IN THE MATTER OF SPARTON TECHNOLOGY, INC.
U.S. EPA DOCKET NO. RCRA-VI-001 (H)-96-H

REPORT OF PIERCE L. CHANDLER, JR., ON GEOLOGY/HYDROGEOLOGY CHARACTERIZATION, CONTAMINANT PLUME CHARACTERIZATION, RISK ASSESSMENT, AND AQUIFER RESTORATION SPARTON TECHNOLOGY COORS ROAD FACILITY ALBUQUERQUE, NEW MEXICO

February 4, 1997

The following report is my analysis and conclusions on the characterization of subsurface conditions and a "contaminant plume" and the resulting assessment of risk/threat posed to human health. The potential for aquifer restoration is also evaluated with respect to site-specific conditions, risk/threat, and technical practicability.

My report is based on my training, education, and experience as a professional engineer and hydrogeologist with particular emphasis on water resource and solid/hazardous waste projects. A copy of my curriculum vitae is attached.

A significant portion of my previous work has been on sites regulated under the Resource Conservation and Recovery Act (RCRA) of 1976 and subsequent amendments. With respect to the Sparton site, I was the principal investigator and author of the RCRA Facility Investigation (RFI) Report (Sparton, 1992), the Corrective Measures Study (CMS) Report (Sparton, 1996), and the Effectiveness of the Groundwater Recovery Well System in the Upper Flow Zone (Effectiveness) Report (Sparton, 1995).

On the basis of education, training, general experience, and specific experience at the Sparton Coors Road Facility, I am qualified to make the conclusions and statements expressed in the following report.

GEOLOGY/HYDROGEOLOGY CHARACTERIZATION

The geology/hydrogeology of the Albuquerque area is well understood and well documented. The Sparton facility is located within the most extensively studied and modelled part of the Albuquerque area. Figure 1 is a map of the Albuquerque Basin and its relative location with respect to the City.

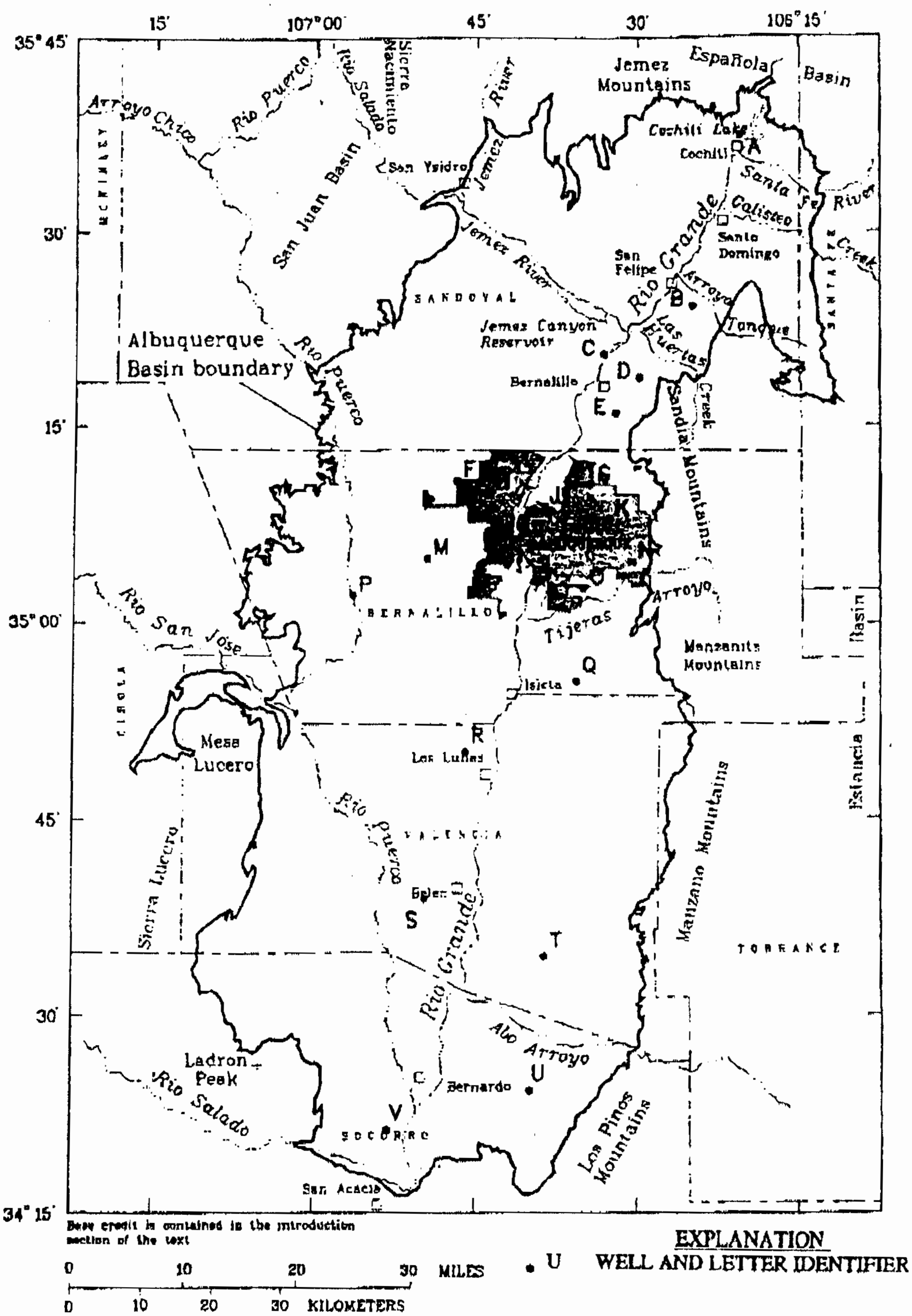
A detailed discussion of geologic/hydrogeologic characterization with supporting maps and references can be found in the 1992 RCRA Facility Investigation (RFI) Report submitted by Sparton. The RFI information was updated in Sparton's 1996 Corrective Measures Study (CMS) Report to include the most recent information developed by USGS, USBR, New Mexico Water Resources Research Institute (NMWRRI) and others. The 1996 CMS Report also contains an extensive bibliography arranged by subject.

Regional. The geology and hydrogeology of the Albuquerque Basin in central New Mexico has been extensively studied, modelled, and documented since at least 1930. This wealth of information has been used to assemble both a conceptual model (USGS, 1993 and USBR, 1996) and a three-dimensional finite-difference groundwater flow model of the Albuquerque Basin (USGS, 1995). These models are the essential tools used in all water resource planning and management in the Albuquerque Basin. However, as Peter Balleau (NMWRRI, 1995) points out, the current understanding of the Basin is remarkably consistent with the historic understanding of the Basin.

The aquifer consists of complex, layered, and interbedded sedimentary basin and valley filling of five deep structural depressions in the Rio Grande Rift. The resulting geology is characterized by heterogeneous and anisotropic conditions throughout the aquifer and includes gravels, sands, silts, and clays.

With respect to hydrogeology, the main source of groundwater (recharge) is from the Rio Grande and adjacent irrigated agriculture. Horizontal hydraulic

Figure 1



—Location of selected wells in the Albuquerque Basin, Central New Mexico.

conductivity ranges from 0.15 feet/day to 70 feet/day with the higher hydraulic conductivities on the east side of the river. Due to the substantial anisotropy, vertical hydraulic conductivities are 1/200 to 1/1000 of horizontal values. Hydraulic gradients range from approximately 0.001 to 0.007 with the higher gradients along the mountain front east of the river and/or associated with heavily pumped well fields. However, the great variation in hydraulic conductivity is the most significant influence on the direction and rate of groundwater movement.

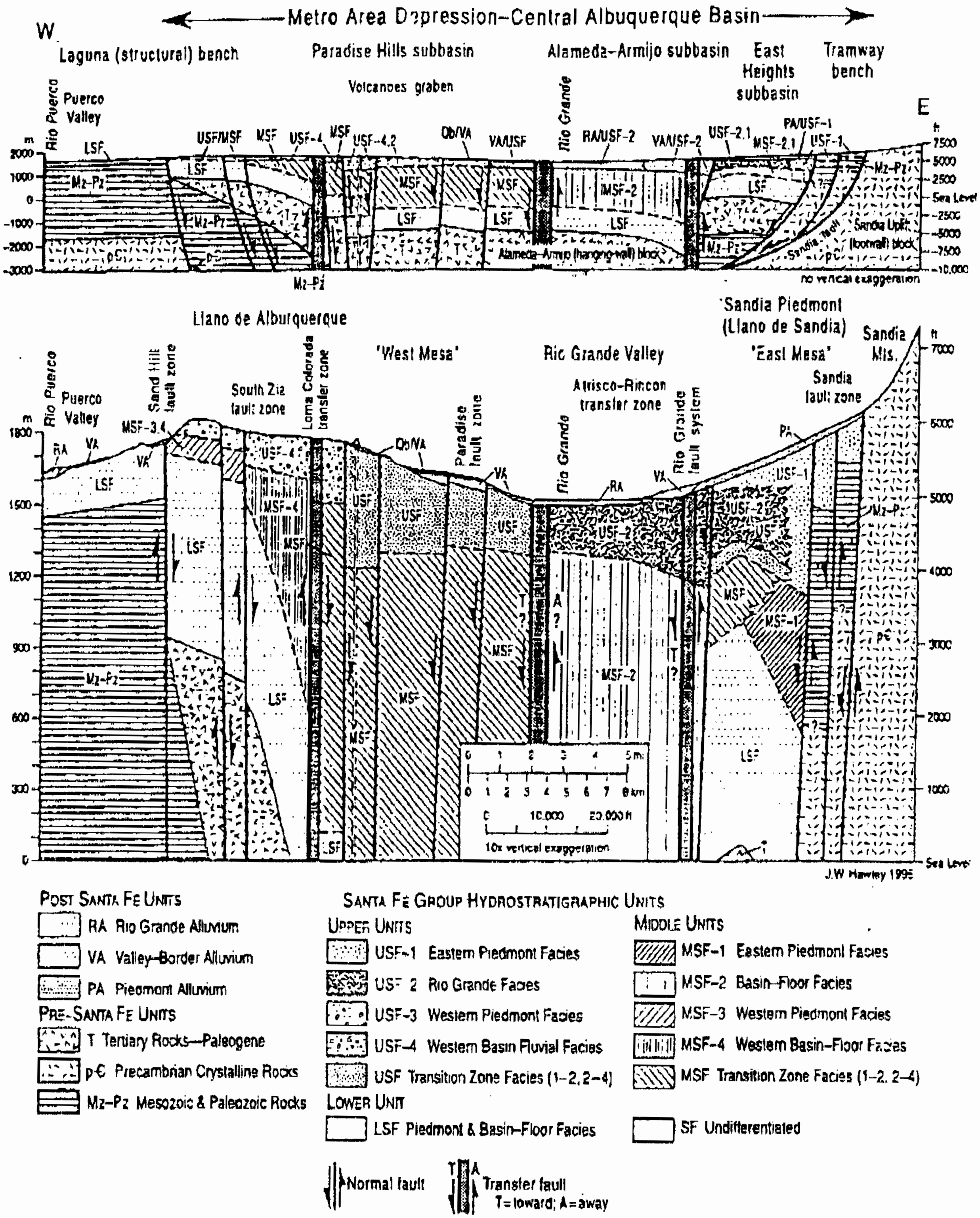
Regional conditions have been determined through the large number of groundwater investigations (and wells) that have been conducted throughout the basin. There are also numerous exposures created by both erosional forces and by man-made construction. In addition, the flow model has been sufficiently calibrated to serve as a predictive tool.

Local Conditions. West of the river, sediments are generally finer, hydraulic conductivities are lower, and hydraulic gradients are flatter (USGS, 1995). An excellent depiction of local conditions is shown in the west-east cross-section along Paseo de Norte Boulevard (USBR, 1996) included as Figure 2.

Local conditions west of the river and to the north of Paseo de Norte have been documented by: municipal production well records; private well installations; pump testing (Intel Shomaker & Assoc., 1995, 1996); exposures along the Calabacillas Arroyo; and the numerous monitoring wells installed by Sparton. Dr. John Hawley, of the Middle Rio Grande Water Assessment Team, believes that the Sparton plume characterization is the best groundwater tracer test conducted in the Albuquerque area and defines the local groundwater flow rate and direction.

Site-Specific. Site geologic/hydrogeologic conditions are remarkably similar to regional and local characterization. Subsurface conditions are extremely heterogeneous and anisotropic as clearly shown by comparison of boring logs for wells completed at different locations and particularly by comparison of boring logs at cluster well locations where several wells are installed in very close proximity. An excellent example is well cluster 9. Using boring logs for

Figure 2



—A cross section of the Metro Area Depression in the central Albuquerque Basin showing relative thickness and discontinuity of the Upper, Middle, and Lower Santa Fe Group and valley fill aquifer systems.

groundwater monitoring wells MW-48, MW-55, and MW-56 (RFI Report, 1992) it is obvious that subsurface conditions vary significantly over short horizontal and vertical distances. Other logs and/or clusters show similar variation.

Hydraulic conductivity has been defined by multiple-well pump testing and the resulting range of 21 to 32 feet/day matches regional values. Documentation and detailed analyses of the pump testing are given in Attachment 10 of the 1992 RFI Report. Hydraulic gradients (and the impact of season, precipitation and irrigation of adjacent fields) have been determined from an extensive, long-term data base of water level readings from numerous groundwater monitoring wells. Water level data through June 1991 is summarized in the RFI Report. Post-RFI water level data and summarizing information is contained in the 1996 CMS Report. Current water level contours are shown on Figure 3. Average gradient is approximately 0.002 which matches well with regional characterization.

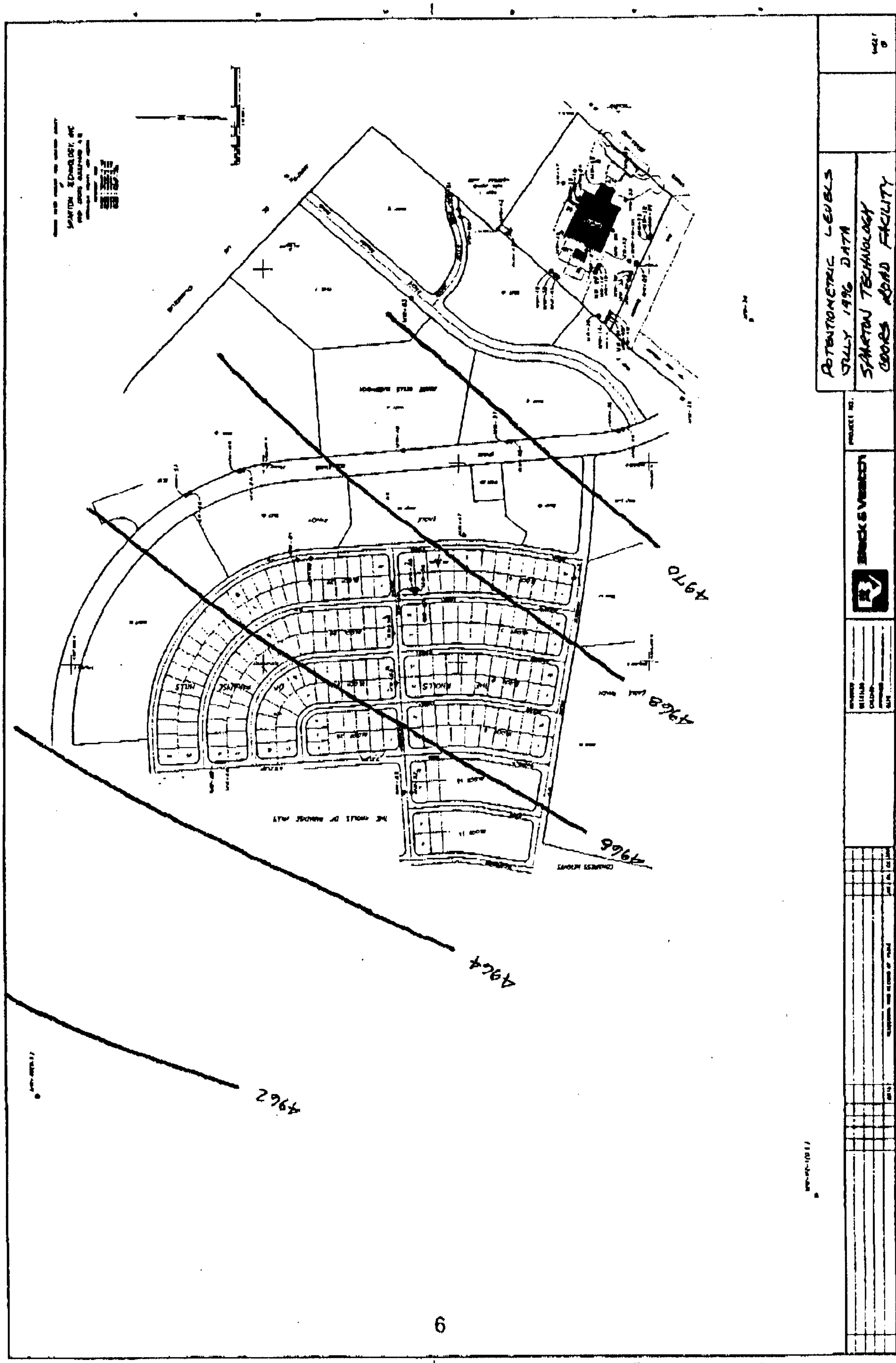
Flow direction has been determined to be to the west-northwest at a rate of less than 100 feet per year based on the hydraulic parameters. The plume "tracer" confirms this assessment. Regionally, flow was predicted to be more westerly to southwesterly in the area. This difference is the result of much higher density well spacing on the Sparton site (hundreds of feet) as compared to the regional well spacing (miles).

Irrigation of the adjacent farmland to the east of the site has a seasonal 2- to 3-foot impact on groundwater levels in wells close to the fields. However, to the west of the Sparton property, water levels are unaffected. Over the last five or six years, overall water levels have dropped one to two feet; however, gradients and direction are relatively unchanged.

Site conditions have been verified by extensive site investigations conducted since 1983. These investigations include:

1. Seventy-two groundwater monitoring well installations;
2. Eleven soil boring installations;
3. Multiple pumping tests (multi-well and single well);
4. Geophysical logging;

Figure 3


POTENTIOMETRIC LEVELS
JULY 1996 DATA
SPARTON TECHNOLOGY
COORS ROAD FACILITY
4970
4968
4966
4964
4962

5. Geotechnical classification;
6. Extended monitoring of water levels and contaminant concentrations;
7. Extensive research of published literature and anecdotal information; and
8. Observation of geologic exposures in immediate area.

Need For Additional Site-Specific Study

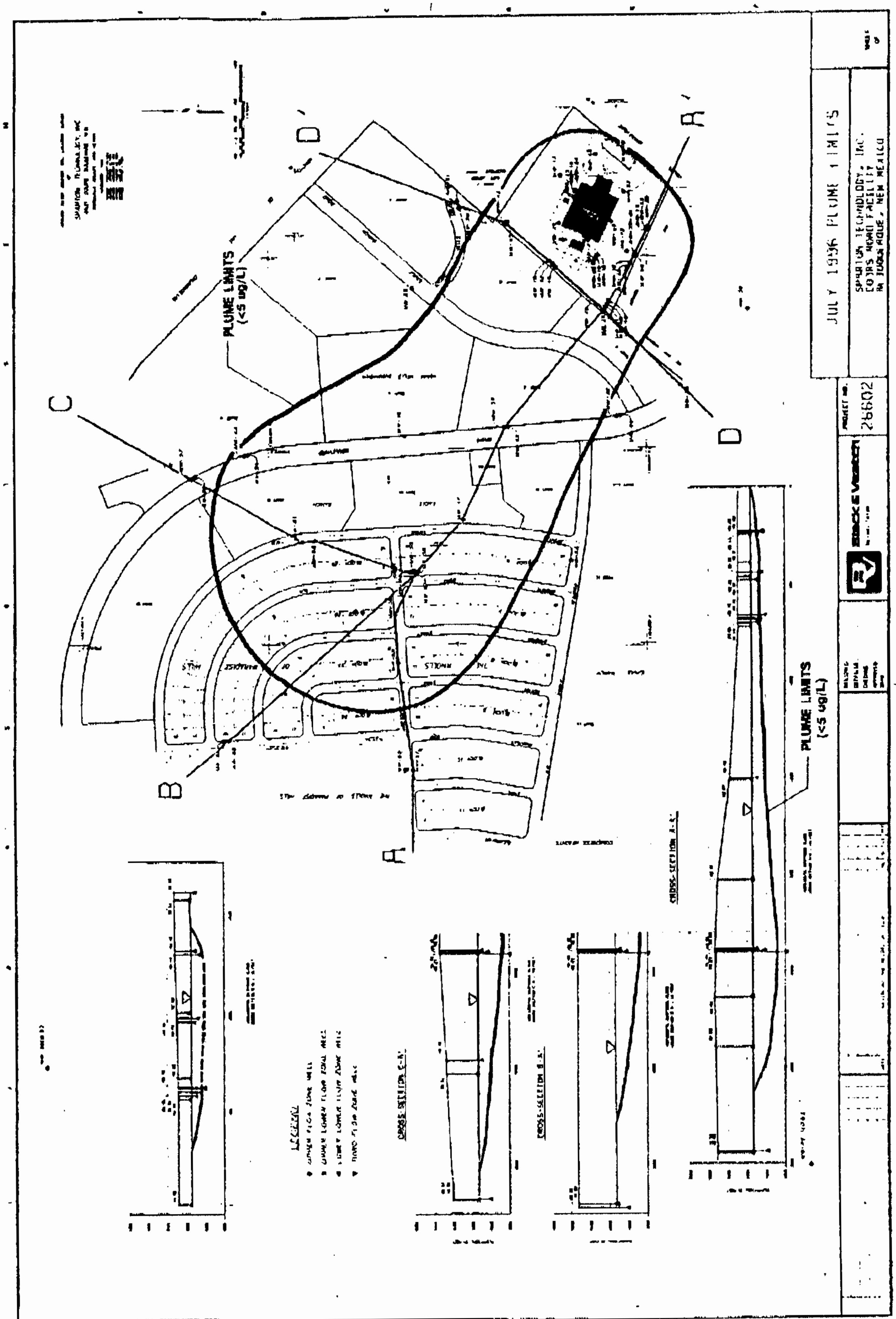
The Albuquerque Basin has been extensively studied and characterization has been developed to the point that long-range projections and modifying impacts can be modelled with confidence. Characterization of the Sparton site is even more detailed and serves as a microscopic view of the upper part of the Basin.
Additional investigation is not needed to fill information/data gaps. The existing characterization is more than sufficient to define, with reasonable certainty, geologic and hydrogeologic conditions at the site. The existing information is also more than adequate for design purposes. Additional investigation would only generate more confirming data at a cost premium.

CONTAMINANT PLUME CHARACTERIZATION

The chlorinated solvent plume at the Sparton facility is well-characterized and understood. Plume constituents are primarily Trichlorethylene (TCE) with lesser concentrations of 1,1,1 - Trichloroethane (TCA), 1,1 - Dichloroethylene (DCE), and Dichloromethane (DMA). Concentration and/or presence of TCE is most appropriate for describing the plume. TCE is the most consistently and commonly detected constituent and also is found at the highest concentration. During preparation of the RFI Report; TCE also had the lowest drinking water MCL of 0.005 mg/l.

The current extent of the plume (July 1996 sampling and analysis) is clearly shown on Figure 4. As discussed in subsequent paragraphs of this section, plume mechanics have been confirmed by extensive investigation and comparison to detailed hydrogeologic characterization for the area. The plume definition is more than adequate to assess potential risk/threat and for any needed remedial design purposes.

Figure 4


JULY 1996 PLUME LIMITS
26602
PLUME LIMITS
(<5 ug/L)
PLUME LIMITS
(<5 ug/L)
A
A'
B
C
D
D'

A detailed discussion of the plume characterization is contained in the 1992 RFI Report. Updated plume information covering the period from June 1991 through early 1996 is detailed in the 1996 CMS Report.

In subsequent investigation in summer of 1996, the CMS report conclusions on plume extent and rate of migration were confirmed by installing five groundwater monitoring wells (MW-65, MW-66, MW-67, MW-68, and MW-69). Well locations were chosen to show that the plume limits presented in the CMS Report were realistic and that direction and rate of migration conclusions were valid. The five wells were installed outside and/or below the leading edge of the plume defined in the CMS Report. Not surprisingly, all five wells were non-detect.

The ability to predict results in advance of installation demonstrates the comprehensive understanding of the plume. Further, as discussed in subsequent sections, the five new wells, together with the updated data base, effectively address and answer EPA's concerns on plume characterization numbered 3, 5, 7, and 9 in their June 20, 1996, Technical Review of the CMS Report.

Extent. Consistent with the documented vertical anisotropy and dominance of horizontal groundwater flow, the plume horizontal extent (approximately 2,600 feet downgradient and 3300 feet overall) is much greater than plume depth (nominally 50 to 125 feet). Plume width is significant (approximately 1,650 feet) due to the low groundwater flow rates and to the heterogeneous subsurface conditions. Plume currently covers about 90 acres.

A total of 72 groundwater monitoring wells have been installed at the site since 1983. There are currently 57 active wells including 8 on-site wells converted to recovery well operation. The 49 monitoring wells have been installed at horizontal locations as shown on Figure 4. Wells have also been installed at various penetration depths into the aquifer. Well depth is shown by legend symbol on the Figure. The nomenclature is as follows:

1. Upper flow zone (UFZ) indicates well is screened across the top of the aquifer.

2. Upper lower flow zone (ULFZ) indicates well is approximately 30 feet below the top of the aquifer.

3. Lower lower flow zone (LLFZ) indicates well is approximately 60 feet below the top of the aquifer.

4. Third flow zone (TFZ) indicates well is 75 to 175 feet into the aquifer.

A summary of all wells including flow zone identification and completion intervals is included as Table 1.

The use of flow zones is for vertical location purposes only. At 13 locations, wells completed in different flow zones have been clustered together to provide vertical definition.

The extent of the plume is defined by detection wells (TCE concentration greater than 5 µg/l) inside the plume and by non-detection wells outside and/or below the plume. TCE concentration histories for each of the monitoring wells are given in Table 2. In 1996, 23 of the 49 wells were below 5 µg/l. These non-detect wells have been circled on Figure 5 to show their relationship to the defined plume limits.

The detect vs non-detect delineation of the plume is further confirmed by the approximately normal or Gaussian distribution of TCE concentration across any given cross-section of the plume. For example:

1. Transverse UFZ section across the leading edge of the plume (wells MW-62, MW-48, MW-61 and MW-57) shows range from non-detect to 1900 µg/l and back to non-detect.

2. Transverse UFZ section at mid-plume (wells MW-62, MW-37, MW-63) shows range from non-detect to 720 µg/l to non-detect.

Table 1

WELL SUMMARY

WELL NUMBER	ZONE *	MEASURING POINT ELEVATION	DEPTH TO TOP OF SCREEN (FT.)	DEPTH TO BOTTOM OF SCREEN (FT.)	ELEVATION AT TOP OF SCREEN (FT.,MSL)	ELEVATION AT BOTTOM OF SCREEN (FT.,MSL)	LENGTH OF SCREEN (FT.)
FW-1	UPZ	5044.54	60.0	70.0	4984.54	4974.54	10.0
7	UPZ	5044.80	63.5	68.5	4981.30	4976.30	5.0
9	UPZ	5044.11	62.5	67.5	4981.61	4976.61	5.0
12	UPZ	5042.58	64.0	74.0	4978.58	4968.58	10.0
13	UPZ	5043.25	60.0	70.0	4983.25	4973.25	10.0
14	UPZ	5041.91	61.5	71.5	4980.41	4970.41	10.0
15	UPZ	5047.49	60.0	70.0	4987.49	4977.49	10.0
16	UPZ	5047.50	68.0	73.0	4979.50	4974.50	5.0
17	UPZ	5049.28	67.0	72.0	4982.28	4977.28	5.0
18	UPZ	5045.58	68.0	78.0	4977.58	4967.58	10.0
19	ULPZ	5046.25	97.0	107.0	4949.25	4939.25	10.0
20	LLPZ	5045.79	125.0	138.0	4920.79	4907.79	13.0
21	UPZ	5048.36	64.5	69.5	4983.86	4978.86	5.0
22	UPZ	5048.06	72.0	77.0	4976.06	4971.06	5.0
23	UPZ	5048.51	72.0	77.0	4976.51	4971.51	5.0
24	UPZ	5048.70	68.4	73.4	4980.30	4975.30	5.0
25	UPZ	5049.00	67.7	72.7	4981.30	4976.30	5.0
26	UPZ	5045.71	73.0	78.0	4972.71	4967.71	5.0
27	UPZ	5045.50	67.0	72.0	4978.50	4973.50	5.0
28	UPZ	5042.69	65.0	70.0	4977.69	4972.69	5.0
29	ULPZ	5044.51	103.0	113.0	4941.51	4931.51	10.0
30	ULPZ	5044.70	97.0	107.0	4947.70	4937.70	10.0
31	ULPZ	5043.53	96.0	106.0	4947.53	4937.53	10.0
32	LLPZ	5048.05	108.0	118.0	4940.05	4930.05	10.0
33	UPZ	5044.29	63.0	73.0	4981.29	4971.29	10.0
34	UPZ	5034.49	56.5	66.5	4977.99	4967.99	10.0
35	UPZ	5042.50	63.2	73.2	4979.30	4969.30	10.0
36	UPZ	5059.35	82.3	92.3	4977.05	4967.05	10.0
37	UPZ	5091.66	115.0	125.0	4976.66	4966.66	10.0
38	LLPZ	5044.32	126.5	136.5	4917.82	4907.82	10.0
39	LLPZ	5044.06	123.0	133.0	4921.06	4911.06	10.0
40	LLPZ	5043.35	117.0	127.0	4926.35	4916.35	10.0
41	ULPZ	5046.77	92.0	97.0	4954.77	4949.77	5.0
42	ULPZ	5057.33	105.0	115.0	4952.33	4942.33	10.0
43	LLPZ	5057.74	127.0	137.0	4930.74	4920.74	10.0
44	ULPZ	5058.71	106.0	116.0	4952.71	4942.71	10.0
45	ULPZ	5090.11	143.0	153.0	4947.11	4937.11	10.0
46	ULPZ	5118.98	170.0	180.0	4948.98	4938.98	10.0
47	UPZ	5155.83	180.0	195.0	4975.83	4960.83	15.0
48	UPZ	5168.31	192.0	207.0	4976.31	4961.31	15.0
49	3rdPZ	5043.67	137.7	147.7	4905.97	4895.97	10.0
50	UPZ	5211.51	235.0	250.0	4976.51	4961.51	15.0
51	UPZ	5058.86	75.0	85.0	4983.86	4973.86	10.0
52	UPZ	5156.79	181.8	197.0	4975.01	4959.81	15.2
53	UPZ	5164.24	189.8	204.0	4974.44	4960.24	14.2
(**) 54	UPZ	5097.64	117.0	132.0	4980.64	4965.64	15.0
55	LLPZ	5168.61	255.0	265.0	4913.61	4903.61	10.0
56	ULPZ	5168.61	220.0	230.0	4948.61	4938.61	10.0
57	UPZ	5103.54	126.0	141.0	4977.54	4962.54	15.0
58	UPZ	5168.89	194.0	209.0	4974.89	4959.89	15.0

Table 1 (cont.)

WELL NUMBER	ZONE *	MEASURING POINT ELEVATION	DEPTH TO TOP OF SCREEN (FT.)	DEPTH TO BOTTOM OF SCREEN (FT.)	ELEVATION AT TOP OF SCREEN (FT.,MSL)	ELEVATION AT BOTTOM OF SCREEN (FT.,MSL)	LENGTH OF SCREEN (FT.)
59	ULFZ	5059.18	104.5	115.0	4954.68	4944.18	10.5
60	ULFZ	5134.72	185.0	195.0	4949.72	4939.72	10.0
61	UFZ	5133.98	158.0	173.0	4975.98	4960.98	15.0
62	UFZ	5075.00	95.0	110.0	4980.00	4965.00	15.0
63	UFZ	5065.74	83.0	98.0	4982.74	4967.74	15.0
64	ULFZ	5097.84	138.8	149.0	4959.04	4948.84	10.2
PZ-1	UFZ	5142.17	182.7	198.0	4959.47	4944.17	15.3
65	LLFZ	5156.45	260.0	270.0	4896.45	4886.45	10.0
66	LLFZ	5103.03	200.0	210.0	4903.03	4893.03	10.0
67	3rd FZ	5169.21	370.0	380.0	4799.21	4789.21	10.0
68	UFZ	5165.53	194.0	214.0	4971.53	4951.53	20.0
69	LLFZ	5165.46	260.0	270.0	4905.46	4895.46	10.0

(*) UFZ = UPPER FLOW ZONE
ULFZ = UPPER LOWER FLOW ZONE
LLFZ = LOWER LOWER FLOW ZONE
3rdFZ = THIRD FLOW ZONE

(**) WELL # 54 IS NONFUNCTIONAL

THE FOLLOWING WELLS HAVE BEEN MODIFIED OR COMPLETELY PLUGGED:

Well Number	Status
PW-1	Plugged back to upper flow zone+ - Converted to recovery well
P-1	Plugged
1	Plugged
2	Plugged
3	Plugged
4	Plugged
5	Plugged
6	Plugged
8	Plugged
10	Plugged
11	Plugged
12	Plugged back to upper flow zone+
13	Plugged back to upper flow zone+
14	Plugged back to upper flow zone+
15	Plugged back to upper flow zone+
18	Converted to recovery well
23	Converted to recovery well
24	Converted to recovery well
25	Converted to recovery well
26	Converted to recovery well
27	Converted to recovery well
28	Converted to recovery well
54	Used only for water level measurements

+ ORIGINALLY OPEN TO UFZ, ULFZ, AND LLFZ

Table 2

Sparton Monitoring Results
TCE Concentrations

Date	Year	Qtr.	Qtr. #	MW-9 UFZ	MW-13 UFZ	MW-14 UFZ	MW-15 UFZ	MW-16 UFZ	MW-19 ULFZ	MW-20 LLFZ	MW-21 UFZ	MW-22 UFZ	MW-29 ULFZ	MW-30 ULFZ	MW-31 ULFZ	MW-32 LLFZ
Oct-83	1983	4		21000												
Oct-84	1984	4		9600		12000	4400	37000								
Jul-85	1985	3		7300												
Jan-86	1986	1	10	6100												
Apr-86		2	11	8300												
Jul-86		3	12	5000				20000								
Oct-86		4	13	5000		4900	940	36000	3600	17	2300	230				
Jan-87	1987	1	14	4500		5000	630	21000	2700	12	1700	170				
Apr-87		2	15	3600		1800	580	23000	2900	32	1400	270				
Jul-87		3	16	6400		2100	650	25000	4600	35	2100	370				
Oct-87		4	17	7100		2700	480	28000	3400	25	2000	240				
Jan-88	1988	1	18	5500		6200	370	26000	2900	10	1800	150				
Apr-88		2	19	4800		5000	10	25000	5	28	1100	230				
Jul-88		3	20	3300		5200	380	26000	1800	19	1200	63				
Oct-88		4	21	4200		5600	250	22000	3600	15	1300	120				
Jan-89	1989	1	22	4000		3300	180	16000	3200	12	900	110				
Feb-89		1	22		610	1100	210						5.7	320	120	4800
Mar-89		1	22		650	3700	210						5.4	320	120	3400
Apr-89		2	23	4400		4900	200	14000	3700	14	520	150				
Aug-89		3	24	2500		3000	200	13000	2400	20	460	120				
Aug-89		3	24													
Nov-89		4	25	2300		2200	260	16000	1500	5	1100	91				
Nov-89		4	25													
Jan-90	1990	1	26	2800		2100	190	13000	880	17	1000	110				
Jan-90		1	26													
Apr-90		2	27	2400		1800	160	20000	1000	21	400	130				
Apr-90		2	27													
Jun-90		2	27													
Aug-90		3	28	2200		2100	230	19000	850	15	670	140				
Aug-90		3	28													
Sep-90		3	28													
Oct-90		4	29	1600		1500	140	16000	590	10	850	83				
Oct-90		4	29													
Oct-90		4	29													
Jan-91	1991	1	30	1700		1700	110	16000	680	28	910	75				
Apr-91		2	31	1600		1400	5	12000	690	5.4	400	92				
Jun-91		2	31	1400		1100	91	17000	570	12	500	110	<5	180	60	57
Jul-91		3	32	1300	330	1400	110	16000	190	12	440	110				
Oct-91		4	33	1000		1100	80	12000	170	16	880	93				5100
Nov-91		4	33													2400
Dec-91		4	33													2400
Jan-92	1992	1	34	1200		1300	64	13000	130	5	680	65				5100
Apr-92		2	35	1400		1400	54	12000	230	5	360	90				6000
Jul-92		3	36	930		860	49	15000	140	5	390	72				7500
Sep-92		4	37	1000		1100	66	14000	120	30	460	48				2600
Jan-93	1993	1	38	690		850	52	13000	57	3	430	51				830
Apr-93		2	39	820		850	1.9	12000	110	31	240	55				1500
Jul-93		3	40	730		720	56	11000	62	7	350	47				4400
Oct-93		4	41	680		700	44	13000	45	23	480	41				780
Dec-93		4	41	680	330	640	39	13000	39	6	490	41	1	47	10	490
Jan-94	1994	1	42	790		680	36	12000	48	1.1	380	50				580
Apr-94		2	43	740		730		11000	81	0.2	280	62				1700
Jul-94		3	44	750		730	52	11000	61	8	210	44				400
Oct-94		4	45	750		700	31	11000	47	44	360	45				1700
Oct-94		4	45													
Feb-95	1995	1	46	850		690	45	8700	72	5	270	72				2000
Apr-95		2	47	790		1000		7100	92	0.2	160	100				1600
Aug-95		3	48	490		470	21	9100	39	11	200	32				4200
Oct-95		4	49	650		470	15	7400	48	26	280	34				2800
Jan-96	1996	1	50	570	380	290		7600	24	1.3	220	46	0.9	19	2.7	760
Apr-96		2	51	710		420		9700	88	0.4	140	81				2400
Jul-96		3	52	460		300		7400	11	<1	180	43				400

Cluster #1 = 13,29,38	Cluster #6 = 36,44	Cluster #11 = 57,66
Cluster #2 = 33,30,39	Cluster #7 = 37,45	Cluster #12 = 68,69
Cluster #3 = 14,31,40,4	Cluster #8 = 51,59	Cluster #13= 52,65
Cluster #4 = 15,41,32	Cluster #9 = 48,55,56,67	
Cluster #5 = 42,43	Cluster #10 = 61,60	

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NOTES:
1.) ND = None Detected
2.) J value indicates an estimation by lab

Table 2 (cont.)

Sparton Monitoring Results
TCE Concentrations

Date	Year	Qtr.	Qtr. #	MW-33 UFZ	MW-34 UFZ	MW-35 UFZ	MW-36 UFZ	MW-37 UFZ	MW-38 LLFZ	MW-39 LLFZ	MW-40 LLFZ	MW-41 ULFZ	MW-42 ULFZ	MW-43 LLFZ	MW-44 ULFZ	MW-45 ULFZ
Oct-83	1983	4														
Oct-84	1984	4														
Jul-85	1985	3														
Jan-86	1986	1	10													
Apr-86		2	11													
Jul-86		3	12													
Oct-86		4	13													
Jan-87	1987	1	14													
Apr-87		2	15													
Jul-87		3	16													
Oct-87		4	17													
Jan-88	1988	1	18													
Apr-88		2	19													
Jul-88		3	20													
Oct-88		4	21													
Jan-89	1989	1	22													
Feb-89		1	22	7500												
Mar-89		1	22	7000												
Apr-89		2	23													
Aug-89		3	24		<5	<5	7.9	1100								
Aug-89		3	24		<5	<5	11	1800								
Nov-89		4	25						<5	<5	<5	1100	1100	270		
Nov-89		4	25						<5	<5	<5	960	1200	160		
Jan-90	1990	1	26												<5	1400
Jan-90		1	26												<5	1400
Apr-90		2	27													
Apr-90		2	27													
Jun-90		2	27													
Aug-90		3	28													
Aug-90		3	28													
Sep-90		3	28													
Oct-90		4	29													
Oct-90		4	29													
Oct-90		4	29													
Jan-91	1991	1	30													
Apr-91		2	31													
Jun-91		2	31	7300	<5	<5	22	2000	<5	<5	<5	620	1000	280	<5	770
Jul-91		3	32													
Oct-91		4	33			<5	19	1400					930	440		
Nov-91		4	33													
Dec-91		4	33													
Jan-92	1992	1	34			<5	15	1200					740	260		
Apr-92		2	35			<5	14	960					690	340		
Jul-92		3	36			<5	10	800					640	200		
Sep-92		4	37			<5	8.3	810				510	600	180		
Jan-93	1993	1	38			<1	7	510					680	200		
Apr-93		2	39			<1	4	340					320	130		
Jul-93		3	40			<1	25	.800				370	620	850	<1	
Oct-93		4	41			<1	3	600					600	160		
Dec-93		4	41		<1	<1	3	980	<1	<1	<1	350	620	150	<1	160
Jan-94	1994	1	42			<1	3	860					570	150		
Apr-94		2	43			<1	2	850					490	120		
Jul-94		3	44			<1	3	370					530	160		
Oct-94		4	45			ND	2	940				420	510	110		
Oct-94		4	45													
Feb-95	1995	1	46			<5	3	770					340	79		
Apr-95		2	47			<5	3	750					340	98		
Aug-95		3	48				2	750					340	100		
Oct-95		4	49				2	750					350	110		
Jan-96	1996	1	50	2000	<0.3	<0.3	1.9	720	<0.3	<0.3	<0.3	290	470	95	<0.3	69
Apr-96		2	51				<5	600					250	87		
Jul-96		3	52				2.4	560					330	73		

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Table 2 (cont.)

Sparton Monitoring Results
TCE Concentrations

Date	Year	Qtr.	Qtr. #	MW-46 ULFZ	MW-47 UFZ	MW-48 UFZ	MW-49 3rd FZ	MW-50 UFZ	MW-51 UFZ	MW-52 UFZ	MW-53 UFZ	MW-55 LLFZ	MW-56 ULFZ	MW-57 UFZ	MW-58 UFZ	MW-59 ULFZ	MW-60 ULFZ
Oct-83	1983	4															
Oct-84	1984	4															
Jul-85	1985	3															
Jan-86	1986	1	10														
Apr-86		2	11														
Jul-86		3	12														
Oct-86		4	13														
Jan-87	1987	1	14														
Apr-87		2	15														
Jul-87		3	16														
Oct-87		4	17														
Jan-88	1988	1	18														
Apr-88		2	19														
Jul-88		3	20														
Oct-88		4	21														
Jan-89	1989	1	22														
Feb-89		1	22														
Mar-89		1	22														
Apr-89		2	23														
Aug-89		3	24														
Aug-89		3	24														
Nov-89		4	25														
Nov-89		4	25														
Jan-90	1990	1	26	4200	310	820	<5										
Jan-90		1	26	2300	330	830	<5										
Apr-90		2	27						8.5								
Apr-90		2	27					<1	6.2								
Jun-90		2	27		220	820			6.7	<1	<1						
Aug-90		3	28			600						13	50				
Aug-90		3	28			1100						9.2	29				
Sep-90		3	28			930						12	98	<1	20	<1	
Oct-90		4	29													<5	<1
Oct-90		4	29												22		<5
Oct-90		4	29												22		<5
Jan-91	1991	1	30														
Apr-91		2	31														
Jun-91		2	31	1300	120	410	<5		<5	<5	<5	45	200	<5	29	<5	<5
Jul-91		3	32														
Oct-91		4	33	5200		220			<5	<5		74	210		31	<5	<5
Nov-91		4	33	2600													
Dec-91		4	33														
Jan-92	1992	1	34	2300		280			11	6.8		96	280		34		<5
Apr-92		2	35	1300		290			<5	9.8		120	290		37		<5
Jul-92		3	36	960		340			<5	14		130	290		37		<5
Sep-92		4	37	4200		240			<5	16		120	240		39		<5
Jan-93	1993	1	38	1200		360			<1		21	190	370		48		1
Apr-93		2	39	1200		310			<1		23	110	230		43		<1
Jul-93		3	40	1400		330			<1		33	240	320		62		4
Oct-93		4	41	2100		420			1		30	310	430		64		2
Dec-93		4	41	1800	93	350	<1		2	<1	32	380	410	<1	74	<1	7
Jan-94	1994	1	42	2500		350			<1		38	370	430		85		3
Apr-94		2	43	2700		340			0.6		34	390	370		93		6
Jul-94		3	44	3200		370			<1		43	550	370		110		9
Oct-94		4	45	2100		300			<5	<5	40	580	420	<5	97		24
Oct-94		4	45								38						
Feb-95	1995	1	46	2600		253			<5		21	580	340		100		16
Apr-95		2	47	2400		300			1		41	640	370		120		44
Aug-95		3	48	3000		250			<5		42	680	360	<5	130		66
Oct-95		4	49	3300		270			<1		48	130	350	<1	140		100
Jan-96	1996	1	50	3200	36	350	<0.3		<0.3	<0.3	100	940	430	<0.3	270	<0.3	170
Apr-96		2	51	2300		150		<5	<5		36	790	330	<1	110		150
Jul-96		3	52	1900		130			<1		36	510	240	<1	130		130

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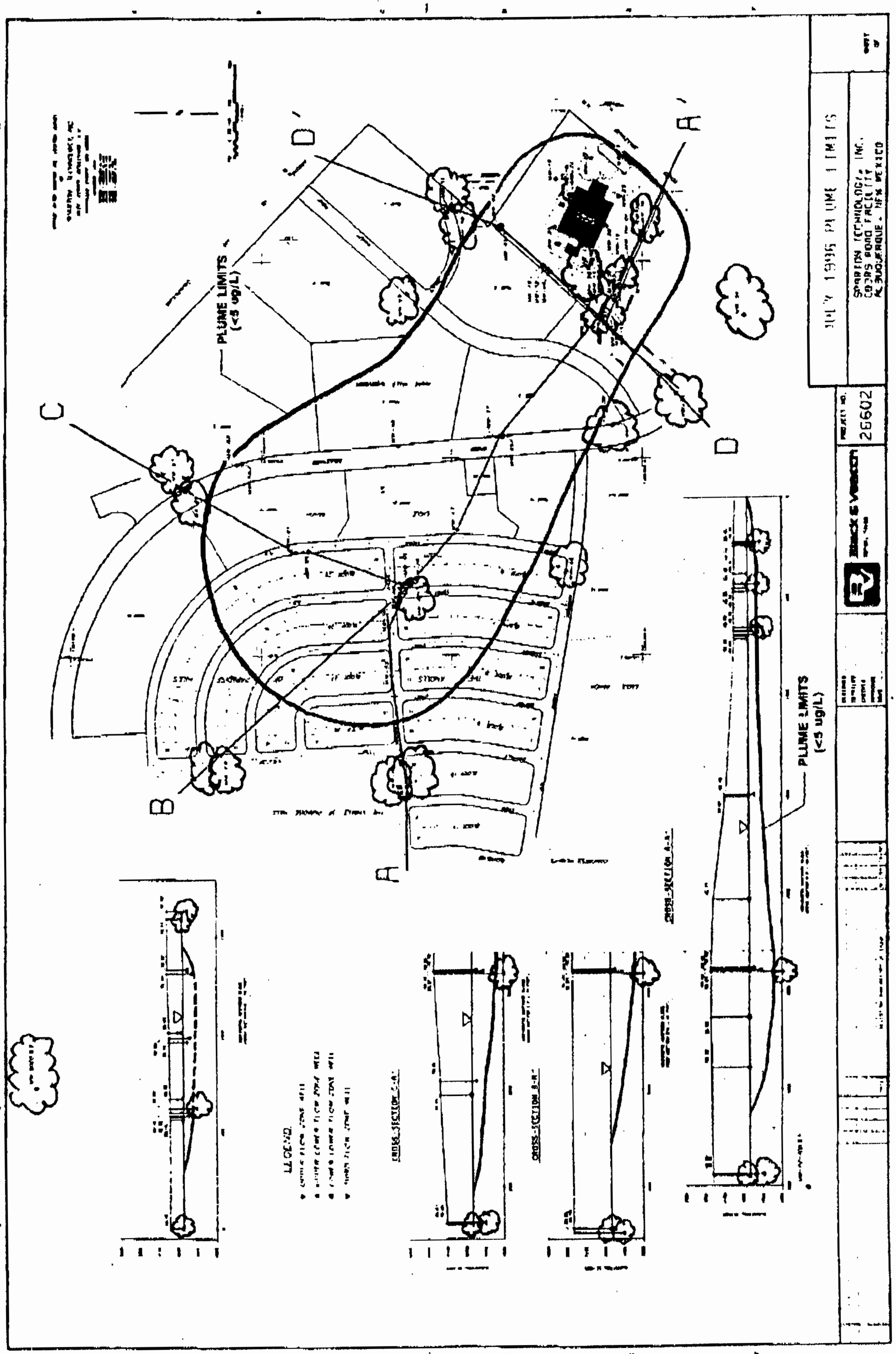
Table 2 (cont.)

Sparton Monitoring Results
TCE Concentrations

Date	Year	Qtr.	Qtr. #	MW-61 UFZ	MW-62 UFZ	MW-63 UFZ	MW-64 ULFZ	MW-65 LLFZ	MW-66 LLFZ	MW-67 3rdFZ	MW-68 UFZ	MW-69 LLFZ	Comments
Oct-83	1983	4											
Oct-84	1984	4											
Jul-85	1985	3											
Jan-86	1986	1	10										
Apr-86		2	11										
Jul-86		3	12										
Oct-86		4	13										
Jan-87	1987	1	14										
Apr-87		2	15										
Jul-87		3	16										
Oct-87		4	17										
Jan-88	1988	1	18										
Apr-88		2	19										
Jul-88		3	20										
Oct-88		4	21										
Jan-89	1989	1	22										
Feb-89		1	22										
Mar-89		1	22										
Apr-89		2	23										
Aug-89		3	24										
Aug-89		3	24										
Nov-89		4	25										#42&43 actual 12-12-89
Nov-89		4	25										#42&43 actual 12-21-89
Jan-90	1990	1	26										#49 - actual 01-25-90
Jan-90		1	26										#49 - actual 01-31-90
Apr-90		2	27										
Apr-90		2	27										
Jun-90		2	27										#51 - actual 05-07-90
Aug-90		3	28										
Aug-90		3	28										
Sep-90		3	28										
Oct-90		4	29	<1	<5	<1	<5						
Oct-90		4	29	<5	2.2	<5	<1						
Oct-90		4	29	<5	<5	<5	<5						
Jan-91	1991	1	30										
Apr-91		2	31										
Jun-91		2	31	<5	<5	<5	<5						EPA split sample
Jul-91		3	32										
Oct-91		4	33		<5								
Nov-91		4	33										
Dec-91		4	33										
Jan-92	1992	1	34		<5								
Apr-92		2	35		<5								
Jul-92		3	36		<5								
Sep-92		4	37		<5								
Jan-93	1993	1	38		2								
Apr-93		2	39		2								
Jul-93		3	40	490	3								
Oct-93		4	41	500	3								#61 - actual 09-03-93
Dec-93		4	41	610	3	<1	<1						EPA split sample
Jan-94	1994	1	42	530	2								
Apr-94		2	43		2								#51 = J value
Jul-94		3	44	800	3								
Oct-94		4	45	870	2		10						#62,36 = J value, EPA split sample
Oct-94		4	45										#53 duplicate sample
Feb-95	1995	1	46	960	2		11						#36 & 62 = J values
Apr-95		2	47	1400	2		18						#36, 51 & 62 = J values
Aug-95		3	48	1700	3		17						#36 & 62 = J values
Oct-95		4	49	2000	2		8						
Jan-96	1996	1	50	1900	1.8	<0.3	15						EPA split sample
Apr-96		2	51	1100	<5		25						EPA split sample
Jul-96		3	52	780	1.7		32	1.5	<1	<1	<1	<1	#66 sampled 6/27/96 & 7/18/96

Figure 5


PLUME LIMITS (<5 ug/L)
PLUME LIMITS (<5 ug/L)
28602
C
B
A
A'
D
D'
LEGEND
CROSS-SECTION A-A'
CROSS-SECTION C-C'
CROSS-SECTION B-B'

3. Transverse UFZ section along west side of Sparton facility (MW-35, MW-14, MW-21, MW-51) shows range from non-detect to 420 µg/l to non-detect.

4. ULFZ section along Irving Boulevard (wells MW-44, MW-45, MW-46, MW-64) shows range from non-detect to 3200 µg/l to 32 µg/l.

Plume delineation is also confirmed by the decreasing TCE concentration with depth at all but one of the 13 vertical cluster wells. In the one increasing cluster consisting of MW-15, MW-41 and MW-32 the bottom LLFZ well MW-32 is not as deep as bottom wells in adjacent clusters. The terminology decreasing with depth means that the bottom well in a vertical cluster shows lower concentration (usually non-detect) than the other wells in the cluster.

Monitor well installation and sampling began in 1983. Through continued well installation and sampling through July 1996, it has been possible to track the development or evolution of the plume to its present form. The shape, both horizontally and vertically, is shown on previous Figure 5.

In the early stages of monitoring, both onsite and near offsite investigation utilized a high density (close-spaced) network of monitoring wells to characterize the plume and subsurface conditions. However, as confidence in the understanding of the plume and subsurface conditions increased, continuing investigations began using greater well spacings to primarily confirm the understanding and to fill, if needed, any data gaps. As the investigations moved further offsite, no anomalous conditions were encountered which would have required more intensive study. The most recent investigation (consisting of the five wells installed in summer 1996) successfully addressed concerns and questions raised since the last previous intrusive investigation in 1990. The number and locations of current non-detect wells, as shown on Figure 5, are more than adequate to define the plume limits. Further, the number and distribution of wells inside the plume provides excellent areal and vertical definition of concentration.

Rate of Migration. The TCE plume is migrating in a west-northwest direction at a current rate of less than 100 feet/year. The rate of migration and direction is consistent with the site-specific hydrogeologic characterization. This consistency was expected. Groundwater flow rates are low and relatively uniform based on hydraulic gradient information shown on previous Figure 3. The dissolved, aqueous phase of TCE is relatively mobile and should travel at the same rate (and in the same direction) as groundwater flow. As previously noted, Dr. John Hawley has opined that the TCE plume definition provides an excellent tracer to show groundwater flow rate and direction.

The rate of plume migration can be verified from a consensus of independent analyses:

1. Dividing the horizontal downgradient length of the plume (2,800 feet) by the estimated age of the release (30 years) provides an average migration rate of approximately 100 feet/year.

2. The prevailing site-specific groundwater flow rate is less than 100 feet/year using site-specific hydraulic gradients obtained from site monitoring wells and site-specific hydraulic conductivity values. Note that the site-specific parameters (and groundwater flow rate) are remarkably consistent with regional hydrogeologic characterization and modelling.

3. By comparing TCE plume extent defined by June 1991 sampling with the current plume extent (July 1996), a migration rate of less than 100 feet/year can be clearly demonstrated.

Contaminant Concentrations in Groundwater. Monitoring wells have been sampled since 1983. Continued installation of wells and sampling has determined that the primary constituent of concern is TCE (1992 RFI Report). TCA is also present at approximately one third of the TCE concentration. DCE and DMA are found less frequently. Of the 49 wells sampled in July 1996, 26 had TCE concentrations above 5 µg/l. Maximum TCE concentration was observed in MW-16, a shallow onsite well near the original source area. Highest offsite TCE concentrations were observed in wells MW-46 and MW-61 in the plume interior. TCE concentration data is given in previous Table 1. Well locations can be obtained from previous Figures 4 and 5.

Plume concentration is decreasing at a much faster rate than that resulting from expansion of the plume. This concentration decrease is the result of previous source material removal, the ongoing, onsite groundwater recovery and treatment implemented in December 1988, and natural attenuation processes. With respect to the TCE concentration data given in previous Table 4, the following trends are readily apparent from the 43 wells with extended time histories:

1. Of the 22 UFZ wells, 5 offsite wells (MW-34, MW-35, MW-57, MW-63, MW-62) have non-detection histories. Of the remaining 17 wells, only 3 offsite wells (MW-53, MW-58, MW-61) have increasing concentration histories. The remaining 14 wells (including all on-site UFZ wells) all show decreasing concentration histories.
2. Of the 13 ULFZ wells, 2 off-site wells (MW-44, MW-59) have non-detection histories. Three off-site wells (MW-56, MW-60, MW-64) have increasing concentration histories. A single well (MW-46) has an erratic history. The remaining 7 wells (including all on-site ULFZ wells) show decreasing concentration histories.
3. Of the 7 LLFZ wells, 3 on-site wells (MW-38, MW-39, and MW-40) have non-detection histories. Only a single off-site well (MW-55) shows an increasing concentration history. The remaining 3 wells have decreasing concentration histories.
4. There is only a single on-site TFZ well (MW-49) and this well has a non-detection history.

The TCE concentration database also shows that of the 13 vertical well clusters shown on previous Figures 4 and 5, only a single well cluster (cluster No. 4 consisting of MW-15, MW-41, and MW-32) shows increasing concentration with depth; however all wells in this cluster have decreasing concentration time histories. Increase in concentration with depth means that the bottom well in a vertical cluster shows higher concentration than the other wells in the cluster. Time-history plots of the 10 vertical clusters with extended time history data are shown on Figures 6 through 15.

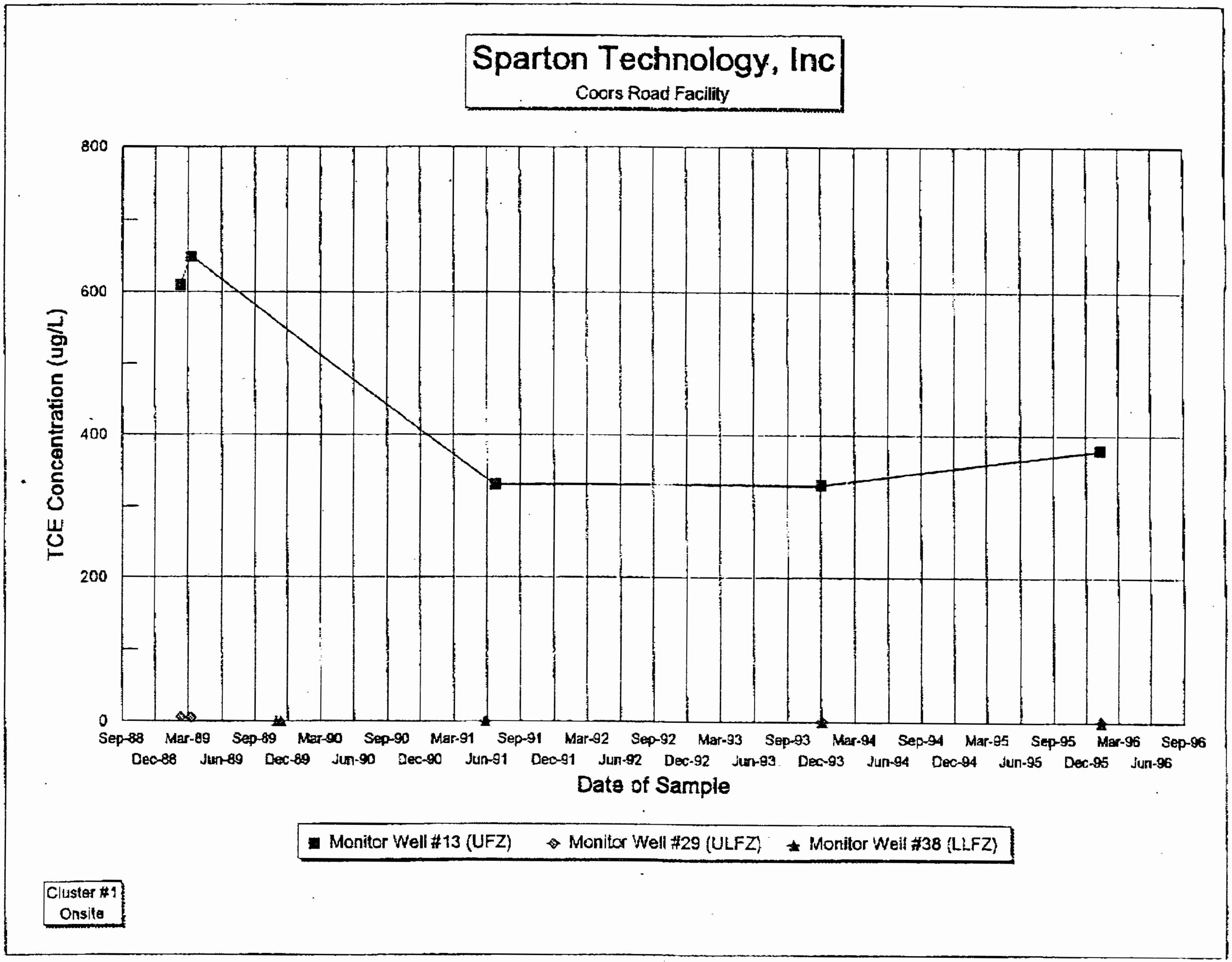


Figure 6

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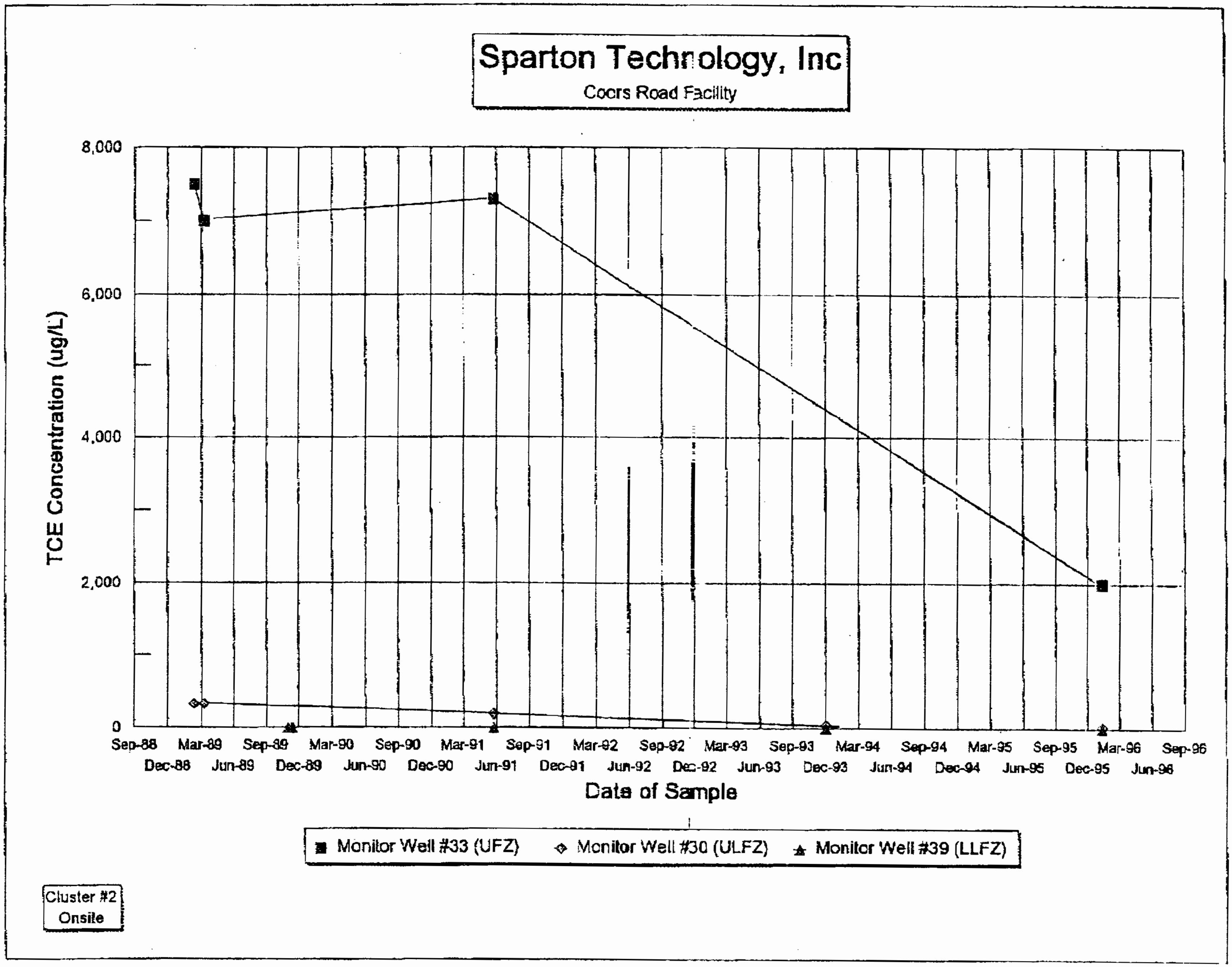

Figure 7

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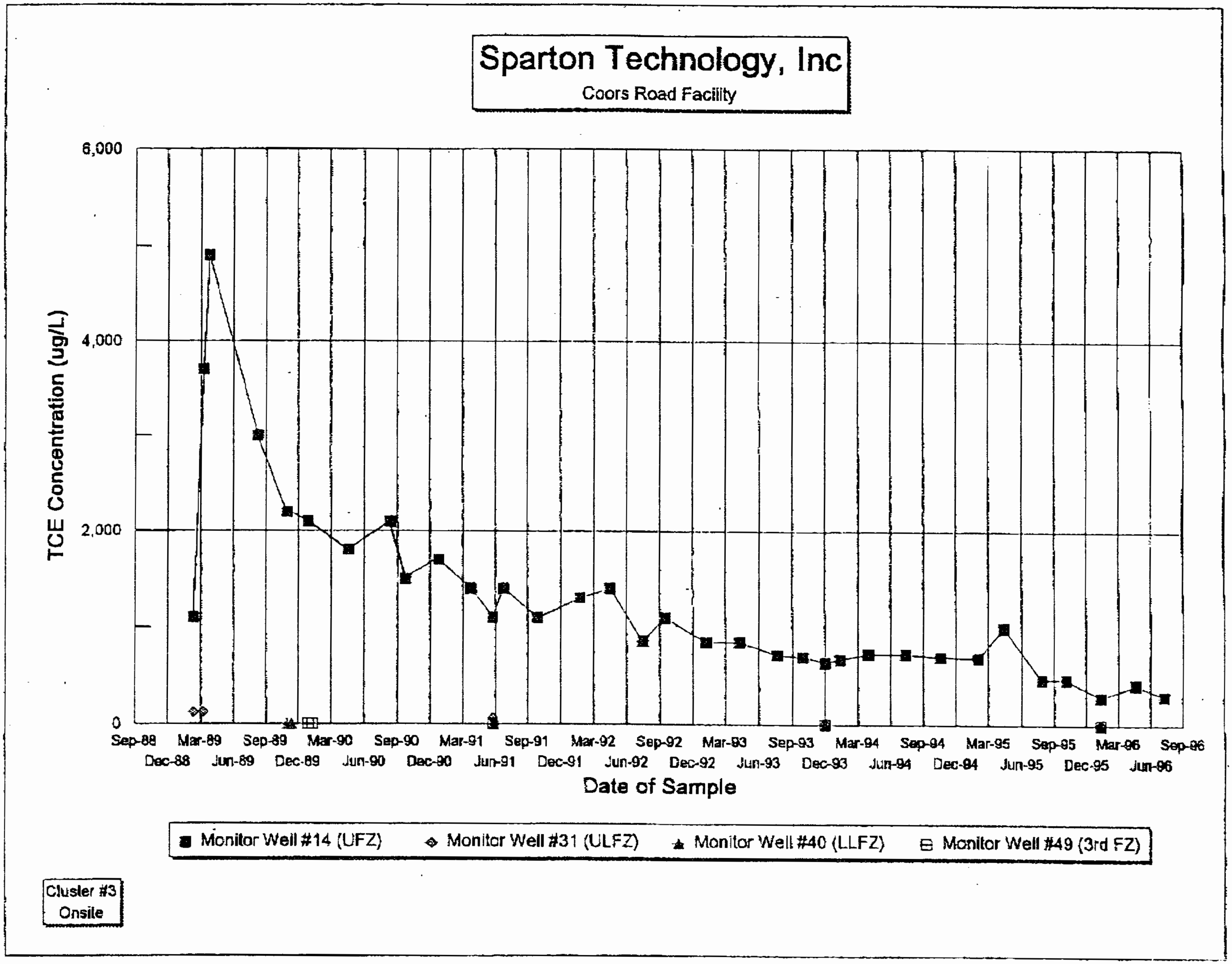
Sparton Technology, Inc
Coors Road Facility
6,000
4,000
2,000
0
TCE Concentration (ug/L)
Sep-88 Mar-89 Sep-89 Mar-90 Sep-90 Mar-91 Sep-91 Mar-92 Sep-92 Mar-93 Sep-93 Mar-94 Sep-94 Mar-95 Sep-95 Mar-96 Sep-96
Dec-88 Jun-89 Dec-89 Jun-90 Dec-90 Jun-91 Dec-91 Jun-92 Dec-92 Jun-93 Dec-93 Jun-94 Dec-94 Jun-95 Dec-95 Jun-96
Date of Sample
Monitor Well #14 (UFZ)
Monitor Well #31 (ULFZ)
Monitor Well #40 (LLFZ)
Monitor Well #49 (3rd FZ)
Cluster #3
Onsite

Figure 8

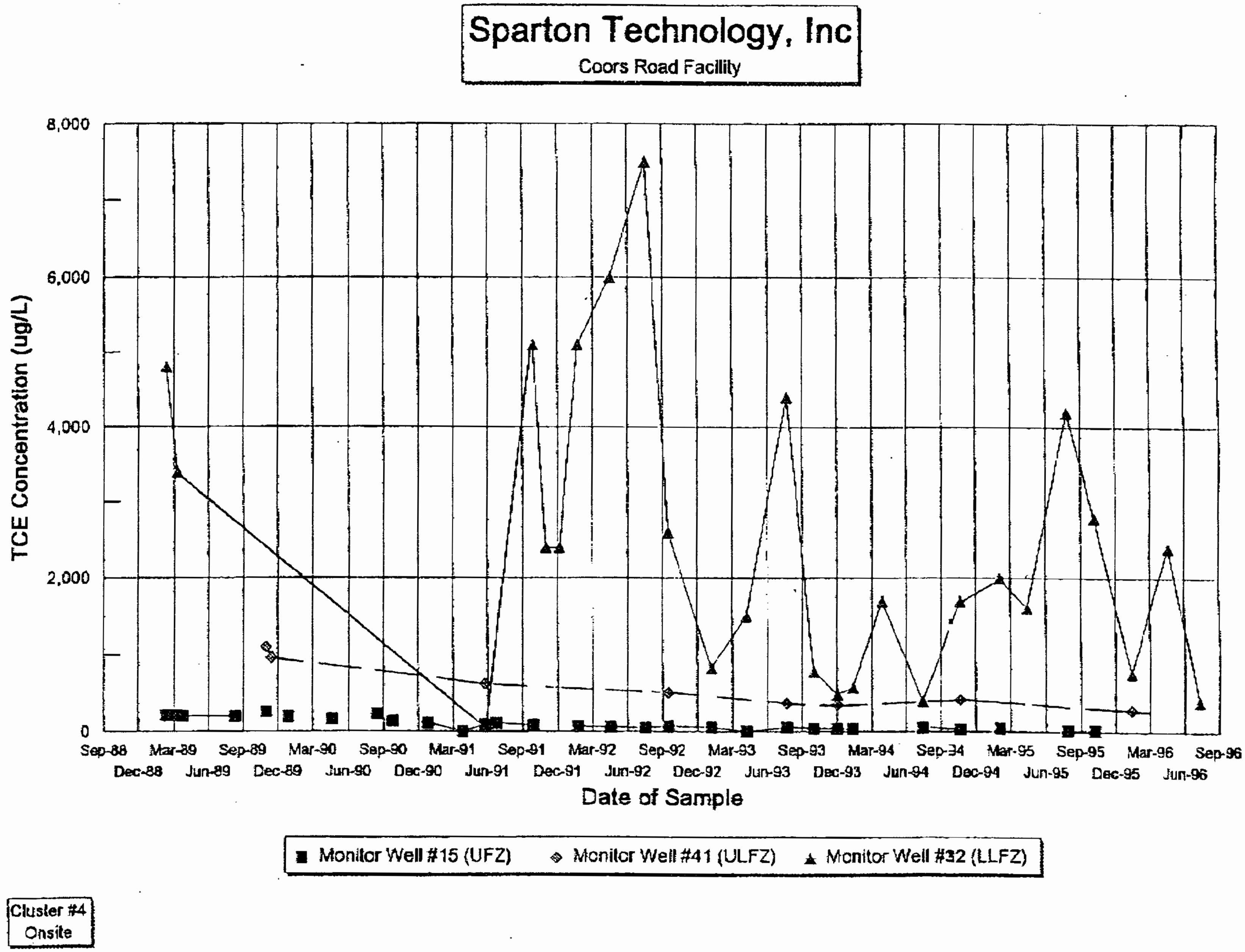
Sparton Technology, Inc
Coors Road Facility
TCE Concentration (ug/L)
8,000
6,000
4,000
2,000
0
Sep-88 Mar-89 Sep-89 Mar-90 Sep-90 Mar-91 Sep-91 Mar-92 Sep-92 Mar-93 Sep-93 Mar-94 Sep-94 Mar-95 Sep-95 Mar-96 Sep-96
Dec-88 Jun-89 Dec-89 Jun-90 Dec-90 Jun-91 Dec-91 Jun-92 Dec-92 Jun-93 Dec-93 Jun-94 Dec-94 Jun-95 Dec-95 Jun-96
Date of Sample
Monitor Well #15 (UFZ)
Monitor Well #41 (ULFZ)
Monitor Well #32 (LLFZ)
Cluster #4
Onsite

Figure 9

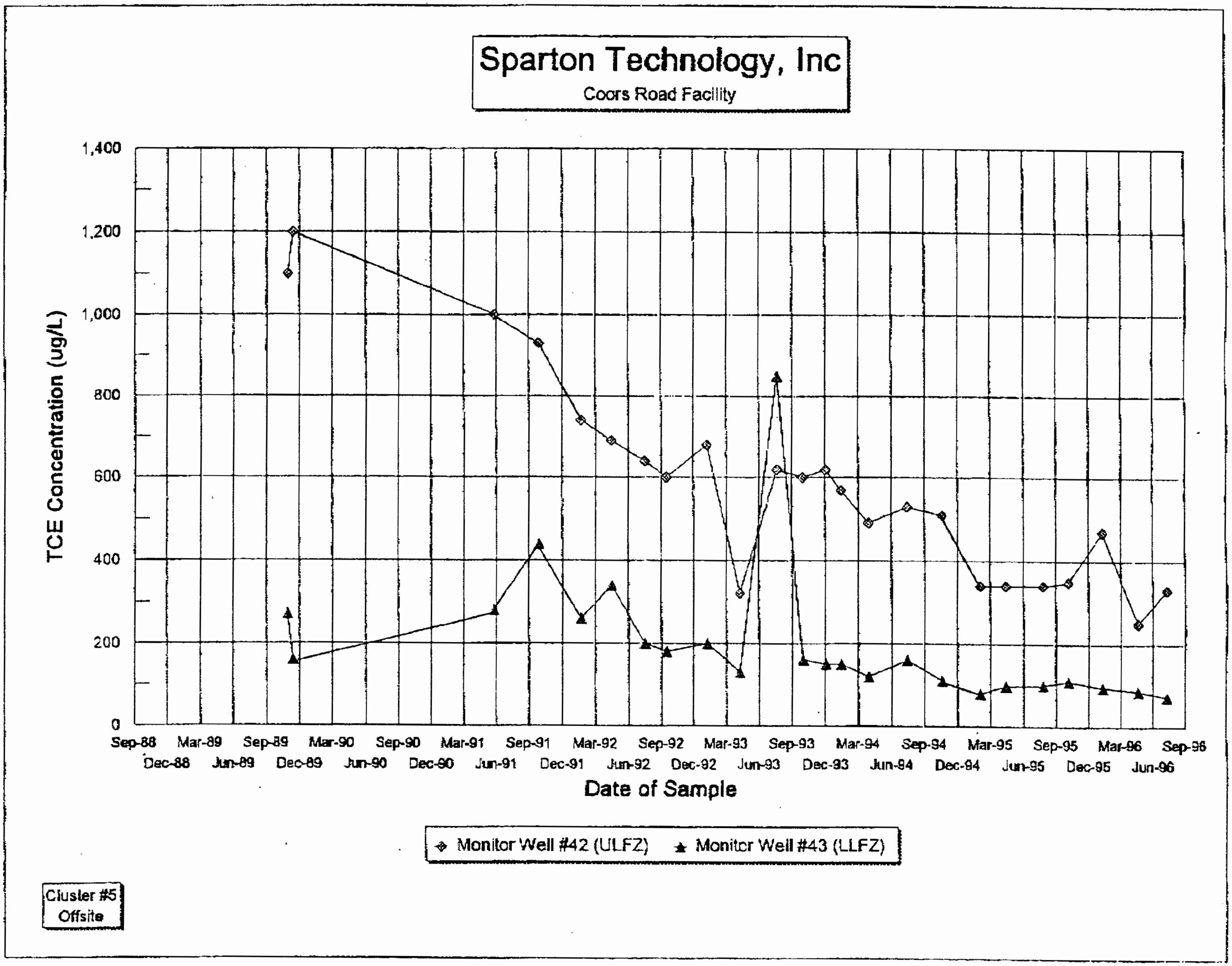

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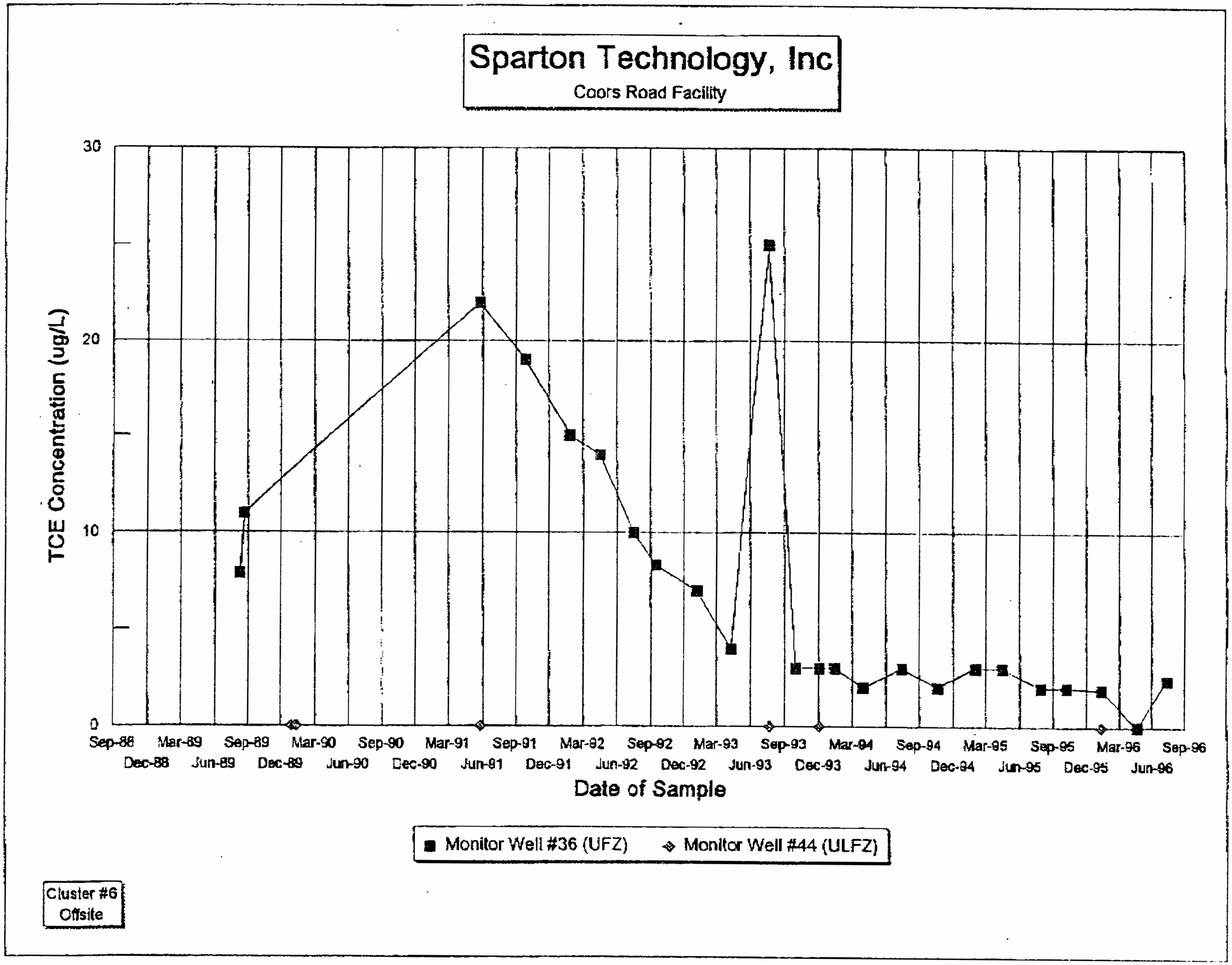
Figure 10

Figure 11



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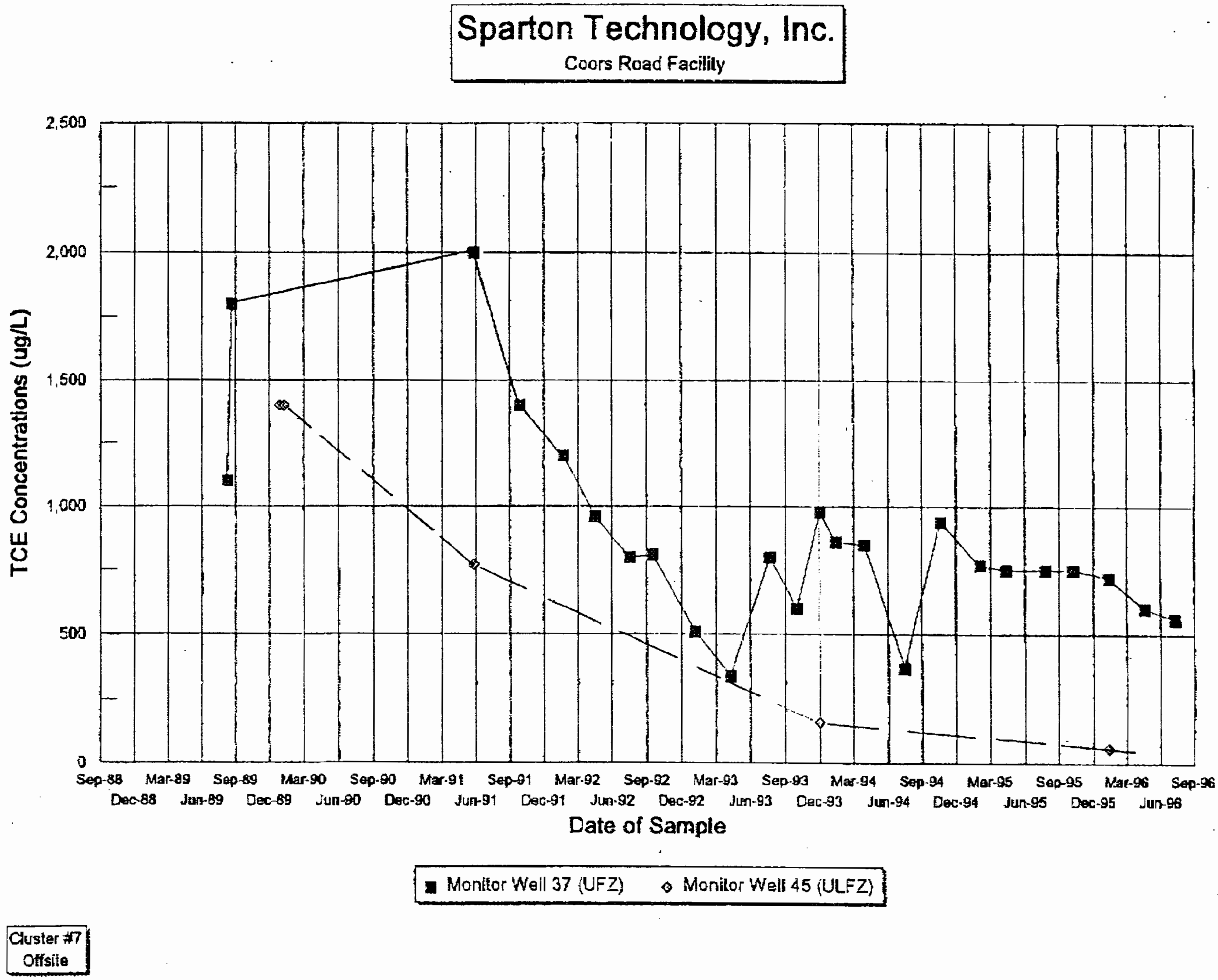
Sparton Technology, Inc.
Coors Road Facility
TCE Concentrations (ug/L)
2,500
2,000
1,500
1,000
500
0
Sep-88
Dec-88
Mar-89
Jun-89
Sep-89
Dec-89
Mar-90
Jun-90
Sep-90
Dec-90
Mar-91
Jun-91
Sep-91
Dec-91
Mar-92
Jun-92
Sep-92
Dec-92
Mar-93
Jun-93
Sep-93
Dec-93
Mar-94
Jun-94
Sep-94
Dec-94
Mar-95
Jun-95
Sep-95
Dec-95
Mar-96
Jun-96
Sep-96
Date of Sample
Monitor Well 37 (UFZ)
Monitor Well 45 (ULFZ)
Cluster #7
Offsite

Figure 12

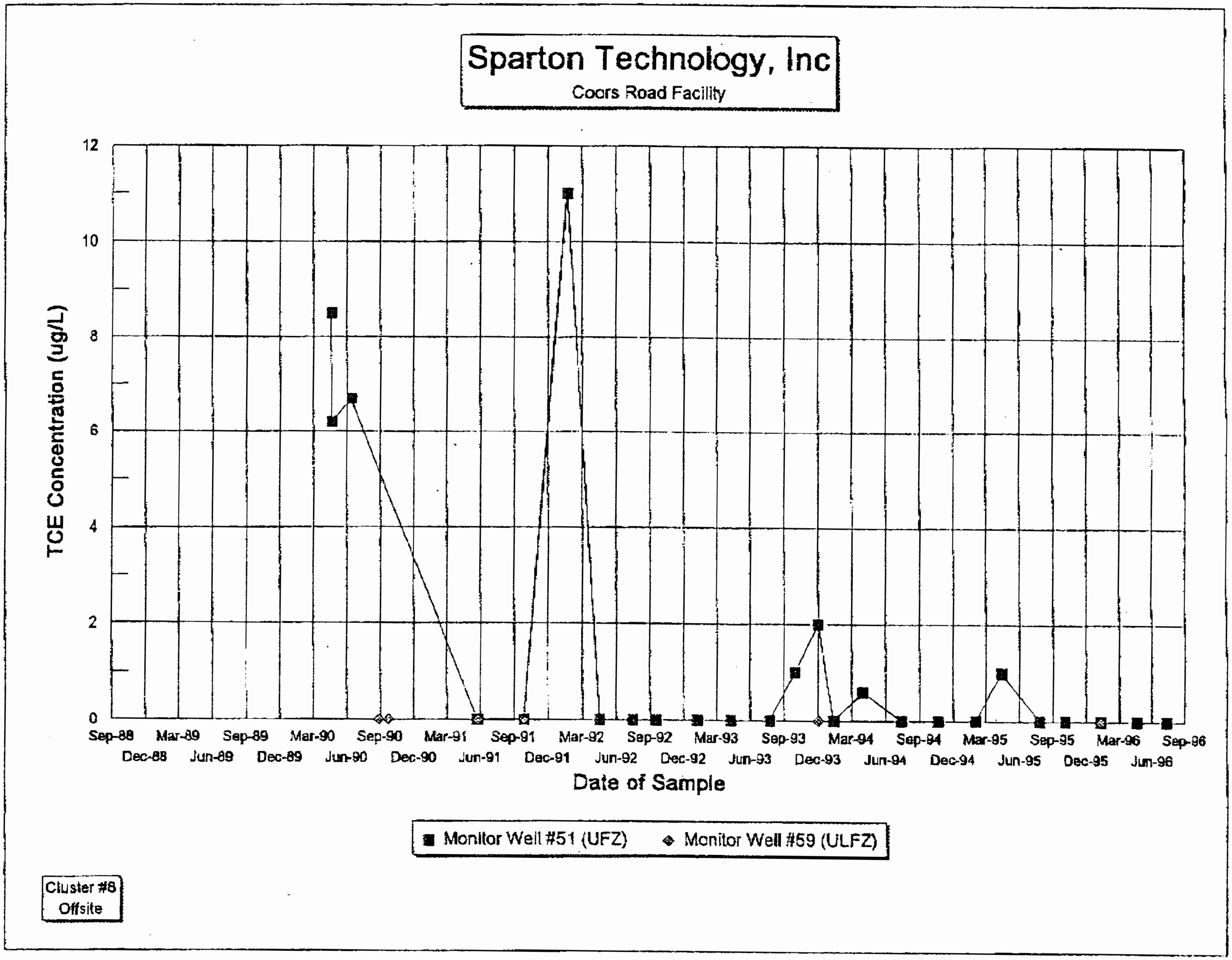
Sparton Technology, Inc
Coors Road Facility
12
10
8
6
4
2
0
TCE Concentration (ug/L)
Sep-88
Dec-88
Mar-89
Jun-89
Sep-89
Dec-89
Mar-90
Jun-90
Sep-90
Dec-90
Mar-91
Jun-91
Sep-91
Dec-91
Mar-92
Jun-92
Sep-92
Dec-92
Mar-93
Jun-93
Sep-93
Dec-93
Mar-94
Jun-94
Sep-94
Dec-94
Mar-95
Jun-95
Sep-95
Dec-95
Mar-96
Jun-96
Sep-96
Date of Sample
Monitor Well #51 (UFZ)
Monitor Well #59 (ULFZ)
Cluster #8
Offsite

Figure 13

Sparton Technology, Inc

Coors Road Facility

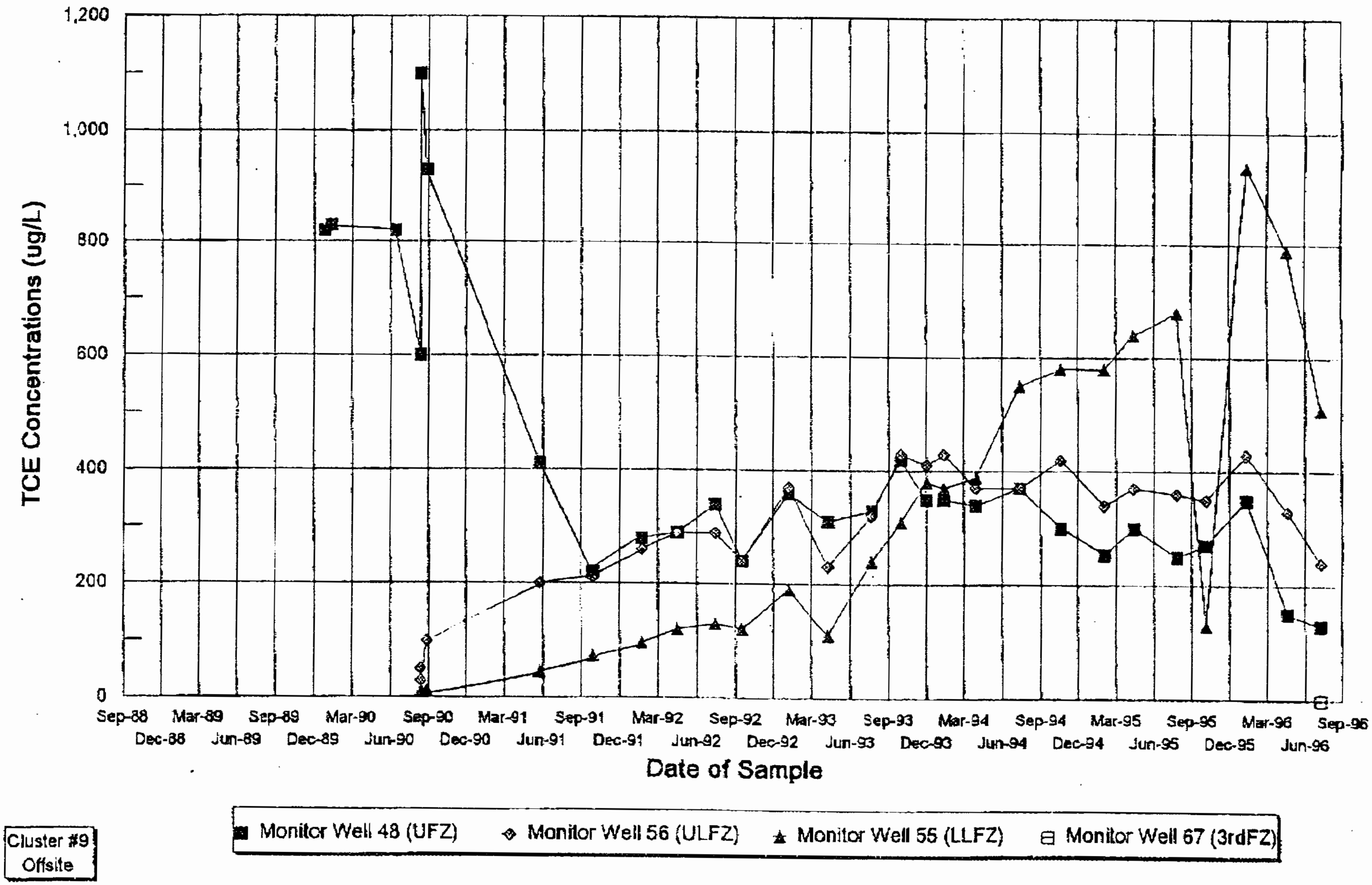

Figure 14

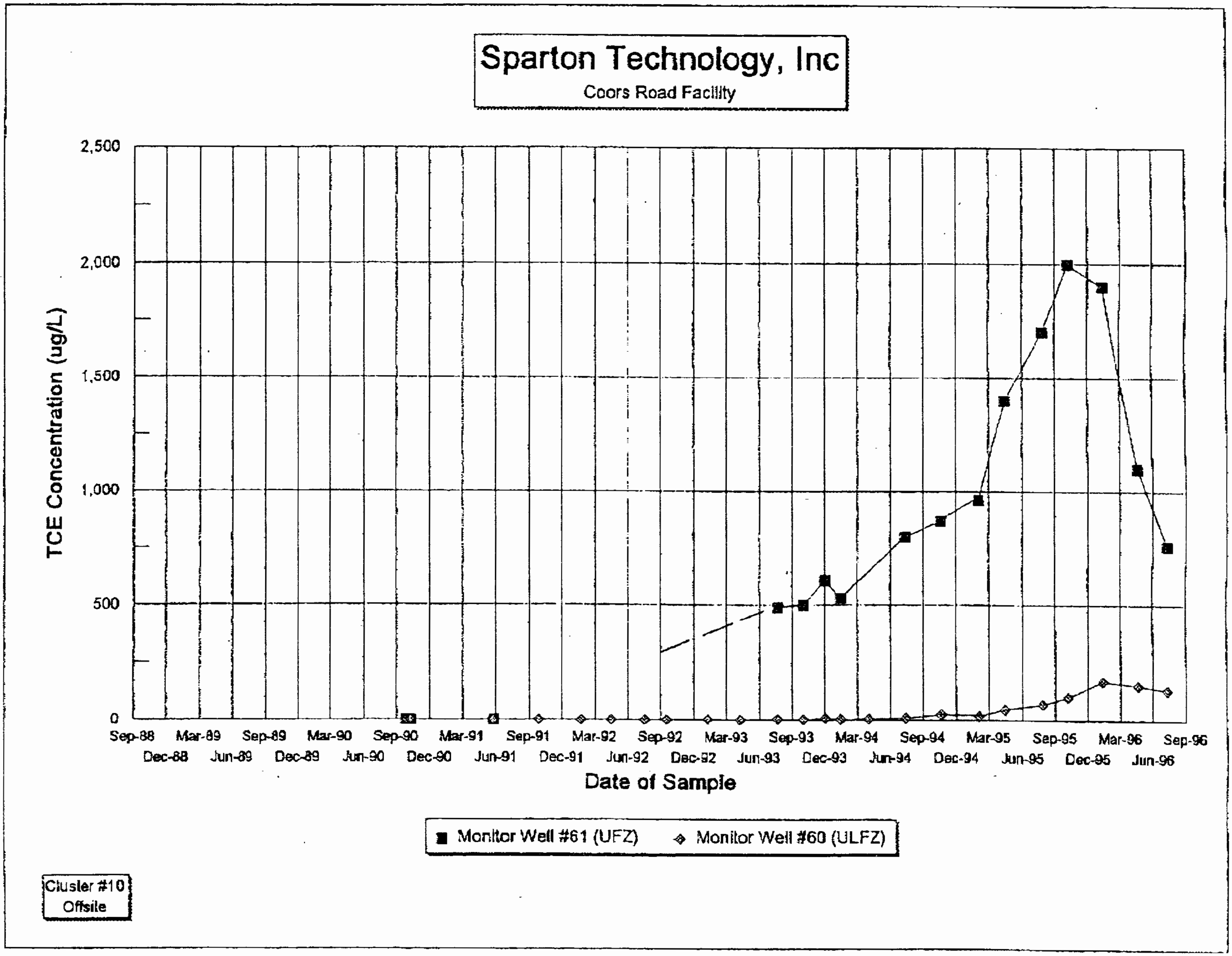

Figure 15

B&V Project : 026802.0100 File : smpl7-96.wk4 Printed : 09/23/96 07:59 AM

Decrease in plume concentration is also demonstrated by mapping and contouring of specific volatile organic constituent (VOC) analytical results obtained from a series of surface soil-gas surveys conducted in 1984, 1987, and 1991. Reports detailing each survey are included in the 1992 RFI Report attachments. Survey information is also summarized in the 1996 CMS Report. A comparison of the plotted results shows a significantly progressive decrease in surface soil-gas VOC concentrations including TCE and TCA.

Comparison of soil gas concentrations indicates a fifty-fold decrease in TCE and thirty-fold decrease in TCA concentration in the period 1984 to 1991. In the 1987 and 1991 surveys, TCE and TCA were detected over approximately the same area; however, TCE concentration dropped almost an order of magnitude and TCA concentration dropped 30 to 50 percent.

Need for Additional Contaminant Characterization Study. Additional site investigation beyond continued groundwater monitoring would only confirm current characterization of the plume. Additional investigation will not fundamentally change understanding or definition of the plume relative to assessing risk/threat or remedial design.

Continued monitoring consisting of semi-annual to annual monitoring of selected, representative wells for VOC is more than adequate based on the following:

1) Plume limits and direction and rate of movement are defined and understood.

2) Plume poses no risk/threat and there are no significant exposure pathways/potential receptors.

3) There is an adequate network of groundwater wells around and under (as well as inside) the plume - particularly near the leading edge.

4) There is an extended history of quarterly results since 1992 and slightly less frequent results dating back into the 1980's as given in previous Table 2.

5) Specific VOC (TCE, TCA, DCE, DMA) are constituents of concern for plume definition and risk/threat assessment. Any degradation products will also be VOC.

6) Standard groundwater monitoring practice is to decrease monitoring frequency, decrease number of wells sampled, and to limit analyses to constituents of concern as plume (and risk/threat) becomes defined and understood.

RISK ASSESSMENT

The defined contaminant plume poses no risk or threat to human health. Contaminant concentrations within the plume exceed drinking water standards; however, there is no foreseeable exposure pathway to current (and future planned) drinking water use from the aquifer in the impacted area.

Potential Receptors/Exposure Pathways. The nearest potential receptor/ exposure pathway is the New Mexico Utilities (NMU) municipal supply well some 2.1 miles downgradient from the leading edge of the plume. In addition to the horizontal and vertical separation of the NMU well intake from the plume, modelling conducted in 1996 showed that the plume's continued migration would not affect drinking water quality at the NMU well. The model was intended to represent a "worst-case" relative to risk posed to the NMU well. Model used the high range of hydraulic conductivity, low range of effective porosity, and assumed the site-specific hydraulic gradient extended all the way to the NMU well. Further, it was assumed that no retardation or degradation of TCE was occurring. The model was calibrated to the plume limits (and age) given in the 1992 RFI Report and then run for elapsed times up to several hundred years. The model was never intended to be an exact simulation, but rather was intended to show the non-impact to the NMU well under conservative modelling.

In concern No. 13 of the Technical Review of the CMS Report dated June 20, 1996, EPA was critical of the groundwater modelling and related conclusions without making any effort to understand the assumptions, input parameters, and calibration efforts. EPA also apparently failed to review requested additional supplemental data on the model furnished by Sparton on June 3, 1996.

The model was run using site-specific hydraulic gradient and hydraulic conductivity values included in both the RFI and CMS Reports. Although challenged by EPA, these parameters are remarkably consistent with regional characterization. The model was then calibrated to the RFI Report plume limits by varying longitudinal and transverse dispersivity values to obtain a good match to plume shape. Vertical matching was also checked. In spite of EPA's erroneous assertion, vertical dispersivity was constant at 0.01 which calculates to approximately 0.2 to 2 percent of the calibrated horizontal values. This value for vertical dispersivity is very close to the value EPA claims should have been used in the absence of site-specific data. EPA further challenged Sparton's decision to model the plume migration toward the nearest potential receptor -- the NMU municipal supply well some 2.1 miles distant.

In spite of EPA's strenuous criticism, the calibrated model appears to match the plume shape and rate of migration very well. Predictions based on that model were readily confirmed by the additional groundwater monitoring wells installed in summer 1996.

Threat. Concentrations of TCE, TCA, DCE, and DMA within the plume exceed drinking water standards; however, due to the lack of any realistic exposure pathways and/or potential receptors, the plume poses no current (or reasonably foreseeable) risk/threat to human health. The impacted ground water is not used by any water system and does not pose an ingestion risk to human health. In addition, homes located over the plume are not at risk from soil gas emanating from the plume. Repeated surface soil gas surveys did not detect any VOC in or near the residential area at a detection limit of 0.00022 ppm_v. Further, deep soil gas surveys conducted at the top of the saturated zone and reported in the CMS Report, did not detect any significant (<1 ppm_v) VOC concentration offsite. Thus, there is no risk by inhalation.

AQUIFER RESTORATION

Restoration is defined as the removal of contaminants to achieve drinking water standards. It is very doubtful that the impacted aquifer can be restored by any "Technically Practicable" methodology(ies) in any reasonable time frame. This conclusion is based on the following site-specific information:

1. The heterogeneous and anisotropic nature of the subsurface will not allow simplistic "broad brush" solutions. "Real world" solutions will have to deal with discrete, isolated contaminant concentrations in attaining restoration.

2. Restoration will require removal of both dissolved phase contamination from groundwater and sorbed-phase (residual DNAPL) contamination from saturated fine-grained clays and silts. Sorbed-phase (residual DNAPL) removal will require long-term activity.

   Sorbed-phase contamination is the result of constituents being adsorbed onto or bound up by capillary forces within the soil pore structure. Sorption of constituents such as TCE is enhanced by the presence of fine-grained silts and clays and/or organic material. It has been reported by Piwani & Keeley (EPA, 1990) that "a few percent of silts and clays can result in a substantial increase in the sorptive behavior of the aquifer material'. These silts and clays are the sorptive sites to contaminants in groundwater moving through the subsurface matrix. Increasing percentages of silts and clays will result in significant sorbed-phase contamination.

   Both regional characterization and site-specific investigation show that silts and clays are significantly present and heterogeneously and anisotropically distributed throughout the aquifer. These silts and clays not only restrict vertical migration, but also readily adsorb contaminants from the ground water.

   John Hawley summarized properties for the lithofacies (sedimentary geologic units) that make up the Albuquerque Basin (USGS, 1993). Hawley indicates that the ratio of sand plus gravel to silt plus clay will range from a high in excess of two to a low of less than 0.5 for the typical geologic materials in the subsurface. Converted to a percent, these ratios would range from less than 30 percent to over 70 percent silt and clay. A review of boring logs from deeper well installations (LLFZ and TFZ wells) at the Sparton facility indicates that approximately 40 percent of the saturated depth interval is comprised of clay, clayey, or silty stratigraphic units. The remaining units also contain clay/silt seams and lenses; however, the use of bentonite as a drilling fluid additive makes identification of minor silt/clay very difficult. Actual amount of silt/clay is estimated in the 20 percent range. Recent investigation north of the Calabacillas Arroyo (USBR, 1996) showed that, in the upper 300 feet of the saturated zone: silt/clay was present in 45 of the 60 five-foot logged intervals; silt/clay content ranged from 0 to 85 percent; and average clay content was approximately 15 percent over the total 300 feet. However, the USBR indicated that drilling fluid precluded a complete evaluation of silt/clay fraction.

3. Hydraulic conductivity and groundwater flow rates are low. As a result, groundwater extraction and treatment will require a very long time frame because of the extremely large volume of water to be treated and the rate at which the water can be removed by wells.

4. The plume is relatively large in horizontal extent due to migration from a long-duration release; however, the plume is relatively thin (in depth) due to the significant vertical anisotropy. The plume dimensions and contaminant distributions will not allow efficient, high-rate groundwater extraction. Highest TCE concentrations are found near the top of the aquifer. Large drawdowns associated with high pumping rates will pull contamination down into lower portions of the aquifer. High pumping rates will also result in more water being removed from the zones with higher hydraulic conductivities (and probably from areas outside the plume) with little effect on either dissolved-phase or sorbed-phase contamination in the less water-transmissive zones. Aggressive pumping will thus result in the removal and treatment of very large volumes of relatively uncontaminated water without achieving significant remediation.

5. Attempts to restore the aquifer will require numerous wells pumping at low rates because of the plume size, drawdown limitations, pumping rate limitations, and resultant influence limitations. Because of the time requirements resulting from pumping rate limitations and the difficulty of removal of sorbed-phase contamination, attempts at restoration will be extremely inefficient.

6. The plume is located under a developing residential area. There will be little room for numerous recovery wells. In addition, bringing large quantities of contaminated water to the surface at numerous locations will greatly increase risk/threat to human health.

7. EPA Region 6 and NMED have been unable to provide any successful case-history documentation to support restoration under similar conditions/contaminants.

Site characteristics and contamination were also analyzed in the context of EPA's Guidance for Evaluating the Technical Impracticability of Groundwater Restoration (EPA, 1993). Procedures in this guidance lead to the conclusion that aquifer restoration is "Technically Impracticable." Application of the guidance procedures is detailed in both text and table form in the 1996 CMS Report.

In their Technical Review of the CMS Report dated June 20, 1996, EPA questioned technical impracticability in concern No. 11. EPA appears to differentiate between dissolved-phase and residual-phase VOC (referred to as "entrained DNAPL" in the concern). EPA agrees that entrained DNAPL would prevent practicable restoration, but argues that entrained DNAPL is found only near the source. It is interesting to note that EPA quotes out of context its own technical guidance (EPA, 1993) page 8, and seems to misuse a second quote from page 12 of the guidance. In light of the numerous studies and case histories reported in the literature, and recognizing the conditions at the Sparton facility, it is surprising that EPA does not believe that sorbed-phase VOC or residual DNAPL is not present throughout the plume. Further, EPA seems unwilling to acknowledge the difficulty of residual DNAPL remediation.

The infeasibility of aquifer restoration at this site is further confirmed by the 24 case histories contained in Evaluation of Ground-Water Extraction Remedies: Phase II (EPA, 1992). This report was used by EPA as a "report card" in response to Congressional inquiry. The report was intended to be a summary of the state-of-practice for groundwater remediation. The following summary of the reported case histories is extremely relevant to the Sparton facility:

1. Contamination - 12 of the 24 sites had TCE contamination; 19 of the 24 sites had chlorinated solvent contamination.

2. Geology - all 12 of the TCE - contaminated sites had fluvial clay, silt, sand, and gravel geology; 18 of the 19 chlorinated solvent sites had same geology.

3. Extent of Plume - the horizontal extent of the plumes was <u>much</u>, <u>much</u> larger than the vertical depth or thickness; the 12 TCE sites ranged from 9 to 760 acres in sizes with depths ranging from 20 to 250 feet; the 19 chlorinated sites ranged from 0.7 to 7,600 acres with depths from 20 to 250 feet.

4. Regulatory Program - the TCE sites included three RCRA, four Superfund, and five state; the chlorinated sites were three RCRA, six Superfund, and 10 state.

5. Containment - containment was achieved at eight of the 12 TCE sites; containment was achieved at 13 of the 19 chlorinated solvent sites.

6. Restoration - restoration was not being achieved, nor had been achieved, at any of the 24 sites.

To-date, EPA has not provided any meaningful case-history data to support the feasibility of restoration. In fact, EPA's Office of Emergency and Remedial Response (OERR) is currently involved in the evaluation of containment as an alternative to restoration because of EPA's dismal experience with restoration and resultant Congressional and technical pressure.

Technical impracticability of restoration at Sparton's site is also confirmed by the additional case history information contained in <u>Alternatives for Groundwater Cleanup</u> (National Research Council, 1994). The above discussions and references are not intended to show that groundwater extraction or "pump and treat" is bad; but rather to show that extraction is more appropriate for containment and contaminant reduction as contrasted to restoration.

Although aquifer restoration is technically impracticable, aquifer remediation is realistic and practicable. Sparton's currently proposed remediation activities will produce comparable results to EPA's proposed Alternative 4 over the same 30-year time frame at substantially less cost. Sparton capital costs are approximately $0.5 million, operation and maintenance costs are approximately $0.2 million/year. EPA's capital cost is approximately $2.5 to $3.1 million with an operations and maintenance cost of approximately $0.85 to $3.6 million annually, depending on extent of water treatment. Costs for additional extraction wells were not quantified in the EPA Final Decision (EPA, 1996); however, additional extraction wells were discussed in the context of final-phase restoration. Each additional extraction well (200 gpm nominal pumping), together with its water treatment and reinjection requirements, would have capital costs in the range of $0.56M to $0.77M and annual O&M of $0.2M to $1.2M, depending on level of treatment.

Sparton's most recent proposed remediation would provide for containment of the leading edge of the plume. This containment would control further plume migration and ultimately capture existing contamination moving downgradient in offsite areas of the plume. Sparton's containment proposal was conditioned to the economical treatment and disposal of extracted groundwater.

In the 1996 CMS Report, Sparton has also proposed expansion of the existing onsite groundwater extraction system to enhance both onsite containment and removal of source material from areas with elevated contaminant concentration. Over eight years of successful operation of this system demonstrate its feasibility.

In their Final Decision Document, EPA provided erroneous and misleading depictions of capture zones for the existing onsite recovery well system. These capture zones are significantly different from, and much smaller than, capture zones and/or radius of influence given in Sparton's Effectiveness Report and in EPA's previous Statement of Basis. In the Final Decision, EPA decided to ignore demonstrations of the actual pumping radius of influence obtained from multiple, multi-well pumping tests conducted on several of the recovery wells. These demonstrations were used to confirm Sparton's calculations for all the recovery wells. EPA elaborated on their calculations under concern No. 1 of their June 20, 1996, Technical Review of the Effectiveness Report. Their comments reflect a basic misunderstanding of the Hvorslev methodology to require "an instantaneous change in the water level" when, in fact, Hvorslev methodology can be applied (and often is) to constant rate or equilibrium conditions (USACOE, 1951). Secondly, EPA averaged well-location-specific hydraulic conductivities ranging two orders of magnitude and hydraulic gradients ranging over an order of magnitude to obtain single values for calculations at all well locations. Such an approach ignores the significant heterogeneity and anisotropy observed and documented on site. EPA also chose to ignore actual field demonstrations of capture determined from long-duration, multiple-well pump tests included in Appendix 2 of Sparton's Effectiveness Report. For example, for two wells in the original source area, MW-24 and MW-25, EPA calculated maximum capture zone widths of 8.88 and 16.00 feet respectively, yet actual pump test results showed that pumping of either MW-24 or MW-25 impacted the drawdown in the other well over a horizontal distance of 32.82 feet. This demonstration would indicate capture zone widths are at least 66 feet wide at the wells and would be somewhat larger upgradient. Obviously, inter-well comparisons of influence obtained under actual field conditions are far superior to any theoretical calculations.

In the 1996 CMS Report, Sparton has also proposed installation of a soil vapor extraction (SVE) system to remove source material from the unsaturated zone in the vicinity of the original contamination source area.

Based on the current rate of plume migration, it will take 25 to 30 years for the majority of contamination to be captured by the leading edge containment; however, natural attenuation including biotic and abiotic processes will be taking place based on site observations to date and recent New Mexico Water Resources Research Institute studies in the Albuquerque Basin (NMWRRI, 1992).

SUMMARY

- Subsurface conditions and plume characterization are more than adequately defined and understood; plume behavior is predictable.
- Potential receptor/exposure pathways are identified and there is no risk/threat to human health.
- There is more than sufficient information to assess risk/threat and/or to design any additional remediation; further study or investigation is not needed.
- Sparton's proposed remediation will accomplish the same objectives as EPA's proposal in the same time-frame at significantly less cost.

I state, under penalty of perjury, that the foregoing is true and correct.

Executed on February 4, 1997.

Black & Veatch

Pierce L. Chandler, Jr.
Project Manager

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Attachments:
Curriculum Vitae - Pierce Chandler
Bibliography