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AGWMR

01/30/2013

USPS DELIVERY CONFIRMATION #
420 87505 9101 9690 0094 0558 4796 79

TRIDENT ENVIRONMENTAL

January 30, 2013

Mr. Glenn Von Gonten
New Mexico Energy, Minerals and Natural Resources Department
Oil Conservation Division – Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

SUBJECT: 2012 ANNUAL GROUNDWATER MONITORING REPORT
FORMER UNOCAL SOUTH VACUUM UNIT
NMOCD CASE NO. 1R-277
SECTION 36, TOWNSHIP 18 SOUTH, RANGE 35 EAST
LEA COUNTY, NEW MEXICO

Dear Mr. Von Gonten:

Enclosed is the *2012 Annual Groundwater Monitoring Report* for the Former Unocal South Vacuum Unit site located in Lea County, New Mexico (hard copy and compact disk). Chevron Environmental Management Company has been managing the groundwater monitoring activities for the site since their acquisition of Unocal Corporation in 2005.

Please contact me at 432-638-8740, Mr. John MacLeod (Chevron EMC) at 925-842 2477, or Dana Koschel (Arcadis) at 714-508-2664 if you have any questions or comments.

Sincerely,

Gilbert J. Van Deventer, REM, PG
Trident Environmental – Odessa, TX

Attachments

xc: John MacLeod, Chevron EMC (San Ramon CA)
Dana Koschel, Arcadis U.S., Inc. (Irvine CA)
Geoffrey Leking, NMOCD District 1 (Hobbs NM)

2012 Annual Groundwater Monitoring Report
Former Unocal South Vacuum Unit
NMOCD Case No. 1R-277
Section 36, Township 18 South, Range 35 East
Lea County, New Mexico

JANUARY 30, 2013

Prepared For:

**Chevron Environmental Management Company
6101 Bollinger Canyon Rd.
San Ramon, CA 94583**

Prepared By:

TRIDENT ENVIRONMENTAL

**P. O. Box 12177
Odessa, Texas 79768**

2012 Annual Groundwater Monitoring Report

Former Unocal South Vacuum Unit

NMOCD Case NO. 1R-277

Section 36, Township 18 South, Range 35 East

Lea County, New Mexico

Prepared for:

Chevron Environmental Management Company

6101 Bollinger Canyon Road

San Ramon, CA 94583

Prepared by:

Trident Environmental
P. O. Box 12177
Odessa, Texas 79768
(432) 638-8740
FAX (413) 403-9968

SUBMITTED BY:

[signature]

Gilbert J. Van Deventer, PG, REM
Project Manager

DATE:

01/30/2013

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APPENDICES

1.0 Executive Summary

Trident Environmental (Trident) was retained by ARCADIS U. S., Inc. (ARCADIS), on behalf of Chevron Environmental Management Company (Chevron EMC), to perform the 2012 annual groundwater sampling and monitoring operations at the Former Unocal South Vacuum Unit (site), which is located at township 18 south, range 35 east, section 36 in Lea County, New Mexico. Chevron EMC is managing Unocal's environmental liability at the site. This report documents the 2012 annual sampling event performed by Trident on August 2, 2012. This report contains the historical groundwater elevation and analytical data from monitoring wells MW-1 through MW-6. The sampling event was conducted in accordance with the November 2, 2000 Groundwater Remediation Plan submitted by Unocal and the requirements specified in the New Mexico Oil and Conservation Division (OCD) letter dated February 8, 2001.

Based on the sampling and monitoring data to date, the following conclusions relevant to groundwater conditions at the Former Unocal South Vacuum Unit are evident:

- Chloride and total dissolved solids (TDS) concentrations in MW-1 (near the source area) have generally decreased since 1996, with the exception of some fluctuations since the 2004 sampling event. Similarly, chloride and TDS levels have decreased significantly in the closest downgradient well, MW-4, since 1999 when that well was installed and have remained relatively stable since 2007. Chloride and TDS concentrations in upgradient well MW-3 have shown slight but steadily increasing trends since 2000 indicating a possible offsite, upgradient contributing source of these constituents. Chloride and TDS concentrations in the remaining wells (MW-2, MW-5, and MW-6) have remained relatively consistent with previous levels.

- The fate and transport modeling results continue to support the conclusion that the chloride and TDS plume is not likely to impact existing sources of water supply, the closest of which, a livestock (windmill) well located over one-half mile south of the source. The windmill has been dismantled and is no longer in operation due to declining water levels in the area.

- According to conservative model simulations, the chloride plume will travel a maximum of 3,200 feet southeast of the source in approximately 145 years before concentrations return to levels below the New Mexico Water Quality Control Commission (WQCC) standard of 250 milligrams per liter (mg/L). The same analysis indicates that the TDS plume will travel only 2,200 feet in approximately 82 years before concentrations return to levels below the WQCC standard of 1,000 mg/L.

- Based on the modeling results and predicted natural attenuation processes (advection and dispersion), there will be no adverse impact to human health and the environment nor will the livestock well exceed WQCC standards for chlorides or TDS due to the plume originating and traveling southeast, versus south, from the former saltwater disposal pit.

- Groundwater elevations have steadily decreased at a rate of approximately 0.3 feet per year since the initial sampling event of monitoring well MW-1 in January 1995; with the exception of the 2005 sampling event due to higher than normal rainfall during 2004 and 2005. The decreasing groundwater elevation trend has resumed since 2005.

Effective remedial actions of the source area were performed by Unocal, which include plugging of the SWD well in 1971 and encapsulating the former saltwater disposal pit with solidification material in 1995, thus preventing any continued release from the source. Based on the identified potential receptor and fate and transport modeling results, the chloride/TDS plume at the site presents low risk to human health and the environment; therefore Trident recommends the following actions:

- Continue the annual groundwater monitoring program with groundwater sampling and analysis of chloride and TDS concentrations for each of the six monitoring wells.

- Update flow and transport model to confirm the plume is naturally attenuating as described.

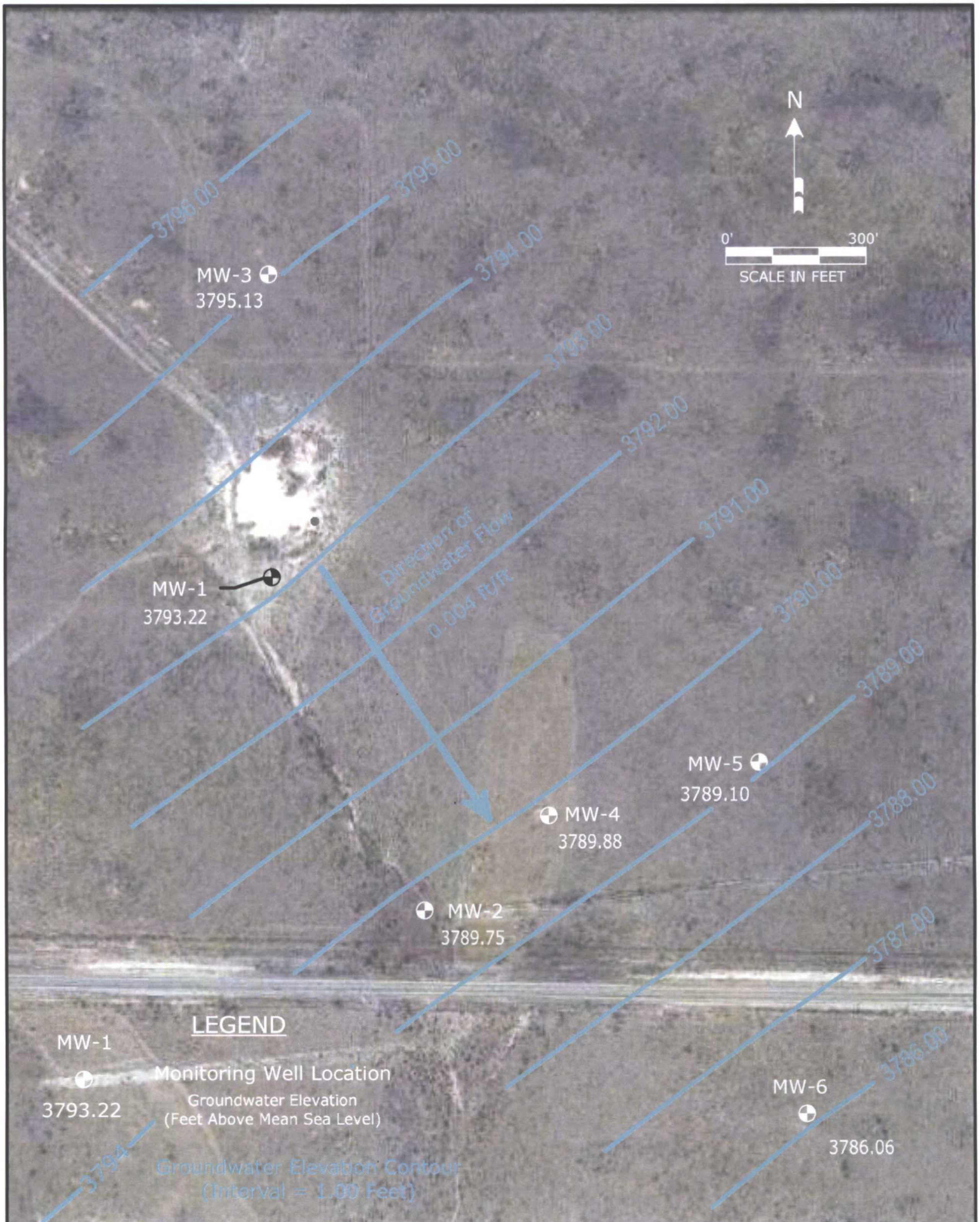
- Submit the 2013 annual groundwater monitoring report to OCD in January 2014 to document natural attenuation conditions.

2.0 Groundwater Sampling Procedures

On August 2, 2012, each of the six monitoring wells, MW-1 through MW-6, was gauged for depth to groundwater using a Solinst Model 101 electronic water indicator immediately prior to purging operations. A total of 33 gallons of groundwater was purged from the site monitoring wells (4 to 10 gallons per well) using a 3-stage submersible pump which was decontaminated using an Alconox solution and a distilled water rinse between sampling points. Groundwater parameters (pH, temperature, and conductivity) were measured using a Hanna Model #98130 multimeter until a minimum of three wells volumes was purged from each well. Water samples from each monitoring well were transferred into 1,000 milliliter (ml) plastic containers for laboratory analysis of chloride using EPA Method SM-4500-Cl-C and TDS using EPA Method SM-2540-C. For each set of samples, chain of custody forms documenting sample identification numbers, collection times, and delivery times to the laboratory were completed. All water samples were placed in an ice-filled cooler immediately after collection and transported to Eurofins Lancaster Laboratories (Lancaster, PA) for analysis.

3.0 Groundwater Elevations, Hydraulic Gradient and Flow Direction

Depth to groundwater varies from 51.89 feet (ft) below top of casing (btoc) at MW-2 to 72.72 ft at MW-6 below ground surface. Groundwater elevations are summarized in Table 1, and a groundwater gradient map depicting the direction of groundwater flow is illustrated in Figure 1. A historical groundwater elevation graph is shown in Figure 2. The groundwater gradient direction is to the southeast with a hydraulic gradient of approximately 0.004 ft/ft. According to published reports (*Ground-Water Conditions in Northern Lea County, New Mexico*, Ash, 1963 and *Geology and Ground-Water Conditions in Southern Lea County, New Mexico*, Nicholson and Clebsch, 1961) the groundwater encountered at the site is that of the Tertiary-aged Ogallala Formation. The Ogallala Formation unconformably overlies the impermeable red-beds of the Triassic Chinle Formation at an elevation of approximately 3,700 ft above mean sea level (AMSL). Based on the current groundwater elevations measured on site and published data referenced, the saturated thickness of the Ogallala Formation at the site ranges from approximately 86 to 95 feet.



Google Earth Aerial (2012)

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FIGURE 1
Former Unocal South Vacuum Unit
Groundwater Gradient Map
August 2, 2012

Table 1
Summary of Groundwater Sampling Results

Monitoring Well	Sampling Date	Chloride (mg/L)	TDS (mg/L)	Depth to Groundwater (feet BTOC)	Top of Casing Elevation (feet AMSL)	Groundwater Elevation (feet AMSL)
MW-1	01/27/1995	**1174**	**2250**	59.57	3858.37	3798.80
	05/18/1995	**983**	**2251**	61.30	3858.37	3797.07
	08/28/1996	**1420**	**2730**	61.57	3858.37	3796.80
	08/13/1997	**1400**	**2800**	61.75	3858.37	3796.62
	09/30/1999	**1094**	**2318**	62.51	3858.37	3795.86
	06/14/2000	**927**	**2040**	62.85	3858.37	3795.52
	06/18/2001	**813**	**1790**	63.07	3858.37	3795.30
	07/11/2002	**784**	**1680**	63.28	3858.37	3795.09
	07/02/2003	**715**	**2090**	63.66	3858.37	3794.71
	08/12/2004	**628**	**2050**	63.83	3858.37	3794.54
	08/10/2005	**774**	**1830**	62.62	3858.37	3795.75
	07/31/2006	**860**	**2010**	62.90	3858.37	3795.47
	07/27/2007	**732**	**1790**	63.43	3858.37	3794.94
	08/26/2008	**895**	**1960**	63.95	3858.37	3794.42
	07/15/2009	**852**	**2300**	64.25	3858.37	3794.12
	07/13/2010	**934**	**2590**	64.51	3858.37	3793.86
	07/14/2011	**824**	**2370**	64.74	3858.37	3793.63
	08/02/2012	**854**	**2740**	65.15	3858.37	3793.22
MW-2	09/30/1999	**298**	922	49.51	3841.64	3792.13
	06/14/2000	**317**	852	49.81	3841.64	3791.83
	06/18/2001	**288**	878	50.06	3841.64	3791.58
	07/11/2002	**284**	808	50.29	3841.64	3791.35
	07/02/2003	**268**	859	50.63	3841.64	3791.01
	08/12/2004	**451**	931	50.81	3841.64	3790.83
	08/10/2005	**355**	844	49.58	3841.64	3792.06
	07/31/2006	**401**	922	49.83	3841.64	3791.81
	07/27/2007	**430**	984	50.33	3841.64	3791.31
	08/26/2008	**354**	980	50.80	3841.64	3790.84
	07/15/2009	**482**	**1060**	51.04	3841.64	3790.60
	07/13/2010	**494**	**1070**	51.37	3841.64	3790.27
	07/14/2011	**486**	974	51.53	3841.64	3790.11
	08/02/2012	**531**	**1110**	51.89	3841.64	3789.75
MW-3	09/30/1999	73.6	427	66.74	3864.73	3797.99
	06/14/2000	75.5	433	67.01	3864.73	3797.72
	06/18/2001	86.4	495	67.29	3864.73	3797.44
	07/11/2002	103	509	67.59	3864.73	3797.14
	07/02/2003	98.3	588	67.94	3864.73	3796.79
	08/12/2004	111	605	68.07	3864.73	3796.66
	08/10/2005	122	533	66.81	3864.73	3797.92
	07/31/2006	141	619	67.21	3864.73	3797.52
	07/27/2007	164	705	67.79	3864.73	3796.94
	08/26/2008	185	592	68.30	3864.73	3796.43
	07/15/2009	199	766	68.50	3864.73	3796.23
	07/13/2010	207	859	68.52	3864.73	3796.21
	07/14/2011	205	816	69.19	3864.73	3795.54
	08/02/2012	232	**1010**	69.60	3864.73	3795.13

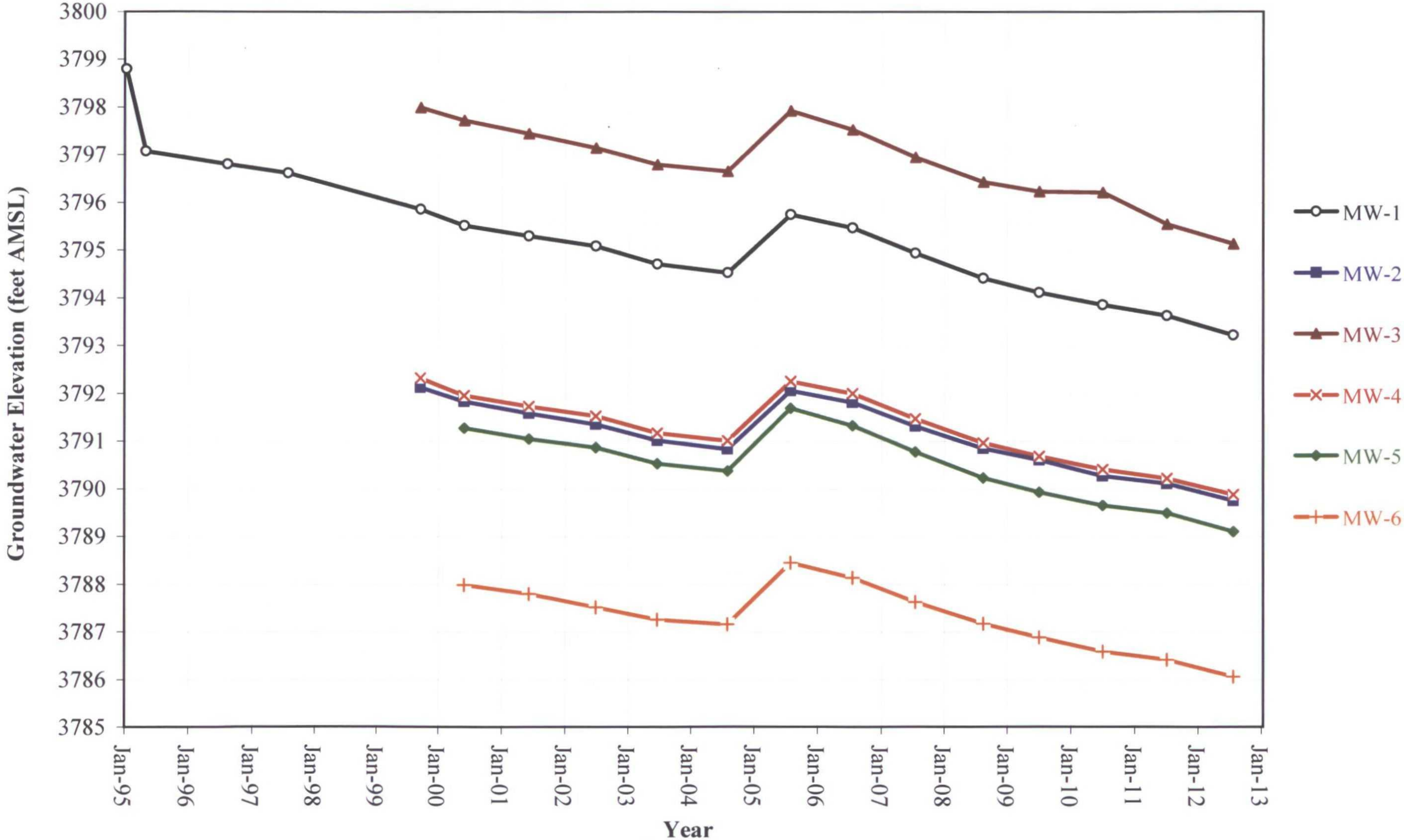
Continued on next page

Table 1
Summary of Groundwater Sampling Results

Monitoring Well	Sampling Date	Chloride (mg/L)	TDS (mg/L)	Depth to Groundwater (feet BTOC)	Top of Casing Elevation (feet AMSL)	Groundwater Elevation (feet AMSL)
MW-4	09/30/1999	**1576**	**2981**	60.18	3852.51	3792.33
	06/14/2000	**1500**	**2910**	60.55	3852.51	3791.96
	06/18/2001	**1530**	**3180**	60.78	3852.51	3791.73
	07/11/2002	**1290**	**2660**	60.98	3852.51	3791.53
	07/02/2003	**1250**	**2610**	61.34	3852.51	3791.17
	08/12/2004	**1130**	**2480**	61.50	3852.51	3791.01
	08/10/2005	**1050**	**2230**	60.25	3852.51	3792.26
	07/31/2006	**926**	**2030**	60.51	3852.51	3792.00
	07/27/2007	**758**	**1940**	61.04	3852.51	3791.47
	08/26/2008	**720**	**1790**	61.55	3852.51	3790.96
	07/15/2009	**632**	**1780**	61.83	3852.51	3790.68
	07/13/2010	**687**	**1750**	62.11	3852.51	3790.40
	07/14/2011	**707**	**1600**	62.29	3852.51	3790.22
	08/02/2012	**804**	**1760**	62.63	3852.51	3789.88
MW-5	06/14/2000	13.7	274	68.57	3859.84	3791.27
	06/18/2001	13.6	322	68.80	3859.84	3791.04
	07/11/2002	15.5	308	68.98	3859.84	3790.86
	07/02/2003	12.5	359	69.32	3859.84	3790.52
	08/12/2004	15.3	375	69.46	3859.84	3790.38
	08/10/2005	14.9	309	68.15	3859.84	3791.69
	07/31/2006	13.3	290	68.52	3859.84	3791.32
	07/27/2007	14.9	296	69.07	3859.84	3790.77
	08/26/2008	13.6	296	69.61	3859.84	3790.23
	07/15/2009	13.4	291	69.91	3859.84	3789.93
	07/13/2010	12.6	291	70.19	3859.84	3789.65
	07/14/2011	13.8	265	70.35	3859.84	3789.49
	08/02/2012	13.8	290	70.74	3859.84	3789.10
MW-6	06/14/2000	48.0	382	70.79	3858.78	3787.99
	06/18/2001	50.8	431	70.98	3858.78	3787.80
	07/11/2002	50.0	422	71.26	3858.78	3787.52
	07/02/2003	46.5	471	71.52	3858.78	3787.26
	08/12/2004	55.1	410	71.62	3858.78	3787.16
	08/10/2005	55.0	391	70.33	3858.78	3788.45
	07/31/2006	52.4	412	70.64	3858.78	3788.14
	07/27/2007	75.3	516	71.15	3858.78	3787.63
	08/26/2008	88.5	548	71.61	3858.78	3787.17
	07/15/2009	81.4	532	71.90	3858.78	3786.88
	07/13/2010	84.1	545	72.20	3858.78	3786.58
	07/14/2011	89.2	531	72.37	3858.78	3786.41
	08/02/2012	93.8	550	72.72	3858.78	3786.06
WQCC Standards		250	1000			

Total Dissolved Soilds (TDS) and chloride concentrations listed in milligrams per liter (mg/L)
Analyses performed by Trace Analysis Inc. (1995-1998), SPL, Inc. (1999-2005), and Lancaster Laboratories (2006-2011).
Values in boldface type indicate concentrations exceed New Mexico Water Quality Commission (WQCC) standards.
AMSL - Above Mean Sea Level; BTOC - Below Top of Casing
Groundwater flow direction is to the southeast with a gradient of approx. 0.004 ft/ft.
Elevations and state plane coordinates surveyed by Basin Surveys, Hobbs, NM.

Figure 2
Historical Groundwater Elevations



4.0 Groundwater Quality Conditions

Groundwater sample analytical results are presented in Table 1 with the WQCC standards shown for comparison. Those constituents that indicate concentrations above the WQCC standards are highlighted in boldface type. The WQCC standard of 250 mg/L for chloride was exceeded in MW-1 (854 mg/L), MW-2 (531 mg/L), and MW-4 (804 mg/L). The WQCC standard of 1,000 mg/L for TDS was exceeded in MW-1 (2,740 mg/L), MW-2 (1,110 mg/L), MW-3 (1,010 mg/L), and MW-4 (1,760 mg/L). The groundwater samples obtained from downgradient wells MW-5 and MW-6 had chloride and TDS concentrations below WQCC standards.

The most recent chloride and TDS concentrations, and estimated isopleths are depicted graphically as Figures 3 and 4, respectively. Graphs depicting historical chloride and TDS concentrations in monitoring wells MW-1 through MW-6 are shown in Figures 5 and 6.

Chloride and TDS concentrations in MW-1, near the source area, have generally decreased since 1996 with the exception of some fluctuations since the 2004 sampling event. Similarly, chloride and TDS levels have steadily decreased in the closest downgradient well, MW-4, since 1999 when that well was installed. This indicates that encapsulating the former saltwater disposal pit with solidification material in 1995, has significantly reduced the threat of any continued release from the source.

Monitoring well MW-3 has exhibited steady increases in chloride and TDS concentrations since 2000, which suggests a possible offsite source of chlorides and TDS located upgradient (northwest) from the site. The chloride (232 mg/L) and TDS (1,010 mg/L) detected in MW-3 during the 2012 monitoring event are the two highest since 1999. Chloride and TDS levels in MW-2, MW-5, and MW-6 have remained relatively consistent with previous years.

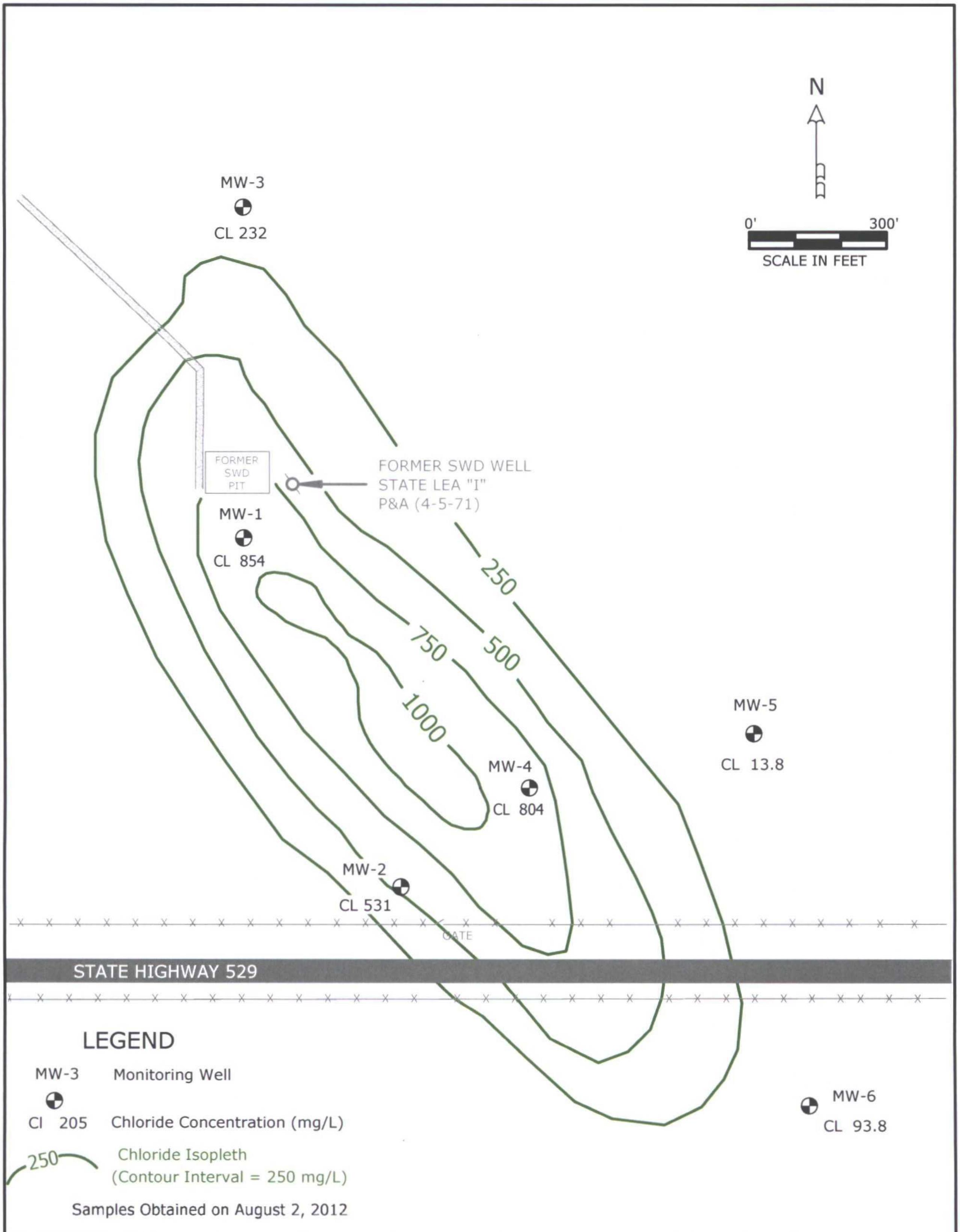


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FIGURE 3

Former Unocal South Vacuum Unit
Chloride Concentration Map
Current Conditions (2012)

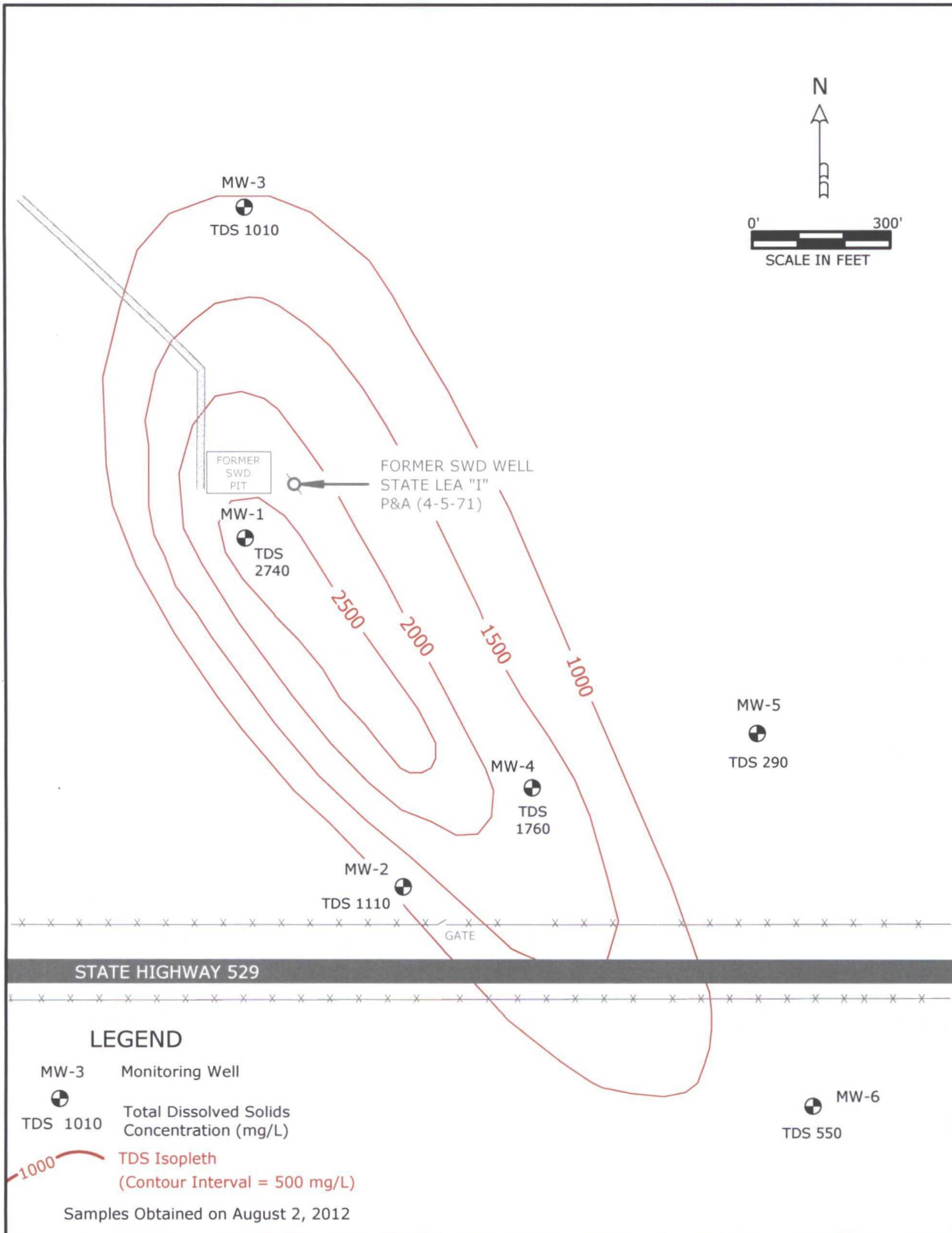

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FIGURE 4

Former Unocal South Vacuum Unit
TDS Concentration Map
Current Conditions (2012)

Figure 5
Chloride Concentrations Versus Time Graph

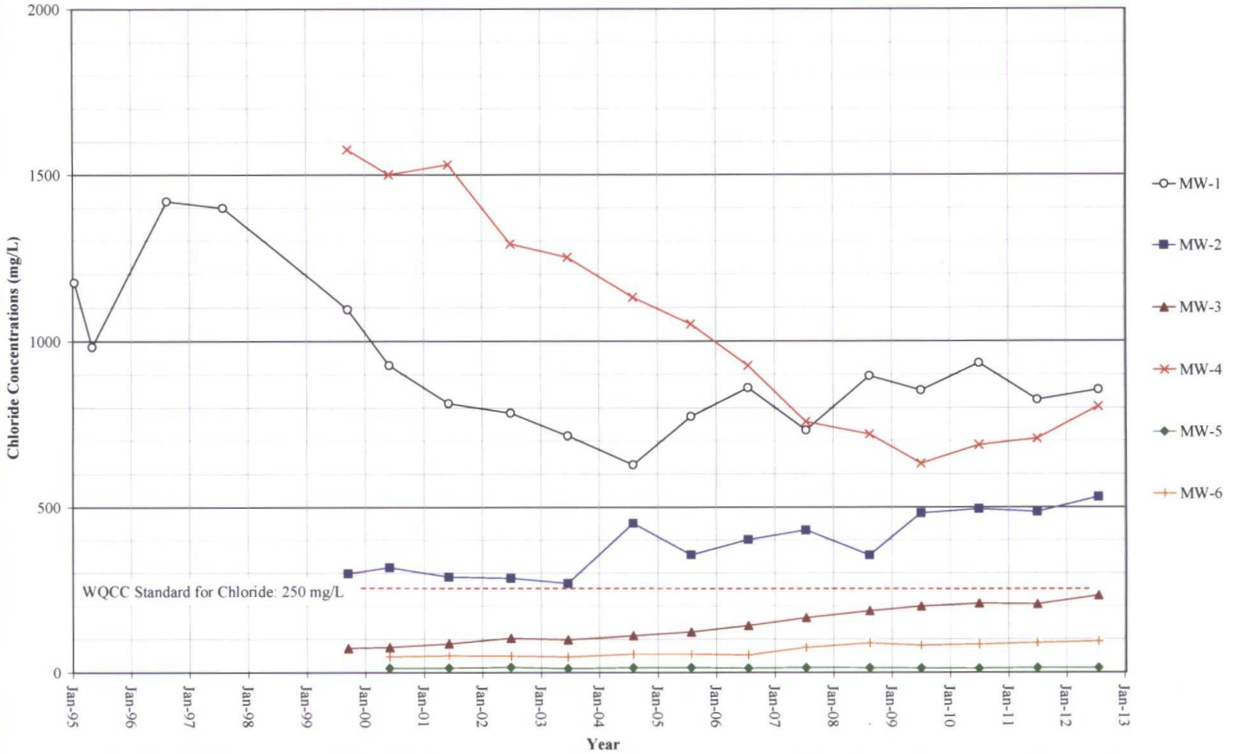
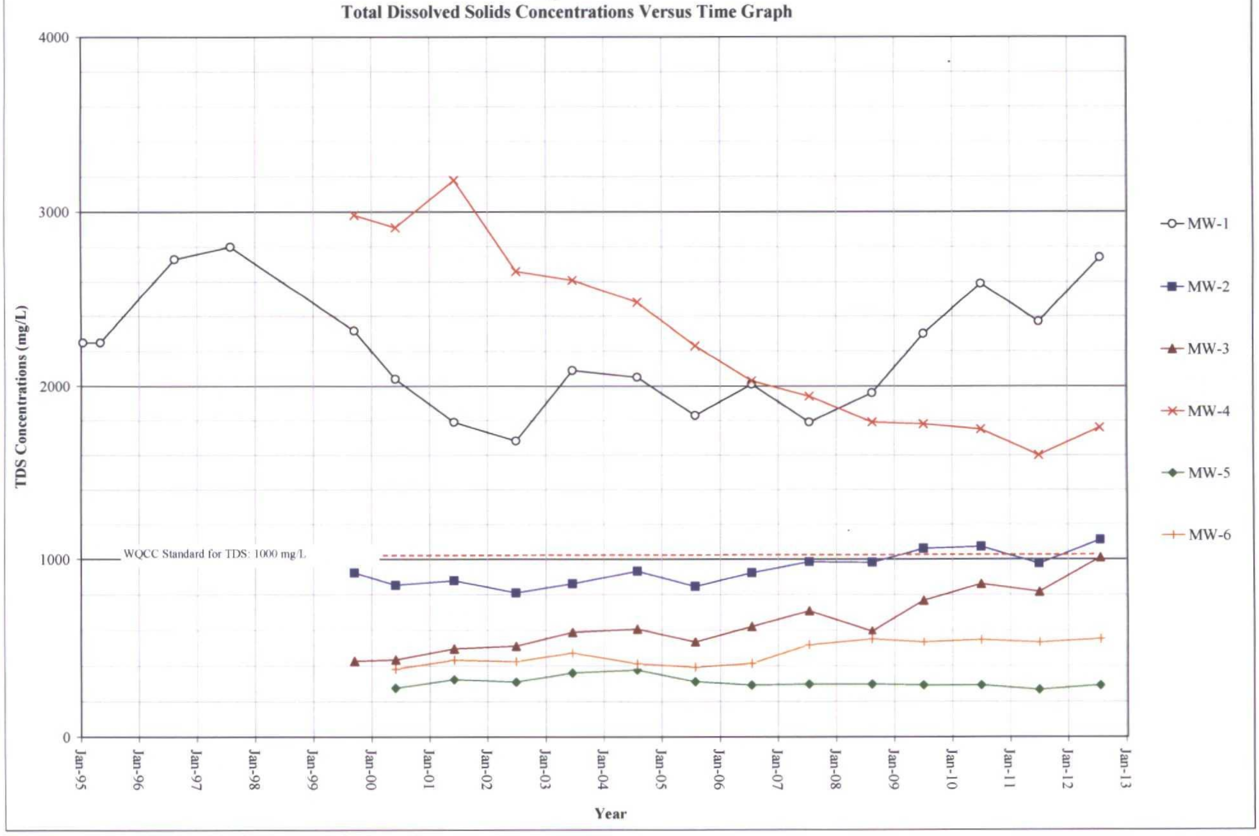


Figure 6
Total Dissolved Solids Concentrations Versus Time Graph



5.0 Fate and Transport Modeling Results

Fate and transport modeling was performed by Trident to simulate the movement of the chloride and TDS groundwater plume over time. Simulations were conducted using the two-dimensional groundwater flow and contaminant transport model WinTran, version 1.03 (1995) designed and distributed by Environmental Simulations, Inc. (ESI) of Herndon, Virginia. WinTran is built around a steady-state analytical element flow model, linked to a finite element contaminant transport model. A more detailed discussion of the flow and transport parameters used, assumptions, model calibrations, and simulation results are described in Appendix D.

Figures displaying modeled simulations of the chloride and TDS plumes over various time increments are included in Appendix C. Advective flow moves the center of plume mass downgradient as depicted in the simulations. The simulations also demonstrate how hydrodynamic dispersion serves to broaden the dimensions of the plume while reducing the concentrations in the middle of the plume.

Continued attenuation by dilution and dispersion of the plume, after the maximum chloride and TDS concentrations decrease to levels below WQCC standards, are shown in the final simulation for each constituent of concern (year 2157 for chloride and year 2094 for TDS). In the year 2157, the center of the chloride plume is approximately 3,200 ft away from the pit and well source. The center of the TDS plume is approximately 2,200 ft away from the pit and well source in the year 2094.

The portions of the chloride and TDS plumes that are above WQCC standards do not reach any of the identified potential receptors at any time during their attenuation, the closest of which is a livestock (windmill) well (NM File No. L05339) located over one-half mile south of the source. The windmill has been dismantled and is no longer in operation due to declining water levels in the area. The results of the updated fate and transport model are consistent with those determined in previous annual reports.

6.0 Conclusions

Conclusions relevant to groundwater conditions and the remediation performance at the Former Unocal South Vacuum Unit are presented below.

- Chloride and TDS concentrations in MW-1 (near the source area) have generally decreased since 1996, with the exception of some fluctuations since the 2004 sampling event. Similarly, chloride and TDS levels have significantly decreased in the closest downgradient well, MW-4, since 1999 when that well was installed and have remained relatively stable since 2007. Chloride and TDS concentrations in upgradient well MW-3 have shown slight but steadily increasing trends indicating a possible offsite, upgradient contributing source of these constituents. Chloride and TDS concentrations in the remaining wells (MW-2, MW-5, and MW-6) have remained relatively consistent with previous levels.
- The fate and transport modeling results continue to demonstrate that the chloride and TDS plume is not likely to impact existing sources of water supply, the closest of which, a livestock (windmill) well located over one-half mile south of the source. The windmill has been dismantled and is no longer in operation due to declining water levels in the area and the shallow depth of the well.
- According to conservative model simulations, the chloride plume will travel a maximum of 3,200 ft southeast of the source in approximately 145 years before concentrations return to levels below the WQCC standard of 250 mg/L. The same analysis indicates that the TDS plume will travel only 2,200 ft in approximately 82 years before concentrations return to levels below the WQCC standard of 1,000 mg/L.
- Based on the modeling results and predicted natural attenuation processes (advection and dispersion), there will be no adverse impact to human health and the environment nor will the livestock well exceed WQCC standards for chlorides or TDS due to the plume originating and traveling southeast, versus south, from the former saltwater disposal pit.
- Groundwater elevations have steadily decreased at a rate of approximately 0.3 feet per year since the initial sampling event of monitoring well MW-1 in January 1995; with the exception of the 2005 sampling event. The recent rise may be attributed to higher than normal rainfall during 2004 and 2005. The decreasing groundwater elevation trend has resumed since 2005.

7.0 Recommendations

Effective remedial actions of the source area were performed by Unocal, which include plugging of the SWD well in 1971 and encapsulating the former saltwater disposal pit with solidification material in 1995, thus preventing any continued release from the source. Based on the identified potential receptor and fate and transport modeling results, the chloride/TDS plume at the site presents low risk to human health and the environment; therefore Trident recommends the following actions:

- Continue the annual groundwater monitoring program with groundwater sampling and analysis of chloride and TDS concentrations for each of the six monitoring wells.
- Update flow and transport model to confirm the plume is naturally attenuating as described.
- Submit the 2013 annual groundwater monitoring report to OCD in January 2014 to document natural attenuation conditions.

APPENDIX A

Laboratory Analytical Report

And

Chain-of-Custody Documentation

ANALYTICAL RESULTS

Prepared by:	Prepared for:
Lancaster Laboratories 2425 New Holland Pike Lancaster, PA 17605-2425	Chevron Environmental Mgmt Co 6101 Bollinger Canyon Road San Ramon CA 94583

August 10, 2012

Project: Former Unocal South Vacuum Unit, Lea County, NM

Submittal Date: 08/04/2012
Group Number: 1326609
PO Number: 0015097476
Release Number: MACLEOD
State of Sample Origin: NM

Client Sample Description	Lancaster Labs (LLI) #
MW-1 Grab Water Sample	6744300
MW-2 Grab Water Sample	6744301
MW-3 Grab Water Sample	6744302
MW-4 Grab Water Sample	6744303
MW-5 Grab Water Sample	6744304
MW-6 Grab Water Sample	6744305

The specific methodologies used in obtaining the enclosed analytical results are indicated on the Laboratory Sample Analysis Record.

ELECTRONIC COPY TO	ARCADIS	Attn: Mark M. Miller
ELECTRONIC COPY TO	ARCADIS	Attn: Allen Just
ELECTRONIC COPY TO	Trident Environmental	Attn: Gilbert Van Deventer
ELECTRONIC COPY TO	ARCADIS	Attn: Dana Koschel
ELECTRONIC COPY TO	ARCADIS	Attn: Sarah Huff
ELECTRONIC COPY TO	ARCADIS	Attn: Robin Simon

Respectfully Submitted,

Katherine A. Klinefelter

Katherine A. Klinefelter
Principal Specialist

(717) 556-7256

eurofins | Lancaster Laboratories

Analysis Report

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Sample Description: MW-1 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

LLI Sample # WW 6744300
LLI Group # 1326609
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 08/02/2012 12:00 by GV

Submitted: 08/04/2012 09:15
Reported: 08/10/2012 10:58

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
Wet Chemistry	**SM20 2540 C**		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	2,740	77.6	240	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	854	20.0	100	50

General Sample Comments

All QC is compliant unless otherwise noted. Please refer to the Quality
ntrol Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	12221021202A	08/08/2012 09:53	Susan A Engle	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	12220112401A	08/07/2012 15:15	Susan A Engle	50

*=This limit was used in the evaluation of the final result

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Analysis Report

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Sample Description: MW-2 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

LLI Sample # WW 6744301
LLI Group # 1326609
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 08/02/2012 11:00 by GV

Submitted: 08/04/2012 09:15
Reported: 08/10/2012 10:58

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
Wet Chemistry	SM20 2540 C		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	1,110	77.6	240	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	531	20.0	100	50

General Sample Comments

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	12221021202A	08/08/2012 09:53	Susan A Engle	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	12220112401A	08/07/2012 15:15	Susan A Engle	50

*=This limit was used in the evaluation of the final result

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2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Analysis Report

Sample Description: MW-3 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

LLI Sample # WW 6744302
LLI Group # 1326609
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 08/02/2012 10:00 by GV

Submitted: 08/04/2012 09:15
Reported: 08/10/2012 10:58

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
Wet Chemistry	**SM20 2540 C**		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	1,010	38.8	120	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	232	8.0	40.0	20

General Sample Comments

All QC is compliant unless otherwise noted. Please refer to the Quality
›ntrol Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	12221021202A	08/08/2012 09:53	Susan A Engle	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	12220112401A	08/07/2012 15:15	Susan A Engle	20

*=This limit was used in the evaluation of the final result

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Analysis Report

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Sample Description: MW-4 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

LLI Sample # WW 6744303
LLI Group # 1326609
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 08/02/2012 13:00 by GV

Submitted: 08/04/2012 09:15
Reported: 08/10/2012 10:58

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
Wet Chemistry	SM20 2540 C		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	1,760	77.6	240	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	804	20.0	100	50

General Sample Comments

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	12221021202A	08/08/2012 09:53	Susan A Engle	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	12220112401A	08/07/2012 15:15	Susan A Engle	50

*=This limit was used in the evaluation of the final result

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Analysis Report

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Sample Description: MW-5 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

LLI Sample # WW 6744304
LLI Group # 1326609
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 08/02/2012 09:00 by GV

Submitted: 08/04/2012 09:15
Reported: 08/10/2012 10:58

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
Wet Chemistry	SM20 2540 C		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	290	9.7	30.0	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	13.8	0.40	2.0	1

General Sample Comments

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	12221021202A	08/08/2012 09:53	Susan A Engle	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	12220112401A	08/07/2012 15:15	Susan A Engle	1

*=This limit was used in the evaluation of the final result

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Analysis Report

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

Sample Description: MW-6 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

LLI Sample # WW 6744305
LLI Group # 1326609
Account # 11969

Project Name: Former Unocal South Vacuum Unit, Lea County, NM

Collected: 08/02/2012 08:10 by GV

Submitted: 08/04/2012 09:15
Reported: 08/10/2012 10:58

Chevron Environmental Mgmt Co
6101 Bollinger Canyon Road
San Ramon CA 94583

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Method Detection Limit*	As Received Limit of Quantitation	Dilution Factor
Wet Chemistry	SM20 2540 C		mg/l	mg/l	mg/l	
00212	Total Dissolved Solids	n.a.	550	19.4	60.0	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	93.8	4.0	20.0	10

General Sample Comments

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
00212	Total Dissolved Solids	SM20 2540 C	1	12221021202A	08/08/2012 09:53	Susan A Engle	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	12220112401A	08/07/2012 15:15	Susan A Engle	10

*=This limit was used in the evaluation of the final result

Quality Control Summary

Client Name: Chevron Environmental Mgmt Co   Group Number: 1326609
Reported: 08/10/12 at 10:58 AM

Matrix QC may not be reported if insufficient sample or site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD was performed, unless otherwise specified in the method.

All Inorganic Initial Calibration and Continuing Calibration Blanks met acceptable method criteria unless otherwise noted on the Analysis Report.

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank MDL**	Blank LOQ	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
Batch number: 12220112401A	Sample number(s): 6744300-6744305								
Chloride (titrimetric)					98		95-103		
Batch number: 12221021202A	Sample number(s): 6744300-6744305								
Total Dissolved Solids	N.D.	9.7	30.0	mg/l	101		80-120		

Sample Matrix Quality Control

Unspiked (UNSPK) = the sample used in conjunction with the matrix spike
Background (BKG) = the sample used in conjunction with the duplicate

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Batch number: 12220112401A	Sample number(s): 6744300-6744305 UNSPK: P738936 BKG: P738936								
Chloride (titrimetric)	94	95	85-110	1	3	665	655	2	5
Batch number: 12221021202A	Sample number(s): 6744300-6744305 UNSPK: 6744300 BKG: 6744300								
Total Dissolved Solids	101		51-144			2,740	2,700	1	9

*- Outside of specification
**-This limit was used in the evaluation of the final result for the blank
(1) The result for one or both determinations was less than five times the LOQ.
(2) The unspiked result was more than four times the spike added.

Environmental Analysis Request/Chain of Custody

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For Lancaster Laboratories use only

Acct. # 11969 Group # 1326609 Sample # 6744300-05

COC # 311976

Please print. Instructions on reverse side correspond with circled numbers.

For Lab Use Only
FSC:
SCR#: 125811

(1)
Client: Chevron Environmental Mgmt. Co Acct. #: 11969
Project Name/#: Former Unocal S. Vacuum Unit PWSID #:
Project Manager: John MacLead (Chevron EMC) Dana Koschel (Arcadis) P.O.#: 125811
Sampler: Gil VanDeventer (Trident Env.) Quote #:
Name of state where samples were collected: NM

(5) Analyses Requested / Preservation Codes

Preservation Codes
H=HCl T=Thiosulfate
N=HNO_3 B=NaOH
S=H_2SO_4 O=Other

(2) Sample Identification	Date Collected	Time Collected	(3) Grab	Composite	Matrix: Soil	Sediment	Water (Potable/NPDES/Ground/Surface)	Other:	(4) Total # of Containers	Chloride	TDS							Remarks	(6) Temperature of samples upon receipt (if requested)
MW-1	8-2-12	1200	✓				✓			✓	✓							0.6°C KMZ	
MW-2	8-2-12	1100	✓				✓			✓	✓							↓	
MW-3	8-2-12	1000	✓				✓			✓	✓								
MW-4	8-2-12	1300	✓				✓			✓	✓								
MW-5	8-2-12	0900	✓				✓			✓	✓								
MW-6	8-2-12	0810	✓				✓			✓	✓								

(7) **Turnaround Time Requested** (TAT) (please circle): (Standard) Rush
(Rush TAT is subject to Lancaster Laboratories approval and surcharge.)
Date results are needed:
Rush results requested by (please circle): Phone E-mail
Phone #: 432-638-8740
E-mail address: gil@trident-environmental.com

(8) **Data Package Options** (please circle if required)
Type I (Validation/non-CLP) MA MCP CT RCP
Type III (Reduced non-CLP)
Type IV (CLP SOW)
Type VI (Raw Data Only)
TX TRRP 13

EDD Required? Yes No

Site-specific QC (MS/MSD/Dup)? Yes (No)
(if yes, indicate QC sample and submit triplicate sample volume)

Relinquished by:	Date	Time	Received by:	Date	Time
[signature]	7/25/12	11:30	[signature]	7/31/12	8:00 pm
[signature]	8/3/12	6:00 pm	Received by:		
Relinquished by:			Received by:		
Relinquished by:			Received by:		
Relinquished by:			[signature]	8.4.12	915

(9)

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Environmental Sample Administration Receipt Documentation Log

Client/Project: Chevron Environmental

Date of Receipt: 8-4-12

Time of Receipt: 915

Source Code: 50-1

Shipping Container Sealed: (YES) NO

Custody Seal Present * : (YES) NO

* Custody seal was intact unless otherwise noted in the discrepancy section

Package: (Chilled) Not Chilled

Temperature of Shipping Containers							
Cooler #	Thermometer ID	Temperature (°C)	Temp Bottle (TB) or Surface Temp (ST)	Wet Ice (WI) or Dry Ice (DI) or Ice Packs (IP)	Ice Present? Y/N	Loose (L) Bagged Ice (B) or NA	Comments
1	2939	0.6	TB	WI	Y	B&L	
2							
3							
4							
5							
6							

Number of Trip Blanks received NOT listed on chain of custody: 0

Paperwork Discrepancy/Unpacking Problems:

Unpacker Signature/Emp#: [signature] 2294 **Date/Time:** 8-4-12 1036

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Explanation of Symbols and Abbreviations

The following defines common symbols and abbreviations used in reporting technical data:

RL	Reporting Limit	**BMQL**	Below Minimum Quantitation Level
N.D.	none detected	**MPN**	Most Probable Number
TNTC	Too Numerous To Count	**CP Units**	cobalt-chloroplatinate units
IU	International Units	**NTU**	nephelometric turbidity units
umhos/cm	micromhos/cm	**ng**	nanogram(s)
C	degrees Celsius	**F**	degrees Fahrenheit
meq	milliequivalents	**lb.**	pound(s)
g	gram(s)	**kg**	kilogram(s)
µg	microgram(s)	**mg**	milligram(s)
mL	milliliter(s)	**L**	liter(s)
m3	cubic meter(s)	**µL**	microliter(s)
		pg/L	picogram/liter

< less than - The number following the sign is the limit of quantitation, the smallest amount of analyte which can be reliably determined using this specific test.

> greater than

ppm parts per million - One ppm is equivalent to one milligram per kilogram (mg/kg), or one gram per million grams. For aqueous liquids, ppm is usually taken to be equivalent to milligrams per liter (mg/l), because one liter of water has a weight very close to a kilogram. For gases or vapors, one ppm is equivalent to one microliter of gas per liter of gas.

ppb parts per billion

Dry weight basis Results printed under this heading have been adjusted for moisture content. This increases the analyte weight concentration to approximate the value present in a similar sample without moisture. All other results are reported on an as-received basis.

Data Qualifiers:

C – result confirmed by reanalysis.

J - estimated value – The result is ≥ the Method Detection Limit (MDL) and < the Limit of Quantitation (LOQ).

U.S. EPA CLP Data Qualifiers:

Organic Qualifiers		Inorganic Qualifiers	
A	TIC is a possible aldol-condensation product	**B**	Value is <CRDL, but ≥IDL
B	Analyte was also detected in the blank	**E**	Estimated due to interference
C	Pesticide result confirmed by GC/MS	**M**	Duplicate injection precision not met
D	Compound quantitated on a diluted sample	**N**	Spike sample not within control limits
E	Concentration exceeds the calibration range of the instrument	**S**	Method of standard additions (MSA) used for calculation
N	Presumptive evidence of a compound (TICs only)	**U**	Compound was not detected
P	Concentration difference between primary and confirmation columns >25%	**W**	Post digestion spike out of control limits
		*****	Duplicate analysis not within control limits
U	Compound was not detected	**+**	Correlation coefficient for MSA <0.995
X,Y,Z	Defined in case narrative		

Analytical test results meet all requirements of NELAC unless otherwise noted under the individual analysis.

Measurement uncertainty values, as applicable, are available upon request.

Tests results relate only to the sample tested. Clients should be aware that a critical step in a chemical or microbiological analysis is the collection of the sample. Unless the sample analyzed is truly representative of the bulk of material involved, the test results will be meaningless. If you have questions regarding the proper techniques of collecting samples, please contact us. We cannot be held responsible for sample integrity, however, unless sampling has been performed by a member of our staff. This report shall not be reproduced except in full, without the written approval of the laboratory.

Times are local to the area of activity. Parameters listed in the 40 CFR part 136 Table II as "analyze immediately" are not performed within 15 minutes.

WARRANTY AND LIMITS OF LIABILITY - In accepting analytical work, we warrant the accuracy of test results for the sample as submitted. THE FOREGOING EXPRESS WARRANTY IS EXCLUSIVE AND IS GIVEN IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED. WE DISCLAIM ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING A WARRANTY OF FITNESS FOR PARTICULAR PURPOSE AND WARRANTY OF MERCHANTABILITY. IN NO EVENT SHALL LANCASTER LABORATORIES BE LIABLE FOR INDIRECT, SPECIAL, CONSEQUENTIAL, OR INCIDENT DAMAGES INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOSS OF PROFIT OR GOODWILL REGARDLESS OF (A) THE NEGLIGENCE (EITH SOLE OR CONCURRENT) OF LANCASTER LABORATORIES AND (B) WHETHER LANCASTER LABORATORIES HAS BEEN INFORMED OF THE POSSIBILITY OF SUCH DAMAGES. We accept no legal responsibility for the purposes for which the client uses the test results. No purchase order or other order for work shall be accepted by Lancaster Laboratories which includes any conditions that vary from the Standard Terms and Conditions, and Lancaster hereby objects to any conflicting terms contained in any acceptance or order submitted by client.

APPENDIX B

Monitoring Well Sampling Data Form

WELL SAMPLING DATA FORM

CLIENT: Chevron Environmental Management Corp.
SITE NAME: Former Unocal South Vacuum Unit (1R-277)
SITE LOCATION: T18S - R35E - Sec 35, Lea County, NM
SAMPLER: Gil Van Deventer

TRIDENT ENVIRONMENTAL

PURGING METHOD: ☐ Hand Bailed ☑ Pump, Type: Proactive Super Twister 3-Stage Pump
SAMPLING METHOD: ☐ Disposable Bailer ☑ Direct from Discharge Hose ☐ Other: ______
DISPOSAL METHOD OF PURGE WATER: ☐ On-site Drum ☐ Drums ☑ SWD Disposal Facility

Date	Time	Monitoring Well No.	Depth to Water (ft btoc)	Total Depth (ft)	Water Column Height (ft)	Well Factor 2"=.16 4"=.65	Calc. Well Vol. (gal)	Volume Purged (gal)	No. of Well Volumes Purged	Temp. °C	Cond. mS/cm	pH	PHYSICAL APPEARANCE AND REMARKS
08/02/12	12:00	MW-1	65.15	70.00	4.85	0.16	0.8	4	5.2	22.5	3.09	7.09	Cloudy but clearing moderately quickly
08/02/12	11:00	MW-2	51.89	71.00	19.11	0.16	3.1	10	3.3	21.7	1.94	8.30	Cloudy but cleared quickly
08/02/12	10:00	MW-3	69.60	77.00	7.40	0.16	1.2	5	4.2	21.7	1.06	7.17	Clear
08/02/12	13:00	MW-4	62.63	71.00	8.37	0.16	1.3	5	3.7	22.3	3.12	7.82	Cloudy but cleared quickly
08/02/12	9:00	MW-5	70.74	79.00	8.26	0.16	1.3	5	3.8	22.0	0.42	7.34	Clear
08/02/12	8:10	MW-6	72.72	77.20	4.48	0.16	0.7	4	5.6	21.3	0.77	6.61	Clear with reddish sediment building up

COMMENTS: Equipment decontamination consists of gloves, Alconox, and Distilled Water Rinse.
Hanna Model 98130 instrument used to obtain pH, conductivity, and temperature measurements.
Shipped samples via FedEx to Lancaster Laboratories for chloride and TDS analysis.

APPENDIX C

Chloride and TDS Plume Simulations

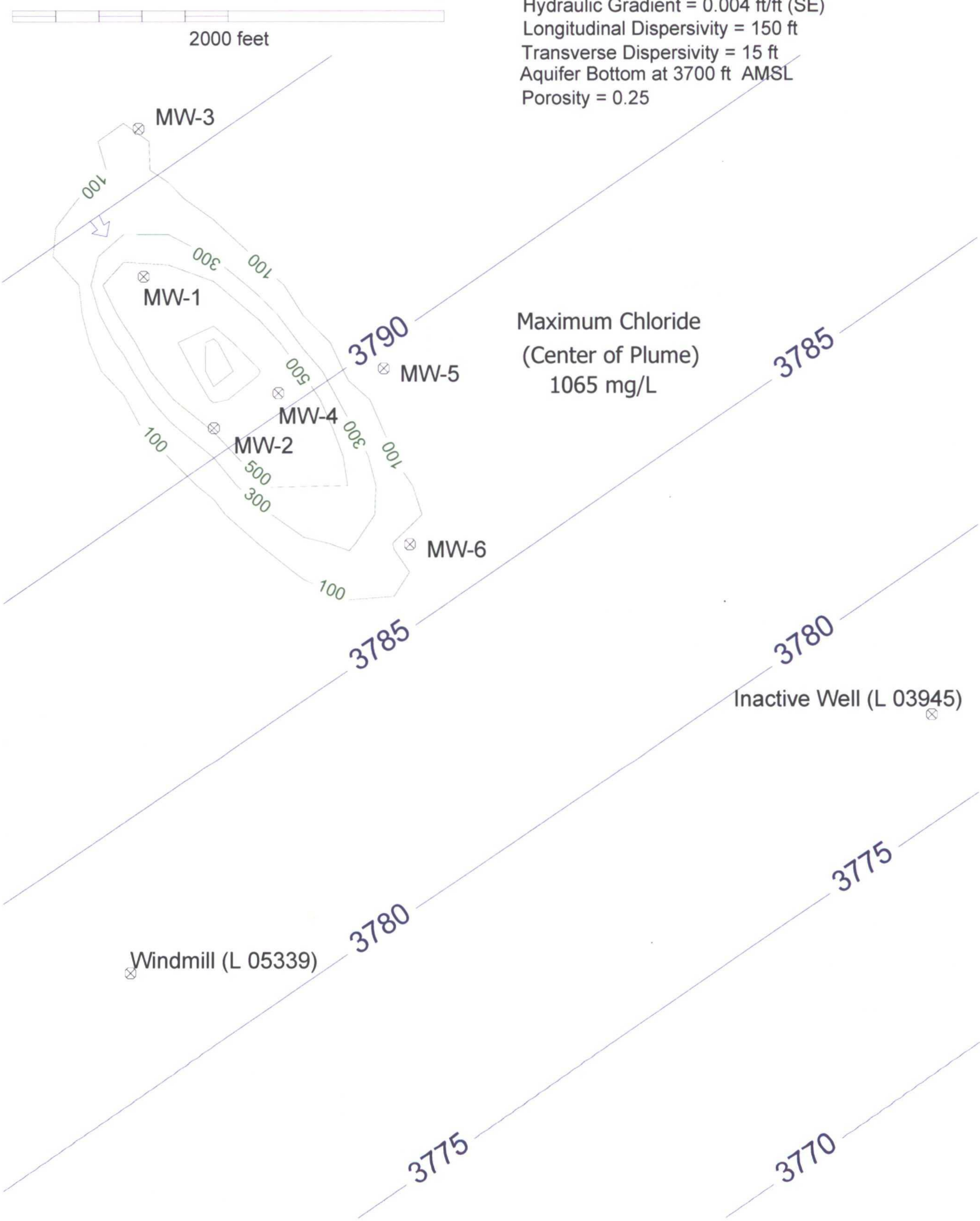
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2012)

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



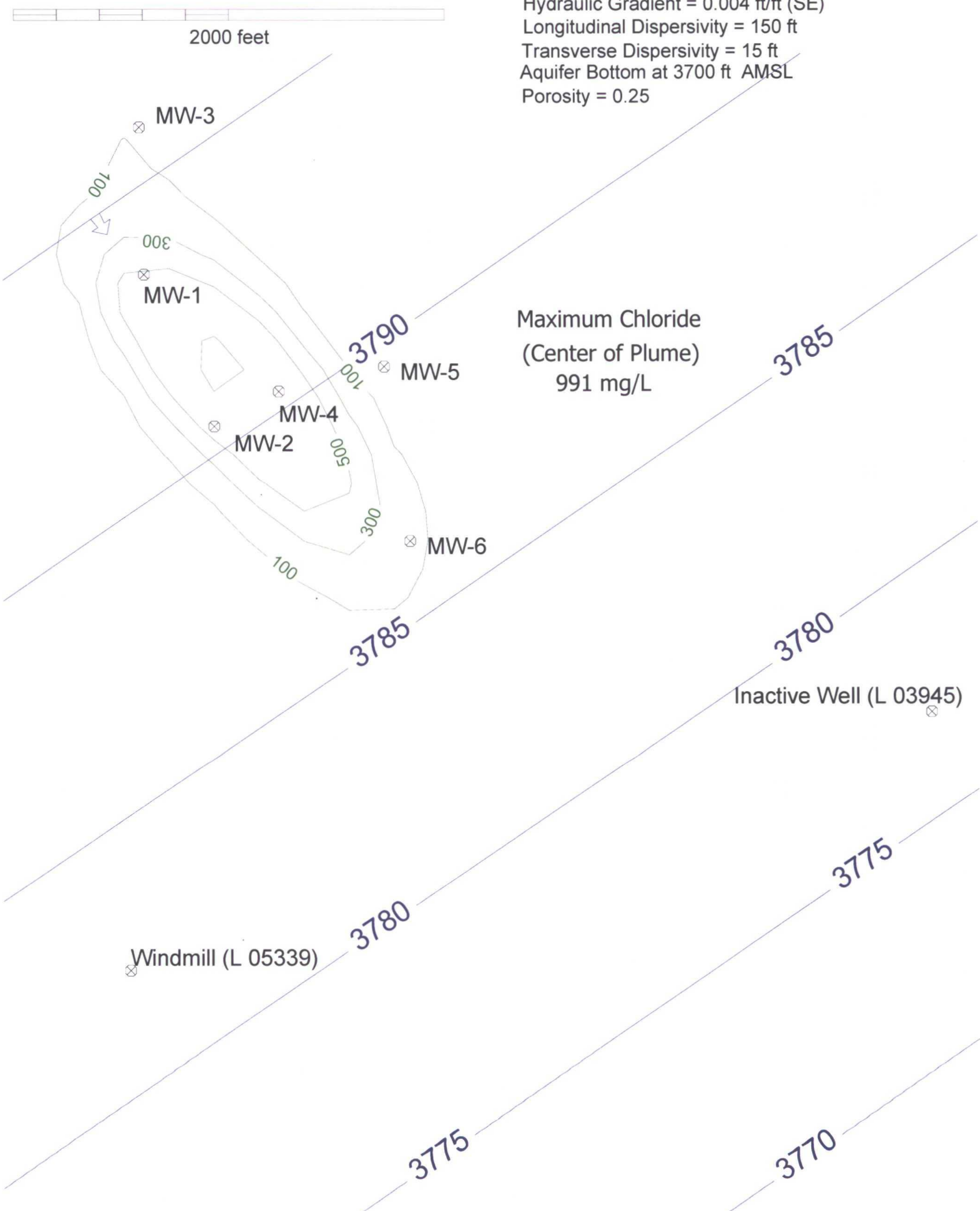
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2015)

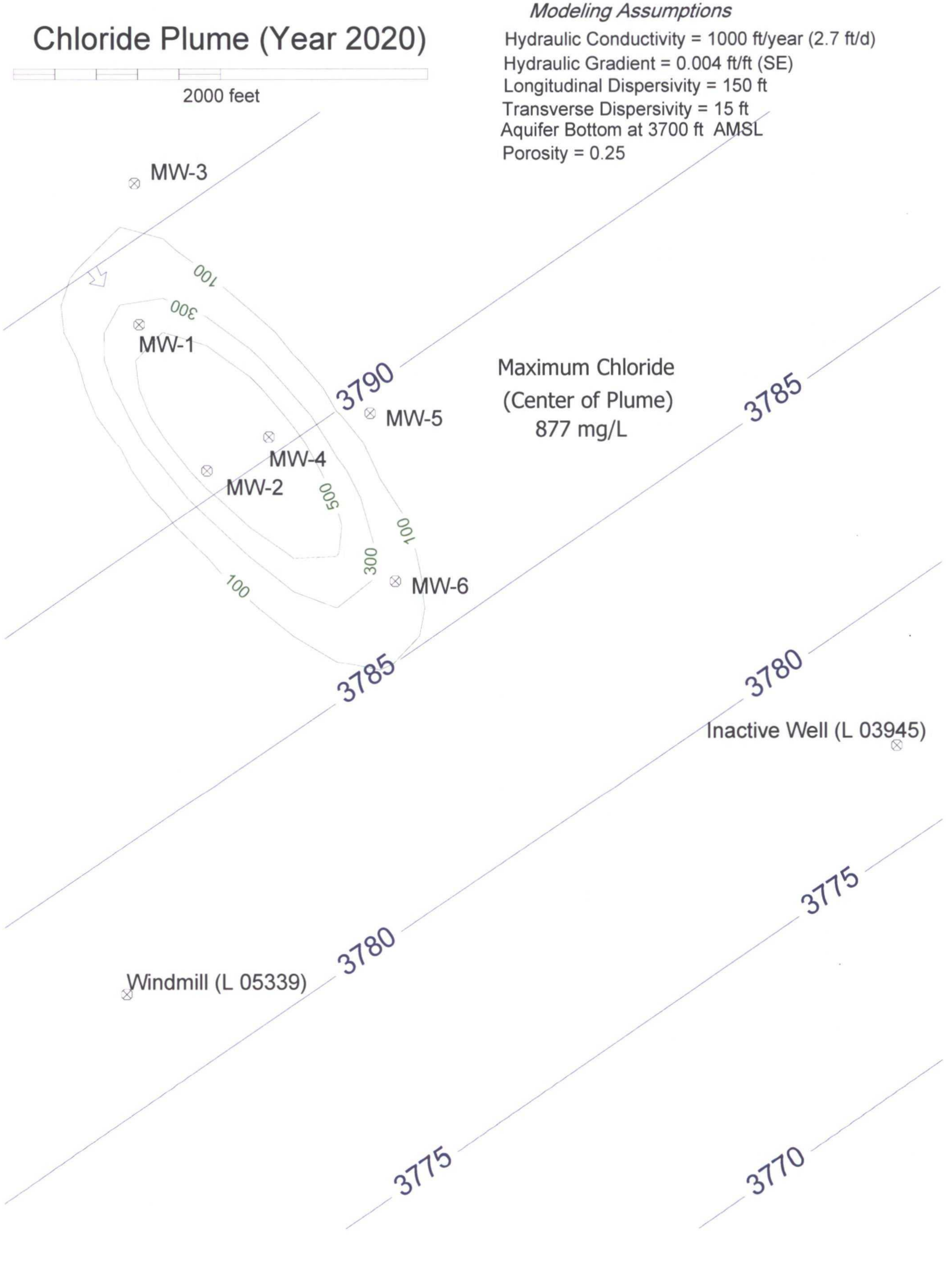
Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



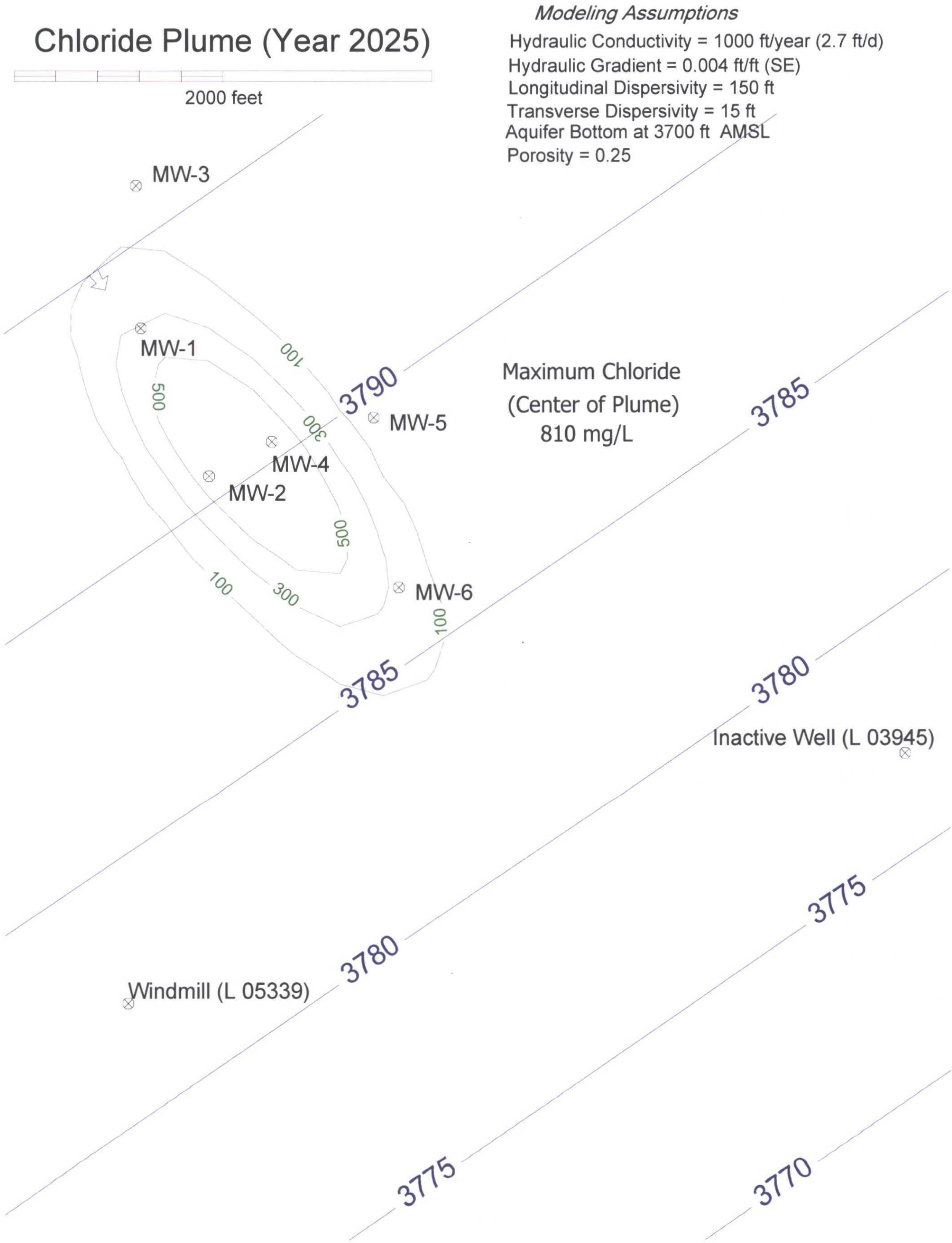
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site



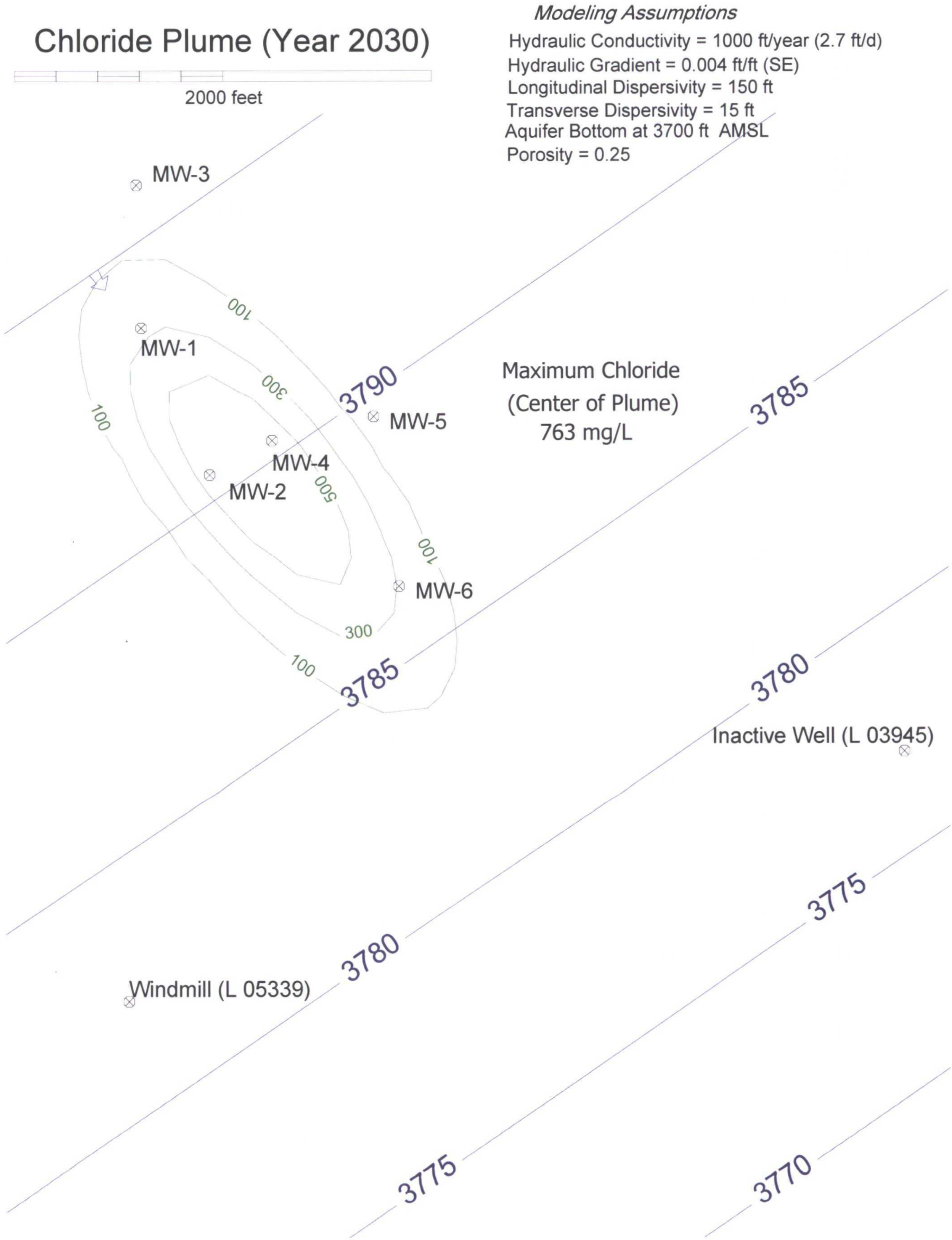
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site



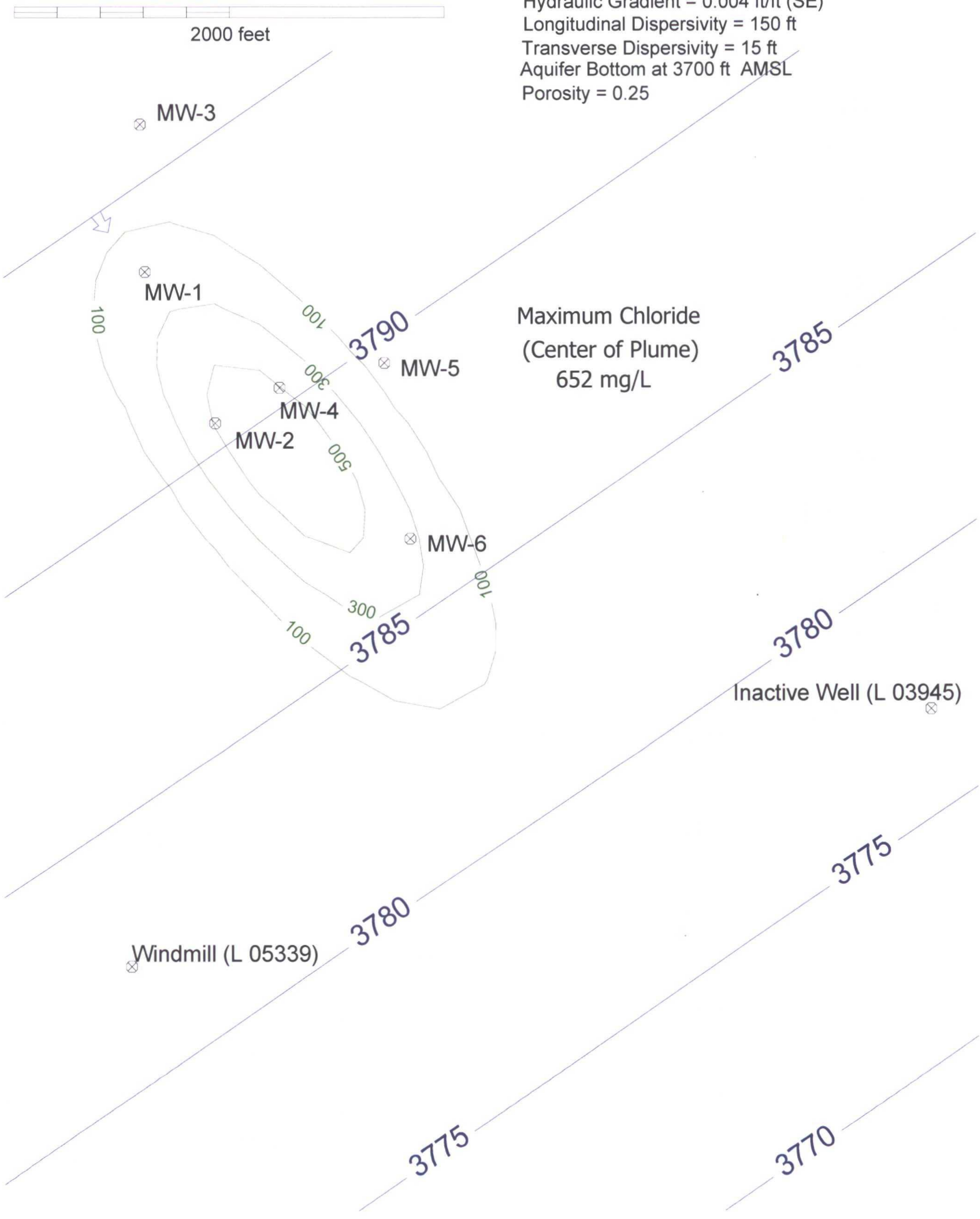
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2040)

Modeling Assumptions

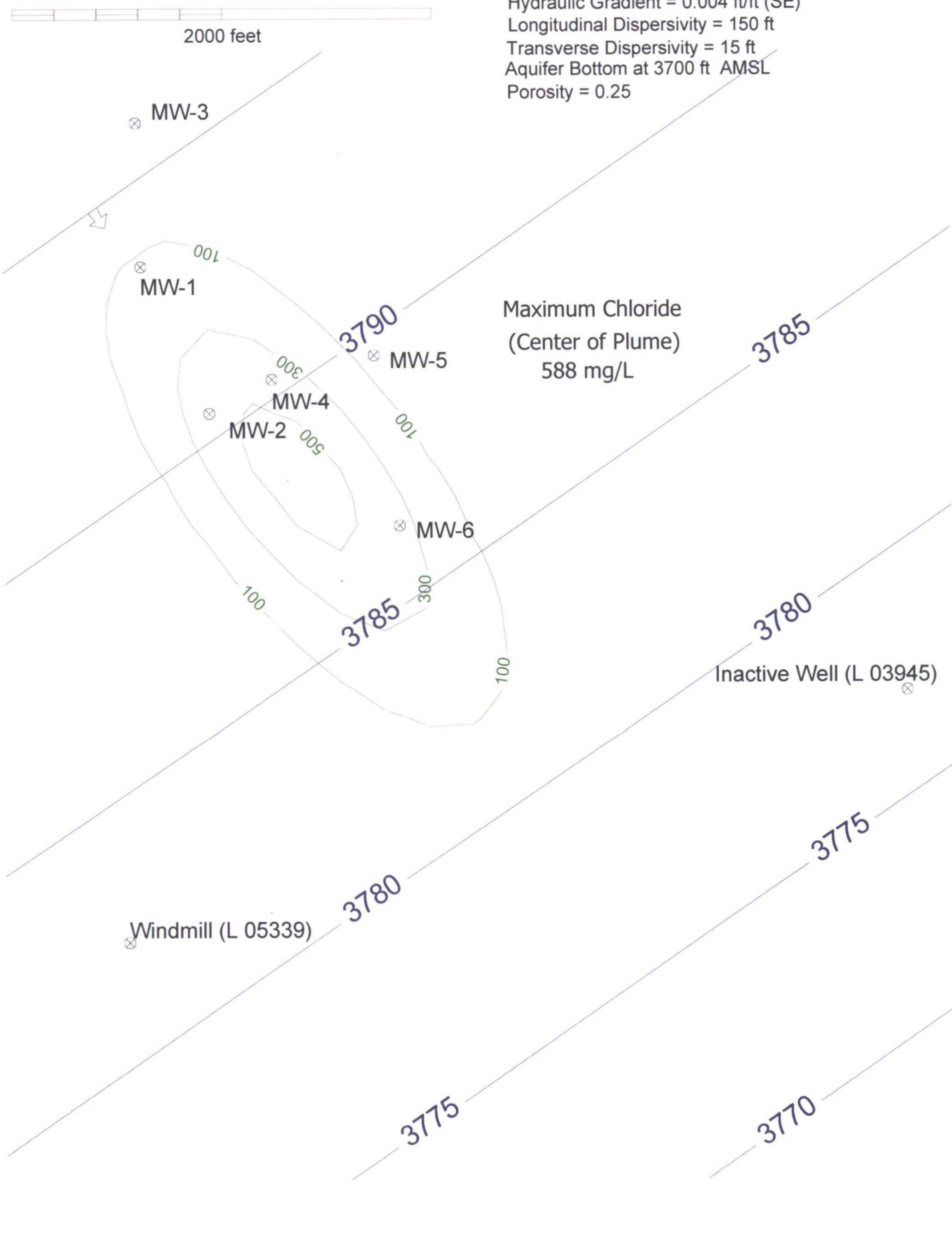
Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

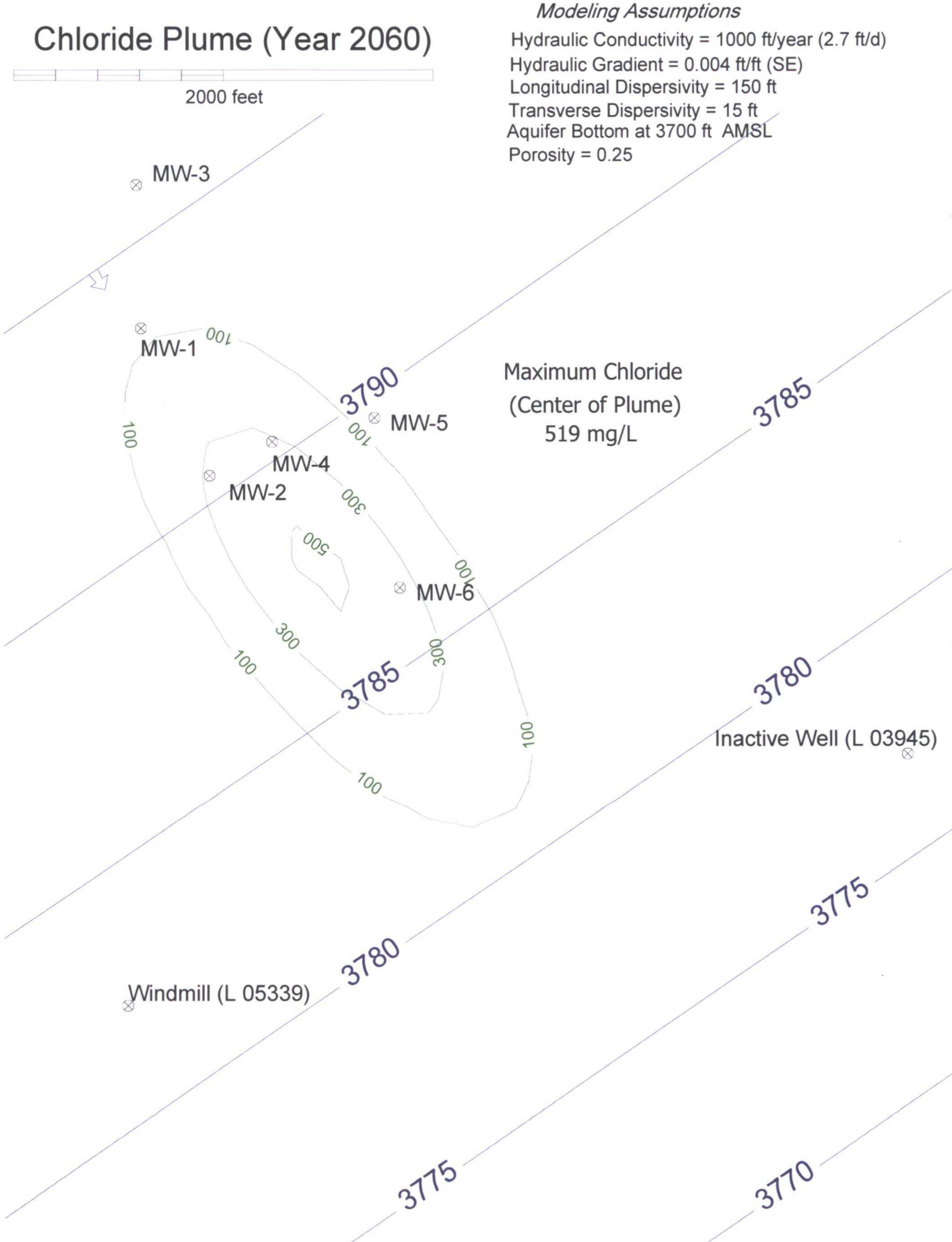
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2050)



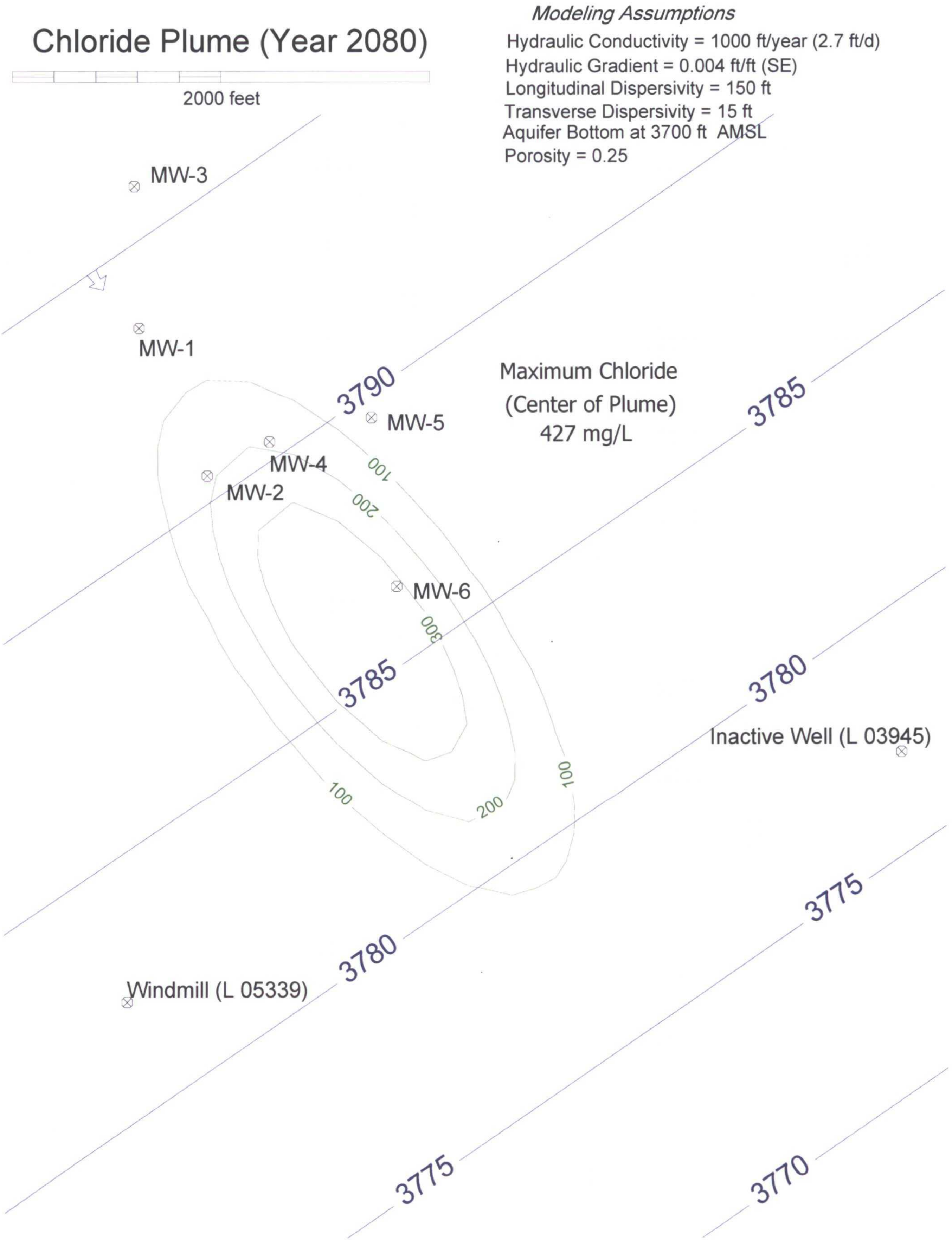
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site



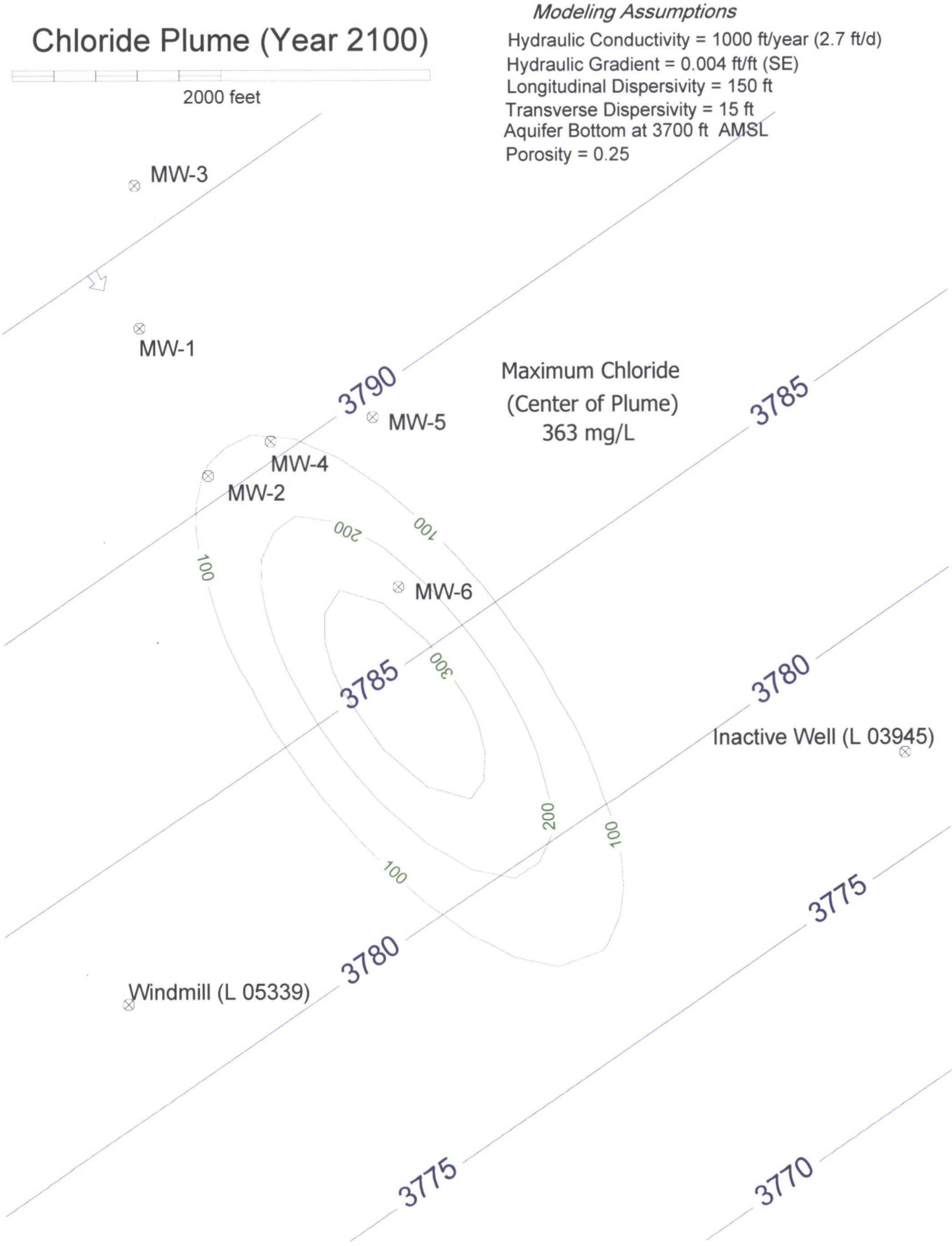
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

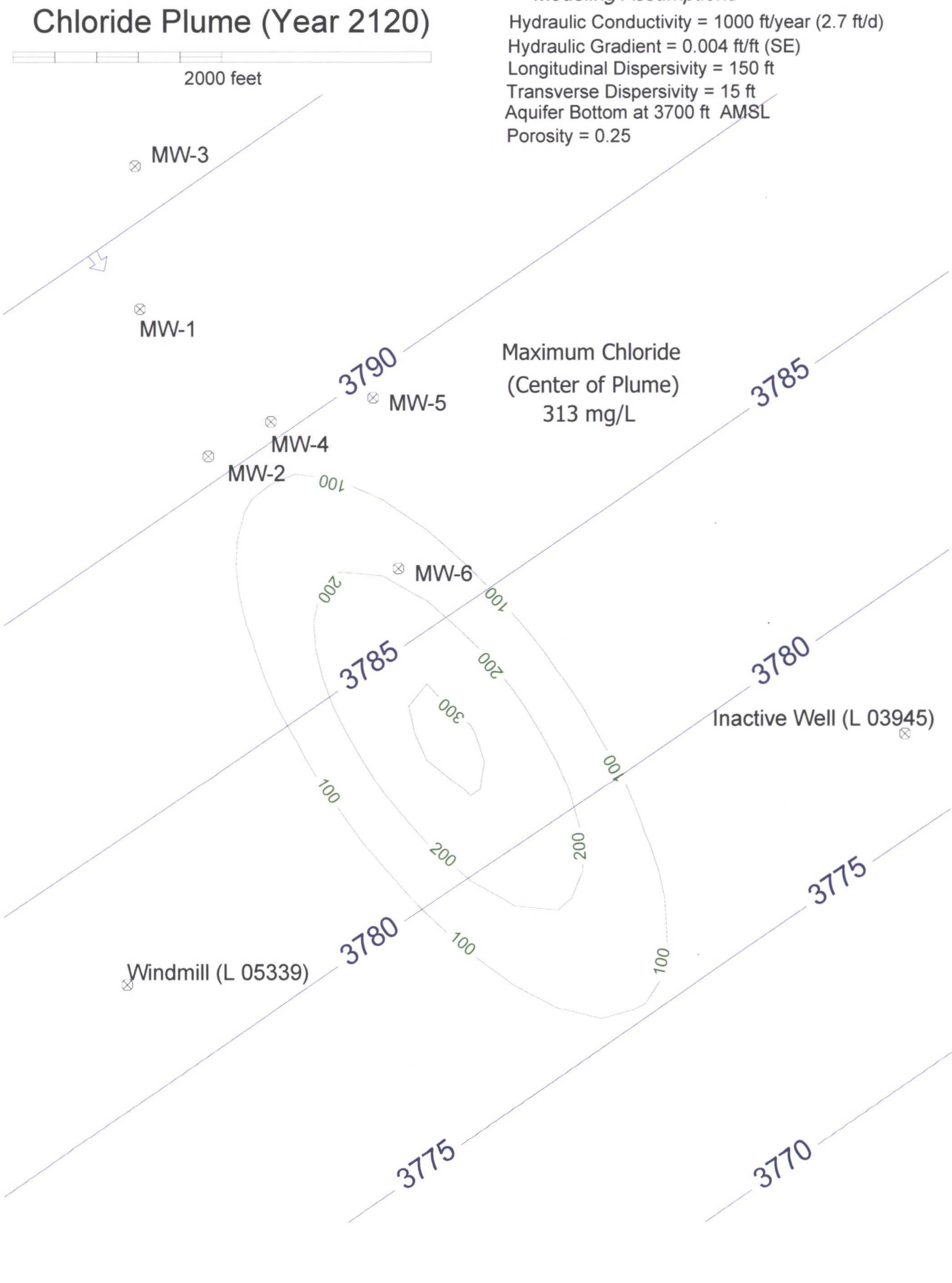


WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

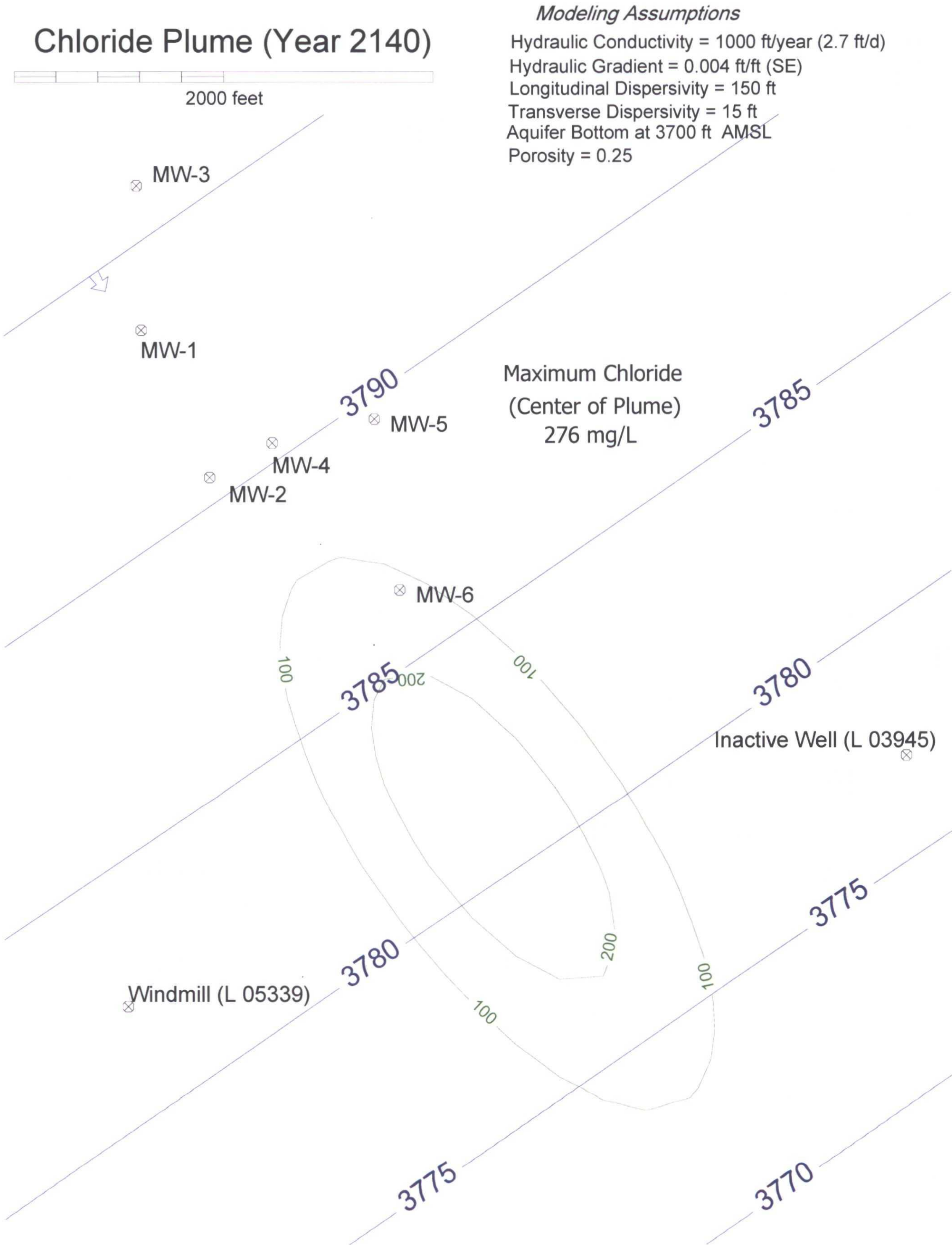
Modeling Assumptions

Hydraulic Conductivity = 1000 ft/year (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



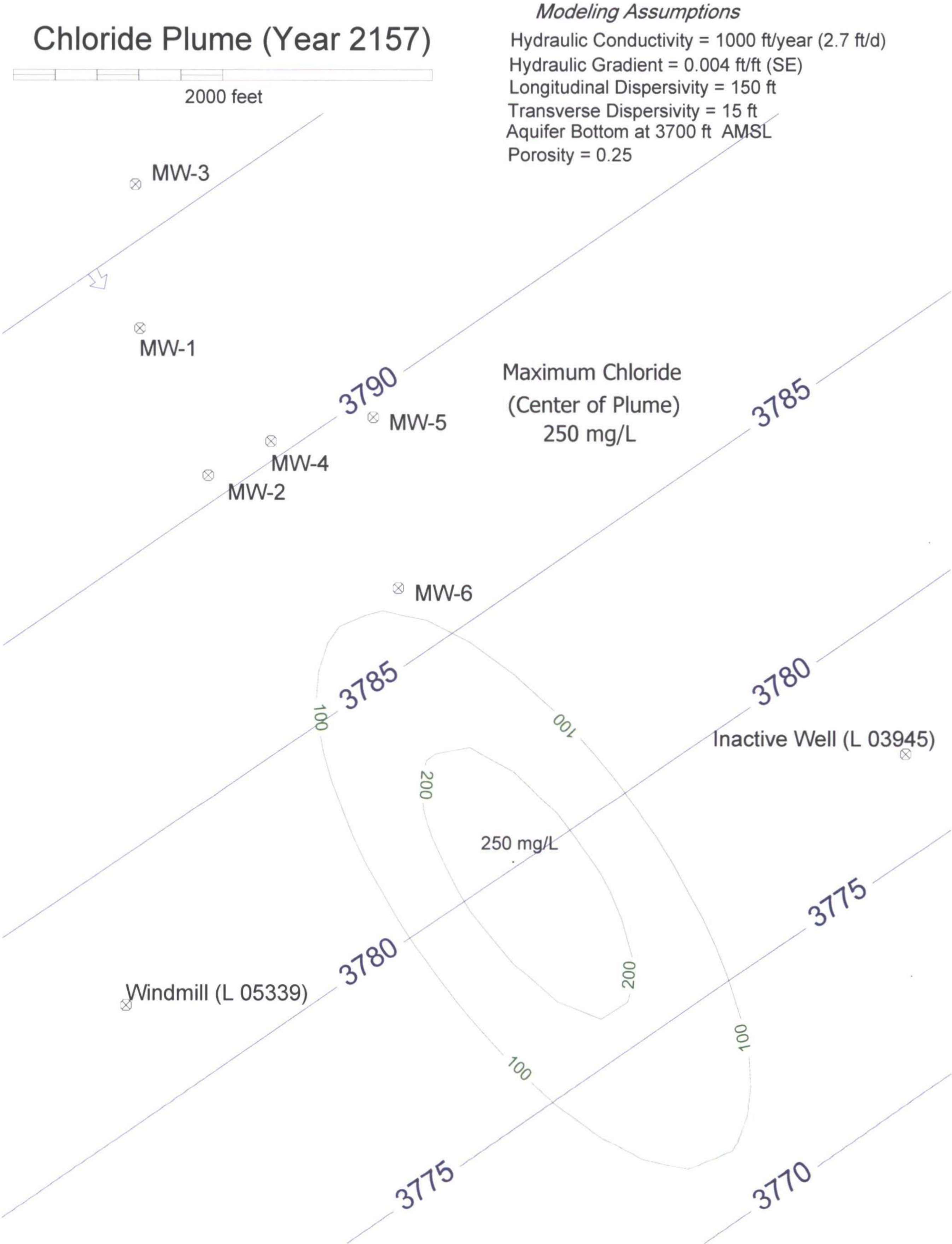
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

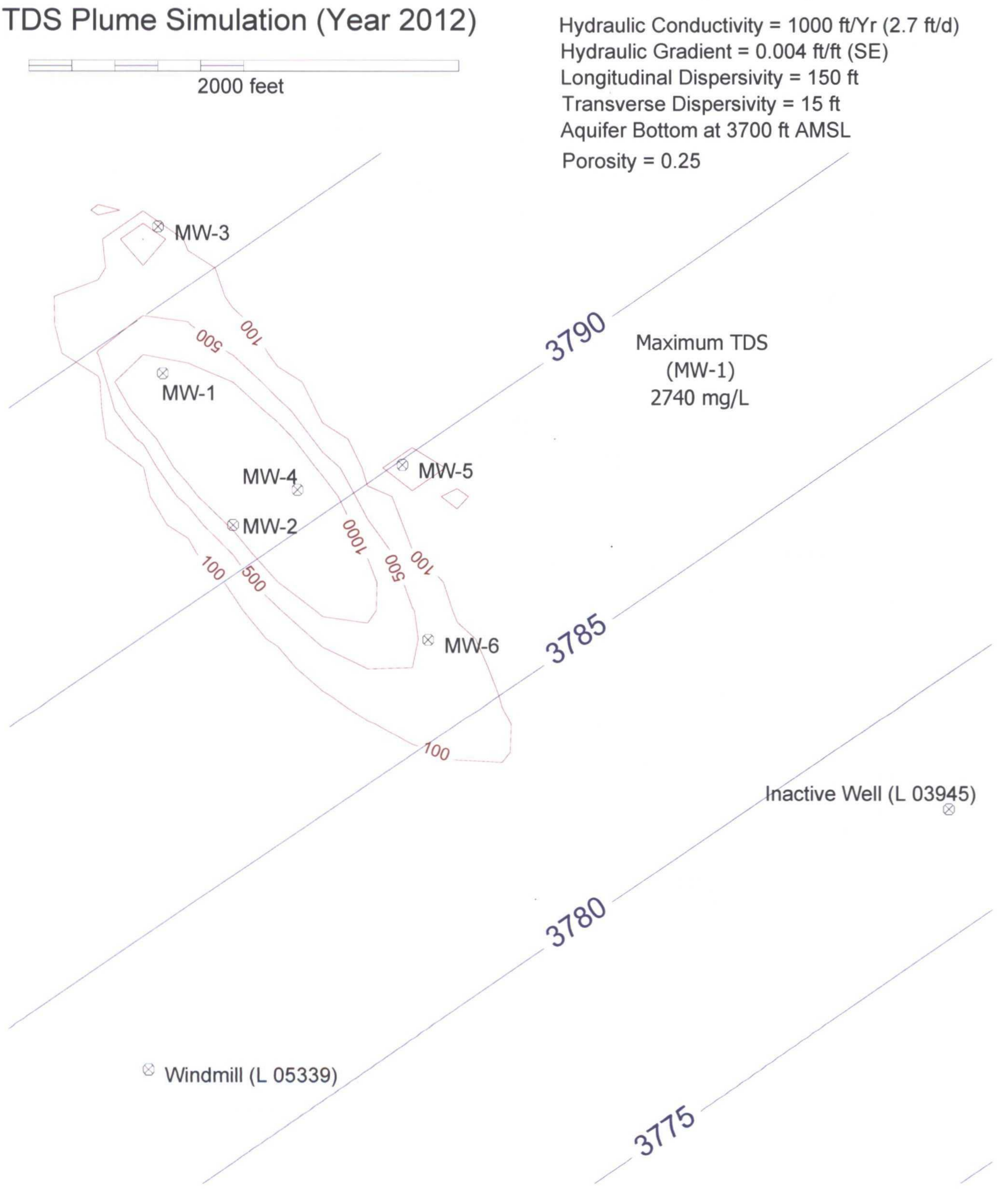


WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



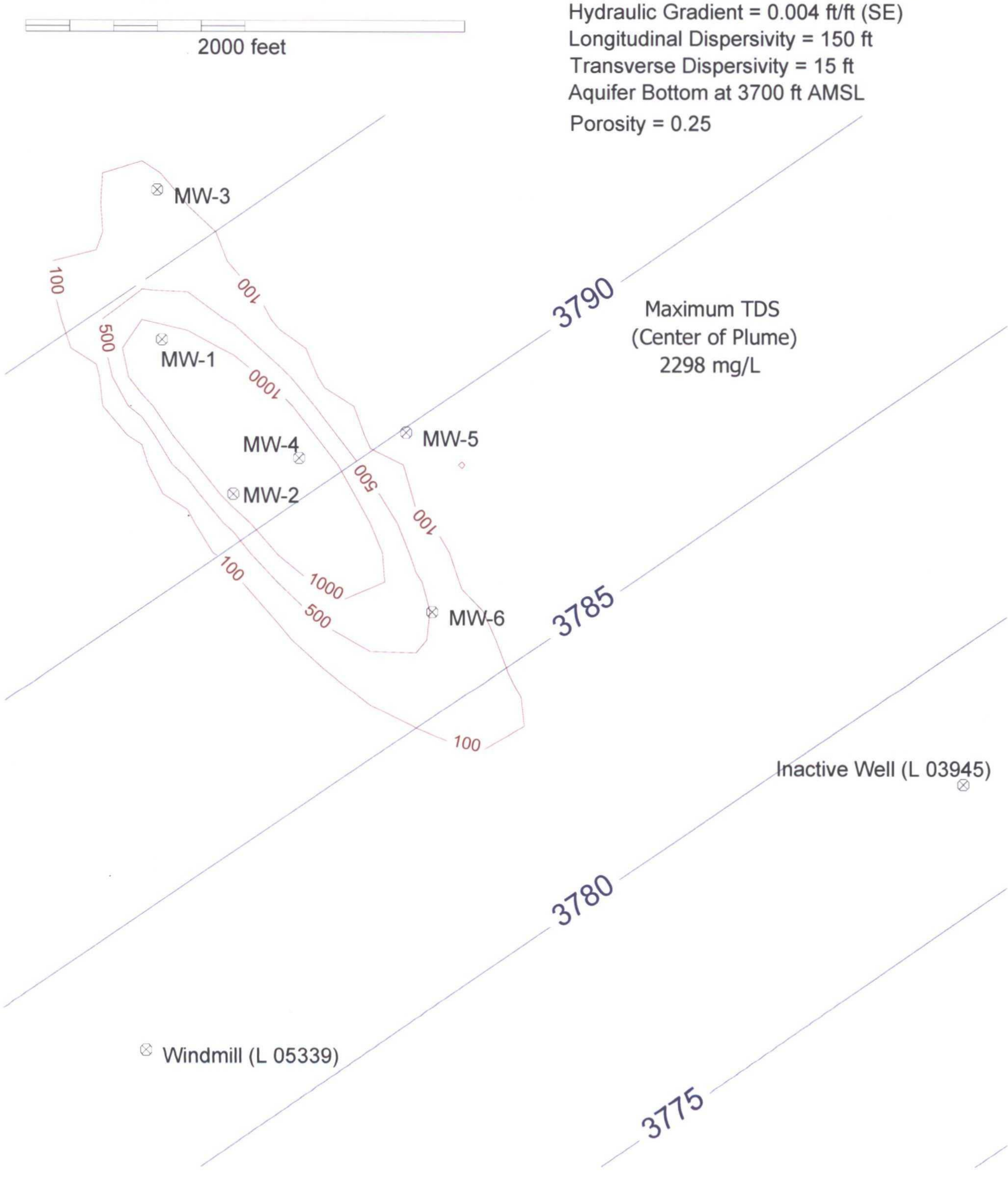
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2015)

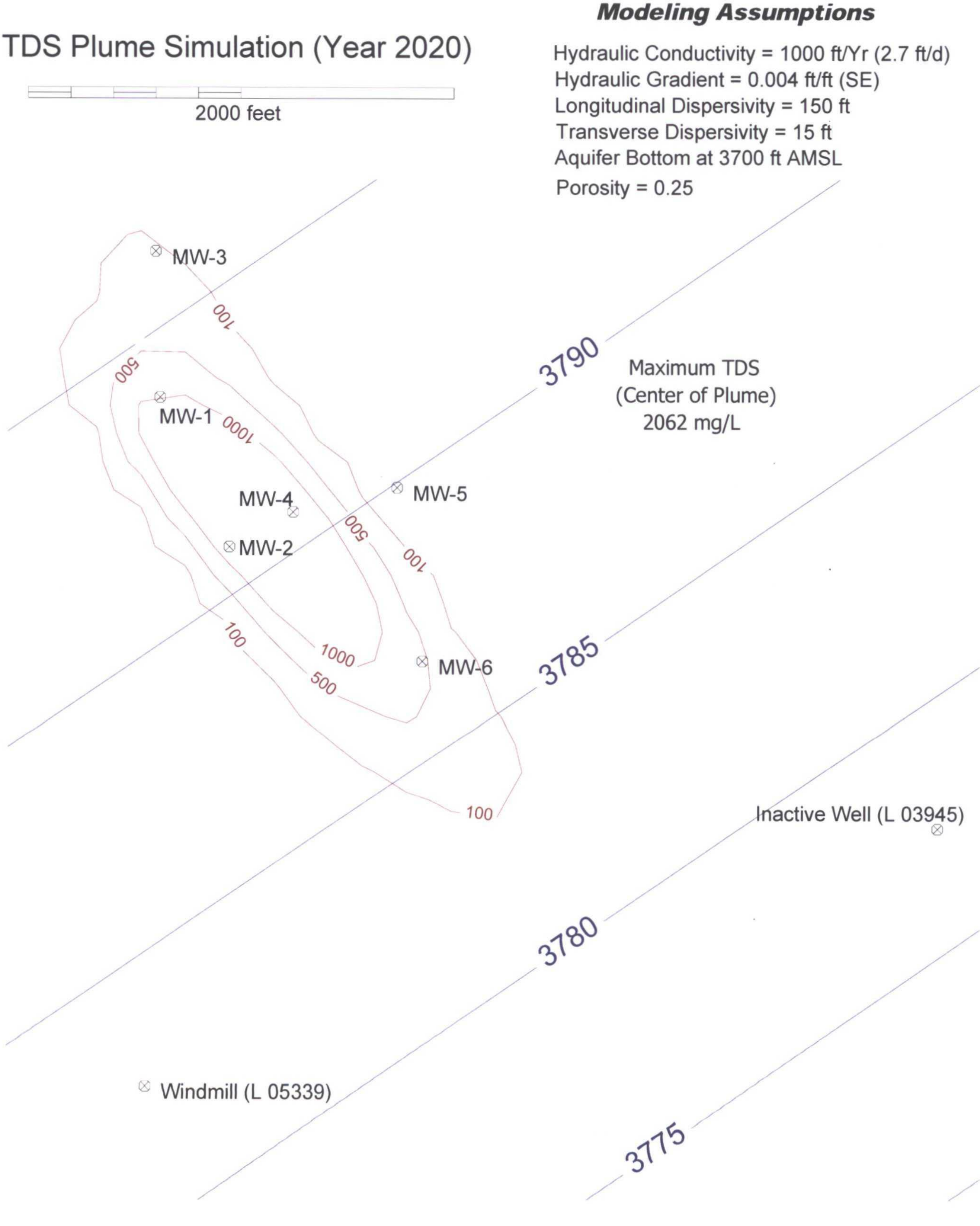
Modeling Assumptions

Hydraulic Conductivity = 1000 ft/Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



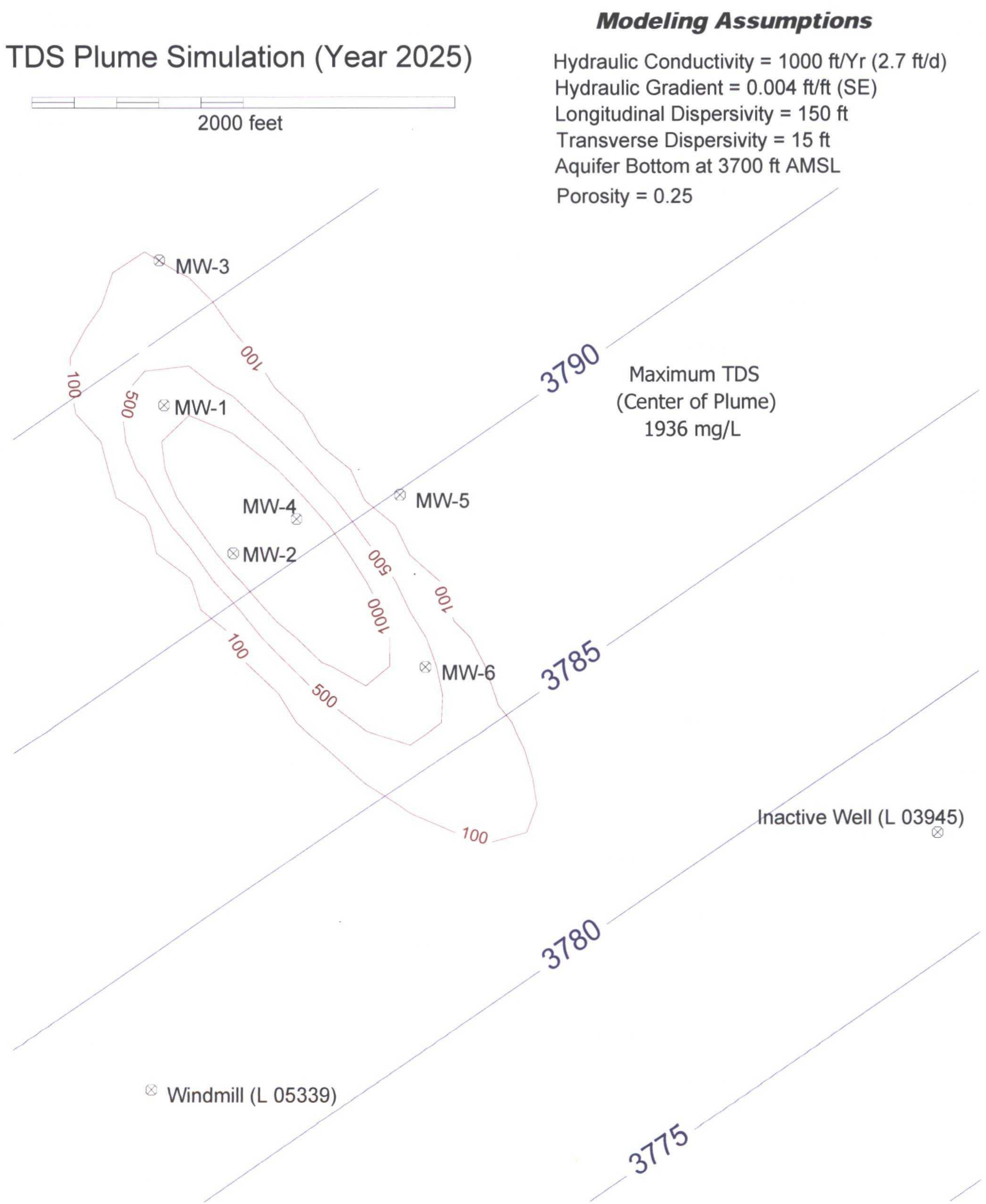
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit



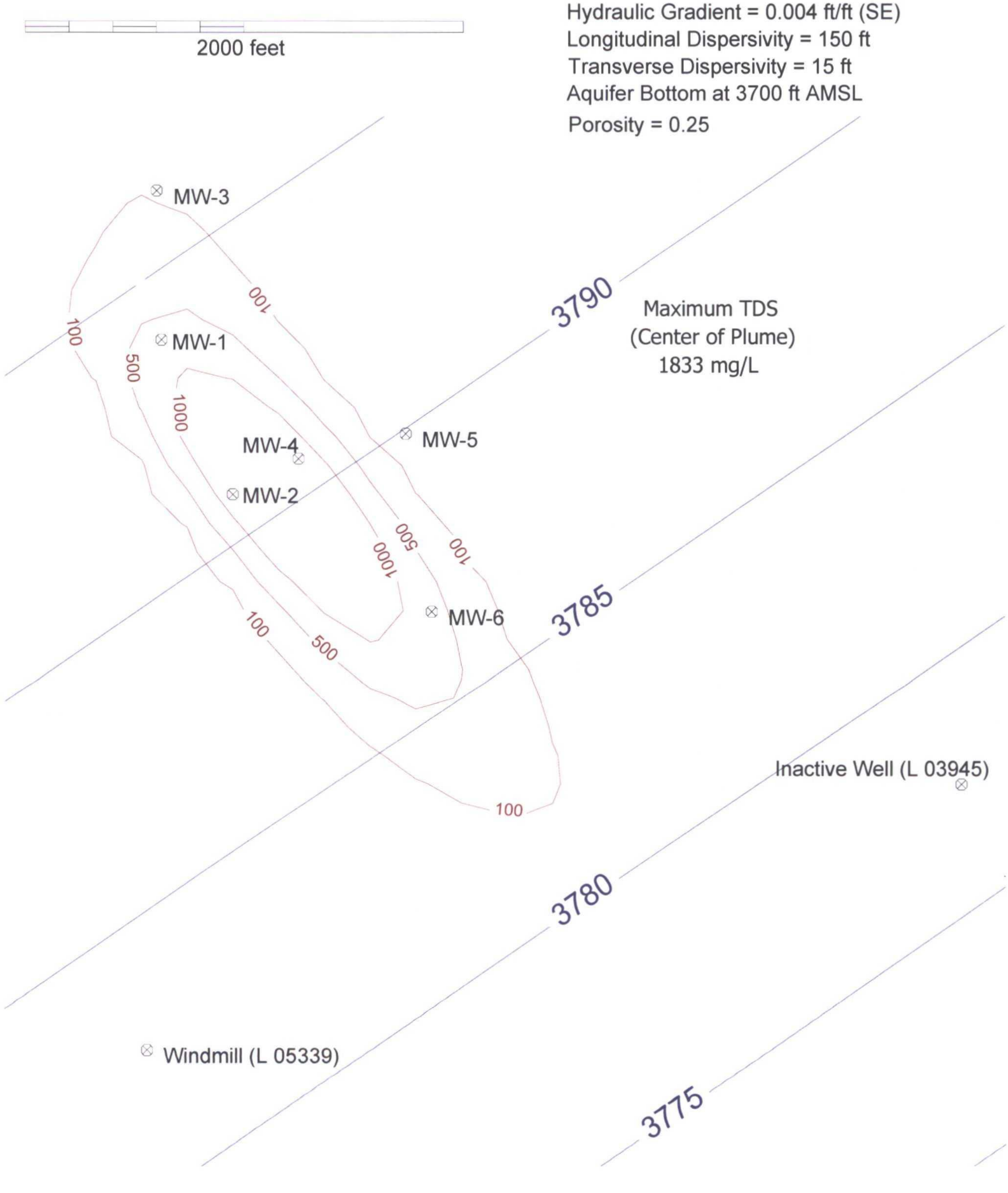
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

TDS Plume Simulation (Year 2030)



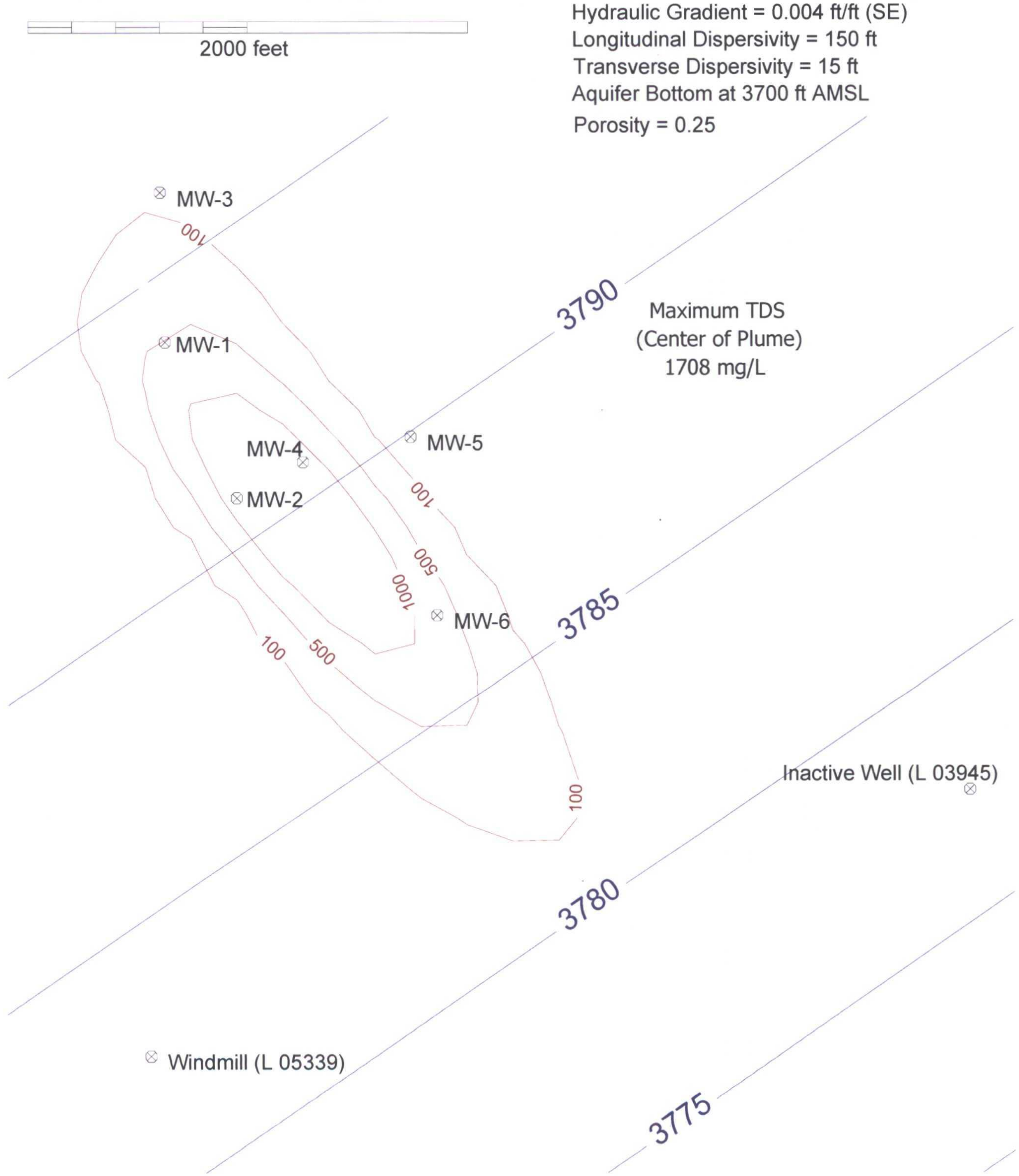
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2035)

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

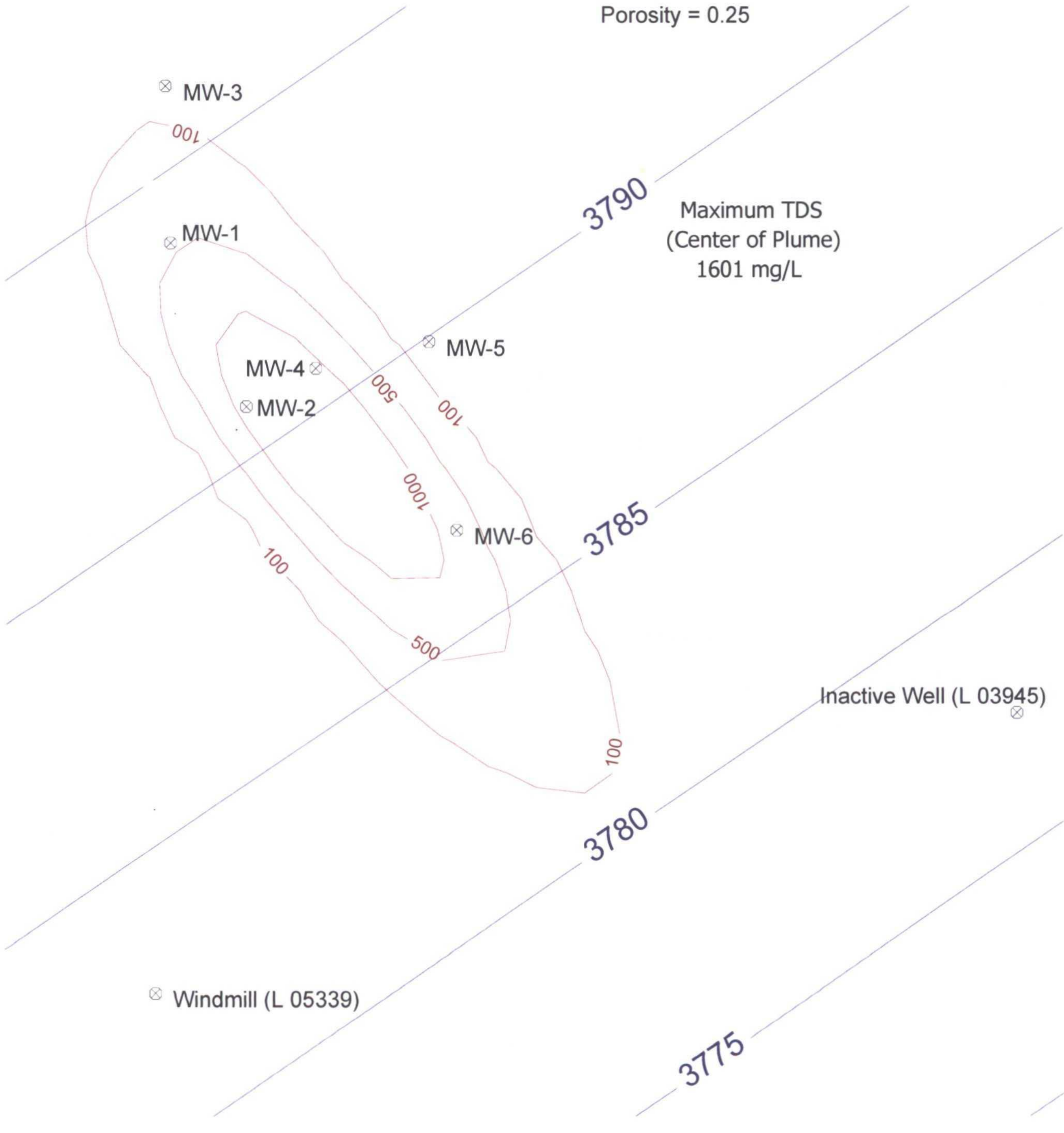
Former Unocal South Vacuum Unit

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

TDS Plume Simulation (Year 2040)

2000 feet



WinTran Fate & Transport Modeling Results

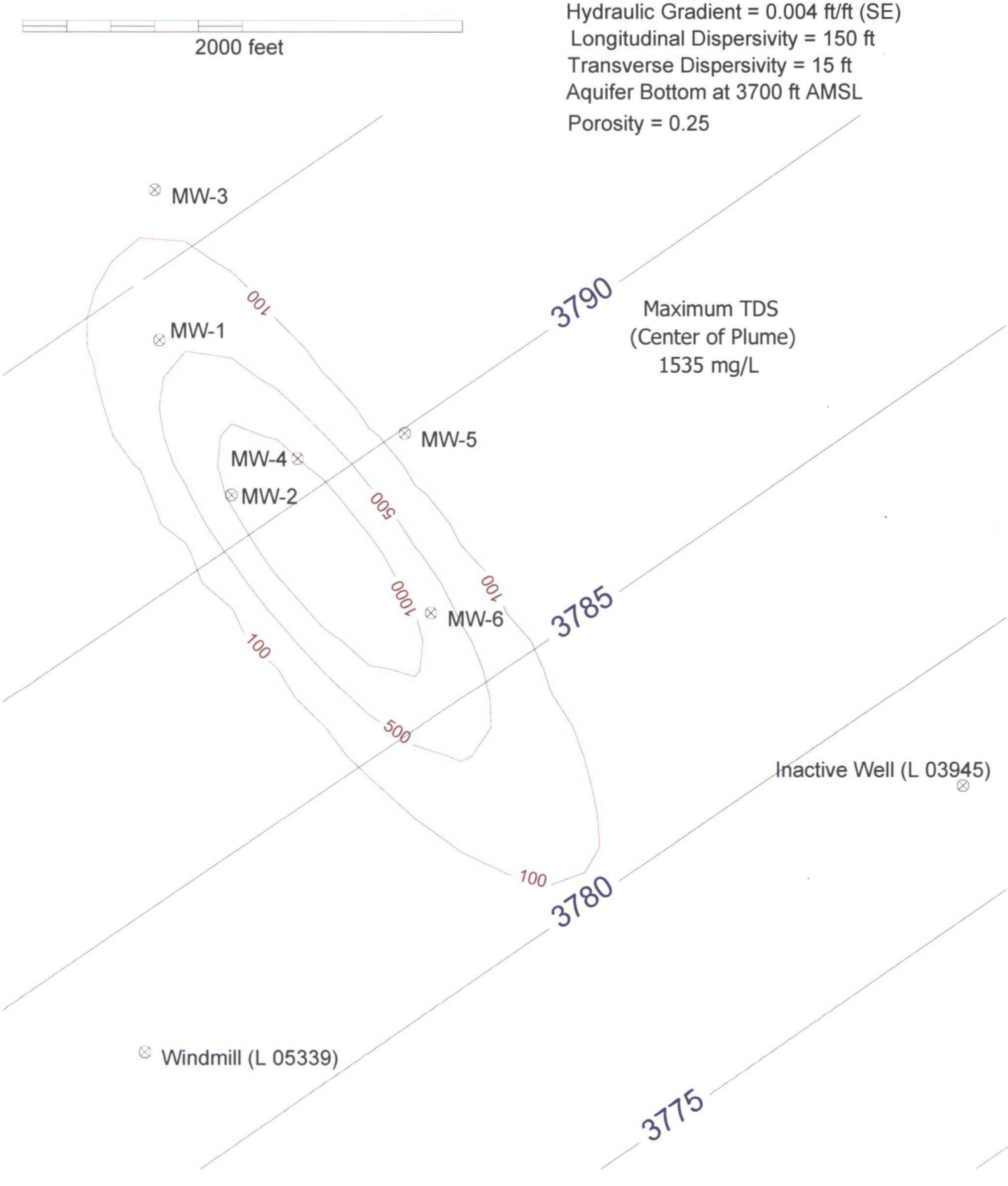
Former Unocal South Vacuum Unit

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25

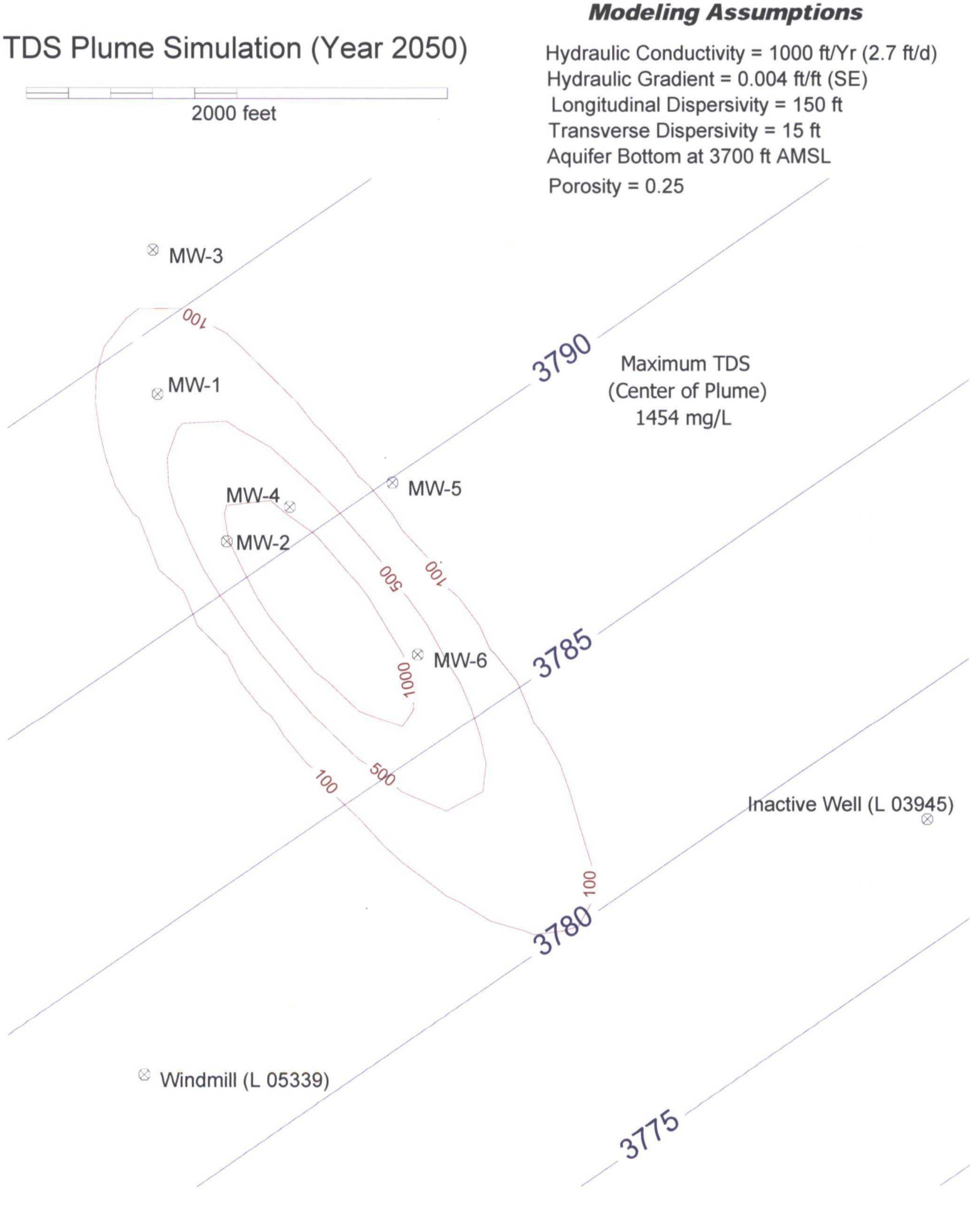
TDS Plume Simulation (Year 2045)

2000 feet



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit



WinTran Fate & Transport Modeling Results

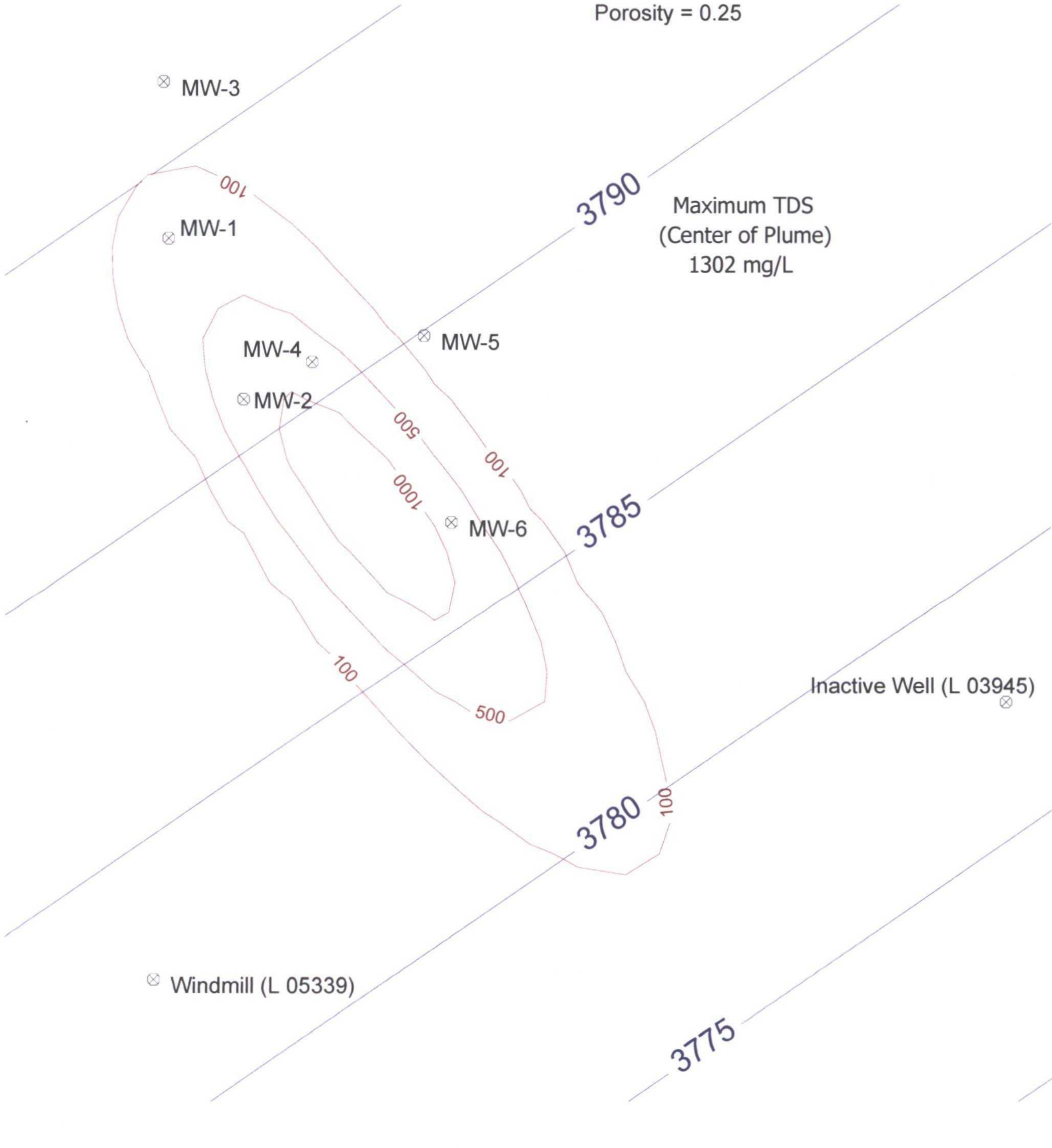
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2060)

2000 feet

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

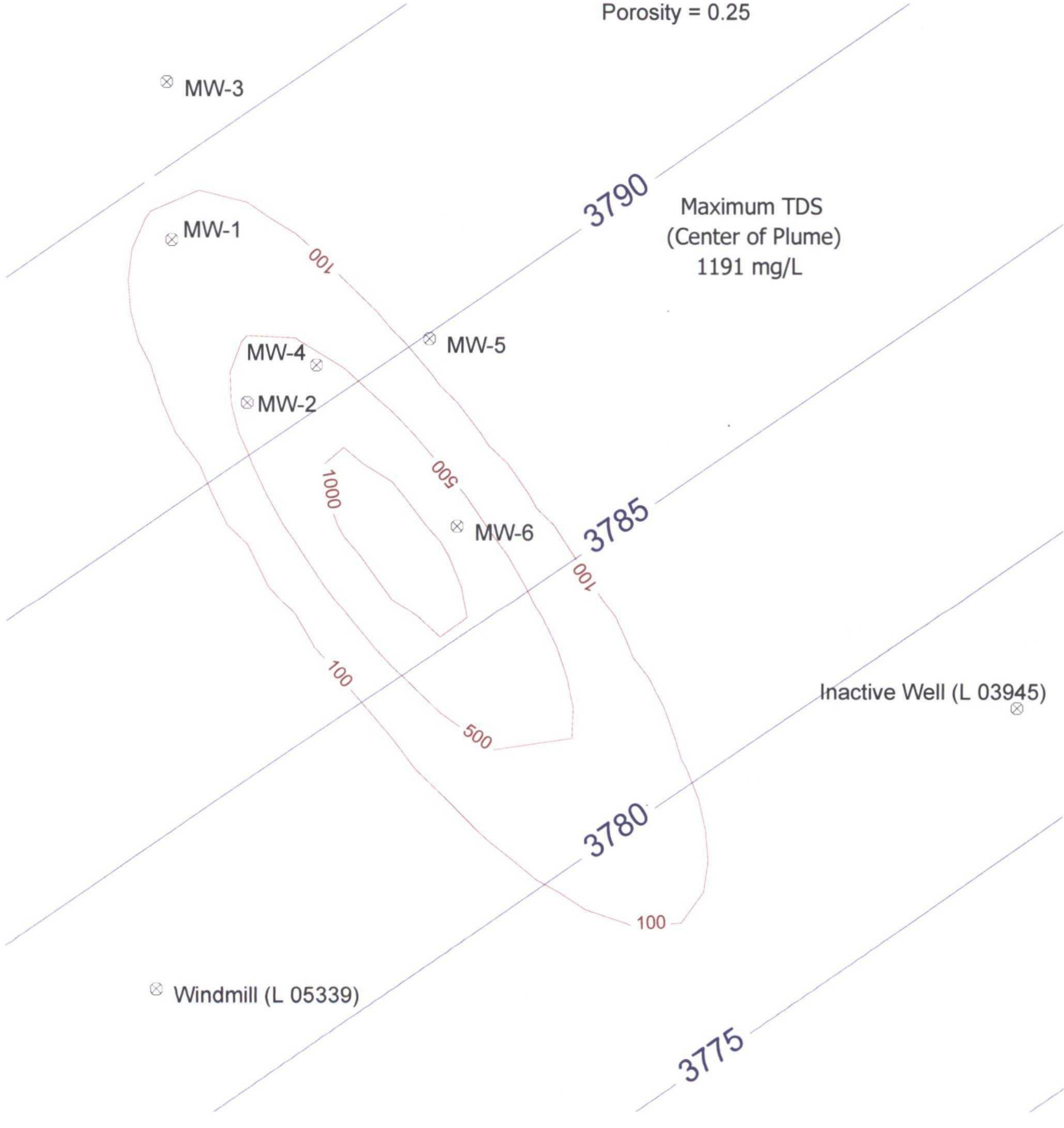
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2070)

2000 feet

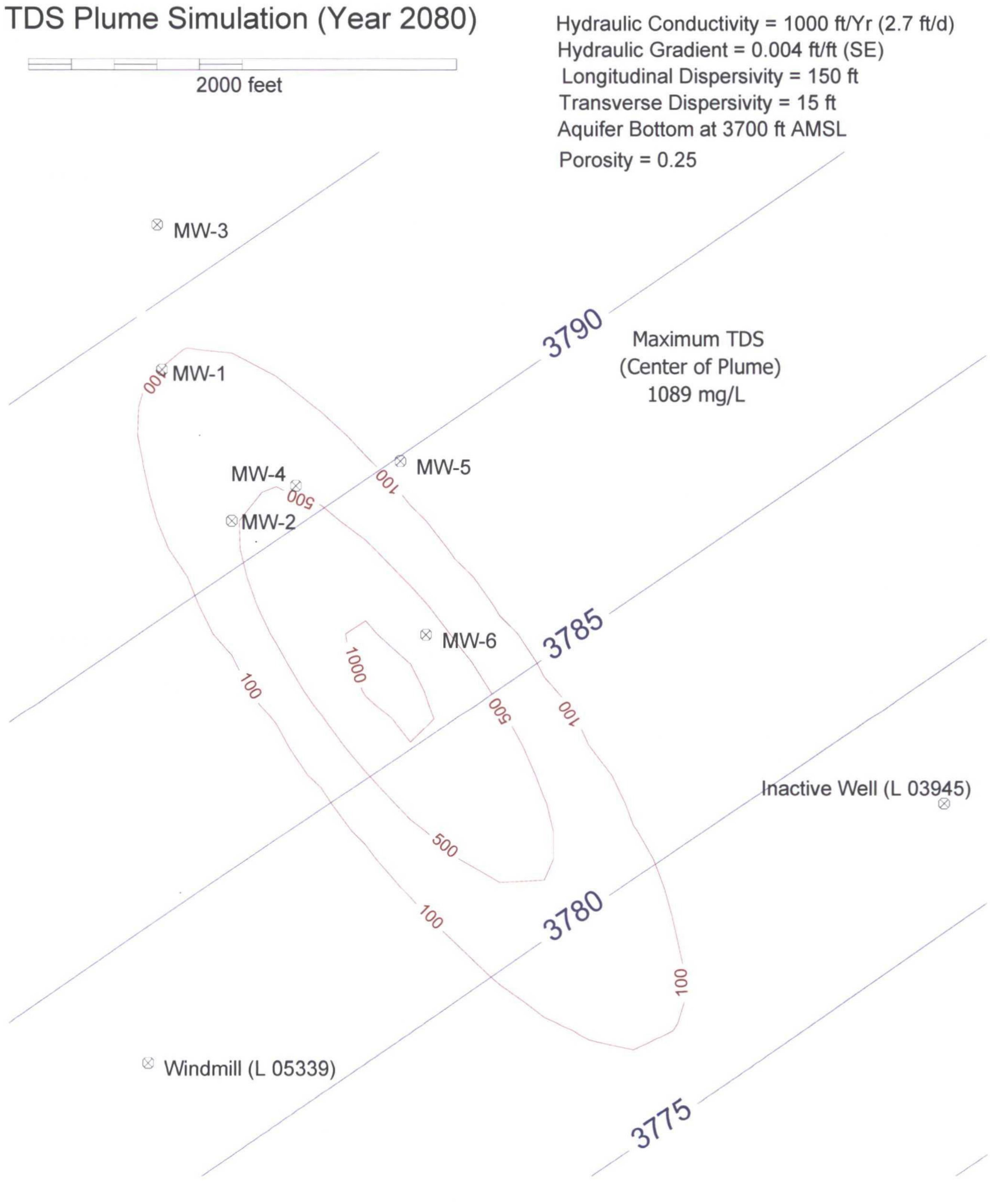
Modeling Assumptions

Hydraulic Conductivity = 1000 ft/Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit



WinTran Fate & Transport Modeling Results

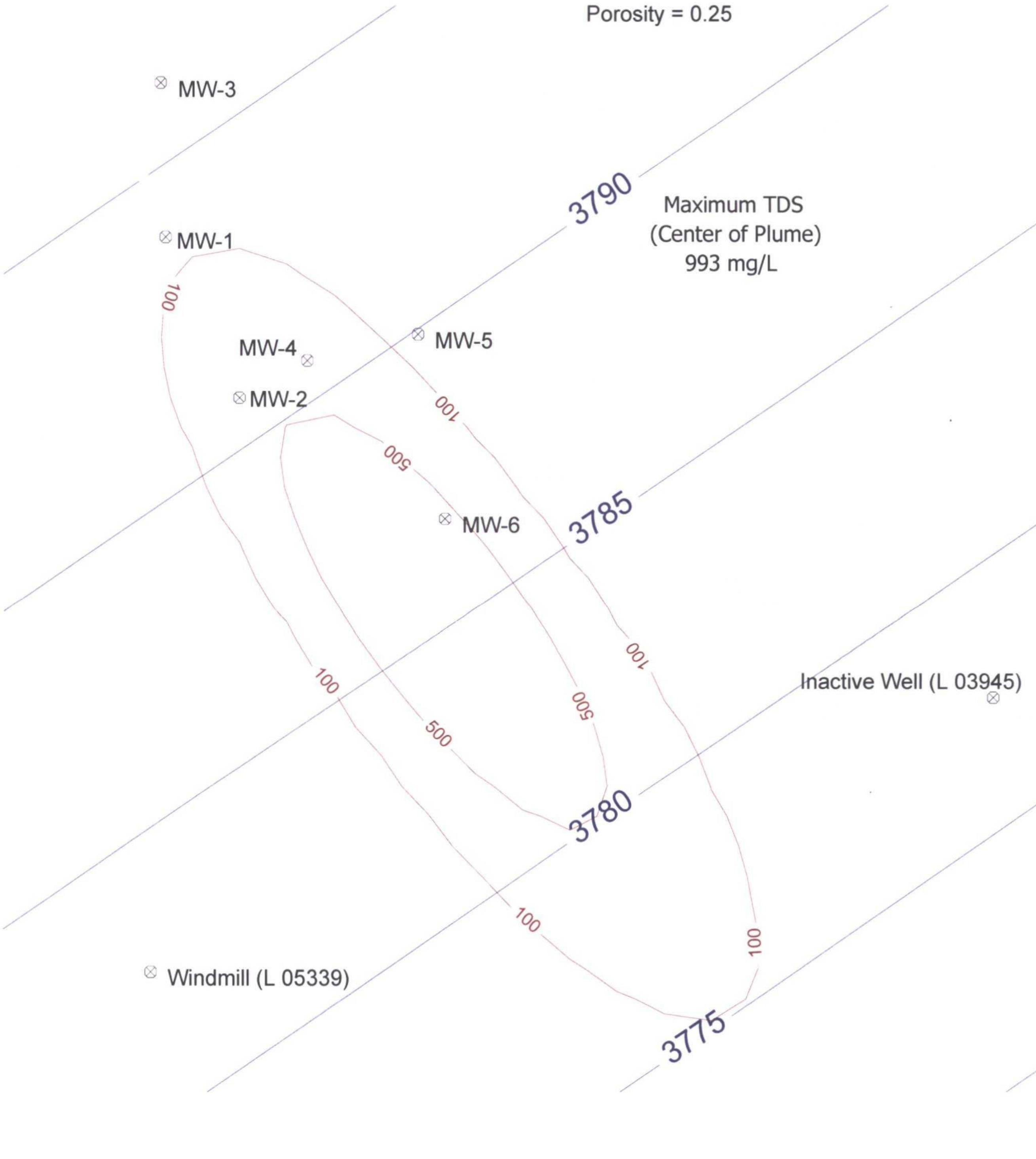
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2094)

2000 feet

Modeling Assumptions

Hydraulic Conductivity = 1000 ft/Yr (2.7 ft/d)
Hydraulic Gradient = 0.004 ft/ft (SE)
Longitudinal Dispersivity = 150 ft
Transverse Dispersivity = 15 ft
Aquifer Bottom at 3700 ft AMSL
Porosity = 0.25



APPENDIX D

Description of Fate and Transport Modeling
And
Input/Output Data

Description of Fate and Transport Modeling

Conceptual Model

Produced water containing high concentrations of chloride, and resultant high levels of total dissolved solids (TDS), was reportedly discharged into a surface pit for a period of about 10 years. A dry hole (State Lea "I" No. 1), adjacent to the former pit, was approved for injection of produced water in 1962, however it was not used for that purpose since it was determined to be impractical; therefore it was later plugged in 1971. A chloride and TDS plume in groundwater continued to migrate southeastwards for the next approximately 29 years after the source input was stopped by encapsulation of the pit in 2000, producing the configuration and constituent concentration distribution observed currently. Extrapolating from current conditions for decades into the future, taking account of both advective flow and attenuation by hydrodynamic dispersion, enables prediction of the probable distance that the residual plume will travel as well as the gradually declining concentrations in the plume.

Basic Site Data

Information about site conditions was obtained from data in a TRW Inc. "Report of Additional Groundwater Investigation, Former Unocal South Vacuum Unit, Lea County, New Mexico" (July 18, 2000). This included lithologic records from well installations, water level data, and water quality analytical results.

Simulation Model

Simulations were conducted with the two-dimensional groundwater flow and contaminant transport model WinTran, version 1.03 (1995) designed and distributed by Environmental Simulations, Inc. (ESI) of Herndon, Virginia. WinTran is built around a steady-state analytical element flow model, linked to a finite element contaminant transport model. The Windows interface allows for rapid data input, processing, parameter manipulation and optimization, and output in multiple formats. The fundamental mathematics of the model solutions, model verification (benchmarked against MODFLOW), and use of WinTran is documented in the "Guide to Using WinTran" published by ESI.

Base Map

A simplified site base map was created using the New Mexico State Plane Coordinates for each monitoring well which were determined by a registered surveyor after installation.

Flow Parameters

Input requirements for the steady-state groundwater flow simulation include: hydraulic gradient and direction of flow, hydraulic conductivity, aquifer top and bottom elevations, and reference head. The values used were based on the following sources:

- Hydraulic gradient – measured gradient of 0.004 feet/foot from based on all site measurements reported by Trident.

- Direction of flow – measured direction of approximately 40° east of due south from 1961until 2009, and 34° east of due south from 2010 to 2012 based on site measurements reported by Trident.

- Hydraulic conductivity – no site measurements were available; therefore, a literature value based on the saturated zone lithology was selected. Typical lithology is described as silty sand and very fine sand. Fetter (1988, Table 4.5, p. 80) cites an average range of 10^{-5} to 10^{-3} cm/sec for hydraulic conductivity of silty sands and fine sands. A conservative upper limit was selected, and converted from S.I. unit to 1000 ft/yr, or approximately 2.7 ft/day.

- Aquifer top and bottom elevations – bottom elevation of Ogallala Formation at 3700 feet according to Nicholson & Clebsch (Groundwater Report 6, 1961). The top elevation for an unconfined aquifer must be greater than the reference head so an elevation of 4,000 feet was assumed.

- Reference head – measured unconfined head of 3,793 feet adjacent to the former pit and upgradient well MW-1 from August 2, 2012 measurements reported by Trident.

Transport Parameters

Input requirements for the contaminant transport numerical simulation include: longitudinal and transverse dispersivity, porosity, diffusion coefficient, contaminant half-life, and retardation coefficient. The values used were based on the following sources:

- Longitudinal and transverse dispersivity – no site measurements were available; therefore, a literature value based on the plume length was selected. Fetter (1993, Section 2.11, pp. 71-77) notes the apparent scale-dependency of longitudinal dispersivity, which typically may be about 0.1 times the flow length. For the current site scale and plume length of approximately 1,500 feet, a value of 150 feet was selected for longitudinal dispersivity. Based on professional judgment, hydrologists commonly assume the longitudinal dispersivity is about one-tenth the length of the plume and 5 to 10 times higher than transverse dispersivity; therefore, a value of 30 feet (i.e., one-fifth of the longitudinal value) was selected for transverse dispersivity.

- Porosity – no site measurements were available; therefore a literature value based on saturated zone lithology was selected. Typical lithology is described as silty sand and very fine sand. A range of 0.25 to 0.50 is typically given for unconsolidated "sand" (e.g., Freeze & Cherry, 1979, Table 2.4, p. 37); however, the Ogallala Formation is predominantly very fine grained, compacted and partly cemented, and may also fit within the range of 0.05 to 0.30 for sandstone. Fetter (1988, Table 4.3 and Figure 4.10, pp. 74-75) cites an average value of 0.20 for the specific yield of very fine sands. Specific retention of silty fine sand is approximately 0.05, for a total porosity of 0.25, which is the value selected for the transport modeling. WinTran uses the porosity term to estimate groundwater velocity, and actually requires an effective porosity value. Fetter (1988, Section 4.4, pp. 84-85) notes that pores of most sediments down to clay size are interconnected and that the effective porosity is virtually equal to the total porosity.

- Diffusion coefficient – this parameter is normally only relevant for very slow fluid movement, and is commonly assumed to be zero for advective-dominated transport, as in the present case.

- Contaminant half-life – this parameter accounts for chemical decay (e.g., radioisotopes, biological transformation of organic molecules); however, the species of interest in the present case are inorganic ions and are not expected to decay to any appreciable extent. A conservative value of 1000 years was used, which produces a negligible decay coefficient of less than 0.001 yr^{-1}.

- Retardation coefficient – this parameter accounts for sorption processes that slow the movement of contaminants relative to the groundwater velocity. Inorganic ions such as chloride are commonly taken as conservative tracers in groundwater and are not considered to be retarded; therefore, a value of 1.0 was selected for the retardation coefficient.

Flow Model Calibration

The vicinity of the site where water level measurements were recorded in August 2, 2012 is simulated closely by the flow model. It is known that groundwater levels in the Ogallala Formation are decreasing slowly (approximately 0.3 ft/yr), but this effect cannot be reproduced in the steady-state flow model. Water levels were probably somewhat higher than the present day during the period of brine disposal and initial transport. Even if the declining trend continues into the future, it does not affect the transport model solution for long extrapolation times, since sufficient saturated thickness remains (i.e., above the assumed aquifer base elevation of 3,700 feet) for a valid flow and transport solution.

The average groundwater velocity may be estimated using the Darcy expression: $v = (k \cdot i) / n$ where k is the hydraulic conductivity (1,000 ft/yr), i is the hydraulic gradient (0.004 ft/foot), and n is the effective porosity (0.25). The resultant average velocity is 16 ft/yr.

Transport Model Calibration

The objective of the transport modeling was to first obtain a plume configuration with concentration values that closely match current observed values. This was done by simulating an initial contaminant release to groundwater for a period of 11 years (c. 1960 to 1971) with a constant source concentration located at the pit and injection well, then simulating a 28-year transport period (c. 1971 to 1999) with no further contaminant input but restarting the model from the end of Year 11 by retaining the mass of contaminant from the initial plume. An iterative approach was needed to optimize the initial source concentration so that the plume at Year 39 resembled the actual plume conditions in 1999. An initial value of 14,000 mg/L for chloride and 30,000 mg/L for TDS were found to produce the best match. The initial chloride value was also chosen because it is typical of chloride concentrations within the producing formation (Devonian) in the South Vacuum Oil Field according to chemists at Martin Water Laboratories (verbal communication, 12-05-01). Actual disposal concentrations during the 1960s are unknown, and may have been higher than these values, but it is presumed that some attenuation and dilution may have occurred in the vadose zone, which is currently 48 to 68 feet thick. WinTran cannot account for the much more complex vadose zone transport algorithms, so the source input was treated as an injection well with instantaneous transfer of contaminant mass to groundwater.

After calibrating the model such that it corresponded to actual 1999 conditions, the model was again run for 13 years (1999 to 2012) at one-year increments while matching the known concentrations at each monitoring well.

Simulation of Fate and Transport

Estimation of chloride and TDS fate and transport was achieved by restarting the transport model in 2012. Figures displaying modeled simulations of the chloride and TDS plumes over various time increments are included in Appendix C. Advective flow moves the center of plume mass downgradient as depicted in the simulations. The simulations also demonstrate how hydrodynamic dispersion serves to broaden the dimensions of the plume while reducing the concentrations in the middle of the plume.

Running the model for 145 years in the future (Year 2157) produces a chloride plume center concentration of 250 mg/L (WQCC standard). The center of the chloride plume is approximately 3,200 ft away from the former pit and well source at that time.

Running the model for 82 years in the future (Year 2094) produces a TDS plume center concentration of 1,000 mg/L (WQCC standard). The center of the TDS plume is approximately 2,200 ft away from the pit and well source at that time.

These results support the conclusion that the chloride and TDS plume is not likely to impact any existing sources of water supply, the closest of which is a windmill (NM File No. L05339) located over one-half mile south of the source. The windmill has been dismantled and is no longer in operation due to declining water levels in the area.

The trend of decreasing concentration is not linear (exponential e^{-kt} function). Interestingly, the center of the plume moves at a greater rate (22 feet/year) over successive time intervals than would be assumed from the groundwater velocity alone (16 feet/year), due to the added effect of dispersion.

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WinTran
Analytical Model of 2D Ground-Water Flow and
Finite-Element Contaminant Transport Model

Developed by
James O. Rumbaugh, III
Douglas B. Rumbaugh

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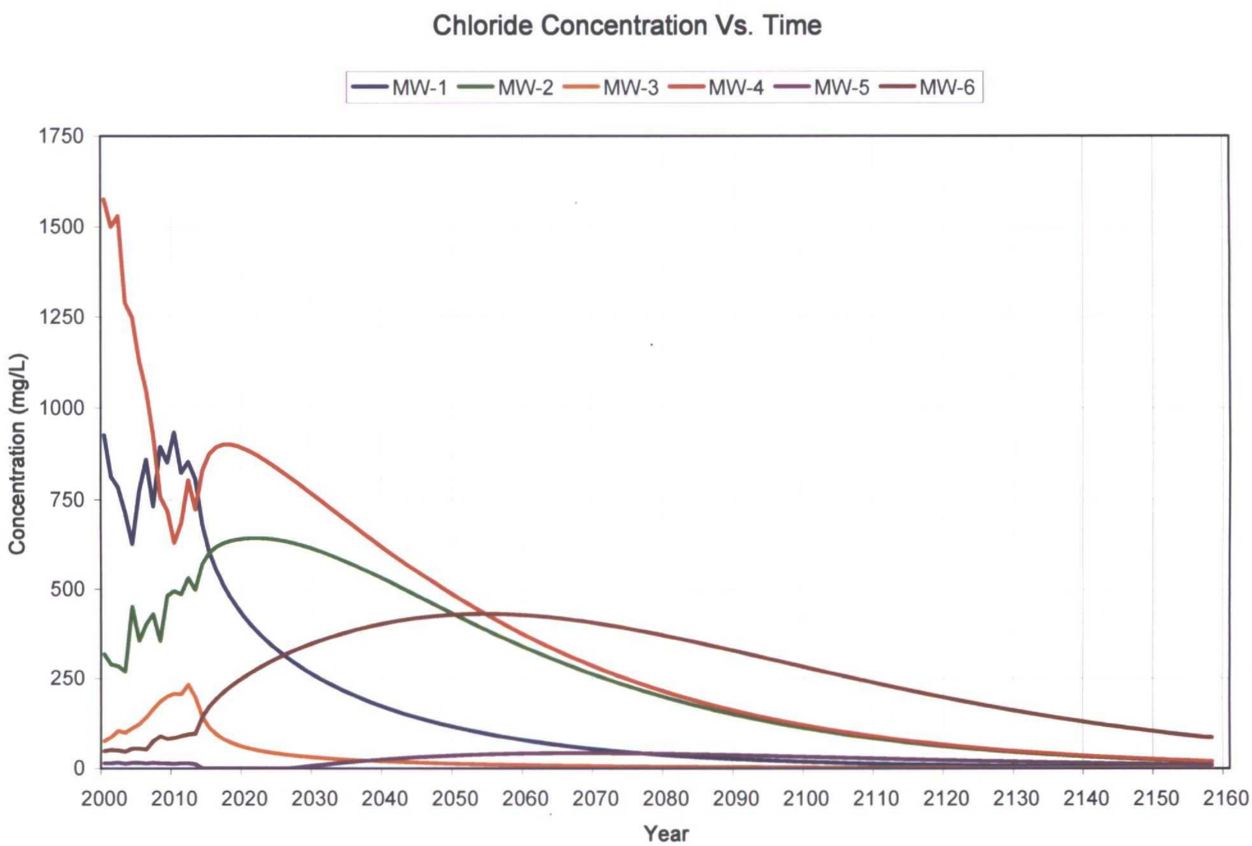
Chloride Fate & Transport Simulation run by:
Gilbert Van Deventer (Trident Environmental)

Date: 11/09/2012

Input File: 2012 CL.WTR



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Model Entities

Number of Wells = 8

Well #1
Center of Well -- x: 716.000000 y: 5281.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 824.000000
Head at Well Radius = 3793.599394

Well #2
Center of Well -- x: 1041.670000 y: 4585.770000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 486.000000
Head at Well Radius = 3790.537237

Well #3
Center of Well -- x: 694.000000 y: 5954.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 205.000000
Head at Well Radius = 3795.725707

Well #4
Center of Well -- x: 1341.000000 y: 4747.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 707.000000
Head at Well Radius = 3790.247606

Well #5
Center of Well -- x: 1829.000000 y: 4861.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 13.800000
Head at Well Radius = 3789.289438

Well #6
Center of Well -- x: 1948.000000 y: 4058.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 89.200000
Head at Well Radius = 3786.295815

Well #7
Center of Well -- x: 650.000000 y: 2081.000000
Radius = 1.000000
Pumping Rate = 10.000000
Concentration of Injected Water = 0.000000
Head at Well Radius = 3783.246885

Well #8
Center of Well -- x: 4375.000000 y: 3275.550000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 0.000000
Head at Well Radius = 3776.195782

Reference Head = 3795.000000 Defined at -- x: 490.030000 y: 5545.270000

==

Aquifer Properties

.... Steady-State Flow Model ....

Permeability................= 1000.000000 [L/T]
Porosity....................= 0.250000
Elevation of Aquifer Top....= 4000.000000
Elevation of Aquifer Bottom.= 3700.000000
Uniform Regional Gradient...= 0.004000
Angle of Uniform Gradient...= 304.000000
Recharge....................= 0.000000

.... Transient Transport Model ....

Longitudinal Dispersivity...= 150.000000 [L]
Transverse Dispersivity.....= 30.000000 [L]
Diffusion Coefficient.......= 0.000000 [L2/T]
Contaminant half-life...... = 1000.000000 [T]
Retardation Coefficient.....= 1.000000
Upstream Weighting in X.....= 0.000000
Upstream Weighting in Y.....= 0.000000

.... Time Stepping Information ....

Number of time steps........= 1450
Starting time value.........= 2012.000000
Initial time step size......= 0.100000
Time step multiplier....... = 1.000000
Maximum time step size......= 0.100000
Time stepping scheme........= Central Differencing

.... Simulation Summary ....

Starting time...............= 2012.000000
Ending time.................= 2157.000000
Number of time steps........= 1450

(NOTE: following mass balance errors expressed as percent)
Transport Mass Balance Error= 0.056133
Peclet Criterion............= 1.388889
Courant Number..............= 0.004595
Flow Model Type.............= Analytic Element

.... Head Contour Matrix

Number of nodes in the X-direction = 49
Number of nodes in the Y-direction = 49

Minimum X Coordinate = 0.000000
Minimum Y Coordinate = 0.000000

Maximum X Coordinate = 10000.000000
Maximum Y Coordinate = 6289.062500

Minimum Head = 3738.597428
Maximum Head = 3798.498580

Direct Chloride Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)	End Point
2000	927	317	75.5	1576	13.7	48.0	0	0	0.0
2001	813	288	86.4	1500	13.6	50.8	0	0	0.0
2002	784	284	103	1530	15.5	50.0	0	0	0.0
2003	715	268	98.3	1290	12.5	46.5	0	0	0.0
2004	628	451	111	1250	15.3	55.1	0	0	0.0
2005	774	355	122	1130	14.9	55	0	0	0.0
2006	860	401	141	1050	13.3	52.4	0	0	0.0
2007	732	430	164	926	14.9	75.3	0	0	0.0
2008	895	354	185	758	13.6	88.5	0	0	0.0
2009	852	482	199	720	13.4	81.4	0	0	0.0
2010	934	494	207	632	12.6	84.1	0	0	0.0
2011	824	486	205	687	13.8	89.2	0	0	0.0
2012	854	531	232	804	13.8	93.8	0	0	0.0
2013	807	498	197	724	11.6	95.6	0	0	0.0
2014	681	572	142	831	0	143	0	0	0.0
2015	606	604	112	876	0	172	0	0	0.0
2016	553	620	93.7	895	0	193	0	0	0.0
2017	511	630	81.2	901	0	211	0	0	0.0
2018	477	637	71.9	901	0	227	0	0	0.0
2019	448	641	64.6	897	0	241	0	0	0.1
2020	422	643	58.8	890	0	254	0	0	0.1
2021	399	645	54.0	880	0	267	0	0	0.2
2022	378	645	49.9	870	0	278	0	0	0.2
2023	359	644	46.4	858	0	289	0	0	0.3
2024	341	642	43.3	845	0	299	0	0	0.4
2025	325	639	40.6	832	0	309	0	0	0.5
2026	309	635	38.2	818	0	318	0	0	0.7
2027	295	631	36.0	804	1.0	327	0	0	0.9
2028	282	626	34.1	790	3.2	335	0	0	1.1
2029	269	620	32.3	775	5.3	343	0	0	1.4
2030	258	614	30.6	761	7.3	350	0	0	1.7
2031	247	607	29.1	746	9.3	357	0	0	2.1
2032	236	599	27.7	731	11.3	364	0	0	2.5
2033	226	591	26.4	716	13.2	370	0	0	3.0
2034	217	583	25.2	701	15.1	376	0	0	3.6
2035	208	574	24.0	687	16.9	381	0	0	4.2
2036	199	565	22.9	672	18.6	387	0	0	4.9
2037	191	556	21.9	657	20.2	392	0	0	5.7
2038	183	547	20.9	643	21.8	396	0	0	6.5
2039	176	537	20.0	628	23.3	400	0	0	7.4
2040	169	527	19.2	614	24.8	404	0	0	8.5
2041	162	517	18.4	600	26.2	408	0	0	9.6
2042	156	507	17.6	586	27.5	411	0	0	10.8
2043	150	497	16.9	572	28.7	415	0	0	12.1

Direct Chloride Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)	End Point
2044	144	487	16.2	558	29.9	417	0	0	13.5
2045	138	477	15.5	545	31.0	420	0	0	15.0
2046	133	467	14.9	532	32.1	422	0	0	16.7
2047	128	457	14.3	519	33.1	424	0	0	18.4
2048	123	447	13.7	506	34.0	426	0	0	20.3
2049	118	437	13.1	493	34.9	427	0	0	22.3
2050	113	428	12.6	481	35.7	429	0	0	24.4
2051	109	418	12.1	469	36.5	430	0	0	26.6
2052	105	408	11.6	457	37.2	430	0	0	28.9
2053	101	399	11.2	445	37.9	431	0	0	31.4
2054	97.0	389	10.7	434	38.5	431	0	0	33.9
2055	93.4	380	10.3	423	39.0	431	0	0	36.6
2056	89.8	371	9.9	412	39.5	430	0	0	39.4
2057	86.4	362	9.5	401	40.0	430	0	0	42.3
2058	83.2	353	9.2	390	40.4	429	0	0	45.3
2059	80.1	344	8.8	380	40.7	428	0	0	48.4
2060	77.1	336	8.5	370	41.0	427	0	0	51.6
2061	74.2	327	8.1	360	41.3	426	0	0	55.0
2062	71.5	319	7.8	351	41.5	424	0	0	58.4
2063	68.8	311	7.5	341	41.7	422	0	0	61.9
2064	66.2	303	7.2	332	41.9	420	0	0	65.5
2065	63.8	295	7.0	323	42.0	418	0	0	69.2
2066	61.4	287	6.7	314	42.1	416	0	0	72.9
2067	59.2	280	6.4	306	42.1	413	0	0	76.8
2068	57.0	272	6.2	297	42.1	411	0	0	80.7
2069	54.9	265	6.0	289	42.1	408	0	0	84.6
2070	52.9	258	5.7	281	42.0	405	0	0	88.7
2071	50.9	251	5.5	273	42.0	402	0	0	92.8
2072	49.1	245	5.3	266	41.9	399	0	0	96.9
2073	47.3	238	5.1	258	41.7	395	0	0	101
2074	45.5	232	4.9	251	41.6	392	0	0	105
2075	43.9	225	4.7	244	41.4	388	0	0	110
2076	42.3	219	4.6	237	41.2	385	0	0	114
2077	40.7	213	4.4	231	40.9	381	0	0	118
2078	39.3	207	4.2	224	40.7	377	0	0	123
2079	37.8	202	4.1	218	40.4	373	0	0	127
2080	36.5	196	3.9	212	40.1	369	0	0	131
2081	35.2	191	3.8	206	39.8	365	0	0	136
2082	33.9	185	3.6	200	39.5	361	0	0	140
2083	32.7	180	3.5	194	39.2	356	0	0	144
2084	31.5	175	3.4	188	38.8	352	0	0	149
2085	30.3	170	3.2	183	38.4	348	0	0	153
2086	29.2	165	3.1	178	38.1	343	0	0	158
2087	28.2	161	3.0	173	37.7	339	0	0	162

Direct Chloride Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)	End Point
2088	27.2	156	2.9	168	37.3	335	0	0	166
2089	26.2	152	2.8	163	36.9	330	0	0	170
2090	25.3	147	2.7	158	36.4	326	0	0	174
2091	24.4	143	2.6	154	36.0	321	0	0	179
2092	23.5	139	2.5	149	35.6	317	0	0	183
2093	22.6	135	2.4	145	35.1	312	0	0	187
2094	21.8	131	2.3	141	34.7	307	0	0	191
2095	21.1	127	2.2	136	34.2	303	0	0	195
2096	20.3	124	2.2	132	33.8	298	0	0	199
2097	19.6	120	2.1	129	33.3	294	0	0	202
2098	18.9	117	2.0	125	32.8	289	0	0	206
2099	18.2	113	1.9	121	32.4	285	0	0	210
2100	17.6	110	1.9	118	31.9	280	0	0	213
2101	16.9	107	1.8	114	31.4	275	0	0	217
2102	16.3	104	1.7	111	30.9	271	0	0	220
2103	15.8	101	1.7	108	30.5	266	0	0	223
2104	15.2	97.8	1.6	104	30.0	262	0	0	227
2105	14.7	95.0	1.5	101	29.5	258	0	0	230
2106	14.1	92.2	1.5	98.3	29.0	253	0	0	233
2107	13.6	89.5	1.4	95.3	28.6	249	0	0	236
2108	13.2	86.8	1.4	92.5	28.1	244	0	0	239
2109	12.7	84.3	1.3	89.8	27.6	240	0	0	241
2110	12.2	81.8	1.3	87.1	27.1	236	0	0	244
2111	11.8	79.4	1.2	84.5	26.7	231	0	0	246
2112	11.4	77.0	1.2	82.0	26.2	227	0	0	249
2113	11.0	74.8	1.1	79.5	25.7	223	0	0	251
2114	10.6	72.6	1.1	77.2	25.3	219	0	0	253
2115	10.2	70.4	1.1	74.9	24.8	215	0	0	255
2116	9.9	68.3	1.0	72.6	24.4	211	0	0	257
2117	9.5	66.3	1.0	70.4	23.9	207	0	0	259
2118	9.2	64.3	1.0	68.3	23.5	203	0	0	261
2119	8.9	62.4	0.9	66.3	23.0	199	0	0	263
2120	8.6	60.5	0.9	64.3	22.6	195	0	0	264
2121	8.3	58.7	0.9	62.4	22.2	191	0	0	266
2122	8.0	57.0	0.8	60.5	21.7	187	0	0	267
2123	7.7	55.3	0.8	58.7	21.3	184	0	0	268
2124	7.4	53.6	0.8	56.9	20.9	180	0	0	269
2125	7.2	52.0	0.7	55.2	20.5	176	0	0	270
2126	6.9	50.5	0.7	53.5	20.1	173	0	0	271
2127	6.7	48.9	0.7	51.9	19.7	169	0	0	272
2128	6.4	47.5	0.7	50.3	19.3	166	0	0	273
2129	6.2	46.0	0.6	48.8	18.9	162	0	0	273
2130	6.0	44.7	0.6	47.3	18.5	159	0	0	274
2131	5.8	43.3	0.6	45.9	18.1	156	0	0	274

Direct Chloride Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)	End Point
2132	5.6	42.0	0.6	44.5	17.7	152	0	0	274
2133	5.4	40.7	0.6	43.2	17.3	149	0	0	274
2134	5.2	39.5	0.5	41.9	17.0	146	0	0	274
2135	5.0	38.3	0.5	40.6	16.6	143	0	0	274
2136	4.8	37.2	0.5	39.4	16.3	140	0	0	274
2137	4.7	36.0	0.5	38.2	15.9	137	0	0	274
2138	4.5	34.9	0.5	37.0	15.6	134	0	0	274
2139	4.4	33.9	0.4	35.9	15.2	131	0	0	273
2140	4.2	32.9	0.4	34.8	14.9	128	0	0	273
2141	4.1	31.9	0.4	33.7	14.6	125	0	0	272
2142	3.9	30.9	0.4	32.7	14.2	122	0	0	272
2143	3.8	29.9	0.4	31.7	13.9	120	0	0	271
2144	3.7	29.0	0.4	30.7	13.6	117	0	0	270
2145	3.5	28.2	0.4	29.8	13.3	114	0	0	269
2146	3.4	27.3	0.3	28.9	13.0	112	0	0	268
2147	3.3	26.5	0.3	28.0	12.7	109	0	0	267
2148	3.2	25.7	0.3	27.1	12.4	107	0	0	266
2149	3.1	24.9	0.3	26.3	12.1	104	0	0	265
2150	3.0	24.1	0.3	25.5	11.9	102	0	0	263
2151	2.9	23.4	0.3	24.7	11.6	100	0	0	262
2152	2.8	22.7	0.3	24.0	11.3	97.3	0	0	261
2153	2.7	22.0	0.3	23.2	11.0	95.1	0	0	259
2154	2.6	21.3	0.3	22.5	10.8	92.8	0	0	256
2155	2.5	20.6	0.3	21.8	10.5	90.7	0	0	254
2156	2.4	20.0	0.2	21.2	10.3	88.6	0	0	252
2157	2.3	19.4	0.2	20.5	10.0	86.5	0	0	250

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WinTran
Analytical Model of 2D Ground-Water Flow and
Finite-Element Contaminant Transport Model

Developed by

James O. Rumbaugh, III

Douglas B. Rumbaugh

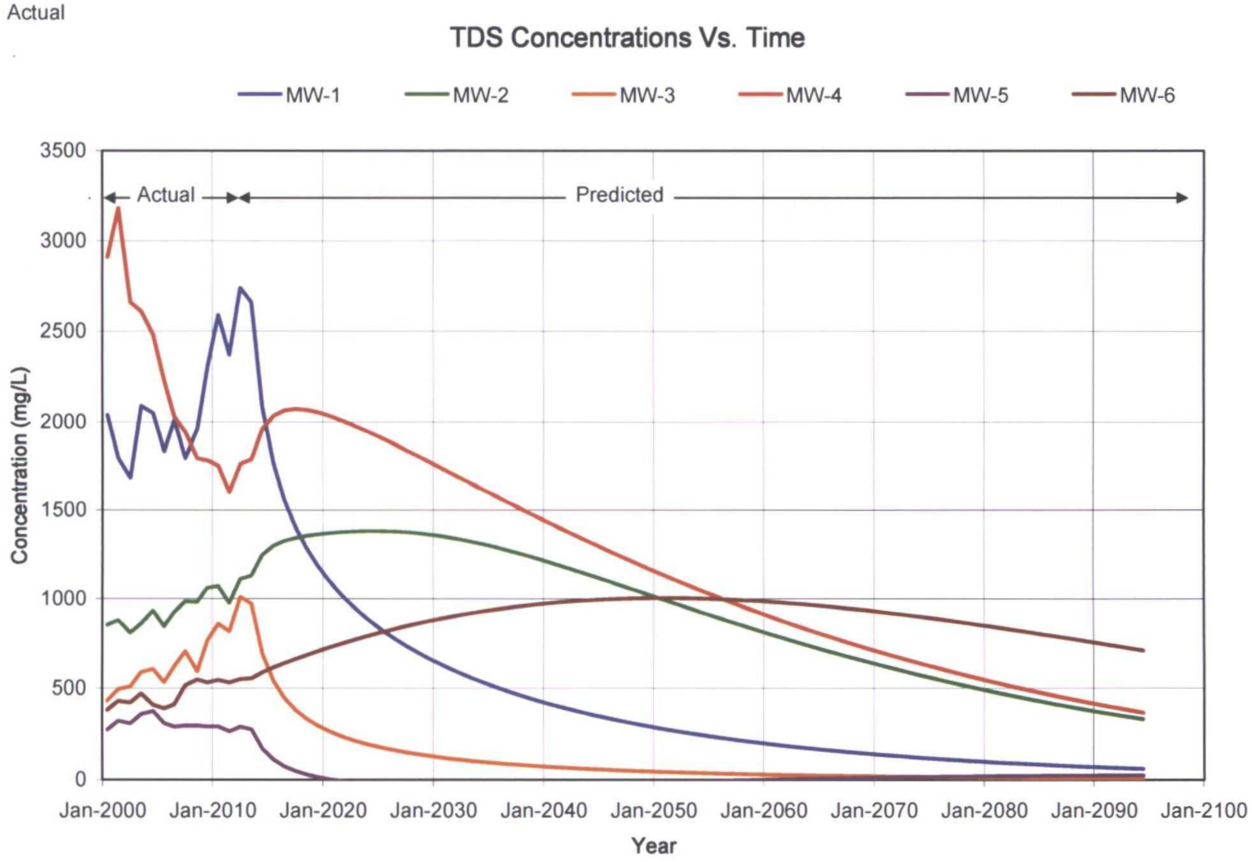
==

TDS Fate & Transport Simulation run by:
Gilbert Van Deventer (Trident Environmental)

Date: 11/09/2012

Input File: TDS 2012.WTR

Actual



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Model Entities

Number of Wells = 8

Well #1
Center of Well -- x: 716.000000 y: 5281.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 2370.000000
Head at Well Radius = 3793.961643

Well #2
Center of Well -- x: 1041.670000 y: 4585.770000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 974.000000
Head at Well Radius = 3790.911689

Well #3
Center of Well -- x: 694.000000 y: 5954.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 816.000000
Head at Well Radius = 3796.079940

Well #4
Center of Well -- x: 1341.000000 y: 4747.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 1600.000000
Head at Well Radius = 3790.623255

Well #5
Center of Well -- x: 1829.000000 y: 4861.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 265.000000
Head at Well Radius = 3789.669101

Well #6
Center of Well -- x: 1948.000000 y: 4058.000000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 531.000000
Head at Well Radius = 3786.688589

Well #7
Center of Well -- x: 650.000000 y: 2081.000000
Radius = 1.000000
Pumping Rate = 10.000000
Concentration of Injected Water = 400.000000
Head at Well Radius = 3783.653976

Well #8
Center of Well -- x: 4375.000000 y: 3275.550000
Radius = 1.000000
Pumping Rate = 0.000000
Concentration of Injected Water = 0.000000
Head at Well Radius = 3776.640336

Reference Head = 3795.000000 Defined at -- x: 619.470000 y: 5537.180000

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Aquifer Properties

.... Steady-State Flow Model ....

Permeability................= 1000.000000 [L/T]
Porosity....................= 0.250000
Elevation of Aquifer Top....= 4000.000000
Elevation of Aquifer Bottom.= 3700.000000
Uniform Regional Gradient...= 0.004000
Angle of Uniform Gradient...= 304.000000
Recharge....................= 0.000000

.... Transient Transport Model ....

Longitudinal Dispersivity...= 150.000000 [L]
Transverse Dispersivity.....= 15.000000 [L]
Diffusion Coefficient.......= 0.000000 [L2/T]
Contaminant half-life...... = 1000.000000 [T]
Retardation Coefficient.....= 1.000000
Upstream Weighting in X.....= 0.000000
Upstream Weighting in Y.....= 0.000000

.... Time Stepping Information ....

Number of time steps........= 820
Starting time value.........= 2012.000000
Initial time step size......= 0.100000
Time step multiplier....... = 1.000000
Maximum time step size......= 0.100000
Time stepping scheme........= Central Differencing

.... Simulation Summary ....

Starting time...............= 2012.000000
Ending time.................= 2094.000000
Number of time steps........= 820

(NOTE: following mass balance errors expressed as percent)
Transport Mass Balance Error= 1.744046
Peclet Criterion............= 1.388889
Courant Number.............= 0.004718
Flow Model Type.............= Analytic Element

.... Head Contour Matrix

Number of nodes in the X-direction = 49
Number of nodes in the Y-direction = 49

Minimum X Coordinate = 0.000000
Minimum Y Coordinate = 0.000000

Maximum X Coordinate = 10000.000000
Maximum Y Coordinate = 6289.062500

Minimum Head = 3738.597428
Maximum Head = 3798.498580

Direct TDS Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)	End Point
2000	2040	852	433	2910	274	382	0	0	0
2001	1790	878	495	3180	322	431	0	0	0
2002	1680	808	509	2660	308	422	0	0	0
2003	2090	859	588	2610	359	471	0	0	0
2004	2050	931	605	2480	375	410	0	0	0
2005	1830	844	533	2230	309	391	0	0	0
2006	2010	922	619	2030	290	412	0	0	0
2007	1790	984	705	1940	296	516	0	0	20
2008	1960	980	592	1790	296	548	0	0	40
2009	2300	1060	766	1780	291	532	0	0	40
2010	2590	1070	859	1750	291	545	0	0	60
2011	2370	974	816	1600	265	531	0	0	80
2012	2740	1110	1010	1760	290	550	0	0	109
2013	2660	1128	971	1786	275	554	0	0	183
2014	2084	1245	691	1961	169	587	0	0	202
2015	1765	1297	540	2036	110	614	0	0	222
2016	1557	1324	447	2066	73	638	0	0	242
2017	1405	1341	382	2074	47	660	0	0	263
2018	1285	1353	334	2069	28	682	0	0	284
2019	1187	1361	297	2056	14	704	0	0	306
2020	1104	1368	267	2037	3	724	0	0	328
2021	1032	1373	242	2014	0	744	0	0	351
2022	968	1377	221	1988	0	762	0	0	374
2023	912	1380	202	1960	0	780	0	0	398
2024	861	1381	187	1931	0	798	0	0	422
2025	815	1380	173	1901	0	814	0	0	445
2026	773	1378	161	1870	0	830	0	0	469
2027	735	1374	150	1839	0	845	0	0	493
2028	699	1369	140	1807	0	859	0	0	517
2029	666	1362	131	1775	0	872	0	0	540
2030	635	1353	123	1743	0	885	0	0	564
2031	607	1343	116	1710	0	897	0	0	587
2032	580	1332	109	1678	0	908	0	0	609
2033	555	1320	103	1646	0	919	0	0	632
2034	531	1306	97	1614	0	928	0	0	654
2035	509	1291	92	1582	0	938	0	0	675
2036	488	1275	87	1551	0	946	0	0	696
2037	468	1259	82	1519	0	954	0	0	717
2038	449	1241	78	1488	0	962	0	0	737
2039	431	1223	74	1457	0	968	0	0	757
2040	414	1204	70	1427	0	974	0	0	776
2041	398	1185	67	1397	0	980	0	0	795
2042	382	1166	63	1367	0	985	0	0	813
2043	367	1146	60	1337	0	989	0	0	831
2044	353	1125	58	1308	0	993	0	0	848
2045	340	1105	55	1279	0	996	0	0	865
2046	327	1084	52	1251	0	999	0	0	881
2047	315	1063	50	1223	0	1001	0	0	897
2048	303	1043	47	1196	0	1002	0	0	912
2049	292	1022	45	1169	0	1003	0	0	926

Direct TDS Concentration (mg/L) Output from WinTran Simulation

Year	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	Windmill (L 05339)	Inactive Well (L 03945)	End Point
2050	281	1001	43	1142	0	1004	0	0	940
2051	271	980	41	1116	0	1004	0	0	953
2052	261	960	39	1090	0	1003	0	0	966
2053	251	939	38	1065	0	1002	0	0	978
2054	242	919	36	1040	0	1001	0	0	989
2055	233	898	35	1015	0	999	0	0	1000
2056	225	878	33	991	0	996	0	0	1011
2057	217	859	32	968	0	994	0	0	1020
2058	209	839	30	944	0	990	0	0	1029
2059	202	820	29	922	0	987	0	0	1038
2060	195	801	28	899	0	983	0	0	1046
2061	188	782	27	877	1	979	0	0	1053
2062	181	763	25	856	2	974	0	0	1060
2063	175	745	24	835	4	969	0	0	1066
2064	169	727	23	814	5	964	0	0	1071
2065	163	710	22	794	6	958	0	0	1076
2066	157	692	22	774	7	952	0	0	1080
2067	151	675	21	755	8	946	0	0	1084
2068	146	659	20	736	9	939	0	0	1087
2069	141	642	19	717	10	932	0	0	1089
2070	136	626	18	699	11	925	0	0	1091
2071	131	611	18	681	12	918	0	0	1093
2072	127	595	17	664	13	911	0	0	1094
2073	123	580	16	647	14	903	0	0	1094
2074	118	565	16	630	14	895	0	0	1094
2075	114	551	15	614	15	887	0	0	1093
2076	110	537	14	598	16	878	0	0	1092
2077	106	523	14	582	17	870	0	0	1090
2078	103	509	13	567	17	861	0	0	1088
2079	99	496	13	552	18	853	0	0	1085
2080	96	483	12	538	18	844	0	0	1082
2081	93	470	12	523	19	835	0	0	1079
2082	89	458	11	510	20	826	0	0	1075
2083	86	446	11	496	20	816	0	0	1070
2084	83	434	10	483	21	807	0	0	1066
2085	81	423	10	470	21	798	0	0	1060
2086	78	411	10	457	21	788	0	0	1055
2087	75	400	9	445	22	778	0	0	1049
2088	73	390	9	433	22	769	0	0	1043
2089	70	379	9	421	23	759	0	0	1036
2090	68	369	8	410	23	749	0	0	1029
2091	65	359	8	399	23	740	0	0	1022
2092	63	349	8	388	23	730	0	0	1015
2093	61	340	7	377	24	720	0	0	1007
2094	59	330	7	367	24	710	0	0	999