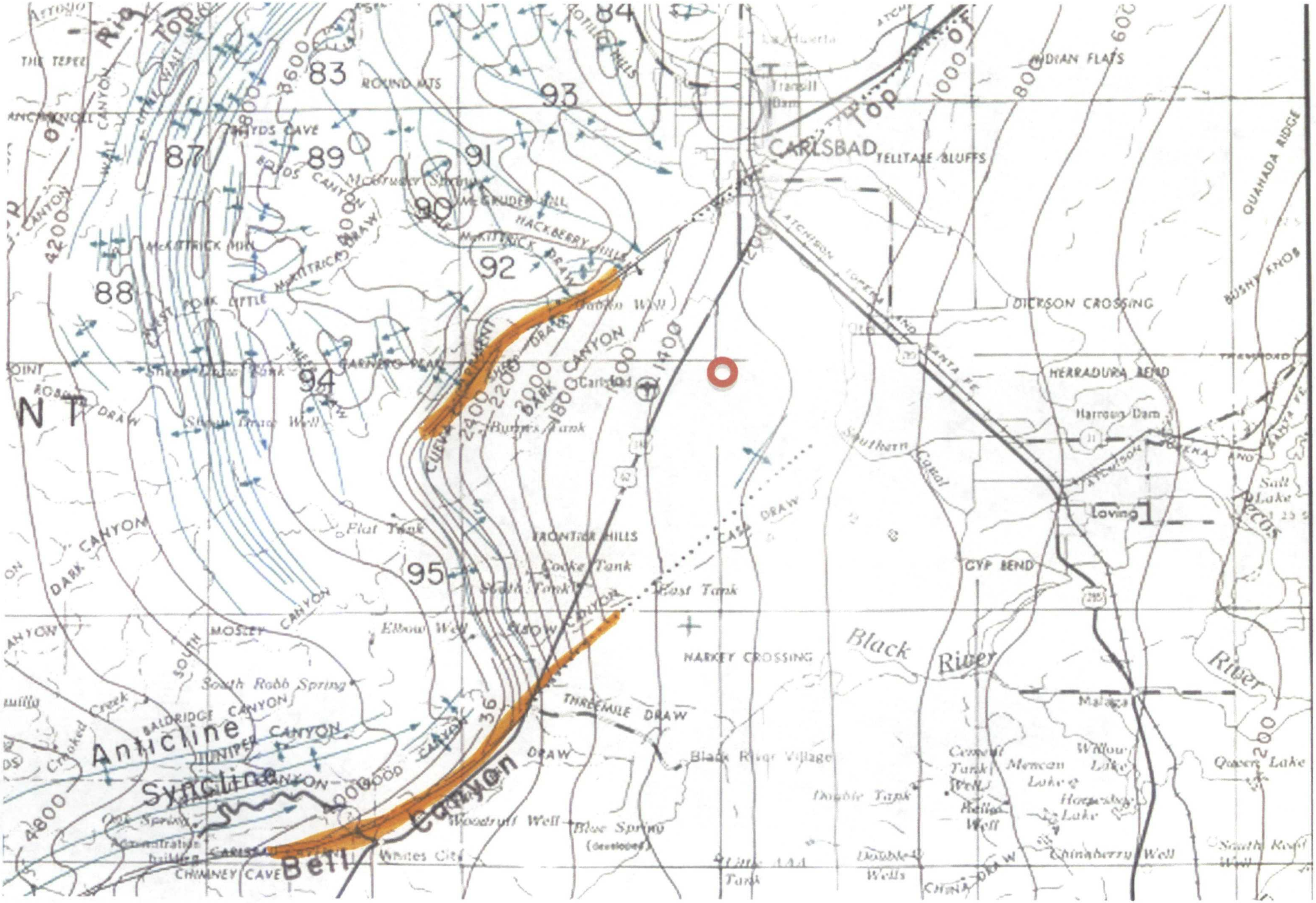
Igneous intrusions (Sills and abundant dikes of Sierra Blanca region not shown)

	Name	Tp	Rge
1	Walker Ranch anticline	3	14 15
2	Ancho anticline	4	11
3	Cowboy anticline	4	21
4	Ignco fault	4	23
5	Salt Draw anticline	4	26
6	Horse Creek anticline	5	24
7	Higgins Creek anticline	5	24
8	White Oaks fault	6	13
9	Robinson fault	6	14
10	Five Mile draw buckle	6	24 25
11	Encinoso anticline	7	15 16
12	Purcella buckle	7 8	18 19
13	Irvin Corn fault	7	22
14	Indian Divide fault	8	13
15	Titsworth dome	8	14
16	Border Buckle splays	8	22
17	Keith fault	9	13 14
18	Champ fault	8 9	11
19	Chavez anticline	9	17
20	Winkler anticline	8 9	19
21	Hollow Hill laccolith	10	14
22	San Patricio syncline	10	16
23	Alamo anticline	10-11	17
24	Meneks sag and anticline	10	22
25	Eight Mile syncline	10	23
26	Godfrey Hills fault	11	9
27	Ruidoso fault	11	14
28	Green Tree fault	11	14
29	Casey anticline	9 11	17
30	Tinnie anticline	10-14	17
31	Picacho anticline	11	18
32	Black Mountains fault	12	10
33	Rinconada fault	12	10-11
34	Dry Canyon fault	12	11
35	Four Mile fault	12	12
36	Apache fault	12	13
37	Turkey Spring fault	12	14
38	Joute syncline	12 13	17
39	Bottomless Lakes fault	11 12	26
40	Soldier Tank fault	13	14
41	Summit fault	13	13
42	Camp dome	13	15
43	Treat syncline	13	19
44	Turkey Creek fault zone	13	14
45	South Fork graben	14	11 12
46	Elk Creek fault	14	14
47	Indian Creek anticline	14	16
48	Funk anticline	14-16	17
49	Vandewart anticline	14 15	17
50	Manning anticline	14 15	17
51	Thimble Canyon faults	15 16	18
52	La Luz anticline	16	10
53	Fresnal Canyon fault	16	11
54	Caballero anticline	16-17	11
55	Karr syncline	15 18	11
56	Penasco syncline	16	16
57	Salt Hill syncline	16	17
58	Mule Peak anticline	17	10
59	Alamo fault	17	10
60	Gobbler anticline	17	11
61	Dry Canyon syncline	17	11
62	Watts Ranch anticline	16-19	16
63	Dunken syncline	16-19	17
64	Meadow Hill anticline	17	18
65	Johnson syncline	18	10
66	Ridge fault	18	11
67	McAfee anticline	18	11
68	Bell Ranch anticline	18	14
69	Coulhape syncline	17 19	17
70	Dunken dome	18	18
71	Red Lake-Turkey Track sinks	18	28 29
72	Table Top syncline	19	11
73	Bug Scuffle anticline and fault	19	11
74	Sacramento River fault	18 19	12
75	Sacramento River monocline	19	12 13
76	Stevenson Ranch fault	19	16-17
77	Coulhape anticline	19	17
78	Lewis buckle	19 20	18
79	Seven River monocline	20	26
80	Russell dome	20	28
81	Gatuna dome	20	28
82	Getty dome	20	29
83	Spencer basin	21	25
84	Tracy dome	21	26
85	Avalon anticline	21	26
86	Cedar Hill anticline	21	26
87	Waterhole anticlinorium	21 23	24 25
88	McKittrick Hill anticline	22	24
89	Boyd Canyon dome	22	25
90	McGruder dome	22	25
91	Hackberry anticline	22	25
92	Little McKittrick syncline	22	25 26
93	Hackberry Draw syncline	21 22	26
94	Carnero Peak dome	22	25
95	Frontier Hills monocline	23 24	25 26
96	Huapache monocline (basin)	25 26	24 25
97	C P Ranch faults	26	24 25

ase from Army Map Service Fort Sumner
oswell, and Carlsbad quadrangles

TECTONIC MAP OF THE PECOS COUNTRY, SOUTH HALF

by Vincent C Kelley



THE TEPEE
83
ROUND MTS
93
INDIAN FLATS
CARLSBAD
TELLTALE BLUFFS
87
89
91
90
McGRUDER HILL
HACKBERRY HILLS
McKITTRICK HILL
92
88
DICKSON CROSSING
BUSHY KNOB
QUAHADA RIDGE
94
DARK CANYON
HERRADURA BEND
Harroun Dam
Southern Canal
Loving
FRONTIER HILLS
95
Cocke Tank
East Tank
CASS DRAW
GYP BEND
DARK CANYON
SOUTH MOSLEY CANYON
Elbow Well
HARKEY CROSSING
Black River
River
South Robb Spring
THREEMILE DRAW
Malaga
Anticline
Syncline
JUNIPER CANYON
BALDRIDGE CANYON
Black River Village
Willow Lake
Queen Lake
Bell Canyon
Woodruff Well
Blue Spring
Whites City
CHIMNEY CAVE
Chinaberry Well
4800
4200
1000
800
600
1200
1400
2400
2200
2000
1800
200

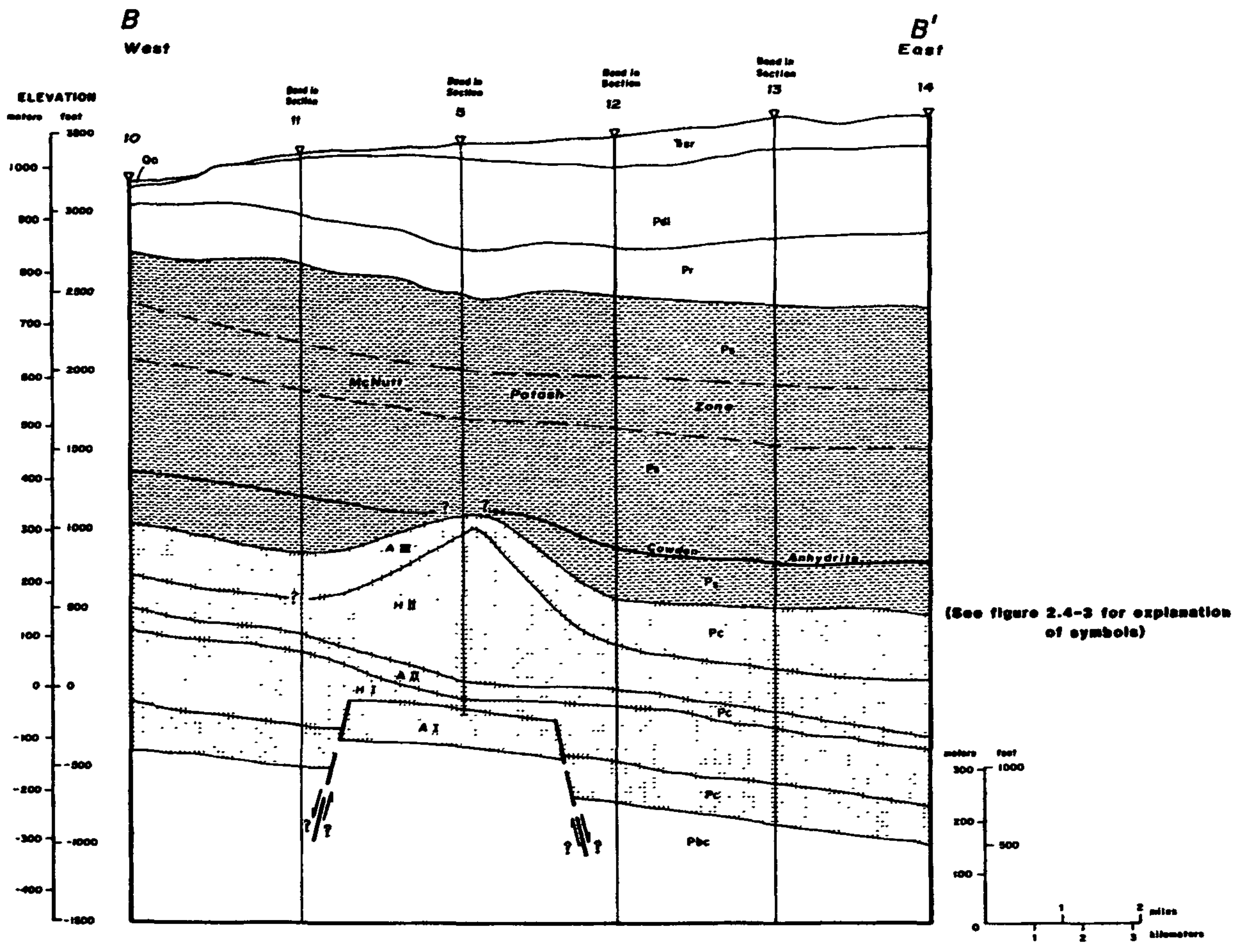


Figure 2-6. East-West Cross Section, WIPP Site

GCR Section III.D- Dissolution, Karsts Regions, Sinkholes and Brine Pockets-Findings:

Much of the broad Pecos Valley in Eddy County, New Mexico, in the vicinity of Carlsbad, NM, is thought to be the result of regional solution of salt and subsidence of the valley floor (Morgan and Sayre, 1942).

Major salt discharges are closely related to the geology and topography of the area. The broad valley of the Pecos River has been deeply cut in the Permian beds and forms a ground-water drain south of Roswell, NM, where the salt discharged downstream from this point increases greatly. A major point of salt discharge is Malaga Spring about 20 miles southeast of Carlsbad, where large amounts of salts are discharged directly into the Pecos River.

It is believed that in southeastern New Mexico, at the end of Ogallala deposition about 4 million years ago, the underlying salt-bearlng Salado Formation extended no farther west than the reef escarpment along the western edge of the Delaware basin.

During Pleistocene and Holocene time extensive erosion stripped the protective Ogallala Formation from the western part of the area and cut into the underlying rocks developing the present Pecos River drainage. During that time any underlying salt beds west of the Pecos River were dissolved and the dissolution front of the buried salt retreated down dip to its present location about 23 miles east of Carlsbad.

It is therefore inferred that since the close of Ogallala time, about A million years ago the salt front in Permian rocks has retreated eastward from 25 to 35 miles. Accordingly, the average rate of movement is estimated to have been about 6-8 miles per million years. In southeastern New Mexico, a north-south belt of dissolution is present east of the Pecos valley in the Clayton Basin and Nash Draw area show in <u>Figure 12 in this GCR III.D. Section appendix.</u> REF: STABILITY OF SALT I THE PERMIAN SALT BASIN OF KANSAS, OKLAHOMA, TEXAS, AND NEW MEXICO By George O. Bachman and Ross B. Johnson with a section on Dissolved salts in surface water By Frank A. Swenson USGS 73-14.

In the Delaware Basin, dissolution of Permian salt beds has apparently occurred since late Permian time (Adams, 1944). In fact, Adams (1944) identified three major dissolution episodes that occurred during the Permian, Triassic and Tertiary periods. Three mechanisms of dissolution have been identified (Adams, 1944; Hendrickson and Jones, 1953, Maley and Huffington, 1953; Vine, 1963; Gard, 1968; Bodenlos, 1978; Anderson, 1978, 1981) and each may be correlated with specific dissolution features. For example, the downward Percolation of groundwater, considered the "classic" theory of solution (Adams, 1944; Maley and Huffington).

Secondly, Adams (1944) noted fracturing, associated with the buried Capitan reef front, facilitated the downward movement of groundwater enhancing dissolution. Maley and Huffington (1953) proposed this theory to correlate solution features within the buried Capitan Reef front. Anderson (1978, 1981) agreed that the Capitan Reef influenced dissolution, however, Anderson noted that many of the suspect depressions were "rooted deep" in or above the Capitan Reef aquifer, and thus attributed their formation to deep seated dissolution by "brine density flow." The "brine density flow" mechanism differs from simple infiltration in that groundwater moves upward from the underlying aquifer to the salt mass. Dissolution occurs when the fresh water contacts the salt, which in turn increases the density of the water, causing the heavier brine to move downward as the fresh water moves in behind, perpetuating the cycle.

Thirdly, leaching of evaporites by laterally moving groundwater has produced thin, extensive blanket breccias by the collapse of overlying strata into the resulting voids (Bodenlos, 1978). This process has been identified along the Salado-Rustler contact (Adams, 1944; Gard, 1968;)

Study of geophysical logs during present work did not totally substantiate this hypothesis. Instead, inter-bedded halite and anhydrite In the Castile inter-finger and are discontinuous. These evaporites were deposited in individual and subordinate depositional pans within the Castile depositional basin. Beds of halite thin and wedge out towards the western edge of the basin and it appears that thick beds of Halite was never deposited near the margins of the Delaware Basin during Castile time.

As mentioned in the GCR III section (Key Energy Study Area) above, thinning of the some of the halite zones were noted on the well logs, especially near the western and northern edges. There was also one area in middle of the study area that showed some thinning. It is unclear at this time what caused this thinning.

Conclusions that thinning of the beds is strictly a result of dissolution, which may lead to unstable areas such as sinkholes, or even deep seated dissolution causing high pressure brine pockets, is not based on total definitive evidence.

As pointed out in the *Assessment of the Potential for Karsts in the Rustler Formation at the WIPP Site John C. Lorenz Sandia National Laboratories Pre-publication Draft November 10, 2005 Quotes " thinning of the Rustler Formation, with or without accompanying thinning of the component halite beds, is not definitive proof, in and of itself, that the beds have been thinned due to dissolution of halite, since thinning and the absence of halite also occur where the Rustler Formation is deeply buried and protected from weathering, erosion, and dissolution. This does not negate thinning due to dissolution in Rustler strata west of WIPP, but rather suggests that such thinning does not prove dissolution since thinning can result from several different, or even from several combined causes."*

Rapid dissolution of salt requires a continuing supply of fresh water to dissolve the salt and carry it away in solution. Without a supply of fresh water, the water in contact with the salt becomes saturated brine that protects the remaining salt rather than dissolving it. The funnel effect of sinkholes provides fresh surface water direct access to any immediately underlying salt beds resulting in their relatively rapid dissolution. The dissolution rate of salt beds and their subsurface retreat on a regional scale are directly related to the regional stratigraphy and structure to climate and to topography.

The Key study area lies in the Pecos River drainage system approximately 5 miles west of the Pecos River, approximately 3 miles east and south of the Capitan reef bank complex. As described above, the dissolution front in this area lies several miles east of this area.

On-site field observations in the study area have been conducted and compared with known references. The surface features do not show any evidence of faulting, fracturing, or obvious signs of dissolution features such as caves, subsidence or sinkholes.

In addition, there are no playas, depressions, significant containment areas that hold water over the study area, or disappearing streambeds. While the site is fairly flat in the study area, it drains well during storm events and does not lie in a flood zone. There is one small pond located approximately 500 feet east of the proposed brine well location. The pond is used for stock and wildlife watering after rainfall events.

Brine Flows have not been encountered in the area of review. There are no known oilfield water flooding is this immediately area. Conversations with the local OCD District office did not reveal any occurrences of natural occurring high-pressure brine pockets.

Several well logs were reviewed in the area and no significant issues of lost circulation, high-pressure brine water encountered, or cementing problems were found. Most of the well log data reviewed was generally below the water protection string, which ranged more or less from 300 to 500 feet BGL. The existing Key BW-19 brine well, located in the study area, also did not experience any issues of this nature and operated for several years without problems.

An Area of Review (AOR) is required as part of the permit process. All wells located in the AOR had cemented casing through the salt zones. As pointed out by *Powers (Witten Ranch Sinkhole near Jal, NM)* report, proper cementing and casing is a prime consideration when working in salts zones. Key Energy believes it is very important to prevent fresh water from reaching any overlying salt or anhydrite zones to prevent the possibility of subsidence and a resulting sinkhole.

As previously noted in this report, Key Energy is proposing a stringent casing and cementing program to ensure the integrity of the zones overlying the solution cavern. It must be said that the requirement of pumping fresh water down the annulus has most likely caused irreversible damage in brine wells, especially if they have experienced casing leaks in or near the top of the salt or anhydrite zone that acts as the roof support.

As part of the review process, Key Energy investigated the "Karst Potential" of the area. The world renowned limestone caves of Carlsbad Caverns National Park lies 30 miles southwest of the proposed site. Closer to the proposed site are the Castile Evaporite features found in the Gypsum Plain in Eddy County. An excerpt from the Journal of Cave and Karst Studies in included in this GCR III.D appendix for reference and a brief introduction.

It shows that the Key Energy proposed site in not included in the potential karst area. Key Energy also contacted the National Cave and Karst Research Institute (NCKRI) to receive their input concerning the proposed brine well. Copies of E-mails are included in the appendix.

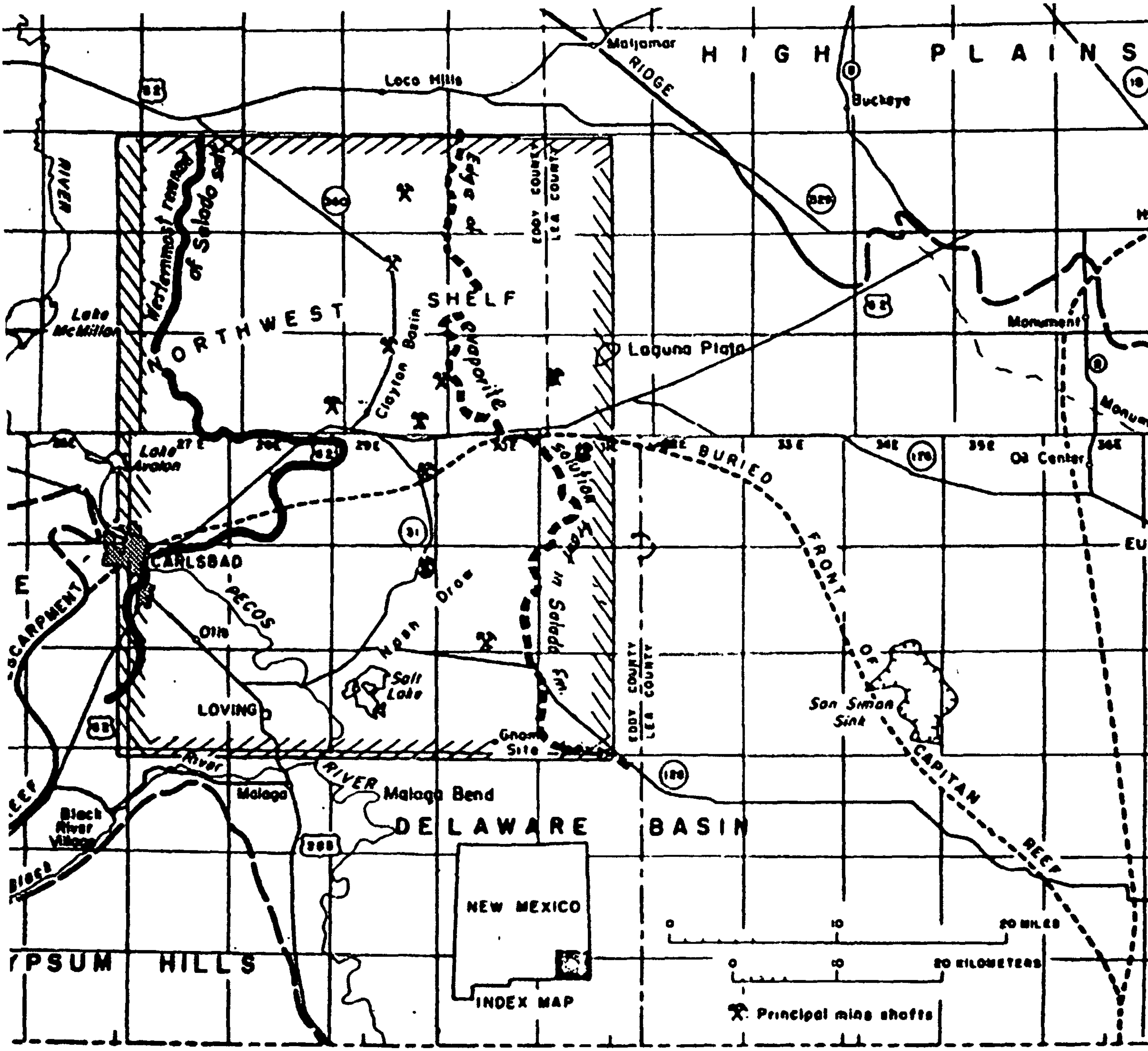
The next section (Hydrology) of this report will include a study of the shallow alluvium zone, which includes valley fill consisting of clay, silt, sand, gravel, caliche, and conglomerate, and the underlying Rustler formation, surface and groundwater conditions found therein.

Ref: UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY REGIONAL GEOLOGY AND CENOZOIC HISTORY OF PECOS REGION, SOUTHEASTERN NEW MEXICO George O. Bachman Open-File Report 80-1099.
REF: SURFICIAL MANIFESTATIONS OF DEEP-SEATED PERMIAN SALT BED DISSOLUTION NEAR LOCO HILLS, NEW MEXICO by KERRY S. HOWARD, B.S. A THESIS IN GEOSCIENCES- Texas Tech Aug. 1987
Ref: Powers *Witten Ranch Sinkhole near Jal, NM*

GCR Section III.D. Dissolution- Appendix

Includes:

1. Figure 12-Map of SENM showing salt dissolution in part of the Permian Salt Basin.
2. Copy of "Journal of Cave and Karst Studies, April 2008-2 pages.
3. E-mails to-from NCKRI. 4-pages.



12.--Map of southeastern New Mexico showing salt dissolution in part of Permian salt basin. Northern boundary of Delaware basin is defined by reef escarpment and buried front of Capitan reef. Mine symbol indicates potash mine (modified after fig. 1 of Brokaw, Jones, Cooley, and Hayes, 1972; hachures outline area of fig. 4).

K. W Stafford, L. Rosales-Lagarde, and P J. Boston – Castile evaporite karst potential map of the Gypsum Plain, Eddy County, New Mexico and Culberson County, Texas: A GIS methodological companson. *Journal of Cave and Karst Studies,* v. 70, no. 1, p. 35–46.

CASTILE EVAPORITE KARST POTENTIAL MAP OF THE GYPSUM PLAIN, EDDY COUNTY, NEW MEXICO AND CULBERSON COUNTY, TEXAS: A GIS METHODOLOGICAL COMPARISON

KEVIN W. STAFFORD[1,2], LAURA ROSALES-LAGARDE[1,2], AND PENELOPE J. BOSTON[1,2]

Abstract: Castile Formation gypsum crops out over ~1,800 km^2 in the western Delaware Basin where it forms the majority of the Gypsum Plain. Karst development is well recognized in the Gypsum Plain (i.e., filled and open sinkholes with associated caves); however, the spatial occurrence has been poorly known. In order to evaluate the extent and distribution of karst development within the Castile portion of the Gypsum Plain, combined field and Geographic Information System (GIS) studies were conducted, which enable a first approximation of regional speleogenesis and delineate karst-related natural resources for management. Field studies included physical mapping of 50, 1-km^2 sites, including identification of karst features (sinkholes, caves, and springs) and geomorphic mapping. GIS-based studies involved analyses of karst features based on public data, including Digital Elevation Model (DEM), Digital Raster Graphic, (DRG) and Digital Orthophoto Quad (DOQ) formats. GIS analyses consistently underestimate the actual extent and density of karst development, based on karst features identified during field studies. However, DOQ analyses coupled with field studies appears to produce accurate models of karst development. As a result, a karst potential map of the Castile outcrop region was developed which reveals that karst development within the Castile Formation is highly clustered. Approximately 40% of the region effectively exhibits no karst development (<1 feature/km^2). Two small regions (<3 km^2 each) display intense karst development (>40 features/km^2) located within the northern extent of the Gypsum Plain, while many regions of significant karst development (>15 features/km^2) are distributed more widely. The clustered distribution of karst development suggests that speleogenesis within the Castile Formation is dominated by hypogenic, transverse processes.

INTRODUCTION

The gypsum facies of the Castile Formation crops out over an area of ~1800 km^2 in Eddy County, New Mexico and Culberson County, Texas on the western edge of the Delaware Basin (Fig. 1). The region has traditionally been referred to as the Gypsum Plain (Hill, 1996), which covers an area of ~2800 km^2 and is composed of outcrops of the Castile and Rustler Formations (Fig. 2). The region is located in the semi-arid southwest on the northern edge of the Chihuahuan Desert, where annual precipitation averages 26.7 cm with the greatest rainfall occurring as monsoonal storms in late summer (July – September) (Sares, 1984). Annual temperature averages 17.3 °C with an average annual minimum and maximum of 9.2 °C and 25.2 °C, respectively.

Throughout Castile outcrops, surficial karren occurs extensively in regions of exposed bedrock, including well-developed rillenkarren, spitzkarren, kamenitzas and tumuli. Sinkhole development is widespread, including both closed and open sinkholes ranging from near-circular features to laterally extensive, incised arroyo-like features. Cave development ranges widely, from small epigenic recharge features to large, complex polygenetic features (Stafford, 2006). The region hosts the second longest documented gypsum cave in North America, Parks Ranch Cave, Eddy County, N.M., with a surveyed length of 6596 m (Stafford, 2006). In addition, many other significant gypsum caves have been documented by the Texas Speleological Survey (TSS) (e.g., Reddell and Fieseler, 1977) and GYPsum KArst Project (GYPKAP) (Eaton, 1987; Belski, 1992; Lee, 1996). However, no systematic investigation has been conducted within the region with respect to karst development. Prior to this study, 246 karst features, primarily caves, were documented within the Castile outcrop region. The BLM (Bureau of Land Management) documented 45 of the total reported karst features (Jon Jasper, 2006, pers. com.); while the TSS

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[2] National Cave and Karst Research Institute, Carlsbad, NM, 88220, USA

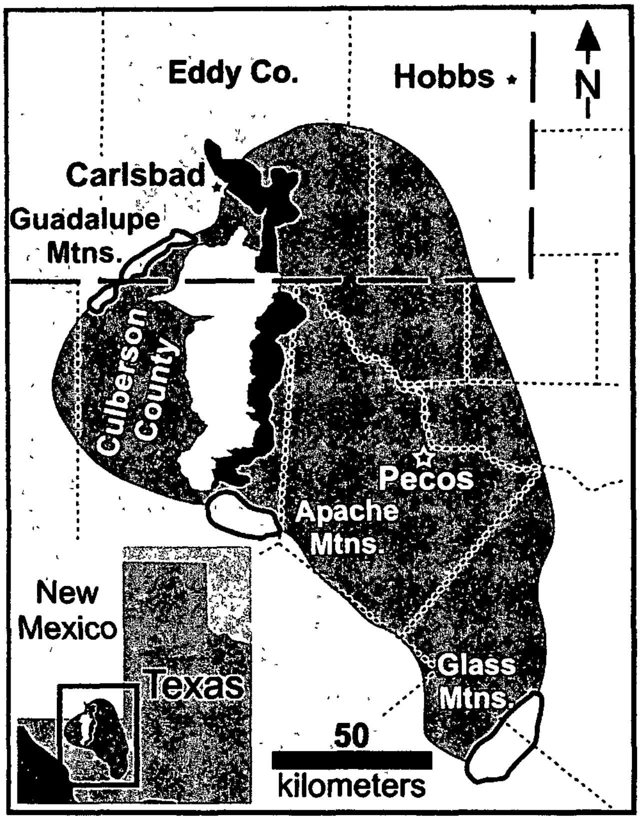


Figure 1. Location map showing location of Gypsum Plain including outcrop areas of the Castile Formation (solid white) and the Rustler Formation (solid black) within the Delaware Basin (dark gray), Eddy County, NM and Culberson County, Texas. Location of the Delaware Basin in relation to Texas and New Mexico is illustrated in bottom left corner, with the enlarged region outlined by the small black rectangle (adapted from Kelley, 1971, Dietrich et al., 1995 and Hill, 1996).

documented 201 of the total reported karst features (Jim Kennedy, 2006, pers. com.).

The rapid solution kinetics and high solubility of gypsum promotes extensive karst development. Gypsum solubility (2.53 g L^{-1}) is approximately three orders of magnitude greater than limestone (1.5 mg L^{-1}) in pure water and two orders of magnitude less than halite (360 g L^{-1}) (Klimchouk, 1996). The high solubility and near-linear solution kinetics of evaporites encourage intense surface dissolution that often forms large sinkholes, incised arroyos and caves that are laterally limited with rapid decreases in passage aperture away from inflows through epigenic speleogenesis (Klimchouk, 2000a). Additionally, the high solubilities of evaporites favor the development of hypogenic transverse speleogenesis driven by mixed convection (forced and free) (Klimchouk, 2000b). Forced convection is established by regional hydraulic gradients in confined settings, while free convection is generated where steep density gradients establish as fresh-waters are continuously supplied to the dissolution fronts (the upper levels) through the simultaneous sinking of saturated fluids by density differences (Anderson and Kirkland, 1980). Therefore epigenic and hypogenic karstic features likely both exist in the study area, often superimposed on each other.

The work we report here focuses on delineating the extent and distribution of karst development within the outcrop region of the Castile Formation, in order to predict regions of intense versus minimal karst development, which can be used for karst resource management as well as a first approximation for understanding regional speleogenesis. A dual approach involving field and Geographic Information System (GIS) analyses were utilized in order to define karst variability within the study area, including field mapping of 50, 1-km^2 regions and GIS analyses, using ESRI ArcGIS 9.2 software, of public data (i.e., Digital Elevation Model [DEM]; Digital Raster Graphic [DRG]; and Digital Orthophoto Quad [DOQ]) for the entire region. The combined results were used to develop a karst potential map of the Castile Formation outcrop region, while simultaneously evaluating different GIS-based techniques for karst analyses.

GEOLOGIC SETTING

The Castile Formation was deposited during the late Permian (early Ochoan), subsequent to deposition of the Guadalupian Capitan Reef, which is well-known for the caves it hosts in the Guadalupe Mountains (e.g., Hose and Pisarowicz, 2000). Castile evaporites represent deep-water deposits within a stratified, brine-filled basin (i.e., Delaware Basin) (Kendall and Harwood, 1989), bounded below by clastics of the Bell Canyon Formation, on the margins by Capitan Reef carbonates, and above by additional evaporitic rocks of the Salado and Rustler Formations (Fig. 2) (Kelley, 1971). Castile evaporites crop out along their western dissolution front in the Gypsum Plain (Fig. 1), dip to the east where they reach a maximum thickness of 480 m in the subsurface (Hill, 1996), and are characterized as massive to laminated sulfates (gypsum/anhydrite) interbedded with halite (Dietrich et al., 1995). Increased thickness in the east has been attributed to dissolution of intrastratal halite to the west and increased deposition to the east in the Ochoa Trough during the Permian (Anderson et al., 1972).

The Castile Formation, including outcrops in the Gypsum Plain, has experienced minimal tectonic deformation although located on the eastern edge of major tectonic events. Triassic and Laramide tectonism produced regional tilting to the northeast, broad flexures and fracturing with minimal offset within southeastern New Mexico and west Texas. The far western edge of the Delaware Basin has been down-dropped along the far eastern margin of Basin

From: wayne price <wayneprice77@earthlink.net>
Subject: **Location of New Proposed Brine Well**
Date: October 5, 2010 3:51:53 PM MDT
To: lland@nckri.org, gveni@nckri.org
Cc: Jim.Griswold@state.nm.us
1 Attachment, 2.3 MB

Good afternoon Gentlemen:

The proposed brine well is located .76 miles east and a little south of your office. Key Energy has an existing brine well at this site that I had recommended we P&A. The new location will be 1100 feet east of this well.
This well will be completed in the Castile formation near the bottom. Dennis Powers will be assisting Key on the geology aspect. We have meet with the city, county, and state. We encourage your input, for or against.
We want this process to be most transparent.

As of to date, we have completed a lot of the technical information for this project and will share this with you. As expected, this application will probably actually be the new guidance for any new wells. That's why I would like you involved. Once again, if Key is turned down, then we know it will be for solid technical reasons and not political.

I would be interested in knowing your findings at Jim water service sink.

From: "George Veni" <gveni@nckri.org>
Subject: **RE: Location of New Proposed Brine Well**
Date: October 5, 2010 5:50:06 PM MDT
To: "'wayne price'" <wayneprice77@earthlink.net>, <lland@nckri.org>
Cc: <Jim.Griswold@state.nm.us>
Reply-To: <gveni@nckri.org>

Wayne,

Thank you for your message and interest in NCKRI's views. It is not our role to issue pro or con positions about this or other projects. Frankly, we don't have enough information about this site to take such a position even if we wanted to. However, I can provide the following basic information for your and the state's deliberation:

1) The location is rural. Based on the available Google Earth imagery, it appears to be about 500 m from the nearest home or notable structures. In the event of a catastrophic collapse on a scale similar to what we've seen so far in this region, those structures should be safe from any immediate damage and possibly from long-term damage. Our own recent aerial photos of Wink Sink in Texas, now more than 30 years since that collapse, show a ring of concentric subsidence fractures that extend more than 100 m from the edge of the collapse, for an approximate radius of 150 m from the collapse's center. However, we did not walk the surface to see if significant and potentially structure-damaging fractures extend beyond what was visible in the aerial photos. If they do, they could suggest an increased risk for long-term structural damage from a collapse at the proposed Key Energy brine well site.

2) While the location is currently rural, recent development in and around the city of Carlsbad is steadily moving southward, encroaching on that site. Potentially in roughly 30 years time, the time of the nearby I&W well's production, there could be significant infrastructure within the area that would be affected should a collapse occur. I don't know what regulations may exist to require long-term or effectively perpetual protection from development of the brine well area so no loss of infrastructure or life occurs. Likewise, I don't know what liabilities may result if Key Energy does not provide such protection.

3) The information you have provided is the proposed map location of the brine well and no details on any geologic site characterization that Key Energy may have conducted. I do not have my own site-specific details to evaluate, which limits some of what I can say. The information I do have suggests the site geology is similar to that of the I&W well. Most geologists I know who have examined that site agree that it is a very

shallow site for a brine well, and inappropriate for that volume of brine production. The salt is a relatively thin deposit. If the same or similar geologic conditions exist at the proposed Key Energy site, significant brine production cannot be achieved by solution mining that creates a cavity with structurally stable dimensions that are proportionally tall and small in diameter. Significant mining would instead lend itself to creating a proportionally short and large diameter cavity, which will be shallow in depth and more prone to collapse.

Please consider this as NCKRI's input. Lewis is out doing field work this week, is booked solid to the end of the month with deadlines (as I am), then we both leave town for a week for the Geological Society America Convention. If Lewis does have any significant additional information or insights to share, he will make the time to get them to you in the interest of public safety.

George

****

George Veni, Ph.D.
Executive Director
National Cave and Karst Research Institute
1400 Commerce Drive
Carlsbad, New Mexico 88220 USA
Office: 575-887-5517
Mobile: 210-863-5919
Fax: 413-383-2276
gveni@nckri.org
www.nckri.org

-----Original Message-----
From: wayne price [mailto:wayneprice77@earthlink.net]
Sent: Tuesday, October 05, 2010 15:52
To: lland@nckri.org; gveni@nckri.org
Cc: Jim.Griswold@state.nm.us
Subject: Location of New Proposed Brine Well

Good afternoon Gentlemen:

The proposed brine well is located .76 miles east and a little south of your office. Key Energy has an existing brine well at this site that I had recommended we P&A. The new location will be 1100 feet east of this well. This well will be completed in the Castile formation near the bottom. Dennis Powers will be assisting Key on the geology aspect. We have

meet with the city, county, and state. We encourage your input, for or against.
We want this process to be most transparent.

As of to date, we have completed a lot of the technical information for this project and will share this with you. As expected, this application will probably actually be the new guidance for any new wells. That's why I would like you involved. Once again, if Key is turned down, then we know it will be for solid technical reasons and not political.

I would be interested in knowing your findings at Jim water service sink.

GCR Section IV- Hydrology of Study Area

Introduction:

Best Reference: The following material "for the most part" is taken directly from the most recent study conducted by the New Mexico State Engineer's office. "THE CARLSBAD AREA GROUNDWATER FLOW MODEL" Prepared by: Dr. Peggy Barroll, New Mexico Office of the State Engineer-2004.

Key's consultant, Price LLC, met with Ms. Barroll of the state engineer's office to confirm the findings in this report as related to the *Proposed Key Brine Well Site.*

Note: Figures and attachments will be underlined and can be found in each section's appendix directly behind the section's write-up.

GCR Section IV.1.- Surface Water Hydrology

GCR IV.1.A- Overview of Area Surface Water-

The *"Key study area"* is located in the Carlsbad Basin, which is located in southeastern New Mexico, in the Pecos River Valley. Figure 1-1 in the GCR section IV.1 appendix, shows the general location in the state. This is a semiarid region, receiving an average of about 12.5 inches of precipitation per year. The Carlsbad area has a long growing season and supports extensive irrigated agriculture. The Pecos River provides the majority of irrigation water that is applied in the basin through the Carlsbad Irrigation District (CID) canals, but numerous wells provide groundwater for this purpose as well. Figure 1-2 included in the GCR section IV.1 appendix, shows the Carlsbad area alluvial aquifer base map that supports the local irrigation.

The flows of the Pecos River are regulated for irrigation purposes. Avalon Dam, which was completed in 1907, forms a reservoir (Lake Avalon) on the Pecos River north of the City of Carlsbad. Surface water is diverted at the dam to the Carlsbad Irrigation District (CID), which delivers irrigation water in the district through a system of canals and laterals. Figure 1-3 included in the GCR section IV.1 appendix, shows the Carlsbad area irrigated lands and CID boundary.

The Pecos River receives surface inflow from Black River, and intermittent inflow from Dark Canyon Draw. Two other intermittent tributaries, Hackberry Draw and Cass Draw, are now terminated by flood control structures. The Pecos River gains considerable amounts of water from groundwater discharge to the ground surface in the vicinity of and downstream of Carlsbad.

GCR Section IV.1.B- One Mile "Area of Review" of Surface Waters

The closest major surface water feature is Dark Canyon located west of the Key study area approximately one mile. The rim of the canyon has an elevation higher than the proposed site thus no run-off from the site would impact this feature.

There are three large irrigation ponds and one small manmade wildlife/stock pond located within the one-mile area of review. The small wildlife/stock pond is located 400 feet east-southeast of the proposed brine well location. This pond is owned by Mr. Will Brantley who is the landowner of the surrounding land area. This pond has a very small and limited drainage area and is a closed manmade structure.

The three irrigation ponds are as follows; .9 miles southeast and south of Derrick road, .43 miles to the east, and .89 miles to the northeast, east of the old Cavern Highway. All of these large containment areas have embankments from 6-10 feet high.

The general site area drainage is easterly, however in the northwest part of section 31-Ts22s-R27e the drainage is more to the northeast with sheet flow characteristics. There is a low spot at the far northeast corner where it intersects with Airport road. During a site visit in September, the area received 3.61 inches of rainfall. While some of the access roads had puddles of water, all roads were passable in two-wheel drive. The site drains very well with most of the water sheet flowing to the northeast. A one-mile Area of Review (AOR) map is included in GCR section IV.1 appendix, showing all surface water features.

GCR Section IV.1.C Flood Zone Issus

The proposed brine well site is not located in a designated floodplain. Please find enclosed in this GCR section IV.1 appendix, verification letters from the City of Carlsbad and Eddy County indicating the site is not within a flood plain pursuant to FEMA designations.

GCR Section IV.1 Appendix

Includes:

1. Figure 1-1. Carlsbad Area Location Map.
2. Figure 1-2. Carlsbad Area Alluvial Aquifer Base Map.
3. Figure 1-3. Carlsbad Area Irrigated Lands and CID Boundary.
4. One-mile surface water features AOR Map.
5. Flood Plain Letters from Eddy County and City of Carlsbad.-2 pages.

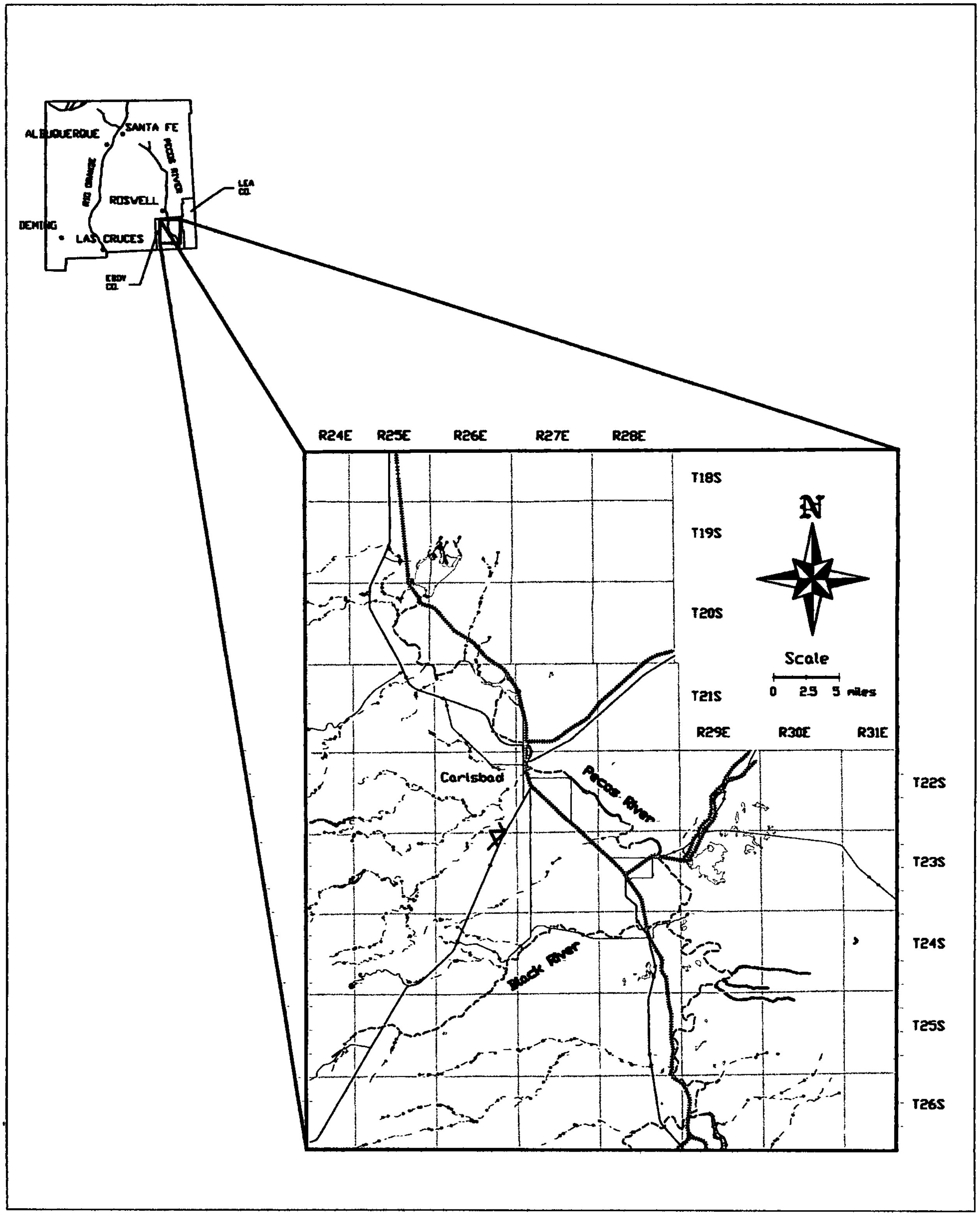


Figure 1-1. Carlsbad Area Location Map.

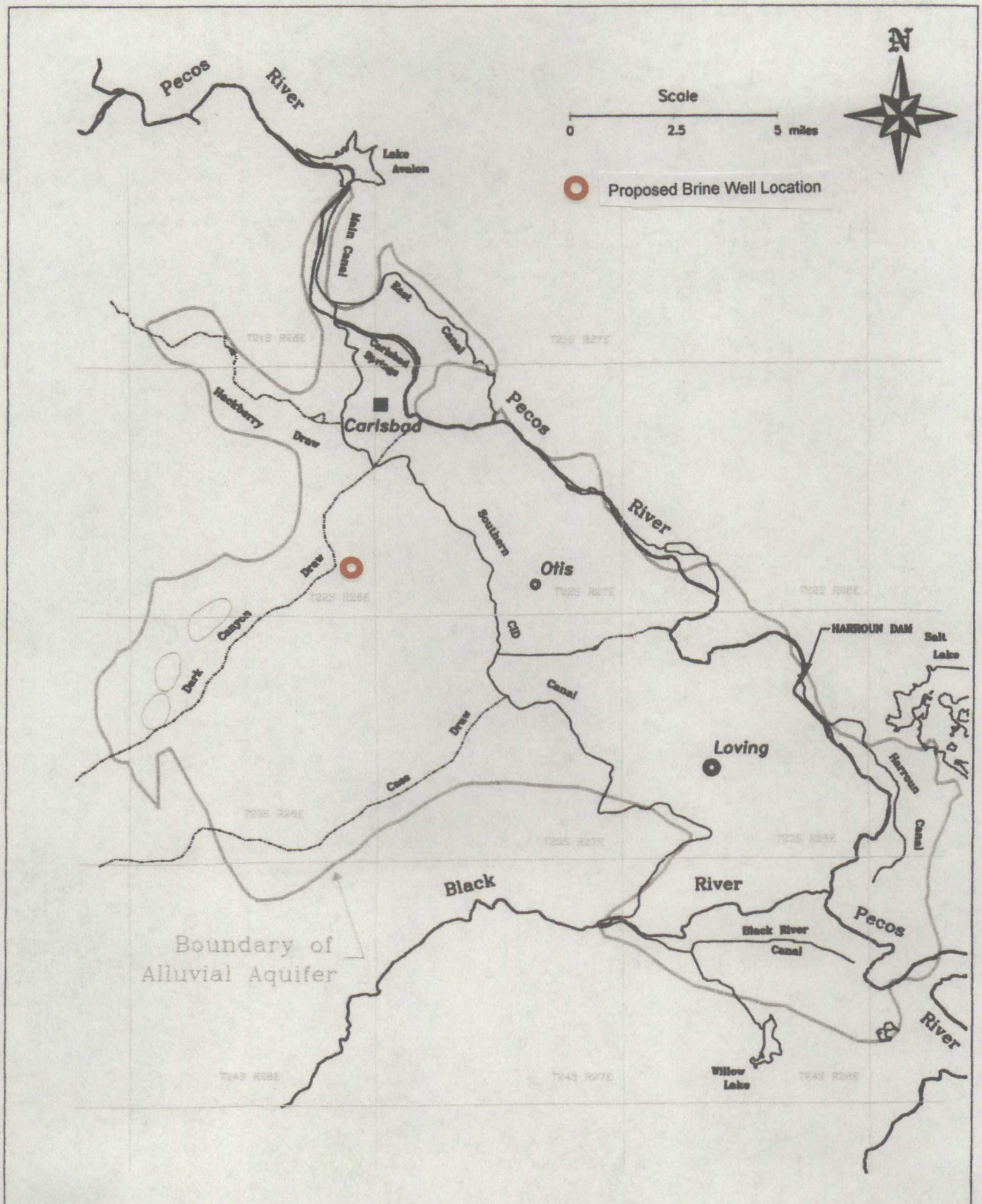


Figure 1-2. Carlsbad Area Alluvial Aquifer Base Map.

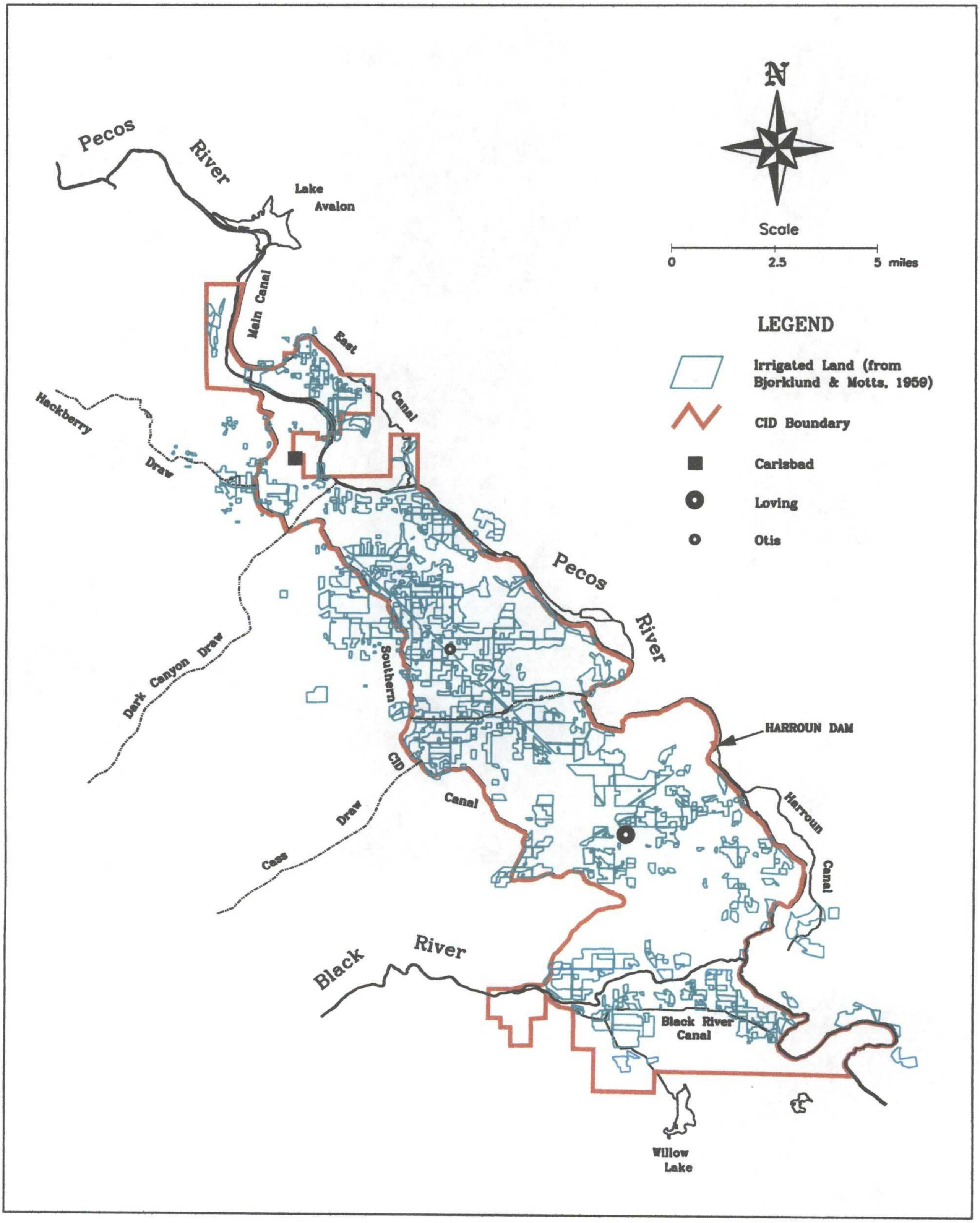
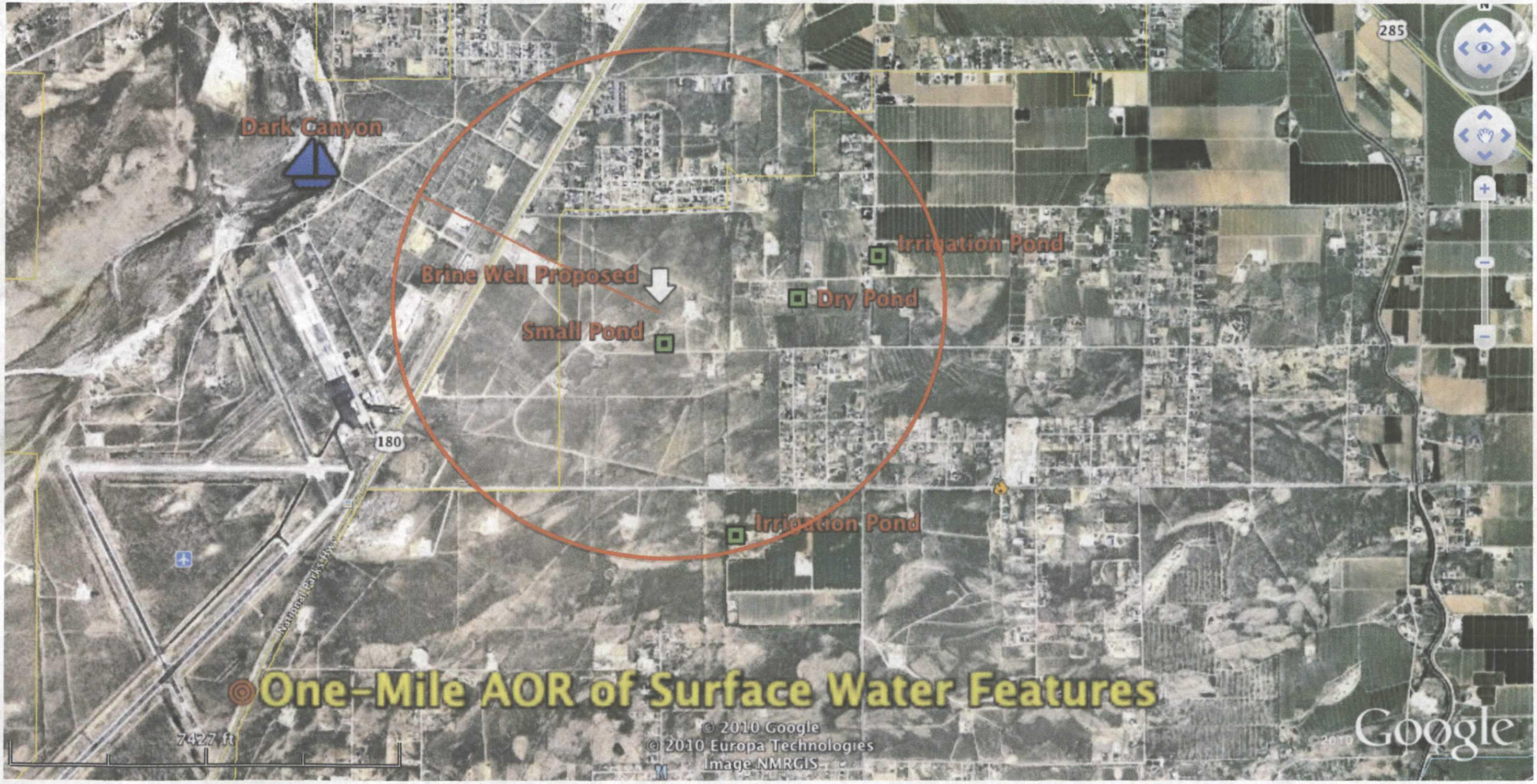


Figure 1-3. Carlsbad Area Irrigated Lands and CID Boundary.



285
Dark Canyon
Brine Well Proposed
Small Pond
Irrigation Pond
Dry Pond
Irrigation Pond
180
National Parks Hwy
One-Mile AOR of Surface Water Features
7427 ft
© 2010 Google
© 2010 Europa Technologies
Image NMRGIS
Google

From: "Georgia Goad" <georgia@co.eddy.nm.us>
Subject: **Brine Well floodplain**
Date: September 23, 2010 11:57:31 AM MDT
To: <wayneprice77@earthlink.net>
2 Attachments, 1.3 MB

Eddy County

September 23, 2010

Eddy County Special Services
101 W. Greene St.
Carlsbad, NM 88220

Re: Floodplain Eddy County

Mr. Price,

The proposed brine well to be located in the NW/4, Section 31 T22S R27E is not located in a designated floodplain. This is referenced on FEMA Panel Number 35015C1325D with an effective date of June 4, 2010. See attached map.

If you need further information or have any other questions please contact my office at 575 628-5462.

Thank you,

CITY OF CARLSBAD
Licensing and Permits Department
101 N. Halagueno St. (PO Box 1569)
Carlsbad, NM 88220
Phone (575) 234-7923
Fax (575) 885-9871

FLOOD INSURANCE RATE MAP (FIRM) DETERMINATION

FIRM INFORMATION	**EFFECTIVE DATE: June 4, 2010**
COMMUNITY NUMBER: 350017	**FIRM PANEL No.: 1325**

PROPERTY INFORMATION:
ADDRESS: N/A, Carlsbad, NM, 88220
LEGAL DESCRIPTION: Section 36, Township 22S, Range 26E
Subdivision: N/A
Lot:
Block:

THE PROPERTY IS LOCATED IN FLOODZONE: X

If located in Floodzone A, AE, AH, AO, AR, or A99, the Base Flood Elevation (BFE) for this property is __, NAVD1988.

_____ A determination of the property/building location cannot be made on the map.

_____ A copy of the GIS photo is attached for your information.

This determination is based on the Flood Insurance Rate Map effective June 4, 2010. This letter does not imply that the referenced property will or will not be free from flooding or damage. A property not located in a Special Flood Hazard Area or Floodzone may be damaged by a storm greater than the 100-year event or from a local drainage problem not shown on the map. This letter does not create a liability on the part of the City of Carlsbad, or any officer or employee thereof, for any damage that may result from reliance on this determination.

Stephanie Shumsky

Stephanie Shumsky, CFM

GCR Section IV.2- Groundwater Hydrogeology

There are two important aquifers in the Carlsbad area: an alluvial aquifer associated with the Pecos River and its tributaries, and a karstic carbonate aquifer associated with the Permian Capitan Reef. Both aquifers provide significant amounts of water for irrigation, municipal, and industrial purposes. Other formations provide small amounts of water to wells. Water in these formations is, for the most part, disconnected from the alluvial and reef aquifers (Bjorklund and Motts, 1959).

The alluvial aquifer consists of surficial deposits associated with the Pecos River and its tributaries. This aquifer connects directly to stream courses in the region and is recharged by a variety of natural and artificial sources. North of the "Key study area", the reef is primarily a subterranean structure that underlies the northern part of the alluvial aquifer. Figure 2-1 in the GCR section IV.2 appendix shows the configuration of the Capitan Reef and Alluvial Aquifers Near Carlsbad.

In the vicinity of the City of Carlsbad, a small part of the alluvial aquifer directly overlies the Capitan Reef aquifer and the two aquifers are in hydraulic connection. Carlsbad Springs, which have in the past discharged to the Pecos River near Carlsbad, indicate the location of this direct connection. For a graphic view of this occurrence please see figure 2-19 in the GCR section IV.2 appendix.

GCR Section IV.2.A Pecos Valley Alluvium:

The Pecos Valley Alluvium extends in a narrow strip along the Pecos River from a few miles north of the City of Carlsbad to approximately the mouth of Dark Canyon. The alluvium expands both laterally and in thickness between Dark Canyon and Cass Draw and then narrows again to a strip along the Pecos River south of Cass Draw. Figure 2-1 shows the approximate boundary of the saturated part of the alluvium. Within the CID, the saturated thickness of the alluvium, which varies in space, is as great as 150 feet between Otis and Loving. (Bjorklund and Motts, 1959). The total thickness of the alluvial materials within the CID ranges from about 100 to 200 feet. In the far southwestern part of the aquifer, the alluvial deposits locally thicken to more than 300 feet, while the saturated thickness is on the order of 50 feet thick. Figure 2-2 in the GCR section IV.2 appendix shows the locations of alluvial aquifer wells for which water level data have been collected by the State Engineer's office.

The Pecos River is generally considered the eastern limit of the Pecos Valley Alluvium although the alluvium extends east of the river in a few locations. Because only a few wells are located east of the Pecos River, little is known about the extent of the alluvial aquifer in that area. However, outcrops of older alluvial deposits on the eastern side of the river, which yield little or no water, indicate that the eastern extent of the Pecos Valley Alluvium is limited to within a few miles of the river.

Where the reef aquifer is not present, as in the Key study area, the alluvial aquifer is directly underlain by the Permian Castile comprising up to 2,500 feet of evaporite beds as mentioned in the GEOLOGICAL CHARACTERIZATION REPORT GCR sections I-III above and forms the basal boundary of most of the alluvial aquifer. These units form the southern and northern boundaries of the Pecos Valley Alluvium.

The alluvial aquifer consists of a variety of materials, ranging from very transmissive sands and gravels to low-permeability clays. Layers of hard, mineralized alluvial material are sometimes found at depth in the alluvium; such material can produce considerable amounts of water where it is either fractured or rendered more permeable by dissolution of carbonate rock.

Some alluvial aquifer wells near Dark Canyon obtain water from solution passages in dense limestone conglomerate (Hale, 1945). One such well is the old US Army airport well (now Carlsbad Airport Well #1) located in the western part of the Key Study area.

Drillers' logs were reviewed and used in conjunction with water level data from nearby wells (some USGS observation wells appear to correspond to the lithologic logs) to develop an understanding of the types of groundwater flow occurring in the alluvial aquifer. Selected lithologic logs, specifically for wells whose locations are shown in Figure 2-3, are plotted in Figures 2-4, 2-5, and 2-6. shown in this GCR Section IV.2 appendix.

Water level data from each well and/or nearby wells are marked on these figures; the maximum and minimum of the observed historical water levels are identified where appropriate.

The lithologic logs show that the distribution of different types of alluvial material is somewhat systematic. Near the Pecos River, the logs tend to show abundant sand and gravel with thin clay layers (Figure 2-4). Farther west, the lithology tends to be dominated by thick clays overlying thin layers of gravel, conglomerate, or "limey" rock (Figures 2-5 and 2-6), with the latter types of rock appearing to be the source of water for these wells. All figures are included in this GCR section IV.2 appendix.

The Permian Castile Formation is a source of water for some relatively deep wells in the western part of the basin (Figure 2-5, Log G). Other wells to the west of Carlsbad appear to obtain water from a thin layer of gravel or conglomerate at the base of the alluvium, directly above the Castile (Figure 2-5, Log F; Figure 2-6, Log K).

The water levels in Castile Formation wells appear to be consistent with alluvial aquifer water levels; thus it is possible that the upper Castile is connected to the alluvial aquifer in the western part of the study area, and that the two units may locally act as one aquifer. It should be noted that it is often difficult to identify the contact between the alluvium and the Castile Formation on the basis of drillers' logs.

Groundwater elevations in the alluvial aquifer for 1962 and 1996 are shown in Figures 2-7 and 2-8, respectively. General groundwater flow directions within the alluvial aquifer and locations where groundwater is recharged by surface watercourses are shown in Figure 2-9.

The alluvial aquifer is recharged by natural and artificial sources. The natural recharge sources are areal recharge from precipitation, recharge from stream flow events in Dark Canyon Arroyo, Cass Draw, and Hackberry Draw, and possible upward seepage from the Capitan Reef near Carlsbad. None of the natural recharge components can be directly measured and are, consequently, poorly quantified. Artificial sources of recharge include leakage from irrigation canals and laterals, on-farm return flow, and leakage from Lake Avalon. The magnitudes of these components can be estimated more reliably than can the natural recharge sources, and are generally considered to be quite large. Of the three types of artificial recharge, on-farm return flow is the least quantifiable component because few data indicative of its magnitude are available.

Natural recharge and artificial recharge provide waters of different quality to the alluvial aquifer. Artificial recharge water consists predominantly of Pecos River water, which is of relatively poor quality and generally not potable. Natural recharge associated with Cass Draw and Dark Canyon Draw provides relatively pure, high quality water to the aquifer. The alluvial aquifer naturally discharges large quantities of water to the Pecos and Black rivers.

Artificial discharge from the alluvial aquifer consists of relatively small quantities of municipal and domestic pumpage, and large amounts of irrigation pumpage. An unknown quantity of groundwater discharges to the atmosphere via evapotranspiration (ET) by phreatophytes (i.e. salt cedars), principally in low-lying areas along the Pecos River and in an area along the Southern Canal south of Otis (Bjorklund and

Motts, p. 216).

Generally groundwater levels in the alluvial aquifer slope from north to south and from west to east, indicating southward and southeastward groundwater flow toward the Pecos River. These general flow patterns are probably similar to the natural directions of flow that occurred in the basin before the effects of human activities were observed.

However, in the Key study area, currently there is a localized westward component of flow in an area west of the Southern Canal and north of Cass Draw, which appears to be the result of irrigation canal leakage and on-farm return flows that have raised water levels within the CID. This westward component of flow might also result from a cone of depression surrounding several pumping wells located west of the CID. Hale (1945) identified a water quality transition in the alluvial aquifer that is likely a manifestation of the localized westward groundwater movement.

Wells due west of the Key study area, located near Dark Canyon in the southeast corner of T22S R26E produced relatively high quality water, whereas 1 or 2 miles farther east, closer to the CID, wells produce more highly mineralized water associated with recharge of irrigation water. A historic log of one of these wells was found and included in the appendix. It shows that water was encountered as a seep at 164 ft, water at 190 ft and rose to 180 ft, and an increase of water encountered at 245 ft. The well was drilled to 256 ft without encountering bedrock. This well appears to be the same well as Airport well #1 of the City of Carlsbad. See the GCR section IV.1.A appendix for photo and well log. Ref: Geology and Groundwater Resources of Eddy County, NM-Hendrickson and Jones 1952, Groundwater Report #3

Water levels in the alluvial aquifer have varied substantially during the past 50 years. Many well hydrographs show water level changes in excess of 40 feet. An example hydrograph from a well located about 1.5 miles north of the town of Otis, shown in Figure 2-10, illustrates the relative magnitude of water level fluctuations that have been observed in the alluvial aquifer since the early 1960s. Time spans exhibiting lower groundwater levels correlate with droughts or extended periods of relatively low surface water supply (e.g., the early 1960s and mid-to-late 1970s); irrigation pumping typically increases during such periods. During periods of high rainfall (e.g., the mid 1960s, the 1980s, and early 1990s) and abundant surface water availability, irrigation pumping is relatively low and water levels tend to stabilize or recover.

A number of anomalously high alluvial aquifer water levels are located near the Southern Canal, which is the main canal used by the CID to deliver water to its lands. These high levels are associated with a zone of perched water in the alluvial aquifer (Bjorklund and Motts, 1959, pp. 205–207) that appears to lie on top of clay units within the alluvial aquifer. The drillers' logs in Figure 2-6 show the best lithologic data available for this area. Ambient groundwater levels are the deepest ones marked on each log. Water levels from nearby wells that appear to tap perched water (Wells A45, A46, and A47) are also shown. These water levels appear to occur near the interface of surficial sands and gravels and underlying clays. A somewhat deeper zone of anomalous groundwater levels is also observed near the 40- to 60-foot depth, which is also assumed to be perched. Bjorklund and Motts (1959) indicate that phreatophytes (*i.e. salt cedars*) have been present in some areas near the canal where perched water is extremely shallow.

Thick clays in the alluvial aquifer appear to create fairly widespread confined conditions both in the western part of the CID and west of it. Lithologic logs from a number of wells in this region suggest that the water bearing unit is a relatively thin sand, gravel, or conglomerate layer that underlies 50–100 feet of clay, sandy clay or "shale."

The water levels for these wells fall in the midst of the overlying clay/shale units (Logs E, F, and G in Figure 2-5 and Logs J and K in Figure 2-6), which indicate that groundwater in the deeper, coarser sediments occurs under pressure. Confined conditions are also manifested in large seasonal groundwater level variations.

Seasonal water level data exist for only a handful of wells tapping the alluvial aquifer. Figure 2-10 shows seasonal water level variations in two wells west of the Southern Canal (Wells A81 and A111) where confined conditions appear to exist. These wells show more than 20 feet of fluctuation in any given year in response to seasonal irrigation pumping. In contrast, within the CID and east of the Southern Canal, at wells A53 and A91, seasonal fluctuations are much less marked (Figure 2-11).

It is uncertain how widespread and how continuous confining conditions are in the western part of the alluvial aquifer. Wells in the vicinity of A111 exhibit thick clays that overlie deeper aquifer units, and Well A111 itself shows strong seasonal water level variations. However, A111 has also been observed to respond very rapidly to surface flood flows in the adjacent Dark Canyon (Bjorklund and Motts, 1959), suggesting, at a minimum, a close hydraulic connection between local groundwater and nearby surface water. This close connection might actually occur as a result of localized recharge to the reef aquifer in Dark Canyon followed by rapid transmission of hydraulic head changes to nearby wells.

Hydrologic conditions in the eastern part of the CID near the river do not appear to be confined (Figure 2-4). Clay beds here are fewer and thinner, and groundwater levels tend to fall within the middle of sand and gravel beds. Reference Figure 2-4 log C.

Pumping tests in the Carlsbad alluvial aquifer specifically aimed at quantifying aquifer hydraulic properties have been limited. Hale (1945) provides data from aquifer tests in the alluvial aquifer at a well located at 22S 27E 20.143. These tests indicate a transmissivity of about 7,500–8,150 square feet per day (ft2/day). When combined with a saturated thickness of about 80–100 feet for the well, this transmissivity range translates to an effective hydraulic conductivity (K) of about 75–100 feet per day (ft/day).

However, it should be noted that the actual hydraulic conductivity at this well might be higher because the transmissive portion of the saturated thickness may be less than 80– 100 feet. Hale (1945) also discusses an aquifer test at the Carlsbad Airport in which a well (22S 26E 35.220 located approximately *one mile west of the Key study area* was pumped at 600 gallons per minute (gpm) for 24 hours. The latter test produced a drawdown of 10.75 feet at the conclusion of pumping, and water levels then recovered so quickly that residual drawdown measurements were unobtainable. This well draws its water from solution cavities in a limestone conglomerate. This well is currently owned by the city of Carlsbad and is not used as a potable source. See photo and well log referenced above.

Well known aquifers such as the Ogallala generally have low capacity variancees in defined areas. However the variance can be quite high in the Carlsbad basin. Figure 2-12. Alluvial Aquifer Specific Capacities (gpm/ft) shows various capacities of wells throughout the basin. The chance of finding water is generally quite high, but finding a well with higher capacities and quality can vary substantially. As will be pointed in the next section, the Capitan Reef Aquifer appears to be just the opposite.

In the Key study area, in the NW/4 of Section of 31-Ts-22s-R27e, Mr. Will Brantley, the current land-owner, drilled an exploratory well 180 feet deep and encountered no water, either shallow or deep.

GCR Section IV.2 and IV.2.A Appendix

Includes:

1. Figure 2-1. Configuration of the Capitan Reef and Alluvial Aquifers Near Carlsbad.
2. Figure 2-19. Schematic of Leakage From Lake Avalon.
3. Figure 2-2. Alluvial Aquifer Observation Well Location.
4. Figure 2-3. Locations of Wells With Lithologic Logs.
5. Figure 2-4. Lithologic Logs for Alluvial Wells Located Close to the Pecos River or Exhibiting Unconfined Conditions.
6. Figure 2-5. Lithologic Logs for Alluvial Wells Encountering Groundwater Under Confined Conditions.
7. Figure 2-6. Lithologic Logs for Alluvial Wells Encountering. Groundwater Under Perched and Confined Conditions.
8. Figure 2-7. Observed Groundwater Levels in the Alluvial Aquifer in 1962.
9. Figure 2-8. Observed Groundwater Levels in the Alluvial Aquifer in 1996.
10. Figure 2-9. General Movement of Groundwater in the Alluvial. Aquifer and Areas of Recharge From Surface Watercourses.
11. Well Log and Photo of Airport Well #1 of the City of Carlsbad.- 2 pages. Note: it appears the log marked airport #3 is actually now #1.
12. Figures 2-10 and 2-11. Seasonal Water Fluctuations in the Confined Portion of the Alluvial Aquifer West of the CID. Seasonal Water Fluctuations in the Unconfined Portion of the Alluvial Aquifer within the CID.
13. Figure 2-12. Alluvial Aquifer Specific Capacities (gpm/ft).

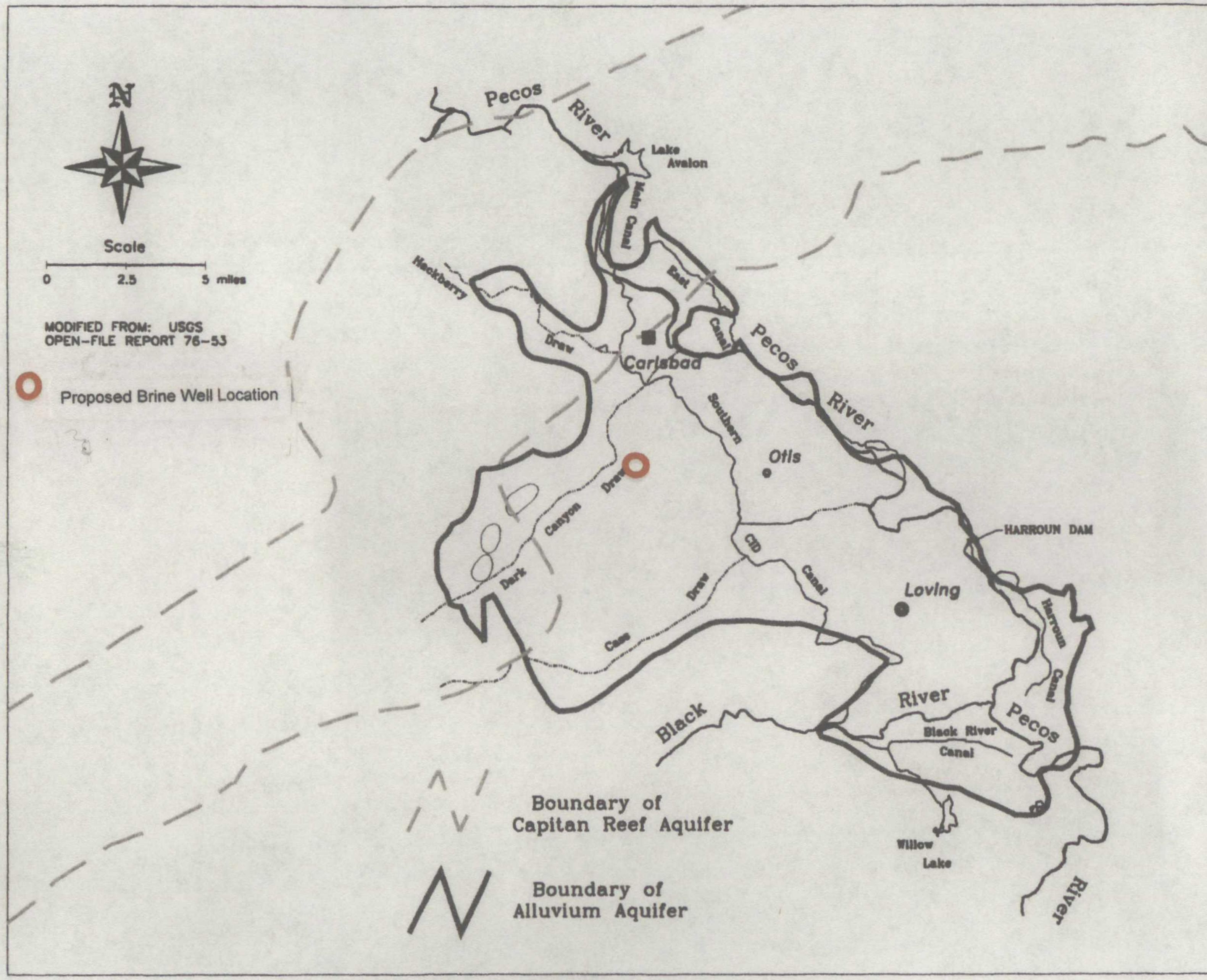


Figure 2-1. Configuration of the Capitan Reef and Alluvial Aquifers Near Carlsbad.

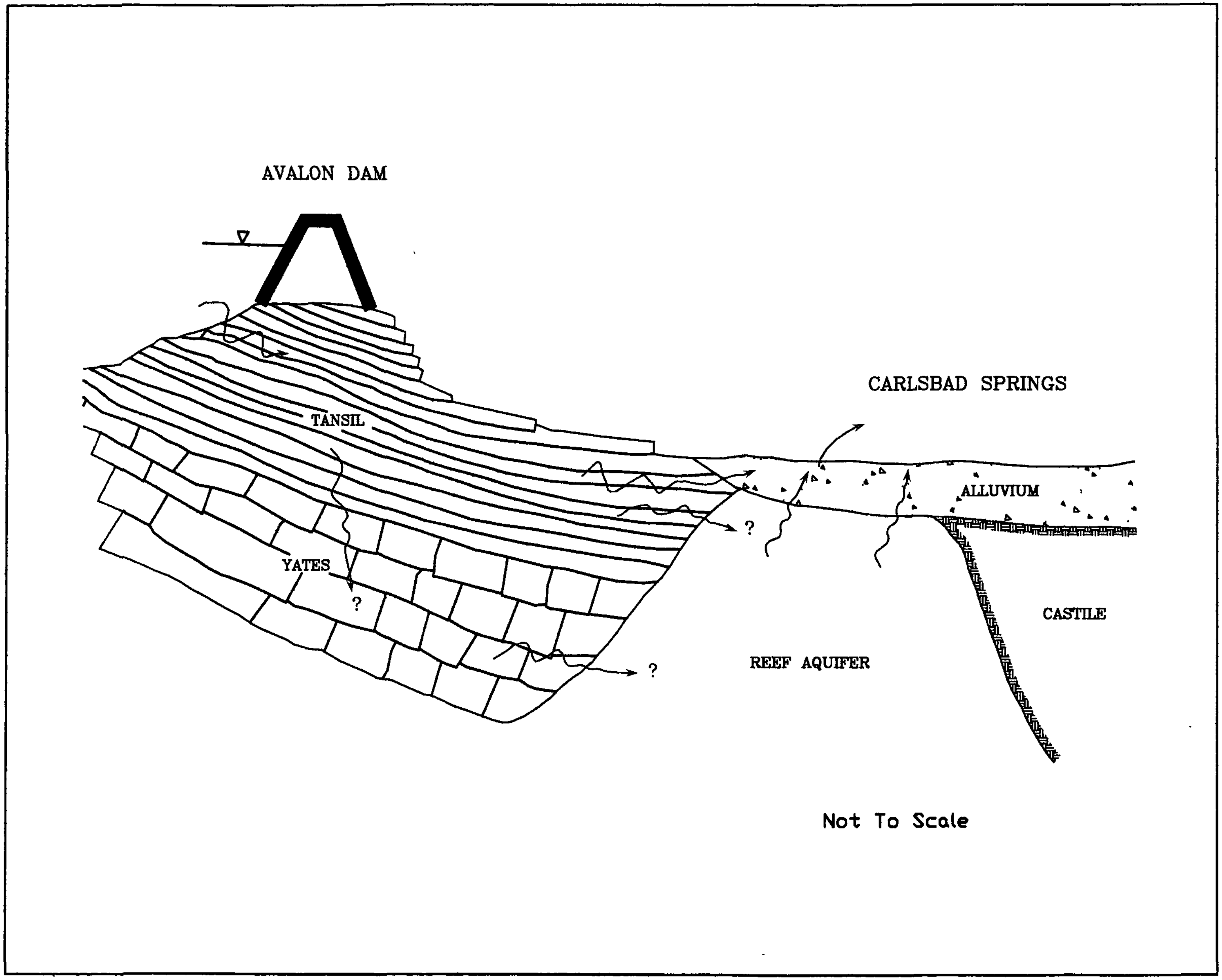


Figure 2-19. Schematic of Leakage From Lake Avalon.

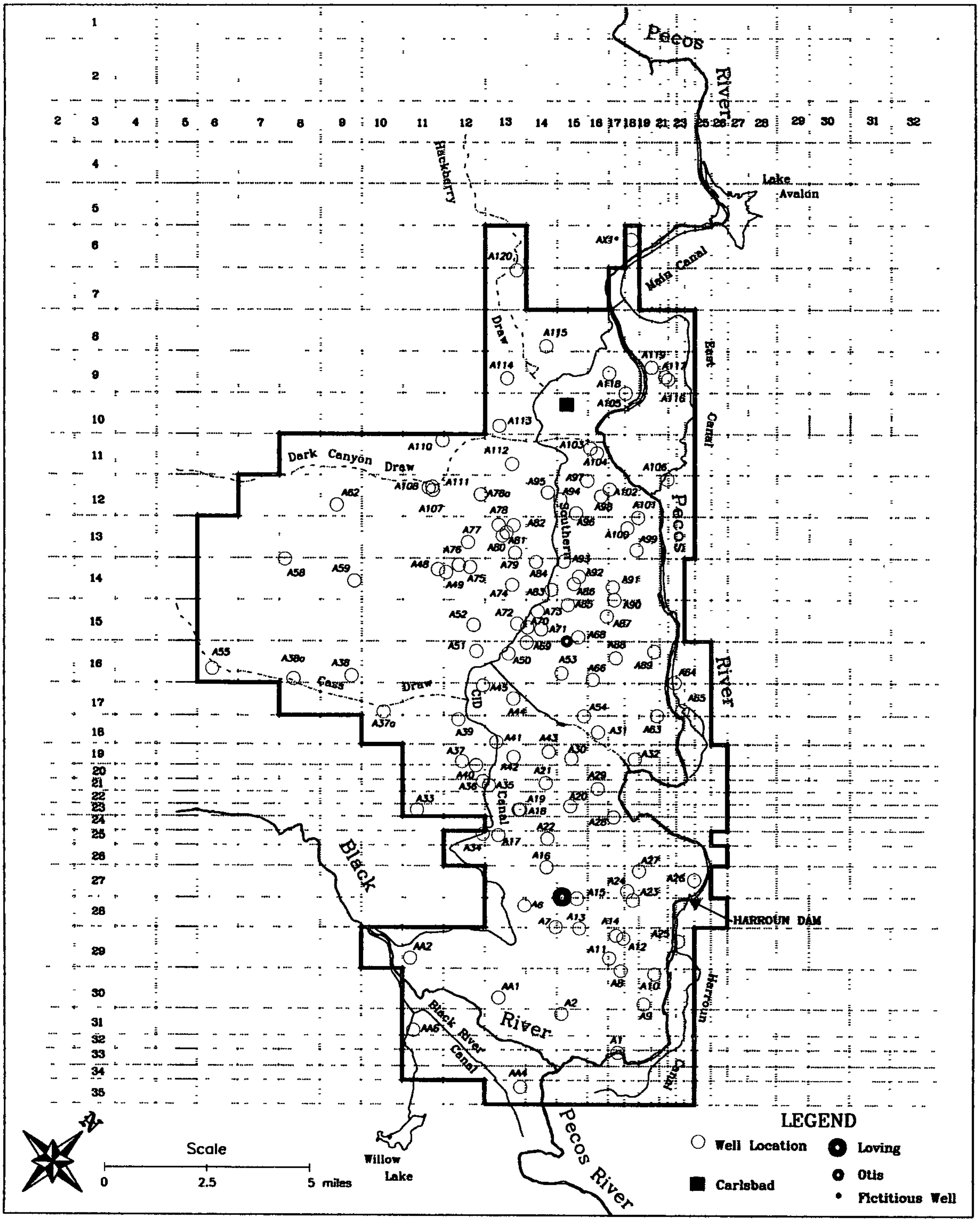


Figure 2-2. Alluvial Aquifer Observation Well Locations.

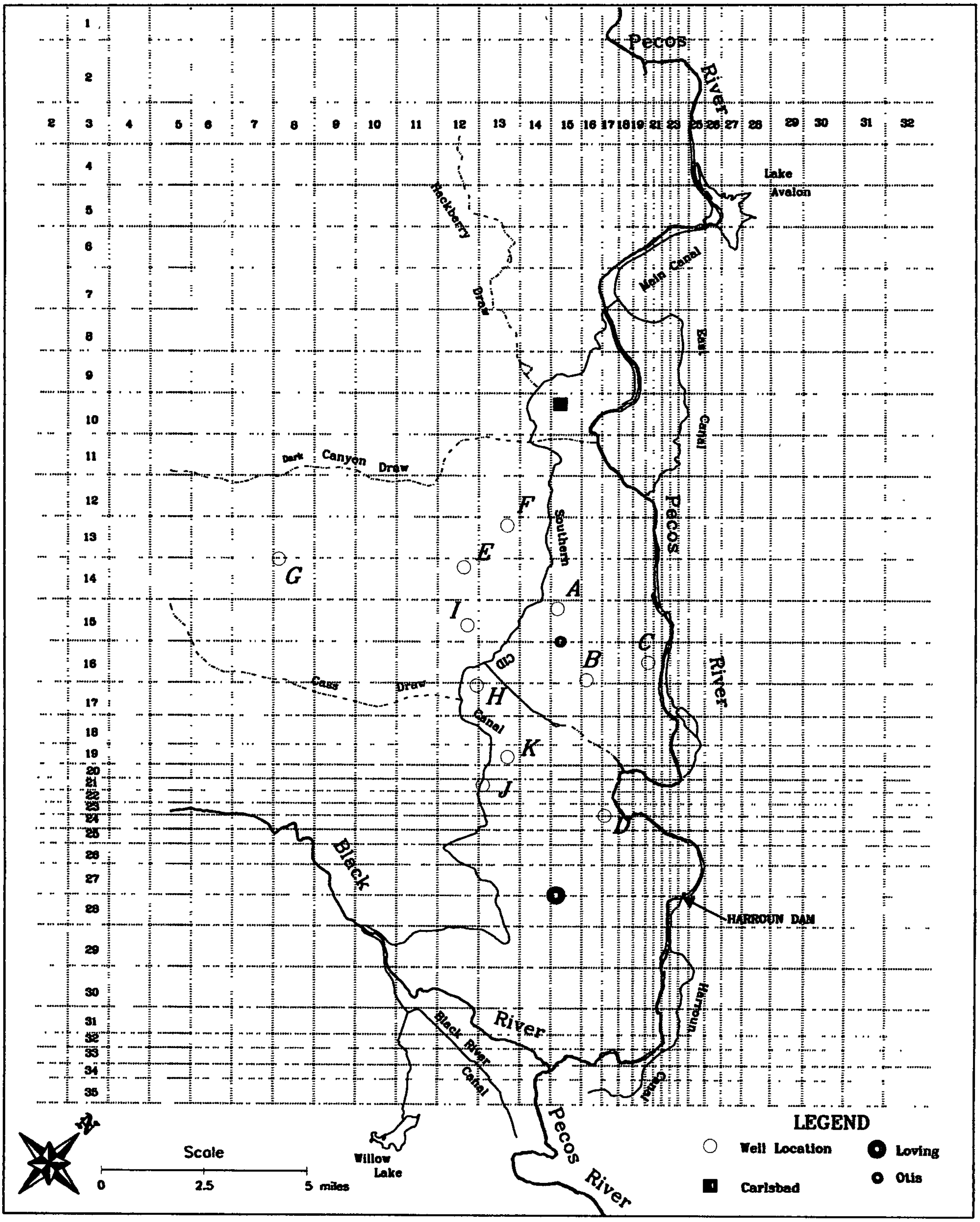


Figure 2-3. Locations of Wells With Lithologic Logs.

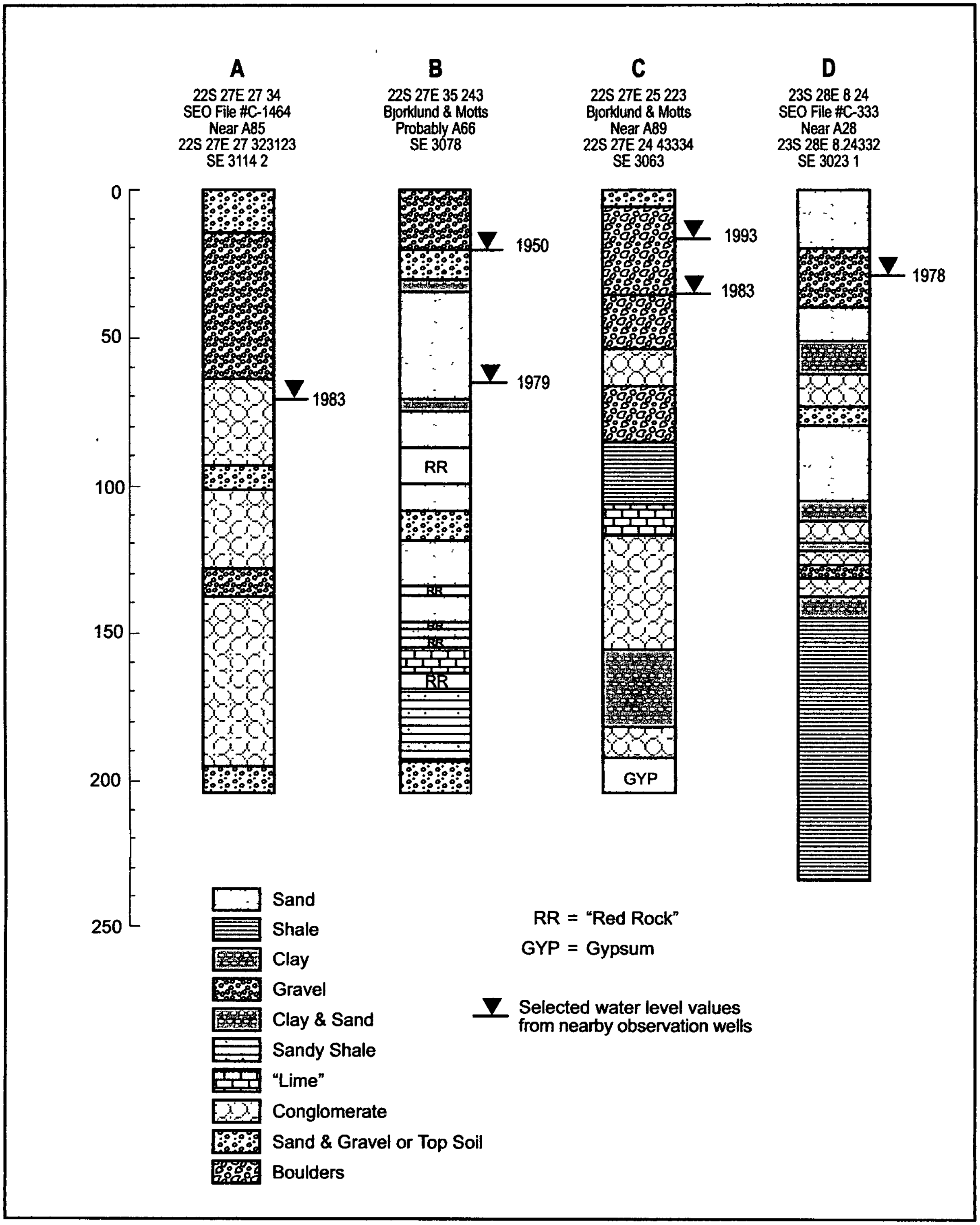


Figure 2-4. Lithologic Logs for Alluvial Aquifer Wells Located Close to the Pecos River or Exhibiting Unconfined Conditions.

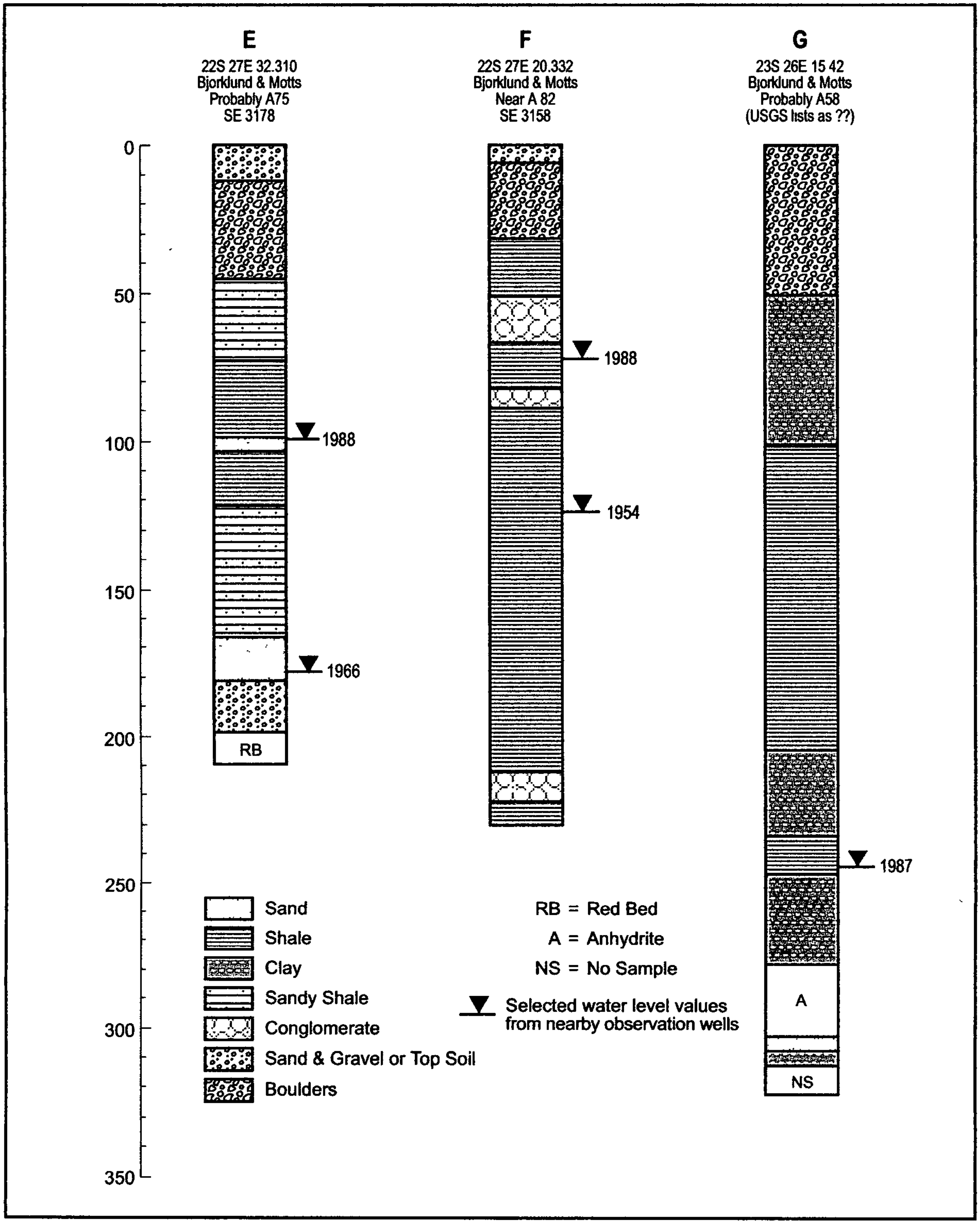


Figure 2-5. Lithologic Logs for Alluvial Aquifer Wells Encountering Groundwater Under Confined Conditions.

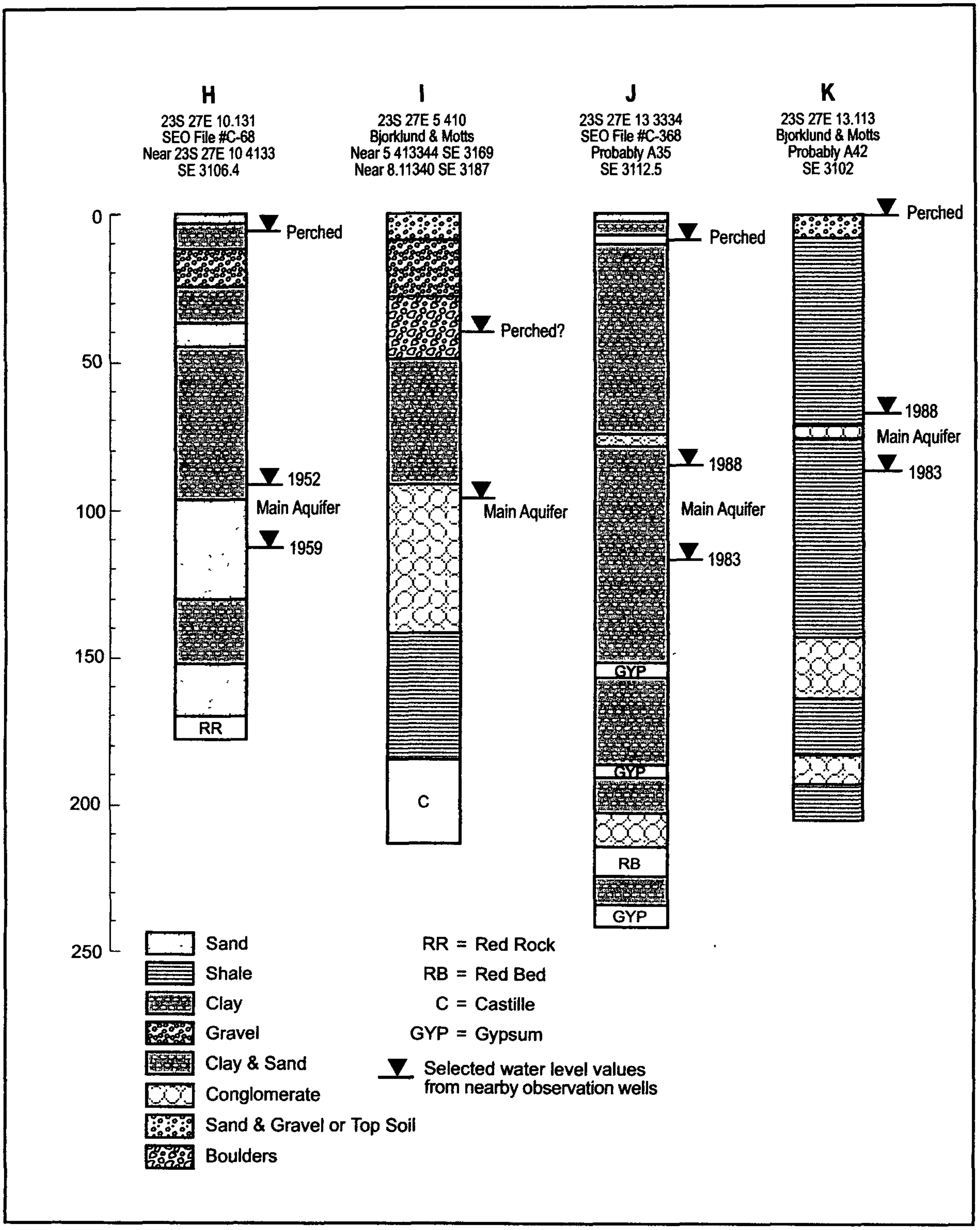


Figure 2-6. Lithologic Logs for Alluvial Aquifer Wells Encountering Groundwater Under Perched and Confined Conditions.

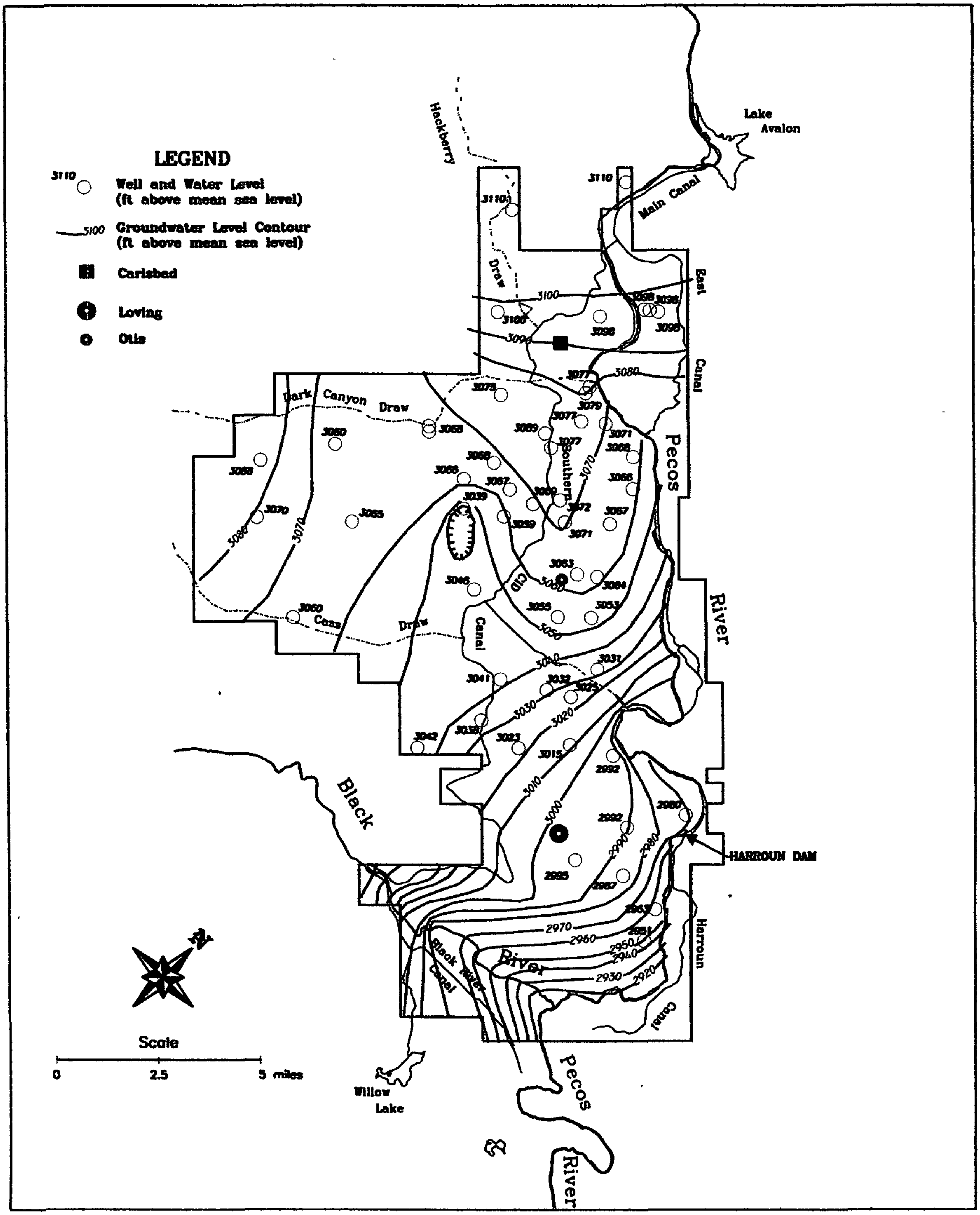


Figure 2-7. Observed Groundwater Levels in the Alluvial Aquifer in 1962.

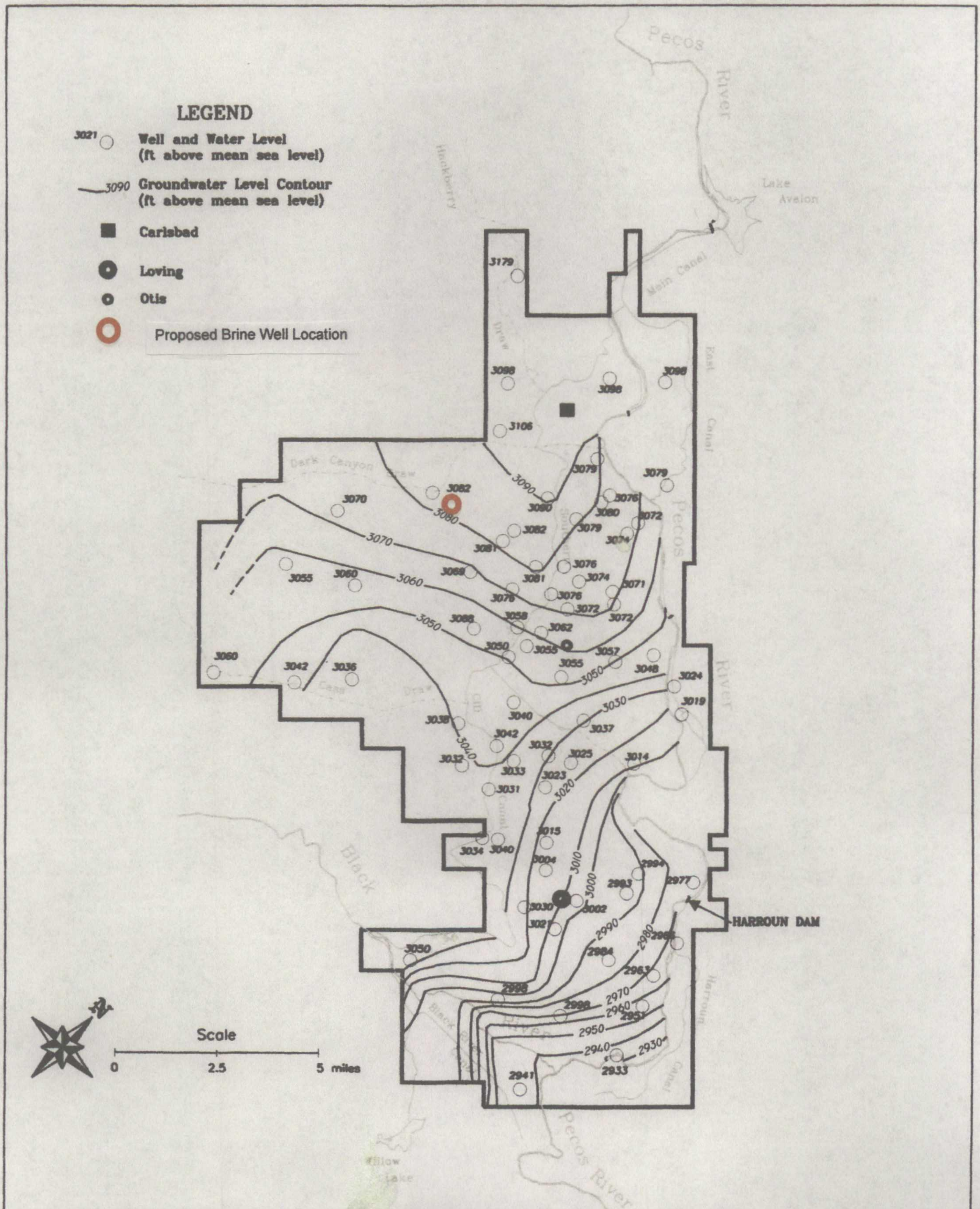


Figure 2-8. Observed Groundwater Levels in the Alluvial Aquifer in 1996.

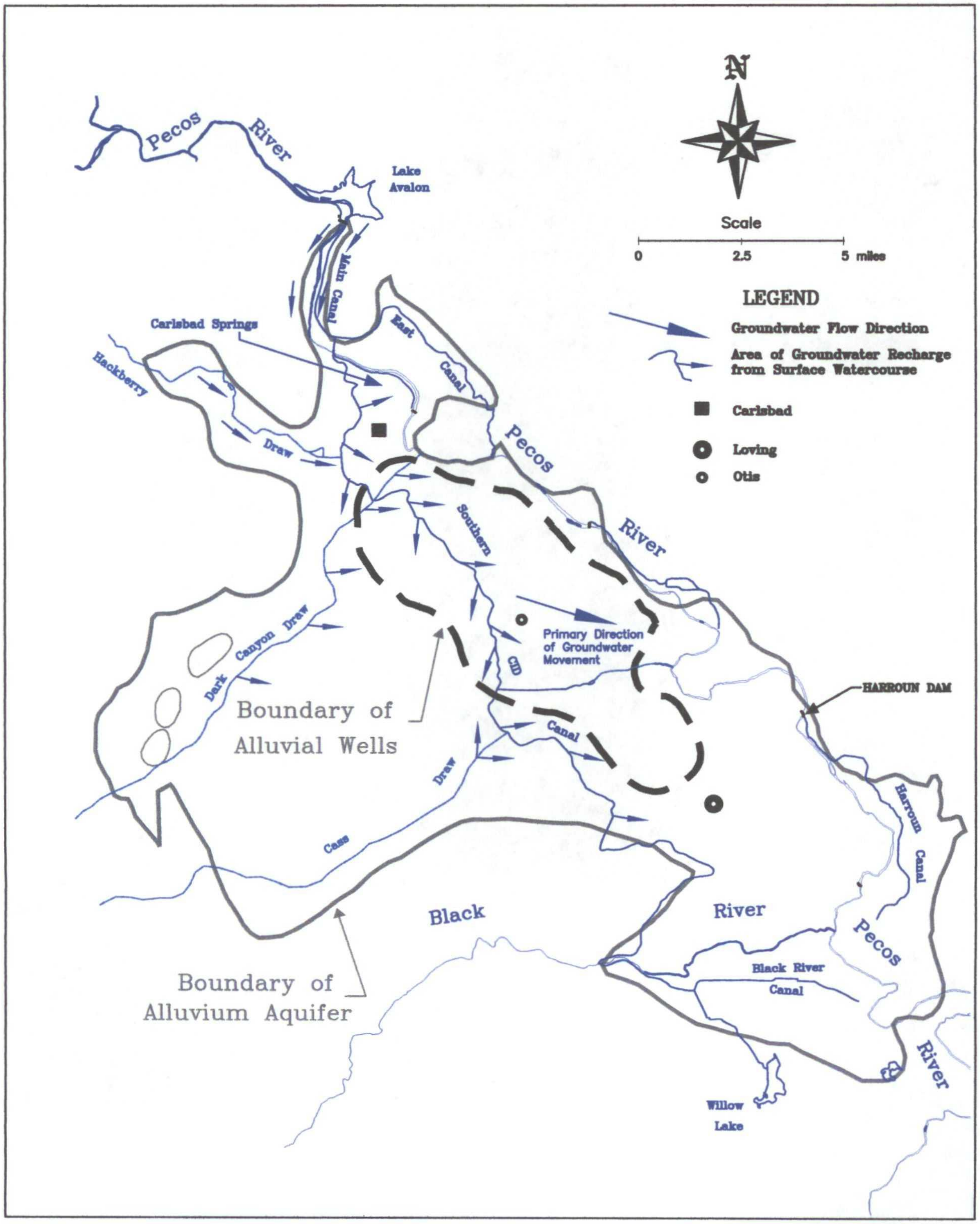


Figure 2-9. General Movement of Groundwater in the Alluvial Aquifer and Areas of Recharge From Surface Watercourses.


CITY OF CARLSBAD
AIRPORT WATER WELL #1
NON POTABLE WATER
05. 15. 2010

a well is conglomerate or limestone (Hale, 1945, p. 15). Following is a log of the air-base well 3 which indicates the character of the alluvium (Hale, 1945, p. 18).

LOG OF WELL 22.26.35.222, FORMER CARLSBAD AIR FORCE BASE WELL 3 (DRILLER'S LOG TO 166 FEET; LOGGED BY J. P. SMITH, GEOLOGIST, U. S. POTASH CO., FROM CUTTINGS 166 TO 256 FEET)

	THICKNESS *(feet)*	DEPTH *(feet)*
Soil	12	12
Gravel	68	80
Pink sandy clay	82	162
Conglomerate (seep of water)	2	164
Pink sandy shale	10	174
Hard indurated buff limy sand and fine gravel conglomerate	3	177
Conglomerate; matrix yellow limestone, medium coarse dolomitic and siliceous pebbles (water at 180 feet)	16	193
Hard buff fine gravel and sand conglomerate	7	200
Hard indurated buff limy sand	10	210
Medium-coarse limestone conglomerate	5	215
Buff, greenish, and pink calcareous shale with a few pebbles and a few sandy laminae	10	225
Very hard indurated limy sand	10	235
Medium-coarse gray and buff conglomerate (increase of water?)	10	245
Hard fine-textured buff conglomerate	11	256

The principal areas of alluvium within the Carlsbad area are the city of Carlsbad, La Huerta, most of the irrigated area in Happy Valley, and a large area south of Carlsbad between the Guadalupe Mountains and the Pecos River. The thickness of the alluvium varies greatly in short distances, owing to pronounced irregularities in the surface on which it was deposited. These irregularities were caused by solution and collapse of the underlying rocks. The thickest part of the alluvium is under the present drainage system (Hale, 1945, p. 14). South of Carlsbad the thickness of the alluvium, on the basis of drillers' logs, ranges from a feather edge near the mountains on the west to more than 200 feet near the Pecos River. In La Huerta the maximum recorded thickness of alluvium is 127 feet. Well 3 at the Carlsbad Air Base near Dark Canyon penetrated valley fill to a depth of 256 feet without encountering bedrock (Hale, 1945, p. 15).

Recharge, movement, and discharge.—Recharge to the alluvium is from several sources. Water from the Carlsbad limestone moves into the alluvium in the Carlsbad area. Underflow from Dark Canyon and other arroyos probably adds a considerable quantity of water to the alluvium, and during heavy storms part of the surface runoff carried

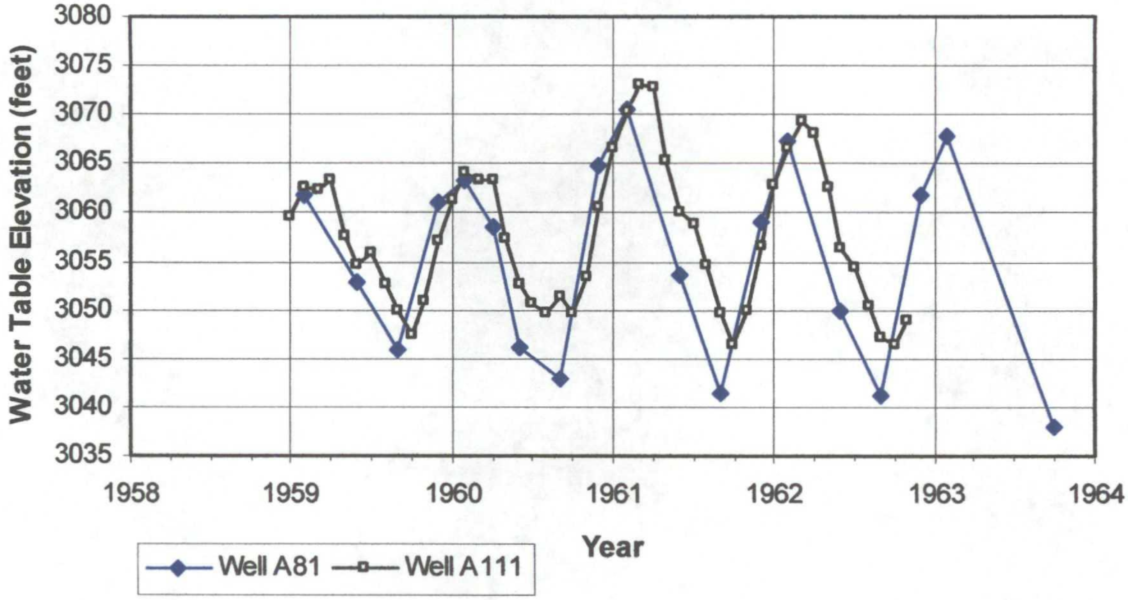


Figure 2-10. Seasonal Water Level Fluctuations in the Confined Portion of the Alluvial Aquifer West of the CID.

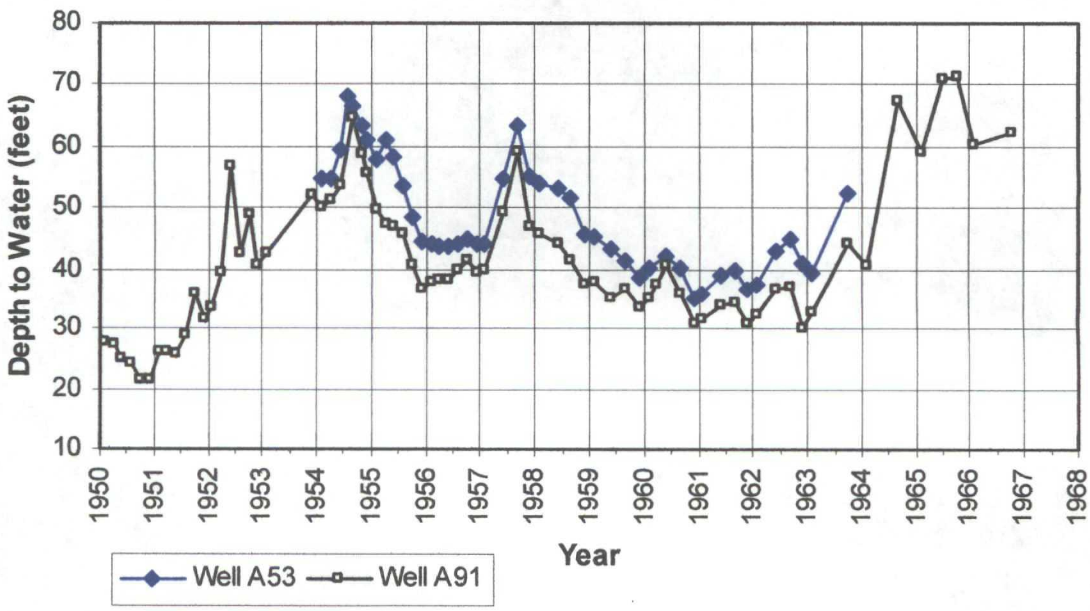


Figure 2-11. Seasonal Water Level Fluctuations in the Unconfined Portion of the Alluvial Aquifer within the CID.

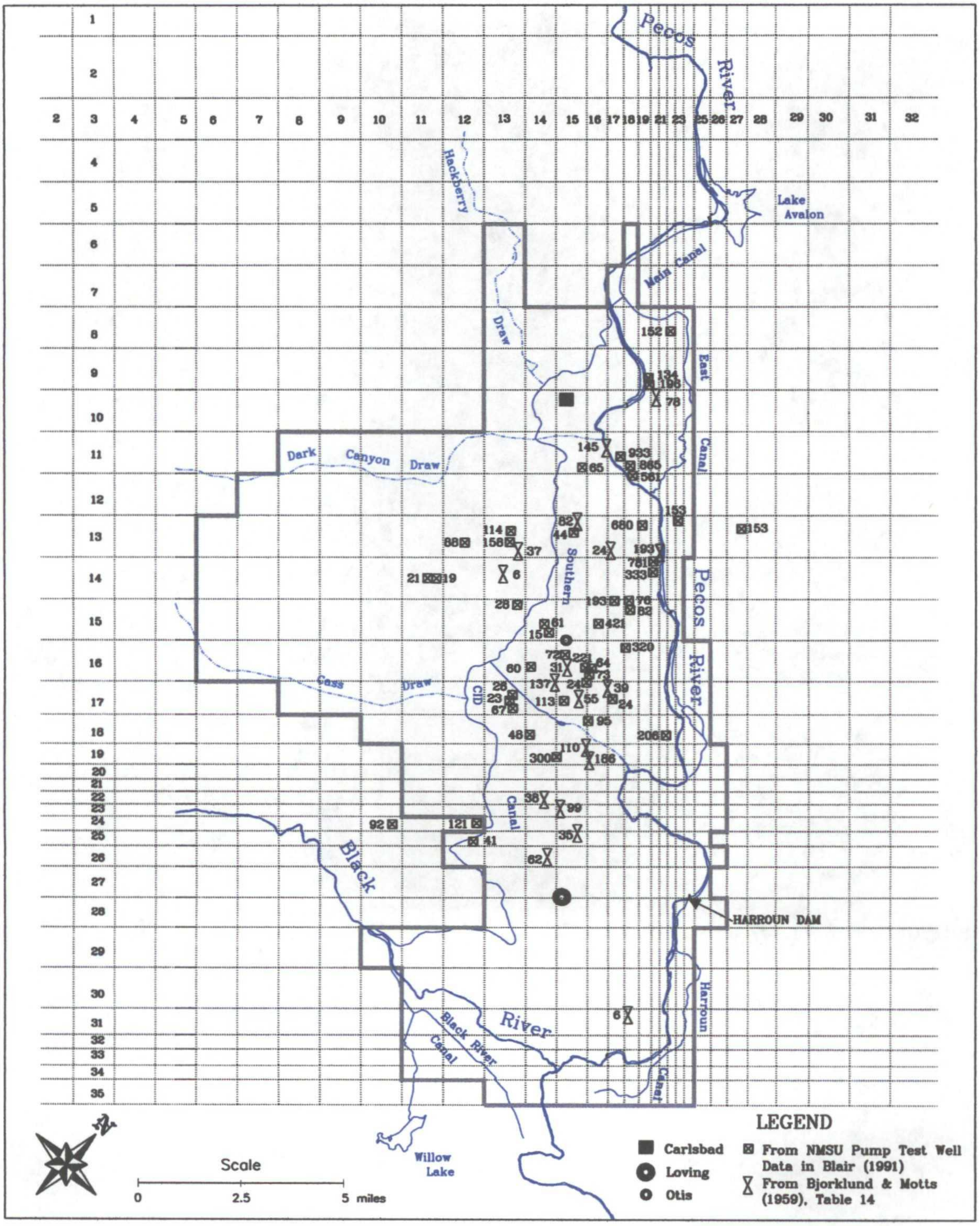


Figure 2-12. Alluvial Aquifer Specific Capacities (gpm/ft).

GCR Section IV.2.B- Capitan Reef Aquifer

The reef aquifer and its surroundings largely consist of rocks laid down in Permian times associated with a shallow marine environment reef. The reef aquifer forms an arcuate strip that is approximately 10 to 14 miles wide and extends in a broad curve from the Guadalupe Mountains in New Mexico to the Glass Mountains, which are located about 40 miles southeast of Balmorhea, Texas. Shelf rocks were deposited in shallow lagoons on the landward side of the reef. Basin rocks were deposited in the deeper water on the seaward side of the reef.

Figures 2-13 and 2-14 included in this GCR section's IV.2.B appendix, shows the reef location in retrospect with the Pecos River and Carlsbad area, and a stratigraphic section of the reef facies.

The reef aquifer is composed of the Capitan and Goat Seep limestones (Hiss, 1975b) and is described as a reef facies in the Delaware Basin in which large solution channels have been formed. Following Bjorklund and Motts (1959), the reef aquifer defined in this study also includes portions of adjacent shelf deposits where these deposits are cavernous and extremely transmissive, such as parts of the Tansil and Yates Formations near Carlsbad Springs. In such areas, it is difficult to distinguish between "true reef" and shelf deposits.

The thickness of the reef aquifer averages about 1,600 feet in the vicinity of the City of Carlsbad (Hiss, 1975b). The reef outcrops near its end points in the Guadalupe Mountains west of Carlsbad, and in the Glass Mountains in Texas. East of Carlsbad, considerable thicknesses of anhydrite and halite in the Rustler, Salado, and Castile formations overlie and confine the reef. West of Carlsbad, the Tansil and Yates formations overlie the reef and convey recharge to it. Near Carlsbad, north of the *Key study area* approximately 5 miles, the reef is in direct contact and hydrologic communication with the alluvial aquifer.

The hydraulic conductivity of the reef is much larger than that of adjacent formations, which means that most of the reef is relatively isolated hydrologically. According to Bjorklund and Motts (1959), the formation underlying the reef "prevents any further downward movement of groundwater and constitutes the lower boundary of the reef aquifer." *The "inner" arc or southeastern arcuate boundary of the reef in the Carlsbad area forms an interface between reef material and the "relatively impervious" basin deposits (Bjorklund and Motts, 1959).* The "outer" arcuate boundary is less clearly defined, and receives flow from adjacent formations associated with the reef shelf, especially the Tansil and Yates formations. Figures 2-16 and 2-17 show graphically the surface geology along the Pecos River.

One could conclude that in the "Key Study Area", the top of the Castile formation, i.e. anhydrite III-IV act as the basal confining zone for groundwater found above in the Rustler. For this reason Key feels it's important to provide a water protection string casing into the anhydrite layer.

Hydraulic gradients are relatively flat throughout the segment of the reef between the Pecos River and White City in the Guadalupe Mountains. That is, at any given time, observed heads between Carlsbad and White City are almost all within a few feet of each other. Given the large areal extent of the reef aquifer, it is difficult to ascribe any slope to the reef aquifer potentiometric surface. In addition, simultaneous hydrographs from wells in the aquifer are found in Figure 2-18 in this GCR section IV.2.B appendix, show that heads in the reef rise and fall together in unison, apparently in response to natural recharge events and man-made stresses. This unusual response indicates extremely high transmissivity within the reef. *As Quoted by Peggy Borrell (OSE) the "Capitan Aquifer really acts like a big bath tube".*

The reef aquifer is recharged by natural and artificial sources. Natural recharge enters the reef largely from the west, originating as precipitation in an area of approximately 800 square miles in and west of the Guadalupe Mountains (NM OSE Technical Memorandum, January, 1964). Natural recharge enters the reef by slow percolation through adjacent shelf deposits, such as the Yates, Tansil, Seven Rivers, and Queen formations.

Natural recharge can also enter the reef by direct infiltration into outcropping cavernous zones of the reef. Surface water recharges the reef as it flows across reef outcrops in Dark Canyon, where there is evidence "that silt laden water is percolating downward through open conduits to the water table" in the reef (Bjorklund and Motts, 1959, p. 116).

Leakage from Lake Avalon contributes artificial recharge to the reef aquifer. As was shown schematically in Figure 2-19, this leakage enters the Tansil Formation under Lake Avalon, and then flows into the reef and alluvial aquifers in the vicinity of Carlsbad Springs.

The chemistry and quality of natural recharge to the reef aquifer are different from the chemistry and quality of artificial recharge to the aquifer. Natural recharge, originating in the Guadalupe Mountains, is relatively pure. In contrast, artificial recharge from Lake Avalon consists of relatively poor quality water because its source is slightly to moderately saline water in the Pecos River. The quality of water in the reef has been declining as pumping from the reef has reached and possibly exceeded natural recharge rates.

Discharge from the reef is predominantly by pumping. During the past 30 years between 15,000 and 20,000 acre-feet per year (AF/yr) have been pumped from the reef for municipal, industrial and irrigation purposes.

Natural discharge from the reef has also taken place near Carlsbad Springs, where, as shown in Figure 2-19, the reef and alluvial aquifers are in hydraulic contact with each other. Groundwater level data from the alluvial and reef aquifers in this area indicate that, though pumping has gradually lowered hydraulic heads in the reef, groundwater still flows from the reef into the alluvial aquifer and subsequently to the Pecos River.

The flat potentiometric surface of the reef makes it difficult to determine either groundwater flow direction or flow magnitude in the reef. Under natural, pre-pumping conditions, groundwater flowed from the western recharge area towards a natural discharge site at Carlsbad Springs (Hiss, 1980). Presumably groundwater flow in this direction continues today, but is perturbed by large amounts of municipal and industrial pumping and leakage from Lake Avalon.

The reef is confined by the alluvial aquifer in the immediate vicinity of Carlsbad Springs, where measured hydraulic heads have typically been 2 to 10 feet higher than comparable heads in the alluvial aquifer. Elsewhere in the Carlsbad area, "both water table and artesian conditions exist owing to the apparently random arrangement of solution channels below and above the water table" (Bjorklund and Motts, 1959, p. 142).

While the reef as a whole is much more transmissive than surrounding formations, the segment of the reef between the Pecos River and the Guadalupe Mountains is especially transmissive. This is indicated qualitatively by the flat potentiometric surface observed in this area and shown in Figure 2-15 and the fact that groundwater levels at widely scattered observation points rise and fall in unison as shown in Figure 2-18. The reef aquifer is comprised of the same unit as found at the Carlsbad Caverns. Even in the Carlsbad area, this unit is described as having large solution cavities and a "cavernous phase" (Bjorklund and Motts, 1959).

Using data from pumping tests in the reef aquifer, Hiss (1975a) cites a hydraulic conductivity range of 1 to 25 ft/day for the reef. He states that: "An average hydraulic conductivity of 5.0 ft/day would seem to be reasonable for the Capitan [reef] aquifer over a span of approximately 15 miles immediately east of the of the Pecos River at Carlsbad. Values of hydraulic conductivity in the Capitan aquifer west of the Pecos River are apparently larger by as much as several orders of magnitude."

However, it appears likely that, in order to account for the "order of magnitude" reduction in transmissivity that Hiss predicts for this area, hydraulic conductivities in the vicinity of the constriction are very low as well. Using aquifer test results from a well near Carlsbad and west of the Pecos River, Hale (1945) computed an estimated reef transmissivity of 57,000 ft^2/day. Assuming an average aquifer thickness of 1,600 feet, this transmissivity translates into a hydraulic conductivity of 36 ft/day. However, this computed hydraulic conductivity is possibly too low. Hale's aquifer test in question demonstrated some interesting effects:

GCR Section IV.2B Appendix

Includes:

1. Figure 2-13. Capitan Reef Aquifer Location Map.
2. Figure 2-14. North-South Stratigraphic Section Showing the Positions and Relationships of Major Lithofacies in Rocks of Guadlupian Age. (Modified from Hiss, 1975b).
3. Figure 2-15 Measured Groundwater Levels in the Reef Aquifer in 1993.
4. Figure 2-16. Surface Geology Along the Pecos River (Modified From Bjorklund and Motts, 1959).
5. Figure 2-17. Cross Section A-A' From Figure 2-16, Illustrating Overlapping and Dipping Formations on the East Flank of the Guadalupe Mountains.
6. Figure 2-18. Hydrographs from Wells Completed in the Capitan Reef Aquifer.
7. Figure 2-19. Schematic of Leakage From Lake Avalon.

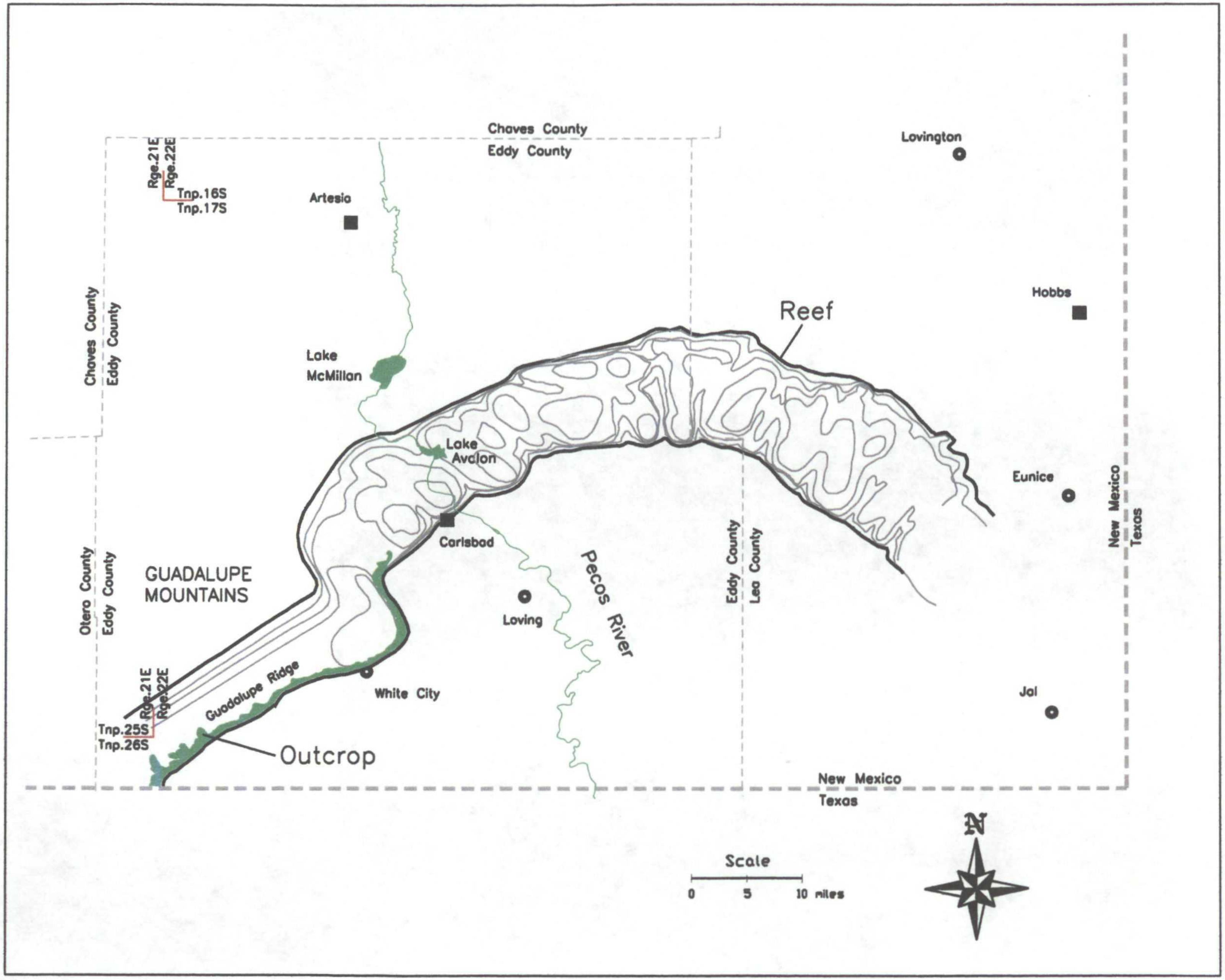


Figure 2-13. Capitan Reef Aquifer Location Map.

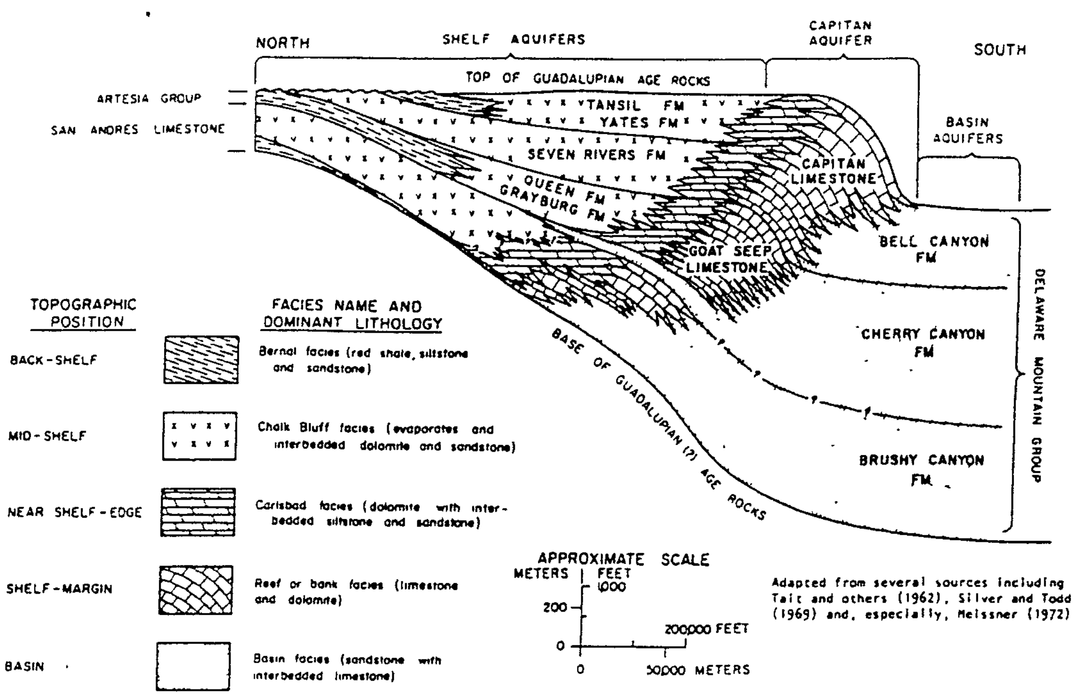


Figure 2-14. North-South Stratigraphic Section Showing the Positions and Relationships of Major Lithofacies in Rocks of Guadalupian Age (Modified from Hiss, 1975b).

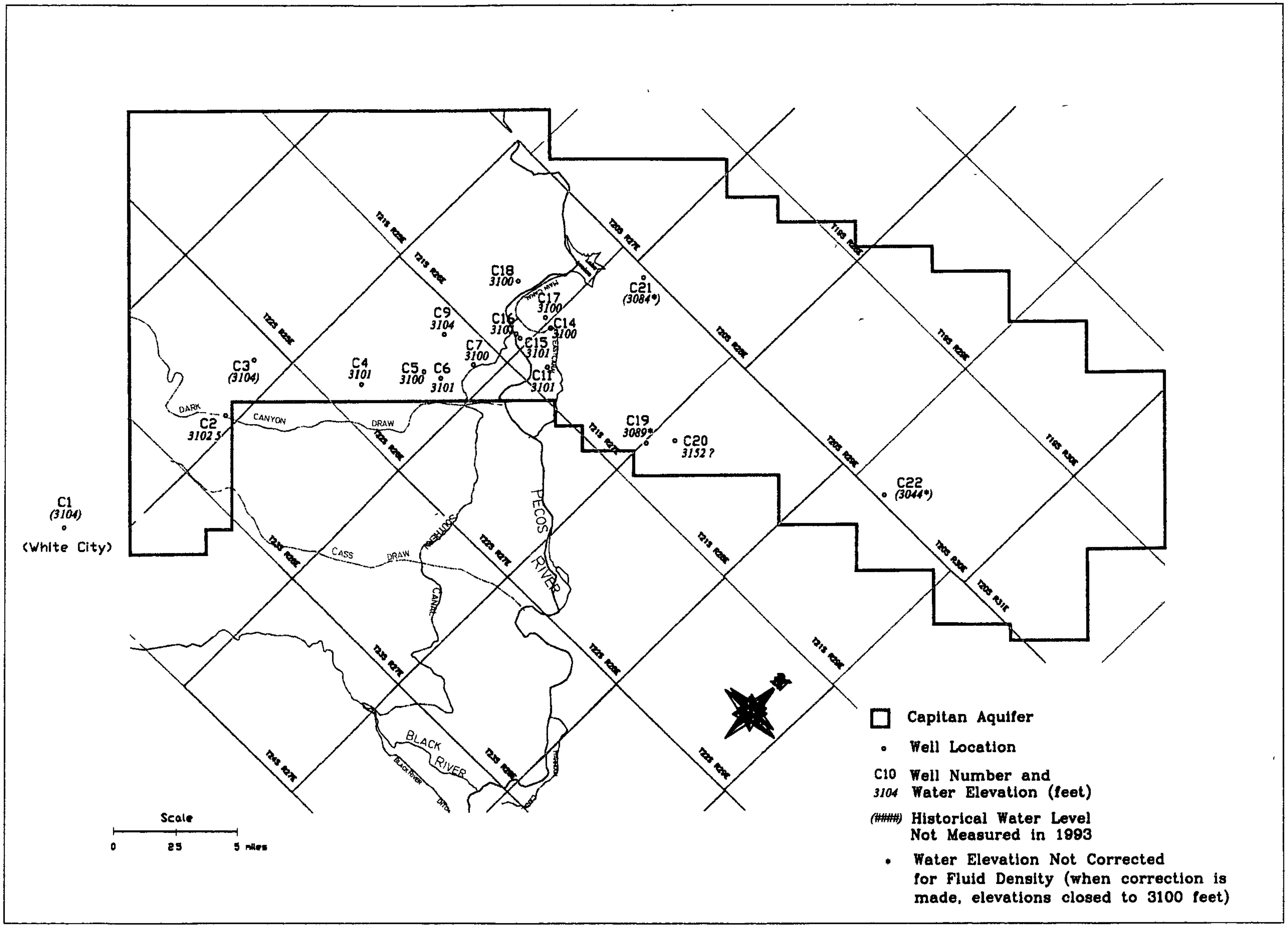


Figure 2-15. Measured Groundwater Levels in the Reef Aquifer in 1993.

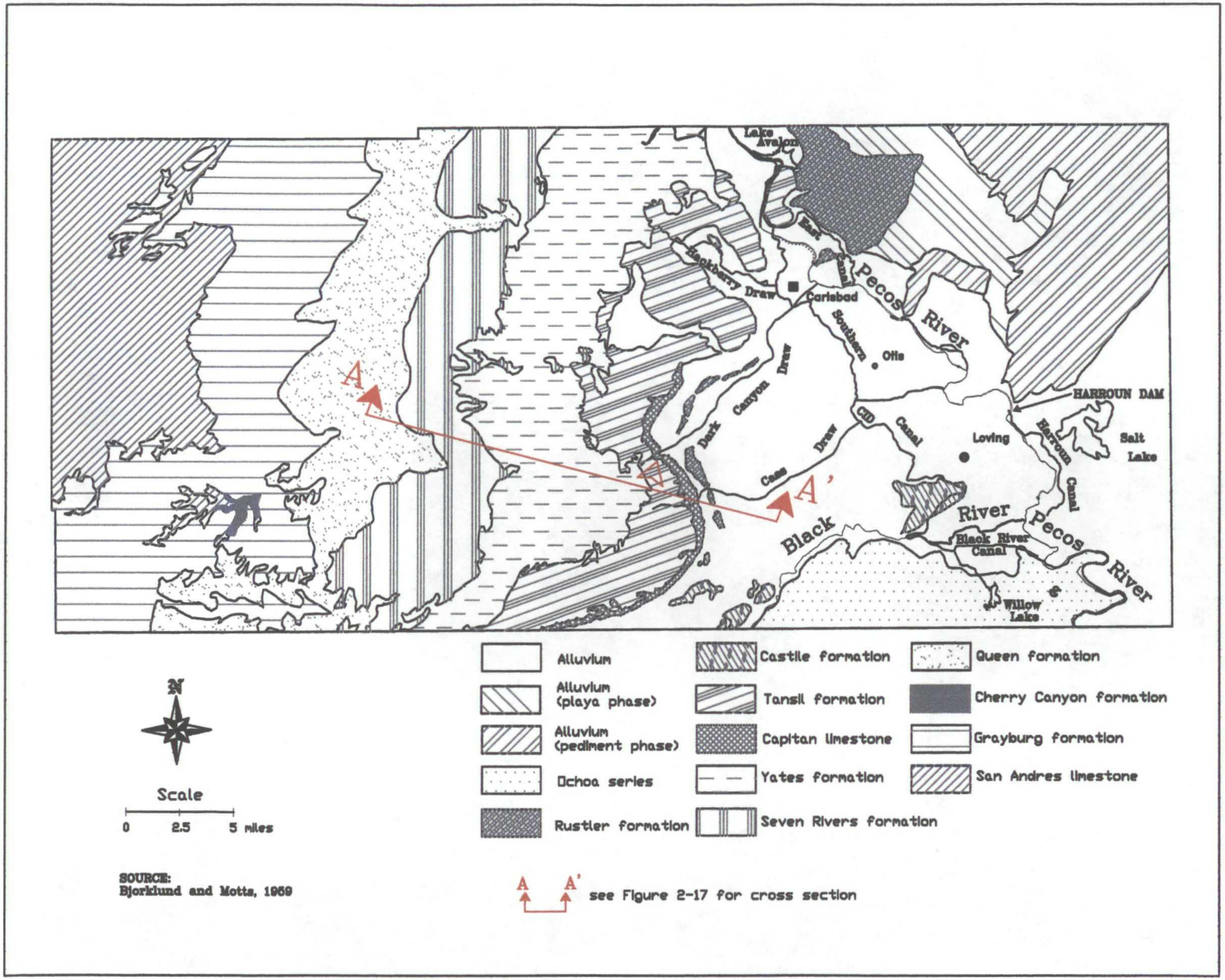


Figure 2-16. Surface Geology Along the Pecos River (Modified From Bjorklund and Motts, 1959).

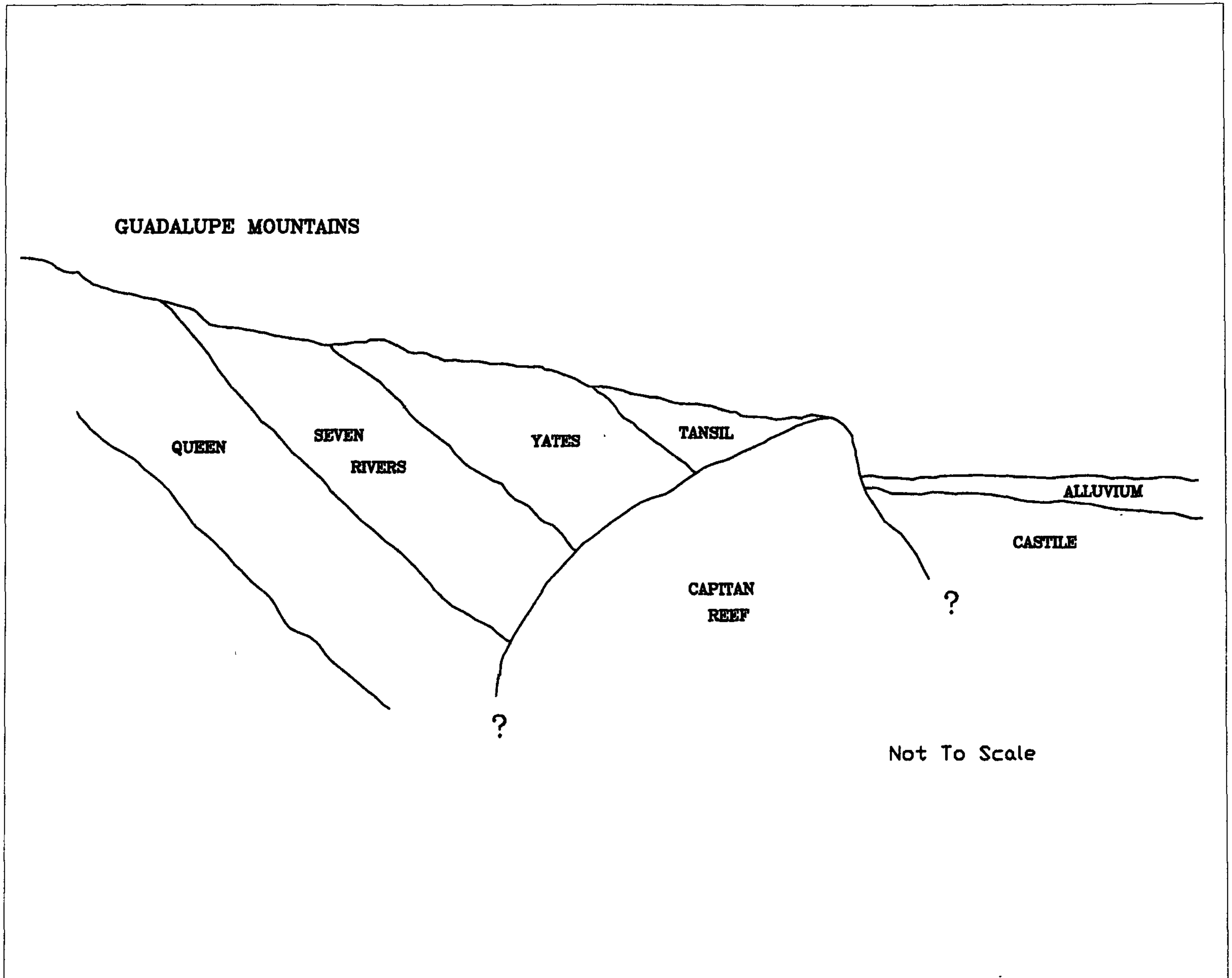


Figure 2-17. Cross Section A-A' From Figure 2-16, Illustrating Overlapping and Dipping Formations on the East Flank of the Guadalupe Mountains.

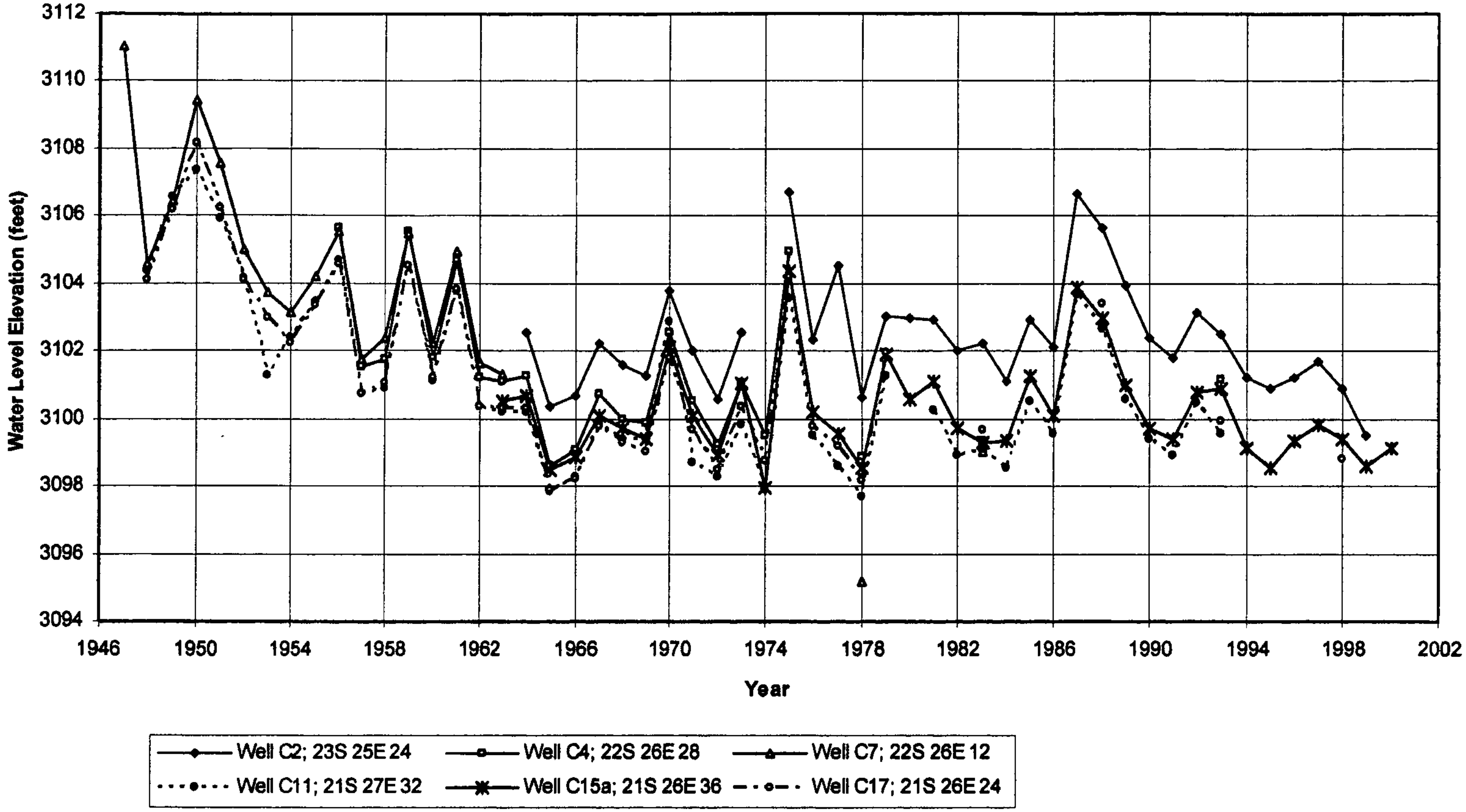


Figure 2-18. Hydrographs from Wells Completed in the Capitan Reef Aquifer.

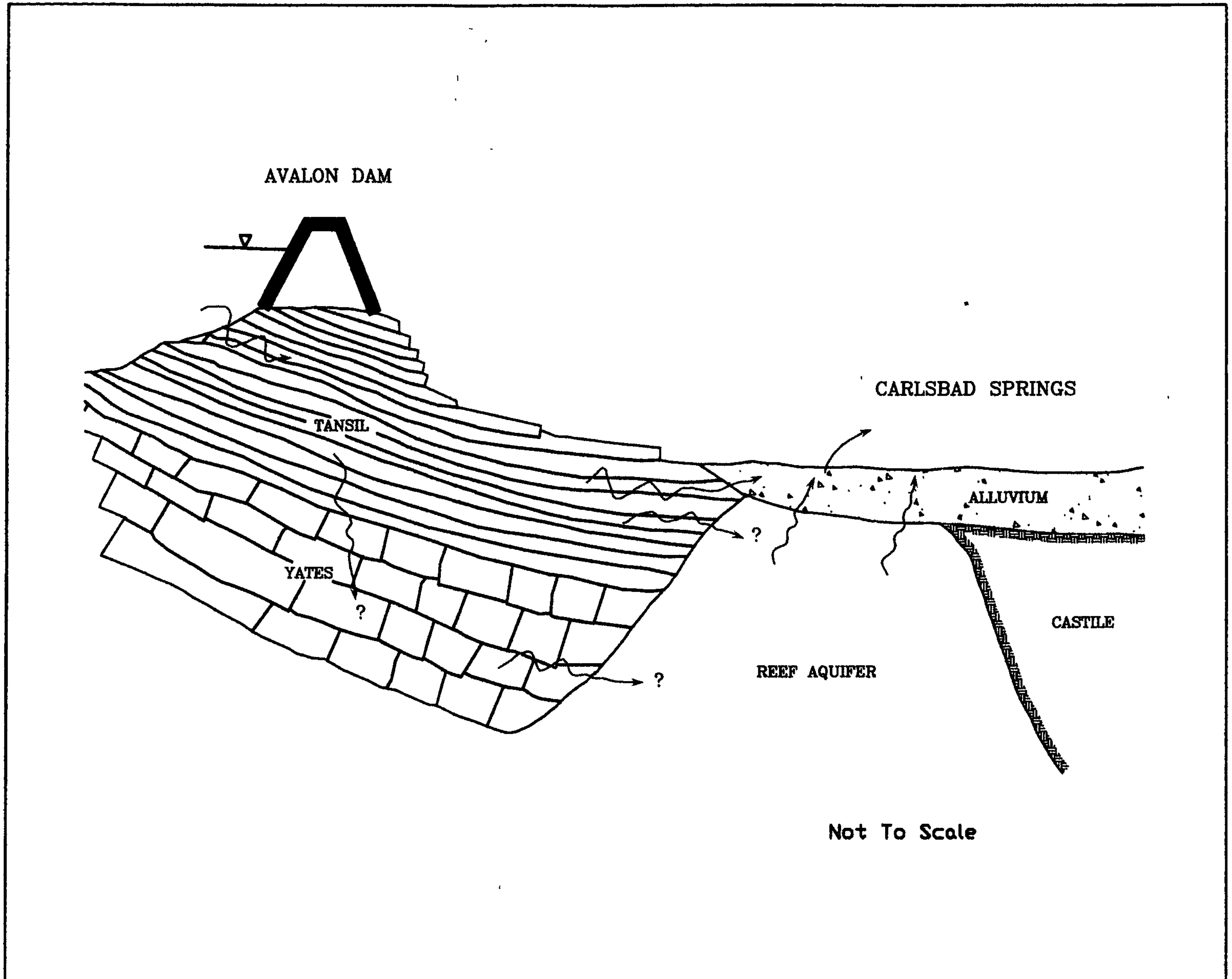


Figure 2-19. Schematic of Leakage From Lake Avalon.

<u>GCR Section IV.2.C- *Area of Review of Water Wells*</u>

A comprehensive review of water wells in the area was conducted by downloading records from the State Engineers' office website and observations from on-site field visits. The review area included all sections surrounding the proposed location of the brine well in UL E Section 31-Ts 22s-R27e. It includes sections 31,32,29,30,25,36,1,2,and 6 of Townships 22 & 23 South and Ranges 26 & 27 East.

The number of water wells were counted from each section and noted below:

Section 31 has 08 wells
Section 32 has 21 wells
Section 29 has 16 wells
Section 30 has 11 wells
Section 32 has 21 wells
Section 25 has 77 wells
Section 36 has 03 wells
Section 01 has 09 wells
Section 02 has 07 wells
Section 06 has 07 wells

A "one-mile" area of review (AOR) revealed that 23 water wells are located within a one-mile radius of the proposed brine well site, and no wells were found within a (1/4) quarter mile. <u>Included in this GCR section IV.2.C appendix, is Figure AOR-1 showing the AOR around the proposed brine well site. Also included in the appendix are the water well records.</u>

The 23 wells in the one-mile AOR includes 18 for domestic use, 03 for irrigation, and 2 for municipal or other uses. The 2 listed for municipal or other uses are as follows; one is located west of the proposed brine well and is the non-potable Airport #1 (formally US Army) owned by the city of Carlsbad filed as C-00853/00854, and the other well is classified as MUL (multiple households) which is located in Section 25 northwest of the proposed brine well filed as C-00277.

According to the State Engineers' office water report 2004, the groundwater level contours previously shown in Figure 2-8 in the area, shows that the average measured ground water depth is approximately 3082 feet Above Mean Sea Level (AMSL). The site elevation is approximately 3195 feet AMSL, which equates to a groundwater depth of approximately 113 feet below grade level. As noted in the hydrology report above, water in this area is probably confined at greater depths under the site and westward towards Dark Canyon. Shallow water (i.e. perched) is probably unconfined, as is the deeper water as it approaches the CID southern canal and Pecos River. According to the State Engineers report 2004, almost all of the water, except for isolated pockets, are hydrologic connected and eventually flows into the Pecos and Black Rivers.

As mentioned previously, the only well drilled recently near the proposed brine well site was about a 1000 feet northwest, which was drilled to a depth of 180 ft with no groundwater encountered as reported by Mr. Will Brantley, the landowner.

It appears that throughout the "Key Study Area", groundwater may be present, both in shallow lenses 30-60 feet deep and in deeper horizons i.e. 100-250 feet. Discussions with local water well drillers and landowners indicate that water quantity and quality can vary substantially both vertically and horizontally in short distances.

A good comparison of water quality is shown <u>in this GCR Section IV.2.C appendix.</u> (Comparison of Water Chemistry City of Carlsbad & OWU) that shows water quality in the Carlsbad Well Field versus the Otis Water Association Well Field. The Carlsbad field water is from the Capitan Aquifer whereas the Otis field water is from the alluvial aquifer.

For comparisons, the Total Dissolved Solids (TDS), Chlorides and Sulfates in the Carlsbad supply is approximately 527-72-91 mg/l respectfully versus 1533-530-853 mg/l for the Otis supply. The water found under the site would most likely be more in range of the Otis Water supply due to the influence from the Rustler formation and the CID-River water on groundwater in the area.

The Pecos river water was sampled at Avalon lake, the <u>analysis are included in this GCR IV.2.C appendix</u>. This water is the source of the CID water, and the results were 2400-537-1030 mg/l for Total Dissolved Solids (TDS), Chlorides and Sulfates respectfully.

GCR Section IV.2.C AOR Appendix

Includes:

1. Figure AOR-1 Key Energy Proposed Brine Well Water Well One-Mile Area of Review around UL E Section 31-Ts22s-R27e.
2. Comparison of water chemistry of city of Carlsbad & Otis Water (OWUC).
3. Carlsbad Irrigation District (CID) water chemistry collected from Avalon Lake. 2-pages.
4. Water Well Records from the NMOSE website downloads. 43-pages.

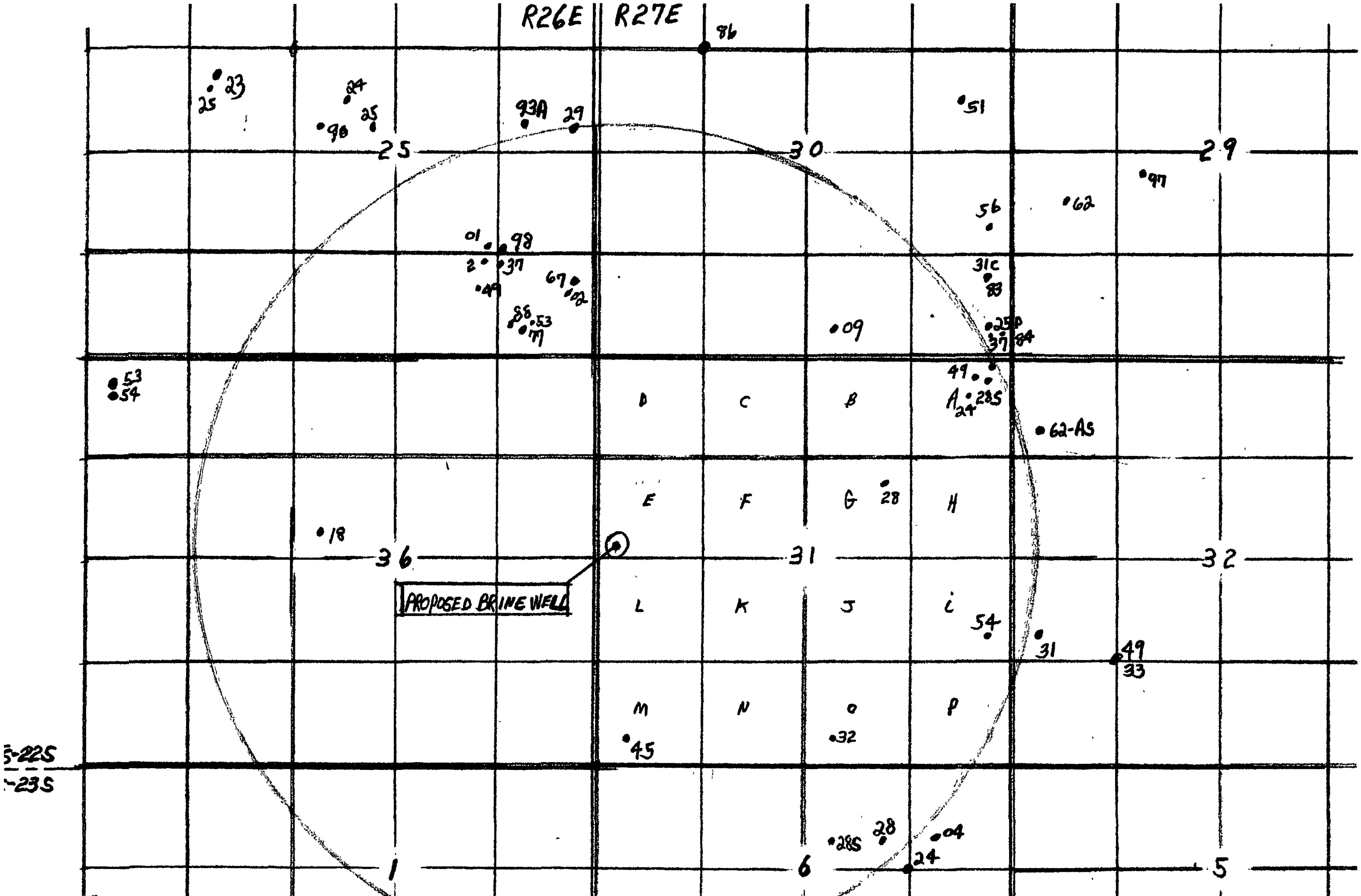


Figure AOR-1
Key Energy Proposed Brine Well
Water Well One Mile Area of Review (AOR)
Around UL E Section 31-Ts 22s-R27e

Note: Well locations were taken from the NM Office of the State Engineers' website. Wells were labeled by using the few last digits of the POD #. Example: Well #28 shown in UL G of Section 31-Ts 22s-R27e is well C00228 from the POD list attached.

COMPARISON OF WATER CHEMISTRY
CITY OF CARLSBAD & OWUC

	CARLSBAD mg/l	OWUC mg/l
ALKALINITY - M	232	170
ALKALINITY - P	0	0
TOTAL HARDNESS	360	1470
CALCIUM HARDNESS CACO3	200	910
MAGNESIUM	-	560
CHLORIDES	72	530
SULFATES	91	853
FLUORIDES	0.76	1 16
ph	7.38	7.03
SPECIFIC CONDUCTANCE (u-mhos/cm)	791	2710
TOTAL DISOLVED SOLIDS	527	1533
TURBIDITY	5	11

Michael W Robinson
Robinson Engineering
5812 Milliron
Carlsbad, New Mexico 88220
505-236-6253 Phone and Fax

BILL LAUER - AWWA 303-347-6220

Summary Report

Wayne Price
Key Energy Services-Carlsbad
1609 E. Green
Carlsbad, NM 88221

Report Date: November 22, 2010

Work Order: 10111014

Project Location: Lake Avalon (CID) Water
Project Name: New Carlsbad Brine Well
Project Number: NCBW-1

Sample	Description	Matrix	Date Taken	Time Taken	Date Received
250075	CID Water	water	2010-11-09	14:00	2010-11-10

Sample: 250075 - CID Water

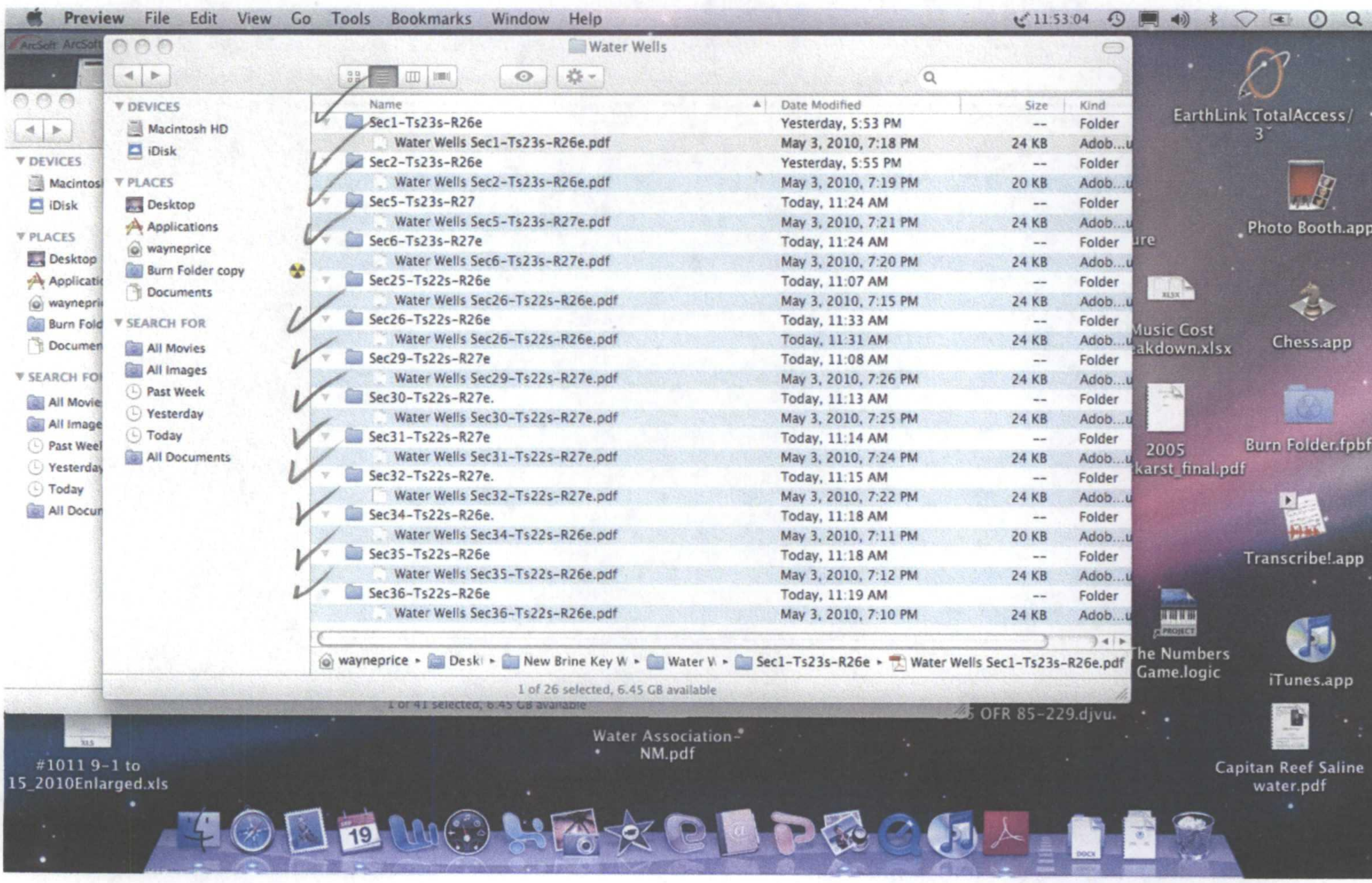
Param	Flag	Result	Units	RL
Total Silver		<0.00500	mg/L	0.00500
Total Aluminum		**0.475**	mg/L	0.0500
Hydroxide Alkalinity		<1.00	mg/L as CaCo3	1.00
Carbonate Alkalinity		<1.00	mg/L as CaCo3	1.00
Bicarbonate Alkalinity		**90.0**	mg/L as CaCo3	4.00
Total Alkalinity		**90.0**	mg/L as CaCo3	4.00
Total Arsenic		<0.0100	mg/L	0.0100
Total Boron		**0.208**	mg/L	0.0100
Total Barium		**0.0740**	mg/L	0.0100
Total Cadmium		<0.00500	mg/L	0.00500
Total Cobalt		<0.00500	mg/L	0.00500
Specific Conductance		**3640**	uMHOS/cm	0.00
Total Chromium		<0.0100	mg/L	0.0100
Total Copper		<0.00500	mg/L	0.00500
Density		**0.995**	g/ml	0.00
Total Iron		**0.299**	mg/L	0.0100
Total Mercury		<0.000200	mg/L	0.000200
Chloride		**537**	mg/L	2.50
Fluoride		<2.50	mg/L	0.500
Sulfate		**1030**	mg/L	2.50
Total Manganese		**0.0230**	mg/L	0.00500

continued ...

sample 250075 continued ...

Param	Flag	Result	Units	RL
Total Molybdenum		<0.0500	mg/L	0.0500
Total Nickel		<0.0100	mg/L	0.0100
Nitrite-N		**3.70**	mg/L	0.500
Nitrate-N	1	**6.67**	mg/L	0.500
Total Lead		<0.00500	mg/L	0.00500
pH		**8.08**	s.u.	2.00
Dissolved Calcium		**347**	mg/L	1.00
Dissolved Magnesium		**73.4**	mg/L	1.00
Dissolved Potassium		**1.56**	mg/L	1.00
Dissolved Sodium		**297**	mg/L	1.00
Total Selenium		<0.0200	mg/L	0.0200
Total Dissolved Solids		**2400**	mg/L	10.00
Total Cyanide		<0.0150	mg/L	0.0150
Total Uranium		<0.0300	mg/L	0.0300
Total Zinc		<0.00500	mg/L	0.00500

[1] Ran out of hold time due to rerun •



Preview File Edit View Go Tools Bookmarks Window Help
11:53:04
Water Wells
DEVICES
Macintosh HD
iDisk
PLACES
Desktop
Applications
wayneprice
Burn Folder copy
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All Images
Past Week
Yesterday
Today
All Documents
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8 wells

R26 R27E

25	30	29
36	31	32
1	2	6

T22S
23S

New Mexico Office of the State Engineer
Point of Diversion by Location
(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)
(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00032		IRR	0	LEWIS E. ALLEN LEWIS	ED	C 00032 1			3	3	4	31	22S	27E	572619	3578609*
C 00062		IRR	24.3	HOWARD HEMLER FARMS INC.	ED	C 00228 2.		Shallow	1	3	2	31	22S	27E	572613	3579617*
C 00228		IRR	-27.9	RAYMOND SPENCER	ED	C 00228		Shallow	1	3	2	31	22S	27E	572613	3579617*
					ED	C 00228 S 3		Shallow	2	2	2	31	22S	27E	573213	3580025*
C 00228 B		IRR	30	OTIS WATER USERS COOPERATIVE	ED	C 00228		Shallow	1	3	2	31	22S	27E	572613	3579617*
C 00228 C		IRR	36.9	RAYMOND SPENCER	ED	C 00228		Shallow	1	3	2	31	22S	27E	572613	3579617*
					ED	C 00228 S		Shallow	2	2	2	31	22S	27E	573213	3580025*
C 00228 D		IRR	15	KRIS & MARY MURRILL	ED	C 00228		Shallow	1	3	2	31	22S	27E	572613	3579617*
					ED	C 00228 S		Shallow	2	2	2	31	22S	27E	573213	3580025*
C 00228 E		IRR	55.8	RAYLENE SPENCER	ED	C 00228		Shallow	1	3	2	31	22S	27E	572613	3579617*
					ED	C 00228 S		Shallow	2	2	2	31	22S	27E	573213	3580025*
C 00228 F		IRR	195 6	DAVID SPENCER	ED	C 00228		Shallow	1	3	2	31	22S	27E	572613	3579617*
					ED	C 00228 S		Shallow	2	2	2	31	22S	27E	573213	3580025*
C 00249	C	DOM	0	CHARLES SPENCER	ED	C 00249 4.			2	2	2	31	22S	27E	573213	3580025*
C 01037	C	DOM	3	RAYMOND SPENCER	ED	C 01037 5.		Shallow	2	2	2	31	22S	27E	573213	3580025*
C 02624	C	DOM	3	MARY MURRILL	ED	C 02624 6		Shallow	3	2	2	31	22S	27E	573013	3579825*
C 02854	C	DOL	0	PAUL KARTCHNER	ED	C 02854 7			4	2	4	31	22S	27E	573219	3579016*
C 03445			0	DANNY STAFFORD	ED	C 03445 8		Shallow	3	3	3	31	22S	27E	571773	3578630

***UTM location was derived from PLSS - see Help**

		(acre ft per annum)						(quarters are 1=NW 2=NE 3=SW 4=SE) (quarters are smallest to largest)				(NAD83 UTM in meters)	
WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q q q 64 16 4	Sec	Tws	Rng	X	Y

Record Count: 18

POD Search:

POD Basin: Carlsbad

PLSS Search:

Section(s): 31 **Township:** 22S **Range:** 27E

Sorted by: File Number

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 00228		IRR	ED	1	3	2	31	22S	27E	572613	3579617*	210		
C 00228 S		IRR	ED	2	2	2	31	22S	27E	573213	3580025*	225	145	80
C 00249		DOM	ED	2	2	2	31	22S	27E	573213	3580025*	200		
C 01037		DOM	ED	2	2	2	31	22S	27E	573213	3580025*	141	109	32
C 02229		DOM	ED				31	22S	27E	572540	3579307*	200		
C 02624		DOM	ED	3	2	2	31	22S	27E	573013	3579825*	220	75	145
C 03078		DOM	ED	1	2	4	31	22S	27E	573019	3579216*	130	60	70
C 03161		STK	ED	3	1	1	31	22S	27E	571829	3579813*	200		
C 03279 POD1		DOM	ED	2	2	4	31	22S	27E	573219	3579216*	250		

Average Depth to Water: **97 feet**

Minimum Depth: **60 feet**

Maximum Depth: **145 feet**

Record Count: 9

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 31 Township: 22S Range: 27E

***UTM location was derived from PLSS - see Help**

21 WELLS

New Mexico Office of the State Engineer
Point of Diversion by Location
(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)
(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner		County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00031		IRR	7 5	CASH CLARKSTON		ED	C 00031		Shallow	3	1	3	32	22S	27E	573423	3579019*
C 00031 A		IRR	0	H E LOVETT		ED	C 00031		Shallow	3	1	3	32	22S	27E	573423	3579019*
C 00031 B		IRR	0	ROY THOMASON	1	ED	C 00031		Shallow	3	1	3	32	22S	27E	573423	3579019*
C 00031 E		IRR	30	OTIS WATER USERS COOP.		ED	C 00031		Shallow	3	1	3	32	22S	27E	573423	3579019*
C 00062 A		IRR	649.32	J&J FARMS	2	ED	C 00062 A-S		Shallow	3	1	1	32	22S	27E	573417	3579830*
C 00193		IRR	3 048	COUNTRY ACRES, INC.	3	ED	C 00193 & C-343-S	NA			3	2	32	22S	27E	574328	3579538*
					4	ED	C 00193 COMB-S-2	NA				2	32	22S	27E	574529	3579739*
					5	ED	C 00343		Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00193 COMB		IRR	39 258	COUNTRY ACRES INC.		ED	C 00343		Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00193 COMBC		IRR	3	ORLANDO & OLIVIA G. FLOREZ		ED	C 00343		Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00193 COMBD		IRR	3	COUNTRY ACRES, INC		ED	C 00343		Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00193 COMBE		IRR	3	PHILLIP L & CELESTE K STONE		ED	C 00343	NA	Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00193 COMBF		IRR	3	CHARLES T. & CHARLENE M MOOTS		ED	C 00343		Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00193 COMBG		IRR	3	ROY & RITA BROOKS		ED	C 00343		Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00193 COMBH		IRR	47 37	ROBERT & BETTY RUSSELL		ED	C 00193 COMBS				3	2	32	22S	27E	574328	3579538*
						ED	C 00193 COMBS2			2	3	2	32	22S	27E	574427	3579637*
						ED	C 00343		Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00193 COMBI		IRR	46 92	CHARLES E & NANCY ELLEN VAN ZANT REVOCABLE TRUST UTA		ED	C 00193 COMBS				3	2	32	22S	27E	574328	3579538*

*UTM location was derived from PLSS - see Help

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)

(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner		County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
						ED	C 00193 COMBS2			2	3	2	32	22S	27E	574427	3579637*
						ED	C 00343		Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00193 COMBJ		IRR	40 5	PATRICK L & FAYE WILSON		ED	C 00193 COMBS				3	2	32	22S	27E	574328	3579538*
						ED	C 00193 COMBS2			2	3	2	32	22S	27E	574427	3579637*
						ED	C 00343		Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00193 COMBK		IRR	7 356	MICHAEL LYNN ROGERS		ED	C 00343		Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00193 COMDK		IRR	7.356	MICHAEL LYNN & ANNA COLLE ROGERS		ED	C 00343		Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00204		IRR	4 2	MARY F PRICE	6	ED	C 00204		Shallow	3	3	2	32	22S	27E	574227	3579437*
C 00204 A		IRR	28.8	DAVID B CULP		ED	C 00204		Shallow	3	3	2	32	22S	27E	574227	3579437*
C 00343		IRR	0	CLAUDE L. SMITH		ED	C 00343	NA	Shallow	4	3	2	32	22S	27E	574427	3579437*
C 00430		IRR	23 4	F & W FARMS	7	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					8	ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 A		IRR	1 5	PAT D CHUMLEY		ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
						ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 B		IRR	1 5	ROY A & ANITA BETH TORRES		ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
						ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 C		IRR	1 5	MITCHELL L & DONNA L CARTER		ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
						ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 D		IRR	1.5	PETRICK M & DONANN B HEDDERMAN		ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
						ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 E		IRR	1 5	RAY & ANGELITA PARRAZ		ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
						ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*

*UTM location was derived from PLSS - see Help

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)
(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00430 F		IRR	1 5	ROBERT M &ROSIE C GOMEZ	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 G		IRR	1.5	RUBIN S ESQUIBEL	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 H		IRR	1.5	LOUIS G & SHELLY M ESCOBEDO	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 H-A		IRR	1 5	WAYNE T & JOHNIE BRADFORD	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 I		IRR	1.5	JIMMY P & KAREN P GENTRY	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					ED	C 00430 S	NA	Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 J		IRR	0.75	PAUL D & KIMBERLY ORR	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 K		IRR	1.5	DONALD R & BETTY K SUGGS	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 L		IRR	1.5	FRANK A & MARY E HAYS	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 M		IRR	18	BOBBY W & ANGELA PORTER	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 N		IRR	1 5	RALPH & ANITA CASTANEDA	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00430 O		IRR	1 5	ERNEST VALDEZ	ED	C 00430		Shallow	1	1	2	32	22S	27E	574225	3580043*
					ED	C 00430 S		Shallow	3	1	2	32	22S	27E	574225	3579843*

***UTM location was derived from PLSS - see Help**

			(acre ft per annum)							(quarters are 1=NW 2=NE 3=SW 4=SE) (quarters are smallest to largest)							(NAD83 UTM in meters)	
WR File Nbr	Sub basin	Use	Diversion	Owner		County	POD Number		Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00430 P		IRR	4 5	ROGELIO V OR PATSY G YBARRA		ED	C 00430			Shallow	1	1	2	32	22S	27E	574225	3580043*
						ED	C 00430 S	NA		Shallow	3	1	2	32	22S	27E	574225	3579843*
C 00619	C		0	GLEN E. BONE	9	ED	C 00619				3	3	2	32	22S	27E	574227	3579437*
C 00625		IRR	60	DOUGLAS C LYNN	10	ED	C 00625				3	3	2	32	22S	27E	574227	3579437*
C 01749	C	DOL	3	ANDY GRAHAN	11	ED	C 01749			Shallow			3	32	22S	27E	573728	3578915*
C 01833	C	DOL	3	FLOYD WILLIAM DIEL	12	ED	C 01833			Shallow			3	32	22S	27E	573728	3578915*
C 02262	C	DOM	3	TOMMY ALFORD	13	ED	C 02262			Shallow		4	2	32	22S	27E	574732	3579544*
C 02383	C	DOM	0	MICHAEL D GRAHAM	14	ED	C 02383				3	3	2	32	22S	27E	574227	3579437*
C 02502	C	DOL	3	AL CASTANEDA	15	ED	C 02502	NA		Shallow		2	2	32	22S	27E	574731	3579950*
C 02590	C	DOM	3	THOMAS G JOHNSON	16	ED	C 02590			Shallow	2	1	2	32	22S	27E	574425	3580043*
						ED	C 02590 POD2			Shallow	2	1	2	32	22S	27E	574425	3580043*
C 02841	C	DOM	0	JEFFERSON L BYRD	17	ED	C 02841				1	1	4	32	22S	27E	574230	3579231*
C 02882	C	DOL	0	JOE MORGAN	18	ED	C 02882				3	1	2	32	22S	27E	574225	3579843*
C 02970	C	DOL	3	RICK CALDERON	19	ED	C 02970	NA		Shallow	3	4	4	32	22S	27E	574635	3578630*
C 03028	C	DOL	3	TRENT KIRKEO	20	ED	C 03028			Shallow	1	1	2	32	22S	27E	574225	3580043*
C 03030	C	DOM	3	RUBEN FLORES	21	ED	C 03030			Shallow	3	1	2	32	22S	27E	574225	3579843*

***UTM location was derived from PLSS - see Help**

The data is furnished by the NMOSE/ISC and is accepted by the recipient with the expressed understanding that the OSE/ISC make no warranties, expressed or implied, concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the data

9 WELLS

New Mexico Office of the State Engineer
Point of Diversion by Location
(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)

(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner		County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00355	C	CLS	0	US SMELTING REGINING & MINING	1	ED	C 00355				1	4	01	23S	26E	571131	3577484*
C 01647	C	DOM	3	ROY LANEY	2	ED	C 01647		Shallow	4	3	3	01	23S	26E	570414	3576969*
C 01665	C	DOM	3	L D. SHIRLEY	3	ED	C 01665			4	4	3	01	23S	26E	570822	3576975*
C 01754	C	DOL	0	JUAN GONZALEZ	4	ED	C 01754	0 - NA		1	3	3	01	23S	26E	570214	3577169*
C 01960	C	DOL	3	FRANCISCO LEYVA	5	ED	C 01960		Shallow	3	3	3	01	23S	26E	570214	3576969*
C 01985	C	DOL	3	ALLISON M KIVEL	6	ED	C 01985		Shallow		4	3	01	23S	26E	570723	3577076*
C 02044	C	DOL	0	BOB D BURNETT	7	ED	C 02044			1	4	3	01	23S	26E	570622	3577175*
C 02429	C	DOL	3	CASIMIRO G HERNANDEZ	8	ED	C 02429		Shallow	1	4	3	01	23S	26E	570622	3577175*
C 02853	C	DOL	3	ERASMO T ROMOS	9	ED	C 02853		Shallow	1	3	3	01	23S	26E	570214	3577169*

Record Count: 9

POD Search:

POD Basin: Carlsbad

PLSS Search:

Section(s): 1 **Township:** 23S **Range:** 26E

Sorted by: File Number

***UTM location was derived from PLSS - see Help**

7 wells

New Mexico Office of the State Engineer
Point of Diversion by Location
(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)

(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner		County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00028		IRR	232	HOWARD HEMLER FARMS	1	ED	C 00028		Shallow	4	1	2	06	23S	27E	572824	3578207*
					2	ED	C 00028 S		Shallow	3	1	2	06	23S	27E	572624	3578207*
C 00028 A		IRR	227 27	PHILLIP L. WALTERSCHEID		ED	C 00028		Shallow	4	1	2	06	23S	27E	572824	3578207*
						ED	C 00028 S		Shallow	3	1	2	06	23S	27E	572624	3578207*
C 00624	C		0	HOWARD HEMLER	3	ED	C 00624					2	06	23S	27E	572932	3578106*
C 01420		EXP	0	HOWARD HEMLER	4	ED	C 01420 — NA			3	1	4	06	23S	27E	572636	3577400*
C 01757	C	DOL	0	STANLEY VEST	5	ED	C 01757 — NA				4	3	06	23S	27E	572341	3577095*
C 01900	C	DOL	0	R G STONE	6	ED	C 01900 — NA			1	2	3	06	23S	27E	572234	3577597*
C 02604	C	PRO	3	DOUGLAS C LYNN JR	7	ED	C 02604		Shallow	3	1	2	06	23S	27E	572624	3578207*

Record Count: 9

POD Search:

POD Basin: Carlsbad

PLSS Search:

Section(s): 6 **Township:** 23S **Range:** 27E

Sorted by: File Number

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer
Point of Diversion by Location
(with Owner Information)

No PODs found.

POD Search:

POD Basin: Carlsbad

PLSS Search:

Section(s): 2 **Township:** 23S **Range:** 26E

10 WELLS

New Mexico Office of the State Engineer
Point of Diversion by Location
(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)
(acre ft per annum)

	WR File Nbr	Sub basin	Use	Diversion	Owner		County	POD Number		Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
	C 00025		IRR	0	WILLIAMS JACK D	1	ED	C 00025	NA			1	1	3	05	23S	27E	573439	3577608*
	C 00176		IRR	0	LOPEZ ANGELA	2	ED	C 00176				1	1	4	05	23S	27E	574244	3577618*
	C 00296		DOM	0	ANGEL LOPEZ	3	ED	C 00296					1	4	05	23S	27E	574345	3577519*
	C 00323	C	DOL	0	U L. WILLIS	4	ED	C 00323					4	4	05	23S	27E	574750	3577122*
	C 01670	C	DOM	3	CHARLES AUGUSTUS	5	ED	C 01670				4	4	2	05	23S	27E	574842	3577826*
	C 01671	C	DOL	3	PASCUAL M. LOPEZ	6	ED	C 01671	✓			3	3	1	05	23S	27E	573434	3577811*
	C 01976	C	DOM	3	EFREN B COLLINS	7	ED	C 01976	NA			3	1	2	05	23S	27E	574236	3578224*
	C 02710	C	DOL	3	TREY GREENWOOD	8	ED	C 02710			Shallow			4	05	23S	27E	574550	3577318*
	C 02711	C	DOL	3	ROSS KIRKES	9	ED	C 02711			Shallow		4	4	05	23S	27E	574750	3577122*
	C 03020	C	DOM	3	O R DAKAN	10	ED	C 03020	✓		Shallow		4	4	05	23S	27E	574750	3577122*

Record Count: 10

POD Search:

POD Basin: Carlsbad

PLSS Search:

Section(s): 5 **Township:** 23S **Range:** 27E

Sorted by: File Number

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer
Point of Diversion by Location
(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)
(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 02792		MON	0	IMC	ED	C 02792				4	3	04	23S	29E	594868	3577336*
C 02793		MON	0	IMC	ED	C 02793				4	3	04	23S	29E	594868	3577336*
C 02794		MON	0	IMC	ED	C 02794				4	3	10	23S	29E	596518	3575731*
C 02795		MON	0	IMC	ED	C 02795				4	3	10	23S	29E	596518	3575731*
C 02796		MON	0	IMC	ED	C 02796				2	3	22	23S	28E	586882	3572838*
C 02797		MON	0	IMC	ED	C 02797				2	3	22	23S	29E	596540	3572895*
C 02804		MON	0	IMC	ED	C 02804				2	1	08	23S	29E	593262	3576905*
C 02805		MON	0	IMC	ED	C 02805				2	1	08	23S	29E	593262	3576905*
C 02806		MON	0	IMC	ED	C 02806				1	1	09	23S	29E	594473	3576927*
C 02807		MON	0	IMC	ED	C 02807				1	1	09	23S	29E	594473	3576927*
C 02808		MON	0	IMC	ED	C 02808				2	3	16	23S	29E	594909	3574501*
C 02809		MON	0	IMC	ED	C 02809				2	3	16	23S	29E	594909	3574501*

***UTM location was derived from PLSS - see Help**

Record Count: 12

POD Search:

POD Basin: Carlsbad

Owner Name Search:

Owner Name: IMC*

Sorted by: File Number

New Mexico Office of the State Engineer

Point of Diversion by Location

(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)

WR File Nbr	Sub basin	Use	Diversion (acre ft per annum)	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00110		IND	4152.46	MOSIAC POTASH CARLSBAD INC	ED	C 00110		Artesian	4	3	4	30	21S	27E	572751	3589924*
					ED	C 00111			4	3	4	30	21S	27E	572751	3589924*

Record Count: 2

POD Search:

POD Basin: Carlsbad

Owner Name Search:

Owner Name: MOSIAC*

Sorted by: File Number

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer
Water Right Summary

WR File Number: C 00110
Primary Purpose: IND INDUSTRIAL
Primary Status: PMT PERMIT
Total Acres: 0
Total Diversion: 4152.46
Owner: MOSIAC POTASH CARLSBAD INC.
Contact: DONALD J PURVIS

Documents on File

Doc	File/Act	Status 1	Status 2	Status 3	Transaction Desc.	From/To	Acres	Diversion	Consumptive
COWNF	2006-06-07	CHG	PRC	PRC	C-110 AND C-111	T	0	0	
CPUR	2004-04-12	PMT	APR	PRC	C 110 & C 111	T	0	150	
CPUR	2004-04-12	PMT	APR	PRC	C 110 & C 111	F	0	150	
CPPU	2003-09-23	APP	CAN	PRC	C-110 & C-111	T	0	300	
CPPU	2003-09-23	APP	CAN	PRC	C-110 & C-111	F	0	300	
COWNP	2000-02-08	PMT	APR	PRC	C-110 AND C-111-A	F	0	2300	
ADM	1999-10-29	PMT	MTR	ABS	C 00110	T	0	6452.46	

Point of Diversion

(NAD83 UTM in meters)

POD Number	Source	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Other Location Desc
C 00110	Artesian	4	3	4	30	21S	27E	572751	3589924*	
C 00111		4	3	4	30	21S	27E	572751	3589924*	

*An (*) after northing value indicates UTM location was derived from PLSS - see Help

Place of Use

Q 256	Q 64	Q 16	Q 4	Sec	Tws	Rng	Acres	Diversion	CU	Use	Priority	Status	Other Location Desc
	4	3	4	30	21S	27E	0	4152.46		IND		APP	

Source

Acres	Diversion	CU	Use	Priority	Source	Description
0	6452.46		IND		GW	
0	150		IND	08/31/1947	GW	ARTESIAN
0	150		COM	08/31/1947	GW	ARTESIAN
0	4152.46		IND		GW	

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 00853		DOM	ED	1	1	1	36	22S	26E	570181	3580043*	164		
C 00853		MUN	ED	1	1	1	36	22S	26E	570181	3580043*	164		
C 00854		DOM	ED	1	1	1	36	22S	26E	570181	3580043*	166		
C 00854		MUN	ED	1	1	1	36	22S	26E	570181	3580043*	166		
C 01018		DOM	ED	3	4	1	36	22S	26E	570603	3579422*	125	115	10

Average Depth to Water: **115 feet**

Minimum Depth: **115 feet**

Maximum Depth: **115 feet**

Record Count: 5

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 36 **Township:** 22S **Range:** 26E

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 00062		IRR	ED		1	3	29	22S	27E	573511	3580743*	270		
C 00559		STK	ED	3	4	4	29	22S	27E	574628	3580255*	200		
C 00597		DOM	ED	1	2	3	29	22S	27E	573815	3580848*	140	90	50
C 00745		EXP	CH				29	22S	27E	574117	3580940*	250		
C 02598		DOM	ED	3	3	1	29	22S	27E	573407	3581048*	250		
C 02631		DOM	ED	4	4	2	29	22S	27E	574823	3581067*	96	69	27
C 02648		DOM	ED		4	2	29	22S	27E	574724	3581168*	200	66	134
C 02648		PRO	ED		4	2	29	22S	27E	574724	3581168*	200	66	134
C 02667		DOM	ED	1	3	4	29	22S	27E	574223	3580448*	128	81	47
C 03130		PRO	ED	4	2	1	29	22S	27E	574010	3581461*	162		
C 03434 POD1		DOM	ED	4	4	2	29	22S	27E	574876	3581101	100	75	25

Average Depth to Water: **74 feet**

Minimum Depth: **66 feet**

Maximum Depth: **90 feet**

Record Count: 11

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 29 **Township:** 22S **Range:** 27E

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer

Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 00031 C		IRR	ED	1	4	4	30	22S	27E	573010	3580430*	204	172	32
C 00451		IRR	ED		4	2	30	22S	27E	573104	3581143*	256	130	126
C 01086		DOM	ED			1	30	22S	27E	572121	3581328*	200	140	60
C 01184		DOM	ED	4	4	4	30	22S	27E	573210	3580230*	144	131	13
C 01356		DOM	ED	4	2	4	30	22S	27E	573207	3580636*	210	130	80
C 01691		DOM	ED	3	1	1	30	22S	27E	571816	3581434*	210	68	142
C 02409		DOM	ED	2	1	4	30	22S	27E	572803	3580831*	191	90	101
C 03123		DOM	ED	2	2	4	30	22S	27E	573207	3580836*	159		
C 03157		STK	ED	1	4	1	30	22S	27E	572196	3581231*	173	100	73

Average Depth to Water: **120 feet**

Minimum Depth: **68 feet**

Maximum Depth: **172 feet**

Record Count: 9

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 30 **Township:** 22S **Range:** 27E

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 00228		IRR	ED	1	3	2	31	22S	27E	572613	3579617*	210		
C 00228 S		IRR	ED	2	2	2	31	22S	27E	573213	3580025*	225	145	80
C 00249		DOM	ED	2	2	2	31	22S	27E	573213	3580025*	200		
C 01037		DOM	ED	2	2	2	31	22S	27E	573213	3580025*	141	109	32
C 02229		DOM	ED				31	22S	27E	572540	3579307*	200		
C 02624		DOM	ED	3	2	2	31	22S	27E	573013	3579825*	220	75	145
C 03078		DOM	ED	1	2	4	31	22S	27E	573019	3579216*	130	60	70
C 03161		STK	ED	3	1	1	31	22S	27E	571829	3579813*	200		
C 03279 POD1		DOM	ED	2	2	4	31	22S	27E	573219	3579216*	250		

Average Depth to Water: **97 feet**

Minimum Depth: **60 feet**

Maximum Depth: **145 feet**

Record Count: 9

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 31 **Township:** 22S **Range:** 27E

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 00031		IRR	ED	3	1	3	32	22S	27E	573423	3579019*	208	170	38
C 00062 A-S		IRR	ED	3	1	1	32	22S	27E	573417	3579830*	200	100	100
C 00204		DOM	ED	3	3	2	32	22S	27E	574227	3579437*	170		
C 00204		IRR	ED	3	3	2	32	22S	27E	574227	3579437*	170		
C 00343		IRR	ED	4	3	2	32	22S	27E	574427	3579437*	200		
C 00619		DOM	ED	3	3	2	32	22S	27E	574227	3579437*	250		
C 01749		DOM	ED			3	32	22S	27E	573728	3578915*	156	126	30
C 01833		DOM	ED			3	32	22S	27E	573728	3578915*	180	155	25
C 02124		DOM	ED		3	3	32	22S	27E	573527	3578714*	195	60	135
C 02262		DOM	ED		4	2	32	22S	27E	574732	3579544*	128	60	68
C 02383		DOM	ED	3	3	2	32	22S	27E	574227	3579437*	175		
C 02487		DOM	ED	1	3	2	32	22S	27E	574227	3579637*	150	70	80
C 02502		DOM	ED	1	2	4	32	22S	27E	574633	3579237*	98	64	34
C 02590		DOM	ED	2	1	2	32	22S	27E	574425	3580043*	300	114	186
C 02841		DOM	ED	1	1	4	32	22S	27E	574230	3579231*	150		
C 02970		DOM	ED	3	4	4	32	22S	27E	574635	3578630*	138	71	67
C 03028		DOM	ED	1	1	2	32	22S	27E	574225	3580043*	217	89	128
C 03030		DOM	ED	3	1	2	32	22S	27E	574225	3579843*	100	53	47
C 03070		DOM	ED	1	4	4	32	22S	27E	574635	3578830*	250		
C 03085		DOM	ED	2	2	2	32	22S	27E	574830	3580049*	155	82	73
C 03179		DOM	ED	1	1	3	32	22S	27E	573423	3579219*	200		

***UTM location was derived from PLSS - see Help**

Average Depth to Water: **93 feet**

Minimum Depth: **53 feet**

Maximum Depth: **170 feet**

Record Count: 21

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 32 **Township:** 22S **Range:** 27E

New Mexico Office of the State Engineer

Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 00296		DOM	ED		1	4	05	23S	27E	574345	3577519*	225		
C 00323		DOM	ED		4	4	05	23S	27E	574750	3577122*	200		
C 01670		DOM	ED	4	4	2	05	23S	27E	574842	3577826*	385		
C 01671		DOM	ED	3	3	2	05	23S	27E	574240	3577821*	350	0	350
C 01976		DOM	ED	3	1	2	05	23S	27E	574236	3578224*	250		
C 02710		DOM	ED			4	05	23S	27E	574550	3577318*	200	72	128
C 02711		DOM	ED		4	4	05	23S	27E	574750	3577122*	170	75	95
C 03020		DOM	ED		4	4	05	23S	27E	574750	3577122*	176	135	41
C 03093		DOM	ED	3	1	2	05	23S	27E	574236	3578224*	250		
C 03098		DOM	ED	3	4	2	05	23S	27E	574642	3577826*	250		
C 03190		DOM	ED	2	2	4	05	23S	27E	574846	3577624*	200		
C 03273 POD1		DOM	ED	1	4	4	05	23S	27E	574649	3577221*	200		

Average Depth to Water: **70 feet**

Minimum Depth: **0 feet**

Maximum Depth: **135 feet**

Record Count: 12

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 5 **Township:** 23S **Range:** 27E

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 00028		IRR	ED	4	1	2	06	23S	27E	572824	3578207*	200		
C 00028 S		IRR	ED	3	1	2	06	23S	27E	572624	3578207*	231	190	41
C 00624		DOM	ED			2	06	23S	27E	572932	3578106*	300		
C 02151		DOM	ED		4	3	06	23S	27E	572341	3577095*	196	130	66

Average Depth to Water: **160 feet**

Minimum Depth: **130 feet**

Maximum Depth: **190 feet**

Record Count: 4

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 6 **Township:** 23S **Range:** 27E

***UTM location was derived from PLSS - see Help**

Water Column/Average Depth to Water

No records found.

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 2 **Township:** 23S **Range:** 26E

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 01647		DOM	ED	4	3	3	01	23S	26E	570414	3576969*	260	210	50
C 01665		DOM	ED	4	4	3	01	23S	26E	570822	3576975*	278		
C 01960		DOM	ED	3	3	3	01	23S	26E	570214	3576969*	242	200	42
C 01985		DOM	ED		2	3	01	23S	26E	570724	3577479*	216	185	31
C 02080		DOM	ED	2	4	3	01	23S	26E	570822	3577175*	240	190	50
C 02081		DOM	ED	2	4	3	01	23S	26E	570822	3577175*	240	190	50
C 02257		DOM	ED		3	3	01	23S	26E	570315	3577070*	247	175	72
C 02429		DOM	ED	1	4	3	01	23S	26E	570622	3577175*	300	140	160
C 02853		DOM	ED	1	3	3	01	23S	26E	570214	3577169*	218	196	22
C 03118		DOM	ED	2	4	3	01	23S	26E	570822	3577175*	260	210	50

Average Depth to Water: **188 feet**

Minimum Depth: **140 feet**

Maximum Depth: **210 feet**

Record Count: 10

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 1 **Township:** 23S **Range:** 26E

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 01053		DOM	ED	2	1	1	26	22S	26E	568742	3581654*	173	71	102
C 01243		DOM	ED		3	1	26	22S	26E	568647	3581149*	200	15	185
C 01506		DOM	ED		3	2	26	22S	26E	569456	3581151*	330		
C 01535		DOM	ED		1	1	26	22S	26E	568643	3581555*	150		
C 01630		DOM	ED		2	1	26	22S	26E	569047	3581557*	155	120	35
C 01655		DOM	ED		4	3	26	22S	26E	569059	3580343*	400		
C 01811		DOM	ED	2	2	1	26	22S	26E	569146	3581656*	250		
C 01863		DOM	ED		1	1	26	22S	26E	568643	3581555*	137	103	34

Average Depth to Water: **77 feet**

Minimum Depth: **15 feet**

Maximum Depth: **120 feet**

Record Count: 8

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 26 **Township:** 22S **Range:** 26E

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 00090		DOM	ED	3	4	1	25	22S	26E	570576	3581045*	65		
C 00167		DOM	ED	1	4	4	25	22S	26E	571411	3580427*	210		
C 00193 A		IRR	ED	3	4	2	25	22S	26E	571405	3581032*	280	190	90
C 00198		DOM	ED			4	25	22S	26E	571298	3580540*	160	145	15
C 00223		IRR	ED	1	3	1	25	22S	26E	570162	3581251*	300		
C 00225		IRR	ED	4	4	1	25	22S	26E	570776	3581045*	235		
C 00226		DOM	ED	1	2	1	25	22S	26E	570572	3581657*	230		
C 00244		DOM	ED	1	4	1	25	22S	26E	570576	3581245*	250	96	154
C 00245		DOM	ED	2	2	2	25	22S	26E	571601	3581642*	250		
C 00277		MUL	ED	3	4	4	25	22S	26E	571411	3580227*	265	147	118
C 00324		DOM	ED		4	1	25	22S	26E	570677	3581146*	200	96	104
C 00325		DOM	ED	2	3	1	25	22S	26E	570362	3581251*	138	68	70
C 00334		MUL	ED	1	4	1	25	22S	26E	570576	3581245*	300	78	222
C 00338		DOM	ED	1	1	1	25	22S	26E	570158	3581664*	119		
C 00358		DOM	ED	1	2	1	25	22S	26E	570572	3581657*	189	81	108
C 00401 RPR		DOM	ED			4	25	22S	26E	571298	3580540*	250	180	70
C 00435		DOM	ED	4	4	1	25	22S	26E	570776	3581045*	153	134	19
C 00452		DOM	ED	2	2	1	25	22S	26E	570772	3581657*	300		
C 00482		DOM	ED	3	3	1	25	22S	26E	570162	3581051*	152		
C 00482 CLW		DOM	XX	3	3	1	25	22S	26E	570162	3581051*	152		
C 00529		DOM	ED	4	4	2	25	22S	26E	571605	3581032*	198		
C 00553		DOM	ED	2	3	1	25	22S	26E	570362	3581251*	140	90	50
C 00568		DOM	ED		1	2	25	22S	26E	571088	3581550*	300		
C 00579		DOM	ED	3	4	1	25	22S	26E	570576	3581045*	127	109	18
C 00639		DOM	ED	3	2	1	25	22S	26E	570572	3581457*	138	85	53
C 00666		DOM	ED	2	2	1	25	22S	26E	570772	3581657*	180	92	88
C 00682		DOM	ED	2	1	1	25	22S	26E	570358	3581664*	145		
C 00723		DOM	ED	3	1	1	25	22S	26E	570158	3581464*	128	87	41
C 00735		DOM	ED	4	2	1	25	22S	26E	570772	3581457*	138	118	20

***UTM location was derived from PLSS - see Help**

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 00737		DOM	ED	2	3	4	25	22S	26E	571196	3580438*	300		
C 00739		DOM	ED	2	4	1	25	22S	26E	570776	3581245*	200		
C 00761		DOM	ED				25	22S	26E	570871	3580963*	220	186	34
C 00763		DOM	ED	3	4	1	25	22S	26E	570576	3581045*	130	99	31
C 00789		DOM	ED			1	25	22S	26E	570464	3581353*	300		
C 00826		DOM	ED				25	22S	26E	570871	3580963*	200		
C 00878		DOM	ED	4	2	1	25	22S	26E	570772	3581457*	125	90	35
C 00902		DOM	ED	1	4	4	25	22S	26E	571411	3580427*	305		
C 00937		DOM	ED			1	25	22S	26E	570464	3581353*	204	132	72
C 00956		DOM	ED	4	2	1	25	22S	26E	570772	3581457*	125	86	39
C 00968		DOM	ED		1	1	25	22S	26E	570259	3581565*	128	86	42
C 01013		DOM	ED			4	25	22S	26E	571298	3580540*	245		
C 01024		DOM	ED			1	25	22S	26E	570464	3581353*	130	95	35
C 01075		DOM	ED	4	4	1	25	22S	26E	570776	3581045*	118	90	28
C 01076		DOM	ED	3	1	1	25	22S	26E	570158	3581464*	110	69	41
C 01121		DOM	ED	4	3	1	25	22S	26E	570362	3581051*	125	102	23
C 01125		DOM	ED	3	2	1	25	22S	26E	570572	3581457*	140	101	39
C 01127		DOM	ED	3	2	1	25	22S	26E	570572	3581457*	140	101	39
C 01135		DOM	ED			1	25	22S	26E	570464	3581353*	140	120	20
C 01141		DOM	ED			1	25	22S	26E	570464	3581353*	218	140	78
C 01149		DOM	ED			4	25	22S	26E	571298	3580540*	245	170	75
C 01153		DOM	ED	3	4	4	25	22S	26E	571411	3580227*	290		
C 01193		DOM	ED	1	4	1	25	22S	26E	570576	3581245*	120	110	10
C 01196		DOM	ED	3	4	1	25	22S	26E	570576	3581045*	175		
C 01235		EXP	ED		1	2	25	22S	26E	571088	3581550*	580	205	375
C 01369		DOM	ED		3	2	25	22S	26E	571091	3581140*	170	158	12
C 01370		DOM	ED	3	3	2	25	22S	26E	570990	3581039*	240	70	170
C 01372		DOM	ED	4	3	2	25	22S	26E	571190	3581039*	210	195	15
C 01439		DOM	ED			1	25	22S	26E	570464	3581353*	140	100	40
C 01459		PRO	ED		3	2	25	22S	26E	571091	3581140*	205	190	15
C 01681		DOM	ED	2	3	1	25	22S	26E	570362	3581251*	150	60	90
C 01739		DOM	ED				25	22S	26E	570871	3580963*	160	90	70

*UTM location was derived from PLSS - see Help

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 01772		DOM	ED	2	1	1	25	22S	26E	570358	3581664*	270	250	20
C 02102		DOM	ED			1	25	22S	26E	570464	3581353*	135	115	20
C 02156		DOM	ED	1	1	1	25	22S	26E	570158	3581664*	100	45	55
C 02328		DOM	ED			1	25	22S	26E	570464	3581353*	385	92	293
C 02328 REPAR		DOM	ED	2	2	1	25	22S	26E	570772	3581657*	385	92	293
C 02450		DOM	ED	1	1	1	25	22S	26E	570158	3581664*	135		
C 02540		DOM	ED			1	25	22S	26E	570464	3581353*	400		
C 02938		DOM	ED	1	1	1	25	22S	26E	570158	3581664*	400		
C 03036		DOM	ED	3	2	1	25	22S	26E	570572	3581457*	400		

Average Depth to Water: **116 feet**

Minimum Depth: **45 feet**

Maximum Depth: **250 feet**

Record Count: 70

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 25 Township: 22S Range: 26E

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters) (In feet)

POD Number	Sub basin	Use	County	Q 64	Q 16	Q 4	Sec	Tws	Rng	X	Y	Depth Well	Depth Water	Water Column
C 00852		MUN	ED	2	2	2	35	22S	26E	569979	3580038*	200		
C 01601		DOM	ED	2	3	2	35	22S	26E	569590	3579619*	94	57	37

Average Depth to Water: **57 feet**

Minimum Depth: **57 feet**

Maximum Depth: **57 feet**

Record Count: 2

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 35 **Township:** 22S **Range:** 26E

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer
Water Column/Average Depth to Water

No records found.

Basin/County Search:

Basin: Carlsbad

PLSS Search:

Section(s): 34 **Township:** 22S **Range:** 26E

GCR Section IV.2.D- Review of Public Water Systems

The New Mexico Environment Department (NMED), Drinking Water Branch, monitors all public water systems in the state. A list of all water systems of Eddy County, NM was down loaded from the NMED website and included in this GCR IV.2.D section appendix. The well system locations were identified by downloading the individual Water System Permit # and obtaining the actual address or telephone numbers. Locations that did not provide a location or address were called to make that determination.

Any water system that was identified to be within 5 miles of the proposed brine well, or to be of significant size, or was actually located down-gradient, was investigated and noted herein with comments:

Carlsbad Municipal Water Supply- The original water wells for the city of Carlsbad were located mostly in and around the town. After extensive development of the area after WWII the quality of the water begin to diminish drastically and the wells were moved to the Sheep Draw area southwest of town located more or less in Sections 8,9,12,24,34 and 35 of Township 23s and Range 25e. The main reason for the reduced water quality was noted to have been the extensive drawdown and additional influx of Pecos River water from the CID storage area Lake Avalon.

Carlsbad also receives water from a well field located approximately 25-30 miles to the northeast up on the Llano Estacado Caprock area. The wells are completed in the Ogallala formation along with many of the Potash Company well fields.

Otis MDWCA- The Otis MDWCA currently has its active well field located in Cass draw area approximately 5-6 miles southeast of the Key Study area. The wells are located in Section 21 and 23 of Township 23s-Range 27e.

Loving Water System- The Loving Water System also receives water from the Cass draw area up-stream from the Otis wells. It is located in section 25-Ts23s-R 26e.

Malaga MDWC &SWA- Has an active well within the 5 mile review, located about 1200 feet north of the Otis Wells in Section 23-Township 23s-Range 27e; This well was pointed out by Mr.Cutter Rogers-Otis MDWCA on a field trip to visit the wells.

WIPP Water Supply- According to the City of Carlsbad, the WIPP water supply is from the Carlsbad Water System.

Potash Mines- The main companies are Intreprid and Mosiac. Intrepid company representative, Mr. Donnie Cantrell, provided a map of the Potash Caprock water systems included in this GCR IV.2.D appendix. He indicated Intrepid receives water exclusively from the water well fields located 20-25 miles to the northeast from the Llano Estacado Caprock area.

Mosiac Potash did not return our call, but according to the OSE records, Mosiac has a large well field located just northeast of Carlsbad on the east side of the river. The POD number is C00110 and the point of diversion is located in Sec 32-Ts21s-R27e. This is approximately 6 miles to the north-northeast of the proposed brine well site. These wells are probably part of the old Carlsbad water system well field of many years ago, or in close proximity.

Potash companies in the past have had wells in the valley, mostly north of the proposed brine well location. According to the state engineers office in Roswell (Mr. Tim Williams) a lot of the water rights for these wells have been state purchased and retired so the inter-state stream commission can meet its water delivery down-stream. However, there are some wells still operated by the potash industry southeast of Carlsbad east of the Pecos River producing mostly out of the brine aquifer.

Port of Entry Carlsbad- The Port of Entry is a Department of Public Safety function and has an office located on National Parks HWY about 4.5 miles southwest of the proposed brine well site. There is one water well located on site in section 15 -Ts 23s-R26e.

Happy Valley Cooperative Water Works- Happy Valley is a small farm and ranch type community located just west of Carlsbad about 5 miles to the north-north-west of the proposed Brine Well Location.

Fountain Steak Room- This was an abandoned site located on the west side of Carlsbad about 5 miles to the north-northwest of the proposed Brine Well Location. Recently, the site appears to have been converted to a private day care center.

Westwinds Mobil Home Park- Located in the southwest part of Carlsbad at the end of Harding Road. The site has two wells and is approximately 3.9 miles north-northwest of the proposed brine well.

Black River Village- A small private community located approximately 10 miles south-south-west of the proposed Brine well in section 23-Ts24s-R26e.

GCR Section IV.2.D Public Water Systems Appendix

Includes:

1. A list of all water systems of Eddy County, NM was down-loaded from the NMED website.
2. Map of the Potash Caprock water systems.

Return Links

Water System Search

County Map

Glossary

Drinking Water Branch

Water Systems

	Water System No.	Water System Name	Type	Status	Principal County Served	Pr S V
NA	NM3520308	ARTESIA MUNICIPAL WATER SYSTEM	C	A	EDDY	
NA	NM3530608	ARTESIA RURAL WATER COOPERATIVE	C	A	EDDY	
NA	NM3500813	B & B HALFWAY BAR & GRILL	NC	A	EDDY	
C	NM3592008	BLACK RIVER CENTER FOR LEARNING	NC	A	EDDY	
NA	NM3592308	BRANTLEY LAKE STATE PARK	NC	A	EDDY	
	NM3521008	CAPROCK WATER COMPANY	C	A	EDDY	
NA	NM3594008	CARC WASHINGTON RANCH	NC	A	EDDY	
NA	NM3549408	CARLSBAD CAVERNS NATIONAL PARK	C	A	EDDY	
NA	NM3500208	CARLSBAD KOA	NC	A	EDDY	
C	NM3520608	CARLSBAD MUNICIPAL WATER SYSTEM	C	A	EDDY	
NA	NM3555008	COTTONWOOD WATER CO-OPERATIVE artesia area	C	A	EDDY	
NA	NM3590308	GUADALUPE ADMIN. SITE - LINCOLN - USFS	NC	A	EDDY	
NA	NM3591108	GUADALUPE CHRISTIAN CAMP	NC	A	EDDY	
NA	NM3520708	HAPPY VALLEY COOPERATIVE WATER WORKS West side	C	A	EDDY	
NA	NM3520808	HOPE WATER SYSTEM	C	A	EDDY	
C	NM3590608	INTREPID POTASH - EAST	NTNC	A	EDDY	
C	NM3590708	INTREPID POTASH - WEST	NTNC	A	EDDY	
C	NM3521108	LOVING WATER SYSTEM copy	C	A	EDDY	
C	NM3521208	MALAGA MDWC & SWA copy	C	A	EDDY	
NA	NM3520408	MORNINGSIDE WATER USERS COOPERATIVE Artesia	C	A	EDDY	
C	NM3591308	MOSAIC POTASH CARLSBAD INC	NTNC	A	EDDY	
NA	NM3510508	NORTH PARK MDWCA Roswell/Artesia	C	A	EDDY	
C	NM3521308	OTIS MDWCA	C	A	EDDY	
NA	NM3598108	QUEEN CAFE & RV	NC	A	EDDY	
NA	NM3520508	RIVERSIDE MDWA Artesia	C	A	EDDY	
NA	NM3590208	SITTING BULL FALLS AREA LINCOLN - USFS	NC	A	EDDY	
NA	NM3592708	SKP RV PARK Lakewood	NC	A	EDDY	
C NA	NM3565508	WESTWINDS MOBILE HOME PARK	C	A	EDDY	

[redacted]

VA	NM3521408	WHITES CITY WATER SYSTEM	C	A	EDDY
VA	NM3598008	WIPP WATER SUPPLY CMW	NTNC	A	EDDY
C	NM3590908	EDDY POTASH CORPORATION	NTNC	I	EDDY
VA	NM3591508	FOUNTAIN STEAK ROOM	NC	I	EDDY
	NM3555708	HEATH TRAILER PARK	C	I	EDDY
C	NM3590408	HORIZON POTASH CORPORATION	NTNC	I	EDDY
VA	NM3593608	MONTERREY CONSTRUCTION	NTNC	I	EDDY
C	NM3500108	NORMAS POTABLE WATER SERVICE QUEEN HWY	C	I	EDDY
C	NM3593508	PORT OF ENTRY #2 - CARLSBAD	NC	I	EDDY
VA	NM3580008	PUREFILL WATER CENTER	NC	I	EDDY
VA	NM3591708	PURIFIED WATER VENDING MACHINE #1	NC	I	EDDY
VA	NM3591908	PURIFIED WATER VENDING MACHINE #2	NC	I	EDDY
VA	NM3592108	PURIFIED WATER VENDING MACHINE #3	NC	I	EDDY
VA	NM3580108	SOUTHWEST PURITY WATER	NC	I	EDDY
VA	NM3591608	SPORT TEE ARTESIA	NC	I	EDDY

Total Number of Records Fetched = 43

Links

[Water System Facilities]
[Sample Schedules]
[Coliform Sample Results]
[Coliform Sample Summary Results]
[Lead And Copper Sample Summary Results]
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Drinking Water Branch

Water System Details

Water System No. :	NM3520608	**Federal Type :**	C
Water System Name :	CARLSBAD MUNICIPAL WATER SYSTEM	**State Type :**	C
Principal County Served :	EDDY	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977

Points of Contact

Name	Job Title	Type	Phone	Address	Email
CAMERO, LUIS	ADMIN CONTACT	AC	575-885-6313	PO BOX 1569, CARLSBAD, NM 88220	Not Available
HAAG, JON R	null	LE	575-887-1191	PO BOX 1569, CARLSBAD, NM 88220	Not Available
HERNANDEZ, MIKE	null	OP	575-887-1191	PO BOX 1569, CARLSBAD, NM 88220	Not Available
HERNANDEZ, MIKE	null	SA	575-887-1191	PO BOX 1569, CARLSBAD, NM 88220	Not Available
ABELL, MIKE	WATER SUPERINTENDENT	DO	575-885-6313	PO BOX 1569, CARLSBAD, NM 88221	water@cityofcarlsbadnm.com

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	27000

Service Connections

Type	Count	Meter Type	Meter Size Measure
CB	10891	MU	0

Sources of Water

Service Areas

[redacted]

Name	Type Code	Status
C-1	WL	A
C-2	WL	A
C-3	WL	A
C-5	WL	A
C-6	WL	A
CAPROCK #10	WL	A
CAPROCK #13	WL	A
CAPROCK #16	WL	A
CAPROCK #17	WL	A
CAPROCK #18	WL	A
CAPROCK #20	WL	A
CAPROCK #6	WL	A
FRONTIER #3	WL	A
WELL #1	WL	A
WELL #1 (AMBASSADOR #1)	WL	A
WELL #2	WL	A
WELL #2 (AMBASSADOR #3)	WL	A
WELL #3	WL	A
WELL #3 (AMBASSADOR #4)	WL	A
WELL #4	WL	A
WELL #5	WL	A
WELL #7	WL	A
WELL #8	WL	A
WELL #9	WL	A
C-4	WL	I
CAPROCK #1	WL	I
CAPROCK #14	WL	I
CAPROCK #15A	WL	I
CAPROCK #19	WL	I
CAPROCK #2	WL	I
CAPROCK #21	WL	I
CAPROCK #3	WL	I
CAPROCK #4	WL	I
CAPROCK #5	WL	I
FRONTIER #1	WL	I

Code	Name
R	RESIDENTIAL AREA

[redacted]

HUDSON #1	WL	I
WELL #6	WL	I

Water Purchases

Seller Water System No.	Water System Name	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

New Mexico Office of the State Engineer

Point of Diversion by Location

(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)

(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00047 A		IRR	60	CITY OF CARLSBAD	ED	C 00047		Artesian	4	2	3	11	22S	26E	569146	3585507*
					ED	C 00047 A		Shallow	2	3	2	26	21S	27E	579218	3591043*
					ED	C 00047 EXPL		Artesian	3	2	4	26	21S	27E	579429	3590444*
C 00076		MUN	9517.15	CITY OF CARLSBAD	ED	C 00076 S		Artesian	1	1	2	26	21S	26E	569357	3591378*
					ED	C 00076 S 13			4	1	2	24	23S	25E	561575	3573235*
					ED	C 00076 S-10				3	3	12	23S	25E	560662	3575383*
					ED	C 00076 S-11				1	1	13	23S	25E	560660	3574977*
					ED	C 00076 S-12		Artesian	3	1	3	28	21S	26E	565310	3590334*
					ED	C 00076 S-2			1	2	2	36	21S	26E	571377	3589720*
					ED	C 00076 S-3				3	3	01	23S	25E	560685	3576993*
					ED	C 00076 S-4				4	3	02	23S	25E	559473	3576991*
					ED	C 00076 S-5				3	4	02	23S	25E	559893	3576993*
					ED	C 00076 S-6				4	4	01	23S	25E	561871	3576979*
					ED	C 00076 S-7				1	2	12	23S	25E	561470	3576576*
					ED	C 00076 S-8				1	3	12	23S	25E	560667	3575783*
					ED	C 00076 S-9			1	3	4	01	23S	25E	561369	3577077*
					ED	C 00080			3	3	2	01	22S	26E	570976	3587510*
					ED	C 00081			3	3	2	01	22S	26E	570976	3587510*

*UTM location was derived from PLSS - see Help

(quarters are 1=NW 2=NE 3=SW 4=SE)

(acre ft per annum) (quarters are smallest to largest) (NAD83 UTM in meters)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
					ED	C 00082			3	3	2	01	22S	26E	570976	3587510*
					ED	C 00083			3	3	2	01	22S	26E	570976	3587510*
					ED	C 00084						01	22S	26E	570853	3587440*
					ED	C 00085			3	3	2	01	22S	26E	570976	3587510*
					ED	C 00386						35	21S	26E	569254	3588988*
					ED	C 00387			1	4	4	35	21S	26E	569774	3588501*
					ED	C 00889 X			4	4	2	34	23S	25E	558766	3569570*
					ED	C 00889 X2			4	3	2	24	23S	25E	561578	3572830*
					ED	C 00889 X3			2	2	2	08	23S	25E	555414	3576642*
C 00076 EFF		NRT	1413 96	CITY OF CARLSBAD	ED	C 00076 EFF		Artesian	3	4	1	10	22S	27E	577027	3585973*
C 00113 A		IRR	0	CITY OF CARLSBAD	ED	C 00113			3	4	4	11	22S	26E	569748	3585109*
					ED	C 00113 & C-446-S		Shallow	3	1	2	14	22S	26E	569347	3584700*
					ED	C 00446			1	3	2	14	22S	26E	569345	3584495*
C 00129 A		IRR	0	CITY OF CARLSBAD	ED	C 00129		Artesian			4	30	21S	27E	572853	3590226*
C 00170	CUB	MUN	0	CITY OF CARLSBAD	ED	C 00170		Shallow	2	2	1	02	22S	26E	569154	3588102*
C 00180		IRR	419.1	CITY OF CARLSBAD	ED	C 00180		Artesian	3	4	1	11	22S	26E	568943	3585915*
					ED	C 00180 S		Artesian	1	2	1	11	22S	26E	568940	3586522*
C 00446		IRR	294 9	CITY OF CARLSBAD	ED	C 00113			3	4	4	11	22S	26E	569748	3585109*
					ED	C 00113 & C-446-S		Shallow	3	1	2	14	22S	26E	569347	3584700*
					ED	C 00446			1	3	2	14	22S	26E	569345	3584495*
C 00484 ETAL		IRR	7250.075	CITY OF CARLSBAD	ED	C 00484			1	4	2	14	23S	28E	589198	3574994*
					ED	C 00484 S-3			4	4	2	14	23S	28E	589398	3574794*

*UTM location was derived from PLSS - see Help

(acre ft per annum)

(quarters are 1=NW 2=NE 3=SW 4=SE)

(quarters are smallest to largest) (NAD83 UTM in meters)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
					ED	C 00484 S-5			4	4	2	14	23S	28E	589398	3574794*
					ED	C 00484 S-7			4	4	1	07	24S	29E	591877	3566702*
C 00632		COM	15	CITY OF CARLSBAD	ED	C 00632		Artesian	2	2	2	32	21S	27E	574773	3589785*
C 00652 D		IRR	18	CITY OF CARLSBAD	ED	C 00652			2	4	4	29	21S	27E	574771	3590188*
C 00852		MUN	61.24	CITY OF CARLSBAD	ED	C 00852		Shallow	2	2	2	35	22S	26E	569979	3580038*
					ED	C 00853			1	1	1	36	22S	26E	570181	3580043*
					ED	C 00854			1	1	1	36	22S	26E	570181	3580043*
C 00853		DOM	0	CITY OF CARLSBAD	ED	C 00853			1	1	1	36	22S	26E	570181	3580043*
C 00854		DOM	0	CITY OF CARLSBAD	ED	C 00854			1	1	1	36	22S	26E	570181	3580043*
C 01819		EXP	0	CITY OF CARLSBAD	ED	C 01819 M			1	1	2	29	22S	28E	583878	3581796*
					ED	C 01819 M-2			1	1	3	29	22S	28E	583100	3580974*
					ED	C 01819 M-3			1	2	3	29	22S	28E	583497	3580983*
					ED	C 01819 M-4			4	1	4	29	22S	28E	584094	3580791*
					ED	C 01819 M-5			1	3	3	28	22S	28E	584698	3580604*
					ED	C 01819 M-6			2	2	2	32	22S	28E	584510	3580194*
					ED	C 01819 M-7			1	4	1	33	22S	28E	585119	3579801*
					ED	C 01819 M-8			4	3	1	29	22S	28E	583295	3581177*
					ED	C 01819 M-9			3	1	2	30	22S	28E	582297	3581579*
C 01849		IRR	12.6	CITY OF CARLSBAD	ED	C 01849		Shallow	2	2	2	14	22S	26E	569947	3584904*
C 02733	C	SAN	3	CITY OF CARLSBAD	ED	C 02733			3	1	3	28	21S	26E	565310	3590334*
C 02874	C	STK	3	CITY OF CARLSBAD	ED	C 02874		Artesian	4	3	2	11	22S	25E	559796	3585738*
C 02875	C	STK	3	CITY OF CARLSBAD	ED	C 02875		Artesian	4	2	1	02	22S	26E	569154	3587902*

***UTM location was derived from PLSS - see Help**

WR File Nbr	Sub basin	Use	Diversion (acre ft per annum)	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X (NAD83 UTM in meters)	Y
C 02876	C	STK	3	CITY OF CARLSBAD	ED	C 02876		Artesian	4	3	2	28	22S	26E	566332	3581028*
C 02877	C	STK	3	CITY OF CARLSBAD	ED	C 02877		Artesian	4	1	4	09	23S	25E	556607	3575633*
C 02878	C	STK	3	CITY OF CARLSBAD	ED	C 02878		Shallow	4	4	4	12	23S	25E	561975	3575258*
C 02879	C	STK	3	CITY OF CARLSBAD	ED	C 02879		Artesian	3	3	1	35	23S	25E	558965	3569565*
SP 01934 A		IRR	271 9	CITY OF CARLSBAD	ED	C 00474					3	32	21S	27E	573665	3588666*

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest)

Record Count: 67

POD Search:

POD Basin: Carlsbad

Owner Name Search:

Owner Name: CITY OF CARLSBAD*

Sorted by: File Number

***UTM location was derived from PLSS - see Help**

New Mexico Office of the State Engineer

Point of Diversion by Location

(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)
(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00064 E		IRR	14 4	CARLSBAD MUNICIPAL SCHOOLS	ED	C 00064			1	1	1	32	21S	27E	573360	3589769*
C 00110 A		IND	2300	CITY OF CARLSBAD	ED	C 00110		Artesian	4	3	4	30	21S	27E	572751	3589924*
					ED	C 00111			4	3	4	30	21S	27E	572751	3589924*
C 00129 AA		IRR	13 5	CARLSBAD MUNICIPAL SCHOOLS	ED	C 00129 A		Shallow	1	4	3	30	21S	27E	572148	3590116*
C 00161		IRR	338 6	CARLSBAD NATIONAL BANK	ED	C 00161		Artesian	3	1	3	25	21S	26E	570178	3590368*
C 00177	C	DOM	3	CARLSBAD BROADCASTING CORP	ED	C 00177		Shallow			1	13	22S	26E	570449	3584603*
C 00201		IRR	13 8	CARLSBAD IRRIGATION DISTRICT	ED	C 00201		Shallow		4	3	30	21S	27E	572249	3590017*
C 00373		IRR	75165	CARLSBAD IRRIGATION DISTRICT	ED	C 00373			2	1	2	13	22S	26E	571176	3584905*
					ED	C 00374			2	2	1	13	22S	26E	570761	3584906*
					ED	C 00375			3	1	2	13	22S	26E	570976	3584705*
C 00974	C	DOM	3	CARLSBAD CITY SCHOOLS	ED	C 00974					3	35	25S	26E	569074	3549831*
C 00975	C	DOM	3	CARLSBAD CITY SCHOOLS	ED	C 00975					3	35	21S	26E	568852	3588586*
C 00978	C	SAN	3	BOARD OF EDUCATION CARLSBAD MUNICIPAL SCHOOL DIST	ED	C 00978		Shallow	3	3	2	18	22S	27E	572582	3584295*
					ED	C 00978 POD2		Shallow	3	3	2	18	22S	27E	572582	3584295*
C 00979	C	SAN	3	BOARD OF EDUCATION CARLSBAD MUNICIPAL SCHOOL DIST	ED	C 00979		Shallow	4	4	2	02	22S	26E	569959	3587519*
					ED	C 00979 POD2			4	4	2	02	22S	26E	569959	3587519*
C 00996	C	SAN	3	BOARD OF EDUCATION CARLSBAD MUNICIPAL SCHOOL DIST	ED	C 00996				4	3	35	21S	26E	569062	3588392*
C 01197	C	DOM	3	CARLSBAD SUPPLY CO.	ED	C 01197					2	06	22S	27E	572860	3587825*

***UTM location was derived from PLSS - see Help**

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)
(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 01422	CUB	IRR	42	CARLSBAD ARC FARM INC	ED	C 01422		Artesian		4	1	25	21S	26E	570674	3590864*
C 02378		IRR	18.51	CARLSBAD BOARD OF EDUCATION	ED	C 02378		Shallow	2	4	3	01	22S	26E	570760	3586925*
C 02407	C	STK	3	ROSWELL DISTRICT CARLSBAD RESOURCE AREA	ED	C 02407		Shallow	1	4	1	08	26S	26E	564347	3547268*
C 02902		IRR	240	CARLSBAD MUNICIPAL SCHOOLS	ED	C 01287		Shallow	2	1	1	12	22S	26E	570349	3586530*
C 02948		EXP	0	US DEPT OF ENERGY CARLSBAD FIELD OFFICE, WIPP	ED	C 02948 EXPL			2	1	1	12	22S	30E	609106	3586801*
C 02949		EXP	0	US DEPT OF ENERGY CARLSBAD FIELD OFFICE, WIPP	ED	C 02949 EXPL		Artesian	1	1	4	34	21S	31E	616140	3589231*
C 02950		EXP	0	US DEPT OF ENERGY CARLSBAD FIELD OFFICE, WIPP	ED	C 02950 EXPL		Shallow	4	2	4	23	22S	30E	608740	3582576*
C 02953		EXP	0	U.S DEPT OF ENERGY CARLSBAD FIELD OFFICE, WIPP	ED	C 02953 EXPL		Artesian	1	3	1	16	21S	31E	613662	3594434*
C 02954		EXP	0	U.S DEPARTMENT OF ENERGY CARLSBAD FIELD OFFICE, WIPP	ED	C 02954 EXPL		Shallow	3	1	4	20	23S	31E	613114	3572906*
C 02960		EXP	0	US DEPT. OF ENERGY CARLSBAD FIELD OFFICE, WIPP	ED	C 02960 EXPL			3	3	3	31	22S	31E	610620	3578915*
C 03451		MUL	3	CARLSBAD ARC FARM INC	ED	C 01422		Artesian		4	1	25	21S	26E	570674	3590864*

Record Count: 29

POD Search:

POD Basin: Carlsbad

Owner Name Search:

Owner Name: CARLSBAD*

Sorted by: File Number

***UTM location was derived from PLSS - see Help**

ON Top of CAPRock

BRINE WELLS off of 124

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Water System Details

Water System No. :	NM3590608	Federal Type :	NTNC
Water System Name :	INTREPID POTASH - EAST -	State Type :	NTNC
Principal County Served :	EDDY	Primary Source :	GW
Status :	A	Activity Date :	06-01-1977

Points of Contact

Name	Job Title	Type	Phone	Address	Email
JACKSON, JACK		OP	575-369-5512	PO BOX 101, CARLSBAD, NM-88220	Not Available
CANTRELL, DONNIE	4PM 361-7030	DO	575-234-3877	PO BOX 101, CARLSBAD, NM-88220	Not Available
NICHOLS, JERRY		OP	575-361-7074	PO BOX 101, CARLSBAD, NM-88220	Not Available
CLARKSTON, EDDIE		OP	575-887-5591	PO BOX 101, CARLSBAD, NM-88220	Not Available
KERTIS, JIM		AC	575-234-3881	P O BOX 101, CARLSBAD, NM-88220	Not Available
MCGUIRE, TOM		OP	575-887-5591	PO BOX 101, CARLSBAD, NM-88220	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	NT	254

Service Connections

Type	Count	Meter Type	Meter Size Measure
CB	35	MU	0

Sources of Water

Name	Type	Status

Service Areas

Code	Name

Name	Code	Status
WELL #1	WL	A
WELL #10	WL	A
WELL #11	WL	A
WELL #5	WL	A
WELL #6	WL	A
WELL #7	WL	A
WELL #8	WL	A
WELL #9	WL	A

Code	Name
NT	INDUSTRIAL/AGRICULTURAL

Water Purchases

Seller Water System No.	Water System Name	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

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Drinking Water Branch

Water System Details

Water System No. :	NM3521308	Federal Type :	C
Water System Name :	OTIS MDWCA	State Type :	C
Principal County Served :	EDDY	Primary Source :	GW
Status :	A	Activity Date :	06-01-1977

Points of Contact

Name	Job Title	Type	Phone	Address	Email
ALLEN, LAURA	LEVEL II WATER	OP	575-236-6351	PO BOX 5069, CARLSBAD, NM 88221	Not Available
FUGATE, GERALD	null	AC	575-236-6351	PO BOX 5069, CARLSBAD, NM 88221	Not Available

cutter Rogers

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	5000

Service Connections

Type	Count	Meter Type	Meter Size Measure
CB	1402	MU	0

Sources of Water

Name	Type Code	Status
WELL #2	WL	A
WELL #3	WL	A
WELL #4	WL	A
WELL #5 (COLWELL WELL)	WL	A
WELL #1	WL	I

Service Areas

Code	Name
R	RESIDENTIAL AREA

New Mexico Office of the State Engineer

Point of Diversion by Location

(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)

(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00014 B		IRR	0	OTIS WATER USERS COOPERATIVE	ED	C 00014		Shallow	3	2	3	28	22S	27E	575434	3580672*
					ED	C 00014 S		Shallow	3	3	1	28	22S	27E	575028	3581074*
C 00031 E		IRR	30	OTIS WATER USERS COOP	ED	C 00031		Shallow	3	1	3	32	22S	27E	573423	3579019*
C 00193 COMBB		IRR	15	OTIS WATER USERS COOPERATIVE	ED	C 00193		Shallow	1	3	1	33	22S	27E	575035	3579649*
C 00228 A		MUN	1246 516	OTIS WATER USERS COOPERATIVE	ED	C 00228 A		Shallow	2	2	4	20	23S	27E	574871	3572782*
					ED	C 00228 AS		Shallow	2	2	4	20	23S	27E	574871	3572782*
					ED	C 00228 AS2		Shallow	1	1	3	21	23S	27E	575074	3572788*
C 00228 B		IRR	30	OTIS WATER USERS COOPERATIVE	ED	C 00228		Shallow	1	3	2	31	22S	27E	572613	3579617*
C 00343 AA		MDW	36.21	OTIS WATER USER'S CO-OPERATIVE	ED	C 00193		Shallow	1	3	1	33	22S	27E	575035	3579649*
C 00518 A		MDW	123 9	OTIS WATER USERS CO OP	ED	C 00518		Shallow	1	1	3	23	23S	27E	578310	3572840*
					ED	C 00518 POD2		Shallow	2	4	4	22	23S	27E	578105	3572431*
C 00621 A		IRR	45	OTIS WATER USERS CO-OP	ED	C 00621		Shallow		4	2	19	22S	27E	573094	3582771*
C 00621 B		IRR	9	OTIS WATER USERS CO-OP	ED	C 00621		Shallow		4	2	19	22S	27E	573094	3582771*
C 00644		IRR	23.25	OTIS MDWC & SWA	ED	C 00644		Shallow	3	2	4	33	22S	27E	576251	3579056*
C 00853 T		MUN	0	OTIS WATER USERS CO-OP	ED	C 00853			1	1	1	36	22S	26E	570181	3580043*
C 01246 AJ		IRR	0	OTIS WATER USERS COOPERATIVE	ED	C 01246		Shallow	3	3	3	20	22S	27E	573401	3581860*
					ED	C 01246 X		Shallow	3	1	1	29	22S	27E	573404	3581454*
					ED	C 01246 X-2		Shallow	3	3	1	29	29S	27E		

***UTM location was derived from PLSS - see Help**

WR File Nbr	Sub basin	Use	Diversion (acre ft per annum)	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X (NAD83 UTM in meters)	Y
					ED	C 01246 X-3		Shallow	3	4	1	29	22S	27E	573812	3581054*
C 01259		EXP	0	OTIS WATERUSERS COOP.	ED	C 01259						15	23S	27E	577393	3574528*
C 01260		EXP	0	OTIS WATERUSERS COOP	ED	C 01260						16	23S	27E	575775	3574503*
C 01261		EXP	0	OTIS WATERUSERS COOP.	ED	C 01261		Shallow				21	23S	27E	575780	3572889*
C 01571		IRR	28 5	OTIS WATER USERS COOP.	ED	C 01571			3	2	3	01	22S	26E	570565	3587120*
C 03219		EXP	0	OTIS WATER CO-OP	ED	C 00518 POD2		Shallow	2	4	4	22	23S	27E	578105	3572431*

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest)

Record Count: 24

POD Search:

POD Basin: Carlsbad

Owner Name Search:

Owner Name: OTIS*

Sorted by: File Number

***UTM location was derived from PLSS - see Help**

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Drinking Water Branch

Water System Details

Water System No. :	NM3521208	**Federal Type :**	C
Water System Name :	MALAGA MDWC & SWA	**State Type :**	C
Principal County Served :	EDDY	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977

Points of Contact

Name	Job Title	Type	Phone	Address	Email
MOORE, GEORGE		OP	575-745-2913	PO BOX 70, MALAGA, NM-88263	Not Available
OGDEN, CRAIG		FC	575-745-2913	10 BLACK RIVER VILLAGE RD, MALAGA, NM-88263	Not Available
CARRASCO, LUPE		AC	575-745-2913	PO BOX 70, MALAGA, NM-88263	Not Available
CARRASCO, LUPE		DO	575-745-2913	PO BOX 70, MALAGA, NM-88263	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	1400

Service Connections

Type	Count	Meter Type	Meter Size Measure
RS	260	ME	0

Sources of Water

Name	Type Code	Status
WELL #1	WL	A
LOVING WSS CC	CC	I

Service Areas

Code	Name
R	RESIDENTIAL AREA

New Mexico Office of the State Engineer
Point of Diversion by Location
(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)
(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00231 A		MDW	201 6	MALAGA WATER USERS CO-OP	ED	C 00231		Shallow	3	3	3	18	23S	28E	581529	3573896*
					ED	C 00231 AS		Shallow	4	1	1	23	23S	27E	578512	3573447*
					ED	C 00231 S		Shallow	4	4	4	13	23S	27E	581326	3573891*
C 00346	C	SAN	3	MALAGA SCHOOL	ED	C 00346		Shallow		2	2	15	24S	28E	587715	3565591*
C 00498 ENL		IRR	0	MALAGA WATER USERS ASSOCIATION	ED	C 00498		Shallow	4	1	1	23	23S	27E	578512	3573447*
C 01353		EXP	0	MALAGA W.U.A	ED	C 01353				2	2	30	23S	27E	573163	3571851*

Record Count: 6

POD Search:

POD Basin: Carlsbad

Owner Name Search:

Owner Name: MALAGA*

Sorted by: File Number

***UTM location was derived from PLSS - see Help**

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Drinking Water Branch

Water System Details

Water System No. :	NM3593508	**Federal Type :**	NC
Water System Name :	PORT OF ENTRY #2 - CARLSBAD	**State Type :**	NC
Principal County Served :	EDDY	**Primary Source :**	GW
Status :	I	**Activity Date :**	01-29-1993

Points of Contact

Name	Job Title	Type	Phone	Address	Email
MASTERS, GEORGE	null	OP	575-885-2026	8507 NATIONAL PARKS HIGHWAY, CARLSBAD, NM-88220	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	T	75

Service Connections

Type	Count	Meter Type	Meter Size Measure
CB	1	UM	0

Sources of Water

Name	Type Code	Status
WELL # 1 (Z-1015)	WL	I

Service Areas

Code	Name
T	OTHER TRANSIENT AREA

Water Purchases

Seller Water System No.	Water System Name	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

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Drinking Water Branch

Water System Details

Water System No. :	NM3565508	Federal Type :	C
Water System Name :	WESTWINDS MOBILE HOME PARK	State Type :	C
Principal County Served :	EDDY	Primary Source :	GW
Status :	A	Activity Date :	06-01-1977

HARDING
"WEST SIDE"

Points of Contact

Name	Job Title	Type	Phone	Address	Email
GASTON, RUSSEL	null	OP	575-887-9573	2505 COLFAX ST, CARLSBAD, NM-88220	Not Available
ANDERSON, HOWARD	null	AC	575-640-2666	PO BOX 1311, ALAMOGORDO, NM-88311	Not Available
ANDERSON, HOWARD	null	OW	575-640-2666	PO BOX 1311, ALAMOGORDO, NM-88311	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	165

Service Connections

Type	Count	Meter Type	Meter Size Measure
CB	59	MU	0

Sources of Water

Name	Type Code	Status
WELL #1	WL	A
WELL #2	WL	A

Service Areas

Code	Name
R	MOBILE HOME PARK

Water Purchases

Seller Water System No.	Water System Name	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

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Drinking Water Branch

Water System Details

Water System No. :	NM3500108	**Federal Type :**	C
Water System Name :	NORMAS POTABLE WATER SERVICE	**State Type :**	C
Principal County Served :	EDDY	**Primary Source :**	GW
Status :	I	**Activity Date :**	08-21-1996

Points of Contact

Name	Job Title	Type	Phone	Address	Email
RODGERS, JOE	null	OW	575-981-2423	3652 QUEEN HWY, CARLSBAD, NM-88220	Not Available
RODGERS, NORMA	null	OP	575-981-2423	3652 QUEEN HWY, CARLSBAD, NM-88220	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	30

Service Connections

Type	Count	Meter Type	Meter Size Measure
CB	1	UM	0

Sources of Water

Name	Type Code	Status
WELL # 1	WL	I

Service Areas

Code	Name
R	RESIDENTIAL AREA

Water Purchases

Seller Water System No.	Water System Name	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

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Water System Details

Water System No. :	NM3592008	Federal Type :	NC
Water System Name :	BLACK RIVER CENTER FOR LEARNING	State Type :	NC
Principal County Served :	EDDY	Primary Source :	GW
Status :	A	Activity Date :	10-01-1983

Points of Contact

Name	Job Title	Type	Phone	Address	Email
MILLER, WILLIAM	ADMIN CONTACT & OPER	AC	575-785-2361	1159 BLACK RIVER VILLAGE RD, CARLSBAD, NM 88220	Not Available
MILLER, WILLIAM	ADMIN CONTACT & OPER	OP	575-785-2361	1159 BLACK RIVER VILLAGE RD, CARLSBAD, NM 88220	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	T	65

Service Connections

Type	Count	Meter Type	Meter Size Measure
RS	6	UM	0

Sources of Water

Name	Type Code	Status
WELL #2	WL	A
WELL #1	WL	I

Service Areas

Code	Name
O	OTHER AREA

Water Purchases

Seller Water System No.	Water System Name	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

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Water System Details

Water System No. :	NM3520708	**Federal Type :**	C
Water System Name :	HAPPY VALLEY COOPERATIVE WATER WORKS	**State Type :**	C
Principal County Served :	EDDY	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977

Points of Contact

Name	Job Title	Type	Phone	Address	Email
WILSHER, JOHN	null	FC	575-885-3661	312 BLUEBIRD ST., CALRSBAD, NM-88220	Not Available
HARVEY, JOE P.	null	OP	575-885-3661	312 BLUEBIRD STREET, CARLSBAD, NM-88220	Not Available
WASHBURN, SHIRLEY	null	AC	575-361-4778	312 Bluebird St., CARLSBAD, NM-88220	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	615

Service Connections

Type	Count	Meter Type	Meter Size Measure
CB	247	ME	0

Sources of Water

Name	Type Code	Status
WELL #2	WL	A
WELL #1	WL	I

Service Areas

Code	Name
R	RESIDENTIAL AREA

Water Purchases

Seller Water System No.	Water System Name	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

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Water System Details

Water System No. :	NM3590908	Federal Type :	NTNC
Water System Name :	EDDY POTASH CORPORATION	State Type :	NTNC
Principal County Served :	EDDY	Primary Source :	GW
Status :	I	Activity Date :	12-15-1997

Points of Contact

Name	Job Title	Type	Phone	Address	Email
CARRILLO, JIM	null	OP	505-857-8085	1801 4TH ST NW, ALBUQUERQUE, NM-87102	Not Available

? 2 W RD R

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	NT	800

Service Connections

Type	Count	Meter Type	Meter Size Measure
CB	1	UM	0

Sources of Water

Name	Type Code	Status
WELL # 1	WL	I
WELL # 2	WL	I
WELL # 3	WL	I
WELL # 4	WL	I
WELL # 5	WL	I
WELL # 6	WL	I

Service Areas

Code	Name
NT	INDUSTRIAL/AGRICULTURAL

#6		
WELL #7	WL	I
WELL #8	WL	I

Water Purchases

Seller Water System No.	Water System Name	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

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Water System Details

Water System No. :	NM3590408	Federal Type :	NTNC
Water System Name :	HORIZON POTASH CORPORATION	State Type :	NTNC
Principal County Served :	EDDY	Primary Source :	GW
Status :	I	Activity Date :	12-01-1993

Points of Contact

Name	Job Title	Type	Phone	Address	Email
QUITBERG, LEO	null	OP	575-885-3157	PO BOX 279, CARLSBAD, NM-88220	Not Available

DISCONNECT

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	NT	100

Service Connections

Type	Count	Meter Type	Meter Size Measure
CB	1	UM	0

Sources of Water

Name	Type Code	Status
WELL #1	WL	I
WELL #2	WL	I
WELL #3	WL	I
WELL #4	WL	I
WELL #5	WL	I
WELL #6	WL	I

Service Areas

Code	Name
NT	INDUSTRIAL/AGRICULTURAL

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Water System Details

Water System No. :	NM3591308	**Federal Type :**	NTNC
Water System Name :	MOSAIC POTASH CARLSBAD INC	**State Type :**	NTNC
Principal County Served :	EDDY	**Primary Source :**	GW
Status :	A	**Activity Date :**	06-01-1977

Points of Contact

Name	Job Title	Type	Phone	Address	Email
BOWEN, JOHN	null	AC	575-887-2871	PO BOX 71, CARLSBAD, NM 88220	Not Available
BOWEN, JOHN	null	DO	575-887-2871	PO BOX 71, CARLSBAD, NM 88220	Not Available
JACKSON, JACK		OP	575-369-5512	PO BOX 101, CARLSBAD, NM 88220	Not Available
KARTCHNER, PAUL		OP	575-887-2871	PO BOX 71, CARLSBAD, NM 88220	Not Available
RUSSO, MELODY	SAMPLER	SA	575-628-6544	PO BOX 17, CARLSBAD, NM 88220	Melody.Russo@Mosaicco.com

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	NT	500

Service Connections

Type	Count	Meter Type	Meter Size Measure
CB	1	UM	0

Sources of Water

Name	Type Code	Status
WELL #1	WL	A

Service Areas

Code	Name
NT	INDUSTRIAL/AGRICULTURAL

WELL #2	WL	A
WELL #3	WL	A
WELL #4	WL	A
WELL #5	WL	A
WELL #6	WL	A
WELL #7	WL	A
WELL #8	WL	A
WELL #9	WL	A
WELL C-110 #2 (LA HUERTA NORTH WELL)	WL	A
WELL C-111 #1 (LA HUERTA SOUTH WELL)	WL	A

Water Purchases

Seller Water System No.	Water System Name	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.

New Mexico Office of the State Engineer

Point of Diversion by Location

(with Owner Information)

(acre ft per annum) — (quarters are 1=NW 2=NE 3=SW 4=SE) (quarters are smallest to largest) (NAD83 UTM in meters)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00231 A		MDW	201.6	MALAGA WATER USERS CO-OP	ED	C 00231		Shallow	3	3	3	18	23S	28E	581529	3573896*
					ED	C 00231 AS		Shallow	4	1	1	23	23S	27E	578512	3573447*
					ED	C 00231 S		Shallow	4	4	4	13	23S	27E	581326	3573891*
C 00346	C	SAN	3	MALAGA SCHOOL	ED	C 00346		Shallow		2	2	15	24S	28E	587715	3565591*
C 00498 ENL		IRR	0	MALAGA WATER USERS ASSOCIATION	ED	C 00498		Shallow	4	1	1	23	23S	27E	578512	3573447*
C 01353		EXP	0	MALAGA W.U.A.	ED	C 01353				2	2	30	23S	27E	573163	3571851*

Record Count: 6

POD Search:

POD Basin: Carlsbad

Owner Name Search:

Owner Name: MALAGA*

Sorted by: File Number

***UTM location was derived from PLSS - see Help**

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Drinking Water Branch

Water System Details

Water System No. :	NM3521108	Federal Type :	C
Water System Name :	LOVING WATER SYSTEM	State Type :	C
Principal County Served :	EDDY	Primary Source :	GW
Status :	A	Activity Date :	06-01-1977

(CELL # 575-200-7439)

Points of Contact

MONICK

Name	Job Title	Type	Phone	Address	Email
GUTIERREZ, ALEX	null	OP	575-745-3511	PO BOX 56, LOVING, NM-88256	Not Available
HERNANDEZ, POLI		AC	575-745-3511	PO BOX 56, LOVING, NM-88256	Not Available
HERNANDEZ, POLI		DO	575-745-3511	PO BOX 56, LOVING, NM-88256	Not Available

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	1700

Service Connections

Type	Count	Meter Type	Meter Size Measure
CB	515	MU	0

Sources of Water

Name	Type Code	Status
WELL #2	WL	A
WELL #3	WL	A
WELL #4A	WL	A
WELL #5	WL	A
WELL #6	WL	A
WELL #7	WL	A

Service Areas

Code	Name
R	RESIDENTIAL AREA

[redacted]

Water Purchases

Seller Water System No.	Water System Name	Seller Facility Type	Seller State Asgn ID No.	Buyer Facility Type	Buyer State Asgn ID No.
NM3521108	LOVING WATER SYSTEM	DS	21108000	CC	21208001

New Mexico Office of the State Engineer
Point of Diversion by Location
(with Owner Information)

(quarters are 1=NW 2=NE 3=SW 4=SE)
(quarters are smallest to largest) (NAD83 UTM in meters)
(acre ft per annum)

WR File Nbr	Sub basin	Use	Diversion	Owner	County	POD Number	Grant	Source	q 64	q 16	q 4	Sec	Tws	Rng	X	Y
C 00259		MUN	800	VILLAGE OF LOVING	ED	C 00259		Shallow		2	4	25	23S	26E	571570	3571027*
					ED	C 00259 S		Shallow	1	1	3	30	23S	27E	571874	3571131*
					ED	C 00259 S-2		Shallow	1	1	3	30	23S	27E	571874	3571131*
					ED	C 00259 S3		Shallow		2	4	25	23S	26E	571570	3571027*
C 02832		EXP	0	VILLAGE OF LOVING	ED	C 02832		Shallow	1	2	1	36	23S	26E	570663	3570308*
C 02834		EXP	0	VILLAGE OF LOVING	ED	C 02834		Shallow	1	1	3	30	23S	27E	571874	3571131*
C 02835		EXP	0	VILLAGE OF LOVING	ED	C 02835		Shallow	3	4	1	30	23S	27E	572258	3571338*

Record Count: 7

POD Search:

POD Basin: Carlsbad

Owner Name Search:

Owner Name: VILLAGE OF LOVING

Sorted by: File Number

***UTM location was derived from PLSS - see Help**

<u>GCR Section IV.2.E- Groundwater Flow and *Down-Gradient Receptors*</u>

The general direction of groundwater can best be seen from the historical Ground-Water Report #3 published by the New Mexico Bureau of Mines & Mineral Resources 1952 Hendrickson and Jones, Geology and Ground-Water Resources of Eddy County, New Mexico. <u>Plate 3 is included in this GCR IV.2.E appendix.</u>

As would be expected and mentioned previously, the groundwater flow in the area generally follows the surface contours and slopes to the east and south, west of the Pecos River and generally slopes west and south, east of the Pecos River.

Historically (1952 Plate #3), groundwater flow in the Key study area came in from the west from Dark Canyon area, from the southwest Black River-Cass draw area, and from the northeast CID southern canal area.

<u>Figure 2-7 and 2-8 (included in this GCR IV.2.E appendix)</u> shows the observed groundwater levels more recently from 1962 and 1996 respectfully. Both drawings indicate that groundwater flow in the area has a south-southwestward direction with a very flat gradient in this area. In 1962, the records indicate that CID flows were reduced and irrigation was increased to offset the low river water flow at that time. This caused a groundwater depression south of the Key Study Area, where the flow developed more of a south and southeasterly direction.

Later observations in 1992, which also represent today's conditions, per the state engineers office Dr. Peggy Barroll-2004 report, shows a groundwater flow direction to the southwest in the Key study area with a fairly flat gradient.

This condition will most likely persist for many years due to the following reasons. The State Engineer's office has declared that the Carlsbad Basin is fully appropriated (Tim Williams-OSE Roswell). New wells will not be permitted in this area anymore, except for small domestic wells. The CID, when water is available, continues to provide large amounts of irrigation water that has built a groundwater mound causing the groundwater to flow away from the canal.

Also, the headwaters of Black River in the Washington Ranch area has a substantial decrease of water in the river, dry in some places, thus probably lowering the hydraulic head along Black river which may allow lesser quality waters from the north to inflow into this area.

In addition, more water is being removed from Cass draw area, which is probably dropping the water levels, thus causing the groundwater to actually reverse its original path. Water in this area that used to flow northeast, now flows to the southwest and then back to the south toward the Cass draw area.

Per Cutter Rogers of Otis Water, this anomaly may have been confirmed by the fact that groundwater in upper Cass Draw, which at one time was noted to have been fair quality, is of lesser quality now.

<u>Figure 2.1 and 2.8 (modified)</u> is included in this GCR IV.2.E appendix and shows the general groundwater flow in the Key study area.

As previously mentioned above, there are no water wells in the ¼ mile AOR. In the one-mile AOR there are no wells located directly down gradient of the proposed brine well site. The groundwater gradient in this area is south-southwest. South and southeast of the proposed site, well #32 and #45 (Sec 31) are old abandon wells owned by the landowner Danny Stafford. Well #54 (Sec 31) is a domestic/irrigation well used by Mr. Stafford who lives just off Old Cavern Highway. Mr. Stafford indicated they do not drink the water but use it for stock watering and crop irrigation.

There are two large irrigation wells # 28/28s (Sec 6) located one mile southeast of the proposed site. These wells are used for irrigation. There is one irrigation well #28 (Sec 31) located about ¾ mile to the east-northeast and appears no longer in service due to the waters rights may have been diverted. There is one domestic well located due west of the proposed site across the National Parks Highway in the Carlsbad Industrial Airpark. This well could not be located. This well is most likely abandoned because the Airpark is on Carlsbad City water.

As shown in <u>figure 2.1 (modified)</u> the city of Otis, Loving and Malaga has public supply wells located more than 5 miles away.

In order to determine the sensitivity of down-gradient receptors, a steady state groundwater flow model was used to determine the estimated time of any unabated groundwater contamination to reach certain fresh water receptors.

Starting with the public water supply systems of Otis, Malaga and Loving, the estimated time to reach Cass draw was equated to be approximately 50 years. Wells within the one mile AOR would be approximately 10 years.

The model indicated some very conservative times to reach the receptors and did not attempt to calculate contamination levels. In reality, these times are probably much longer than shown.

<u>The calculations of the groundwater flow Rate using "Darcy's Law" in included in this GCR IV.2.E appendix.</u>

<u>Special note:</u> In October of 2010 Key Energy presented this proposal in part to the board members of Otis, Loving, Malaga and CID in a public meeting held in Otis, NM. In addition to the meeting a field trip was conducted by Cutter Rogers of the Otis water system. <u>Included in the appendix</u> are some photos of that trip and other water systems reviewed earlier in the year.

GCR Section IV.2.E Groundwater Flow Appendix

Includes:

1. Plate 3 Historical Groundwater Flow in Area.
2. Figure 2-7 and 2-8 observed groundwater flow in 1962 and 1996 respectfully.
3. Figure 2-1 and 2.8 modified general groundwater flow in area.
4. Calculations of groundwater flow rate to down-gradient receptors.
5. Photos of field trips.

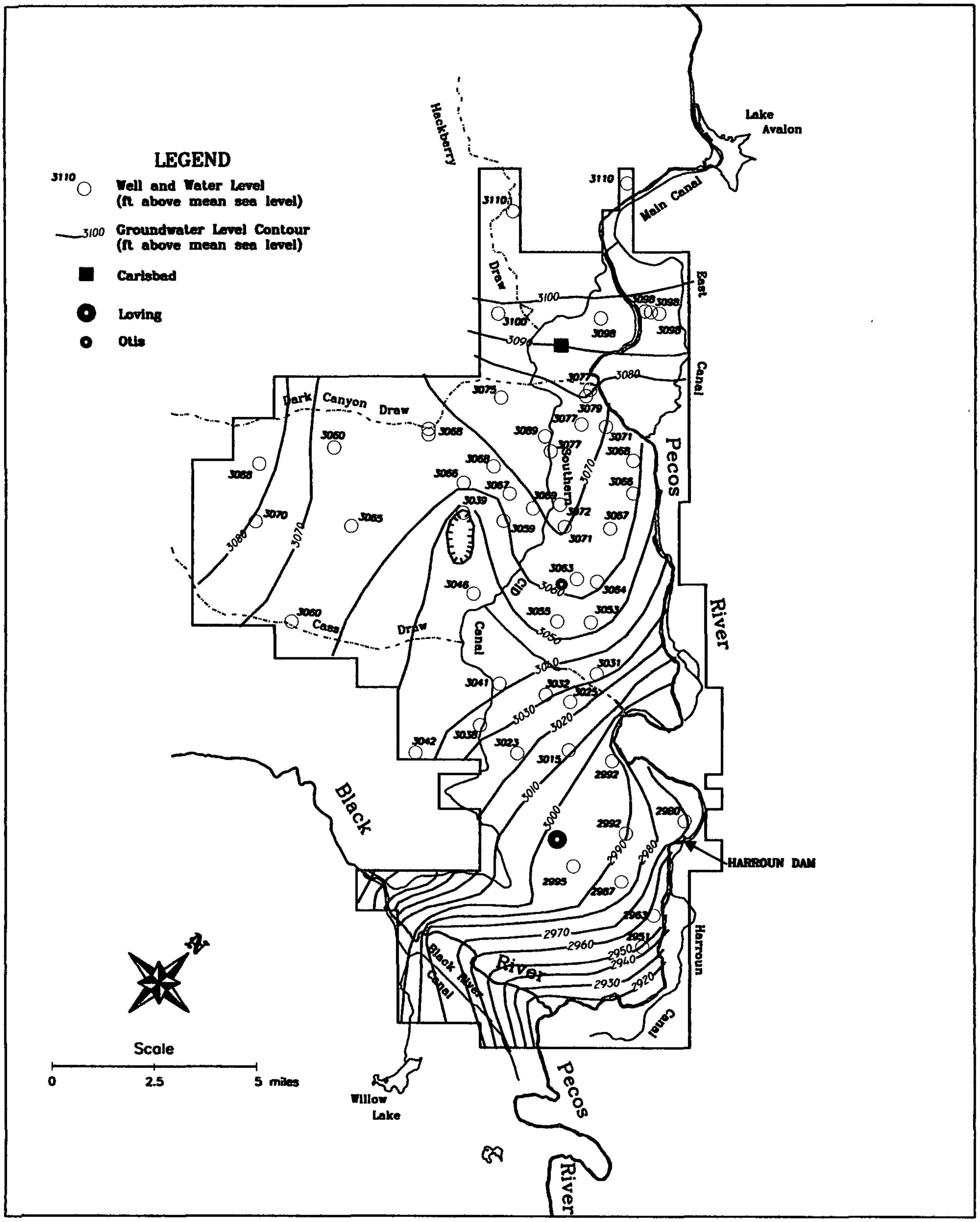


Figure 2-7. Observed Groundwater Levels in the Alluvial Aquifer in 1962.

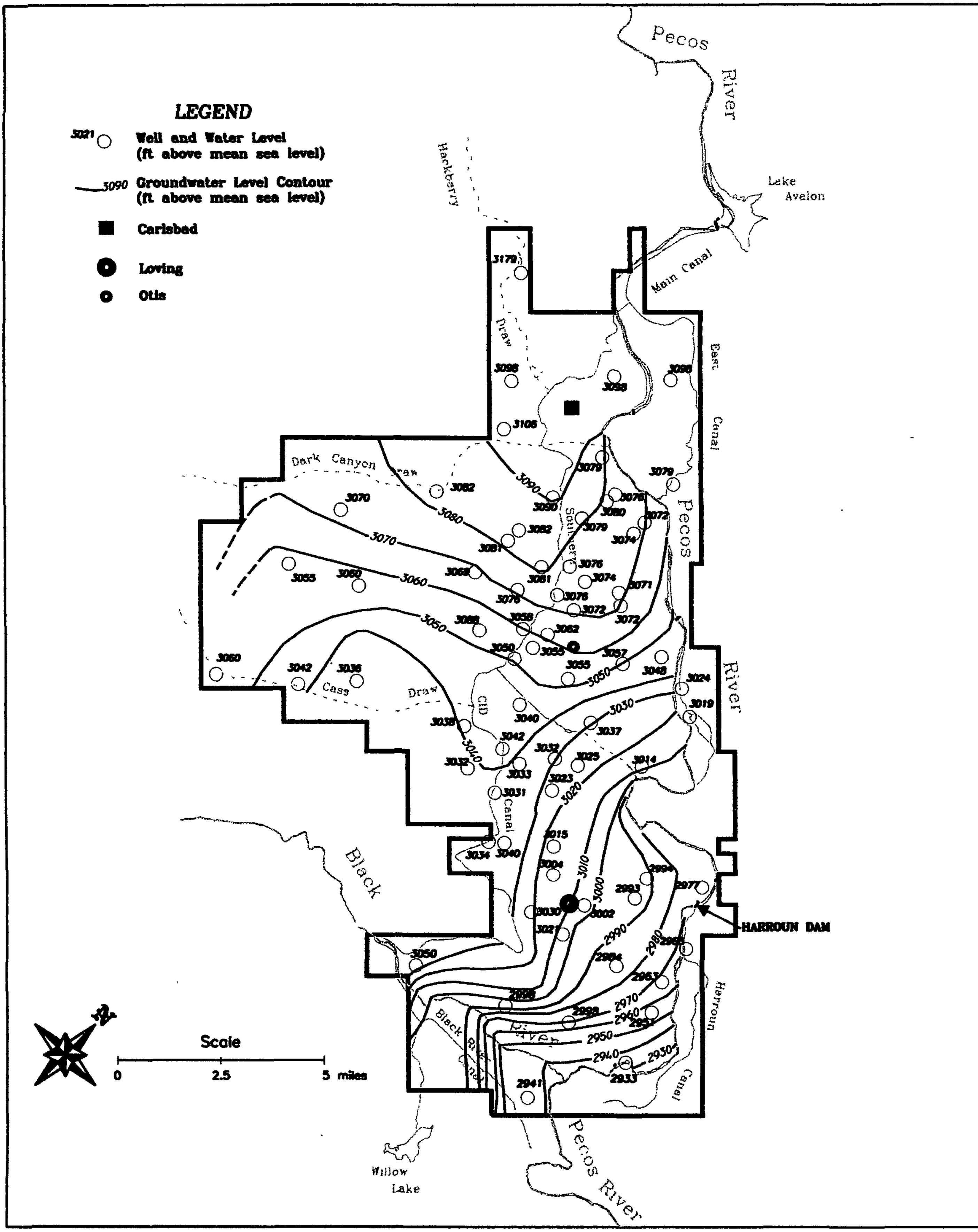
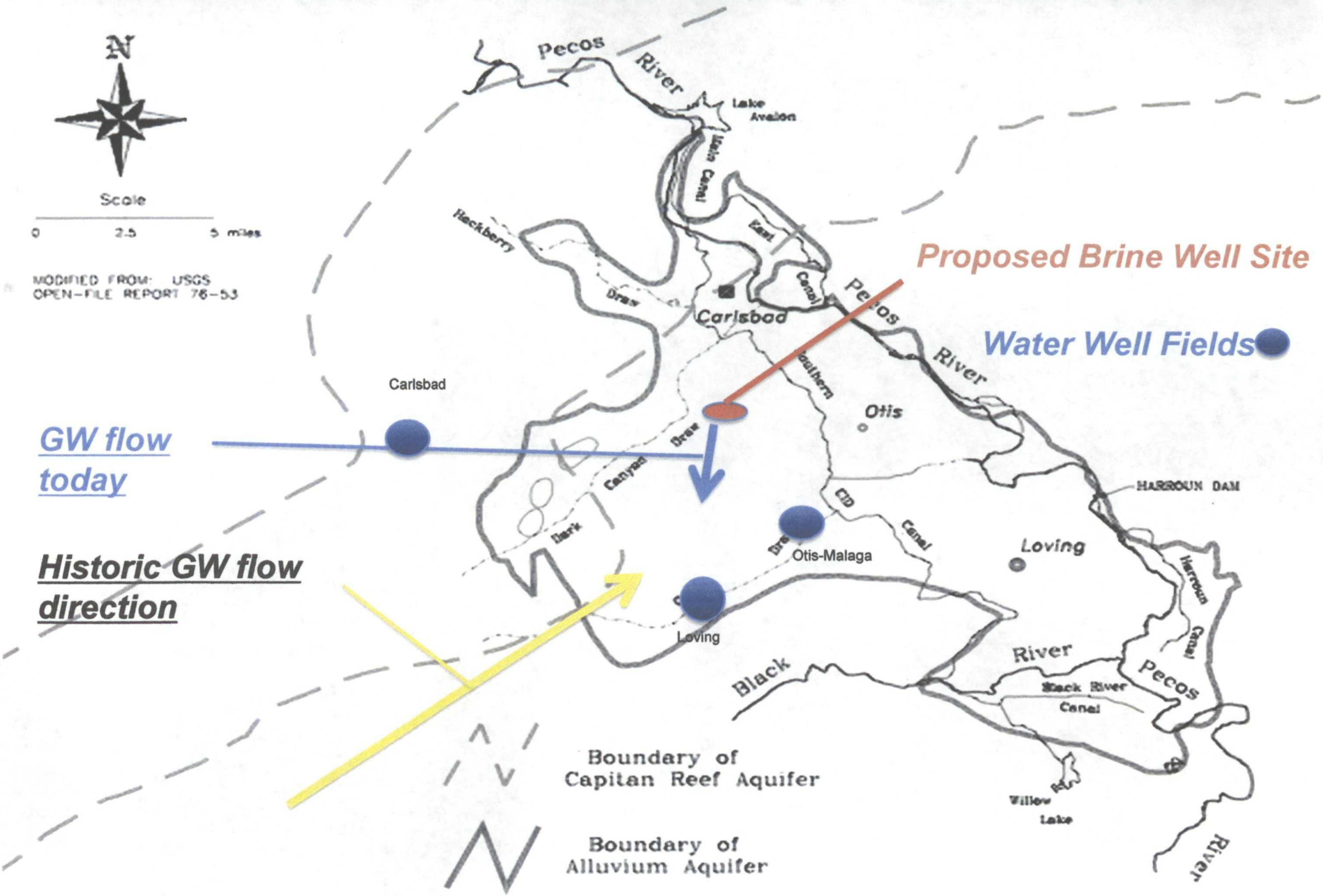


Figure 2-8. Observed Groundwater Levels in the Alluvial Aquifer in 1996.

Local Groundwater Information Fig 2-1 modified.



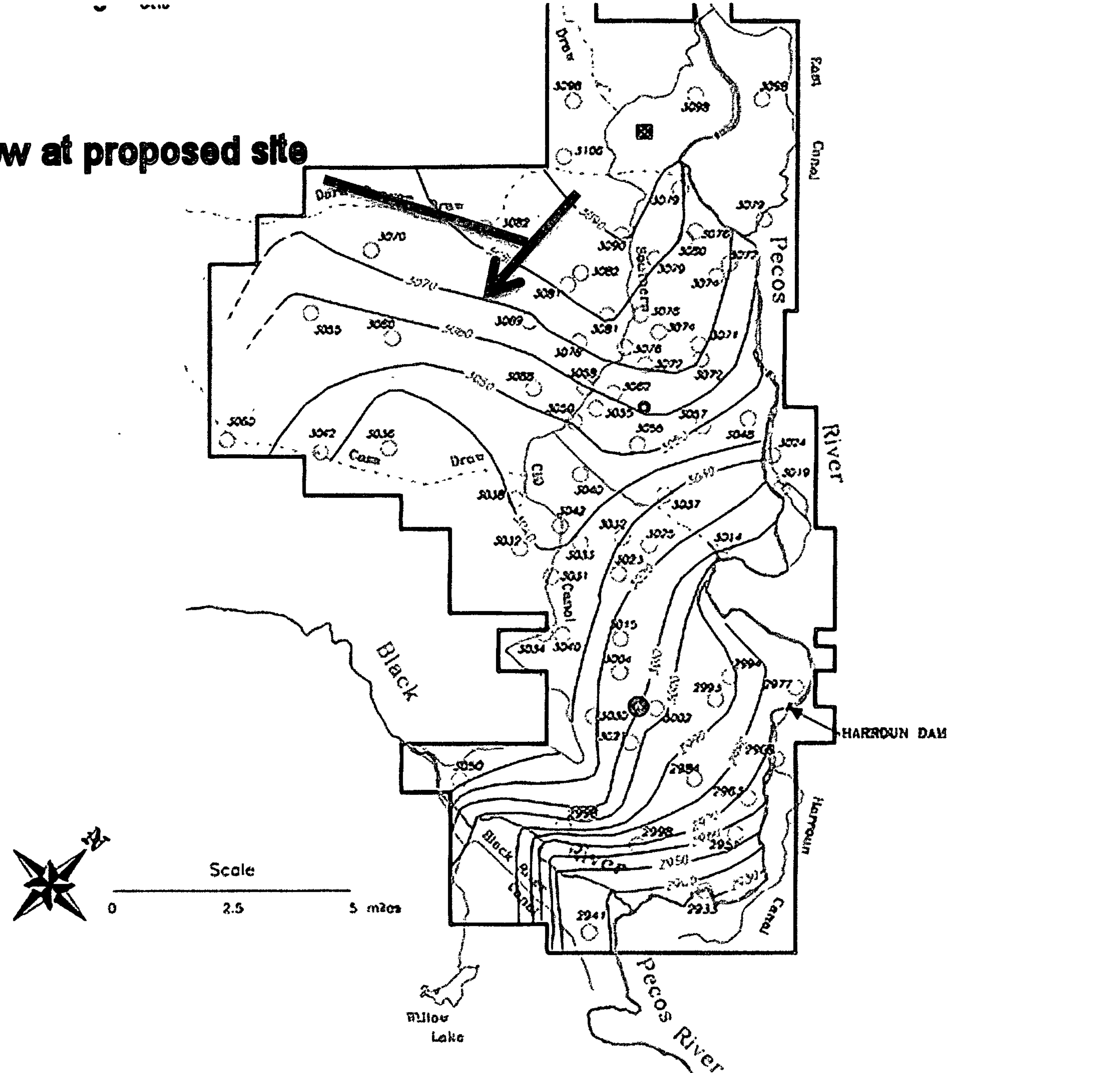


Figure 2-8. Observed Groundwater Levels in the Alluvial Aquifer in 1996.

Estimated Groundwater Flow Rate-
using Darcy's Law

Velocity of GW (ft/day) = (K * i)/n

Where K = hydraulic conductivity ft/day
I = hydraulic gradient in ft/ft
n = porosity = 30%

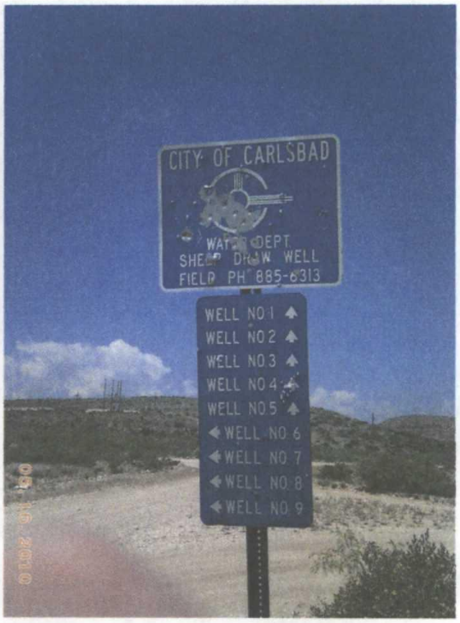
From actual pump test in Carlsbad Alluvium aquifer K = 100 ft/day
I = .00152 (no units) potentiometric surface measured from the Key site to Cass Draw from GW contours OSE 3080-3040 = 40 ft
Distance from site to Cass draw = 5 miles.

V = .506 ft/day

(5 mi x 5280 ft/mi)/ .506 ft/day = 52174 days/365 day /yr = 143 years
Using a 3:1 SF 143/3 = 48 years

ated time to reach Cass Draw is 48 ye

Otis Well Field



Carlsbad Well Field

Malaga Well Field

DOT Well

Key® Energy Services

Key Energy Services
6 Desta Drive
Suite 4300
Midland, Texas 79705

Telephone 713 651 4300
Facsimile. 713 652 4005
www keyenergy com

Date: May 18, 2011

RECEIVED OCD

2011 JUN 14 A 10: 10

Glenn vonGonten- Acting Environmental Bureau Chief
Jim Griswold- Senior Hydrologist
1220 South St. Francis
Santa Fe, New Mexico 87505

Subject: Addendum to application for the new (replacement) brine well, Carlsbad, New Mexico

Dear Mr. vonGonten and Griswold:

Please find attached an addendum to the application originally submitted on January 31, 2011, for the new (replacement) brine well to be located near Carlsbad, New Mexico. The addendum up-dates the application in the following areas:

1. The public notices were modified to provide a better description of the site and to properly adhere to the public notice requirements. Enclosed are the up-dated public notices for your review and approval.

2. The original well design has been up-dated to include a salt roof blanket protection and monitoring system, and a different double tubing arrangement to facilitate tubing movement in order to properly develop and shape the cavern. Enclosed herein is an addendum to Section V1 appendix, updating the original brine well piping schematic and includes a new MSDS for the blanket fluid.

3. A rewrite of Section VII Brine Extraction Well(s) with up-dated appendices, (enclosed herein), includes PB Energy's recommended design, development, operation and monitoring plans that will be incorporated into the permit. PB Energy is one of the companies that designed and installed the US Strategic Petroleum Reserves in nature salt formations and has vast experience in brine well operations.

4. An up dated Section VII.A.1-4 appendix (enclosed herein) includes the C-101 form drilling permit and amended plan to coincide with the brine well design.

5. Also included is a geologic summary prepared by Dr. Dennis Powers, included at the end of the document.

Special note concerning water issues: The existing station used fresh water supplied from the city of Carlsbad. The new replacement well will continue to use city water as available and other municipal, commercial and local private water sources, including using treated water from various non-potable sources. Key Energy Services, LLC. (Key) will adhere to all local, state, federal laws, rules and regulations concerning water usage.

Key fully anticipates that the Oil Conservation Division may now make a proper administrative completeness determination. Upon division approval, Key will issue public notices and continue the permit process. If OCD requires additional information concerning this application please do not hesitate to call me at 432-571-7536 or Wayne Price at 505-715-2809, or E-mail wayneprice77@earthlink.net.

Sincerely,

Daniel K. Gibson, P.G.
Corporate Environmental Director

Attachments-1

Performance *is* Key

Key Energy Services

Addendum for Application to the New (replacement) Brine Well

Carlsbad, New Mexico

Submitted to:

New Mexico Oil Conservation Division

May 18, 2011

by:

Daniel K. Gibson
Corporate Environmental Director

Key Energy Services, LLC.
6 Desta Drive
Suite 4300
Midland, Texas 79705

Public Notice

Legal notification for 2'x3' signage per Water Quality Control Commission Regulations 20.6.2.3.108 B.1 NMAC

Key Energy Services LLC, 6 Desta Drive Suite 4300 Midland, TX 79705, Dan Gibson Corporate Environmental Director, has filed an application with the New Mexico Oil Conservation Division (OCD) to install and operate a replacement class III brine well for its existing brine and fresh water station previously permitted by the OCD as BW-19.

The existing water station and replacement brine well is located approximately One-half mile behind this sign. A detail description and aerial photo is hereby attached below.

A brine well pumps water into deep salt zones commonly found in this area and produces a concentrated Salt-water called "brine water". This brine water is used in the oilfield primarily for drilling and completion operations. It is anticipated brine water will be produced at a rate of less than 1700 barrels per day with a total dissolved concentration of 320,000 mg/l. Groundwater in this area may be present in limited quantities in zones ranging from 30 to 60 feet and from 100-250 feet below the ground surface. The concentration in total dissolved solids in this groundwater generally ranges from 500 to 2000 mg/l. The permit requires that the well and associated operations must be constructed and operated in a manner that will not adversely affect groundwater quality.

The New Mexico Oil Conservation Division (OCD) will accept comments and statements of interest regarding this application and will create a facility-specific mailing list for persons who wish to receive future notices. Interested persons may contact Jim Griswold, Oil Conservation Division (OCD) 505-476-3465 or by writing 1220 South Saint Francis, Santa Fe, New Mexico, 87505.

Para obtener más información sobre esta solicitud en espanol, sirvase comunicarse por favor: New Mexico Energy, Minerals and Natural Resources Department (Depto. Del Energia, Minerals y Recursos Naturales de Nuevo México), Oil Conservation Division (Depto. Conservacio´n Del Petróleo), 1220 South St. Francis Drive, Santa Fe, New México (Contacto: Dorothy Phillips, 505-476-3461)

Will contain the 8.5 x 11 inch detail off-site notice laminated in plastic Page 1	Will contain the 8.5 x 11 inch detail off-site notice laminated in plastic Page 2	Will contain the 8.5 x 11 inch Aerial photo of the site area Laminated in plastic

Public Notice Display Ad

Legal notification for 3"x4" newspaper display add per Water Quality Control Commission Regulations 20.6.2.3.108.B.4 NMAC

Key Energy Services LLC, 6 Desta Drive Suite 4300 Midland, TX 79705, Dan Gibson Corporate Environmental Director, has filed an application with the New Mexico Oil Conservation Division (OCD) to install and operate a replacement class III brine well for its existing brine and fresh water station previously permitted by the OCD as BW-19. This well site will be located approximately 3 miles southwest of Carlsbad, New Mexico, Eddy County, in the Carlsbad ET Zone, located east of the airport and US highway 62-180. The portion of the land is actually part of the east side of the Old Carlsbad Army Airbase, currently used for commercial and industrial activity.

The existing water station is located in (SE/4 NE/4 UL H of Section 36 -Township 22 South- Range 26 East) on private land. The new replacement brine well will be located approximately 1000 feet east of the existing facility in (SW/4 NW/4 UL E of Section 31-Township 22 South-Range 27 East) on private land.

Brine water is used in the Oil and Gas industry to supply a "heavy pure sodium chloride" concentrated salt water (i.e. brine water) with a total dissolved solids concentration of approximately 320,000 mg/l and a density that is 20% higher than fresh water. Heavy brine water is essential in preventing blow-outs in high pressure gas wells and prevents loss of circulation when drilling through salt zones typically found in the Carlsbad area

Fresh water will be injected deep into the Castile salt formation at a depth ranging from 1300 to 1500 feet below the surface to produce brine water. The Castile formation is the same deep stable formation found under the WIPP site. The formation is known to contain a pure "Sodium" salt that is preferred in the oil and gas drilling operations. Other salts typically found, in the potash area, playa lakes and salt-water aquifers, can interfere with the drilling mud programs, thus causing significant control problems and added cost.

The Castile formation contains thick continuous anhydrite rock layers, that act a lot like natural concrete beams, that overly the targeted salt section. These layers have been identified and geo-engineering calculations show they will provide a natural support and barrier for the cavern created as a result of solution mining. An engineering model that included safety factors was developed to verify the long- term stability of the site.

The brine well will be designed to produce at a rate of less than 1700 barrels per day, which equates to approximately 12 million barrels of brine water over a 20-year life period The anticipated cavern radius will be approximately 150 feet. The well has been located on private land to generally provide a minimum of approximately 1000 foot separation from all existing significant features, such as houses, roads, utilities, pipelines, water supplies, buildings, schools, businesses, etc.

All land owners within 1/3 mile (i.e. 1760 ft) of the site will receive a special written notice.

This site has no public water supplies that may be impacted, and ground water in this area is somewhat limited, with some dry holes being encountered while in other wells groundwater may be present, both in shallow lenses 30-60 feet deep and in deeper horizons i.e 100-250 feet. The shallow groundwater in this area is typically not used for drinking water and when found is in very limited quantity. The deeper zone is considered usable as an irrigation water source, when sufficient quantities are found, with an average quality concentration of 500-2000 mg/l of total dissolved solids

This facility will be designed and permitted to have no intentional water contaminants discharged to the surface or subsurface for the protection of groundwater. The system will have concrete and synthetic liners to prevent any spills or leaks from reaching the ground surface. The brine well will have double-cemented casing and tubing pipes to protect groundwater.

Key Energy has determined that bulk mixing of purchased pure salt is neither, economically feasible or environmentally safe. The volumes required during drilling programs cannot be met other than using brine caverns that can safely store large volumes of brine water.

If you have any questions or concerns please do not hesitate to contact Key Energy at the address above or you may contact Wayne Price 505-715-2809 or E-mail [illegible]. Key welcomes your input.

The New Mexico Oil Conservation Division (OCD) will accept comments and statements of interest regarding this application and will create a facility-specific mailing list for persons who wish to receive future notices. Interested persons may contact Jim Griswold, Oil Conservation Division (OCD) 505-476-3465 or by writing 1220 South Saint Francis, Santa Fe, New Mexico, 87505.

Para obtener más información sobre esta solicitud en espanol, sirvase comunicarse por favor: New Mexico Energy, Minerals and Natural Resources Department (Depto. Del Energia, Minerals y Recursos Naturales de Nuevo México), Oil Conservation Division (Depto. Conservacio'n Del Petróleo), 1220 South St Francis Drive, Santa Fe, New México (Contacto: Dorothy Phillips, 505-476-3461)

Public Notice Letter

Certified Mail:

Property Owner of Record:

Name:

Address:

City/County:

State:

Public Notice

Legal notification to property owner(s) of record within one-third mile per Water Quality Control Commission Regulations 20.6.2.3.108.B.2 NMAC

Key Energy Services LLC, 6 Desta Drive Suite 4300 Midland, TX 79705, Dan Gibson Corporate Environmental Director, has filed an application with the New Mexico Oil Conservation Division (OCD) to install and operate a replacement class III brine well for its existing brine and fresh water station previously permitted by the OCD as BW-19. This well site will be located approximately 3 miles southwest of Carlsbad, New Mexico, Eddy County, in the Carlsbad ET Zone, located east of the airport and US highway 62-180. The portion of the land is actually part of the east side of the Old Carlsbad Army Airbase, currently used for commercial and industrial activity.

The existing water station and replacement brine well may be located within one-third mile (i.e. 1760 ft) from your property boundary. An aerial photo has been attached in this notification for your review.

The existing water station is located in (SE/4 NE/4 UL H of Section 36 -Township 22 South- Range 26 East) on private land. The new replacement brine well will be located approximately 1000 feet east of the existing facility in (SW/4 NW/4 UL E of Section 31-Township 22 South-Range 27 East) on private land.

Brine water is used in the Oil and Gas industry to supply a "heavy pure sodium chloride" concentrated salt water (i.e. brine water) with a total dissolved solids concentration of approximately 320,000 mg/l and a density that is 20% higher than fresh water. Heavy brine water is essential in preventing blow-outs in high pressure gas wells and prevents loss of circulation when drilling through salt zones typically found in the Carlsbad area.

Fresh water will be injected deep into the Castile salt formation at a depth ranging from 1300 to 1500 feet below the surface to produce brine water. The Castile formation is the same deep stable formation found under the WIPP site The formation is known to contain a pure "Sodium" salt that is preferred in the oil and gas drilling operations. Other salts typically found, in the potash area, playa lakes and salt-water aquifers, can interfere with the drilling mud programs, thus causing significant control problems and added cost.

The Castile formation contains thick continuous anhydrite rock layers, that act a lot like natural concrete beams, that overly the targeted salt section. These layers have been identified and geo-engineering calculations show they will provide a natural support and barrier for the cavern created as a result of solution mining. An engineering model that included safety factors was developed to verify the long-term stability of the site.

The brine well will be designed to produce at a rate of less than 1700 barrels per day, which equates to approximately 12 million barrels of brine water over a 20-year life period. The anticipated cavern radius will be approximately 150 feet. The well has been located on private land to provide a ***minimum of (insert distance) feet separation from all your property line.***

This site has no public water supplies that may be impacted, and ground water in this area is somewhat limited, with some dry holes being encountered while in other wells groundwater may be present, both in shallow lenses 30-60 feet deep and in deeper horizons i.e. 100-250 feet. The shallow groundwater in this area is typically not used for drinking water and when found is in very limited quantity. The deeper zone is considered usable as an irrigation water source, when sufficient quantities are found, with an average quality concentration of 500-2000 mg/l of total dissolved solids.

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Public Notice

Legal off-site notification per Water Quality Control Commission Regulations 20.6.2.3.108.B.1 NMAC

Key Energy Services LLC, 6 Desta Drive Suite 4300 Midland, TX 79705, Dan Gibson Corporate Environmental Director, has filed an application with the New Mexico Oil Conservation Division (OCD) to install and operate a replacement class III brine well for its existing brine and fresh water station previously permitted by the OCD as BW-19. This well site will be located approximately 3 miles southwest of Carlsbad, New Mexico, Eddy County, in the Carlsbad ET Zone, located east of the airport and US highway 62-180. The portion of the land is actually part of the east side of the Old Carlsbad Army Airbase, currently used for commercial and industrial activity.

An aerial photo has been attached in this notification for your review.

The existing water station is located in (SE/4 NE/4 UL H of Section 36 -Township 22 South- Range 26 East) on private land The new replacement brine well will be located approximately 1000 feet east of the existing facility in (SW/4 NW/4 UL E of Section 31-Township 22 South-Range 27 East) on private land

Brine water is used in the Oil and Gas industry to supply a "heavy pure sodium chloride" concentrated salt water (i.e. brine water) with a total dissolved solids concentration of approximately 320,000 mg/l and a density that is 20% higher than fresh water. Heavy brine water is essential in preventing blow-outs in high pressure gas wells and prevents loss of circulation when drilling through salt zones typically found in the Carlsbad area.

Fresh water will be injected deep into the Castile salt formation at a depth ranging from 1300 to 1500 feet below the surface to produce brine water The Castile formation is the same deep stable formation found under the WIPP site The formation is known to contain a pure "Sodium" salt that is preferred in the oil and gas drilling operations Other salts typically found, in the potash area, playa lakes and salt-water aquifers, can interfere with the drilling mud programs, thus causing significant control problems and added cost.

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All land owners within 1/3 mile (i.e 1760 ft) of the site will receive a special written notice

This site has no public water supplies that may be impacted, and ground water in this area is somewhat limited, with some dry holes being encountered while in other wells groundwater may be present, both in shallow lenses 30 60 feet deep and in deeper horizons i.e 100-250 feet The shallow groundwater in this area is typically not used for drinking water and when found is in very limited quantity. The deeper zone is considered usable as an irrigation water source, when sufficient quantities are found, with an average quality concentration of 500-2000 mg/l of total dissolved solids.

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Public Notice Letter

Legal notification to property owner(s) of the site per Water Quality Control Commission Regulations 20.6.2.3.108.B.3 NMAC

Certified Mail Return Receipt Requested:

Property Owner of Record:

Name:

Address:

City/County:

State:

Public Notice

Key Energy Services LLC, 6 Desta Drive Suite 4300 Midland, TX 79705, Dan Gibson Corporate Environmental Director, has filed an application with the New Mexico Oil Conservation Division (OCD) to install and operate a replacement class III brine well for its existing brine and fresh water station previously permitted by the OCD as BW-19. This well site will be located approximately 3 miles southwest of Carlsbad, New Mexico, Eddy County, in the Carlsbad ET Zone, located east of the airport and US highway 62-180. The portion of the land is actually part of the east side of the Old Carlsbad Army Airbase, currently used for commercial and industrial activity.

The existing water station and replacement brine well may be located within one-third mile (i.e. 1760 ft) from your property boundary or on your property. An aerial photo has been attached in this notification for your review.

The existing water station is located in (SE/4 NE/4 UL H of Section 36 -Township 22 South- Range 26 East) on private land. The new replacement brine well will be located approximately 1000 feet east of the existing facility in (SW/4 NW/4 UL E of Section 31-Township 22 South-Range 27 East) on private land.

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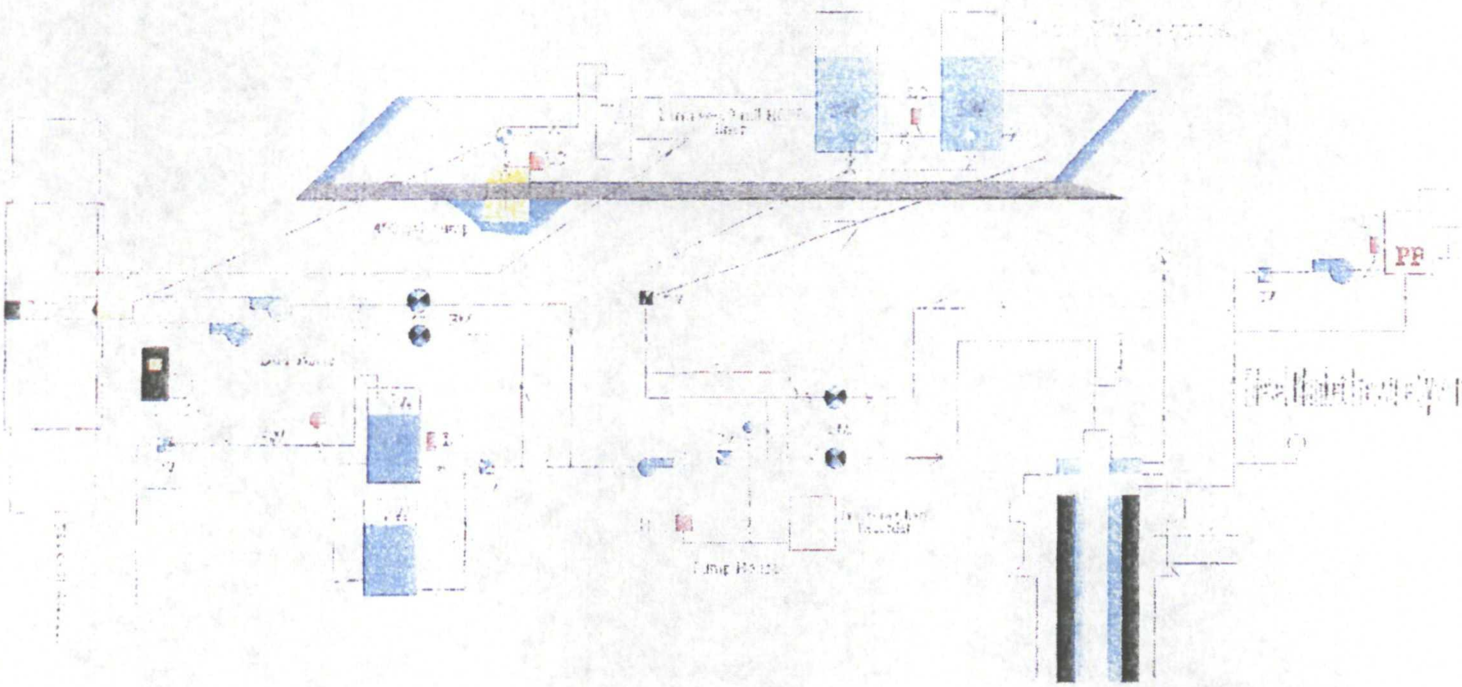
<u>Addendum (5/2011)</u> <u>Section VI. Appendix for Brine Well Application Guideline</u>
Includes

1. Brine well piping schematic-***<u>Updated to include Diesel Blanket Pressure System.</u>***
2. Facility and Fluid Flow Diagram
3. Recent photo of the Key Energy brine water tank storage area
4. ***<u>Packer Fluid MSDS- Changed to #2 Diesel.</u>***

Key Energy Brine Well Piping Schematic

Date: Up Dated 5/2011
Drawn by: LWP-Price LLC
New Carlsbad Replacement Brine Well and Water Station



BW	Brine Water	PF	Packer Fluid Tank		Pressure gauge
FW	Fresh Water	CV	Check Valve		Elect valve
LC	Level Control				
FM	Flow Meters	HPC	Hi Press cut-off		
	Valves		sump with liner	SW	Sump Water T

Chevron

Material Safety Data Sheet

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

DIESEL FUEL No. 2

Product Use: Fuel
Product Number(s): CPS203410 [See Section 16 for Additional Product Numbers]
Synonyms: 15 S Diesel Fuel 2, Alternative Low Aromatic Diesel (ALAD), Calco LS Diesel 2, Calco ULS DF2, Calco ULS Diesel 2, Chevron LS Diesel 2, Chevron ULS Diesel 2, Diesel Fuel Oil, Diesel Grade No 2, Diesel No. 2-D S15. Diesel No 2-D S500. Diesel No. 2-D S5000. Distillates, straight run. Gas Oil. HS Diesel 2. HS Heating Fuel 2 Light Diesel Oil Grade No. 2-D, LS Diesel 2, LS Heating Fuel 2 Marine Diesel, RR Diesel Fuel, Texaco Diesel. Texaco Diesel No 2. Ultra Low Sulfur Diesel 2
Company Identification
Chevron Products Company
Marketing, MSDS Coordinator
6001 Bollinger Canyon Road
San Ramon, CA 94583
United States of America

Transportation Emergency Response
CHEMTREC (800) 424-9300 or (703) 527-3887
Health Emergency
Chevron Emergency Information Center: Located in the USA. International collect calls accepted. (800) 231-0623 or (510) 231-0623
Product Information
MSDS Requests: (800) 689-3998
Technical Information. (510) 242-5357

SPECIAL NOTES: This MSDS covers all Chevron and Calco non-CARB Diesel No 2 Fuels. The sulfur content is less than 0 5% (mass) Red dye is added to non-taxable fuel (MSDS 6894)

SECTION 2 COMPOSITION/ INFORMATION ON INGREDIENTS

COMPONENTS	CAS NUMBER	AMOUNT
Diesel Fuel No. 2	68476-34-6	100 %wt/wt
Distillates. hydrodesulfurized, middle	64742-80-9	0 - 100 %wt/wt
Distillates, straight run middle (gas oil, light)	64741-44-2	0 - 100 %wt/wt
Kerosine	8008-20-6	0 - 25 %wt/wt
Kerosine, hydrodesulfurized	64742-81-0	0 - 25 %wt/wt
Distillates (petroleum), light catalytic cracked	64741-59-9	0 - 50 %wt/wt
Naphthalene	91-20-3	0 02 - 0.2 %wt/wt
Total sulfur	None	0 - 0 5 %wt/wt

SECTION 3 HAZARDS IDENTIFICATION

****

EMERGENCY OVERVIEW

- COMBUSTIBLE LIQUID AND VAPOR
- HARMFUL OR FATAL IF SWALLOWED - MAY CAUSE LUNG DAMAGE IF SWALLOWED
- CAUSES SKIN IRRITATION
- MAY CAUSE CANCER BASED ON ANIMAL DATA
- TOXIC TO AQUATIC ORGANISMS

****

IMMEDIATE HEALTH EFFECTS

Eye: Not expected to cause prolonged or significant eye irritation

Skin: Contact with the skin causes irritation. Skin contact may cause drying or defatting of the skin. Symptoms may include pain itching, discoloration, swelling, and blistering. Contact with the skin is not expected to cause an allergic skin response. Not expected to be harmful to internal organs if absorbed through the skin

Ingestion: Because of its low viscosity, this material can directly enter the lungs if swallowed, or if subsequently vomited. Once in the lungs it is very difficult to remove and can cause severe injury or death. May be irritating to mouth throat, and stomach Symptoms may include pain, nausea vomiting, and diarrhea

Inhalation: Mists of this material may cause respiratory irritation. Symptoms of respiratory irritation may include coughing and difficulty breathing. Breathing this material at concentrations above the recommended exposure limits may cause central nervous system effects. Central nervous system effects may include headache, dizziness, nausea, vomiting, weakness loss of coordination, blurred vision, drowsiness, confusion, or disorientation. At extreme exposures, central nervous system effects may include respiratory depression, tremors or convulsions, loss of consciousness, coma or death.

DELAYED OR OTHER HEALTH EFFECTS:

Cancer: Prolonged or repeated exposure to this material may cause cancer. Whole diesel engine exhaust has been classified as a Group 2A carcinogen (probably carcinogenic to humans) by the International Agency for Research on Cancer (IARC). Diesel exhaust particulate has been classified as reasonably anticipated to be a human carcinogen in the National Toxicology Program's Ninth Report on Carcinogens The National Institute of Occupational Safety and Health (NIOSH) has recommended that whole diesel exhaust be regarded as potentially causing cancer Diesel engine exhaust is known to the State of California to cause cancer. Contains naphthalene, which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

See Section 11 for additional information. Risk depends on duration and level of exposure

SECTION 4 FIRST AID MEASURES

Eye: No specific first aid measures are required As a precaution, remove contact lenses if worn and flush eyes with water

Skin: Wash skin with water immediately and remove contaminated clothing and shoes Get medical attention if any symptoms develop. To remove the material from skin, use soap and water. Discard contaminated clothing and shoes or thoroughly clean before reuse.

Ingestion: If swallowed, get immediate medical attention Do not induce vomiting Never give anything by mouth to an unconscious person

Inhalation: Move the exposed person to fresh air. If not breathing, give artificial respiration If breathing is difficult, give oxygen Get medical attention if breathing difficulties continue

Note to Physicians: Ingestion of this product or subsequent vomiting may result in aspiration of light hydrocarbon liquid, which may cause pneumonitis

SECTION 5 FIRE FIGHTING MEASURES

See Section 7 for proper handling and storage.

FIRE CLASSIFICATION:
OSHA Classification (29 CFR 1910.1200): Combustible liquid.

NFPA RATINGS: Health 0 Flammability 2 Reactivity 0

FLAMMABLE PROPERTIES:
Flashpoint: (Pensky-Martens Closed Cup) 52 °C (125 °F) (Min)
Autoignition: 257 °C (494 °F)
Flammability (Explosive) Limits (% by volume in air): Lower: 0.6 Upper: 4.7

EXTINGUISHING MEDIA: Use water fog, foam, dry chemical or carbon dioxide (CO_2) to extinguish flames.

PROTECTION OF FIRE FIGHTERS:
Fire Fighting Instructions: For fires involving this material, do not enter any enclosed or confined fire space without proper protective equipment, including self-contained breathing apparatus.
Combustion Products: Highly dependent on combustion conditions. A complex mixture of airborne solids, liquids, and gases including carbon monoxide, carbon dioxide, and unidentified organic compounds will be evolved when this material undergoes combustion.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Protective Measures: Eliminate all sources of ignition in the vicinity of the spill or released vapor. If this material is released into the work area, evacuate the area immediately. Monitor area with combustible gas indicator.
Spill Management: Stop the source of the release if you can do it without risk. Contain release to prevent further contamination of soil, surface water or groundwater. Clean up spill as soon as possible, observing precautions in Exposure Controls/Personal Protection. Use appropriate techniques such as applying non-combustible absorbent materials or pumping. All equipment used when handling the product must be grounded. A vapor suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Where feasible and appropriate, remove contaminated soil. Place contaminated materials in disposable containers and dispose of in a manner consistent with applicable regulations.
Reporting: Report spills to local authorities and/or the U.S. Coast Guard's National Response Center at (800) 424-8802 as appropriate or required.

SECTION 7 HANDLING AND STORAGE

Precautionary Measures: Liquid evaporates and forms vapor (fumes) which can catch fire and burn with explosive force. Invisible vapor spreads easily and can be set on fire by many sources such as pilot lights, welding equipment, and electrical motors and switches. Fire hazard is greater as liquid temperature rises above 29C (85F).
Do not get in eyes, on skin, or on clothing. Do not taste or swallow. Do not breathe vapor or fumes. Do not breathe mist. Wash thoroughly after handling. Keep out of the reach of children.
Unusual Handling Hazards: WARNING! Do not use as portable heater or appliance fuel. Toxic fumes may accumulate and cause death.
General Handling Information: Avoid contaminating soil or releasing this material into sewage and drainage systems and bodies of water.
Static Hazard. Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not, by themselves, be sufficient. Review all operations which have the potential of generating and accumulating an electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing, agitation, and vacuum truck operations)

and use appropriate mitigating procedures For more information, refer to OSHA Standard 29 CFR 1910.106 'Flammable and Combustible Liquids', National Fire Protection Association (NFPA 77, 'Recommended Practice on Static Electricity', and/or the American Petroleum Institute (API) Recommended Practice 2003 'Protection Against Ignitions Arising Out of Static, Lightning and Stray Currents'.

General Storage Information. DO NOT USE OR STORE near heat, sparks, flames, or hot surfaces. USE AND STORE ONLY IN WELL VENTILATED AREA Keep container closed when not in use.

Container Warnings: Container is not designed to contain pressure. Do not use pressure to empty container or it may rupture with explosive force. Empty containers retain product residue (solid, liquid, and/or vapor) and can be dangerous Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, static electricity, or other sources of ignition They may explode and cause injury or death Empty containers should be completely drained, properly closed, and promptly returned to a drum reconditioner or disposed of properly

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

GENERAL CONSIDERATIONS:

Consider the potential hazards of this material (see Section 3), applicable exposure limits, job activities, and other substances in the work place when designing engineering controls and selecting personal protective equipment If engineering controls or work practices are not adequate to prevent exposure to harmful levels of this material, the personal protective equipment listed below is recommended. The user should read and understand all instructions and limitations supplied with the equipment since protection is usually provided for a limited time or under certain circumstances

ENGINEERING CONTROLS.

Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below the recommended exposure limits

PERSONAL PROTECTIVE EQUIPMENT

Eye/Face Protection: No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields as a good safety practice.

Skin Protection: Wear protective clothing to prevent skin contact. Selection of protective clothing may include gloves apron, boots, and complete facial protection depending on operations conducted. Suggested materials for protective gloves include: Chlorinated Polyethylene (or Chlorosulfonated Polyethylene), Nitrile Rubber, Polyurethane, Viton.

Respiratory Protection: Determine if airborne concentrations are below the recommended occupational exposure limits for jurisdiction of use. If airborne concentrations are above the acceptable limits, wear an approved respirator that provides adequate protection from this material, such as Air-Purifying Respirator for Organic Vapors.

When used as a fuel, this material can produce carbon monoxide in the exhaust. Determine if airborne concentrations are below the occupational exposure limit for carbon monoxide. If not, wear an approved positive-pressure air-supplying respirator.

Use a positive pressure air-supplying respirator in circumstances where air-purifying respirators may not provide adequate protection

Occupational Exposure Limits:

Component	Agency	TWA	STEL	Ceiling	Notation
Diesel Fuel No 2	ACGIH	100 mg/m3	--	--	Skin A3 total hydrocarbon
Diesel Fuel No. 2	CVX	--	1000 mg/m3	--	--
Kerosine	ACGIH	200 mg/m3	--	--	Skin A3 Total hydrocabon

					vapor
Kerosine	CVX	--	1000 mg/m3	--	--
Kerosine hydrodesulfurized	ACGIH	200 mg/m3	--	--	Skin A3 Total hydrocabon vapor
Kerosine, hydrodesulfurized	CVX	--	1000 mg/m3	--	--
Naphthalene	ACGIH	10 ppm (weight)	15 ppm (weight)	--	Skin
Naphthalene	OSHA Z-1	50 mg/m3	--	--	--

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Attention. the data below are typical values and do not constitute a specification

Color: Varies depending on specification
Physical State: Liquid
Odor: Petroleum odor
pH: Not Applicable
Vapor Pressure: 0.04 kPa (Approximate) @ 40 °C (104 °F)
Vapor Density (Air = 1): >1
Boiling Point: 175.6°C (348°F) - 370°C (698°F)
Solubility: Soluble in hydrocarbons insoluble in water
Freezing Point: Not Applicable
Melting Point: Not Applicable
Specific Gravity: 0.8 - 0 88 @ 15 6°C (60 1°F) (Typical)
Viscosity: 1.9 cSt - 4.1 cSt @ 40°C (104°F)

SECTION 10 STABILITY AND REACTIVITY

Chemical Stability: This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
Incompatibility With Other Materials: May react with strong acids or strong oxidizing agents, such as chlorates, nitrates peroxides etc
Hazardous Decomposition Products: None known (None expected)
Hazardous Polymerization: Hazardous polymerization will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

IMMEDIATE HEALTH EFFECTS

Eye Irritation: The eye irritation hazard is based on evaluation of data for similar materials or product components
Skin Irritation: The skin irritation hazard is based on evaluation of data for similar materials or product components.
Skin Sensitization: This material did not cause skin sensitization reactions in a Buehler guinea pig test
Acute Dermal Toxicity: LD50: >5ml/kg (rabbit).
Acute Oral Toxicity: LD50. > 5 ml/kg (rat)
Acute Inhalation Toxicity: 4 hour(s) LC50: > 5mg/l (rat).

ADDITIONAL TOXICOLOGY INFORMATION:

This product contains gas oils.
CONCAWE (product dossier 95/107) has summarized current health, safety and environmental data available for a number of gas oils, typically hydrodesulfurized middle distillates, CAS 64742-80-9, straight-

run middle distillates, CAS 64741-44-2, and/or light cat-cracked distillate CAS 64741-59-9.
CARCINOGENICITY: All materials tested have caused the development of skin tumors in mice but all featured severe skin irritation and sometimes a long latency period before tumors developed. Straight-run and cracked gas oil samples were studied to determine the influence of dermal irritation on the carcinogenic activity of middle distillates. At non-irritant doses the straight-run gas oil was not carcinogenic but at irritant doses, weak activity was demonstrated. Cracked gas oils, when diluted with mineral oil, demonstrated carcinogenic activity irrespective of the occurrence of skin irritation. Gas oils were tested on male mice to study tumor initiating/promoting activity. The results demonstrated that while a straight-run gas oil sample was neither an initiator or promotor, a blend of straight-run and FCC stock was both a tumor initiator and a promoter.
GENOTOXICITY: Hydrotreated & hydrodesulfurized gas oils range in activity from inactive to weakly positive in in-vitro bacterial mutagenicity assays. Mouse lymphoma assays on straight-run gas oils without subsequent hydrodesulphurization gave positive results in the presence of S9 metabolic activation. In-vivo bone marrow cytogenetics and sister chromatic exchange assay exhibited no activity for straight-run components with or without hydrodesulphurization. Thermally or catalytically cracked gas oils tested with in-vitro bacterial mutagenicity assays in the presence of S9 metabolic activation were shown to be mutagenic. In-vitro sister chromatic exchange assays on cracked gas oil gave equivocal results both with and without S9 metabolic activation. In-vivo bone marrow cytogenetics assay was inactive for two cracked gas oil samples. Three hydrocracked gas oils were tested with in-vitro bacterial mutagenicity assays with S9 and one of the three gave positive results. Twelve distillate fuel samples were tested with in-vitro bacterial mutagenicity assays & with S9 metabolic activation and showed negative to weakly positive results. In one series, activity was shown to be related to the PCA content of samples tested. Two in-vivo studies were also conducted. A mouse dominant lethal assay was negative for a sample of diesel fuel. In the other study, 9 samples of No 2 heating oil containing 50% cracked stocks caused a slight increase in the number of chromosomal aberrations in bone marrow cytogenetics assays. DEVELOPMENTAL TOXICITY: Diesel fuel vapor did not cause fetotoxic or teratogenic effects when pregnant rats were exposed on days 6-15 of pregnancy. Gas oils were applied to the skin of pregnant rats daily on days 0-19 of gestation. All but one (coker light gas oil) caused fetotoxicity (increased resorptions, reduced litter weight, reduced litter size) at dose levels that were also maternally toxic.

This product contains naphthalene. GENERAL TOXICITY: Exposure to naphthalene has been reported to cause methemoglobinemia and/or hemolytic anemia, especially in humans deficient in the enzyme glucose-6-phosphate dehydrogenase. Laboratory animals given repeated oral doses of naphthalene have developed cataracts. REPRODUCTIVE TOXICITY AND BIRTH DEFECTS: Naphthalene did not cause birth defects when administered orally to rabbits, rats and mice during pregnancy, but slightly reduced litter size in mice at dose levels that were lethal to the pregnant females. Naphthalene has been reported to cross the human placenta. GENETIC TOXICITY: Naphthalene caused chromosome aberrations and sister chromatid exchanges in Chinese hamster ovary cells, but was not a mutagen in several other in-vitro tests.CARCINOGENICITY: In a study conducted by the National Toxicology Program (NTP), mice exposed to 10 or 30 ppm of naphthalene by inhalation daily for two years had chronic inflammation of the nose and lungs and increased incidences of metaplasia in those tissues. The incidence of benign lung tumors (alveolar/bronchiolar adenomas) was significantly increased in the high-dose female group but not in the male groups. In another two-year inhalation study conducted by NTP, exposure of rats to 10, 30, and 60 ppm naphthalene caused increases in the incidences of a variety of nonneoplastic lesions in the nose. Increases in nasal tumors were seen in both sexes, including olfactory neuroblastomas in females at 60 ppm and adenomas of the respiratory epithelium in males at all exposure levels. The relevance of these effects to humans has not been established. No carcinogenic effect was reported in a 2-year feeding study in rats receiving naphthalene at 41 mg/kg/day.

This product may contain significant amounts of Polynuclear Aromatic Hydrocarbons (PAH's) which have been shown to cause skin cancer after prolonged and frequent contact with the skin of test animals. Brief or intermittent skin contact with this product is not expected to have serious effects if it is washed from the skin. While skin cancer is unlikely to occur in human beings following use of this product, skin contact and breathing of mists, vapors or dusts should be reduced to a minimum

SECTION 12 ECOLOGICAL INFORMATION

ECOTOXICITY
96 hour(s) LC50: 21-210 mg/l (Salmo gairdneri)
48 hour(s) EC50 20-210 mg/l (Daphnia magna)
72 hour(s) EC50: 2 6-25 mg/l (Raphidocellus subcapitata)
This material is expected to be toxic to aquatic organisms

ENVIRONMENTAL FATE
On release to the environment the lighter components of diesel fuel will generally evaporate but depending on local environmental conditions (temperature, wind, mixing or wave action, soil type, etc) the remainder may become dispersed in the water column or absorbed to soil or sediment. Diesel fuel would not be expected to be readily biodegradable In a modified Strum test (OECD method 301B) approximately 40% biodegradation was recorded over 28 days. However, it has been shown that most hydrocarbon components of diesel fuel are degraded in soil in the presence of oxygen. Under anaerobic conditions, such as in anoxic sediments, rates of biodegradation are negligible.

SECTION 13 DISPOSAL CONSIDERATIONS

Use material for its intended purpose or recycle if possible. This material, if it must be discarded, may meet the criteria of a hazardous waste as defined by US EPA under RCRA (40 CFR 261) or other State and local regulations. Measurement of certain physical properties and analysis for regulated components may be necessary to make a correct determination If this material is classified as a hazardous waste, federal law requires disposal at a licensed hazardous waste disposal facility

SECTION 14 TRANSPORT INFORMATION

The description shown may not apply to all shipping situations Consult 49CFR or appropriate Dangerous Goods Regulations, for additional description requirements (e g., technical name) and mode-specific or quantity-specific shipping requirements

DOT Shipping Description: GAS OIL, COMBUSTIBLE LIQUID, UN1202.III

IMO/IMDG Shipping Description: UN1202, GAS OIL, 3 III, FLASH POINT SEE SECTION 5

ICAO/IATA Shipping Description: UN1202, GAS OIL, 3, III

SECTION 15 REGULATORY INFORMATION

EPCRA 311/312 CATEGORIES:	1	Immediate (Acute) Health Effects:	YES
	2.	Delayed (Chronic) Health Effects:	YES
	3.	Fire Hazard.	YES
	4.	Sudden Release of Pressure Hazard.	NO
	5	Reactivity Hazard:	NO

REGULATORY LISTS SEARCHED:

01-1=IARC Group 1	03=EPCRA 313
01-2A=IARC Group 2A	04=CA Proposition 65
01-2B=IARC Group 2B	05=MA RTK
02=NTP Carcinogen	06=NJ RTK

07=PA RTK

The following components of this material are found on the regulatory lists indicated

Diesel Fuel No. 2	07
Distillates, straight run middle (gas oil light)	06
Kerosine	05, 06, 07
Naphthalene	01-2B, 02, 03, 04, 05 06 07

CERCLA REPORTABLE QUANTITIES(RQ)/EPCRA 302 THRESHOLD PLANNING QUANTITIES(TPQ):

Component	Component RQ	Component TPQ	Product RQ
Naphthalene	100 lbs	None	55556 lbs

CHEMICAL INVENTORIES:
All components comply with the following chemical inventory requirements: AICS (Australia), DSL (Canada), EINECS (European Union), IECSC (China), KECI (Korea), PICCS (Philippines), TSCA (United States)

NEW JERSEY RTK CLASSIFICATION:
Refer to components listed in Section 2 Under the New Jersey Right-to-Know Act L 1983 Chapter 315 N J.S A. 34.5A-1 et. seq., the product is to be identified as follows. DIESEL FUEL

WHMIS CLASSIFICATION:
Class B, Division 3 Combustible Liquids
Class D Division 2 Subdivision A: Very Toxic Material - Carcinogenicity
Class D, Division 2, Subdivision B, Toxic Material - Skin or Eye Irritation

SECTION 16 OTHER INFORMATION

NFPA RATINGS: Health 0 Flammability 2 Reactivity: 0

(0-Least, 1-Slight 2-Moderate, 3-High, 4-Extreme, PPE:- Personal Protection Equipment Index recommendation, *- Chronic Effect Indicator) These values are obtained using the guidelines or published evaluations prepared by the National Fire Protection Association (NFPA) or the National Paint and Coating Association (for HMIS ratings).

Additional Product Number(s): CPS203413, CPS203417, CPS220122, CPS225114, CPS225115, CPS225150, CPS266176 CPS270000, CPS270005, CPS270094, CPS270095, CPS270096, CPS271006, CPS272006, CPS272007, CPS272008, CPS272009, CPS272010, CPS272011, CPS272012 CPS272013, CPS272093, CPS272102, CPS272126, CPS272152, CPS272165, CPS272190, CPS272195, CPS272593, CPS272601, CPS272693, CPS272793, CPS273003, CPS273030, CPS273053, CPS275000
REVISION STATEMENT: This revision updates the following sections of this Material Safety Data Sheet: 16
Revision Date: July 31, 2006

ABBREVIATIONS THAT MAY HAVE BEEN USED IN THIS DOCUMENT:

TLV	- Threshold Limit Value	TWA	- Time Weighted Average
STEL	- Short-term Exposure Limit	PEL	- Permissible Exposure Limit

	CAS - Chemical Abstract Service Number
ACGIH - American Conference of Government Industrial Hygienists	IMO/IMDG - International Maritime Dangerous Goods Code
API - American Petroleum Institute	MSDS - Material Safety Data Sheet
CVX - Chevron	NFPA - National Fire Protection Association (USA)
DOT - Department of Transportation (USA)	NTP - National Toxicology Program (USA)
IARC - International Agency for Research on Cancer	OSHA - Occupational Safety and Health Administration

Prepared according to the OSHA Hazard Communication Standard (29 CFR 1910 1200) and the ANSI MSDS Standard (Z400.1) by the Chevron Energy Technology Company, 100 Chevron Way, Richmond, California 94802

The above information is based on the data of which we are aware and is believed to be correct as of the date hereof. Since this information may be applied under conditions beyond our control and with which we may be unfamiliar and since data made available subsequent to the date hereof may suggest modifications of the information, we do not assume any responsibility for the results of its use. This information is furnished upon condition that the person receiving it shall make his own determination of the suitability of the material for his particular purpose.

*VII. **Addendum 5/2011** -Brine Extraction Well(s)- In-situ brine extraction wells must meet the requirements of Part 5 of the Water Quality Control Commission Regulations in addition to other applicable requirements of WQCC and Oil Conservation Division Rules and Regulations.*

Answer and Description for New Brine Well(s):

Brine Well, Cavern Development, Operation and Design Considerations:
The original well bore design has been changed to the following configuration. Drill and install 40 feet of 16 inch 75 #/ft J-55 BT&C conductor pipe and cement to the surface. The well bore will still consist of two casing and tubing strings, but arranged in the following manner. The water protection casing string will consist of 13.375 inch 61 #/ft J-55 BT&C and cemented to the surface, and set at a depth of approximately 500 ft below ground level. A 1250-foot long casing string consisting of 10.75 inch 40.5 #/ft J-55 BT&C will be installed where at least 50 feet will be cemented into the Castile Salt I Zone and cemented back to the surface.

The original design called for a double tubing packer set to isolate the salt formation from the annulus. This design has been changed to have no packer, with two integral tubing strings, one inside the other, hung from the surface.

The outer tubing string will consist of 1300 feet of 7 inch J-55 20 #/ft pipe, and will be set approximately 50 feet below the casing shoe. This string will normally act as the brine water return pipe. The inner tubing string consisting of 1548 feet of 4.5 inch, 9.5 #/ft J-55 tubing will be set approximately 250 feet below the outer tubing string. This inner string will normally be used for fresh water injection.

Even though the original design was inline with the OCD Brine Well Work Group discussions held in 2009, Key Energy opted to change the design after discussions with PB Energy Storage Services, Inc., a company with extensive experience in developing caverns for the US Strategic Petroleum Reserves. Key Energy contracted PB Services to assist in providing procedures to develop the cavern properly and innovative techniques to protect the roof salt zone. In addition, PB Services conducted cavern modeling for optimum shape and size.

It was determine that a design change was in order to be able to properly develop the cavern and provide protection of the roof salt. The most noted change was the fact that the original design did not allow for a viable means to install and maintain a blanket fluid and monitor cavern pressure on a full time basis. Also, the original design would have been very cumbersome in moving the tubing strings to allow for cavern shaping.

The original design generally would have allowed the cavern to grow from the bottom up, creating an elongated conical cavern resembling a flask. The new design uses techniques mastered by PB Services by using modeling programs to provide information on times, flow rate, tubing placement, including reversing flow at times for optimal cavern shaping. In addition, the new design allows for a more aggressive and accurate sonar testing.

The annulus will be filled with a protective roof blanket fluid, like diesel. This fluid will be monitored on a continuous basis and fluid added as required. The original well design has been up-dated to include a salt roof blanket protection and monitoring system, and a different double tubing arrangement to facilitate tubing movement in order to properly develop and shape the cavern. Enclosed in the addendum to Section VI Appendix, is an updated brine well piping schematic that includes the changes and a new MSDS for the blanket fluid.

Enclosed in the updated addendum to Appendix Section VII, is PB Energy's proposal showing the new well bore design, Plan for Brine Well Operations, Brine Well Leaching Plan, and System Hydraulics.

An updated *C-101 form, with attachments, that includes the changes from the original design, including the casing/tubing/packer/cement type, size, installation depths, location, formation details and drilling plan are included in the addendum to appendix VII A.1-4 attached herein*

The lithology of the formation has been described in detail in the Geological Characterization Report in section IX Site Characteristics. The brine well has been selected to be located in UL E (1000 FWL & 2140 FNL) of Section 31, Township 21s, Range 27e. This zone provides approximately 500 feet of Surface/Rustler/Salado, 330 feet of the Anhydrite III-IV, 200 feet of Salt II, 150 feet of Anhydrite II, 350 feet of Salt I, and 300 feet of base consisting of Anhydrite I.

An updated W-E cross-section showing the location of the brine well cavern in the proposed zone is included in the addendum for Section VII Appendix for review. The original location was accidently located in the wrong unit letter In addition, the original cross-section indicated the limestone found on the west side was marked as Capitan Reef Limestone The updated cross-section indicates it's a limestone, which most likely is the Carlsbad Limestone.

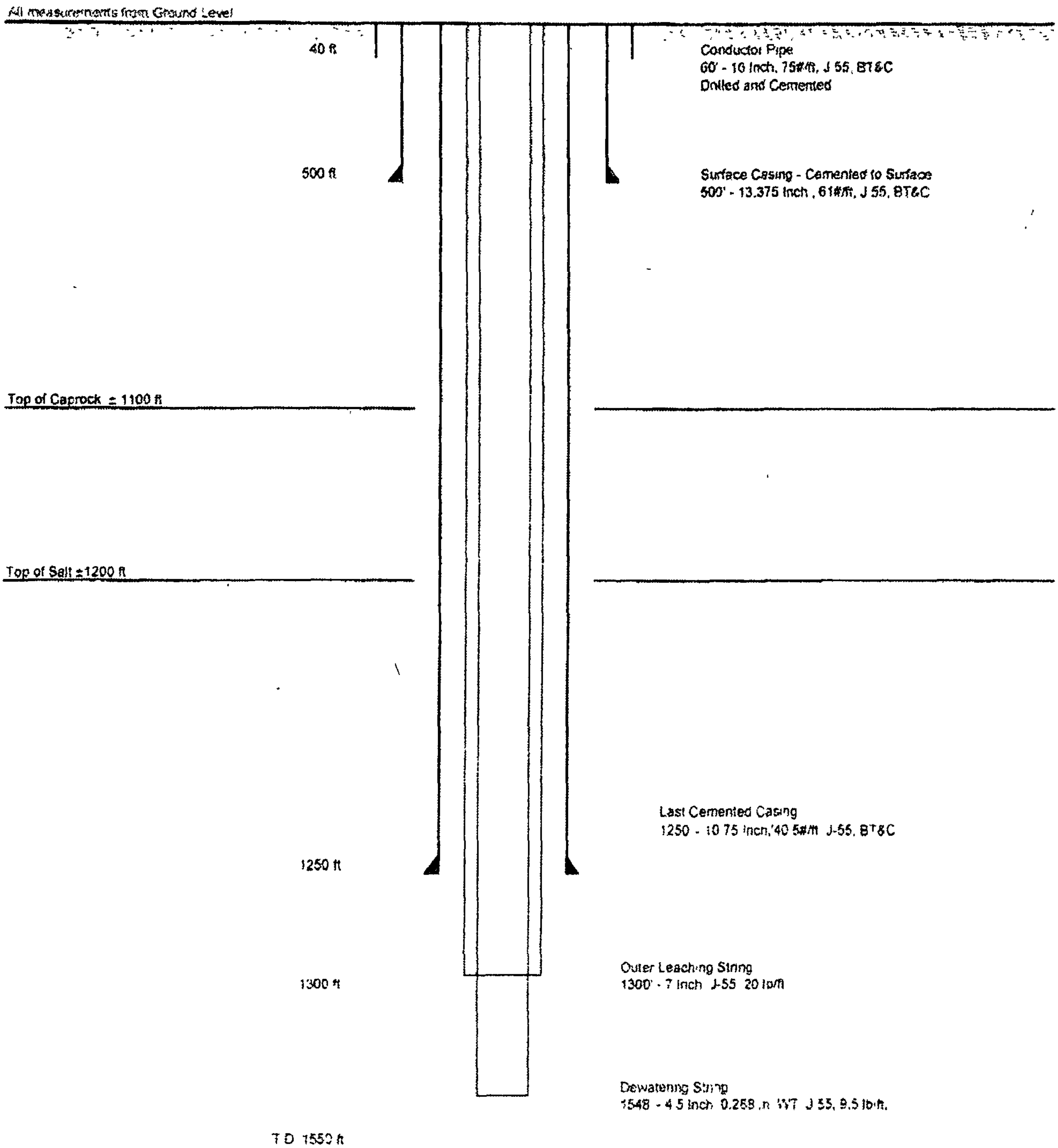
A Key Geology Summary composed by Dr. Dennis Powers, a consulting Geologist with extensive experience in the Key Study area, is attached for reference.

This geologic location provides for approximately 480 feet of anhydrite overlying the anticipated mined area. A Brine Well Roof Stability Steady State Model was developed to determine critical parameters such as maximum safe diameter and is included in the original submittal section VII.

Addendum (5/2011) Section VII. Appendix for Brine Well Application Guideline

Includes:

1. Conceptual Brine Well Drawing- ***Replaced with PB-Energy Storage Services, Inc. Well Bore Diagram.***
2. ***PB Energy's Plan for Brine Well Operations.*** (14 pages)
3. ***PB Energy's Brine Well Leaching Plan.*** *(10 pages)*
4. ***PB Energy's System Hydraulics Schematics.*** (3 pages)
5. Modified West-East Cross-Section showing locations of Old Brine BW-19 and the New Proposed Brine Well in the Castile Formation- ***Minor corrections made.***
6. Figure of the Fractured Anhydrite Circular Plate over Brine Cavern
7. Brine Well Cavern Volume Calculation
8. Results of Model for Key Proposed Brine Well
9. JWS Model Results
10. Loco Hills Model Results
11. I&W Model Results
12. Key P&A Model Results
13. Drawing of Cantilever Beam Design



PB - ENERGY STORAGE SERVICES, INC	Key Energy Services

Carlsbad NM Brine Cavern

DRAWN: JMc	CHECKED.	DATE 05/26/11	SCALE: NONE	JOB NO. 50772A

PB Energy Storage Services, Inc

16285 Park Ten Place, Suite 400
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Key Energy Well Brine Well Operations

Introduction

Key Energy proposes to operate a brine production facility at Carlsbad. New Mexico. This facility will supply brine for oil and gas drilling activities in the region. During the course of a year. the brine demand will vary considerably. Key Energy desires that the well be capable of producing saturated brine at about 200 gpm.

Key Energy will drill one new well and will develop it to produce brine as required. This report describes the activities needed to mine the Key Energy Well. The challenge in mining Key Energy Well is to produce saturated brine (over 310 grams of salt per liter of water) in as short a time as possible.

Technical Approach to Brine Production

Brine is produced by dissolving salt with water In a well. this is generally accomplished by injecting water in one string of tubing and having brine forced out a second string of tubing. The degree of saturation of the resulting brine is a function of temperature and contact time of the water with the salt.

In a salt cavern. the temperature is a function of the temperature of the salt body at the depth of the cavern and the temperature of the injected water and is essentially unchangeable by the operator. In solution mining operations the saturation of the produced brine is controlled through the contact time between the water and salt. The operator can control some items that affect the saturation such as the area of salt exposed to water (the height and volume of the cavern). the rate of water injection. and the position of the tubing strings.

Cavern Design

The cavern for Key Energy Well was designed using SANSMIC. a numerical simulation code which approximates the dissolution of salt by water. SANSMIC is a widely used cavern modeling program developed by Sandia National Laboratories.

The program is an axisymmetric model that provides information on the cavern radius with depth and the rate of salt mining. The primary inputs into the model are:

1. Initial cavern or well radii with depth.
2. Water injection rate.
3. Positions of the tubing strings used for mining.
4. Location of the roof blanket material.
5. Insoluble content of the salt. and
6. Temperature of the cavern.

The outputs from the model are the cavern radii with depth and the salinity of the brine both produced from and remaining in the cavern.

As with all numerical models. SANSMIC does not fully represent the actual salt caverns In the case of SANSMIC. this is due to 1) the axisymmetric assumption in the model (that the cavern will develop evenly about the central wellbore) and 2) limitations in the equations for flow within the cavern.

In most flat lying bedded salts the caverns tend to be regular and the axisymmetric assumption is *generally* not a significant limitation to modeling.

The limitations in the hydraulic equations result in over-estimation of development near the bottom of the injection tubing in both reverse and direct mining and a corresponding underestimation of mining in the upper portions of the cavern. This limitation is more pronounced at higher water injection rates than will be used by Key Energy. These limitations also affect the simulated specific gravity of the cavern brine. SANSMIC generally predicts the brine specific gravity to be about 0.001 to 0.003 points lower than will be obtained in the field.

Solution Mining

General

The concept for Key Energy Well was based on the desire to minimize required workovers and to maximize brine production The cavern design has two stages of development:

1. Sump (Stage 1) from 1.550 to 1.300 feet depth with a volume of about 45.000 barrels
2. Development (Stage 2) from TD to 1.300 feet with a volume of about 547,000 barrels
3. Production (Stage 3) as needed at 200 gpm to a final volume of about 1,760.000 bbls.

The volumes given are the volumes of salt produced. not the open volume of the cavern. The open volume of the cavern will be about 3% less than the mined volume due to bulking of the insolubles. The maximum production capability of the well is limited to 200 gpm after the second stage. The plan is given in Table 1. The SANSMIC simulated shape of the cavern is shown in Figure 1.

The initial borehole radius was assumed to be a constant one foot. The average temperature of the brine in the cavern was estimated to be 75° F during mining. The insoluble content of the salt was estimated to average 1% by volume. The depth of the tubing strings was to minimize the need for workovers and to obtain an acceptable cavern shape and was then kept constant. The water injection rates were varied with time to match maturity of the cavern.

Table 1 Solution Mining Plan for Key Energy Well

Stage	Blanket Depth (ft)	Production Depth (ft)	Injection Depth (ft)	Insoluble Depth (ft)	Water Injection (gpm)	Cumulative Brine Produced (barrels)	Mined Salt Volume (barrels)
1	1300	1400	1550	1547	75	272.000	45.000
2a	1300	1540	1400	1537	125	1.679.000	282.000
2b	1300	1525	1400	1532	150	2,405,000	405.000
2c	1300	1525	1400	1525	175	3.251,000	547.000
3	1300	1525	1400	1495	200	10,481.000	1.763.000

Solution mining was evaluated from initial development of a sump, through a development stage and to completion of the cavern. The plan *requires* no workover involving a rig. **However, workovers may be needed if the tubing string plugs or to perform sonar surveys to monitor cavern development.** Several casing cuts using wireline tools will be required during solution mining in order to keep the inner tubing above the insolubles.

The plan assumes that weak brine from the sump stage will be piped to surface tanks and recirculated through the well until saturated. This assumption is necessary to produce saturated brine from the early stages of development.

The first two stages of development (sump) use direct mining (water injection through the inner string and brine production from the shallower string) to develop a large area in the bottom of the caverns for accumulation of insolubles in the salt that will fall to the bottom of the cavern during leaching. The subsequent stages of development use reverse circulation (injection in the shallower, outer tubing with brine production from the deeper, inner tubing string). This method of mining develops the upper portion of the cavern and mines the salt more efficiently so that saturated brine is produced.

Preparation

Prior to starting leaching in Key Energy Well, the well must be prepared for solution mining operations. The final casing will have been set and cemented at about 1,250 feet depth, or about 50 feet into the lower salt. The borehole will have been drilled to about 1,550 feet (about 10 feet below the base of the lower salt) and opened to a diameter of 12".

In the well the tubing strings used for leaching must be hung at the correct depths. The outer 7" tubing string should be set at 1,400 feet depth and hung in its spool. The inner 4-1/2" mining string should be set and hung in its spool at about 1,550 feet.

The blanket to protect the roof should be set at about 1,300 feet. This will require about 58 bbls of fluid. The depth of the blanket must be verified with an appropriate geophysical (interface) log. A well schematic is shown in Figure 1.

On the surface, the water and brine lines should be connected to the site systems. For the first stage of mining in Key Energy Well, the brine line should be connected to a pump to allow the brine to be injected into the well from the brine storage tanks. This step is crucial for producing saturated brine for the initial 272,000 barrels produced from leaching operations in the well.

The wellhead should be equipped with pressure gauges or transmitters to allow monitoring of the water, brine and blanket pressures, and flow meters on both the water and brine lines. Prior to the start of leaching, the well must be tested to ensure mechanical integrity.

Sump Stage

The initial step in mining will create a sump at the bottom of the borehole. This sump will provide space for collection of the insolubles that are contained within the salt and are freed during the dissolution of the salt.

Mining in the sump stage will be conducted in direct circulation – water injection in the inner deeper tubing string and brine production from the outer, shallower tubing string. This will concentrate most of the initial mining near the bottom of the borehole creating the desired *sump* for accumulation of the insolubles during later mining.

In order to form the sump and to minimize fill up of the borehole and proto cavern, the blanket should be set at a depth of 1,300 feet. If the blanket is set higher than the specified depth, there may be insufficient borehole to perform required mechanical integrity tests later in the life of the well.

During the sump stage, the flow will need to be regulated to be as low as possible and recycled through the surface brine holding tanks. Model simulations indicate that the brine will be unsaturated until it has circulated through the well about four times. As the cavern size increase, the amount of recirculation that is needed to saturate the brine will decrease slightly. The brine salinity will have to be monitored closely at the surface to produce the desired strength for each customer.

During the sump stage, the blanket level should be monitored constantly by observing the pressure on both the brine and blanket. The difference in the pressures should remain relatively constant at similar flow rates. In the event that the differential pressure changes, the blanket level should be checked by an interface log run in the well. Initially, the interface depth should be verified by a geophysical log at least every two months. As experience indicates that the blanket pressure is tracking the interface depth, the frequency of the interface logging can increase to every six months (even if production has not been continuous.)

The sump stage will be completed once about 45,000 bbls of salt have been mined. Approximately 272,000 barrels of saturated brine will be produced during the sump development. To be useable for Key Energy, this brine will need to be recirculated through the well to become saturated.

Development Stage

Upon completion of the sump stage, solution mining of the well can be changed to reverse mining – water injected in the 7" string and brine produced from the 4-1/2" string. The 4-1/2" string may need to be cut to be about five feet above the insolubles on the floor of the cavern in order to avoid plugging by solid materials that may be carried up the string with the brine. The roof blanket needs to be kept at about 1,300 feet depth.

Mining in the development stage will be conducted in reverse circulation. This method of mining will develop the upper section of the cavern above the shoe of the 7" tubing, and will result in production of almost saturated brine from the base of the cavern at low flow rates.

The development stage is divided into three steps in Table 1. Each step is a period of constant and progressively higher raw water injection rate into Key Energy Well to complete the development stage.

The development stage of Key Energy Well will continue until an additional 235,000 (total of about 280,000) barrels of salt have been mined producing about 1,400,000 barrels of brine. The flow rate initially will be low (an estimated 125 gpm) to produce saturated brine. The flow rate can be increased slowly as field measurements indicate that saturated brine is being produced.

The duration of the development stage will be determined by the rate of brine required from Key Energy Well. During this stage, the 4-1/2" tubing will need to be kept above the insolubles.

During the development stage, the blanket level should continue to be monitored constantly by observing the pressure on both the brine and blanket. The difference in the pressures should remain relatively constant at similar flow rates. In the event that the differential pressure changes, the blanket level should be checked by an interface log run in the well

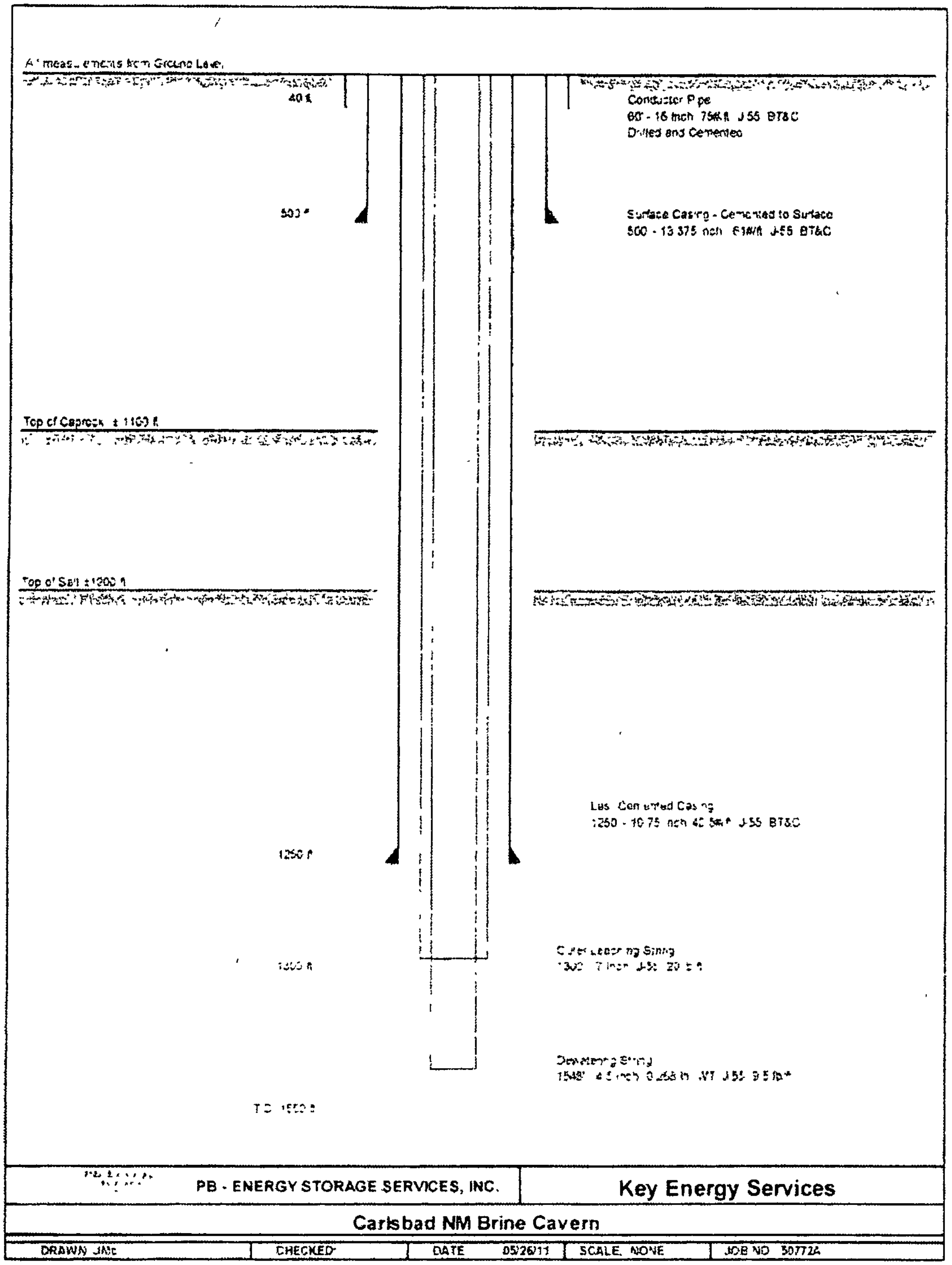


Figure 1 Well Schematic

In any event, the interface depth should be verified by a geophysical log at least every six months (even if production has not been continuous.) About one barrel of blanket material should be added to the well at each interface log to compensate for the increasing roof diameter and very minor losses that occur with brine production.

Brine Production

Upon completion of the development stage, reverse injection can continue as needed. The position of the interface at 1,300 feet should be verified by an interface log, but no adjustment to the blanket depth is required. During reverse injection, water will be injected in the outer shallow 7" tubing and brine will be produced from the deeper inner 4-1/2" tubing. This mining will continue to develop the upper section of the cavern above the shoe of the 7" tubing, and will result in production of almost saturated brine from the base of the cavern at rates up to about 200 gpm.

The reverse stage continues until the cavern has reached the maximum allowable size. Although no workovers are required to reconfigure the strings for subsequent mining of Key Energy Well, Key Energy should plan on a workover every three years. These workovers are for the purpose of removing at least one string of tubing and running a sonar caliper survey of the cavern to ensure that it is developing as planned.

During this long stage of mining, water injection can be conducted as needed for operations at rates up to about 200 gpm. The only operational constraint is to ensure that the inner production tubing is above the insoluble pile on the floor f the cavern.

The final stage of leaching of Key Energy Well will continue until a total of about 1,760,000 barrels of salt have been mined. This will produce about 10,480,000 barrels of saturated brine. The time that the mining will last is dependent upon the demand for the product. The minimum life of the well is five and one-half years at full production.

The blanket level should continue to be monitored by pressure readings as well as interface logs every six months (even if production is not continuous.) The addition of one to two barrels of blanket material at each interface log should also continue.

During this long stage, the depth of the cavern floor and the bottom of the 4-1/2" tubing should be monitored on a semi-annual basis (at the same time as interface surveys). This is to ensure that the inner tubing is high enough above the insolubles for the mining projected to occur in the next six months in order to prevent plugging of the inner string by insolubles. The 4-1/2" tubing should be kept at least five feet above the insolubles

Key Energy Reporting Requirements

Key Energy personnel will need to maintain a log of operational parameters for Key Energy Well. These parameters include:

1. Water pressure
2. Brine pressure
3. Blanket pressure
4. Water (recirculated brine) injection rate
5. Brine production rate
6. Water temperature
7. Brine temperature
8. Salinity of water or brine injected
9. Salinity of brine produced
10. Volume of blanket material injected or removed
11. Calculated volume of salt mined daily
12. Calculated cumulative volume of salt mined

This information should be tabulated on a daily basis. Pressures should be monitored at least once a day but more often is preferable.

Once every 100,000 barrels, Key Energy should obtain a sample of the water injected into and brine produced from Key Energy Well. These fluid samples should be sent to a laboratory to be tested for:

1. Chloride
2. Sodium
3. Calcium
4. Magnesium
5. Potassium
6. Sulfate
7. Total Hardness
8. pH

The testing will provide some verification on the progress of mining as well as possibly providing warning if anomalous areas in the salt are intercepted by the cavern.

Key Energy will supervise all scheduled interface surveys and blanket material additions. The schedule for these activities is given in the "Technical Approach to Brine Production" above. Key Energy should keep copies of all geophysical logs, sonar caliper surveys and wireline casing cuts run in Key Energy Well.

Expected Well Completions and Modifications

Key Energy Well will be completed with 10-3/4" casing cemented at about 1,250 feet depth. The borehole below the casing will be drilled to about 1,550 feet depth and opened to a diameter of 12".

Tubing Settings

Tubing strings for mining will be run in the well upon completion of drilling. The 7" tubing will be run and set at about 1,400 feet depth, and 4-1/2" tubing will be run and set at about 1,550 feet depth. These tubing strings will be used for solution mining for the life of Key Energy Well unless there is an accident, such as a salt fall, that damages one or both strings.

The outer string will be left at the 1,400 feet setting for the duration of solution mining in Key Energy Well. The 4-1/2" tubing will be shortened as needed to keep it above the insolubles that accumulate on the floor. During the sump stage it is not necessary to shorten the 4-1/2" tubing as long as water is continuously injected through it. If water injection stops abruptly, as in the event of a power outage, it is possible the 4-1/2" tubing will become plugged with insolubles that will be carried up inside the tubing. In this event the 4-1/2" tubing may have to be perforated or cut above the blockage to allow water injection to resume. Due to the short height of the cavern, a workover may be required to pull and reset the tubing to keep the entire section of available salt exposed to mining.

During the reverse mining stage (the bulk of the mining program) it is important to keep the 4-1/2" tubing above the insolubles so that they are not carried up into the tubing string with the brine being produced from it. The 4-1/2" tubing can be shortened by cutting it with a wireline conveyed casing cutter or perforating it. Unless the string is plugged with insolubles, a workover involving a rig is not necessary for shortening the string.

Sonar Surveys

Sonar surveys are required every three years during the solution mining of the Key Energy Well. These sonar surveys will probably require a workover rig to pull the inner string. Sonar survey tools can adequately survey caverns through one string of tubing but not two strings. At the completion of the sonar survey, the inner tubing can be run back into the well and set about five feet above the floor of the cavern as seen by the survey. Additionally, any workover required to repair or unplug the tubing strings should be used as an opportunity to run a sonar survey to inspect the cavern.

Following completion of the sonar survey the results of the survey will be incorporated into the Sansmic model. The model will allow any required alterations of the hanging string depths or blanket interface which are necessary to ensure proper cavern development.

Another sonar survey should be run at completion of mining operations. This sonar survey will also require a workover to remove the inner string to allow the survey to be run.

Completion of Leaching

At the completion of mining operations, a workover will be needed to properly plug and abandon the well. Details on this workover will depend upon the state regulations at that time.

Well Testing

During the construction of Key Energy Well, the various casing strings and cement jobs will be tested as they are emplaced. Mechanical integrity testing will be performed annually using a fluid pressurization method approved by the State of New Mexico.

Prior to Leaching

Upon completion of drilling and before solution mining operations begin, the entire well assembly must be tested to verify integrity. This test will preferably be run with blanket material in the wellbore. The well will be pressurized to about 75% of lithostatic pressure at the 10-3/4" casing shoe by injecting brine. The pressure on all three strings, the 10-3/4", the 7" and the 4-1/2", will be monitored for 24 hours. There should be no pressure drop during the test.

Subsidence Monitoring

Key Energy will develop a formal subsidence monitoring plan prior to the start of leaching. Subsidence monuments will be constructed on site and subsidence surveys will be performed and evaluated on an annual basis.

Appendix I Potential Problems

Unable to Inject Water

During the sump or development stage, Key Energy may experience difficulties in injecting water into Key Energy Well. This may be evidenced by the water injection pumps shutting off do to high pressure or a restricted rate of water injection. The brine production from the well will decrease rapidly at the same time. The pressure on the brine and blanket sides of the cavern will remain constant.

The problem will likely be the result of the inner 4-1/2" tubing having been plugged by insolubles. This can be verified by running a log in the tubing to determine the depth to the bottom. A log may also show the top of insolubles outside the tubing, in the event the plug is near the bottom of the tubing and below the floor.

If the plug inside the tubing is below the floor of the cavern or is within five feet of the estimated level of the floor (based on previous depth measurements or modeling), the tubing can be perforated or cut five feet above the floor. This will allow water injection to be resumed.

If the plug inside the tubing is more than five feet above the floor, then a workover rig will be required to either wash out the tubing or pull the tubing out of the well until the plug falls free or is brought to the surface.

Unable to Produce Brine

During reverse mining, a problem in producing brine from the well may develop even though water can be injected into the well. As water continues to be injected, the pressures on the water and blanket will slowly increase with the brine pressure remaining constant.

This problem is likely caused by the inner tubing, now used for brine production, becoming plugged. This can be verified by running a log in the tubing to determine the depth to the bottom. A log may also show the top of insolubles outside the tubing, in the event the plug is near the bottom of the tubing and below the floor.

If the plug inside the tubing is below the floor of the cavern or is within five feet of the estimated level of the floor (based on previous depth measurements or modeling), the tubing can be cut or perforated five feet above the floor or above the plug. This will allow brine production to resume.

If the plug inside the tubing is more than five feet above the floor, then a workover rig will be required to wash out the plug inside the tubing or pull the tubing until the plug falls free or is brought to the surface.

Brine Saturation Drops

During routine mining operations, the saturation of the brine may decrease with no change in operational procedures. This drop in salinity may be minor and stable or gradually increasing or sudden and large.

A sudden, large drop indicates that most likely the tubing strings have been broken off. The damaged area will be very near to or above the bottom of the outer 7" tubing. A density log will indicate where the tubing has broken off.

A minor drop in salinity indicates that one or more collars in the inner string are leaking. A small drop in the salinity that does not continue to decrease indicates a small leak that is relatively stable. A drop in the salinity that continues to decrease indicates that a collar leak is worsening due to washing of the threads. Such a leak, if it continues, could result in the collar losing integrity and allowing the string to drop. A noise log or flow log may indicate which collar(s) is bad.

A workover will be required to pull the tubing strings and replace the damaged joints. If the leak is minor and stable, Key Energy may elect to not repair the tubing string and instead use the slightly weakened brine.

Blanket Material is brought to Surface in the Brine

During mining of Key Energy Well, blanket material may show up in the produced brine during direct mining. The blanket material may appear as a large volume slug or may be small quantities entrained in the brine. If the blanket shows up as a large quantity, the outer 7" hanging string has been severely damaged. If small quantities of blanket material are produced with the brine, one or more collars of the 7" tubing have developed leaks.

Both failures will require a workover to pull the tubing strings and replace the damaged joints in the 7" tubing. If the blanket has come up as a slug, mining must be suspended immediately with the brine side of the cavern shut-in to prevent further contamination of the brine system. Small quantities of blanket material in the brine may not require *immediate* suspension of mining if Key Energy can tolerate minor contamination of the brine, but close attention should be paid to the blanket pressure to ensure that the blanket is at the proper depth.

Brine-Blanket Interface Not Found

When attempting to run an interface log, occasionally the interface may not be detected. This may occur even if the relative pressures of the brine, water, and blanket indicate that the blanket is at approximately the correct depth. The blanket may be at the correct level with the density difference between the blanket and brine just difficult to discriminate through the tubing strings or the cavern may have mined into an anomalous zone that has allowed the blanket on the roof of the cavern to move into a void above the intended roof.

The location of the blanket can probably be ascertained by injecting several barrels of blanket material while monitoring the intended roof location. The amount of blanket added should not need to exceed about one half foot of thickness for the estimated roof diameter to be found. If this quantity of blanket is still not detected, it may be necessary to shut in mining, bring in a workover rig to pull a string of tubing and run a sonar survey.

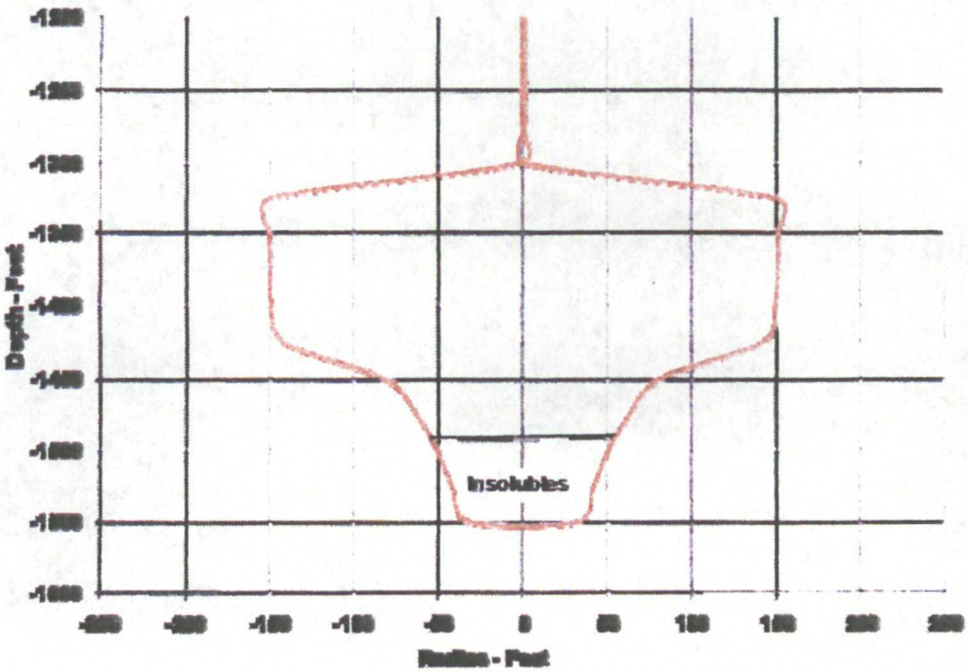


Figure 2 – Sansmic Image of Cavern at Completion

Brine Well Development Plan

Introduction

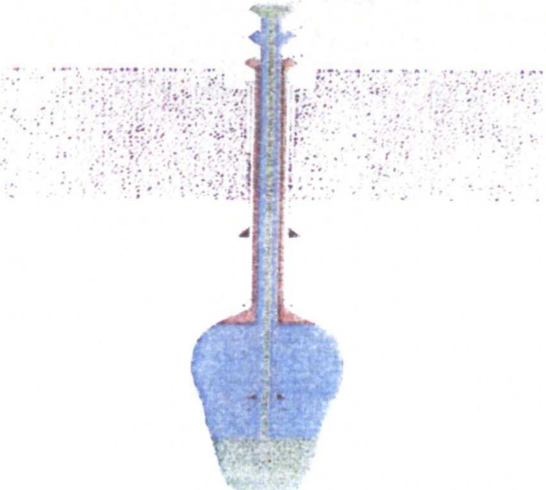
Key Energy Services LLC Develop new brine production cavern at its Carlsbad Fresh and Brine Water Station. The cavern is designed to produce saturated brine from an interval within the Lower Castile Salt between approximately 1,300 ft and 1,550 ft. The cavern is to have a maximum diameter of 300 ft.. The cavern will have a protective roof blanket to control cavern roof growth. The cavern development has been modeled using the Sansmic Solution Mining Code, which was developed by Sandia National Labs.

Well Configuration

Number of wells:	1
Surface casing (Groundwater Protection):	13-3/8" Diameter – Cemented to Surface
Last cemented casing: 10-3/4" (50' Into Salt):	Cemented to Surface
Outer suspended string:	7" to 1,400 ft
Inner suspended string:	4-1/2" to 1,550 ft
Insoluble Roof Blanket Depth:	1,300 ft

Brine Production Process Description

1. Inject Protective Roof Blanket
2. Inject Fresh Water (75 gpm) into 4-1/2" and Recover Brine Through 7" to Storage Tanks
3. Re-Inject Brine from Storage Tanks Until Brine Reaches Saturation (10 lb/gal)
4. Continue Leaching Using this Method until cavern volume reaches 45,000 bbl (280 days)
5. Begin Reverse Flow – Inject Water at 125 gpm down 7" and recover brine through 4-1/2"
6. Produce saturated (10 lb/gal) Brine until Cavern Volume Reaches 282,000 bbl (630 days)
7. Increase Injection Rate to 175 gpm
8. Produce Saturated Brine until cavern volume reaches 405,000 bbl (780 days)
9. Increase Injection Rate to 200 gpm
10. Cavern Can Sustain Production of Saturated Brine at 200 gpm



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Key Energy Well Brine Well Leaching Plan

Introduction

This document presents alternate solution mining plans for the development of the Key Energy (KE) Well. This well will be used for production of saturated brine for use in drilling operations in the Southeast New Mexico area. The well will be used only as brine demand from oil field services requires it.

The well has not been drilled. For this study the final cemented casing string was assumed to be set at 50 feet in the Lower Castile Salt. The top of the cavern will be about 50 feet below the last cemented casing. The total depth of the well will be about 1,550 feet based on cross-sections developed from nearby wells.

This report presents two conceptual plans to accommodate the development of saturated brine from the KE Well. The report also discusses the possibility of using two wells to produce saturated brine more quickly than with a single well.

Methodology

The study utilized the SANSMIC cavern simulation model to project the development of the cavern utilizing a single well. SANSMIC is a two-dimensional numerical simulation code which approximates the dissolution of salt by water. SANSMIC is a widely used cavern-modeling program developed by Sandia National Laboratories.

The basic input for the model consists of average radii of the well, the depth of the water injection and brine production strings, the depth of the product level, water injection rates, and duration of mining. If a cavern exhibits a region of abnormal or non-symmetric growth, SANSMIC cannot fully evaluate continued growth in such a region.

As with all numerical models, SANSMIC does not fully represent the actual salt caverns. This is due to 1) the axisymmetric assumption in the model (that the cavern will develop evenly about the central wellbore) and 2) limitations in the equations for flow within the cavern.

The axisymmetric assumption is not necessarily a significant limitation to modeling the development of salt caverns in bedded salts. Most caverns developed in flat lying bedded salt deposits tend to be uniform in horizontal cross-sections when developed by means of a single well. There are localized exceptions to the symmetry. The limitations in the hydraulic equations result in over-estimation of development near the bottom of the injection tubing in both reverse and direct mining and a corresponding underestimation of mining in the upper portions of the cavern. This limitation becomes more evident at high water injection rates (over 4,000 gpm).

which were not utilized in this study, and at prolonged stage durations (over one year) which were used in the simulations.

SANSMIC and other commercially available cavern simulation models cannot simulate development of two-well caverns. Discussion of two well caverns will rely on anecdotal experience.

For this model, the cavern interval from total depth of the well at 1,550 feet to the top of the lower Castile Salt at about 1,200 feet depth was divided into fourteen 25-feet tall cells. The final cemented casing was assumed to be 10-3/4 inches. The inner string was assumed to be 4-1/2" tubing and the outer string to be 7-5/8" tubing. The casing sizes do not impact the final solution mining plan; although they have some influence on the very early days of mining. The roof was kept below 1,200 feet depth.

The production flow rate was modeled at numerous injection rates of between 20 gpm and 210 gpm. The insoluble content of the salt was set at 2%. A normal dissolution factor of "1" was used for the salt. The SANSMIC simulations were carried out until saturated brine can be produced at a maximum rate from a single well configuration without recycling.

Cavern Development Plan

General

Several plans were developed for mining of the Carlsbad KE Well. The plans for initial development of the cavern differed in the height of salt available for mining, the amount of the recycling of the brine to increase saturation, the flow rates and the direction of flow.

The mining plans begin from a borehole completed in the salt in the Lower Castile at a depth of about 1,550 feet. The initial mining method for all the plans is direct – water injected in the deeper, inner tubing and brine produced form the outer, shallower tubing. The inner tubing string should be set within a few feet of the total depth of the wellbore. This is necessary to develop a sump at the bottom of the cavern for accumulation of material that will fall to the bottom of the cavern.

The final 10-3/4" casing is cemented at about 1,250 feet, 50 feet above the proposed roof of the cavern. The tubing strings used for solution mining are assumed to be 4-1/2" inside of 7-5/8". The sizes of the tubing are immaterial to the mining plan after the first few tens of barrels of salt have been mined. Solution mining rates vary between plans and during mining.

Direct Mining Solution Mining Plan

Mining begins with the inner tubing string set close to the bottom of the borehole as shown in Table 1. The outer string is set about 1,350 feet depth, about 150 feet below the top of the lower salt. The blanket in the plan is set at about 1,300 feet depth or about 50 feet below the final cemented casing.

Mining in this combined sump and chimney stage develops a sump near the bottom of the cavern for accumulation of the insolubles that will be freed during mining of the salt and begins development of the chimney throughout the exposed length of the salt. This direct mining continues for all mining of the salt. The setting depths and cavern volumes for the various stages of the plan are shown in Tables 1 and 2.

Table 1 Setting Depths for Development of KE Well in Direct Flow

Mining Step	Blanket Setting – Feet	Production Setting - Feet	Injection Setting – Feet	Insoluble Depth – Feet
Sump/Chimney	1350	1400	1550	1547
Mining	1350	1400	1540	1547
Mining	1350	1400	1540	1547
Mining	1350	1400	1540	1547
Mining	1350	1400	1540	1547

Table 2 Duration and Volumes for Development of KE Well in Direct Mining

Mining Step	Mining Rate - gpm	Total Mining Time – Days	Gross Cavern Volume – barrels	Cumulative Brine Produced - Barrels	Brine Specific Gravity
Sump/Chimney	Cycling at 75	280	45,000	279,000	1.202
Mining	20	780	100,000	612,000	1.204
Mining	40	930	132,000	809,000	1.204
Mining	60	1,080	178,000	1,097,000	1.204
Mining	50	1,230	218,000	1,344,000	1.203

During the mining, the inner tubing may need to be cut one or more times to keep it above the building insoluble pile. In order to maintain the maximum height of the cavern and exposure of salt to water, the inner tubing should be kept as near to the floor during the mining as is practical.

During the sump/chimney stage, which develops the cavern to about 45,000 barrels, the brine will need to be cycled through above ground storage tanks with a total capacity of 2,500 barrels and back into the well to bring the saturation to 10 pounds per gallon (specific gravity of 1.201). For this study, this was assumed to be done at a rate of 75 gpm until saturation was achieved. Initially, five days of pumping through the well at 75 gpm are required. As the cavern grows in size, exposing more salt surface for dissolution, the recycling time drops to about 3 days after about 70 water-brine cycles.

After the cavern volume reaches about 45,000 barrels (about 279,000 barrels of produced brine) the cavern will be able to produce saturated brine without recycling at a rate of 20 gpm. The sustainable saturation rate will slowly increase as the cavern grows in size, but will peak at around 60 gpm with mining in the direct mode.

During mining no workover is required. However, the inner tubing string will need to be cut to be above the insolubles on the floor. In conformance with New Mexico regulations, a sonar calliper survey should be run every three years. This will most likely require a workover to remove one or both strings so that the entire cavern can be surveyed. The shape of the cavern during development as simulated by SANSMIC is shown in Figure 1.

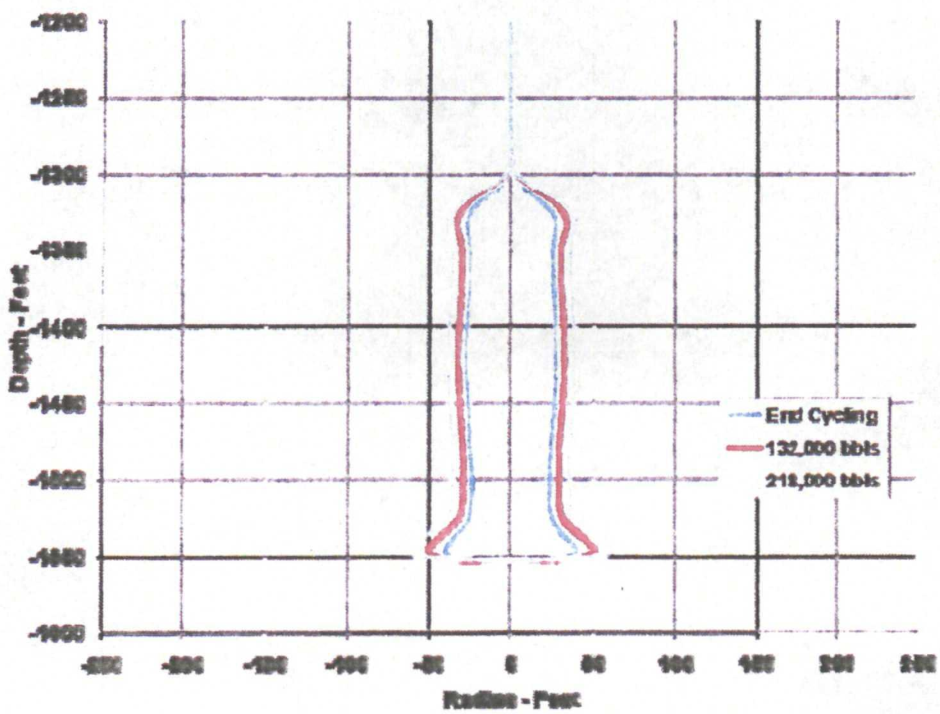


Figure 1 SANSMIC Simulation of KE Well during Mining

Reverse Mining Solution Mining Plan

Mining begins with the inner tubing string set close to the bottom of the borehole as shown in Table 3. The outer string is set about 1,400 feet depth, about 200 feet below the top of the lower salt. The blanket in the plan is set at about 1,300 feet depth or about 50 feet below the final cemented casing.

Mining in this combined sump and chimney stage develops a sump near the bottom of the cavern for accumulation of the insolubles that will be freed during mining of the salt and begins development of the chimney throughout the exposed length of the salt. This direct mining continues for all mining of the initial 45,000 barrels of salt. The setting depths and cavern volumes for the various stages of the plan are shown in Tables 3 and 4.

Table 3 Setting Depths for Development of KE Well in Reverse Mining

Mining Step	Blanket Setting – Feet	Production Setting – Feet	Injection Setting – Feet	Insoluble Depth – Feet
Sump/Chimney	1300	1400	1550	1547
Reverse Mining	1300	1540	1400	1537
Reverse Mining	1300	1525	1400	1532
Reverse Mining	1300	1525	1400	1525

Table 4 Duration and Volumes for Development of KE Well in Reverse Mining

Mining Step	Mining Rate – gpm	Total Mining Time – Days	Gross Cavern Volume – barrels	Cumulative Brine Produced - Barrels	Brine Specific Gravity
Sump/Chimney	Cycling at 75	280	45,000	277,000	1.202
Reverse Mining	125	630	282,000	1,703,000	1.204
Reverse Mining	175	780	405,000	2,446,000	1.203
Reverse Mining	200	930	547,000	3,303,000	1.202

During the mining, the inner tubing will need to be cut one or more times to keep it above the building insoluble pile. In order to maintain the maximum height of the cavern, the inner tubing should be kept as near to the floor during this stage as is practical.

During the sump/chimney stage, which develops the cavern to about 45,000 barrels, the brine will need to be cycled through above ground storage tanks with a total capacity of 2,500 barrels and back into the well to bring the saturation to 10 pounds per gallon (specific gravity of 1.201). For this study, this was assumed to be done at a rate of 75 gpm until saturation was achieved. Initially, five days of pumping through the well at 75 gpm are required. As the cavern grows in size, exposing more salt surface for dissolution, the recycling time drops to about 3 days after about 70 water-brine cycles.

After the cavern volume reaches about 45,000 barrels (about 277,000 barrels of produced brine) the cavern will be able to produce saturated brine at least 125 gpm without recycling if the flow is switched to reverse - water injected in the outer shallower tubing and brine produced from the deeper inner tubing. The sustainable saturation rate will continue to increase as the cavern grows in size, reaching a sustainable saturation rate of 200 gpm once the cavern is about 400,000 barrels in size. The shape of the cavern during development as simulated by SANSMIC is shown in Figure 2.

During mining no workover is required. However, the inner tubing string will need to be cut to be kept above the insolubles on the floor, especially after reverse mining beings. In conformance with New Mexico regulations, a sonar calliper survey should be run every three years. This will most likely require a workover to remove one or both strings so that the entire cavern can be surveyed.

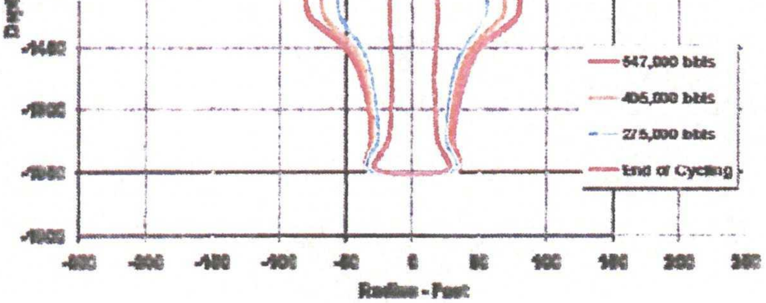


Figure 2 SANSMIC Simulation of KF Well during Reverse Mining

Two Well System

Salt producers in bedded salt regions (Kansas, Northeast U.S.) frequently use two or more wells to produce saturated brine. The wells are connected either by directional drilling of one well or by hydro-fracturing between wells. One well is then used for water injection and the

other well or wells are used for brine production. The multiple-well concept allows production of saturated brine at much greater rates than could be produced from a single-well setup.

Generally the distance between the wells is on the order of hundreds of feet to allow a long exposure of salt for high-rate brine production. Some wells, primarily storage wells in salt domes, have been developed less than 100 feet separation.

Based on experience with multiple well caverns, use of two wells at the Key facility in Carlsbad will likely reduce the time that cycling is needed from about 280 days (70 cycles) to about 70 days (15 cycles or total production of about 37,500 barrels of brine), assuming that the wells are hydraulically connected almost from the start. After this initial recycling, the pair of wells will probably be able to produce saturated brine at a rate of 60 gpm. The sustained rate of saturated brine production will increase to over 125 gpm after producing about 300,000 barrels of brine.

Discussion

Development of the KE Well will require an extensive period of recirculating brine to increase its saturation to near 100%. The actual mechanics of this recycling will be difficult to accomplish. Essentially, it involves water injected, brine production to the tanks until filled, then discontinuing water injection and switching to injecting the brine in the tanks until the desired saturation is achieved. SANSMIC modeling indicates this will take 5 days at 75 gpm to saturate 2500 barrels of brine in this method at the very beginning of production.

This method of cycling 2500 barrels of brine would likely need to continue for about 70 cycles. The duration of each cycle will decrease slightly with time as the cavern enlarges, but the total time will approach 280 days before the well is capable of producing brine without recirculating. Each cycle of five days (eventually decreasing to about three days) will produce 2,500 barrels of saturated brine, or an average of 500 barrels per day.

SANSMIC simulation indicates that the cavern will not be capable of producing saturated brine from injected fresh water at a rate of 100 gpm until the cavern size is at least 39,000 barrels (about 240,000 barrels of saturated brine production) in size for the short cavern (roof 100 feet

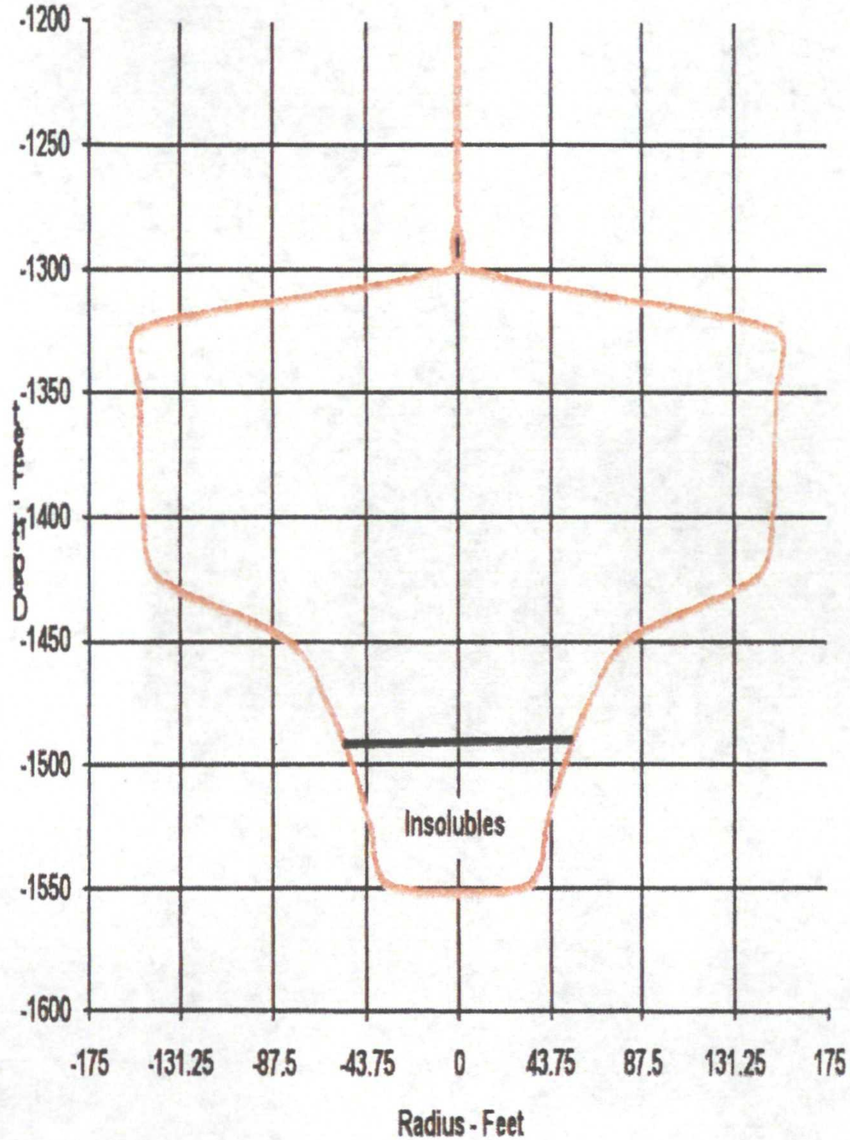
Key

below the top of the lower salt) or about 35,000 barrels (about 215,000 barrels of saturated brine production) for the tall cavern. The production of saturated brine at this point requires that flow be changed to reverse at those cavern volumes with prior mining done in direct (using recycled brine) to create a sump.

SANSMIC modeling indicates that saturated brine from sustained fresh water injection of 50 gpm in the direct mode cannot be produced until the cavern volume is about 128,000 barrels.

The actual production from the well will be intermittent although the modeling in the report has continuous production. Intermittent production will result in slightly higher saturation of produced brine when mining is first resumed. As the cavern increases in size and as the idle period increases in duration, the amount of saturated brine initially produced from the well will increase.

If Key Energy proceeds with development of a brine well at Carlsbad, the mining simulations should be updated after each sonar survey of the cavern.



-1200
-1250
-1300
-1350
-1400
-1450
-1500
-1550
-1600
Depth - Feet
Insolubles
-175
-131.25
-87.5
-43.75
0
43.75
87.5
131.25
175
Radius - Feet

Brine Well Operation Management Plan

1. Predict Cavern Development (completed)
   a. Used to Determine Injection and Production String Depths
   b. Used to Determine Protective Blanket Depth for Control of Roof Height
   c. Used to Predict Cavern Shape and Growth Through Time

2. Confirm Cavern Development
   a. Perform Sonar Through Pipe Survey Every 3 Years
   b. If Infeasible Perform Workover and Perform Sonar Each 3 Years

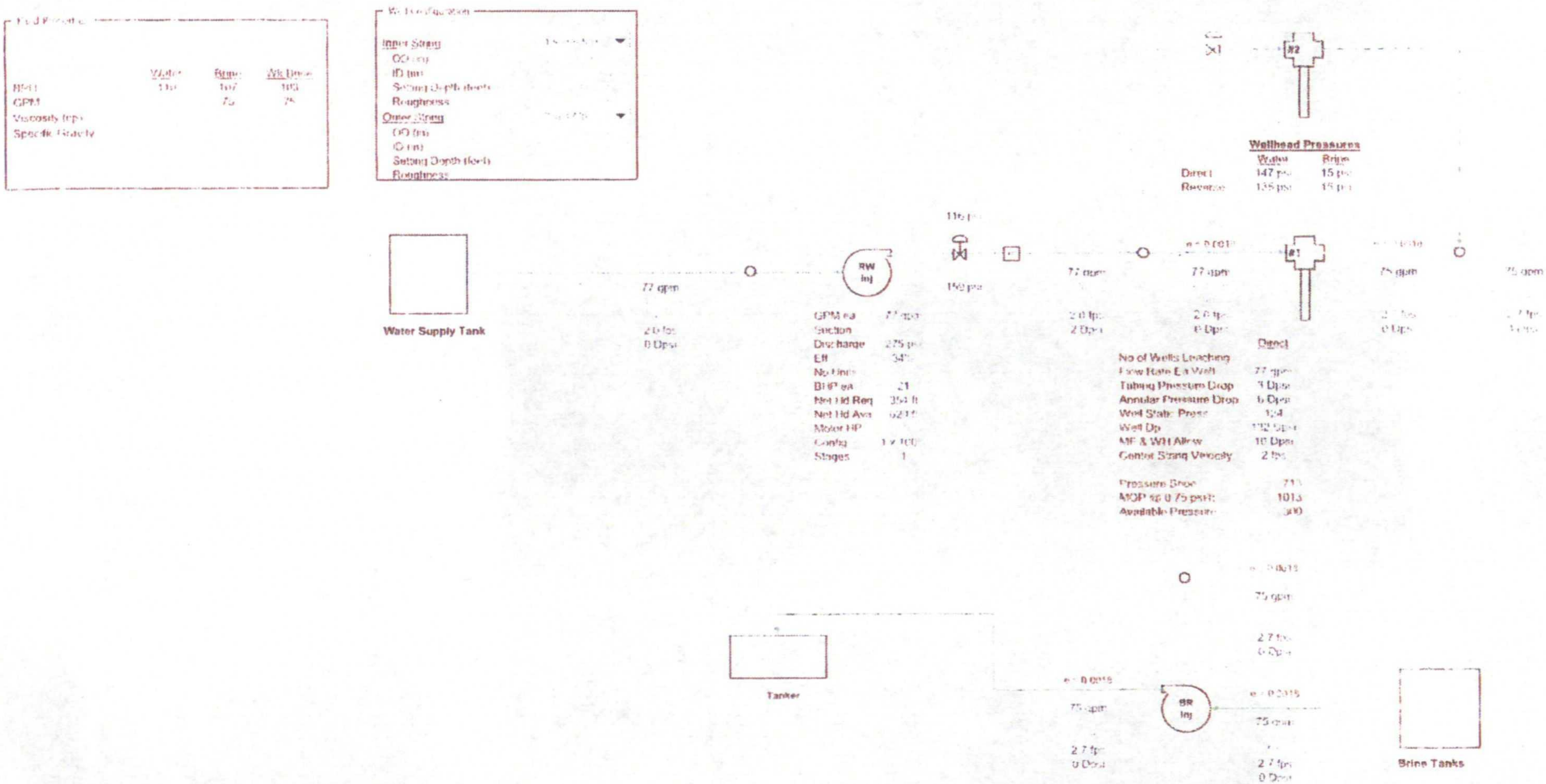
3. Update Cavern Development Prediction
   a. Use Sonar Data to Update Sansmic Modeling
   b. Re-Evaluate Cavern Development Plan

4. Monitor Roof Blanket Depth
   a. Measure Blanket Pressure Daily
   b. Perform Confirmatory Blanket Interface Survey Every 6 Months

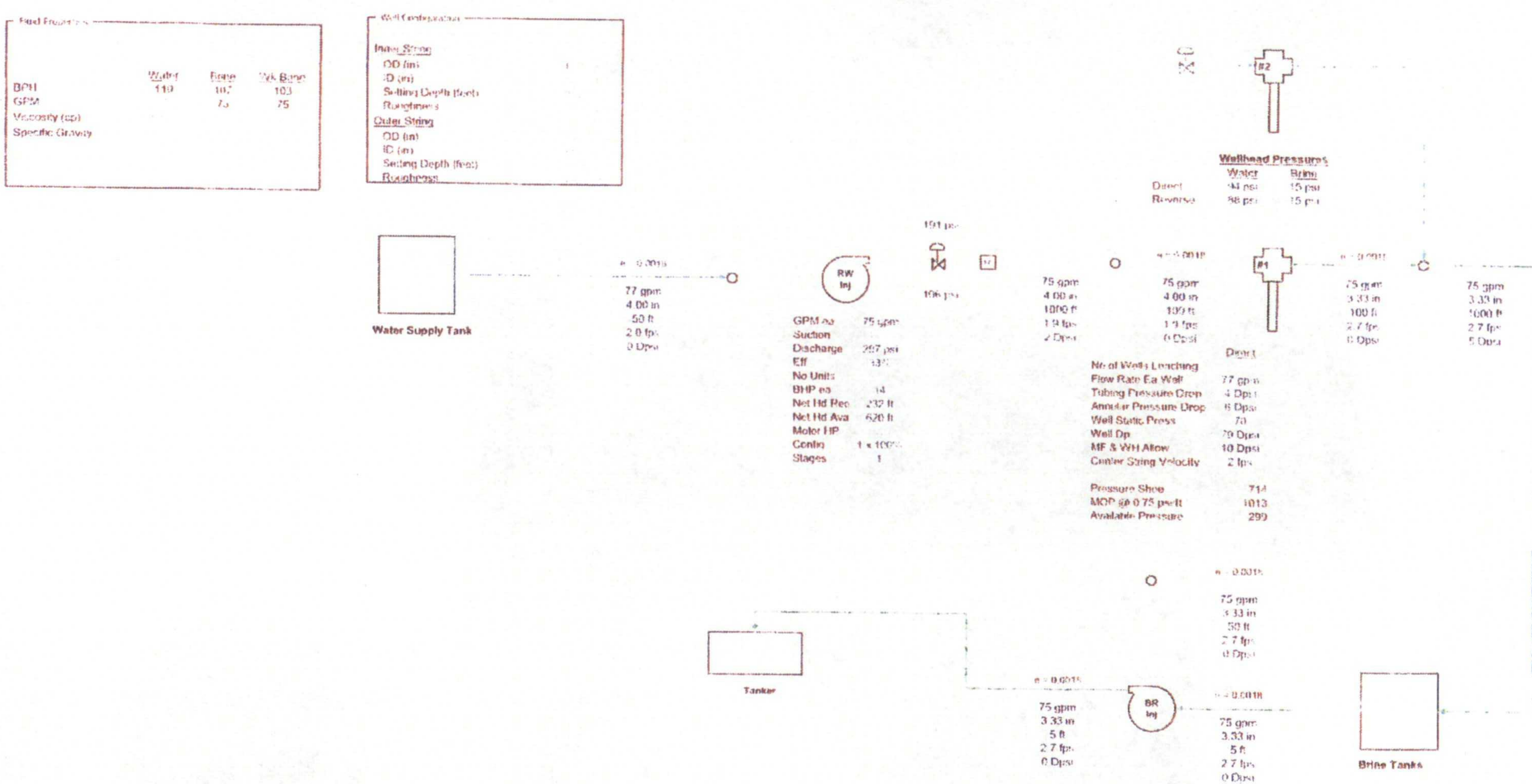
5. Add Blanket Material to Maintain Roof Depth
   a. As required based upon interface data

6. Ensure Continued Mechanical Integrity
   a. Perform Daily Monitoring of Blanket Pressure
   b. Perform Annual Fluid Pressure Test of Cavern

7. Perform Annual Subsidence Monitoring



Wellhead Pressures
Water
Brine
Direct
147 psi
15 psi
Water Supply Tank
77 gpm
RW Inj
GPM ea
Suction
Discharge
275 psi
Eff
No Units
BHP ea
21
Net Hd Req
Net Hd Avail
Motor HP
Config
Stages
1
Direct
No of Wells Leaching
Flow Rate Ea Well
Tubing Pressure Drop
Annular Pressure Drop
Well Static Press
Well Dp
MF & WH Allow
Center String Velocity
Pressure Drop
Available Pressure
Tanker
BR Inj
75 gpm
Brine Tanks



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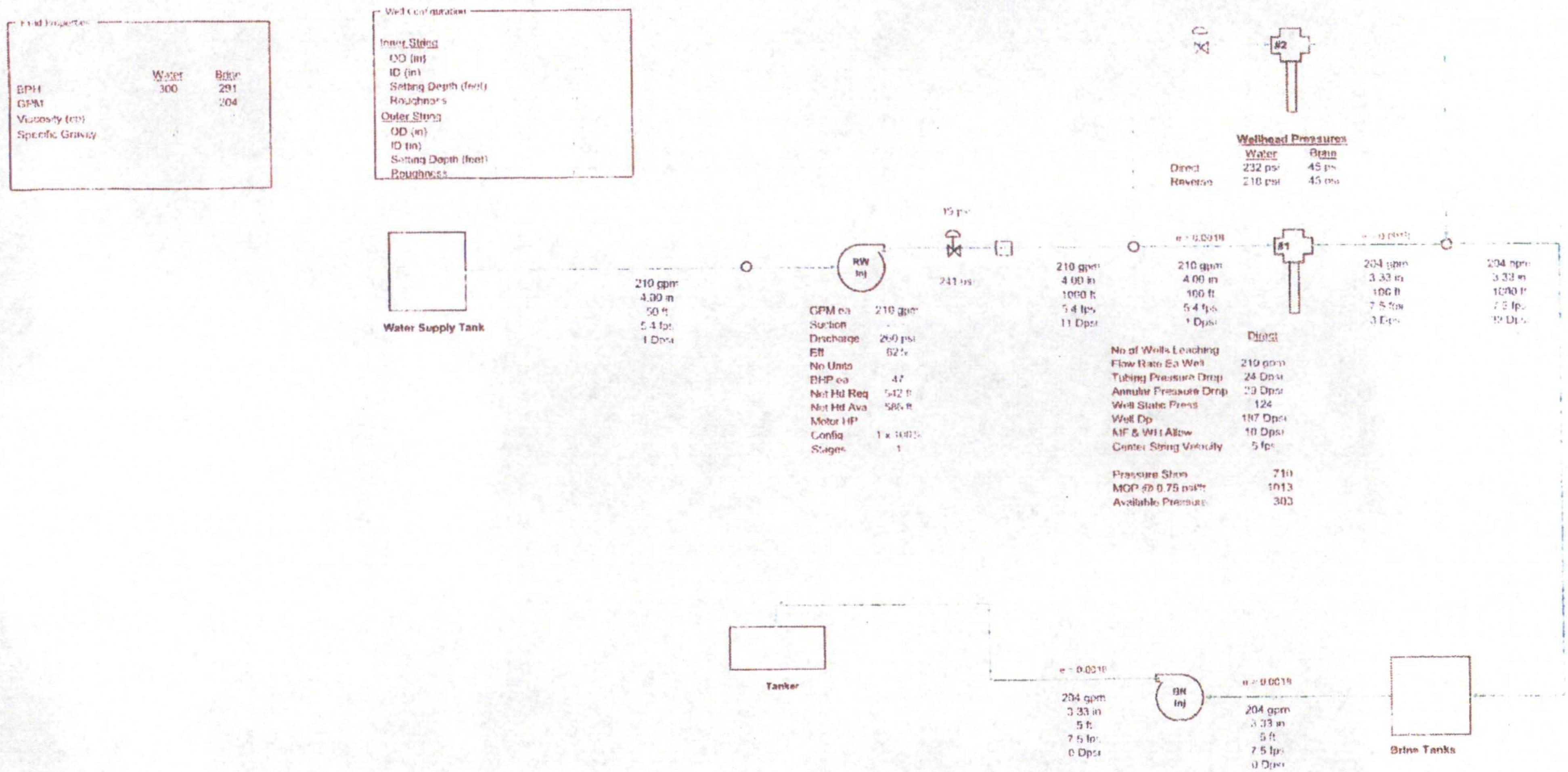
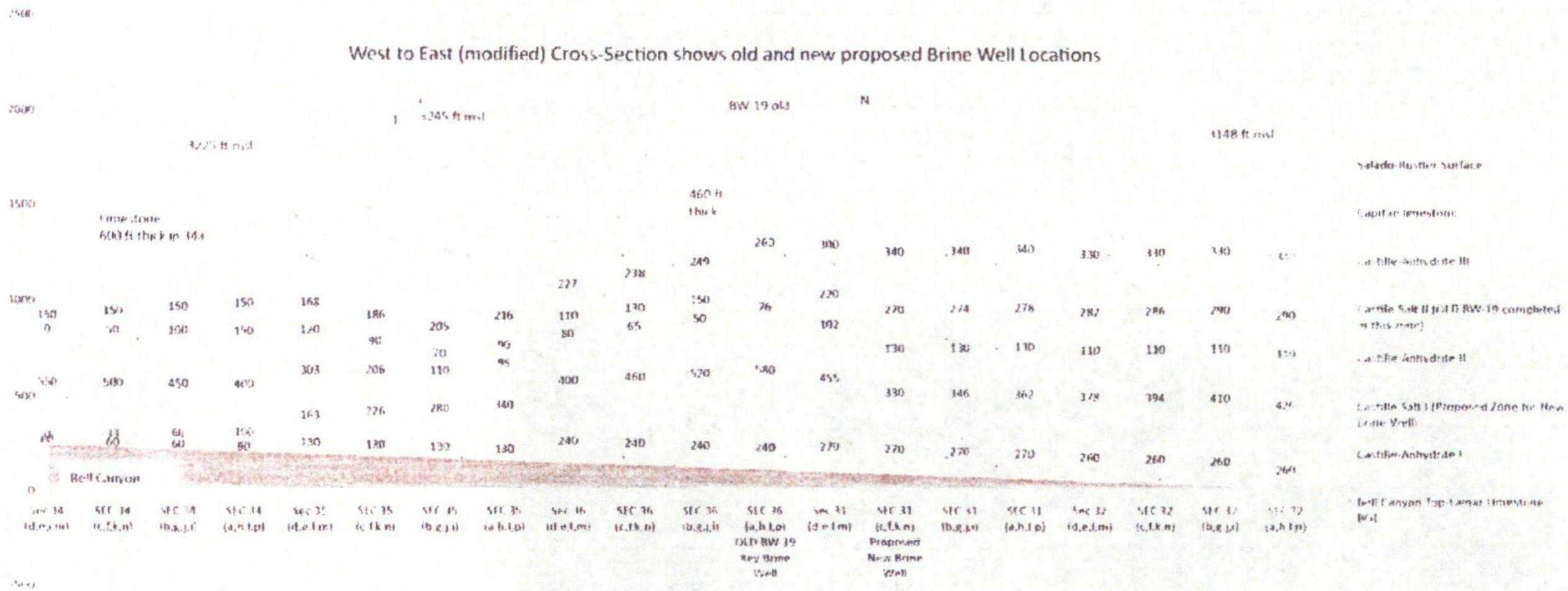

Water
Brine
BPH
300
291
GPM
204
Viscosity (cp)
Specific Gravity
Well Configuration
Inner String
OD (in)
ID (in)
Setting Depth (feet)
Roughness
Outer String
OD (in)
ID (in)
Setting Depth (feet)
Roughness
Water Supply Tank
210 gpm
4.00 in
50 ft
5.4 fps
1 Dpsi
RW Inj
GPM ea
210 gpm
Suction
Discharge
260 psi
Eff
62%
No Units
BHP ea
47
Net Hd Req
542 ft
Net Hd Ava
585 ft
Motor HP
Config
Stages
1
241 psi
210 gpm
4.00 in
1090 ft
5.4 fps
11 Dpsi
e = 0.0018
210 gpm
4.00 in
100 ft
5.4 fps
1 Dpsi
#1
#2
Wellhead Pressures
Water
Brine
Direct
232 psi
45 psi
Reverse
218 psi
45 psi
204 gpm
3.33 in
100 ft
7.5 fps
3 Dpsi
204 gpm
3.33 in
1090 ft
7.5 fps
Direct
No of Wells Leaching
Flow Rate Ea Well
210 gpm
Tubing Pressure Drop
24 Dpsi
Annular Pressure Drop
29 Dpsi
Well Static Press
124
Well Dp
187 Dpsi
MF & WH Allow
10 Dpsi
Center String Velocity
5 fps
Pressure Shoe
710
MOP @ 0.75 psi/ft
1013
Available Pressure
303
Tanker
e = 0.0018
204 gpm
3.33 in
5 ft
7.5 fps
0 Dpsi
BR Inj
e = 0.0018
204 gpm
3.33 in
5 ft
7.5 fps
0 Dpsi
Brine Tanks

West to East (modified) Cross-Section shows old and new proposed Brine Well Locations



Addendum (5/2011) Section VII.A.1-4 Appendix for Brine Well Application Guideline

Includes:

1. ***Updated C-101 form "Application for Permit to Drill, Deepen, or Plug Back" with drilling plan attachments and*** C-144 CLEZ and C-102 "Well Location and Acreage Dedicated Plat"
2. Copy of original Notice of Intent.
3. OCD's response letter to Notice of Intent.

State of New Mexico
Energy Minerals and Natural Resources

[illegible]

[illegible] PERMIT TO DRILL, RE-ENTER, DEEPEN, PLUGBACK, OR ADD A ZONE

[illegible]

Surface Location

[illegible]

Additional Well Information

[illegible]

Proposed Casing and Cement Program

18"	16	75 [illegible]	60		
[illegible]	13-3/8"	[illegible]	500	505	Circulated
[illegible]	10-3/4	40.5 [illegible]	[illegible]	480	Circulated
[illegible]	—	20 [illegible]	1360	Casing	
[illegible]	[illegible]	[illegible]	1528	Tubing	

OIL CONSERVATION DIVISION

State of New Mexico
Energy Minerals and Natural Resources
Oil Conservation Division
Form C-101 [illegible] Attachment pg

Operator: Key Energy Services LLC
[illegible] Desta Drive Suite [illegible]
Midland TX 79705

Property Name: Carlsbad Brine Well #2

2? Describe the proposed program.

All activities of the design plan will be in compliance with the appropriate requirements of 19.15.17 NMAC

All drilling activities will be utilizing a closed loop system in compliance with the appropriate requirements of 19.15.17 NMAC

[illegible] 18 hole to 60 install 75#/ft 16 J-55 BT&C casing and cement to surface with [illegible] sacks cement twice the annular volume

Drill 12-1/2 hole to 500

Condition hole to stabilize

Run deviation survey

Log 500 to surface run Triple Combo log – Dual Induction Resistivity/Compensated Neutron Log/Litho-Density

[illegible]

[illegible]

Cement to surface with 695 sacks cement twice annular volume

[illegible] cement for 24 hours notify NMOCD to witness test

[illegible]

Run cement evaluation tool from TD to surface

[illegible] conductor and surface casing and weld on 13-3/8 [illegible] 5M slip-on casing [illegible]

[illegible] BOP stack double ram and annular preventer and choke [illegible]

[illegible]

State [illegible]
[illegible]
Oil Conservation Division
[illegible] Attachment pg 2

Operator: Key Energy Services LLC
6 Desta Drive Suite [illegible]
Midland [illegible] 79705

Project Name: Carlsbad Brine Well #2

Drill 12 1/4 hole with Automated Drilling System (ADS or similar) to ~ 1250' (or 50' into top of salt) to insure ~0 deviation

Condition hole to stabilize

Log from 1250' to surface with Triple Combo Log – Dual Induction Resistivity/Compensated Neutron Log/Litho-Density

Run mechanical sidewall coring tool and sample

Condition hole to run casing

Run ~ 1250' of 10-3/4 J-55 40.5#/ft BT&C casing

Cement to surface with 483 sacks cement (twice annular volume)

Wait on cement 24 hours, notify NMOCD to witness test

Pressure test casing to 650 psi for 30 minutes

[illegible]

Drill [illegible] hole to ~1550'

[illegible]

[illegible]

[illegible] 5#/ft tubing

[illegible] location

KEY Geology Summary

The proposed location is located in the northwest corner of the Delaware Basin, a major depositional feature for ~250 Ma during the Paleozoic Era. The Capitan reef surrounded the basin near the end of this time, restricting circulation from the open ocean and resulting in the deposition of the salt-bearing formations (Castile, Salado, and Rustler, from base upward) in southeastern New Mexico (SENM). Castile salt is the proposed source at the brine well location.

Castile rocks are restricted to the basin (inside the rimming Capitan reef) by definition. It consists of beds of laminated sulfate-carbonate (A-1, A-2, etc., upward) alternating with salt (H-1, H-2, etc). A-1 is commonly 200-250 ft thick. H-1, the target salt bed, is generally greater than 300 ft thick and is locally more than 500 ft thick. Thicker (generally 300 ft or more) sulfate beds of the Castile overlie H-2. It is likely that all salt has been dissolved from the Salado, and the Rustler is poorly represented or removed by erosion in the vicinity of the site. The upper sediments are alluvial to fan deposits from Dark Canyon and the low Guadalupe escarpment.

The Delaware Mountain Group-Castile contact is well mapped and shows a slight eastward dip that is related to uplifts to the west that largely ended before Ogallala deposition beginning ~13 Ma. Lineaments along the eastern Guadalupe Mountain escarpment have been examined and are not faulted. US Geological Survey mapping indicates that the nearest younger faulting of tectonic origin is along the western escarpment of the Guadalupe Mountains. Low-magnitude seismic activity in SENM continues to be recorded, and occasionally felt, that is believed associated with oil and gas recovery. An igneous intrusion into the evaporite beds east of the location is ~34 Ma old.

Other potential geologic issues include flooding, salt deformation, pressurized brine, possible H_2S, and evaporite dissolution. Drainage is established through Dark Canyon Draw for outflow from Dark Canyon. Castile salts and overlying rocks are deformed most commonly near the northern perimeter of the basin, especially northeast of WIPP and at the WIPP site. Some wells encounter pressurized brine and H_2S. The Castile at the proposed brine well is deformed, providing a thicker salt interval for brine operations. If encountered, pressurized brine and H_2S should be controllable through safe drilling practices. Pressurized brine without H_2S may be used as an asset. Along the western part of the Delaware Basin, Castile to Rustler rocks have been exposed by erosion and subjected to both erosion and dissolution. While the upper Castile appears generally intact at the site, Salado salts and sulfates have been removed or thinned by erosion/solution. The Rustler crops out to the southwest, but is generally poorly preserved or removed in the area of the brine well. There is no surface evidence of sinkholes or collapse features at or near the well location indicating recent or modern natural solution of significance. Bedded salt tends to maintain internal fluid pressures greater than normal fresh water hydrostatic levels, countering invasion by fresh water. In the absence of a natural break and conduit (e.g., fault) or man-made access (e.g., uncased and unplugged drillholes), such processes are expected to be very slow and not a short-term concern.