2R - 56

WORKPLANS

DATE:

March 8, 2011

March 09, 2011

To: Ed Hansen-OCD

From: Wayne Price-Price LLC.

Subject: Devon Avalon Hills 7 Fed Com#3 Blowout June 2006

Reference: OCD Case # 2R0056

Dear Ed:

During our last meeting, around the holidays, I had an opportunity to discuss this site with you and Glenn. At that time, your initial indication was that we probably could close MW-5 and MW-7 because of the distance from the site and the fact the chemical analysis have not changed over the past 5 years.

MW-7 is actually located in the Avalon lakebed, high reservoir storage area. While the lake hasn't seen those levels in many years, it is possible for that to happen and the well could go under water. This well is located in the lake-bed alluvium and it is directly affected by the lake chemical parameters. Upstream is Brantely lake, which releases water directly to Lake Avalon.

Please find attached a copy of a recent data set taken by New Mexico State University (Ag dept) of various storage waters in the area. I have highlighted a couple of parameters for Chlorides and Sulfates. You can see the lake water ranges from about 500-2200 mg/l chlorides. MW-7 has most likely been at very static levels and the chloride has a tendency to rise in stagnant areas. Over the past 3 year monitoring period, Chlorides in MW-7 has ranged from 2250-2500 mg/l.

MW-5 lies between MW-7 and the Devon well, and is over 700 feet from the blow-out site. Over the past 3 year monitoring period, MW-5 has ranged from 608-1260 mg/l. The installation of these wells was hastily requested under somewhat emergency conditions by the agency at the time. The idea was to provide protection for the lake, thinking there was one local aquifer.

MW-5 and MW-7 do not have well logs, and therefore it is difficult to evaluate these wells.
What is disturbing, is that the wells may be completed across different water zones. We do know this area is highly disturbed, with the four different hydro-geologic zones that focal in this area. The Pecos Valley Alluvium, the Chalk Bluff, The Rustler, and most important, The Carlsbad Limestone. Please find enclosed an excerpt from the Groundwater Report #3 Plate 1, showing the geology in this area. Also, included are site photos showing the out-cropping of the limestone near the lake and east of there, toward the site.

MW-5 could actually be completed across the Chalk Bluff, Rustler and Carlsbad limestone at this point. Even if these wells were logged, if may be impossible to make any formable conclusion on the underlying hydro-geology due the extreme cavernous zones found, which are not confined to certain beds and appear to be extremely irregular and erratic. It must be pointed out that monitor well construction was very difficult due to the cavernous zones encountered.

There may actually be four different water zones, five if perched water is included, to contend with. One thing that we do know, is the Carlsbad limestone, as reported by the State Engineer's office, is usually under confined conditions and has very good quality water.

The MW-4 log shows that water was encountered and was measured at the same elevation that is encountered at the Carlsbad Spring. During the drilling of this well, a large cavern was encountered. It appears that we may be mixing Rustler or Chalk Bluff water with the Carlsbad Limestone water. Or even worse, if MW-4 was impacted by the blowout, then we are mixing contaminated water with very good water of the Carlsbad Limestone. Over the past five year monitoring period, the chlorides in MW-4 has ranged from 950-1270 mg/l.

The current hydraulic head at the site is most likely higher than the Carlsbad Limestone, thus even though the limestone is under pressure, it may not be enough to overcome the water found locally.

MW-6 appears to be up gradient, referencing local historic groundwater maps. It is either completed in the Chalk Bluff or Rustler. Since there is no well log, this is a logical assumption. It also statically match's the chemical of the water found in the Chalk Bluff or Rustler.

Located just over the hill, northeast of the site, is a large salt playa, which is most likely a collapsed feature. It is unknown if this feature influences the groundwater quality in the area. See aerial photo attached.

MW-2 appears to be on the very edge of the Carlsbad Limestone, and has fairly good water, with Chlorides ranging from 300-420 mg/l. The borehole logs of MW-1 (near the Devon Well) and MW-2 located approximately 180 feet to the southeast, show a clear demarcation that this is a transitional zone. MW-1 encountered salt, no limestone, while MW-2 was completed in Limestone.

It is very possible this local area is a transitional zone between Carbonate and Evaporite features in the area. It should also be pointed out this site is located on top of the Capitan Reef. The Reef water is over a 1000 ft deep in this area.

MW-1 was located as close as possible to the well site, and drilling fluids were encountered in the well and were pumped out routinely. The soils and water were contaminated. From all of the investigation data, it does appear that the contamination is very localized just around the well.

Please refer to the aerial photo, where I attempted to provide a visual delineation and transitional zones. I feel very confident that the transitional lines approximately locate the focal point in this area. I drew a red line where I know there is confirmed limestone features. Below the red line, I feel is the Carbonate facies. Please see my field photos showing the limestone.

West of the yellow line approximates the river valley alluvium and probably some chalk Bluff. East of the Yellow line is definitely Chalk Bluff and Rustler. If you look to the NE you will see a salt playa lake, which demonstrates the Evaporite features.

What we do know from information obtained from the State Engineers Office, is that the Carlsbad Limestone feeds the Carlsbad Spring, which for the most part is the major source of water for Lake Carlsbad and the Pecos River in Carlsbad. See photos attached.

At this point and time, Devon feels that it would be extremely wise to plug and abandon MW 4, 5 and 7 immediately. Especially since MW 5 and 7 apparently have no essential value to the project. MW-4 may be completed across two zones and may be cross-contaminating the Carlsbad limestone.

We will continue to remove any contamination from the MW-1 and monitor very closely MW-2. None of the wells could be correlated and we may actually be doing more harm than good by leaving these conduits open.

Devon hereby request that it be immediately allowed to plug and abandon the three monitor wells MW-4, 5 & 7 at this time.

If you have any questions please do not hesitate to call or write.

Sincerely,

Wayne Price-Agent for Devon Energy

Devon Project Notes:

Carlsbad limestone interfingers with and in parts overlaps the Capitan limestone. Plunges beneath the surface a short distance north of Carlsbad. The formation thins to the northwest as it grades into redbeds and evaporates of the Chalk Bluff formation. Principal aquifer in the Carlsbad area.
Carlsbad Limestone Water Levels- Generally confined but when released rises to 3105-3110 ft amsl.

Chalk Bluff formation: Back reef sedimentary rocks, which includes evaporates, dolomites, redbeds, and sandstones. Chalk Bluff basal Limestone contains recharge water from the west and is the principal source of water north of the site area. Water of good quality and a very good predicitability of water levels can be made.

Rustler Formation: Anhydrite, gypsum, interbedded red and green sandy clay, and some beds of dolomite. (some salt ?) Outcrops east of the Pecos river as a belt of gypsum and redbeds. Overlies Chalk Bluff and is hard to distinguished from it. Yields water to many wells, usually high in chloride and sulfates. **Salt Playa NE of site.**

Older Alluvium: Quartzose conglomerate, mainly west of the River going north of Seven Rivers. Thickness in the valley from Zero to more than 300 feet. Thickest a few miles west of the river and thinning going east. Consist of clay, silt, sand, gravel, and conglomerate. It is slumped and deformed in the river valley. Chief source of water in Roswell and Carlsbad irrigated basins.

Younger Alluvium: Undisturbed silt, sand, gravel, and cobbles. About 40 feet thick. Not a major source of water. Most of the wells that do produce are in the Older Alluvium conglomerate.

River Valley: Dip of the beds under the river is generally east and southeast. Locally in the valley the beds are much disrupted by slumping. Valley was developed largely by solution of the gypsum, anhydrite and salt of the underlying Chalk Bluff formation and subsequent collapse.

All wells in this area: The depth to water and yield from wells in this area which chiefly take water from cavities (in the limestone which are irregularly distributed) over very short distances.

Groundwater Movement: West of the Pecos water generally move east into the river. East of the river, water generally moves south and southwest. The amount of water that enters the river from the east is relative small.

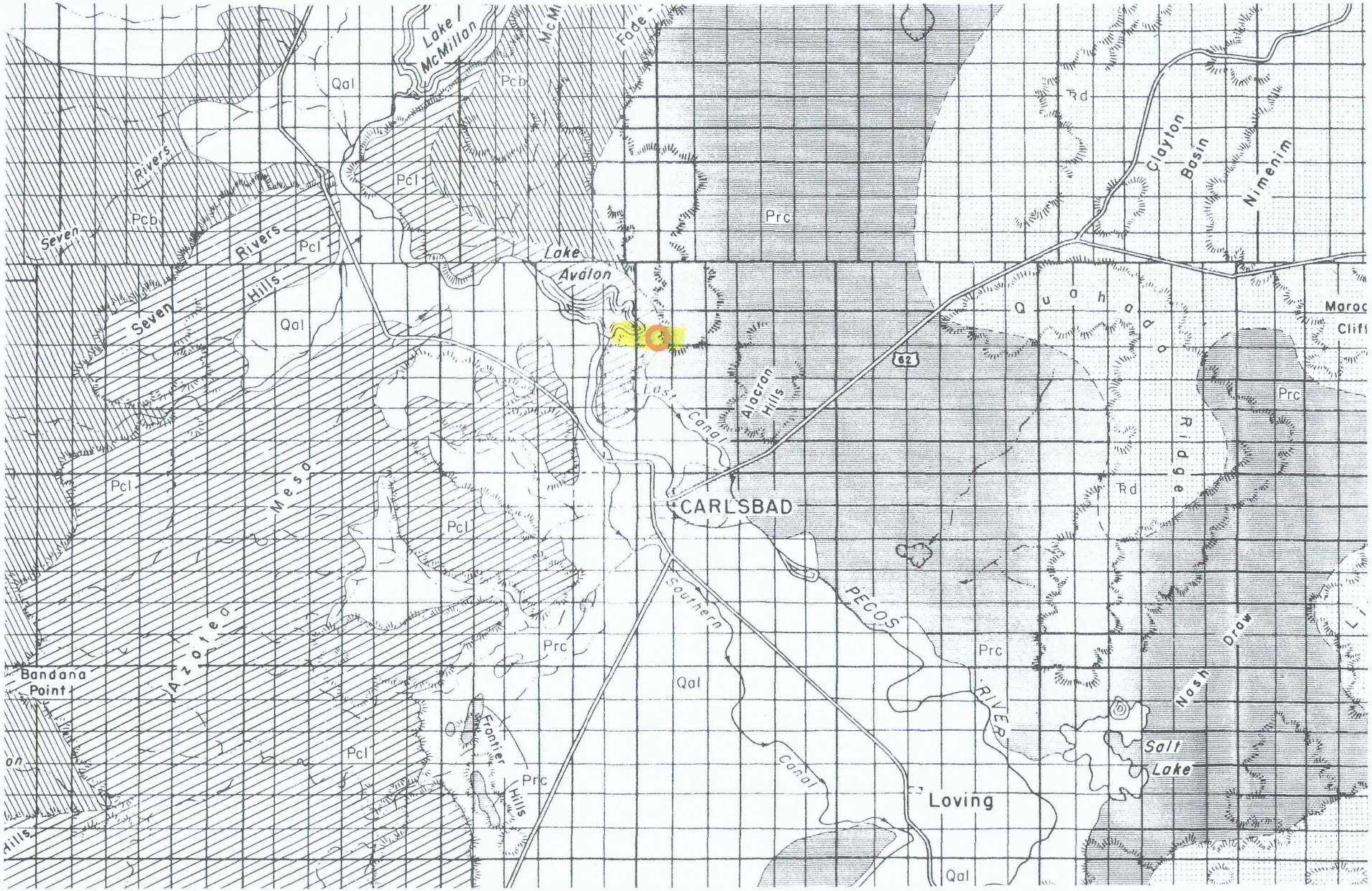
Salt Flow: At 60 cfs River is transporting 320,000 lbs of salt/day. @1000 ppm.

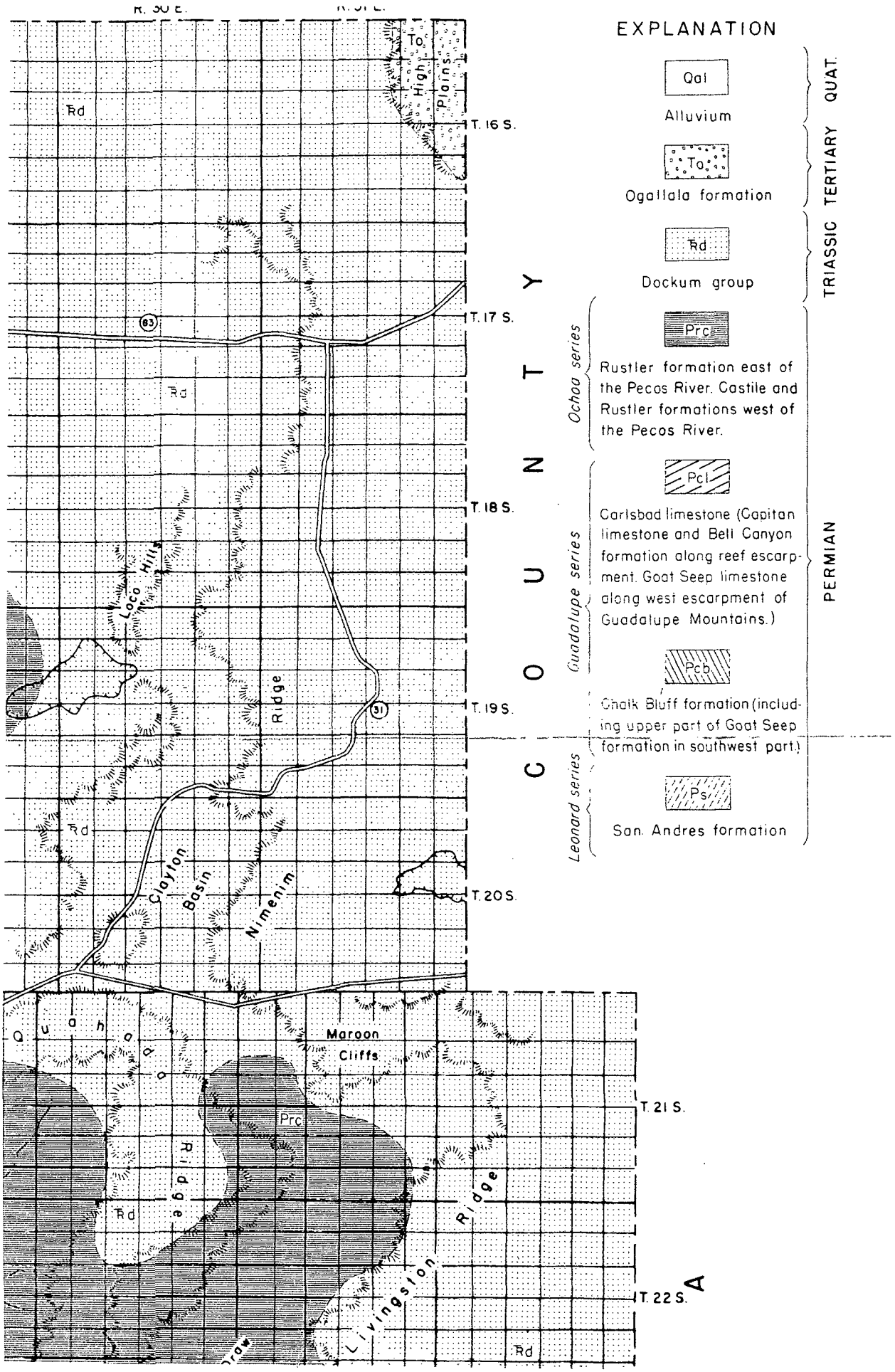
Water is declining: NO Surprise, as it declines it becomes more saltly.

Soil located in the Avalon Lake bed acts as a playa lake conditions, where repeated flooded of the area and resultant drying and evaporation have caused a large build up of salts over time. This via "Density Flow" has caused increased salt content at the bottom of the alluvium aquifer. Compounding this problem is the invasive Salt Cedars which concentrate salts. Chloride ions are more soluble than sulfates and has a tendency to flow to the bottom of the aquifer.

If the alluvium is near the Carlsbad limestone or Chalk Bluff we could cross-contaminate the area with pumping of monitor wells.

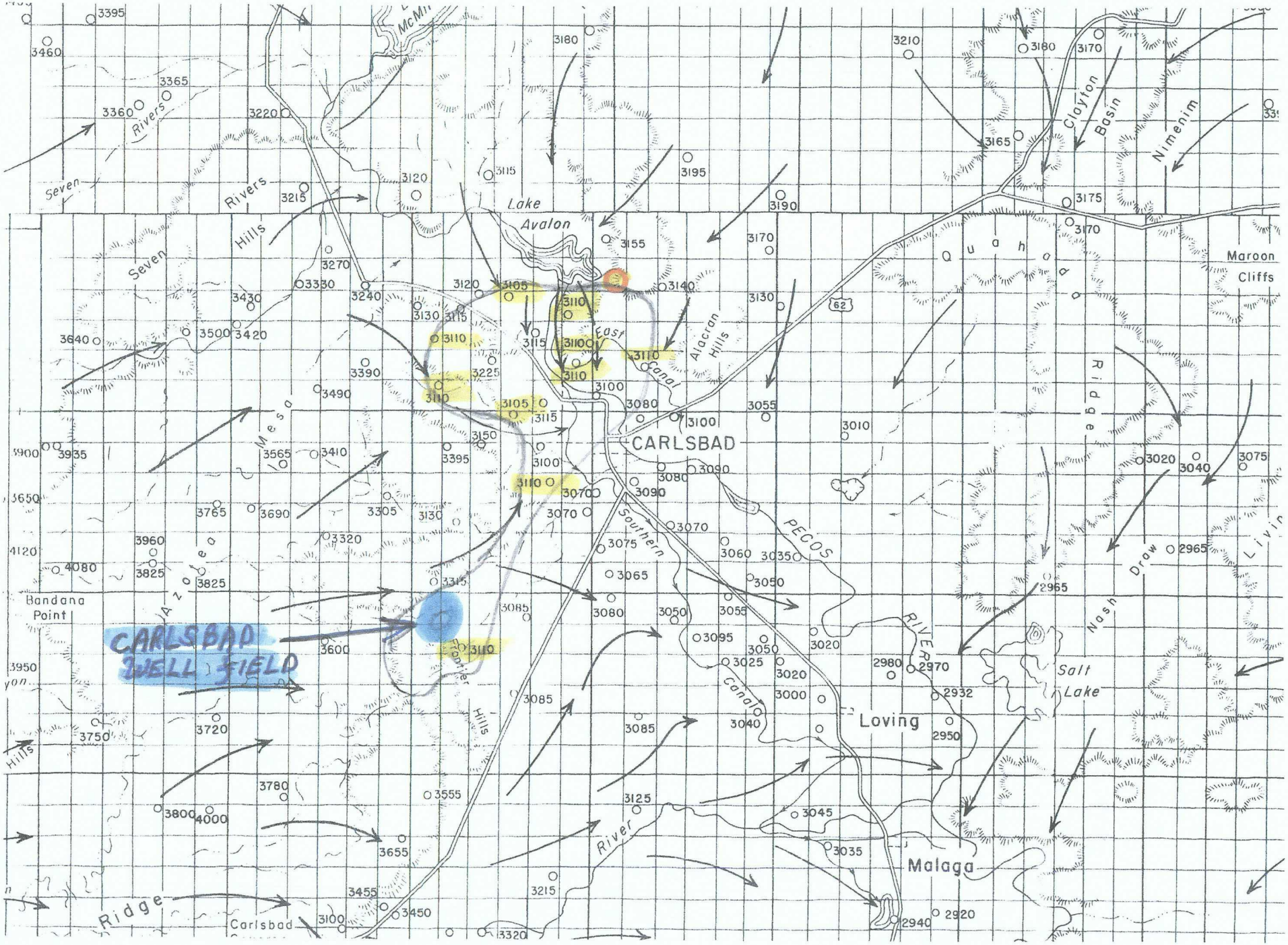
Excavating in this area may be hazardous and cause cross-contamination, especially if we break into some of the good quality limestone solution channels. ***There would be no way to seal them back.*** Drilling more MW's same scenario.


Lake McMillan
McM
Fade
Qal
Pcb
Pcl
Prc
Rivers
Seven
Seven Rivers
Hills
Lake Avalon
Clayton Basin
Nimenim
Quahada Ridge
Rd
62
Alacran Hills
Last Canal
CARLSBAD
Mesa
Azotea
Southern Canal
PECOS RIVER
Nash Draw
Salt Lake
Loving
Bandana Point
Frontier Hills
Canal


R. 30 E.
R. 31 E.
To.
High Plains
Rd
T. 16 S.
T. 17 S.
T. 18 S.
T. 19 S.
T. 20 S.
T. 21 S.
T. 22 S.
83
31
Loco Hills
Ridge
Clayton Basin
Nimenim
Maroon Cliffs
Prc
Livingston Ridge
Rd
EXPLANATION
Qal
Alluvium
To.
Ogallala formation
Rd
Dockum group
Prc
Rustler formation east of the Pecos River. Castile and Rustler formations west of the Pecos River.
Pcl
Carlsbad limestone (Capitan limestone and Bell Canyon formation along reef escarpment. Goat Seep limestone along west escarpment of Guadalupe Mountains.)
Pcb
Chalk Bluff formation (including upper part of Goat Seep formation in southwest part.)
Ps
San. Andres formation
Ochoa series
Guadalupe series
Leonard series
PERMIAN
TRIASSIC
TERTIARY
QUAT.
COUNTY

3/8/11
LWP

CARLSBAD LIMESTONE AQUIFER



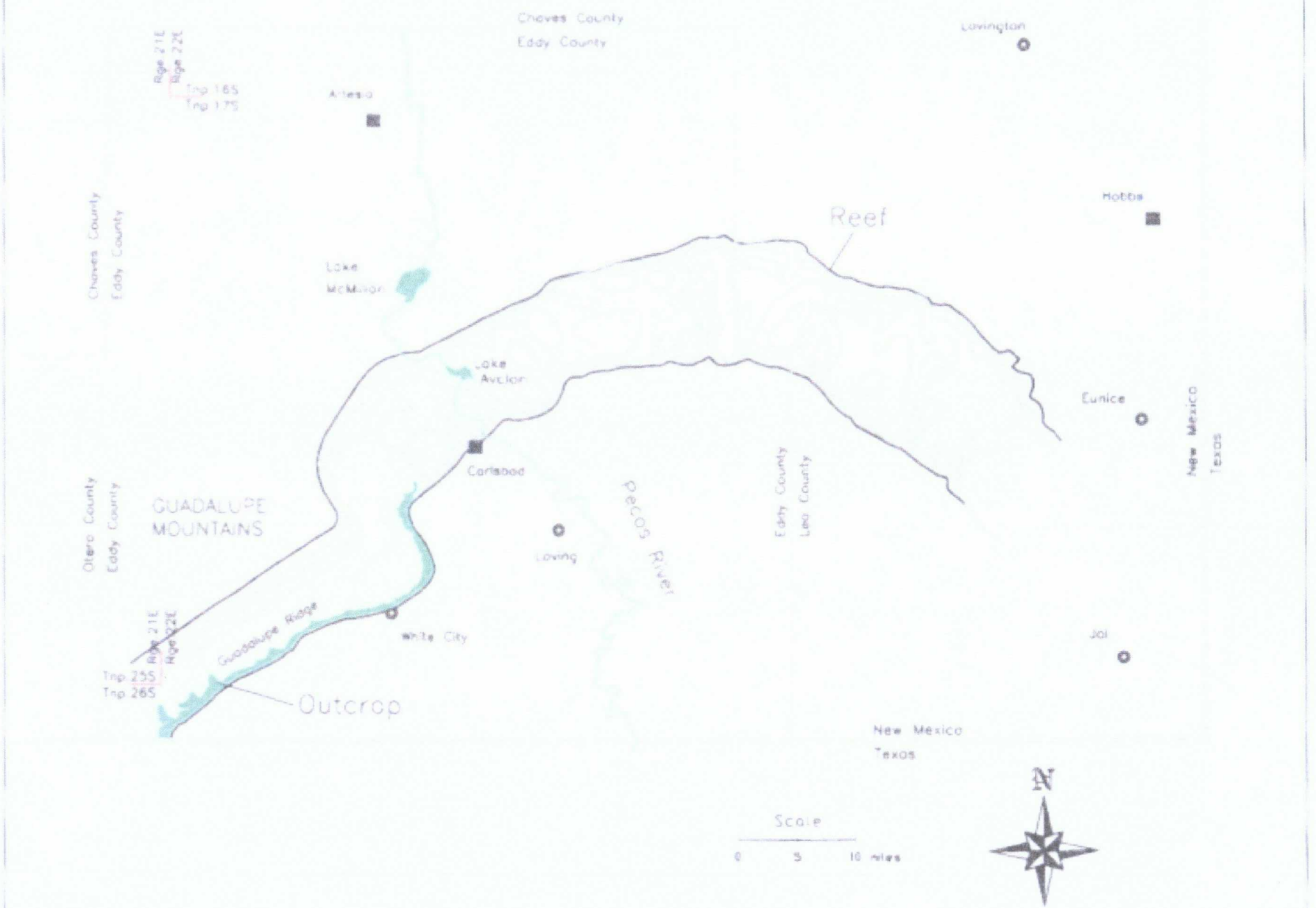
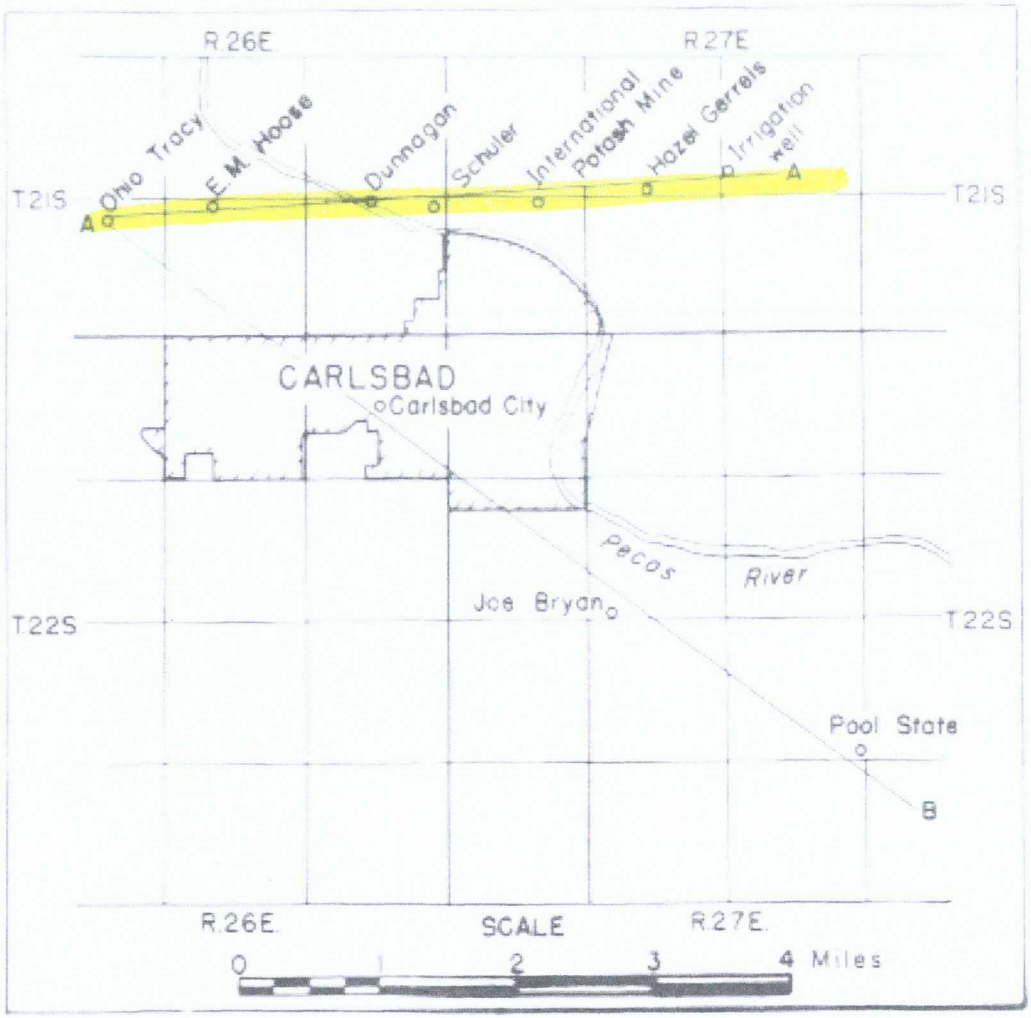
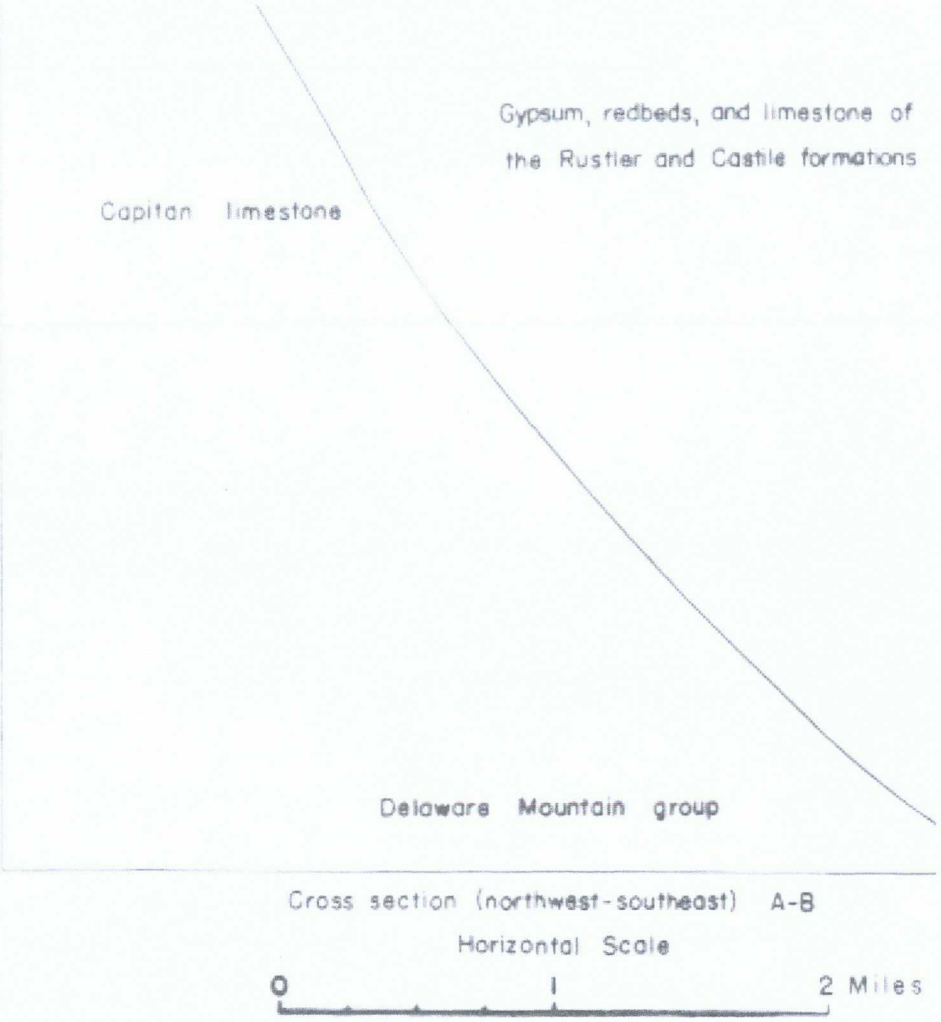


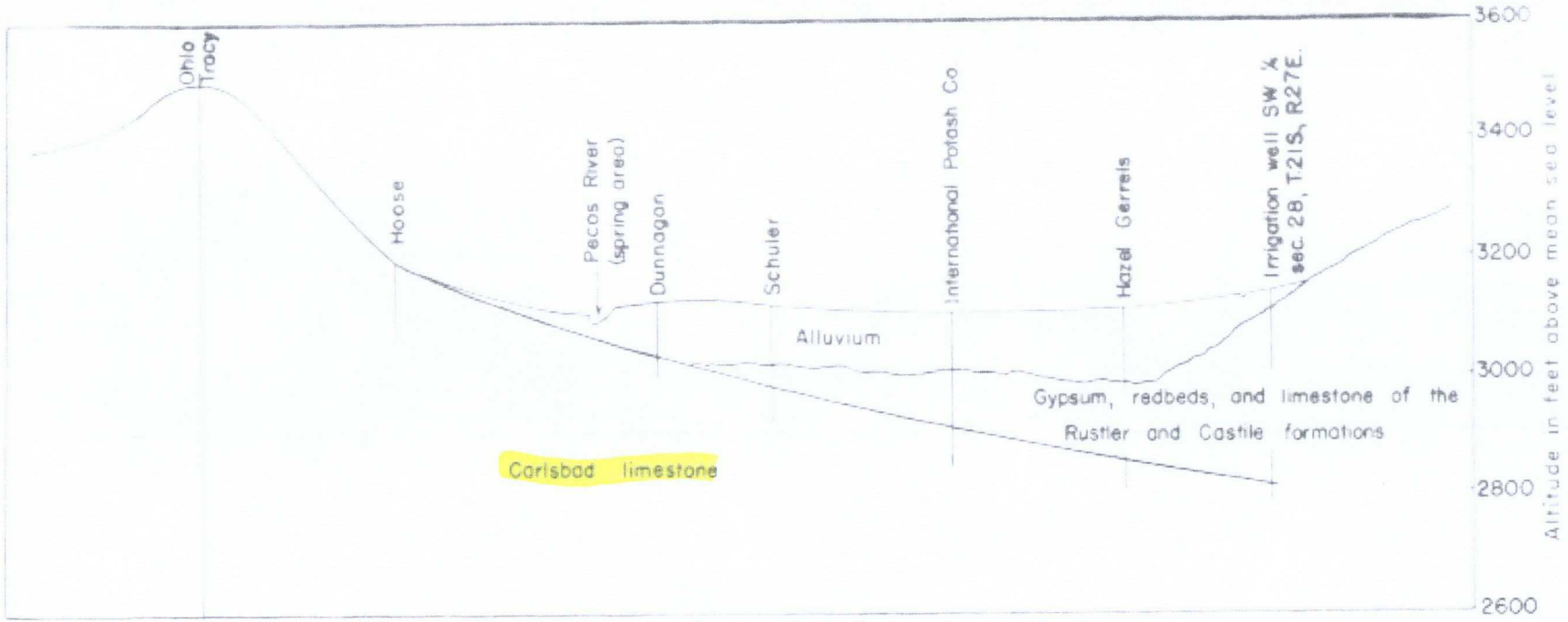
Figure 2-13. Capitan Reef Aquifer Location Map





GEOLOGIC CROSS SECTIONS OF THE CARLSBAD AREA, EDDY COUNTY, N. MEX.

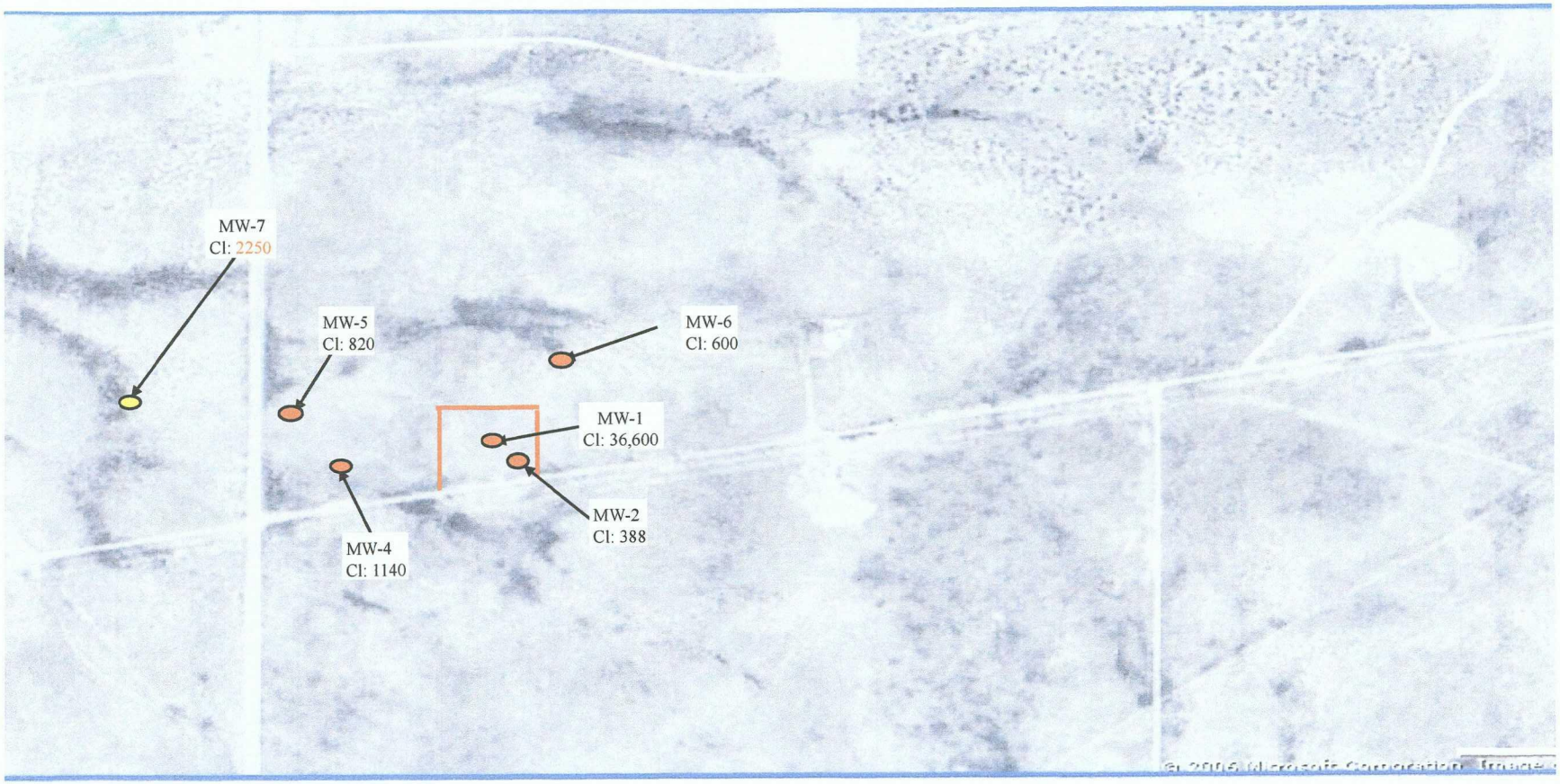
Fig. 5



Cross section (west-east) A-A' through La Huerta

Horizontal Scale

0 1 2 Miles


MW-7
Cl: 2250
MW-5
Cl: 820
MW-6
Cl: 600
MW-1
Cl: 36,600
MW-2
Cl: 388
MW-4
Cl: 1140

Devon Energy Company
Avalon Hills Fed 7 2R-0056
Water Analytical Summary

MW-1

Date	Lab Name	Lab. No	Benzene	Toluene	Ethylbenzene	Xylene	Chlorides
10/29/06	Cardinal	H11728					34,984
11/19/06	Hall	0611272	6,100	22,000	770	9,400	51,000
11/26/06	Hall	0611337	4,000	20,000	570	6,500	50,000
01/10/07	Env. Labs of TX	7A15009	2,760	4,950	475	4,900	65,900
05/14/07	Xenco	282577	2.577	6.605	0.480	4.859	65,700
11/02/07	Cardinal	H13647	2,370	2.520	0.493	4.820	36,600
03/02/08	Cardinal	H14366					40,000
03/08/08	Xenco	299235					38,600
03/22/08	Xenco	300277					40,100
04/04/08	Xenco	300279					47,500
05/16/08	Cardinal	H14830					41,600
09/29/08	Cardinal	H16000	1,920	1.300	7.320	78,900	35,600
08/28/09	Cardinal	H18138	475	1,210	1,240	15,100	34,000
08/05/10	Source volume too small to measure						

34,984	34,984		
51,000	51,000		
50,000	50,000		
65,900	65,900		
65,700	65,700		
36,600	36,600		
40,000	40,000		
38,600	38,600		
40,100	40,100		
47,500	47,500		
41,600	41,600		
35,600	35,600		
34,000	34,000		
44,737 AVG	10,853 STDEV	24.26%	

MW-2

Date	Lab Name	Lab. No	Benzene	Toluene	Ethylbenzene	Xylene	Chlorides
11/19/06	Hall	0611272	ND	4.40	ND	3.00	370
11/26/06	Hall	0611337					300
01/10/07	Env. Labs of TX	7A15009	ND	ND	ND	ND	393
02/28/07	Env. Labs of TX	7B23004					369
05/14/07	Xenco	282577	ND	ND	ND	ND	393
11/02/07	Cardinal	H13647	ND	ND	ND	ND	396
05/16/08	Cardinal	H14830					392
09/29/08	Cardinal	H16000					388
08/28/09	Cardinal	H18138	ND	ND	ND	ND	392
08/05/10	Cardinal	H20584	0.003	ND	ND	0.003	420

370	370		
300	300		
393	393		
369	369		
393	393		
396	396		
392	392		
388	388		
392	392		
420	420		
381 AVG	32 STDEV	8.36%	

MW-4

Date	Lab Name	Lab. No	Benzene	Toluene	Ethylbenzene	Xylene	Chlorides
11/19/06	Hall	0611272					1,200
11/26/06	Hall	0611337					1,200
01/10/07	Env. Labs of TX	7A15009	ND	ND	ND	ND	1,270
02/28/07	Env. Labs of TX	7B23004					1,020
05/14/07	Xenco	282577	ND	ND	ND	ND	1,220
11/02/07	Cardinal	H13647	ND	ND	ND	ND	1,200
03/02/08	Cardinal	H14366					1,180
03/08/08	Xenco	299235					1,160
03/22/08	Xenco	300279					1,200
05/16/08	Cardinal	H14830					1,140
09/29/08	Cardinal	H16000					1,140
08/28/09	Cardinal	H18138	ND	ND	ND	ND	1,160
08/05/10	Cardinal	H20584	0.001	ND	ND	0.003	950

1,200	1,200		
1,200	1,200		
1,270	1,270		
1,020	1,020		
1,220	1,220		
1,200	1,200		
1,180	1,180		
1,160	1,160		
1,200	1,200		
1,140	1,140		
1,140	1,140		
1,160	1,160		
950	950		
1,157 AVG	85 STDEV	7.35%	

MW-5

Date	Lab Name	Lab. No	Benzene	Toluene	Ethylbenzene	Xylene	Chlorides
02/28/07	Env. Labs of TX	7B23004	ND	0.00	ND	0.007	967
05/14/07	Xenco	282577	ND	ND	ND	ND	608
11/02/07	Cardinal	H13647	ND	ND	ND	ND	880
05/16/08	Cardinal	H14830					920
09/29/08	Cardinal	H16000					820
08/28/09	Cardinal	H18138	ND	ND	ND	ND	840
08/05/10	Cardinal	H20584	ND	ND	ND	ND	1,260

967	967		
608	608		
880	880		
920	920		
820	820		
840	840		
1,260	1,260		
899 AVG	196 STDEV	21.78%	

MW-6

Date		Lab. No	Benzene	Toluene	Ethylbenzene	Xylene	Chlorides
02/28/07	Env. Labs of TX	7C01005	ND	ND	ND	ND	587
05/14/07	Xenco	282577	ND	ND	ND	ND	769
11/02/07	Cardinal	H13647	ND	ND	ND	ND	536
03/22/08	Xenco	300279					420
05/16/08	Cardinal	H14830					590
09/29/08	Cardinal	H16000					600
08/28/09	Cardinal	H18138	ND	ND	ND	ND	600
08/05/10	Cardinal	H20584	0.01	ND	0.002	0.00	540

587	587		
769	769		
536	536		
420	420		
590	590		
600	600		
600	600		
540	540		
580 AVG	97 STDEV	16.71%	

MW-7

Date	Lab Name	Lab. No	Benzene	Toluene	Ethylbenzene	Xylene	Chlorides
05/14/07	Xenco	282577	ND	ND	ND	ND	2,490
11/02/07	Cardinal	H13647	ND	ND	ND	ND	2,440
05/16/08	Cardinal	H14830					2,280

2,490	2,490		
2,440	2,440		
2,280	2,280		

09/29/08	Cardinal	H16000					2,250
08/28/09	Cardinal	H18138	ND	ND	ND	ND	2,250
08/05/10	Cardinal	H20584	ND	ND	ND	ND	2,500

2,250		2,250	
2,250		2,250	
2,500		2,500	
2,368	AVG	121 STDEV	5.10%

MODIFIED + CORRECTED
3/8/11

Devon Energy Site
Avalon Hills
Whole Earth Environmental
2103 Arbor Cove
Katy, Texas 77494

GW LEVEL MSL

	Boring number	Latitude	Longitude	Mean Sea Level Elevation	
MW-1	BH-1	32° 29.4066656'	104° 13.361357'	3215.23' -65	= 3150'
MW-2	BH-2	32° 29.3891898'	104° 13.332315'	3215.49' -75	= 3140'
	BH-3	32° 29.3639943'	104° 13.533745'	3195.37'	
MW-4	BH-4	32° 29.3823505'	104° 23.384612'	~~3214.63'~~ -85	= 3112'

3197 MSL

Notes:

1.Horizontal Data referenced to United States Coast and Geodetic Survey Tri-Station named "Carlsbad" set in 1922. The Coordinates are given in Latitude and Longitude.
2.Vertical Data referenced to National Geodetic Survey Benchmark designated "D-345". Vertical Data is NAVD 88 Datum. All elevations taken at land surface at bore hole locations.

MW-4 3197
-85
3112 FEET MSL

CARLSBAD SPRING ≈ 3110' MSL

1999 Brantley Lake	3 Al	bICPMS	4.25E+01
1999 Brantley Lake	3 As	cAA	1.68E+00
1999 Brantley Lake	3 Ba	ICPMS	6.41E+01
1999 Brantley Lake	3 Be	ICPMS	1.91E-02
1999 Brantley Lake	3 Ca	ICPMS	3.47E+05
1999 Brantley Lake	3 Ce	ICPMS	8.07E-02
1999 Brantley Lake	3 Chloride	IC	1.07E+06
1999 Brantley Lake	3 Co	ICPMS	1.81E+00
1999 Brantley Lake	3 Cr	ICPMS	3.17E-01
1999 Brantley Lake	3 Cu	ICPMS	4.69E+00
1999 Brantley Lake	3 Dy	ICPMS	5.79E-03
1999 Brantley Lake	3 Er	ICPMS	3.52E-03
1999 Brantley Lake	3 Eu	ICPMS	1.76E-02
1999 Brantley Lake	3 Fe	ICPMS	5.30E+01
1999 Brantley Lake	3 Gd	ICPMS	7.34E-03
1999 Brantley Lake	3 K	ICPMS	6.61E+03
1999 Brantley Lake	3 La	ICPMS	5.32E-02
1999 Brantley Lake	3 Li	ICPMS	4.33E+01
1999 Brantley Lake	3 Mg	ICPMS	1.04E+05
1999 Brantley Lake	3 Mo	ICPMS	3.28E+00
1999 Brantley Lake	3 Na	ICPMS	5.05E+05
1999 Brantley Lake	3 Nd	ICPMS	3.73E-02
1999 Brantley Lake	3 Ni	ICPMS	3.65E+00
1999 Brantley Lake	3 Pr	ICPMS	1.08E-02
1999 Brantley Lake	3 Sb	ICPMS	-1.19E-01
1999 Brantley Lake	3 Sm	ICPMS	2.93E-02
1999 Brantley Lake	3 Sr	ICPMS	5.00E+03
1999 Brantley Lake	3 Sulfate	IC	1.52E+06
1999 Brantley Lake	3 Th	ICPMS	2.58E-03

1999	Brantley Lake	3	U	ICPMS	3.42E+00
1999	Brantley Lake	3	V	ICPMS	5.90E+00
1999	Brantley Lake	3	Zn	ICPMS	1.33E+01
1999	Brantley Lake	43.8	Ag	ICPMS	-5.26E-02
1999	Brantley Lake	43.8	Al	ICPMS	1.30E+02
1999	Brantley Lake	43.8	As	AA	5.21E+00
1999	Brantley Lake	43.8	Ba	ICPMS	7.45E+01
1999	Brantley Lake	43.8	Ca	ICPMS	5.00E+05
1999	Brantley Lake	43.8	Ce	ICPMS	2.66E-01
1999	Brantley Lake	43.8	Chloride	IC	2.20E+06
1999	Brantley Lake	43.8	Co	ICPMS	2.99E+00
1999	Brantley Lake	43.8	Cr	ICPMS	5.51E-01
1999	Brantley Lake	43.8	Cu	ICPMS	5.56E+00
1999	Brantley Lake	43.8	Dy	ICPMS	2.34E-02
1999	Brantley Lake	43.8	Er	ICPMS	1.25E-02
1999	Brantley Lake	43.8	Eu	ICPMS	2.16E-02
1999	Brantley Lake	43.8	Fe	ICPMS	2.04E+02
1999	Brantley Lake	43.8	Fluoride	IC	3.13E+03
1999	Brantley Lake	43.8	Gd	ICPMS	3.60E-02
1999	Brantley Lake	43.8	K	ICPMS	7.61E+03
1999	Brantley Lake	43.8	La	ICPMS	1.52E-01
1999	Brantley Lake	43.8	Li	ICPMS	6.85E+01
1999	Brantley Lake	43.8	Mg	ICPMS	1.63E+05
1999	Brantley Lake	43.8	Mn	ICPMS	6.55E+02
1999	Brantley Lake	43.8	Mo	ICPMS	2.41E+00
1999	Brantley Lake	43.8	Na	ICPMS	8.85E+05
1999	Brantley Lake	43.8	Nd	ICPMS	1.59E-01
1999	Brantley Lake	43.8	Ni	ICPMS	6.11E+00
1999	Brantley Lake	43.8	Pr	ICPMS	3.67E-02

1999	Brantley Lake	43.8	Sb	ICPMS	-1.73E-01
1999	Brantley Lake	43.8	Sm	ICPMS	5.67E-02
1999	Brantley Lake	43.8	Sr	ICPMS	7.40E+03
1999	Brantley Lake	43.8	Sulfate	IC	2.61E+06
1999	Brantley Lake	43.8	Th	ICPMS	1.67E-02
1999	Brantley Lake	43.8	U	ICPMS	3.80E+00
1999	Brantley Lake	43.8	V	ICPMS	5.13E+00
1999	Brantley Lake	43.8	Zn	ICPMS	1.71E+01
1999	Lake Carlsbad	2	Al	ICPMS	5.70E+01
1999	Lake Carlsbad	2	As	AA	1.82E+00
1999	Lake Carlsbad	2	Ba	ICPMS	1.86E+01
1999	Lake Carlsbad	2	Be	ICPMS	3.15E-02
1999	Lake Carlsbad	2	Ca	ICPMS	3.04E+05
1999	Lake Carlsbad	2	Ce	ICPMS	8.08E-02
1999	Lake Carlsbad	2	Chloride	IC	6.31E+05
1999	Lake Carlsbad	2	Co	ICPMS	1.67E+00
1999	Lake Carlsbad	2	Cr	ICPMS	3.02E-01
1999	Lake Carlsbad	2	Cu	ICPMS	3.88E+00
1999	Lake Carlsbad	2	Dy	ICPMS	6.67E-03
1999	Lake Carlsbad	2	Er	ICPMS	1.17E-03
1999	Lake Carlsbad	2	Eu	ICPMS	6.54E-03
1999	Lake Carlsbad	2	Fe	ICPMS	7.60E+01
1999	Lake Carlsbad	2	Fluoride	IC	9.53E+02
1999	Lake Carlsbad	2	Gd	ICPMS	9.10E-03
1999	Lake Carlsbad	2	K	ICPMS	5.26E+03
1999	Lake Carlsbad	2	La	ICPMS	4.29E-02
1999	Lake Carlsbad	2	Li	ICPMS	4.33E+01
1999	Lake Carlsbad	2	Mg	ICPMS	1.09E+05
1999	Lake Carlsbad	2	Mo	ICPMS	2.66E+00

1999	Lake Carlsbad	2	Na	ICPMS	3.38E+05
1999	Lake Carlsbad	2	Nd	ICPMS	3.79E-02
1999	Lake Carlsbad	2	Ni	ICPMS	2.33E+00
1999	Lake Carlsbad	2	Nitrate	IC	3.16E+03
1999	Lake Carlsbad	2	Pr	ICPMS	1.11E-02
1999	Lake Carlsbad	2	Sb	ICPMS	-4.37E-01
1999	Lake Carlsbad	2	Sm	ICPMS	1.51E-02
1999	Lake Carlsbad	2	Sr	ICPMS	4.16E+03
1999	Lake Carlsbad	2	Sulfate	IC	1.15E+06
1999	Lake Carlsbad	2	Th	ICPMS	9.10E-03
1999	Lake Carlsbad	2	U	ICPMS	3.78E+00
1999	Lake Carlsbad	2	V	ICPMS	6.13E+00
1999	Lake Carlsbad	2	Zn	ICPMS	1.35E+01
1999	Lake Carlsbad	8.3	Al	ICPMS	2.12E+02
1999	Lake Carlsbad	8.3	As	AA	2.37E+00
1999	Lake Carlsbad	8.3	Ba	ICPMS	3.30E+01
1999	Lake Carlsbad	8.3	Be	ICPMS	1.51E-02
1999	Lake Carlsbad	8.3	Ca	ICPMS	3.34E+05
1999	Lake Carlsbad	8.3	Ce	ICPMS	4.16E-01
1999	Lake Carlsbad	8.3	Chloride	IC	1.06E+06
1999	Lake Carlsbad	8.3	Co	ICPMS	2.83E+00
1999	Lake Carlsbad	8.3	Cr	ICPMS	1.08E+00
1999	Lake Carlsbad	8.3	Cu	ICPMS	7.89E+00
1999	Lake Carlsbad	8.3	Dy	ICPMS	3.51E-02
1999	Lake Carlsbad	8.3	Er	ICPMS	1.51E-02
1999	Lake Carlsbad	8.3	Eu	ICPMS	1.81E-02
1999	Lake Carlsbad	8.3	Fe	ICPMS	3.96E+03
1999	Lake Carlsbad	8.3	Fluoride	IC	1.05E+03
1999	Lake Carlsbad	8.3	Gd	ICPMS	4.84E-02

1999	Lake Carlsbad	8.3	K	ICPMS	6.51E+03
1999	Lake Carlsbad	8.3	La	ICPMS	2.21E-01
1999	Lake Carlsbad	8.3	Li	ICPMS	7.75E+01
1999	Lake Carlsbad	8.3	Mg	ICPMS	1.51E+05
1999	Lake Carlsbad	8.3	Mn	ICPMS	6.65E+01
1999	Lake Carlsbad	8.3	Mo	ICPMS	2.65E+00
1999	Lake Carlsbad	8.3	Na	ICPMS	4.48E+05
1999	Lake Carlsbad	8.3	Nd	ICPMS	2.31E-01
1999	Lake Carlsbad	8.3	Ni	ICPMS	5.63E+00
1999	Lake Carlsbad	8.3	Nitrate	IC	6.28E+03
1999	Lake Carlsbad	8.3	Pb	ICPMS	2.65E+00
1999	Lake Carlsbad	8.3	Pr	ICPMS	5.66E-02
1999	Lake Carlsbad	8.3	Sb	ICPMS	-4.24E-01
1999	Lake Carlsbad	8.3	Se	AA	4.47E-01
1999	Lake Carlsbad	8.3	Sm	ICPMS	5.94E-02
1999	Lake Carlsbad	8.3	Sr	ICPMS	5.95E+03
1999	Lake Carlsbad	8.3	Sulfate	IC	2.01E+06
1999	Lake Carlsbad	8.3	Th	ICPMS	5.40E-02
1999	Lake Carlsbad	8.3	U	ICPMS	9.17E+00
1999	Lake Carlsbad	8.3	V	ICPMS	8.21E+00
1999	Lake Carlsbad	8.3	Zn	ICPMS	2.08E+01
1999	Red Bluff	1	Al	ICPMS	1.65E+01
1999	Red Bluff	1	As	AA	2.88E+00
1999	Red Bluff	1	Ba	ICPMS	7.03E+01
1999	Red Bluff	1	Be	ICPMS	3.28E-02
1999	Red Bluff	1	Ca	ICPMS	4.19E+05
1999	Red Bluff	1	Ce	ICPMS	3.93E-02
1999	Red Bluff	1	Chloride	IC	1.52E+06
1999	Red Bluff	1	Co	ICPMS	1.42E+00

1999	Red Bluff	1	Cr	ICPMS	6.12E-02
1999	Red Bluff	1	Cu	ICPMS	6.73E+00
1999	Red Bluff	1	Dy	ICPMS	2.99E-03
1999	Red Bluff	1	Er	ICPMS	2.08E-03
1999	Red Bluff	1	Eu	ICPMS	-6.66E+00
1999	Red Bluff	1	Fe	ICPMS	3.38E+01
1999	Red Bluff	1	Fluoride	IC	3.01E+03
1999	Red Bluff	1	Gd	ICPMS	-7.41E+00
1999	Red Bluff	1	K	ICPMS	1.92E+04
1999	Red Bluff	1	La	ICPMS	3.51E-02
1999	Red Bluff	1	Mg	ICPMS	1.24E+05
1999	Red Bluff	1	Mn	ICPMS	3.85E+01
1999	Red Bluff	1	Mo	ICPMS	3.86E+00
1999	Red Bluff	1	Na	ICPMS	7.21E+05
1999	Red Bluff	1	Nd	ICPMS	2.06E-02
1999	Red Bluff	1	Ni	ICPMS	1.35E+01
1999	Red Bluff	1	Pr	ICPMS	7.11E-03
1999	Red Bluff	1	Sb	ICPMS	3.35E-01
1999	Red Bluff	1	Sm	ICPMS	3.80E-02
1999	Red Bluff	1	Sr	ICPMS	5.76E+03
1999	Red Bluff	1	Sulfate	IC	1.77E+06
1999	Red Bluff	1	Th	ICPMS	4.68E-03
1999	Red Bluff	1	U	ICPMS	4.70E+00
1999	Red Bluff	1	V	ICPMS	3.37E+00
1999	Red Bluff	1	Zn	ICPMS	1.09E+01
1999	Red Bluff	43.2	Al	ICPMS	1.23E+01
1999	Red Bluff	43.2	As	AA	4.99E+00
1999	Red Bluff	43.2	Ba	ICPMS	6.04E+03
1999	Red Bluff	43.2	Ca	ICPMS	4.85E+05

1999 Red Bluff	43.2 Ce	ICPMS	2.28E+00
1999 Red Bluff	43.2 Chloride	IC	2.20E+06
1999 Red Bluff	43.2 Co	ICPMS	1.64E+00
1999 Red Bluff	43.2 Cr	ICPMS	1.25E-01
1999 Red Bluff	43.2 Cu	ICPMS	7.67E+00
1999 Red Bluff	43.2 Dy	ICPMS	4.59E-03
1999 Red Bluff	43.2 Er	ICPMS	3.42E-03
1999 Red Bluff	43.2 Eu	ICPMS	-6.66E+00
1999 Red Bluff	43.2 Fe	ICPMS	6.65E+01
1999 Red Bluff	43.2 Fluoride	IC	3.77E+03
1999 Red Bluff	43.2 Gd	ICPMS	-7.40E+00
1999 Red Bluff	43.2 K	ICPMS	2.63E+04
1999 Red Bluff	43.2 La	ICPMS	4.23E-02
1999 Red Bluff	43.2 Li	ICPMS	6.10E+01
1999 Red Bluff	43.2 Mg	ICPMS	1.77E+05
1999 Red Bluff	43.2 Mn	ICPMS	2.64E+02
1999 Red Bluff	43.2 Mo	ICPMS	2.83E+00
1999 Red Bluff	43.2 Na	ICPMS	1.01E+06
1999 Red Bluff	43.2 Nd	ICPMS	2.71E-02
1999 Red Bluff	43.2 Ni	ICPMS	1.34E+01
1999 Red Bluff	43.2 Pb	ICPMS	9.67E-01
1999 Red Bluff	43.2 Pr	ICPMS	6.75E-03
1999 Red Bluff	43.2 Sb	ICPMS	4.19E-01
1999 Red Bluff	43.2 Sm	ICPMS	3.42E-02
1999 Red Bluff	43.2 Sr	ICPMS	7.46E+03
1999 Red Bluff	43.2 Sulfate	IC	2.31E+06
1999 Red Bluff	43.2 Th	ICPMS	4.70E-03
1999 Red Bluff	43.2 U	ICPMS	5.61E+00
1999 Red Bluff	43.2 V	ICPMS	2.34E+00

2000 Brantley Lake	2 Ag	ICPMS	3.91E-03
2000 Brantley Lake	2 Al	ICPMS	1.56E+02
2000 Brantley Lake	2 As	AA	1.17E+00
2000 Brantley Lake	2 Ba	ICPMS	4.43E+01
2000 Brantley Lake	2 Be	ICPMS	4.20E-02
2000 Brantley Lake	2 Ca	ICPMS	4.20E+05
2000 Brantley Lake	2 Ce	ICPMS	1.11E-01
2000 Brantley Lake	2 Chloride	IC	5.46E+05
2000 Brantley Lake	2 Co	ICPMS	4.13E+00
2000 Brantley Lake	2 Cr	ICPMS	1.16E+00
2000 Brantley Lake	2 Cu	ICPMS	6.35E+00
2000 Brantley Lake	2 Dy	ICPMS	9.33E-03
2000 Brantley Lake	2 Eu	ICPMS	1.57E-02
2000 Brantley Lake	2 Fe	AA	9.84E+01
2000 Brantley Lake	2 Fluoride	IC	1.56E+03
2000 Brantley Lake	2 Gd	ICPMS	1.35E-02
2000 Brantley Lake	2 K	ICPMS	1.17E+04
2000 Brantley Lake	2 La	ICPMS	-1.46E-02
2000 Brantley Lake	2 Li	ICPMS	3.90E+01
2000 Brantley Lake	2 Mg	ICPMS	9.31E+04
2000 Brantley Lake	2 Mn	ICPMS	8.99E+00
2000 Brantley Lake	2 Mo	ICPMS	3.70E+00
2000 Brantley Lake	2 Na	ICPMS	3.69E+05
2000 Brantley Lake	2 Nd	ICPMS	6.39E-02
2000 Brantley Lake	2 Ni	ICPMS	1.90E+01
2000 Brantley Lake	2 Pb	ICPMS	3.53E-01
2000 Brantley Lake	2 Sb	ICPMS	2.51E-01
2000 Brantley Lake	2 Sr	ICPMS	6.36E+03
2000 Brantley Lake	2 Sulfate	IC	1.41E+06

2000	Brantley Lake	2	Th	ICPMS	2.35E-02
2000	Brantley Lake	2	U	ICPMS	5.35E+00
2000	Brantley Lake	2	V	ICPMS	5.60E+00
2000	Brantley Lake	2	Zn	ICPMS	7.89E+00
2000	Brantley Lake	43.5	Ag	ICPMS	7.58E-03
2000	Brantley Lake	43.5	Al	ICPMS	8.44E+02
2000	Brantley Lake	43.5	As	AA	2.23E+00
2000	Brantley Lake	43.5	Ba	ICPMS	6.90E+01
2000	Brantley Lake	43.5	Be	ICPMS	3.04E-02
2000	Brantley Lake	43.5	Ca	ICPMS	6.58E+05
2000	Brantley Lake	43.5	Ce	ICPMS	8.07E-01
2000	Brantley Lake	43.5	Chloride	IC	1.37E+06
2000	Brantley Lake	43.5	Co	ICPMS	7.39E+00
2000	Brantley Lake	43.5	Cr	ICPMS	2.25E+00
2000	Brantley Lake	43.5	Cu	ICPMS	7.93E+00
2000	Brantley Lake	43.5	Dy	ICPMS	5.71E-02
2000	Brantley Lake	43.5	Er	ICPMS	3.41E-02
2000	Brantley Lake	43.5	Eu	ICPMS	4.07E-02
2000	Brantley Lake	43.5	Fe	AA	6.13E+02
2000	Brantley Lake	43.5	Fluoride	IC	1.96E+03
2000	Brantley Lake	43.5	Gd	ICPMS	9.50E-02
2000	Brantley Lake	43.5	Hg	AA	4.61E-03
2000	Brantley Lake	43.5	K	ICPMS	1.57E+04
2000	Brantley Lake	43.5	La	ICPMS	3.24E-01
2000	Brantley Lake	43.5	Li	ICPMS	8.32E+01
2000	Brantley Lake	43.5	Mg	ICPMS	2.14E+05
2000	Brantley Lake	43.5	Mn	ICPMS	8.49E+02
2000	Brantley Lake	43.5	Mo	ICPMS	3.48E+00
2000	Brantley Lake	43.5	Na	ICPMS	1.14E+06

2000	Brantley Lake	43.5	Nd	ICPMS	3.94E-01
2000	Brantley Lake	43.5	Ni	ICPMS	3.10E+01
2000	Brantley Lake	43.5	Pb	ICPMS	7.97E-01
2000	Brantley Lake	43.5	Pr	ICPMS	9.88E-02
2000	Brantley Lake	43.5	Sb	ICPMS	2.53E-01
2000	Brantley Lake	43.5	Sm	ICPMS	1.69E-01
2000	Brantley Lake	43.5	Sr	ICPMS	1.08E+04
2000	Brantley Lake	43.5	Sulfate	IC	2.20E+06
2000	Brantley Lake	43.5	Th	ICPMS	1.39E-01
2000	Brantley Lake	43.5	Tl	ICPMS	4.81E-02
2000	Brantley Lake	43.5	U	ICPMS	8.20E+00
2000	Brantley Lake	43.5	V	ICPMS	6.30E+00
2000	Brantley Lake	43.5	Zn	ICPMS	1.08E+01
2000	Lake Carlsbad	1.5	Al	ICPMS	1.81E+02
2000	Lake Carlsbad	1.5	As	AA	1.23E+00
2000	Lake Carlsbad	1.5	Ba	ICPMS	2.56E+01
2000	Lake Carlsbad	1.5	Be	ICPMS	2.70E-02
2000	Lake Carlsbad	1.5	Ca	ICPMS	4.19E+05
2000	Lake Carlsbad	1.5	Ce	ICPMS	1.48E-01
2000	Lake Carlsbad	1.5	Chloride	IC	6.88E+05
2000	Lake Carlsbad	1.5	Co	ICPMS	4.68E+00
2000	Lake Carlsbad	1.5	Cr	ICPMS	1.32E+00
2000	Lake Carlsbad	1.5	Cu	ICPMS	6.52E+00
2000	Lake Carlsbad	1.5	Dy	ICPMS	8.53E-03
2000	Lake Carlsbad	1.5	Er	ICPMS	9.20E-03
2000	Lake Carlsbad	1.5	Eu	ICPMS	1.31E-02
2000	Lake Carlsbad	1.5	Fe	AA	1.35E+02
2000	Lake Carlsbad	1.5	Fluoride	IC	1.36E+03
2000	Lake Carlsbad	1.5	Gd	ICPMS	1.91E-02

2000	Lake Carlsbad	1.5	K	ICPMS	1.24E+04
2000	Lake Carlsbad	1.5	La	ICPMS	-3.44E-02
2000	Lake Carlsbad	1.5	Li	ICPMS	6.30E+01
2000	Lake Carlsbad	1.5	Mg	ICPMS	1.46E+05
2000	Lake Carlsbad	1.5	Mn	ICPMS	1.92E+01
2000	Lake Carlsbad	1.5	Mo	ICPMS	3.26E+00
2000	Lake Carlsbad	1.5	Na	ICPMS	5.06E+05
2000	Lake Carlsbad	1.5	Nd	ICPMS	9.05E-02
2000	Lake Carlsbad	1.5	Ni	ICPMS	1.88E+01
2000	Lake Carlsbad	1.5	Nitrate	IC	4.95E+03
2000	Lake Carlsbad	1.5	Pb	ICPMS	6.38E-01
2000	Lake Carlsbad	1.5	Sr	ICPMS	6.15E+03
2000	Lake Carlsbad	1.5	Sulfate	IC	1.40E+06
2000	Lake Carlsbad	1.5	Th	ICPMS	2.71E-02
2000	Lake Carlsbad	1.5	Tl	ICPMS	1.20E-01
2000	Lake Carlsbad	1.5	U	ICPMS	7.53E+00
2000	Lake Carlsbad	1.5	V	ICPMS	8.93E+00
2000	Lake Carlsbad	1.5	Zn	ICPMS	5.93E+00
2000	Lake Carlsbad	7.5	Ag	ICPMS	4.56E-03
2000	Lake Carlsbad	7.5	Al	ICPMS	2.16E+02
2000	Lake Carlsbad	7.5	As	AA	1.30E+00
2000	Lake Carlsbad	7.5	Ba	ICPMS	2.62E+01
2000	Lake Carlsbad	7.5	Be	ICPMS	-4.26E-03
2000	Lake Carlsbad	7.5	Ca	ICPMS	4.13E+05
2000	Lake Carlsbad	7.5	Cd	ICPMS	7.95E-02
2000	Lake Carlsbad	7.5	Ce	ICPMS	2.05E-01
2000	Lake Carlsbad	7.5	Chloride	IC	6.81E+05
2000	Lake Carlsbad	7.5	Co	ICPMS	5.05E+00
2000	Lake Carlsbad	7.5	Cr	ICPMS	2.04E+00

2000	Lake Carlsbad	7.5	Cu	ICPMS	1.14E+01
2000	Lake Carlsbad	7.5	Dy	ICPMS	1.13E-02
2000	Lake Carlsbad	7.5	Er	ICPMS	1.03E-02
2000	Lake Carlsbad	7.5	Eu	ICPMS	1.25E-02
2000	Lake Carlsbad	7.5	Fe	AA	1.67E+02
2000	Lake Carlsbad	7.5	Fluoride	IC	1.36E+03
2000	Lake Carlsbad	7.5	Gd	ICPMS	2.11E-02
2000	Lake Carlsbad	7.5	K	ICPMS	1.13E+04
2000	Lake Carlsbad	7.5	La	ICPMS	-9.64E-03
2000	Lake Carlsbad	7.5	Li	ICPMS	6.01E+01
2000	Lake Carlsbad	7.5	Mg	ICPMS	1.44E+05
2000	Lake Carlsbad	7.5	Mn	ICPMS	2.03E+01
2000	Lake Carlsbad	7.5	Mo	ICPMS	3.19E+00
2000	Lake Carlsbad	7.5	Na	ICPMS	5.00E+05
2000	Lake Carlsbad	7.5	Nd	ICPMS	9.72E-02
2000	Lake Carlsbad	7.5	Ni	ICPMS	2.14E+01
2000	Lake Carlsbad	7.5	Nitrate	IC	5.20E+03
2000	Lake Carlsbad	7.5	Pb	ICPMS	1.37E+00
2000	Lake Carlsbad	7.5	Se	AA	8.89E+00
2000	Lake Carlsbad	7.5	Sr	ICPMS	6.42E+03
2000	Lake Carlsbad	7.5	Sulfate	IC	1.37E+06
2000	Lake Carlsbad	7.5	Th	ICPMS	3.25E-02
2000	Lake Carlsbad	7.5	Tl	ICPMS	1.26E-01
2000	Lake Carlsbad	7.5	U	ICPMS	7.33E+00
2000	Lake Carlsbad	7.5	V	ICPMS	9.15E+00
2000	Lake Carlsbad	7.5	Zn	ICPMS	1.35E+01
2000	Red Bluff	1.5	Ag	ICPMS	7.56E-04
2000	Red Bluff	1.5	Al	ICPMS	6.54E+01
2000	Red Bluff	1.5	As	AA	1.96E+00

2000	Red Bluff	1.5	Ba	ICPMS	7.22E+01
2000	Red Bluff	1.5	Be	ICPMS	3.05E-02
2000	Red Bluff	1.5	Ca	ICPMS	6.18E+05
2000	Red Bluff	1.5	Ce	ICPMS	9.78E-02
2000	Red Bluff	1.5	Chloride	IC	1.61E+06
2000	Red Bluff	1.5	Co	ICPMS	6.01E+00
2000	Red Bluff	1.5	Cr	ICPMS	2.24E+00
2000	Red Bluff	1.5	Cu	ICPMS	8.27E+00
2000	Red Bluff	1.5	Eu	ICPMS	2.36E-02
2000	Red Bluff	1.5	Fe	AA	6.41E+01
2000	Red Bluff	1.5	Gd	ICPMS	1.51E-02
2000	Red Bluff	1.5	Hg	AA	2.36E-03
2000	Red Bluff	1.5	K	ICPMS	3.63E+04
2000	Red Bluff	1.5	La	ICPMS	2.30E-02
2000	Red Bluff	1.5	Li	ICPMS	9.48E+01
2000	Red Bluff	1.5	Mg	ICPMS	2.25E+05
2000	Red Bluff	1.5	Mn	ICPMS	6.79E+01
2000	Red Bluff	1.5	Mo	ICPMS	4.92E+00
2000	Red Bluff	1.5	Na	ICPMS	1.36E+06
2000	Red Bluff	1.5	Ni	ICPMS	2.84E+01
2000	Red Bluff	1.5	Pb	ICPMS	7.76E-01
2000	Red Bluff	1.5	Sb	ICPMS	4.83E-01
2000	Red Bluff	1.5	Sr	ICPMS	9.49E+03
2000	Red Bluff	1.5	Sulfate	IC	2.33E+06
2000	Red Bluff	1.5	Th	ICPMS	1.32E-02
2000	Red Bluff	1.5	U	ICPMS	9.51E+00
2000	Red Bluff	1.5	V	ICPMS	4.91E+00
2000	Red Bluff	1.5	Zn	ICPMS	6.21E+00
2000	Red Bluff	37	Ag	ICPMS	7.34E-04

2000 Red Bluff	37 As	AA	2.82E+00
2000 Red Bluff	37 Ba	ICPMS	9.58E+01
2000 Red Bluff	37 Be	ICPMS	5.14E-02
2000 Red Bluff	37 Ca	ICPMS	5.98E+05
2000 Red Bluff	37 Ce	ICPMS	7.10E-02
2000 Red Bluff	37 Chloride	IC	1.63E+06
2000 Red Bluff	37 Co	ICPMS	5.74E+00
2000 Red Bluff	37 Cr	ICPMS	1.86E+00
2000 Red Bluff	37 Cu	ICPMS	8.70E+00
2000 Red Bluff	37 Er	ICPMS	8.34E-03
2000 Red Bluff	37 Eu	ICPMS	3.43E-02
2000 Red Bluff	37 Fe	AA	8.24E+01
2000 Red Bluff	37 Gd	ICPMS	1.44E-02
2000 Red Bluff	37 Hg	AA	2.72E-03
2000 Red Bluff	37 K	ICPMS	3.60E+04
2000 Red Bluff	37 La	ICPMS	6.00E-02
2000 Red Bluff	37 Li	ICPMS	9.32E+01
2000 Red Bluff	37 Mg	ICPMS	2.17E+05
2000 Red Bluff	37 Mn	ICPMS	2.97E+02
2000 Red Bluff	37 Mo	ICPMS	4.31E+00
2000 Red Bluff	37 Na	ICPMS	1.24E+06
2000 Red Bluff	37 Ni	ICPMS	2.83E+01
2000 Red Bluff	37 Nitrate	IC	2.38E+03
2000 Red Bluff	37 Pb	ICPMS	9.75E-01
2000 Red Bluff	37 Phosphate	IC	5.68E+03
2000 Red Bluff	37 Sb	ICPMS	2.47E-01
2000 Red Bluff	37 Sr	ICPMS	9.18E+03
2000 Red Bluff	37 Sulfate	IC	2.35E+06
2000 Red Bluff	37 Th	ICPMS	1.72E-02

2000 Red Bluff	37	U	ICPMS	9.14E+00
2000 Red Bluff	37	V	ICPMS	4.64E+00
2000 Red Bluff	37	Zn	ICPMS	1.07E+01
2001 Brantley Lake	1.5	Al	ICPMS	2.48E+02
2001 Brantley Lake	1.5	Ba	ICPMS	4.96E+01
2001 Brantley Lake	1.5	Ca	ICPMS	4.85E+05
2001 Brantley Lake	1.5	Cd	ICPMS	2.10E-01
2001 Brantley Lake	1.5	Ce	ICPMS	2.03E-01
2001 Brantley Lake	1.5	Chloride	IC	5.11E+05
2001 Brantley Lake	1.5	Co	ICPMS	1.37E+00
2001 Brantley Lake	1.5	Dy	ICPMS	2.88E-02
2001 Brantley Lake	1.5	Eu	ICPMS	3.62E-02
2001 Brantley Lake	1.5	Fe	ICPMS	2.88E+02
2001 Brantley Lake	1.5	Fluoride	IC	5.31E+02
2001 Brantley Lake	1.5	Gd	ICPMS	3.23E-02
2001 Brantley Lake	1.5	Hg	ICPMS	1.90E-01
2001 Brantley Lake	1.5	K	ICPMS	4.84E+03
2001 Brantley Lake	1.5	Li	ICPMS	4.41E+01
2001 Brantley Lake	1.5	Mg	ICPMS	9.85E+04
2001 Brantley Lake	1.5	Mn	ICPMS	1.90E+01
2001 Brantley Lake	1.5	Mo	ICPMS	4.19E+00
2001 Brantley Lake	1.5	Na	ICPMS	3.74E+05
2001 Brantley Lake	1.5	Ni	ICPMS	1.73E+01
2001 Brantley Lake	1.5	Pb	ICPMS	8.72E-01
2001 Brantley Lake	1.5	Sb	ICPMS	8.33E-02
2001 Brantley Lake	1.5	Sc	ICPMS	1.08E+00
2001 Brantley Lake	1.5	Se	AA	1.62E+00
2001 Brantley Lake	1.5	Si	ICPMS	2.71E+03
2001 Brantley Lake	1.5	Sr	ICPMS	6.58E+03

2001	Brantley Lake		1.5	Sulfate	IC	1.25E+06
2001	Brantley Lake		1.5	U	ICPMS	3.94E+00
2001	Brantley Lake		1.5	V	ICPMS	5.64E+00
2001	Brantley Lake		42.5	Ba	ICPMS	6.40E+01
2001	Brantley Lake		42.5	Ca	ICPMS	5.15E+05
2001	Brantley Lake		42.5	Ce	ICPMS	1.17E-01
2001	Brantley Lake		42.5	Chloride	IC	1.26E+06
2001	Brantley Lake		42.5	Co	ICPMS	1.50E+00
2001	Brantley Lake		42.5	Dy	ICPMS	2.97E-02
2001	Brantley Lake		42.5	Eu	ICPMS	3.08E-02
2001	Brantley Lake		42.5	Fe	ICPMS	4.26E+02
2001	Brantley Lake		42.5	Fluoride	IC	5.48E+02
2001	Brantley Lake		42.5	K	ICPMS	7.07E+03
2001	Brantley Lake		42.5	Li	ICPMS	6.40E+01
2001	Brantley Lake		42.5	Mg	ICPMS	1.46E+05
2001	Brantley Lake		42.5	Mn	ICPMS	7.09E+02
2001	Brantley Lake		42.5	Mo	ICPMS	2.89E+00
2001	Brantley Lake		42.5	Na	ICPMS	7.40E+05
2001	Brantley Lake		42.5	Ni	ICPMS	1.92E+01
2001	Brantley Lake		42.5	Sc	ICPMS	1.66E+00
2001	Brantley Lake		42.5	Si	ICPMS	3.22E+03
2001	Brantley Lake		42.5	Sr	ICPMS	7.53E+03
2001	Brantley Lake		42.5	Sulfate	IC	1.45E+06
2001	Brantley Lake		42.5	U	ICPMS	4.27E+00
2001	Brantley Lake		42.5	V	ICPMS	3.28E+00
2001	Brantley Lake	Trip Blank		Al	ICPMS	4.51E+01
2001	Brantley Lake	Trip Blank		Ca	ICPMS	-2.00E+02
2001	Brantley Lake	Trip Blank		Cr	ICPMS	2.59E+00
2001	Brantley Lake	Trip Blank		Dy	ICPMS	6.49E-03

2001	Brantley Lake	Trip Blank		Er	ICPMS	6.74E-03
2001	Brantley Lake	Trip Blank		Fe	ICPMS	-6.43E+00
2001	Brantley Lake	Trip Blank		K	ICPMS	2.60E+01
2001	Brantley Lake	Trip Blank		Mg	ICPMS	1.62E+01
2001	Brantley Lake	Trip Blank		Mn	ICPMS	-1.22E-01
2001	Brantley Lake	Trip Blank		Mo	ICPMS	1.90E-01
2001	Brantley Lake	Trip Blank		Na	ICPMS	9.08E+01
2001	Brantley Lake	Trip Blank		Pb	ICPMS	-9.83E-02
2001	Brantley Lake	Trip Blank		Sb	ICPMS	2.01E-01
2001	Brantley Lake	Trip Blank		Sc	ICPMS	-2.88E-01
2001	Brantley Lake	Trip Blank		Sn	ICPMS	3.63E+00
2001	Brantley Lake	Trip Blank		Sr	ICPMS	1.46E+00
2001	Brantley Lake	Trip Blank		Zn	ICPMS	-6.89E+00
2001	Lake Carlsbad		1.5	Al	ICPMS	2.72E+02
2001	Lake Carlsbad		1.5	Ba	ICPMS	2.80E+01
2001	Lake Carlsbad		1.5	Ca	ICPMS	3.32E+05
2001	Lake Carlsbad		1.5	Cd	ICPMS	6.36E-01
2001	Lake Carlsbad		1.5	Ce	ICPMS	2.48E-01
2001	Lake Carlsbad		1.5	Chloride	IC	6.31E+05
2001	Lake Carlsbad		1.5	Co	ICPMS	9.89E-01
2001	Lake Carlsbad		1.5	Fe	ICPMS	4.19E+02
2001	Lake Carlsbad		1.5	Fluoride	IC	5.50E+02
2001	Lake Carlsbad		1.5	K	ICPMS	5.81E+03
2001	Lake Carlsbad		1.5	Li	ICPMS	5.05E+01
2001	Lake Carlsbad		1.5	Mg	ICPMS	1.12E+05
2001	Lake Carlsbad		1.5	Mn	ICPMS	2.68E+01
2001	Lake Carlsbad		1.5	Mo	ICPMS	3.60E+00
2001	Lake Carlsbad		1.5	Na	ICPMS	3.68E+05
2001	Lake Carlsbad		1.5	Ni	ICPMS	1.40E+01

2001	Lake Carlsbad	1.5	Pb	ICPMS	2.33E+00
2001	Lake Carlsbad	1.5	Pr	ICPMS	3.13E-02
2001	Lake Carlsbad	1.5	Sc	ICPMS	4.85E+00
2001	Lake Carlsbad	1.5	Si	ICPMS	7.68E+03
2001	Lake Carlsbad	1.5	Sr	ICPMS	4.50E+03
2001	Lake Carlsbad	1.5	Sulfate	IC	1.02E+06
2001	Lake Carlsbad	1.5	Ti	ICPMS	1.41E+01
2001	Lake Carlsbad	1.5	U	ICPMS	4.61E+00
2001	Lake Carlsbad	1.5	V	ICPMS	8.46E+00
2001	Lake Carlsbad	9.4	Al	ICPMS	5.01E+02
2001	Lake Carlsbad	9.4	Ba	ICPMS	2.98E+01
2001	Lake Carlsbad	9.4	Ca	ICPMS	3.32E+05
2001	Lake Carlsbad	9.4	Ce	ICPMS	4.84E-01
2001	Lake Carlsbad	9.4	Chloride	IC	6.38E+05
2001	Lake Carlsbad	9.4	Co	ICPMS	1.90E+00
2001	Lake Carlsbad	9.4	Dy	ICPMS	3.84E-02
2001	Lake Carlsbad	9.4	Eu	ICPMS	3.33E-02
2001	Lake Carlsbad	9.4	Fe	ICPMS	4.67E+02
2001	Lake Carlsbad	9.4	Fluoride	IC	5.48E+02
2001	Lake Carlsbad	9.4	Gd	ICPMS	5.72E-02
2001	Lake Carlsbad	9.4	Hg	ICPMS	3.24E-02
2001	Lake Carlsbad	9.4	K	ICPMS	5.52E+03
2001	Lake Carlsbad	9.4	Li	ICPMS	5.08E+01
2001	Lake Carlsbad	9.4	Mg	ICPMS	1.14E+05
2001	Lake Carlsbad	9.4	Mn	ICPMS	2.95E+01
2001	Lake Carlsbad	9.4	Mo	ICPMS	3.52E+00
2001	Lake Carlsbad	9.4	Na	ICPMS	3.62E+05
2001	Lake Carlsbad	9.4	Ni	ICPMS	1.34E+01
2001	Lake Carlsbad	9.4	Pb	ICPMS	1.02E+00

2001	Lake Carlsbad	9.4	Pr	ICPMS	4.50E-02
2001	Lake Carlsbad	9.4	Sc	ICPMS	4.40E+00
2001	Lake Carlsbad	9.4	Si	ICPMS	7.67E+03
2001	Lake Carlsbad	9.4	Sr	ICPMS	4.37E+03
2001	Lake Carlsbad	9.4	Sulfate	IC	1.03E+06
2001	Lake Carlsbad	9.4	Th	ICPMS	4.83E-02
2001	Lake Carlsbad	9.4	Ti	ICPMS	1.38E+01
2001	Lake Carlsbad	9.4	U	ICPMS	4.43E+00
2001	Lake Carlsbad	9.4	V	ICPMS	7.84E+00
2001	Red Bluff	1.5	Al	ICPMS	1.76E+02
2001	Red Bluff	1.5	Ba	ICPMS	7.04E+01
2001	Red Bluff	1.5	Ca	ICPMS	6.49E+05
2001	Red Bluff	1.5	Cd	ICPMS	3.09E-01
2001	Red Bluff	1.5	Ce	ICPMS	2.66E-01
2001	Red Bluff	1.5	Chloride	IC	2.31E+06
2001	Red Bluff	1.5	Co	ICPMS	2.13E+00
2001	Red Bluff	1.5	Dy	ICPMS	3.66E-02
2001	Red Bluff	1.5	Eu	ICPMS	3.95E-02
2001	Red Bluff	1.5	Fe	ICPMS	3.28E+02
2001	Red Bluff	1.5	Fluoride	IC	6.67E+02
2001	Red Bluff	1.5	K	ICPMS	3.33E+04
2001	Red Bluff	1.5	La	ICPMS	3.05E-01
2001	Red Bluff	1.5	Li	ICPMS	1.23E+02
2001	Red Bluff	1.5	Mg	ICPMS	2.45E+05
2001	Red Bluff	1.5	Mn	ICPMS	9.73E+01
2001	Red Bluff	1.5	Mo	ICPMS	5.88E+00
2001	Red Bluff	1.5	Na	ICPMS	1.32E+06
2001	Red Bluff	1.5	Ni	ICPMS	2.23E+01
2001	Red Bluff	1.5	Pr	ICPMS	2.92E-02

2001	Red Bluff	1.5	Sb	ICPMS	3.36E-01
2001	Red Bluff	1.5	Sc	ICPMS	6.11E-01
2001	Red Bluff	1.5	Si	ICPMS	2.76E+03
2001	Red Bluff	1.5	Sr	ICPMS	9.57E+03
2001	Red Bluff	1.5	Sulfate	IC	2.07E+06
2001	Red Bluff	1.5	Ti	ICPMS	1.19E+01
2001	Red Bluff	1.5	U	ICPMS	8.04E+00
2001	Red Bluff	1.5	V	ICPMS	5.37E+00
2001	Red Bluff	15.1	Al	ICPMS	4.01E+02
2001	Red Bluff	15.1	Ba	ICPMS	7.17E+01
2001	Red Bluff	15.1	Ca	ICPMS	6.44E+05
2001	Red Bluff	15.1	Cd	ICPMS	1.04E+00
2001	Red Bluff	15.1	Ce	ICPMS	5.53E-01
2001	Red Bluff	15.1	Chloride	IC	2.32E+06
2001	Red Bluff	15.1	Co	ICPMS	1.34E+00
2001	Red Bluff	15.1	Dy	ICPMS	3.69E-02
2001	Red Bluff	15.1	Eu	ICPMS	5.19E-02
2001	Red Bluff	15.1	Fe	ICPMS	3.47E+02
2001	Red Bluff	15.1	Fluoride	IC	6.70E+02
2001	Red Bluff	15.1	Gd	ICPMS	6.82E-02
2001	Red Bluff	15.1	K	ICPMS	3.17E+04
2001	Red Bluff	15.1	La	ICPMS	4.36E-01
2001	Red Bluff	15.1	Li	ICPMS	1.18E+02
2001	Red Bluff	15.1	Mg	ICPMS	2.49E+05
2001	Red Bluff	15.1	Mn	ICPMS	9.35E+01
2001	Red Bluff	15.1	Mo	ICPMS	5.75E+00
2001	Red Bluff	15.1	Na	ICPMS	1.35E+06
2001	Red Bluff	15.1	Nd	ICPMS	2.89E-01
2001	Red Bluff	15.1	Ni	ICPMS	2.24E+01

2001	Red Bluff	15.1 Pr	ICPMS	6.13E-02
2001	Red Bluff	15.1 Sb	ICPMS	2.90E-01
2001	Red Bluff	15.1 Sc	ICPMS	3.54E-01
2001	Red Bluff	15.1 Si	ICPMS	2.54E+03
2001	Red Bluff	15.1 Sr	ICPMS	9.66E+03
2001	Red Bluff	15.1 Sulfate	IC	2.04E+06
2001	Red Bluff	15.1 Th	ICPMS	3.05E-02
2001	Red Bluff	15.1 Ti	ICPMS	1.29E+01
2001	Red Bluff	15.1 U	ICPMS	8.30E+00
2001	Red Bluff	15.1 V	ICPMS	5.26E+00

aMDC = Minimum Detectable Concentration; ICPMS values previously reported for samples collected dı
bICPMS = Inductively-Coupled Mass Spectrometry
cAA = Atomic Absorption Spectroscopy
dIC = Ion Chromatography
eGFAA = Graphite Furnace Atomic Adsorption Spectroscopy

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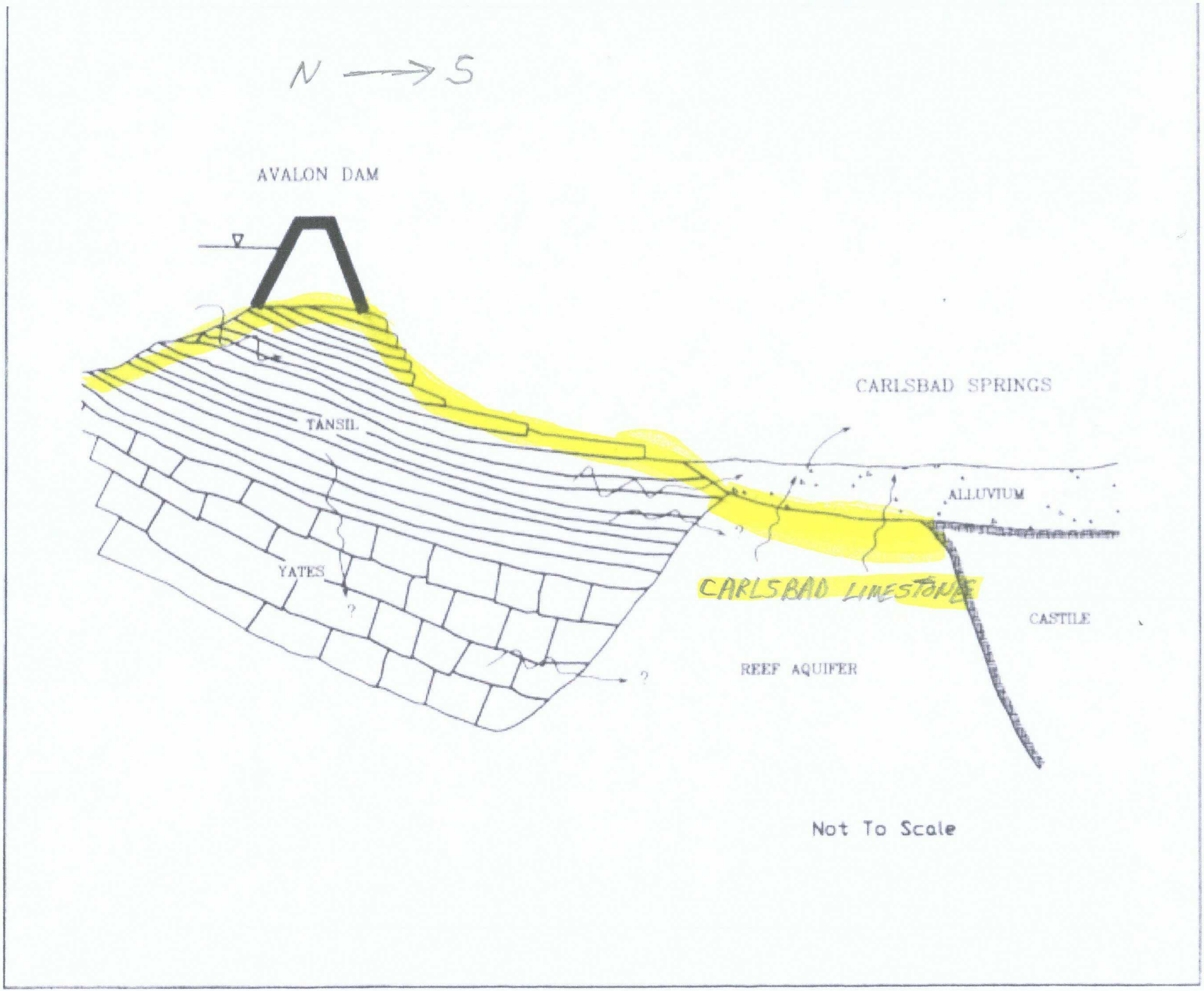
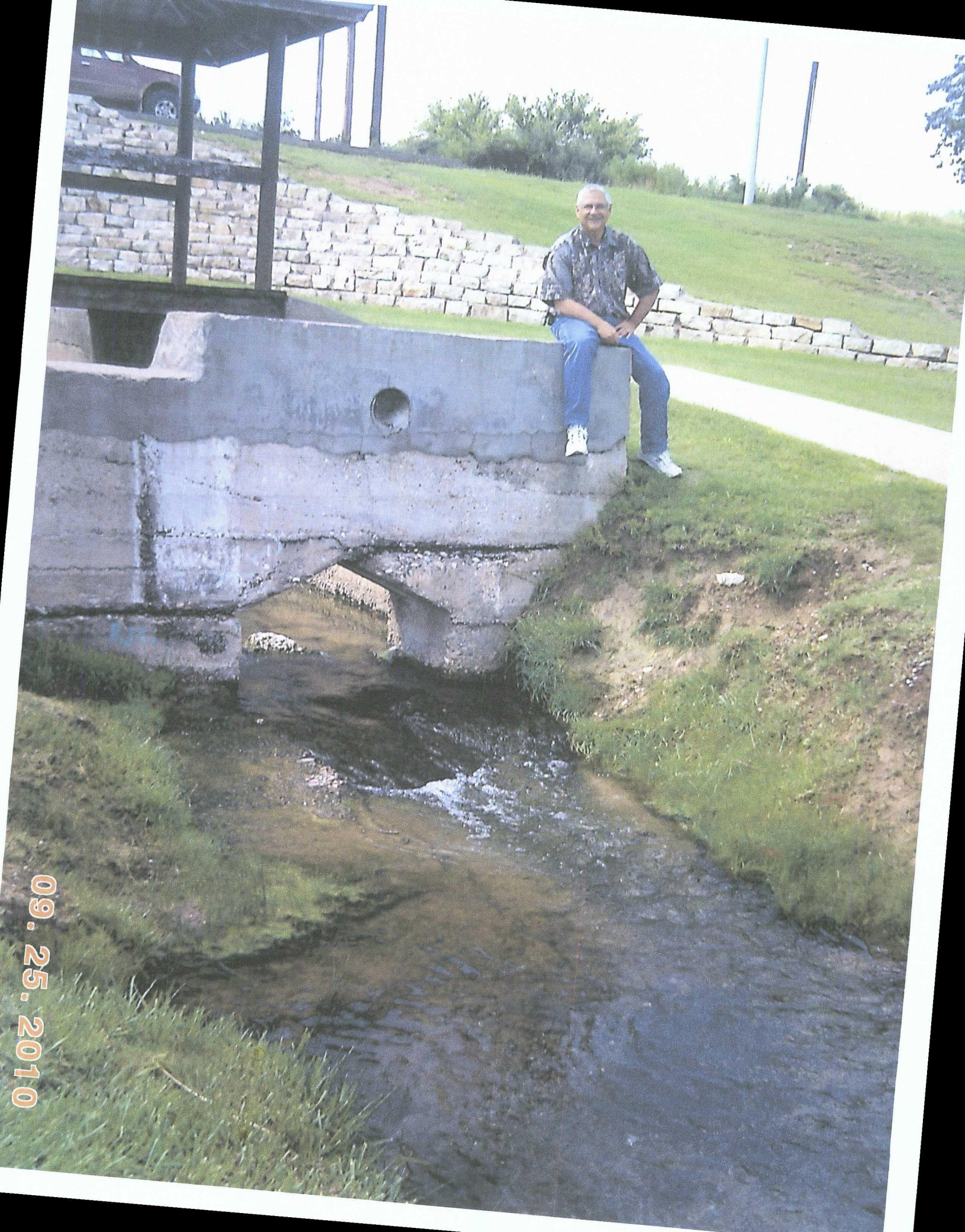


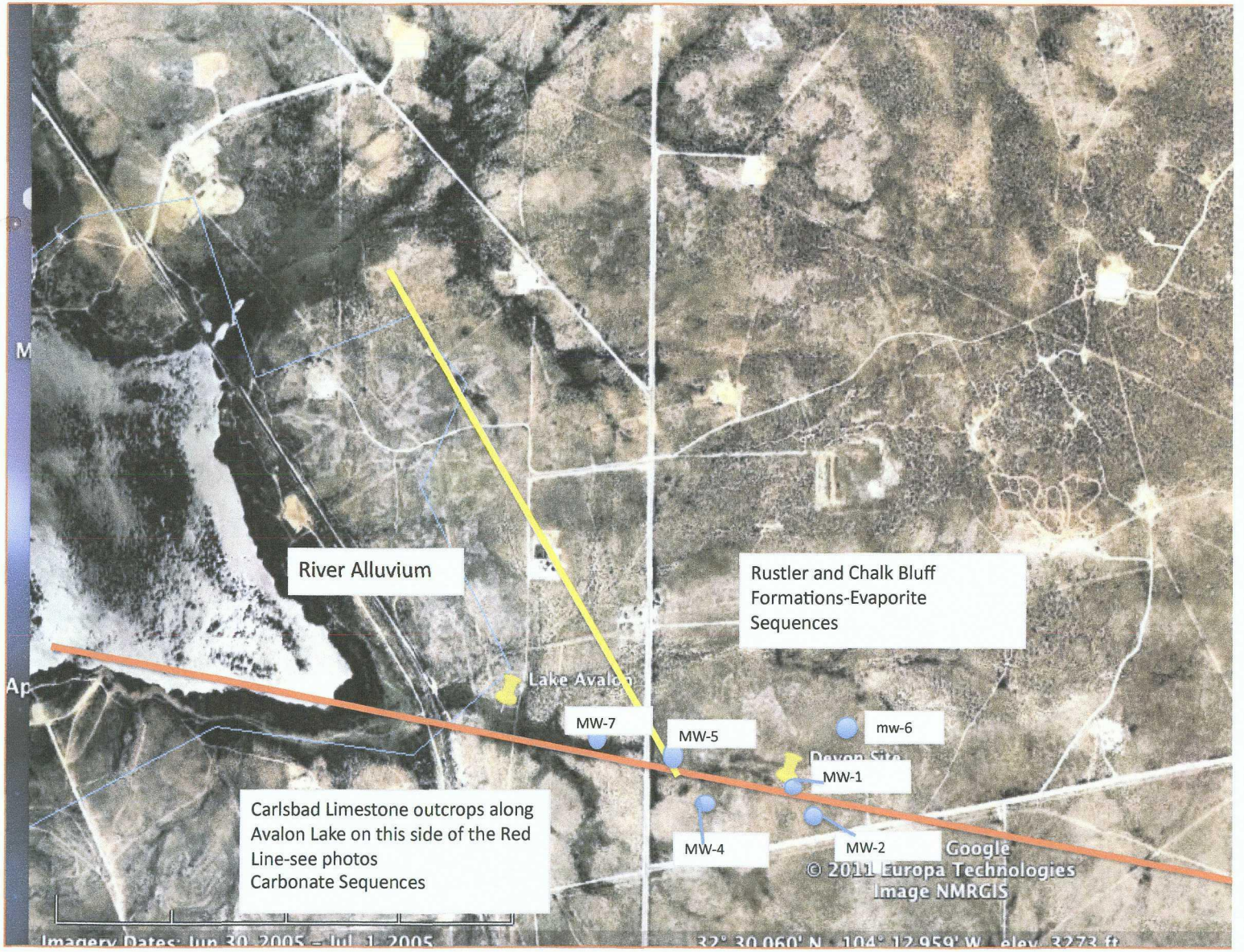
Figure 2-19. Schematic of Leakage From Lake Avalon.

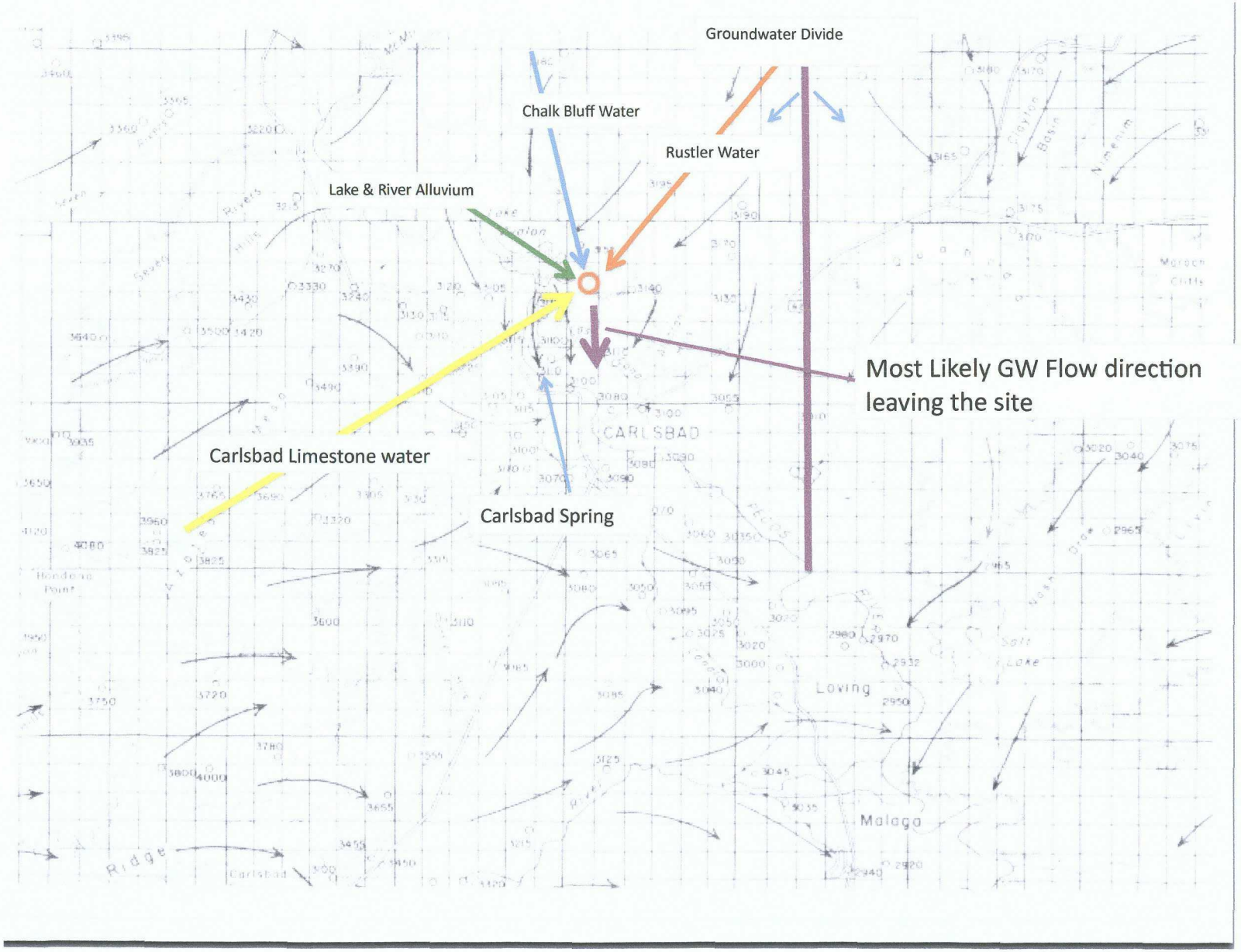

10. 14. 2010


10.14.2010


09. 25. 2010


09. 25. 2010


River Alluvium
Rustler and Chalk Bluff Formations-Evaporite Sequences
Carlsbad Limestone outcrops along Avalon Lake on this side of the Red Line-see photos
Carbonate Sequences
Lake Avalon
MW-7
MW-5
mw-6
MW-1
MW-4
MW-2
Google
© 2011 Europa Technologies
Image NMRGIS


Groundwater Divide
Chalk Bluff Water
Rustler Water
Lake & River Alluvium
Most Likely GW Flow direction leaving the site
Carlsbad Limestone water
Carlsbad Spring
CARLSBAD
Loving
Malaga

ATKINS ENGINEERING ASSOCIATES, INC.
Professional Engineering Land Surveying
Water Resources Environmental Science

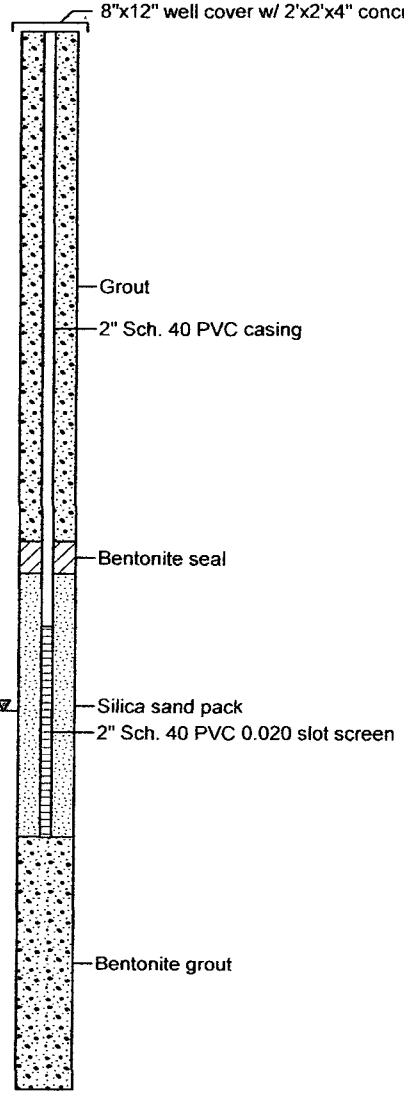
Log of Boring Devon Energy Borehole 1

Whole Earth Environmental
2103 Arbor Cove
Katy, TX 77494
Contact: Mike Griffin
Job #: CRDEVON.DRL.06

Drill Start	: 07-17-06 (0800)	Logged By	: Mort Bates
Drill End	: 07-18-06 (1000)		
Boring Location	: N32°29.370', W104°13.526'		
Site Location	: T21S, R27E, Sec. 07		
Auger Type	: 4¼ Hollow		

Depth in Feet	GRAPHIC	USCS	DESCRIPTION
0			Fill, imported caliche
5		CL	Clay, loose, red, dry
10			
15			
20		CL	Clay w/ caliche, firm, tan & white, dry
25			
30		CL	Clay, loose, red, dry
35		SS	Sandstone, firm, tan, dry
40		SS	Sandstone, hard, tan, dry
45			
50		CL	Sandy clay w/ cemented gravel, firm
55		CL	Sandy clay w/ cemented gravel, firm
60			
65			
70		CL	Clay, loose, greyish green, moist
75			
80		CL	Clay, stiff, red, moist
85			
90			
95		SM	Silty sand, loose, reddish tan
100			Total Depth 100'
105			Water Level 64'
110			

BH-1



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Professional Engineering Land Surveying
Water Resources Environmental Science

Log of Boring Devon Energy Borehole 2

Whole Earth Environmental
2103 Arbor Cove
Katy, TX 77494

Contact: Mike Griffin

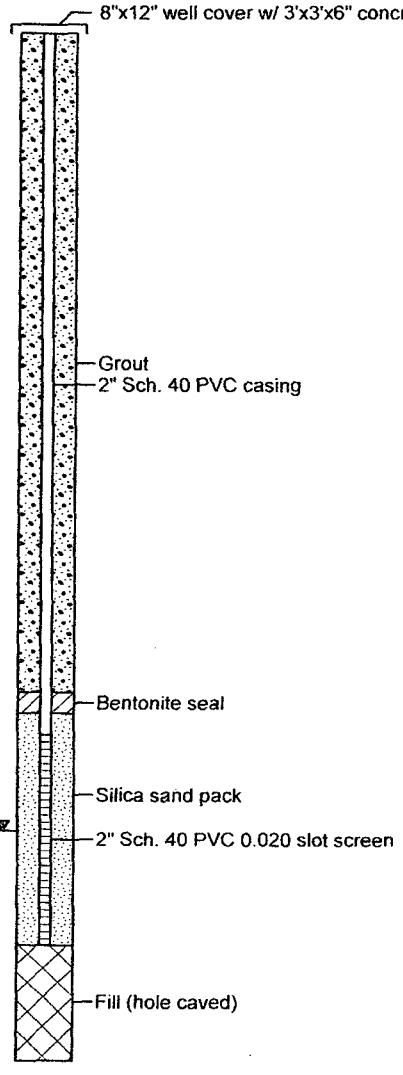
Job #: CRDEVON.DRL.06

Drill Start	: 07-19-06 (1100)	Logged By	: Mort Bates
Drill End	: 07-26-06 (1300)		
Boring Location	: Southeast of drilling pad		
Site Location	: T21S, R27E, Sec. 07		
Auger Type	: 4¼ Hollow		

Depth in Feet	GRAPHIC	USCS	DESCRIPTION
0			Fill caliche pad
5		CL	Clay, loose to firm, red, dry
70		SS	Sandstone, firm, reddish tan, dry
75		LS	Limestone, hard, grey, dry
85		SC	Clayey sand, loose, red, dry
90		SC	Clayey sand, loose, reddish, tan, damp
97			Total Depth 97'
			Water Level 75.16'

Note: 0' to 67' Atkins auger drill, 67' to 97' drilled with M&M drill rig.

BH-2



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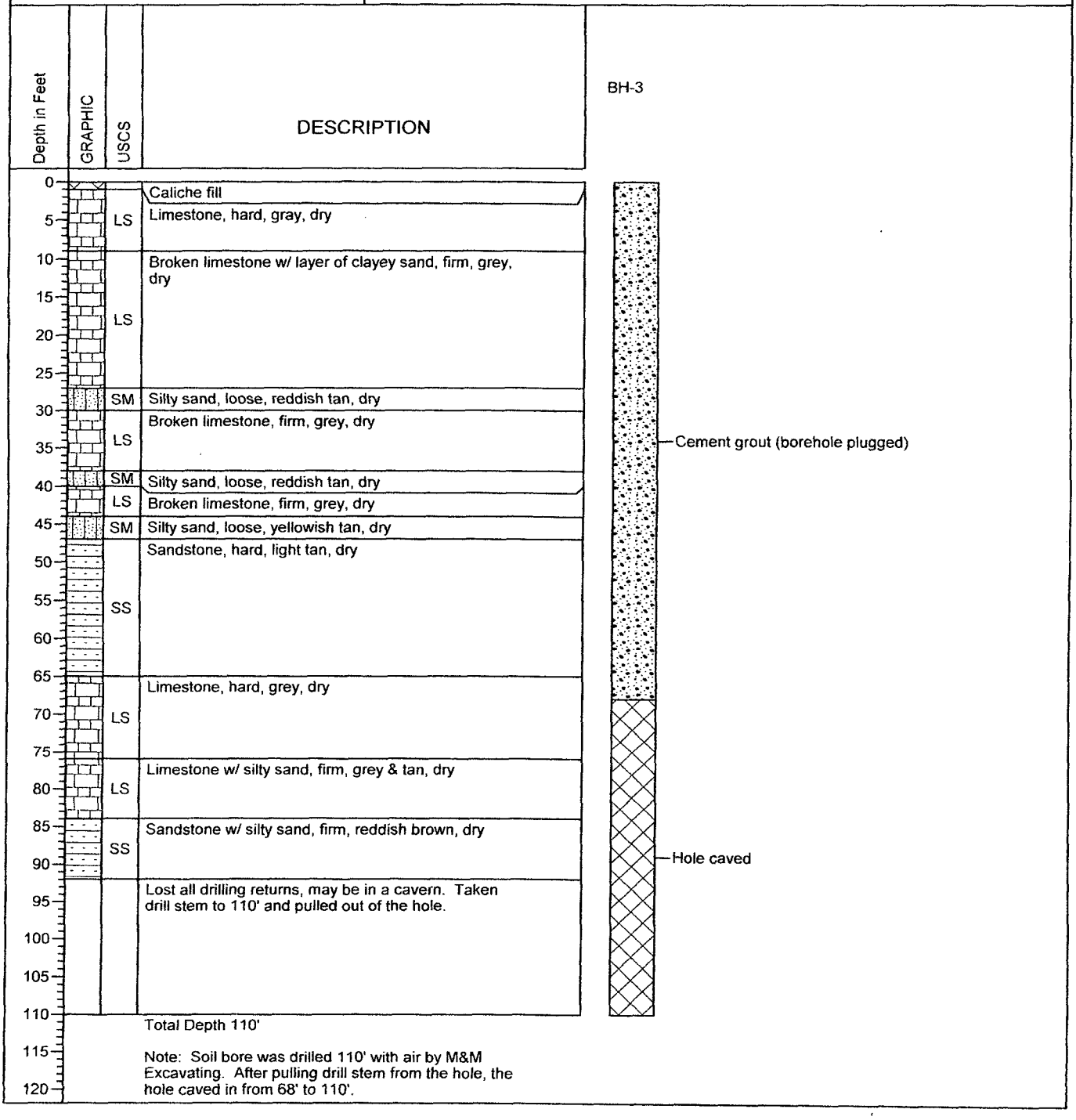
Water Resources Environmental Science

Log of Boring Devon Energy Borehole 3

Whole Earth Environmental
2103 Arbor Cove
Katy, TX 77494
Contact: Mike Griffin
Job #: CRDEVON.DRL.06

Drill Start	: 07-26-06 (1300)	Logged By	: Mort Bates
Drill End	: 07-27-06 (1600)		
Boring Location	: 200'W of M/W #2		
Site Location	: T21S, R27E, Sec. 07		
Auger Type	: Air drilled w/M&M		



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Water Resources Environmental Science

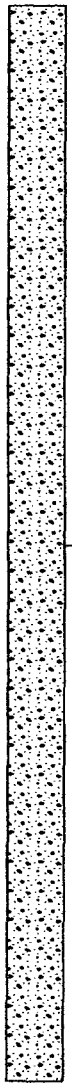
Log of Boring Devon Energy Borehole 3A

Whole Earth Environmental
2103 Arbor Cove
Katy, TX 77494
Contact: Mike Griffin
Job #: CRDEVON.DRL.06

Drill Start	: 07-28-06 (1050)	Logged By	: Mort Bates
Drill End	: 08-02-06		
Boring Location	: 75'W of Borehole #3		
Site Location	: T21S, R27E, Sec. 07		
Auger Type	: Air & auger		

Depth in Feet	GRAPHIC	USCS	DESCRIPTION
0			Caliche w/silty sand, firm, white & tan, dry
5		LS	Broken limestone, hard, grey, dry
10		SS	Sandstone, hard, yellowish tan, dry
15		SS	Sandstone, hard, tan, dry
20			
25			
30		SS	Sandstone w/silty clay, hard, reddish tan, dry
35			
40		SS	Sandstone, hard, red & tan, dry
45		CL	Clay, loose, greenish gray, damp
50		CL	Clay, loose, red, damp
55		SS	Cavernous sandstone, firm, tan, dry
60			May be cavern? Lost drill returns.
65		CL	Clay, stiff, red, damp
70			
75			
80		CL	Sandy clay, loose, greyish tan, damp
85			
90		CL	Sandy clay, firm, greyish green, damp
95			
100		CL	Silty clay, soft, greyish green, damp
105		CL	Silty clay, hard, greyish green, dry
110			
115			
120			
125			
130			
135			
140			

BH-5



Total Depth 130'
Borehole dry
Note: M&M air drill from 0' to 65', Atkins auger drill from 65' to 130'.

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Professional Engineering Land Surveying
Water Resources Environmental Science

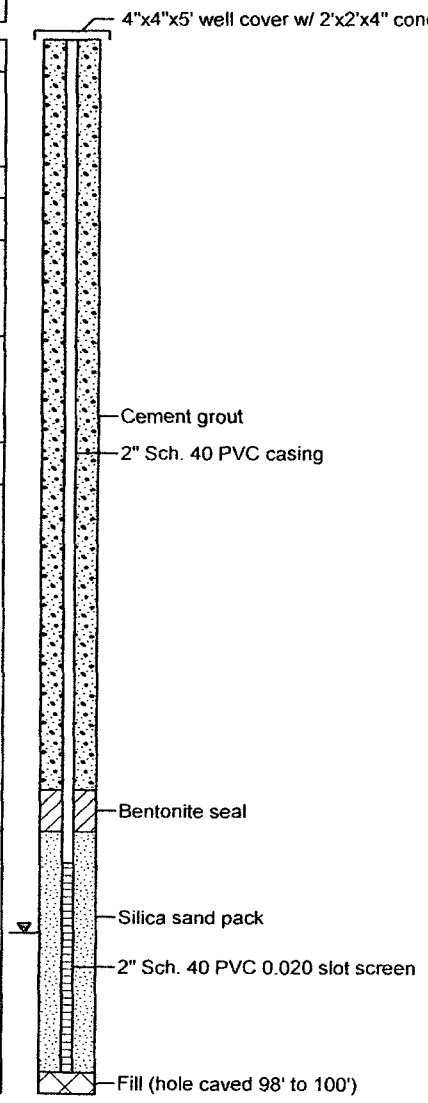
Log of Boring Devon Energy Borehole 4

Whole Earth Environmental
2103 Arbor Cove
Katy, TX 77494
Contact: Mike Griffin
Job #: CRDEVON.DRL.06

Drill Start	: 07-28-06 (0750)	Logged By	: Mort Bates
Drill End	: 07-29-06 (1500)		
Boring Location	: 700'W of Borehole #3		
Site Location	: T21S, R27E, Sec. 07		
Auger Type	: Air & auger		

Depth in Feet	GRAPHIC	USCS	DESCRIPTION
0		SM	Silty sand w/caliche, loose, brown & white, dry
5			Caliche, firm, light tan, dry
10			
15		SS	Sandstone w/caliche, hard, pink, dry
		LS	Limestone, hard, grey, dry
20		LS	Limestone w/ silty sand, hard, pink & grey, dry
25			
30		SS	Sandstone, hard, tan, dry
35			
40		SS	Sandstone, caverns, firm, tan, dry
45		CL	Clay, stiff, red, damp
50			
55			
60			
65			
70			
75		SC	Sandy clay, firm to soft, greyish tan, damp
80			
85			
90			
95		SM	Silty sand, soft, grey, wet
100			Total Depth 100'
105			Water Level 84.78'
110			Note: M&M drilled w/air from 0' to 48', Atkins drilled w/auger from 48' to 100'

BH-4



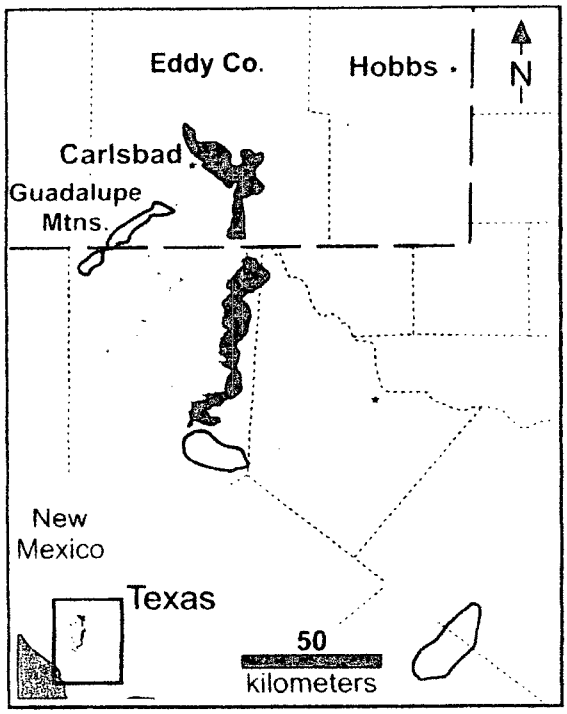


Figure 1. Location map showing location of Gypsum Plain including outcrop areas of the Castile Formation (solid white) and the Rustler Formation (solid black) within the Delaware Basin (dark gray), Eddy County, NM and Culberson County, Texas. Location of the Delaware Basin in relation to Texas and New 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