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February 17, 2012

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: 2011 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 *2011 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 (Irvine CA)

Subject: 2011 Annual Groundwater Monitoring Report - Former Unocal South Vacuum Unit (1R-277)
From: Gil Van Deventer <gil@trident-environmental.com>
Date: 02/17/12 4:30 PM
To: Glenn Von Gonten <glenn.vongonten@state.nm.us>
CC: John MacLeod <johnmacleod@chevron.com>, "Koschel, Dana" <Dana.Koschel@arcadis-us.com>, Geoffrey Leking <GeoffreyR.Leking@state.nm.us>, "Allen C. Just" <allen.just@arcadis-us.com>

Subject: 2011 Annual Groundwater Monitoring Report
Site Name: Former Unocal South Vacuum Unit (1R-277)
Location: T18S-R35E, Section 36, Lea County, New Mexico

Hello Glenn:

On behalf of Chevron Environmental Management Company, Trident Environmental is submitting the attached *2011 Annual Groundwater Monitoring Report* for the *Former Unocal South Vacuum Unit* (NMOCD Case No. 1R-277). I will also send you a hard copy and compact disk via USPS Priority Mail (Delivery Confirmation # 420 87505 9101 9690 0094 0802 6459 80) today.

We look forward to working with you on this project. You can 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.

Thanks - Gil

Gilbert J. Van Deventer, PG, REM
Trident Environmental
P. O. Box 12177, Odessa TX 79768
Work/Mobile: 432-638-8740
Fax: 413-403-9968

— Attachments:

xmittal11.pdf	19.3 KB
AGWMR_2011.pdf	1.3 MB

2011 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

FEBRUARY 17, 2012

Prepared For:

Chevron Environmental
Management Company
6111 Bollinger Canyon Rd.
San Ramon, CA 94583

Prepared By:

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P. O. Box 12177
Odessa, Texas 79768

2011 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
6111 Bollinger Canyon Road
San Ramon, CA 94583

Prepared by:

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Odessa, Texas 79768
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FAX (413) 403-9968

SUBMITTED BY:

Gilbert J. Van Deventer, PG, REM
Project Manager

DATE:

02/17/2012

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APPENDICES

1.0 Executive Summary

Trident Environmental (Trident) was retained by ARCADIS, on behalf of Chevron Environmental Management Company (Chevron EMC), to perform the 2011 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 2011 annual sampling event performed by Trident at the site on July 14, 2011. 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. Chloride and TDS concentrations in 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 146 years before concentrations return to levels below the New Mexico Water Quality Control Commission (WQCC) standard of 250 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 were performed to the source area by Unocal, which include plugging of the SWD well in 1971 and encapsulating the former saltwater disposal pit with solidification material in 1995, thus significantly reducing the threat of 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 for site closure:

- Continue the annual 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.

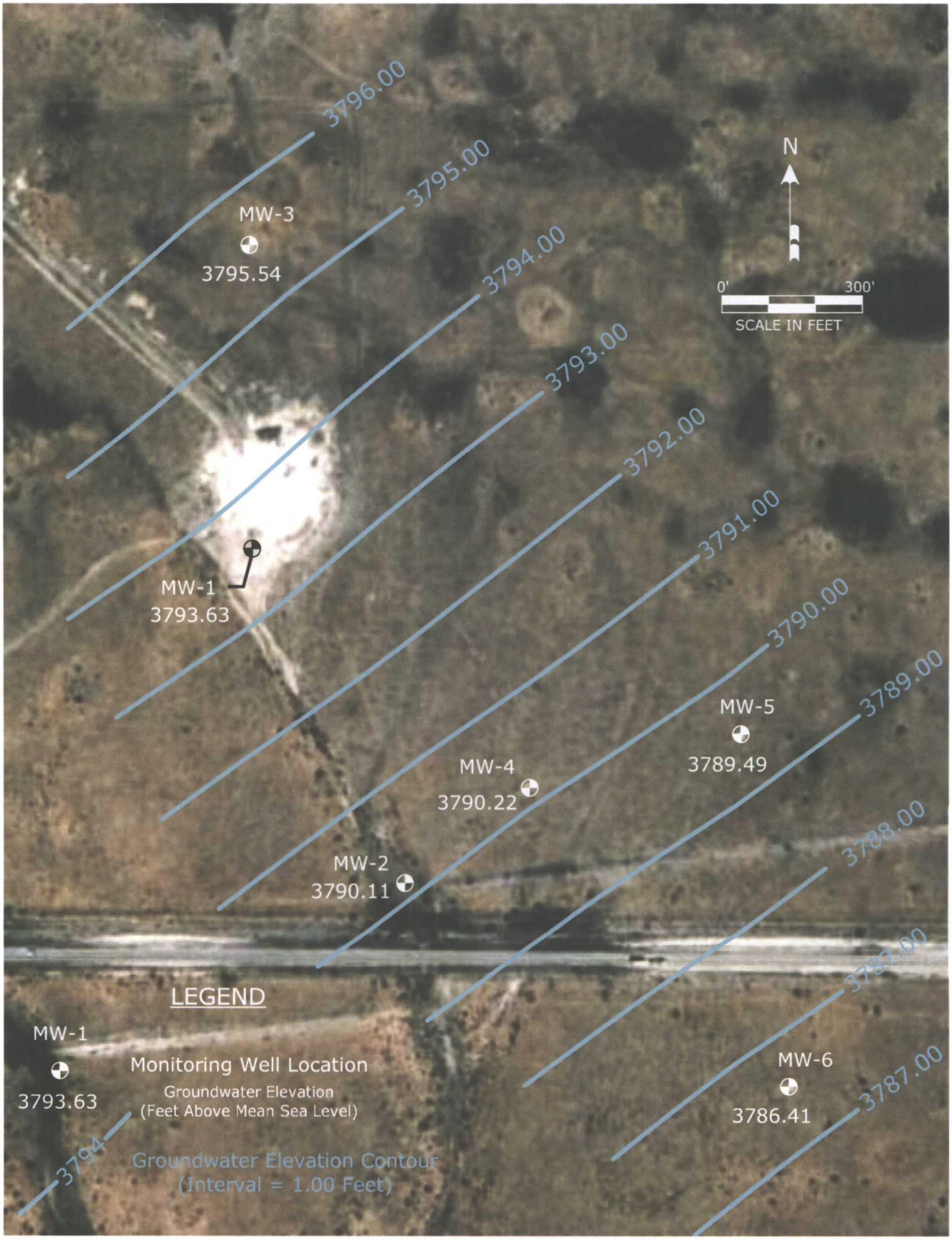
- Submit the 2012 annual groundwater monitoring report to OCD in January 2013 to document natural attenuation conditions.

2.0 Groundwater Sampling Procedures

On July 14, 2011, 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 31 gallons of groundwater was purged from the site monitoring wells (3 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 for 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-2541. 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 Lancaster Laboratories (Lancaster, PA) for analysis.

3.0 Groundwater Elevations, Hydraulic Gradient and Flow Direction

Depth to groundwater varies from approximately 49 feet (ft) at MW-2 to 69 ft at MW-6 below ground surface. Groundwater elevations are summarized in Table 1. 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 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 87 to 96 feet.



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Former Unocal South Vacuum Unit
Groundwater Gradient Map
July 14, 2011

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
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
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

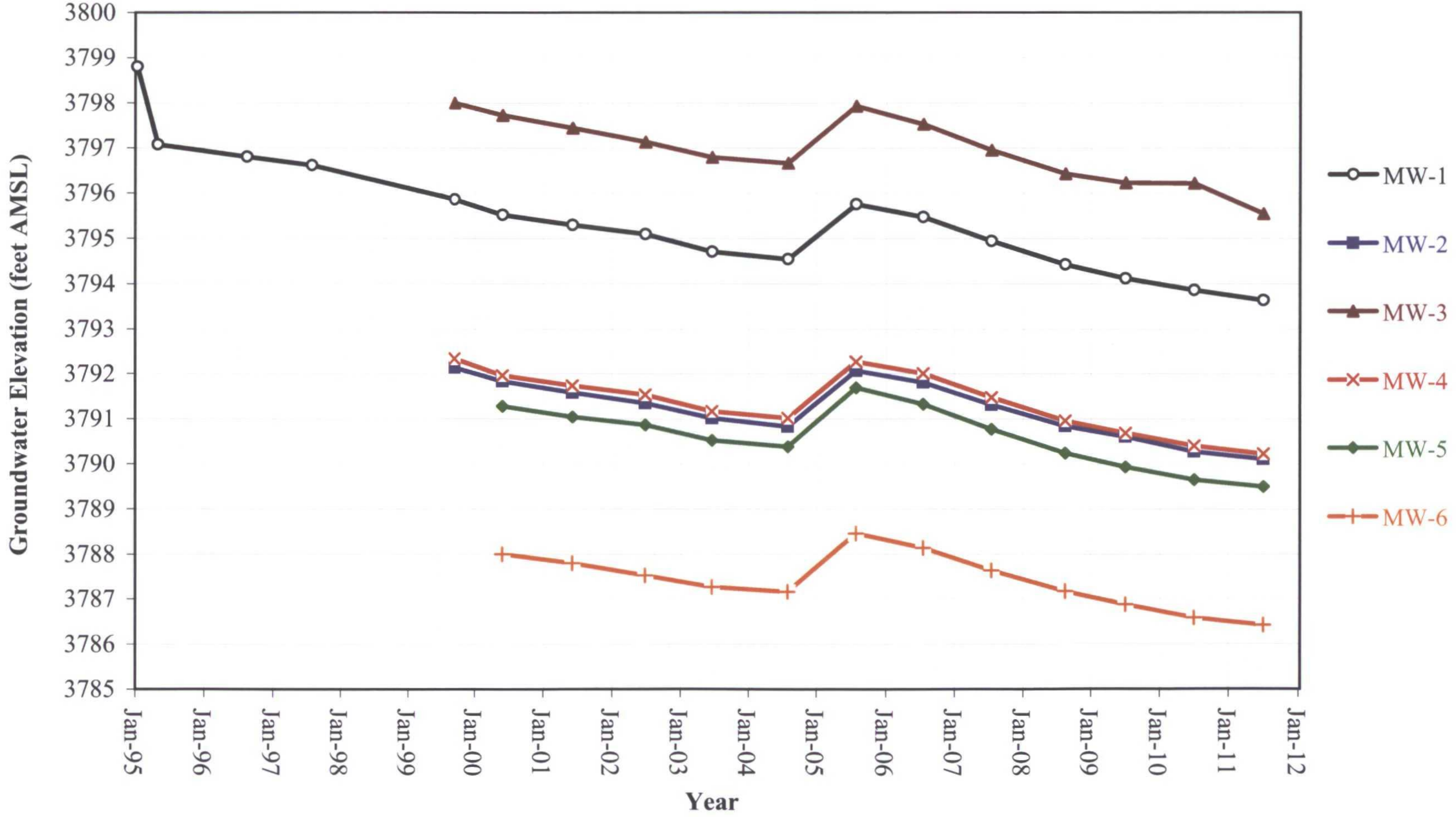
Continued on next page

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
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
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
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 recorded concentrations above the WQCC standards are highlighted in boldface type. The WQCC standard of 250 mg/L for chloride was exceeded in MW-1 (824 mg/L), MW-2 (486 mg/L), and MW-4 (707 mg/L). The WQCC standard of 1,000 mg/L for TDS was exceeded in MW-1 (2,370 mg/L) and MW-4 (1,600 mg/L). The groundwater samples obtained from upgradient monitoring well MW-3 and downgradient wells MW-2, MW-5, and MW-6 had chloride and TDS concentrations below WQCC standards.

The chloride and TDS concentrations are depicted graphically in Figures 3 and 4, respectively. Graphs depicting historical TDS and chloride 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 slight but 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. Chloride and TDS levels in MW-2, MW-5, and MW-6 have remained relatively consistent with previous years.

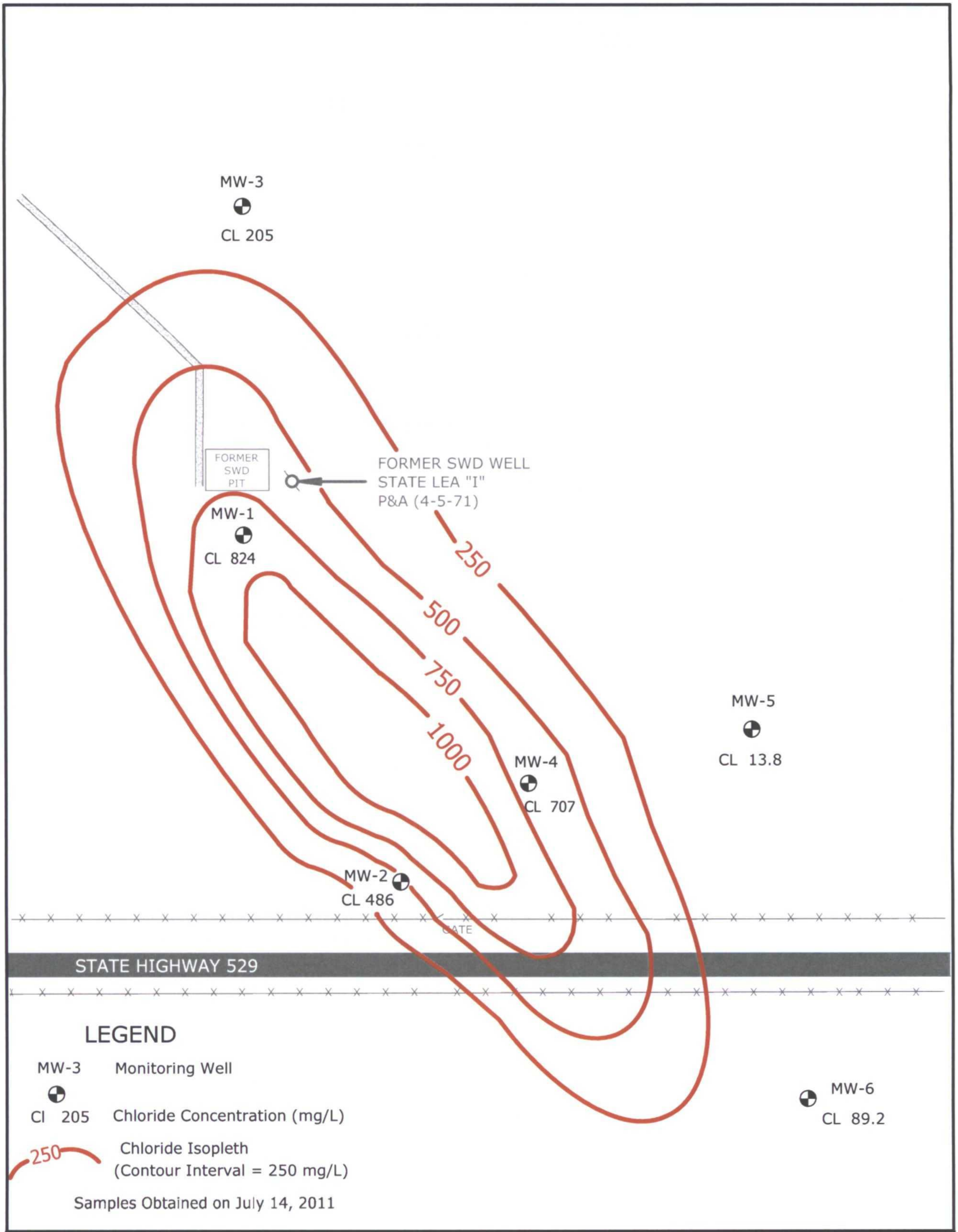


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FIGURE 3

Former Unocal South Vacuum Unit
Chloride Concentration Map
Current Conditions (2011)

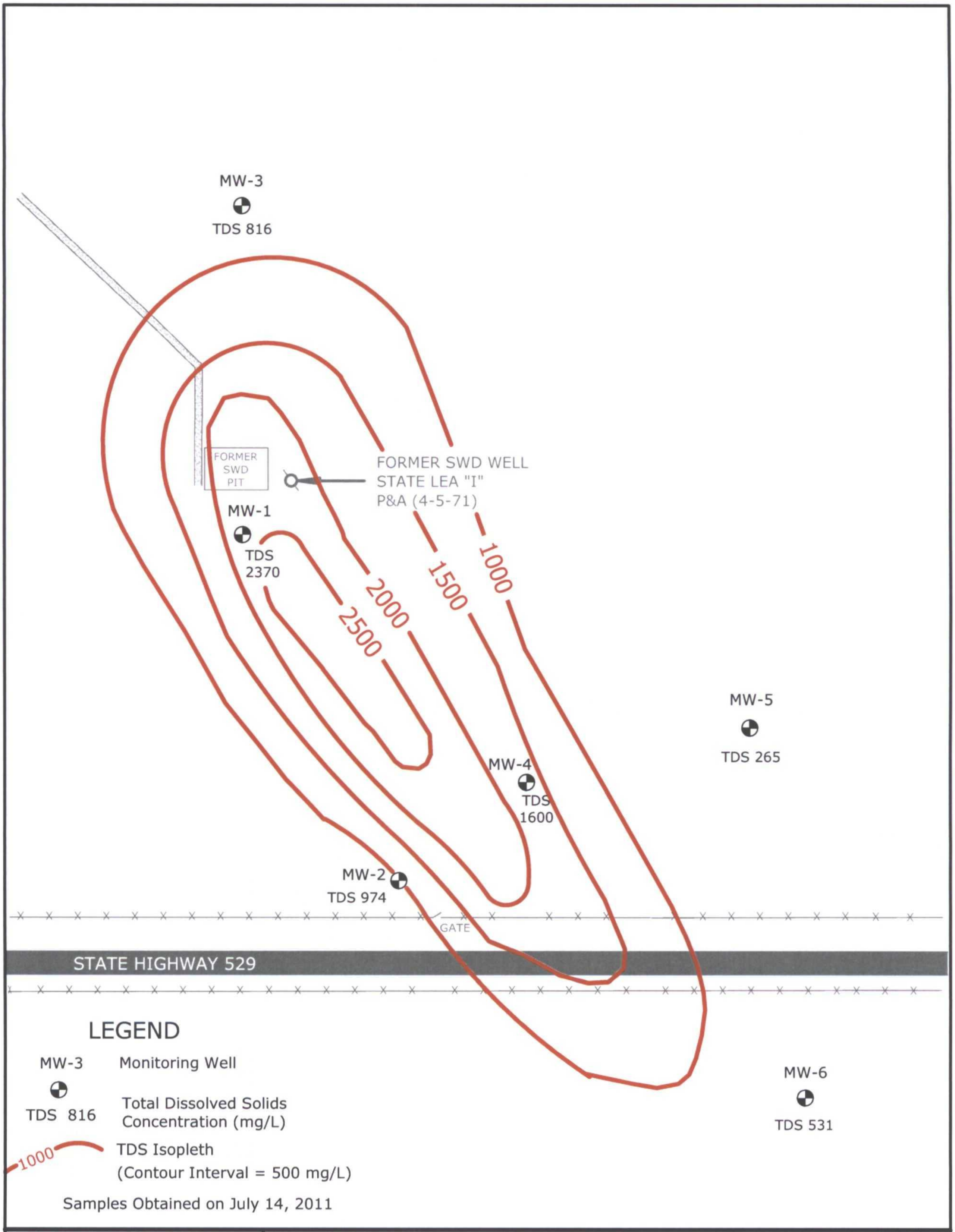

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FIGURE 4

Former Unocal South Vacuum Unit
TDS Concentration Map
Current Conditions (2011)

Figure 5
Chloride Concentrations Versus Time Graph

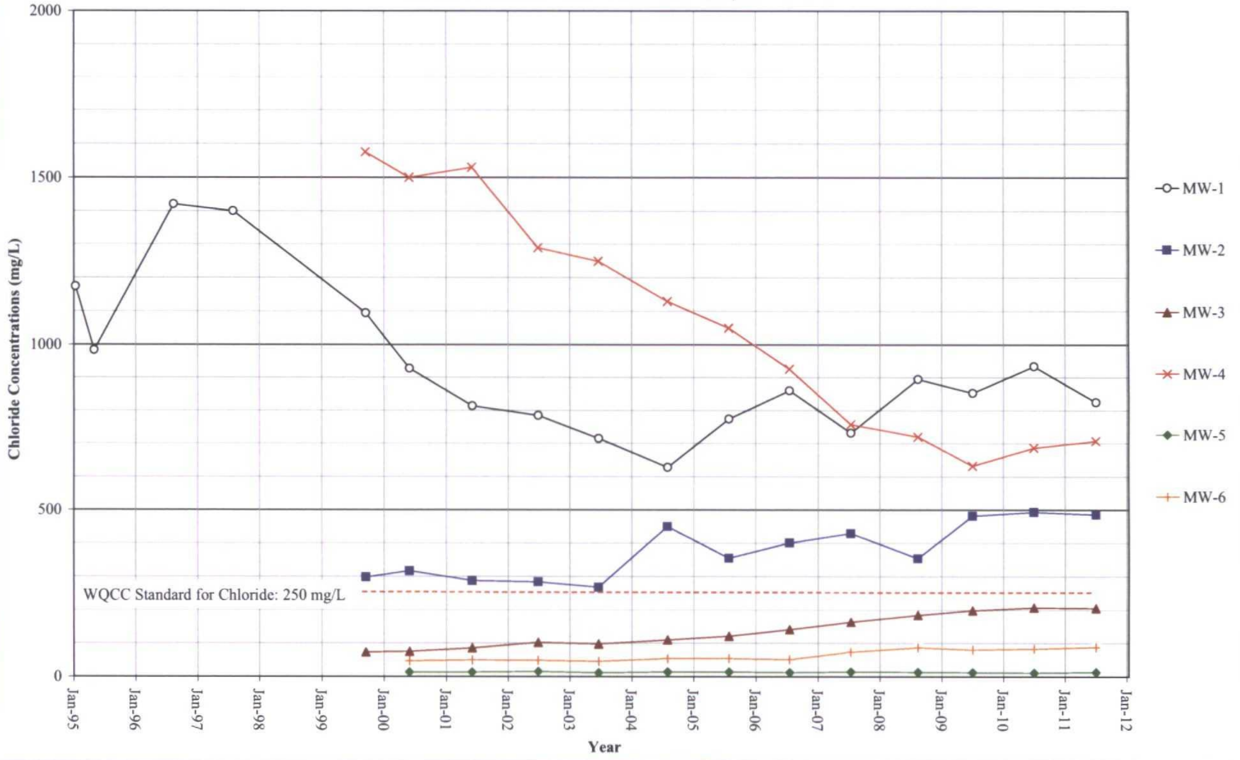
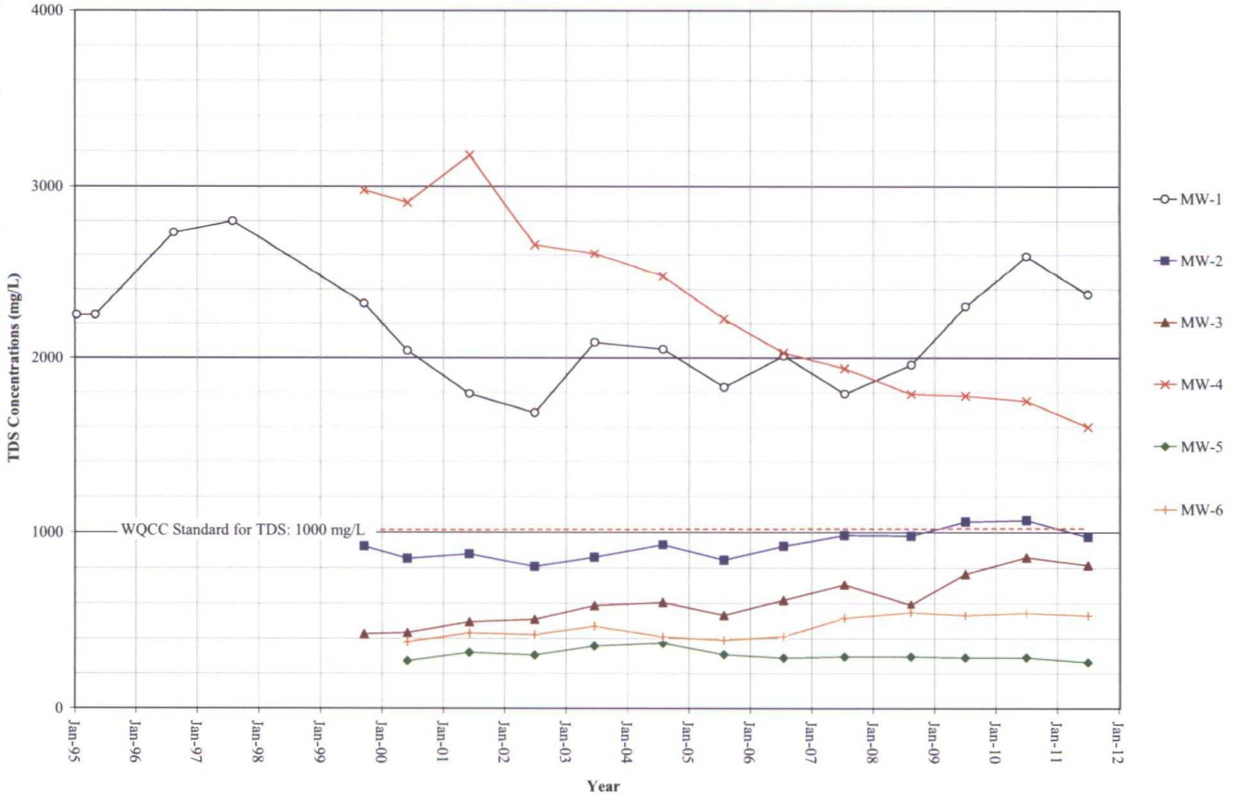


Figure 6
Total Dissolved Solids Concentrations Versus Time Graph



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 2093 for TDS, respectively). The center of the chloride plume is approximately 3,200 ft away from the pit and well source in the year 2157. The center of the TDS plume is approximately 2,200 ft away from the pit and well source in the year 2093.

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 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. Chloride and TDS concentrations in 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. Operation of the windmill well has been discontinued 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 146 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 (dispersion and dilution), 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 had 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; however during 2005 the groundwater table increased to an elevation similar to the 1999 level. 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

Chevron EMC has performed exemplary remedial actions to the source area, including plugging of the SWD well in 1971 and encapsulating the former saltwater disposal pit with solidification material in 1995, thus eliminating the threat of 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 for site closure:

- Continue the natural attenuation annual 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 2012 annual groundwater monitoring report to OCD in January 2013 to document natural attenuation conditions.

APPENDIX A

Laboratory Analytical Reports
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

July 28, 2011

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

Submittal Date: 07/20/2011
Group Number: 1257158
PO Number: 0015076319
Release Number: MACLEOD
State of Sample Origin: NM

Client Sample Description	Lancaster Labs (LLI) #
MW-1 Grab Water Sample	6349566
MW-2 Grab Water Sample	6349567
MW-3 Grab Water Sample	6349568
MW-4 Grab Water Sample	6349569
MW-5 Grab Water Sample	6349570
MW-6 Grab Water Sample	6349571

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

Questions? Contact your Client Services Representative
Katherine A Klinefelter at (717) 656-2300 Ext. 1566

Respectfully Submitted,

Robert Heisey

Robert Heisey
Senior Specialist

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 6349566
LLI Group # 1257158
Account # 11969

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

Collected: 07/14/2011 14:00 by GV

Submitted: 07/20/2011 09:15
Reported: 07/28/2011 13:32

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.	2,370	38.8	120	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	824	8.0	40.0	20

General Sample Comments

ll 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	11202021201A	07/21/2011 10:11	Yolunder Y Bunch	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	11207112401A	07/26/2011 07:20	Susan A Engle	20

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

Lancaster Laboratories

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

LLI Sample # WW 6349567
LLI Group # 1257158
Account # 11969

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

Collected: 07/14/2011 13:00 by GV

Submitted: 07/20/2011 09:15
Reported: 07/28/2011 13:32

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.	974	38.8	120	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	486	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	11202021201A	07/21/2011 10:11	Yolunder Y Bunch	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	11207112401A	07/26/2011 07:20	Susan A Engle	20

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

Lancaster Laboratories

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 6349568
LLI Group # 1257158
Account # 11969

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

Collected: 07/14/2011 11:50 by GV

Submitted: 07/20/2011 09:15
Reported: 07/28/2011 13:32

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.	816	19.4	60.0	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	205	4.0	20.0	10

General Sample Comments

ll QC is compliant unless otherwise noted. Please refer to the Quality
trol 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	11202021201A	07/21/2011 10:11	Yolunder Y Bunch	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	11207112401A	07/26/2011 07:20	Susan A Engle	10

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

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

LLI Sample # WW 6349569
LLI Group # 1257158
Account # 11969

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

Collected: 07/14/2011 13:30 by GV

Submitted: 07/20/2011 09:15
Reported: 07/28/2011 13:32

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.	1,600	38.8	120	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	707	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	11202021201A	07/21/2011 10:11	Yolunder Y Bunch	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	11207112401A	07/26/2011 07:20	Susan A Engle	20

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

Lancaster Laboratories
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-5 Grab Water Sample
Former Unocal South Vacuum Unit
Lea County, NM

LLI Sample # WW 6349570
LLI Group # 1257158
Account # 11969

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

Collected: 07/14/2011 12:30 by GV

Submitted: 07/20/2011 09:15
Reported: 07/28/2011 13:32

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.	265	9.7	30.0	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	13.8	0.80	4.0	2

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	11202021201A	07/21/2011 10:11	Yolunder Y Bunch	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	11207112401A	07/26/2011 07:20	Susan A Engle	2

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

Lancaster Laboratories

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

LLI Sample # WW 6349571
LLI Group # 1257158
Account # 11969

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

Collected: 07/14/2011 11:00 by GV

Submitted: 07/20/2011 09:15
Reported: 07/28/2011 13:32

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.	531	9.7	30.0	1
	SM20 4500 Cl C		mg/l	mg/l	mg/l	
01124	Chloride (titrimetric)	16887-00-6	89.2	0.80	4.0	2

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	11202021201A	07/21/2011 10:11	Yolunder Y Bunch	1
01124	Chloride (titrimetric)	SM20 4500 Cl C	1	11207112401A	07/26/2011 07:20	Susan A Engle	2

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

Quality Control Summary

Client Name: Chevron Environmental Mgmt Co
Reported: 07/28/11 at 01:32 PM

Group Number: 1257158

Matrix QC may not be reported if 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.

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: 11202021201A	Sample number(s): 6349566-6349571								
Total Dissolved Solids	N.D.	9.7	30.0	mg/l	92		80-120		
Batch number: 11207112401A	Sample number(s): 6349566-6349571								
Chloride (titrimetric)					99		95-103		

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: 11202021201A	Sample number(s): 6349566-6349571 UNSPK: 6349567 BKG: 6349567								
Total Dissolved Solids	100		62-135			974	978	0	9
Batch number: 11207112401A	Sample number(s): 6349566-6349571 UNSPK: 6349570 BKG: 6349570								
Chloride (titrimetric)	97	96	85-110	1	3	13.8	13.5	2 (1)	5

*- 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.

Analysis Request/ Environmental Services Chain of Custody

Lancaster Laboratories

For Lancaster Laboratories use only

Acct. # 11969 Group# 1257158 Sample # 6349566-71

COC # 265691

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

For Lab Use Only
FSC:
SCR#: 107853

① Client: Chevron EMC Acct. #: 11969
Project Name/#: Former Unocal S. Vacuum Unit PWSID #:
Project Manager: John MacLeod (Chevron EMC) Allen Just (Arcadis) P.O.#:
Sampler: Gil VanDeventer (Trident Env.) Quote #:
Name of state where samples were collected: NM

④ Matrix: Soil / Water (☐ Potable ☐ NPDES, Check if Applicable) / Other

⑤ Analyses Requested / Preservation Codes

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

⑥ Temperature of samples upon receipt (if requested)

② Sample Identification	Date Collected	Time Collected	③ Grab	Composite	Soil	Water	Other	Total # of Containers	Chloride	TDS								Remarks
																		20°C Kmz
MW-1	7/14/11	1400	✓			1			✓	✓								
MW-2	7/14/11	1300	✓			1			✓	✓								
MW-3	7/14/11	1150	✓			1			✓	✓								
MW-4	7/14/11	1330	✓			1			✓	✓								
MW-5	7/14/11	1230	✓			1			✓	✓								
MW-6	7/14/11	1100	✓			1			✓	✓								

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

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

SDG Complete?
Yes No

Site-specific QC (MS/MSD/Dup)? Yes [✓ No]
(If yes, indicate QC sample and submit triplicate volume.)
Internal COC Required? Yes / No

Relinquished by:	Date	Time	Received by:	Date	Time ⑨
	7/5/11	07:40		7/7/11	12:00
	7/14/11	6:30p			
			Kristin Zeigler	7-20-11	0915

Lancaster Laboratories, Inc., 2425 New Holland Pike, Lancaster, PA 17601 (717) 656-2300 Fax: (717) 656-6766
Copies: White and yellow should accompany samples to Lancaster Laboratories. The pink copy should be retained by the client.

Issued by Dept. 6042 Management
2102.05

Lancaster Laboratories

Environmental Sample Administration
Receipt Documentation Log

Client/Project: Chevron EMC

Date of Receipt: 7-20-11

Time of Receipt: 0915

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	9422	2.0°	TB	WI	Y	B	
2							
3							
4							
5							
6							

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

Paperwork Discrepancy/Unpacking Problems:

Unpacker Signature/Emp#: Kristin Leigh 2123 **Date/Time:** 7-20-11 0955

Issued by Dept. 6042 Management

2174.06

Lancaster Laboratories

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)
ug	microgram(s)	**mg**	milligram(s)
ml	milliliter(s)	**l**	liter(s)
m3	cubic meter(s)	**ul**	microliter(s)

<	less than - The number following the sign is the <u>limit of quantitation</u>, the smallest amount of analyte which can be reliably determined using this specific test.
>	greater than
J	estimated value – The result is ≥ the Method Detection Limit (MDL) and < the Limit of Quantitation (LOQ).
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.

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.

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 INCIDENTAL DAMAGES INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOSS OF PROFIT OR GOODWILL REGARDLESS OF (A) THE NEGLIGENCE (EITHER 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)
ITE 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: ____________
SPOSAL 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
07/14/11	14:00	MW-1	64.74	70.00	5.26	0.16	0.8	3	3.6	22.0	2.97	6.98	Clear
07/14/11	13:00	MW-2	51.53	71.00	19.47	0.16	3.1	10	3.2	21.5	1.89	7.41	Clear
07/14/11	11:50	MW-3	69.19	77.00	7.81	0.16	1.2	5	4.0	21.7	1.01	7.04	Clear
07/14/11	13:30	MW-4	62.29	71.00	8.71	0.16	1.4	5	3.6	22.9	2.93	7.04	Clear
07/14/11	12:30	MW-5	70.35	79.00	8.65	0.16	1.4	5	3.6	21.7	0.42	7.33	Clear
07/14/11	11:00	MW-6	72.37	77.20	4.83	0.16	0.8	3	3.9	22.6	0.87	7.52	Clear

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 2011)

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

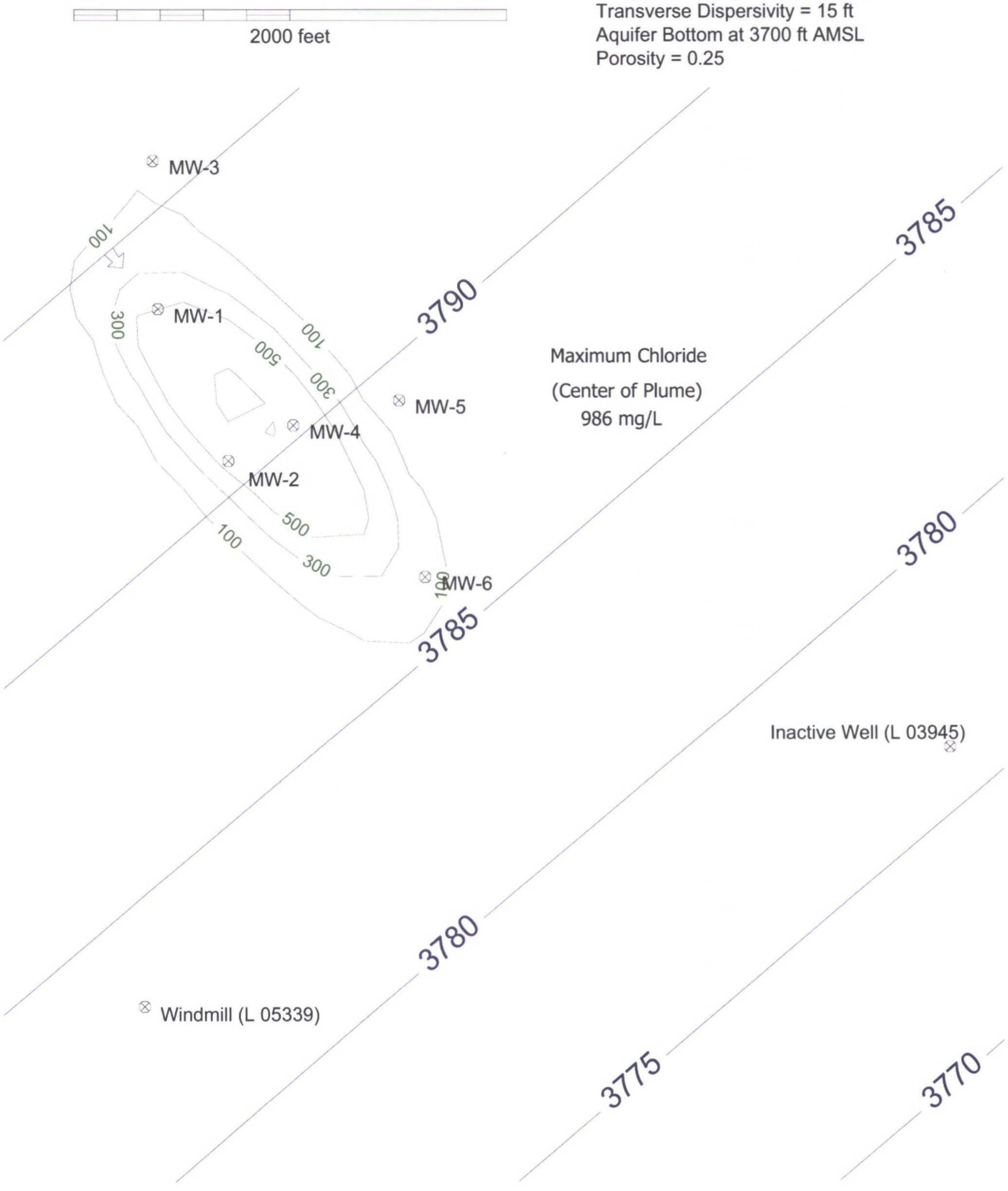
WinTran Fate & Transport Modeling Results

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



Maximum Chloride
(Center of Plume)
986 mg/L

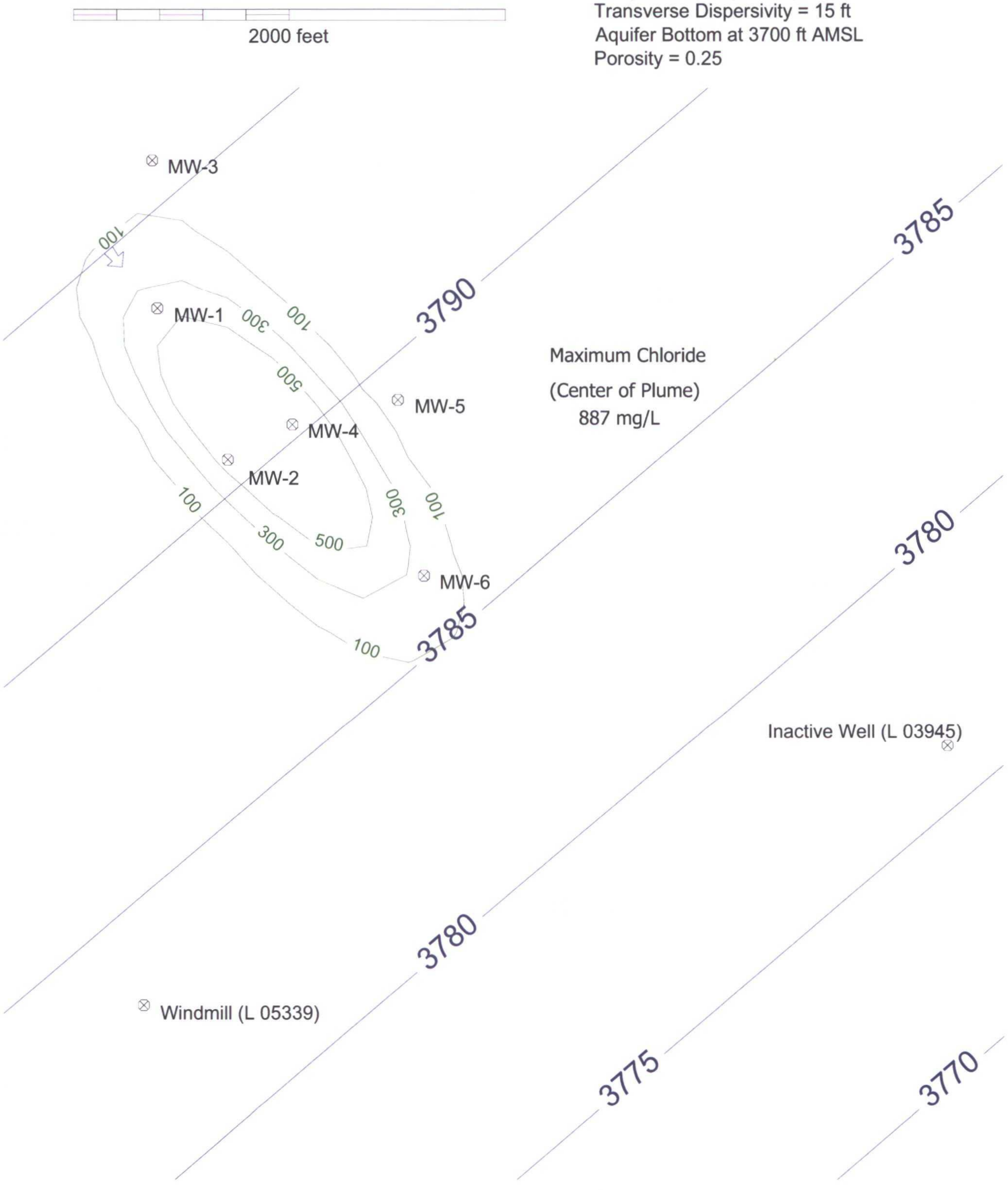
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2020)

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



Maximum Chloride
(Center of Plume)
887 mg/L

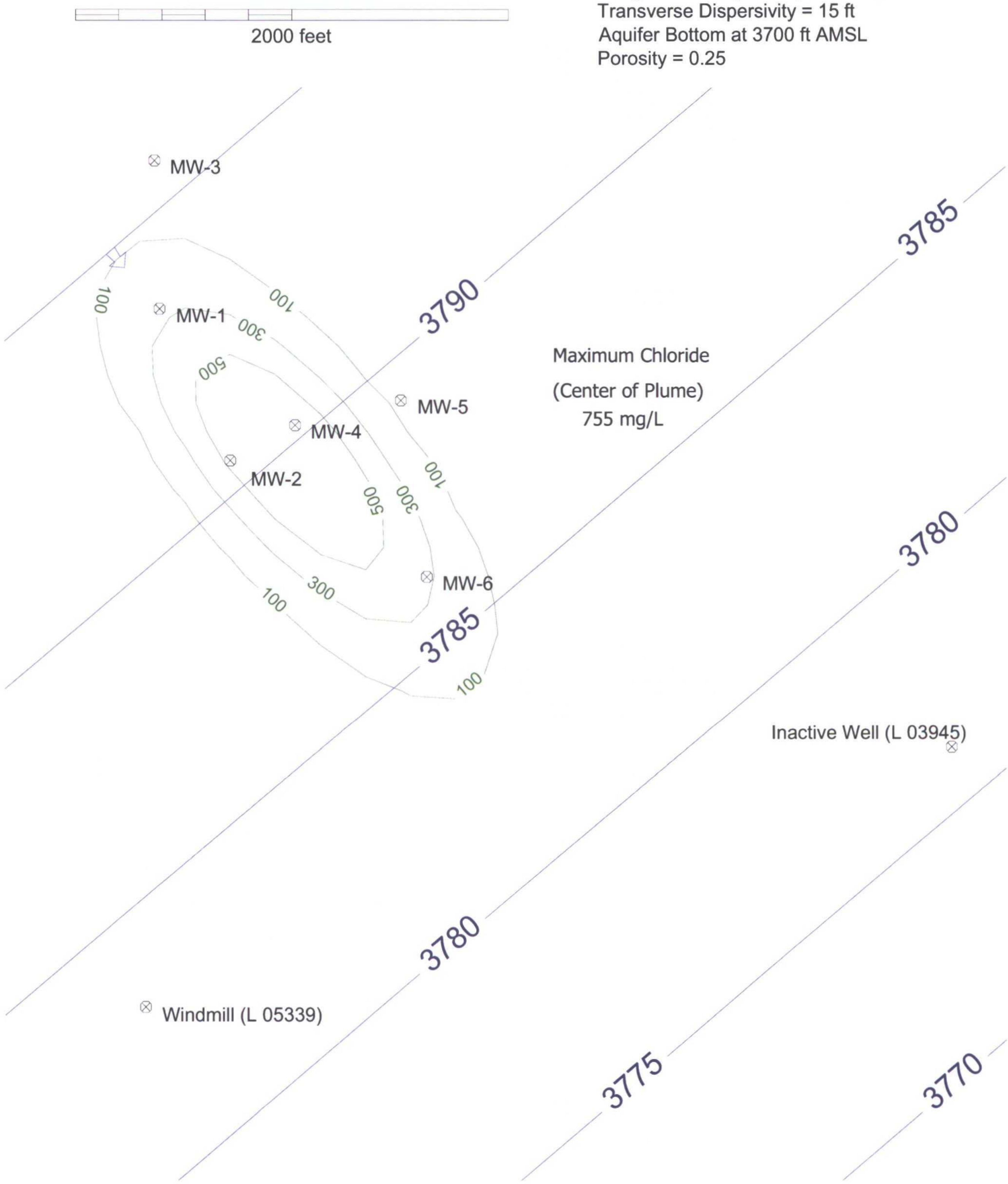
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2030)

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



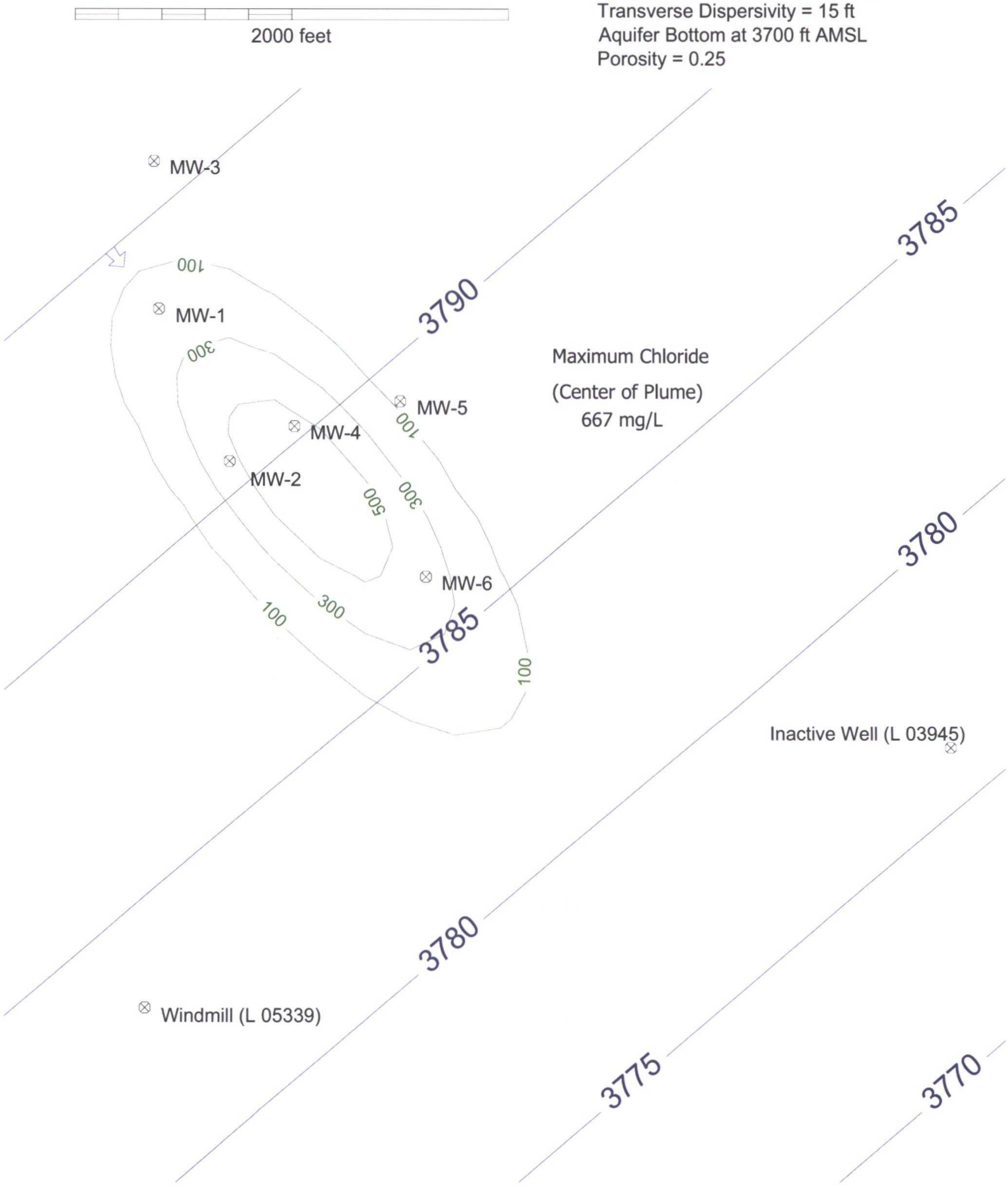
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 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



Maximum Chloride
(Center of Plume)
667 mg/L

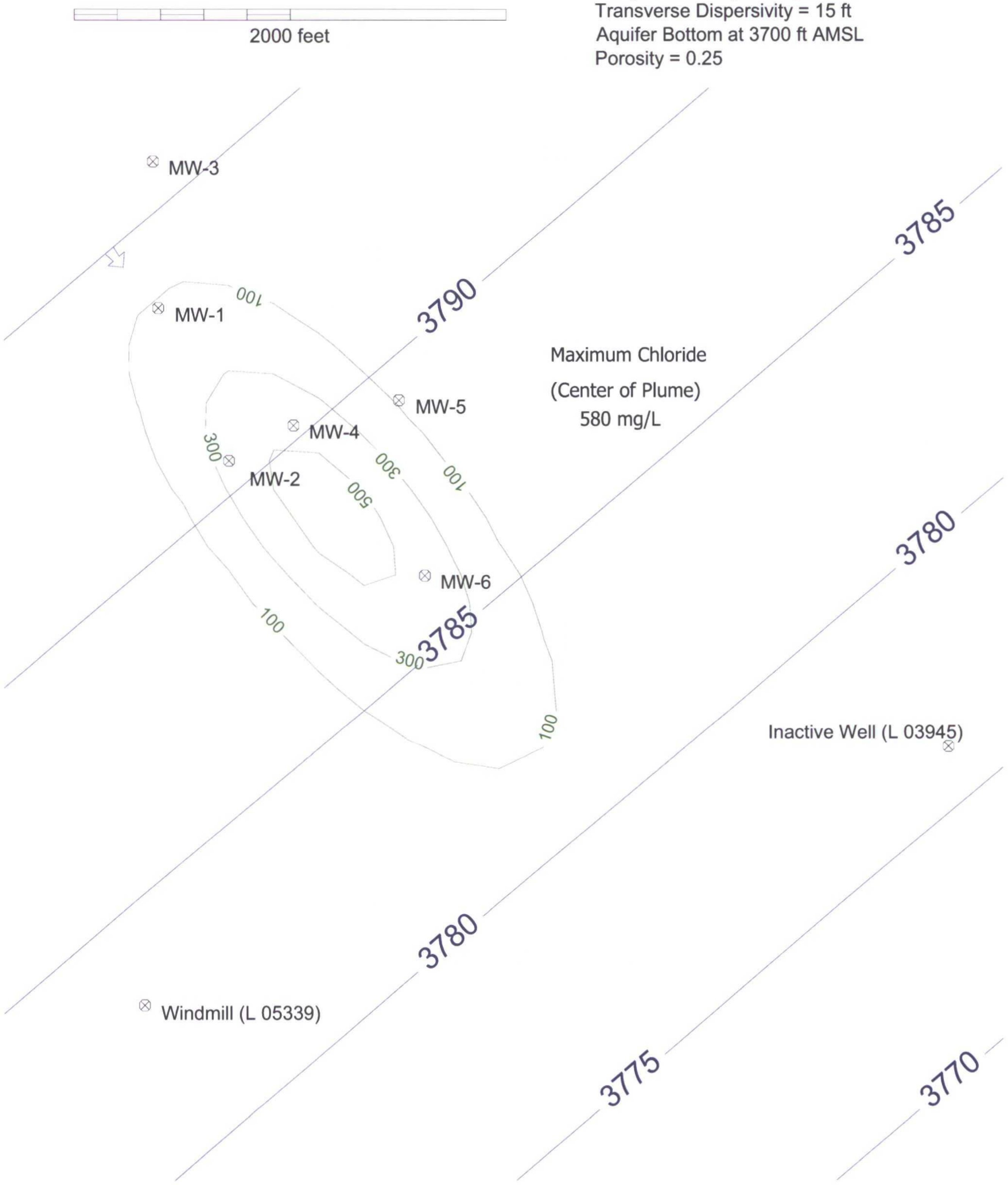
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2050)

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



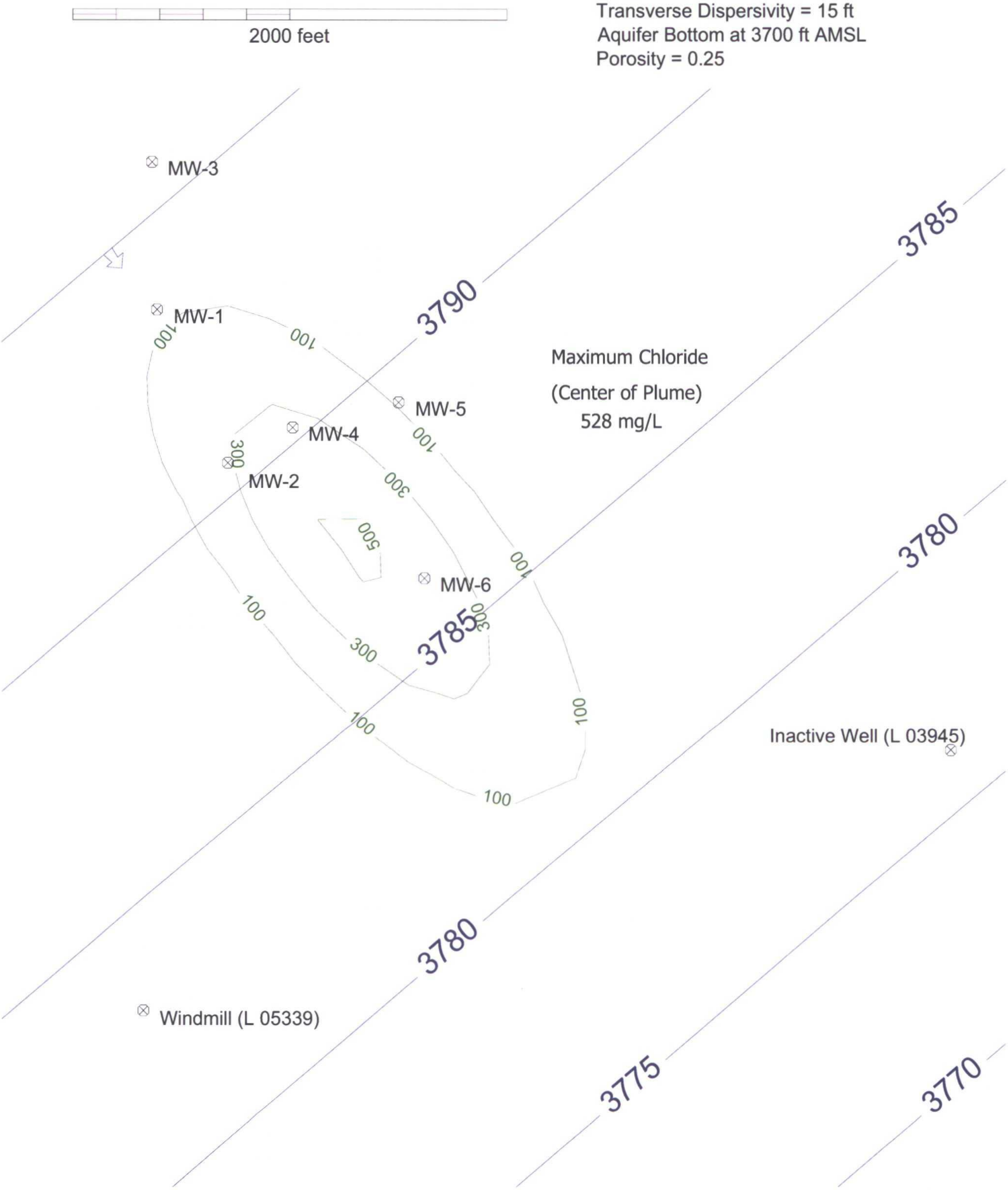
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2060)

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



Maximum Chloride
(Center of Plume)
528 mg/L

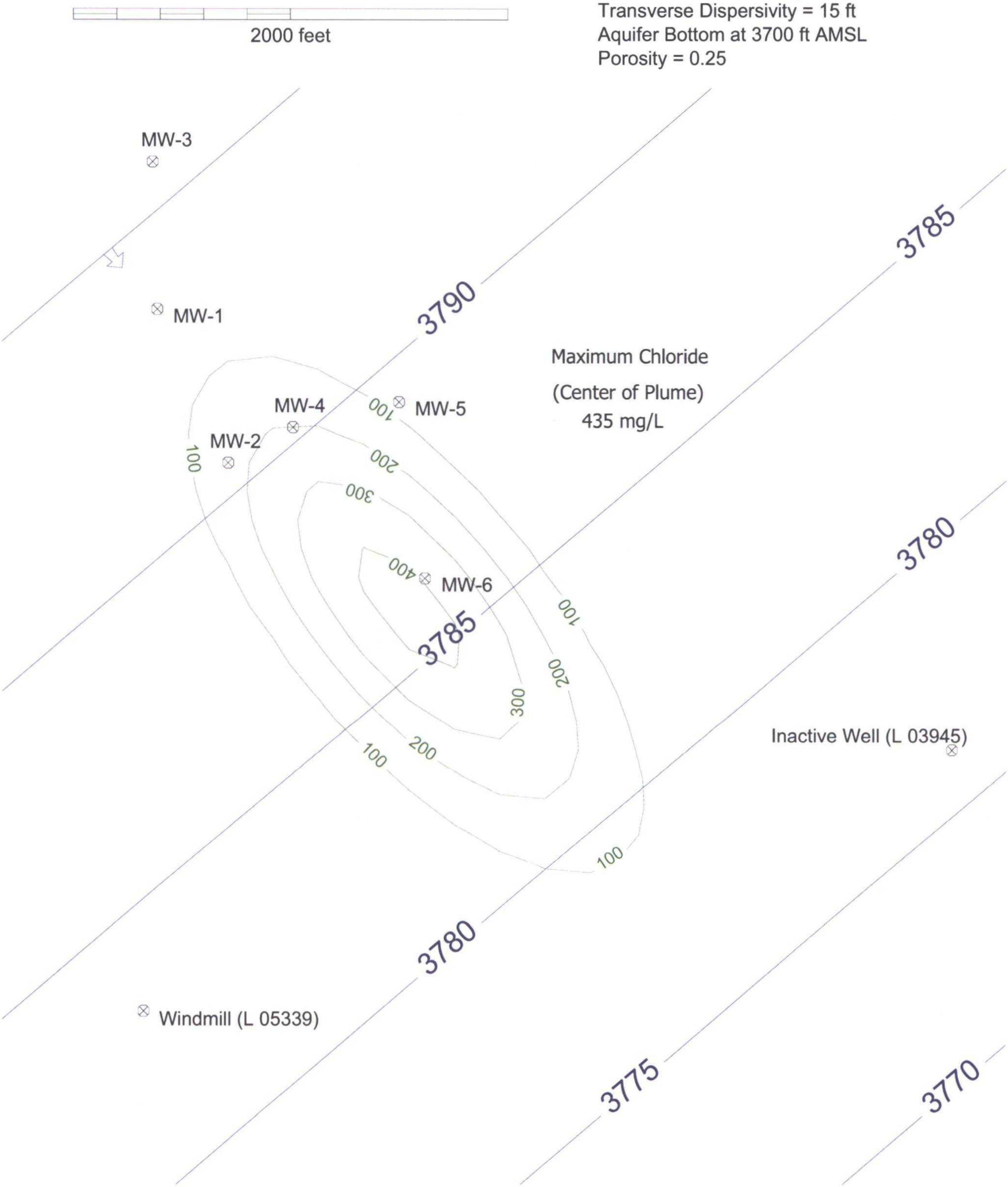
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2080)

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



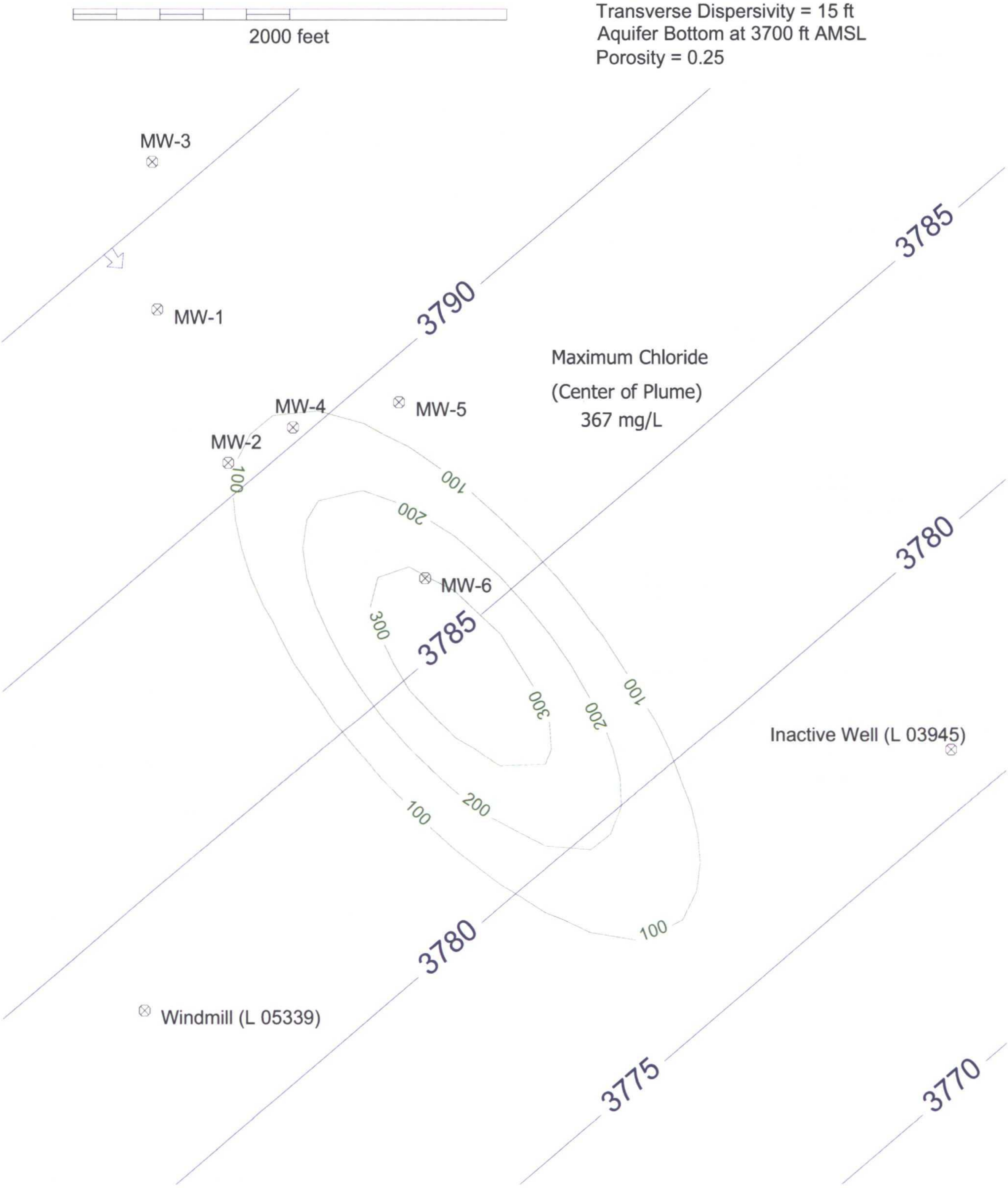
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2100)

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



Maximum Chloride
(Center of Plume)
367 mg/L

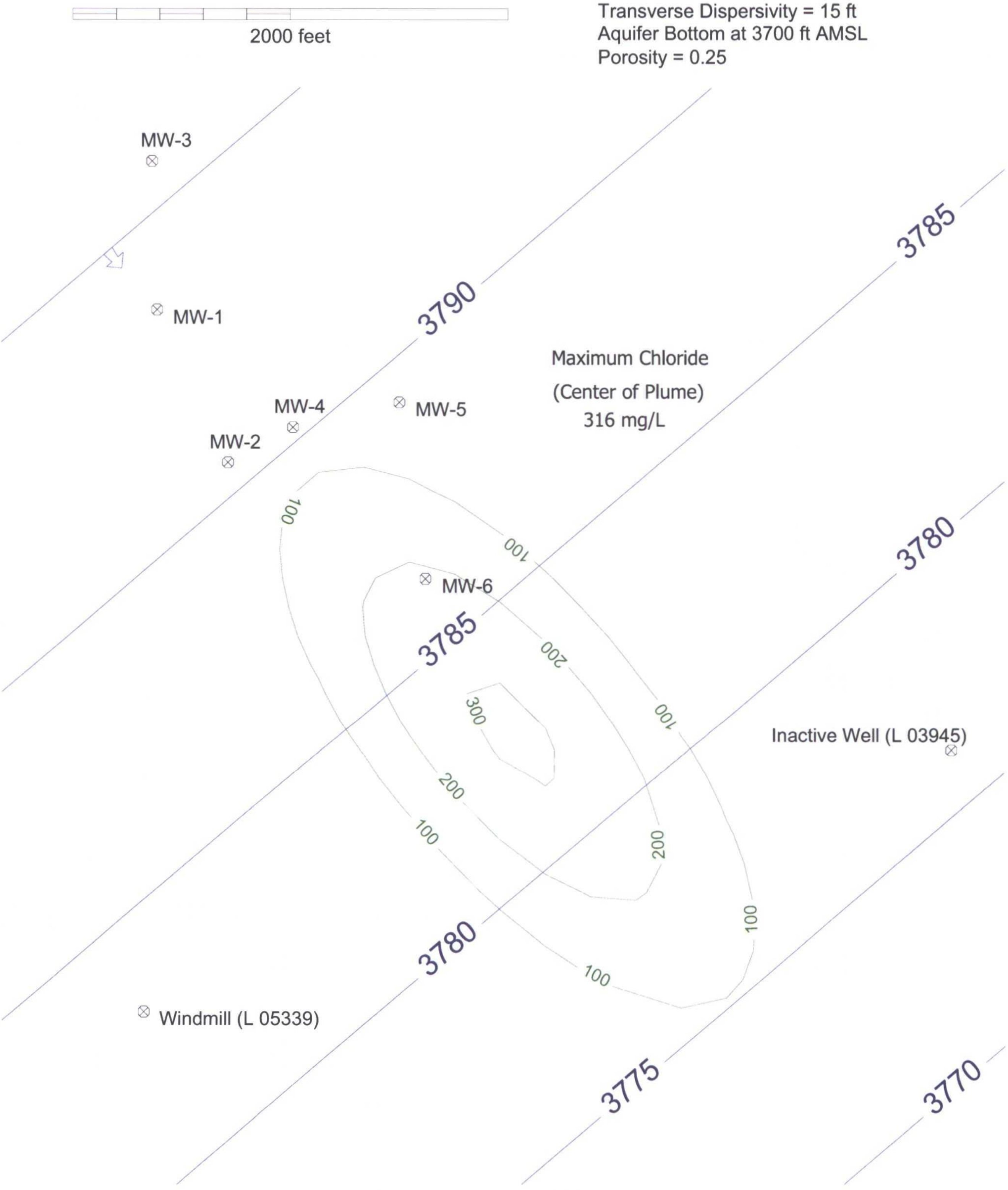
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2120)

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



Maximum Chloride
(Center of Plume)
316 mg/L

WinTran Fate & Transport Modeling Results

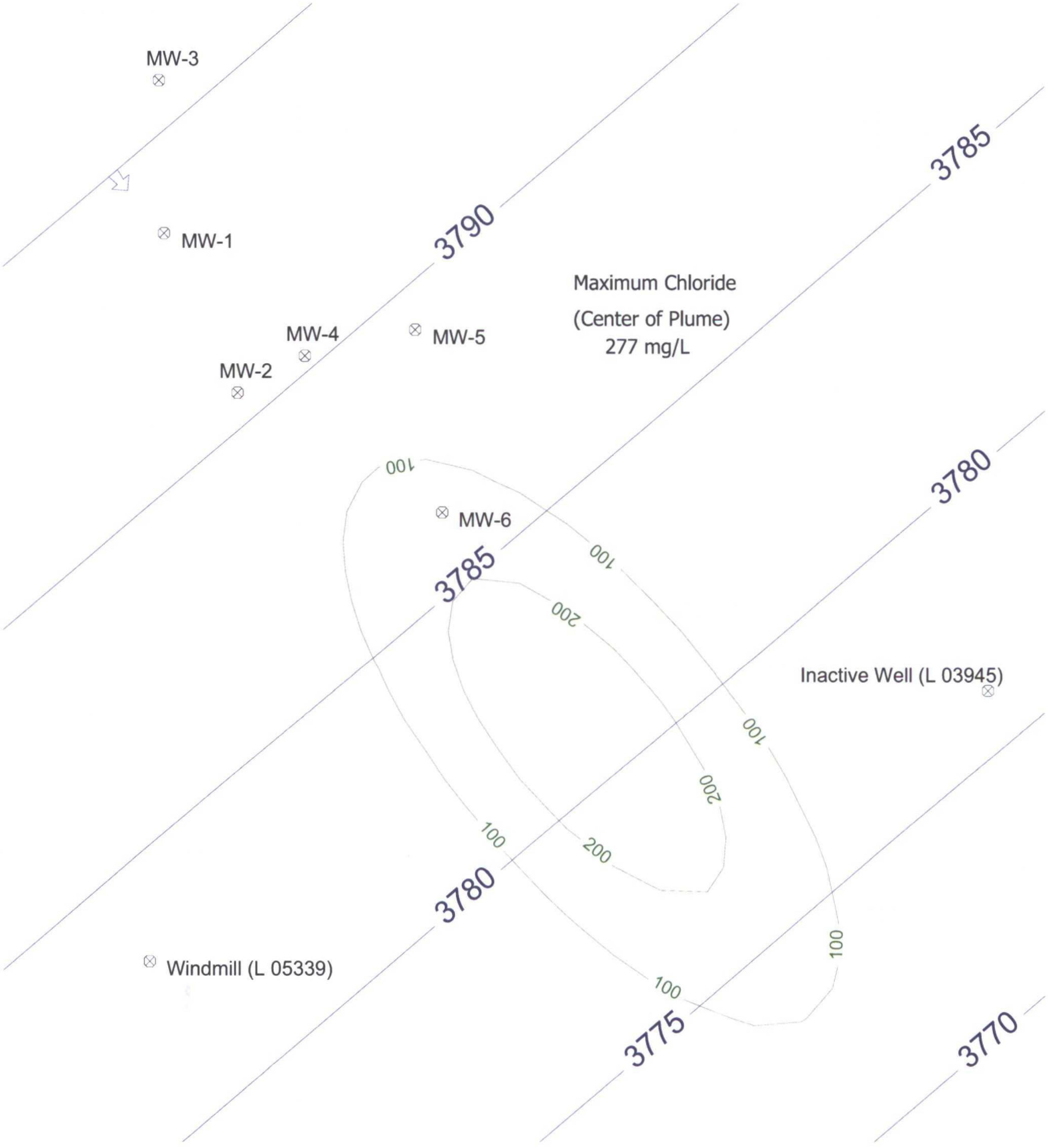
Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2140)

2000 feet

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



Maximum Chloride
(Center of Plume)
277 mg/L

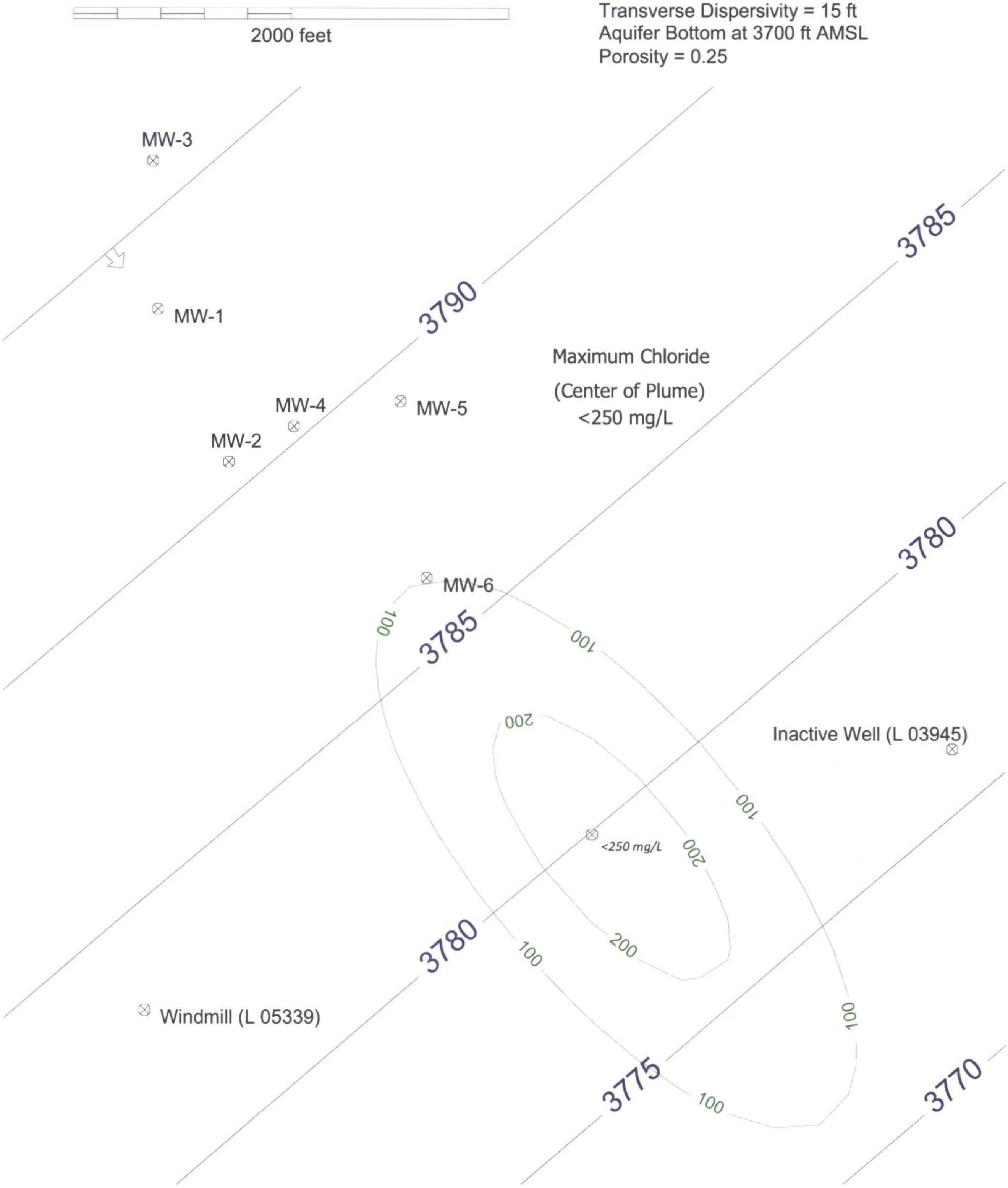
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit Site

Chloride Plume (Year 2157)

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



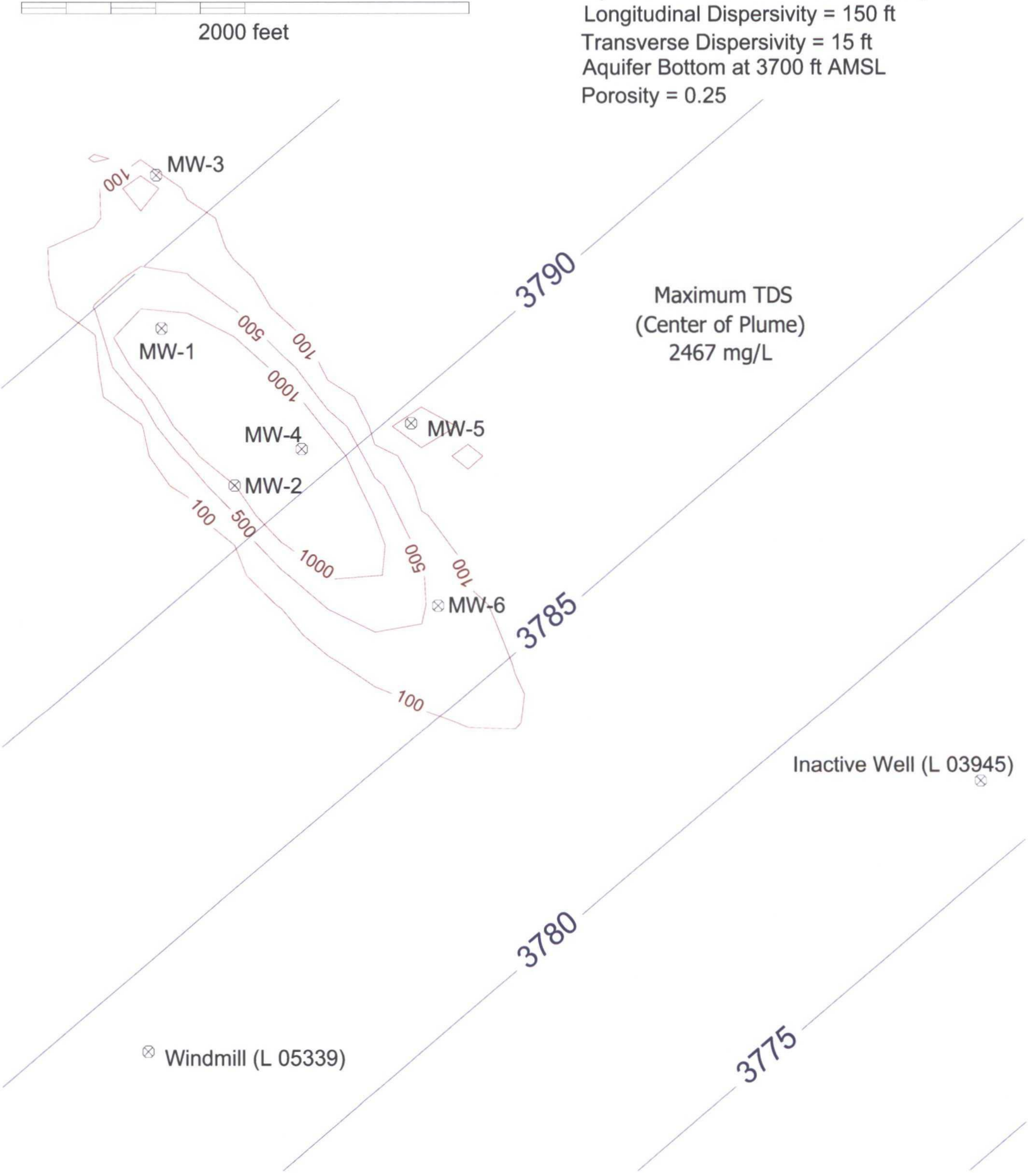
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2011)

Modeling Assumptions

Hydraulic Conductivity = 100 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



Maximum TDS
(Center of Plume)
2467 mg/L

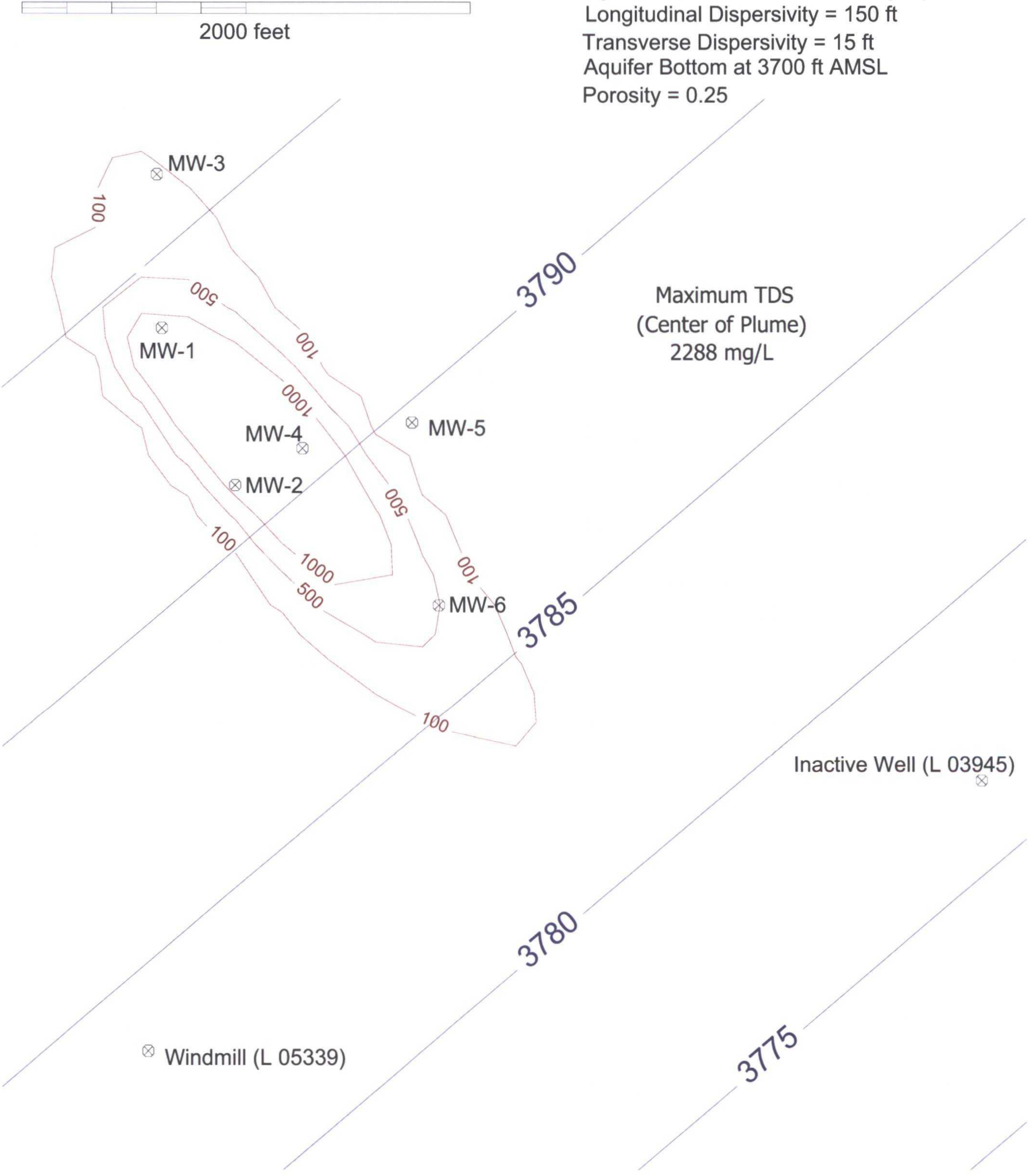
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2015)

Modeling Assumptions

Hydraulic Conductivity = 100 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



Maximum TDS
(Center of Plume)
2288 mg/L

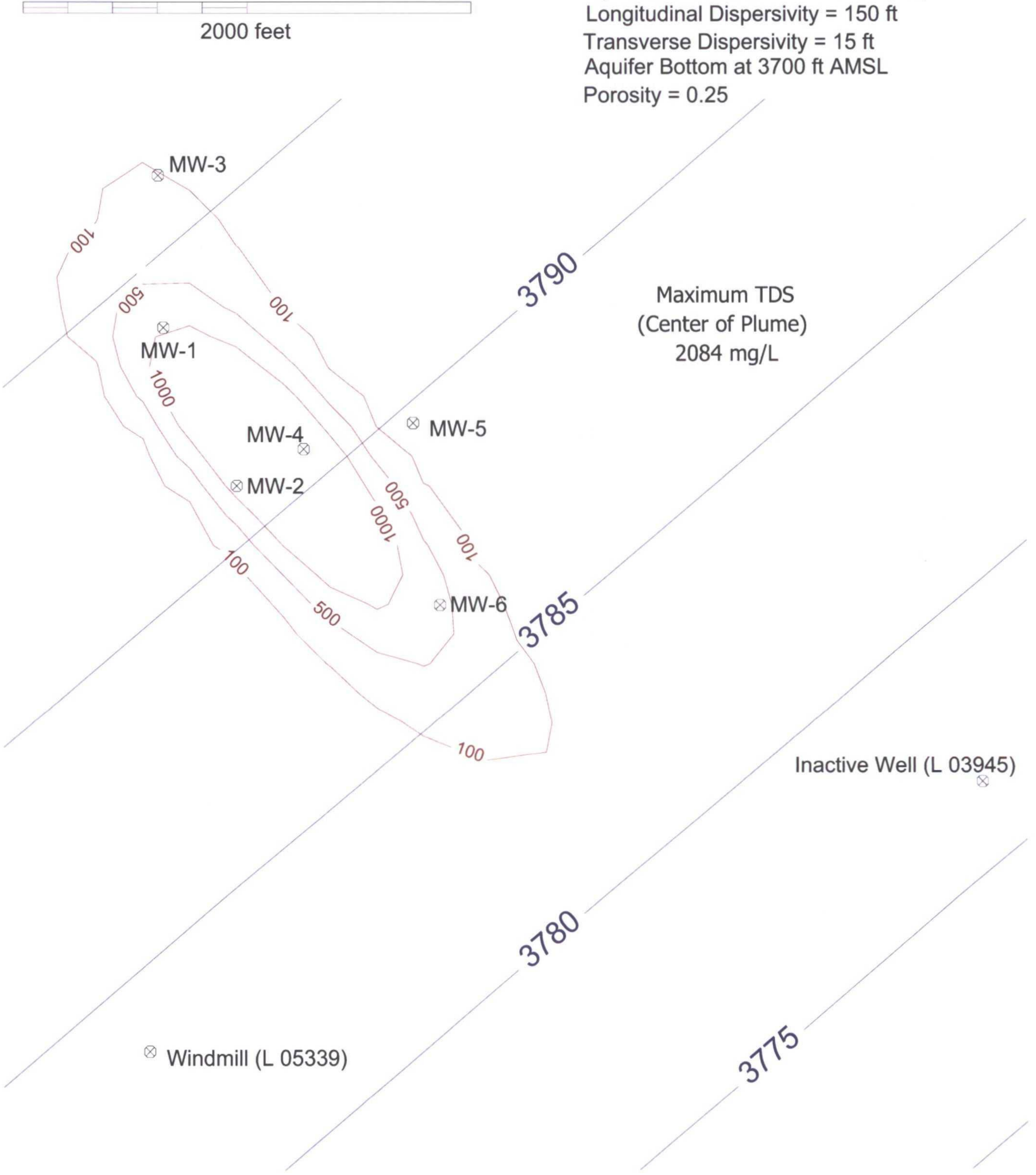
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2020)

Modeling Assumptions

Hydraulic Conductivity = 100 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



Maximum TDS
(Center of Plume)
2084 mg/L

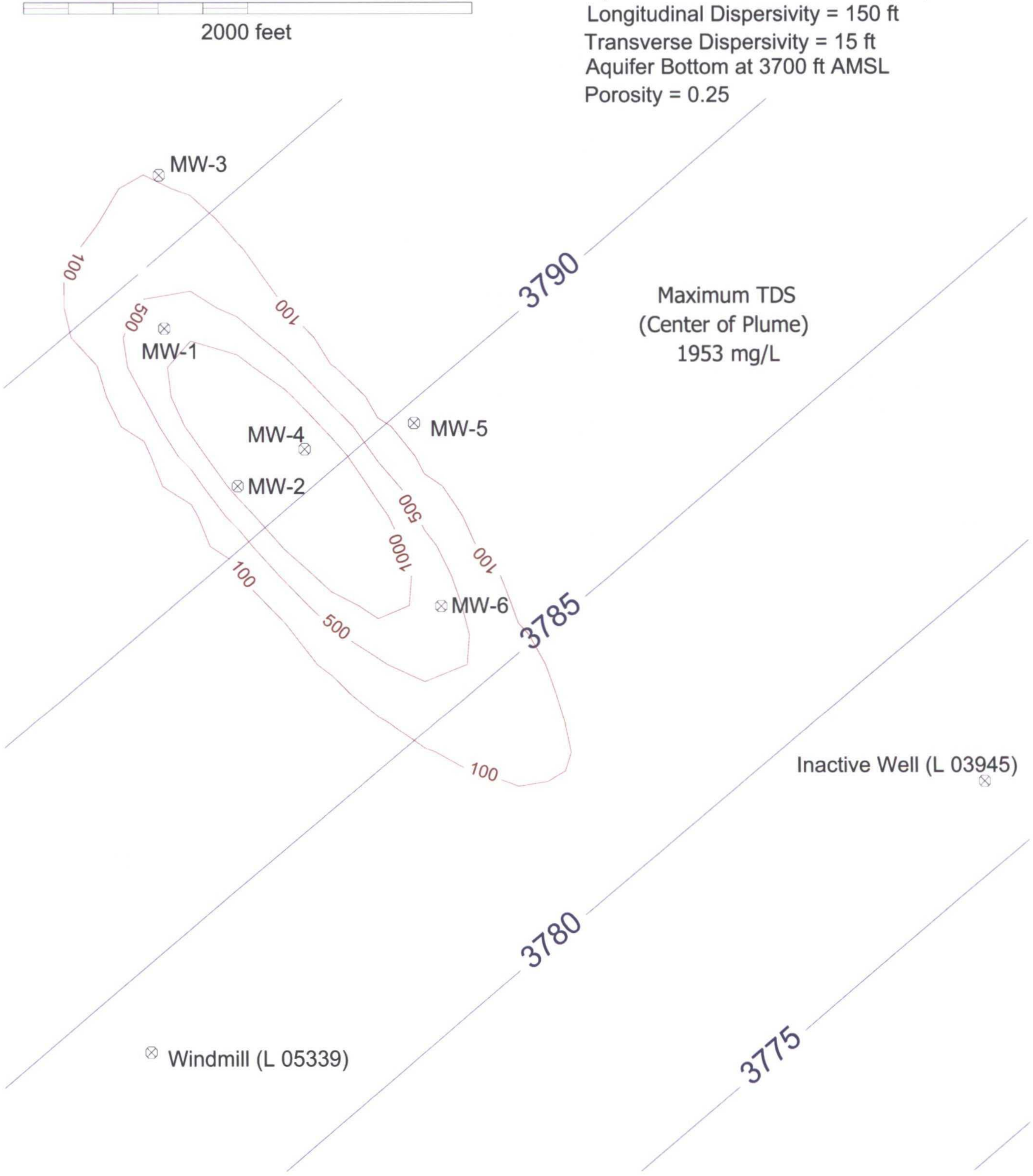
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2025)

Modeling Assumptions

Hydraulic Conductivity = 100 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



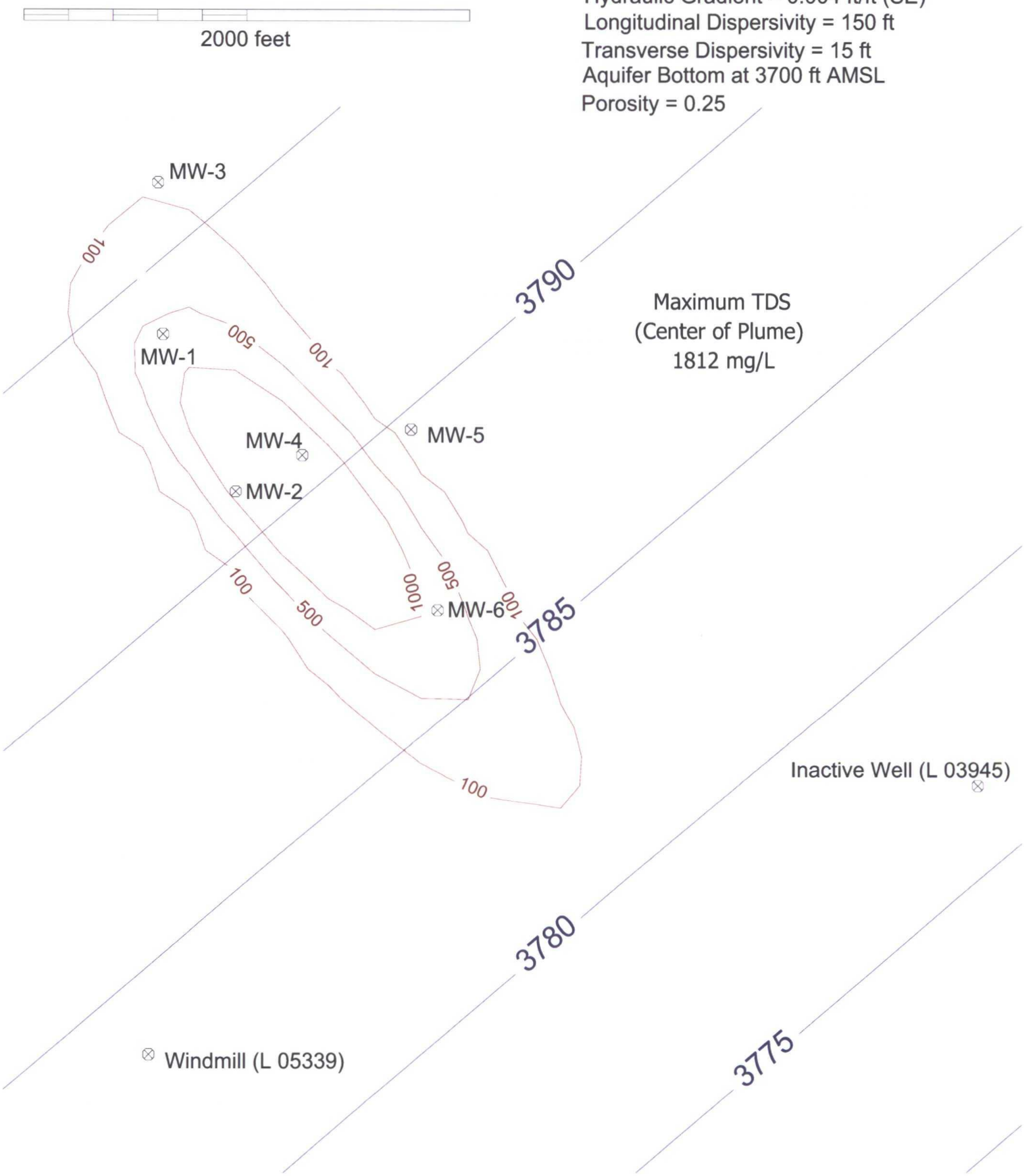
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

Modeling Assumptions

Hydraulic Conductivity = 100 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)



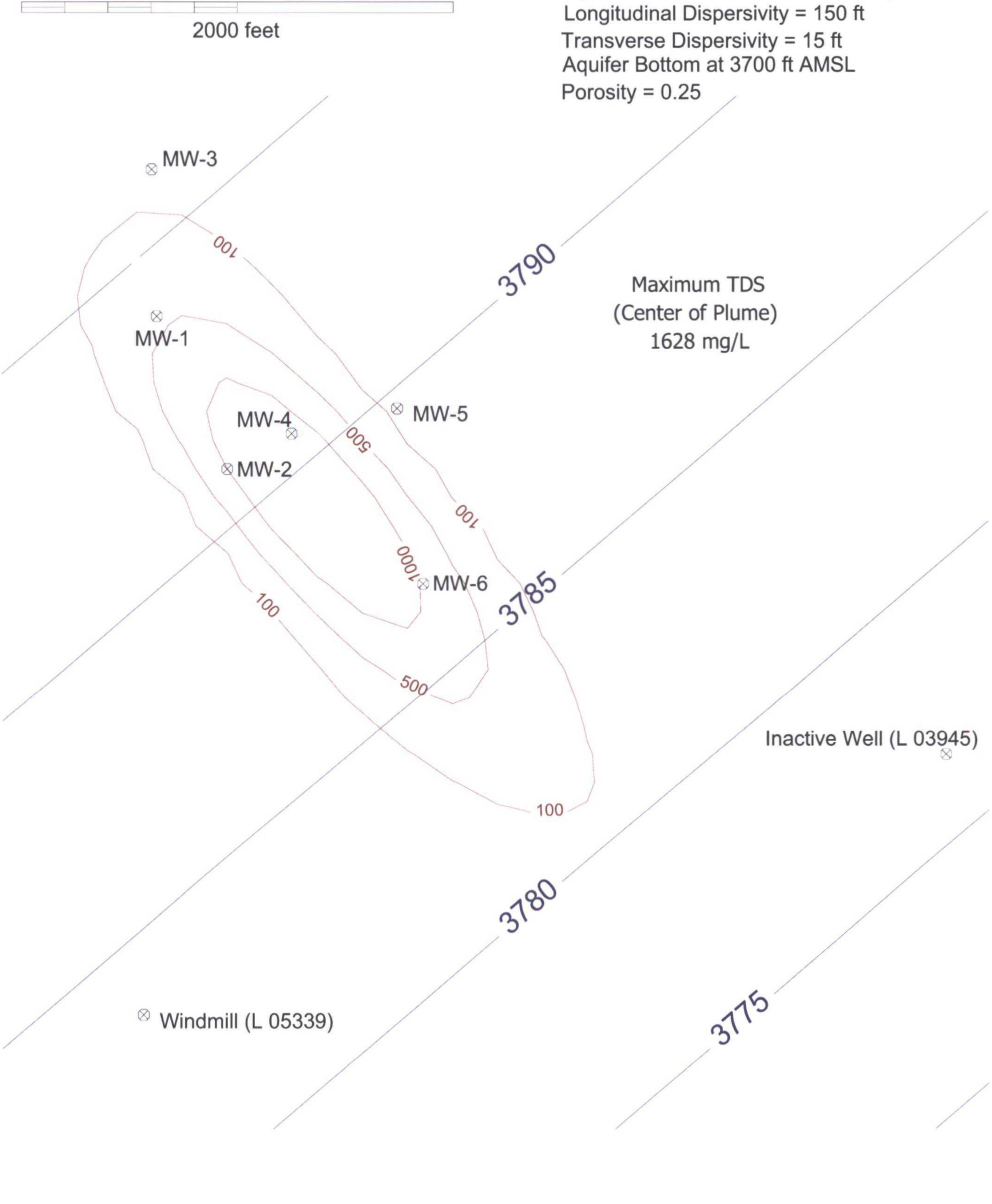
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2040)

Modeling Assumptions

Hydraulic Conductivity = 100 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



Maximum TDS
(Center of Plume)
1628 mg/L

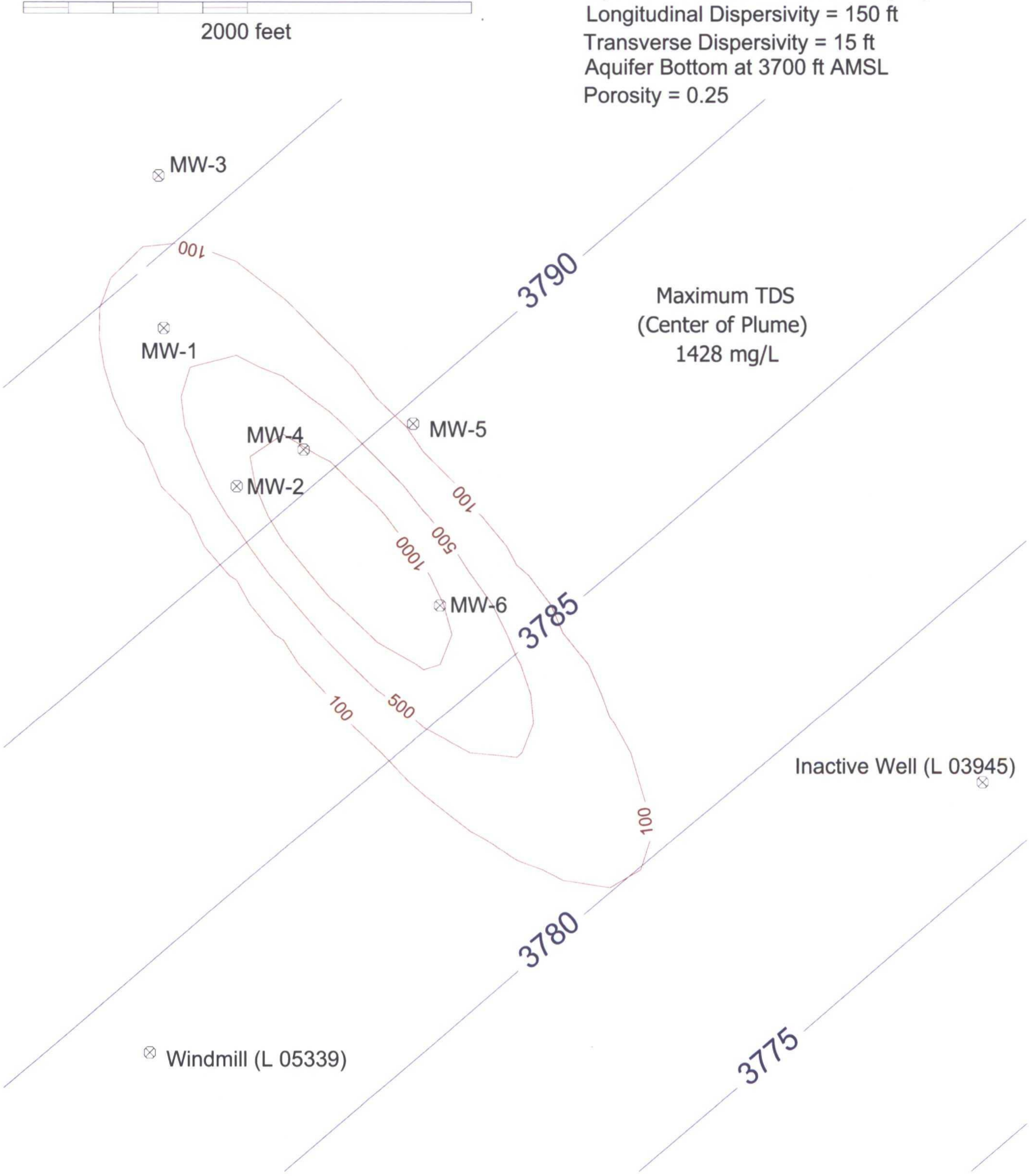
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

Modeling Assumptions

Hydraulic Conductivity = 100 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 2050)



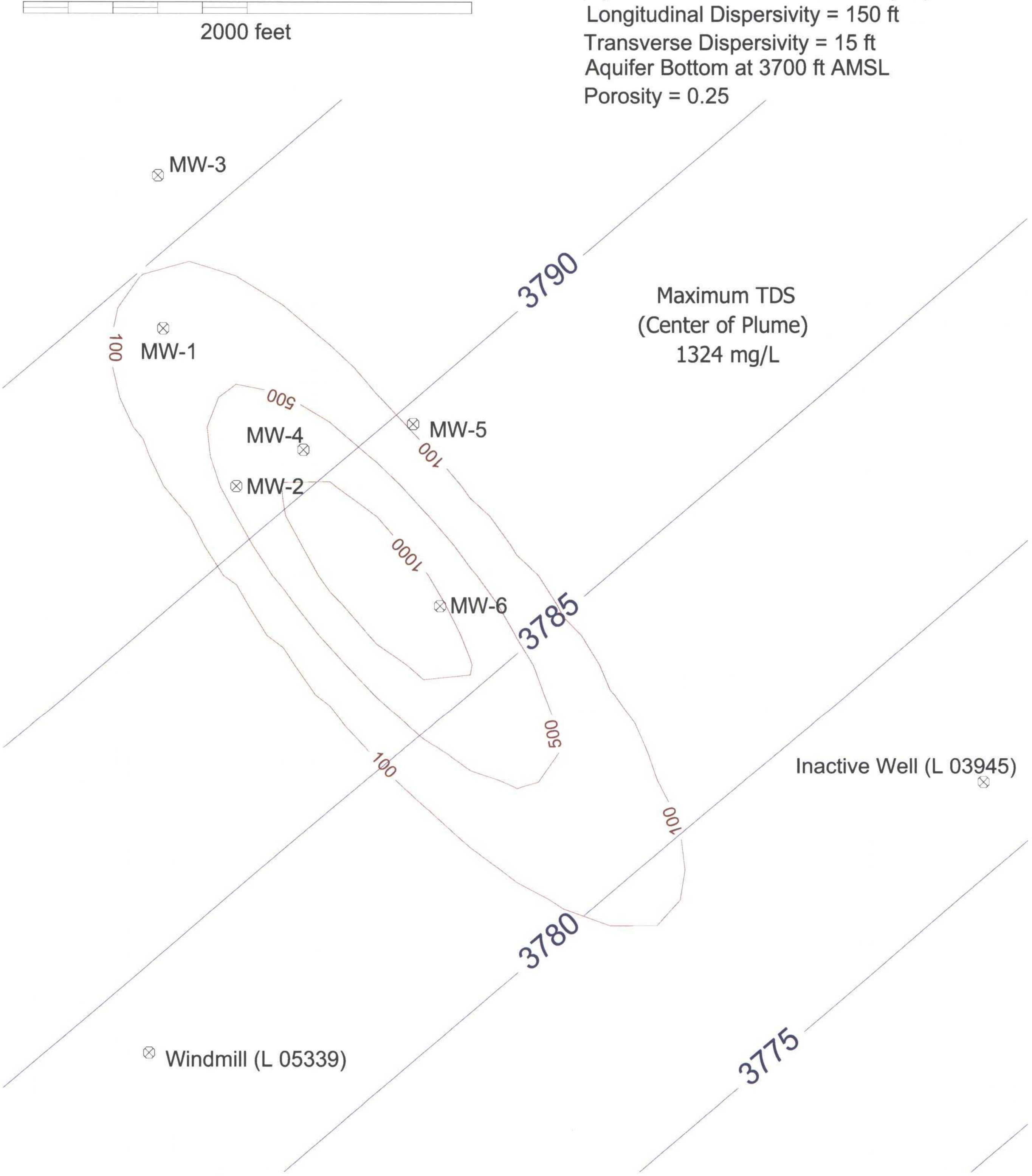
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2060)

Modeling Assumptions

Hydraulic Conductivity = 100 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



Maximum TDS
(Center of Plume)
1324 mg/L

WinTran Fate & Transport Modeling Results

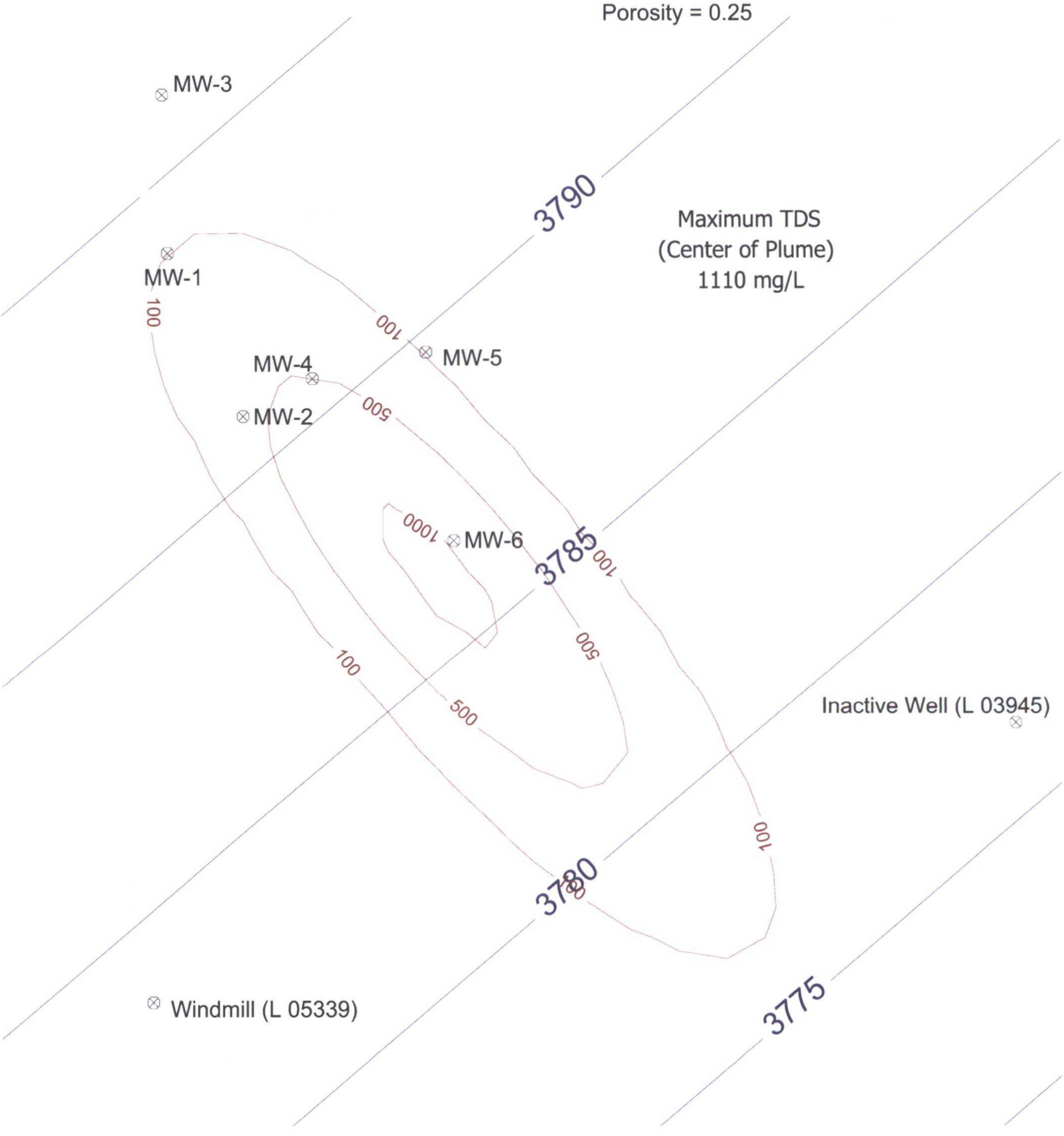
Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2080)

2000 feet

Modeling Assumptions

Hydraulic Conductivity = 100 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



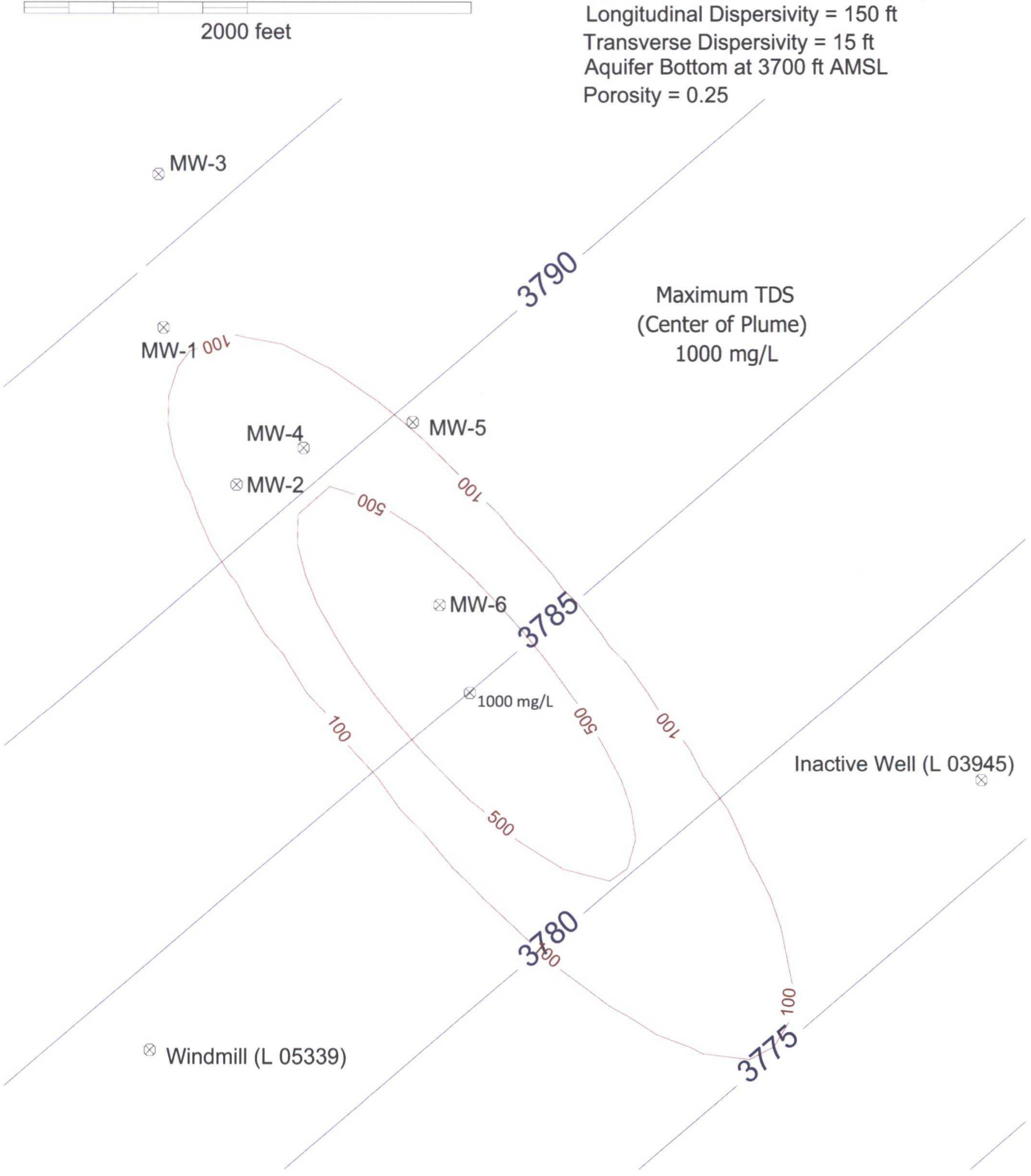
WinTran Fate & Transport Modeling Results

Former Unocal South Vacuum Unit

TDS Plume Simulation (Year 2093)

Modeling Assumptions

Hydraulic Conductivity = 100 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 July 14, 2011 site measurements reported by Trident.

- Direction of flow – measured direction of approximately S 40° E from July 14, 2011 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 2.7 ft/day, or approximately 1000 ft/yr.

- Aquifer top and bottom elevations – bottom elevation of Ogallala Formation at 3700 feet reported by Trident. The top elevation for an unconfined aquifer must be greater than the reference head. An elevation of 4,000 feet was assumed.

- Reference head – measured unconfined head of 3,795 feet adjacent to the former pit and upgradient well MW-1 from July 14, 2011 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 July 14, 2011 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: $v = (k \, . \, i) / n$ 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 does not account for vadose zone transport, and the source input is 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 12 years (1999 to 2011) at one-year increments after entering in 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 2011. 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 de picted 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 146 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 2093) 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

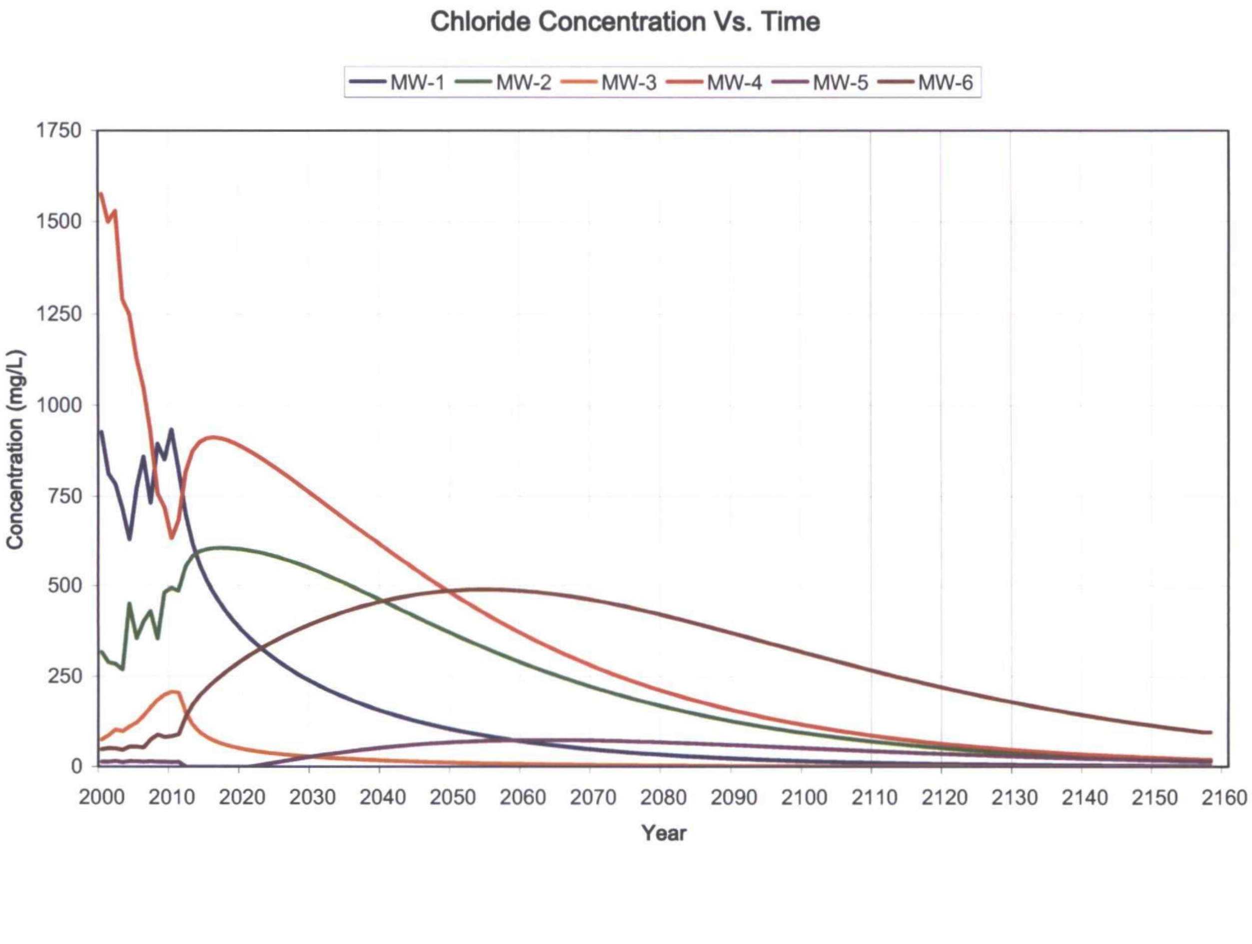
Developed by
James O. Rumbaugh, III
Douglas B. Rumbaugh

==

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

Date: 11/22/2011

Input File: 2015 CL.WTR



```
                    ==========================================================================
                                              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...= 310.000000
   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........= 1460
   Starting time value.........= 2011.000000
   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...............= 2011.000000
   Ending time.................= 2157.000000
   Number of time steps........= 1460

   (NOTE: following mass balance errors expressed as percent)
   Transport Mass Balance Error= 0.000006

   Peclet Criterion............= 1.388889
   Courant Number.............= 0.005180
   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 = 3733.923218
Maximum Head = 3798.475483
```

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
2012	700	552	150	819	0	138	0	0	0.0
2013	616	582	116	875	0	172	0	0	0.0
2014	559	595	95.6	900	0	197	0	0	0.0
2015	515	601	82.0	911	0	217	0	0	0.0
2016	480	603	72.2	913	0	235	0	0	0.0
2017	449	604	64.7	911	0	251	0	0	0.0
2018	423	604	58.7	905	0	267	0	0	0.0
2019	399	603	53.7	897	0	281	0	0	0.0
2020	378	601	49.6	888	0	294	0	0	0.1
2021	358	598	46.1	877	0	307	0	0	0.1
2022	340	594	43.0	866	2.7	319	0	0	0.1
2023	323	590	40.3	853	5.9	330	0	0	0.1
2024	308	585	37.9	841	9.1	341	0	0	0.2
2025	294	580	35.8	827	12.4	351	0	0	0.2
2026	280	574	33.8	814	15.6	361	0	0	0.3
2027	267	567	32.1	800	18.8	370	0	0	0.4
2028	255	561	30.4	786	21.9	379	0	0	0.5
2029	244	553	28.9	771	24.9	388	0	0	0.6
2030	234	546	27.5	757	27.9	396	0	0	0.7
2031	224	538	26.2	742	30.8	404	0	0	0.8
2032	214	530	25.0	727	33.6	411	0	0	1.0
2033	205	521	23.9	713	36.3	418	0	0	1.2
2034	196	513	22.8	698	38.9	425	0	0	1.4
2035	188	504	21.8	683	41.5	431	0	0	1.7
2036	180	495	20.9	668	43.9	437	0	0	2.0
2037	173	486	20.0	654	46.2	443	0	0	2.3
2038	166	477	19.1	639	48.4	448	0	0	2.7
2039	159	467	18.3	625	50.6	453	0	0	3.1
2040	153	458	17.6	611	52.6	458	0	0	3.6
2041	147	449	16.8	597	54.5	462	0	0	4.1
2042	141	440	16.2	583	56.3	466	0	0	4.7
2043	135	430	15.5	569	58.0	470	0	0	5.3
2044	130	421	14.9	555	59.6	473	0	0	6.0
2045	125	412	14.3	542	61.2	476	0	0	6.8
2046	120	403	13.7	529	62.6	479	0	0	7.6
2047	115	394	13.2	516	63.9	481	0	0	8.5
2048	111	385	12.7	503	65.1	484	0	0	9.5
2049	106	376	12.2	490	66.3	485	0	0	10.6
2050	102	367	11.7	478	67.3	487	0	0	11.7
2051	98	358	11.2	466	68.3	488	0	0	12.9
2052	94.4	350	10.8	454	69.1	489	0	0	14.2
2053	90.8	341	10.4	442	69.9	490	0	0	15.6
2054	87.3	333	10.0	431	70.6	490	0	0	17.1
2055	84.0	325	9.6	420	71.2	490	0	0	18.7

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
2056	80.8	317	9.3	409	71.8	490	0	0	20.4
2057	77.7	309	8.9	398	72.2	489	0	0	22.1
2058	74.8	301	8.6	387	72.6	488	0	0	24.0
2059	71.9	294	8.2	377	72.9	487	0	0	25.9
2060	69.2	286	7.9	367	73.2	486	0	0	28.0
2061	66.6	279	7.6	357	73.4	484	0	0	30.1
2062	64.1	271	7.3	347	73.5	483	0	0	32.3
2063	61.7	264	7.1	338	73.6	481	0	0	34.7
2064	59.4	258	6.8	329	73.6	478	0	0	37.1
2065	57.2	251	6.6	320	73.5	476	0	0	39.6
2066	55.0	244	6.3	311	73.4	473	0	0	42.2
2067	53.0	238	6.1	303	73.2	470	0	0	44.9
2068	51.0	231	5.9	294	73.0	467	0	0	47.6
2069	49.1	225	5.6	286	72.7	464	0	0	50.5
2070	47.3	219	5.4	278	72.4	461	0	0	53.4
2071	45.6	213	5.2	270	72.1	457	0	0	56.4
2072	43.9	207	5.0	263	71.7	453	0	0	59.5
2073	42.3	202	4.9	255	71.2	449	0	0	62.7
2074	40.7	196	4.7	248	70.8	445	0	0	65.9
2075	39.2	191	4.5	241	70.3	441	0	0	69.2
2076	37.8	186	4.3	235	69.7	437	0	0	72.6
2077	36.4	180	4.2	228	69.2	433	0	0	76.0
2078	35.0	175	4.0	221	68.6	428	0	0	79.5
2079	33.8	171	3.9	215	67.9	424	0	0	83.0
2080	32.5	166	3.7	209	67.3	419	0	0	86.6
2081	31.3	161	3.6	203	66.6	414	0	0	90.2
2082	30.2	157	3.5	197	65.9	409	0	0	93.9
2083	29.1	152	3.3	192	65.2	404	0	0	97.6
2084	28.0	148	3.2	186	64.5	399	0	0	101
2085	27.0	144	3.1	181	63.7	394	0	0	105
2086	26.0	140	3.0	175	63.0	389	0	0	109
2087	25.1	136	2.9	170	62.2	384	0	0	113
2088	24.2	132	2.8	165	61.4	379	0	0	116
2089	23.3	128	2.7	161	60.6	374	0	0	120
2090	22.5	124	2.6	156	59.8	369	0	0	124
2091	21.6	121	2.5	151	58.9	363	0	0	128
2092	20.9	117	2.4	147	58.1	358	0	0	132
2093	20.1	114	2.3	143	57.3	353	0	0	136
2094	19.4	111	2.2	138	56.4	347	0	0	140
2095	18.7	108	2.2	134	55.6	342	0	0	143
2096	18.0	104	2.1	130	54.7	337	0	0	147
2097	17.4	101	2.0	127	53.9	332	0	0	151
2098	16.7	98	1.9	123	53.0	326	0	0	155
2099	16.1	95.6	1.9	119	52.2	321	0	0	158

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
2100	15.6	92.8	1.8	116	51.3	316	0	0	162
2101	15.0	90.1	1.7	112	50.5	311	0	0	166
2102	14.5	87.4	1.7	109	49.6	305	0	0	169
2103	14.0	84.9	1.6	106	48.8	300	0	0	173
2104	13.5	82.4	1.5	103	48.0	295	0	0	177
2105	13.0	80.0	1.5	100	47.1	290	0	0	180
2106	12.5	77.6	1.4	96.6	46.3	285	0	0	183
2107	12.1	75.3	1.4	93.7	45.4	280	0	0	187
2108	11.6	73.1	1.3	91.0	44.6	275	0	0	190
2109	11.2	70.9	1.3	88.2	43.8	270	0	0	193
2110	10.8	68.8	1.2	85.6	43.0	265	0	0	197
2111	10.4	66.8	1.2	83.0	42.2	260	0	0	200
2112	10.1	64.8	1.2	80.6	41.4	255	0	0	203
2113	9.7	62.9	1.1	78.1	40.6	250	0	0	206
2114	9.4	61.0	1.1	75.8	39.8	246	0	0	209
2115	9.0	59.2	1.0	73.5	39.0	241	0	0	211
2116	8.7	57.4	1.0	71.3	38.3	236	0	0	214
2117	8.4	55.7	1.0	69.2	37.5	232	0	0	217
2118	8.1	54.1	0.9	67.1	36.7	227	0	0	219
2119	7.8	52.5	0.9	65.1	36.0	223	0	0	222
2120	7.5	50.9	0.9	63.1	35.3	218	0	0	224
2121	7.3	49.4	0.8	61.2	34.6	214	0	0	227
2122	7.0	47.9	0.8	59.3	33.8	209	0	0	229
2123	6.8	46.4	0.8	57.6	33.1	205	0	0	231
2124	6.5	45.0	0.8	55.8	32.4	201	0	0	233
2125	6.3	43.7	0.7	54.1	31.8	197	0	0	235
2126	6.1	42.4	0.7	52.5	31.1	193	0	0	237
2127	5.9	41.1	0.7	50.9	30.4	189	0	0	239
2128	5.7	39.9	0.7	49.3	29.8	185	0	0	240
2129	5.5	38.7	0.6	47.8	29.1	181	0	0	242
2130	5.3	37.5	0.6	46.4	28.5	177	0	0	243
2131	5.1	36.4	0.6	45.0	27.9	173	0	0	245
2132	4.9	35.3	0.6	43.6	27.2	170	0	0	246
2133	4.7	34.2	0.5	42.3	26.6	166	0	0	247
2134	4.6	33.2	0.5	41.0	26.1	162	0	0	248
2135	4.4	32.2	0.5	39.7	25.5	159	0	0	249
2136	4.3	31.2	0.5	38.5	24.9	155	0	0	250
2137	4.1	30.2	0.5	37.4	24.3	152	0	0	251
2138	4.0	29.3	0.5	36.2	23.8	149	0	0	252
2139	3.8	28.4	0.4	35.1	23.2	145	0	0	253
2140	3.7	27.6	0.4	34.0	22.7	142	0	0	253
2141	3.6	26.7	0.4	33.0	22.2	139	0	0	254
2142	3.4	25.9	0.4	32.0	21.7	136	0	0	254
2143	3.3	25.1	0.4	31.0	21.2	133	0	0	254

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
2144	3.2	24.4	0.4	30.1	20.7	130	0	0	254
2145	3.1	23.6	0.4	29.1	20.2	127	0	0	255
2146	3.0	22.9	0.3	28.2	19.7	124	0	0	255
2147	2.9	22.2	0.3	27.4	19.2	121	0	0	255
2148	2.8	21.5	0.3	26.5	18.8	118	0	0	254
2149	2.7	20.9	0.3	25.7	18.3	115	0	0	254
2150	2.6	20.2	0.3	24.9	17.9	113	0	0	254
2151	2.5	19.6	0.3	24.2	17.5	110	0	0	254
2152	2.4	19.0	0.3	23.4	17.1	108	0	0	253
2153	2.3	18.4	0.3	22.7	16.6	105	0	0	253
2154	2.3	17.8	0.3	22.0	16.2	103	0	0	252
2155	2.2	17.3	0.3	21.3	15.8	100	0	0	251
2156	2.1	16.8	0.2	20.7	15.5	98	0	0	251
2157	2.0	16.3	0.2	20.0	15.1	95	0	0	250
2158	2.0	16.2	0.2	19.9	14.9	95	0	0	249

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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

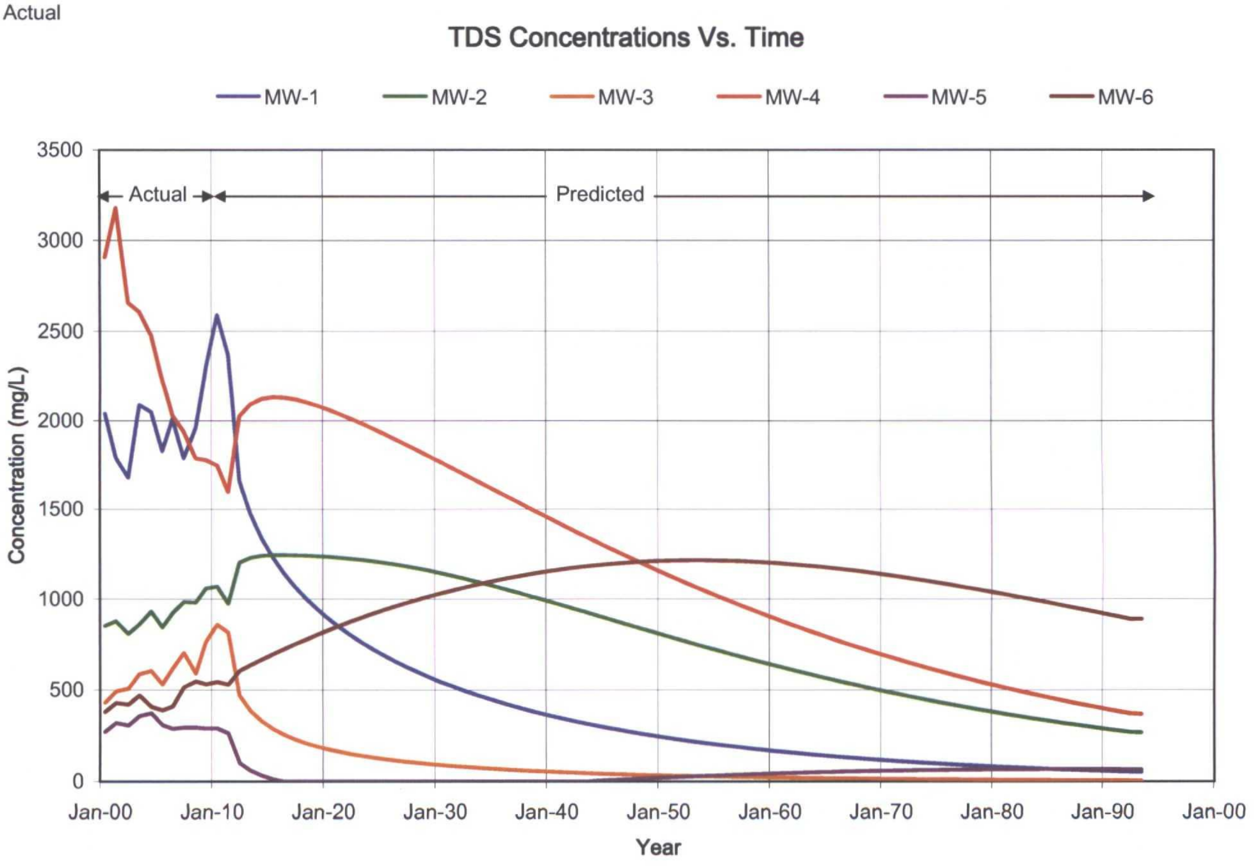
==

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

Date: 11/22/2011

Input File: TDS 2015.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...= 310.000000
   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.........= 2011.000000
   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...............= 2011.000000
   Ending time.................= 2093.000000
   Number of time steps........= 820

   (NOTE: following mass balance errors expressed as percent)
   Transport Mass Balance Error= 0.000421

   Peclet Criterion............= 1.388889
   Courant Number..............= 0.005044
   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 = 3734.910293
Maximum Head = 3798.819859
```

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
2012	1660	1203	471	2027	102	606	0	0	118
2013	1474	1230	388	2095	61.1	637	0	0	127
2014	1338	1240	331	2125	33.4	667	0	0	137
2015	1231	1244	290	2135	13.7	696	0	0	147
2016	1143	1245	258	2132	-0.8	724	0	0	158
2017	1067	1243	232	2122	0	752	0	0	170
2018	1001	1241	211	2106	0	779	0	0	182
2019	943	1238	193	2086	0	804	0	0	194
2020	890	1234	177	2064	0	829	0	0	208
2021	842	1229	164	2039	0	853	0	0	221
2022	799	1224	152	2013	0	877	0	0	236
2023	759	1217	142	1985	0	899	0	0	250
2024	721	1210	132	1956	0	920	0	0	266
2025	687	1201	124	1927	0	941	0	0	281
2026	655	1192	117	1896	0	961	0	0	297
2027	625	1181	110	1865	0	980	0	0	313
2028	597	1170	103	1834	0	998	0	0	330
2029	570	1158	97.4	1802	0	1015	0	0	347
2030	545	1145	92.0	1769	0	1032	0	0	364
2031	522	1131	87.1	1737	0	1048	0	0	381
2032	500	1116	82.5	1704	0	1063	0	0	399
2033	479	1101	78.2	1672	0	1078	0	0	416
2034	459	1085	74.2	1639	0	1091	0	0	434
2035	440	1069	70.4	1606	0	1105	0	0	452
2036	422	1052	67.0	1574	0	1117	0	0	469
2037	405	1035	63.7	1541	0	1128	0	0	487
2038	389	1018	60.6	1509	0	1139	0	0	505
2039	373	1000	57.7	1477	0	1150	0	0	522
2040	358	982	55.0	1445	0	1159	0	0	539
2041	344	964	52.4	1413	0	1168	0	0	557
2042	331	946	50.0	1382	0	1176	0	0	574
2043	318	928	47.7	1351	0	1183	0	0	591
2044	306	909	45.6	1321	5.3	1189	0	0	607
2045	294	891	43.6	1291	8.1	1195	0	0	624
2046	283	873	41.6	1261	10.9	1200	0	0	640
2047	272	855	39.8	1232	13.7	1205	0	0	656
2048	262	837	38.1	1203	16.5	1208	0	0	672
2049	252	819	36.4	1174	19.2	1211	0	0	687
2050	243	801	34.9	1146	21.8	1214	0	0	703
2051	234	783	33.4	1119	24.4	1215	0	0	717
2052	225	765	32.0	1092	27.0	1216	0	0	732
2053	217	748	30.6	1065	29.5	1217	0	0	746
2054	209	731	29.3	1039	31.9	1216	0	0	760
2055	201	714	28.1	1014	34.2	1215	0	0	773

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
2056	194	697	27.0	989	36.5	1214	0	0	786
2057	187	681	25.8	964	38.7	1212	0	0	799
2058	180	665	24.8	940	40.8	1209	0	0	811
2059	174	649	23.8	916	42.9	1205	0	0	823
2060	167	633	22.8	893	44.8	1201	0	0	834
2061	161	618	21.9	870	46.7	1197	0	0	845
2062	156	603	21.0	848	48.5	1192	0	0	855
2063	150	588	20.2	826	50.2	1187	0	0	865
2064	145	573	19.4	805	51.8	1181	0	0	875
2065	140	559	18.6	784	53.4	1174	0	0	884
2066	135	545	17.9	764	54.8	1167	0	0	892
2067	130	531	17.2	744	56.2	1160	0	0	901
2068	125	518	16.5	725	57.5	1152	0	0	908
2069	121	505	15.9	705	58.7	1144	0	0	915
2070	117	492	15.3	687	59.8	1136	0	0	922
2071	112	479	14.7	669	60.9	1127	0	0	928
2072	109	467	14.1	651	61.8	1118	0	0	934
2073	105	455	13.6	634	62.7	1108	0	0	939
2074	101	443	13.0	617	63.5	1099	0	0	944
2075	97.5	431	12.6	600	64.2	1089	0	0	948
2076	94.1	420	12.1	584	64.9	1078	0	0	952
2077	90.8	409	11.6	568	65.5	1068	0	0	955
2078	87.7	398	11.2	553	66.0	1057	0	0	958
2079	84.6	387	10.8	538	66.4	1046	0	0	961
2080	81.7	377	10.4	524	66.8	1035	0	0	963
2081	78.8	367	10.0	509	67.1	1023	0	0	964
2082	76.1	357	9.6	495	67.4	1012	0	0	965
2083	73.5	348	9.2	482	67.6	1000	0	0	966
2084	70.9	338	8.9	469	67.7	988	0	0	966
2085	68.5	329	8.6	456	67.8	976	0	0	966
2086	66.1	320	8.2	443	67.8	964	0	0	965
2087	63.8	312	7.9	431	67.8	952	0	0	964
2088	61.6	303	7.6	419	67.7	939	0	0	963
2089	59.5	295	7.4	407	67.6	927	0	0	961
2090	57.5	287	7.1	396	67.4	914	0	0	959
2091	55.5	279	6.8	385	67.2	902	0	0	956
2092	53.6	271	6.6	374	66.9	889	0	0	953
2093	53.0	269	6.3	371	65.6	891	0	0	950