

Figure 3–167. Relative Average Annual Total U Loads from Major COU Drainages and Former WWTP

3.1.5 Groundwater Data Interpretation and Evaluation

This section provides a summary of groundwater monitoring performed in 2008, separated into RFLMA-required and non-RFLMA-required. A discussion of groundwater conditions during 2008, focusing on the most important water-quality aspects in the areas of interest (i.e., the main plumes), is then presented.

3.1.5.1 RFLMA Groundwater Monitoring Activities of 2008

Groundwater was monitored in accordance with RFLMA beginning in March 2007, when that agreement was signed. Routine activities of the groundwater monitoring program in 2008 included sample collection, water-level measurement, groundwater treatment system maintenance, and well maintenance. Note that this “groundwater” monitoring also includes monitoring activities at several surface-water locations, as well as at some locations that may not clearly belong to either category. (Examples of the former include groundwater treatment system-related performance monitoring locations within streams and ponds; examples of the latter include locations monitoring effluent from a treatment system.) However, because all of these locations support groundwater monitoring objectives, the data collected from them in support of these objectives are included as part of the groundwater discussion.

Special, non-RFLMA monitoring was also performed in 2008 to support various objectives. This is discussed in Section 3.1.5.2. Analytical data and other information generated via RFLMA (a.k.a. routine) and non-RFLMA (a.k.a. nonroutine) sampling have been reported in the corresponding quarterly reports for 2008 (DOE 2008d, 2008e, 2009e) and are included in Appendix B for the fourth quarter of CY 2008.

The network of groundwater monitoring locations changed slightly during 2008, with two locations being replaced and one eliminated. Each of these changes was documented in an approved regulatory Contact Record. A summary of these changes is presented in Table 3–81.

Table 3–81. Changes to the Groundwater Monitoring Network in CY 2008

Location	General Area	Contact Record	Nature of Change	Reason for Change
45608	Hillside south of B991	2007-07, 2008-04	Well 45608 was installed to replace well 45605 (abandoned in 2007)	RFLMA-required location; original well was heavily damaged by slumping hillside
SPPMM01	SPPTS	2008-09	Eliminated from network, replaced with more accessible location	SPPTS Phase I upgrades allowed installation of a safer and more accessible replacement location, SPOUT
SPOUT	SPPTS	2008-09	Added to network to replace SPPMM01	Original location difficult to access and required confined space entry (a safety concern)
TH046992 ^a	ETPTS / Pond B-3	2008-09	Eliminated from network	Redundant

Notes: ^aWell TH046992 was monitored in accordance with the RFLMA during 2008, being sampled in the second and fourth calendar quarters as required. As such, this change to the monitoring network will not be evident until 2009.

The groundwater monitoring network set forth in RFLMA is subdivided and categorized as shown in Table 3–82.

Table 3–82. RFLMA Monitoring Classifications for the Groundwater Monitoring Network

Well Classification	General Objective	Number of Wells ^a	Monitoring Frequency
AOC	Monitor groundwater quality and water levels in a drainage downgradient of a contaminant plume or group of plumes	9	Semiannual (2x/year)
Boundary	Monitor groundwater quality and water levels in Woman Creek and Walnut Creek drainages at eastern (downgradient) Site boundary	2	Annual (1x/year)
Sentinel	Monitor groundwater quality and water levels near contaminant plume edges and in drainages	28	Semiannual (2x/year)
Evaluation	Monitor groundwater quality and water levels in or near contaminant source areas and in the former IA	42	Biennial (1x/every 2 years)
RCRA	Monitor groundwater quality and water levels upgradient and downgradient of the PLF and the OLF	10	Quarterly (4x/year)
Treatment System ^{a, b}	Monitor quality of groundwater treatment system influent, effluent, and downgradient surface water	9	Semiannual (2x/year)
Surface-Water Support ^a	Monitor quality of surface water downgradient of contaminant plume	1	Semiannual (2x/year)

^aThe numbers of locations listed are current through 2008, and do not reflect the reduction in the network discussed previously (elimination of one Sentinel well). That change did not affect monitoring requirements in 2008, but will affect monitoring requirements beginning in 2009.

^bTreatment system and surface-water support locations are not monitoring wells but are included for completeness.

^cThe PLF/TS is discussed separately.

Table 3–83 presents the full 2008 schedule for RFLMA groundwater sample collection, a subset of which is summarized in Table 3–84 as those scheduled samples that were not successfully collected (e.g., due to dry conditions). Corresponding analytical results are published in the associated quarterly reports (DOE 2008d, 2008e, 2009e) and Appendix B.

Table 3–83. Summary of Scheduled RFLMA-Required Groundwater Sampling in CY 2008 (by Quarter)

Location		Analytes					
ID	Location Classification	VOCs	U	Nitrate	Metals	Pu/Am	SVOCs
00191	E	2					
00193	AOC	2,4	2,4				
00203	E	2	2	2			
00491	E	2					
00797	S	2,4	2,4				
00897	E	2					
00997	AOC	2,4	2,4	2,4			
03991	E	2					
04091	S	2,4					
05691	E	2					
07391	E	2	2				
10304	AOC	2,4	2,4	2,4			
10394	B	2	2	2			
10594	AOC	2,4	2,4	2,4			
11104	AOC	2,4	2,4				
11502	S	2,4	2,4				
15699	S	2,4					
18199	E	2					
20205	S	2,4	2,4			2,4	
20505	S	2,4	2,4			2,4	
20705	S	2,4	2,4	2,4		2,4	
20902	E	2					
21505	E	2					
22205	E	2	2	2			
22996	E	2	2				
23296	S	2,4	2,4				
3687	E	2					
30002	S	2,4					
30900	E	2					
33502	E	2					
33604	E	2					
33703	S	2,4					
33905	E	2					
37405	S	2,4	2,4	2,4		2,4	
37505	S	2,4	2,4	2,4			
37705	S	2,4	2,4	2,4		2,4	
4087	AOC	2,4	2,4	2,4			
40005	E	2	2				
40205	E	2	2				
40305	S	2,4	2,4				

Table 3–83 (continued). Summary of Scheduled RFLMA-Required Groundwater Sampling in CY 2008
(by Quarter)

Location		Analytes					
ID	Location Classification	VOCs	U	Nitrate	Metals	Pu/Am	SVOCs
41691	B	2	2	2			
42505	AOC	2,4					
45608 ^a	S	2,4					
50299	E	2					
51605	E		2	2			
52505	S	2,4					
55905	E	2	2	2			
56305	E	2	2	2			
70099	S		2,4	2,4			
70193	RCRA	1,2,3,4			1,2,3,4		
70393	RCRA	1,2,3,4			1,2,3,4		
70693	RCRA	1,2,3,4			1,2,3,4		
70705	E	2	2				
73005	RCRA	1,2,3,4			1,2,3,4		
73105	RCRA	1,2,3,4			1,2,3,4		
73205	RCRA	1,2,3,4			1,2,3,4		
79102	E	2	2	2			
79202	E	2	2	2			
79302	E		2	2			
79402	E		2	2			
79502	E		2	2			
79605	E		2	2			
80005	RCRA	1,2,3,4			1,2,3,4		1,2,3,4
80105	RCRA	1,2,3,4			1,2,3,4		1,2,3,4
80205	RCRA	1,2,3,4			1,2,3,4		1,2,3,4
88104	S	2,4	2,4				
88205	E	2	2				
89104	AOC	2,4					
891WEL	E	2					
90299	S	2,4					
90399	S	2,4					
90402	E	2					
90804	E	2					
91105	E	2					
91203	S	2,4					
91305	S	2,4	2,4	2,4			
95099	S	2,4					
95199	S	2,4					
95299	S	2,4					
99305	S	2,4	2,4	2,4			
99405	S	2,4	2,4	2,4			
B206989	AOC	2,4	2,4	2,4			
B210489	E		2	2			
P114689	E	2					
P115589	E	2					
P208989	E	2	2	2			
P210089	S	2,4	2,4	2,4			

Table 3–83 (continued). Summary of Scheduled RFLMA-Required Groundwater Sampling in CY 2008 (by Quarter)

Location		Analytes					
ID	Location Classification	VOCs	U	Nitrate	Metals	Pu/Am	SVOCs
P210189	E	2	2	2			
P416589	RCRA	1,2,3,4			1,2,3,4		1,2,3,4
P416889	E	2	2				
P419689	E	2	2				
TH046992 ^b	S	2,4					
MOUND R1-0	TS	2,4					
MOUND R2-E	TS	2,4					
GS10	TS	2,4					
ET INFLUENT	TS	2,4					
ET EFFLUENT	TS	2,4					
POM2	TS	2,4					
SPPMM01 ^c	TS		2,4	2,4			
SPIN	TS		2,4	2,4			
GS13	TS		2,4	2,4			
SW018	SS	2,4					

Notes: ID = Identification (name) of well/sampling location
 Location classifications: AOC = Area of Concern, B = Boundary, S = Sentinel, DD = Decision Document, E = Evaluation, RCRA = Resource Conservation and Recovery Act, TS = Treatment System, and SS = Surface Water Support
 SVOCs = semivolatile organic compounds
 2 (or other numeral) = Analyte requested for that quarter; if blank, analyte not requested
^aLocation takes the place of well 45605 in the RFLMA.
^bLocation was eliminated in late 2008 as indicated in 3.1.1.2.
^cLocation was replaced as indicated in 3.1.1.2 following required fourth-quarter sampling in 2008.

Table 3–84. Summary of Groundwater Samples Not Successfully Collected in 2008

Location		Analytes						Comments
ID	Classification	VOCs	U	Nitrate	Metals	Pu/Am	SVOCs	
00191	E	2						Inadvertently not sampled in 2008; samples collected March 13, 2009.
50299	E	2						Inadvertently not sampled in 2008; samples collected March 13, 2009.
90299	S	2, 4						Dry well
95299	S	2, 4						Dry well
B206989	AOC	2						Insufficient water available for VOC samples

Notes: ID = Identification (name) of well/sampling location
RFLMA classifications: AOC = Area of Concern, B = Boundary, S = Sentinel, E = Evaluation, RCRA = Resource Conservation and Recovery Act, TS = Treatment System, SS = Surface Water Support
SVOCs = semivolatile organic compounds
2 (or other numeral) in analyte column = Corresponding analyte requested in the indicated calendar quarter of 2008; if blank, analyte not requested

3.1.5.2 Non-RFLMA Groundwater Monitoring Activities of 2008

Non-RFLMA (a.k.a. nonroutine) groundwater monitoring was performed in 2008 in support of several data needs, which generally fall within the following two categories:

- Investigative sampling; and
- Performance sampling.

Table 3–85 summarizes all non-RFLMA sample collection performed in 2008. In addition to this non-RFLMA sampling, additional non-RFLMA monitoring was performed through the Site-wide measurement of water levels as discussed in Section 3.1.3.5.

Table 3–85. Summary of Non-RFLMA Groundwater Monitoring Performed in 2008

Location		Analytes ^{a,b}							
ID	Classification	VOCs	U	U Iso.	U (LANL)	Nitrate	α/β	Major Ions	Nitrite, Ammonia, TOC, Major Ions, Microbial Parameters
00193	AOC		3		3		3		
B206989	AOC				3				
15699	S		3		3		3		
1786			4			4			
Mound R1-0	TS							2	
Mound BETW	TS	2						2	
Mound R2-E	TS							2	
ET-INFLUENT	TS	3						2	
ET BETW	TS	2						2	
ET-EFFLUENT	TS	3						2	

Table 3–85 (continued). Summary of Non-RFLMA Groundwater Monitoring Performed in 2008

Location		Analytes ^{a,b}							
ID	Classification	VOCs	U	U Iso.	U (LANL)	Nitrate	α/β	Major Ions	Nitrite, Ammonia, TOC, Major Ions, Microbial Parameters
POM2	TS		3		3		3		
SPIN	TS		2,3,4 (10) (includes 2 sets of split samples collected in 4th quarter)		2,3	4 (7) (includes 2 sets of split samples collected)	2,3	2	2
SPPMM01	TS		4 (3)			4 (3)		2	2
SPP Discharge Gallery ^c	TS		2,4 (8) (includes 1 set of split samples collected in 4th quarter)		2	2,4 (9) (includes 2 sets of split samples collected in 4th quarter)	2	2	2
GS13	TS		4 (8) (includes 2 sets of split samples collected)		2	2,4 (9) (includes 2 sets of split samples collected in 4th quarter)	2	2	2
SW093			4 (2) (samples shipped to Test America)			4 (5) (includes 2 sets of split samples)	2		
ITSW ^c			4 (8) (includes 2 sets of split samples)			4 (8) (includes 2 sets of split samples)			
ITSE ^c			4 (8) (includes 2 sets of split samples)			4 (8) (includes 2 sets of split samples)			
ITSS ^c			4 (8) (includes 2 sets of split samples)			4 (8) (includes 2 sets of split samples)			
SPOUT	TS		4 (8) (includes 2 sets of split samples)			4 (8) (includes 2 sets of split samples)			

Notes: ^aThe numeral in the “analyte” column (e.g., 2) indicates the 2008 quarter in which the analyte was requested; if blank, analyte not requested. For those locations where more than one non-RFLMA-required sample was collected in the indicated quarter(s), the total number of non-RFLMA samples collected is indicated in parentheses.

^bSeveral split samples were collected at locations associated with the SPPTS; one set was sent to a contract laboratory and the other to the ESL for analysis.

^cThe Solar Ponds Plume Discharge Gallery (SPP DIS GAL, a.k.a. SPP DG) is sampled in accordance with the RFSOG (DOE 2009a). Locations ITSW, ITSE, and ITSS are associated with the Phase I upgrades to the SPPTS and were sampled to evaluate system effectiveness (i.e., quality of additional water being captured by the Phase I upgrades).

ID = Identification (name) of well/sampling location

U iso. = isotopic uranium

RFLMA classifications: AOC = Area of Concern; B = Boundary; S = Sentinel; E = Evaluation; RCRA = Resource Conservation and Recovery Act; TS = Treatment System; and SS = Surface Water Support

LANL = Los Alamos National Laboratory

α/β = gross alpha/gross beta

TOC = total organic carbon

Investigative and performance sampling may be conducted when additional data needs are identified that may not be satisfied by the routine monitoring schedule. In 2008, as in recent years, this was most applicable to the SPPTS; due to the significant effort and unusual events related to that treatment system, this topic is discussed separately in Section 3.1.2.10.

Investigative sampling was also performed to support data needs associated with the Colorado WQCC negotiations. This topic is addressed in Section 2.2. A related effort that supported both general and WQCC objectives was the collection of samples from selected groundwater and

surface-water monitoring locations for the determination of U isotopic signature. The resulting data were used to inform negotiations on the Site-specific U standard and gross alpha and gross beta standards. These negotiations are discussed in greater detail in Section 2.2.

In addition to that performed at the SPPTS and discussed elsewhere, performance sampling was conducted to evaluate groundwater treatment system effectiveness at the ETPTS. This sampling was performed because system conditions (e.g., water levels within the treatment cells) indicated that the ZVI media was becoming clogged. Previously, treatment performance—concentrations of VOCs, particularly TCE, in system effluent—has been a good indicator of the need to replace the ETPTS media, so an extra round of samples was collected from the influent and effluent locations in August 2008 to determine whether effluent-water quality suggested media replacement was urgently needed. Results were consistent with previous data, so media replacement was postponed to 2009. See Section 2.5.3 for system maintenance information.

3.1.5.3 Groundwater at the Rocky Flats Site: Discussion and Interpretations

This section presents a summary evaluation of groundwater quality at the Site during 2008. Groundwater quality is addressed first, followed by descriptions of special studies and activities. Included in the discussion of water quality are descriptions of the behavior of and any notable activities at the groundwater treatment systems during 2008.

Trend Plots

Numerous statistical trend plots were constructed for this report using analytical data collected from Sentinel, Evaluation, and RCRA wells. Trend plots were also constructed for two AOC and two Boundary wells because they either require trending or are being evaluated for trend for reasons of professional judgment. Trend plots are presented in Appendix B. In addition to these statistical trend plots, many non-statistical time-series plots were also prepared and are included in this report.

The Sanitas™ software package (version 8.7; Sanitas Technologies 2007) was used for statistical calculations, including the construction of trend plots. (This is noted for the purpose of completeness only; this report does not make any software recommendations.) For simplicity, because the fundamental objective of Sentinel wells is related to detection monitoring and that of Evaluation wells is related to the exit strategy, and because no interwell statistics were planned for these classes of wells (only intrawell assessment of the trend of an analyte over time at each given well), each of these wells was assigned a downgradient position. (The same applies to the AOC wells evaluated for trend.) Only RCRA wells were assigned either upgradient or downgradient positions to support the related statistical evaluations, as described in Section 3.1.2.8 and Section 3.1.2.9.

Analytical data were handled as described in Section 3.1.1.3. Trends for wells sampled more than once a year were calculated and plotted using the S-K statistical method, as recommended for Rocky Flats groundwater data (K-H 2004a) and in accordance with the RFSOG (DOE 2009a). Where data are only collected once in a given year (e.g., Evaluation wells), removing aspects of seasonality, the Mann-Kendall (M-K) statistical method was used. S-K trends were only plotted where they were calculated to be at least 80 percent significant, and M-K trends were plotted if at least 95 percent significant.

Table 3–86 summarizes the results of S-K and M-K trend calculations performed for Sentinel, Evaluation, and RCRA wells; calculations for selected analytes in samples from AOC wells B206989 and 10594, and Boundary wells 10394 and 41691, are also included. Only increasing and decreasing trends calculated to be at least 80 percent significant using the S-K test, or 95 percent significant using the M-K test, are included in this table. (Therefore, even if 95 percent significant, trends with zero slope are not included.) Additionally, only those groundwater monitoring well classifications that require statistical evaluation of concentration trends per RFLMA are included; for this reason, AOC wells, Boundary wells, the Surface Water Support location, and groundwater treatment system locations as a whole are not included. Refer to Appendix B for the plots and associated summary tables, and Figure 3–1 for well locations. Significant trends for selected analytes and locations are discussed later in this section in the context of their respective groundwater contaminant plumes.

Table 3–86. Summary of Statistical Trend Calculations

Well	General Location	Analyte	Trend	Significant at 95%?
Sentinel Wells				
15699	MSPTS	1,1,1-TCA	Decreasing	No
91203	OBP#2	1,1,1-TCA	Increasing	No
45608	Hillside south of B991	1,1-DCE	Increasing	No
90399	903 Pad/Ryan's Pit Plume-SID	1,1-DCE	Increasing	No
91203	OBP#2	1,1-DCE	Increasing	No
TH046992	ETPTS/Pond B-3	1,1-DCE	Decreasing	No
33703	OBP#1	1,2-DCB	Increasing	Yes^a
15699	MSPTS	1,2-DCA	Increasing	Yes^b
33703	OBP#1	1,3-DCB	Increasing	Yes^b
45608	Hillside south of B991	1,3-DCB	Increasing	No
33703	OBP#1	1,4-DCB	Increasing	Yes
04091	East Trenches Plume	Carbon tet	Decreasing	Yes^c
23296	ETPTS	Carbon tet	Decreasing	Yes
90299	903 Pad/Ryan's Pit Plume-SID	Carbon tet	Decreasing	Yes^c
91203	OBP#2	Carbon tet	Decreasing	No
33703	OBP#1	Chlorobenzene	Decreasing	Yes
15699	MSPTS	Chloroform	Decreasing	No ^c
23296	ETPTS	Chloroform	Decreasing	Yes
90299	903 Pad/Ryan's Pit Plume-SID	Chloroform	Decreasing	No
91203	OBP#2	Chloroform	Decreasing	No
20705	B771	Cis-1,2-DCE	Increasing	Yes^c
23296	ETPTS	Cis-1,2-DCE	Increasing	Yes
33703	OBP#1	Cis-1,2-DCE	Increasing	Yes^b
90399	903 Pad/Ryan's Pit Plume-SID	Cis-1,2-DCE	Increasing	No
91203	OBP#2	Cis-1,2-DCE	Increasing	Yes^c
99305	B991	Cis-1,2-DCE	Increasing	Yes
99405	B991	Cis-1,2-DCE	Increasing	No
04091	East Trenches Plume	PCE	Decreasing	Yes^{b, c}
15699	MSPTS	PCE	Decreasing	Yes^b
23296	ETPTS	PCE	Decreasing	Yes
40305	B444	PCE	Increasing	Yes^a
45608	Hillside south of B991	PCE	Increasing	No
95199	ETPTS	PCE	Increasing	No

Table 3–86 (continued). Summary of Statistical Trend Calculations

Well	General Location	Analyte	Trend	Significant at 95%?
99305	B991	PCE	Increasing	Yes ^b
99405	B991	PCE	Increasing	Yes ^c
15699	MSPTS	Trans-1,2-DCE	Increasing	Yes ^c
23296	ETPTS	Trans-1,2-DCE	Increasing	Yes ^a
33703	OBP#1	Trans-1,2-DCE	Increasing	Yes ^b
15699	MSPTS	TCE	Decreasing	No
23296	ETPTS	TCE	Decreasing	No
45608	Hillside south of B991	TCE	Increasing	No
90299	903 Pad/Ryan's Pit Plume-SID	TCE	Decreasing	Yes
91305	OBP#2/B991	TCE	Increasing	No
99305	B991	TCE	Increasing	No
99405	B991	TCE	Increasing	Yes ^c
15699	MSPTS	VC	Increasing	Yes ^c
20705	B771	VC	Increasing	Yes ^b
33703	OBP#1	VC	Increasing	Yes ^a
45608	Hillside south of B991	VC	Increasing	Yes ^a
00797	B881	U	Increasing	Yes
20205	B771	U	Increasing	Yes ^a
20505	B771	U	Increasing	No
20705	B771	U	Increasing	Yes ^d
37505	B371	U	Increasing	No
40305	B444	U	Increasing	No
88104	B881	U	Decreasing	Yes ^d
99305	B991	U	Increasing	Yes
99405	B991	U	Decreasing	Yes ^b
P210089	SEP/SPPTS	U	Increasing	Yes ^a
37405	B371	Nitrate	Increasing	No
37705	B371	Nitrate	Increasing	Yes ^c
70099	SPPTS	Nitrate	Decreasing	Yes
20705	B771	Am-241	Decreasing	Yes ^b
<i>RCRA Wells</i>				
70393	PLF	1,1,1-TCA	Decreasing	Yes
70693	PLF	1,1,1-TCA	Decreasing	Yes ^a
70393	PLF	1,1-DCE	Decreasing	Yes
70693	PLF	1,1-DCE	Decreasing	Yes ^a
70693	PLF	Carbon tet	Decreasing	Yes ^a
70693	PLF	Chloroform	Decreasing	Yes ^a
70393	PLF	PCE	Decreasing	Yes
70693	PLF	PCE	Decreasing	Yes ^a
70393	PLF	TCE	Decreasing	Yes
70693	PLF	TCE	Decreasing	Yes ^a
70193	PLF	Se	Decreasing	No
70193	PLF	U	Decreasing	Yes ^b
70393	PLF	U	Decreasing	Yes ^a

Table 3–86 (continued). Summary of Statistical Trend Calculations

Well	General Location	Analyte	Trend	Significant at 95%?
<i>Evaluation Wells^o</i>				
30900	PU&D Yard	1,1,1-TCA	Decreasing	Yes ^c
40205	B444	1,1-DCE	Decreasing	Yes
33502	OBP#1	1,2,4-TCB	Decreasing	Yes
03991	East Trenches Plume	Carbon tet	Decreasing	Yes
05691	East Trenches Plume	Carbon tet	Decreasing	Yes
79202	SEPs	Carbon tet	Decreasing	Yes
91105	OBP#2	Carbon tet	Decreasing	Yes ^{c, d}
891WEL	OU 1 Plume	Carbon tet	Decreasing	Yes
P114689	Central IA	Carbon tet	Decreasing	Yes
03991	East Trenches Plume	Chloroform	Decreasing	Yes ^c
05691	East Trenches Plume	Chloroform	Decreasing	Yes
07391	Ryan's Pit	Chloroform	Decreasing	Yes
40205	B444	Chloroform	Increasing	Yes
79202	SEPs	Chloroform	Decreasing	Yes
91105	OBP#2	Chloroform	Increasing	Yes
891WEL	OU 1 Plume	Chloroform	Increasing	Yes ^c
3687	East Trenches Plume	Cis-1,2-DCE	Increasing	Yes
05691	East Trenches Plume	Cis-1,2-DCE	Decreasing	Yes
07391	Ryan's Pit	Cis-1,2-DCE	Increasing	Yes ^c
30900	PU&D Yard	Cis-1,2-DCE	Increasing	Yes
40205	B444	Cis-1,2-DCE	Decreasing	Yes
88205	B881	Cis-1,2-DCE	Increasing	Yes ^c
91105	OBP#2	Cis-1,2-DCE	Increasing	Yes ^c
891WEL	OU 1 Plume	Cis-1,2-DCE	Increasing	Yes ^c
P416889	South IA	Cis-1,2-DCE	Decreasing	Yes
88205	B881	Naphthalene	Increasing	Yes ^c
03991	East Trenches Plume	PCE	Decreasing	Yes
05691	East Trenches Plume	PCE	Decreasing	Yes
33502	OBP#1	PCE	Decreasing	Yes ^c
33905	North IA	PCE	Decreasing	Yes
40205	B444	PCE	Decreasing	Yes
88205	B881	Total Xylenes	Increasing	Yes ^c
00897	Mound	TCE	Decreasing	Yes
03991	East Trenches Plume	TCE	Decreasing	Yes
05691	East Trenches Plume	TCE	Decreasing	Yes
33604	OBP#1	TCE	Decreasing	Yes
40205	B444	TCE	Decreasing	Yes
79202	SEPs	TCE	Decreasing	Yes
88205	B881	TCE	Increasing	Yes ^c
90402	903 Pad/Ryan's Pit Plume-SID	TCE	Increasing	Yes
891WEL	OU 1 Plume	TCE	Decreasing	Yes
P114689	North IA	TCE	Increasing	Yes
40005	B444	U	Increasing	Yes
79302	SEPs	U	Increasing	Yes
B210489	SPPTS/N. Walnut Creek	U	Increasing	Yes

Table 3–86 (continued). Summary of Statistical Trend Calculations

Well	General Location	Analyte	Trend	Significant at 95%?
Selected AOC Wells				
B206989	Landfill Pond Dam	Nitrate	Decreasing	No
Boundary Wells, Selected Analytes^e				
10394	Woman Ck./Indiana St.	U	Decreasing	Yes
41691	Walnut Ck./Indiana St.	U	Increasing	Yes

Notes: Only increasing and decreasing trends are included; indeterminate and zero-slope trends are not. Trends are listed if there is an 80 percent statistical significance; any decisions that may be made would be based on trends having a 95 percent significance. **Bold** entries designate those trends having a 95 percent significance; only these trends were assessed for applicability of the footnotes below. Locations other than Evaluation and Boundary wells were assessed for trend using the S-K statistical method; Evaluation and Boundary wells were assessed using the M-K method (because seasonality would not be a factor).

DCA = dichloroethane; DCE = dichloroethene; DCB = dichlorobenzene; OBP = Oil Burn Pit; TCB = trichlorobenzene

^aTrend was not calculated to be significant at 80% level in previous (2007) report, but with 2008 data is now 95% significant. (See note e below.)

^bTrend was calculated to be significant in previous (2007) report, but at less than a 95% significance; it now meets the 95% level of significance. (See note e below.)

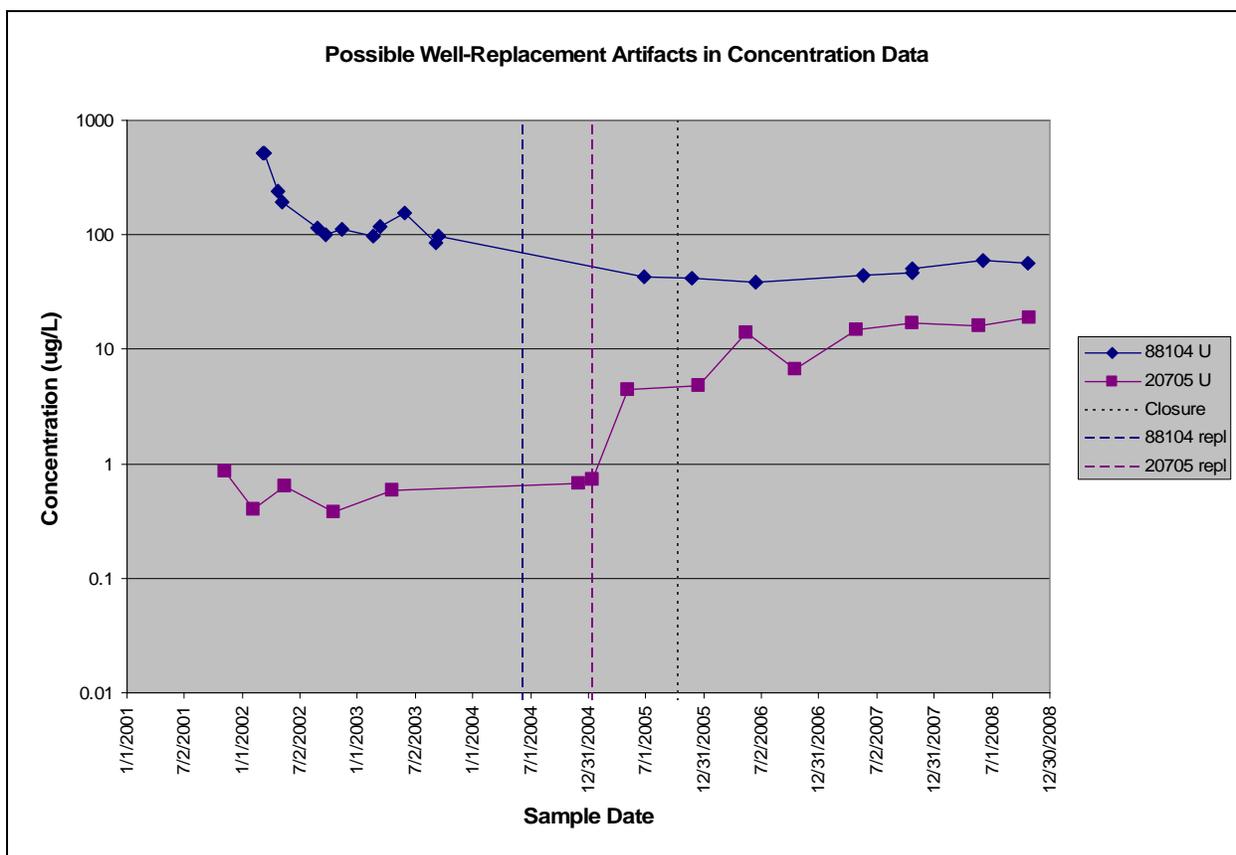
^cTrend may not be valid even though it is calculated to have a 95 percent significance, because 25 percent or more of the analytical data used to calculate this trend are nondetects. See Section 3.1.1.3 for discussion of how nondetects were handled in trending calculations.

^dAlthough the trend is calculated to have a 95 percent significance, the data used to calculate this trend may be affected by well replacement. Results for this constituent in samples from the original well are markedly different from those from the replacement well. These data sets may be separated in the future, rather than continue to be pooled, as additional data are collected from the replacement well and are sufficient for trending separately.

^eEvaluation and Boundary wells are not flagged as indicated in notes a and b above.

Comparing the results of trend calculations for Sentinel and RCRA wells reported in the 2007 Annual Report (DOE 2008g) with those presented above shows very few changes from one year to the next. There are a few instances in which a concentration trend did not meet the 95 percent level of significance using 2007 data, but with 2008 data that level was attained; these instances are identified in the table. There are also instances in which a trend that had been calculated to be significant no longer met that test when 2008 data were included in the calculation. A tally of those trends meeting the 95 percent level of significance indicates 54 of these trends are decreasing, while 44 are increasing.

Additional data will be collected in accordance with RFLMA, and will further refine the concentration trends. Given that much or, in many instances, most of the analytical data used in the trend calculations were collected before the Site was closed, and in many cases are from wells that have since been replaced, some instances of slope change due to well replacement are to be expected, and may impact analytical as well as water elevation data. Figure 3–168 is an example of data that appear (even on a logarithmic concentration scale) to be strongly impacted by well replacements, as noted in the summary of calculated trends above. For a cross-walk of closure-era original and replacement wells, refer to the *Rocky Flats Site 2006 Integrated Monitoring Plan Background Document* (2006 IMP) (DOE 2006d, Appendix B, Table B-4); since that date, the only well replacement comprised the abandonment of well 45605 and its replacement with well 45608.



Notes: Well 88104 is located immediately south of former B881, and well 20705 is located immediately north of former B771. "Repl" = replacement; "Closure" = Site closure date (declaration). The date of well replacement is represented by the date the original well was abandoned, because this is the last possible date on which samples from the original location could have been collected.

Figure 3-168. Time-Series Plot of Discontinuous U Concentrations from Select Wells

Groundwater Plumes with Treatment Systems

Groundwater-quality data were obtained for all monitored areas in 2008. Analytical data have been published in quarterly reports issued for 2008 (DOE 2008d, 2008e, 2009e), plus Appendix B, and will not be duplicated here. Appendix B also includes S-K and M-K trend plots for CY 2008.

Groundwater quality at the Site in 2008 was largely consistent with data reported in prior years (as can be deduced from the summary of statistical trends presented in Table 3-86). Generally speaking, groundwater quality within plumes that were identified and characterized through the decades of pre-closure groundwater monitoring at the Site do not appear to have been greatly affected by closure of the Site.

This section describes the general groundwater quality in various areas of interest across the Site. Descriptions of conditions in 2008 at the three main groundwater contaminant plume treatment systems (MSPTS, ETPTS, and SPPTS) are also provided.

Mound Plume, Oil Burn Pit #2 (OBP#2) Plume, and MSPTS

The Mound Plume (a.k.a. Mound Site Plume) is located north of the former 903 Pad. The source of the plume is a former drum storage area (“the Mound”) that was in use in the 1950s. Some of the drums leaked, creating a groundwater contaminant plume extending north toward South Walnut Creek. The drums were removed in 1970, and contaminated soils were removed in 1997. A groundwater treatment system was installed in 1998 to intercept and treat contaminated groundwater before it reaches the creek.

OBP#2 was located at the southeast corner of the former Protected Area fence, just west of the Mound source area. Groundwater monitoring of OBP#2 was not feasible until the Protected Area was decommissioned due to the related security infrastructure. Groundwater and soil were subsequently sampled and elevated concentrations of VOCs were observed. This led to a source removal action in 2005 that addressed elevated concentrations in the soils. Hydrogen Release Compound[®] (HRC) was added to the backfill to enhance biodegradation of residual VOCs. Because the flow path for the OBP#2 Plume is to the north, generally parallel to the flow direction of the nearby Mound Plume, a gravel drain was installed in 2005 to intercept and direct this flow into the MSPTS intercept trench, from which it is directed to the MSPTS for treatment.

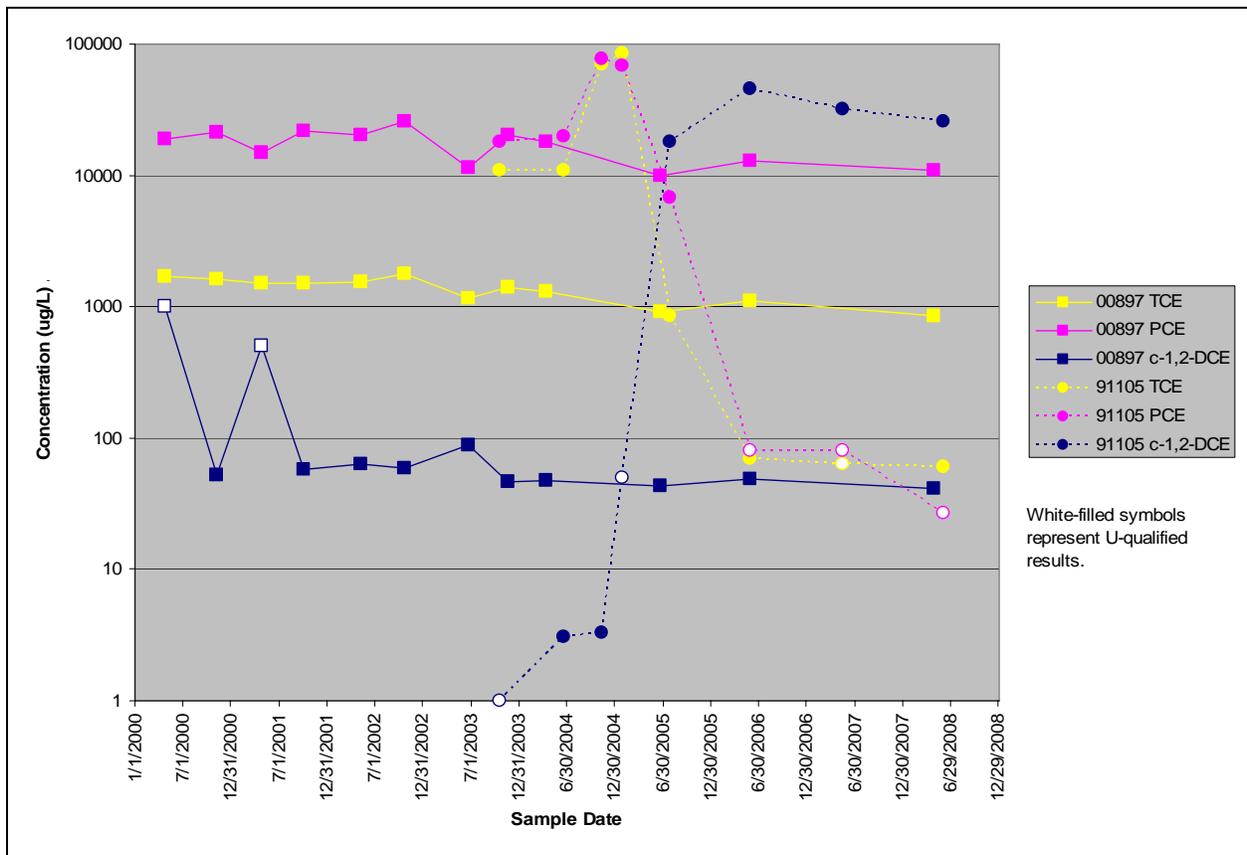
The following paragraphs describe these plumes and the MSPTS.

Mound Plume and OBP#2 Plume

Previous annual reports (e.g., DOE 2007e, 2008g) provide separate discussions of the Mound Plume and the nearby OBP#2 Plume. However, because groundwater flow from the Mound Plume as well as the OBP#2 Plume is captured and treated by the MSPTS, the two plumes have been grouped and are discussed together in this report. Refer to previous reports for additional detail on closure-era activities in these areas and their impacts on the local groundwater.

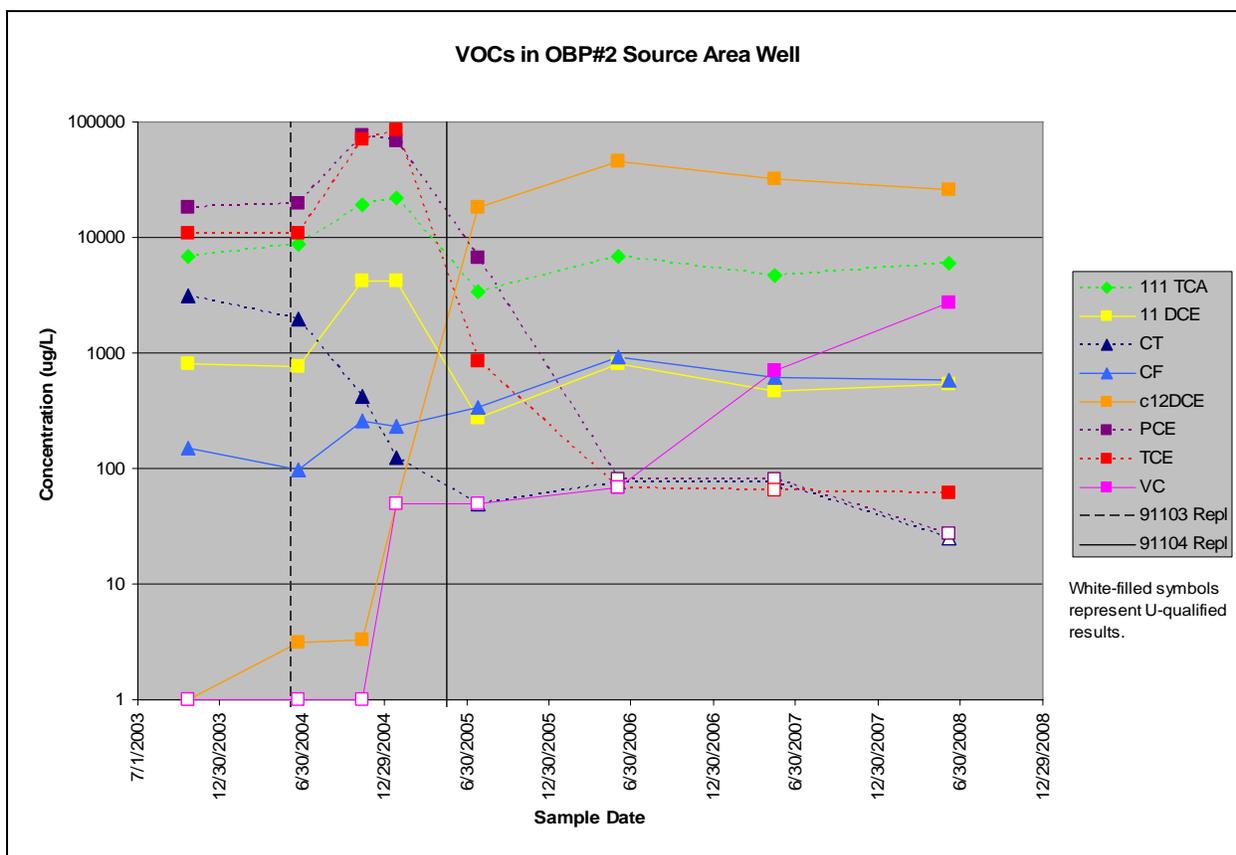
At its source area, the Mound Plume is characterized by elevated concentrations of PCE and TCE. Groundwater in the OBP#2 source area was originally characterized by elevated concentrations of 1,1,1-TCA, PCE, TCE, and 1,1-DCE, but since the source removal and addition of HRC to the backfill, concentrations of cis-1,2-DCE and other daughter products have increased sharply in samples from the OBP#2 source-area well. Note that this well, 91105, is the third to monitor the OBP#2 source area; the previous two (91103, 91104) were installed within the contaminated soils while the current well is on the downgradient edge of the backfilled source-removal excavation.

Figure 3–169 displays concentrations of PCE, TCE, and cis-1,2-DCE in samples from Mound source-area Evaluation well 00897 and OBP#2 source-area Evaluation well 91105. The effects of source removal and biodegradation on groundwater in the OBP#2 source area are clearly evident on this figure, and on Figure 3–170, which focuses solely on selected constituents in samples from well 91105. Concentrations of parent compounds decrease sharply in response to a combination of mechanisms—the source removal, well replacement and relocation to outside of the excavation area, and degradation of parent compounds. This latter mechanism is confirmed by the sharp increase in concentrations of cis-1,2-DCE, a metabolic byproduct of the breakdown of PCE and TCE.



Notes: RFLMA surface-water action levels for these constituents (µg/L; DOE 2007a, Attachment 2, Table 1): PCE, 5; TCE, 5; cis-1,2-DCE, 70. Several results are qualified ("J," "D"), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

Figure 3-169. VOC Concentrations in Samples from Mound Plume and OBP#2 Plume Source Area Evaluation Wells 00897 and 91105



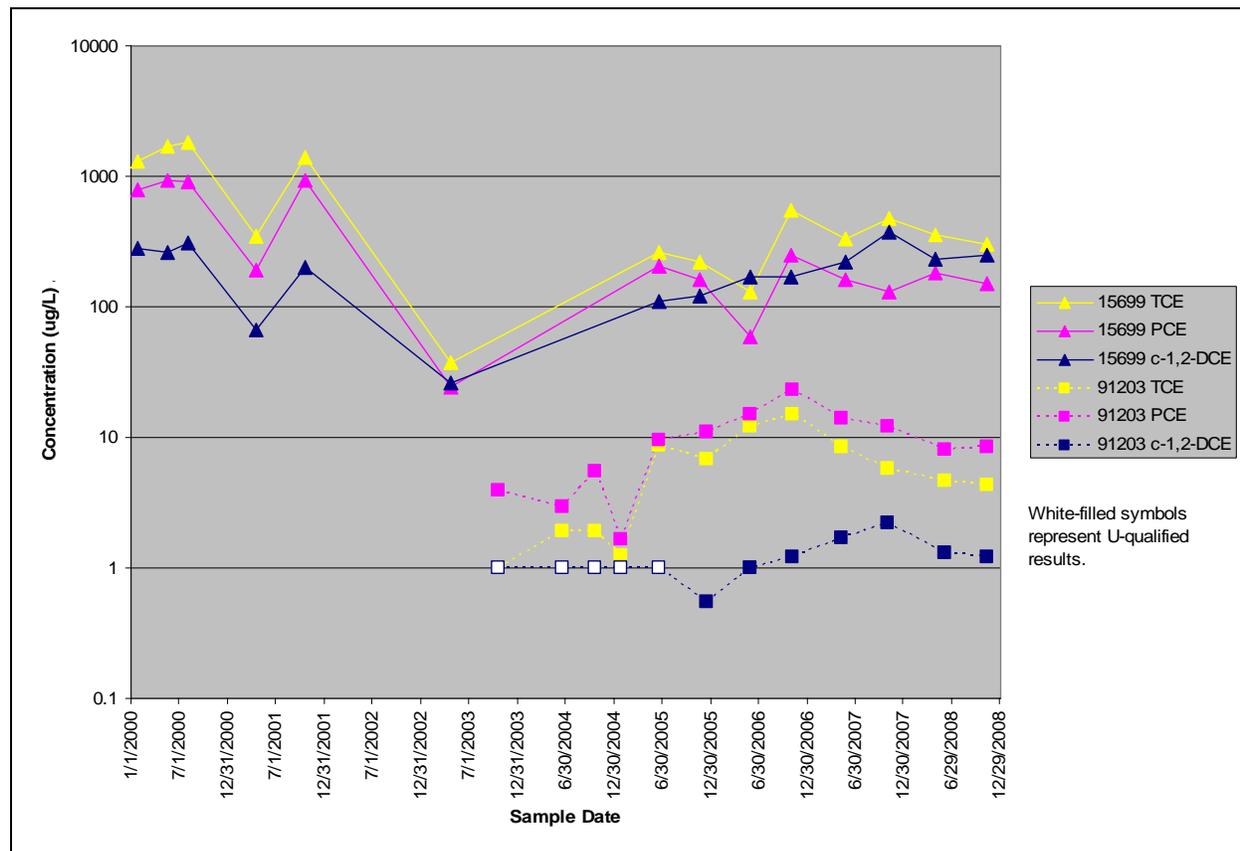
Notes: 111TCA = 1,1,1-TCA; 11DCE = 1,1-DCE; CT = carbon tetrachloride; CF = chloroform; c12DCE = cis-1,2-DCE; VC = vinyl chloride. RFLMA surface-water action levels for these constituents (ug/L; DOE 2007a): 1,1,1-TCA, 200; 1,1-DCE, 7; CT, 5; CF, 3.4; cis-1,2-DCE, 70; PCE, 5; TCE, 5; VC (PQL), 0.2. In addition to the nondetects ("U"-qualified results) that are illustrated, several other results were qualified ("J," "D") but are not shown differently for the sake of simplicity. Well replacement dates are noted on the figure; original PVC well 91103 provided samples from the contaminated source area through June 21, 2004; stainless-steel replacement well 91104 provided subsequent samples from the contaminated source area through January 26, 2005; OBP#2 was remediated and replacement well 91105 installed as shown, providing the balance of the samples. Note logarithmic scale for concentrations.

Figure 3–170. Concentrations of VOCs in OBP#2 Source Area Evaluation Well 91105

Analytical data from Mound source-area Evaluation well 00897 were assessed for trend using the M-K method. Results indicate a statistically significant (95 percent) decreasing trend for TCE, which is evident on the time-series plot above (Figure 3–169). OBP#2 source-area Evaluation well 91105 is represented by three statistically significant concentration trends: decreasing carbon tetrachloride, increasing chloroform, and increasing cis-1,2-DCE. The trends for carbon tetrachloride and cis-1,2-DCE may be affected by numerous nondetects in the data. However, each of these trends is visually evident on Figure 3–170. Similar to cis-1,2-DCE, chloroform is a primary byproduct of biodegradation—in this case, of carbon tetrachloride. Therefore, the decreasing carbon tetrachloride (parent) concentration and coincidental increasing chloroform (daughter product) concentration may reflect the enhanced biodegradation resulting from addition of HRC to the OBP#2 backfill.

Figure 3–171 displays reported concentrations of PCE, TCE, and cis-1,2-DCE in samples from Sentinel wells 91203 (downgradient of OBP#2) and 15699 (downgradient of the Mound and MSPTS groundwater intercept trench). Samples from well 91203 show a temporary increase in some parent compound concentrations that generally coincides with the disruption associated

with remediation of OBP#2 completed on April 1, 2005. This suggests that, while groundwater at well 91203 is not strongly impacted by the OBP#2 source area, it does receive some input from that area under certain conditions.



Notes: RFLMA surface-water action levels for these constituents (µg/L; DOE 2007a, Attachment 2, Table 1): PCE, 5; TCE, 5; cis-1,2-DCE, 70. Several results are qualified ("J," "D"), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

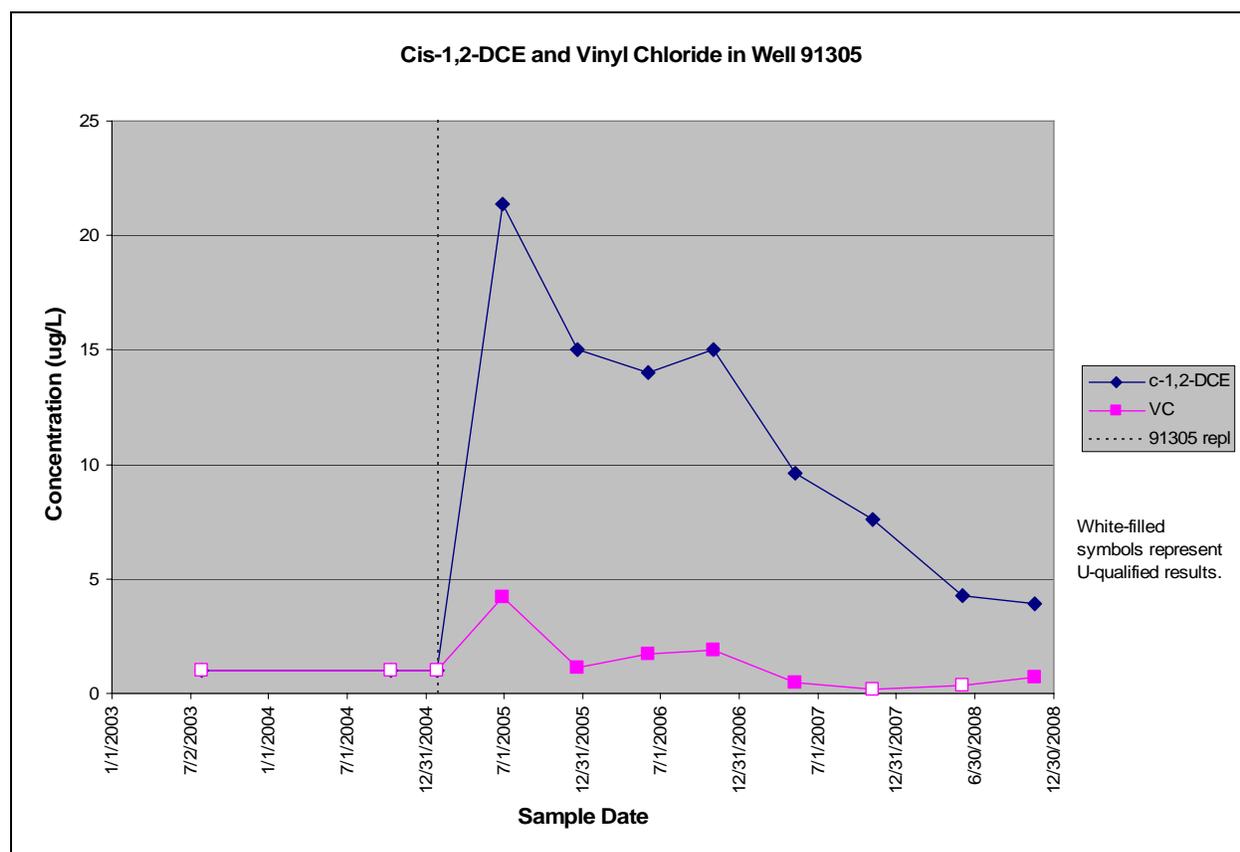
Figure 3-171. VOC Concentrations in Samples from Mound Plume and OBP#2 Plume Downgradient Wells 15699 and 91203

The concentrations of these constituents in samples from well 15699 continue to show correlation for most data collected since 2000, with the relative concentration of each mirroring its position in the degradation pathway of PCE. (With successive dechlorination, PCE is transformed to TCE and then to cis-1,2-DCE, 1,1-DCE, and VC [K-H 2004d, ATSDR 2007].) However, since mid-2005, concentrations of cis-1,2-DCE in samples from well 15699 have increased relative to those of PCE and TCE. This is interpreted to be an indication of the increased biodegradation of parent compounds in the OBP#2 source area following the addition of HRC to the backfill after source removal activities, and the installation of a gravel drain that routes OBP#2-area groundwater to the MSPTS.

S-K trend calculations indicate the concentration of cis-1,2-DCE in samples from Sentinel well 91203 (Table 3-86) has an increasing trend at a 95 percent confidence level; however, this trend may not be valid due to numerous nondetects in the data set. S-K trend plots for well 15699 show a statistically significant (95 percent) decreasing trend for PCE, and similarly significant increasing trends in 1,2-dichloroethane, trans-1,2-DCE, and VC concentrations. The latter two

increasing trends may not be valid, however, again because most of the data for this well since 2000 for these constituents are reported as nondetects with elevated detection limits (e.g., 100 µg/L). Refer to Appendix B for S-K plots and detailed summary tables.

Data from well 91305, located west of well 91203, suggest the OBP#2 source area does not contribute significant quantities of groundwater to this well. Concentrations of cis-1,2-DCE and VC were nondetect until the original well, 2187, was replaced. The original well was located approximately 60 feet north of 91305. Whether the increasing concentrations in daughter products are related to the location of the replacement well or the activities underway in this area is not known, but the initial increase in concentrations of these constituents has been followed by a steady decrease. Note that well 91305 is also east (generally downgradient in the valley bottom) of former B991 and corresponding Sentinel well 99405, which also reflects a sudden increase in VOC concentrations (see separate discussion below). However, the increase in VOC concentrations in samples from well 91305 precedes that reported by data from upgradient well 99405 by about a year. This suggests that while the time-series plots may have a similar appearance, the sudden increases in VOC concentrations at wells 99405 and 91305 do not have the same cause(s).



Notes: RFLMA surface-water action levels for these constituents (µg/L; DOE 2007a, Attachment 2, Table 1): cis-1,2-DCE, 70; VC, 0.2. Several results are qualified ("J"), but are not shown differently for the sake of simplicity. The date of well replacement is represented by the date the original well was abandoned, because this is the last possible date on which samples from the original location could have been collected.

Figure 3-172. Selected VOC Concentrations in Samples from Well 91305

Mound Site Plume Treatment System

The MSPTS was the first groundwater intercept/treatment system installed at the Site to incorporate ZVI, and is actually among the first of its type in the world. This work was completed in 1998, and the ZVI was replaced in the summer of 2006. Routine maintenance activities performed at the MSPTS in 2008 are discussed in Section 2.5.1.

As with all years from 2005 on, flow rates through the MSPTS in 2008 were well above pre-2005 levels. This is due to the routing of groundwater flow from the OBP#2 area into the MSPTS intercept trench. (For additional background, see the 2005 Annual Report, DOE 2006e.) The total volume of water treated by the MSPTS during 2008 is estimated at approximately 358,000 gallons, very similar to the 326,000 gallons estimated for 2007. Closure-related activities in 2005 followed by gradual dewatering of the area to more stabilized levels may be the reason for the higher flows in 2005 and 2006. Table 3–87 provides annual estimates of the volume of water treated by the MSPTS, and Figure 3–173 presents the corresponding hydrograph. Figure 3–174 provides a hydrograph for CY 2008.

Table 3–87. Estimated Volumes of Water Treated by the MSPTS

Calendar Year	Annual Estimates of Volume Treated (gallons)	Estimated Cumulative Volume Treated (gallons)
2000	258,000	660,000
2001	119,000	780,300
2002	53,000	833,000
2003	82,000	915,000
2004	86,000	1,001,000
2005	506,000	1,507,000
2006	430,000	1,937,000
2007	326,000	2,263,000
2008	358,000	2,621,000

Note: Estimates for years 2000 through 2004 are compiled from K-H (2000a, 2000b, 2000c, 2000d, 2002, 2003, 2005b, 2005c).

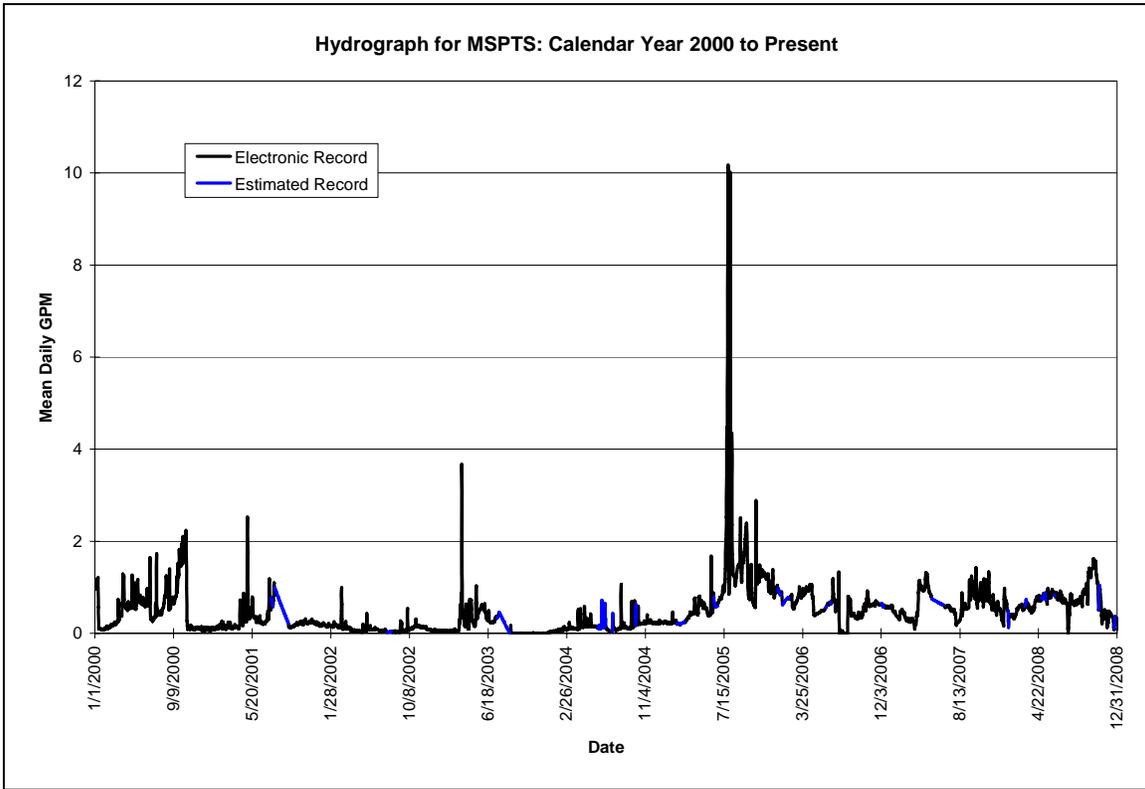


Figure 3-173. Hydrograph for MSPTS Since 2000

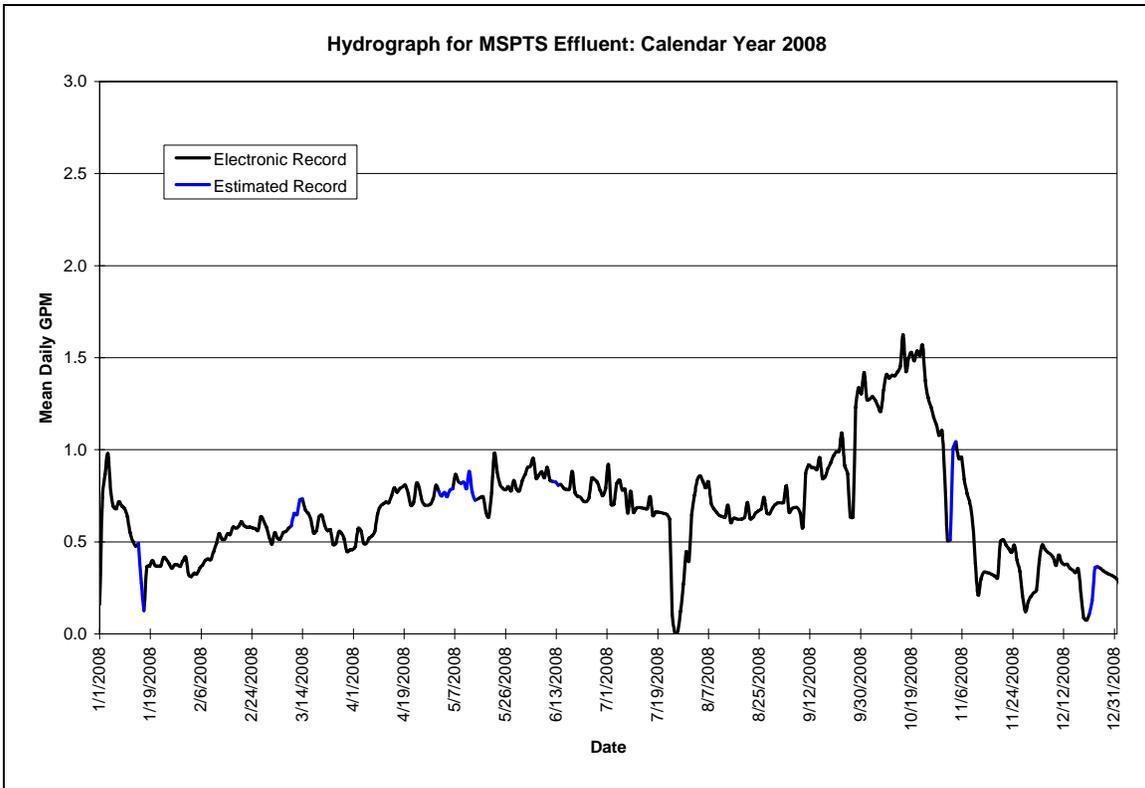


Figure 3-174. Hydrograph for MSPTS for CY 2008

As described for the MSPTS and ETPTS in the 2007 Annual Report (DOE 2008g), differences in treatment effectiveness under upflow vs. downflow configurations was assessed in late 2007, and both systems were returned to downflow on January 17, 2008, due to maintenance increases under upflow conditions.

The MSPTS was sampled twice in 2008, once in April and once in November, in accordance with RFLMA. In 2008, eight VOCs were detected in MSPTS influent at concentrations exceeding their respective Table 1 levels (DOE 2007a): 1,1,1-trichloroethane (TCA), 1,1-DCE, carbon tetrachloride, chloroform, cis-1,2-DCE, PCE, TCE, and VC. The same eight constituents exceeded these levels in 2007. As indicated in the 2007 Annual Report (DOE 2008g), 1,1,1-TCA had not been detected in MSPTS influent at these levels (i.e., above 200 µg/L) until July of that year, and is one of the primary contaminants detected in groundwater from the OBP#2 source area; its concentration in 2008 was consistent with those reported in 2007. The presence of 1,1,1-TCA in MSPTS influent continues to illustrate the effectiveness of the gravel drain routing groundwater from the OBP#2 area to the MSPTS intercept trench.

Three VOCs were detected in MSPTS treated effluent in 2008 at concentrations exceeding RFLMA Table 1 values: cis-1,2-DCE, methylene chloride, and VC. These represent some of the more recalcitrant compounds, and are the same compounds in system effluent that exceeded Table 1 values in 2007. Conditions at surface-water performance monitoring location GS10 were also very similar to those reported for 2007, as discussed below, with several detections of very low concentrations of VOCs but no exceedances of RFLMA Table 1 values.

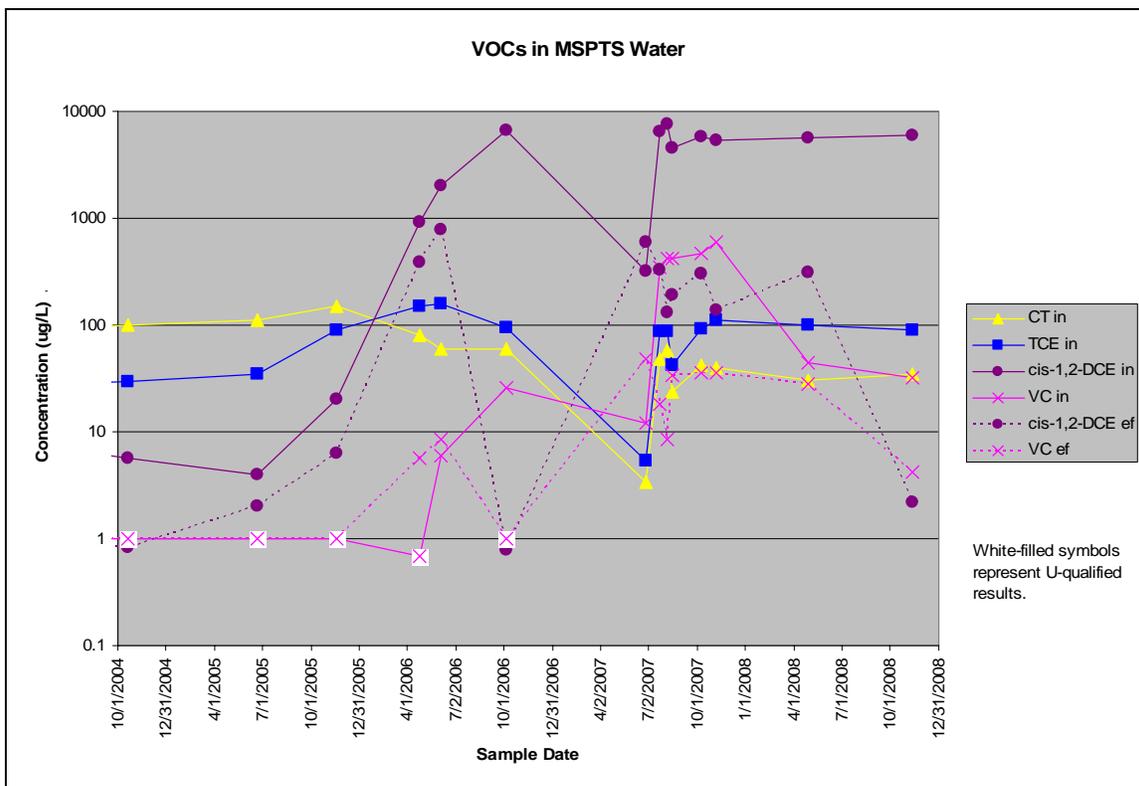
Table 3–88 summarizes MSPTS influent and effluent data. Refer to the quarterly reports (DOE 2008d, 2008e, 2009e) and Appendix B for additional water-quality data for the MSPTS. As discussed above, data from samples of MSPTS influent show the influence of closure activities performed upgradient of the system, particularly the installation of a preferential pathway (backfilled storm drain corridor) that now routes groundwater impacted by the OBP#2 into the MSPTS groundwater intercept trench. (For more information on this feature, see DOE 2006e, 2007e.) Because the source area was remediated and HRC was added to the backfill to stimulate biodegradation of residual VOCs, the concentrations of daughter products cis-1,2-DCE, 1,1-DCE, and VC in MSPTS influent have increased. However, concentrations of one daughter product in system influent, VC, decreased sharply in 2008, possibly signaling decreasing rates or degrees of biodegradation in the source area(s). More data will be required to confirm whether this is indeed the start of a trend in decreasing VC concentrations.

Figure 3–175 and Table 3–88 illustrate how concentrations of some VOCs in MSPTS influent and effluent have been affected by closure activities. The figure encompasses the period from immediately prior to the OBP#2 remediation to the end of 2007. As shown, the concentration of carbon tetrachloride has decreased over this period, while concentrations of TCE (which are also very similar to those of PCE at this scale; refer to the table), 1,1,1-TCA (shown on the table), and daughter products from the biodegradation of these constituents have increased. Again, the decrease in VC concentrations in system influent and effluent are apparent on the figure. These patterns reflect the increased volume of water reaching the MSPTS from the OBP#2 area, relative to the volume of flow from this area reaching the treatment system prior to remediation of that source area; and the addition of HRC to enhance bioremediation, with the effects of this addition appearing to decrease somewhat in 2008. The reason for the sharp decrease in cis-1,2-DCE concentrations in system effluent in the fourth quarter of 2008 is not known.

Table 3–88. Select VOC Data (µg/L) from MSPTS Influent and Effluent

DATE	1,1,1-TCA		1,1-DCE		CT		CF		cis-1,2-DCE		MCI		PCE		TCE		VC	
	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E	R1-0	R2-E
1/27/2000	8 (J)	1 (U)	10	1 (U)	110	1 (U)	25	1 (U)	57	1	5 (BJ)	1 (B)	120	0.1 (J)	150	1 (U)	10 (U)	1 (U)
2/8/2000	9 (J)	1 (U)	10	1 (U)	110	1 (U)	25	1 (U)	59	2	6 (JB)	2 (B)	96	1 (U)	140	1 (U)	10 (U)	0.1 (J)
3/7/2000	9 (J)	1 (U)	12	1 (U)	110	1 (U)	26	1 (U)	62	2	14 (B)	0.9 (JB)	100	1 (U)	160	1 (U)	10 (U)	1 (U)
4/26/2000	7 (J)	1 (U)	10	1 (U)	96	1 (U)	24	1 (U)	61	4	20 (B)	0.8 (JB)	110	1 (U)	140	1 (U)	10 (U)	0.2 (J)
5/15/2000	6	1 (U)	8	1 (U)	49 (D)	1 (U)	19	1 (U)	42 (D)	3	0.1 (JB)	0.7 (BJ)	68 (D)	1 (U)	87 (D)	1 (U)	0.3 (J)	1 (U)
6/14/2000	8	1 (U)	10	1 (U)	130	1 (U)	24	1 (U)	42	1	3 (BJ)	0.2 (BJ)	130	1 (U)	150	1 (U)	10 (U)	1 (U)
7/19/2000	4 (J)	1 (U)	6	1 (U)	63	1 (U)	12	1 (U)	42	2	4 (JB)	0.9 (JB)	64	1 (U)	79	1 (U)	5 (U)	1 (U)
8/16/2000	10 (J)	1 (U)	10 (J)	1	180	1 (U)	31	1 (U)	39	1 (J)	23 (B)	0.3 (BJ)	100	1 (U)	140	1 (U)	10 (U)	1 (U)
9/13/2000	5.9	0.5 (U)	7	0.5 (U)	122	0.5 (U)	25.4	0.5 (U)	32.1	0.74	1 (U)	0.57	65.3	0.5 (U)	99.9	0.5 (U)	1 (U)	0.5 (U)
10/25/2000	6.3	0.5 (U)	8	0.5 (U)	133	0.5 (U)	25.6	0.5 (U)	37.3	0.69	1 (U)	0.5 (U)	68.7	0.33 (J)	104	0.5 (U)	1 (U)	0.5 (U)
4/19/2001	4 (D)	1 (U)	5 (D)	1 (U)	73 (D)	1 (U)	20 (D)	0.6 (J)	38 (D)	3	2 (U)	6	44 (D)	1 (U)	76 (D)	1 (U)	2 (U)	1 (U)
10/25/2001	3.4	1 (U)	5.1	1 (U)	130	1 (U)	23	1 (U)	23	0.9 (J)	1 (U)	1 (U)	50	1 (U)	74	1 (U)	1 (U)	1 (U)
4/25/2002	2.9	1 (U)	4.5	1 (U)	110	1 (U)	26	1 (U)	24	1.8	1 (U)	1 (U)	41	1 (U)	76	1 (U)	1 (U)	1 (U)
10/21/2002	2.6	1 (U)	1.06	1 (U)	155	1 (U)	27.5	1 (U)	11.3	1 (U)	1 (U)	1 (U)	33.6	1 (U)	46.8	1 (U)	1 (U)	1 (U)
4/17/2003	2.8	1 (U)	2.5	0.23 (J)	73	1 (U)	19	0.93 (J)	23	4.4	1 (U)	3.5 (B)	31	0.38 (J)	38	0.31 (J)	0.81 (J)	1 (U)
12/1/2003	2	1 (U)	2	1 (U)	104 (D)	1 (U)	21.4	1 (U)	9	1	1 (U)	1 (U)	22.6	1 (U)	31.4	1 (U)	1 (U)	1 (U)
6/9/2004	1.34	1 (U)	1.49	1 (U)	91.9	1 (U)	22.4	1 (U)	6.98	1 (U)	1 (U)	1 (U)	21.5	1 (U)	28.3	1 (U)	1 (U)	1 (U)
10/20/2004	2.07	1 (U)	2.47	1 (U)	100	1 (U)	24.6	1 (U)	5.59	0.83 (J)	1 (U)	1 (U)	25.7	0.72 (J)	29.4	2.74	1 (U)	1 (U)
6/21/2005	1 (U)	1 (U)	1.58	1 (U)	110	1 (U)	30.4	0.48 (J)	3.93	2.04	0.74 (J)	1 (U)	29.1	1.66	34.9	1.28	1 (U)	1 (U)
11/18/2005	11	1 (U)	5.2	0.67 (J)	150	1 (U)	31	0.42 (J)	20	6.3	1 (U)	1 (U)	81	4.5	90	1.6	1 (U)	1 (U)
4/25/2006	35	0.16 (U)	18	4.8	81	0.19 (U)	56	0.16 (U)	920	390	20	1.7	150	5.7	150	7.6	0.68 (U)	5.6
6/5/2006	27.4	1 (U)	1 (U)	1 (U)	60.1	1 (U)	45	1 (U)	2040 (D)	793 (D)	27.2	1 (U)	125 (D)	3	158 (D)	4.6	6	8.6
10/5/2006	53.3	1 (U)	73.1	1 (U)	60.1	1 (U)	45.1	1 (U)	6580 (D)	0.78 (J)	6.9	7.3	87.2	1 (U)	93.7	1 (U)	26.1	1 (U)
6/26/2007	11	0.43 (U)	5.2	1.4 (J)	3.4	0.51 (U)	4.1	0.43 (U)	320	590	0.32 (U)	2.6 (J)	6.8	0.53 (U)	5.3	0.43 (U)	12	48
7/24/2007	290	0.32 (U)	95	0.52 (J)	48 (J)	0.38 (U)	77	0.32 (U)	6500	330	21 (U)	6.7	94	0.4 (U)	88	0.32 (U)	350	18
8/6/2007	370	0.16 (U)	99	0.35 (J)	58	0.19 (U)	99	0.16 (U)	7700	130	8.5 (U)	3.3	89	0.2 (U)	88	0.16 (U)	420	8.6
8/16/2007	180	0.32 (U)	47	0.4 (J)	24	0.38 (U)	67	0.32 (U)	4500	190	4.1 (JB)	5.4 (B)	28	0.4 (U)	42	0.32 (U)	420	34
10/9/2007	300	0.16 (U)	93	0.44 (J)	42	0.19 (U)	88	0.16 (U)	5800	300	13 (U)	4.8	70	0.2 (U)	93	0.16 (U)	470	36
11/8/2007	270	0.16 (U)	94	0.5 (J)	40	0.19 (U)	85	0.16 (U)	5400	140	13 (U)	4.7	78	0.2 (U)	110	0.16 (U)	590	36
4/29/2008	340	0.16 (U)	94	1.3	30	0.19 (U)	100	0.45 (J)	5700	310	6.4 (U)	6.2	97	0.32 (J)	100	0.56 (J)	44	28
11/11/2008	310	0.16 (U)	71	0.14 (U)	35	0.19 (U)	80	0.16 (U)	5900	2.2	9.2 (JB)	1.3 (B)	88	0.2 (U)	89	0.17 (J)	32	4.2

Notes: 1,1,1-TCA = 1,1,1-trichloroethane; 1,1-DCE = 1,1-dichloroethene; CT = carbon tetrachloride; CF = chloroform; cis-1,2-DCE = cis-1,2-dichloroethene; MCI = methylene chloride; PCE = tetrachloroethene; TCE = trichloroethene; VC = vinyl chloride. R1-0 = influent, R2-E = effluent; formal sampling location names are Mound R1-0 and Mound R2-E. Shaded, bold value indicates detected concentration exceeds corresponding level stipulated in RFLMA Attachment 2, Table 1 (DOE 2007a). Lab qualifiers: J = result is estimated below the sample quantitation limit; U = analyte not detected at the indicated concentration; B = chemical was also detected in the blank; D = analysis was performed at a dilution.



Notes: Constituents and their respective RFLMA Table 1 standards (µg/L; DOE 2007a): CT = carbon tetrachloride, 5; TCE, 5; cis-1,2-DCE, 70; VC, 0.2. in = influent (Mound R1-0), ef = effluent (Mound R2-E). Lab qualifiers not indicated except for U (analyte not detected at the indicated concentration); other qualified data plotted at reported value for simplicity. Note logarithmic concentration scale.

Figure 3–175. Recent Concentrations of Select VOCs in MSPTS Influent and Effluent

Two grab samples for the analysis of VOCs were collected in 2008 at the performance monitoring location for the MSPTS, surface-water station GS10. As in prior years, results include detections of VOCs; none exceeded the corresponding surface-water action levels. VOCs detected in 2008 at location GS10 are summarized in Table 3–89. The same analytes were detected in samples from this location during 2007, but in that year TCE was also detected. During 2008, no detections of TCE were reported.

Table 3–89. Summary of VOCs Detected in 2008 at GS10

Date	Constituent	Result (µg/L)	Qualifier
4/29/2008	1,2-DCA	0.36	J
4/29/2008	Cis-1,2-DCE	19	
11/11/2008	Cis-1,2-DCE	0.54	J

East Trenches Plume and Treatment System

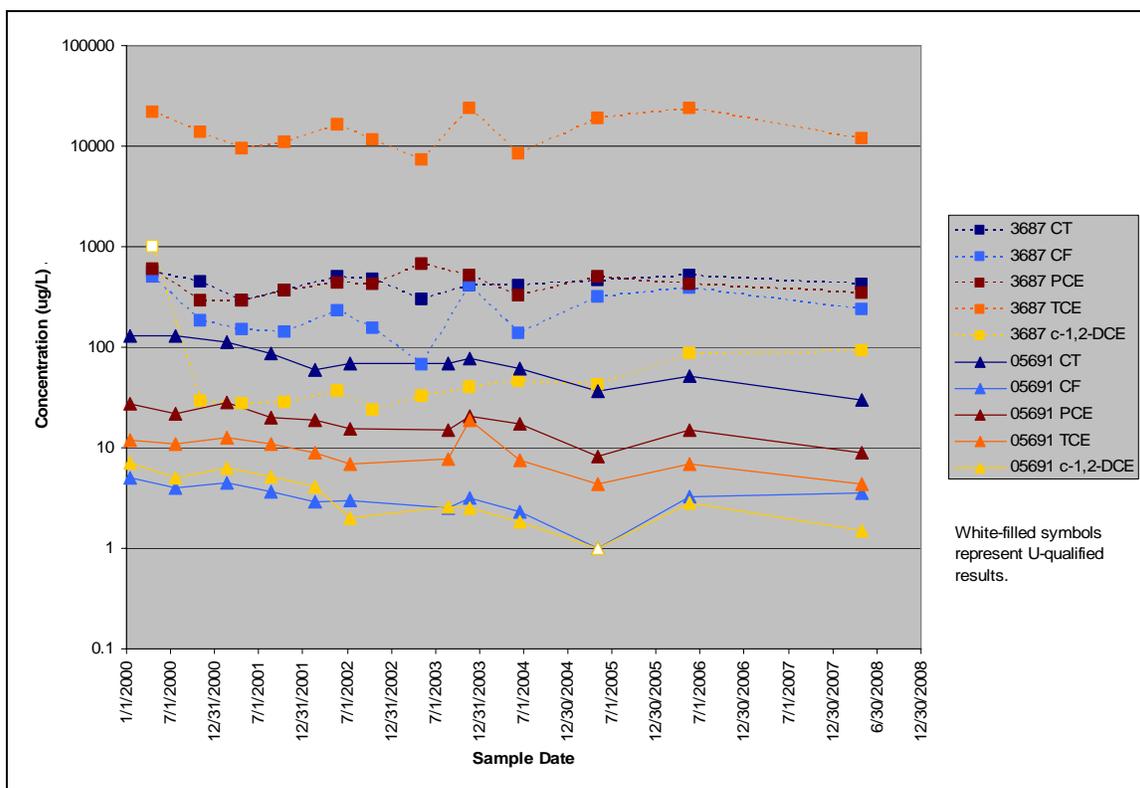
The East Trenches Plume is an area of contamination named after several buried disposal trenches that contribute VOCs to groundwater. These trenches are located on the pediment south of South Walnut Creek, in former OU 2. The source of this plume is predominantly Trenches T-3 and T-4, which were remediated in 1996. In addition, a portion of the 903 Pad Plume flows

toward the northeast and joins the East Trenches Plume. A treatment system (the ETPTS) was installed in 1999 to intercept and treat contaminated groundwater flowing toward the B-Series Ponds and South Walnut Creek.

East Trenches Plume

Evaluation wells 3687 and 05691 monitor the primary source areas of the East Trenches Plume, Trenches T-3 and T-4, respectively. More distal portions of the plume are monitored by Evaluation well 03991 and Sentinel well 04091 to the east-northeast, and AOC well 00997 at the mouth of Pond B-5 in the South Walnut Creek drainage. Sentinel wells 95099, 95199, 95299, 23296, and TH046991 monitor the ETPTS and downgradient portions of the plume. (Note: Well TH046992 was removed from the monitoring network following its fourth-quarter 2008 sampling event. See Section 3.1.1.2 for details.)

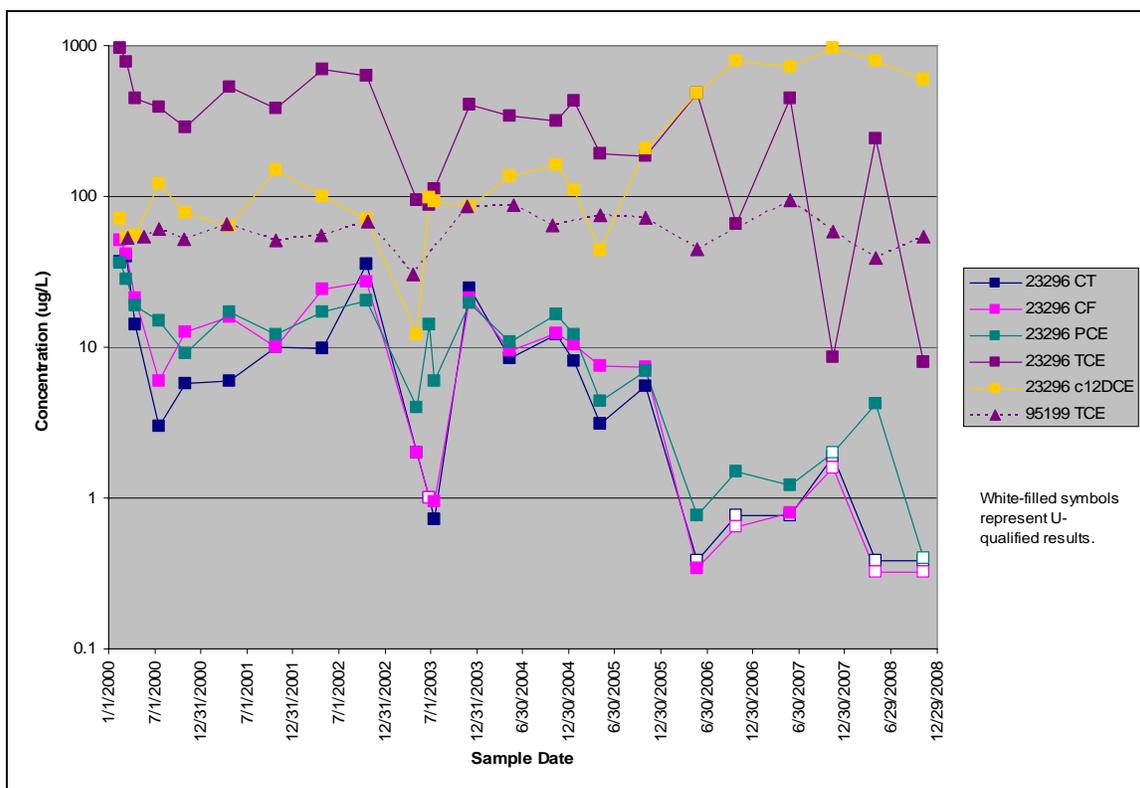
All of the East Trenches Plume Evaluation wells were sampled in 2008, as were the AOC and Sentinel wells. The source-area Evaluation wells, 3687 and 05691, produced samples with VOC concentrations that are consistent with past results (Figure 3–176). Time-series plots of the primary VOCs show similar behavior. Most notably for well 05691, trend calculations using the M-K statistical test indicate statistically significant (at the 95 percent level) decreasing trends in concentrations of all five plotted compounds in samples from this well (Table 3–86). At 3687, concentrations of cis-1,2-DCE are increasing, suggesting biodegradation of parent compounds (TCE and PCE) in the source area may be increasing. This trend is confirmed to be significant at the 95 percent level using the M-K statistical test. Conversely, concentrations of the breakdown product of carbon tetrachloride, chloroform, do not appear to be increasing at this well.



Notes: Constituents and their respective RFLMA Table 1 standards (ug/L; DOE 2007a): CT = carbon tetrachloride, 5; CF = chloroform, 3.4; PCE, 5; TCE, 5; cis-1,2-DCE, 70. Lab qualifiers not indicated except for U (analyte not detected at the indicated concentration); other qualified data plotted at reported value for simplicity. Note logarithmic concentration scale.

Figure 3–176. Concentrations of Selected VOCs in East Trenches Plume Source-Area Evaluation Wells 3687 and 05691

All Sentinel wells supporting the East Trenches Plume/ETPTS were sampled twice in 2008. Analytical data for these wells in 2008 were generally consistent with those from recent years. RFLMA Table 1 standards were exceeded in samples from wells 23296 and 95199, which is consistent with past conditions, as is the fact that samples from well 23296 contained the highest concentrations of VOCs of this group of wells. Figure 3–177 displays VOCs most commonly detected in these two wells at concentrations exceeding the corresponding RFLMA action level. Note that concentrations of some parent compounds appear to be decreasing, while those of some daughter products show increases. The unusual distribution evident in the past several TCE results from well 23296 may relate to seasonal effects, although those effects would be expected to also be reflected in data for other constituents.



Notes: Constituents and their respective RFLMA Table 1 standards (ug/L; DOE 2007a): CT = carbon tetrachloride, 5; CF = chloroform, 3.4; PCE, 5; TCE, 5; c12DCE = cis-1,2-DCE, 70. In addition to nondetects (“U”-qualified results), several other results were qualified (“D,” “J”), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

Figure 3–177. Most Commonly Detected VOCs in Sentinel Wells Downgradient of the ETPTS

S-K trend plots (Appendix B.3, and summarized above in Table 3–86) indicate 95 percent significant trends for several constituents monitored in East Trenches Plume wells. As might be expected from viewing Figure 3–177, well 23296 is represented by significant (at the 95 percent level) decreasing trends for carbon tetrachloride, chloroform, and TCE; and increasing trends (same level of significance) for both isomers of 1,2-DCE. These trend plots confirm the apparent patterns noted above, with concentrations of parent compounds decreasing and those of metabolic byproducts increasing as biodegradation proceeds.

Sentinel well 03991 monitors the eastern limb of the East Trenches Plume. The data from this well indicate statistically significant (at the 95 percent level) decreasing trends in PCE, TCE, carbon tetrachloride, and chloroform concentrations. The analytical data for chloroform and TCE include many estimated (“J”-qualified) results and isolated nondetects. On the eastern edge of the East Trenches Plume, Sentinel well 04091 is represented by significant decreasing trends for carbon tetrachloride and PCE. However, these data contain many nondetects, making the calculated trends unreliable.

AOC well 00997 is located near the inlet to Pond B-5. This well was sampled twice in 2008 (May and November). No constituents exceeded the RFLMA Table 1 levels. Consistent with previous data, nitrate was detected in the May sample (at 0.199 mg/L, “J”-qualified). No VOCs were detected. U was detected at concentrations of 11 ug/L in May and 9.3 ug/L in November.

Wells monitoring the East Trenches Plume will continue to be monitored in accordance with RFLMA. As more data are collected, additional significant trends should become evident. Note that well TH046992 was abandoned in late 2008 (following sampling in the fourth quarter) and will not be replaced; refer to Section 3.1.1.2 for additional information.

East Trenches Plume Treatment System

The ETPTS was installed in 1999. Its design is very similar to that of the MSPTS. However, the intercept trench for the ETPTS is 1,200 feet long, compared to the 220-foot-long MSPTS trench. The longer trench is required to intercept the broader East Trenches Plume as it flows toward South Walnut Creek and the B-Series Ponds.

The ETPTS treated approximately 629,000 gallons of water in 2008, a significant decrease from the volume treated in 2007 but similar to that treated in 2006. This volume continues the pattern observed since closure, when the flow to the system was reduced by a factor of two to three. See Table 3–90 for annual estimates of the volume of water treated by the ETPTS, and Figure 3–178 for a hydrograph showing flow estimates since January 2000. Figure 3–179 provides a hydrograph for CY 2008.

Table 3–90. Estimated Volumes of Water Treated by the ETPTS

Calendar Year	Annual Estimates of Volume Treated (gallons)	Estimated Cumulative Volume Treated (gallons)
2000	1,633,000	2,800,000
2001	1,900,000	4,700,000
2002	≤1,000,000	5,700,000
2003	2,100,000	7,800,000
2004	1,500,000	9,300,000
2005	1,800,000	11,100,000
2006	675,000	11,775,000
2007	951,000	12,726,000
2008	629,000	13,355,000

Note: Estimates for years 2000 through 2004 are compiled from K-H (2000a, 2000b, 2000c, 2000d, 2002, 2003, 2005b, 2005c).

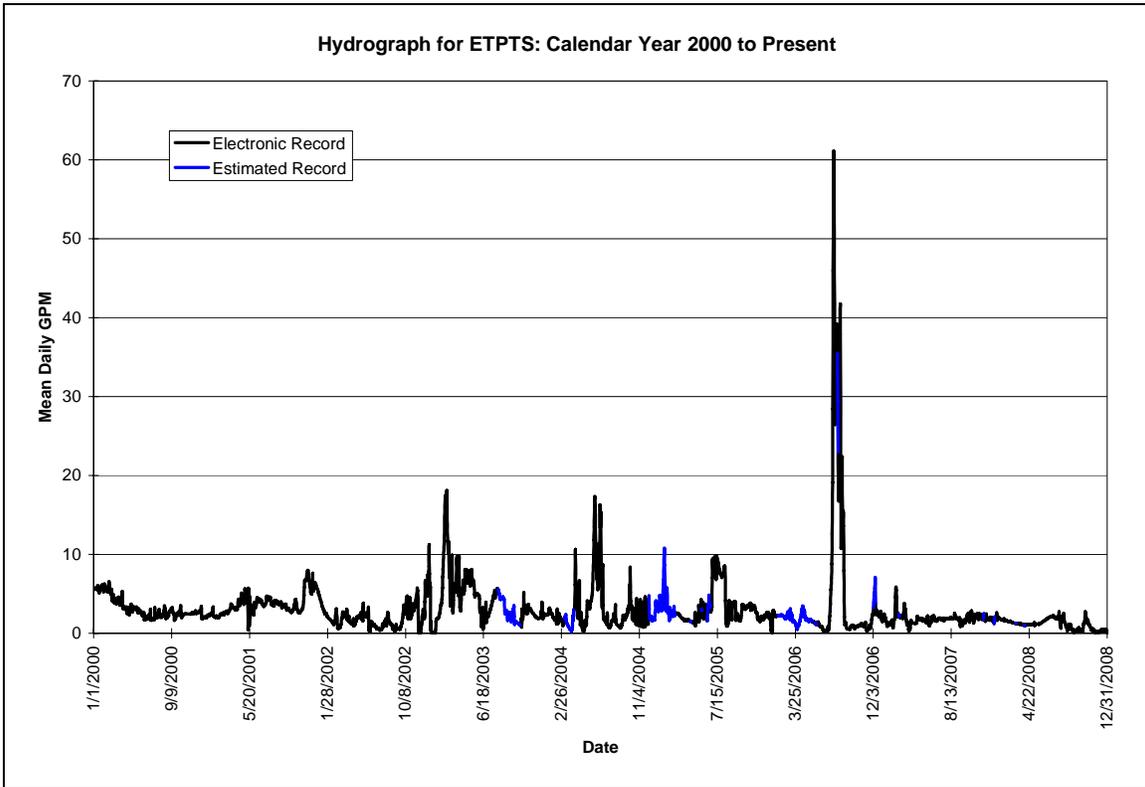


Figure 3–178. Hydrograph for ETPTS Since 2000

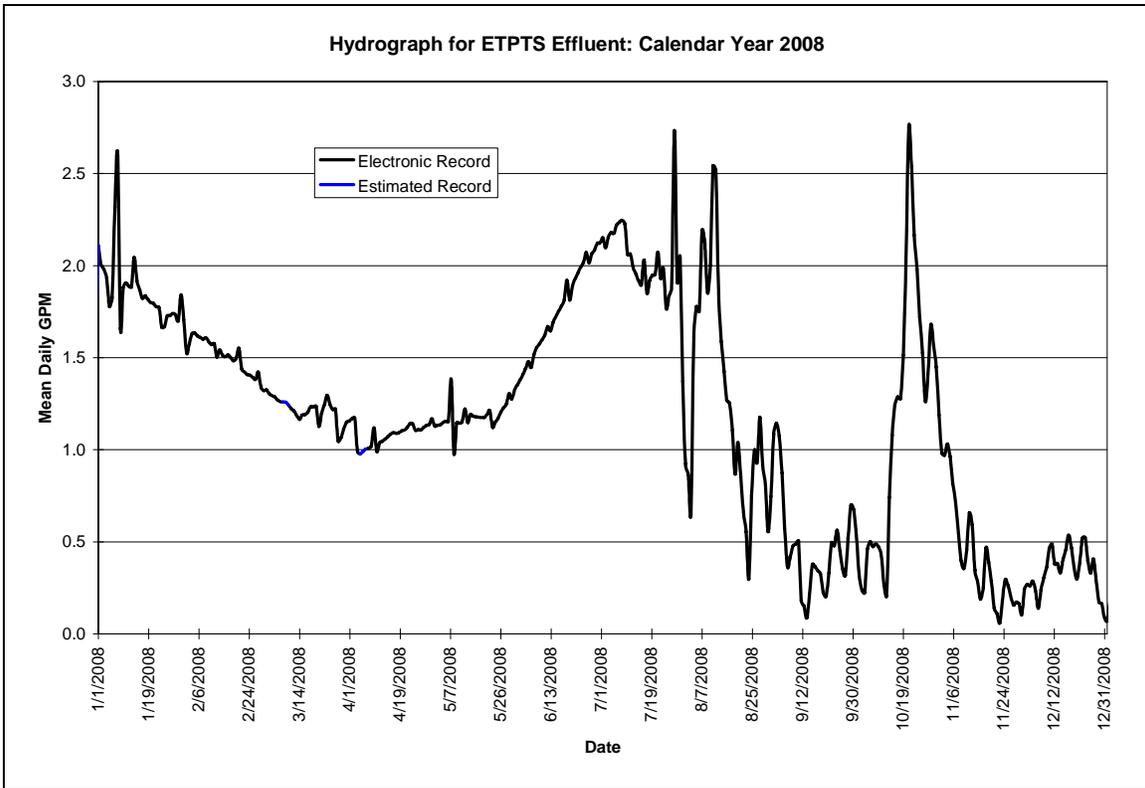


Figure 3–179. Hydrograph for ETPTS for CY 2008

Routine maintenance activities at the ETPTS were conducted throughout 2008, and are reported in Section 2.5.2. As described in the 2007 Annual Report (DOE 2008g), differences in treatment effectiveness under upflow vs. downflow configurations was assessed at the ETPTS and MSPTS in late 2007, and both systems were returned to downflow on January 17, 2008, due to maintenance increases under upflow conditions.

The ETPTS was sampled three times in 2008: once each in April, August, and November. The April and November samples were collected in accordance with RFLMA, while the August samples were collected for performance checks.

Treatment of groundwater by the ETPTS in 2008 was generally consistent with previous years in which the media was not replaced. Effluent-water quality reflected a dramatic reduction in VOC load, but as in other years some VOCs were detected in the effluent. A summary of the VOCs most commonly detected since 2003 is presented in Table 3–91; refer to quarterly reports (DOE 2008d, 2008e, 2009e) and Appendix B.6 for additional data from 2008.

Table 3–91. Summary of Recent VOC Data from ETPTS Influent and Effluent

DATE	CT		CF		MCI		PCE		TCE		VC	
	ET In	ET Ef	ET In	ET Ef	ET In	ET Ef	ET In	ET Ef	ET In	ET Ef	ET In	ET Ef
1/28/2004	130	1 (U)	71	1.1	5 (U)	20	290	0.93 (J)	2300	1.8	5 (U)	1 (U)
2/25/2004	150	1 (U)	71	1.4	2.7 (JB)	19 (B)	270	1.1	2400	2.5	10 (U)	1 (U)
3/22/2004	180	1 (U)	71	1	2.6 (JB)	21	270	1.2	2400	1.8	6.7 (U)	0.39 (J)
5/26/2004	216	1 (U)	65.1	1 (U)	1 (U)	17	618 (D)	3.38	5510 (D)	6.36	1 (U)	1 (U)
6/22/2004	130	1 (U)	59	1 (U)	6.7 (JB)	14 (B)	240	1.9	1900	1.8	10 (U)	1 (U)
7/29/2004	142 (D)	1 (U)	54.1	1 (U)	2.3	14.1 (B)	354 (D)	1.8	1960 (D)	0.69 (J)	1 (U)	1 (U)
8/19/2004	68.1	1 (U)	26.6	1 (U)	1 (U)	13.7	137 (D)	1.2	774 (D)	0.55 (J)	1 (U)	1 (U)
10/20/2004	160	1 (U)	72.9	2.56	1 (U)	15.6	230 (D)	2.13	1170 (D)	1.91	1 (U)	1 (U)
5/12/2005	131	1 (U)	66	22.2	1 (U)	14.6	256 (D)	21.9	2280 (D)	33.1	1 (U)	1 (U)
6/7/2005	160	1 (U)	81	30	10 (U)	22 (B)	340	36	3300	66	10 (U)	1 (U)
11/2/2005	151	1 (U)	74.8	0.73 (J)	250 (U)	18.2	350	1 (U)	2500	4.4	50 (U)	1.2
5/17/2006	170	0.23 (J)	75 (J)	1.9	0.32 (U)	32	280	4.1	2800	2.8	0.17 (U)	0.77 (J)
10/31/2006	120	0.19 (U)	75	0.16 (U)	6.4 (U)	0.32 (U)	290	0.85 (J)	2100	0.18 (J)	3.4 (U)	0.17 (U)
6/26/2007	110	0.19 (U)	70	0.16 (U)	1.6 (U)	0.32 (U)	320	9.7	2500	4.8	0.85 (U)	1.2
8/16/2007	150	0.19 (U)	81	0.16 (U)	8 (JB)	0.73 (JB)	390	4.4	2500	1.1	2.7 (U)	1.7
10/9/2007	130	0.19 (U)	71	0.25 (J)	3.2 (U)	1.7	270	9.5	2200	5.3	1.7 (U)	0.43 (J)
11/8/2007	110	0.19 (U)	64	0.16 (U)	3.2 (U)	0.32 (U)	260	9.1	2200	4.4	1.7 (U)	0.46 (J)
4/16/2008	160	0.19 (U)	78	0.16 (U)	36 (B)	1.5 (B)	270	7.3	2800	1.5	7.6 (U)	1
8/25/2008	150	0.19 (U)	77	0.16 (U)	1.6 (U)	0.89 (J)	260	17	2300	7.9	1.9 (U)	0.38 (U)
11/5/2008	110	0.19 (U)	66	0.16 (U)	9.7 (J)	0.88 (J)	210	10	1800	3.2	3.8 (U)	0.5 (J)

Notes: Constituents and their respective RFLMA Table 1 standards (µg/L; DOE 2007a): CT = carbon tetrachloride, 5; CF = chloroform, 3.4; MCI = methylene chloride, 4.6; PCE, 5; TCE, 5. ET In = influent (ET INFLUENT), ET Ef = effluent (ET EFFLUENT). Shaded, bold value indicates detected concentration exceeds corresponding RFLMA standard. Lab qualifiers: J = result is estimated below the sample quantitation limit; U = analyte not detected at the indicated concentration; B = chemical was also detected in the blank; D = analysis was performed at a dilution.

In addition to the constituents summarized in Table 3–91, other VOCs (cis-1,2-DCE, 1,1-DCE, and benzene) were detected in system effluent in 2008 (see DOE 2008d, 2008e, 2009e and

Appendix B.6 for the data). None of those constituents were reported at a level exceeding the RFLMA Table 1 concentration.

The performance monitoring location for the ETPTS is POM2, which is located in Pond B-4. Sampling in support of the ETPTS began at this location in 2005. Grab samples were collected from POM2 in April, August, and November 2008. (The August sample was collected in support of WQCC-related activities, as discussed in Section 2.2.) No VOCs were detected except for one reported detection of methylene chloride at a “J”- and “B”-qualified concentration of 0.89 µg/L. These qualifiers signify the concentration as estimated (J) and indicate blank contamination was also detected (B). Given that methylene chloride is a common laboratory contaminant and was reported at such a low concentration, this result is not a reliable indicator of methylene chloride contamination at POM2.

Solar Ponds Plume and Treatment System

The Solar Ponds Plume (SPP) is an area of elevated nitrate and U concentrations in groundwater. (Note: The analytical data report concentrations of nitrate+nitrite as nitrogen; this is typically referred to herein simply as nitrate.) Liquid wastes generated during the production era were stored in the former SEPs, which were located on the pediment in the northeastern portion of the former IA. Leaks from these ponds that occurred over the years are the source of the groundwater plume. The following paragraphs describe the plume, the treatment system installed to address this contamination, and work performed in 2008 on the system.

Solar Ponds Plume

Groundwater in the SEP area is contaminated with nitrate and U. Groundwater in the westernmost portion of this area, generally coinciding with the location of former Pond 207C, is also contaminated with VOCs. However, due to the localized nature of VOC contamination, it is not considered part of the SPP, but rather as a separate plume.

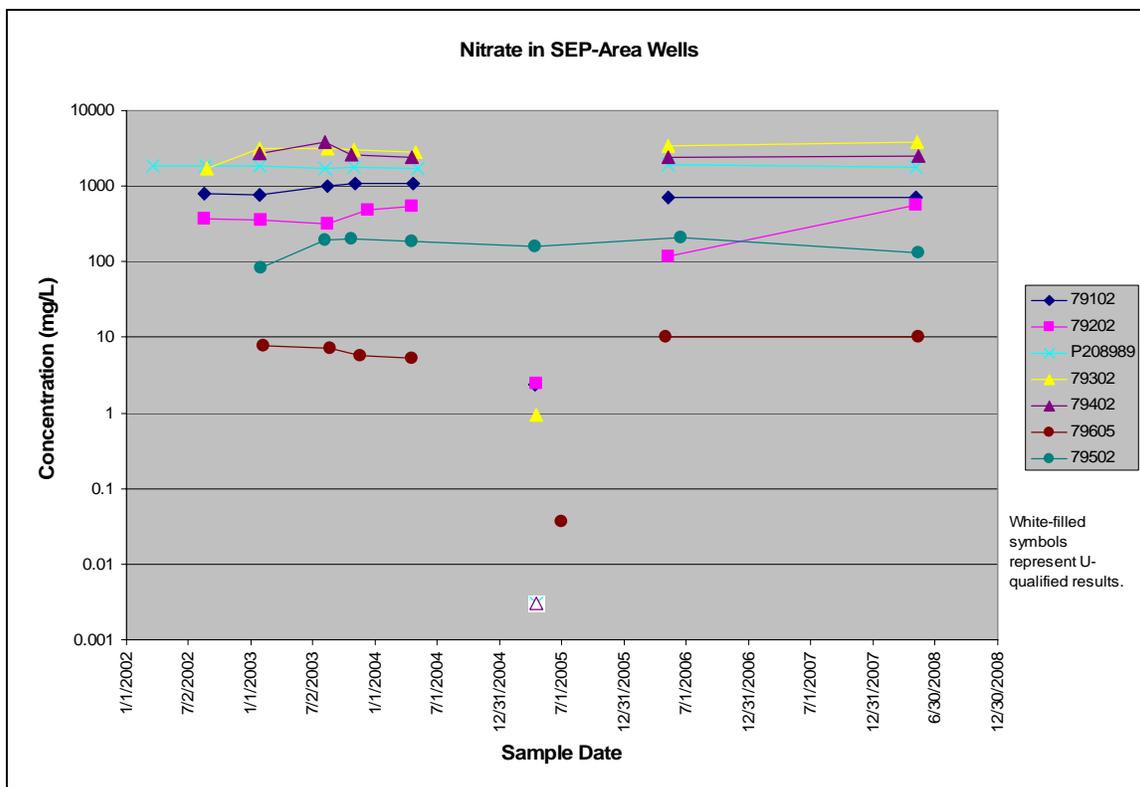
The source area of the SPP (the SEPs) is monitored by a line of eight Evaluation wells installed immediately downgradient of the SEPs (generally along the north, east, and south sides of the former SEPs), with additional wells located at greater distances from the source. Another Evaluation well is positioned at the south edge of former Pond 207-C, in the VOC source area. This distribution effectively monitors groundwater flowing north/northeastward, the primary contaminant flowpath, as well as eastward and southeastward, which are less significant flowpaths.

All of these Evaluation wells were sampled once in 2008, and Sentinel wells P210089 and 70099 and AOC well 10594 were sampled twice in accordance with RFLMA.

Figure 3–180 presents a summary of nitrate concentrations in samples from wells around the edges of the former SEPs. (Well 00203, located south of former Ponds 207A and 207B-South, is omitted from the figure because concentrations of nitrate in groundwater from this location are consistently low, e.g., the result in 2008 was 5.4 mg/L.) These data indicate the highest concentrations of nitrate in groundwater are present along the northeastern corner of the SEP area, generally south to south-southeast of the SPPTS. The data also show that to date there has been no meaningful decrease in nitrate concentrations that might be evident if clean water was

flushing the area. This is not surprising, given that most of the contaminated groundwater has been detected within the less-permeable weathered claystone, not the overlying and more-permeable alluvium.

As stated in the notes to Figure 3–180, the gaps in the time-series plots relate to erroneous data (reported as nondetect to the low single-digit mg/L) reported for samples collected on April 19, 2005. (See also the 2006 Annual Report, DOE 2007e, for a discussion of this topic.) These data are displayed on Figure 3–180 as unconnected points rather than being deleted, or being connected to the other data as if they were valid; in this way the reader may judge for themselves the validity of the associated results.



Notes: With one exception (well 79502), data reported for samples collected in April and June 2005 are outliers, ranging from nondetect (at 0.003 mg/L) to 2.42 mg/L. Two of these results are qualified as nondetects (U) and one is “B”-qualified but is not shown differently for the sake of simplicity; no other data were qualified. SEP source-area Evaluation well 00203 is omitted due to consistently low concentrations. Note logarithmic concentration scale.

Figure 3–180. Nitrate Concentrations in Evaluation Wells Along the Former SEP Margins

Figure 3–181 provides a similar display of U concentrations in these same wells, plus well 00203. Worth noting are the highly variable concentrations in samples from wells 79102 and 79605. Mechanisms responsible for the varying concentrations reported for well 79102 (and, to a lesser degree, its nearest neighbor, well 79202) are not known, but may relate to what were then ongoing or recent closure activities focused on former B779, B776/777, or the B-Pond sediments that were stockpiled in the vicinity for packaging and transport. The pattern seen in the time-series plot for well 79605, however, may relate to well replacement. The original well (P207989) was damaged during closure and abandoned on March 21, 2005. Its replacement, 79605, was installed on April 5, 2005—2 months before collection of the sample reporting the most elevated U result for this well. Also important are the results of statistical trending

calculations, which indicate a statistically significant (at 95 percent confidence level) increasing U trend in samples from well 79302. (See Appendix B.3 for trend plots.)

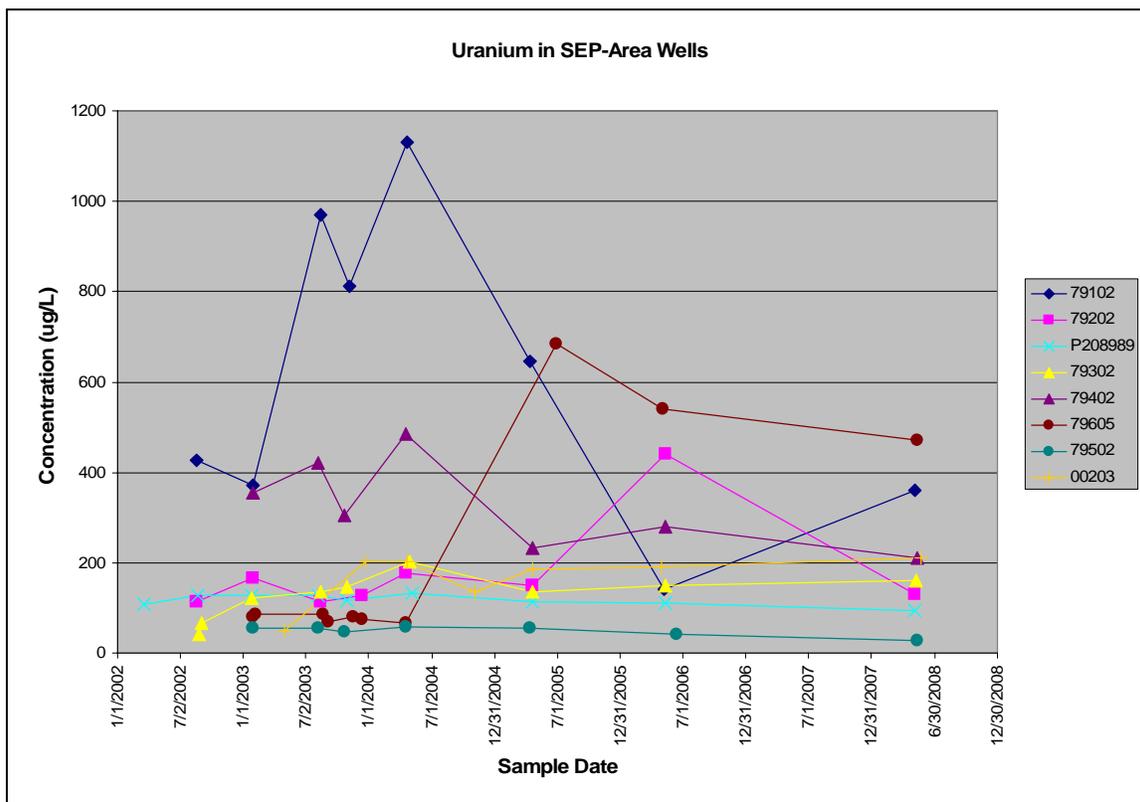
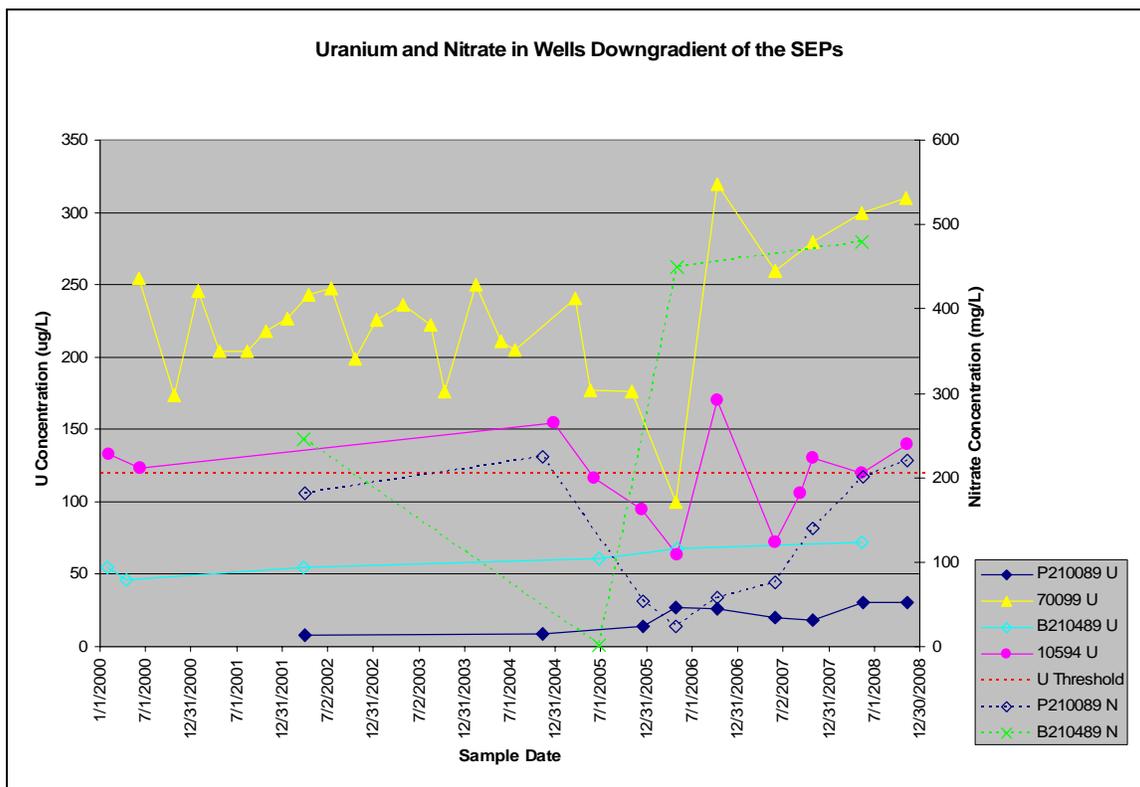


Figure 3–181. U Concentrations in Evaluation Wells Along the Former SEP Margins

Figure 3–182 displays U and N concentrations from wells downgradient of the SEP source area. With respect to the SPPTS, these include upgradient (P210089), side-gradient (70099), and downgradient (B210489, 10594) wells. Nitrate data for wells 70099 and 10594 are not included because concentrations are uniformly low (nondetect to low single-digit mg/L). Although several U results from AOC well 10594 have exceeded the 120- μ g/L threshold, since Site closure no two consecutive routine samples have exceeded that concentration; if and when that condition is met, a reportable condition as defined by the RFLMA for AOC wells will exist at this well and consultation with the regulators will follow. As has been reported previously (e.g., DOE 2008g), U in this well has been repeatedly characterized as 100 percent natural, most recently in September 2007.

Figure 3–182 illustrates the variable concentrations of nitrate and U in several of these wells. However, results from the samples collected in 2008 are generally consistent with those from the most recent sets of samples. The well nearest the source area (Sentinel well P210089) does not produce groundwater samples with the highest concentrations of U; rather, this is the case with samples from well 70099, located at the northwestern end of the SPPTS groundwater intercept trench. Of these wells, even most-distal well 10594 produces samples with higher concentrations of U than does well P210089. In contrast, concentrations of nitrate are highest in well P210089, and are uniformly low in wells 70099 and 10594. This further substantiates the previous conclusion that U in groundwater samples from wells 70099 and 10594 is natural, and is not part

of a plume of anthropogenic U and nitrate. (Samples from well 70099 were characterized in 2002 as being 99.4 percent natural.)

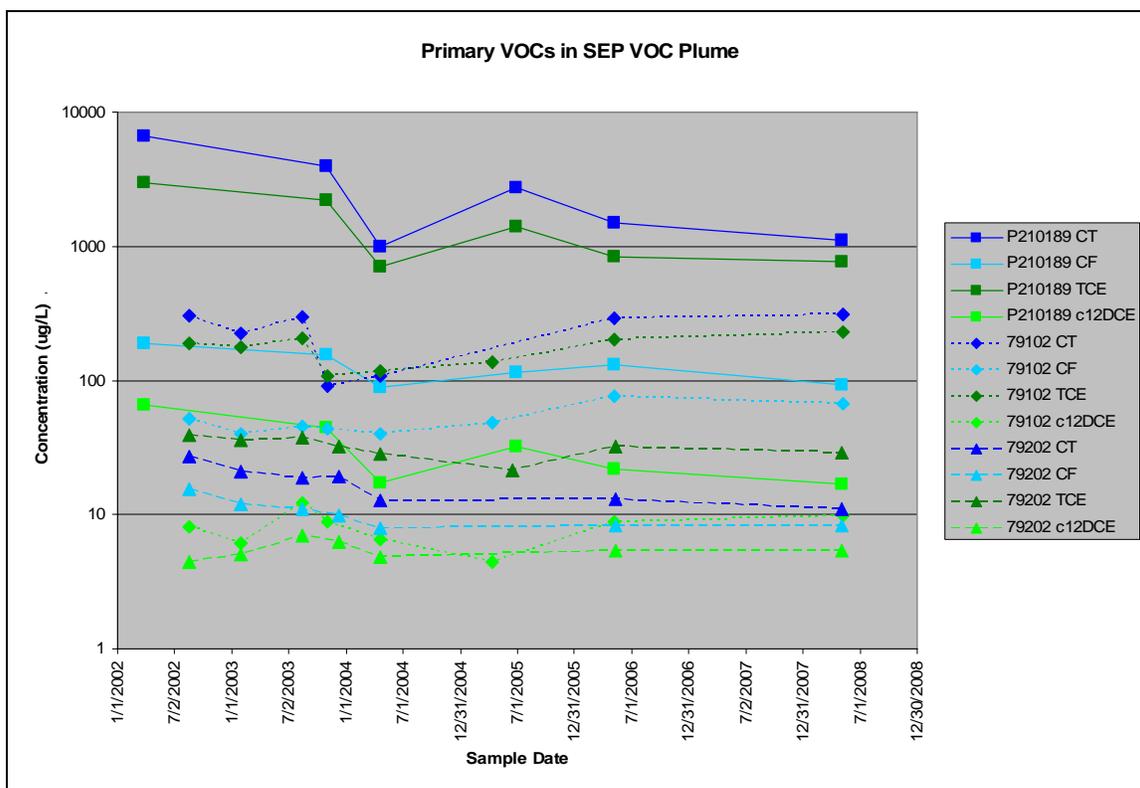


Note: U = total uranium, N = nitrate+nitrite as nitrogen.

Figure 3–182. U and Nitrate Concentrations in Wells Downgradient of the Former SEPs

Statistically significant (at the 95 percent level) increasing trends were identified for nitrate at well 70099 (which, as noted above, is present at uniformly low concentrations ranging from nondetect to under 3 mg/L), and U at Sentinel well P210089 and Evaluation well B210489 (but in both cases, concentrations remain well below the U threshold of 120 µg/L).

The VOC plume in the western SEP area was also monitored in 2008. Results (Figure 3–183) were generally consistent with those reported in previous samples. For each well shown, the distribution of constituents mirrors their position on a degradation pathway, with carbon tetrachloride degrading to chloroform, and TCE degrading to cis-1,2-DCE. The fact that parent compounds are present at higher concentrations than daughter products, and the corresponding time-series plots are nearly parallel over the past five years, suggests there has not been a significant increase in biodegradation of the parent compounds. Notably, M-K statistical calculations for these Evaluation wells indicated statistically significant (95 percent) decreasing trends in the concentrations of carbon tetrachloride, chloroform, and TCE in well 79202. What appear in the figure to be decreasing trends in carbon tetrachloride and chloroform at well P210189 are not yet statistically significant.



Notes: Several results are qualified (D, JD) but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

Figure 3–183. Primary VOCs in the SEP-Area VOC Plume

VOCs were not detected at elevated concentrations in wells farther downgradient from the source area, although detections were reported. Evaluation well 22205, located north of the VOC plume source area, reported no detections in the sample collected in 2008. Sentinel well P210089, which is farther north/northeast of the source area, reported “J”-qualified detections of chloroform (0.112 µg/L) and cis-1,2-DCE (0.37 µg/L) in samples collected in 2008.

Additional data will be collected from all SEP- and SPPTS-area wells per RFLMA.

Solar Ponds Plume Treatment System

Like the ETPTS, the SPPTS was installed in 1999. In basic terms, the system is very similar to the MSPTS and ETPTS, with an intercept trench (1,100 feet long) and two treatment cells. However, unlike the ETPTS and MSPTS, this system is designed to treat water with elevated concentrations of nitrate and U rather than VOCs. As such, the treatment media in the SPPTS differs from the ZVI media in the MSPTS and ETPTS. The treatment media in the SPPTS consists of organic material (sawdust) and ZVI.

Another difference between the SPPTS and the other two systems is that the water collected in the intercept trench is actively pumped into the treatment cells, rather than flowing into the cells by gravity. This is accomplished using a solar-charged, battery-powered pump system. This component of the SPPTS, together with the collection well that houses the pump and is installed within the trench, was added in 2002.

Routine maintenance activities at the SPPTS were conducted throughout 2008, and are reported in Section 2.5.3. An important upgrade was also made to the system that enables it to capture significantly more contaminated groundwater. This upgrade is discussed in greater detail below.

The SPPTS removed nitrate and U effectively through the first three quarters of 2008. The upgrades described below caused effluent-water quality in the fourth quarter of 2008 to exceed target concentrations of nitrate and U. Additional work is planned, and is summarized below.

The SPPTS treated approximately 280,000 gallons in 2008. This is generally consistent with volumes treated since the system was modified with the addition of the pump. Table 3–92 lists the annual estimates of the volume of water treated by the SPPTS, and Figure 3–184 presents a hydrograph showing flow since January 2000. Figure 3–185 provides a hydrograph for CY 2008.

Table 3–92. Estimated Volumes of Water Treated by the SPPTS

Calendar Year	Annual Estimates of Volume Treated (gallons)	Estimated Cumulative Volume Treated (gallons)
2000*	64,000	64,000
2001*	424,000	452,700
2002	5,600**	458,000
2003	340,000	797,000
2004	230,000	1,027,000
2005	140,000	1,167,000
2006	251,000	1,418,000
2007	244,000	1,662,000
2008	280,000	1,942,000

Notes: Estimates for years 2000 through 2004 are compiled from KH (2000a, 2000b, 2000c, 2000d, 2002, 2003, 2005b, 2005c).

* = Annual and cumulative volume estimates for 2000 and 2001 are suspect, as a sum of the volumes presented in each of the quarterly reports for 2000 and statements regarding the volume for 2001 disagree by approximately 35,000 gallons.

** = Most of this volume was from the former Modular Storage Tanks (K-H 2003).

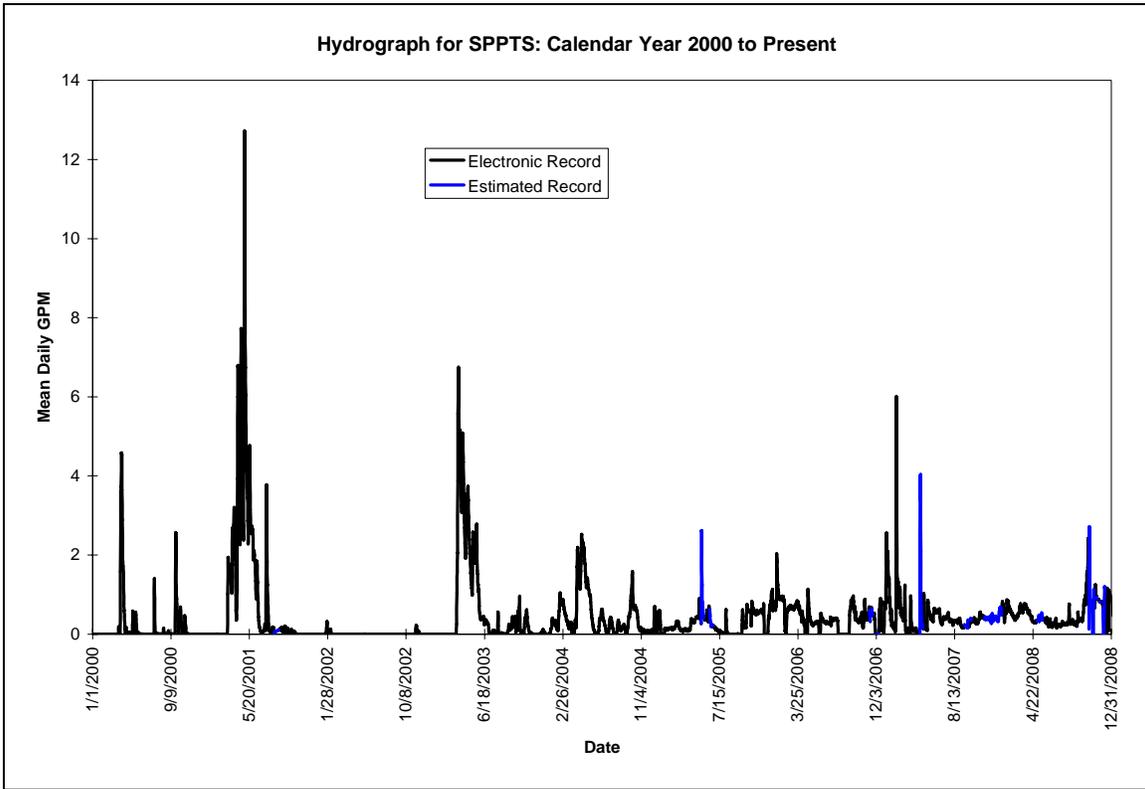


Figure 3–184. Hydrograph for SPPTS Since 2000

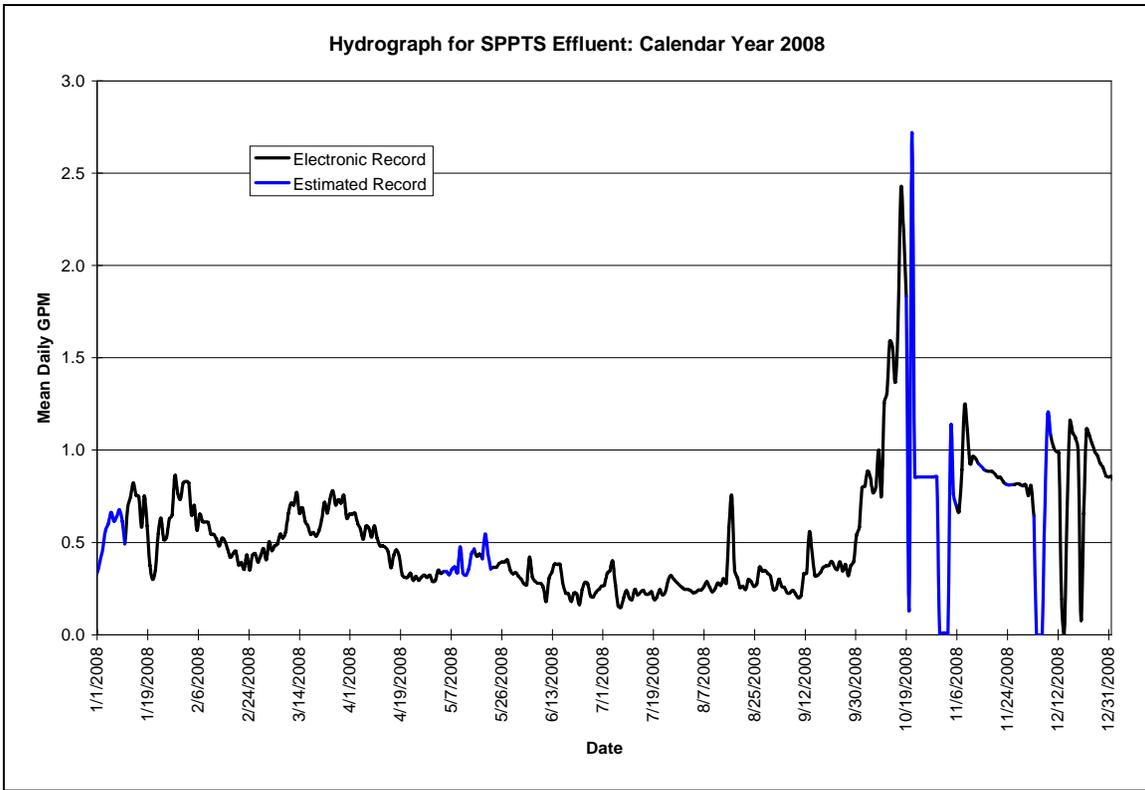
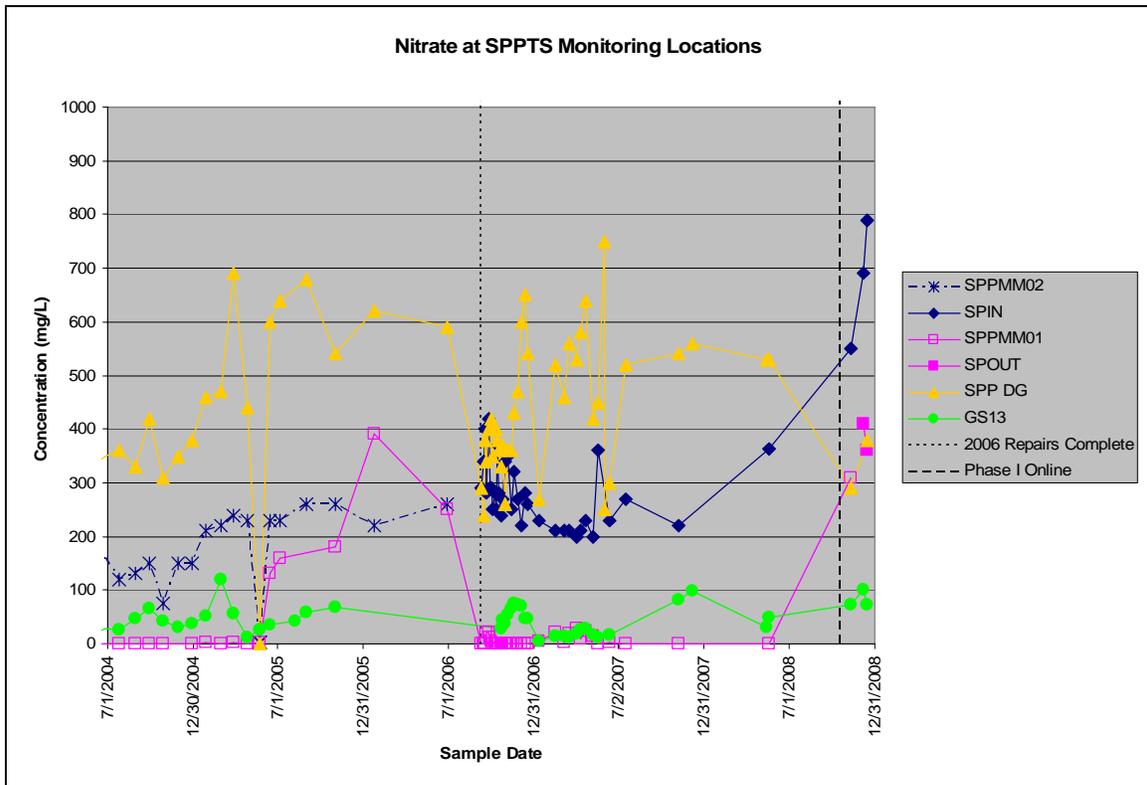


Figure 3–185. Hydrograph for SPPTS for CY 2008

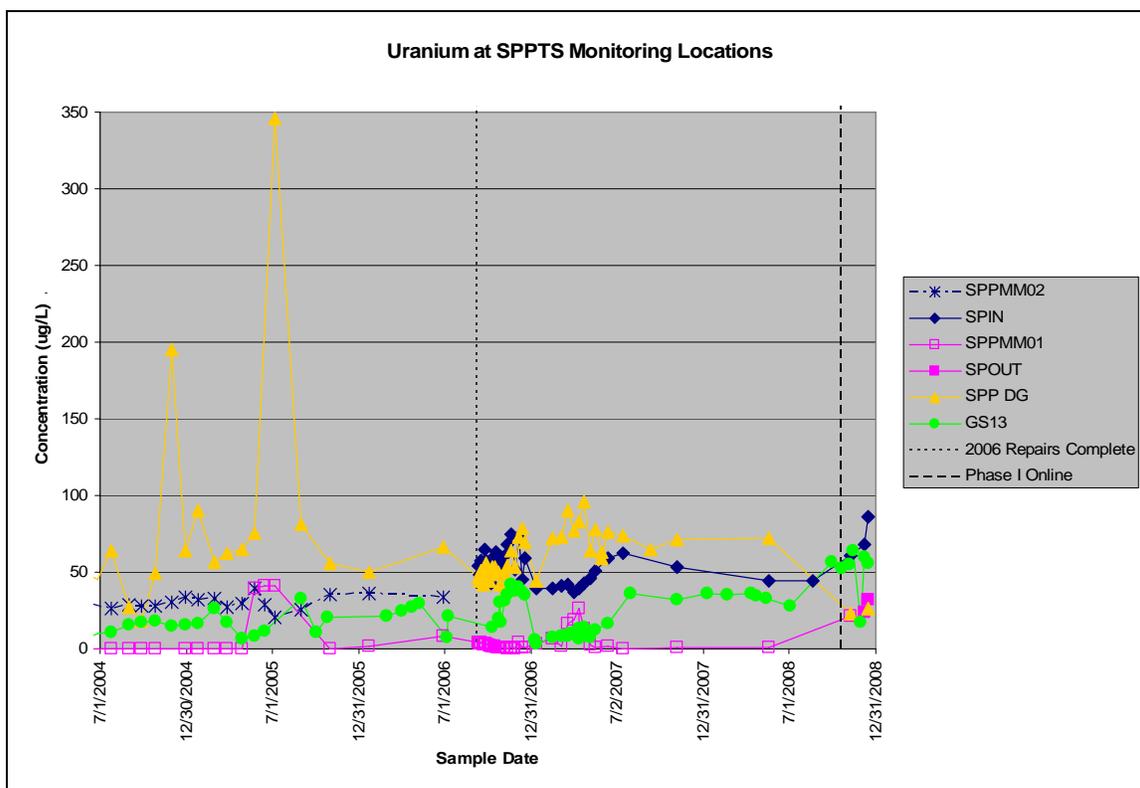
Although flow rates observed in 2008 were consistent with rates observed in previous years, the average flow rates in the latter few months of the year are clearly higher than the average for the rest of the year (Figure 3–185). This is not due to increased precipitation—the fourth quarter of 2008 was relatively dry, receiving slightly more than 50 percent of the average fourth quarter precipitation measured from 1993 through 2007—but rather is due to the additional water routed through the system following the installation of the Phase I upgrades that were completed in October 2008. Nitrate and U concentrations in system effluent (location SPPMM01 for most of the year) were also generally consistent with previous years until the Phase I upgrades were completed. As reported in the 2007 Annual Report (DOE 2008g), the formal influent monitoring point was revised in 2007 from a piezometer (SPPMM02, a.k.a. 71099) near the collection well (SPIN) to that collection well itself. In 2008, the upgrades discussed below allowed the effluent monitoring point to be revised as well, thereby eliminating the hazards associated with permit-required confined space entry at SPPMM01 and the need to perform regular maintenance at that location. The new effluent monitoring location is within an easily accessed vault and is referred to as SPOUT.

Figure 3–186 provides an illustration of nitrate concentrations in SPPTS monitoring locations since mid-2004; Figure 3–187 shows a similar graph for U concentrations. In both figures, the effects of valve changes made in mid-2005 are obvious on concentrations of these constituents in the effluent, and to some degree at the DG and GS13 as well (see the 2006 Annual Report, DOE 2007e, for additional discussion of these events). The effects of the system repairs made in 2006 are also obvious on the nitrate graph (Figure 3–186; refer to the same Annual Report for additional information). Most recently, the effects of the Phase I upgrades in late 2008 are clear on both figures, with concentrations of nitrate in system influent increasing by a factor of about three as effluent concentrations also increase sharply. Concentrations of U in system influent also increased, though not as greatly, and U concentrations in system effluent increased as well (Figure 3–187).



Notes: SPPMM02 = historic "influent" monitoring location; SPIN = true system influent (collection well); SPPMM01 = system effluent, replaced in late 2008 with SPOUT; SPP DG = SPP Discharge Gallery; GS13 = surface water performance monitoring location. Analytical data from SPPMM02 are included for comparison only; this location is no longer monitored. See the 2006 Annual Report (DOE 2007e) for a more detailed discussion of this location, as well as a discussion of the activities responsible for the abrupt concentration changes seen in data for May 24, 2005. Some data are qualified with U (nondetect) or B (reported concentration is less than the required detection limit but above the instrument detection limit), but are not displayed differently for simplicity. All data are from contract laboratories (not ESL).

Figure 3–186. Recent Concentrations of Nitrate in Samples from SPPTS Monitoring Locations



Notes: SPPMM02 = historic "influent" monitoring location; SPIN = true system influent (collection well); SPPMM01 = system effluent, replaced in late 2008 with SPOUT; SPP DG = SPP Discharge Gallery; GS13 = surface water performance monitoring location. Analytical data from SPPMM02 are included for comparison only; this location is no longer monitored. See the 2006 Annual Report (DOE 2007e) for a more detailed discussion of this location, as well as a discussion of the activities responsible for the abrupt concentration changes seen in data for May 24, 2005. Some data are qualified with J (detected at less than the detection limit; result is estimated) or H (one set of isotopic results at GS13; indicates analysis was done outside method maximum holding time) but are not displayed differently for simplicity. In addition, some of the data for individual isotopes, which are used to calculate total U concentrations, are "U"-qualified, but are not shown as nondetects for simplicity. All data are from contract laboratories (not ESL).

Figure 3–187. Recent Concentrations of U in Samples from SPPTS Monitoring Locations

Nitrate concentrations in 2008 at the performance monitoring location for the SPPTS, GS13, were within their typical range. None of the nitrate results exceeded the 100-mg/L TM stipulated in RFLMA, although one sample, collected on December 8, was equal to that value. Concentrations of U were slightly higher than is typical at GS13. Additional field-screening data were collected to support an evaluation of the impacts of the Phase I upgrades on water quality, and are discussed below.

Summary of SPPTS Phase I

This section describes the activities performed in 2008 to upgrade the SPPTS and the planned path forward for additional improvements to this treatment system. Routine system maintenance is discussed in Section 2.5.3.

Prior to Site closure in 2005, water that collected in the former Interceptor Trench Pump House (ITPH) was pumped elsewhere for treatment/disposal. This was no longer the case after closure, as the ITPH and all transfer and receiving facilities had been demolished. Waters that had

formerly collected in and been transferred from the ITPH were now able to saturate this area and migrate downgradient, toward North Walnut Creek. The result of this was noticeably higher concentrations of nitrate (and U, though to a lesser extent) in the creek.

Indications of how this change was impacting water quality were evident in the results from samples collected at the SPP Discharge Gallery (informally referred to herein as the DG). Concentrations of nitrate and U reported in samples collected at the DG typically had been higher than those from the untreated SPPTS influent, but following closure the differences increased. Table 3–93 shows how the averaged concentration of these analytes increased in samples from the DG from before closure to after closure.

Table 3–93. Summary of Nitrate and U Concentrations in Samples from the DG Prior to and Following Site Closure

Analyte	Date Range	Average Concentration	Standard Deviation	Median Concentration
Nitrate+nitrite as nitrogen (mg/L)	1/1/2000-10/13/2005 (before closure)	260	123	233
	10/14/2005-10/21/2008 (after closure)	450	123	425
Total U (µg/L)	1/1/2000-10/13/2005 (before closure)	53	45	43
	10/14/2005-10/21/2008 (after closure)	60	15	56

Notes: Only contract lab data were used for these calculations. Summary statistics presented are rounded to the nearest whole number.

End date of 10/21/08 is used for post-closure data because the SPPTS Phase I modifications were completed on that date, and subsequent data reflect the effects of those modifications. See text for further explanation.

Pre-closure statistics for U at the DG include several outlier results, the most obvious being approximately 346 µg/L on 7/6/2005; the presence of these outliers is evident in the larger standard deviation shown for pre-closure data. While it is not necessarily valid to do so, selectively omitting the three values over 100 µg/L (128 µg/L on 2/28/2002; 195 µg/L on 11/30/2004; and 346 µg/L on 7/6/2005) sharply reduces this standard deviation and results in the calculated pre-closure U summary statistics of 45 µg/L, 17 µg/L, and 43 µg/L, respectively.

Prior to the Phase I upgrades, SPPTS effluent was formally monitored in the metering manhole adjacent to the treatment cells, identified as SPPMM01. Effluent then exited this manhole and flowed down the hill through a perforated remnant of the former Interceptor Trench System (ITS) to near the former location of the ITPH, where the water was routed through an unperforated line to the DG. The perforations of the ITS allowed contaminated groundwater present downgradient of the SPPTS groundwater intercept trench to enter the ITS lines and commingle with the treated water, then exit at the DG.

As reported in the 2007 Annual Report (DOE 2008g), exploratory excavations were made that year to locate and sample the main contributors to flow at the DG. Targeted locations included the main western ITS line (referred to as the ITS west manifold), through which SPPTS effluent was routed; and the ITS east manifold. Both were located and sampled, and results confirmed pre-closure information that of these locations, the west manifold contributes the greatest flow and highest contaminant concentrations.

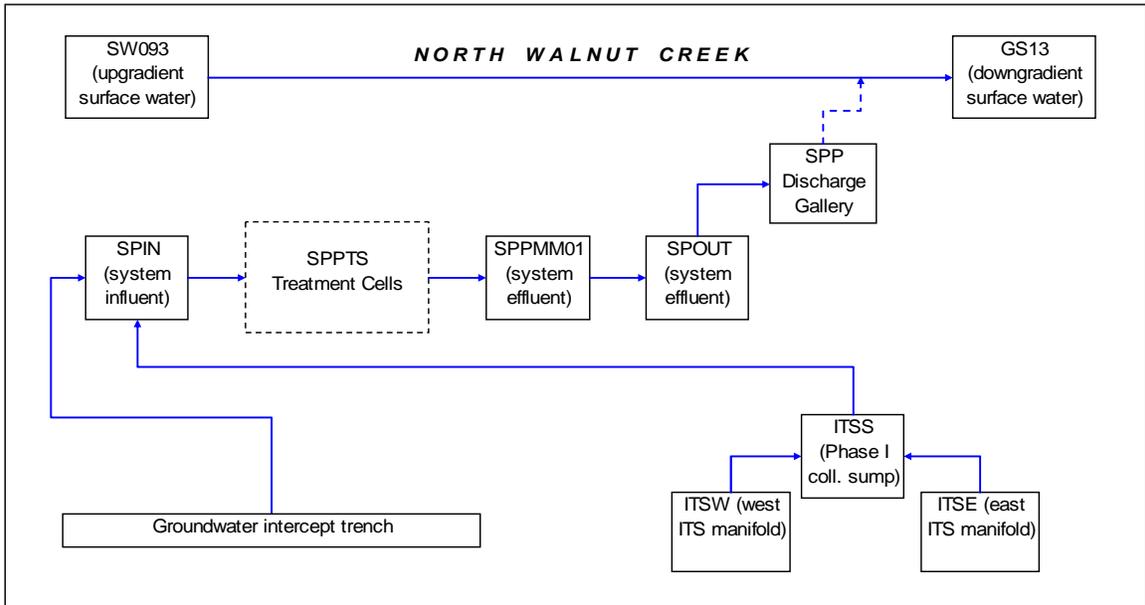
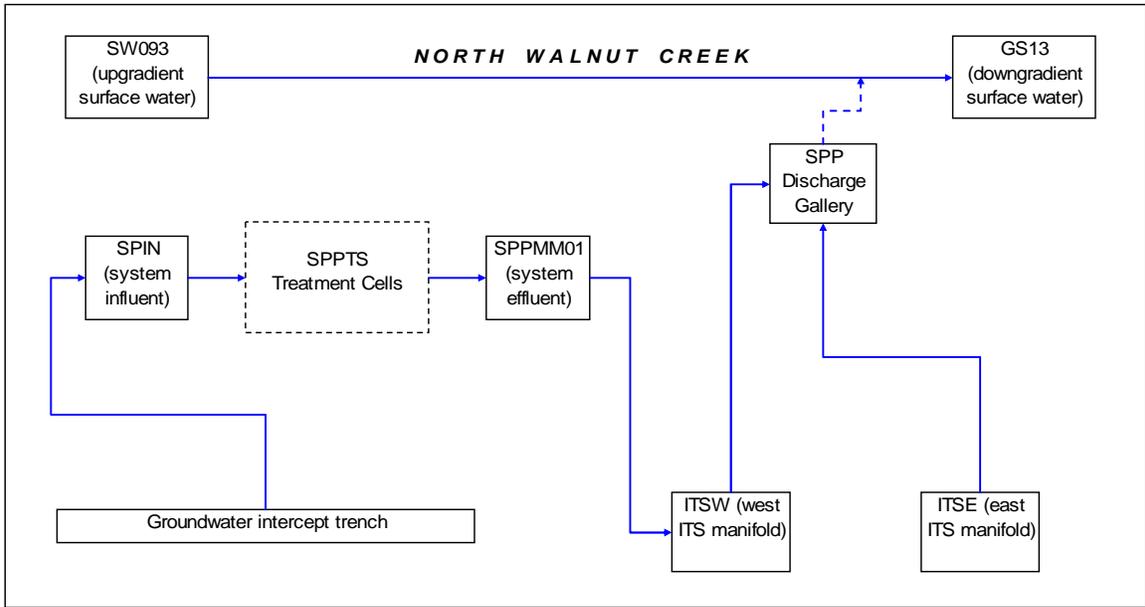
A multiphased approach to improving treatment by and operation of the SPPTS was devised in 2008. Four primary factors drove this initiative, and are listed below in no particular order.

- Maintenance of the existing SPPTS treatment cells and associated plumbing, though infrequently required, is difficult, hazardous, and costly due to their size and depth. Improving the access and decreasing maintenance costs was desired.
- Elimination of the temporary modification for nitrate (100 mg/L as nitrogen, effective through 2009) in favor of the underlying drinking water standard (10 mg/L as nitrogen) would almost certainly require additional contaminant reduction in order for standards that apply to the surface water that is monitored at GS13 to be met. While GS13 is not a point of compliance, meeting this lower standard at GS13 would provide additional confidence that this standard would also be met at GS11 (the POC below Pond A-4).
- Breaching the dams in the A-series ponds would result in flow-through conditions, potentially increasing the risk of exceeding the drinking water standard at GS11 if additional nitrate load was not removed.
- Treating U first, rather than after nitrate, would allow disposal of future nitrate treatment media as a sanitary waste, rather than as a low-level radioactive waste. While the amount of U removed from the groundwater since the installation of the SPPTS is extremely small (estimated to be less than one pound, distributed throughout the more than 8,000 cubic feet of media in SPPTS Cells 1 and 2), in the system's current configuration DOE's "no rad added" policy requires this media be disposed as low-level waste.

Phase I

The most efficient way to improve water quality in North Walnut Creek is to capture and treat more contaminated groundwater that would otherwise discharge, without treatment, to the creek. The Phase I upgrade to the SPPTS was designed to accomplish this. A collection sump (formally referred to as the ITS sump, ITSS) was constructed adjacent to the former ITPH, and the east and west ITS manifolds were connected to the ITSS. (Because this activity was associated with a critical component of the remedy and included excavation to more than 3 feet below ground surface, a Contact Record was written to document CDPHE approval. The Contact Record associated with Phase I is Contact Record 2008-08.) Water that collects in the ITSS is pumped up the hill into SPIN, the collection well installed within the groundwater intercept trench. The pump in SPIN then routes water in the trench (both intercepted groundwater and that transferred from the ITSS) into the SPPTS treatment cells.

Figure 3-188 displays a flow schematic of the effects of the Phase I additions, and Figure 3-189 provides a portion of the detailed as-built "plan view" drawing of the Phase I upgrades.



Notes: Schematic only; no scale or orientation implied.

Figure 3–188. Schematic of How SPPTS Phase I Upgrades Affect the System (Top = before Phase I, Bottom = after Phase I)

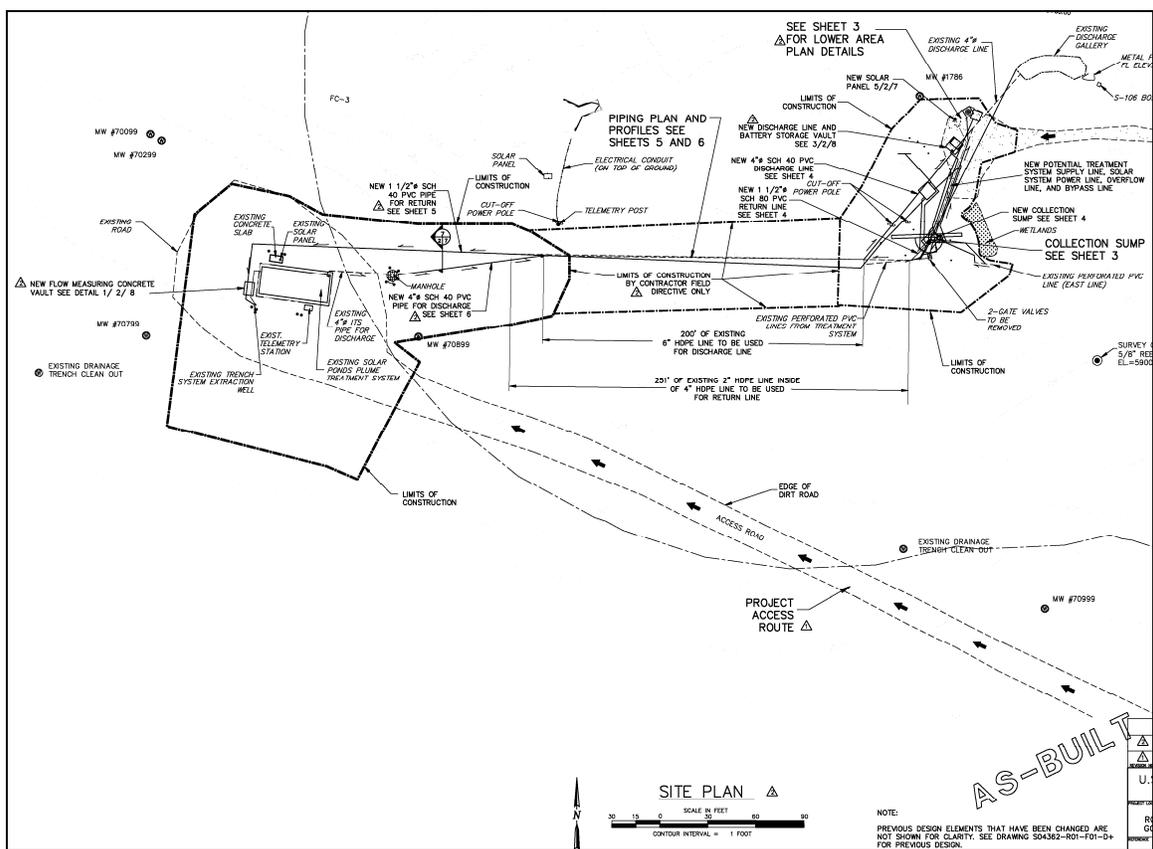


Figure 3-189. Plan View Drawing of SPPTS Phase I Upgrades

To add confidence that the majority of the easily intercepted contaminated groundwater in this location was collected by the sump, the perforated section of the sump was wrapped in gravel, and a subsurface gravel “curtain” was installed that extends along the base of this hillside approximately 23 feet west and 20 feet east of the sump itself. Groundwater encountering this gravel (for example, as it flows within the bedding materials for the ITS lines) drains by gravity into the ITSS for transfer to SPIN.

Additional improvements that were made in the Phase I effort included installing a new metering vault, effluent monitoring point, and effluent discharge line, and incorporating preexisting subsurface lines in the design. The metering vault is adjacent to SPPTS Cell 1 and SPIN, and is referred to as the SPIN vault; within this vault, flows from the ITSS into SPIN, and from SPIN into the treatment cells, are monitored. The new effluent monitoring point, SPOUT, is located in a second new vault that also houses the controller and batteries for the solar-powered pump installed in the ITSS. The new discharge line was necessary because otherwise treated water would discharge to the ITS lines and flow back to the ITSS, from which it would be transferred back to the treatment cells, only to discharge again to the ITSS in an endless “do-loop.” (Note that this discharge line operates by gravity, with effluent continuing to exit SPPTS Cell 2, flow into the bottom of the manhole adjacent to Cell 2, then flow by gravity down the hill to the DG.) The use of preexisting lines was not necessary, but helped to minimize environmental impacts in the work area (which is Preble’s meadow jumping mouse habitat) by reducing the need to excavate and lay new lines.

Phase I was completed in late October, 2008. Extra monitoring was initiated to assess the effects of the Phase I upgrades; results are discussed below.

Phases II, III, and IV

Phases II, III, and IV are planned for completion in later years. Phase II includes the construction of a new U treatment cell situated “upstream” of nitrate treatment, allowing future nitrate media to be handled and disposed as sanitary waste or, if desired and appropriate, used as compost on Site. The media used in the U treatment cell will be ZVI with gravel, just as is currently used in existing Cell 2 of the SPPTS. Phase II is planned for installation in spring 2009.

Phase III focuses on construction of a pilot-scale nitrate treatment facility to optimize removal of this contaminant from SPP water that has already been treated for U. A letter report was issued in January 2009 entitled *SPPTS Phase III: Pilot-Scale Optimization of Nitrate Treatment* (Appendix F). This document provides the general plan for Phase III. Media planned for evaluation included an inert substrate to which a carbon source (such as an inexpensive brewery byproduct) is added, and an organic media (envisioned to be walnut shells) infused with a higher-quality carbon source (e.g., vegetable oil). (Further testing has refined these choices, and the final selections will be discussed in the 2009 Annual Report.) Additional activities are recommended in the letter report, as discussed below. Phase III is also planned for completion in spring 2009.

Phase IV encompasses a full-scale renovation of the existing nitrate treatment to incorporate what will be learned from Phases I through III, including flow rates, contaminant concentrations, treatment media effectiveness, and operation/maintenance requirements. Phase III will be designed and constructed with consideration of potential longer-term application of the associated facilities; therefore, Phase IV may incorporate the pilot-scale treatment cells installed for Phase III together with all, part, or none of the existing SPPTS Cells 1 and 2. The design of Phase IV will not be determined until late 2009 or early 2010, and construction of this phase is planned for completion in 2010.

Additional Recommended Activities

As noted above, the letter report (Appendix F) recommended additional activities be undertaken outside of the proposed phased upgrades to the SPPTS. The fundamental recommendation focused on determining whether the sawdust-based media within the existing Cell 1 might be amenable to rejuvenation—that is, whether this media might be enhanced to improve its treatment effectiveness. The steps to be taken in order to make this determination included (1) performing a tracer test to determine flow characteristics through the SPPTS treatment media, and if these characteristics are found to be suitable, to (2) consider rejuvenating the media, such as through injection of vegetable oil into the existing sawdust-based nitrate treatment media. If the tracer test indicated significant short-circuiting is occurring—i.e., water is pumped into Cell 1 and a significant portion bypasses, rather than flows through, the media—then media rejuvenation would have little effect on effluent-water quality. Rejuvenation was only seen as a temporary measure to address the reduced treatment effectiveness observed since Phase I was completed (see below for discussion); over the longer term, the other phases described above should be effective in achieving the goals outlined above with respect to water quality in North Walnut Creek.

The recommendation to consider rejuvenation presupposed the determination that the sawdust actually could be rejuvenated from outside of the treatment cells, without excavating or otherwise disturbing/displacing the media. However, it was subsequently found through laboratory tests that the most attractive carbon sources being considered for injection into the sawdust-based media, forms of food-grade vegetable oil, would not fractionate to the solid phase. Instead, the oil would simply flush through the system. This means that even if flow conditions are suitable and there is no appreciable short-circuiting, such a rejuvenation attempt would be of very limited and short-lived value. Instead of enhancing the existing media, the vegetable oil would end up at the Discharge Gallery, which would not be desirable. Other amendments were also considered (e.g., simple and more complex sugars), but similar behavior was seen as the likely result. *Therefore, the tracer test and media rejuvenation activities are no longer recommended and are not being pursued.*

Changes in Water Quality Following Phase I Completion

Non-RFLMA water samples were collected frequently following completion of the Phase I upgrades. Table 3–94 below summarizes sampling conducted in 2008, much of which continued into 2009; refer to Figure 3–188 to identify the various locations sampled.

Table 3–94. Summary of Evaluation Sampling Performed in 2008 Following SPPTS Phase I Completion

Sample Date	Location								
	SW093	ITSW	ITSE	ITSS	SPIN	SPPMM01	SPOUT	DG	GS13
10/22/2008	N,U	N,U	N,U	N,U	N,U	N,U	N,U	N,U	N,U
11/10/2008	N,U	N,U	N,U	N,U	[N,U]	[N,U]	N,U	[N,U]	N,U
11/17/2008	N,U	N,U	N,U	N,U	N,U	N,U	N,U	N,U	N,U
11/24/2008	N,U	N,U	N,U	N,U	N,U	N,U	N,U	N,U	N,U
12/2/2008	N,U	N,U	N,U	N,U	N,U	xx	N,U	N,U	N,U
12/8/2008	N,U	N,U	N,U	N,U	N,U	xx	N,U	--	N,U
12/17/2008	N,U	N,U	N,U	N,U	N,U	xx	N,U	N,U	N,U
12/29/2008	--	N,U	N,U	N,U	N,U	xx	N,U	N,U	N,U

NOTES:

SW093 and GS13 are surface water locations. ITSW is ITS west manifold; ITSE is ITS east manifold; ITSS is ITS sump. SPIN is SPPTS influent monitoring location. SPPMM01 is SPPTS effluent sampling location prior to approval of Contact Record 2008-09; SPOUT is SPPTS effluent sampling location following approval of that CR. DG is SPP Discharge Gallery.

N = nitrate+nitrite as nitrogen; U = uranium, either as total (mass units) or isotopic (activity units). Brackets identify those samples submitted to a contract lab; all others were submitted to the ESL. See text for additional information.

-- = Sampling scheduled, but location was frozen; xx = sampling not scheduled.

Most of these water samples were analyzed in the DOE’s Environmental Sciences Lab (ESL) in Grand Junction, CO. Results were not validated or otherwise assessed for quality (e.g., via audits of the lab, as is the case with contract labs). As such, these data are not appropriate for compliance purposes, but instead may be used for general evaluation purposes. Several samples, particularly those for U analysis collected at SW093 and GS13, were analyzed by contract labs for U isotopes (as opposed to total U mass concentration, as analyzed by the ESL). These contract lab-analyzed samples are flow-paced and therefore better represent overall concentrations in the stream at the corresponding location, for the associated block of time, than do the grab samples analyzed by the ESL.

Results reported by the ESL for several sampling rounds confirmed that the water quality of system effluent that was monitored at SPPMM01, the original effluent monitoring location, was equivalent to that monitored at SPOUT, the newly constructed location. The effluent monitoring requirements were then formally changed from SPPMM01 to SPOUT through Contact Record 2008-09 to eliminate the hazards and difficulties associated with the permit-required confined space entries necessary to maintain SPPMM01; the new location is safer and allows easier access for sampling.

Concentrations of nitrate and U at the DG have decreased significantly since Phase I was completed, as shown in Table 3–95. The average concentration of nitrate at the DG following Site closure was reduced from about 450 mg/L to about 335 mg/L following Phase I. Concentrations of U at the DG over the same period decreased from an average of approximately 60 µg/L to 25 µg/L.

Table 3–95. Summary of Nitrate and U Concentrations in Samples from the DG Prior to and Following Site Closure, and Following Phase I SPPTS Upgrades

Analyte	Date Range	Average Concentration	Standard Deviation	Median Concentration
Nitrate+nitrite as nitrogen (mg/L)	1/1/2000-10/13/2005 (before closure)	260	123	233
	10/14/2005-10/21/2008 (after closure)	450	123	425
	10/22/2008-12/31/2008 (after Phase I)	335	64	335 ^a
Total U (µg/L)	1/1/2000-10/13/2005 (before closure)	53	45	43
	10/14/2005-10/21/2008 (after closure)	60	15	56
	10/22/2008-12/31/2008 (after Phase I)	25	2	25 ^a

Notes: Only contract lab data were used for these calculations. Summary statistics presented are rounded to the nearest whole number.

End date of 10/21/08 is used for post-closure data because the SPPTS Phase I modifications were completed on that date, and subsequent data reflect the effects of those modifications. See text for further explanation.

Pre-closure statistics for U at the DG include several outlier results, the most obvious being approximately 346 µg/L on 7/6/2005; the presence of these outliers is evident in the larger standard deviation shown for pre-closure data. While it is not necessarily valid to do so, selectively omitting the three values over 100 µg/L (128µg/L on 2/28/2002; 195 µg/L on 11/30/2004; and 346 µg/L on 7/6/2005) sharply reduces this standard deviation and results in the calculated pre-closure U summary statistics of 45 µg/L, 17 µg/L, and 43 µg/L, respectively.

^aTwo sets of samples were collected in the period from 10/22/08 through 12/31/08, and therefore the average and median are identical.

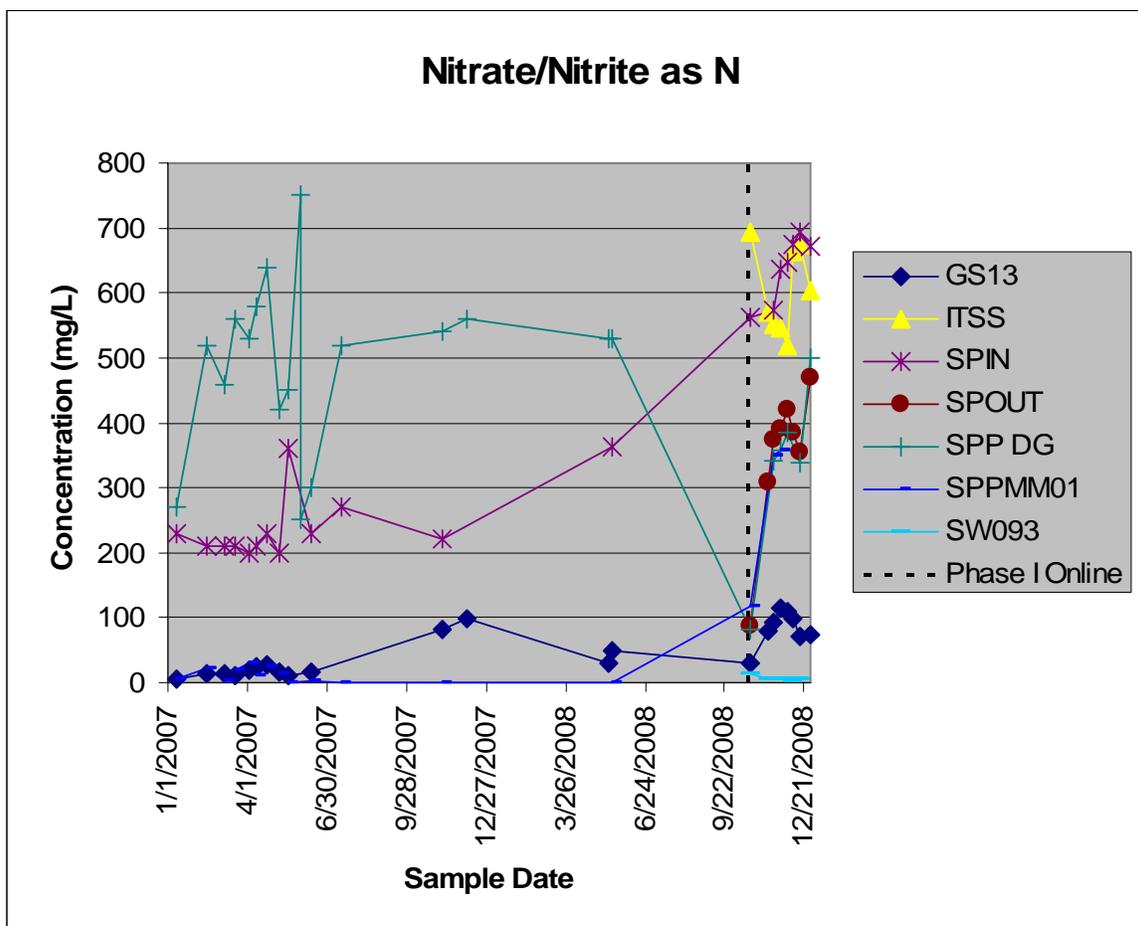
Sample results also confirm that effluent concentrations (whether measured at SPPMM01 or SPOUT) are now very similar to those reported at the DG. (Prior to the Phase I upgrades, system effluent was clean but DG water contained higher concentrations of the contaminants of interest than did the untreated influent monitored at SPIN.) This indicates that the contaminated groundwater that had been monitored at the DG is being effectively collected by the Phase I upgrades.

Although the concentrations of contaminants at the DG have decreased significantly, the treatment media has been challenged and treatment effectiveness has been reduced. This was anticipated, given the system’s response to high snowmelt-related flows in the winter of 2006–2007 (see 2007 Annual Report, DOE 2008g). In that case, estimated flows increased from

a long-term average of approximately 0.2 gpm to as high as about 6 gpm for a brief period (less than an hour; longer-term average flows were still well under 1 gpm), while influent concentrations increased slightly. Following the completion of the Phase I upgrades, long-term average flows approximately doubled or tripled to an averaged flow rate over the balance of the calendar year of about 0.8 gpm, and influent concentrations increased sharply. Analytical data indicate concentrations of nitrate in post-Phase I system influent nearly tripled, from an average of around 275 mg/L before Phase I was installed to about 675 mg/L after the upgrades were completed (refer to Figure 3–186). Concentrations of U also increased, though much less so (from about 50 µg/L to about 70 µg/L; Figure 3–187).

As explained in the 2007 Annual Report (DOE 2008g), higher flow rates through the system correlate to a reduced hydraulic residence time (HRT) within the system. That is, with higher flows coming into the system, the flow rate moving through and exiting the system also must increase. Reducing the HRT consequently reduces the duration of contaminant contact with the media. Such a reduction in HRT is what caused the temporarily elevated effluent concentrations in 2007. Reducing the HRT while simultaneously sharply increasing the contaminant load magnifies this effect, as is evident in data for effluent concentrations of nitrate subsequent to the Phase I upgrades. (The effect is also seen in U data, but not as dramatically.)

Figure 3–190 summarizes analytical results from the ESL (therefore, suitable only for field evaluations, not compliance) for nitrate concentrations. Refer to Figure 3–186 and Figure 3–187 for graphical summaries using data from contract labs.



Notes:
 SW093 and GS13 are surface water locations. ITSS is ITS sump. SPIN is SPPTS influent monitoring location. SPPMM01 is SPPTS effluent sampling location prior to approval of Contact Record 2008-09; SPOUT is SPPTS effluent sampling location following approval of that CR. SPP DG is SPP Discharge Gallery. Refer to Figure 3-188 for a schematic of the locations. Only ESL data are shown for clarity; see Figure 3-186 and Figure 3-187 for time-series plots constructed from contract lab data.

Figure 3-190. Summary of Non-RFLMA Field-Evaluation Nitrate Concentration Data from SPPTS Locations Preceding and Following Phase I Upgrades

The summary results shown on Figure 3-190 (as well as Figure 3-186 and Figure 3-187) clearly indicate the increase in effluent and influent concentrations described above. Some improvement in effluent-water quality may result from the construction of the Phase III facilities, since a portion of the influent water will be treated by that pilot-scale component; in addition, if any residual carbon remains in the water exiting the Phase III cell(s), it may help to stimulate the denitrifying bacteria within the original SPPTS Cell 1 media.

Additional performance data will be collected throughout 2009 for SPPTS locations, and will be interpreted and discussed in the 2009 Annual Report.

Other Plumes

In accordance with RFLMA, several other groundwater contaminant plumes at Rocky Flats were monitored during 2008. These include the 903 Pad/Ryan's Pit Plume, the collection of small

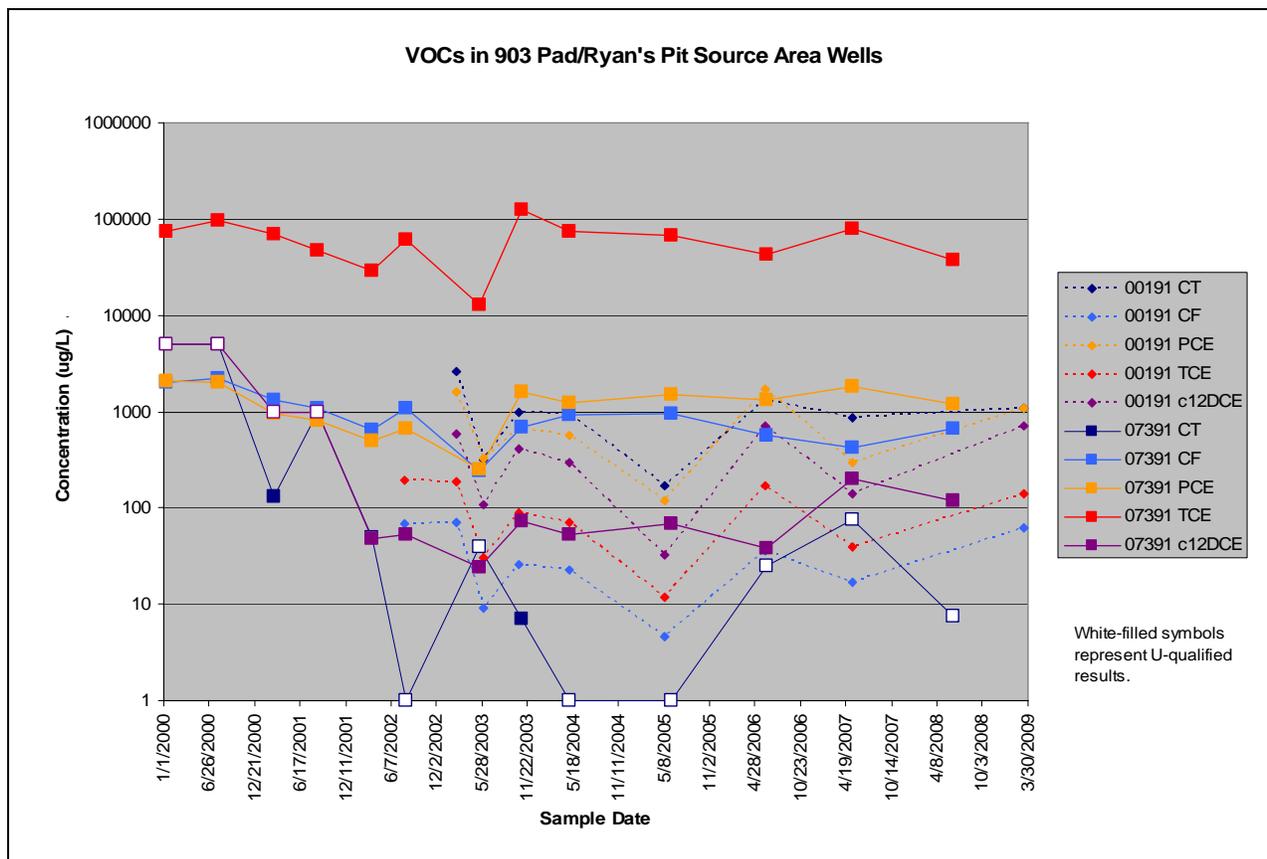
plumes collectively referred to as the IA Plume, the VC Plume (or OBP#1 Plume) located south of former B371, the IHSS 118.1 Plume (a.k.a. the carbon tetrachloride plume) located north-northwest of former B776, the PU&D Yard Plume, and the OU 1 Plume. Each of these is discussed below, followed by a short summary of data from other locations of special interest.

903 Pad/Ryan's Pit Plume

The 903 Pad/Ryan's Pit Plume was monitored in 2008 via several wells distributed within and at the margins of the plume. This plume bifurcates, with one portion flowing toward the southeast and Woman Creek, and the other flowing toward the northeast and joining the East Trenches Plume. The northeastern branch is not discussed here; refer to the text on the East Trenches Plume above. Note that two Evaluation wells that serve to monitor this plume, wells 00191 and 50299, were inadvertently omitted from sampling in 2008. The wells were sampled in March 2009 and results will be reported in the 2009 report, but for discussion purposes data for the constituents of greatest interest are included in the graphics and text prepared for this section.

Water quality within the southeastern portion of the 903 Pad/Ryan's Pit Plume appears generally consistent with that reported in previous years. Perhaps most important, the detections of VOCs (1,3-DCB, TCE) and nitrate in samples from AOC well 10304 that were reported in 2007 were not confirmed in 2008. Had they been repeated, these detections might have been an indication that contaminants from the 903 Pad/Ryan's Pit Plume were beginning to reach Woman Creek. The lack of detections in both 2008 samples does not suggest that this may never happen, but it does indicate that if the plume edge is approaching Woman Creek it would probably take years for concentrations to exceed RFLMA Table 1 levels. This well will continue to be monitored and analytical data will be evaluated in accordance with RFLMA.

This plume is also monitored by source-area Evaluation wells 00191 (just east of the former 903 Pad) and 07391 (just south of the former Ryan's Pit), in-plume Evaluation wells 90402, 50299, 00491, and 90804, and downgradient Sentinel wells 90299 and 90399,. Analytical data for samples collected in early 2009 from Evaluation wells 00191 and 50299, and from the other wells in 2008, are generally consistent with previous data. Groundwater near the 903 Pad source area (represented by well 00191) has been shown to be enriched in carbon tetrachloride relative to the PCE-TCE chain of compounds, although concentrations of PCE approach those of carbon tetrachloride; the most recent data continue to confirm this characteristic. Conversely, groundwater near Ryan's Pit (represented by well 07391) contains much higher concentrations of TCE relative to carbon tetrachloride, which is frequently not detected (although the need to perform these analyses at a dilution has resulted in detection limits for carbon tetrachloride as high as 5,000 µg/L since 2000). Figure 3-191 shows time-series plots of carbon tetrachloride and its primary daughter product, chloroform, as well as PCE and its daughter products TCE and cis-1,2-DCE, for source-area wells 00191 (which is represented by data from early 2009, as explained above) and 07391. Note that some daughter products, particularly TCE, were heavily used during production at the Site and therefore do not always represent metabolic byproducts.



Notes: Well 00191 was inadvertently not sampled during 2008. CT = carbon tetrachloride, CF = chloroform, c12DCE = cis-1,2-DCE. Of the CT data from well 07391 since 1/1/2000, only two results are detections, the other 10 are nondetects. Both detections are shown. RFLMA surface-water action levels for these constituents ($\mu\text{g/L}$; DOE 2007a): CT, 5; CF, 3.4; PCE, 5; TCE, 5; cis-1,2-DCE, 70. Not shown are "U"-qualified data for CT from well 07391, as discussed. Several other results were qualified (D, E, J), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

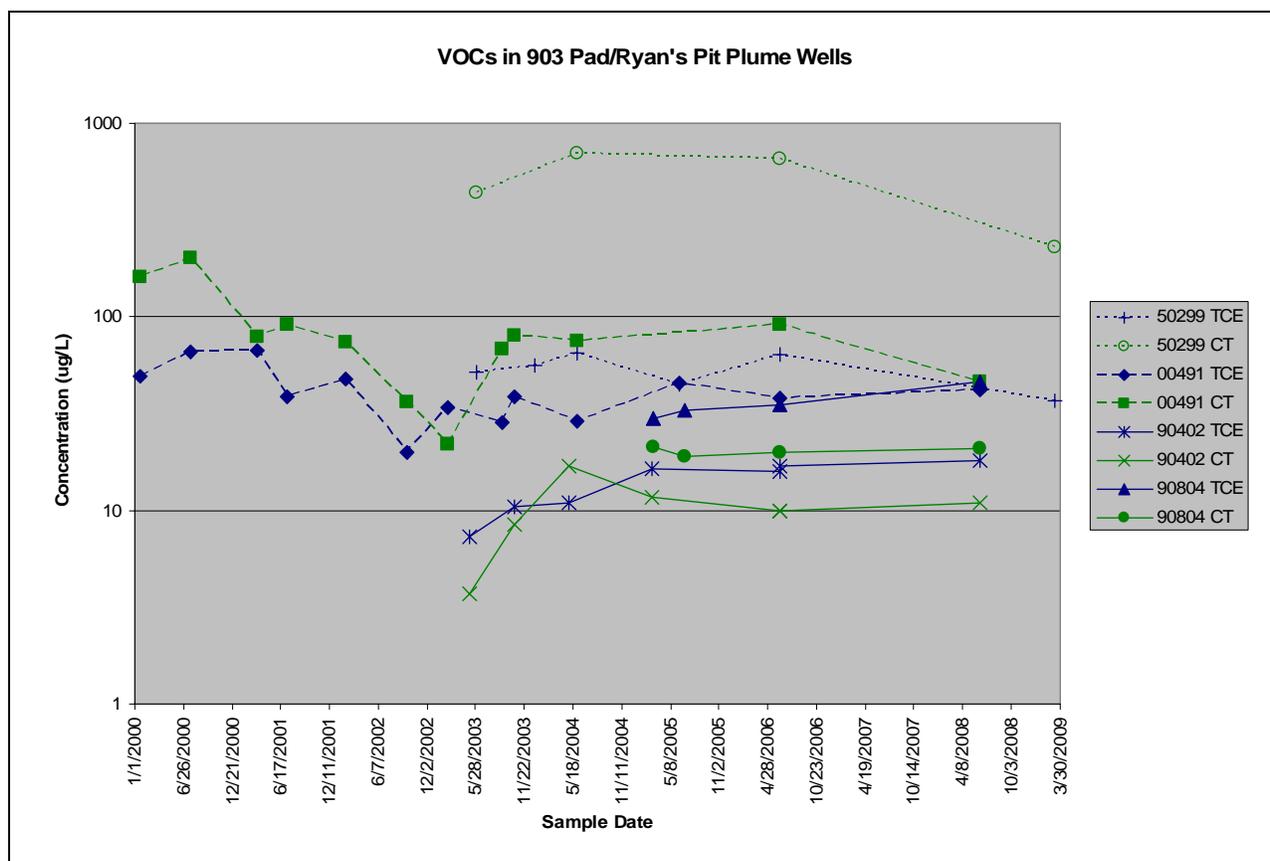
Figure 3–191. Concentrations of VOCs in Source-Area Wells 00191 (903 Pad) and 07391 (Ryan's Pit)

As is evident on Figure 3–191, the relative concentrations of different VOCs in each source-area well appear to track one another closely, although concentrations in one well do not closely track those in the other. Concentrations of the primary VOCs in samples collected from Evaluation well 07391 in 2008 were consistent with previous data. The 2007 increase in cis-1,2-DCE concentrations in samples from well 07391 did not continue into 2008, although concentrations were still higher than in preceding years. Indeed, concentrations of cis-1,2-DCE are found to be on an increasing trend (95 percent significant) using the M-K statistical test. However, the four nondetects in the first few years of this calculation, which were replaced prior to statistical calculations with values of 0.001 as previously discussed, place doubt on the validity of this trend. This concern does not apply to the decreasing trend, also at the 95 percent level of significance, that was calculated for chloroform (a byproduct of carbon tetrachloride degradation).

Judging from the data reported for samples from well 07391, the effects to date on groundwater contamination as a result of HRC insertion into the subsurface in the Ryan's Pit source area prior to Site closure do not appear to have been great. Results from well 00191, downgradient from another area of HRC insertion, are similar in that they do not suggest a strong increase in

biodegradation of VOCs. Additional data will be collected to continue to assess the effects of HRC on contaminant concentrations in the Ryan's Pit and 903 Pad source areas.

Concentrations of the primary compounds TCE and carbon tetrachloride in wells monitoring the interior of the 903 Pad/Ryan's Pit Plume, 90402, 50299, 00491, and 90804, show no remarkable changes in 2008. Results were relatively consistent with those obtained in prior years, as shown on Figure 3–192, with one possible exception: concentrations of carbon tetrachloride in samples from well 50299 appear to be somewhat lower in the most recent sample (collected in early 2009, as explained above). A concurrent increase in concentrations of chloroform, the common byproduct of carbon tetrachloride degradation, is not reflected in the analytical data. Additional data will be required to determine if this apparent decrease will develop into a definitive trend.



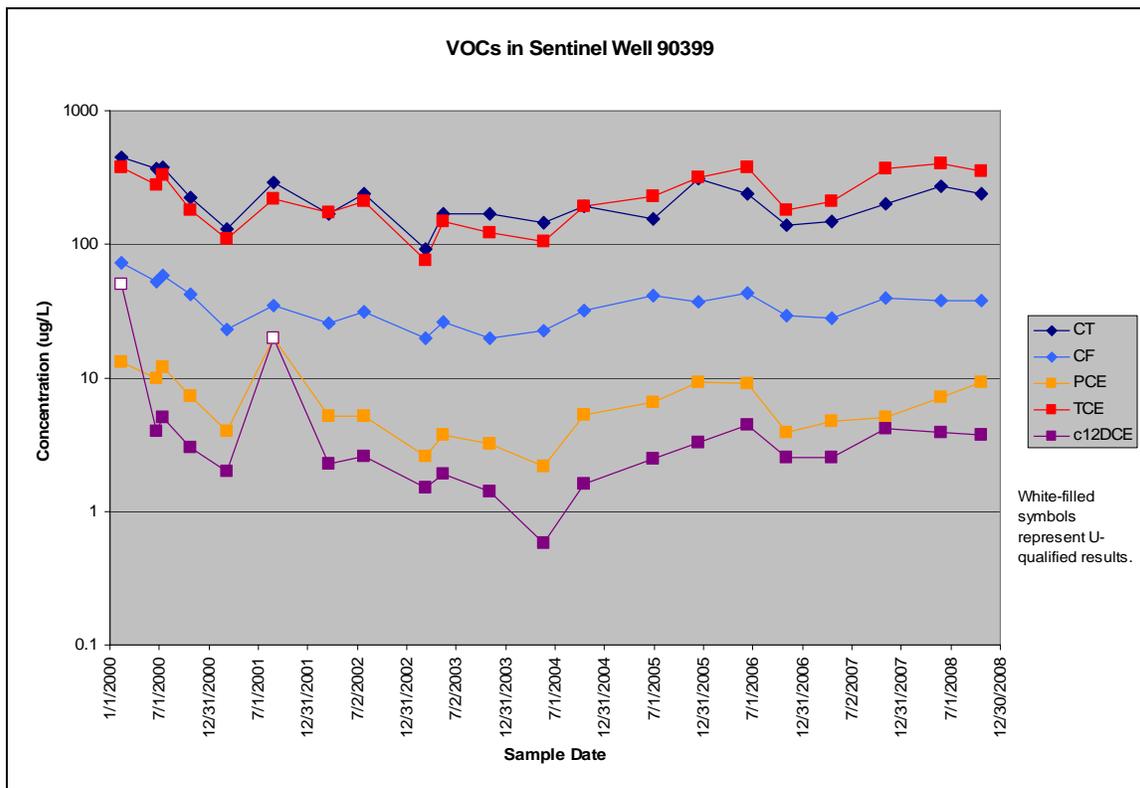
Notes: CT = carbon tetrachloride. RFLMA surface-water action levels for these constituents (µg/L; DOE 2007a): CT, 5; TCE, 5. Several results were qualified (D), but are not shown differently for the sake of simplicity.

Figure 3–192. Concentrations of VOCs Within 903 Pad/Ryan's Pit Plume

Downgradient Sentinel well 90299 was dry during 2008, but concentrations of VOCs in downgradient well 90399 in 2008 were generally consistent with previous data. The S-K calculations for well 90399 did not identify any increasing or decreasing trends at a 95 percent level of confidence.

The main VOCs present in samples from well 90399 are displayed on Figure 3–193. As shown, concentrations of carbon tetrachloride and TCE—the two dominant VOCs in the two source areas for the 903 Pad/Ryan's Pit Plume—are very similar, hence the conclusion that both source

areas contribute to the contamination reported in samples from this well. While biodegradation of the PCE to TCE may also be contributing to the higher TCE concentrations, previous reports (K-H 2004d; ATSDR 2007) suggest this mechanism would be of minor importance in this area.



Notes: RFLMA surface-water action levels for these constituents (µg/L; DOE 2007a): CT, 5; CF, 3.4; PCE, 5; TCE, 5; cis-1,2-DCE, 70. In addition to the nondetects (“U”-qualified results), several other results were qualified (D, J), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

Figure 3–193. VOCs in Downgradient 903 Pad/Ryan’s Pit Plume Well 90399

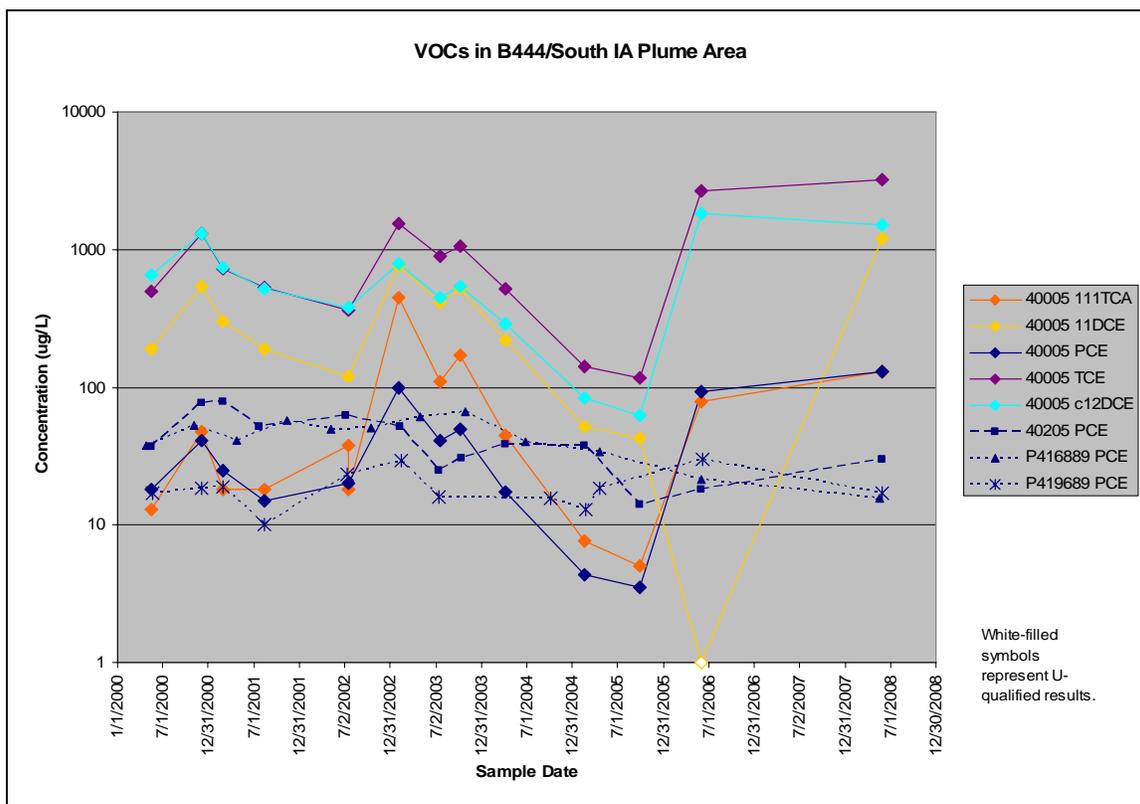
IA Plume

The IA Plume is actually a collection of several small VOC plumes grouped together for convenience and, in some cases, because of uncertainties regarding specific sources.

The pathway to surface water for the South IA Plume is monitored by AOC well 11104. One VOC detection was reported in each of the samples collected in 2008 from this well. The sample collected in April reported an estimated (“J”-qualified) concentration of 1,3-DCB of 0.22 µg/L (RFLMA Table 1 standard is 94 µg/L), and the sample collected in October reported a “J”-qualified concentration of TCE of 0.52 µg/L (RFLMA Table 1 standard is 5 µg/L). Concentrations of U, samples for which are collected because of the proximity of the OLF and former B444, continue to be well below the U threshold of 120 µg/L; the highest concentration in 2008 was reported at 36 µg/L.

Upgradient of well 11104, wells monitoring the South IA Plume include Sentinel wells 11502 and 40305, and Evaluation wells 40005, 40205, P419689, and P416889. Each of these wells was sampled in 2008. Results are consistent with past samples. As with previous data collected from

these wells, concentrations of VOCs in samples from Evaluation well 40005 collected during 2008 were the highest of any of these wells. Concentrations of TCE and its degradation byproduct, cis-1,2-DCE, are the highest among the VOCs detected in samples from this well. However, concentrations of other VOCs are also present at elevated concentrations, including PCE and a less commonly detected solvent at the Site, 1,1,1-TCA, and its associated metabolic byproduct, 1,1-DCE. Time-series plots of these analytes are presented in Figure 3–194. Each of these constituents is displayed for samples from well 40005 (obviously, the 1,1-DCE result reported in 2006 is an outlier), and illustrate how well the different analytes track one another. The generally lower concentrations evident in 2004–2005 may be related to localized dilution of groundwater contamination by the addition of dust-suppression water that was applied during D&D of the B444 complex and B460 (which was immediately upgradient of this well), as well as other nearby facilities. Extended discussion of historic aspects of the source area monitored by well 40005 has been presented in previous annual reports (for example, Safe Sites 2002, in which the predecessor well, 40099, is discussed at length). Well 40005 is represented by U data that are found to have a statistically significant (at the 95 percent confidence level) increasing trend, using the M-K statistical method; however, concentrations reported to date are all less than 2 µg/L.



Notes: 111TCA = 1,1,1-TCA; 11DCE = 1,1-DCE; c12DCE = cis-1,2-DCE. Only PCE is shown for wells 40205, P416889, and P419689 because the other analytes depicted are present at uniformly low concentrations (most under 5 µg/L). In addition to the nondetects ("U"-qualified results), several other results were qualified (E, J, D), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

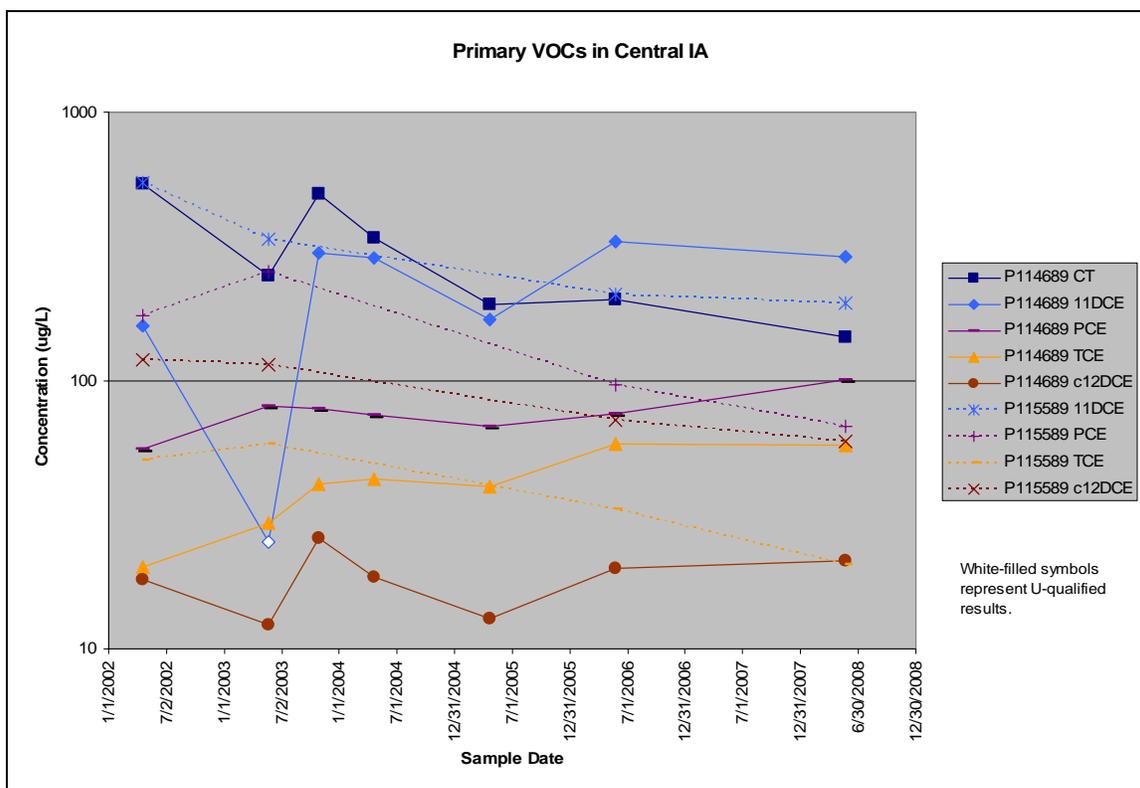
Figure 3–194. Concentrations of Primary VOCs in Former B444/South IA Plume Area Evaluation Wells

Only plots of PCE are shown for Evaluation wells farther downgradient from the source area (40205, P419689, and P416889) because concentrations of the other constituents are low (most

are consistently reported at less than 5 µg/L). Concentrations of PCE are more uniform in samples from these wells than is the case at well 40005, although some slight decrease may be perceived in PCE concentrations at wells 40205 (on the southern edge of former B444, closest to well 40005) and P416889 (south of the B444 complex, on Cactus Road). This suggests the effects of dust suppression waters on groundwater contamination were reduced as distance from the source area increased, as would be expected. Indeed, concentrations of PCE (and TCE, cis-1,2-DCE, and 1,1-DCE) in samples from well 40205 were found to be on a statistically significant (95 percent) decreasing trend; one increasing trend was also identified (chloroform; of the 15 results, 11 are qualified as nondetects); refer to Table 3–86 for a summary of statistically significant increasing and decreasing trends. Well P416889 is represented by a decreasing trend in concentrations of cis-1,2-DCE. Analytical data from well P419689 were found to contain no statistically significant trends. Refer to Appendix B.3 for associated trend plots.

As indicated in Table 3–86, S-K statistical trending indicates that concentrations of PCE in samples from Sentinel well 40305, located at the eastern edge of former B444, are increasing at a 95 percent level of significance. The highest concentration to date of PCE in samples from this well was reported in the October 2008 sample, with a concentration of 1.8 µg/L. U is also calculated to be on an increasing trend at this location, though not at this level of significance; as the associated concentrations are consistently below 1 µg/L (only a single exception, in 2005), even if the trend was significant it would likely not be of great concern at this time. Sentinel well 11502, located on Cactus Road near Evaluation well P416889, is not represented by any trends at a 95 percent level of significance. Note that in the 2007 Annual Report (DOE 2008g), statistical trending had indicated that TCE in well 40305 was decreasing; updated calculations resulted in a zero-slope trend for this analyte that does not reach the 80 percent level of significance.

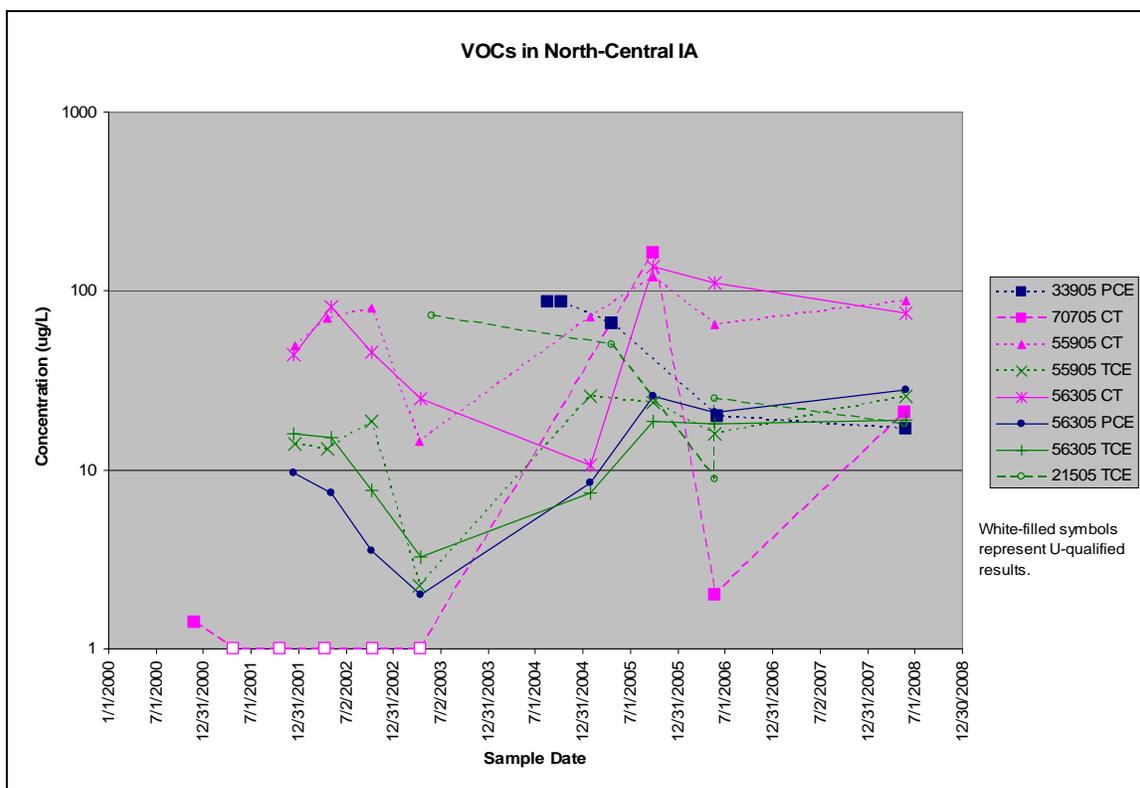
The central portion of the IA is monitored by wells P114689 and P115589; concentrations of the main VOCs present in samples from these two wells are shown in Figure 3–195. As shown, concentrations of VOCs appear to be declining in groundwater at well P115589, located on the western edge of the former B551 Warehouse. Additional data are required to statistically confirm any trends. M-K trending does indicate a 95 percent significant increasing trend in TCE and decreasing trend in carbon tetrachloride in samples from well P114689, located northeast of the former Warehouse.



Notes: CT = carbon tetrachloride; 11DCE = 1,1-DCE; c12DCE = cis-1,2-DC. In addition to the nondetects ("U"-qualified results), several other results were qualified (D), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

Figure 3-195. Concentrations of Primary VOCs in Central IA Evaluation Wells

The North IA Plume is monitored by wells P114689, P115589, 33905, 55905, 56305, 70705, and 21505. Wells 55905 and 56305 monitor B559, well 70705 monitors the eastern edge of B707, and well 33905 monitors the area generally west of B559 and south of B371. These wells were also sampled in 2008; selected VOC concentrations are displayed on Figure 3-196. Worth mentioning is the concentration of carbon tetrachloride in samples from well 70705, which was noted in the 2005 Annual Report (DOE 2006e) due to a sharp increase from nondetect prior to closure to 163 µg/L; the next sample, collected in 2006, reported a concentration of 2 µg/L, but that collected in 2008 reported a carbon tetrachloride concentration of 21 µg/L. As is evident on Figure 3-196, concentrations of this analyte in samples collected in 2005 from the B707 and B559 wells all increased relative to concentrations in previous and subsequent samples. Additional data are required to determine the nature of any trends that may ultimately be present. Concentrations of PCE in samples from well 33905 are on a statistically significant (at the 95 percent confidence level) decreasing trend, according to results of the M-K calculations (Table 3-86). The wells adjacent to former B559 do not report any statistically significant trends at the 95 percent level of confidence, as is generally apparent from Figure 3-196. Concentrations of PCE in samples from well 21505, located northwest of B559 and adjacent to FC-2, show no established trend.



Notes: CT = carbon tetrachloride In addition to the nondetects (“U”-qualified results), several other results were qualified (D), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

Figure 3–196. Concentrations of Primary VOCs in North-Central IA Evaluation Wells

The terminal end of the North IA Plume is monitored by AOC well 42505. This well was sampled twice in 2008 (May and October), and two VOCs were detected in each sample. Each of the detections was “J”-qualified (estimated concentrations). Chloroform (RFLMA Table 1 standard = 3.4 µg/L) was reported at estimated concentrations of 0.21 µg/L and 0.2 µg/L in the May and October samples, respectively, and TCE (RFLMA Table 1 standard = 5 µg/L) was reported at concentrations of 0.48 µg/L and 0.56 µg/L, respectively.

This area is also monitored by Sentinel well 52505. Samples collected in 2008 from this well reported two “J”-qualified (estimated) detections of cis-1,2-DCE and a single “J”-qualified detection of VC. The same analytes were reported in 2007 the same number of times. The cis-1,2-DCE concentration increased from a high of 0.30 µg/L in the October 2007 sample to a high of 0.32 µg/L in the October 2008 sample (RFLMA standard is 70 µg/L), and the VC concentration increased from an estimated concentration of 0.46 µg/L in the October 2007 sample to an estimated concentration of 0.64 µg/L in the October 2008 sample (RFLMA standard is represented by the PQL of 0.2 µg/L). The samples collected in May 2007 and May 2008 reported no VC detections. This may relate to increased biodegradation of PCE degradation chain compounds during the warmer months, leading to detectable concentrations of VC at this well in the fall; the spring samples would have been collected following the colder winter months. Because subsurface (groundwater) thermal conditions are fairly stable, another mechanism (perhaps related to higher microbial productivity in shallow soils during the warmer months) may be at play. Alternatively, because these are low, estimated concentrations, this apparent behavior may simply be related to laboratory uncertainty. Note that this location is one

of only two Site-wide that was found to provide at least adequate evidence of biodegradation (K-H 2004d), the other being Evaluation well 33502, which monitors the VC Plume source area.

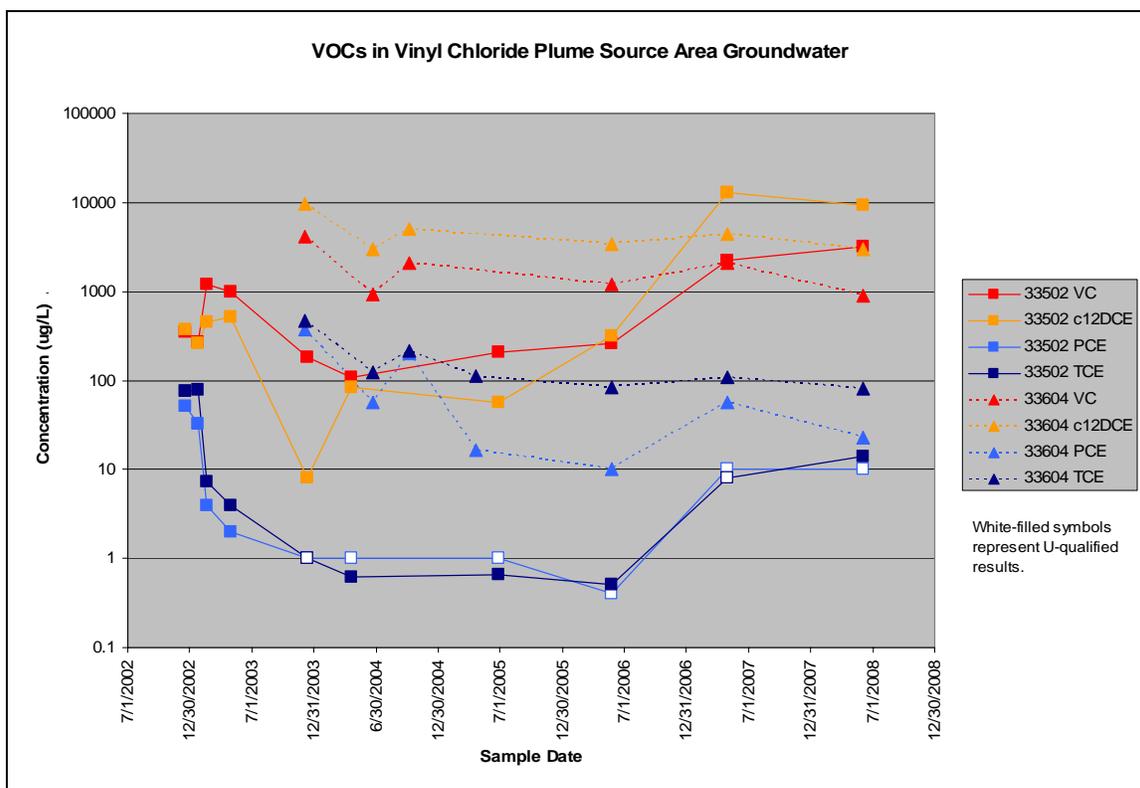
VC Plume

The VC Plume emanates from OBP#1 and nearby metal disposal/destruction sites that were on the margin of a valley that was buried during construction of B371 and became the site of the Portal 2 parking lots, among other facilities. The plume resides and groundwater flow appears to be routed within that buried valley. This is the only Rocky Flats area where VC is present in such elevated concentrations.

The VC Plume is monitored by source-area Evaluation wells 33502 and 33604 and more distal Sentinel well 33703. (Evaluation well 33905 monitors the groundwater near the outlet of this buried valley, and is discussed above.) Each of these wells was scheduled for RFLMA monitoring in 2008.

Well 33502 is one of only two locations where strong evidence for biodegradation has been found (K-H 2004d; the second location identified in that report is well 1986, the predecessor to well 52505, as discussed above). This is a likely explanation for both the high concentrations of VC as well as the extremely limited aerial extent over which it has been observed. This biodegradation is probably a result of the slowly decomposing organic matter remaining from the vegetation that once grew within the valley. This process would consume oxygen, providing an anaerobic environment and carbon source suitable for reductive dechlorination of the chlorinated solvents most commonly found at the Site. Another breakdown product that is present at higher levels in samples from the source area is cis-1,2-DCE. Parent compounds including PCE and TCE are present in the groundwater in this area but at much lower concentrations compared with those of the daughter products. While VC and cis-1,2-DCE are reported in groundwater samples from source-area wells 33502 and 33604 at concentrations in the hundreds to thousands of $\mu\text{g/L}$, PCE and TCE are typically reported in the tens to hundreds (and PCE is frequently not detected in well 33502, as was the case in the sample collected in 2008). A time-series plot of these compounds in wells 33502 and 33604 is presented as Figure 3–197. Note that M-K trending calculations indicate that concentrations of PCE are decreasing in samples from Evaluation well 33502 (Table 3–86), though the data record contains abundant nondetects so this conclusion may not be valid; concentrations of 1,2,4-trichlorobenzene (TCB) in samples from this well are also on a decreasing trend. Similarly, concentrations of TCE in samples from well 33604 are calculated to be on a statistically significant (95 percent) decreasing trend. Decreasing concentrations of parent compounds would be consistent with the relatively high level of biodegradation indicated for this area. (See Appendix B for tabulated and graphical results of trending calculations.)

Concentrations of VC, and even more so cis-1,2-DCE, have been quite variable in samples from well 33502. Exact mechanisms for this variability are not certain, but may relate at least in part to the closure activities in this area, particularly the removal of utilities and impervious surfaces overlying the plume source area, and regrading of the area in 2007 to reduce the occurrence of ponding water around these wells. However, concentrations of these constituents in groundwater samples from adjacent well 33604 have not reported the same degree of variability (Figure 3–197).



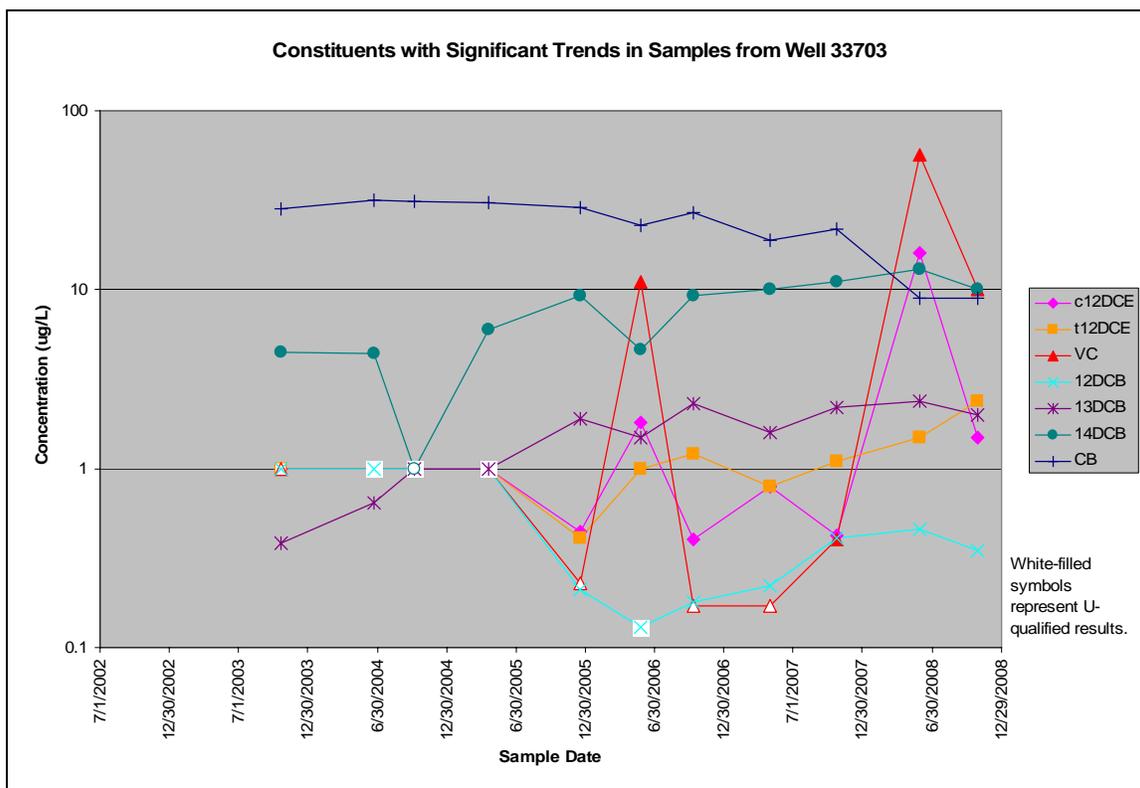
Notes: VC = vinyl chloride; c12DCE = cis-1,2-DCE. RFLMA surface-water action levels for these constituents ($\mu\text{g/L}$; DOE 2007a): VC, 0.2; cis-1,2-DCE, 70; PCE, 5; TCE, 5. In addition to the nondetects (“U”-qualified results), several other results were qualified (J, D), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

Figure 3–197. VOCs Present in the VC Plume Source Area

Downgradient Sentinel well 33703 produced samples in 2008 that were somewhat unusual for that location in that they included higher-than-previous concentrations of VC and cis-1,2-DCE. The May sample reported the highest concentrations yet detected of these constituents at this location, 57 $\mu\text{g/L}$ and 16 $\mu\text{g/L}$, respectively. While still orders of magnitude below the concentrations in the nearby wells 33502 and 33604, these increases may signal downgradient expansion of the plume of contaminated groundwater. The primary reason for the regrading performed in 2007 to improve drainage in this area was to reduce the potential for decreased rates of biodegradation resulting from an influx of oxygenated surface water, as might occur if puddles were allowed to persist on soils overlying the source area. An expanded plume, especially if accompanied by increased concentrations of parent products, was one anticipated result. However, increasing concentrations of parent products, as indicated above and in Figure 3–197, are not evident in the source area. Expansion of the plume might also be caused by the direct groundwater recharge that is now possible in this area, following removal of impervious surfaces that once covered the source area. The 2008 data from well 33703 may relate to either or both of these mechanisms; additional data will be required to better determine longer-term concentration trends and causes for these trends.

S-K statistical trending indicates significant (at the 95 percent level) increasing trends are present in samples from well 33703 for both isomers of 1,2-DCE as well as VC, 1,2- DCB, 1,3-DCB, and 1,4-DCB; concentrations of chlorobenzene are on calculated to be on a statistically

significant decreasing trend. As shown on Figure 3–198, some of these trends do not appear to be as strongly defined as would be expected with a 95 percent confidence. Several of these constituents are represented by nondetects for all samples collected prior to Site closure in the fourth quarter of 2005, after which the constituents were detected (in most cases using lower detection limits, as with both isomers of DCE as well as 1,2-DCB and VC). Therefore, as may be concluded from visual examination of this figure, in some cases the combination of lower detection limits following closure and the data replacement methods used for statistical trending of groundwater data (replacing nondetects with a value of 0.001) may artificially impact statistical calculations, in this case leading to the calculated conclusion that trends are increasing. Refer to Appendix B for statistical trend plots, which incorporate these data replacements, leading to more visually apparent trends. Additional data will be collected per RFLMA and will help to determine whether the indicated trends for these constituents are valid.



Notes: c12DCE = cis-1,2-DCE; t12DCE = trans-1,2-DCE; VC = vinyl chloride; 12DCB = 1,2-DCB; 13DCB = 1,3-DCB; 14DCB = 1,4-DCB; CB = chlorobenzene. In addition to the nondetects ("U"-qualified results), several other results were qualified (J, D), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

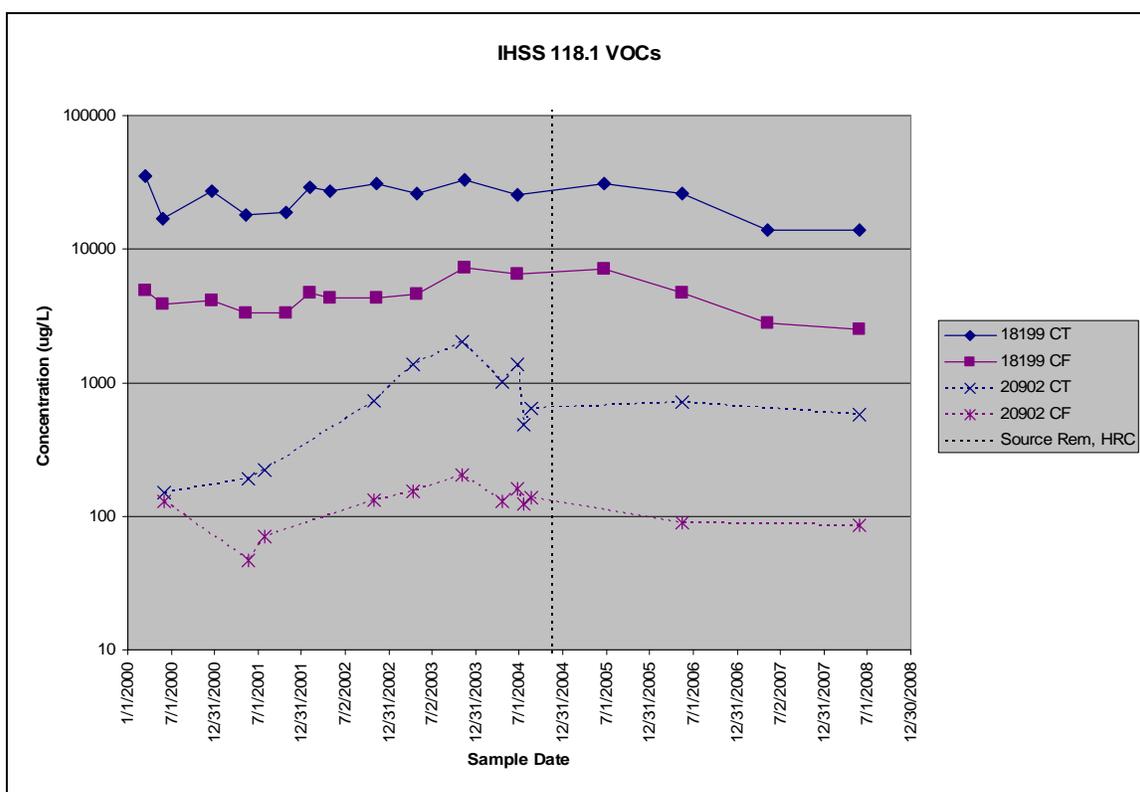
Figure 3–198. Constituents with Statistically Significant Trends in Samples from Sentinel Well 33703

IHSS 118.1 (Carbon Tetrachloride) Plume

The area referred to as former IHSS 118.1 is the source of a carbon tetrachloride plume. In late 2004, the dense, nonaqueous phase liquid source material was removed along with an adjacent subsurface tank group referred to as B730. HRC was added to the backfill material to enhance biodegradation of residual contamination.

Evaluation well 18199 is located immediately north of the former IHSS, roughly 80 to 90 feet north-northwest of the area in which free-phase carbon tetrachloride was present and perhaps 30 feet north of the source-removal excavation boundaries. The plume has been mapped to extend to well 20902, located approximately 350 feet to the northwest. Both of these wells were scheduled for RFLMA sampling in 2008.

Data from 2008 suggest that concentrations of carbon tetrachloride and chloroform, the primary contaminants in this plume, appear to be decreasing in groundwater in the source area based on a visual inspection of data from well 18199. This pattern is not as evident for data from well 20902. Time-series plots are presented on Figure 3–199. Trend calculations do not confirm a statistically significant trend for either well. If biodegradation was increasing, one would expect to see increasing trends in the concentrations of the principal carbon tetrachloride daughter products, chloroform, methylene chloride, and chloromethane (the terminal daughter products, methane and CO₂, are not analyzed), and concurrent decreases in carbon tetrachloride concentrations. However, as can be seen in the plot for chloroform (Figure 3–199), such a trend is not clearly evident; data for the other daughter products do not show apparent increases in concentration, and many are not detected. Additional samples will be required to confirm whether what appears to be a decrease in carbon tetrachloride represents the start of a trend.



Notes: CT = carbon tetrachloride; CF = chloroform; Source Rem, HRC = date on which source removal and backfilling with soil and HRC was completed. RFLMA surface-water action levels for these constituents (µg/L; DOE 2007a): CT, 5; CF, 3.4. Several results were qualified (J, D, E), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

Figure 3–199. Concentrations of Primary VOCs in IHSS 118.1 Source Area and Plume

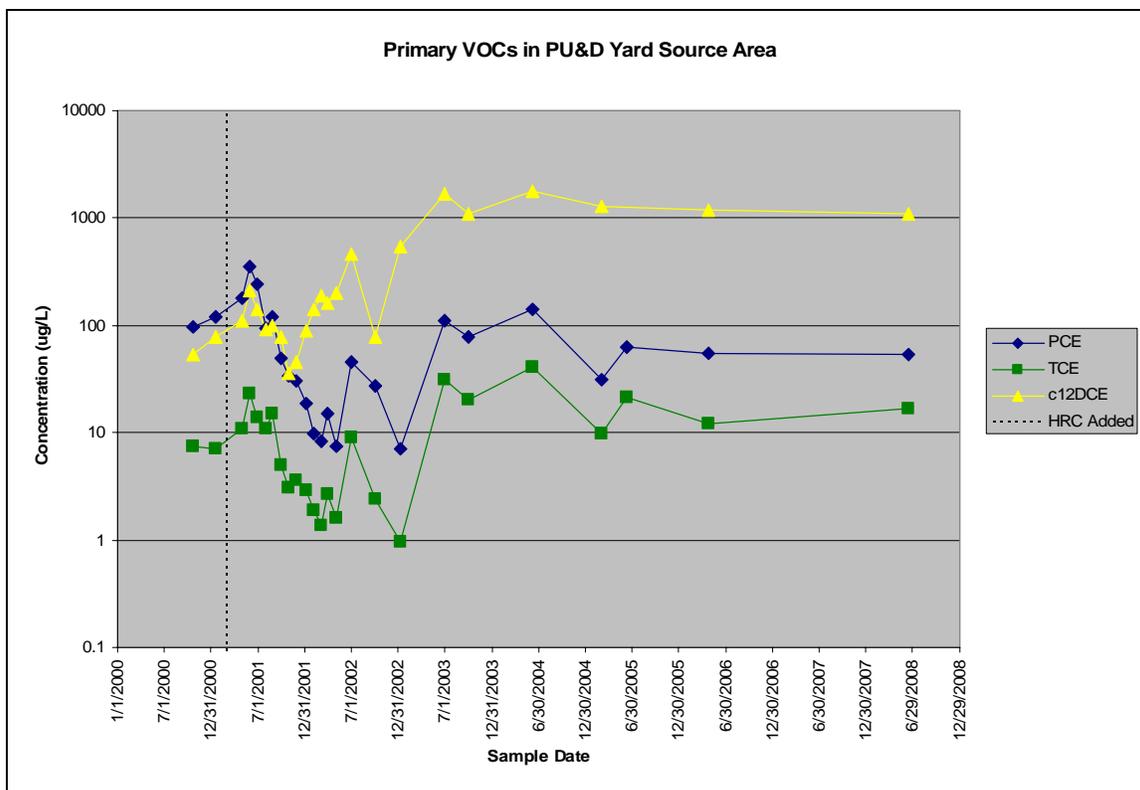
Concentrations of PCE and TCE are not shown in Figure 3–199 because they are relatively low compared to those of carbon tetrachloride and chloroform. PCE is consistently reported at well under 100 µg/L in source-area well 18199, and in 2008 was estimated (“J”-qualified) at 32 µg/L; and the most common result for TCE is nondetect, which was the case in the 2008 sample with a detection limit of 16 µg/L. PCE in samples from well 20902 in 2008 was detected at a “J”-qualified (estimated) concentration of 0.69 µg/L, while TCE was not detected.

Water-quality data from wells 20705, 20505, and 20205, all of which are located generally north of IHSS 118.1 and former B771, will also continue to be assessed to determine whether a more northerly groundwater flow path is indicated. (With the closure of B771 and abandonment of the associated foundation drain system, the anticipated flow path for this plume was more northerly, toward well 20505; hence the well pairing provided in Table 3–44.) Such a path is not suggested by data collected in 2008, which are generally consistent with pre-closure results. However, carbon tetrachloride was detected in both samples collected from well 20205 in 2008, with estimated concentrations reported as 0.657 µg/L in May and 0.47 µg/L in October (both “J”-qualified). These were the first detections reported for any of the three wells. Chloroform was also detected in the same samples, at estimated concentrations of 0.183 µg/L and 0.25 µg/L, respectively; it was also reported in a sample collected in May 2005 from well 20705. As noted in Table 3–86 and Appendix B.3, S-K trend calculations indicate statistically significant (95 percent) increasing trends in cis-1,2-DCE, VC, and U concentrations at well 20705; however, the VOC data are complicated by the presence of many nondetects and the U data may be affected by the well replacement. The highest U concentrations (19 µg/L in the October 2008 sample) are an order of magnitude lower than the U threshold defined in RFLMA. Note that well 20205 is also reported (Table 3–86) as suggesting an increasing trend in U, and was most recently (again in October 2008) reported at its highest concentration to date, 60 µg/L. These wells will continue to be monitored and the data evaluated in accordance with RFLMA.

PU&D Yard Plume

The PU&D Yard Plume is an area of groundwater with low concentrations of primarily PCE-family VOCs. This area was the site of the first HRC application performed at Rocky Flats, which took the form of a treatability study performed in early 2001 (K-H 2001, 2002; see K-H 2005c for a final summary report on this study). This plume is monitored by Evaluation well 30900 in the source area and Sentinel well 30002 to the east, at the margin of North Walnut Creek. In addition, upgradient PLF RCRA wells 70393 and 70693 monitor the northern edge of this plume. Each of these wells was sampled in 2008.

The PU&D Yard source area continues to impact groundwater, as indicated by samples from well 30900 collected in 2008. RFLMA Table 1 standards (DOE 2007a) for PCE, TCE, and cis-1,2-DCE continued to be exceeded (Figure 3–200). Comparing the most recent data with those collected before the HRC was added in 2001 indicates that concentrations of PCE have decreased while those for cis-1,2-DCE have increased sharply and those of TCE have shown a lesser increase. The increase of cis-1,2-DCE is consistent with biodegradation of parent products PCE and TCE.



Notes: c12DCE = cis-1,2-DCE. Date of HRC addition shown represents the date addition was completed (3/1/2000). Several results were qualified (J, D, E), but are not shown differently for the sake of simplicity.

Figure 3-200. Concentrations of Primary VOCs in PU&D Yard Plume Source Area Well 30900

Data representing samples collected from well 30900 support two statistically significant (at the 95 percent level of confidence) trends: using the M-K statistical method, cis-1,2-DCE is calculated to be on an increasing trend and 1,1,1-TCA is on a decreasing trend. The former trend is evident in the data and on Figure 3-200; the latter may not be real, as many nondetects are present in the data set.

Downgradient of the source area monitored by Evaluation well 30900, the two RCRA wells (70393 and 70693) impacted by this plume consistently report detections of VOCs including 1,1,1-TCA, 1,1-DCE, PCE, and TCE. As with previous years, only TCE concentrations in samples from well 70393 exceeded the RFLMA Table 1 standards. Concentrations of TCE were very uniform in 2008, ranging from 9.2 µg/L to 12 µg/L in the four samples collected; the Table 1 standard for this analyte is 5 µg/L (DOE 2007a). As summarized in Table 3-86 (see also Appendix B.3), the S-K trend calculations indicate concentrations of the VOCs 1,1,1-TCA, 1,1-DCE, PCE, and TCE in samples from well 70393 are decreasing at the 95 percent confidence level. The same applies to 1,1,1-TCA, 1,1-DCE, PCE, TCE, carbon tetrachloride, and chloroform in samples from well 70693; each of these decreasing trends at well 70693 is newly significant, having not met the 80 percent level of significance in 2007 but with the 2008 data now meeting the 95 percent level of significance. The extent to which this may or may not be related to application of HRC in 2001 is not known.

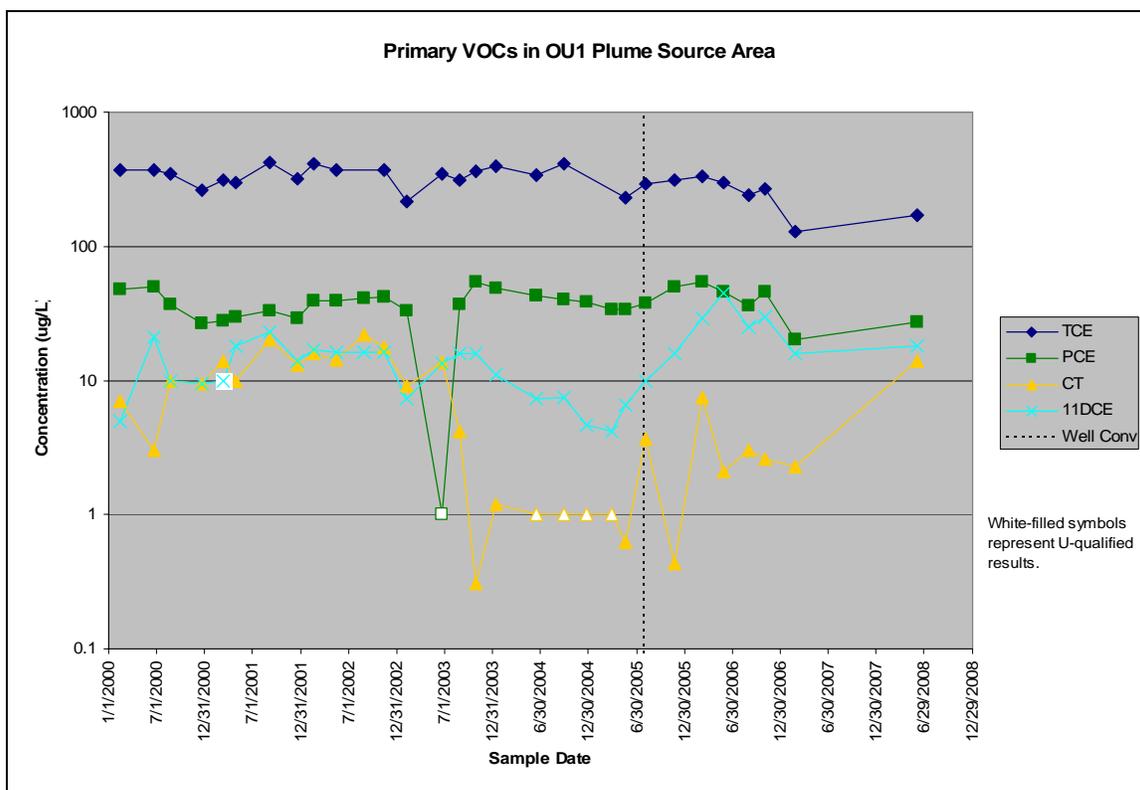
Data collected in 2008 from Sentinel well 30002 include one “J”-qualified (estimated) detection of 1,3-DCB at a reported concentration of 0.21 µg/L (RFMLA Table 1 standard is 94 µg/L); no other VOCs were detected. This analyte has not been detected in samples from source-area Evaluation well 30900, although occasionally it has been reported, also at “J”-qualified concentrations of less than 1 µg/L, in samples from RCRA wells 70393 and 70693. The source of 1,3-DCB is not known, but from these data it appears this analyte does not represent a significant threat to surface water quality.

OU 1 Plume

The OU 1 Plume is located on the 881 Hillside, immediately south of the former Contractor Yard portion of the IA. Its source area, former IHSS 119.1, was a drum and scrap metal storage area. As described in the 2007 Annual Report (DOE 2008g), prior to the signing of the RFLMA on March 14, 2007 this area was monitored according to the *Major Modification to the Operable Unit 1: 881 Hillside Area Corrective Action Decision/Record of Decision* (OU 1 CAD/ROD) (DOE 2001), which specified that six wells be monitored on set monitoring frequencies ranging from quarterly to semiannually. In that year (2007), the OU 1 CAD/ROD was followed for the first quarter, and RFLMA for the balance of the year. The current reporting year (2008) is the first full year in which monitoring was conducted solely in accordance with the RFLMA (DOE 2007a). The source area is monitored by well 891WEL (the modification of which has been detailed in previous documents, e.g., DOE 2006d), and the pathway to surface water is monitored by AOC well 89104, located to the south adjacent to Woman Creek (Figure 3–1).

Concentrations of TCE, the constituent of greatest historic interest in this plume, in samples collected from well 891WEL were consistent with those reported in 2007, continuing to suggest a slight decrease (Figure 3–201) that was first noted in the 2007 Annual Report (DOE 2008g). This decreasing trend is confirmed so be significant at the 95 percent level of confidence through M-K statistical trending (Table 3–86). The same level of significance was calculated for a decreasing trend in concentrations of carbon tetrachloride (also displayed on Figure 3–201), and for increasing trends in chloroform and cis-1,2-DCE. However, these calculated increasing trends may not be valid, as the corresponding datasets include many nondetects. The maximum concentration of chloroform that has been detected since January 2000 in samples from well 891WEL was 5.1 µg/L in June 2004; for cis-1,2-DCE, the highest detected concentration was 6.3 µg/L in March 2006.

No VOCs were detected in either sample collected from AOC well 89104 in 2007.



Notes: CT = carbon tetrachloride; 11DCE = 1,1-DCE; Well Conv = date on which the industrial pump-equipped collection well, 891COLWEL, was converted to a more standard monitoring well, 891WEL (as described in DOE 2006e). In addition to the nondetects ("U"-qualified results), several other results were qualified (J, D), but are not shown differently for the sake of simplicity.

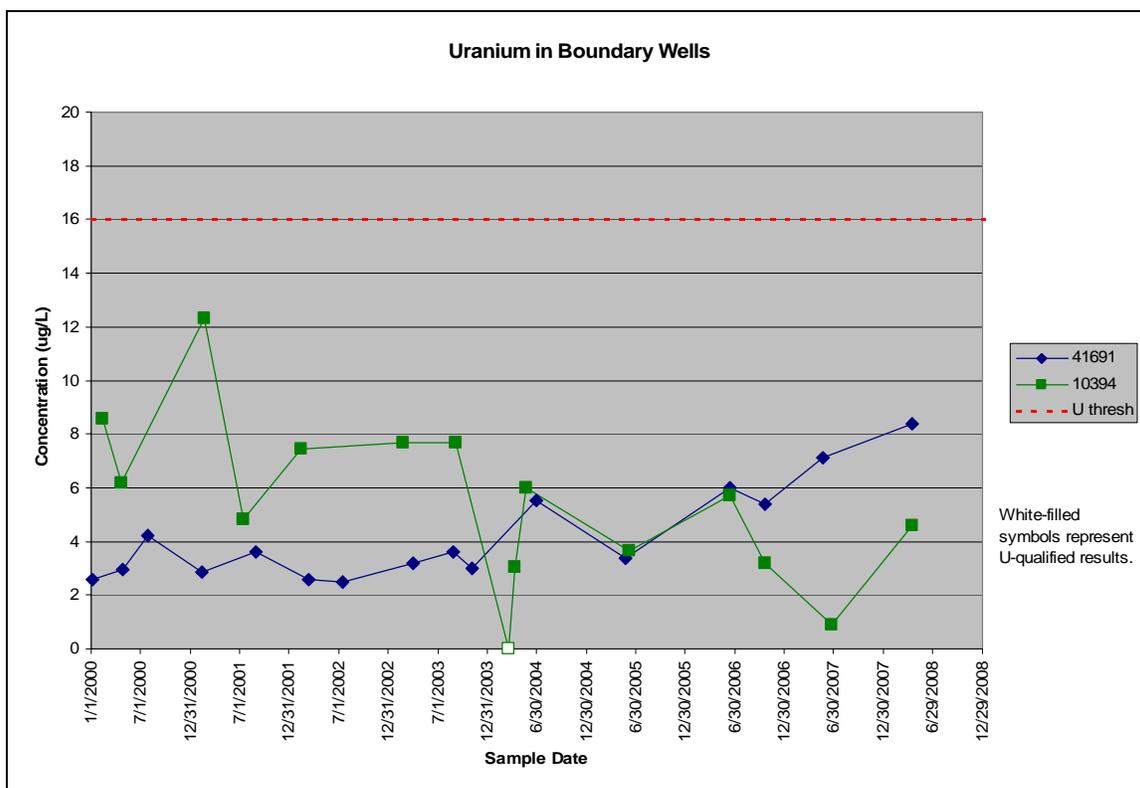
Figure 3–201. Concentrations of Primary VOCs in OU 1 Source Area Well 891WEL

Other Areas

Although not marked by plumes, other areas warrant mention because they may be of interest. These are summarized below.

East Government property boundary: Boundary wells 10394 (Woman Creek and Indiana Street) and 41691 (Walnut Creek and Indiana Street) were each sampled once in 2008 per RFLMA (DOE 2007a) and results were consistent with previous data. No VOCs were detected.

Constituents that were detected at both wells in 2008 included nitrate and U. Concentrations of nitrate were reported as 0.24 mg/L (well 10304) and 0.27 mg/L (well 41691); concentrations of U (Figure 3–202) were 4.6 µg/L and 8.4 µg/L respectively. This concentration of U in samples from well 41691 represents an increase from previous data, and is consistent with expectations that groundwater in this area will exhibit increasing concentrations of U as the effects of once-common but now-rare pond discharges wane. Indeed, M-K statistical analyses of U in samples from well 41691 indicate a statistically significant (at the 95 percent level of confidence) increasing trend in U; a correspondingly significant decreasing trend is found for U in samples from well 10394. (Refer to Table 3–86 for a summary of results of statistical trending, and Appendix B for associated plots and summary tables.)

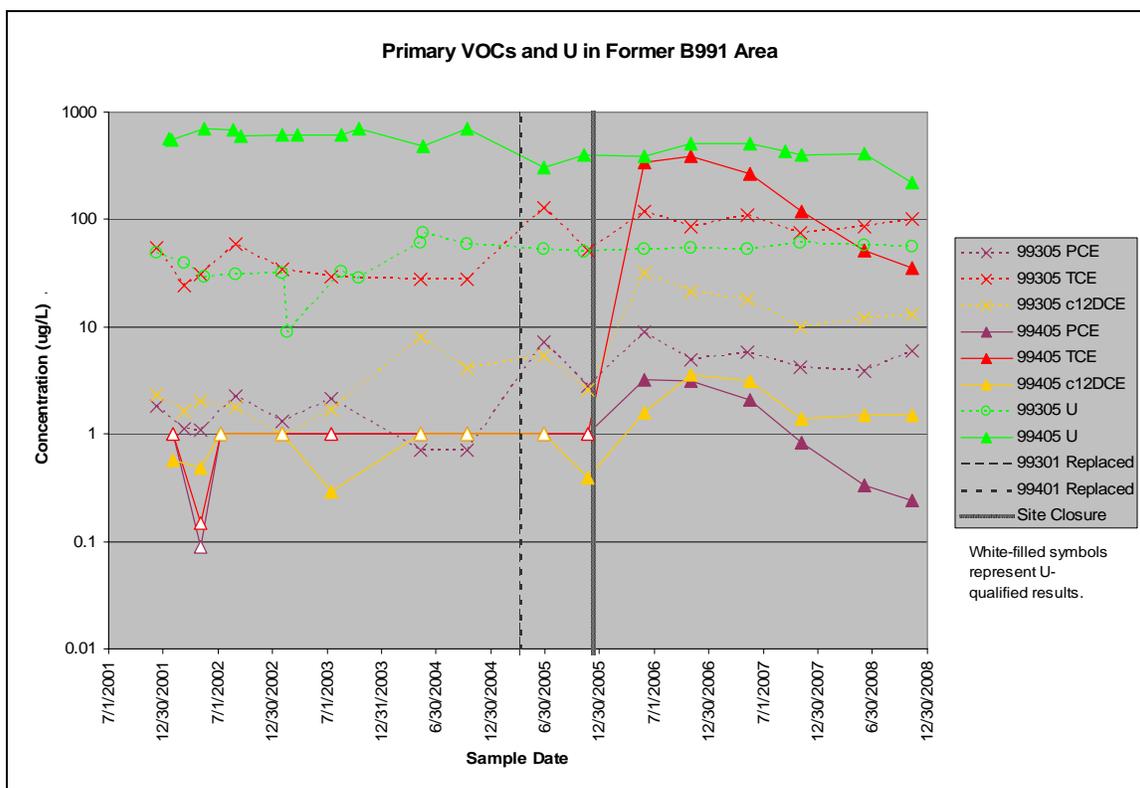


Notes: U thresh = RFLMA uranium threshold for Boundary wells (16 µg/L; see DOE 2007a).

Figure 3-202. Concentrations of U in Boundary Wells

Former B991: Groundwater samples from wells 99305 and 99405 have reported detections of VOCs at higher concentrations than were typical prior to closure. S-K trend plots show 95 percent confidence in several calculated trends at each well (Table 3-86). Samples from well 99305 show increasing trends in cis-1,2-DCE, PCE, and U; and samples from well 99405 show increasing trends in PCE and TCE, and a decreasing trend in U. Both of these wells were located near the eastern edge of B991, with well 99405 positioned in the east loading dock area. As shown on Figure 3-203, VOC-related water-quality changes occurred suddenly at 99405, but gradually at nearby 99305, and the trends in U concentrations are gradual at both wells. Since 2006, VOC concentrations in samples from well 99405 are clearly decreasing. Refer to Appendix B for statistically calculated trend plots.

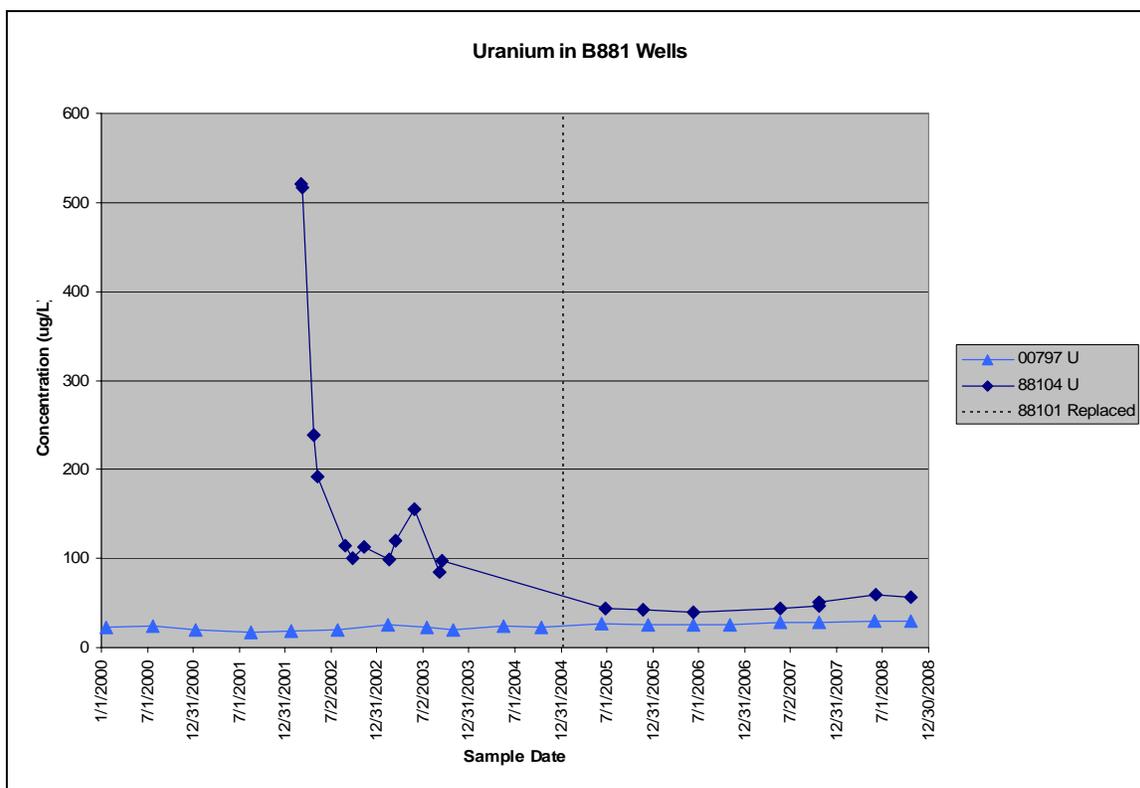
Also shown on Figure 3-203 are the dates of the well replacements, when well 99301 was replaced with 99305 and well 99401 with 99405, and Site closure. This illustrates that the changes in water quality—particularly with respect to VOCs at well 99405—do not appear to be an artifact of well replacements, but instead relate to other activities performed to close the Site. As noted above, VOC concentrations in grab samples from downgradient surface-water location GS10 have been below RFLMA standards.



Notes: c12DCE = cis-1,2-DCE. RFLMA action levels for these constituents (µg/L; DOE 2007a): cis-1,2-DCE, 70; TCE, 5; PCE, 5; U (threshold), 120. In addition to the nondetects (“U”-qualified results), several other results were qualified (J, B, N), but are not shown differently for the sake of simplicity. U data include results for U-mass and converted isotopic activities. Note logarithmic concentration scale.

Figure 3–203. Concentrations of Primary VOCs and U in B991 Sentinel Wells

Former B881: As noted in recent annual reports (e.g., DOE 2007e, 2008g) and Table 3–86, S-K calculations indicate there is a statistically significant (at the 95 percent confidence level) decreasing trend for U in well 88104, while in well 00797 the trend for this analyte is increasing. The trend calculated for well 88104 is complicated by the well replacement performed in 2004, when well 88101 was replaced with well 88104. The replacement well is located approximately 110 feet south of the original location. Concentrations of U in the original well had decreased significantly between the installation and final sampling of that well (from a maximum concentration of approximately 521 µg/L in March 2001, to approximately 85 µg/L in September 2003). Figure 3–204 illustrates U concentrations in these two wells since 2000, and clearly shows the difference in U concentrations between the original well, 88101, and replacement well, 88104. Also evident is the relatively uniform concentrations of U in groundwater samples from well 00797; the increasing trend has a very slight positive slope (calculated to be 1.345, slightly higher than the 1.167 calculated for the 2007 report; see the S-K plots and summary tables in Appendix B.3). Note that concentrations of U in both wells are and have been below the RFLMA U threshold of 120 µg/L (DOE 2007a) since before B881 was demolished.



Notes: RFLMA U threshold is 120 µg/L (DOE 2007a). Several results were qualified (J, E, B, N), but are not shown differently for the sake of simplicity. U data include results for U-mass and converted isotopic activities.

Figure 3–204. Concentrations of U in B881 Sentinel Wells

3.1.5.4 Other Water-Related Issues in 2008

This section summarizes some of the more notable events, activities, and conditions related to groundwater at the Site in 2008, and provides updates to previously reported conditions where appropriate.

Reportable Condition: Nitrate at AOC Well B206989

Well B206989 entered a reportable condition in 2007 due to the presence of nitrate in groundwater at concentrations exceeding the applicable standard in RFLMA. This condition was set up by the well being reclassified via RFLMA from a Sentinel well to an AOC well. (The former classification has no reportable conditions, while the latter does.) This reportable condition was anticipated, because the well produces groundwater samples that are consistently above the nitrate standard (10 mg/L in No Name Gulch, where the TM does not apply). Discussions were held with the CDPHE regarding the elevated nitrate concentrations in samples from this well, and Contact Record 2007-06 was issued to document the resulting agreement.

The Contact Record stipulates that if the decreasing trend is confirmed at a confidence level of 80 percent or more, the evaluation shall terminate. (Until the evaluation terminates, additional samples that exceed the nitrate standard shall not constitute a new reportable condition.) If the trend appears to reverse, even at less than 80 percent confidence, or if an 80 percent confidence in the decreasing trend (full record or last eight routinely collected samples) is still not reached

by the end of CY 2011, consultation shall ensue to determine the appropriate path forward. (Refer to the full contact record for details.)

As shown in the S-K trend plots (Appendix B.3, excerpt below as Figure 3–205), the decreasing trend is now significant at the 80 percent level. Discussions with the regulators will be held and a path forward will be defined in a Contact Record to be issued in 2009.

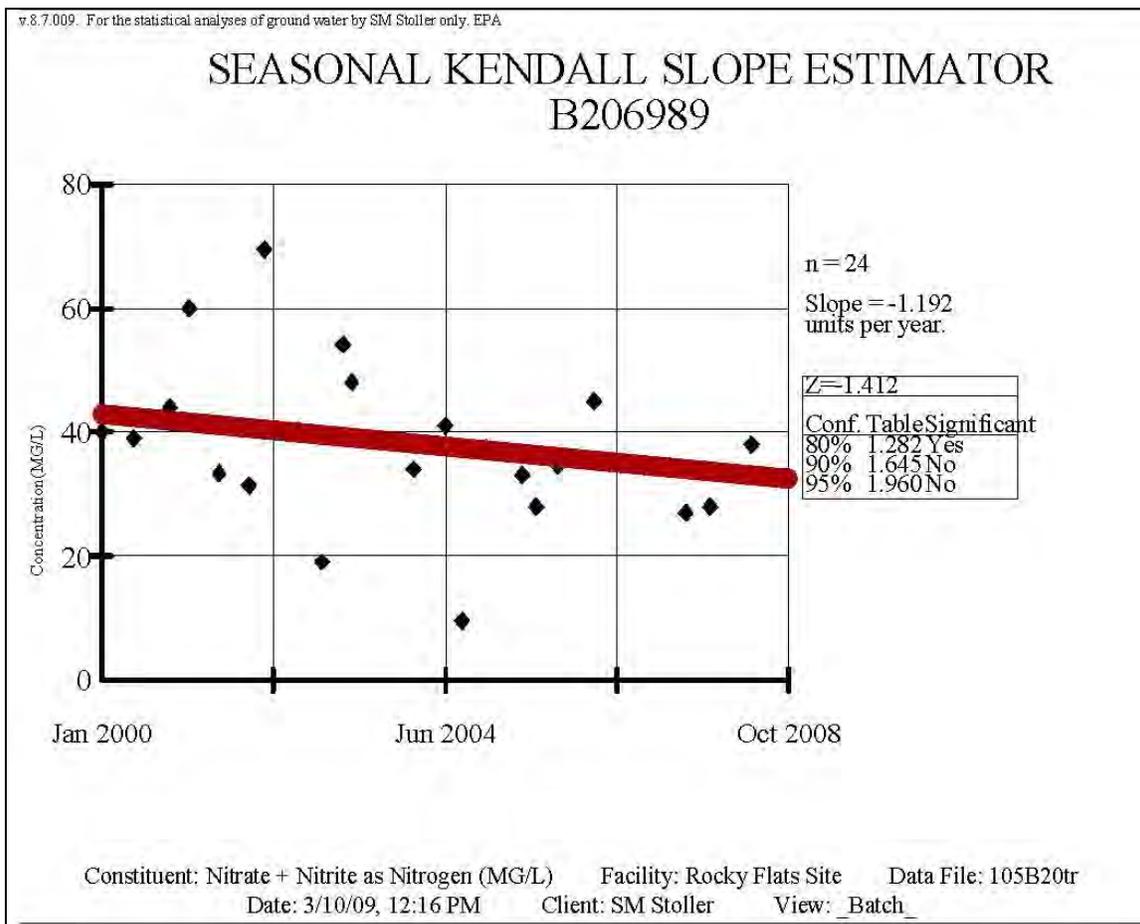
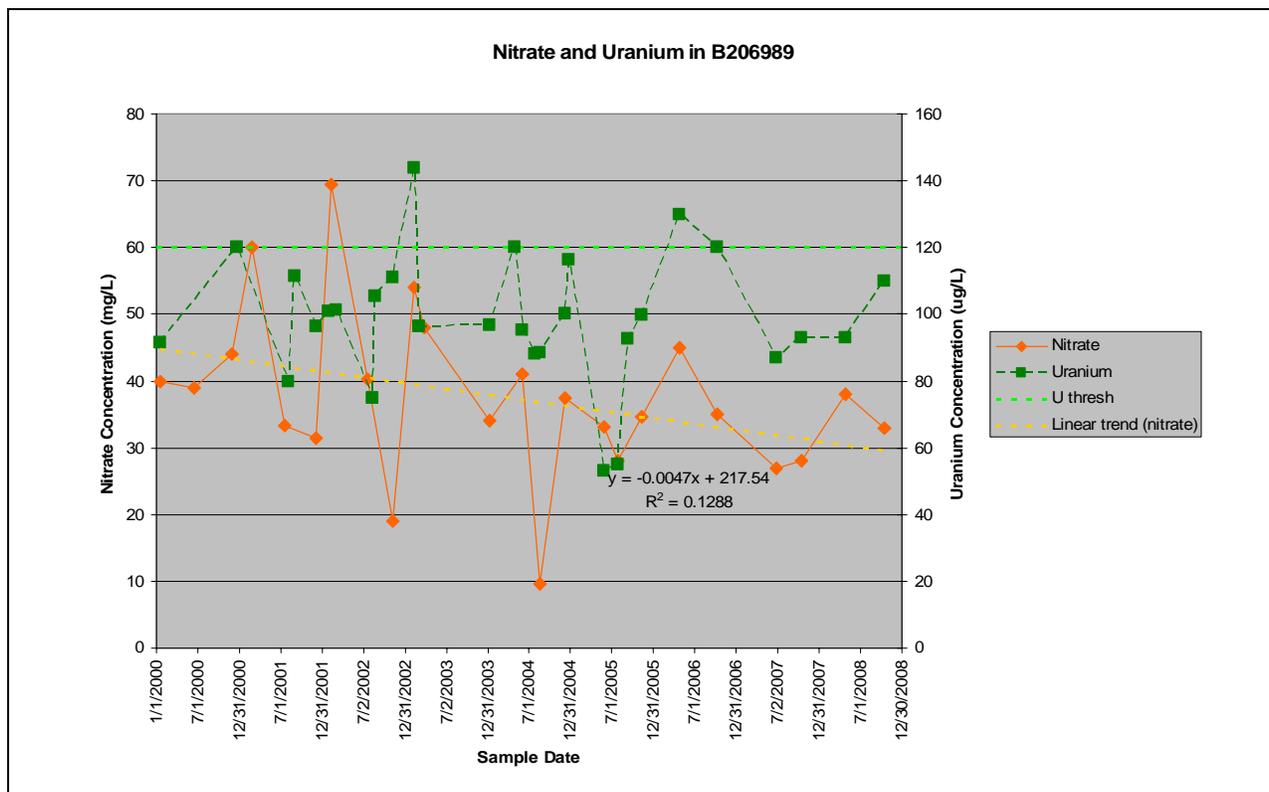


Figure 3–205. S-K Trend Plot for Nitrate+nitrite as Nitrogen in Samples from AOC Well B206989

The U concentrations in groundwater samples from well B206989 continue to occasionally exceed the 120 µg/L total U threshold. A corresponding reportable condition has not yet existed, however, and S-K trending for U (Appendix B.3) indicate the data have no slope.

Figure 3–206 provides updated time-series plots of nitrate and U in groundwater samples collected through the end of 2007 from well B206989. The trend line shown for nitrate is a simple regression curve; its negative slope indicates the general trend is decreasing, but the low R² value confirms the data are widely variable.



Notes: The applicable action level for nitrate is 10 mg/L; that for U is 120 µg/L (DOE 2007a). Note the use of two axes to help illustrate the different concentrations.

Figure 3-206. Concentrations of Nitrate and U in Groundwater Samples from AOC Well B206989

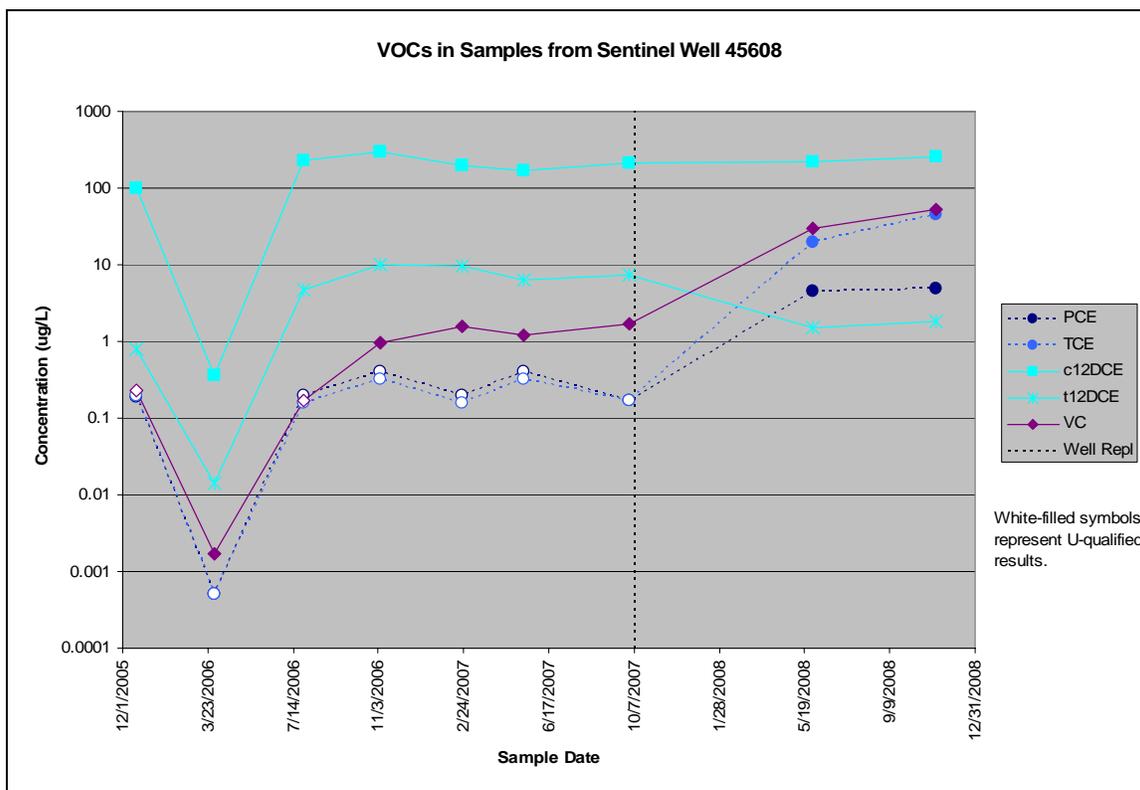
Update: Slump South of B991

The slumping hillside south of former B991 was regraded in late 2007, as discussed in detail in the annual report for that year (DOE 2008g). Sentinel well 45605, which was by 2007 heavily damaged, was abandoned in support of that effort. On March 27, 2008, installation of replacement Sentinel well 45608 was completed. (Refer to Section 3.1.1.2 for a discussion of well abandonment and replacement activities.)

As previously reported, seeps were observed in several locations on the slumping hillside (DOE 2008g), and presumably represented discharge points for the water that continued to be collected by the French drain remnants present underneath and to the west of this constructed hillside. Seeps have not been observed since the hillside was regraded. However, well 45608 has experienced artesian flow since it was first installed. Given that this hillside was stable for many years until the outfall for the still-present French drain was removed in 2005 (see DOE 2006e for summary information, and DOE 2007e for a more detailed discussion), well 45608 may be effectively replacing the French drain outfall (and the seeps observed on the slumping hillside), releasing the groundwater within the French drain and thereby helping to stabilize the hillside against additional slumping.

Water quality in samples collected to date from well 45608 is similar to that reported for the original well, 45605, except that concentrations of parent compounds (PCE and TCE) are now detected. This may indicate the enhanced biodegradation that resulted from addition of HRC to

the backfill that was placed following removal of the French drain outfall is waning, as would be expected at some point as the HRC is “used up.” The concentrations of PCE are lower and those of TCE are within the range of corresponding results from the former French drain outfall (SW056; see DOE 2005b for tabulated data). However, concentrations of VC in samples from well 45608 are well above those reported at the outfall (consistently under 30 µg/L, and frequently less than half that). The concentration reported in a sample collected November 2008, 52 µg/L, is the highest yet reported for the well and the outfall. This signifies continuing biodegradation.



Notes: c12DCE = cis-1,2-DCE; t2DCE = trans-1,2-DCE; Well Repl = date on which well 45605 was abandoned, with subsequent samples collected from its replacement, well 45608. In addition to the nondetects (“U”-qualified results), several other results were qualified (J, D), but are not shown differently for the sake of simplicity. Note logarithmic concentration scale.

Figure 3–207. Concentrations of VOCs in Sentinel Well Monitoring Hillside South of Former B991

High-Resolution Analysis of Water Samples for U Isotope Characterization

Several sets of samples were collected from various groundwater and surface-water monitoring locations for characterization of their U content using the TIMS high-resolution analytical method. Results obtained through these analyses may be used to determine the isotopic distribution of U—its isotopic signature—and whether the water reflects any anthropogenic (human-altered, i.e., with respect to its isotopic signature) U, and if so, how much. This information is useful in discussions with WQCC regarding the U standard in place at the Site (see Section 2.2). The reports generated from these sample submittals have been included in previous quarterly reports for 2008, but are discussed in the aforementioned section and briefly summarized below.

Several of the locations that were selected for this sampling were previously characterized for their U signature on at least one occasion. However, all previous data were from the pre-closure era. Therefore, at those locations the general objective was to see whether post-closure results varied significantly (in a qualitative sense) from pre-closure results. In addition, an objective at several locations was to determine whether flow was a factor (i.e., whether the isotopic distribution of U was different under relatively lower-flow conditions vs. relatively higher-flow conditions).

Table 3–96 summarizes the 2008 sampling efforts and associated results. See Figure 3–1 for a map of sampling locations and refer to Appendix E for the complete analytical reports.

Table 3–96. High-Resolution U Isotopic Characterization in 2008

Location	Area	Date	Objective	Total U result, µg/L	% Natural
GS13	Inlet to Pond A1	12/6/07	Lower-flow sample	47.3	71.3
GS13	Inlet to Pond A1	5/15/08	Higher-flow sample	21.5	74.8
SW093 ^a	FC-3	12/6/07	Lower-flow sample	9.93	90.9
SW093 ^a	FC-3	5/15/08	Higher-flow sample	7.11	92.7
SPP DG	SPPTS	12/6/07	Lower-flow sample	60.7	41.6
SPP DG	SPPTS	5/14/08	Higher-flow sample	58.7	41.4
SPIN ^a	SPPTS	6/6/08	Lower-flow sample	40.9	62.0
SPIN ^a	SPPTS	8/20/08	Higher-flow sample	45.5	61.9
Well 00193	Inlet to Pond C2	8/25/08	Follow-up	74.0	100.0
POM2 ^a	ETPTS	8/28/08	Between GS10 and Pond B-5	32.2	69.2
Well B206989	East Landfill Pond	9/2/08	Follow-up	97.0	99.9
Well 15699 ^a	MSPTS	8/27/08	Groundwater contributing to GS10	33.2	99.1
C2 Pond ^a		9/16/08	WQCC	4.84	75.5
A3 Pond ^a		9/16/08	WQCC	5.94	74.7
A4 Pond ^a		9/16/08	WQCC	0.64	77.0
B5 Pond ^a		9/16/08	WQCC	0.79	78.8
PLFPONDEFF ^a	East Landfill Pond	9/16/08	WQCC	2.55	99.9
GS10	South Walnut Creek	8/25/08	WQCC	15.2	66.8

Notes: Locations listing the objective as “Follow-up” have been characterized by LANL for U isotope signature in the past, and the listed sample was analyzed to confirm conditions had not changed significantly.

^aLocation has not been characterized previously for isotopic signature.

Five RFLMA locations had not been previously characterized for their U isotopic distributions, including FC-3/North Walnut Creek location SW093, SPPTS influent location SPIN, ETPTS surface water performance location POM2, downgradient MSPTS Sentinel well 15699, and PLFPONDEFF. The non-RFLMA locations Pond C2, Pond A3, Pond A4, and Pond B5 had also not been characterized previously.

Samples were shipped to LANL for analysis. LANL is the same laboratory that performed similar analyses for numerous monitoring locations prior to closure, using both the TIMS analytical method and the HR ICP/MS method. The associated results have been published in various reports, including individual Annual RFCA Groundwater Monitoring Reports

(e.g., RMRS 2000a; Safe Sites 2001, 2002; K-H 2004b), the report on U in various media at Rocky Flats (K-H 2004c), and the summary report by Janecky (2006) that tabulates all such data collected from 1998 through 2005.

Because groundwater samples from several locations had not been characterized for U isotopic signature before, no comparison with previous results at these locations is possible. However, other locations listed in Table 3–96 have been so characterized before. For these locations, results from 2008 are consistent with those reported previously. Most notably, two separate samples collected in 2008 from the SPP DG, with results of 41.6 and 41.4 percent natural U (Appendix E), confirmed the single post-closure result (reported in 2007; see DOE 2008g) of 42.9 percent natural U. These three post-closure results suggest that the amount of natural U reaching the SPP DG has decreased since before closure, based on the fact that a sample collected in 2002 provided a result of 67.2 percent natural U. Possible reasons for such a change—including the possibility that temporal variability in the isotopic character, as has been indicated in results from Ryan’s Pit well 07391, may be a factor—were discussed in the 2007 Annual Report (DOE 2008g).

Also notable is the minor to negligible difference in the isotopic distribution of U between samples collected during relatively lower-flow conditions vs. relatively higher-flow conditions. The largest difference is reported at location GS13, but this difference is less than 5 percent. However, the total concentration of U in the lower-flow sample is more than double that in the higher-flow sample. This is because the lower-flow sample contains a higher proportion of groundwater discharge (baseflow) than does the higher-flow sample, which contains this baseflow plus runoff related to recent precipitation events. As has been discussed in previous annual reports, since closure, the relatively higher-U concentrations typical of groundwater at Rocky Flats are causing the U content of the surface water to increase.

3.2 Air Monitoring

3.2.1 Introduction

Air monitoring and emissions assessments have been performed at the Site since the Site began operations in the early 1950s. The Site has historically been subject to 40 CFR 61, Subpart H which specifies radionuclide air emissions limitations and monitoring requirements for DOE facilities. However, following decommissioning and environmental restoration activities pursuant to RFCA (CDPHE et al 1996), completed in fall 2005, the remaining DOE-retained lands are no longer a “facility” as defined in 40 CFR 61.91(b). Consequently, 40 CFR 61, Subpart H, no longer applies.

Air monitoring is not required as part of the CERCLA remedy; however, it was performed for a period of time so that data could be available if needed during the early post-closure period. The air monitoring program at the Rocky Flats Plant and RFETS included ambient (Radioactive Ambient Air Monitoring Program), effluent, and meteorological monitoring activities. As of September 2005, only ambient monitoring was voluntarily performed at two locations along Indiana Street to confirm low emissions. LM ceased ambient air monitoring at the end of September 2008.