APPENDIX A

COST ESTIMATES

Table A-1. Feasibility Study Cost Estimate Summaries

Area/ Alternatives	Total	No Further Action	Long Term Ground Water Monitoring	Land Use Restrictions	Asphalt Cap	Removal with Offsite Disposal	Removal and On-Site Treatment	Limited Removal with Offsite Disposal	In-Situ Bioremediation
RADIUM/STRONTIUM TREATMENT SYSTEMS AREA									
Alternative 1	$0	$0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 2	$246,000	N/A	$246,000	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 3	$646,000	N/A	$246,000	$50,000	$350,000	N/A	N/A	N/A	N/A
Alternative 4A	$3,335,000 - $5,052,000	N/A	N/A	N/A	N/A	$3,335,000 - $5,052,000	N/A	N/A	N/A
Alternative 4B	$2,363,000 - $3,234,000	N/A	N/A	N/A	N/A	N/A	$2,363,000 - $3,234,000	N/A	N/A
Alternative 4C	$2,091,000 - $2,492,000	N/A	$246,000	N/A	N/A	N/A	N/A	$1,845,000 - $2,246,000	N/A
Alternative 5	$1,206,000	N/A	$246,000	N/A	N/A	N/A	N/A	N/A	$960,000
Cost Detail Tables		N/A	Table A-2	Table A-7	Table A-13	Table A-18 and A-19	Table A-26 and A-27	Table A-31 and A-32	Table A-37
DOMESTIC SEPTIC SYSTEM NO. 3									
Alternative 1	$0	$0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 2	$221,000	N/A	$221,000	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 3	$468,000	N/A	$221,000	$50,000	$197,000	N/A	N/A	N/A	N/A
Alternative 4A	$4,562,000	N/A	N/A	N/A	N/A	$4,562,000	N/A	N/A	N/A
Alternative 4B	$4,471,000	N/A	N/A	N/A	N/A	N/A	$4,471,000	N/A	N/A
Alternative 4C	$2,159,000	N/A	$221,000	N/A	N/A	N/A	N/A	$1,938,000	N/A
Alternative 5	$1,319,000	N/A	$221,000	N/A	N/A	N/A	N/A	N/A	$1,098,000
Cost Detail Tables		N/A	Table A-3	Table A-8	Table A-14	Table A-20	Table A-28	Table A-33	Table A-38
DOMESTIC SEPTIC SYSTEM NO. 4									
Alternative 1	$0	$0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 2	$260,000	N/A	$210,000	$50,000	N/A	N/A	N/A	N/A	N/A
Alternative 3	$432,000	N/A	$210,000	$50,000	$172,000	N/A	N/A	N/A	N/A
Alternative 4	$547,000	N/A	N/A	$50,000	N/A	$497,000	N/A	N/A	N/A
Cost Detail Tables		N/A	Table A-4	Table A-9	Table A-15	Table A-21	N/A	N/A	N/A

Table A-1. Feasibility Study Cost Estimate Summaries (continued)

Area/ Alternatives	Total	No Further Action	Long Term Ground Water Monitoring	Land Use Restrictions	Asphalt Cap	Removal with Offsite Disposal	Removal and On-Site Treatment	Limited Removal with Offsite Disposal	In-Situ Bioremediation
DRY WELLS									
Alternative 1	$0	$0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 2	$145,000	N/A	$145,000	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 3	$404,000	N/A	$145,000	$50,000	$209,000	N/A	N/A	N/A	N/A
Alternative 4a	$1,201,000	N/A	N/A	N/A	N/A	$1,201,000	N/A	N/A	N/A
Alternative 4b	$843,000	N/A	$145,000	N/A	N/A	N/A	N/A	$698,000	N/A
Cost Detail Tables		N/A	Table A-5	Table A-10	Table A-16	Table A-22	N/A	Table A-34	N/A
SOUTHWEST TRENCHES AREA									
Alternative 1	$0	$0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 2a	$322,000	N/A	$322,000	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 2b	$372,000	N/A	$322,000	$50,000	N/A	N/A	N/A	N/A	N/A
Alternative 3	$735,000	N/A	$322,000	$50,000	$363,000	N/A	N/A	N/A	N/A
Alternative 4a	$7,271,000 - $8,831,000	N/A	N/A	N/A	N/A	$7,271,000 - $8,831,000	N/A	N/A	N/A
Alternative 4b	$6,426,000 - $7,980,000	N/A	N/A	N/A	N/A	N/A	$6,426,000 - $7,980,000	N/A	N/A
Alternative 4c	$4,636,000 - $5,183,000	N/A	$322,000	N/A	N/A	N/A	N/A	$4,314,000 - $4,861,000	N/A
Alternative 5	$1,298,000	N/A	$322,000	$50,000	N/A	N/A	N/A	N/A	$926,000
Cost Detail Tables		N/A	Table A-6	Table A-11	Table A-17	Table A-23 and A-24	Table A-29 and A-30	Table A-35 and A-36	Table A-39
EASTERN DOG PENS AREA									
Alternative 1	$0	$0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 2	$50,000	N/A	N/A	$50,000	N/A	N/A	N/A	N/A	N/A
Alternative 3	$1,626,000	N/A	N/A	N/A	N/A	$1,626,000	N/A	N/A	N/A
Cost Detail Tables		N/A	N/A	Table A-12	N/A	Table A-25	N/A	N/A	N/A

Abbreviation
N/A not applicable

Table A-2. Well Installation and Long-Term Ground Water Monitoring, Radium/Strontium Treatment Systems

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Well installation work plan/sampling and analysis plan	1	$15,000.00	each	$15,000	C
Well installation subcontractor costs	1	$5,000.00	each	$5,000	F
Drilling scheduling, oversight, and soil sampling/logging	1	$12,000.00	each	$12,000	C
Ground water protocol, scheduling [4]	4	$1,000.00	event	$4,000	D
Mobilize and collect ground water samples	4	$1,600.00	event	$6,400	D
Analyze full-suite [5] ground water samples	8	$3,045.04	sample	$24,360	B
Validate data and import/update database	4	$1,200.00	each	$4,800	H
Evaluate results and summarize in annual report	1	$8,000.00	each	$8,000	D
Archive [6] hard copy records	1	$2,000.00	each	$2,000	H
Contingency		10%		$8,156	
		Direct Capital Costs Subtotal		**$89,716**	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design		10%		$8,972	
Project Management		10%		$8,972	
		Indirect Capital Costs Subtotal		$17,943	
		Capital Costs Subtotal[2]		**$108,000**	
ANNUAL COSTS [1]					
Protocol, scheduling	1	$335.90	each	$336	D
Mobilize and collect ground water samples	1	$565.66	event	$566	D
Analyze ground water samples	2	$763.69	sample	$1,527	B
Validate data and import/update database	2	$420.00	COC	$840	H
Evaluate results and summarize in annual report	1	$1,764.87	each	$1,765	D
Archive hard copy records	1	$250.13	each	$250	H
Contingency	10%			$528	
Project Management	5%			$264	
Technical Support	10%			$528	
		Annual Costs Subtotal		$6,605	
		Present Worth of Annual Costs Subtotal [2,3]		**$128,000**	
PERIODIC COSTS [1]					
Closure negotiations with agencies and public	1	$5,221.30	each	$5,221	I
Well demolition	1	$10,000.00	each	$10,000	I
Final records archiving	1	$4,376.40	each	$4,376	H
Contingency	10%			$1,960	
Project Management	5%			$980	
Technical Support	10%			$1,960	
		Periodic Costs Subtotal		$24,497	
		Present Worth of Periodic Costs Subtotal[2,3]		**$10,000**	

Table A-2. Well Installation and Long-Term Ground Water Monitoring, Radium/Strontium Treatment Systems (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
			TOTAL	**$246,000**	

Notes

[1] Capital costs occur in year 0, annual monitoring costs occur in years 1 - 30 and periodic cost occurs in year 30
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.
[4] Preparation of explicit instructions for field personnel to follow - tasks, methods, equipment supplies, quality control parameters, quality assurance procedures. Tabulated sample identifiers, containers, volumes, preservatives, filtration, refrigeration, analysis parameters, laboratory methods and special instructions. Draft Chain-of-custody forms, task specific health and safety plans, hospital route map, site task map. Includes assigning work dates for available staff, rescheduling work to accommodate other projects and obtaining permission from other project managers to move their scheduled work.
[5] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[6] Archiving includes locating original copies of correspondence, issued report drafts and final reports, cataloging hardcopies into library, library database entry, database maintenance, library hardcopy maintenance, document loan, locating unreturned documents, archive packaging, archive labeling, shipping to archives.

Assumptions

1) Install a new HSU-1 monitoring well downgradient of the southern Ra-226 leach trench for carbon-14 monitoring.
2) Collect quarterly full-suite ground water samples in duplicate from the new well during year 0.
3) Collect annual samples from well UCD1-21 and the new HSU-1 monitoring well for 30 years.
4) Well UCD1-21 annual samples (one primary plus one duplicate) will be analyzed for nitrate, carbon-14, and radium-226.
5) Samples from the new HSU-1 well will be collected in duplicate and analyzed for carbon-14.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-3. Well Installation and Long-Term Ground Water Monitoring, Domestic Septic System No. 3

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Well installation work plan/sampling and analysis plan	1	$15,000.00	each	$15,000	C
Well installation subcontractor costs	1	$5,000.00	each	$5,000	F
Drilling scheduling, oversight, and soil sampling/logging	1	$12,000.00	each	$12,000	C
Ground water protocol, scheduling [4]	4	$1,000.00	event	$4,000	D
Mobilize and collect ground water samples	4	$1,600.00	event	$6,400	D
Analyze full-suite [5] ground water samples	8	$3,045.04	sample	$24,360	B
Validate data and import/update database	4	$1,200.00	each	$4,800	H
Evaluate results and summarize in annual report	1	$8,000.00	each	$8,000	D
Archive [6] hard copy records	1	$2,000.00	each	$2,000	H
Contingency	10%			$8,156	
		Direct Capital Costs Subtotal		$89,716	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	10%			$8,972	
Project Management	10%			$8,972	
		Indirect Capital Costs Subtotal		$17,943	
		Capital Costs Subtotal [2]		**$108,000**	
ANNUAL COSTS [1]					
Protocol, scheduling	1	$335.90	each	$336	D
Mobilize and collect ground water samples	1	$565.66	event	$566	D
Analyze ground water samples	2	$254.99	sample	$510	B
Validate data and import/update database	2	$420.00	COC	$840	H
Evaluate results and summarize in annual report	1	$1,764.87	each	$1,765	D
Archive hard copy records	1	$250.13	each	$250	H
Contingency	10%			$427	
Project Management	5%			$213	
Technical Support	10%			$427	
		Annual Costs Subtotal		$5,333	
		Present Worth of Annual Costs Subtotal [2,3]		**$103,000**	
PERIODIC COSTS [1]					
Closure negotiations with agencies and public	1	$5,221.30	each	$5,221	I
Well demolition	1	$10,000.00	each	$10,000	I
Final records archiving	1	$4,376.40	each	$4,376	H
Contingency	10%			$1,960	
Project Management	5%			$980	
Technical Support	10%			$1,960	
		Periodic Costs Subtotal		$24,497	
		Present Worth of Periodic Costs Subtotal [2,3]		**$10,000**	
		TOTAL		**$221,000**	

Table A-3. Well Installation and Long-Term Ground Water Monitoring, Domestic Septic System No. 3 (continued)

Notes

[1] Capital costs occur in year 0, annual monitoring costs occur in years 1 - 30 and periodic cost occurs in year 30.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.
[4] Preparation of explicit instructions for field personnel to follow - tasks, methods, equipment supplies, quality control parameters, quality assurance procedures. Tabulated sample identifiers, containers, volumes, preservatives, filtration, refrigeration, analysis parameters, laboratory methods and special instructions. Draft Chain-of-custody forms, task specific health and safety plans, hospital route map, site task map. Includes assigning work dates for available staff, rescheduling work to accommodate other projects and obtaining permission from other project managers to move their scheduled work.
[5] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[6] Archiving includes locating original copies of correspondence, issued report drafts and final reports, cataloging hardcopies into library, library database entry, database maintenance, library hardcopy maintenance, document loan, locating unreturned documents, archive packaging, archive labeling, shipping to archives.

Assumptions

1) Install one downgradient monitoring well in HSU-1.
2) Collect quarterly full-suite ground water samples in duplicate during year 0.
3) Collect annual ground water samples in duplicate for next 30 years. Analyze annual samples for nitrate, formaldehyde and molybdenum.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-4. Well Installation and Long-Term Ground Water Monitoring, Domestic Septic System No. 4

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Well installation work plan/sampling and analysis plan	1	$15,000.00	each	$15,000	C
Well installation subcontractor costs	1	$5,000.00	each	$5,000	F
Drilling scheduling, oversight, and soil sampling/logging	1	$12,000.00	each	$12,000	C
Ground water protocol, scheduling [4]	4	$1,000.00	event	$4,000	D
Mobilize and collect ground water samples	4	$1,600.00	event	$6,400	D
Analyze full-suite [5] ground water samples	8	$3,045.04	sample	$24,360	B
Validate data and import/update database	4	$1,200.00	each	$4,800	H
Evaluate results and summarize in annual report	1	$8,000.00	each	$8,000	D
Archive [6] hard copy records	1	$2,000.00	each	$2,000	H
Contingency	10%			$8,156	
		Direct Capital Costs Subtotal		$89,716	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	10%			$8,972	
Project Management	10%			$8,972	
		Indirect Capital Costs Subtotal		$17,943	
		Capital Costs Subtotal [2]		**$108,000**	
ANNUAL COSTS [1]					
Protocol, scheduling	1	$335.90	each	$336	D
Mobilize and collect ground water samples	1	$565.66	event	$566	D
Analyze ground water samples	2	$21.00	sample	$42	B
Validate data and import/update database	2	$420.00	COC	$840	H
Evaluate results and summarize in annual report	1	$1,764.87	each	$1,765	D
Archive hard copy records	1	$250.13	each	$250	H
Contingency	10%			$380	
Project Management	5%			$190	
Technical Support	10%			$380	
		Annual Costs Subtotal		$4,748	
		Present Worth of Annual Costs Subtotal [2,3]		**$92,000**	
PERIODIC COSTS [1]					
Closure negotiations with agencies and public	1	$5,221.30	each	$5,221	I
Well demolition	1	$10,000.00	each	$10,000	I
Final records archiving	1	$4,376.40	each	$4,376	H
Contingency	10%			$1,960	
Project Management	5%			$980	
Technical Support	10%			$1,960	
		Periodic Costs Subtotal		$24,497	
		Present Worth of Periodic Costs Subtotal [2,3]		**$10,000**	

Table A-4. Well Installation and Long-Term Ground Water Monitoring, Domestic Septic System No. 4 (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
			TOTAL	**$210,000**	

Notes

[1] Capital costs occur in year 0, annual monitoring costs occur in years 1 - 30 and periodic cost occurs in year 30.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.
[4] Preparation of explicit instructions for field personnel to follow - tasks, methods, equipment supplies, quality control parameters, quality assurance procedures. Tabulated sample identifiers, containers, volumes, preservatives, filtration, refrigeration, analysis parameters, laboratory methods and special instructions. Draft Chain-of-custody forms, task specific health and safety plans, hospital route map, site task map. Includes assigning work dates for available staff, rescheduling work to accommodate other projects and obtaining permission from other project managers to move their scheduled work.
[5] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[6] Archiving includes locating original copies of correspondence, issued report drafts and final reports, cataloging hardcopies into library, library database entry, database maintenance, library hardcopy maintenance, document loan, locating unreturned documents, archive packaging, archive labeling, shipping to archives.

Assumptions

1) Install one downgradient monitoring well in HSU-1.
2) Collect quarterly full-suite ground water samples in duplicate during year 0.
3) Collect annual ground water samples in duplicate for next 30 years. Analyze annual samples for selenium.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-5. Long-Term Ground Water Monitoring, Domestic Septic System Nos. 1 and5 Leach Field (Dry Wells A-E)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare sampling and analysis plan	1	$7,606.57	each	$7,607	H
Contingency	10%			$761	
Direct Capital Costs Subtotal				$8,367	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	10%			$837	
Project Management	10%			$837	
		Indirect Capital Costs Subtotal		$1,673	
		Capital Costs Subtotal [2]		**$10,000**	
ANNUAL COSTS [1]					
Protocol, scheduling	1	$335.90	each	$336	D
Mobilize and collect ground water samples	1	$565.66	event	$566	D
Analyze ground water samples	2	$710.66	sample	$1,421	B
Validate data and import/update database	2	$420.00	COC	$840	H
Evaluate results and summarize in annual report	1	$1,764.87	each	$1,765	D
Archive hard copy records	1	$250.13	each	$250	H
Contingency	10%			$518	
Project Management	5%			$259	
Technical Support	10%			$518	
		Annual Costs Subtotal		$6,472	
		Present Worth of Annual Costs Subtotal [2,3]		**$125,000**	
PERIODIC COSTS [1]					
Closure negotiations with agencies and public	1	$5,221.30	each	$5,221	I
Well demolition	1	$10,000.00	each	$10,000	I
Final records archiving	1	$4,376.40	each	$4,376	H
Contingency	10%			$1,960	
Project Management	5%			$980	
Technical Support	10%			$1,960	
		Periodic Costs Subtotal		$24,497	
		Present Worth of Periodic Costs Subtotal [2,3]		**$10,000**	
		TOTAL		**$145,000**	

Notes
[1] Capital costs occur in year 0, annual monitoring costs occur in years 1 - 30 and periodic cost occurs in year 30.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.

Assumptions
1) One HSU-1 monitoring well will be sampled annually.
2) Two samples (one primary plus one duplicate) will be analyzed for hexavalent chromium, chromium, mercury, molybdenum, silver, cesium-137 and strontium-90.

Data Source
A) Based on previously completed LEHR removal action cost.

Table A-5. Long-Term Ground Water Monitoring, Domestic Septic System Nos. 1 and5 Leach Field (Dry Wells A-E) (continued)

B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-6. Long-Term Ground Water Monitoring, Southwest Trenches

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Well installation work plan/sampling and analysis plan	1	$15,000.00	each	$15,000	C
Well installation subcontractor costs	1	$5,000.00	each	$5,000	F
Drilling scheduling, oversight, and soil sampling/logging	1	$12,000.00	each	$12,000	C
Ground water protocol, scheduling [4]	4	$1,000.00	event	$4,000	D
Mobilize and collect ground water samples	4	$1,600.00	event	$6,400	D
Analyze full-suite [5] ground water samples	8	$3,045.04	sample	$24,360	B
Validate data and import/update database	4	$1,200.00	each	$4,800	H
Evaluate results and summarize in annual report	1	$8,000.00	each	$8,000	D
Archive [6] hard copy records	1	$2,000.00	each	$2,000	H
Contingency	10%			$8,156	
		Direct Capital Costs Subtotal		$89,716	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	10%			$8,972	
Project Management	10%			$8,972	
		Indirect Capital Costs Subtotal		$17,943	
		Capital Costs Subtotal [2]		**$108,000**	
ANNUAL COSTS [1]					
Protocol, scheduling	1	$335.90	each	$336	D
Mobilize and collect ground water samples	2	$565.66	event	$1,131	D
Analyze ground water samples	4	$320.71	sample	$1,283	B
Validate data and import/update database	4	$420.00	COC	$1,680	H
Evaluate results and summarize in annual report	2	$1,764.87	each	$3,530	D
Archive hard copy records	1	$250.13	each	$250	H
Contingency	10%			$821	
Project Management	5%			$410	
Technical Support	10%			$821	
		Annual Costs Subtotal		$10,262	
		Present Worth of Annual Costs Subtotal [2,3]		**$199,000**	
PERIODIC COSTS [1]					
Closure negotiations with agencies and public	1	$5,221.30	each	$5,221	I
Well demolition	2	$10,000.00	each	$20,000	I
Final records archiving	1	$4,376.40	each	$4,376	H
Contingency	10%			$2,960	
Project Management	5%			$1,480	
Technical Support	10%			$2,960	
		Periodic Costs Subtotal		$36,997	
		Present Worth of Periodic Costs Subtotal [2,3]		**$15,000**	
		TOTAL		**$322,000**	

Table A-6. Long-Term Ground Water Monitoring, Southwest Trenches (continued)

Notes

[1] Capital costs occur in year 0, annual monitoring costs occur in years 1 - 30 and periodic cost occurs in year 30.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.
[4] Preparation of explicit instructions for field personnel to follow - tasks, methods, equipment supplies, quality control parameters, quality assurance procedures. Tabulated sample identifiers, containers, volumes, preservatives, filtration, refrigeration, analysis parameters, laboratory methods and special instructions. Draft Chain-of-custody forms, task specific health and safety plans, hospital route map, site task map. Includes assigning work dates for available staff, rescheduling work to accommodate other projects and obtaining permission from other project managers to move their scheduled work.
[5] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[6] Archiving includes locating original copies of correspondence, issued report drafts and final reports, cataloging hardcopies into library, library database entry, database maintenance, library hardcopy maintenance, document loan, locating unreturned documents, archive packaging, archive labeling, shipping to archives.

Assumptions

1) Install one downgradient monitoring well in HSU-1.
2) Collect quarterly full-suite ground water samples in duplicate during year 0.
3) Collect annual ground water samples in duplicate from the new well and well UCD1-23 for next 30 years. Analyze annual samples for nitrate and carbon-14.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-7. Land-Use Restrictions, Radium/Strontium Treatment Systems

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Implement land use restrictions	1	$32,500.00	lump sum	$32,500.00	none
			Direct Capital Costs	$32,500.00	
Contingency	25%			$8,125	
			Direct Capital Costs Subtotal	$40,625	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	15%			$6,094	
Project Management	8%			$3,250	
			Indirect Capital Costs Subtotal	$9,344	
			Capital Costs Subtotal [2]	**$50,000**	
			TOTAL	**$50,000**	

Notes
[1] Capital costs occur in year 0, no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.

Assumptions
1) Land-use restrictions will cost $50,000.

Table A-8. Land-Use Restrictions, Domestic Septic System 3

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Implement land use restrictions	1	$32,500.00	lump sum	$32,500.00	none
			Direct Capital Costs	$32,500.00	
$8,125	25%			$2,206	
			Direct Capital Costs Subtotal	$40,625	
INDIRECT CAPITAL COSTS [1]					
$6,094	15%			$1,655	
$3,250	8%			$883	
			Indirect Capital Costs Subtotal	$9,344	
			Capital Costs Subtotal	**$50,000**	
			TOTAL	**$50,000**	

Notes
[1] Capital costs occur in year 0, no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.

Assumptions
1) Land-use restrictions will cost $50,000.

Table A-9. Land-Use Restrictions, Domestic Septic System 4

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Implement land use restrictions	1	$32,500.00	lump sum	$32,500.00	none
			Direct Capital Costs	$32,500.00	
$8,125	25%			$2,706	
			Direct Capital Costs Subtotal	$40,625	
INDIRECT CAPITAL COSTS [1]					
$6,094	15%			$2,030	
$3,250	8%			$1,083	
			Indirect Capital Costs Subtotal	$9,344	
			Capital Costs Subtotal [2]	**$50,000**	
			TOTAL	**$50,000**	

Notes
[1] Capital costs occur in year 0, no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.

Assumptions
1) Land-use restrictions will cost $50,000.

Table A-10. Land-Use Restrictions, Domestic Septic System Nos. 1 and 5 Leach Field (Dry Wells A-E)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Implement land use restrictions	1	$32,500.00	lump sum	$32,500.00	none
			Direct Capital Costs	$32,500.00	
$8,125	25%			$2,206	
			Direct Capital Costs Subtotal	$40,625	
INDIRECT CAPITAL COSTS [1]					
$6,094	15%			$1,655	
$3,250	8%			$883	
			Indirect Capital Costs Subtotal	$9,344	
			Capital Costs Subtotal [2]	**$50,000**	
			TOTAL	**$50,000**	

Notes
[1] Capital costs occur in year 0, no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.

Assumptions
1) Land-use restrictions will cost $50,000.

Table A-11. Land-Use Restrictions, Southwest Trenches Area

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Implement land use restrictions	1	$32,500.00	lump sum	$32,500.00	none
		Direct Capital Costs		$32,500.00	
$8,125	25%			$2,706	
		Direct Capital Costs Subtotal		$40,625	
INDIRECT CAPITAL COSTS [1]					
$6,094	15%			$2,030	
$3,250	8%			$1,083	
		Indirect Capital Costs Subtotal		$9,344	
		Capital Costs Subtotal [2]		**$50,000**	
		TOTAL		**$50,000**	

Notes
[1] Capital costs occur in year 0 , no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
Assumptions
1) Land-use restrictions will cost $50,000.

Table A-12. Land-Use Restrictions, Eastern Dog Pens Area

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS[1]					
Implement land use restrictions	1	$32,500.00	lump sum	$32,500	none
Direct Capital Costs				$32,500	
Contingency	25%			$8,125	
		Direct Capital Costs Subtotal		$40,625	
INDIRECT CAPITAL COSTS[1]					
Engineering and Design	15%			$6,094	
Project Management	8%			$3,250	
		Indirect Capital Costs Subtotal		$9,344	
		Capital Costs Subtotal[2]		**$50,000**	
			TOTAL	**$50,000**	

Notes
[1] Capital costs occur in year 0, no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
Assumption
1) Land-use restrictions will cost $50,000.

Table A-13. Asphalt/High-Density Polyethylene Cap, Radium/Strontium Treatment Systems

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare cap design and installation work plan	1	$42,000	lump sum	$42,000	I
Collect parking lot waste characterization samples	6	$130	sample	$780	H
Analyze waste characterization samples (full suite)	6	$3,367	sample	$20,201	B
Validate and import waste characterization data	6	$615	sample	$3,690	H
Designate and profile parking lot waste	1	$20,000	lump sum	$20,000	A
Profile imported fill for disposal using existing data	1	$6,000	lump sum	$6,000	H
Remove parking lot and imported fill, and dispose	678	$34.00	cubic yard	$23,048	A
Grade native soil into excavation and compact	261	$5.00	cubic yard	$1,304	J
Install 40-mil high-density polyethylene liner	14,079	$0.32	square foot	$4,505	G
Grade and compact eight inches of base material	348	$46.00	cubic yard	$16,008	J
Install four inches of asphalt pavement	14,079	$3.75	square foot	$52,796	G
Replace chain-link fence	270	$10.02	linear foot	$2,705	J
Survey Cap and Report Cap Installation	1	$12,000	lump sum	$12,000	I
Contingency	10%			$20,504	
		Direct Capital Costs Subtotal		$225,541	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	10%			$22,554	
Project Management	25%			$56,385	
		Indirect Capital Costs Subtotal		$78,939	
		Capital Costs Subtotal [2]		**$304,000**	
ANNUAL COSTS [1]					
Visually inspect asphalt surface	1	$1,000.00	lump sum	$1,000	I
Contingency	10%			$100	
		Annual Costs Subtotal		$1,100	
		Present Worth of Annual Costs Subtotal [2,3]		**$21,000**	
PERIODIC COSTS [1]					
Repair surface with two-inch asphalt overlay	9,650	$1.15	square foot	$11,098	G
Contingency	10%			$1,110	
Project Management	25%			$2,774	
		Periodic Costs Subtotal		$14,982	
		Present Worth of Periodic Costs Subtotal [2,3]		**$25,000**	
		TOTAL		**$350,000**	

Notes
[1] Capital costs occur at year 0, annual costs for 30 years, and periodic costs at 10, 20, and 30 years.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.

Assumptions
1) Only Area I of the Radium/Strontium Treatment Systems area (9,650 square feet) will require capping.

Table A-13. Asphalt/High-Density Polyethylene Cap, Radium/Strontium Treatment Systems (continued)

2) Cap construction will consist of parking lot, fence, and soil removal, grading, installation of a 40-mil high-density polyethylene liner, placement of eight inches of base material, and paving with four inches of asphalt, and re-installing the fence.
3) Parking lot waste will consist of asphalt, concrete, and base rock. Each waste media will be sampled in duplicate. Full-suite analysis.
4) Approximately 521 cubic yards of parking lot waste and previously imported fill will be removed and disposed at a Class III landfill; Assumes none of the parking lot waste or previously imported fill contains added radioactivity. No native soil disposed.
5) A swell factor of 1.3 was used to estimate waste disposal volume.
6) The fill will be removed from within the Area 1 excavation boundary. The import fill analytic data will be used to profile the fill.
7) Approximately 261 cubic yards (0.5 ft) of native surface soil will be graded into the Area 1 excavation and compacted prior to installing the liner, base material and asphalt.
8) Work will conform to UC Davis Campus Standard 02500, “Paving."
9) The cap’s condition will be visually inspected on an annual basis and minor maintenance (i.e., asphalt overlay) is expected every 10 years.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-14. Asphalt/High-Density Polyethylene Cap, Domestic Septic System No. 3

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare cap design and installation work plan	1	$42,000	lump sum	$42,000	I
Collect parking lot waste characterization samples	4	$130	sample	$520	H
Analyze waste characterization samples (full suite)	4	$3,367	sample	$13,467	B
Validate and import waste characterization data	4	$615	sample	$2,460	H
Designate and profile parking lot waste	1	$20,000	lump sum	$20,000	A
Profile fill for disposal using import fill data	1	$6,000	lump sum	$6,000	H
Remove parking lot and imported fill, and dispose	120	$34.00	cubic yard	$4,093	A
Grade native soil into excavation and compact	46	$5.00	cubic yard	$231	J
Install 40-mil high-density polyethylene liner	2,500	$0.32	square foot	$800	G
Grade and compact eight inches of base material	62	$46.00	cubic yard	$2,840	J
Install four inches of asphalt pavement	2,500	$3.75	square foot	$9,375	G
Survey Cap and Report Cap Installation	1	$12,000	lump sum	$12,000	I
Contingency	10%			$11,379	
			Direct Capital Costs Subtotal	$125,165	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	10%			$12,516	
Project Management	25%			$31,291	
			Indirect Capital Costs Subtotal[2]	$43,808	
			Capital Costs Subtotal [2]	**$169,000**	
ANNUAL COSTS [1]					
Visually inspect asphalt surface	1	$1,000.00	lump sum	$1,000	I
Contingency	10%			$100	
			Annual Costs Subtotal	$1,100	
			Present Worth of Annual Costs Subtotal [2,3]	**$21,000**	
PERIODIC COSTS [1]					
Repair surface with two-inch asphalt overlay	2,500	$1.15	square foot	$2,875	G
Contingency	10%			$288	
Project Management	25%			$719	
			Periodic Costs Subtotal	$3,881	
			Present Worth of Periodic Costs Subtotal [2,3]	**$7,000**	
			TOTAL	**$197,000**	

Notes
[1] Capital costs occur at year 0, annual costs for 30 years, and periodic costs at 10, 20, and 30 years.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.

Assumptions
1) Only the leach field and surrounding area (2,500 square feet) will require capping.

Table A-14. Asphalt/High-Density Polyethylene Cap, Domestic Septic System No. 3 (continued)

2) Cap construction will consist of parking lot and soil removal, grading, installation of a 40-mil high-density polyethylene liner, placement of eight inches of base material, and paving with four inches of asphalt.
3) Parking lot waste will consist of asphalt and base rock. Each waste media will be sampled in duplicate. Full-suite analysis.
4) Approximately 93 cubic yards of parking lot waste and previously imported fill will be removed and disposed at a Class III landfill; Assumes none of the parking lot waste or previously imported fill contains added radioactivity. No native soil disposed.
5) A soil swell factor of 1.3 used for estimating disposal volume.
6) The fill will be removed from within the leach field excavation boundary. The import fill analytic data will be used to profile the waste.
7) Approximately 46 cubic yards (0.5 ft) of native surface soil will be graded into the leach field excavation and compacted prior to
8) installing the liner, base material and asphalt.
9) Work will conform to UC Davis Campus Standard 02500, “Paving."
10) The cap’s condition will be visually inspected on an annual basis and minor maintenance (i.e., asphalt overlay) is expected every 10 years.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-15. Asphalt/High-Density Polyethylene Cap, Domestic Septic System No. 4

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare cap design and installation work plan	1	$42,000	lump sum	$42,000	I
Collect site characterization samples [4]	5	$130	sample	$650	H
Analyze site characterization samples [5]	5	$378.05	sample	$1,890	B
Survey site characterization sample locations	1	$3,000	lump sum	$3,000	F
Validate and import site characterization data	5	$410	sample	$2,050	H
Evaluate site characterization data	1	$2,000	lump sum	$2,000	H
Collect waste characterization samples	2	$130	sample	$260	H
Analyze waste characterization samples (full suite) [6]	2	$3,367	sample	$6,734	B
Validate and import waste characterization data	2	$615	sample	$1,230	H
Designate and profile waste	1	$20,000	lump sum	$20,000	A
Remove surface soil and dispose	34	$34.00	cubic yard	$1,156	A
Install 40-mil high-density polyethylene liner	702	$0.32	square foot	$225	G
Grade and compact eight inches of base material	18	$46.00	cubic yard	$828	J
Install four inches of asphalt pavement	702	$3.75	square foot	$2,633	G
Survey Cap and Report Cap Installation	1	$12,000	lump sum	$12,000	I
Contingency	10%			$9,666	
			Direct Capital Costs Subtotal	$106,321	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	10%			$10,632	
Project Management	25%			$26,580	
			Indirect Capital Costs Subtotal	$37,212	
			Capital Costs Subtotal [2]	**$144,000**	
ANNUAL COSTS [1]					
Visually inspect asphalt surface	1	$1,000.00	lump sum	$1,000	I
Contingency	10%			$100	
			Annual Costs Subtotal	$1,100	
			Present Worth of Annual Costs Subtotal [2,3]	**$21,000**	
PERIODIC COSTS [1]					
Repair surface with two-inch asphalt overlay	2,500	$1.15	square foot	$2,875	G
Contingency	10%			$288	
Project Management	25%			$719	
			Periodic Costs Subtotal	$3,881	
			Present Worth of Periodic Costs Subtotal [2,3]	**$7,000**	
			TOTAL	**$172,000**	

Notes
[1] Capital costs occur at year 0, annual costs for 30 years, and periodic costs at 10, 20, and 30 years.
[2] Subtotal is rounded to the nearest $1,000.

Table A-15. Asphalt/High-Density Polyethylene Cap, Domestic Septic System No. 4 (continued)

[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.
[4] Five site characterization samples would be collected at the trench area west of building H-215 prior to capping.
[5] Site characterization sample analysis suite includes selenium and semivolatile organic compounds.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.

Assumptions

1) Only the leach field and distribution box area (702 square feet) will require capping.
2) Cap construction will consist of soil removal, grading, installation of a 40-mil high-density polyethylene liner, placement of eight inches of base material, and paving with four inches of asphalt.
3) Soil waste will be sampled in duplicate. Full-suite analysis.
4) Approximately 34 cubic yards of soil will be removed and disposed at a Class III landfill; Excavated surface soil assumed to be clean overburden that contains no added radioactivity or chemical contamination.
5) A soil swell factor of 1.3 used for estimating disposal volume.
6) Work will conform to UC Davis Campus Standard 02500, “Paving."
7) The cap’s condition will be visually inspected on an annual basis and minor maintenance (i.e., asphalt overlay) is expected every 10 years.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-16. Asphalt/High-Density Polyethylene Cap, Domestic Septic System Nos. 1 and 5 Leach Field (Dry Wells A-E)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare cap design and installation work plan	1	$42,000	lump sum	$42,000	I
Collect parking lot waste characterization samples	4	$130	sample	$520	H
Analyze waste characterization samples (full suite)	4	$3,367	sample	$13,467	B
Validate and import waste characterization data	4	$615	sample	$2,460	H
Designate and profile parking lot waste	1	$20,000	lump sum	$20,000	A
Profile fill for disposal using import fill data	1	$6,000	lump sum	$6,000	H
Remove and replace chain-link fence	90	$10.02	linear foot	$902	J
Remove parking lot and imported fill, and dispose	172	$34.00	cubic yard	$5,839	A
Grade native soil into excavation and compact	66	$5.00	cubic yard	$330	J
Install 40-mil high-density polyethylene liner	3,567	$0.32	square foot	$1,141	G
Grade and compact eight inches of base material	89	$46.00	cubic yard	$4,094	J
Install four inches of asphalt pavement	3,567	$3.75	square foot	$13,376	G
Survey Cap and Report Cap Installation	1	$12,000.00	lump sum	$12,000	I
Contingency	10%			$12,213	
		Direct Capital Costs Subtotal		$134,344	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	10%			$13,434	
Project Management	25%			$33,586	
		Indirect Capital Costs Subtotal		$47,020	
		Capital Costs Subtotal [2]		**$181,000**	
ANNUAL COSTS [1]					
Visually inspect asphalt surface	1	$1,000.00	lump sum	$1,000	I
Contingency	10%			$100	
		Annual Costs Subtotal		$1,100	
		Present Worth of Annual Costs Subtotal [2,3]		**$21,000**	
PERIODIC COSTS [1]					
Repair surface with two-inch asphalt overlay	2,800	$1.15	square foot	$3,220	G
Contingency	10%			$322	
Project Management	25%			$805	
		Periodic Costs Subtotal		$4,347	
		Present Worth of Periodic Costs Subtotal [2,3]		**$7,000**	
		TOTAL		**$209,000**	

Table A-16. Asphalt/High-Density Polyethylene Cap, Domestic Septic System Nos. 1 and 5 Leach Field (Dry Wells A-E) (continued)

Notes
[1] Capital costs occur at year 0, annual costs for 30 years, and periodic costs at 10, 20, and 30 years.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.

Assumptions
1) The Dry Wells area and adjacent drainage ditch (3,567 square feet) will be capped.
2) Cap construction will consist of parking lot, fence, and soil removal, grading, installation of a 40-mil high-density polyethylene liner, placement of eight inches of base material, and paving with four inches of asphalt, and re-installing the fence.
3) Parking lot waste will consist of asphalt, concrete, and base rock. Each waste media will be sampled in duplicate. Full-suite analysis.
4) Approximately 172 cubic yards of parking lot waste and previously imported fill will be removed and disposed at a Class III landfill; Assumes none of the parking lot waste or previously imported fill contains added radioactivity. No native soil disposed.
5) A soil swell factor of 1.3 used for estimating disposal volume.
6) The fill will be removed from within the 1999 excavation boundary. The import fill analytic data will be used to profile the waste.
7) Approximately 66 cubic yards of native surface soil will be graded into the 1999 excavation and compacted prior to installing the liner,
8) base material and asphalt.
9) Work will conform to UC Davis Campus Standard 02500, “Paving."
10) The cap’s condition will be visually inspected on an annual basis and minor maintenance (i.e., asphalt overlay) is expected every 10 years.

Data Source
A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-17. Asphalt/High-Density Polyethylene Cap, Southwest Trenches

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare cap design and installation work plan	1	$42,000	lump sum	$42,000	I
Profile fill for disposal using import fill data	1	$6,000	lump sum	$6,000	H
Remove and replace chain-link fence	120	$10.02	linear foot	$1,202	J
Excavate fill and dispose	926	$34.00	cubic yard	$31,470	A
Grade native soil into excavation and compact	712	$5.00	cubic yard	$3,560	J
Install 40-mil high-density polyethylene liner	19,250	$0.32	square foot	$6,160	G
Grade and compact eight inches of base material	476	$46.00	cubic yard	$21,896	J
Install four inches of asphalt pavement	19,250	$3.75	square foot	$72,188	G
Survey Cap and Report Cap Installation	1	$12,000	lump sum	$12,000	I
Contingency	10%			$19,648	
		Direct Capital Costs Subtotal		$216,124	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	10%			$21,612	
Project Management	25%			$54,031	
		Indirect Capital Costs Subtotal		$75,643	
		Capital Costs Subtotal [2]		**$292,000**	
ANNUAL COSTS [1]					
Visually inspect asphalt surface	1	$1,000.00	lump sum	$1,000	I
Contingency	10%			$100	
		Annual Costs Subtotal		$1,100	
		Present Worth of Annual Costs Subtotal [2,3]		**$21,000**	
PERIODIC COSTS [1]					
Repair surface with two-inch asphalt overlay	19,250	$1.15	square foot	$22,138	G
Contingency	10%			$2,214	
Project Management	25%			$5,534	
		Periodic Costs Subtotal		$29,886	
		Present Worth of Periodic Costs Subtotal [2,3]		**$50,000**	
		TOTAL		**$363,000**	

Notes
[1] Capital costs occur at year 0, annual costs for 30 years, and periodic costs at 10, 20, and 30 years.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.

Assumptions
1) The entire Southwest Trenches area (19,250 square feet) will require capping.
2) Cap construction will consist of soil removal and grading, installation of a 40-mil high-density polyethylene liner, placement of eight inches of base material, and paving with four inches of asphalt.

Table A-17. Asphalt/High-Density Polyethylene Cap, Southwest Trenches (continued)

3) Approximately 712 cubic yards of previously imported fill will be removed and disposed at a Class III landfill; no native soil removal.
4) A soil swell factor of 1.3 used for estimating disposal volume.
5) The fill will be removed from within the 1998 excavation boundaries. The import fill analytic data will be used to profile the waste.
6) Approximately 712 cubic yards of native surface soil will be graded into the 1998 excavations and compacted prior to installing the liner, base material and asphalt.
7) Work will conform to UC Davis Campus Standard 02500, "Paving."
8) The cap's condition will be visually inspected on an annual basis and minor maintenance (i.e., asphalt overlay) is expected every 10 years.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-18. Removal and Off-Site Disposal—Upper Range Cleanup Goals, Radium/Strontium Treatment Systems

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	700	$2.00	linear foot	$1,400	J
Health and safety meetings [4]	50	$1,000.00	day	$50,000	H
Task meetings [5]	25	$2,000.00	lump sum	$50,000	H
Field operations management	50	$2,000.00	day	$100,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Remove and temporarily stockpile clean overburden	585	$30.00	cubic yard	$17,550	A
Excavate and stockpile soil using conventional equipment	819	$30.00	cubic yard	$24,570	A
Excavate soil with oversize auger	3,101	$173.00	cubic yard	$536,473	G
Collect waste characterization samples	7	$130.00	sample	$910	H
Analyze waste characterization samples (full suite) [6]	7	$3,366.85	sample	$23,568	B
Validate and import waste characterization data	7	$615.00	sample	$4,305	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, transport and dispose Class II waste soil	2,419	$60.00	cubic yard	$145,127	A
Package low level rad soil in Lift Liners and ship to NTS	1,633	$306.00	cubic yard	$499,726	A
Dispose low level waste at the Nevada Test Site	1,633	$216.00	cubic yard	$352,748	A
Document field activities	50	$130.00	day	$6,500	H
Collect field screening samples	50	$48.75	sample	$2,438	H
Onsite lab analysis	50	$76.88	sample	$3,844	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	35	$130.00	sample	$4,550	H
Analyze confirmation samples [7]	35	$384.00	sample	$13,440	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	35	$410.00	sample	$14,350	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material (none needed)	0	$15.00	cubic yard	$-	
Low density concrete fill material	3,117	$90.00	cubic yard	$280,514	G
Delineate the excavaton area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the excavation areas	1,044	$11.00	cubic yard	$11,485	A
Install gravel base material in previously paved area	58	$46.00	cubic yard	$2,676	J

Table A-18. Removal and Off-Site Disposal—Upper Range Cleanup Goals, Radium/Strontium Treatment Systems (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Install four inches of asphalt pavement	2,356	$3.75	square foot	$8,836	G
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Contingency	25%			$590,252	
		Direct Capital Costs Subtotal		$2,951,262	
		INDIRECT CAPITAL COSTS			
Engineering and Design	8%			$236,101	
Project Management	5%			$147,563	
		Indirect Capital Costs Subtotal		$383,664	
		Capital Costs Subtotal [2]		**$3,335,000**	
		TOTAL		$3,335,000	

Notes
[1] Capital costs occur in year 0;no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes nitrate, carbon-14 and radium-226.

Key Assumptions
1) Excavation volumes based on achieving upper range cleanup goals. Excavation shown in Appendix B.
2) Low level radiological contamination assumed to extend to 20 ft bgs.
3) The confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Ra-226.
4) Waste disposal volumes generated by conventional and oversize auger excavation were assumed to expand by a factor of 1.3
5) Oversize auger borings will overlap and increase the auger waste volume by an additional assumed factor of 1.4.
6) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to
7) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
8) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to
9) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
10) All of the clean fill from the 1999 Area 1 excavation will be returned to the new excavation without testing.
11) The top 5 feet of native soil is assumed clean, given the depth of the treatment system leach trenches, and will be reused as backfill.
12) Seven waste characterization samples will be collected; 1 per each 800 cubic yards and 1 duplicate.
13) No excavation dewatering will be required.
14) No shoring will be required.
15) The conventional excavations will be filled with clean fill recovered from the 1999 Area 1 excavation and top 5 feet of native soil.
16) The borings will be filled with controlled density fill and the remaining clean soil. The CDF will not require compaction.
17) The excavation will not be delineated with geotextile fabric.

Data Source
A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.

Table A-18. Removal and Off-Site Disposal—Upper Range Cleanup Goals, Radium/Strontium Treatment Systems (continued)

H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-19. Removal and Off-Site Disposal – Lower range cleanup goals, Radium/Strontium Treatment Systems

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	700	$2.00	linear foot	$1,400	J
Health and safety meetings [4]	60	$1,000.00	day	$60,000	H
Task meetings [5]	30	$2,000.00	lump sum	$60,000	H
Field operations management	60	$2,000.00	day	$120,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Remove and temporarily stockpile clean overburden	585	$30.00	cubic yard	$17,550	A
Excavate and stockpile soil using conventional equipment	454	$30.00	cubic yard	$13,620	A
Excavate soil with oversize auger	5,653	$173.00	cubic yard	$978,004	G
Collect waste characterization samples	10	$130.00	sample	$1,300	H
Analyze waste characterization samples (full suite) [6]	10	$3,366.85	sample	$33,669	B
Validate and import waste characterization data	10	$615.00	sample	$6,150	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, transport and dispose Class II waste soil	4,409	$60.00	cubic yard	$264,570	A
Package low level rad soil in Lift Liners and ship to Envirocare	2,419	$306.00	cubic yard	$740,119	A
Dispose low level waste at Envirocare	2,419	$216.00	cubic yard	$522,437	A
Document field activities	60	$130.00	day	$7,800	H
Collect field screening samples	60	$48.75	sample	$2,925	H
Onsite lab analysis	60	$76.88	sample	$4,613	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	40	$130.00	sample	$5,200	H
Analyze confirmation samples [7]	40	$384.00	sample	$15,360	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	40	$410.00	sample	$16,400	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material (none needed)	0	$15.00	cubic yard	$-	
Low density concrete fill material	5,252	$90.00	cubic yard	$472,721	G
Delineate the excavation area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the excavation areas	1,111	$11.00	cubic yard	$12,223	A
Install gravel base material in previously paved area	72	$46.00	cubic yard	$3,308	J
Install four inches of asphalt pavement	2,913	$3.75	square foot	$10,923	G

Table A-19. Removal and Off-Site Disposal – Lower range cleanup goals, Radium/Strontium Treatment Systems (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Contingency	25%			$894,072	
		Direct Capital Costs Subtotal		$4,470,362	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	8%			$357,629	
Project Management	5%			$223,518	
		Indirect Capital Costs Subtotal		$581,147	
		Capital Costs Subtotal [2]		**$5,052,000**	
		TOTAL		**$5,052,000**	

Notes

[1] Capital costs occur at year 0, no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes nitrate, carbon-14 and radium-226.

Assumptions

1) The volumes are based on the excavations determined in Appendix X.
2) Nitrate contamination assumed to extend to 50 ft bgs based on the seasonal low water table.
3) Low-level radiological contamination assumed to extend to 20 ft bgs.
4) The confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Ra-226.
5) Waste disposal volumes generated by conventional and oversize auger excavation were assumed to expand by a factor of 1.3.
6) Oversize auger borings will overlap and increase the auger waste volume by an additional assumed factor of 1.4.
7) The engineering and design and project management percentages are based on Exhibit 5.8 in *A Guide to Developing Cost Estimates During the Feasibility Study* (EPA, 2000).
8) The scope contingency is assumed to be 15% and bid contingency is 10% based on *A Guide to Developing Cost Estimates During the Feasibility Study* (EPA, 2000).
9) All of the clean fill from the 1999 Area 1 excavation will be returned to the new excavation without testing.
10) The top 5 feet of native soil is assumed clean, given the depth of the treatment system leach trenches, and will be reused as backfill.
11) Ten waste characterization samples will be collected; 1 per each 800 cubic yards and 1 duplicate.
12) No excavation dewatering will be required.
13) No shoring will be required.
14) The conventional excavations will be filled with clean fill recovered from the 1999 Area 1 excavation and top 5 feet of native soil.
15) The borings will be filled with controlled density fill and the remaining clean soil. The CDF will not require compaction.
16) The excavation will not be delineated with geotextile fabric.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.

Table A-19. Removal and Off-Site Disposal – Lower range cleanup goals, Radium/Strontium Treatment Systems (continued)

J) RS Means environmental remediation cost data, 9th Edition.

Table A-20. Removal and Off-Site Disposal, Domestic Septic System No. 3

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	700	$2.00	linear foot	$1,400	J
Health and safety meetings [4]	40	$1,000.00	day	$40,000	H
Task meetings [5]	20	$2,000.00	lump sum	$40,000	H
Field operations management	40	$2,000.00	day	$80,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Excavate soil with oversize auger	5,536	$173.00	cubic yard	$957,659	G
Collect waste characterization samples	10	$130.00	sample	$1,300	H
Analyze waste characterization samples (full suite) [6]	10	$3,366.85	sample	$33,669	B
Validate and import waste characterization data	10	$615.00	sample	$6,150	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, transport and dispose Class II waste soil	4,318	$60.00	cubic yard	$259,066	A
Package low level waste and ship to Envirocare	2,129	$306.00	cubic yard	$651,620	A
Dispose low level waste at Envirocare	2,129	$216.00	cubic yard	$459,967	A
Document field activities	40	$130.00	day	$5,200	H
Collect field screening samples	40	$48.75	sample	$1,950	H
Onsite lab analysis	40	$76.88	sample	$3,075	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	25	$130.00	sample	$3,250	H
Analyze confirmation samples [7]	25	$246.55	sample	$6,164	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	25	$410.00	sample	$10,250	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	238	$105.00	cubic yard	$24,978	E
Low density concrete fill material (8 - 50 ft)	4,650	$90.00	cubic yard	$418,491	G
Delineate the excavation area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the excavation area	822	$11.00	cubic yard	$9,047	A
Install gravel base material in previously paved area	53	$46.00	cubic yard	$2,425	J
Install four inches of asphalt pavement	2,135	$3.75	square foot	$8,006	G
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Contingency	25%			$807,416	
		Direct Capital Costs Subtotal		$4,037,082	

Table A-20. Removal and Off-Site Disposal, Domestic Septic System No. 3 (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	8%			$322,967	
Project Management	5%			$201,854	
		Indirect Capital Costs Subtotal		$524,821	
		Capital Costs Subtotal [2]		**$4,562,000**	
		TOTAL		**$4,562,000**	

Notes
[1] Capital costs occur in year 0;no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes formaldehyde, molybdenum and nitrate.

Assumptions
1) Excavation will be conducted using an oversized auger.
2) The excavation depth will be 50 feet based on the seasonal low water table.
3) The top 4 feet of native soil is assumed clean and will be reused as backfill.
4) Native soil between 4 and 20 feet is assumed low level rad added waste.
5) Soil between 20 and 50 feet below ground surface is assumed Class II waste with no rad added.
6) Waste disposal volumes generated by excavation were assumed to expand by a factor of 1.3
7) Oversize auger borings will overlap and increase the auger waste volume by an additional assumed factor of 1.4.
8) The import backfill volume in the 2002 removal action was approximately 260 cubic yards (assuming an expansion factor of 1.3).
9) The clean import backfill in the 2002 excavation will be returned to the excavation without testing.
10) The engineering and design and project management percentages are based on Exhibit 5.8 in *A Guide to* D*eveloping Cost Estimates During the Feasibility Study* (EPA, 2000).
11) The confirmation sample suite will be formaldehyde, molybdenum and nitrate.
12) Ten waste characterization samples will be collected; 1 per each 800 cubic yards, 1 duplicate per matrix (soil, gravel).
13) The scope contingency is assumed to be 15% and bid contingency is 10% based on *A Guide to Developing Cost Estimates During the Feasibility Study* (EPA, 2000).
14) No excavation dewatering will be required.
15) No shoring will be required.
16) The borings will be filled with controlled density fill (CDF) between 8 and 50 feet. The CDF will not require compaction.
17) The upper 8 feet will be backfilled with clean overburden, 2002 backfill and new import fill.
18) The excavation will not be delineated with geotextile fabric.

Data Source
A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-21. Removal and Off-Site Disposal, Domestic Septic System No. 4

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	100	$2.00	linear foot	$200	J
Collect site characterization samples [4]	5	$130	sample	$650	H
Analyze site characterization samples [5]	5	$378.05	sample	$1,890	B
Survey site characterization sample locations	1	$3,000	lump sum	$3,000	F
Validate and import site characterization data	5	$410	sample	$2,050	H
Evaluate site characterization data	1	$2,000	lump sum	$2,000	H
Health and safety meetings [6]	10	$1,000.00	day	$10,000	H
Task meetings [7]	5	$2,000.00	lump sum	$10,000	H
Field operations management	10	$2,000.00	day	$20,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Excavate and stockpile soil and distribution box	20	$30.00	cubic yard	$600	A
Rubbelize distribution box	1	$10,000.00	lump sum	$10,000	A
Collect waste characterization samples	4	$130.00	sample	$520	H
Analyze waste characterization samples (full suite) [8]	4	$3,366.85	sample	$13,467	B
Validate and import waste characterization data	4	$615.00	sample	$2,460	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, transport and dispose Class II waste soil	13	$60.00	cubic yard	$805	A
Document field activities	10	$130.00	day	$1,300	H
Collect field screening samples	20	$48.75	sample	$975	H
Onsite lab analysis	20	$76.88	sample	$1,538	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	15	$130.00	sample	$1,950	H
Analyze confirmation samples [4]	15	$378.05	sample	$5,671	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	15	$410.00	sample	$6,150	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Locate, survey, and sample import backfill source	1	$10,000.00	lump sum	$10,000	H
Analyze import backfill samples (full suite)	2	$3,366.85	sample	$6,734	B
Validate and import data	2	$615.00	sample	$1,230	H
Evaluate/profile backfill data	1	$2,500.00	lump sum	$2,500	H
Import backfill material	13	$105.00	cubic yard	$1,409	E
Delineate the excavation area with	560	$0.19	square	$106	G

Table A-21. Removal and Off-Site Disposal, Domestic Septic System No. 4 (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
geotextile fabric			foot		
Backfill, compact and grade the excavation area	23	$11.00	cubic yard	$258	A
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Contingency	25%			$80,866	
		Direct Capital Costs Subtotal		$404,328	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	15%			$60,649	
Project Management	8%			$32,346	
		Indirect Capital Costs Subtotal		$92,996	
		Capital Costs Subtotal [2]		**$497,000**	
			TOTAL	**$497,000**	

Notes
[1] Capital costs occur in year 0;no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Five site characterization samples would be collected at the trench area west of building H-215 prior to excavating.
[5] Site characterization and confirmation sample analysis suite includes SVOCs and selenium.
[6] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[7] Assignment/coordination of tasks, technical problem solving, planning.
[8] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.

Assumptions
1) Domestic Septic Tank 4 and the portion of the leach field underlying the clinical pathology building will not be removed.
2) The excavation will consist of removing the distribution box, 8 yards of clean overburden, and 10 yards of contaminated leach field soil.
3) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to Developing Cost Estimates *During the Feasibility Study* (EPA, 2000).
4) Soil and concrete waste characterization samples will be collected in duplicate .
5) The confirmation sample suite will be SVOCs and selenium.
6) The scope contingency is assumed to be 15% and bid contingency is 10% based on *A Guide to Developing Cost Estimates During the Feasibility Study* (EPA, 2000).

Data Source
A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-22. Removal and Off-Site Disposal, Domestic Septic System Nos. 1 and 5 Leach Field (Dry Wells A through E)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	170	$2.00	linear foot	$340	J
Health and safety meetings [4]	20	$1,000.00	day	$20,000	H
Task meetings [5]	10	$2,000.00	lump sum	$20,000	H
Field operations management	20	$2,000.00	day	$40,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Excavate distribution box and surrounding soil	96	$30.00	cubic yard	$2,880	A
Excavate drywell soil with oversize auger	465	$173.00	cubic yard	$80,445	G
Rubbelize distribution box	1	$10,000.00	lump sum	$10,000	A
Collect waste characterization samples	4	$130.00	sample	$520	H
Analyze waste characterization samples (full suite) [6]	4	$3,366.85	sample	$13,467	B
Validate and import waste characterization data	4	$615.00	sample	$2,460	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Package low level waste and ship to Envirocare	633	$306.00	cubic yard	$193,569	A
Dispose low level waste at Envirocare	633	$216.00	cubic yard	$136,637	A
Document field activities	20	$130.00	day	$2,600	H
Collect field screening samples	40	$48.75	sample	$1,950	H
Onsite lab analysis	40	$76.88	sample	$3,075	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	30	$130.00	sample	$3,900	H
Analyze confirmation samples [7]	30	$554.78	sample	$16,643	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	30	$410.00	sample	$12,300	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	25	$105.00	cubic yard	$2,675	E
Low density concrete fill material	465	$90.00	cubic yard	$41,850	G
Delineate the excavaton area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the distribution box excavation	122	$11.00	cubic yard	$1,344	A
Install gravel base material in previously paved area	7	$46.00	cubic yard	$322	J
Install four inches of asphalt pavement	255	$3.75	square foot	$956	G
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Contingency	25%			$203,484	

Table A-22. Removal and Off-Site Disposal, Domestic Septic System Nos. 1 and 5 Leach Field (Dry Wells A through E) (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
		Direct Capital Costs Subtotal		$1,017,419	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	15%			$122,090	
Project Management	8%			$61,045	
		Indirect Capital Costs Subtotal		$183,135	
		Capital Costs Subtotal [2]		**$1,201,000**	
		TOTAL		$1,201,000	

Notes

[1] Capital costs occur in year 0;no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes hexavalent chromium, chromium, mercury, molybdenum, silver, Cs-137 and Sr-90.

Assumptions

1) Cylindrical dry well excavations will extend to 50 feet in depth with a diameter of 8 feet each.
2) The total estimated volume of the five dry well excavations is 465 cubic yards
3) The total estimated volume of the distribution box excavation is 94 cubic yards
4) The distribution box will be about 2 cubic yards of waste
5) Waste disposal volumes generated by excavation were assumed to expand by a factor of 1.3
6) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to Developing Cost Estimates During the Feasibility Study (EPA, 2000).
7) The dry well excavations will be filled with controlled density fill (CDF).
8) The CDF will not require compaction.
9) Clean fill from the upper 8 feet of the dry wells will be used to backfill the distribution box excavation.
10) No excavation dewatering will be required.
11) The excavation will not be delineated with geotextile fabric
12) The confirmation sample suite will be hexavalent chromium, chromium, mercury, molybdenum, silver, Cs-137 and Sr-90.
13) 2 waste characterization samples will be collected; 1 per each 800 cubic yards, 1 duplicate
14) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to Developing Cost Estimates During the Feasibility Study (EPA, 2000).
15) No shoring will be required.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-23. Removal and off-Site Disposal—Upper Range Cleanup Goals, Southwest Trenches

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	600	$2.00	linear foot	$1,200	J
Health and safety meetings [4]	45	$1,000.00	day	$45,000	H
Task meetings [5]	20	$2,000.00	lump sum	$40,000	H
Field operations management	45	$2,000.00	day	$90,000	H
Remove and temporarily stockpile clean overburden	656	$30.00	cubic yard	$19,680	A
Excavate and stockpile soil using conventional equipment	1481	$30.00	cubic yard	$44,430	A
Excavate soil with oversize auger	5727	$173.00	cubic yard	$990,840	G
Collect waste characterization samples	13	$130.00	sample	$1,690	H
Analyze waste characterization samples (full suite) [6]	13	$3,367	sample	$43,769	B
Validate and import waste characterization data	13	$615.00	sample	$7,995	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, transport and dispose Class II waste soil	4,202	$60.00	cubic yard	$252,143	A
Package low level waste and ship to Envirocare	5,067	$306.00	cubic yard	$1,550,386	A
Dispose low level waste at Envirocare	5,067	$216.00	cubic yard	$1,094,390	A
Document field activities	45	$130.00	day	$5,850	H
Collect field screening samples	80	$48.75	sample	$3,900	H
Onsite lab analysis	80	$76.88	sample	$6,150	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	45	$130.00	sample	$5,850	H
Analyze confirmation samples [7]	45	$453.45	sample	$20,405	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	45	$410.00	sample	$18,450	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	1,925	$105.00	cubic yard	$202,157	E
Low density concrete fill material	5,727	$90.00	cubic yard	$515,466	G
Delineate the excavaton area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the conventional excavations	2,778	$11.00	cubic yard	$30,559	A
Replace chain-link fence along levee	110	$10.02	linear foot	$1,102	J
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Contingency	25%			$1,286,853	

Table A-23. Removal and off-Site Disposal—Upper Range Cleanup Goals, Southwest Trenches (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
		Direct Capital Costs Subtotal		$6,434,266	
INDIRECT CAPITAL COSTS					
Engineering and Design	8%			$514,741	
Project Management	5%			$321,713	
		Indirect Capital Costs Subtotal		$836,455	
		Capital Costs Subtotal [2]		**$7,271,000**	
		TOTAL		$7,271,000	

Notes
[1] Capital costs occur in year 0;no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes nitrate, C-14 and Sr-90.

Key Assumptions
1) Excavation volumes based on achieving upper range cleanup goals. Excavation shown in Appendix B.
2) The confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Sr-90.
3) Waste disposal volumes generated by conventional and oversize auger excavation were assumed to expand by a factor of 1.3
4) Oversize auger borings will overlap and increase the auger waste volume by an additional assumed factor of 1.4.
5) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to
6) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
7) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to
8) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
9) Thirteen waste characterization samples will be collected; 1 per each 800 cubic yards, 2 duplicates.
10) All of the clean fill from the 1998 excavation will be returned to the new excavation without testing.
11) No excavation dewatering will be required.
12) No shoring will be required.
13) The deep excavations will be filled with controlled density fill (CDF). The CDF will not require compaction.
14) The conventional excavations will be backfilled with 1998 backfill and new import fill.
15) The excavation will not be delineated with geotextile fabric

Data Source
A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-24. Removal and Off-Site Disposal – Lower range cleanup goals, Southwest Trenches

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	600	$2.00	linear foot	$1,200	J
Health and safety meetings [4]	50	$1,000.00	day	$50,000	H
Task meetings [5]	25	$2,000.00	lump sum	$50,000	H
Field operations management	50	$2,000.00	day	$100,000	H
Remove and temporarily stockpile clean overburden	656	$30.00	cubic yard	$19,680	A
Excavate and stockpile soil using conventional equipment	1,652	$30.00	cubic yard	$49,560	A
Excavate soil with oversize auger	6,696	$173.00	cubic yard	$1,158,443	G
Collect waste characterization samples	16	$130.00	sample	$2,080	H
Analyze waste characterization samples (full suite) [6]	16	$3,367	sample	$53,870	B
Validate and import waste characterization data	16	$615.00	sample	$9,840	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, transport and dispose Class II waste soil	4,202	$60.00	cubic yard	$252,143	A
Package low level waste and ship to Envirocare	6,548	$306.00	cubic yard	$2,003,657	A
Dispose low level waste at Envirocare	6,548	$216.00	cubic yard	$1,414,346	A
Document field activities	50	$130.00	day	$6,500	H
Collect field screening samples	100	$48.75	sample	$4,875	H
Onsite lab analysis	100	$76.88	sample	$7,688	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	50	$130.00	sample	$6,500	H
Analyze confirmation samples [7]	50	$453.45	sample	$22,673	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	50	$410.00	sample	$20,500	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	2,148	$105.00	cubic yard	$225,498	E
Low density concrete fill material	6,696	$90.00	cubic yard	$602,658	G
Delineate the excavation area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the conventional excavations	3,000	$11.00	cubic yard	$33,004	A
Replace chain-link fence along levee	110	$10.02	linear foot	$1,102	J
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Contingency	25%			$1,562,954	

Table A-24. Removal and Off-Site Disposal – Lower range cleanup goals, Southwest Trenches (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
	Direct Capital Costs Subtotal			$7,814,770	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	8%			$625,182	
Project Management	5%			$390,739	
	Indirect Capital Costs Subtotal			$1,015,920	
	Capital Costs Subtotal [2]			**$8,831,000**	
	TOTAL			**$8,831,000**	

Notes

[1] Capital costs occur in year 0;no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes nitrate, C-14 and Sr-90.

Assumptions

1) The volumes are based on the excavations determined in Appendix X.
2) The confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Sr-90.
3) Waste disposal volumes generated by conventional and oversize auger excavation were assumed to expand by a factor of 1.3
4) Oversize auger borings will overlap and increase the auger waste volume by an additional assumed factor of 1.4.
5) The engineering and design and project management percentages are based on Exhibit 5.8 in *A Guide to Developing Cost Estimates During the Feasibility Study* (EPA, 2000).
6) The scope contingency is assumed to be 15% and bid contingency is 10% based on *A Guide to Developing Cost Estimates During the Feasibility Study* (EPA, 2000).
7) Sixteen waste characterization samples will be collected; 1 per each 800 cubic yards, 2 duplicates.
8) All of the clean fill from the 1998 excavation will be returned to the new excavation without testing.
9) No excavation dewatering will be required.
10) No shoring will be required.
11) The deep nitrate excavation will be filled with controlled density fill (CDF). The CDF will not require compaction.
12) The conventional excavations will be backfilled with 1998 backfill and new import fill.
13) The excavation will not be delineated with geotextile fabric

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-25. Removal and Off-Site Disposal, Eastern Dog Pens

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS					
Prepare work plan [3]	1	$40,000.00	lump sum	$40,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Remove existing fencing	760	$10.00	linear foot	$7,600	J
Install perimeter fence	900	$2.00	linear foot	$1,800	J
Health and safety meetings [4]	30	$1,000.00	day	$30,000	H
Task meetings [5]	15	$2,000.00	lump sum	$30,000	H
Field operations management	30	$2,000.00	day	$60,000	H
Mitigation fee for elderberry tree removal	10	$5,000.00	tree	$50,000	A
Demolish and stockpile concrete curbing	0	$4.33	linear foot	-	A
Demolish and stockpile asphalt	116	$20.00	cubic yard	$2,320	A
Excavate and stockpile gravel	995	$30.00	cubic yard	$29,850	A
Excavate and stockpile soil	219	$30.00	cubic yard	$6,584	A
Collect waste characterization samples	7	$130.00	sample	$910	H
Analyze waste characterization samples (full suite) [6]	7	$3,366.85	sample	$23,568	B
Validate and import waste characterization data	7	$615.00	sample	$4,305	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Package low level rad in Lift Liners and ship to Envirocare	1,431	$306.00	cubic yard	$437,925	A
Dispose low level waste at Envirocare	1,431	$216.00	cubic yard	$309,123	A
Document field activities	30	$130.00	day	$3,900	H
Collect field screening samples	127	$48.75	sample	$6,191	H
Onsite lab analysis	127	$76.88	sample	$9,763	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	30	$130.00	sample	$3,900	H
Analyze confirmation samples [7]	30	$318.50	sample	$9,555	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	30	$410.00	sample	$12,300	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	1,730	$60.00	cubic yard	$103,778	E
Delineate the excavaton area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the excavation area	1,730	$11.00	cubic yard	$19,026	A
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A

Table A-25. Removal and Off-Site Disposal, Eastern Dog Pens (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Contingency	20%			$255,680	
		Direct Capital Costs Subtotal		$1,534,078	
INDIRECT CAPITAL COSTS					
Engineering and Design	2%			$30,682	
Project Management	4%			$61,363	
		Indirect Capital Costs Subtotal		$92,045	
		Capital Costs Subtotal [2]		**$1,626,000**	
		TOTAL		$1,626,000	

Notes
[1] Capital costs occur in year 0;no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes dieldrin and Sr-90.

Key Assumptions
1) The Eastern Dog Pens excavation will be 1.5 feet deep after the asphalt and gravel are removed, based on Western Dog Pens experience.
2) Pre-characterization field screening samples will be collected on a 20 foot grid prior to soil excavation.
3) Six inches of soil will be removed at locations shown on Figure 4-28.
4) The underlying landfill will be encountered at two feet below ground surface.
5) The confirmation samples will be analyzed with a normal turn around time for the following constituents: dieldrin and Sr-90.
6) Removed gravel, asphalt and soil were assumed low-level rad-added waste.
7) Soil and asphalt volume generated by excavation was assumed to expand by a factor of 1.3
8) Gravel was not assumed to expand upon excavation.
9) Seven waste characterization samples will be collected; 1 per each 800 cubic yards, 1 duplicate per matrix (soil, gravel, asphalt).
10) The excavation will be backfilled with clean import fill.

Data Source
A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-26. Removal and Phytoremediation with Limited Off-Site Disposal—Upper Range Cleanup Goals, Radium/Strontium Treatment System

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan	1	$80,000.00	lump sum	$80,000	A
Removal Action					
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	700	$2.00	linear foot	$1,400	J
Health and safety meetings	50	$1,000.00	day	$50,000	H
Task meetings	25	$2,000.00	lump sum	$50,000	H
Field operations management	50	$2,000.00	day	$100,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Remove and temporarily stockpile clean overburden	805	$30.00	cubic yard	$24,149	A
Excavate and stockpile soil using conventional equipment	479	$30.00	cubic yard	$14,383	A
Excavate soil with oversize auger	2,636	$173.00	cubic yard	$456,019	G
Collect waste characterization samples	2	$130.00	sample	$260	H
Analyze waste characterization samples (full suite) [4]	2	$3,367	sample	$6,734	B
Validate and import waste characterization data	2	$615.00	sample	$1,230	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, transport and dispose Class II waste soil	0	$60.00	cubic yard	$-	A
Package low level waste and ship to Envirocare	349	$306.00	cubic yard	$106,741	A
Dispose low level waste at Envirocare	349	$216.00	cubic yard	$75,346	A
Document field activities	50	$130.00	day	$6,500	H
Collect excavation field screening samples	50	$48.75	sample	$2,438	H
Onsite lab analysis	50	$76.88	sample	$3,844	F
Evaluate excavation field screening data	1	$5,000.00	lump sum	$5,000	H
Collect excavation confirmation samples	35	$130.00	sample	$4,550	H
Analyze excavation confirmation samples [5]	35	$384.00	sample	$13,440	B
Validate and import excavation confirmation data	35	$410.00	sample	$14,350	H
Evaluate excavation confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	14	$105.00	cubic yard	$1,499	E
Low density concrete fill material	2,215	$90.00	cubic yard	$199,357	G
Delineate the excavaton area with geotextile fabric	0	$0.38	square foot	$-	
Backfill, compact and grade the conventional excavations	1,065	$11.00	cubic yard	$11,715	A
Removal Action Confirmation Report	1	$25,000.00	lump sum	$25,000	A

Table A-26. Removal and Phytoremediation with Limited Off-Site Disposal—Upper Range Cleanup Goals, Radium/Strontium Treatment System (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Phytoremediation					
Western Dog Pens preparatory earthwork	3,459	$11.00	cubic yard	$38,049	A
HDPE liner material	93,400	$0.38	square foot	$35,492	G
HDPE liner seam welding/ installation	1	$15,000.00	lump sum	$15,000	G
Move and grade contaminated soil into Western Dog Pens	3,701	$11.00	cubic yard	$40,713	A
Install timed irrigation system	1	$20,000.00	lump sum	$20,000	I
Plastic sheets for winter coverage	93,400	$0.16	square foot	$14,944	G
Contingency	25%			$377,788	
		Direct Capital Costs Subtotal		$1,888,941	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	8%			$151,115	
Project Management	5%			$94,447	
		Indirect Capital Costs Subtotal		$245,562	
		Capital Costs Subtotal [2]		**$2,135,000**	
ANNUAL COSTS [1]					
Adjust phosphorus, potassium, and pH levels in soil	1	$2,200.00	lump sum	$2,200	I
Apply warm season grass seed	1	$2,200.00	lump sum	$2,200	I
Liner and irrigation system maintenance/inspections/repairs	1	$12,000.00	lump sum	$12,000	I
Trim grass and store cuttings [6]	1	$8,000.00	lump sum	$8,000	I
Collect soil and grass samples	20	$130.00	sample	$2,600	H
Analyze soil/grass samples [7]	20	$30.00	sample	$600	B
Evaluate annual data	1	$2,500.00	lump sum	$2,500	H
Annual Costs				$30,100	
Contingency	10%			$3,010	
		Annual Costs Subtotal		$33,110	
		Present Worth of Annual Costs Subtotal [2,3]		**$93,000**	
PERIODIC COSTS [1]					
Collect phytoremediation confirmation samples	25	$130.00	sample	$3,250	H
Analyze phytoremediation confirmation samples [7]	25	$30.00	sample	$750	B
Validate and import phytoremediation confirmation data	25	$410.00	sample	$10,250	H
Evaluate phytoremediation confirmation data	1	$5,000.00	lump sum	$5,000	H
Move soil, remove liner and sprinkler system, re-grade soil	1	$20,000.00	lump sum	$20,000	A
Collect HDPE, sprinkler system, grass	6	$130.00	sample	$780	H

Table A-26. Removal and Phytoremediation with Limited Off-Site Disposal—Upper Range Cleanup Goals, Radium/Strontium Treatment System (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
cuttings waste samples					
Analyze waste samples [4]	6	$3,366.85	sample	$20,201	B
Validate and import waste data	6	$615.00	sample	$3,690	H
Release report [8] for HDPE, sprinkler system, grass cuttings	1	$20,000.00	lump sum	$20,000	H
Dispose HDPE, sprinkler system, grass cuttings	7	$60.00	ton	$420	A
Phytoremediation confirmation report / risk assessment	1	$25,000.00	lump sum	$25,000	H
Periodic Costs				$109,341	
Contingency	10%			$10,934	
Project Management	25%			$27,335	
			Periodic Costs Subtotal	$147,610	
			Present Worth of Periodic Costs Subtotal [2,3]	**$135,000**	
			TOTAL	$2,363,000	

Notes
[1] Capital costs occur in year 0, annual costs occur for 3 years, and one periodic cost occurs at year 3.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.
[4] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[5] Confirmation sample analysis suite includes nitrate, C-14 and Ra-226
[6] The phytoremediation growing season will extend over more than 20 weeks per year (May through September). Grass trimming will occur weekly for optimal growth. The trimming process must retrieve all of the grass cuttings to prevent contamination from being reintroduced on to the soil surface. One worker will trim/retrieve grass cuttings over the 2.14 acre area, decontaminate the mower, service the mower and store the waste within a day. Based on a $50 per hour labor rate, the total labor cost to cut and store the grass over 20 weeks is $8,000. Cost does not include mower fuel and mower replacement parts.
[7] Sample analysis suite includes nitrate.
[8] Release report for materials with low levels of added radioactivity prepared according to DOE Order 5400.5 to release materials for unrestricted use/disposal. Materials that may contain low levels of added radioactivity upon decommissioning are the HDPE liner, sprinkler system and grass cuttings. Release report evaluation requires extensive exposure modeling of transportation and disposal options. Release report cost is based on actual costs for previous LEHR release reports.

Key Assumptions

Removal Action

1) Excavation volumes based on achieving upper range cleanup goals. Excavation shown in Appendix B.
2) Low level waste is located between 5 and 10 feet bgs based on Sr-90 data.
3) Half of the soil located between 5 and 10 feet bgs is clean backfill from the 1999 Area 1 excavation.
4) The confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Ra-226.
5) Waste disposal volumes generated by conventional and oversize auger excavation were assumed to expand by a factor of 1.3
6) Oversize auger borings will overlap and increase the auger waste volume by an additional assumed factor of 1.4.
7) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to
8) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
9) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to
10) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
11) 2 waste characterization samples will be collected; 1 per each 800 cubic yards, 1 duplicate.
12) All of the clean fill from the 1999 Area 1 excavation will be returned to the new excavation without testing.
13) The top 5 feet of native soil is assumed clean, given the depth of the treatment system leach trenches, and will be reused as backfill.

Table A-26. Removal and Phytoremediation with Limited Off-Site Disposal—Upper Range Cleanup Goals, Radium/Strontium Treatment System (continued)

14) No excavation dewatering will be required.
15) No shoring will be required.
16) The conventional excavations will be filled with clean fill recovered from the 1999 Area 1 excavation and top 5 feet of native soil.
17) The borings will be filled with controlled density fill and the remaining clean soil. The CDF will not require compaction.
18) The excavation will not be delineated with geotextile fabric

Phytoremediation

1) The phytoremediation project will consist of installation in year 0, annual growing seasons for 3 years, and decommissioning at the end of year 3.
2) Western Dog Pens preparatory earthwork consists of grading soil to prevent ponding during the rainy season.
3) The liner will be a single welded seamless sheet of high density polyethylene.
4) The contaminated soil will be placed on the liner and graded to an even thickness.
5) The sprinkler system piping will be installed in shallow (6 inch deep) trenches after soil placement.
6) No institutional controls will be necessary because strontium-90 contaminated soil would be segregated and disposed at Envirocare.
7) The phytoremediation area will be covered with a waterproof tarp during the rainy season to prevent stormwater contact.
8) The grass will be trimmed several times during the growing season and the cuttings will be stored for release upon decommissioning.
9) The plastic liner and sheets, sprinkler system, and grass cuttings will be approved for release to a Class II landfill upon decommissioning.
10) The treated soil will remain in the Western Dog Pens after decommissioning. The treated soil will be graded into an even thickness lift.
11) Discount rate of 3.1% for Federal Facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-27. Removal and Phytoremediation with Limited Off-Site Disposal – Lower range cleanup goals, Radium/Strontium Treatment Systems

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan	1	$80,000.00	lump sum	$80,000	A
Removal Action					
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	700	$2.00	linear foot	$1,400	J
Health and safety meetings	60	$1,000.00	day	$60,000	H
Task meetings	30	$2,000.00	lump sum	$60,000	H
Field operations management	60	$2,000.00	day	$120,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Remove and temporarily stockpile clean overburden	1,051	$30.00	cubic yard	$31,538	A
Excavate and stockpile soil using conventional equipment	250	$30.00	cubic yard	$7,507	A
Excavate soil with oversize auger	4,804	$173.00	cubic yard	$831,114	G
Collect waste characterization samples	2	$130.00	sample	$260	H
Analyze waste characterization samples (full suite) [4]	2	$3,367	sample	$6,734	B
Validate and import waste characterization data	2	$615.00	sample	$1,230	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, transport and dispose Class II waste soil	0	$60.00	cubic yard	$-	A
Package low level waste and ship to Envirocare	456	$306.00	cubic yard	$139,397	A
Dispose low level waste at Envirocare	456	$216.00	cubic yard	$98,398	A
Document field activities	60	$130.00	day	$7,800	H
Collect excavation field screening samples	60	$48.75	sample	$2,925	H
Onsite lab analysis	60	$76.88	sample	$4,613	F
Evaluate excavation field screening data	1	$5,000.00	lump sum	$5,000	H
Collect excavation confirmation samples	40	$130.00	sample	$5,200	H
Analyze excavation confirmation samples [5]	40	$384.00	sample	$15,360	B
Validate and import excavation confirmation data	40	$410.00	sample	$16,400	H
Evaluate excavation confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	0	$105.00	cubic yard	$-	
Low density concrete fill material	3,440	$90.00	cubic yard	$309,557	G
Delineate the excavation area with geotextile fabric	0	$0.38	square foot	$-	
Backfill, compact and grade the conventional excavations	1,367	$11.00	cubic yard	$15,033	A

Table A-27. Removal and Phytoremediation with Limited Off-Site Disposal – Lower range cleanup goals, Radium/Strontium Treatment Systems (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Removal Action Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Phytoremediation					
Western Dog Pens preparatory earthwork	3,459	$11.00	cubic yard	$38,049	A
HDPE liner material	93,400	$0.38	square foot	$35,492	G
HDPE liner seam welding/ installation	1	$15,000.00	lump sum	$15,000	G
Move and grade contaminated soil into Western Dog Pens	6,115	$11.00	cubic yard	$67,266	A
Install timed irrigation system	1	$20,000.00	lump sum	$20,000	I
Plastic sheets for winter coverage	93,400	$0.16	square foot	$14,944	G
Contingency	25%			$532,054	
		Direct Capital Costs Subtotal		$2,660,269	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	8%			$212,822	
Project Management	5%			$133,013	
		Indirect Capital Costs Subtotal		$345,835	
		Capital Costs Subtotal [2]		**$3,006,000**	
ANNUAL COSTS [1]					
Adjust phosphorus, potassium, and pH levels in soil	1	$2,200.00	lump sum	$2,200	I
Apply warm season grass seed	1	$2,200.00	lump sum	$2,200	I
Liner and irrigation system maintenance/inspections/repairs	1	$12,000.00	lump sum	$12,000	I
Trim grass and store cuttings [6]	1	$8,000.00	lump sum	$8,000	I
Collect soil and grass samples	20	$130.00	sample	$2,600	H
Analyze soil/grass samples [7]	20	$30.00	sample	$600	B
Evaluate annual data	1	$2,500.00	lump sum	$2,500	H
Contingency	10%			$3,010	
		Annual Costs Subtotal		$33,110	
		Present Worth of Annual Costs Subtotal [2,3]		**$93,000**	
PERIODIC COSTS [1]					
Collect phytoremediation confirmation samples	25	$130.00	sample	$3,250	H
Analyze phytoremediation confirmation samples [7]	25	$30.00	sample	$750	B
Validate and import phytoremediation confirmation data	25	$410.00	sample	$10,250	H
Evaluate phytoremediation confirmation data	1	$5,000.00	lump sum	$5,000	H
Move soil, remove liner and sprinkler system, re-grade soil	1	$20,000.00	lump sum	$20,000	A

Table A-27. Removal and Phytoremediation with Limited Off-Site Disposal – Lower range cleanup goals, Radium/Strontium Treatment Systems (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Collect HDPE, sprinkler system, grass cuttings waste samples	6	$130.00	sample	$780	H
Analyze waste samples [4]	6	$3,366.85	sample	$20,201	B
Validate and import waste data	6	$615.00	sample	$3,690	H
Release report [8] for HDPE, sprinkler system, grass cuttings	1	$20,000.00	lump sum	$20,000	H
Dispose HDPE, sprinkler system, grass cuttings	7	$60.00	ton	$420	A
Phytoremediation confirmation report / risk assessment	1	$25,000.00	lump sum	$25,000	H
Contingency	10%			$10,934	
Project Management	25%			$27,335	
			Periodic Costs Subtotal	$147,610	
			Present Worth of Periodic Costs Subtotal [2,3]	**$135,000**	
			TOTAL	**$3,234,000**	

Notes

[1] Capital costs occur in year 0, annual costs occur for 3 years, and one periodic cost occurs at year 3.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.
[4] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[5] Confirmation sample analysis suite includes nitrate, C-14 and Ra-226
[6] The phytoremediation growing season will extend over more than 20 weeks per year (May through September). Grass trimming will occur weekly for optimal growth. The trimming process must retrieve all of the grass cuttings to prevent contamination from being reintroduced on to the soil surface. One worker will trim/retrieve grass cuttings over the 2.14 acre area, decontaminate the mower, service the mower and store the waste within a day. Based on a $50 per hour labor rate, the total labor cost to cut and store the grass over 20 weeks is $8,000. Cost does not include mower fuel and mower replacement parts.
[7] Sample analysis suite includes nitrate.
[8] Release report for materials with low levels of added radioactivity prepared according to DOE Order 5400.5 to release materials for unrestricted use/disposal. Materials that may contain low levels of added radioactivity upon decommissioning are the HDPE liner, sprinkler system and grass cuttings. Release report evaluation requires extensive exposure modeling of transportation and disposal options. Release report cost is based on actual costs for previous LEHR release reports.

Assumptions

Removal Action:

1) The excavation volumes are based on the excavations determined in Appendix X.
2) Low level waste is located between 5 and 10 feet bgs based on Sr-90 data.
3) Half of the soil located between 5 and 10 feet bgs is clean backfill from the 1999 Area 1 excavation.
4) The confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Ra-226.
5) Waste disposal volumes generated by conventional and oversize auger excavation were assumed to expand by a factor of 1.3
6) Oversize auger borings will overlap and increase the auger waste volume by an additional assumed factor of 1.4.
7) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to Developing Cost Estimates During the Feasibility Study (EPA, 2000).
8) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to Developing Cost Estimates During the Feasibility Study (EPA, 2000).
9) Two waste characterization samples will be collected; 1 per each 800 cubic yards, 1 duplicate.
10) All of the clean fill from the 1999 Area 1 excavation will be returned to the new excavation without testing.
11) The top 5 feet of native soil is assumed clean, given the depth of the treatment system leach trenches, and will be reused as backfill.
12) No excavation dewatering will be required.
13) No shoring will be required.
14) The conventional excavations will be filled with clean fill recovered from the 1999 Area 1 excavation and top 5 feet of native soil.

Table A-27. Removal and Phytoremediation with Limited Off-Site Disposal – Lower range cleanup goals, Radium/Strontium Treatment Systems (continued)

15) The borings will be filled with controlled density fill and the remaining clean soil. The CDF will not require compaction.
16) The excavation will not be delineated with geotextile fabric

Phytoremediation:

1) The phytoremediation project will consist of installation in year 0, annual growing seasons for 3 years, and decommissioning at the end of year 3.
2) Western Dog Pens preparatory earthwork consists of grading soil to prevent ponding during the rainy season.
3) The liner will be a single welded seamless sheet of high density polyethylene.
4) The contaminated soil will be placed on the liner and graded to an even thickness.
5) The sprinkler system piping will be installed in shallow (6 inch deep) trenches after soil placement.
6) No institutional controls will be necessary because strontium-90 contaminated soil would be segregated and disposed at Envirocare.
7) The phytoremediation area will be covered with a waterproof tarp during the rainy season to prevent storm water contact.
8) The grass will be trimmed several times during the growing season and the cuttings will be stored for release upon decommissioning.
9) The plastic liner and sheets, sprinkler system, and grass cuttings will be approved for release to a Class II landfill upon decommissioning.
10) The treated soil will remain in the Western Dog Pens after decommissioning. The treated soil will be graded into an even thickness lift.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-28. Removal, Soil Drying, Phytoremediation, and Limited Off-Site Disposal, Domestic Septic System No. 3

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan	1	$80,000.00	lump sum	$80,000	A
Removal Action					
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	700	$2.00	linear foot	$1,400	J
Health and safety meetings	40	$1,000.00	day	$40,000	H
Task meetings	20	$2,000.00	lump sum	$40,000	H
Field operations management	40	$2,000.00	day	$80,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Excavate soil with oversize auger	5,536	$173.00	cubic yard	$957 ,659	G
Collect waste characterization samples	4	$130.00	sample	$520	H
Analyze waste characterization samples (full suite) [4]	4	$3,367	sample	$13,467	B
Validate and import waste characterization data	4	$615.00	sample	$2,460	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, transport and dispose Class II waste soil	0	$60.00	cubic yard	$-	A
Package low level waste and ship to Envirocare	2,129	$306.00	cubic yard	$651,620	A
Dispose low level waste at Envirocare	2,129	$216.00	cubic yard	$459,967	A
Document field activities	40	$130.00	day	$5,200	H
Collect excavation field screening samples	40	$48.75	sample	$1,950	H
Onsite lab analysis	40	$76.88	sample	$3,075	F
Evaluate excavation field screening data	1	$5,000.00	lump sum	$5,000	H
Collect excavation confirmation samples	25	$130.00	sample	$3,250	H
Analyze excavation confirmation samples [5]	25	$246.55	sample	$6,164	B
Validate and import excavation confirmation data	25	$410.00	sample	$10,250	H
Evaluate excavation confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	238	$105.00	cubic yard	$24,978	E
Low density concrete fill material (8 - 50 ft)	3,321	$90.00	cubic yard	$298,922	G
Delineate the excavation area with geotextile fabric	0	$0.38	square foot	$-	
Backfill, compact and grade the excavation area	822	$11.00	cubic yard	$9,047	A
Removal Action Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Phytoremediation					
Western Dog Pens preparatory earthwork	3,459	$11.00	cubic yard	$38,049	A
Formaldehyde air permitting	1	$20,000.00	lump sum	$20,000	I
HDPE liner material	93,400	$0.38	square foot	$35,492	G
HDPE liner seam welding/ installation	1	$15,000.00	lump sum	$15,000	G

Table A-28. Removal, Soil Drying, Phytoremediation, and Limited Off-Site Disposal, Domestic Septic System No. 3 (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Move and grade contaminated soil into Western Dog Pens	4,318	$11.00	cubic yard	$47,495	A
Install timed irrigation system	1	$20,000.00	lump sum	$20,000	I
Plastic sheets for winter coverage	93,400	$0.16	square foot	$14,944	G
Contingency	25%			$750,977	
		Direct Capital Costs Subtotal		$3,754,886	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	8%			$300,391	
Project Management	5%			$187,744	
		Indirect Capital Costs Subtotal		$488,135	
		Capital Costs Subtotal [2]		**$4,243,000**	
ANNUAL COSTS [1]					
Adjust phosphorus, potassium, and pH levels in soil	1	$2,200.00	lump sum	$2,200	I
Apply warm season grass seed	1	$2,200.00	lump sum	$2,200	I
Liner and irrigation system maintenance/inspections/repairs	1	$12,000.00	lump sum	$12,000	I
Trim grass and store cuttings [6]	1	$8,000.00	lump sum	$8,000	I
Collect soil and grass samples	20	$130.00	sample	$2,600	H
Analyze soil/grass samples [7]	20	$30.00	sample	$600	B
Evaluate annual data	1	$2,500.00	lump sum	$2,500	H
Contingency	10%			$3,010	
		Annual Costs Subtotal		$33,110	
		Present Worth of Annual Costs Subtotal [2,3]		**$93,000**	
PERIODIC COSTS [1]					
Collect phytoremediation confirmation samples	25	$130.00	sample	$3,250	H
Analyze phytoremediation confirmation samples [7]	25	$30.00	sample	$750	B
Validate and import phytoremediation confirmation data	25	$410.00	sample	$10,250	H
Evaluate phytoremediation confirmation data	1	$5,000.00	lump sum	$5,000	H
Move soil, remove liner and sprinkler system, re-grade soil	1	$20,000.00	lump sum	$20,000	A
Collect HDPE, sprinkler system, grass cuttings waste samples	6	$130.00	sample	$780	H
Analyze waste samples [4]	6	$3,366.85	sample	$20,201	B
Validate and import waste data	6	$615.00	sample	$3,690	H
Release report [8] for HDPE, sprinkler system, grass cuttings	1	$20,000.00	lump sum	$20,000	H
Dispose HDPE, sprinkler system, grass cuttings	7	$60.00	ton	$420	A
Phytoremediation confirmation report /	1	$25,000.00	lump sum	$25,000	H

Table A-28. Removal, Soil Drying, Phytoremediation, and Limited Off-Site Disposal, Domestic Septic System No. 3 (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
risk assessment					
Contingency	10%			$10,934	
Project Management	25%			$27,335	
		Periodic Costs Subtotal		$147,610	
		Present Worth of Periodic Costs Subtotal [2,3]		**$135,000**	
			TOTAL	**$4,471,000**	

Notes

[1] Capital costs occur in year 0, annual costs occur for 3 years, and one periodic cost occurs at year 3.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.
[4] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[5] Confirmation sample analysis suite includes formaldehyde, molybdenum and nitrate.
[6] The phytoremediation growing season will extend over more than 20 weeks per year (May through September). Grass trimming will occur weekly for optimal growth. The trimming process must retrieve all of the grass cuttings to prevent contamination from being reintroduced on to the soil surface. One worker will trim/retrieve grass cuttings over the 2.14 acre area, decontaminate the mower, service the mower and store the waste within a day. Based on a $50 per hour labor rate, the total labor cost to cut and store the grass over 20 weeks is $8,000. Cost does not include mower fuel and mower replacement parts.
[7] Sample analysis suite includes nitrate.
[8] Release report for materials with low levels of added radioactivity prepared according to DOE Order 5400.5 to release materials for unrestricted use/disposal. Materials that may contain low levels of added radioactivity upon decommissioning are the HDPE liner, sprinkler system and grass cuttings. Release report evaluation requires extensive exposure modeling of transportation and disposal options. Release report cost is based on actual costs for previous LEHR release reports.

Assumptions

Removal Action:

1) Excavation will be conducted using an oversized auger.
2) The excavation depth will be 50 feet based on the seasonal low water table.
3) The top 4 feet of native soil is assumed clean and will be reused as backfill.
4) Native soil between 4 and 20 feet is assumed low level rad added waste.
5) Soil between 20 and 50 feet below ground surface is assumed treated with soil drying and phytoremediation.
6) The excavation confirmation sample suite will be formaldehyde, molybdenum and nitrate.
7) Waste disposal volumes generated by conventional and oversize auger excavation were assumed to expand by a factor of 1.3
8) Oversize auger borings will overlap and increase the auger waste volume by an additional assumed factor of 1.4.
9) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to Developing Cost Estimates During the Feasibility Study (EPA, 2000).
10) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to Developing Cost Estimates During the Feasibility Study (EPA, 2000).
11) Four waste characterization samples will be collected; 1 per each 800 cubic yards, 1 duplicate.
12) The import backfill volume in the 2002 removal action was approximately 260 cubic yards (assuming an expansion factor of 1.3).
13) The clean import backfill in the 2002 excavation will be returned to the excavation without testing.
14) No excavation dewatering will be required.
15) No shoring will be required.
16) The top 8 feet of each boring will be filled with a combination of clean fill recovered from the 2002 excavation, overburden and import fill.
17) The borings will be filled with controlled density fill (CDF) between 8 and 50 feet deep. The CDF will not require compaction.
18) The excavation will not be delineated with geotextile fabric.

Phytoremediation/Soil Drying:

1) The phytoremediation project will consist of installation in year 0, annual growing seasons for 3 years, and decommissioning at the end of year 3.
2) Soil drying will be conducted during the summer of year 0
3) Western Dog Pens preparatory earthwork consists of grading soil to prevent ponding during the rainy season.

Table A-28. Removal, Soil Drying, Phytoremediation, and Limited Off-Site Disposal, Domestic Septic System No. 3 (continued)

4) The liner will be a single welded seamless sheet of high density polyethylene.
5) The contaminated soil will be placed on the liner and graded to an even thickness.
6) The sprinkler system piping will be installed in shallow (6 inch deep) trenches after soil placement.
7) No institutional controls will be necessary because strontium-90 contaminated soil would be segregated and disposed at Envirocare.
8) The phytoremediation area will be covered with a waterproof tarp during the rainy season to prevent storm water contact.
9) The grass will be trimmed several times during the growing season and the cuttings will be stored for release upon decommissioning.
10) The plastic liner and sheets, sprinkler system, and grass cuttings will be approved for release to a Class II landfill upon decommissioning.
11) The treated soil will remain in the Western Dog Pens after decommissioning. The treated soil will be graded into an even thickness lift.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-29. Removal and Phytoremediation with Limited Off-Site Disposal—Upper Range Cleanup Goals, Southwest Trenches

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan	1	$80,000.00	lump sum	$80,000	A
Removal Action					
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	600	$2.00	linear foot	$1,200	J
Health and safety meetings	45	$1,000.00	day	$45,000	H
Task meetings	20	$2,000.00	lump sum	$40,000	H
Field operations management	45	$2,000.00	day	$90,000	H
Remove and temporarily stockpile clean overburden	656	$30.00	cubic yard	$19,680	A
Excavate and stockpile soil using conventional equipment	1481	$30.00	cubic yard	$44,430	A
Excavate soil with oversize auger	5727	$173.00	cubic yard	$990,840	G
Collect waste characterization samples	6	$130.00	sample	$780	H
Analyze waste characterization samples (full suite) [4]	6	$3,367	sample	$20,201	B
Validate and import waste characterization data	6	$615.00	sample	$3,690	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, transport and dispose Class II waste soil	0	$60.00	cubic yard	$-	A
Package low level waste and ship to Envirocare	3,806	$306.00	cubic yard	$1,164,691	A
Dispose low level waste at Envirocare	3,806	$216.00	cubic yard	$822,135	A
Document field activities	45	$130.00	day	$5,850	H
Collect excavation field screening samples	80	$48.75	sample	$3,900	H
Onsite lab analysis	80	$76.88	sample	$6,150	F
Evaluate excavation field screening data	1	$5,000.00	lump sum	$5,000	H
Collect excavation confirmation samples	45	$130.00	sample	$5,850	H
Analyze excavation confirmation samples [5]	45	$453.45	sample	$20,405	B
Validate and import excavation confirmation data	45	$410.00	sample	$18,450	H
Evaluate excavation confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	1,925	$105.00	cubic yard	$202,157	E
Low density concrete fill material	5,727	$90.00	cubic yard	$515,466	G
Delineate the excavation area with geotextile fabric	0	$0.38	square foot	$-	
Backfill, compact and grade the conventional excavations	2,778	$11.00	cubic yard	$30,559	A
Removal Action Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Phytoremediation					
Western Dog Pens preparatory earthwork	3,459	$11.00	cubic yard	$38,049	A

Table A-29. Removal and Phytoremediation with Limited Off-Site Disposal—Upper Range Cleanup Goals, Southwest Trenches (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
HDPE liner material	93,400	$0.38	square foot	$35,492	I
HDPE liner seam welding/ installation	1	$15,000.00	lump sum	$15,000	G
Move and grade contaminated soil into Western Dog Pens	5,463	$11.00	cubic yard	$60,091	G
Install timed irrigation system	1	$20,000.00	lump sum	$20,000	A
Plastic sheets for winter coverage	93,400	$0.16	square foot	$14,944	I
Contingency	25%			$1,097,003	
		Direct Capital Costs Subtotal		$5,485,014	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	8%			$438,801	
Project Management	5%			$274,251	
		Indirect Capital Costs Subtotal		$713,052	
		Capital Costs Subtotal [2]		**$6,198,000**	
ANNUAL COSTS [1]					
Adjust phosphorus, potassium, and pH levels in soil	1	$2,200.00	lump sum	$2,200	I
Apply warm season grass seed	1	$2,200.00	lump sum	$2,200	I
Liner and irrigation system maintenance/inspections/repairs	1	$12,000.00	lump sum	$12,000	I
Trim grass and store cuttings [6]	1	$8,000.00	lump sum	$8,000	I
Collect soil and grass samples	20	$130.00	sample	$2,600	H
Analyze soil/grass samples [7]	20	$30.00	sample	$600	B
Evaluate annual data	1	$2,500.00	lump sum	$2,500	H
Annual Costs				$30,100	
Contingency	10%			$3,010	
		Annual Costs Subtotal		$33,110	
		Present Worth of Annual Costs Subtotal [2,3]		**$93,000**	
PERIODIC COSTS [1]					
Collect phytoremediation confirmation samples	25	$130.00	sample	$3,250	H
Analyze phytoremediation confirmation samples [7]	25	$30.00	sample	$750	B
Validate and import phytoremediation confirmation data	25	$410.00	sample	$10,250	H
Evaluate phytoremediation confirmation data	1	$5,000.00	lump sum	$5,000	H
Move soil, remove liner and sprinkler system, re-grade soil	1	$20,000.00	lump sum	$20,000	A
Collect HDPE, sprinkler system, grass cuttings waste samples	6	$130.00	sample	$780	H
Analyze waste samples [4]	6	$3,366.85	sample	$20,201	B

Table A-29. Removal and Phytoremediation with Limited Off-Site Disposal—Upper Range Cleanup Goals, Southwest Trenches (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Validate and import waste data	6	$615.00	sample	$3,690	H
Release report [8] for HDPE, sprinkler system, grass cuttings	1	$20,000.00	lump sum	$20,000	H
Dispose HDPE, sprinkler system, grass cuttings	7	$60.00	ton	$420	A
Phytoremediation confirmation report / risk assessment	1	$25,000.00	lump sum	$25,000	H
Periodic Costs				$109,341	
Contingency	10%			$10,934	
Project Management	25%			$27,335	
			Periodic Costs Subtotal	$147,610	
			Present Worth of Periodic Costs Subtotal [2,3]	**$135,000**	
			TOTAL	**$6,426,000**	

Notes
[1] Capital costs occur in year 0, annual costs occur for 3 years, and one periodic cost occurs at year 3.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.
[4] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[5] Confirmation sample analysis suite includes nitrate, C-14 and Ra-226
[6] The phytoremediation growing season will extend over more than 20 weeks per year (May through September). Grass trimming will occur weekly for optimal growth. The trimming process must retrieve all of the grass cuttings to prevent contamination from being reintroduced on to the soil surface. One worker will trim/retrieve grass cuttings over the 2.14 acre area, decontaminate the mower, service the mower and store the waste within a day. Based on a $50 per hour labor rate, the total labor cost to cut and store the grass over 20 weeks is $8,000. Cost does not include mower fuel and mower replacement parts.
[7] Sample analysis suite includes nitrate.
[8] Release report for materials with low levels of added radioactivity prepared according to DOE Order 5400.5 to release materials for unrestricted use/disposal. Materials that may contain low levels of added radioactivity upon decommissioning are the HDPE liner, sprinkler system and grass cuttings. Release report evaluation requires extensive exposure modeling of transportation and disposal options. Release report cost is based on actual costs for previous LEHR release reports.

Key Assumptions

Removal Action

1) Excavation volumes based on achieving upper range cleanup goals. Excavation shown in Appendix B.
2) The excavation confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Sr-90.
3) Waste disposal volumes generated by conventional and oversize auger excavation were assumed to expand by a factor of 1.3
4) Oversize auger borings will overlap and increase the auger waste volume by an additional assumed factor of 1.4.
5) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to
6) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
7) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to
8) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
9) Six waste characterization samples will be collected; 1 per each 800 cubic yards, 1 duplicate.
10) All of the clean fill from the 1998 excavation will be returned to the new excavation without testing.
11) No excavation dewatering will be required.
12) No shoring will be required.
13) The deep excavation will be filled with controlled density fill (CDF). The CDF will not require compaction.
14) The conventional excavations will be backfilled with 1998 backfill and new import fill.
15) The excavation will not be delineated with geotextile fabric

Phytoremediation

Table A-29. Removal and Phytoremediation with Limited Off-Site Disposal—Upper Range Cleanup Goals, Southwest Trenches (continued)

1) The phytoremediation project will consist of installation in year 0, annual growing seasons for 3 years, and decommissioning at the end of year 3.
2) Western Dog Pens preparatory earthwork consists of grading soil to prevent ponding during the rainy season.
3) The liner will be a single welded seamless sheet of high density polyethylene.
4) The contaminated soil will be placed on the liner and graded to an even thickness.
5) The sprinkler system piping will be installed in shallow (6 inch deep) trenches after soil placement.
6) No institutional controls will be necessary because strontium-90 contaminated soil would be segregated and disposed at Envirocare.
7) The phytoremediation area will be covered with a waterproof tarp during the rainy season to prevent stormwater contact.
8) The grass will be trimmed several times during the growing season and the cuttings will be stored for release upon decommissioning.
9) The plastic liner and sheets, sprinkler system, and grass cuttings will be approved for release to a Class II landfill upon decommissioning.
10) The treated soil will remain in the Western Dog Pens after decommissioning. The treated soil will be graded into an even thickness lift.
11) Discount rate of 3.1% for Federal Facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-30. Removal and Phytoremediation with Limited Off-Site Disposal – Lower range cleanup goals, Southwest Trenches

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan	1	$80,000.00	lump sum	$80,000	A
Removal Action					
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	600	$2.00	linear foot	$1,200	J
Health and safety meetings	50	$1,000.00	day	$50,000	H
Task meetings	25	$2,000.00	lump sum	$50,000	H
Field operations management	50	$2,000.00	day	$100,000	H
Remove and temporarily stockpile clean overburden	656	$30.00	cubic yard	$19,680	A
Excavate and stockpile soil using conventional equipment	1,652	$30.00	cubic yard	$49,560	A
Excavate soil with oversize auger	6,696	$173.00	cubic yard	$1,158,443	G
Collect waste characterization samples	8	$130.00	sample	$1,040	H
Analyze waste characterization samples (full suite) [4]	8	$3,367	sample	$26,935	B
Validate and import waste characterization data	8	$615.00	sample	$4,920	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, transport and dispose Class II waste soil	0	$60.00	cubic yard	$-	A
Package low level waste and ship to Envirocare	5,287	$306.00	cubic yard	$1,617,950	A
Dispose low level waste at Envirocare	5,287	$216.00	cubic yard	$1,142,083	A
Document field activities	50	$130.00	day	$6,500	H
Collect excavation field screening samples	100	$48.75	sample	$4,875	H
Onsite lab analysis	100	$76.88	sample	$7,688	F
Evaluate excavation field screening data	1	$5,000.00	lump sum	$5,000	H
Collect excavation confirmation samples	50	$130.00	sample	$6,500	H
Analyze excavation confirmation samples [5]	50	$453.45	sample	$22,673	B
Validate and import excavation confirmation data	50	$410.00	sample	$20,500	H
Evaluate excavation confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	2,148	$105.00	cubic yard	$225,498	E
Low density concrete fill material	6,696	$90.00	cubic yard	$602,658	G
Delineate the excavation area with geotextile fabric	0	$0.38	square foot	$-	
Backfill, compact and grade the conventional excavations	3,000	$11.00	cubic yard	$33,004	A
Removal Action Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Phytoremediation					
Western Dog Pens preparatory earthwork	3,459	$11.00	cubic yard	$38,049	A
HDPE liner material	93,400	$0.38	square	$35,492	I

Table A-30. Removal and Phytoremediation with Limited Off-Site Disposal – Lower range cleanup goals, Southwest Trenches (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
			foot		
HDPE liner seam welding/ installation	1	$15,000.00	lump sum	$15,000	G
Move and grade contaminated soil into Western Dog Pens	5,463	$11.00	cubic yard	$60,091	G
Install timed irrigation system	1	$20,000.00	lump sum	$20,000	A
Plastic sheets for winter coverage	93,400	$0.16	square foot	$14,944	I
Contingency	25%			$1,372,071	
		Direct Capital Costs Subtotal		$6,860,353	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	8%			$548,828	
Project Management	5%			$343,018	
		Indirect Capital Costs Subtotal		$891,846	
		Capital Costs Subtotal [2]		**$7,752,000**	
ANNUAL COSTS [1]					
Adjust phosphorus, potassium, and pH levels in soil	1	$2,200.00	lump sum	$2,200	I
Apply warm season grass seed	1	$2,200.00	lump sum	$2,200	I
Liner and irrigation system maintenance/inspections/repairs	1	$12,000.00	lump sum	$12,000	I
Trim grass and store cuttings [6]	1	$8,000.00	lump sum	$8,000	I
Collect soil and grass samples	20	$130.00	sample	$2,600	H
Analyze soil/grass samples [7]	20	$30.00	sample	$600	B
Evaluate annual data	1	$2,500.00	lump sum	$2,500	H
Contingency	10%			$3,010	
		Annual Costs Subtotal		$33,110	
		Present Worth of Annual Costs Subtotal [2,3]		**$93,000**	
PERIODIC COSTS [1]					
Collect phytoremediation confirmation samples	25	$130.00	sample	$3,250	H
Analyze phytoremediation confirmation samples [7]	25	$30.00	sample	$750	B
Validate and import phytoremediation confirmation data	25	$410.00	sample	$10,250	H
Evaluate phytoremediation confirmation data	1	$5,000.00	lump sum	$5,000	H
Move soil, remove liner and sprinkler system, re-grade soil	1	$20,000.00	lump sum	$20,000	A
Collect HDPE, sprinkler system, grass cuttings waste samples	6	$130.00	sample	$780	H
Analyze waste samples [4]	6	$3,366.85	sample	$20,201	B
Validate and import waste data	6	$615.00	sample	$3,690	H
Release report [8] for HDPE, sprinkler system, grass cuttings	1	$20,000.00	lump sum	$20,000	H
Dispose HDPE, sprinkler system, grass	7	$60.00	ton	$420	A

Table A-30. Removal and Phytoremediation with Limited Off-Site Disposal – Lower range cleanup goals, Southwest Trenches (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
cuttings					
Phytoremediation confirmation report / risk assessment	1	$25,000.00	lump sum	$25,000	H
Contingency	10%			$10,934	
Project Management	25%			$27,335	
			Periodic Costs Subtotal	$147,610	
			Present Worth of Periodic Costs Subtotal [2,3]	**$135,000**	
			TOTAL	**$7,980,000**	

Notes

[1] Capital costs occur in year 0, annual costs occur for 3 years, and one periodic cost occurs at year 3.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for federal facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C.
[4] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[5] Confirmation sample analysis suite includes nitrate, C-14 and Sr-90.
[6] The phytoremediation growing season will extend over more than 20 weeks per year (May through September). Grass trimming will occur weekly for optimal growth. The trimming process must retrieve all of the grass cuttings to prevent contamination from being reintroduced on to the soil surface. One worker will trim/retrieve grass cuttings over the 2.14 acre area, decontaminate the mower, service the mower and store the waste within a day. Based on a $50 per hour labor rate, the total labor cost to cut and store the grass over 20 weeks is $8,000. Cost does not include mower fuel and mower replacement parts.
[7] Sample analysis suite includes nitrate.
[8] Release report for materials with low levels of added radioactivity prepared according to DOE Order 5400.5 to release materials for unrestricted use/disposal. Materials that may contain low levels of added radioactivity upon decommissioning are the HDPE liner, sprinkler system and grass cuttings. Release report evaluation requires extensive exposure modeling of transportation and disposal options. Release report cost is based on actual costs for previous LEHR release reports.

Assumptions

Removal Action:

1) The volumes are based on the excavations determined in Appendix X.
2) The excavation confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Sr-90.
3) Waste disposal volumes generated by conventional and oversize auger excavation were assumed to expand by a factor of 1.3
4) Oversize auger borings will overlap and increase the auger waste volume by an additional assumed factor of 1.4.
5) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to Developing Cost Estimates During the Feasibility Study (EPA, 2000).
6) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to Developing Cost Estimates During the Feasibility Study (EPA, 2000).
7) Eight waste characterization samples will be collected; 1 per each 800 cubic yards, 1 duplicate.
8) All of the clean fill from the 1998 excavation will be returned to the new excavation without testing.
9) No excavation dewatering will be required.
10) No shoring will be required.
11) The deep nitrate excavation will be filled with controlled density fill (CDF). The CDF will not require compaction.
12) The conventional excavations will be backfilled with 1998 backfill and new import fill.
13) The excavation will not be delineated with geotextile fabric

Phytoremediation:

1) The phytoremediation project will consist of installation in year 0, annual growing seasons for 3 years, and decommissioning at the end of year 3.
2) Western Dog Pens preparatory earthwork consists of grading soil to prevent ponding during the rainy season.
3) The liner will be a single welded seamless sheet of high density polyethylene.
4) The contaminated soil will be placed on the liner and graded to an even thickness.
5) The sprinkler system piping will be installed in shallow (6 inch deep) trenches after soil placement.

Table A-30. Removal and Phytoremediation with Limited Off-Site Disposal – Lower range cleanup goals, Southwest Trenches (continued)

6) No institutional controls will be necessary because strontium-90 contaminated soil would be segregated and disposed at Envirocare.
7) The phytoremediation area will be covered with a waterproof tarp during the rainy season to prevent storm water contact.
8) The grass will be trimmed several times during the growing season and the cuttings will be stored for release upon decommissioning.
9) The plastic liner and sheets, sprinkler system, and grass cuttings will be approved for release to a Class II landfill upon decommissioning.
10) The treated soil will remain in the Western Dog Pens after decommissioning. The treated soil will be graded into an even thickness lift.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-31. Limited Removal and Off-Site Disposal—Upper Range Cleanup Goals, Radium/Strontium Treatment Systems

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	700	$2.00	linear foot	$1,400	J
Health and safety meetings [4]	25	$1,000.00	day	$25,000	H
Task meetings [5]	12	$2,000.00	lump sum	$24,000	H
Field operations management	25	$2,000.00	day	$50,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Remove and temporarily stockpile clean overburden	585	$30.00	cubic yard	$17,550	A
Excavate and stockpile soil using conventional equipment	1,160	$30.00	cubic yard	$34,811	A
Collect waste characterization samples	3	$130.00	sample	$390	H
Analyze waste characterization samples (full suite) [6]	3	$3,366.85	sample	$10,101	B
Validate and import waste characterization data	3	$615.00	sample	$1,845	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Package low level rad soil in Lift Liners and ship to NTS	1,508	$306.00	cubic yard	$461,595	A
Dispose low level waste at the Nevada Test Site	1,508	$216.00	cubic yard	$325,832	A
Document field activities	25	$130.00	day	$3,250	H
Collect field screening samples	40	$48.75	sample	$1,950	H
Onsite lab analysis	40	$76.88	sample	$3,075	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	27	$130.00	sample	$3,510	H
Analyze confirmation samples [7]	27	$384.00	sample	$10,368	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	27	$410.00	sample	$11,070	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	1,508	$15.00	cubic yard	$22,627	E
Delineate the excavaton area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the excavation areas	2,269	$11.00	cubic yard	$24,959	A
Install gravel base material in previously paved area	58	$46.00	cubic yard	$2,676	J
Install four inches of asphalt pavement	2,356	$3.75	square foot	$8,836	G
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A

Table A-31. Limited Removal and Off-Site Disposal—Upper Range Cleanup Goals, Radium/Strontium Treatment Systems (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Contingency	25%			$312,711	
		Direct Capital Costs Subtotal		$1,563,556	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	12%			$187,627	
Project Management	6%			$93,813	
		Indirect Capital Costs Subtotal		$281,440	
		Capital Costs Subtotal [2]		**$1,845,000**	
		TOTAL		$1,845,000	

Note

[1] Capital costs occur in year 0; no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes nitrate, C-14 and Ra-226.

Key Assumptions

1) Excavation volumes based on achieving upper range cleanup goals. Excavation shown in Appendix B.
2) Excavation will be conducted using conventional excavation equipment.
3) The excavation depth will be 20 feet based on the limits of conventional excavation.
4) Low level radiological contamination assumed to extend to 20 ft bgs.
5) The confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Ra-226.
6) Waste disposal volumes were assumed to expand by a factor of 1.3
7) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to
8) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
9) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to
10) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
11) All of the clean fill from the 1999 Area 1 excavation will be returned to the new excavation without testing.
12) The top 5 feet of native soil is assumed clean, given the depth of the treatment system leach trenches, and will be reused as backfill.
13) Three waste characterization samples will be collected; 1 per each 800 cubic yards and 1 duplicate.
14) No excavation dewatering will be required.
15) No shoring will be required.
16) The excavations will be filled with clean fill recovered from the 1999 Area 1 excavation and import fill.
17) The excavation will not be delineated with geotextile fabric.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-32. Limited Removal and Off-Site Disposal—Lower Range Cleanup Goals, Radium/Strontium Treatment Systems

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	700	$2.00	linear foot	$1,400	J
Health and safety meetings [4]	30	$1,000.00	day	$30,000	H
Task meetings [5]	15	$2,000.00	lump sum	$30,000	H
Field operations management	30	$2,000.00	day	$60,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Remove and temporarily stockpile clean overburden	585	$30.00	cubic yard	$17,550	A
Excavate and stockpile soil using conventional equipment	1,484	$30.00	cubic yard	$44,520	A
Collect waste characterization samples	4	$130.00	sample	$520	H
Analyze waste characterization samples (full suite) [6]	4	$3,366.85	sample	$13,467	B
Validate and import waste characterization data	4	$615.00	sample	$2,460	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Package low level rad soil in Lift Liners and ship to NTS	1,929	$306.00	cubic yard	$590,335	A
Dispose low level waste at the Nevada Test Site	1,929	$216.00	cubic yard	$416,707	A
Document field activities	30	$130.00	day	$3,900	H
Collect field screening samples	45	$48.75	sample	$2,194	H
Onsite lab analysis	45	$76.88	sample	$3,459	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	30	$130.00	sample	$3,900	H
Analyze confirmation samples [7]	30	$384.00	sample	$11,520	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	30	$410.00	sample	$12,300	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	1,929	$15.00	cubic yard	$28,938	E
Delineate the excavaton area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the excavation areas	2,690	$11.00	cubic yard	$29,587	A
Install gravel base material in previously paved area	72	$46.00	cubic yard	$3,308	J
Install four inches of asphalt pavement	2,913	$3.75	square foot	$10,923	G
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A

Table A-32. Limited Removal and Off-Site Disposal—Lower Range Cleanup Goals, Radium/Strontium Treatment Systems (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Contingency	25%			$380,747	
		Direct Capital Costs Subtotal		$1,903,736	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	12%			$228,448	
Project Management	6%			$114,224	
		Indirect Capital Costs Subtotal		$342,672	
		Capital Costs Subtotal [2]		**$2,246,000**	
			TOTAL	$2,246,000	

Notes

[1] Capital costs occur in year 0; no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes nitrate, C-14 and Ra-226.

Key Assumptions

1) Excavation will be conducted using conventional excavation equipment.
2) The excavation depth will be 20 feet based on the limits of conventional excavation.
3) Low level radiological contamination assumed to extend to 20 ft bgs.
4) The confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Ra-226.
5) Waste disposal volumes were assumed to expand by a factor of 1.3
6) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to
7) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
8) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to
9) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
10) All of the clean fill from the 1999 Area 1 excavation will be returned to the new excavation without testing.
11) The top 5 feet of native soil is assumed clean, given the depth of the treatment system leach trenches, and will be reused as backfill.
12) Four waste characterization samples will be collected; 1 per each 800 cubic yards and 1 duplicate.
13) No excavation dewatering will be required.
14) No shoring will be required.
15) The excavations will be filled with clean fill recovered from the 1999 Area 1 excavation and import fill.
16) The excavation will not be delineated with geotextile fabric.

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-33. Limited Removal and Off-Site Disposal, Domestic Septic System 3

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	700	$2.00	linear foot	$1,400	J
Health and safety meetings [4]	20	$1,000.00	day	$20,000	H
Task meetings [5]	10	$2,000.00	lump sum	$20,000	H
Field operations management	20	$2,000.00	day	$40,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Excavate soil with conventional equipment	1,581	$30.00	cubic yard	$47,430	A
Collect waste characterization samples	3	$130.00	sample	$390	H
Analyze waste characterization samples (full suite) [6]	3	$3,366.85	sample	$10,101	B
Validate and import waste characterization data	3	$615.00	sample	$1,845	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Package low level waste and ship to Envirocare	1,471	$306.00	cubic yard	$450,097	A
Dispose low level waste at Envirocare	1,471	$216.00	cubic yard	$317,716	A
Document field activities	20	$130.00	day	$2,600	H
Collect field screening samples	20	$48.75	sample	$975	H
Onsite lab analysis	20	$76.88	sample	$1,538	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	20	$130.00	sample	$2,600	H
Analyze confirmation samples [7]	20	$246.55	sample	$4,931	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	20	$410.00	sample	$8,200	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	1,384	$105.00	cubic yard	$145,345	E
Delineate the excavaton area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the excavation area	2,055	$11.00	cubic yard	$22,608	A
Install gravel base material in previously paved area	53	$46.00	cubic yard	$2,425	J
Install four inches of asphalt pavement	2,135	$3.75	square foot	$8,006	G
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Contingency	25%			$328,552	
		Direct Capital Costs Subtotal		$1,642,759	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	12%			$197,131	

Table A-33. Limited Removal and Off-Site Disposal, Domestic Septic System 3 (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Project Management	6%			$98,566	
		Indirect Capital Costs Subtotal		$295,697	
		Capital Costs Subtotal [2]		**$1,938,000**	
		TOTAL		$1,938,000	

Notes

[1] Capital costs occur in year 0; no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes formaldehyde, molybdenum and nitrate.

Key Assumptions

1) Excavation will be conducted using conventional excavation equipment.
2) The excavation depth will be 20 feet based on the limits of conventional excavation.
3) The top 4 feet of native soil is assumed clean and will be reused as backfill.
4) Native soil between 4 and 20 feet is assumed low level rad added waste.
5) Waste disposal volumes generated by excavation were assumed to expand by a factor of 1.3
6) The import backfill volume in the 2002 removal action was approximately 260 cubic yards (assuming an expansion factor of 1.3).
7) The clean import backfill in the 2002 excavation will be returned to the excavation without testing.
8) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to
9) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
10) The confirmation sample suite will be formaldehyde, molybdenum and nitrate.
11) Three waste characterization samples will be collected; 1 per each 800 cubic yards, 1 duplicate per matrix (soil, gravel).
12) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to
13) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
14) No excavation dewatering will be required.
15) No shoring will be required.
16) The excavation will be backfilled with clean overburden, 2002 backfill and new import fill.
17) The excavation will not be delineated with geotextile fabric

Data Source

A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-34. Limited Removal and Off-Site Disposal, Domestic Septic Systems 1 and 5 Leach Field (Dry Wells A through E)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	170	$2.00	linear foot	$340	J
Health and safety meetings [4]	10	$1,000.00	day	$10,000	H
Task meetings [5]	5	$2,000.00	lump sum	$10,000	H
Field operations management	10	$2,000.00	day	$20,000	H
Utility relocation	1	$50,000.00	lump sum	$50,000	I
Excavate distribution box and surrounding soil	96	$30.00	cubic yard	$2,880	A
Excavate drywell soil	186	$30.00	cubic yard	$5,580	A
Rubbelize distribution box	1	$10,000.00	lump sum	$10,000	A
Collect waste characterization samples	2	$130.00	sample	$260	H
Analyze waste characterization samples (full suite) [6]	2	$3,366.85	sample	$6,734	B
Validate and import waste characterization data	2	$615.00	sample	$1,230	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Package low level waste and ship to Envirocare	270	$306.00	cubic yard	$82,583	A
Dispose low level waste at Envirocare	270	$216.00	cubic yard	$58,294	A
Document field activities	10	$130.00	day	$1,300	H
Collect field screening samples	20	$48.75	sample	$975	H
Onsite lab analysis	20	$76.88	sample	$1,538	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	20	$130.00	sample	$2,600	H
Analyze confirmation samples [7]	20	$554.78	sample	$11,096	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	20	$410.00	sample	$8,200	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	270	$105.00	cubic yard	$28,337	E
Delineate the excavaton area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the excavation	367	$11.00	cubic yard	$4,033	A
Install gravel base material in previously paved area	7	$46.00	cubic yard	$322	J
Install four inches of asphalt pavement	255	$3.75	square foot	$956	G
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Contingency	25%			$118,314	

Table A-34. Limited Removal and Off-Site Disposal, Domestic Septic Systems 1 and 5 Leach Field (Dry Wells A through E) (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
		Direct Capital Costs Subtotal		$591,572	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	12%			$70,989	
Project Management	6%			$35,494	
		Indirect Capital Costs Subtotal		$106,483	
		Capital Costs Subtotal [2]		**$698,000**	
		TOTAL		$698,000	

Notes
[1] Capital costs occur in year 0; no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes hexavalent chromium, chromium, mercury, molybdenum, silver, Cs-137 and Sr-90.

Assumptions
1) Dry well excavations will extend to 20 feet in depth with a diameter of 8 feet each.
2) The total estimated volume of the five dry well excavations is 186 cubic yards
3) The total estimated volume of the distribution box excavation is 94 cubic yards
4) The distribution box will be about 2 cubic yards of waste
5) Waste disposal volumes generated by excavation were assumed to expand by a factor of 1.3
6) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to
7) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
8) Clean fill from the upper 8 feet of the dry wells will be used to backfill the distribution box excavation.
9) No excavation dewatering will be required.
10) The excavation will not be delineated with geotextile fabric
11) The confirmation sample suite will be hexavalent chromium, chromium, mercury, molybdenum, silver, Cs-137 and Sr-90.
12) 2 waste characterization samples will be collected; 1 per each 800 cubic yards, 1 duplicate
13) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to
14) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
15) No shoring will be required.

Data Source
A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-35. Limited Removal and Off-Site Disposal—Upper Range Cleanup Goals, Southwest Trenches

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	600	$2.00	linear foot	$1,200	J
Health and safety meetings [4]	25	$1,000.00	day	$25,000	H
Task meetings [5]	10	$2,000.00	lump sum	$20,000	H
Field operations management	25	$2,000.00	day	$50,000	H
Remove and temporarily stockpile clean overburden	656	$30.00	cubic yard	$19,680	A
Excavate and stockpile soil using conventional equipment	3152	$30.00	cubic yard	$94,546	A
Collect waste characterization samples	7	$130.00	sample	$910	H
Analyze waste characterization samples (full suite) [6]	7	$3,367	sample	$23,568	B
Validate and import waste characterization data	7	$615.00	sample	$4,305	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Package low level waste and ship to Envirocare	4,097	$306.00	cubic yard	$1,253,679	A
Dispose low level waste at Envirocare	4,097	$216.00	cubic yard	$884,950	A
Document field activities	25	$130.00	day	$3,250	H
Collect field screening samples	50	$48.75	sample	$2,438	H
Onsite lab analysis	50	$76.88	sample	$3,844	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	25	$130.00	sample	$3,250	H
Analyze confirmation samples [7]	25	$453.45	sample	$11,336	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	25	$410.00	sample	$10,250	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	4,097	$105.00	cubic yard	$430,184	E
Delineate the excavaton area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the conventional excavations	4,950	$11.00	cubic yard	$54,448	A
Replace chain-link fence along levee	110	$10.02	linear foot	$1,102	J
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Contingency	25%			$763,485	
		Direct Capital Costs Subtotal		$3,817,423	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	8%			$305,394	

Table A-35. Limited Removal and Off-Site Disposal—Upper Range Cleanup Goals, Southwest Trenches (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Project Management	5%			$190,871	
		Indirect Capital Costs Subtotal		$496,265	
		Capital Costs Subtotal [2]		**$4,314,000**	
			TOTAL	$4,314,000	

Notes
[1] Capital costs occur in year 0; no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes nitrate, C-14 and Sr-90.

Key Assumptions
1) Excavation volumes based on achieving upper range cleanup goals. Excavation shown in Appendix B.
2) The excavation depth will not exceed 20 feet based on the limits of conventional excavation.
3) The confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Sr-90.
4) Waste disposal volumes generated by excavation were assumed to expand by a factor of 1.3
5) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to
6) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
7) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to
8) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
9) Seven waste characterization samples will be collected; 1 per each 800 cubic yards, 2 duplicates.
10) All of the clean fill from the 1998 excavation will be returned to the new excavation without testing.
11) No excavation dewatering will be required.
12) No shoring will be required.
13) The excavations will be backfilled with 1998 backfill and new import fill.
14) The excavation will not be delineated with geotextile fabric

Data Source
A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-36. Limited Removal and Off-Site Disposal—Lower Range Cleanup Goals, Southwest Trenches

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS [1]					
Prepare work plan [3]	1	$80,000.00	lump sum	$80,000	A
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	F
Install perimeter fence	600	$2.00	linear foot	$1,200	J
Health and safety meetings [4]	30	$1,000.00	day	$30,000	H
Task meetings [5]	15	$2,000.00	lump sum	$30,000	H
Field operations management	30	$2,000.00	day	$60,000	H
Remove and temporarily stockpile clean overburden	656	$30.00	cubic yard	$19,680	A
Excavate and stockpile soil using conventional equipment	3565	$30.00	cubic yard	$106,950	A
Collect waste characterization samples	7	$130.00	sample	$910	H
Analyze waste characterization samples (full suite) [6]	7	$3,367	sample	$23,568	B
Validate and import waste characterization data	7	$615.00	sample	$4,305	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Package low level waste and ship to Envirocare	4,635	$306.00	cubic yard	$1,418,157	A
Dispose low level waste at Envirocare	4,635	$216.00	cubic yard	$1,001,052	A
Document field activities	30	$130.00	day	$3,900	H
Collect field screening samples	60	$48.75	sample	$2,925	H
Onsite lab analysis	60	$76.88	sample	$4,613	F
Evaluate field screening data	1	$5,000.00	lump sum	$5,000	H
Collect confirmation samples	30	$130.00	sample	$3,900	H
Analyze confirmation samples [7]	30	$453.45	sample	$13,604	B
Survey excavation and confirmation sample locations	1	$3,000.00	lump sum	$3,000	F
Validate and import confirmation data	30	$410.00	sample	$12,300	H
Evaluate confirmation data	1	$20,000.00	lump sum	$20,000	H
Import backfill material	4,635	$105.00	cubic yard	$486,623	E
Delineate the excavaton area with geotextile fabric	0	$0.19	square foot	$-	
Backfill, compact and grade the conventional excavations	5,487	$11.00	cubic yard	$60,360	A
Replace chain-link fence along levee	110	$10.02	linear foot	$1,102	J
Summarize results in the Confirmation Report	1	$25,000.00	lump sum	$25,000	A
Contingency	25%			$860,287	
		Direct Capital Costs Subtotal		$4,301,435	
INDIRECT CAPITAL COSTS [1]					
Engineering and Design	8%			$344,115	

Table A-36. Limited Removal and Off-Site Disposal—Lower Range Cleanup Goals, Southwest Trenches (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Project Management	5%			$215,072	
		Indirect Capital Costs Subtotal		$559,187	
		Capital Costs Subtotal [2]		**$4,861,000**	
		TOTAL		$4,861,000	

Notes
[1] Capital costs occur in year 0; no annual or periodic costs.
[2] Subtotal is rounded to the nearest $1,000.
[3] Includes site background, removal action objectives, planned activities, excavation design, sampling and analysis design, management of materials with added radioactivity, excavation health and safety, radiation health and safety.
[4] Meetings covering excavation safety, heavy equipment safety, chemical exposure safety, radiation safety and emergency response planning.
[5] Assignment/coordination of tasks, technical problem solving, planning.
[6] Full suite parameters include volatile organic compounds, semivolatile organic compounds, pesticides, polychlorinated biphenyl compounds, metals, nitrate, hexavalent chromium, tritium, radium-226 by ingrowth of daughters, gamma scan radionuclides, carbon-14, americium-241, thorium isotopes by alpha spec, uranium isotopes by alpha spec, plutonium-241 and strontium-90.
[7] Confirmation sample analysis suite includes nitrate, C-14 and Sr-90.

Key Assumptions
1) The excavation depth will not exceed 20 feet based on the limits of conventional excavation.
2) The confirmation samples will be analyzed with a normal turn around time for the following constituents: nitrate, C-14 and Sr-90.
3) Waste disposal volumes generated by excavation were assumed to expand by a factor of 1.3
4) The engineering and design and project management percentages are based on Exhibit 5.8 in A Guide to
5) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
6) The scope contingency is assumed to be 15% and bid contingency is 10% based on A Guide to
7) Developing Cost Estimates During the Feasibility Study (EPA, 2000).
8) Seven waste characterization samples will be collected; 1 per each 800 cubic yards, 2 duplicates.
9) All of the clean fill from the 1998 excavation will be returned to the new excavation without testing.
10) No excavation dewatering will be required.
11) No shoring will be required.
12) The excavations will be backfilled with 1998 backfill and new import fill.
13) The excavation will not be delineated with geotextile fabric

Data Source
A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-37. *In Situ* Bioremediation, Radium/Strontium Treatment Systems

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS[1]					
Pilot Test					
Prepare pilot test work plan	1	$10,000.00	lump sum	$10,000	I
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	H
Drill and collect 30 foot continuous core samples	2	$2,085.90	borehole	$4,172	F
Field infiltration test	1	$1,200.00	test	$1,200	I
Bench scale pilot tests	5	$1,000.00	sample	$5,000	I
Nitrate, plate count and geochemical parameter analysis	10	$337.25	sample	$3,373	B
Hydraulic conductivity and porosity tests	2	$250.00	sample	$500	B
Pilot Test Report	1	$20,000.00	lump sum	$20,000	I
Well installations					
Prepare well installation work plan	1	$15,000.00	lump sum	$15,000	C
Well installation permitting	1	$2,000.00	lump sum	$2,000	C
Install 30-ft deep injection wells	34	$856.80	injection well	$29,131	I
Install HSU-1 Monitoring Wells	4	$2,693.18	monitor well	$10,773	C
Install clustered piezometers	6	$3,598.80	piez cluster	$21,593	I
Field Geologist	12	$1,200.00	day	$14,400	H
Collect soil cuttings waste characterization samples	2	$130.00	sample	$260	H
Analyze waste characterization samples	2	$3,366.85	sample	$6,734	B
Validate and import waste characterization data	2	$615.00	sample	$1,230	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, ship, and dispose Class II waste	10	$60.00	cubic yard	$600	H
Treatment system installation					
Permit with UC Davis	1	$5,000.00	lump sum	$5,000	I
Trenching, backfilling, repaving	700	$10.00	linear foot	$7,000	J
Piping manifold materials and installation	2,000	$8.84	linear foot	$17,680	J
Electrical service	1	$5,000.00	lump sum	$5,000	I
Slab, 12" thick structural	800	$8.02	square foot	$6,416	J
Fence	120	$34.93	linear foot	$4,192	J
Carbon-source solution 1,000 gal tank	1	$1,704.00	tank	$1,704	G
Chemical feed system for carbon-source concentrate	1	$2,535.00	lump sum	$2,535	G
Pump, source solution delivery (10 HP)	1	$3,030.00	pump	$3,030	G
Controls	1	$15,000.00	lump sum	$15,000	I
Carbon Filters (1,000 gal)	2	$10,000.00	filter	$20,000	I
Treatment System Installation Report	1	$25,000.00	lump sum	$25,000	I

Table A-37. *In Situ* Bioremediation, Radium/Strontium Treatment Systems (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Treatment System Startup					
Operations and Maintenance Manual	1	$10,000.00	lump sum	$10,000	I
Carbon-source concentrate	120	$21.52	gallon	$2,582	G
System startup visits	21	$1,720.48	visit	$36,130	I
Nitrate, plate count and geochemical parameter analysis	126	$337.25	sample	$42,494	B
Validate and import sample data	126	$205.00	sample	$25,830	H
Evaluate startup data for system optimization	1	$5,000.00	lump sum	$5,000	I
Contingency	25%			$100,889	
		Direct Capital Costs Subtotal		$504,447	
INDIRECT CAPITAL COSTS[1]					
Engineering and Design	12%			$60,534	
Project Management	6%			$30,267	
		Indirect Capital Costs Subtotal		$90,800	
		Capital Costs Subtotal[2]		**$595,000**	
ANNUAL O&M COSTS[1]					
Carbon-source concentrate	1,200	$21.52	gallon	$25,824	G
Routine O&M Visits	33	$990.24	visit	$32,678	I
Nitrate analysis	198	$29.75	sample	$5,891	B
Validate and import nitrate data	198	$51.25	sample	$10,148	H
Evaluate O&M data	1	$5,000.00	lump sum	$5,000	I
Annual O&M report	1	$10,000.00	lump sum	$10,000	I
			Annual Costs	$89,540	
Contingency	10%			$8,954	
		Annual Costs Subtotal		$98,494	
		Present Worth of Annual Costs Subtotal[2,3]		**$188,000**	
PERIODIC COSTS[1]					
Confirmation Sampling					
Confirmation sampling work plan [4]	1	$20,000.00	lump sum	$20,000	H
Geoprobe sample collection	30	$436.59	sample	$13,098	H
Field Geologist	3	$1,200.00	day	$3,600	H
Nitrate analysis	30	$29.75	sample	$893	B
Validate and import confirmation data	30	$51.25	sample	$1,538	H
Evaluate confirmation data [5]	1	$5,000.00	lump sum	$5,000	H
Prepare confirmation report [6]	1	$20,000.00	lump sum	$20,000	H
Treatment System Decommissioning					
Well destruction permit	1	$2,000.00	lump sum	$2,000	I
Monitoring well destruction	6	$900.00	each	$5,400	J
Injection well destruction	34	$450.00	each	$15,300	J
piezometer destruction	6	$600.00	each	$3,600	J
grout treatment system pipes	2,000	$2.00	linear foot	$4,000	J
Release [7] solution tanks, filter, and pumps to public	1	$10,000.00	lump sum	$10,000	H
Collect equipment waste characterization samples	2	$130.00	sample	$260	H

Table A-37. *In Situ* Bioremediation, Radium/Strontium Treatment Systems (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Analyze waste characterization samples	2	$3,366.85	sample	$6,734	B
Validate and import waste characterization data	2	$615.00	sample	$1,230	H
Designate and profile waste [8]	1	$20,000.00	lump sum	$20,000	H
Load, ship, and dispose Class II waste	30	$60.00	cubic yard	$1,800	H
Prepare decommissioning report	1	$5,000.00	lump sum	$5,000	H
			Periodic Costs	$139,451	
Contingency	10%			$13,945	
Project Management	25%			$34,863	
			Periodic Costs Subtotal	$188,259	
			Present Worth of Periodic Costs Subtotal[2,3]	**$177,000**	
			TOTAL	**$960,000**	

Notes
[1] Capital costs occur in year 0, annual costs occur in years 1 - 2 and one periodic cost occurs in year 2.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for Federal Facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C
[4] Project objectives/background, statistical sampling design and formulation of null hypothesis, sampling specifications and project health and safety.
[5] Statistical data analysis/cleanup hypothesis testing.
[6] Document achievement of cleanup objectives, treatment performance data, statistical test results and final status of site.
[7] Release materials with potential added radioactivity according to DOE Order 5400.5 for unrestricted use/disposal.
[8] determine waste classification, obtain landfill acceptance.

Key Assumptions
1) Nitrate contamination is located between 10 and 30 feet below ground surface.
2) Five bench scale pilot tests will be sufficient to determine the optimal chemical species for the carbon source, its concentration, and amendments.
3) Nitrate, plate count and geochemical parameters will be analyzed at the beginning and end of each pilot test.
4) One sample from each continuous core (2 total) will be tested for hydraulic conductivity and porosity.
5) 34 Injection wells will be installed on 10 foot centers in a triangular grid pattern.
6) Four monitoring wells will be installed in HSU-1. One at the center of the plume and three surrounding the plume, approximately 20 feet from the edge. Two existing monitoring wells will be used in the monitoring system (UCD1-006 and UCD1-022).
7) Six clustered piezometers will be installed. Each cluster will consist of 3 piezometers (18 piezometers total).
8) Each injection well will be connected individually to the treatment system by a common manifold.
9) All drill cuttings from installing wells and piezometers are Class II waste.
10) All delivery system piping, water supply piping, and electrical source conduit will be routed in underground trenches.
11) The treatment system compound will consist of a fenced slab containing the manifold, source pump, solution and concentrate tanks, metering pump carbon filters, piping, and electrical and mechanical controls.
12) Treatment system startup will consist of three weeks of operation with daily visits to adjust the system and collect samples.
13) All six monitoring wells will be sampled daily during startup.
14) Operations and maintenance will include biweekly visits for the first month, weekly visits during the second month, and bimonthly visits thereafter.
15) Nitrate samples will be collected from the system monitoring wells during each routine operations and maintenance visit.
16) The treatment system will be operated for two years.
17) After system shut-down, 30 confirmation soil samples will be collected from a random grid to verify whether the nitrate goal is achieved.
18) All monitoring wells, injection wells and piezometers will be drilled out and properly destroyed after treatment system operation is complete.
19) The carbon concentrate and solution tanks, pumps, carbon filter housings, and fence will be released to the public upon decommissioning.
20) The slab, manifold, and unsalvageable parts will be sampled and disposed at a Class II landfill upon decommissioning.
21) All below grade piping will be grouted and left in place.

Data Source
A) Based on previously completed LEHR removal action cost.

Table A-37. *In Situ* Bioremediation, Radium/Strontium Treatment Systems (continued)

B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A- 38. *In Situ* Bioremediation, Domestic Septic System 3

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS[1]					
Pilot Test					
Prepare pilot test work plan	1	$10,000.00	lump sum	$10,000	I
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	H
Drill and collect 30 foot continuous core samples	2	$2,085.90	borehole	$4,172	F
Field infiltration test	1	$1,200.00	test	$1,200	I
Bench scale pilot tests	10	$1,000.00	sample	$10,000	I
Nitrate, formaldehyde and bio/geo parameter analysis	20	$537.25	sample	$10,745	B
Hydraulic conductivity and porosity tests	2	$250.00	sample	$500	B
Pilot Test Report	1	$20,000.00	lump sum	$20,000	I
Well installations					
Prepare well installation work plan	1	$15,000.00	lump sum	$15,000	C
Well installation permitting	1	$2,000.00	lump sum	$2,000	C
Install 30-ft deep injection wells	29	$856.80	injection well	$24,847	I
Install HSU-1 Monitoring Wells	4	$2,693.18	monitor well	$10,773	C
Install clustered piezometers	6	$3,598.80	piez cluster	$21,593	I
Field Geologist	11	$1,200.00	day	$13,200	H
Collect soil cuttings waste characterization samples	2	$130.00	sample	$260	H
Analyze waste characterization samples	2	$3,366.85	sample	$6,734	B
Validate and import waste characterization data	2	$615.00	sample	$1,230	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, ship, and dispose Class II waste	10	$60.00	cubic yard	$600	H
Treatment system installation					
Permit with UC Davis	1	$5,000.00	lump sum	$5,000	I
Trenching, backfilling, repaving	600	$10.00	linear foot	$6,000	J
Piping manifold materials and installation	1,700	$8.84	linear foot	$15,028	J
Electrical service	1	$5,000.00	lump sum	$5,000	I
Slab, 12" thick structural	800	$8.02	square foot	$6,416	J
Fence	120	$34.93	linear foot	$4,192	J
Carbon-source solution 1,000 gal tank	1	$1,704.00	tank	$1,704	G
Chemical feed system for carbon-source concentrate	1	$2,535.00	lump sum	$2,535	G
Pump, source solution delivery (10 HP)	1	$3,030.00	pump	$3,030	G
Controls	1	$15,000.00	lump sum	$15,000	I
Carbon Filters (1,000 gal)	2	$10,000.00	filter	$20,000	I
Treatment System Installation Report	1	$25,000.00	lump sum	$25,000	I

Table A- 38. *In Situ* Bioremediation, Domestic Septic System 3 (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Treatment System Startup					
Operations and Maintenance Manual	1	$10,000.00	lump sum	$10,000	I
Carbon-source concentrate	110	$21.52	gallon	$2,367	G
System startup visits	21	$1,720.48	visit	$36,130	I
Nitrate, formaldehyde and bio/geo parameter analysis	105	$537.25	sample	$56,411	B
Validate and import sample data	105	$205.00	sample	$21,525	H
Evaluate startup data for system optimization	1	$5,000.00	lump sum	$5,000	I
Contingency	25%			$104,048	
		Direct Capital Costs Subtotal		$520,239	
INDIRECT CAPITAL COSTS[1]					
Engineering and Design	12%			$62,429	
Project Management	6%			$31,214	
		Indirect Capital Costs Subtotal		$93,643	
		Capital Costs Subtotal[2]		**$614,000**	
ANNUAL O&M COSTS[1]					
Carbon-source concentrate	1,100	$21.52	gallon	$23,672	G
Routine O&M Visits	33	$990.24	visit	$32,678	I
Nitrate and formaldehyde analysis	165	$229.75	sample	$37,909	B
Validate and import sample data	165	$205.00	sample	$33,825	H
Evaluate O&M data	1	$5,000.00	lump sum	$5,000	I
Annual O&M report	1	$10,000.00	lump sum	$10,000	I
		Annual Costs		$143,084	
Contingency	10%			$14,308	
		Annual Costs Subtotal		$157,392	
		Present Worth of Annual Costs Subtotal[2,3]		**$301,000**	
Confirmation Sampling					
Confirmation sampling work plan [4]	1	$20,000.00	lump sum	$20,000	H
Geoprobe sample collection	27	$436.59	sample	$11,788	H
Field Geologist	3	$1,200.00	day	$3,600	H
Nitrate and formaldehyde analysis	27	$229.75	sample	$6,203	B
Validate and import confirmation data	27	$205.00	sample	$5,535	H
Evaluate confirmation data [5]	1	$5,000.00	lump sum	$5,000	H
Prepare confirmation report [6]	1	$20,000.00	lump sum	$20,000	H
Treatment System Decommissioning					
Well destruction permit	1	$2,000.00	lump sum	$2,000	I
Monitoring well destruction	5	$900.00	each	$4,500	J
Injection well destruction	29	$450.00	each	$13,050	J
piezometer destruction	6	$600.00	each	$3,600	J
grout treatment system pipes	1,700	$2.00	linear foot	$3,400	J
Release [7] solution tanks, filter, and pumps to public	1	$10,000.00	lump sum	$10,000	H
Collect equipment waste characterization samples	2	$130.00	sample	$260	H
Analyze waste characterization samples	2	$3,366.85	sample	$6,734	B

Table A- 38. *In Situ* Bioremediation, Domestic Septic System 3 (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
Validate and import waste characterization data	2	$615.00	sample	$1,230	H
Designate and profile waste [8]	1	$20,000.00	lump sum	$20,000	H
Load, ship, and dispose Class II waste	30	$60.00	cubic yard	$1,800	H
Prepare decommissioning report	1	$5,000.00	lump sum	$5,000	H
			Periodic Costs	$143,700	
Contingency	10%			$14,370	
Project Management	25%			$35,925	
			Periodic Costs Subtotal	$193,995	
			Present Worth of Periodic Costs Subtotal[2,3]	**$183,000**	
			TOTAL	**$1,098,000**	

Notes
[1] Capital costs occur in year 0, annual costs occur in years 1 - 2 and one periodic cost occurs in year 2.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for Federal Facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C
[4] Project objectives/background, statistical sampling design and formulation of null hypothesis, sampling specifications and project health and safety.
[5] Statistical data analysis/cleanup hypothesis testing.
[6] Document achievement of cleanup objectives, treatment performance data, statistical test results and final status of site.
[7] Release materials with potential added radioactivity according to DOE Order 5400.5 for unrestricted use/disposal.
[8] determine waste classification, obtain landfill acceptance.

Key Assumptions
1) Nitrate and formaldehyde contamination is located between 10 and 30 feet below ground surface.
2) Ten bench scale pilot tests will be sufficient to determine the optimal chemical species for the carbon source, its concentration, and amendments.
3) Nitrate, formaldehyde, plate count, and geochemical parameters will be analyzed at the beginning and end of each pilot test.
4) One sample from each continuous core (2 total) will be tested for hydraulic conductivity and porosity.
5) 29 Injection wells will be installed on 10 foot centers in a triangular grid pattern.
6) Four monitoring wells will be installed in HSU-1. One at the center of the plume and three surrounding the plume, approximately 20 feet from the edge. One existing monitoring well will be used in the monitoring system (UCD1-023).
7) Six clustered piezometers will be installed. Each cluster will consist of 3 piezometers (18 piezometers total).
8) Each injection well will be connected individually to the treatment system by a common manifold.
9) All drill cuttings from installing wells and piezometers are Class II waste.
10) All delivery system piping, water supply piping, and electrical source conduit will be routed in underground trenches.
11) The treatment system compound will consist of a fenced slab containing the manifold, source pump, solution and concentrate tanks, metering pump carbon filters, piping, and electrical and mechanical controls.
12) Treatment system startup will consist of three weeks of operation with daily visits to adjust the system and collect samples.
13) All five monitoring wells will be sampled daily during startup.
14) Operations and maintenance will include biweekly visits for the first month, weekly visits during the second month, and bimonthly visits thereafter.
15) Nitrate and formaldehyde samples will be collected from the system monitoring wells during each routine operations and maintenance visit.
16) The treatment system will be operated for two years.
17) After shut-down, 27 confirmation soil samples will be collected from a random grid to verify whether the nitrate and formaldehyde goals are achieved.
18) All monitoring wells, injection wells and piezometers will be drilled out and properly destroyed after treatment system operation is complete.
19) The carbon concentrate and solution tanks, pumps, carbon filter housings, and fence will be released to the public upon decommissioning.
20) The slab, manifold, and unsalvageable parts will be sampled and disposed at a Class II landfill upon decommissioning.
21) All below grade piping will be grouted and left in place.

Data Source
A) Based on previously completed LEHR removal action cost.

Table A- 38. *In Situ* Bioremediation, Domestic Septic System 3 (continued)

B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.
I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9th Edition.

Table A-39. *In Situ* Bioremediation, Southwest Trenches

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
DIRECT CAPITAL COSTS[1]					
Pilot Test					
Prepare pilot test work plan	1	$10,000.00	lump sum	$10,000	I
Perform geophysical survey	1	$3,000.00	lump sum	$3,000	H
Drill and collect 30 foot continuous core samples	4	$2,085.90	borehole	$8,344	F
Field infiltration test	1	$1,200.00	test	$1,200	I
Bench scale pilot tests	5	$1,000.00	sample	$5,000	I
Nitrate, plate count and geochemical parameter analysis	10	$337.25	sample	$3,373	B
Hydraulic conductivity and porosity tests	4	$250.00	sample	$1,000	B
Pilot Test Report	1	$20,000.00	lump sum	$20,000	I
Well installations					
Prepare well installation work plan	1	$15,000.00	lump sum	$15,000	C
Well installation permitting	1	$2,000.00	lump sum	$2,000	C
Install 30-ft deep injection wells	26	$856.80	injection well	$22,277	I
Install HSU-1 Monitoring Wells	6	$2,693.18	monitor well	$16,159	C
Install clustered piezometers	6	$3,598.80	piez cluster	$21,593	I
Field Geologist	10	$1,200.00	day	$12,000	H
Collect soil cuttings waste characterization samples	2	$130.00	sample	$260	H
Analyze waste characterization samples	2	$3,366.85	sample	$6,734	B
Validate and import waste characterization data	2	$615.00	sample	$1,230	H
Designate and profile waste	1	$20,000.00	lump sum	$20,000	H
Load, ship, and dispose Class II waste	10	$60.00	cubic yard	$600	H
Treatment system installation					
Permit with UCOP	1	$5,000.00	lump sum	$5,000	I
Trenching, backfilling, repaving	500	$10.00	linear foot	$5,000	J
Piping manifold materials and installation	1,500	$8.84	linear foot	$13,260	J
Electrical service	1	$5,000.00	lump sum	$5,000	I
Slab, 12" thick structural	450	$8.02	square foot	$3,609	J
Fence	90	$34.93	linear foot	$3,144	J
Carbon-source solution 1,000 gal tank	1	$1,704.00	tank	$1,704	G
Chemical feed system for carbon-source concentrate	1	$2,535.00	lump sum	$2,535	G
Pump, source solution delivery (10 HP)	1	$3,030.00	pump	$3,030	G
Controls	1	$15,000.00	lump sum	$15,000	I
Carbon Filters (1,000 gal)	2	$10,000.00	filter	$20,000	I
Treatment System Installation Report	1	$25,000.00	lump sum	$25,000	I
Treatment System Startup					
Operations and Maintenance Manual	1	$10,000.00	lump sum	$10,000	I
Carbon-source concentrate	100	$21.52	gallon	$2,152	G
System startup visits	21	$1,720.48	visit	$36,130	I
Nitrate, plate count and geochemical parameter	126	$337.25	sample	$42,494	B

Table A-39. *In Situ* Bioremediation, Southwest Trenches (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
analysis					
Validate and import sample data	126	$205.00	sample	$25,830	H
Evaluate startup data for system optimization	1	$5,000.00	lump sum	$5,000	I
Contingency	25%			$98,414	
		Direct Capital Costs Subtotal		$492,070	
INDIRECT CAPITAL COSTS[1]					
Engineering and Design	12%			$59,048	
Project Management	6%			$29,524	
		Indirect Capital Costs Subtotal		$88,573	
		Capital Costs Subtotal[2]		**$581,000**	
ANNUAL O&M COSTS[1]					
Carbon-source concentrate	1,000	$21.52	gallon	$21,520	G
Routine O&M Visits	33	$990.24	visit	$32,678	I
Nitrate analysis	198	$29.75	sample	$5,891	B
Validate and import nitrate data	198	$51.25	sample	$10,148	H
Evaluate O&M data	1	$5,000.00	lump sum	$5,000	I
Annual O&M report	1	$10,000.00	lump sum	$10,000	I
		Annual Costs		$85,236	
Contingency	10%			$8,524	
		Annual Costs Subtotal		$93,760	
		Present Worth of Annual Costs Subtotal[2,3]		**$179,000**	
PERIODIC COSTS[1]					
Confirmation Sampling					
Confirmation sampling work plan [4]	1	$20,000.00	lump sum	$20,000	H
Geoprobe sample collection	25	$436.59	sample	$10,915	H
Field Geologist	2	$1,200.00	day	$2,400	H
Nitrate analysis	25	$29.75	sample	$744	B
Validate and import confirmation data	25	$51.25	sample	$1,281	H
Evaluate confirmation data [5]	1	$5,000.00	lump sum	$5,000	H
Prepare confirmation report [6]	1	$20,000.00	lump sum	$20,000	H
Treatment System Decommissioning					
Well destruction permit	1	$2,000.00	lump sum	$2,000	I
Monitoring well destruction	6	$900.00	each	$5,400	J
Injection well destruction	26	$450.00	each	$11,700	J
piezometer destruction	6	$600.00	each	$3,600	J
grout treatment system pipes	1,500	$2.00	linear foot	$3,000	J
Release [7] solution tanks, filter, and pumps to public	1	$10,000.00	lump sum	$10,000	H
Collect equipment waste characterization samples	2	$130.00	sample	$260	H
Analyze waste characterization samples	2	$3,366.85	sample	$6,734	B
Validate and import waste characterization data	2	$615.00	sample	$1,230	H
Designate and profile waste [8]	1	$20,000.00	lump sum	$20,000	H
Load, ship, and dispose Class II waste	30	$60.00	cubic yard	$1,800	H
Prepare decommissioning report	1	$5,000.00	lump sum	$5,000	H

Table A-39. *In Situ* Bioremediation, Southwest Trenches (continued)

Task	Quantity	Unit Cost	Unit	Total Cost	Data Source
			Periodic Costs	$131,063	
Contingency	10%			$13,106	
Project Management	25%			$32,766	
			Periodic Costs Subtotal	$176,936	
			Present Worth of Periodic Costs Subtotal[2,3]	**$166,000**	
			TOTAL	**$926,000**	

Notes
[1] Capital costs occur in year 0, annual costs occur in years 1 - 2 and one periodic cost occurs in year 2.
[2] Subtotal is rounded to the nearest $1,000.
[3] Discount rate of 3.1% for Federal Facilities from United States Office of Management and Budget, Circular No. A-94, Appendix C
[4] Project objectives/background, statistical sampling design and formulation of null hypothesis, sampling specifications and project health and safety.
[5] Statistical data analysis/cleanup hypothesis testing.
[6] Document achievement of cleanup objectives, treatment performance data, statistical test results and final status of site.
[7] Release materials with potential added radioactivity according to DOE Order 5400.5 for unrestricted use/disposal.
[8] determine waste classification, obtain landfill acceptance.

Key Assumptions
1) Nitrate contamination is located between 10 and 30 feet below ground surface.
2) Five bench scale pilot tests will be sufficient to determine the optimal chemical species for the carbon source, its concentration, and amendments.
3) Nitrate, plate count and geochemical parameters will be analyzed at the beginning and end of each pilot test.
4) One sample from each continuous core (4 total) will be tested for hydraulic conductivity and porosity.
5) 26 Injection wells will be installed on 10 foot centers in a triangular grid pattern.
6) Six monitoring wells will be installed in HSU-1. One at the center of the plume and five surrounding the plume, approximately 20 feet from the edge.
7) Six clustered piezometers will be installed. Each cluster will consist of 3 piezometers (18 piezometers total).
8) Each injection well will be connected individually to the treatment system by a common manifold.
9) All drill cuttings from installing wells and piezometers are Class II waste.
10) All delivery system piping, water supply piping, and electrical source conduit will be routed in underground trenches.
11) The treatment system compound will consist of a fenced slab containing the manifold, source pump, solution and concentrate tanks, metering pump carbon filters, piping, and electrical and mechanical controls.
12) Treatment system startup will consist of three weeks of operation with daily visits to adjust the system and collect samples.
13) All six monitoring wells will be sampled daily during startup.
14) Operations and maintenance will include biweekly visits for the first month, weekly visits during the second month, and bimonthly visits thereafter.
15) Nitrate samples will be collected from the system monitoring wells during each routine operations and maintenance visit.
16) The treatment system will be operated for two years.
17) After system shut-down, 25 confirmation soil samples will be collected from a random grid to verify whether the nitrate goal is achieved.
18) All monitoring wells, injection wells and piezometers will be drilled out and properly destroyed after treatment system operation is complete.
19) The carbon concentrate and solution tanks, pumps, carbon filter housings, and fence will be released to the public upon decommissioning.
20) The slab, manifold, and unsalvageable parts will be sampled and disposed at a Class II landfill upon decommissioning.
21) All below grade piping will be grouted and left in place.

Data Source
A) Based on previously completed LEHR removal action cost.
B) Based on LEHR contracted laboratory costs.
C) Based on actual cost for LEHR well installation.
D) Based on actual LEHR ground water monitoring cost.
E) Based on actual cost for removal action materials at LEHR.
F) Based on actual vendor cost for LEHR project services.
G) Based on vendor estimate.
H) Based on actual LEHR cost for same task.

Table A-39. *In Situ* Bioremediation, Southwest Trenches (continued)

I) Based on actual cost for similar project.
J) RS Means environmental remediation cost data, 9^{th} Edition.

APPENDIX B

EXCAVATION VOLUME DETERMINATIONS

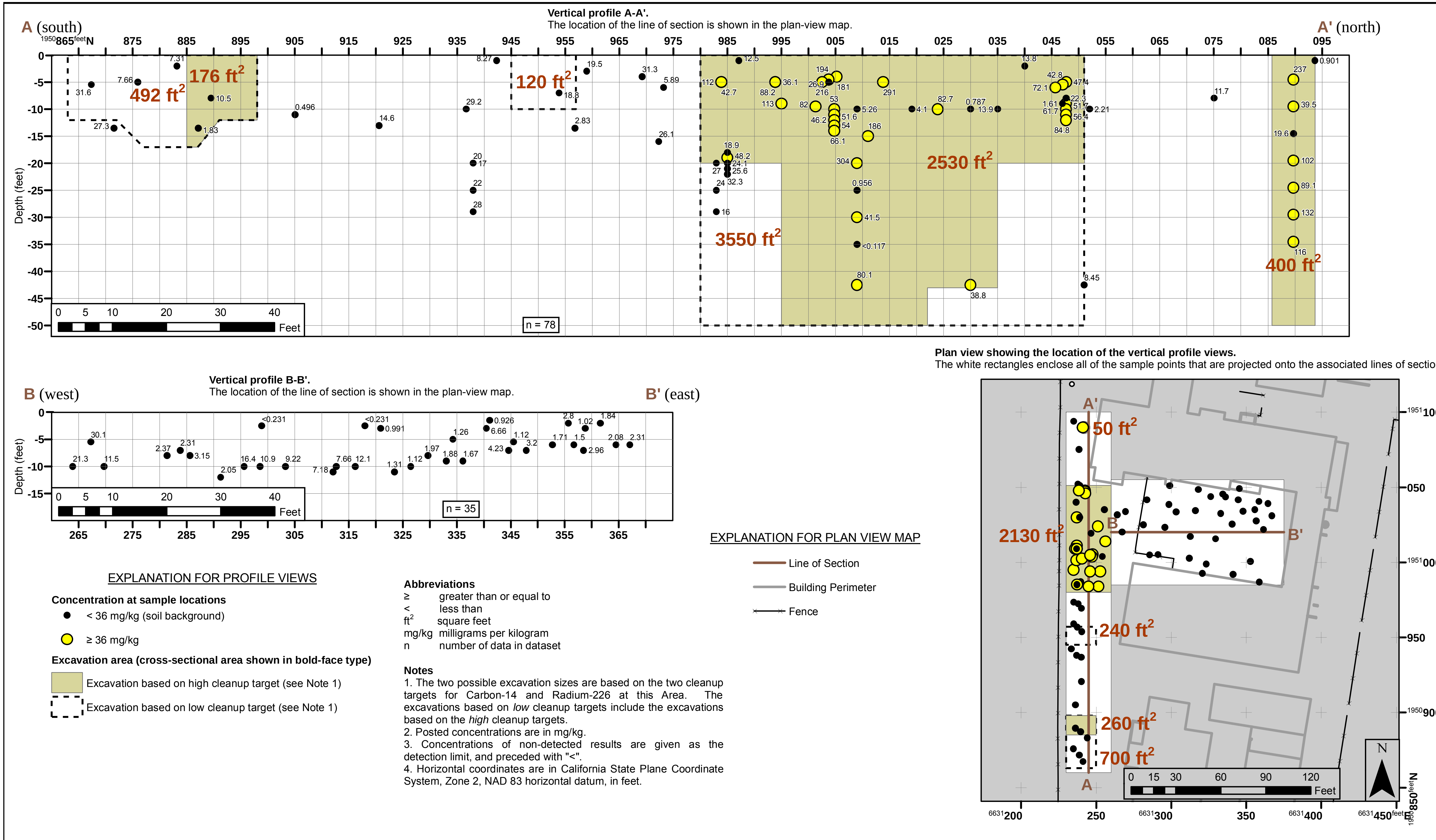


Figure B-1. Nitrate Concentrations and Excavation Areas for Alternatives 4a and 4b at the Radium/Strontium Treatment Systems Area

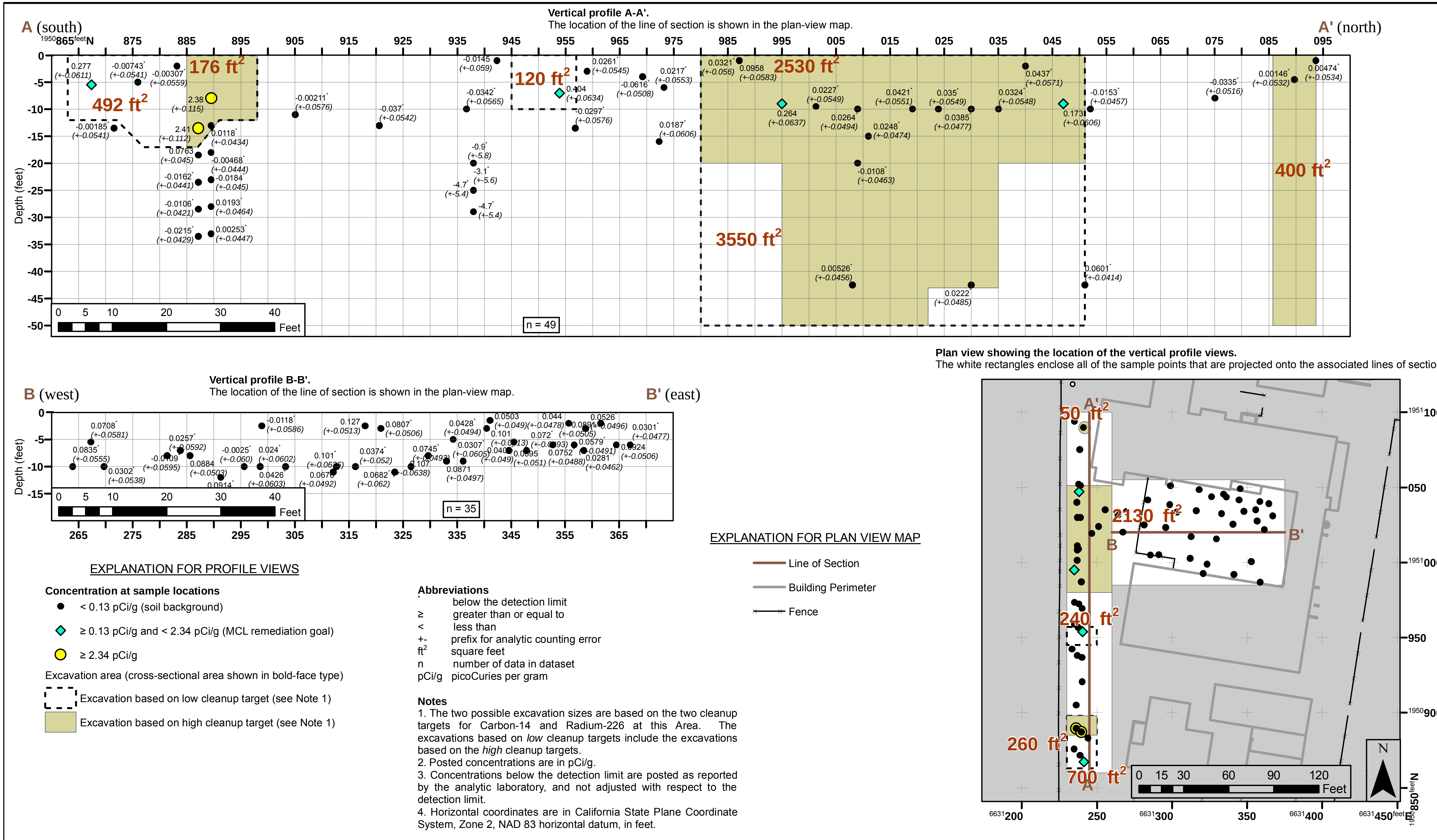


Figure B-2. Carbon-14 Concentrations and Excavation Areas for Alternatives 4a and 4b at the Radium/Strontium Treatment Systems Area

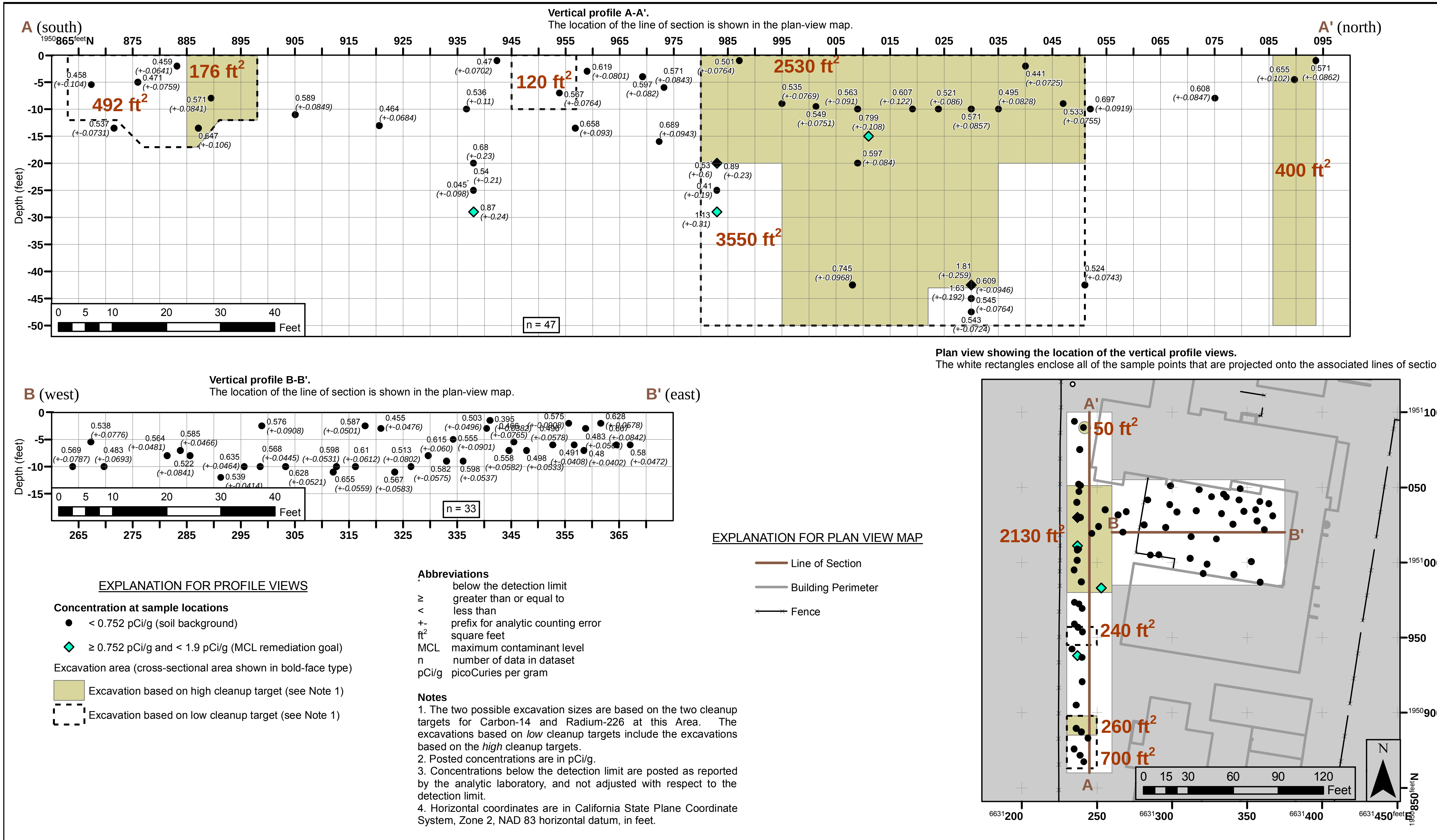


Figure B-3. Radium-226 Concentrations and Excavation Areas for Alternatives 4a and 4b at the Radium/Strontium Treatment Systems Area

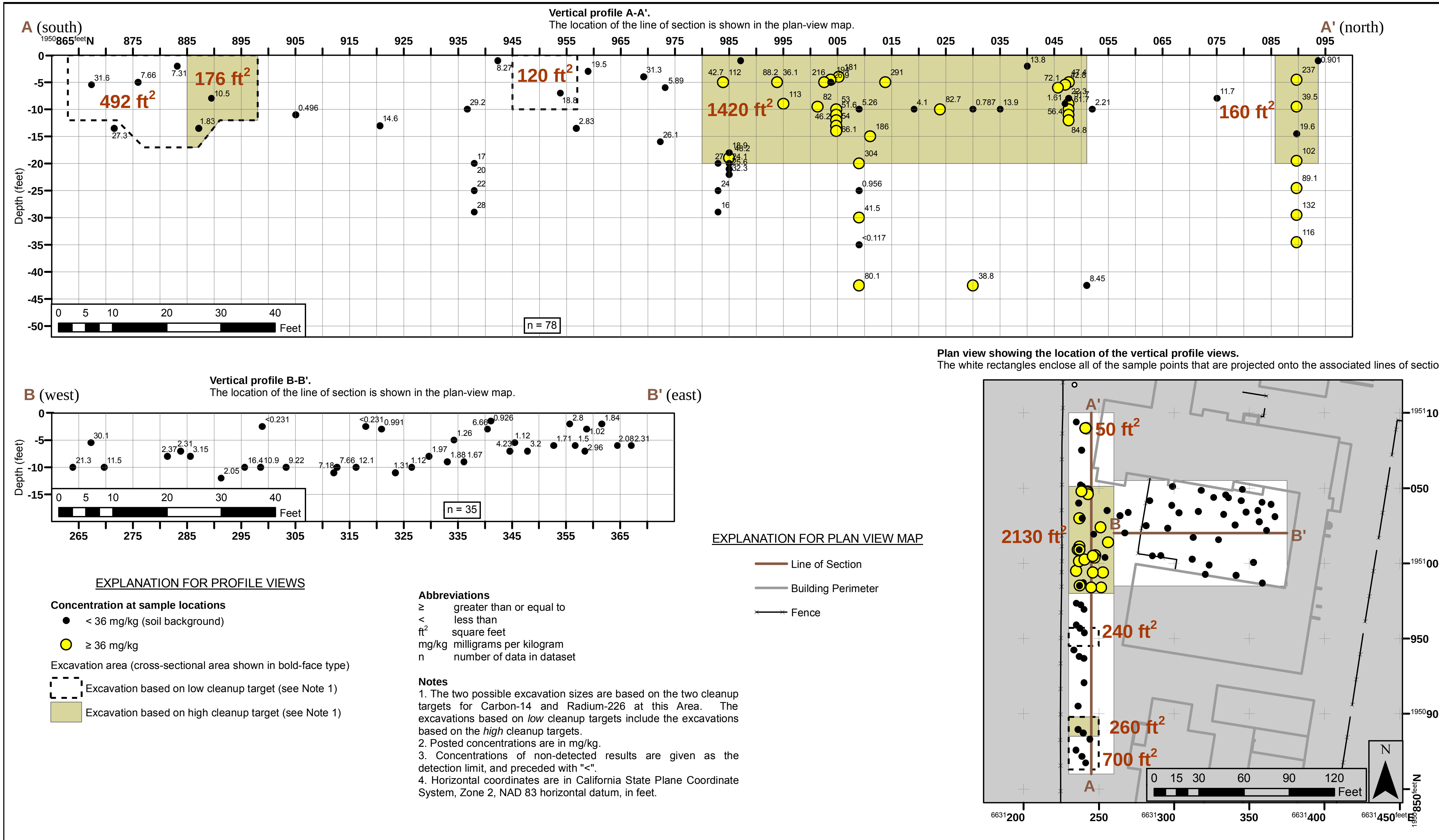


Figure B-4. Nitrate Concentrations and Excavation Areas for Alternative 4c at the Radium/Strontium Treatment Systems Area

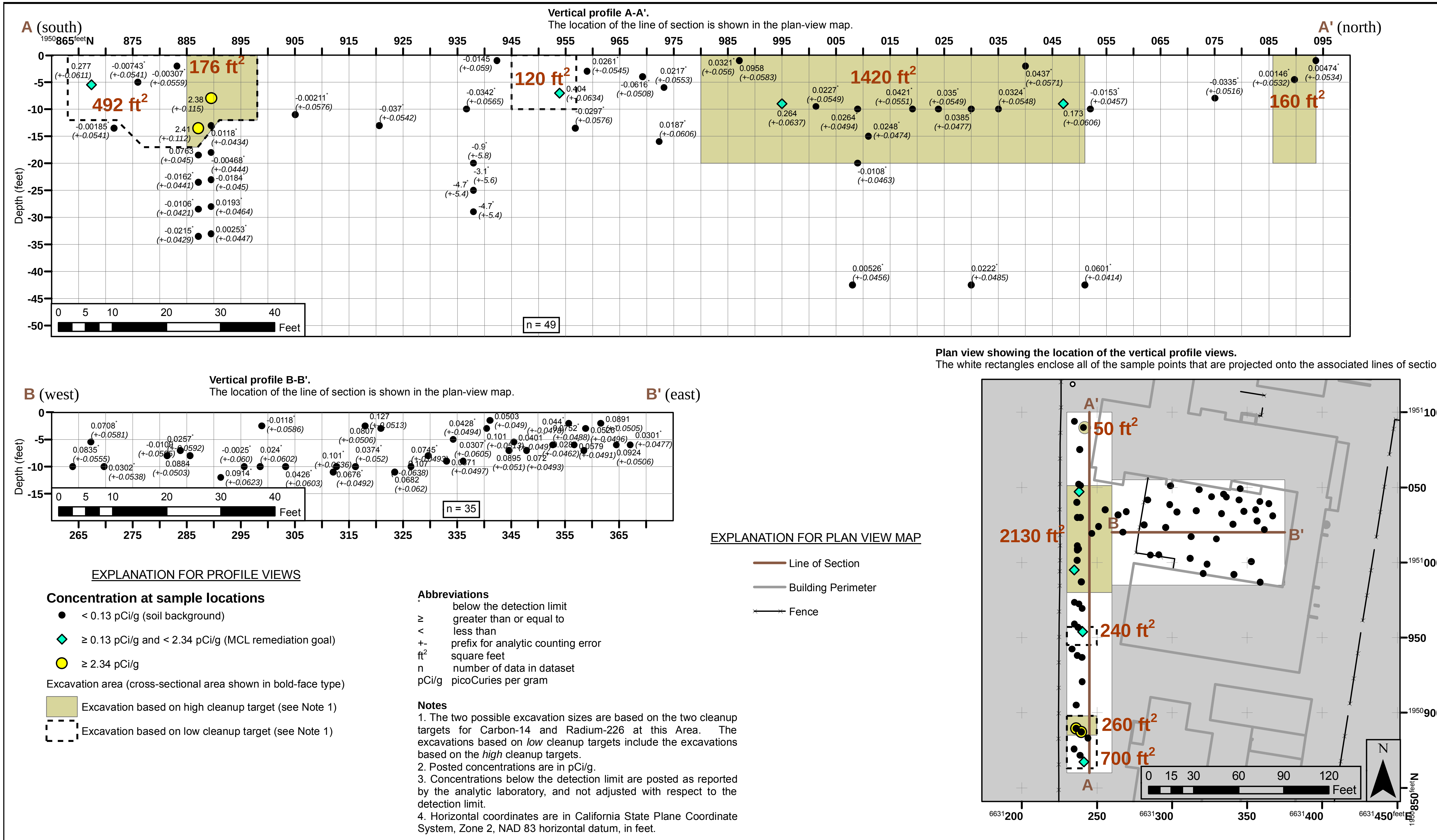


Figure B-5. Carbon-14 Concentrations and Excavation Areas for Alternative 4c at the Radium/Strontium Treatment Systems Area

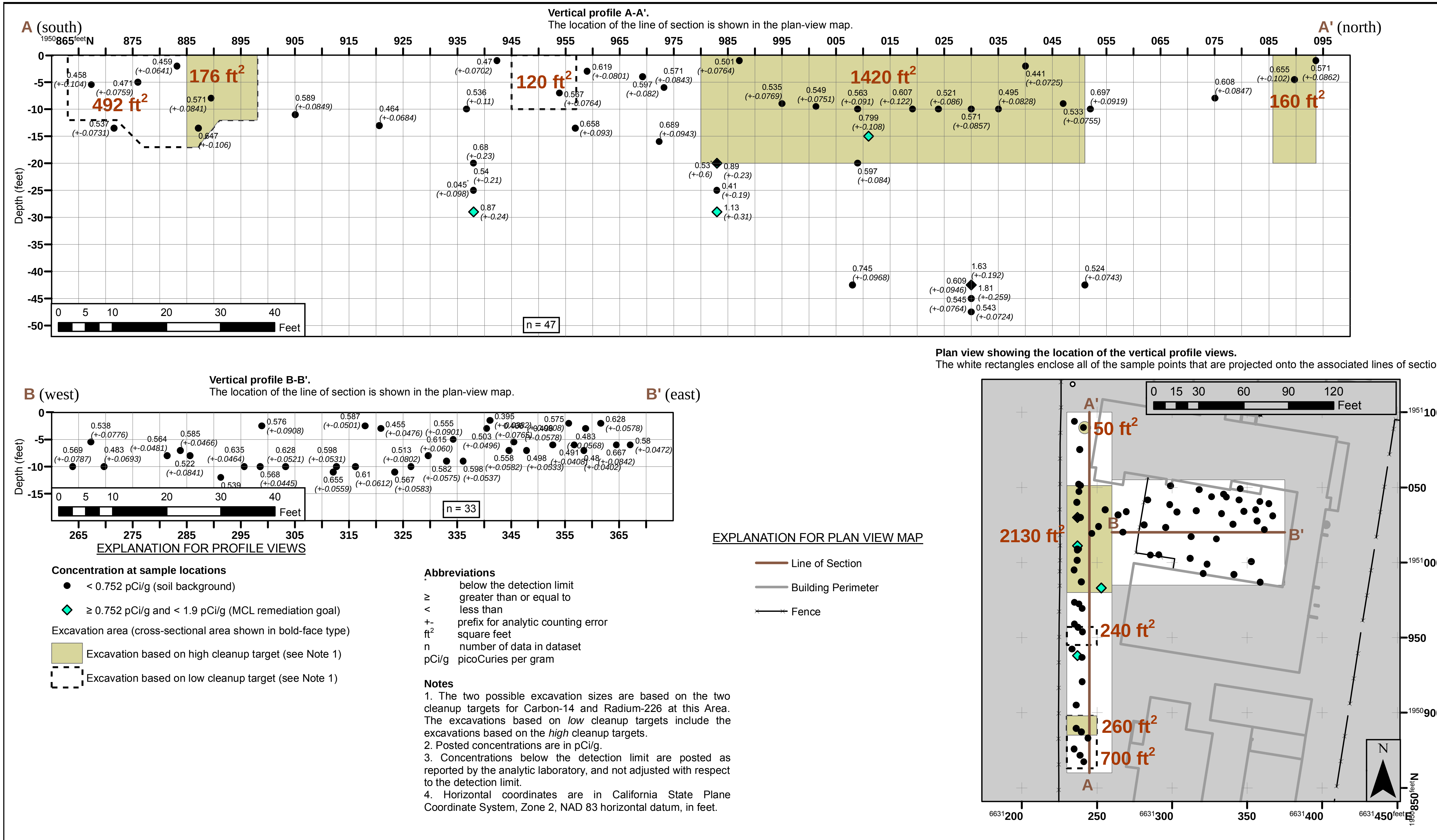
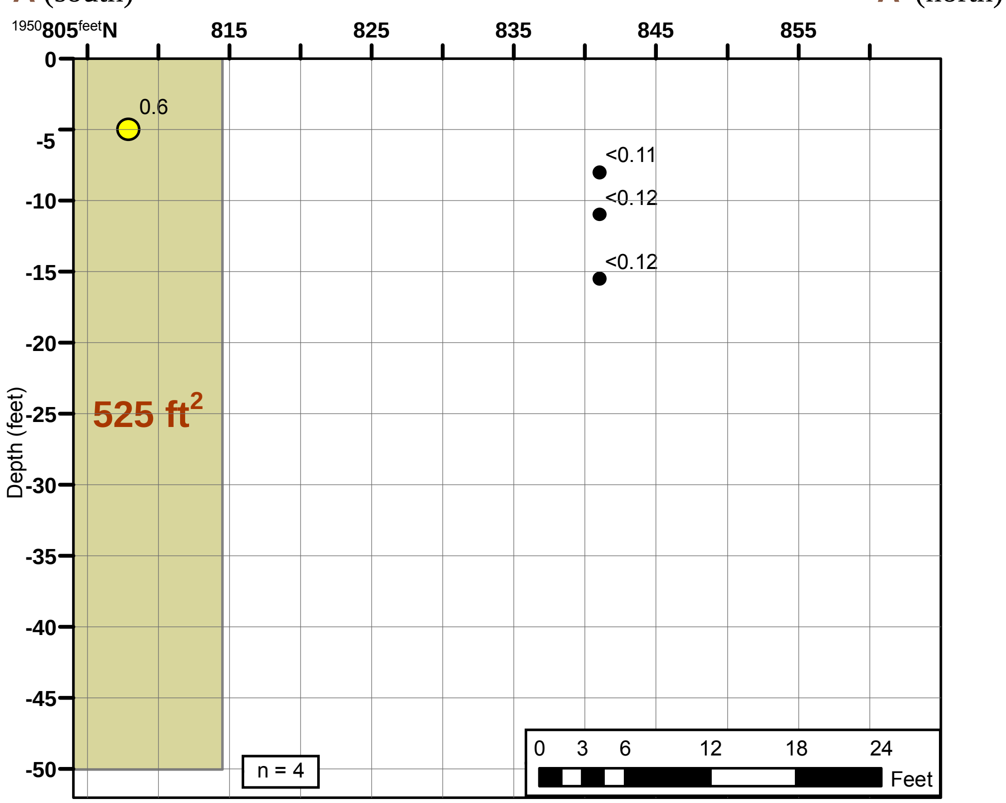
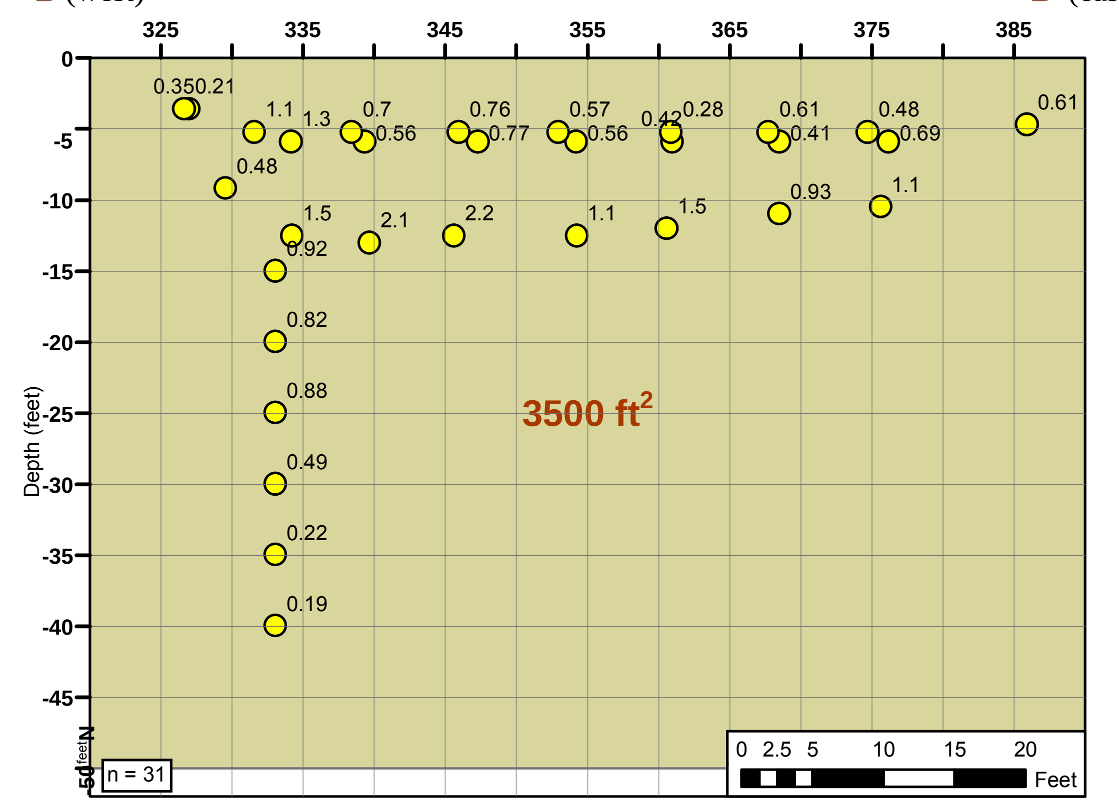


Figure B-6. Radium-226 Concentrations and Excavation Areas for Alternative 4c at the Radium/Strontium Treatment Systems Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Vertical profile B-B'.
The location of the line of section is shown in the plan-view map.



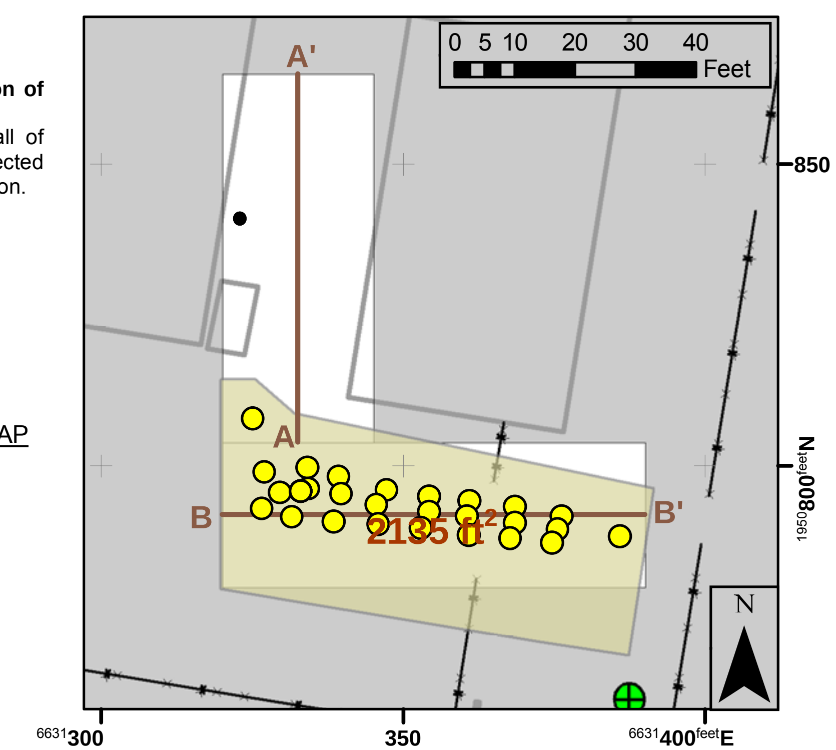
EXPLANATION FOR PROFILE VIEWS

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 0.00378 mg/kg (soil background goal)
- ≥ 0.00378 mg/kg

Plan view showing the location of the vertical profile views.
The white rectangles enclose all of the sample points that are projected onto the associated lines of section.



Abbreviations

≥	greater than or equal to
<	less than
ft^2	square feet
mg/kg	milligrams per kilogram
n	number of data in dataset

Notes

1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Figure B-7. Formaldehyde Concentrations and Excavation Areas for Alternatives 4a and 4b at the Domestic Septic Systems No. 3 Area

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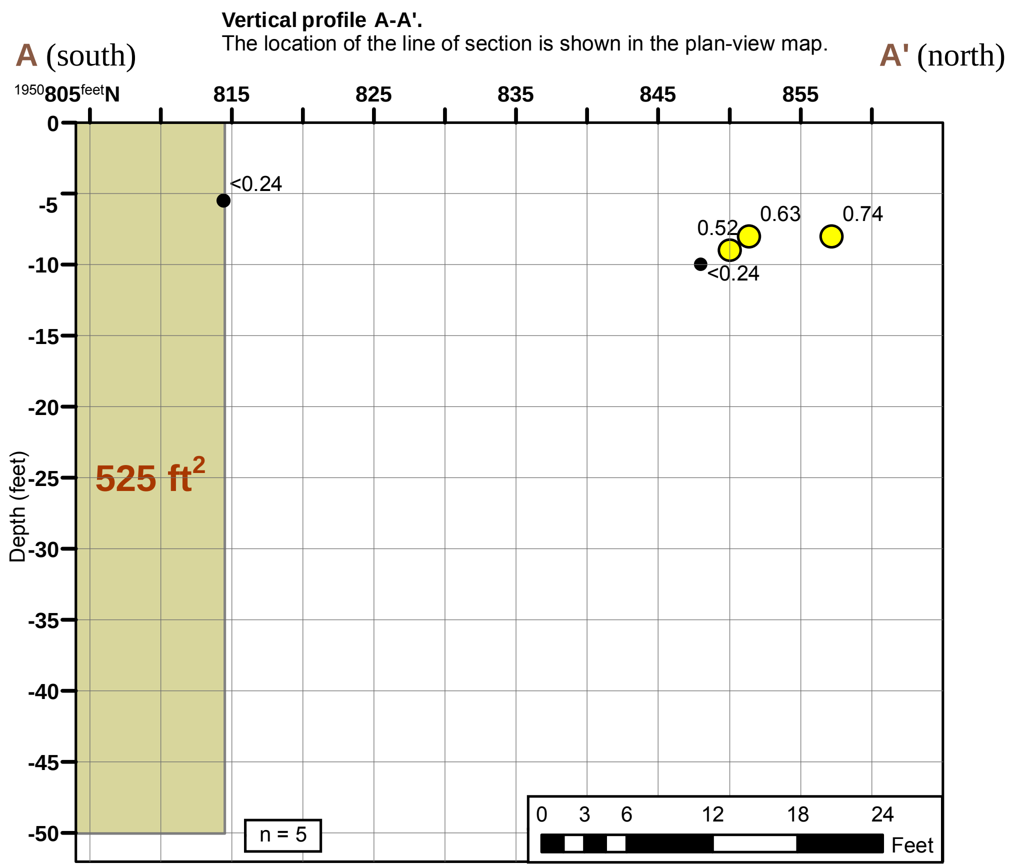
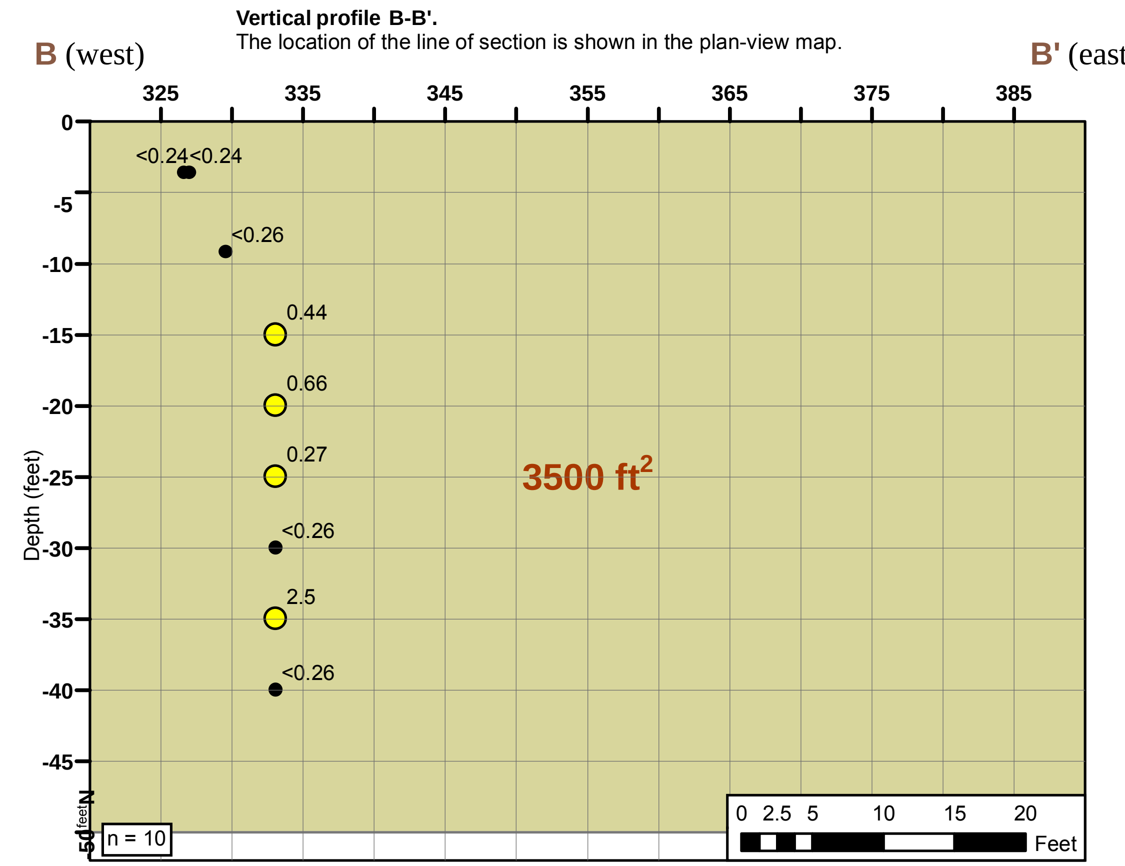
10/11/2006





EXPLANATION FOR PROFILE VIEWS

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

● < 0.26 mg/kg (soil background)

○ ≥ 0.26 mg/kg

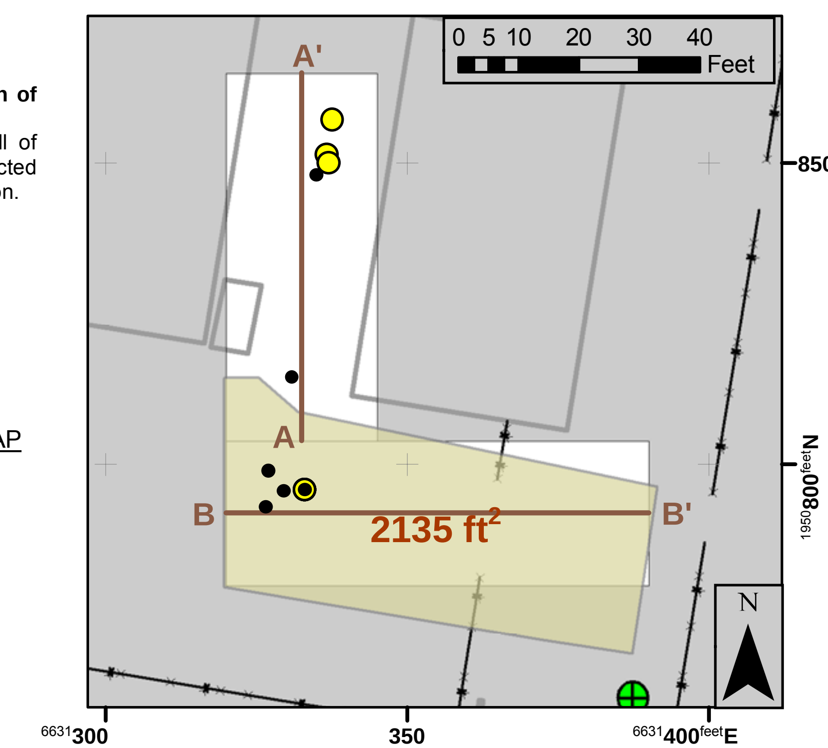
Abbreviations

≥ greater than or equal to
< less than
ft^2 square feet
mg/kg milligrams per kilogram
n number of data in dataset

Notes

1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

Plan view showing the location of the vertical profile views.
The white rectangles enclose all of the sample points that are projected onto the associated lines of section.



EXPLANATION FOR PLAN-VIEW MAP

Line of section

Building Perimeter

Fence

Excavation Area (Area shown in bold-face type)

Figure B-8. Molybdenum Concentrations and Excavation Areas for Alternatives 4a and 4b at the Domestic Septic Systems No. 3 Area

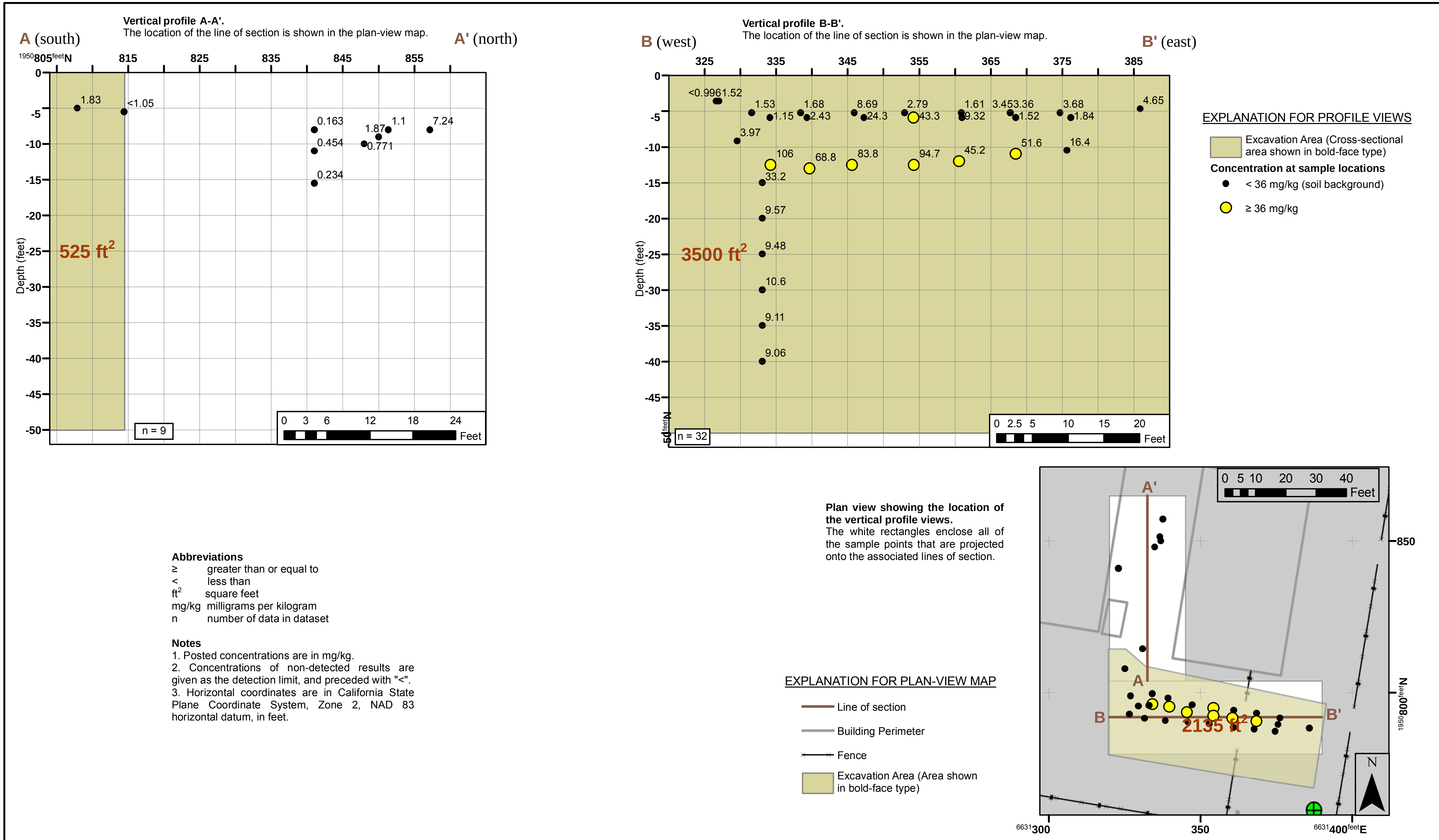
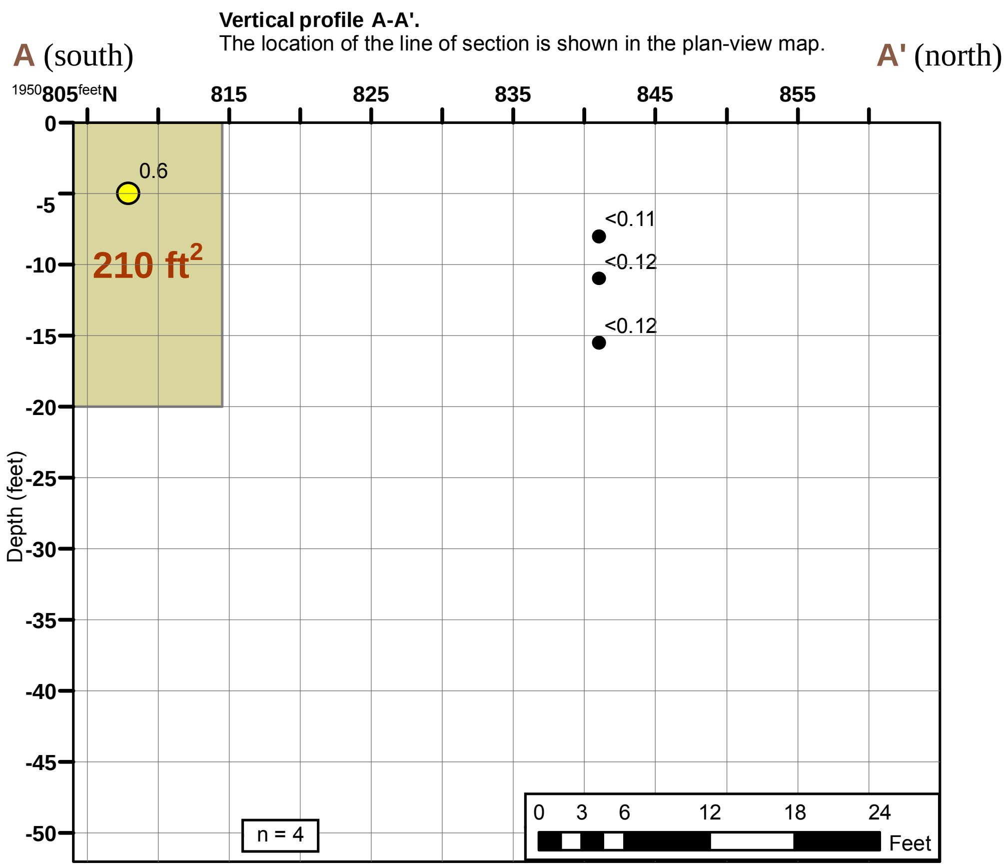
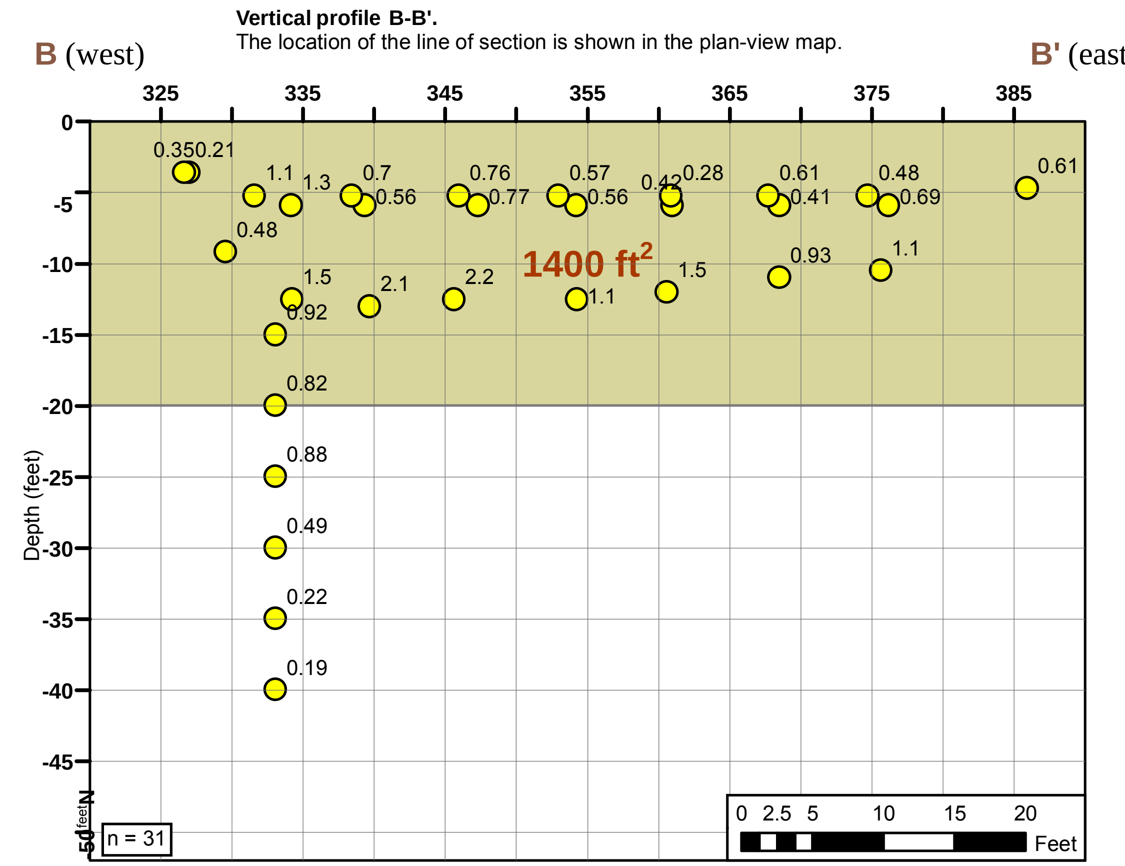


Figure B-9. Nitrate Concentrations and Excavation Areas for Alternatives 4a and 4b at the Domestic Septic Systems No. 3 Area





EXPLANATION FOR PROFILE VIEWS

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 0.00378 mg/kg (soil background goal)
- ≥ 0.00378 mg/kg

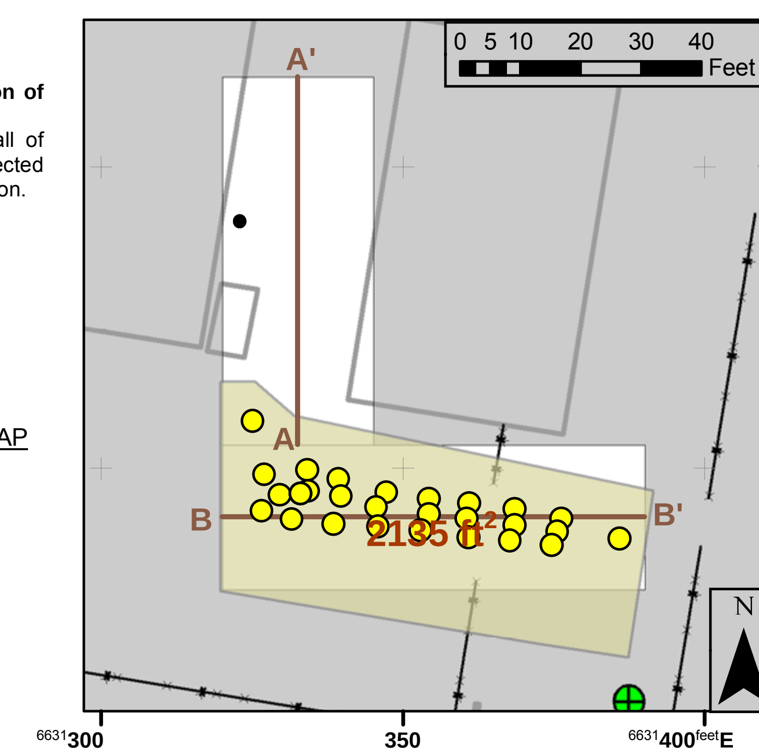
Abbreviations

- ≥ greater than or equal to
- < less than
- ft^2 square feet
- mg/kg milligrams per kilogram
- n number of data in dataset

Notes

1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

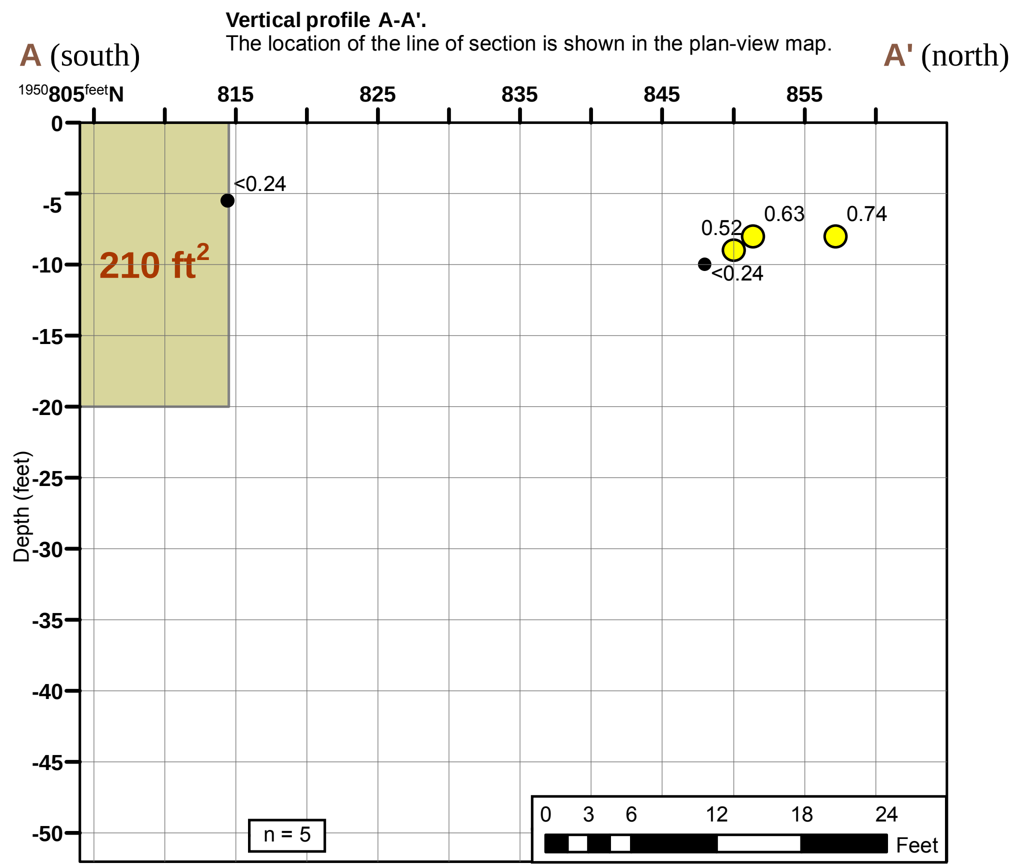
Plan view showing the location of the vertical profile views.
The white rectangles enclose all of the sample points that are projected onto the associated lines of section.

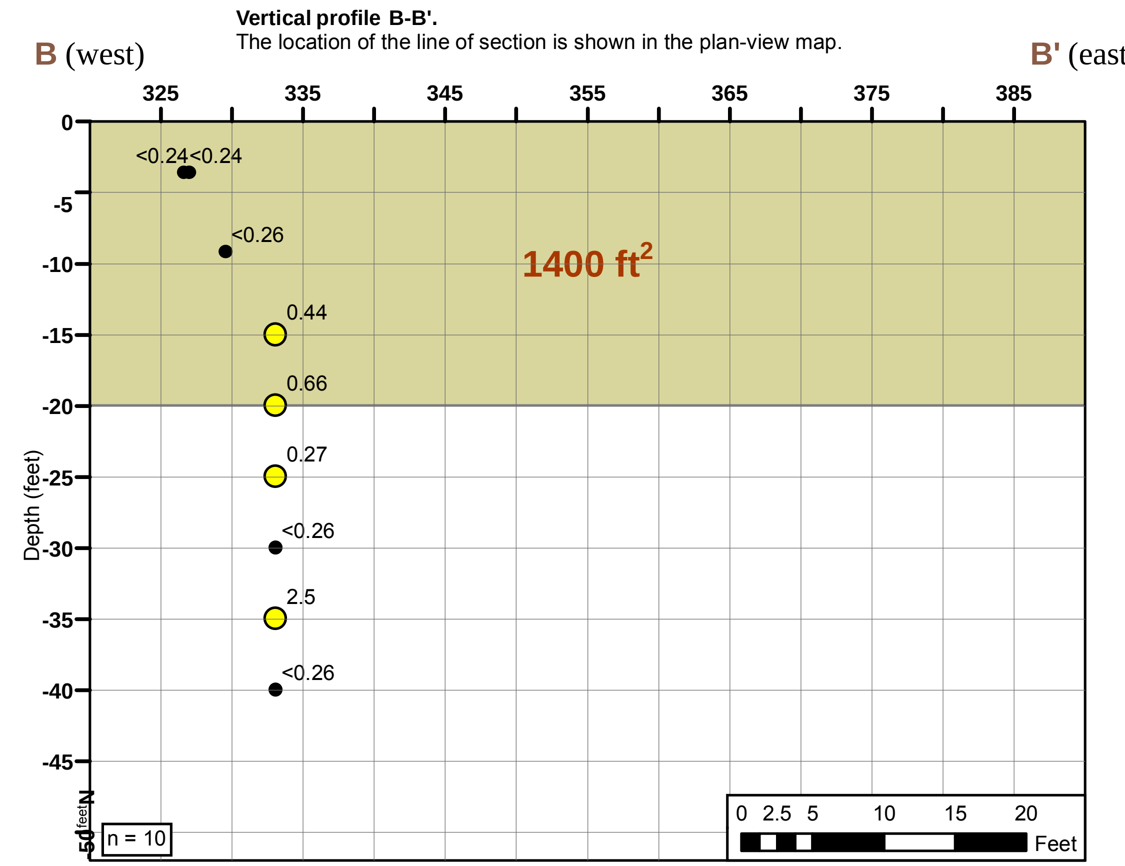


EXPLANATION FOR PLAN-VIEW MAP

- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Figure B-10. Formaldehyde Concentrations and Excavation Areas for Alternative 4c at the Domestic Septic Systems No. 3 Area





EXPLANATION FOR PROFILE VIEWS

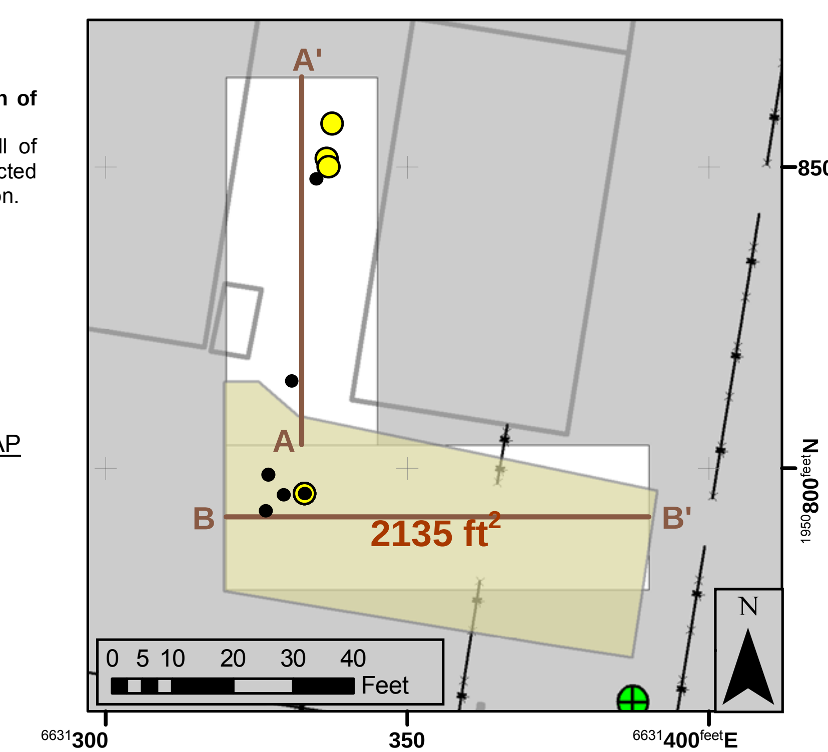
Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

< 0.26 mg/kg (soil background)

≥ 0.26 mg/kg

Plan view showing the location of the vertical profile views.
The white rectangles enclose all of the sample points that are projected onto the associated lines of section.



Abbreviations
≥ greater than or equal to
< less than
ft2 square feet
mg/kg milligrams per kilogram
n number of data in dataset

Notes
1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

Line of section

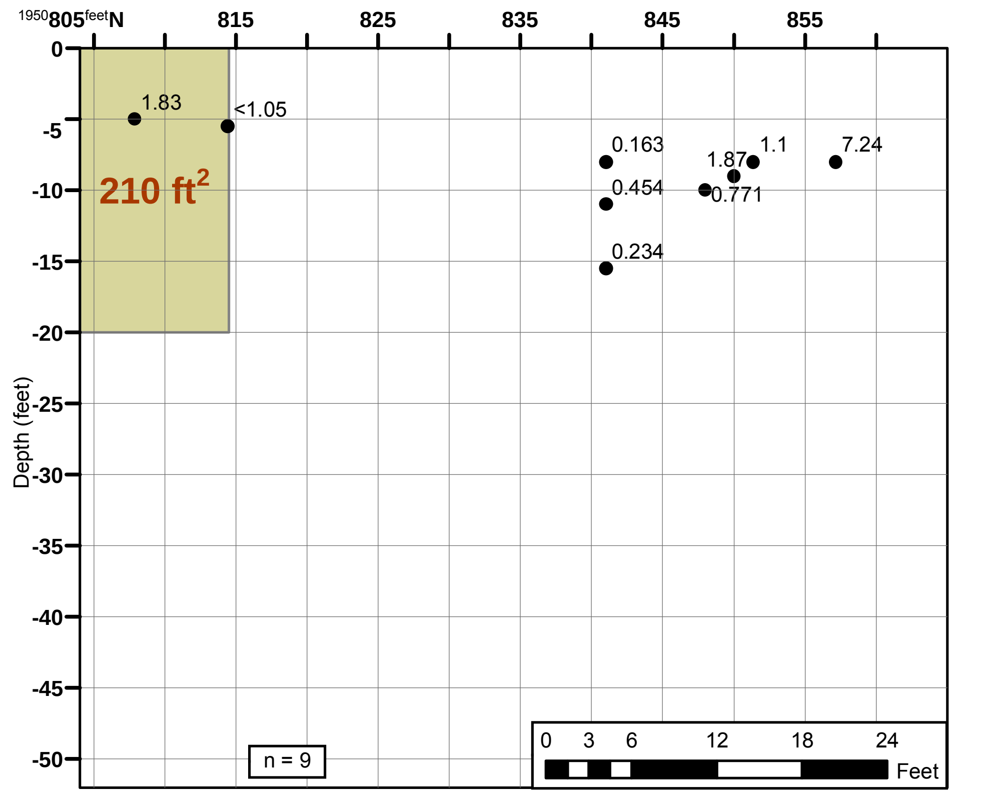
Building Perimeter

Fence

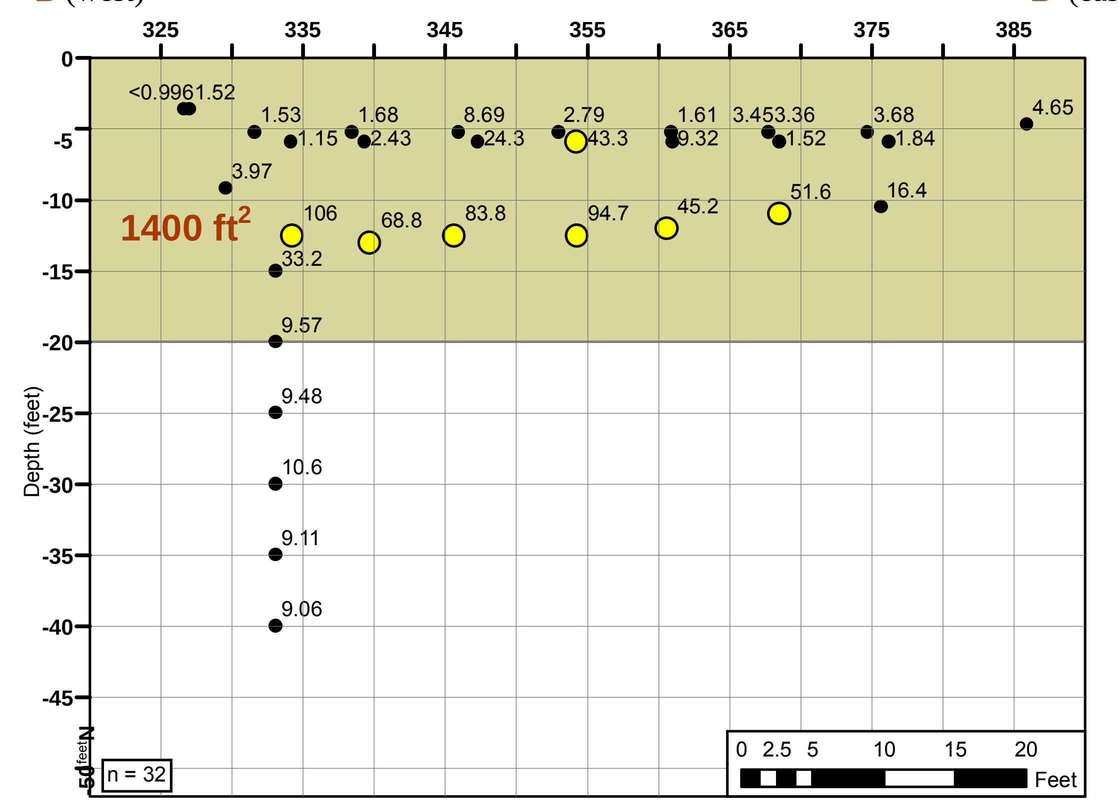
Excavation Area (Area shown in bold-face type)

Figure B-11. Molybdenum Concentrations and Excavation Areas for Alternative 4c at the Domestic Septic Systems No. 3 Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Vertical profile B-B'.
The location of the line of section is shown in the plan-view map.



EXPLANATION FOR PROFILE VIEWS

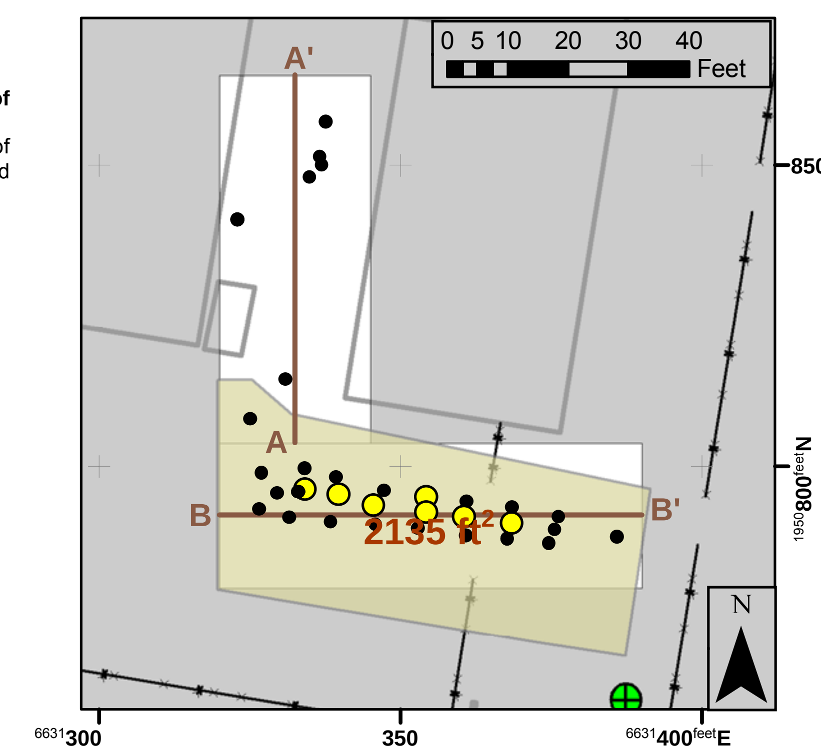
Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

< 36 mg/kg (soil background)

≥ 36 mg/kg

Plan view showing the location of the vertical profile views.
The white rectangles enclose all of the sample points that are projected onto the associated lines of section.



Abbreviations
≥ greater than or equal to
< less than
ft² square feet
mg/kg milligrams per kilogram
n number of data in dataset

Notes
1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

Line of section

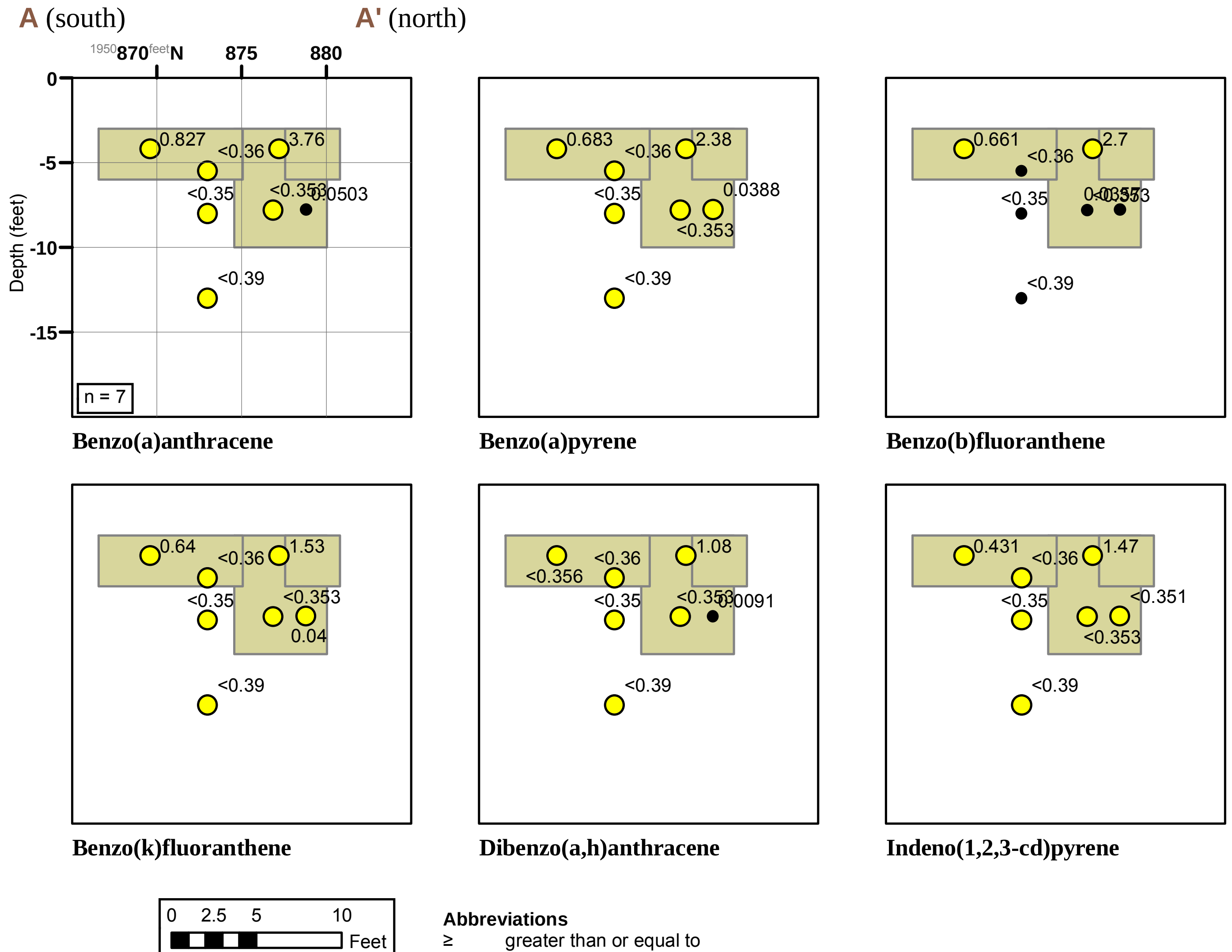
Building Perimeter

Fence

Excavation Area (Area shown in bold-face type)

Figure B-12. Nitrate Concentrations and Excavation Areas for Alternative 4c at the Domestic Septic Systems No. 3 Area

Vertical profile A-A'.
Each panel represents a different species of polynuclear aromatic hydrocarbon projected onto the same line of section. The location of the line of section is shown in the plan-view map.



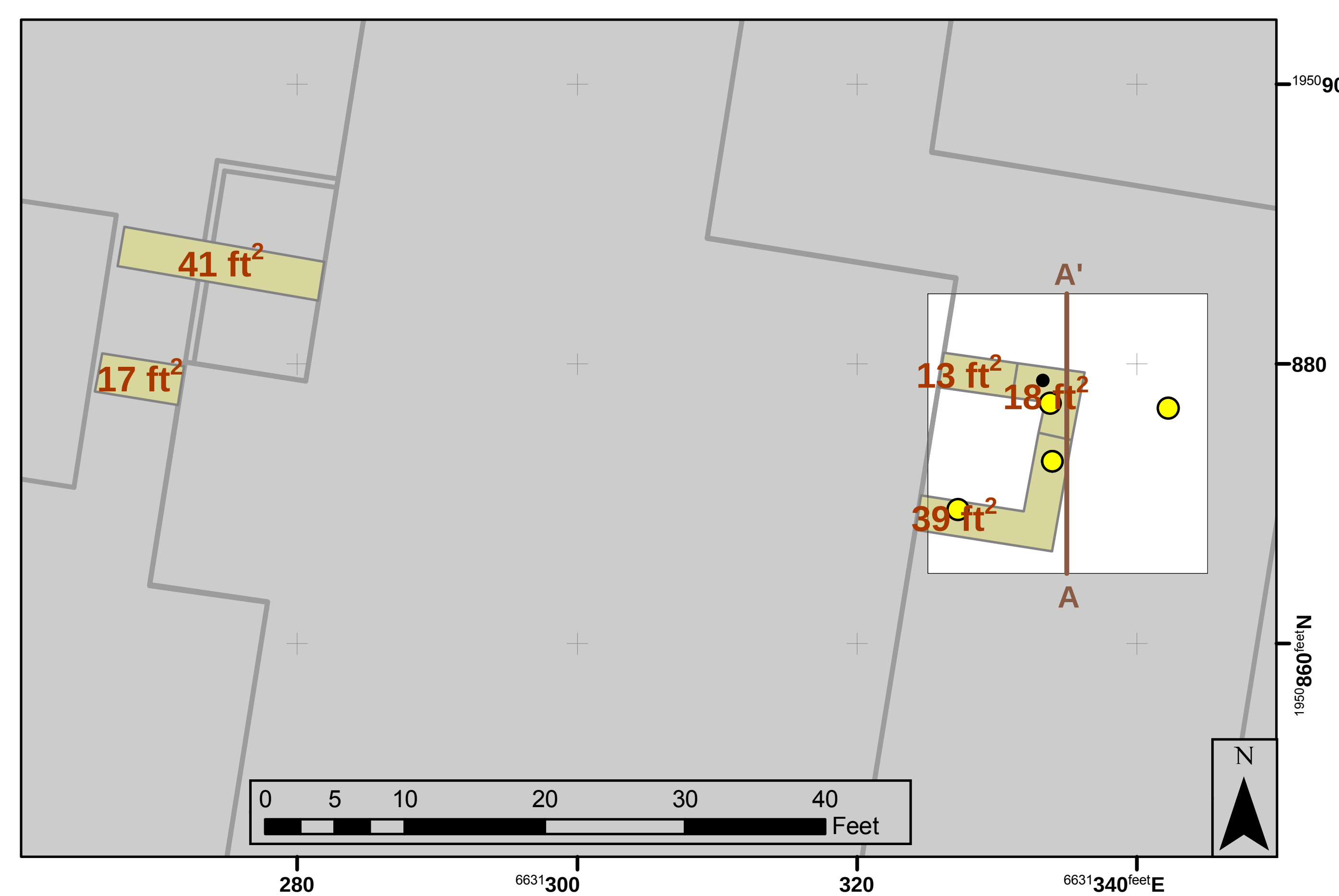
Concentrations of Polynuclear Aromatic Hydrocarbons at which the Risk to Human Resident Receptors is 1E-06	
Constituent of Concern	**Concentration at Risk 1E-06 (mg/kg)**
Benzo(a)anthracene	0.2
Benzo(a)pyrene	0.03*
Benzo(b)fluoranthene	0.4
Benzo(k)fluoranthene	0.004
Dibenzo(a,h)anthracene	0.1
Indeno(1,2,3-cd)pyrene	0.2

* Benzo(a)pyrene also causes a risk for the on-site construction-worker receptor, but at a much higher concentration.

EXPLANATION FOR PLAN-VIEW MAP

- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Plan view showing the location of the vertical profile views.
The white rectangles enclose all of the sample points that are projected onto the line of section.



Abbreviations
≥ greater than or equal to
< less than
ft² square feet
mg/kg milligrams per kilogram
n number of data in dataset

Notes
1. Posted concentrations are in mg/kg. See the associated table for the concentrations associated with 1E-06 risk. The contaminant-level symbols are associated with the risk to the on-site resident receptor.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PROFILE VIEWS

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations
- < 1E-06 risk
- ≥ 1E-06 risk

Figure B-13. Polynuclear-Aromatic-Hydrocarbon Concentrations and Excavation Areas for Alternative 4 at the Domestic Septic Systems No. 4 Area

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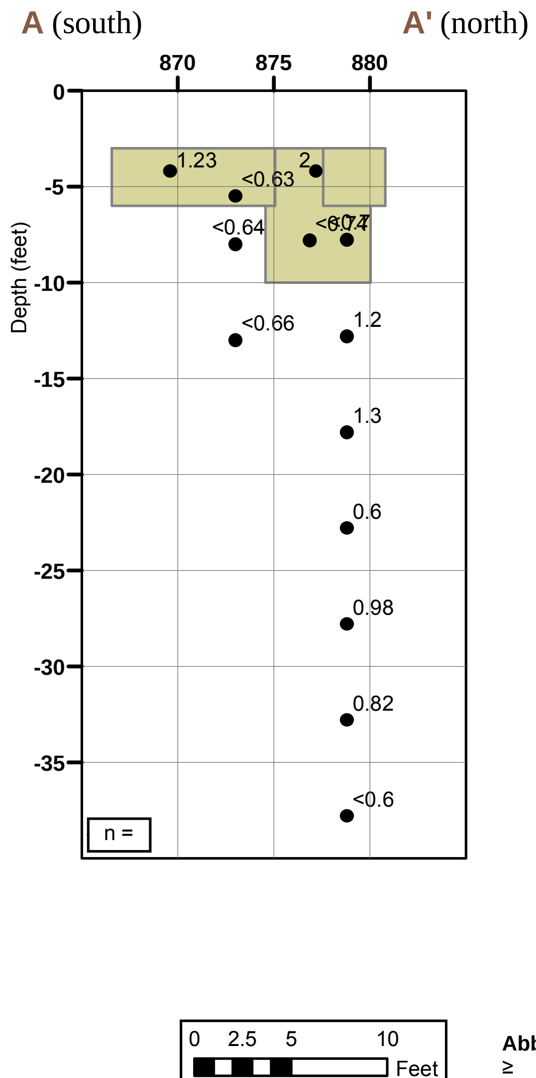
Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Abbreviations

- ≥ greater than or equal to
- < less than
- ft^2 square feet
- mg/kg milligrams per kilogram
- n number of data in dataset

Notes

1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PROFILE VIEWS

- Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 4.0 mg/kg (background goal)
- ≥ 4.0 mg/kg (background goal)

EXPLANATION FOR PLAN-VIEW MAP

- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Plan view showing the location of the vertical profile views.
The white rectangles enclose all of the sample points that are projected onto the line of section.

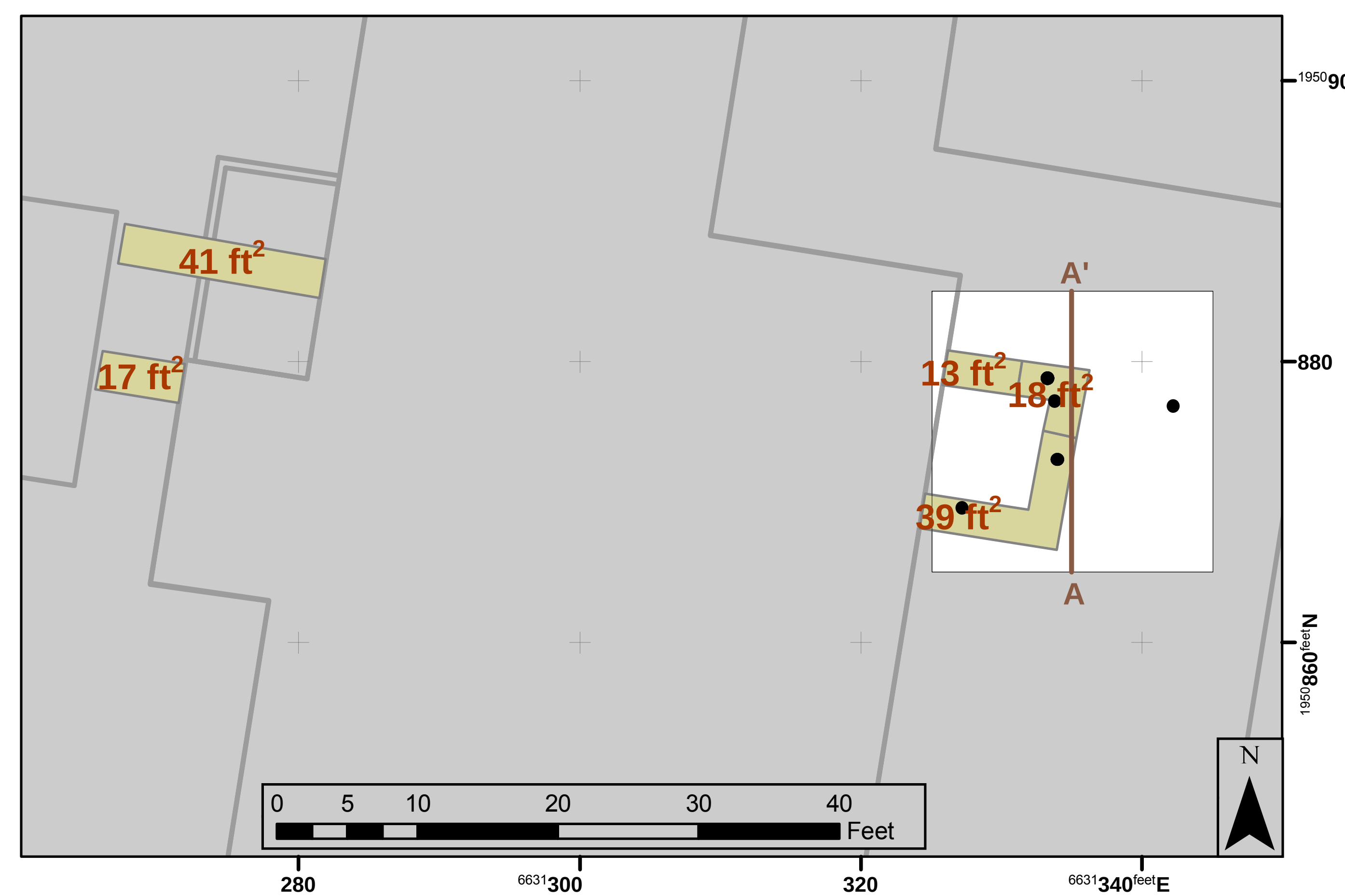
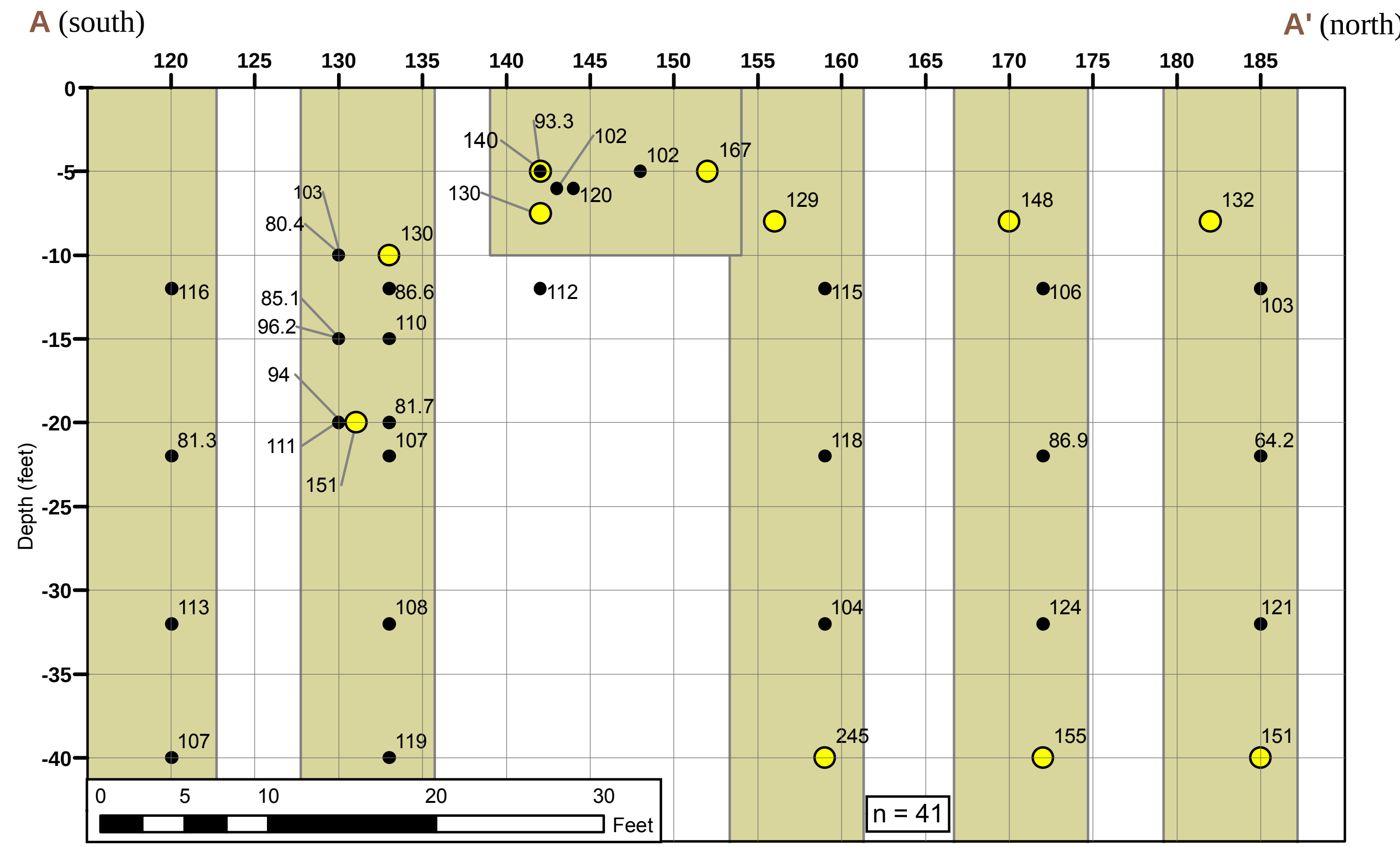
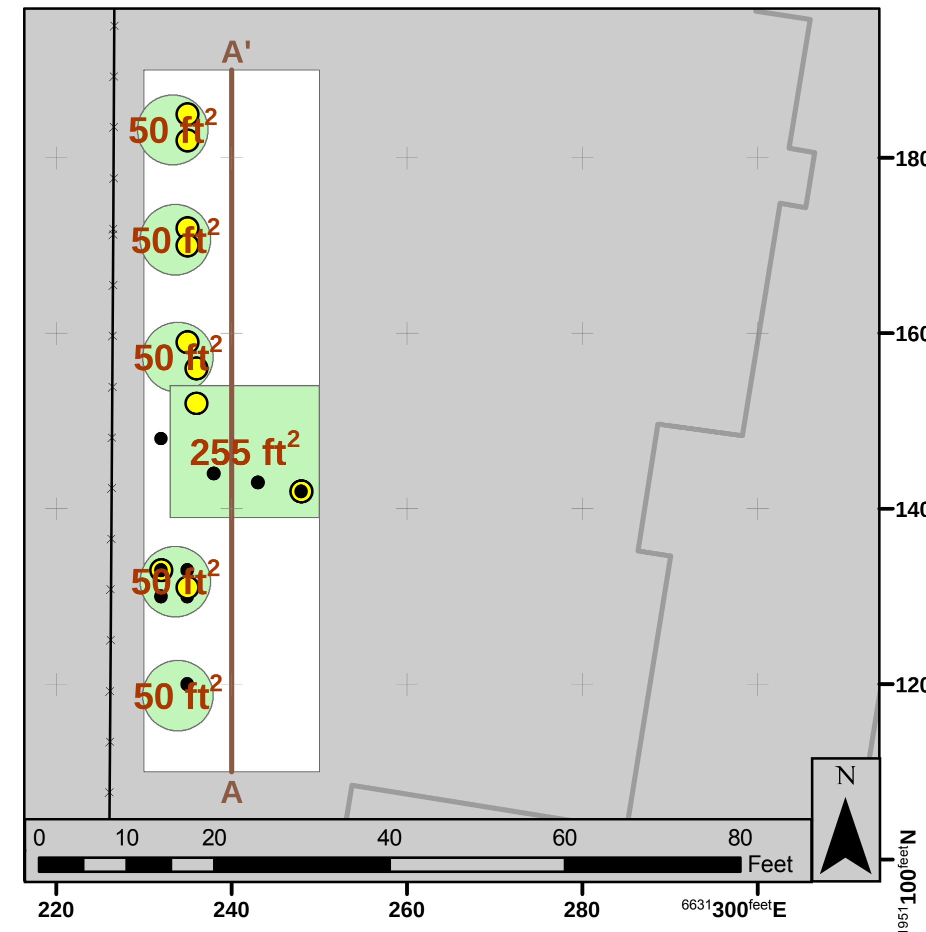


Figure B-14. Selenium Concentrations and Excavation Areas for Alternative 4 at the Domestic Septic Systems No. 4 Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 125 mg/kg (soil background)
- ≥ 125 mg/kg

Abbreviations

≥ greater than or equal to
< less than
ft^2 square feet
mg/kg milligrams per kilogram
n number of data in dataset

Notes

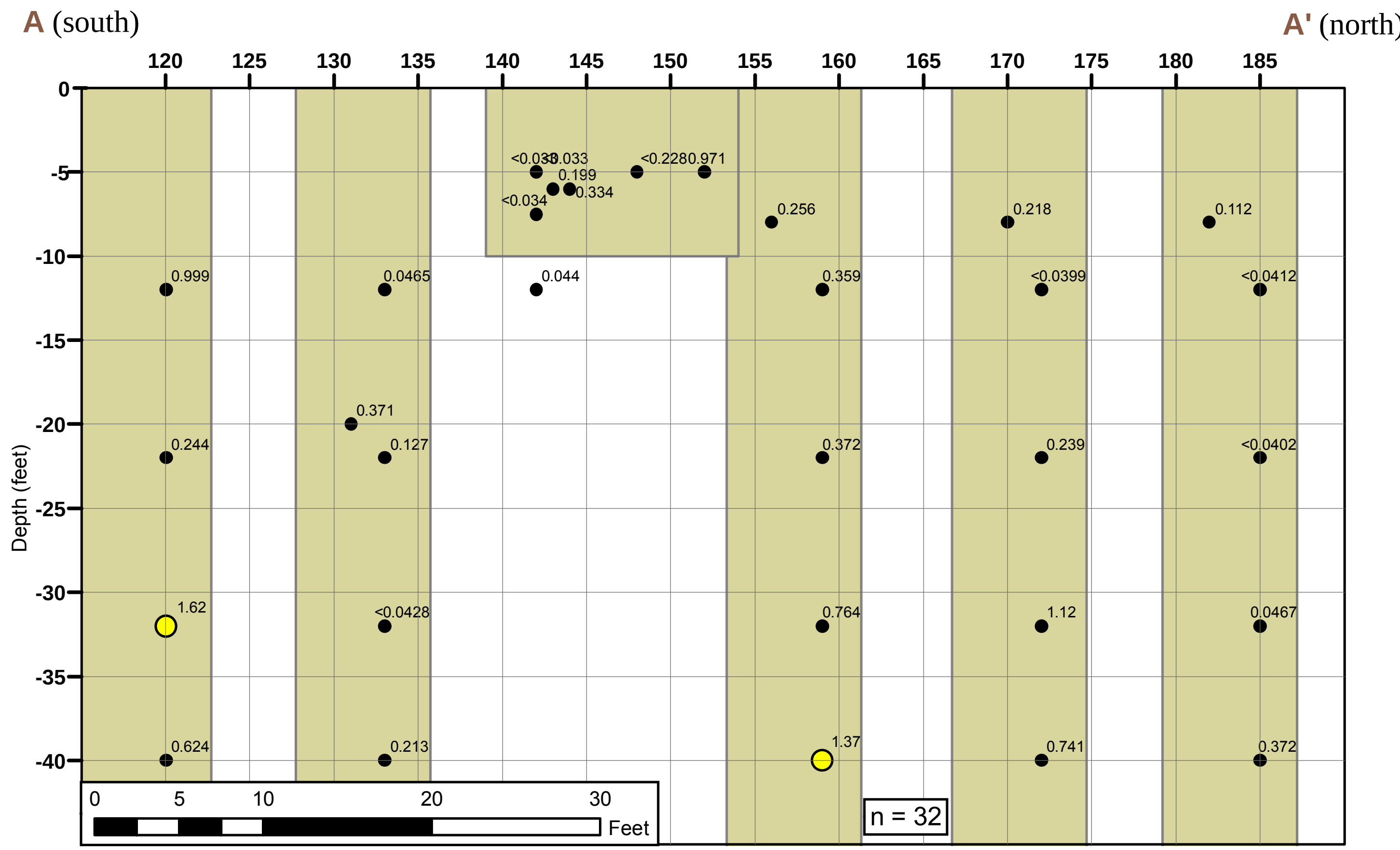
1. Posted concentrations are in mg/kg.
2. All of the samples were detects.
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

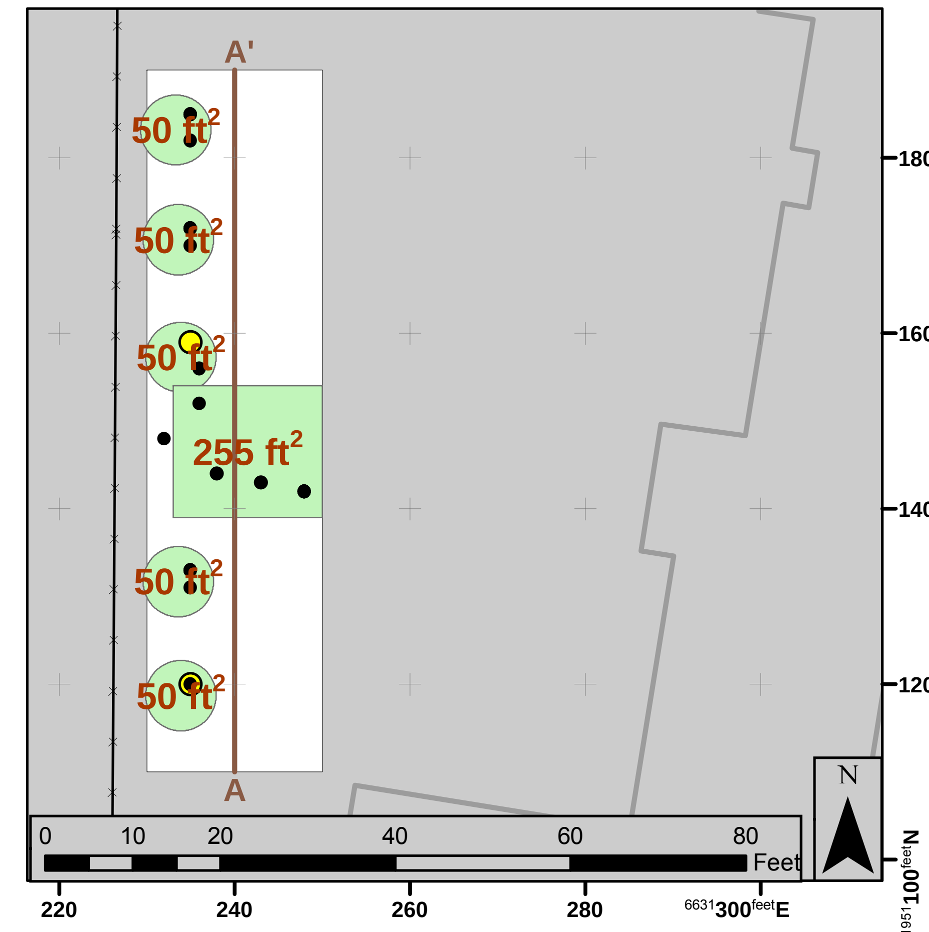
- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Figure B-15. Chromium Concentrations and Excavation Areas for Alternative 4a at the Drywells A-E Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 1.3 mg/kg (soil background)
- ≥ 1.3 mg/kg

Abbreviations

≥ greater than or equal to
< less than
ft² square feet
mg/kg milligrams per kilogram
n number of data in dataset

Notes

1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

Line of section
Building Perimeter
Fence
Excavation Area (Area shown in bold-face type)

Figure B-16. Hexavalent Chromium Concentrations and Excavation Areas for Alternative 4a at the Drywells A-E Area

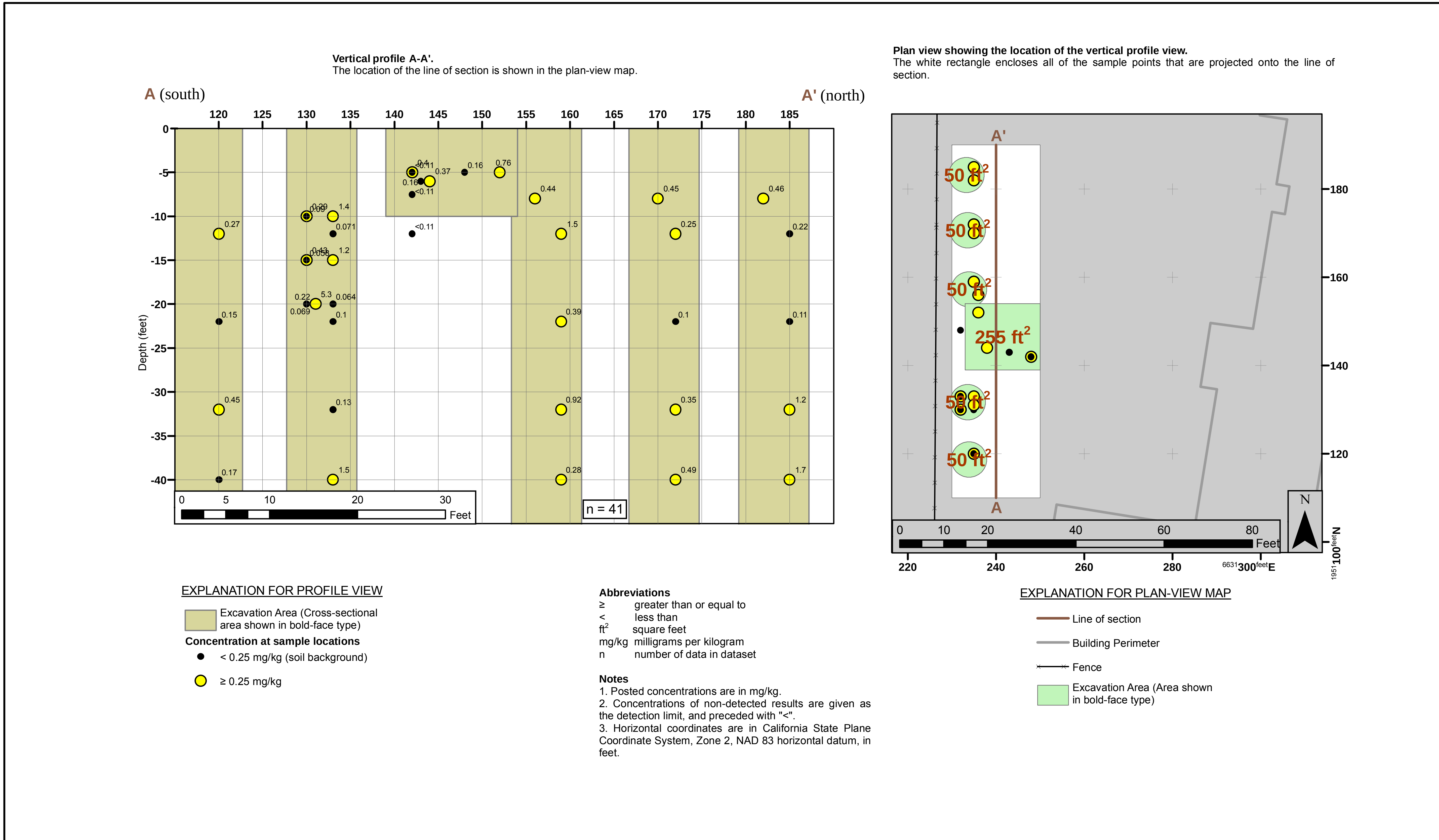
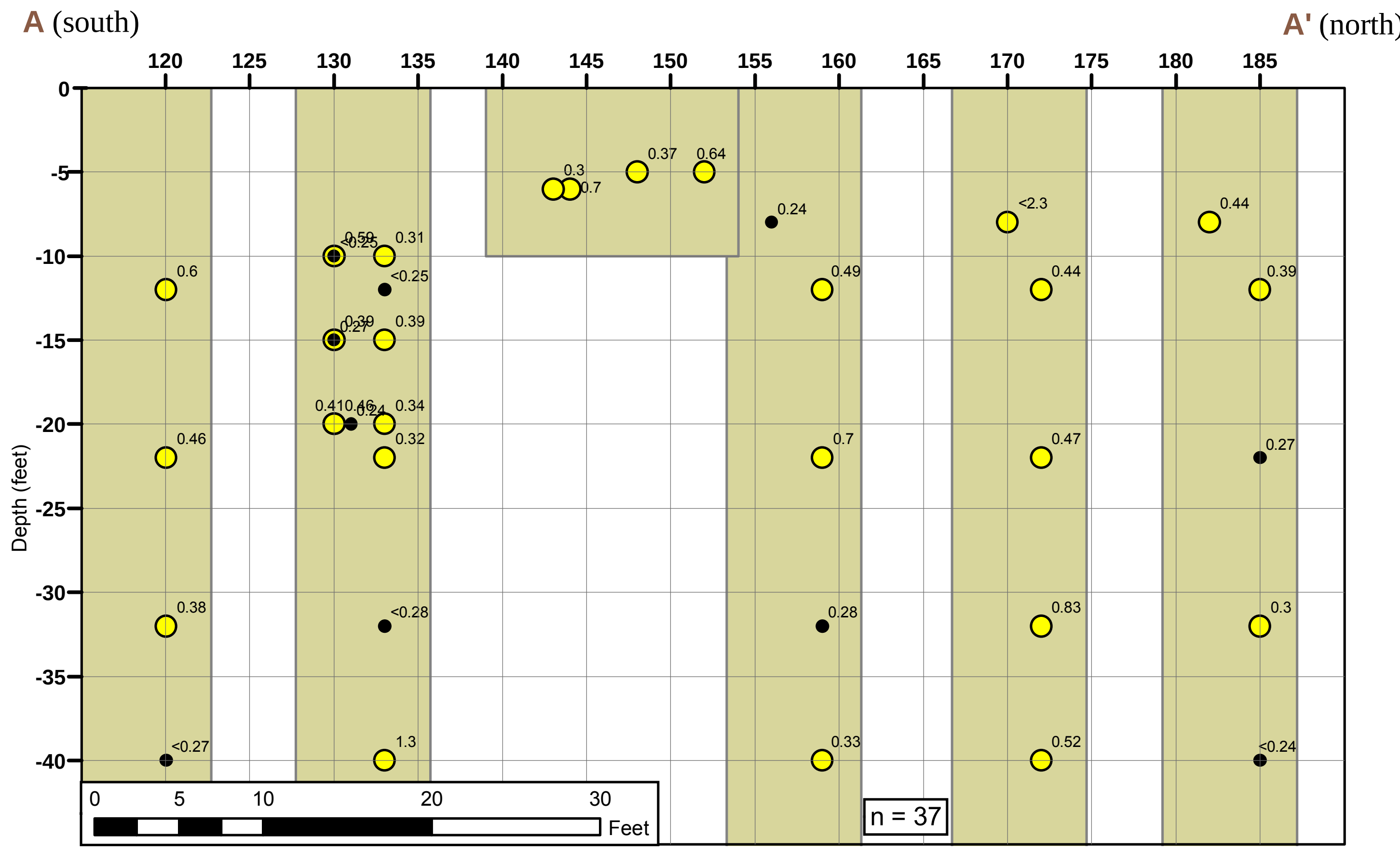
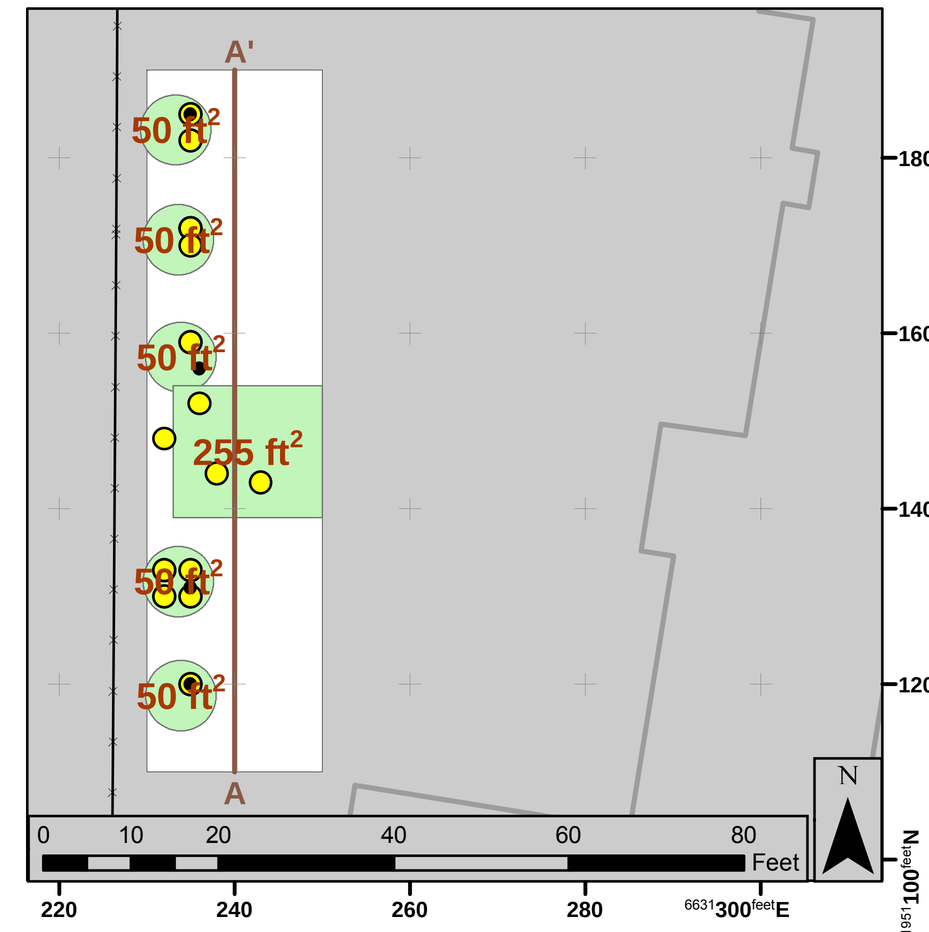


Figure B-17. Mercury Concentrations and Excavation Areas for Alternative 4a at the Drywells A-E Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 0.30 mg/kg (soil background goal)
- ≥ 0.30 mg/kg

Abbreviations

≥ greater than or equal to
< less than
ft² square feet
mg/kg milligrams per kilogram
n number of data in dataset

Notes

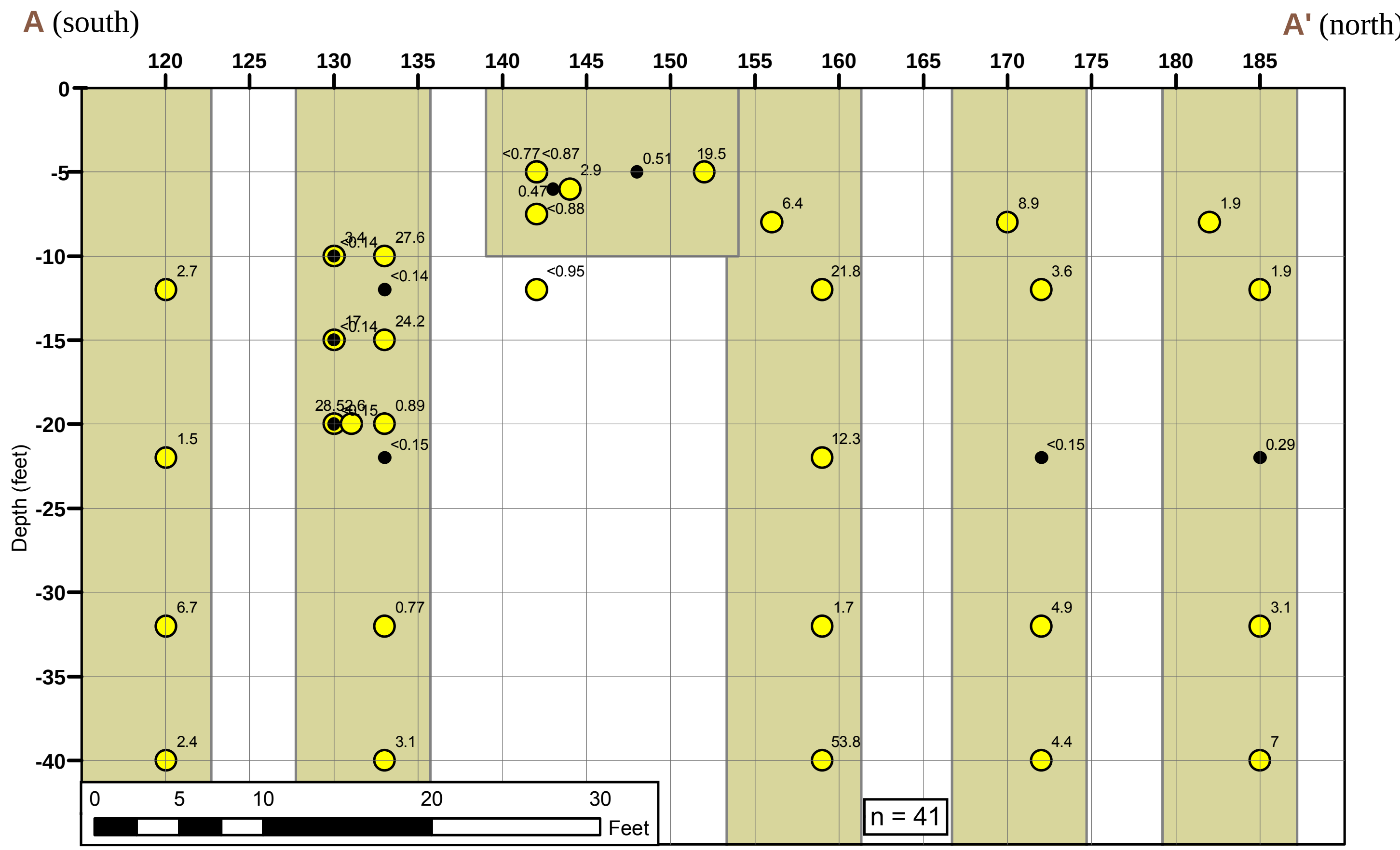
1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

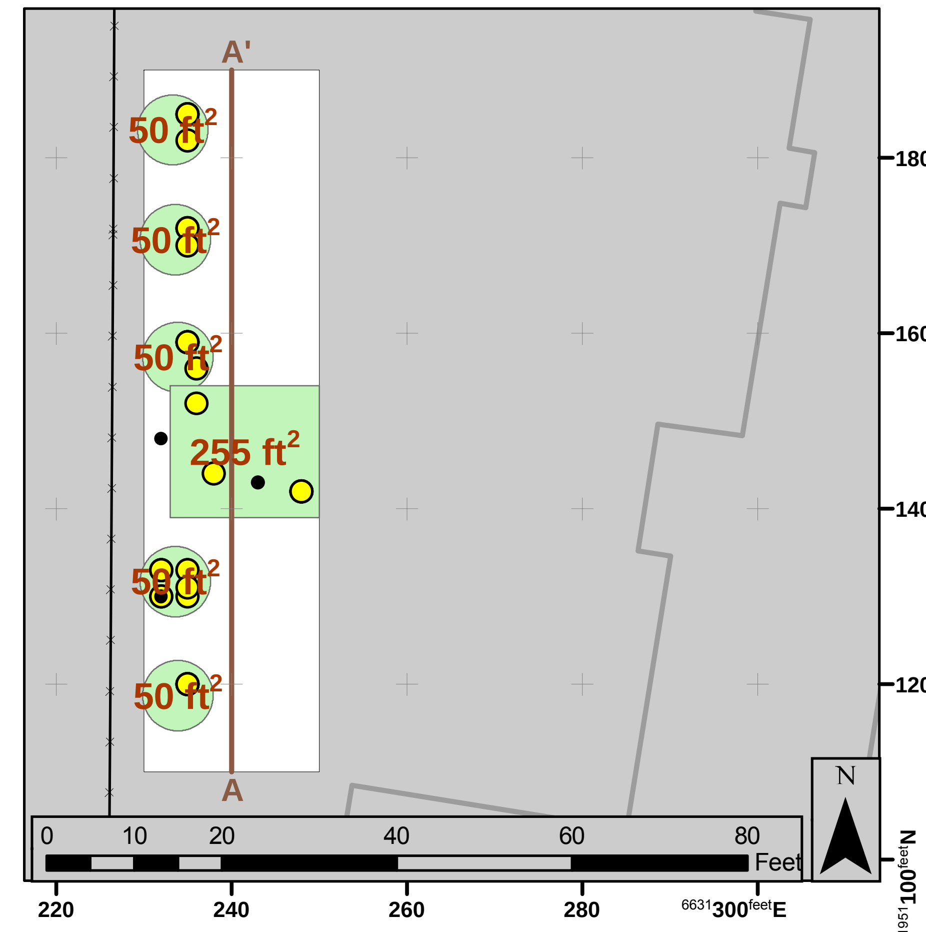
Line of section
Building Perimeter
Fence
Excavation Area (Area shown in bold-face type)

Figure B-18. Molybdenum Concentrations and Excavation Areas for Alternative 4a at the Drywells A-E Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

- Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 0.55 mg/kg (soil background)
- ≥ 0.55 mg/kg

Abbreviations

≥	greater than or equal to
<	less than
ft^2	square feet
mg/kg	milligrams per kilogram
n	number of data in dataset

Notes

1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Figure B-19. Silver Concentrations and Excavation Areas for Alternative 4a at the Drywells A-E Area

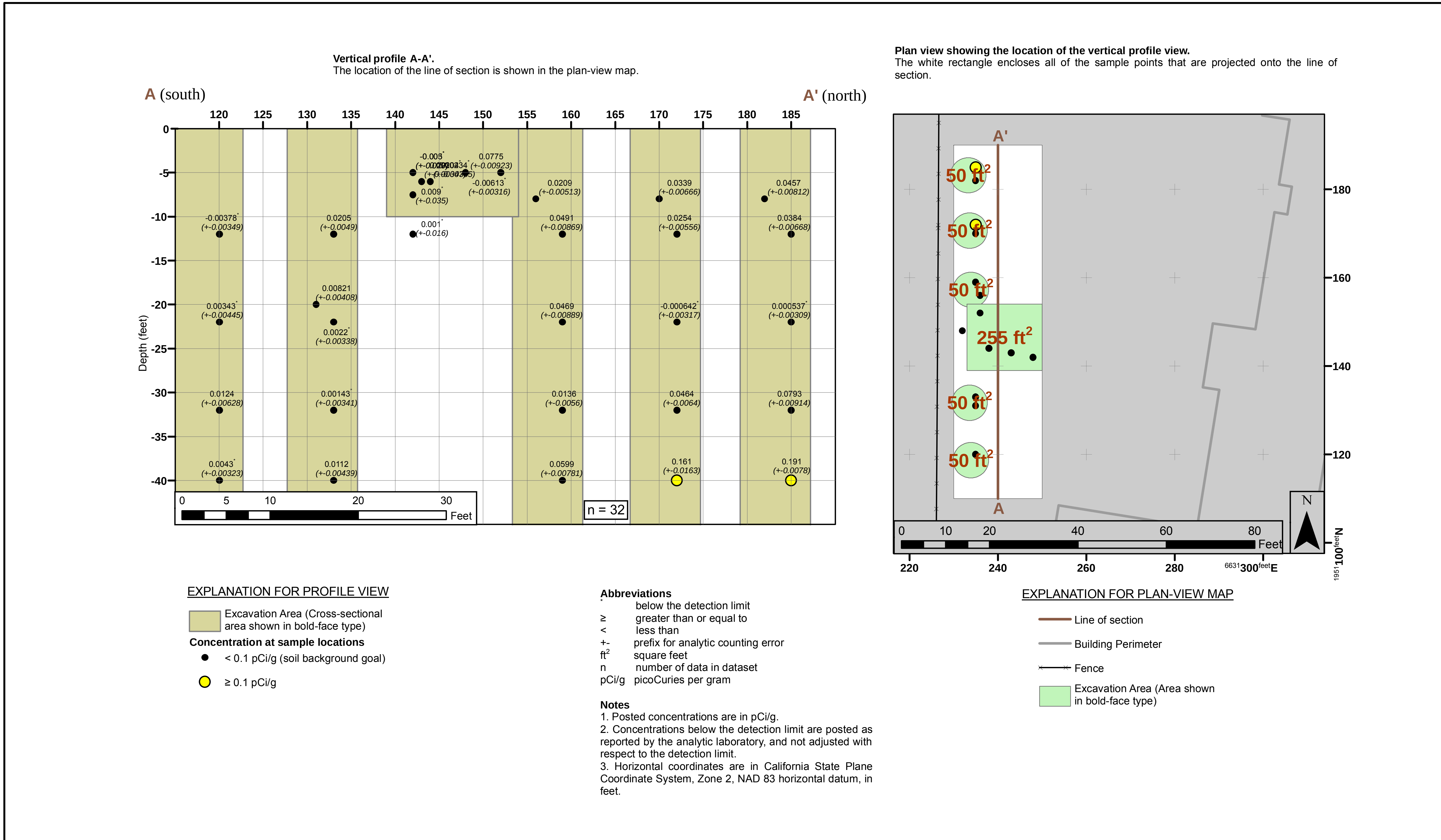
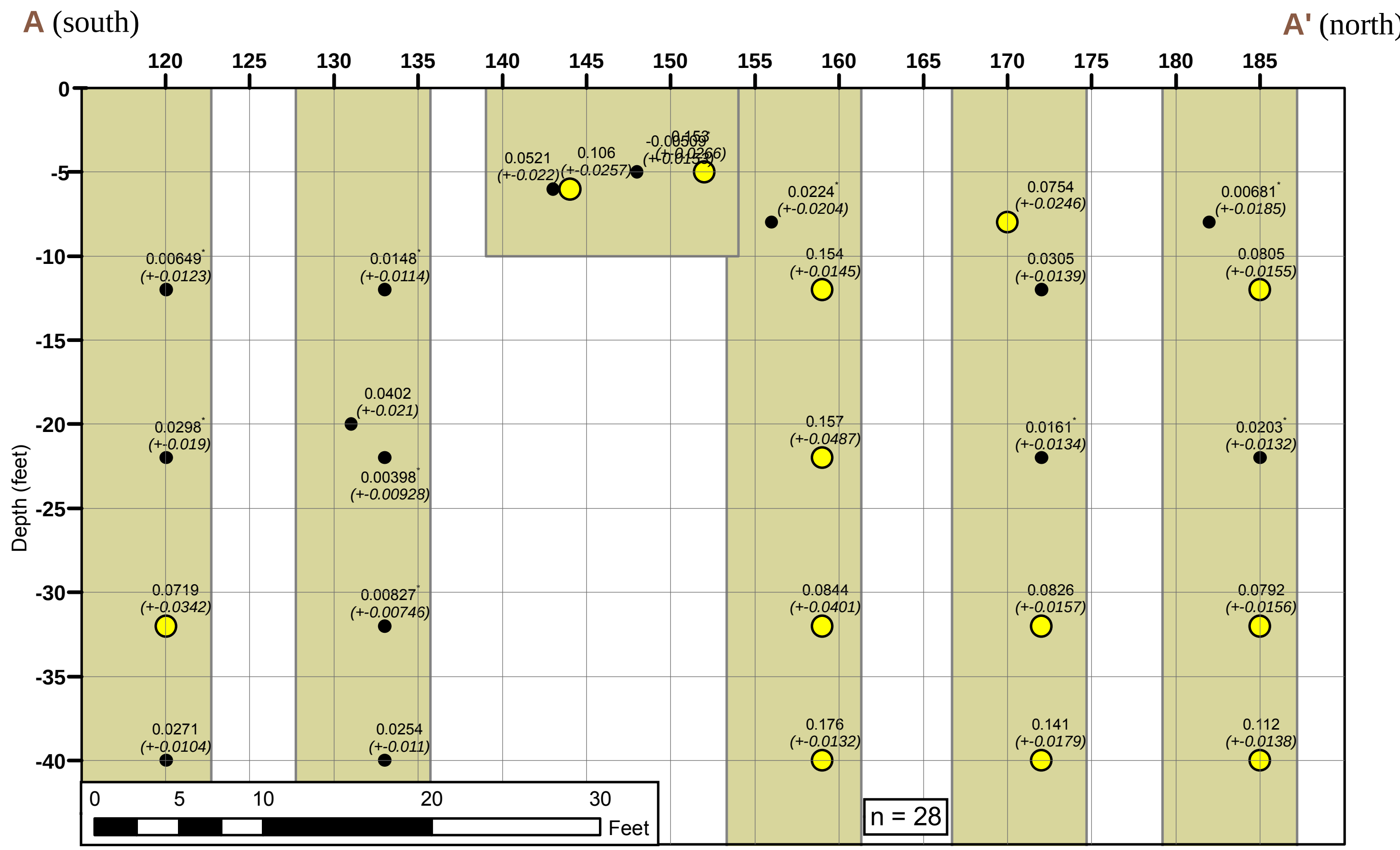
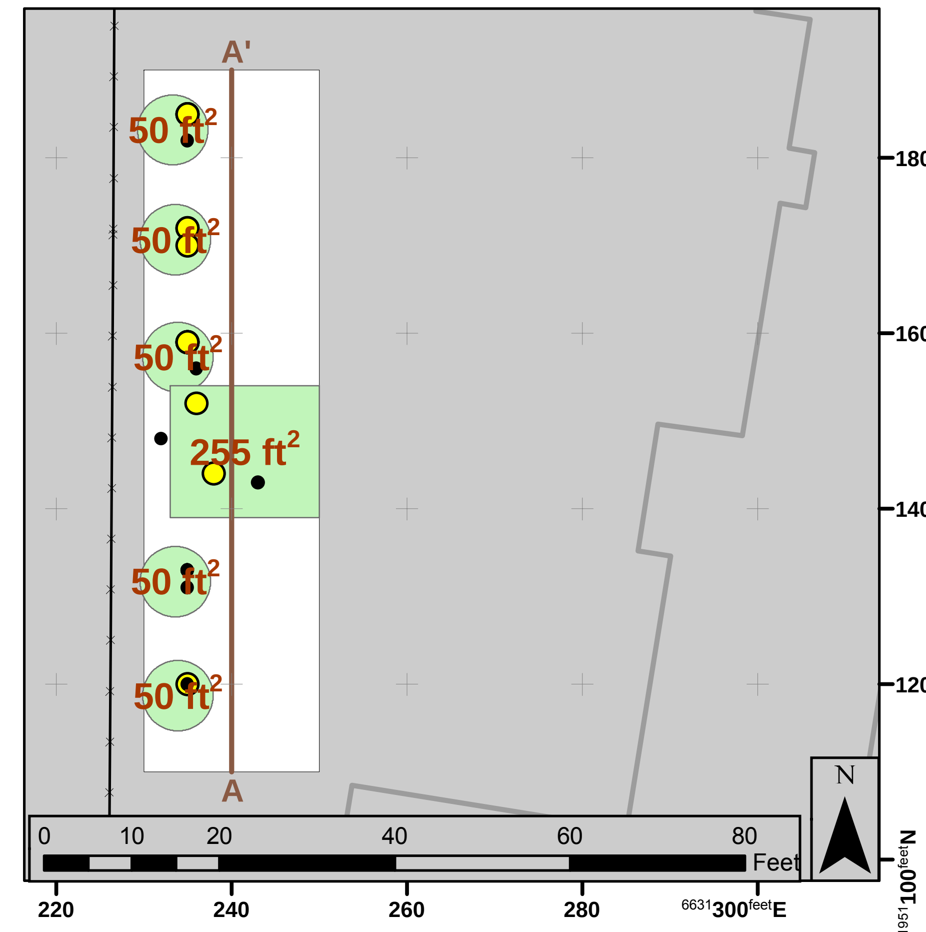


Figure B-20. Cesium-137 Concentrations and Excavation Areas for Alternative 4a at the Drywells A-E Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

● < 0.0595 pCi/g (soil background goal)

○ ≥ 0.0595 pCi/g

Abbreviations

*	below the detection limit
≥	greater than or equal to
<	less than
+-	prefix for analytic counting error
ft^2	square feet
n	number of data in dataset
pCi/g	picoCuries per gram

Notes
1. Posted concentrations are in pCi/g.
2. Concentrations below the detection limit are posted as reported by the analytic laboratory, and not adjusted with respect to the detection limit.
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

Line of section

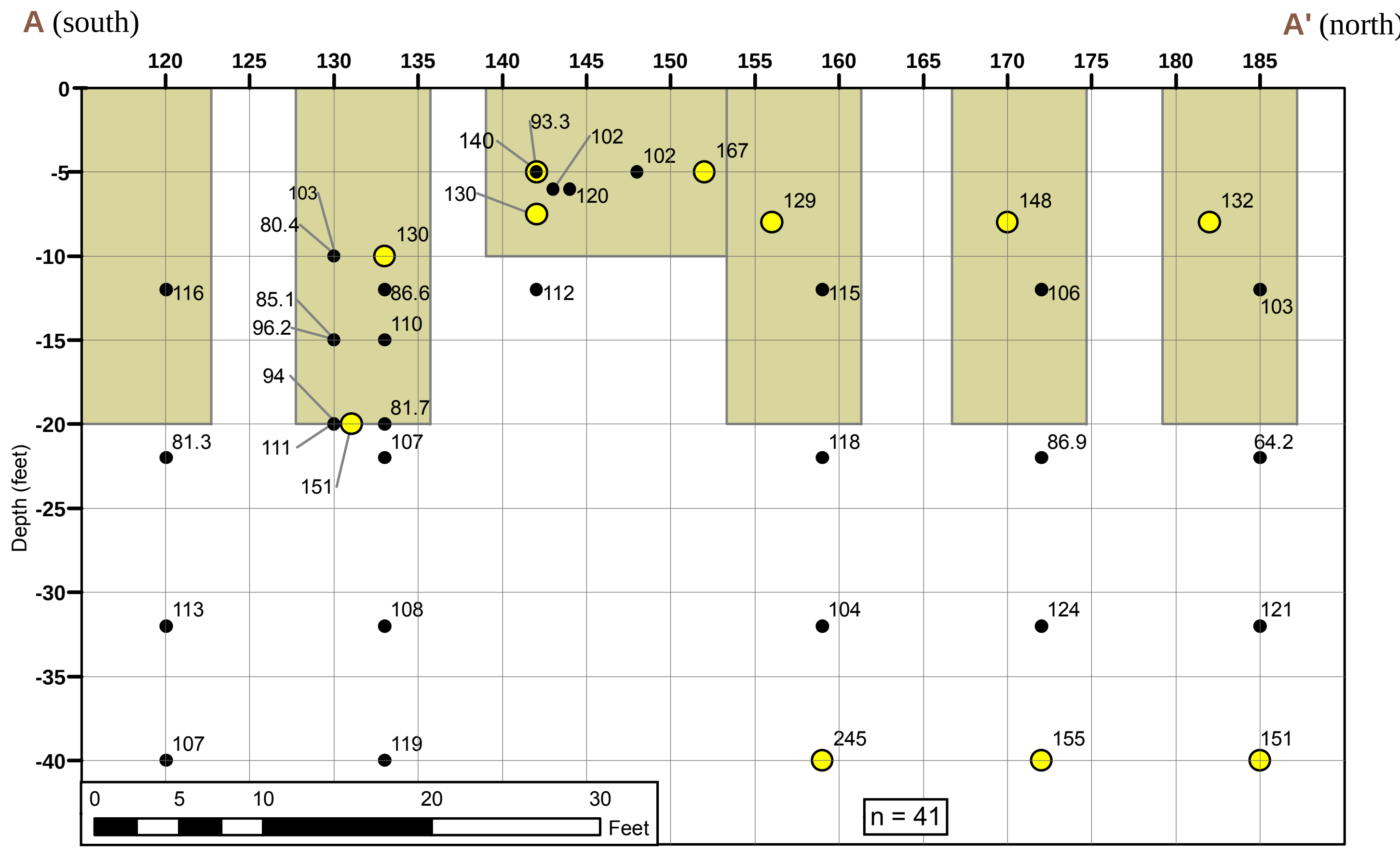
Building Perimeter

Fence

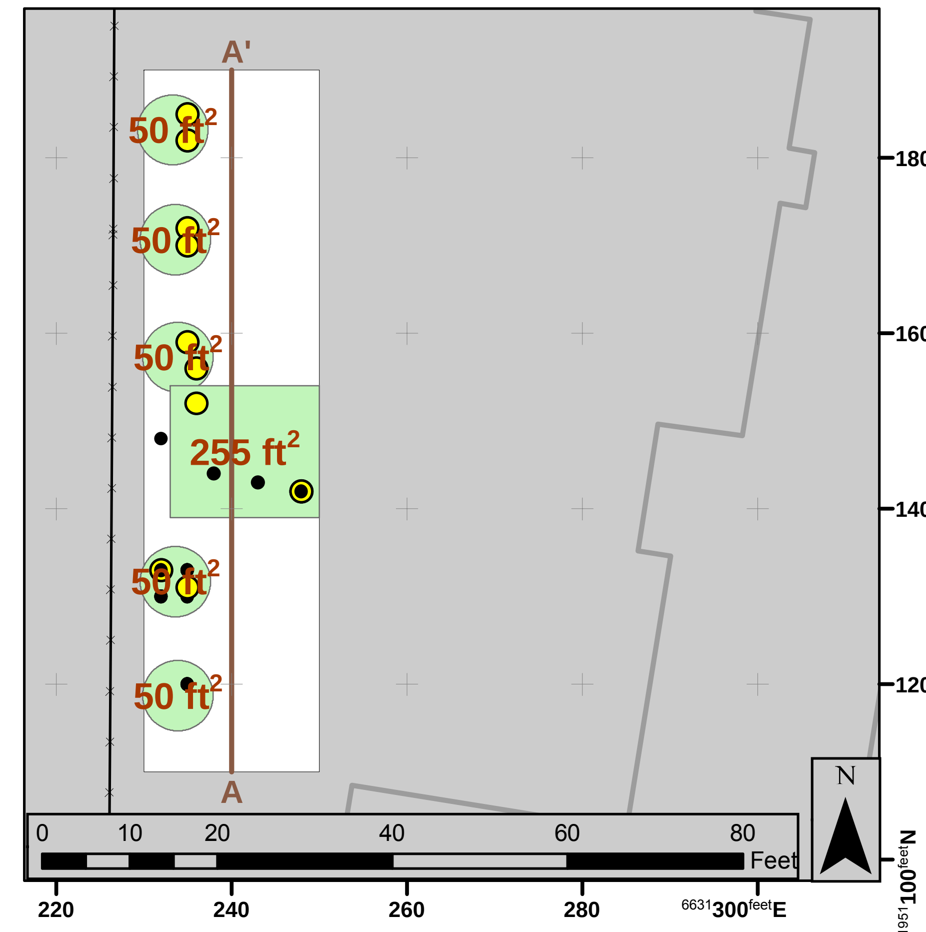
Excavation Area (Area shown in bold-face type)

Figure B-21. Strontium-90 Concentrations and Excavation Areas for Alternative 4a at the Drywells A-E Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 125 mg/kg (soil background)
- ≥ 125 mg/kg

Abbreviations

≥	greater than or equal to
<	less than
ft^2	square feet
mg/kg	milligrams per kilogram
n	number of data in dataset

Notes
1. Posted concentrations are in mg/kg.
2. All of the samples were detects.
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

Line of section

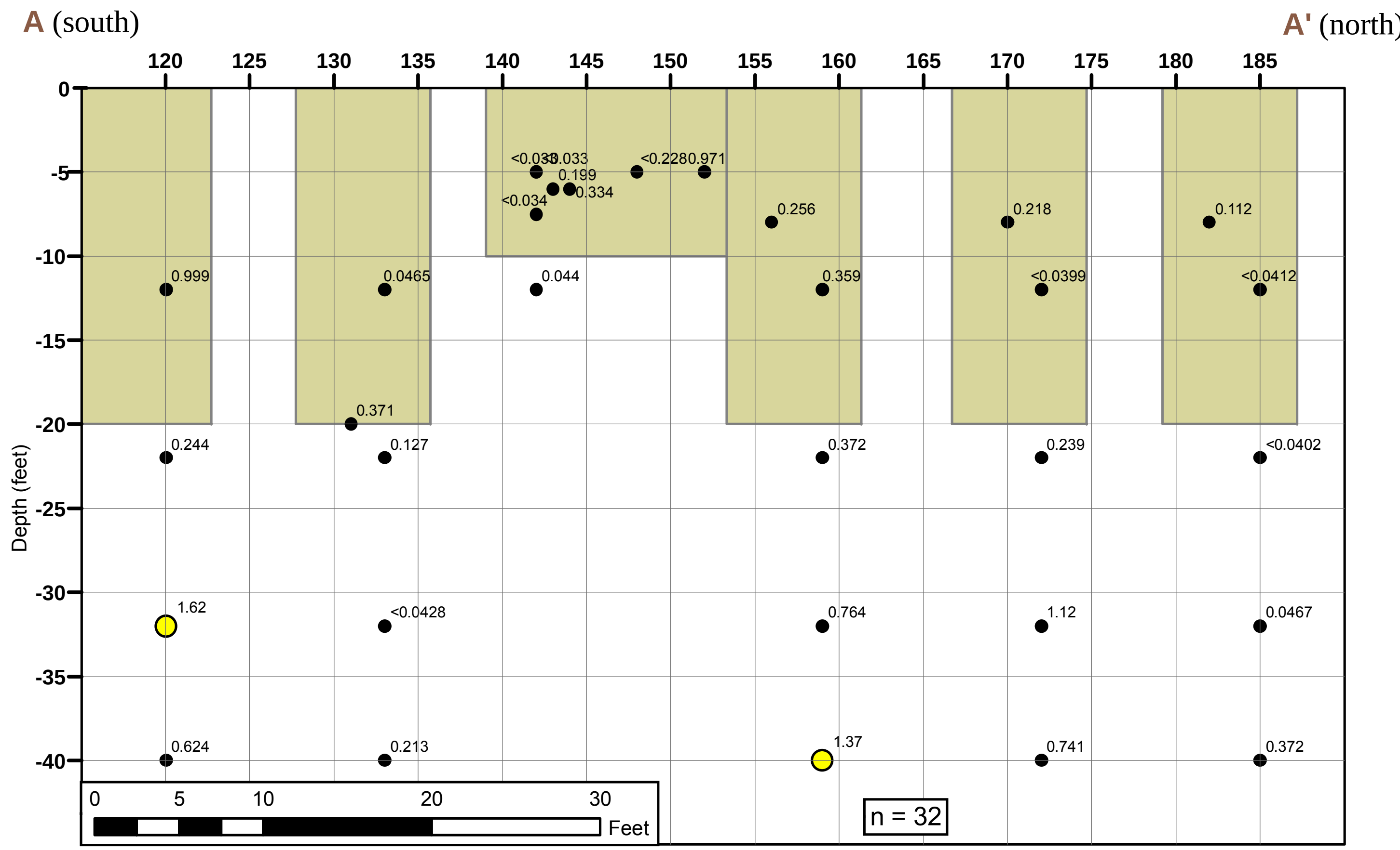
Building Perimeter

Fence

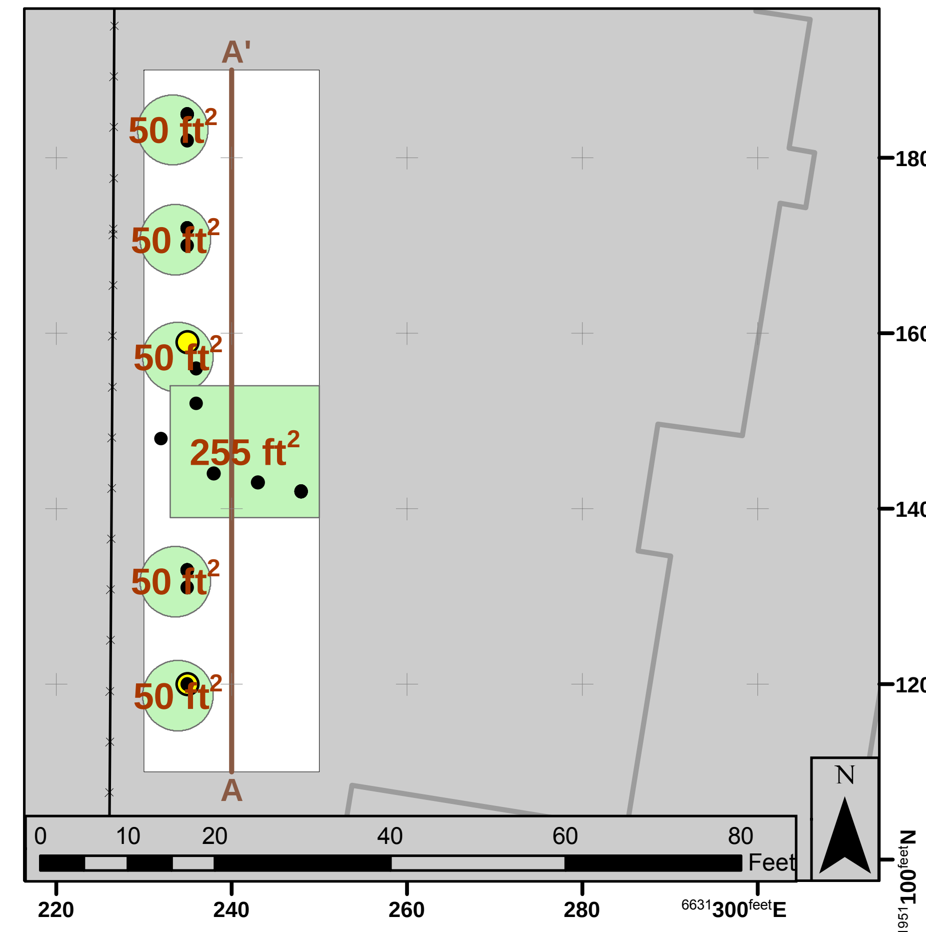
Excavation Area (Area shown in bold-face type)

Figure B-22. Chromium Concentrations and Excavation Areas for Alternative 4b at the Drywells A-E Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 1.3 mg/kg (soil background)
- ≥ 1.3 mg/kg

Abbreviations

≥	greater than or equal to
<	less than
ft²	square feet
mg/kg	milligrams per kilogram
n	number of data in dataset

Notes

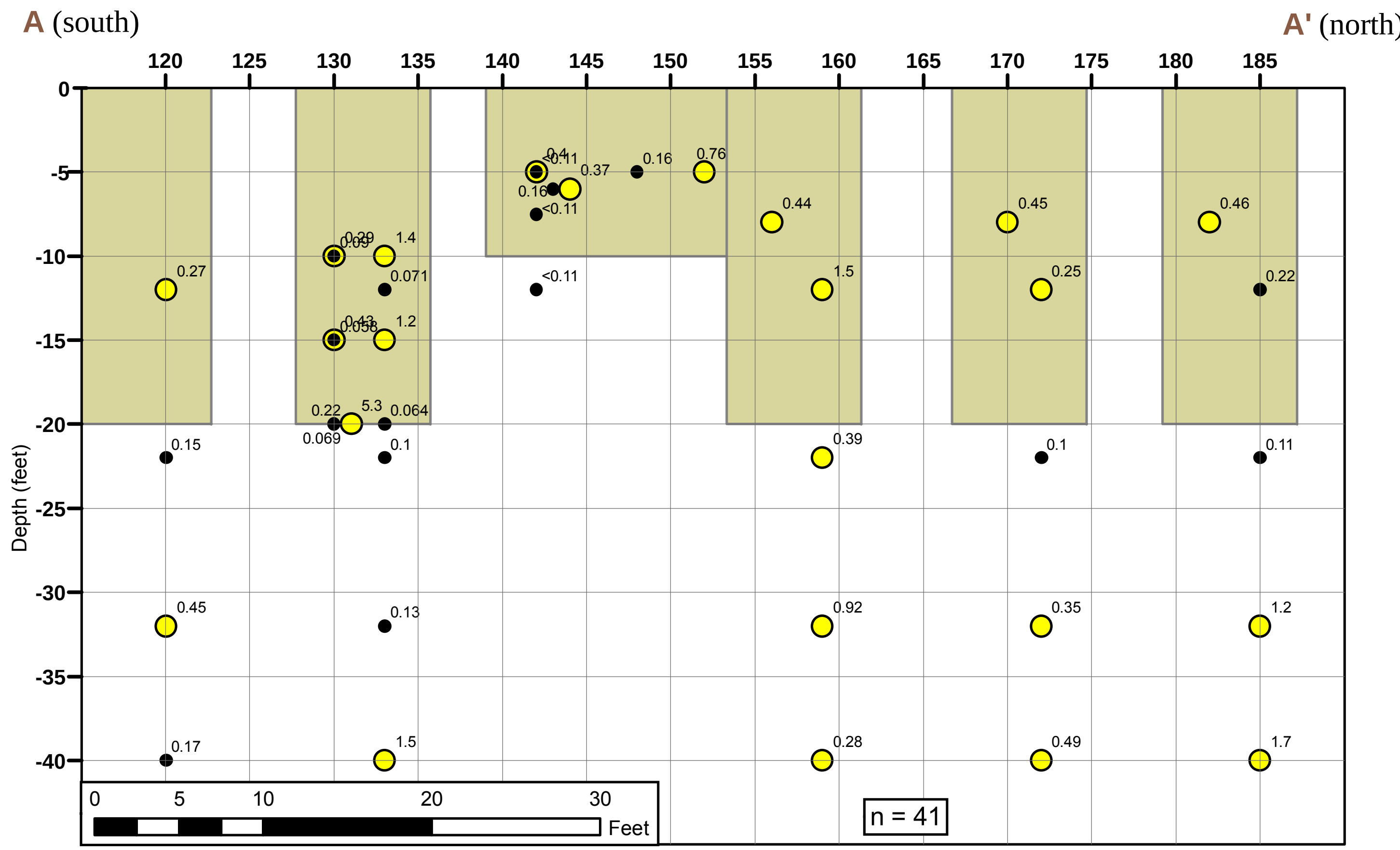
1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

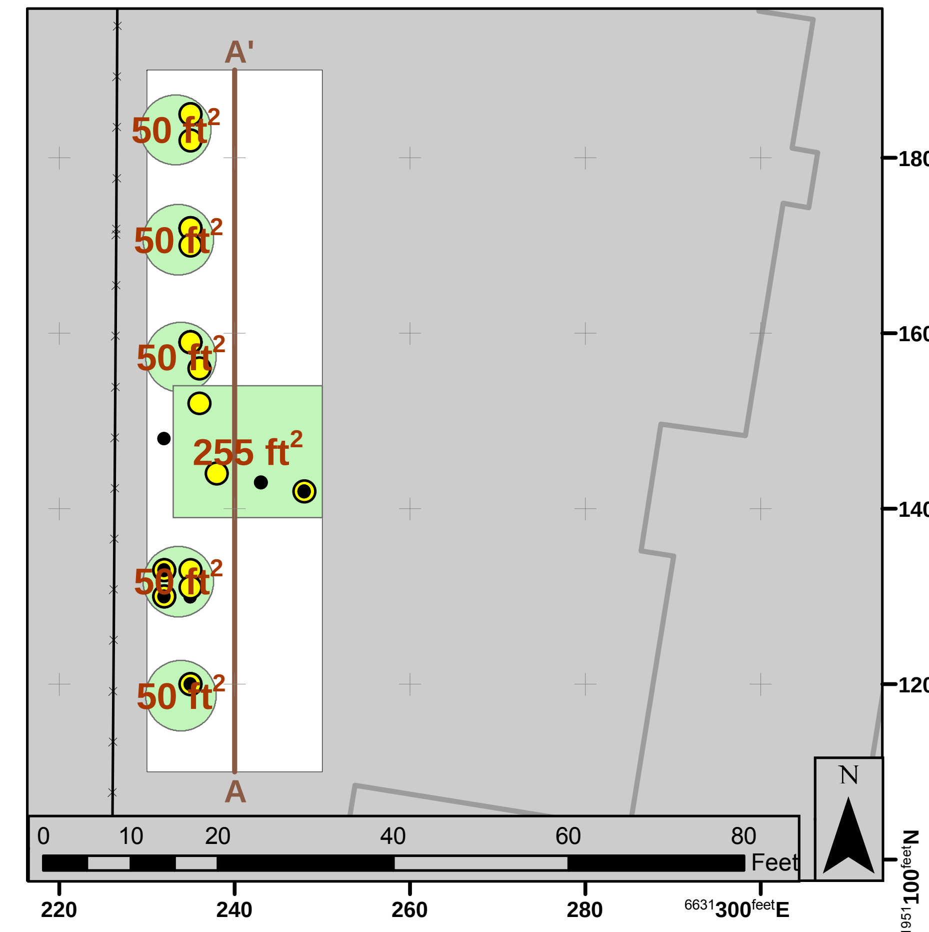
- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Figure B-23. Hexavalent Chromium Concentrations and Excavation Areas for Alternative 4b at the Drywells A-E Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 0.25 mg/kg (soil background)
- ≥ 0.25 mg/kg

Abbreviations

≥	greater than or equal to
<	less than
ft^2	square feet
mg/kg	milligrams per kilogram
n	number of data in dataset

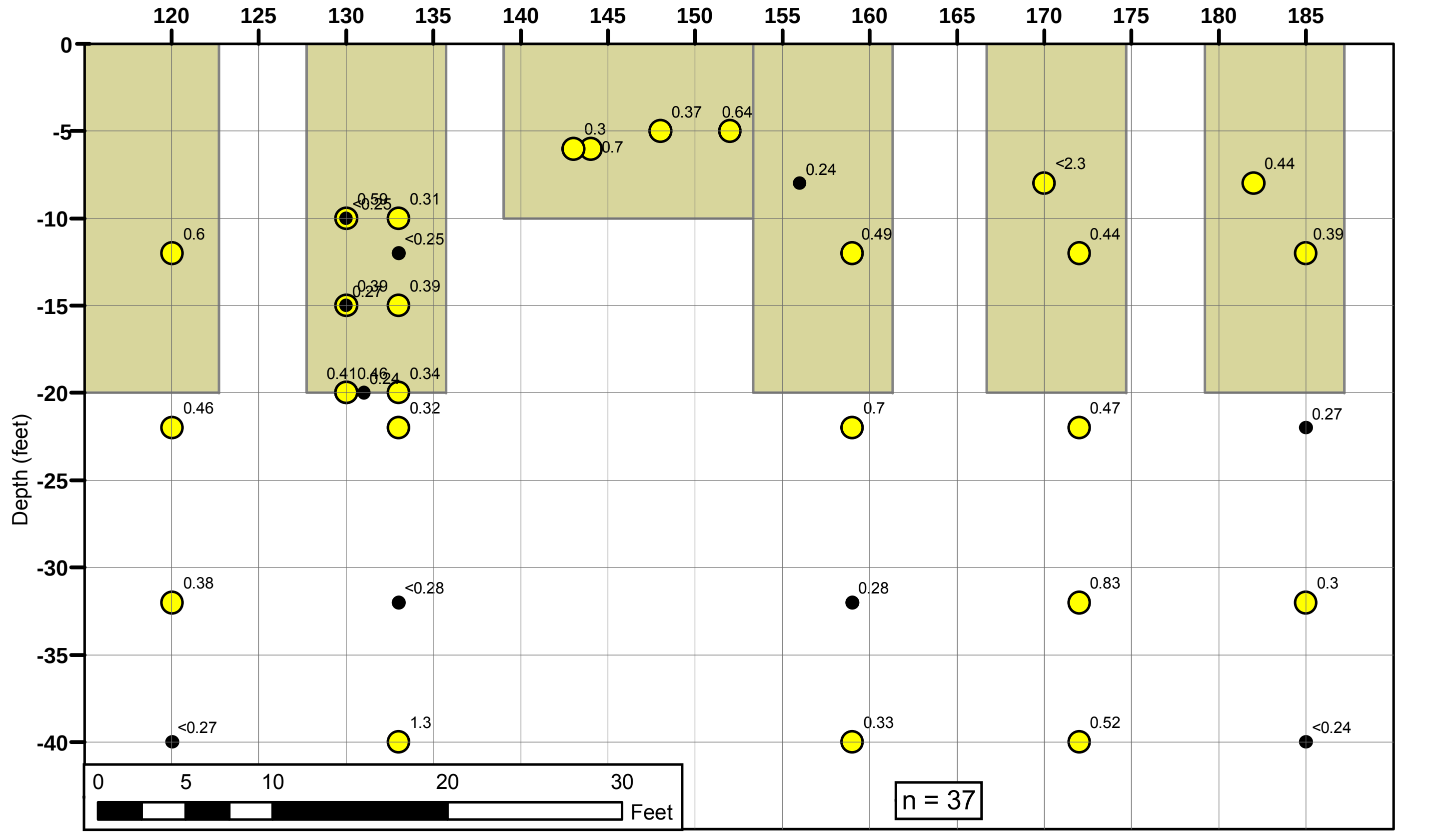
Notes
1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

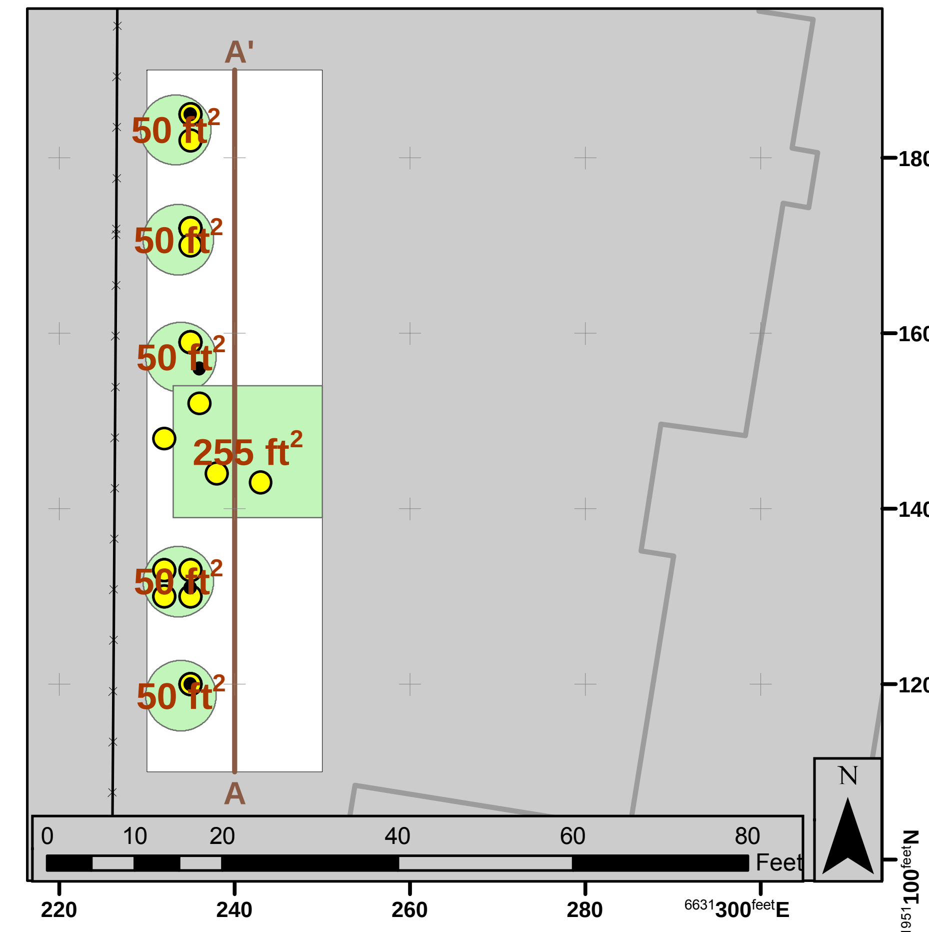
- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Figure B-24. Mercury Concentrations and Excavation Areas for Alternative 4b at the Drywells A-E Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 0.30 mg/kg (soil background goal)
- ≥ 0.30 mg/kg

Abbreviations

≥	greater than or equal to
<	less than
ft^2	square feet
mg/kg	milligrams per kilogram
n	number of data in dataset

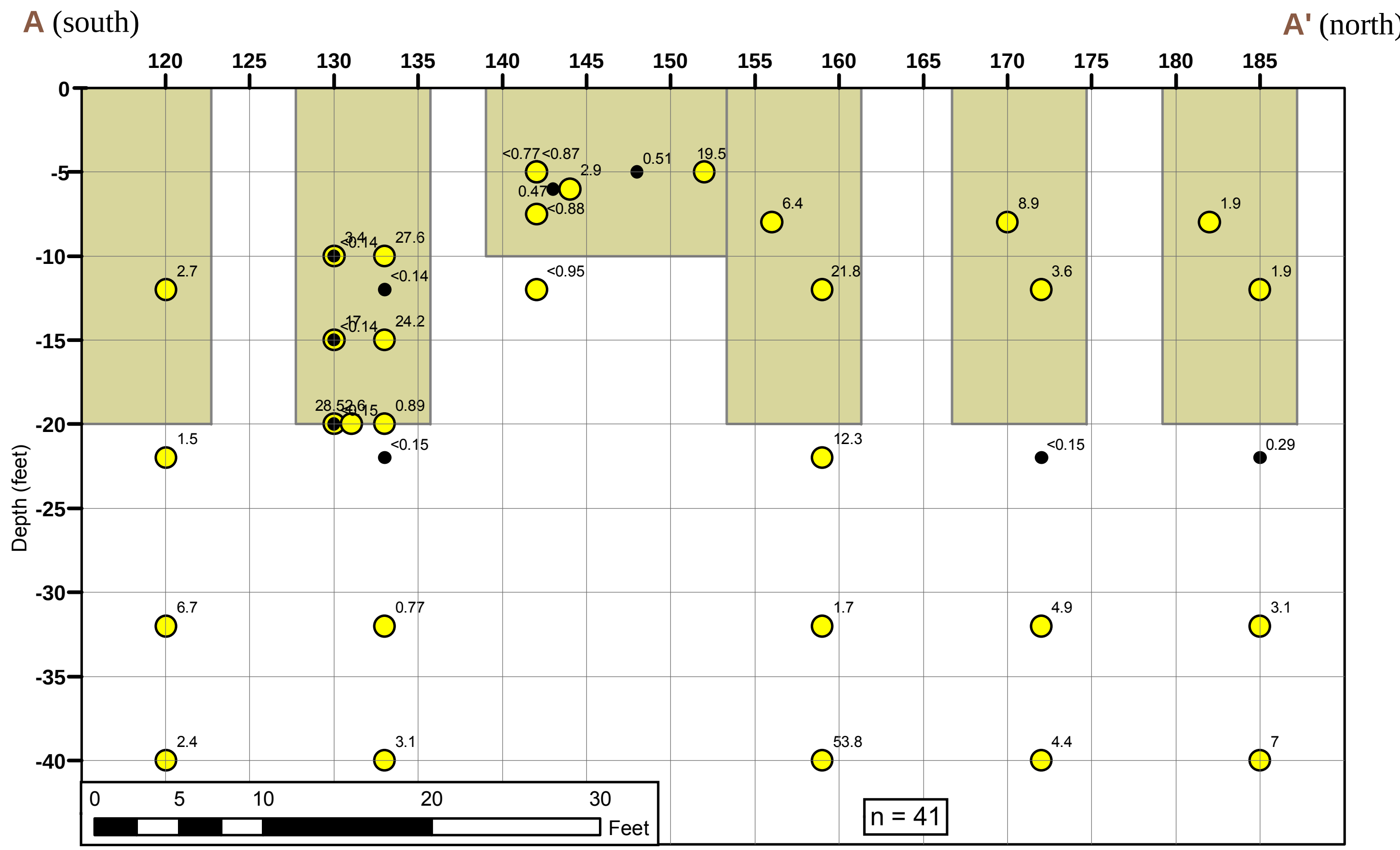
Notes
1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

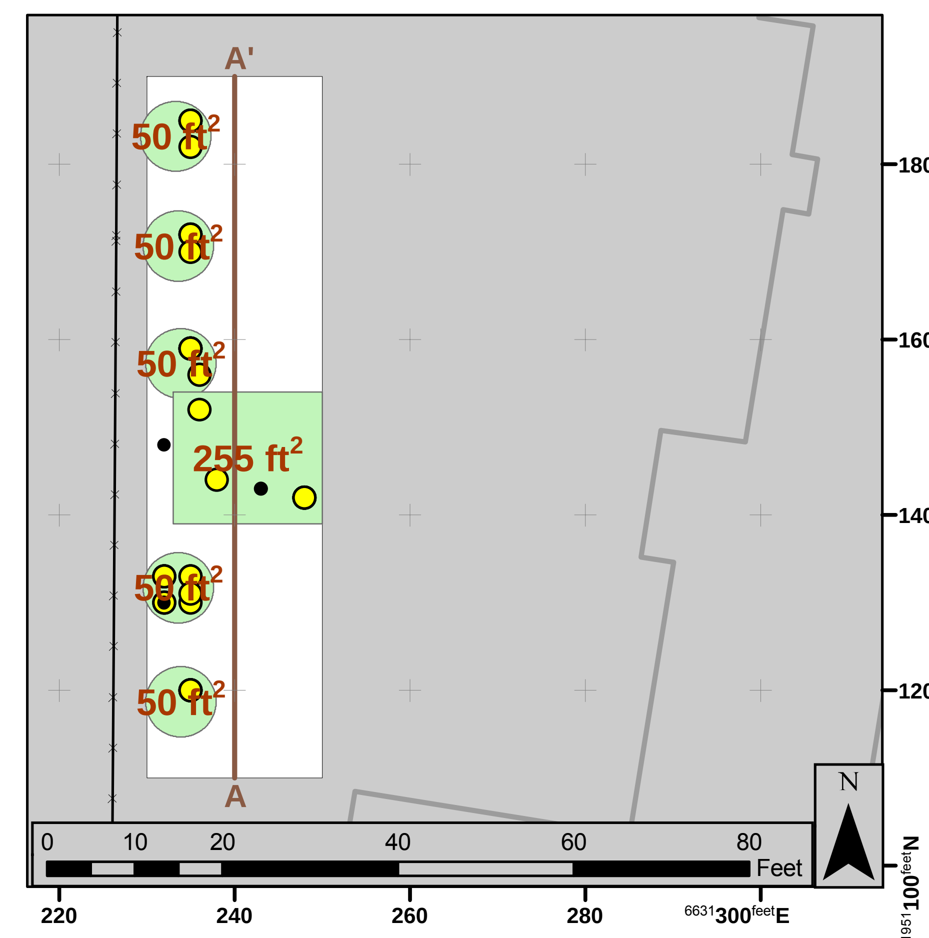
- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Figure B-25. Molybdenum Concentrations and Excavation Areas for Alternative 4b at the Drywells A-E Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 0.55 mg/kg (soil background)
- ≥ 0.55 mg/kg

Abbreviations

≥ greater than or equal to
< less than
ft² square feet
mg/kg milligrams per kilogram
n number of data in dataset

Notes

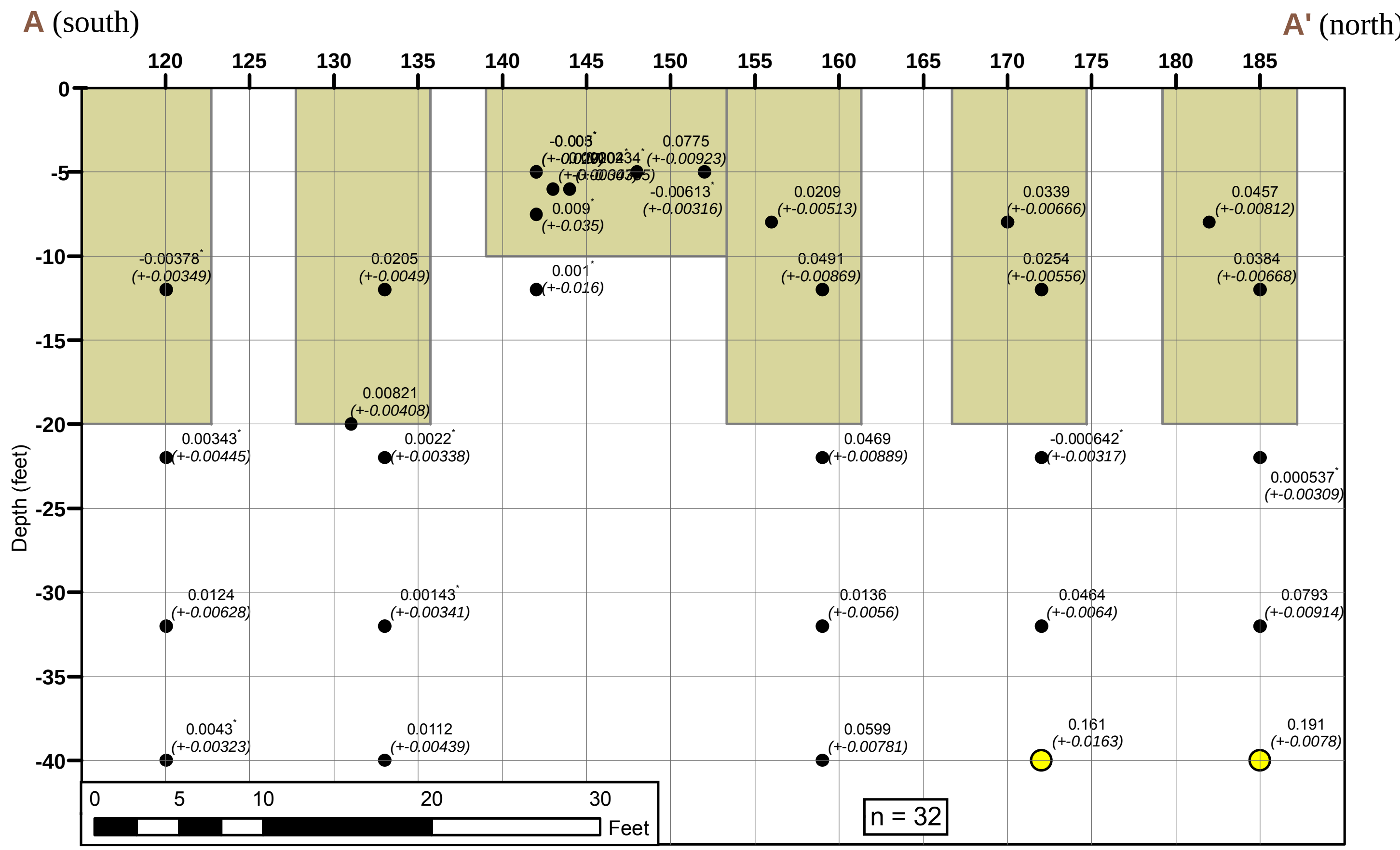
1. Posted concentrations are in mg/kg.
2. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

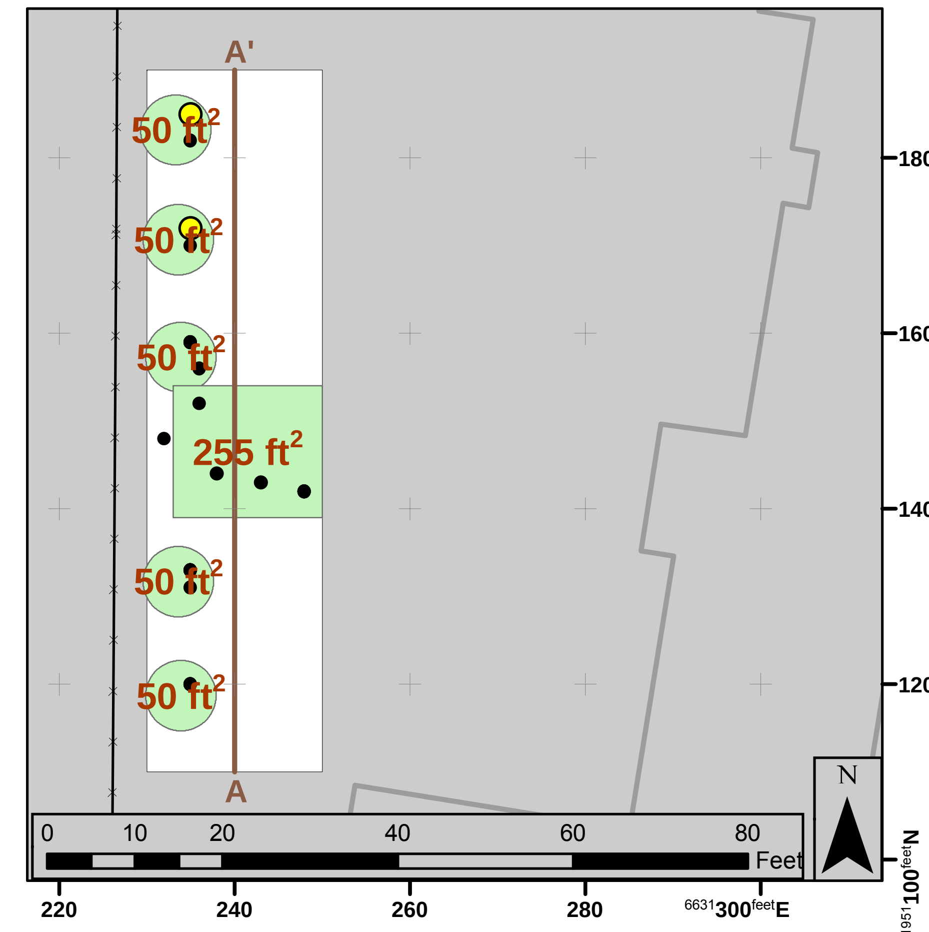
- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Figure B-26. Silver Concentrations and Shallow Excavation Areas for Alternative 4b at the Drywells A-E Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 0.1 pCi/g (soil background goal)
- ≥ 0.1 pCi/g

Abbreviations

*	below the detection limit
≥	greater than or equal to
<	less than
+-	prefix for analytic counting error
ft^2	square feet
n	number of data in dataset
pCi/g	picoCuries per gram

Notes

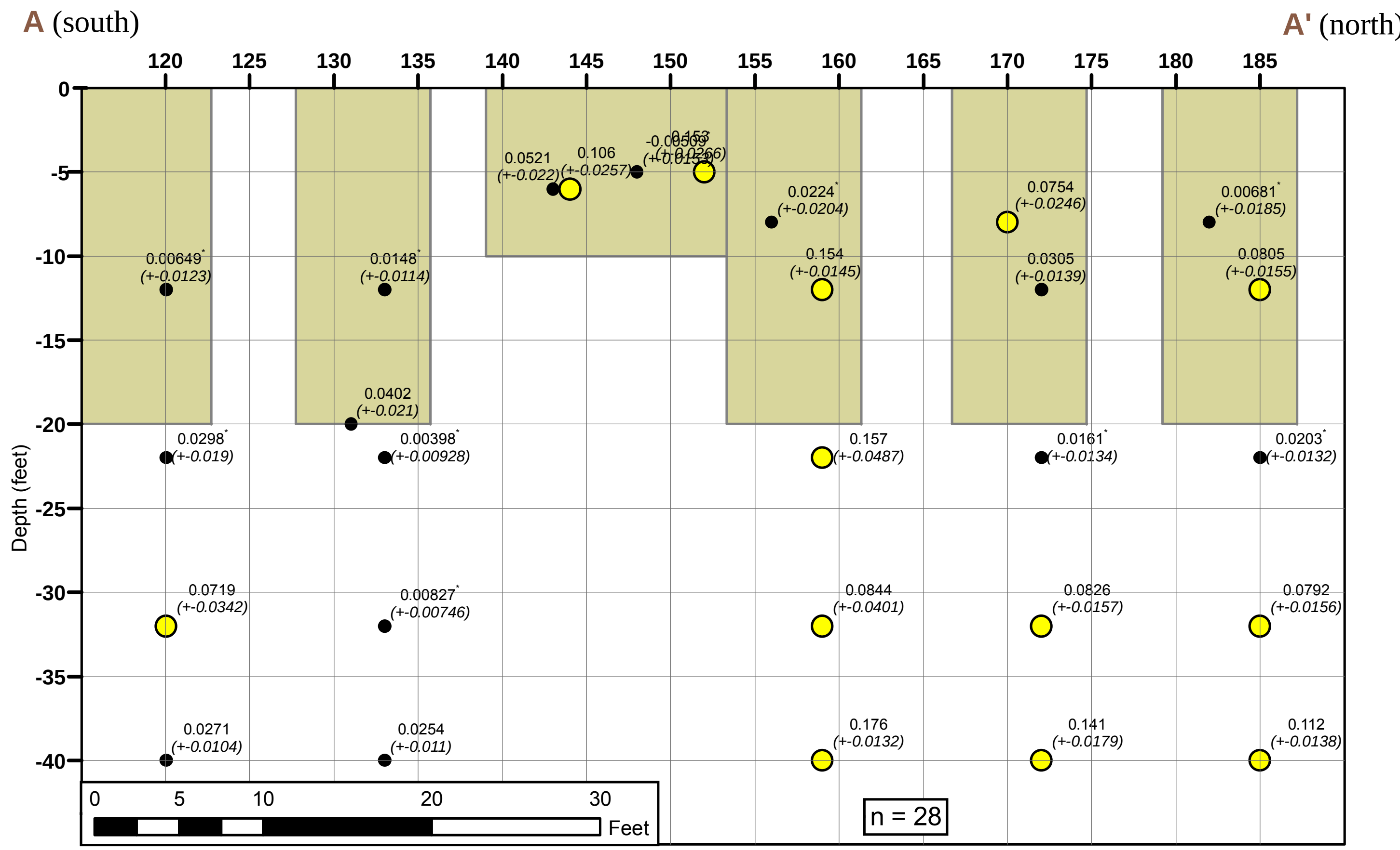
1. Posted concentrations are in pCi/g.
2. Concentrations below the detection limit are posted as reported by the analytic laboratory, and not adjusted with respect to the detection limit.
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

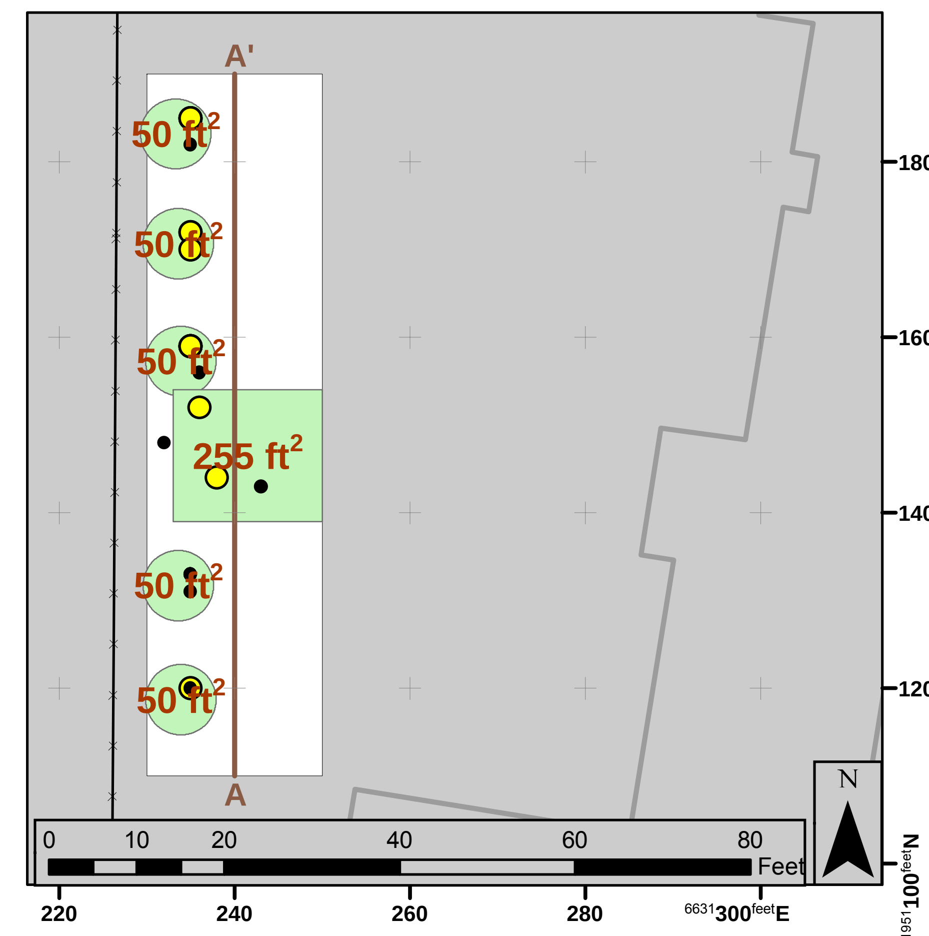
- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Figure B-27. Cesium-137 Concentrations and Excavation Areas for Alternative 4b at the Drywells A-E Area

Vertical profile A-A'.
The location of the line of section is shown in the plan-view map.



Plan view showing the location of the vertical profile view.
The white rectangle encloses all of the sample points that are projected onto the line of section.



EXPLANATION FOR PROFILE VIEW

Excavation Area (Cross-sectional area shown in bold-face type)

Concentration at sample locations

- < 0.0595 pCi/g (soil background goal)
- ≥ 0.0595 pCi/g

Abbreviations

*	below the detection limit
≥	greater than or equal to
<	less than
+-	prefix for analytic counting error
ft^2	square feet
n	number of data in dataset
pCi/g	picoCuries per gram

Notes
1. Posted concentrations are in pCi/g.
2. Concentrations below the detection limit are posted as reported by the analytic laboratory, and not adjusted with respect to the detection limit.
3. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

EXPLANATION FOR PLAN-VIEW MAP

- Line of section
- Building Perimeter
- Fence
- Excavation Area (Area shown in bold-face type)

Figure B-28. Strontium-90 Concentrations and Excavation Areas for Alternative 4b at the Drywells A-E Area

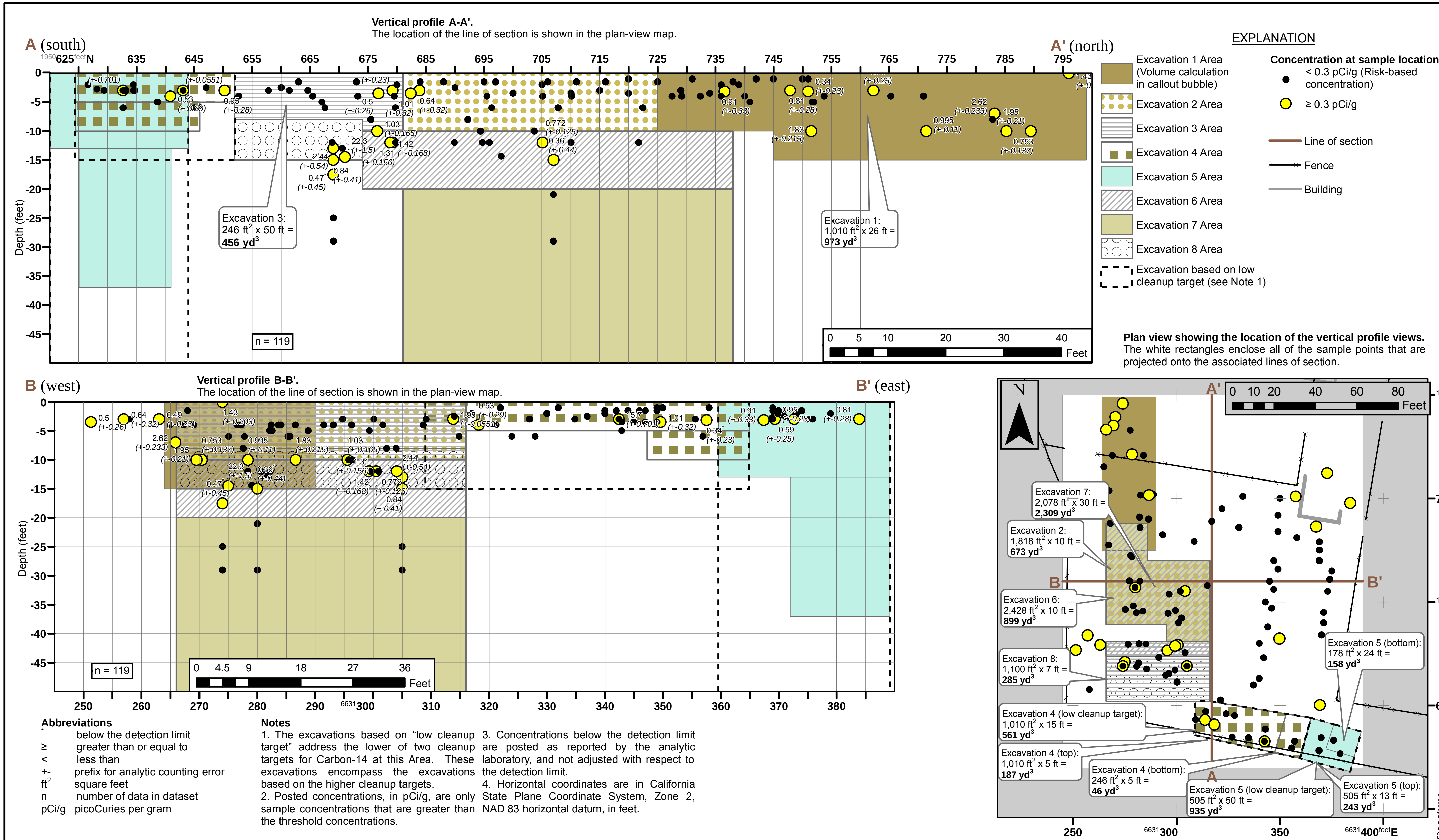
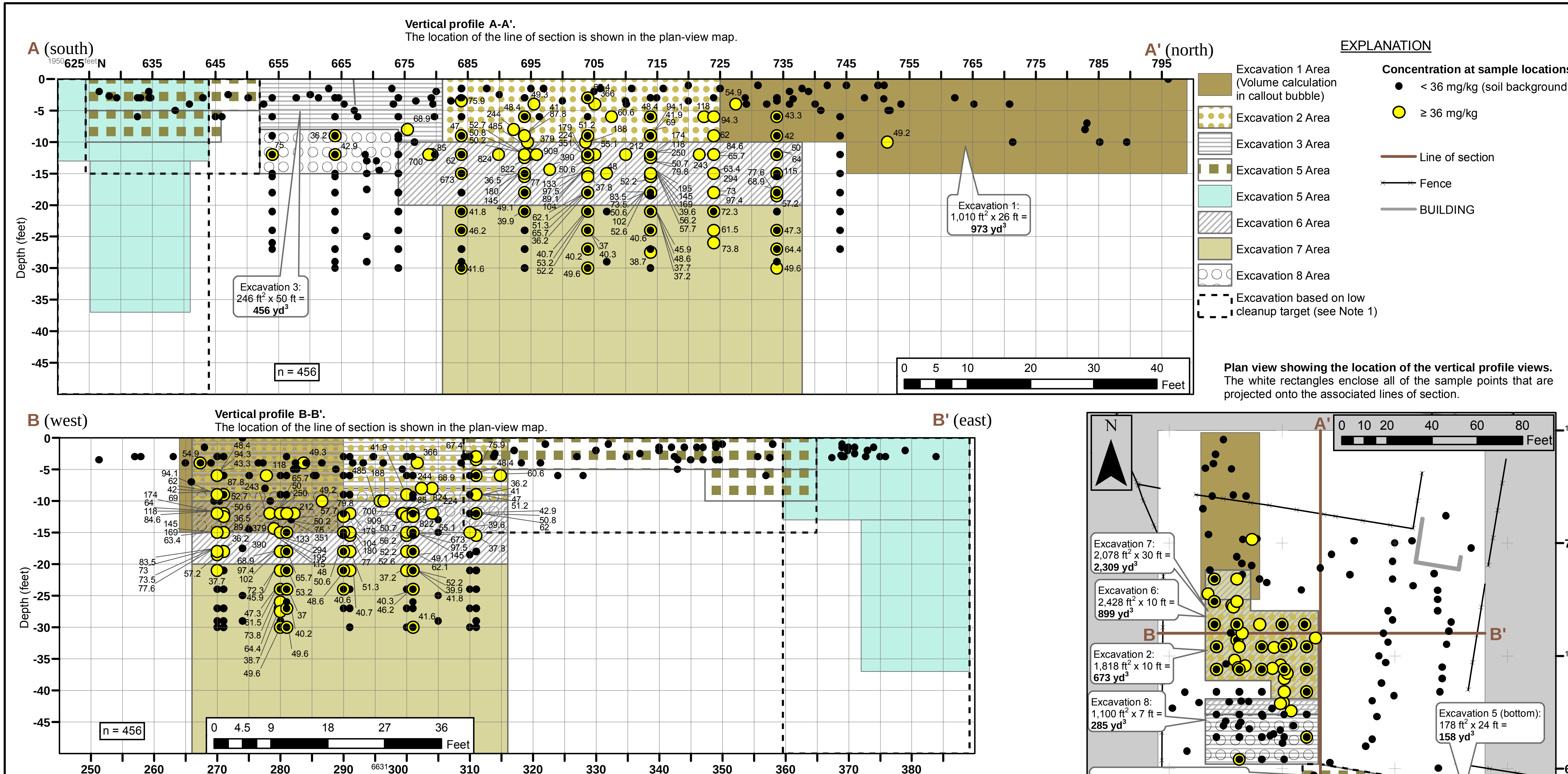


Figure B-29. Strontium-90 Concentrations and Excavation Areas for Alternatives 4a and 4b at the Southwest Trenches Area



Abbreviations

≥	greater than or equal to
<	less than
ft²	square feet
mg/kg	milligrams per kilogram
n	number of data in dataset

Notes

1. The excavations based on "low cleanup target" address the lower of two cleanup targets for Carbon-14 at this Area. These excavations encompass the excavations based on the higher cleanup targets.
2. Posted concentrations, in mg/kg, are only sample concentrations that are greater than the threshold concentrations.
3. Concentrations of non-detected results are given as the detection limit, and preceded with "<".
4. Horizontal coordinates are in California State Plane Coordinate System, Zone 2, NAD 83 horizontal datum, in feet.

Figure B-30. Nitrate Concentrations and Excavation Areas for Alternatives 4a and 4b at the Southwest Trenches Area

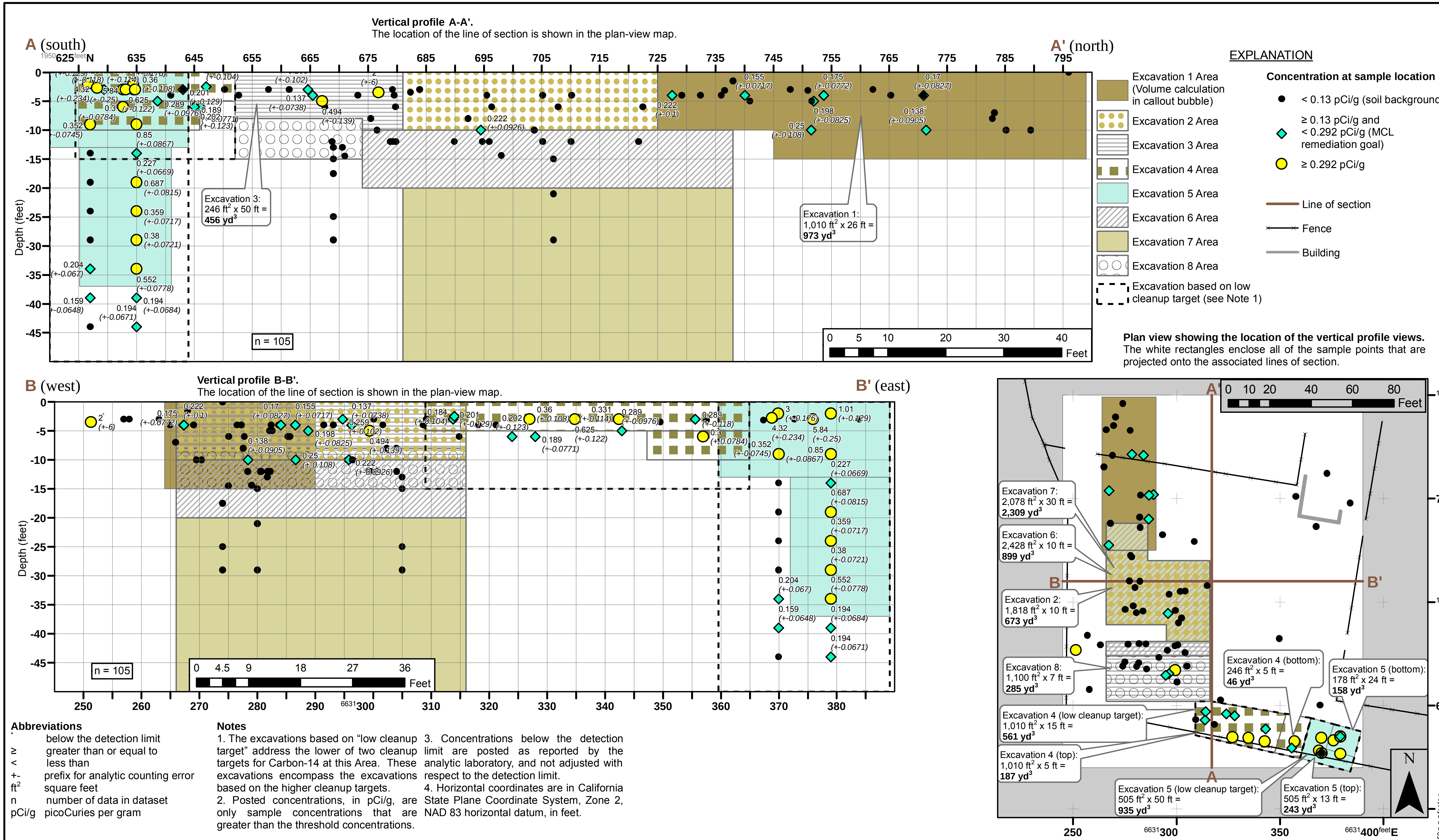


Figure B-31. Carbon-14 Concentrations and Excavation Areas for Alternatives 4a and 4b at the Southwest Trenches Area

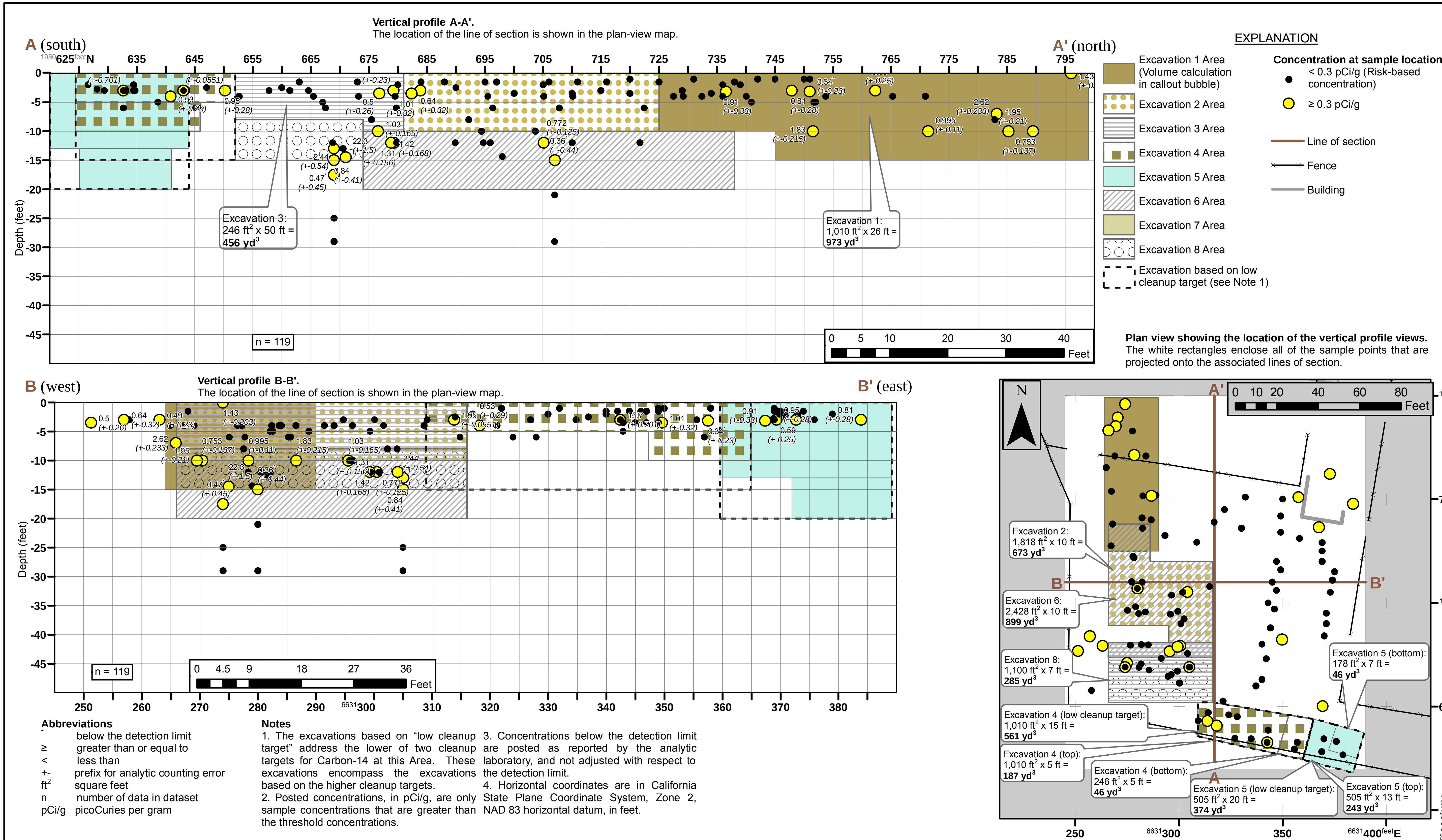


Figure B-32. Strontium-90 Concentrations and Excavation Areas for Alternative 4c at the Southwest Trenches Area

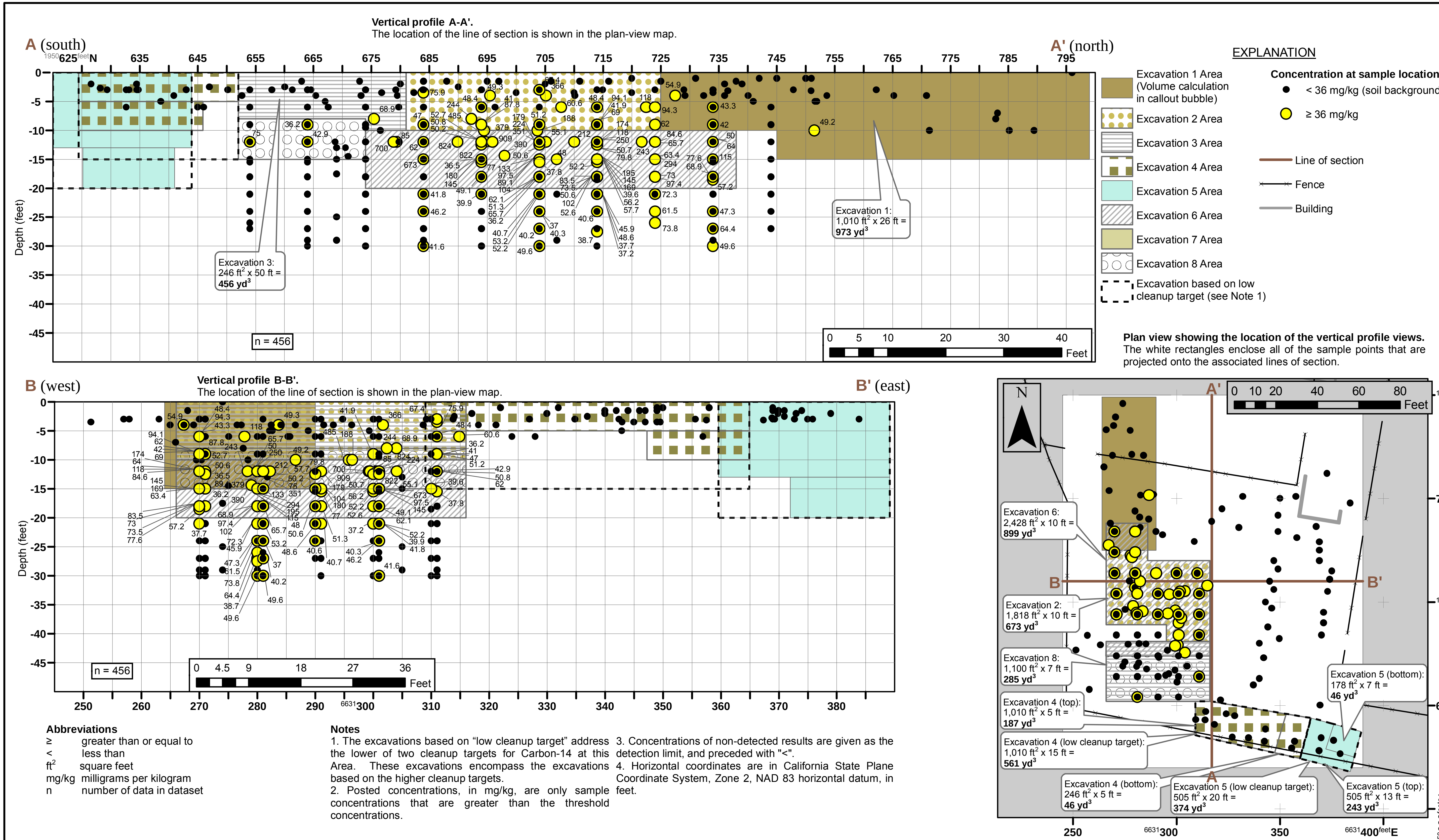


Figure B-33. Nitrate Concentrations and Excavation Areas for Alternative 4c at the Southwest Trenches Area

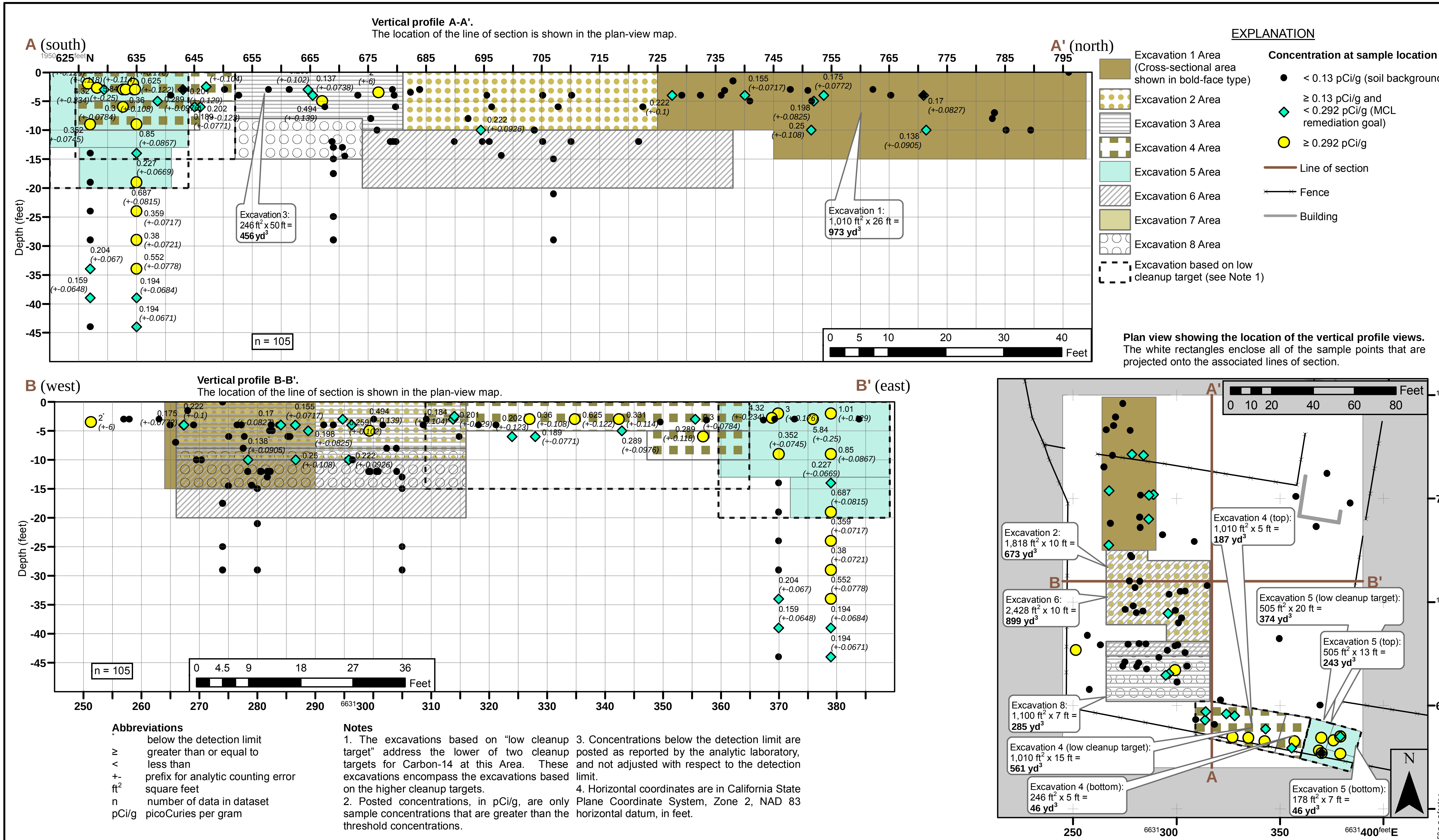


Figure B-34. Carbon-14 Concentrations and Excavation Areas for Alternative 4c at the Southwest Trenches Area

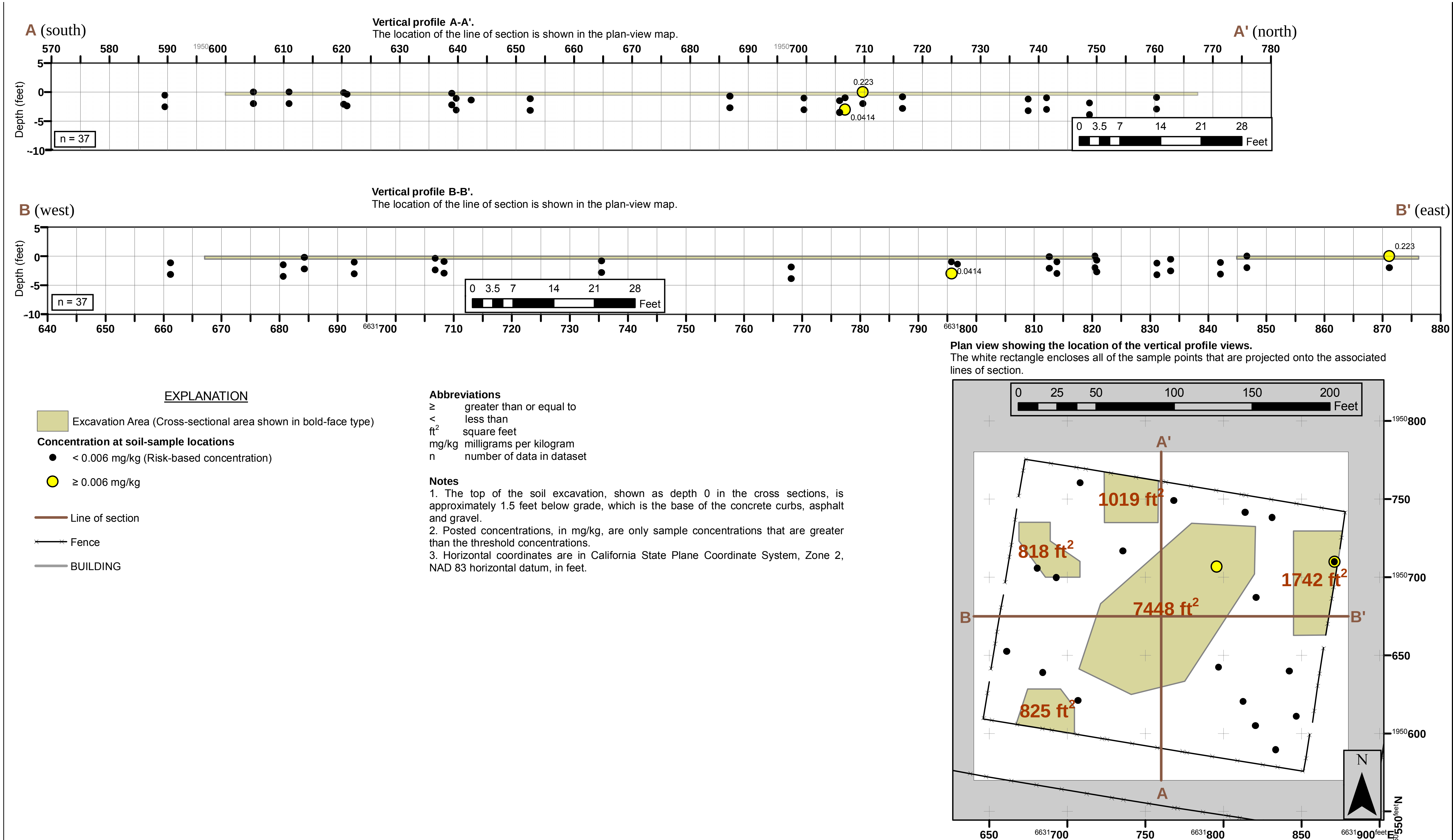


Figure B-35. Dieldrin Concentrations and Soil-Excavation Areas for Alternative 3 at the Eastern Dog Pens Area

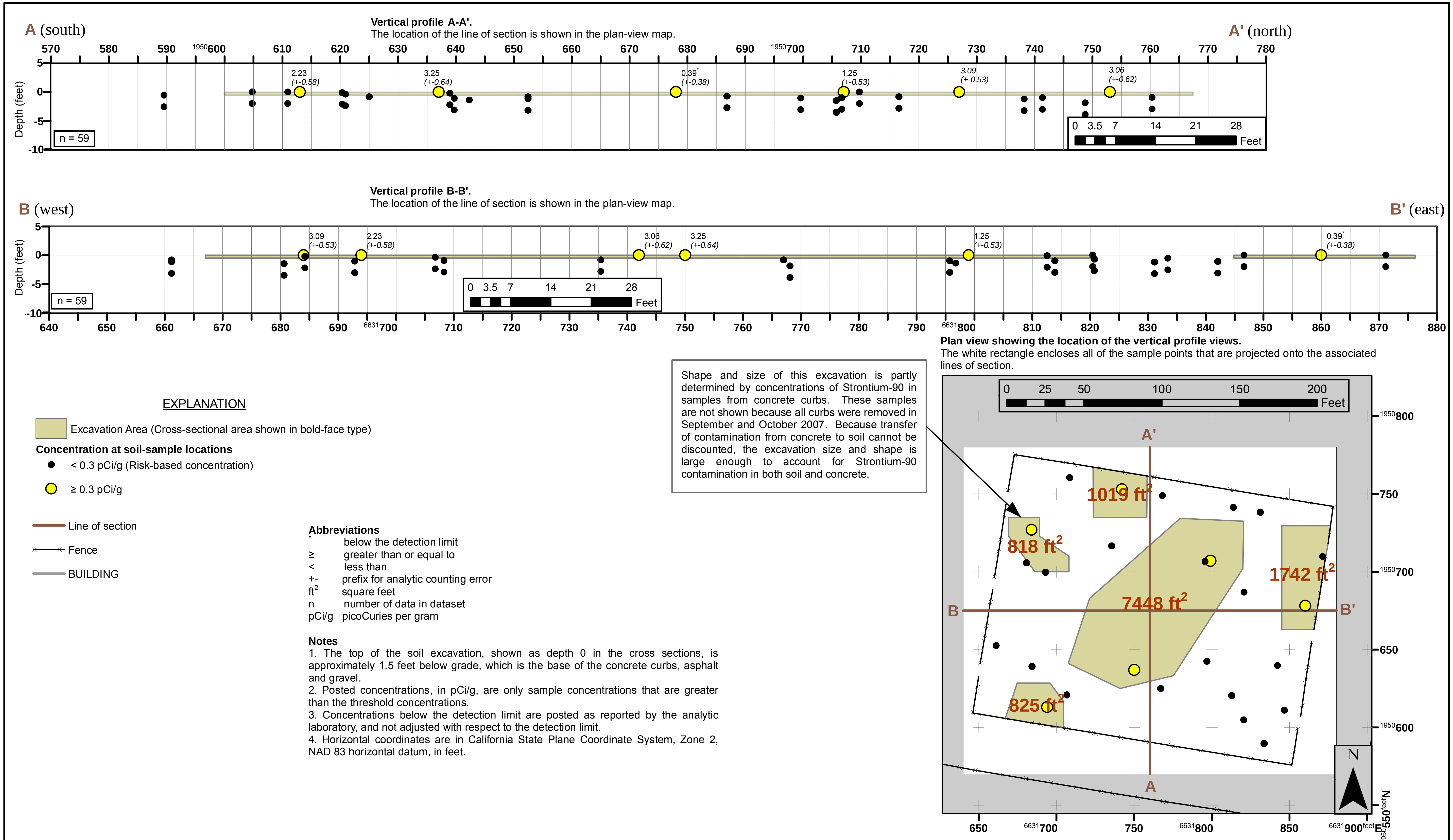


Figure B-36. Strontium-90 Concentrations and Soil-Excavation Areas for Alternative 3 at the Eastern Dog Pens Area

APPENDIX C

DRY WELLS A-E AREA GROUND WATER INVESTIGATION

C.1. INTRODUCTION

This report presents the results of sampling, well installation and ground water impact assessment at the United States Department of Energy National Nuclear Security Administration (DOE-NNSA) Dry Wells A through E Area (Dry Wells Area) at the Laboratory for Energy-Related Health Research (LEHR), University of California, Davis (UC Davis) (Figure C-1). Hydropunch sampling, well installation and ground water monitoring activities were performed to fill data gaps identified downgradient of the Dry Wells Area. A preliminary ground water impact screening evaluation (WA, 2003) indicated that maximum concentrations of hexavalent chromium, chromium, mercury, molybdenum, silver, cesium-137 (Cs-137), and strontium-90 (Sr-90) in Dry Wells Area soil could result in localized ground water impact above background. The screening evaluation also indicated potential impact above California maximum contaminant levels (MCLs) for hexavalent chromium, total chromium, mercury, and silver. No monitoring wells were located immediately downgradient of the Dry Wells Area to evaluate the potential ground water impacts. Sampling and well installation activities were performed according to the Dry Wells Area Hydrogeologic and Well Installation Work Plan (WA, 2004) to address the data gap.

C.1.1 Background

The LEHR site began operating at its present location in 1958. Research at LEHR through the mid-1980s focused on the health effects from chronic exposure to radionuclides, primarily radium-226 (Ra-226) and Sr-90. The Radium/Strontium (Ra/Sr) Treatment Systems were installed at LEHR to treat liquid wastes containing low levels of Ra-226, Sr-90, and other radionuclides used in LEHR research activities. The Domestic Septic Systems (DSSs) were installed to dispose of non-radioactive liquid waste and sewage. A typical DSS consisted of a domestic septic tank, leach field, and interconnecting piping. Because radionuclide and chemical wastes could have been improperly disposed in the DSSs, site investigation and characterization data were collected from the DSS areas between 1996 and 2001 (WA, 2003). The investigations were:

- August 1996 soil investigation at DSS-1 and DSS-7;
- June 1997 soil investigation at DSS-1, DSS-3 and DSS-6;
- September 1997 further investigation of soil near DSS-1, DSS-3, DSS-4 and DSS-6; and
- 2001 soil investigation to find and sample unlocated portions of DSS-1, DSS-3, DSS-5 and DSS-6.

On July 26, 1999, during the 1999 Ra/Sr Treatment Systems Area I removal action (WA, 2003), a concrete structure was uncovered approximately 15 ft north of a northern leach trench.

Additional excavation in this area revealed a leach system containing five dry wells (Dry Wells A through E), a distribution box, and piping connecting the system. Based on a review of existing site maps, it is believed that the dry wells were used as leachfields for Domestic Septic Tanks (DSTs) 1 and 5 beginning in 1962, and ending in 1970 when the sanitary sewer system was connected. It is likely that DSTs 1 and 5 and the Dry Wells served LEHR Building H-213. DSTs 1 and 5 were reportedly backfilled with sand and the influent/effluent lines for each tank were reportedly cut and capped in 1971 (WA, 2003). No formal closure reports for these DSTs are known to exist.

The dry well structures consisted of circular concrete manways 30 inches in diameter that extended from one to six ft below ground surface (bgs). Two-inch diameter rounded drain rock filled the manway structures from three to eight ft bgs. In Dry Wells D and A, large cobbles six to 12 inches in diameter were observed between seven and eight ft bgs. The upper portions of Dry Wells A through E were removed to depths ranging from eight to 20 ft bgs. Excavation in the vicinity of Dry Wells A, B, C, and E reached a depth of eight ft bgs.

Dry Well D was excavated to a depth of 20 ft bgs. Gravel was observed to the maximum excavation depth indicating that Dry Well D is at least 20 ft deep. A distribution box was located approximately one ft bgs and measured four ft wide by four ft long by three ft high. The distribution box was removed and the area was excavated to a depth of approximately 5.5 ft bgs. Following excavation and waste removal, the area was backfilled and compacted. DSTs 1 and 5 and the residual lower portions of the dry wells, which may extend to 30-40 ft bgs, were not removed.

Investigation samples were collected from the Dry Wells Area in 1999 and 2001 to identify and characterize the occurrence of any constituents of potential ground water concern (COPGWCs). These investigation data were used in a preliminary designated-level analysis (WA, 2003) to identify COPGWCs associated with the Dry Wells Area. Because the maximum concentrations of all of these COPGWCs were detected at depths typically below the water table (i.e., generally 30 ft bgs or greater), vadose zone modeling was not needed to evaluate potential impact to ground water. Instead, “equilibrium soil concentrations” were calculated (WA, 2003) using conservative literature-derived partitioning coefficients (Kds) and possible ground water clean-up goals (background levels and California MCLS). The preliminary designated-level analysis indicated that the maximum concentrations of hexavalent chromium, total chromium, mercury, molybdenum, silver, Cs-137, and Sr-90 in soil were greater than the background equilibrium concentrations and could result in localized ground water impact above background. The maximum soil concentrations were also above MCL equilibrium concentrations for hexavalent chromium, chromium, mercury, and silver. Hexavalent chromium, total chromium, mercury, molybdenum, silver, Cs-137, and Sr-90 were identified as COPGWCs based on the preliminary designated level analysis results.

Between December 2003 and October 2004, a data gaps investigation was conducted to determine whether the COPGWCs were impacting ground water downgradient of the Dry Wells Area. On December 15 and 16, 2003, four cone penetrometer (CPT) soil borings were advanced to determine the Dry Wells Area geology (Figure C-2). Hydropunch ground water samples were also collected on December 15 and 16, 2003, at locations adjacent to each CPT boring. On February 6 and 10, 2004, well UCD1-054 was installed immediately downgradient of the Dry Wells Area at the location shown on Figure C-2. Four quarters of ground water samples were collected from well

UCD1-054 during 2004. The procedures and results of these data gaps investigation activities are presented in detail below.

C.2. PRE -DRILLING ACTIVITIES

Weiss Associates notified The UC Davis, Environmental Health and Safety department and the Center for Health and Environment one week prior to starting drilling activities.

On December 5, 2004, Solano County Department of Environmental Management (SCDEM) issued well permit W002130 for the installation of well UCD1-054. SCDEM did not require drilling permits for the CPT/hydropunch borings.

On December 9, 2003, Norcal Geophysical Consultants Inc of Santa Rosa, California surveyed the CPT/hydropunch locations using ground penetrating radar. The drilling locations were cleared after slight adjustments (no more than two feet) to avoid subsurface objects.

On December 15, 2003, before starting CPT/hydropunch drilling activities, Weiss Associates measured the depth to water in wells UCD1-1 and UCD1-22. The water levels were encountered at 40.96 feet and 39.86 feet below the top of casing in wells UCD1-1 and UCD1-22, respectively.

C.3. CONE PENETROMETER AND HYDROPUNCH SAMPLING RESULTS

C.3.1 Lithologic Logging

On December 15 and 16, 2003, Gregg In Situ Inc (Gregg Drilling) of Martinez, California advanced CPT probes at the four locations shown on Figure C-2. Investigation activities were overseen by registered geologist and hydrogeologist Bob Devany of Weiss Associates (Weiss). CPT lithologic logging was conducted in conjunction with hydropunch sampling (described below) to identify the optimum location for well UCD1-054.

CPT cone resistance and sleeve friction measurements were supplemented with pore water pressure measurements (CPTU). The CPTU measurements were advanced to 80 feet below ground surface (ft bgs) at locations DW-B1 and DW-B2 and advanced to 83 ft bgs and 100 ft bgs at locations DW-B3 and DW-B 4, respectively. The CPTU logs are shown in Figures C-3 through C-6. Each log provides measurement output for cone resistance (qt) in tons per square foot (tsf), sleve friction in tsf, pore water pressure (U) in pounds per square inch (psi). The calculated friction ratio (Rf) in percent and the soil behavior type (SBT) are also shown in each log.

As shown in Figures C-3 through C-6, the Dry Wells Area geology generally consists of alternating clay and silt deposits with occasional thin sand deposits (DW-B3) to approximately 80 feet bgs. These clay and silt deposits are consistent with hydrostratigraphic unit 1 (HSU-1) boring log data collected throughout the LEHR site. Below 80 feet bgs, the deposits change to high permeability HSU-2 sand and gravel as shown in Figure C-6 for DW-B4. As expected of a high yield aquifer, a significant increase in cone resistance was accompanied by significant decreases in friction ratio and pore water pressure when HSU-2 was encountered in DW-B4.

A region within HSU-1 of relatively higher permeability silt was noted between 56 ft bgs and 73 ft bgs in DW-B1 at a location of potentially high contamination downgradient of the Dry Wells Area. Well UCD1-054 was installed at DW-B1 based on the geologic and chemical data.

The CPTU borings and data collection activities were performed in accordance with Standard Operating Procedure (SOP) 10.2, Cone Penetration Testing and Hydropunch® Ground Water Sampling (WA, 2002).

C.3.2 Hydrogeology

Hydrogeology in the vicinity of the Dry Wells Area was generally well known before CPTU data were collected in December of 2003. The CPT data provided more detailed HSU-1 and HSU-2 geologic records in the Dry Wells Area. These details were incorporated into the following hydrogeologic description.

In the Dry Wells Area, HSU-1 extends from ground surface to approximately 80 ft bgs. Sediments within HSU-1 are horizontal deposits of fine-grained silt and clay with occasional interbedded, discontinuous sand. The HSU-1 depth to ground water ranges from 25 ft to 80 ft bgs (WA, 2003) and varies seasonally. Results from pumping tests and slug tests indicate that HSU-1 hydraulic conductivity is low, ranging from two to 11 ft per day. HSU-1 vertical hydraulic conductivity is likely within the low end of range due to the predominant horizontal layers of fine-grained silt and clay.

The second closest HSU to the Dry Wells Area is HSU-2, which begins at approximately 80 ft bgs and consists primarily of sand and gravel to approximately 125 ft bgs. The hydraulic conductivity in HSU-2 was estimated at 1,020 ft per day and is relatively high compared to HSUs -1 and -3, located above and below, respectively. HSU-2 is used as a local source of water for domestic and agricultural applications due to its relatively high conductivity and storage capacity.

Ground water elevation data collected at the LEHR site indicate that the vertical gradient between HSU-1 and HSU-2 varies seasonally. In 2000, vertical gradients were downward during the summer due to agricultural pumping and fairly neutral during the winter months (WA, 2003). In the summer of 2000, the hydraulic head difference between HSU-1 and HSU-2 was three ft, indicating a small seasonal downward gradient.

The fine-grained deposits in HSU-1 are expected to provide a confining layer that will prevent Dry Wells Area contaminants from migrating downward to HSU-2. The confining layer may be up to 40 ft thick because HSU-1 extends to approximately 80 ft bgs and the deepest Dry Wells Area contamination was detected at 40 ft bgs. Because the seasonal downward vertical gradient between HSU-1 and HSU-2 is small and the mobility of Dry Wells Area contaminants is relatively low (e.g., no dense non-aqueous phase liquids) the contamination will not likely migrate down through the HSU-1 confining layer to reach HSU-2.

LEHR ground water gradient maps indicate that HSU-1 flow is typically toward the northeast in the vicinity of the Dry Wells Area, and can range from direct north to southeast. Lateral contaminant migration was considered possible in HSU-1 if contaminated soil is in contact with relatively higher permeability deposits that connect downgradient. However, the ground water sampling conducted within higher permeability HSU-1 deposits downgradient of the Dry Wells Area did not indicate contamination as described below.

C.3.3 Hydropunch Sampling

On December 15 and 16, 2003, Gregg Drilling advanced Hydropunch® probes at the four locations shown on Figure C-2. Weiss registered geologist and hydrogeologist Bob Devany provided sampling oversight and Weiss field geologist Maureen Wan directed field activities. Weiss field technician Chris Redmond assisted with sampling.

Ground water samples were collected using a Hydropunch® sampling system driven by a CPT rig. The ground water samples were collected in accordance with SOP 10.2, Cone Penetration Testing and Hydropunch® Ground Water Sampling (WA, 2002). Five ground water samples and one field duplicate were collected from HSU-1 at depths ranging from 47.5 ft bgs to 67.5 ft bgs. One sample was collected from HSU-2 at 82.5 ft bgs. The Hydropunch sample results are shown in Table C-1.

As shown, silver, cesium-137, and strontium-90 were not detected in any of the Hydropunch ground water samples. Chromium and hexavalent chromium were detected in some of the samples, but were below the California maximum contaminant levels (MCLs), United States Environmental Protection Agency (EPA) Region 9 preliminary remediation goals (PRGs), and background. Mercury was below the MCL, PRG and background in all but one sample. The concentration of mercury in sample WSDWI005 collected from boring B-1 at 47.5 feet bgs was 2.5 micrograms per liter (ug/L). This elevated mercury concentration was above the MCL and background, but the result was qualified due to a sample collection issue. The mercury fraction of sample WSDWI005 was not filtered before preservation with acid. The acidic sample preservation solution may have leached natural metals from the unfiltered particles and generated a higher concentration than the true dissolved metal concentration. Thus, the true dissolved mercury concentration in sample WSDWI005 may be lower than 2.5 ug/L. Molybdenum was below the PRG, but above background in all but one sample. The molybdenum concentration in HSU-2 sample WSDWI003 (11 ug/L) was within the range of detected concentrations in HSU-1 samples (9.4 ug/L to 24.3 ug/L).

Hydropunch ground water sample results did not indicate significant contamination downgradient of the Dry Wells Area. Mercury and molybdenum are the only potential contaminants of concern based on the Hydropunch results.

C.4. WELL INSTALLATION AND MONITORING

C.4.1 Well Installation

On February 6 and 10, 2004, Gregg Drilling installed well UCD1-054. Weiss registered geologist and hydrogeologist Bob Devany provided project oversight and Weiss field geologist Maureen Wan directed drilling and logged soil.

The location of well UCD1-054 (Figure C-2) was selected based on the CPTU/Hydropunch® data and previously collected soil characterization data. The Hydropunch® sample collected at DW-B1 had potential mercury contamination and the CPTU log for that location indicated a higher permeability soil unit that could intercept contamination. The highest levels of contamination in previously collected soil samples were near Dry Wells C and D with the highest mercury concentration in soil at Dry Well D. The highest molybdenum concentration in soil was also located at Dry Well D. Mercury and molybdenum are the only potential constituents of ground water concern based on the Hydropunch® sample results described above.

Well installation was performed according to LEHR SOP 8.1, Monitoring Well Installation (WA, 2002). Gregg Drilling operated a hollow-stem auger drill rig to advance an 8-inch diameter borehole to 73.5 ft bgs (Figure C-7). The well was constructed of 2-inch diameter blank polyvinyl chloride (PVC) casing between ground surface and 58 feet bgs and constructed of 0.01 inch slotted PVC casing between 58 feet bgs and 73 feet bgs. The well annulus was packed with Lonestar #2/12 sand between 73.5 feet bgs and 56 feet bgs. The bentonite seal was installed between 56 feet bgs and 54 feet bgs with grout between 54 feet bgs and a few inches bgs. The wellhead was enclosed in an 8" diameter traffic rated vault set in concrete with a slight rise above the parking lot surface to prevent drainage into the well.

C.4.2 Well Monitoring

On February 13, 2004, monitoring well UCD1-054 was developed following SOP 8.2, Monitoring Well Development (WA, 2002). Monitoring well samples were collected in duplicate on February 13, May 12, August 11, and October 20, 2004. The monitoring well samples were collected following LEHR SOP 9.1, Ground Water Sampling, and SOP 2.1, Sample Handling, Packaging and Shipping (WA, 2002). The water level monitoring and analytical results are summarized in Table C-2 and Table C-3, respectively.

As shown in Table C-2, the ground water elevation in well UCD1-054 ranged from -2.88 feet above mean sea level (amsl) in August to 11.58 feet amsl in February. The negative ground water elevation in August may reflect a slight drawdown due to local pumping. The recorded depths to ground water and the determined ground water elevations are within the mid range of historical water level data from other LEHR HSU-1 monitoring wells.

Table C-3 contains a summary of ground water monitoring results for constituents of potential ground water concern. The ground water monitoring results were similar to the Hydropunch® sample results. Silver, cesium-137, and strontium-90 were not detected in most of the samples. Silver was above the detection limit in sample GWDWI002 collected on February 13, 2004, but the result was qualified due to laboratory contamination. Silver was not detected in the February field duplicate sample (GWDWI002). The concentration of cesium-137 in fourth quarter 2004 sample GWDWI008 was 2.15 -+ 1.44 picocuries per liter (pCi/L); and was slightly above the detection limit of 1.97 pCi/L. Cesium-137 was not detected in the fourth quarter field duplicate sample (GWDWI007). Similarly, strontium-90 was slightly above the detection limit in third quarter sample GWDWI005 (0.51 +- 0.282 pCi/L, detection limit = 0.496 pCi/L), but strontium-90 was not detected in third quarter field duplicate sample GWDWI006.

Chromium and hexavalent chromium were detected in some of the samples, but were well below the MCLs, PRGs and background. Mercury was not detected in any of the samples. Based on the monitoring data, mercury does not appear to be a constituent of potential ground water concern in the Dry Wells Area. Molybdenum was below the PRG, but above background in all of the monitoring well samples.

Full suite analysis was conducted on the ground water monitoring samples collected during the first and third quarters of 2004. Full suite analysis parameters included nitrate, hexavalent chromium, metals, polychlorinated biphenyls (PCBs), pesticides, radionuclides, semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs). Second, third and fourth quarter samples were analyzed for total dissolved solids, carbon-14 and tritium. The ground water monitoring analytical data are presented in detail in Table C-4.

Concentrations of nitrate detected in well UCD1-054 ranged from 5.9 mg/L to 11 mg/L and were within the range of ground water background concentrations in well UCD1-018 (2mg/l to 27 mg/L). Total dissolved solids concentrations ranged from 937 mg/L to 1020 mg/L. Tritium and carbon-14 were not detected in any of the monitoring samples. Concentrations of arsenic, barium, cobalt, iron, magnesium, nickel, vanadium, and zinc were detected in the monitoring well samples, but were within the range of background concentrations from well UCD1-018. Antimony, beryllium, cadmium, copper, lead, selenium, and thallium were not detected in any of the monitoring well samples. Aluminum concentrations in ground water ranged from 111 ug/L to 781 ug/L, but could not be compared to background because aluminum has not been monitored in well UCD1-018. The range of manganese concentrations (12 ug/L to 24.2 ug/L) were above the background concentration range (0.297 ug/L to 9.9 ug/L).

The radionuclides actinium-228, bismuth-212, bismuth-214, cobalt-60, lead-210, lead-212, lead-214, plutonium-241, radium-226, sodium-22, thallium-208, thorium-228, thorium-232, and thorium-234 were not detected in any of the ground water monitoring samples. Potassium-40 was detected within the background range. Two americium-241 results (0.22+- 0.163 pCi/L, DL= 0.0945 pCi/L and 0.0935+- 0.0819 pCi/L, DL= 0.0561 pCi/L) were above background. Americium-241 was not detected in any of the background well samples and the highest background detection limit was 0.205 pCi/L.

Detected concentrations of thorium-230 ranged from 0.378 pCi/L to 0.72 pCi/L. Uranium-233/234 concentrations ranged from 1.83 pCi/L to 2.74 pCi/L. Uranium-235/236 was detected in one sample (0.0908 +- 0.0785 pCi/L). Background data were not available for comparison to thorium-230, uranium-233/234 and uranium-235/236 monitoring well data. Uranium-238 concentrations ranged from 1.14 pCi/L to 1.92 pCi/L, but a background comparison was not possible due to high background detection limits (136 pCi/L to 176 pCi/L).

No pesticides, PCBs, or VOCs were detected in any of the well UCD1-054 samples. Low concentrations of the SVOCs benzaldehyde, bis(2-ethylhexyl)phthalate, caprolactam, diethylphthalate, di-n-butylphthalate, and pyrene were detected. All three phthalates are common laboratory contaminants and bis(2-ethylhexyl)phthalate and di-n-butylphthalate results were qualified due to laboratory contamination. The benzaldehyde and pyrene concentrations were very low, 0.1 ug/L and 0.02 ug/L, respectively. The concentration of caprolactam in sample GWDWI005 was 14.5 ug/l, but caprolactam was not detected in field duplicate sample (GWDWI005) and there is no history of caprolactam use in LEHR experiments.

C.5. POST-DRILLING ACTIVITIES

Hunter Surveying, a California-registered land surveyor determined the coordinates and elevations of the soil borings and wellhead using the California Coordinate System. The survey data was entered into the LEHR site electronic database for storage and retrieval.

The analytical results were validated by Weiss Associates Project Chemist in accordance with SOP 21.1, Data Validation (WA, 2002). General Engineering Laboratories in South Carolina also performed internal data validation on their laboratory analyses. Once validated, the data were transferred to the project database in accordance with procedures described in the Quality Assurance Project Plan (WA, 2000).

C.6. CONCLUSIONS

Seven COPGWCs were identified based on data from previously collected soil samples. CPTU/Hydropunch® sampling and ground water monitoring was conducted in the Dry Wells Area to determine whether the COPGWCs were present in ground water. The ground water sampling results indicate that:

- Chromium, hexavalent chromium, mercury, silver, cesium-137, and strontium-90 have not impacted HSU-1 or HSU-2 ground water downgradient of the Dry Wells.
- Elevated molybdenum concentrations were found in HSU-1 and HSU-2 ground water downgradient of the Dry Wells.

Ground water monitoring samples collected in February and August of 2004 from new well UCD1-054 were also analyzed for an expanded suite of analytes. The results of expanded suite monitoring indicated that:

- Concentrations of manganese and americium-241 were above ground water background.
- All other metals and radionuclides were either below background or not detected.
- No pesticides, PCBs or VOCs were detected in the ground water monitoring samples.
- Low concentrations of a few SVOCs were detected in some of the monitoring samples. The detected SVOC concentrations were either due to laboratory contamination or were less than 0.1 ug/L or were not confirmed in the field duplicate samples.

The ground water investigation data do not indicate significant impact downgradient of the Dry Wells Area.

C.7. REFERENCES

WA, 2000, Final Quality Assurance Project Plan for the Laboratory for Energy-Related Health Research, University of California, Davis, June.

WA, 2002, Final Standard Operating Procedures for the Laboratory for Energy-Related Health Research, University of California, Davis, April.

WA, 2003, Draft DOE Areas Remedial Investigation Report for the Laboratory for Energy-Related Health Research, University of California, Davis, September.

WA, 2004, Dry Wells Area Hydrogeologic Characterization and Well Installation Work Plan at the Laboratory for Energy-Related Health Research, University of California, Davis, February.

Table C-1. Summary of Dissolved Concentrations in Dry Wells Hydropunch Ground Water Samples

Analyte	Units	WSDWI005	WSDWI006	WSDWI008	WSDWI004	WSDWI001/2	WSDWI003	MCL[a]	PRG[b]	Background
Chromium	ug/L	14.1 J+	<2.1	26	10.6	9.6	9.3	50	110	33[c]
Hexavalent Chromium	mg/L	<0.01	<0.01	0.0226 Jh	0.0125	<0.01 UJh	<0.01	50	110	0.055[c]
Mercury	ug/L	**2.5 J+**	<0.033	<0.033	<0.033	<0.033	<0.033	2.0	11.0	0.38[d]
Molybdenum	ug/L	<1.4	9.4	12	24.3	10.9	11	NA	180	2[c]
Silver	ug/L	<2	<2	<2	<2	<2	<2	100[e]	180	1[c]
Cesium-137	pCi/L	<1.72±1.02	<2.06±1.08	<1.37±0.819	<1.44±0.885	<1.52±0.880	<1.57±0.986	200[f]	1.57	7.5[d]
Strontium-90	pCi/L	<0.424±0.192	<0.445±0.220	<0.4±0.148	<0.424±0.157	<0.407±0.192	<0.38±0.147	8	0.644	1.7[d]

Notes

[a]Califorina MCL, 1996, unless otherwise noted.
[b]Chemical constituent PRGs from Region 9 PRG Table, 2004, http://www.epa.gov/region9/waste/sfund/prg/index.html. Radiological PRGs from Federal EPA PRGs Table, August 4, 2004, http://epa-prgs.ornl.gov/radionuclides/download.shtml.
[c]Table 2-6. Background Levels for Constituents in Groundwater, HSU-1, UCD Draft Remedial Investigation Report, LEHR/SCDS Environmental Restoration, January 8, 2003.
[d]Maximum detected concentration in Well UCD1-18.
[e]Secondary MCL. No primary MCL available.
[f]Federal MCL from EPA Soil Screening Guidance for Radionuclides: User's Guide, October 2000. No California MCL available.

Abbreviations

±	Error of plus or minus
<	Result is non detect at the detection limit shown
bgs	below ground surface
EPA	Environmental Protection Agency
ft	feet
J+	Result may be biased high relative to true dissolved concentration. Sample was not filtered before preservation.
Jh, UJh	Hexavalent chromium samples analyzed slightly outside holding time specification.
MCL	maximum contaminant level
mg/L	milligrams per liter
NA	Not available
pCi/L	picocuries per liter
PRG	preliminary remediation goal
ug/L	micrograms per liter

Table C-2. Well UCD1-054, Water Level Data

2004 Quarter	Date	Depth to Water from Top of Casing[a] (feet AMSL)	Ground Water Elevation (feet AMSL)
1	2/13/2004	37.00	11.58
2	5/12/2004	40.80	7.78
3	8/11/2004	51.46	-2.88
4	10/20/2004	45.43	3.15

Note
[a] Top of casing elevation is 48.58 feet AMSL.
Abbreviation
AMSL above mean sea level

Table C-3. 2004 Ground Water Monitoring Data at Well UCD1-054

Constituent of Concern	Units	Quarter 1 2/13/2004	Quarter 2 5/12/2004	Quarter 3 8/11/2004	Quarter 4 10/20/2004	MCL	PRG[b]	Background
Chromium	ug/L	5.6	3.89 J_q	3 J_q	3.1 UJ_z	50[a,h]	110	33[d]
Hexavalent Chromium	ug/L	<5.4	<5.4	<5.4	7.35	50[a,h]	110	55[d]
Mercury	ug/L	<0.066	<0.06	<0.06	<0.037	2.0[a,h]	11	0.38[e]
Molybdenum	ug/L	6.7 UJ_z	7.11 J_q	4.4 J_q	3.2	NA	180	2.0[d]
Silver	ug/L	3.2 UJ_z	<1.61	<1.6	<0.72	100[a,i]	180	1.0[d]
Cesium-137	pCi/L	<2.27	<2.81	<1.92	2.15[f] ± 1.44	200[c]	1.57	7.5[e]
Strontium-90	pCi/L	<0.684	<0.379	0.51[g] ± 0.282	<0.567	8[a,h]	0.644	1.7[e]

Notes
[a]Califorina MCL, 1996
[b]Chemical constituent PRGs from Region 9 PRG Table, 2004, http://www.epa.gov/region9/waste/sfund/prg/index.html
Radiological PRGs from Federal EPA PRGs Table, August 4, 2004, http://epa-prgs.ornl.gov/radionuclides/download.shtml
[c]EPA Soil Screening Guidance for Radionuclides: User's Guide, October 2000
[d]Table 2-6. Background Levels for Constituents in Groundwater, HSU-1, UCD Draft Remedial Investigation Report, LEHR/SCDS Environmental Restoration, January 8, 2003
[e]Maximum detected concentration in Well UCD1-18.
[f]Detection limit = 1.97 pCi/L
[g]Detection limit = 0.496 pCi/L
[h]Primary MCL
[i]Secondary MCL

Abbreviations

EPA	Environmental Protection Agency
J_q	The analyte was positively identified but the concentration is approximate.
MCL	maximum contaminant level
NA	not available
pCi/L	picocuries per liter
PRG	preliminary remediation goal
ug/L	micrograms per liter
UJ_z	Non-detect result. Reported concentration is due to laboratory contamination as found in the laboratory method blank.

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI001	02/13/04	GEN	Hexavalent Chromium	<			0.0054	mg/L	
GWDWI001	02/13/04	GEN	Nitrate		5.9		0.0341	mg/L	
GWDWI001	02/13/04	METAL	Aluminum		135		60	ug/L	J
GWDWI001	02/13/04	METAL	Antimony	<			7.1	ug/L	
GWDWI001	02/13/04	METAL	Arsenic	<			3.7	ug/L	
GWDWI001	02/13/04	METAL	Barium		88.5		0.43	ug/L	
GWDWI001	02/13/04	METAL	Beryllium	<			0.26	ug/L	
GWDWI001	02/13/04	METAL	Cadmium	<			0.65	ug/L	
GWDWI001	02/13/04	METAL	Calcium		40800		9.5	ug/L	
GWDWI001	02/13/04	METAL	Chromium		3.4		2.4	ug/L	J
GWDWI001	02/13/04	METAL	Cobalt	<			1.5	ug/L	
GWDWI001	02/13/04	METAL	Copper	<			2.3	ug/L	
GWDWI001	02/13/04	METAL	Iron	<			6.5	ug/L	
GWDWI001	02/13/04	METAL	Lead	<			2.7	ug/L	
GWDWI001	02/13/04	METAL	Magnesium		75600		15	ug/L	
GWDWI001	02/13/04	METAL	Manganese		12		0.68	ug/L	
GWDWI001	02/13/04	METAL	Mercury	<			0.066	ug/L	
GWDWI001	02/13/04	METAL	Molybdenum		6		1.7	ug/L	UJ
GWDWI001	02/13/04	METAL	Nickel		3.9		2.6	ug/L	UJ
GWDWI001	02/13/04	METAL	Potassium		2380		27.3	ug/L	
GWDWI001	02/13/04	METAL	Selenium	<			4.3	ug/L	
GWDWI001	02/13/04	METAL	Silver	<			1.6	ug/L	
GWDWI001	02/13/04	METAL	Sodium		264000		60.2	ug/L	
GWDWI001	02/13/04	METAL	Thallium	<			4.1	ug/L	
GWDWI001	02/13/04	METAL	Vanadium		16.3		3	ug/L	
GWDWI001	02/13/04	METAL	Zinc		1.2		0.92	ug/L	UJ
GWDWI001	02/13/04	PES	4,4'-DDD	<			0.095	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI001	02/13/04	PES	4,4'-DDE	<			0.095	ug/L	
GWDWI001	02/13/04	PES	4,4'-DDT	<			0.095	ug/L	
GWDWI001	02/13/04	PES	Aldrin	<			0.048	ug/L	
GWDWI001	02/13/04	PES	alpha-BHC	<			0.048	ug/L	
GWDWI001	02/13/04	PES	alpha-Chlordane	<			0.048	ug/L	
GWDWI001	02/13/04	PES	Aroclor-1016	<			0.95	ug/L	
GWDWI001	02/13/04	PES	Aroclor-1221	<			1.9	ug/L	
GWDWI001	02/13/04	PES	Aroclor-1232	<			0.95	ug/L	
GWDWI001	02/13/04	PES	Aroclor-1242	<			0.95	ug/L	
GWDWI001	02/13/04	PES	Aroclor-1248	<			0.95	ug/L	
GWDWI001	02/13/04	PES	Aroclor-1254	<			0.95	ug/L	
GWDWI001	02/13/04	PES	Aroclor-1260	<			0.95	ug/L	
GWDWI001	02/13/04	PES	beta-BHC	<			0.048	ug/L	
GWDWI001	02/13/04	PES	delta-BHC	<			0.048	ug/L	
GWDWI001	02/13/04	PES	Dieldrin	<			0.095	ug/L	
GWDWI001	02/13/04	PES	Endosulfan I	<			0.048	ug/L	
GWDWI001	02/13/04	PES	Endosulfan II	<			0.095	ug/L	
GWDWI001	02/13/04	PES	Endosulfan sulfate	<			0.095	ug/L	
GWDWI001	02/13/04	PES	Endrin	<			0.095	ug/L	
GWDWI001	02/13/04	PES	Endrin aldehyde	<			0.095	ug/L	
GWDWI001	02/13/04	PES	Endrin ketone	<			0.095	ug/L	
GWDWI001	02/13/04	PES	gamma-BHC (Lindane)	<			0.048	ug/L	
GWDWI001	02/13/04	PES	gamma-Chlordane	<			0.048	ug/L	
GWDWI001	02/13/04	PES	Heptachlor	<			0.048	ug/L	
GWDWI001	02/13/04	PES	Heptachlor epoxide	<			0.048	ug/L	
GWDWI001	02/13/04	PES	Methoxychlor	<			0.48	ug/L	
GWDWI001	02/13/04	PES	Toxaphene	<			4.8	ug/L	
GWDWI001RE	02/13/04	RAD	Actinium-228	<	5.05	9.52	9.52	pCi/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI001	02/13/04	RAD	Americium-241		0.22	0.163	0.0945	pCi/L	
GWDWI001RE	02/13/04	RAD	Bismuth-212	<	8.2	10.4	18.9	pCi/L	
GWDWI001RE	02/13/04	RAD	Bismuth-214	<	0	2.69	5.06	pCi/L	
GWDWI001RE	02/13/04	RAD	Cesium-137	<	0.855	1.24	2.27	pCi/L	
GWDWI001RE	02/13/04	RAD	Cobalt-60	<	-0.543	1.31	2.28	pCi/L	
GWDWI001	02/13/04	RAD	Gross Alpha		4.3	1.24	1.38	pCi/L	
GWDWI001	02/13/04	RAD	Gross Beta	<	2.39	1.65	2.71	pCi/L	
GWDWI001RE	02/13/04	RAD	Lead-210	<	0	26.4	44.3	pCi/L	
GWDWI001RE	02/13/04	RAD	Lead-212	<	0	2.08	3.82	pCi/L	
GWDWI001RE	02/13/04	RAD	Lead-214	<	3.31	2.34	4.17	pCi/L	
GWDWI001	02/13/04	RAD	Plutonium-241	<	2.54	4.03	7.84	pCi/L	
GWDWI001	02/13/04	RAD	Potassium-40	<	25.6	18.1	37.1	pCi/L	
GWDWI001	02/13/04	RAD	Radium-226	<	0.479	0.41	0.616	pCi/L	
GWDWI001RE	02/13/04	RAD	Sodium-22	<	-0.999	1.32	2.24	pCi/L	
GWDWI001	02/13/04	RAD	Strontium-90	<	0.222	0.405	0.832	pCi/L	
GWDWI001RE	02/13/04	RAD	Thallium-208	<	2.49	2.94	2.72	pCi/L	
GWDWI001	02/13/04	RAD	Thorium-228	<	0.105	0.199	0.443	pCi/L	
GWDWI001	02/13/04	RAD	Thorium-230		0.435	0.208	0.154	pCi/L	
GWDWI001	02/13/04	RAD	Thorium-232	<	0.0483	0.0705	0.126	pCi/L	
GWDWI001RE	02/13/04	RAD	Thorium-234	<	2.89	51.6	50.9	pCi/L	
GWDWI001	02/13/04	RAD	Uranium-233/234		1.83	0.417	0.0978	pCi/L	
GWDWI001	02/13/04	RAD	Uranium-235/236		0.0908	0.0785	0.0832	pCi/L	
GWDWI001	02/13/04	RAD	Uranium-238		1.37	0.344	0.0472	pCi/L	
GWDWI001	02/13/04	SVOC	1,1'-Biphenyl	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	2,4,5-Trichlorophenol	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	2,4,6-Trichlorophenol	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	2,4-Dichlorophenol	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	2,4-Dimethylphenol	<			9.6	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI001	02/13/04	SVOC	2,4-Dinitrophenol	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	2,4-Dinitrotoluene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	2,6-Dinitrotoluene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	2-Chloronaphthalene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	2-Chlorophenol	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	2-Methyl-4,6-dinitrophenol	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	2-Methylnaphthalene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	2-Nitrophenol	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	3,3'-Dichlorobenzidine	<			9.6	ug/L	UJ
GWDWI001	02/13/04	SVOC	4-Bromophenyl Phenyl Ether	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	4-Chloro-3-Methylphenol	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	4-Chloroaniline	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	4-Chlorophenyl Phenyl Ether	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	4-Nitrophenol	<			9.6	ug/L	R
GWDWI001	02/13/04	SVOC	Acenaphthene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Acenaphthylene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Acetophenone	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Anthracene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Atrazine	<			9.6	ug/L	UJ
GWDWI001	02/13/04	SVOC	Benzaldehyde	<			9.6	ug/L	UJ
GWDWI001	02/13/04	SVOC	Benzo(a)anthracene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Benzo(a)pyrene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Benzo(b)fluoranthene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Benzo(ghi)perylene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Benzo(k)fluoranthene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	bis(2-Chloroethoxy)methane	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Bis(2-Chloroethyl)ether	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	bis(2-Chloroisopropyl)ether	<			9.6	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI001	02/13/04	SVOC	bis(2-Ethylhexyl)phthalate		2.8		9.6	ug/L	UJ
GWDWI001	02/13/04	SVOC	Butylbenzylphthalate	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Caprolactam	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Carbazole	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Chrysene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Dibenzo(a,h)anthracene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Dibenzofuran	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Diethylphthalate	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Dimethylphthalate	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Di-n-butylphthalate		0.5		9.6	ug/L	UJ
GWDWI001	02/13/04	SVOC	Di-n-octylphthalate	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Diphenylamine	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Fluoranthene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Fluorene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Hexachlorobenzene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Hexachlorobutadiene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Hexachlorocyclopentadiene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Hexachloroethane	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Indeno(1,2,3-cd)pyrene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Isophorone	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	m,p-cresol	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	m-Nitroaniline	<			9.6	ug/L	R
GWDWI001	02/13/04	SVOC	Naphthalene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Nitrobenzene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	N-Nitrosodipropylamine	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	o-Cresol	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	o-Nitroaniline	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Pentachlorophenol	<			9.6	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI001	02/13/04	SVOC	Phenanthrene	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	Phenol	<			9.6	ug/L	
GWDWI001	02/13/04	SVOC	p-Nitroaniline	<			9.6	ug/L	R
GWDWI001	02/13/04	SVOC	Pyrene	<			9.6	ug/L	
GWDWI001	02/13/04	VOC	1,1,1-Trichloroethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,1,2,2-Tetrachloroethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,1,2-Trichloroethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,1-Dichloroethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,1-Dichloroethene	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,2,4-Trichlorobenzene	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,2-Dibromo-3-chloropropane	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,2-Dibromoethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,2-Dichlorobenzene	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,2-Dichloroethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,2-Dichloropropane	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,3-Dichlorobenzene	<			10	ug/L	
GWDWI001	02/13/04	VOC	1,4-Dichlorobenzene	<			10	ug/L	
GWDWI001	02/13/04	VOC	2-Butanone	<			10	ug/L	
GWDWI001	02/13/04	VOC	2-Hexanone	<			10	ug/L	
GWDWI001	02/13/04	VOC	4-Methyl-2-pentanone	<			10	ug/L	
GWDWI001	02/13/04	VOC	Acetone	<			10	ug/L	
GWDWI001	02/13/04	VOC	Benzene	<			10	ug/L	
GWDWI001	02/13/04	VOC	Bromodichloromethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	Bromoform	<			10	ug/L	
GWDWI001	02/13/04	VOC	Bromomethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	Carbon disulfide	<			10	ug/L	
GWDWI001	02/13/04	VOC	Carbon tetrachloride	<			10	ug/L	
GWDWI001	02/13/04	VOC	Chlorobenzene	<			10	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI001	02/13/04	VOC	Chlorodibromomethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	Chloroethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	Chloroform	<			10	ug/L	
GWDWI001	02/13/04	VOC	Chloromethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	cis-1,2-Dichloroethene	<			10	ug/L	
GWDWI001	02/13/04	VOC	cis-1,3-Dichloropropylene	<			10	ug/L	
GWDWI001	02/13/04	VOC	Cyclohexane	<			10	ug/L	
GWDWI001	02/13/04	VOC	Dichlorodifluoromethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	Ethylbenzene	<			10	ug/L	
GWDWI001	02/13/04	VOC	Isopropylbenzene	<			10	ug/L	
GWDWI001	02/13/04	VOC	Methyl acetate	<			10	ug/L	
GWDWI001	02/13/04	VOC	Methylcyclohexane	<			10	ug/L	
GWDWI001	02/13/04	VOC	Methylene chloride	<			10	ug/L	
GWDWI001	02/13/04	VOC	Styrene	<			10	ug/L	
GWDWI001	02/13/04	VOC	tert-Butyl methyl ether	<			10	ug/L	
GWDWI001	02/13/04	VOC	Tetrachloroethylene	<			10	ug/L	
GWDWI001	02/13/04	VOC	Toluene	<			10	ug/L	
GWDWI001	02/13/04	VOC	trans-1,2-Dichloroethene	<			10	ug/L	
GWDWI001	02/13/04	VOC	trans-1,3-Dichloropropene	<			10	ug/L	
GWDWI001	02/13/04	VOC	Trichloroethene	<			10	ug/L	
GWDWI001	02/13/04	VOC	Trichlorofluoromethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	Trichlorotrifluoroethane	<			10	ug/L	
GWDWI001	02/13/04	VOC	Vinyl chloride	<			10	ug/L	
GWDWI001	02/13/04	VOC	Xylenes (total)	<			30	ug/L	
GWDWI002	02/13/04	GEN	Hexavalent Chromium	<			0.0054	mg/L	
GWDWI002	02/13/04	GEN	Nitrate		5.98		0.0341	mg/L	
GWDWI002	02/13/04	METAL	Aluminum		111		60	ug/L	J
GWDWI002	02/13/04	METAL	Antimony	<			7.1	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI002	02/13/04	METAL	Arsenic	<			3.7	ug/L	
GWDWI002	02/13/04	METAL	Barium		87.7		0.43	ug/L	
GWDWI002	02/13/04	METAL	Beryllium	<			0.26	ug/L	
GWDWI002	02/13/04	METAL	Cadmium	<			0.65	ug/L	
GWDWI002	02/13/04	METAL	Calcium		40100		9.5	ug/L	
GWDWI002	02/13/04	METAL	Chromium		5.6		2.4	ug/L	
GWDWI002	02/13/04	METAL	Cobalt		1.9		1.5	ug/L	J
GWDWI002	02/13/04	METAL	Copper	<			2.3	ug/L	
GWDWI002	02/13/04	METAL	Iron		7.9		6.5	ug/L	UJ
GWDWI002	02/13/04	METAL	Lead	<			2.7	ug/L	
GWDWI002	02/13/04	METAL	Magnesium		73500		15	ug/L	
GWDWI002	02/13/04	METAL	Manganese		12.9		0.68	ug/L	
GWDWI002	02/13/04	METAL	Mercury	<			0.066	ug/L	
GWDWI002	02/13/04	METAL	Molybdenum		6.7		1.7	ug/L	UJ
GWDWI002	02/13/04	METAL	Nickel		2.9		2.6	ug/L	UJ
GWDWI002	02/13/04	METAL	Potassium		2540		27.3	ug/L	
GWDWI002	02/13/04	METAL	Selenium	<			4.3	ug/L	
GWDWI002	02/13/04	METAL	Silver		3.2		1.6	ug/L	UJ
GWDWI002	02/13/04	METAL	Sodium		255000		60.2	ug/L	
GWDWI002	02/13/04	METAL	Thallium	<			4.1	ug/L	
GWDWI002	02/13/04	METAL	Vanadium		17.6		3	ug/L	
GWDWI002	02/13/04	METAL	Zinc		3.6		0.92	ug/L	UJ
GWDWI002	02/13/04	PES	4,4'-DDD	<			0.096	ug/L	
GWDWI002	02/13/04	PES	4,4'-DDE	<			0.096	ug/L	
GWDWI002	02/13/04	PES	4,4'-DDT	<			0.096	ug/L	
GWDWI002	02/13/04	PES	Aldrin	<			0.048	ug/L	
GWDWI002	02/13/04	PES	alpha-BHC	<			0.048	ug/L	
GWDWI002	02/13/04	PES	alpha-Chlordane	<			0.048	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI002	02/13/04	PES	Aroclor-1016	<			0.96	ug/L	
GWDWI002	02/13/04	PES	Aroclor-1221	<			1.9	ug/L	
GWDWI002	02/13/04	PES	Aroclor-1232	<			0.96	ug/L	
GWDWI002	02/13/04	PES	Aroclor-1242	<			0.96	ug/L	
GWDWI002	02/13/04	PES	Aroclor-1248	<			0.96	ug/L	
GWDWI002	02/13/04	PES	Aroclor-1254	<			0.96	ug/L	
GWDWI002	02/13/04	PES	Aroclor-1260	<			0.96	ug/L	
GWDWI002	02/13/04	PES	beta-BHC	<			0.048	ug/L	
GWDWI002	02/13/04	PES	delta-BHC	<			0.048	ug/L	
GWDWI002	02/13/04	PES	Dieldrin	<			0.096	ug/L	
GWDWI002	02/13/04	PES	Endosulfan I	<			0.048	ug/L	
GWDWI002	02/13/04	PES	Endosulfan II	<			0.096	ug/L	
GWDWI002	02/13/04	PES	Endosulfan sulfate	<			0.096	ug/L	
GWDWI002	02/13/04	PES	Endrin	<			0.096	ug/L	
GWDWI002	02/13/04	PES	Endrin aldehyde	<			0.096	ug/L	
GWDWI002	02/13/04	PES	Endrin ketone	<			0.096	ug/L	
GWDWI002	02/13/04	PES	gamma-BHC (Lindane)	<			0.048	ug/L	
GWDWI002	02/13/04	PES	gamma-Chlordane	<			0.048	ug/L	
GWDWI002	02/13/04	PES	Heptachlor	<			0.048	ug/L	
GWDWI002	02/13/04	PES	Heptachlor epoxide	<			0.048	ug/L	
GWDWI002	02/13/04	PES	Methoxychlor	<			0.48	ug/L	
GWDWI002	02/13/04	PES	Toxaphene	<			4.8	ug/L	
GWDWI002RE	02/13/04	RAD	Actinium-228	<	0	3.65	7.07	pCi/L	
GWDWI002	02/13/04	RAD	Americium-241	<	0	0.0626	0.0959	pCi/L	
GWDWI002RE	02/13/04	RAD	Bismuth-212	<	-4.9	9.52	13.4	pCi/L	
GWDWI002RE	02/13/04	RAD	Bismuth-214	<	1.08	5.21	3.73	pCi/L	
GWDWI002RE	02/13/04	RAD	Cesium-137	<	0.568	0.963	1.71	pCi/L	
GWDWI002RE	02/13/04	RAD	Cobalt-60	<	0.324	0.967	1.76	pCi/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI002	02/13/04	RAD	Gross Alpha		3.37	1.34	1.86	pCi/L	
GWDWI002	02/13/04	RAD	Gross Beta	<	2.46	1.87	3.1	pCi/L	
GWDWI002	02/13/04	RAD	Lead-210	<	52.8	392	357	pCi/L	
GWDWI002	02/13/04	RAD	Lead-212	<	2.7	5.9	3.52	pCi/L	
GWDWI002RE	02/13/04	RAD	Lead-214	<	-0.291	2.09	3.63	pCi/L	
GWDWI002	02/13/04	RAD	Plutonium-241	<	4.11	3.84	7.39	pCi/L	
GWDWI002RE	02/13/04	RAD	Potassium-40	<	19.9	13.1	24.7	pCi/L	UJ
GWDWI002	02/13/04	RAD	Radium-226	<	0.381	0.335	0.502	pCi/L	
GWDWI002RE	02/13/04	RAD	Sodium-22	<	-0.0415	0.960	1.69	pCi/L	
GWDWI002	02/13/04	RAD	Strontium-90	<	0.366	0.344	0.684	pCi/L	
GWDWI002RE	02/13/04	RAD	Thallium-208	<	0.0953	1.96	2.09	pCi/L	
GWDWI002	02/13/04	RAD	Thorium-228	<	-0.0021	0.0203	0.345	pCi/L	
GWDWI002	02/13/04	RAD	Thorium-230		0.378	0.256	0.198	pCi/L	
GWDWI002	02/13/04	RAD	Thorium-232	<	0.00879	0.068	0.26	pCi/L	
GWDWI002	02/13/04	RAD	Thorium-234	<	81.1	115	109	pCi/L	
GWDWI002	02/13/04	RAD	Uranium-233/234		2.17	0.485	0.14	pCi/L	
GWDWI002	02/13/04	RAD	Uranium-235/236	<	0.061	0.0764	0.129	pCi/L	
GWDWI002	02/13/04	RAD	Uranium-238		1.23	0.34	0.129	pCi/L	
GWDWI002	02/13/04	SVOC	1,1'-Biphenyl	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	2,4,5-Trichlorophenol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	2,4,6-Trichlorophenol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	2,4-Dichlorophenol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	2,4-Dimethylphenol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	2,4-Dinitrophenol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	2,4-Dinitrotoluene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	2,6-Dinitrotoluene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	2-Chloronaphthalene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	2-Chlorophenol	<			9.6	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI002	02/13/04	SVOC	2-Methyl-4,6-dinitrophenol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	2-Methylnaphthalene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	2-Nitrophenol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	3,3'-Dichlorobenzidine	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	4-Bromophenyl Phenyl Ether	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	4-Chloro-3-Methylphenol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	4-Chloroaniline	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	4-Chlorophenyl Phenyl Ether	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	4-Nitrophenol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Acenaphthene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Acenaphthylene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Acetophenone	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Anthracene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Atrazine	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Benzaldehyde	<			9.6	ug/L	UJ
GWDWI002	02/13/04	SVOC	Benzo(a)anthracene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Benzo(a)pyrene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Benzo(b)fluoranthene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Benzo(ghi)perylene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Benzo(k)fluoranthene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	bis(2-Chloroethoxy)methane	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Bis(2-Chloroethyl)ether	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	bis(2-Chloroisopropyl)ether	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	bis(2-Ethylhexyl)phthalate	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Butylbenzylphthalate	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Caprolactam	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Carbazole	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Chrysene	<			9.6	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI002	02/13/04	SVOC	Dibenzo(a,h)anthracene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Dibenzofuran	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Diethylphthalate	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Dimethylphthalate	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Di-n-butylphthalate	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Di-n-octylphthalate	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Diphenylamine	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Fluoranthene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Fluorene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Hexachlorobenzene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Hexachlorobutadiene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Hexachlorocyclopentadiene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Hexachloroethane	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Indeno(1,2,3-cd)pyrene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Isophorone	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	m,p-cresol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	m-Nitroaniline	<			9.6	ug/L	R
GWDWI002	02/13/04	SVOC	Naphthalene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Nitrobenzene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	N-Nitrosodipropylamine	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	o-Cresol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	o-Nitroaniline	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Pentachlorophenol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Phenanthrene	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	Phenol	<			9.6	ug/L	
GWDWI002	02/13/04	SVOC	p-Nitroaniline	<			9.6	ug/L	UJ
GWDWI002	02/13/04	SVOC	Pyrene	<			9.6	ug/L	
GWDWI002	02/13/04	VOC	1,1,1-Trichloroethane	<			10	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI002	02/13/04	VOC	1,1,2,2-Tetrachloroethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	1,1,2-Trichloroethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	1,1-Dichloroethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	1,1-Dichloroethene	<			10	ug/L	
GWDWI002	02/13/04	VOC	1,2,4-Trichlorobenzene	<			10	ug/L	
GWDWI002	02/13/04	VOC	1,2-Dibromo-3-chloropropane	<			10	ug/L	
GWDWI002	02/13/04	VOC	1,2-Dibromoethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	1,2-Dichlorobenzene	<			10	ug/L	
GWDWI002	02/13/04	VOC	1,2-Dichloroethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	1,2-Dichloropropane	<			10	ug/L	
GWDWI002	02/13/04	VOC	1,3-Dichlorobenzene	<			10	ug/L	
GWDWI002	02/13/04	VOC	1,4-Dichlorobenzene	<			10	ug/L	
GWDWI002	02/13/04	VOC	2-Butanone	<			10	ug/L	
GWDWI002	02/13/04	VOC	2-Hexanone	<			10	ug/L	
GWDWI002	02/13/04	VOC	4-Methyl-2-pentanone	<			10	ug/L	
GWDWI002	02/13/04	VOC	Acetone	<			10	ug/L	
GWDWI002	02/13/04	VOC	Benzene	<			10	ug/L	
GWDWI002	02/13/04	VOC	Bromodichloromethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	Bromoform	<			10	ug/L	
GWDWI002	02/13/04	VOC	Bromomethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	Carbon disulfide	<			10	ug/L	
GWDWI002	02/13/04	VOC	Carbon tetrachloride	<			10	ug/L	
GWDWI002	02/13/04	VOC	Chlorobenzene	<			10	ug/L	
GWDWI002	02/13/04	VOC	Chlorodibromomethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	Chloroethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	Chloroform	<			10	ug/L	
GWDWI002	02/13/04	VOC	Chloromethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	cis-1,2-Dichloroethene	<			10	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI002	02/13/04	VOC	cis-1,3-Dichloropropylene	<			10	ug/L	
GWDWI002	02/13/04	VOC	Cyclohexane	<			10	ug/L	
GWDWI002	02/13/04	VOC	Dichlorodifluoromethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	Ethylbenzene	<			10	ug/L	
GWDWI002	02/13/04	VOC	Isopropylbenzene	<			10	ug/L	
GWDWI002	02/13/04	VOC	Methyl acetate	<			10	ug/L	
GWDWI002	02/13/04	VOC	Methylcyclohexane	<			10	ug/L	
GWDWI002	02/13/04	VOC	Methylene chloride	<			10	ug/L	
GWDWI002	02/13/04	VOC	Styrene	<			10	ug/L	
GWDWI002	02/13/04	VOC	tert-Butyl methyl ether	<			10	ug/L	
GWDWI002	02/13/04	VOC	Tetrachloroethylene	<			10	ug/L	
GWDWI002	02/13/04	VOC	Toluene	<			10	ug/L	
GWDWI002	02/13/04	VOC	trans-1,2-Dichloroethene	<			10	ug/L	
GWDWI002	02/13/04	VOC	trans-1,3-Dichloropropene	<			10	ug/L	
GWDWI002	02/13/04	VOC	Trichloroethene	<			10	ug/L	
GWDWI002	02/13/04	VOC	Trichlorofluoromethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	Trichlorotrifluoroethane	<			10	ug/L	
GWDWI002	02/13/04	VOC	Vinyl chloride	<			10	ug/L	
GWDWI002	02/13/04	VOC	Xylenes (total)	<			30	ug/L	
GWDWI003	05/12/04	GEN	Hexavalent Chromium	<			0.0054	mg/L	
GWDWI003	05/12/04	GEN	Total Dissolved Solids		952		3.07	mg/L	
GWDWI003	05/12/04	METAL	Chromium		3.89		1.22	ug/L	J
GWDWI003	05/12/04	METAL	Mercury	<			0.06	ug/L	
GWDWI003	05/12/04	METAL	Molybdenum		7.11		1.71	ug/L	J
GWDWI003	05/12/04	METAL	Silver	<			1.61	ug/L	
GWDWI003	05/12/04	RAD	Carbon-14	<	0	5.18	8.9	pCi/L	
GWDWI003	05/12/04	RAD	Cesium-137	<	0.459	2.27	2.81	pCi/L	
GWDWI003	05/12/04	RAD	Strontium-90	<	0.202	0.195	0.379	pCi/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI003	05/12/04	RAD	Tritium	<	47.1	170	299	pCi/L	
GWDWI004	05/12/04	GEN	Hexavalent Chromium	<			0.0054	mg/L	
GWDWI004	05/12/04	GEN	Total Dissolved Solids		937		3.07	mg/L	
GWDWI004	05/12/04	METAL	Chromium		2.89		1.22	ug/L	J
GWDWI004	05/12/04	METAL	Mercury	<			0.06	ug/L	
GWDWI004	05/12/04	METAL	Molybdenum		5.56		1.71	ug/L	J
GWDWI004	05/12/04	METAL	Silver	<			1.61	ug/L	
GWDWI004	05/12/04	RAD	Carbon-14	<	-3.61	5.37	9.39	pCi/L	
GWDWI004	05/12/04	RAD	Cesium-137	<	-0.171	1.31	2.31	pCi/L	
GWDWI004	05/12/04	RAD	Strontium-90	<	-0.0248	0.170	0.377	pCi/L	
GWDWI004	05/12/04	RAD	Tritium	<	94.5	174	300	pCi/L	
GWDWI005	08/11/04	GEN	Hexavalent Chromium	<			0.0054	mg/L	
GWDWI005	08/11/04	GEN	Nitrate		11		0.0682	mg/L	J
GWDWI005	08/11/04	GEN	Total Dissolved Solids		1010		3.07	mg/L	
GWDWI005	08/11/04	METAL	Aluminum		781		96.6	ug/L	
GWDWI005	08/11/04	METAL	Antimony	<			6.4	ug/L	
GWDWI005	08/11/04	METAL	Arsenic		8.4		3.2	ug/L	
GWDWI005	08/11/04	METAL	Barium		58.7		0.36	ug/L	
GWDWI005	08/11/04	METAL	Beryllium	<			0.17	ug/L	
GWDWI005	08/11/04	METAL	Cadmium	<			0.84	ug/L	
GWDWI005	08/11/04	METAL	Calcium		42500		7	ug/L	
GWDWI005	08/11/04	METAL	Chromium		2.6		1.2	ug/L	J
GWDWI005	08/11/04	METAL	Cobalt	<			1.8	ug/L	
GWDWI005	08/11/04	METAL	Copper	<			2	ug/L	
GWDWI005	08/11/04	METAL	Iron	<			6.7	ug/L	
GWDWI005	08/11/04	METAL	Lead	<			2.2	ug/L	
GWDWI005	08/11/04	METAL	Magnesium		78800		14.9	ug/L	
GWDWI005	08/11/04	METAL	Manganese		23.8		0.51	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI005	08/11/04	METAL	Mercury	<			0.06	ug/L	
GWDWI005	08/11/04	METAL	Molybdenum		4.4		1.7	ug/L	J
GWDWI005	08/11/04	METAL	Nickel		2.9		2.2	ug/L	J
GWDWI005	08/11/04	METAL	Potassium		2310		20.4	ug/L	
GWDWI005	08/11/04	METAL	Selenium	<			3.7	ug/L	
GWDWI005	08/11/04	METAL	Silver	<			1.6	ug/L	
GWDWI005	08/11/04	METAL	Sodium		253000		169	ug/L	
GWDWI005	08/11/04	METAL	Thallium	<			3.8	ug/L	
GWDWI005	08/11/04	METAL	Vanadium		14		2.6	ug/L	
GWDWI005	08/11/04	METAL	Zinc		2.6		1.5	ug/L	UJ
GWDWI005	08/11/04	PES	4,4'-DDD	<			0.093	ug/L	
GWDWI005	08/11/04	PES	4,4'-DDE	<			0.093	ug/L	
GWDWI005	08/11/04	PES	4,4'-DDT	<			0.093	ug/L	
GWDWI005	08/11/04	PES	Aldrin	<			0.047	ug/L	
GWDWI005	08/11/04	PES	alpha-BHC	<			0.047	ug/L	
GWDWI005	08/11/04	PES	alpha-Chlordane	<			0.047	ug/L	
GWDWI005	08/11/04	PES	Aroclor-1016	<			0.93	ug/L	
GWDWI005	08/11/04	PES	Aroclor-1221	<			1.9	ug/L	
GWDWI005	08/11/04	PES	Aroclor-1232	<			0.93	ug/L	
GWDWI005	08/11/04	PES	Aroclor-1242	<			0.93	ug/L	
GWDWI005	08/11/04	PES	Aroclor-1248	<			0.93	ug/L	
GWDWI005	08/11/04	PES	Aroclor-1254	<			0.93	ug/L	
GWDWI005	08/11/04	PES	Aroclor-1260	<			0.93	ug/L	
GWDWI005	08/11/04	PES	beta-BHC	<			0.047	ug/L	
GWDWI005	08/11/04	PES	delta-BHC	<			0.047	ug/L	
GWDWI005	08/11/04	PES	Dieldrin	<			0.093	ug/L	
GWDWI005	08/11/04	PES	Endosulfan I	<			0.047	ug/L	
GWDWI005	08/11/04	PES	Endosulfan II	<			0.093	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI005	08/11/04	PES	Endosulfan sulfate	<			0.093	ug/L	
GWDWI005	08/11/04	PES	Endrin	<			0.093	ug/L	
GWDWI005	08/11/04	PES	Endrin aldehyde	<			0.093	ug/L	
GWDWI005	08/11/04	PES	Endrin ketone	<			0.093	ug/L	
GWDWI005	08/11/04	PES	gamma-BHC (Lindane)	<			0.047	ug/L	
GWDWI005	08/11/04	PES	gamma-Chlordane	<			0.047	ug/L	
GWDWI005	08/11/04	PES	Heptachlor	<			0.047	ug/L	
GWDWI005	08/11/04	PES	Heptachlor epoxide	<			0.047	ug/L	
GWDWI005	08/11/04	PES	Methoxychlor	<			0.47	ug/L	
GWDWI005	08/11/04	PES	Toxaphene	<			4.7	ug/L	
GWDWI005	08/11/04	RAD	Actinium-228	<	1.74	4.43	6.63	pCi/L	
GWDWI005	08/11/04	RAD	Americium-241		0.0935	0.0819	0.0561	pCi/L	
GWDWI005	08/11/04	RAD	Bismuth-212	<	4.62	8.03	14.7	pCi/L	
GWDWI005	08/11/04	RAD	Bismuth-214	<	0.828	5.01	4.65	pCi/L	
GWDWI005	08/11/04	RAD	Carbon-14	<	-5.88	7.65	13.3	pCi/L	
GWDWI005	08/11/04	RAD	Cesium-137	<	0.833	1.03	1.92	pCi/L	
GWDWI005	08/11/04	RAD	Cobalt-60	<	1.32	2.62	3.21	pCi/L	
GWDWI005	08/11/04	RAD	Gross Alpha	<	-2.53	2.07	3.94	pCi/L	UJ
GWDWI005	08/11/04	RAD	Gross Beta	<	0.95	0.806	1.32	pCi/L	
GWDWI005	08/11/04	RAD	Lead-210	<	69.4	196	295	pCi/L	
GWDWI005	08/11/04	RAD	Lead-212	<	0.338	3.68	3.12	pCi/L	
GWDWI005	08/11/04	RAD	Lead-214	<	0	2.43	4.46	pCi/L	
GWDWI005RE	08/11/04	RAD	Plutonium-241	<	-1.73	3.45	5.96	pCi/L	
GWDWI005	08/11/04	RAD	Potassium-40	<	0	28.3	17.1	pCi/L	
GWDWI005	08/11/04	RAD	Radium-226	<	0.046	0.376	0.739	pCi/L	
GWDWI005	08/11/04	RAD	Sodium-22	<	0.00952	1.16	2	pCi/L	
GWDWI005	08/11/04	RAD	Strontium-90		0.51	0.282	0.496	pCi/L	
GWDWI005	08/11/04	RAD	Thallium-208	<	0.0116	2.25	2.28	pCi/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI005	08/11/04	RAD	Thorium-228	<	0.053	0.329	0.851	pCi/L	
GWDWI005	08/11/04	RAD	Thorium-230	<	0.401	0.330	0.431	pCi/L	
GWDWI005	08/11/04	RAD	Thorium-232	<	0.109	0.175	0.328	pCi/L	
GWDWI005	08/11/04	RAD	Thorium-234	<	0	52.6	98	pCi/L	
GWDWI005	08/11/04	RAD	Tritium	<	-32.4	124	224	pCi/L	
GWDWI005	08/11/04	RAD	Uranium-233/234		2.74	0.830	0.626	pCi/L	
GWDWI005	08/11/04	RAD	Uranium-235/236	<	0.183	0.265	0.528	pCi/L	
GWDWI005	08/11/04	RAD	Uranium-238		1.14	0.526	0.382	pCi/L	
GWDWI005	08/11/04	SVOC	1,1'-Biphenyl	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2,4,5-Trichlorophenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2,4,6-Trichlorophenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2,4-Dichlorophenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2,4-Dimethylphenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2,4-Dinitrophenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2,4-Dinitrotoluene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2,6-Dinitrotoluene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2-Chloronaphthalene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2-Chlorophenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2-Methyl-4,6-dinitrophenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2-Methylnaphthalene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	2-Nitrophenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	3,3'-Dichlorobenzidine	<			9.4	ug/L	UJ
GWDWI005	08/11/04	SVOC	4-Bromophenyl Phenyl Ether	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	4-Chloro-3-methylphenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	4-Chloroaniline	<			9.4	ug/L	UJ
GWDWI005	08/11/04	SVOC	4-Chlorophenyl Phenyl Ether	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	4-Nitrophenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Acenaphthene	<			9.4	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI005	08/11/04	SVOC	Acenaphthylene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Acetophenone	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Anthracene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Atrazine	<			9.4	ug/L	UJ
GWDWI005	08/11/04	SVOC	Benzaldehyde		0.1		9.4	ug/L	J
GWDWI005	08/11/04	SVOC	Benzo(a)anthracene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Benzo(a)pyrene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Benzo(b)fluoranthene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Benzo(ghi)perylene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Benzo(k)fluoranthene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	bis(2-Chloroethoxy)methane	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Bis(2-Chloroethyl)ether	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	bis(2-Chloroisopropyl)ether	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	bis(2-Ethylhexyl)phthalate	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Butylbenzylphthalate	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Caprolactam		14.5		9.4	ug/L	
GWDWI005	08/11/04	SVOC	Carbazole	<			9.4	ug/L	UJ
GWDWI005	08/11/04	SVOC	Chrysene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Dibenzo(a,h)anthracene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Dibenzofuran	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Diethylphthalate		0.28		9.4	ug/L	J
GWDWI005	08/11/04	SVOC	Dimethylphthalate	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Di-n-butylphthalate		0.54		9.4	ug/L	J
GWDWI005	08/11/04	SVOC	Di-n-octylphthalate	<			9.4	ug/L	UJ
GWDWI005	08/11/04	SVOC	Diphenylamine	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Fluoranthene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Fluorene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Hexachlorobenzene	<			9.4	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI005	08/11/04	SVOC	Hexachlorobutadiene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Hexachlorocyclopentadiene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Hexachloroethane	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Indeno(1,2,3-cd)pyrene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Isophorone	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	m,p-cresol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	m-Nitroaniline	<			9.4	ug/L	UJ
GWDWI005	08/11/04	SVOC	Naphthalene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Nitrobenzene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	N-Nitrosodipropylamine	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	o-Cresol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	o-Nitroaniline	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Pentachlorophenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Phenanthrene	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	Phenol	<			9.4	ug/L	
GWDWI005	08/11/04	SVOC	p-Nitroaniline	<			9.4	ug/L	UJ
GWDWI005	08/11/04	SVOC	Pyrene		0.02		9.4	ug/L	J
GWDWI005	08/11/04	VOC	1,1,1-Trichloroethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	1,1,2,2-Tetrachloroethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	1,1,2-Trichloroethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	1,1-Dichloroethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	1,1-Dichloroethene	<			1	ug/L	
GWDWI005	08/11/04	VOC	1,2,4-Trichlorobenzene	<			1	ug/L	
GWDWI005	08/11/04	VOC	1,2-Dibromo-3-chloropropane	<			1	ug/L	R
GWDWI005	08/11/04	VOC	1,2-Dibromoethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	1,2-Dichlorobenzene	<			1	ug/L	
GWDWI005	08/11/04	VOC	1,2-Dichloroethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	1,2-Dichloropropane	<			1	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI005	08/11/04	VOC	1,3-Dichlorobenzene	<			1	ug/L	
GWDWI005	08/11/04	VOC	1,4-Dichlorobenzene	<			1	ug/L	
GWDWI005	08/11/04	VOC	2-Butanone	<			5	ug/L	
GWDWI005	08/11/04	VOC	2-Hexanone	<			5	ug/L	
GWDWI005	08/11/04	VOC	4-Methyl-2-pentanone	<			5	ug/L	
GWDWI005	08/11/04	VOC	Acetone	<			5	ug/L	
GWDWI005	08/11/04	VOC	Benzene	<			1	ug/L	
GWDWI005	08/11/04	VOC	Bromodichloromethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	Bromoform	<			1	ug/L	
GWDWI005	08/11/04	VOC	Bromomethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	Carbon disulfide	<			5	ug/L	
GWDWI005	08/11/04	VOC	Carbon tetrachloride	<			1	ug/L	
GWDWI005	08/11/04	VOC	Chlorobenzene	<			1	ug/L	
GWDWI005	08/11/04	VOC	Chlorodibromomethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	Chloroethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	Chloroform	<			1	ug/L	
GWDWI005	08/11/04	VOC	Chloromethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	cis-1,2-Dichloroethene	<			1	ug/L	
GWDWI005	08/11/04	VOC	cis-1,3-Dichloropropylene	<			1	ug/L	
GWDWI005	08/11/04	VOC	Cyclohexane	<			1	ug/L	
GWDWI005	08/11/04	VOC	Dichlorodifluoromethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	Ethylbenzene	<			1	ug/L	
GWDWI005	08/11/04	VOC	Isopropylbenzene	<			1	ug/L	
GWDWI005	08/11/04	VOC	Methyl acetate	<			5	ug/L	
GWDWI005	08/11/04	VOC	Methylcyclohexane	<			1	ug/L	
GWDWI005	08/11/04	VOC	Methylene chloride	<			5	ug/L	
GWDWI005	08/11/04	VOC	Styrene	<			1	ug/L	
GWDWI005	08/11/04	VOC	tert-Butyl methyl ether	<			1	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI005	08/11/04	VOC	Tetrachloroethylene	<			1	ug/L	
GWDWI005	08/11/04	VOC	Toluene	<			1	ug/L	
GWDWI005	08/11/04	VOC	trans-1,2-Dichloroethene	<			1	ug/L	
GWDWI005	08/11/04	VOC	trans-1,3-Dichloropropene	<			1	ug/L	
GWDWI005	08/11/04	VOC	Trichloroethene	<			1	ug/L	
GWDWI005	08/11/04	VOC	Trichlorofluoromethane	<			1	ug/L	
GWDWI005	08/11/04	VOC	Trichlorotrifluoroethane	<			5	ug/L	
GWDWI005	08/11/04	VOC	Vinyl chloride	<			1	ug/L	
GWDWI005	08/11/04	VOC	Xylenes (total)	<			1	ug/L	
GWDWI006	08/11/04	GEN	Hexavalent Chromium	<			0.0054	mg/L	
GWDWI006	08/11/04	GEN	Nitrate		11		0.0682	mg/L	J
GWDWI006	08/11/04	GEN	Total Dissolved Solids		1010		3.07	mg/L	
GWDWI006	08/11/04	METAL	Aluminum		360		96.6	ug/L	J
GWDWI006	08/11/04	METAL	Antimony	<			6.4	ug/L	
GWDWI006	08/11/04	METAL	Arsenic		7.4		3.2	ug/L	
GWDWI006	08/11/04	METAL	Barium		59		0.36	ug/L	
GWDWI006	08/11/04	METAL	Beryllium	<			0.17	ug/L	
GWDWI006	08/11/04	METAL	Cadmium	<			0.84	ug/L	
GWDWI006	08/11/04	METAL	Calcium		42300		7	ug/L	
GWDWI006	08/11/04	METAL	Chromium		3		1.2	ug/L	J
GWDWI006	08/11/04	METAL	Cobalt	<			1.8	ug/L	
GWDWI006	08/11/04	METAL	Copper	<			2	ug/L	
GWDWI006	08/11/04	METAL	Iron	<			6.7	ug/L	
GWDWI006	08/11/04	METAL	Lead	<			2.2	ug/L	
GWDWI006	08/11/04	METAL	Magnesium		78300		14.9	ug/L	
GWDWI006	08/11/04	METAL	Manganese		24.2		0.51	ug/L	
GWDWI006	08/11/04	METAL	Mercury	<			0.06	ug/L	
GWDWI006	08/11/04	METAL	Molybdenum		4.1		1.7	ug/L	J

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI006	08/11/04	METAL	Nickel		2.5		2.2	ug/L	J
GWDWI006	08/11/04	METAL	Potassium		2350		20.4	ug/L	
GWDWI006	08/11/04	METAL	Selenium	<			3.7	ug/L	
GWDWI006	08/11/04	METAL	Silver	<			1.6	ug/L	
GWDWI006	08/11/04	METAL	Sodium		246000		169	ug/L	
GWDWI006	08/11/04	METAL	Thallium	<			3.8	ug/L	
GWDWI006	08/11/04	METAL	Vanadium		13.7		2.6	ug/L	
GWDWI006	08/11/04	METAL	Zinc		2.4		1.5	ug/L	UJ
GWDWI006	08/11/04	PES	4,4'-DDD	<			0.096	ug/L	
GWDWI006	08/11/04	PES	4,4'-DDE	<			0.096	ug/L	
GWDWI006	08/11/04	PES	4,4'-DDT	<			0.096	ug/L	
GWDWI006	08/11/04	PES	Aldrin	<			0.048	ug/L	
GWDWI006	08/11/04	PES	alpha-BHC	<			0.048	ug/L	
GWDWI006	08/11/04	PES	alpha-Chlordane	<			0.048	ug/L	
GWDWI006	08/11/04	PES	Aroclor-1016	<			0.96	ug/L	
GWDWI006	08/11/04	PES	Aroclor-1221	<			1.9	ug/L	
GWDWI006	08/11/04	PES	Aroclor-1232	<			0.96	ug/L	
GWDWI006	08/11/04	PES	Aroclor-1242	<			0.96	ug/L	
GWDWI006	08/11/04	PES	Aroclor-1248	<			0.96	ug/L	
GWDWI006	08/11/04	PES	Aroclor-1254	<			0.96	ug/L	
GWDWI006	08/11/04	PES	Aroclor-1260	<			0.96	ug/L	
GWDWI006	08/11/04	PES	beta-BHC	<			0.048	ug/L	
GWDWI006	08/11/04	PES	delta-BHC	<			0.048	ug/L	
GWDWI006	08/11/04	PES	Dieldrin	<			0.096	ug/L	
GWDWI006	08/11/04	PES	Endosulfan I	<			0.048	ug/L	
GWDWI006	08/11/04	PES	Endosulfan II	<			0.096	ug/L	
GWDWI006	08/11/04	PES	Endosulfan sulfate	<			0.096	ug/L	
GWDWI006	08/11/04	PES	Endrin	<			0.096	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI006	08/11/04	PES	Endrin aldehyde	<			0.096	ug/L	
GWDWI006	08/11/04	PES	Endrin ketone	<			0.096	ug/L	
GWDWI006	08/11/04	PES	gamma-BHC (Lindane)	<			0.048	ug/L	
GWDWI006	08/11/04	PES	gamma-Chlordane	<			0.048	ug/L	
GWDWI006	08/11/04	PES	Heptachlor	<			0.048	ug/L	
GWDWI006	08/11/04	PES	Heptachlor epoxide	<			0.048	ug/L	
GWDWI006	08/11/04	PES	Methoxychlor	<			0.48	ug/L	
GWDWI006	08/11/04	PES	Toxaphene	<			4.8	ug/L	
GWDWI006	08/11/04	RAD	Actinium-228	<	2.74	5.00	9.22	pCi/L	
GWDWI006	08/11/04	RAD	Americium-241	<	0.0571	0.0834	0.146	pCi/L	
GWDWI006	08/11/04	RAD	Bismuth-212	<	9.89	10.5	19.1	pCi/L	
GWDWI006	08/11/04	RAD	Bismuth-214	<	1.49	5.65	5.54	pCi/L	
GWDWI006	08/11/04	RAD	Carbon-14	<	-3.83	7.67	13.3	pCi/L	
GWDWI006	08/11/04	RAD	Cesium-137	<	0.464	1.52	2.63	pCi/L	
GWDWI006	08/11/04	RAD	Cobalt-60	<	0.148	1.40	2.53	pCi/L	
GWDWI006	08/11/04	RAD	Gross Alpha		4.38	1.57	1.9	pCi/L	UJ
GWDWI006	08/11/04	RAD	Gross Beta		2.64	0.960	1.47	pCi/L	
GWDWI006	08/11/04	RAD	Lead-210	<	457	406	637	pCi/L	
GWDWI006	08/11/04	RAD	Lead-212	<	0.268	4.96	5.43	pCi/L	
GWDWI006	08/11/04	RAD	Lead-214	<	3.64	5.72	6	pCi/L	
GWDWI006RE	08/11/04	RAD	Plutonium-241	<	-1.89	4.36	7.53	pCi/L	
GWDWI006	08/11/04	RAD	Potassium-40	<	23.9	16.4	32.1	pCi/L	
GWDWI006	08/11/04	RAD	Radium-226	<	0.0795	0.271	0.525	pCi/L	
GWDWI006	08/11/04	RAD	Sodium-22	<	0.0496	1.63	2.88	pCi/L	
GWDWI006	08/11/04	RAD	Strontium-90	<	0.146	0.323	0.665	pCi/L	
GWDWI006	08/11/04	RAD	Thallium-208	<	2.07	1.54	2.82	pCi/L	
GWDWI006	08/11/04	RAD	Thorium-228	<	-0.289	0.193	0.959	pCi/L	
GWDWI006	08/11/04	RAD	Thorium-230		0.72	0.476	0.578	pCi/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI006	08/11/04	RAD	Thorium-232	<	0.237	0.325	0.644	pCi/L	
GWDWI006	08/11/04	RAD	Thorium-234	<	36.4	153	137	pCi/L	
GWDWI006	08/11/04	RAD	Tritium	<	127	131	219	pCi/L	
GWDWI006	08/11/04	RAD	Uranium-233/234		1.98	0.692	0.329	pCi/L	
GWDWI006	08/11/04	RAD	Uranium-235/236	<	0.283	0.277	0.389	pCi/L	
GWDWI006	08/11/04	RAD	Uranium-238		1.92	0.682	0.329	pCi/L	
GWDWI006	08/11/04	SVOC	1,1'-Biphenyl	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2,4,5-Trichlorophenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2,4,6-Trichlorophenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2,4-Dichlorophenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2,4-Dimethylphenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2,4-Dinitrophenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2,4-Dinitrotoluene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2,6-Dinitrotoluene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2-Chloronaphthalene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2-Chlorophenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2-Methyl-4,6-dinitrophenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2-Methylnaphthalene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	2-Nitrophenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	3,3'-Dichlorobenzidine	<			9.6	ug/L	UJ
GWDWI006	08/11/04	SVOC	4-Bromophenyl Phenyl Ether	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	4-Chloro-3-methylphenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	4-Chloroaniline	<			9.6	ug/L	UJ
GWDWI006	08/11/04	SVOC	4-Chlorophenyl Phenyl Ether	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	4-Nitrophenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Acenaphthene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Acenaphthylene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Acetophenone	<			9.6	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI006	08/11/04	SVOC	Anthracene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Atrazine	<			9.6	ug/L	UJ
GWDWI006	08/11/04	SVOC	Benzaldehyde		0.09		9.6	ug/L	J
GWDWI006	08/11/04	SVOC	Benzo(a)anthracene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Benzo(a)pyrene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Benzo(b)fluoranthene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Benzo(ghi)perylene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Benzo(k)fluoranthene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	bis(2-Chloroethoxy)methane	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Bis(2-Chloroethyl)ether	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	bis(2-Chloroisopropyl)ether	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	bis(2-Ethylhexyl)phthalate	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Butylbenzylphthalate	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Caprolactam	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Carbazole	<			9.6	ug/L	UJ
GWDWI006	08/11/04	SVOC	Chrysene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Dibenzo(a,h)anthracene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Dibenzofuran	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Diethylphthalate		0.28		9.6	ug/L	J
GWDWI006	08/11/04	SVOC	Dimethylphthalate	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Di-n-butylphthalate		0.65		9.6	ug/L	J
GWDWI006	08/11/04	SVOC	Di-n-octylphthalate	<			9.6	ug/L	UJ
GWDWI006	08/11/04	SVOC	Diphenylamine	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Fluoranthene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Fluorene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Hexachlorobenzene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Hexachlorobutadiene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Hexachlorocyclopentadiene	<			9.6	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI006	08/11/04	SVOC	Hexachloroethane	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Indeno(1,2,3-cd)pyrene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Isophorone	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	m,p-cresol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	m-Nitroaniline	<			9.6	ug/L	UJ
GWDWI006	08/11/04	SVOC	Naphthalene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Nitrobenzene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	N-Nitrosodipropylamine	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	o-Cresol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	o-Nitroaniline	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Pentachlorophenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Phenanthrene	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	Phenol	<			9.6	ug/L	
GWDWI006	08/11/04	SVOC	p-Nitroaniline	<			9.6	ug/L	UJ
GWDWI006	08/11/04	SVOC	Pyrene	<			9.6	ug/L	
GWDWI006	08/11/04	VOC	1,1,1-Trichloroethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	1,1,2,2-Tetrachloroethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	1,1,2-Trichloroethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	1,1-Dichloroethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	1,1-Dichloroethene	<			1	ug/L	
GWDWI006	08/11/04	VOC	1,2,4-Trichlorobenzene	<			1	ug/L	
GWDWI006	08/11/04	VOC	1,2-Dibromo-3-chloropropane	<			1	ug/L	R
GWDWI006	08/11/04	VOC	1,2-Dibromoethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	1,2-Dichlorobenzene	<			1	ug/L	
GWDWI006	08/11/04	VOC	1,2-Dichloroethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	1,2-Dichloropropane	<			1	ug/L	
GWDWI006	08/11/04	VOC	1,3-Dichlorobenzene	<			1	ug/L	
GWDWI006	08/11/04	VOC	1,4-Dichlorobenzene	<			1	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI006	08/11/04	VOC	2-Butanone	<			5	ug/L	
GWDWI006	08/11/04	VOC	2-Hexanone	<			5	ug/L	
GWDWI006	08/11/04	VOC	4-Methyl-2-pentanone	<			5	ug/L	
GWDWI006	08/11/04	VOC	Acetone	<			5	ug/L	
GWDWI006	08/11/04	VOC	Benzene	<			1	ug/L	
GWDWI006	08/11/04	VOC	Bromodichloromethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	Bromoform	<			1	ug/L	
GWDWI006	08/11/04	VOC	Bromomethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	Carbon disulfide	<			5	ug/L	
GWDWI006	08/11/04	VOC	Carbon tetrachloride	<			1	ug/L	
GWDWI006	08/11/04	VOC	Chlorobenzene	<			1	ug/L	
GWDWI006	08/11/04	VOC	Chlorodibromomethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	Chloroethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	Chloroform	<			1	ug/L	
GWDWI006	08/11/04	VOC	Chloromethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	cis-1,2-Dichloroethene	<			1	ug/L	
GWDWI006	08/11/04	VOC	cis-1,3-Dichloropropylene	<			1	ug/L	
GWDWI006	08/11/04	VOC	Cyclohexane	<			1	ug/L	
GWDWI006	08/11/04	VOC	Dichlorodifluoromethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	Ethylbenzene	<			1	ug/L	
GWDWI006	08/11/04	VOC	Isopropylbenzene	<			1	ug/L	
GWDWI006	08/11/04	VOC	Methyl acetate	<			5	ug/L	
GWDWI006	08/11/04	VOC	Methylcyclohexane	<			1	ug/L	
GWDWI006	08/11/04	VOC	Methylene chloride	<			5	ug/L	
GWDWI006	08/11/04	VOC	Styrene	<			1	ug/L	
GWDWI006	08/11/04	VOC	tert-Butyl methyl ether	<			1	ug/L	
GWDWI006	08/11/04	VOC	Tetrachloroethylene	<			1	ug/L	
GWDWI006	08/11/04	VOC	Toluene	<			1	ug/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI006	08/11/04	VOC	trans-1,2-Dichloroethene	<			1	ug/L	
GWDWI006	08/11/04	VOC	trans-1,3-Dichloropropene	<			1	ug/L	
GWDWI006	08/11/04	VOC	Trichloroethene	<			1	ug/L	
GWDWI006	08/11/04	VOC	Trichlorofluoromethane	<			1	ug/L	
GWDWI006	08/11/04	VOC	Trichlorotrifluoroethane	<			5	ug/L	
GWDWI006	08/11/04	VOC	Vinyl chloride	<			1	ug/L	
GWDWI006	08/11/04	VOC	Xylenes (total)	<			1	ug/L	
GWDWI007	10/20/04	GEN	Hexavalent Chromium	<			0.0054	mg/L	
GWDWI007	10/20/04	GEN	Total Dissolved Solids		1020		3.07	mg/L	
GWDWI007	10/20/04	METAL	Chromium		3		0.81	ug/L	UJ
GWDWI007	10/20/04	METAL	Mercury	<			0.037	ug/L	
GWDWI007	10/20/04	METAL	Molybdenum		3.1		1.9	ug/L	J
GWDWI007	10/20/04	METAL	Silver	<			0.72	ug/L	
GWDWI007	10/20/04	RAD	Actinium-228	<	4.15	4.78	9.09	pCi/L	
GWDWI007	10/20/04	RAD	Bismuth-212	<	4.89	10.4	18.4	pCi/L	
GWDWI007	10/20/04	RAD	Bismuth-214	<	0.965	4.82	5.31	pCi/L	
GWDWI007	10/20/04	RAD	Carbon-14	<	0.727	3.73	6.52	pCi/L	
GWDWI007	10/20/04	RAD	Cesium-137	<	0.61	1.28	2.29	pCi/L	
GWDWI007	10/20/04	RAD	Cobalt-60	<	0.745	1.29	2.47	pCi/L	
GWDWI007	10/20/04	RAD	Lead-210	<	231	312	301	pCi/L	
GWDWI007	10/20/04	RAD	Lead-212	<	2.68	5.54	5.12	pCi/L	UJ
GWDWI007	10/20/04	RAD	Lead-214	<	5.13	5.20	5.68	pCi/L	
GWDWI007	10/20/04	RAD	Potassium-40	<	18.7	25.0	20.5	pCi/L	
GWDWI007	10/20/04	RAD	Sodium-22	<	-1.43	1.19	1.82	pCi/L	
GWDWI007	10/20/04	RAD	Strontium-90	<	0.0492	0.248	0.567	pCi/L	
GWDWI007	10/20/04	RAD	Thallium-208	<	2.18	1.45	2.71	pCi/L	
GWDWI007	10/20/04	RAD	Thorium-234	<	29.9	97.0	105	pCi/L	
GWDWI007	10/20/04	RAD	Tritium	<	146	148	248	pCi/L	

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

Sample ID	Sample Date	Class	Analyte	DL Flag	Concentration	Error	Detection Limit	Units	ER Q
GWDWI007	10/20/04	RAD	Uranium-235	<	7.19	9.67	16.5	pCi/L	
GWDWI007	10/20/04	RAD	Uranium-238	<	29.9	97.0	105	pCi/L	
GWDWI008	10/20/04	GEN	Hexavalent Chromium		0.00735		0.0054	mg/L	
GWDWI008	10/20/04	GEN	Total Dissolved Solids		1000		3.07	mg/L	
GWDWI008	10/20/04	METAL	Chromium		3.1		0.81	ug/L	UJ
GWDWI008	10/20/04	METAL	Mercury	<			0.037	ug/L	
GWDWI008	10/20/04	METAL	Molybdenum		3.2		1.9	ug/L	J
GWDWI008	10/20/04	METAL	Silver	<			0.72	ug/L	
GWDWI008	10/20/04	RAD	Actinium-228	<	2.9	11.1	9.4	pCi/L	
GWDWI008	10/20/04	RAD	Bismuth-212	<	14.8	26.5	15.5	pCi/L	
GWDWI008	10/20/04	RAD	Bismuth-214	<	3.44	5.76	5.29	pCi/L	
GWDWI008	10/20/04	RAD	Carbon-14	<	3.87	5.54	9.39	pCi/L	
GWDWI008	10/20/04	RAD	Cesium-137		2.15	1.44	1.97	pCi/L	
GWDWI008	10/20/04	RAD	Cobalt-60	<	1.21	3.56	2.31	pCi/L	
GWDWI008	10/20/04	RAD	Lead-210	<	62.6	204	331	pCi/L	
GWDWI008	10/20/04	RAD	Lead-212	<	1.13	4.54	3.7	pCi/L	UJ
GWDWI008	10/20/04	RAD	Lead-214	<	0	2.88	5.06	pCi/L	
GWDWI008	10/20/04	RAD	Potassium-40	<	0	15.6	32.1	pCi/L	
GWDWI008	10/20/04	RAD	Sodium-22	<	-0.493	1.24	2.05	pCi/L	
GWDWI008	10/20/04	RAD	Strontium-90	<	-0.0134	0.250	0.583	pCi/L	
GWDWI008	10/20/04	RAD	Thallium-208	<	0	1.34	2.55	pCi/L	
GWDWI008	10/20/04	RAD	Thorium-234	<	0	66.5	110	pCi/L	
GWDWI008	10/20/04	RAD	Tritium	<	46.8	130	221	pCi/L	
GWDWI008	10/20/04	RAD	Uranium-235	<	-2.35	8.48	14.4	pCi/L	
GWDWI008	10/20/04	RAD	Uranium-238	<	0	66.5	110	pCi/L	

Abbreviations

DL Flag detection limit flag
ER Q data validation qualifier

Table C-4. 2004 Ground Water Monitoring Data - Well UCD1-054, LEHR (continued)

GEN	general chemistry parameters
J	analyte was detected but concentration is uncertain
mg/L	milligrams per liter
pCi/L	picoCuries per liter
PES	pesticides and polychlorinated biphenyls
R	analytical result was rejected
RAD	radionuclides
SVOC	semivolatile organic compounds
ug/L	micrograms per liter
UJ	analyte was not detected and detection limit is uncertain
VOC	volatile organic compounds

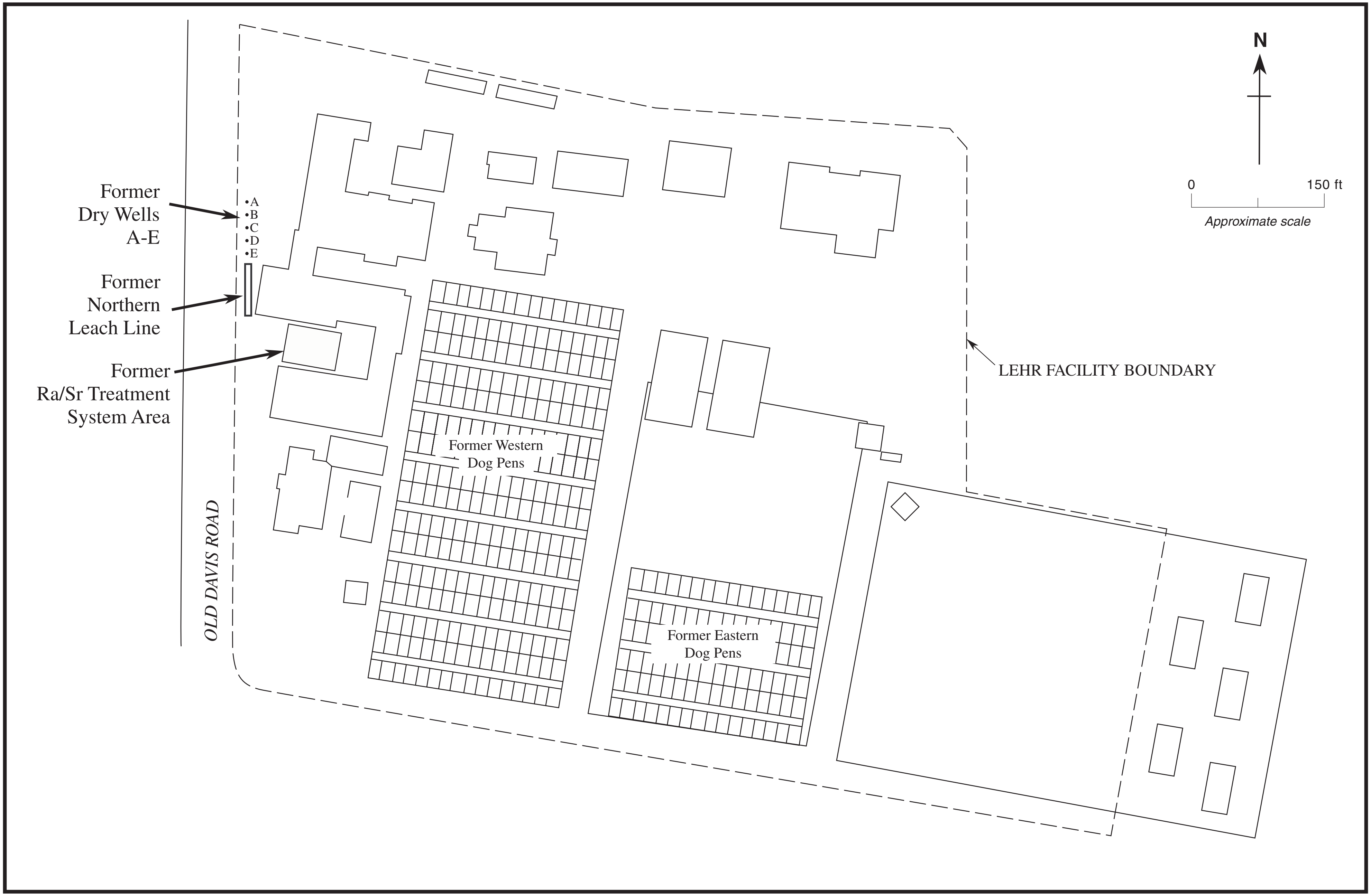


Figure C-1. Location of Former Dry Wells A-E, LEHR Site, UC Davis, California

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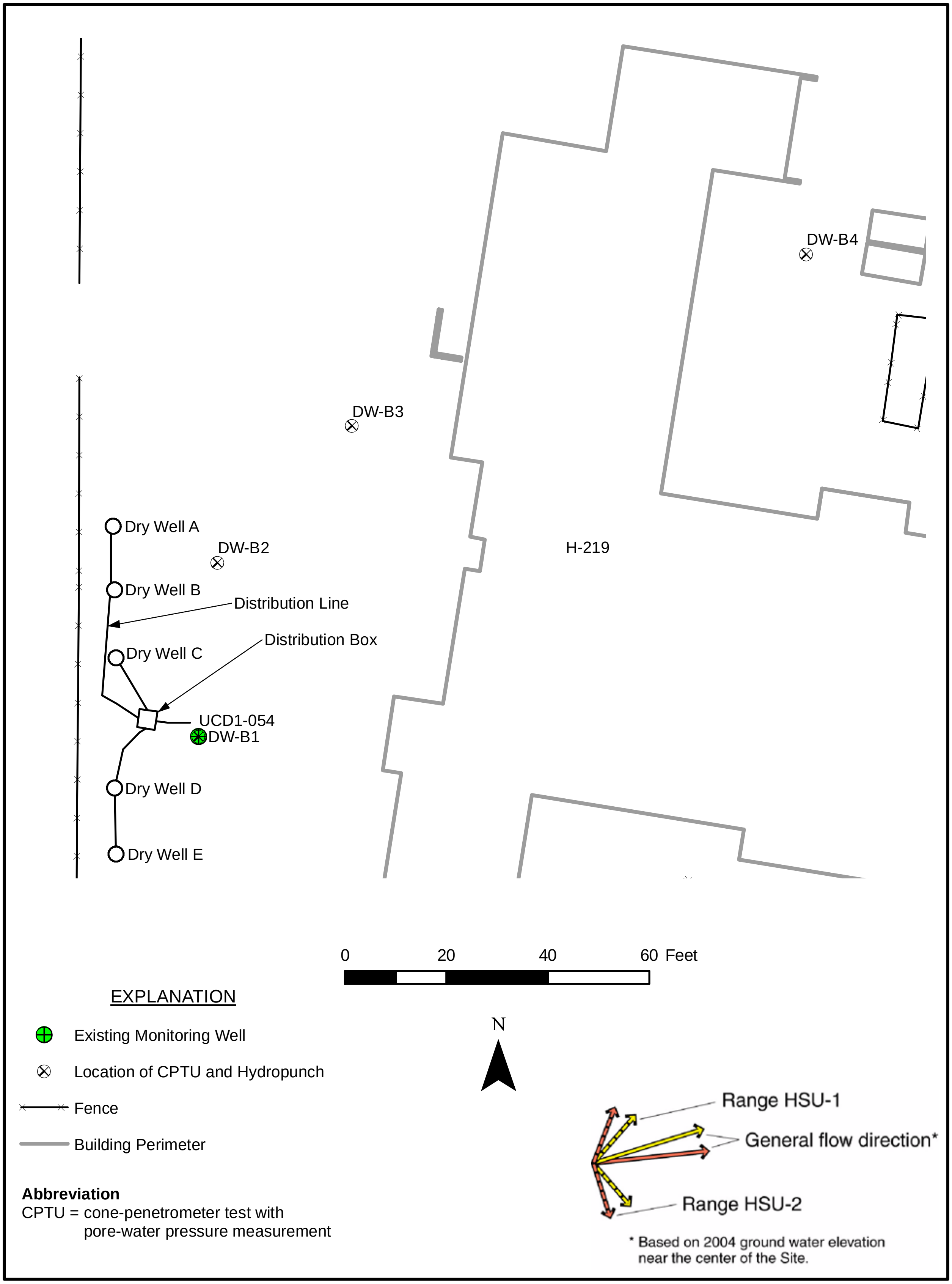

Figure C-2. Locations of Borings and Well UCD1-054, Domestic Septic System Dry Wells A-E Area

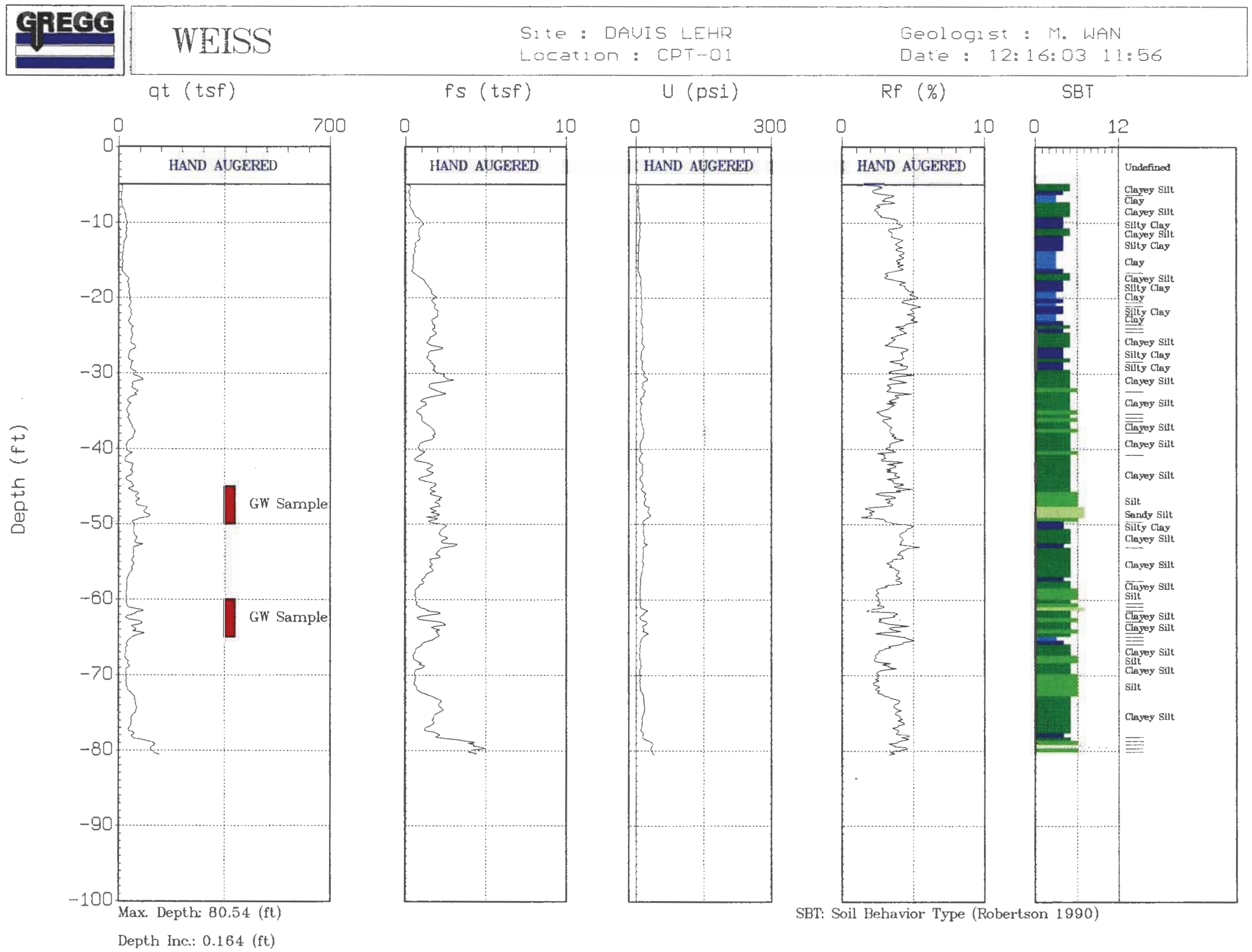

Figure C-3. CPTU Log of Boring DW-B1

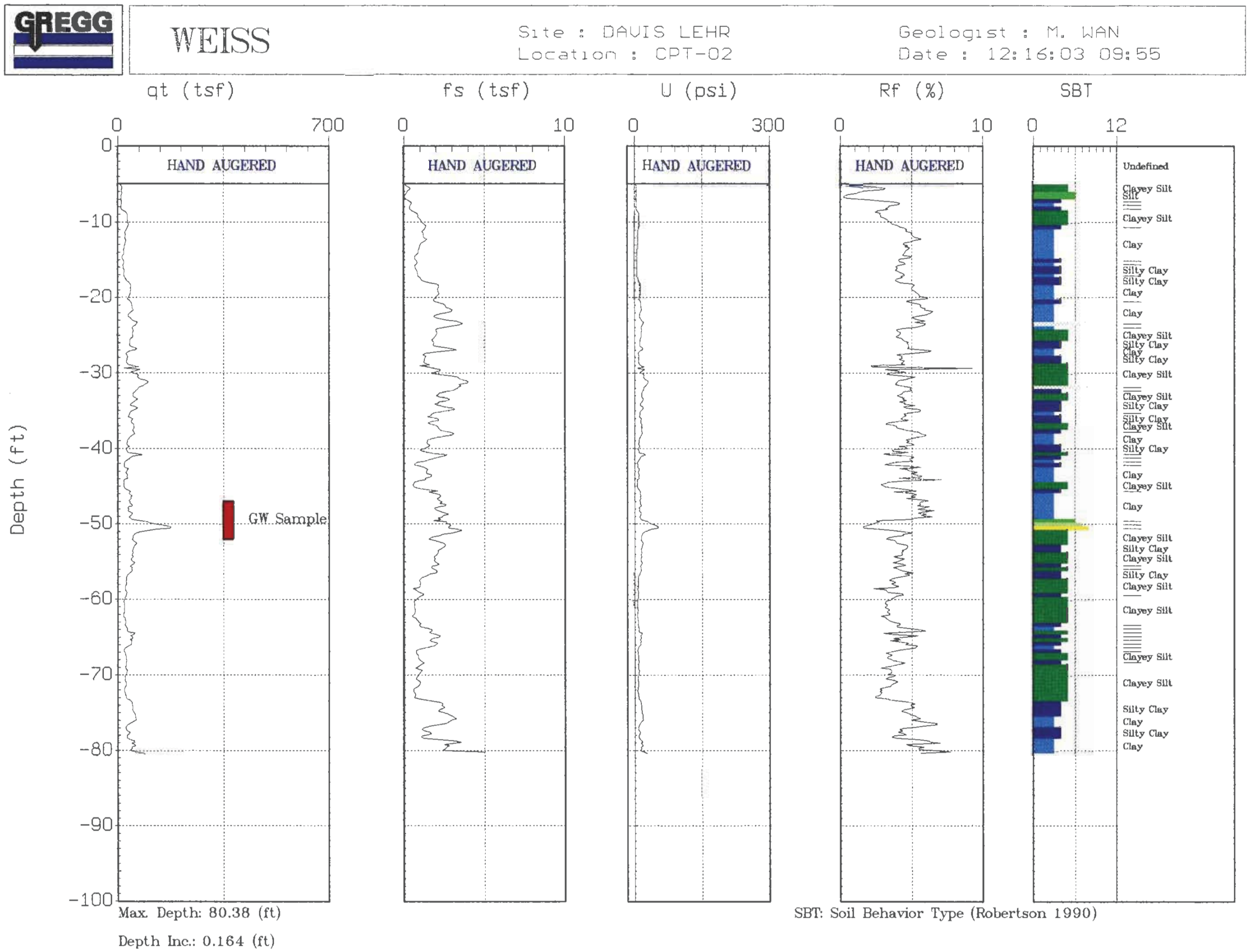

Figure C-4. CPTU Log of Boring DW-B2

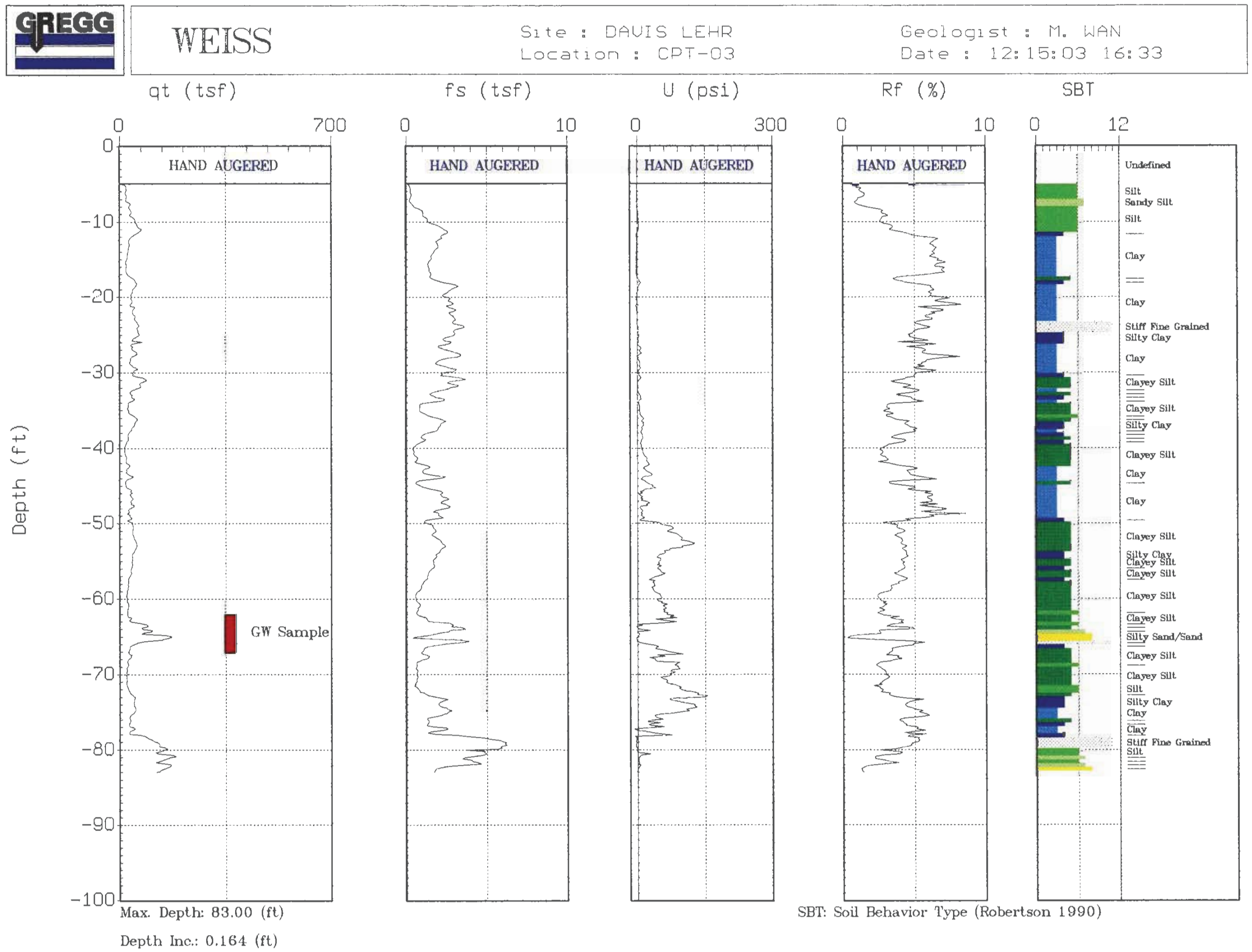

Figure C-5. CPTU Log of Boring DW-B3

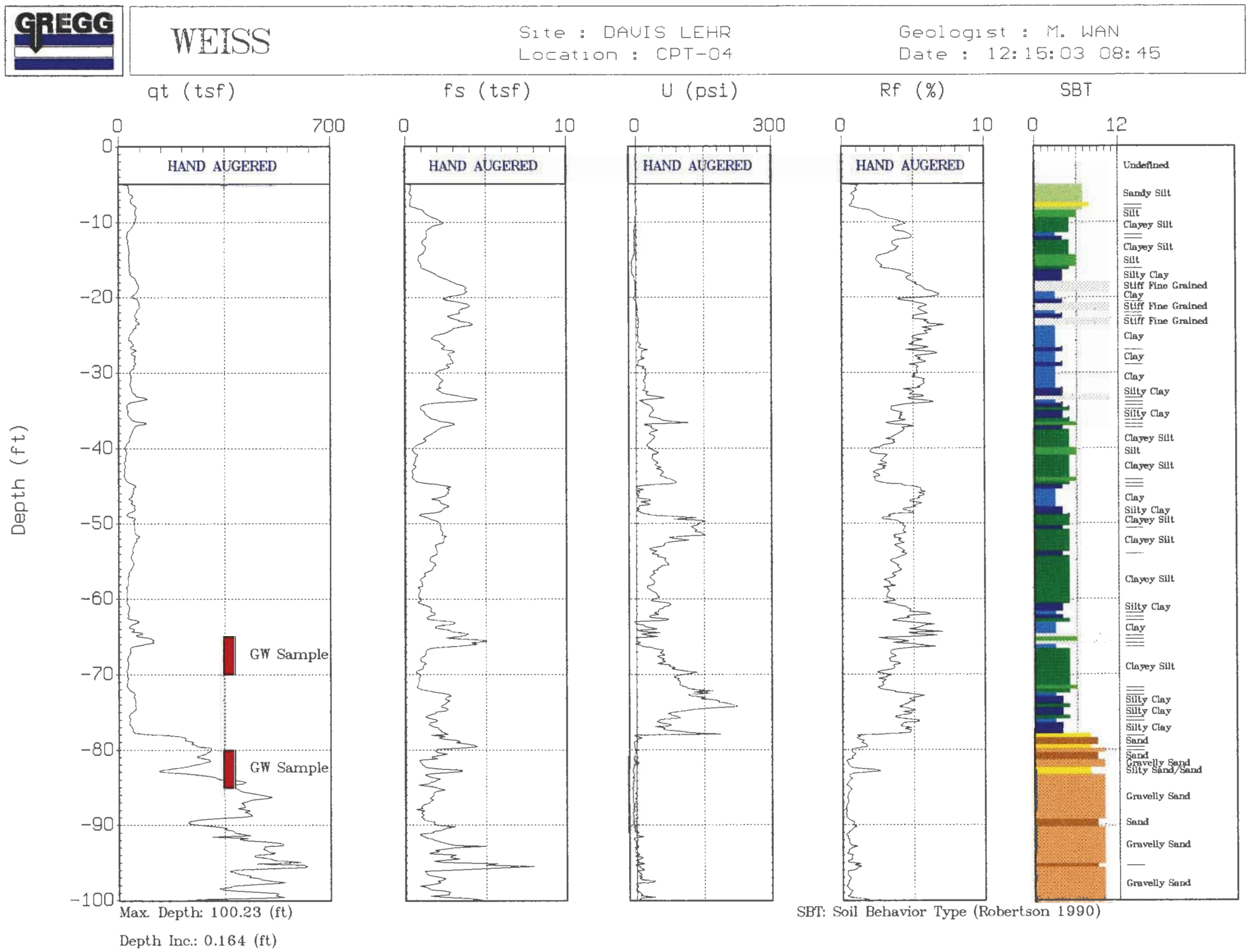

Figure C-6. CPTU Log of Boring DW-B4

APPENDIX D

FORMALDEHYDE VAPOR RISK ESTIMATE

D.1. FORMALDEHYDE VAPOR RISK ESTIMATE

Formaldehyde is present in subsurface soil around and below the former leach line at Domestic Septic System No. 3 (DSS 3). If an excavation alternative (Alternative 4a, 4b or 4c) is selected as the remedial action option for DSS 3, formaldehyde will volatilize from the excavated soil. The Formaldehyde concentration in air was estimated for each excavation alternative and compared to the United States Environmental Protection Agency (US EPA) Region 9, preliminary remediation goal (PRG) for ambient air. The daily intake of inhaled formaldehyde was also estimated and compared to the California Proposition 65 Safe Harbor – No Significant Risk Level (NSRL).

D.1.1 Air Concentration

The concentration of formaldehyde in air was estimated using the soil-to-air volatilization factor (VFs) approach presented in the US EPA Region 9, PRG Users Guide (US EPA, 2004). A VFs is an estimated ratio of soil concentration to air concentration. Following the PRG Users Guide, VFs are estimated from soil physical parameters, chemical specific data and the results of a conservative vapor emission model.

The VFs calculations for formaldehyde in air are shown in Tables D1, D2 and D3 for feasibility study Alternatives 4a, 4b and 4c, respectively. Soil physical parameter values were obtained from a study of site soil samples (D.B. Stephens, 1996). A standard default value for the fraction of organic carbon was obtained from the PRG Users Guide (US EPA, 2004) because no site specific data were available for this parameter.

Chemical specific diffusivities for formaldehyde in air and water were not available. Formaldehyde diffusivity values were extrapolated from acetone and acetaldehyde diffusivities provided in the US EPA Region 9 PRGs table of physical chemical data for volatile organic compounds. The diffusivity extrapolations were based on chemical structure and physical property similarities between formaldehyde, acetaldehyde and acetone.

Site-specific exposure intervals were estimated for Alternatives 4a and 4c based on the period soil would be stockpiled awaiting disposal. The stockpile period was based on the time to load all of the soil for offsite disposal. Loading operations were assumed to occur eight hours per day excluding weekends and holidays (250 workdays per year). Under Alternative 4b, the exposure interval was assumed to last throughout a three-year onsite soil treatment period.

The PRG Users Guide default value for the inverse of the mean concentration at the center of a half-acre square source (Q/C) was used in the VFs calculation (US EPA, 2004). This default value was determined by US EPA Region 9 using a conservative vapor emission model.

The VFs was determined using the expressions provided by US EPA Region 9 in the PRG Users Guide (US EPA, 2004). The soil concentration was divided by VFs to get air concentration. The soil concentration for Alternatives 4a and 4b (0.943 mg/kg) was the 95% upper confidence limit on the mean concentration (95% UCL) of formaldehyde data located within the excavation limits shown on Figure B-7 (Appendix B). Similarly, the 95% UCL for limited excavation in Alternative 4c (0.903 mg/kg) was used based on formaldehyde data located within the excavation limits shown in Figure B-10. The resulting air concentrations were 0.077 micrograms per cubic meter (ug/m^3), 0.044 ug/m^3 and 0.154 ug/m^3 for Alternatives 4a, 4b and 4c, respectively. The US EPA Region 9 PRG is 0.15 ug/m^3.

The estimated air concentration for Alternative 4c was slightly above the PRG. Air concentrations for Alternatives 4a and 4b were below the PRG.

D.1.2 Daily Intake

Daily intake was calculated using the US EPA default exposure parameter for inhalation (US EPA, 1991). The calculations are shown in Tables D4, D5 and D6. Daily intakes for Alternatives 4a, 4b and 4c were 1.5 micrograms per day (ug/day), 0.88 ug/day and 3.1 ug/day, respectively. The California Proposition 65 Safe Harbor NSRL is 40 ug/day. All of the estimated daily intakes were below the NSRL.

D.1.3 References:

Daniel B. Stephens and Associates Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.

US EPA, 2004, Users' Guide and Background Technical Document for USEPA Region 9's Preliminary Remediation Goals (PRG) table, http://www.epa.gov/region9/waste/sfund/prg /files/04usersguide.pdf

US EPA. 1991. Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual. Supplemental Guidance 'Standard Default Exposure Factors'. Office of Emergency and Remedial Response, Washington, D.C. March.

Table D-1. Calculation of Ambient Air Concentration for Volatilization of Formaldehyde from Excavated Soil, Domestic Septic System Number 3, Alternative 4a

Parameter	Value	Source
Soil dry density ρ_d (g/cm^3)	1.72	Average dry density[a]
porosity n (cm^3/cm^3)	0.36	Average porosity[a]
Water filled soil porosity Θ_w (cm^3/cm^3)	0.27	Average water filled soil porosity[a]
Air filled soil porosity Θ_a (cm^3/cm^3)	0.09	$\Theta_a = n - \Theta_w$
Diffusivity in air Di (cm^2/sec)	0.12	Chemical specific[b]
Diffusivity in water Dw (cm^2/sec)	1.7E-05	Chemical specific[b]
Dimensionless Henry's Law Constant H'	1.34E-05	Chemical specific[c]
Organic carbon/water partition coefficient K_{oc} (cm^3/g)	37	Chemical specific[c]
Fraction of organic carbon in soil f_{oc} (g/g)	0.006	Standard Default[d]
Apparent Diffusivity D_a (cm^2/sec)	2.57E-06	$D_a = ((\Theta_a^{10/3} \text{ x Di x H'} + \Theta_w^{10/3} \text{ x Dw}) / n^2)/(\rho_d \text{ x } f_{oc} \text{ x } K_{oc} + \Theta_w + \Theta_a \text{ x H'})$
Truckloads n_t	645	Estimated number truckloads to haul DSS3 soil offsite.[e]
Time to load and secure one shipment t_{ls} (hr)	3	Standard Default[f]
Exposure interval T (sec)	3.06E+07	$T = n_t \text{ x } t_{ls}$ / 8 (hr/workday) / 250 (workdays/year) x 3.16E+7 (sec/year)
Inverse mean concentration Q/C (g/m^2-sec per kg/m^3)	68.81	Standard Default[d]
Soil volatilization factor VFs (m^3/kg)	1.22E+04	$VFs = Q/C \text{ x } (3.14 \text{ x } D_a \text{ x T})^{0.5} / (2 \text{ x } \rho_d \text{ x } D_a) \text{ x } 0.0001 \text{ (m}^2\text{/cm}^2)$
Soil Concentration C_{soil} (mg/kg)	0.943	excavation 95% UCL[g]
Air concentration at receptor C_a (µg/m^3)	0.077	$C_a = C_{soil}$ / VFs x 1,000 µg/mg
Ambient Air PRG (µg/m^3)	0.15	

Notes

[a]Dry density, total porosity, and water filled soil porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.
[b]US EPA Region 9, 2004, PRGs Physical Chemical Data, diffusivities extrapolated from acetone and acetaldehyde based on chemical structure and property similarity.
[c]ATSDR, Formaldehyde Chemical and Physical Information, http://www.atsdr.cdc.gov/toxprofiles/tp111-c3.pdf
[d]US EPA Region 9, 2004, PRG Users Guide, VFs default parameters http://www.epa.gov/region9/waste/sfund/prg/files/04usersguide.pdf
[e]Estimated truckloads based on 10 cubic yard capacity and 6447 cubic yards of excavated soil in Alternative 4a.
[f]Argonne National Laboratory, 1998, Transport Storage and Disposal - Dose, Version 2.22, September.
[g]95% UCL of formaldehyde sample results within the excavation limits shown in Figure B-7 in Appendix B

Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
95% UCL	95 percent upper confidence limit on the mean
cm^2	square centimeters
cm^3	cubic centimeters
DSS 3	Domestic Septic System Number 3

Table D-1. Calculation of Ambient Air Concentration for Volatilization of Formaldehyde from Excavated Soil, Domestic Septic System Number 3, Alternative 4a (continued)

g	grams
hr	hours
kg	kilograms
m	meters
m^2	square meters
m^3	cubic meters
mg	milligrams
mg/kg	milligrams per kilogram
PRG	preliminary remediation goal
sec	seconds
USEPA	United States Environmental Protection Agency
VFs	soil volatilization factor
$\mu g/m^3$	micrograms per cubic meter

Table D-2. Calculation of Ambient Air Concentration for Volatilization of Formaldehyde from Excavated Soil, Domestic Septic System Number 3, Alternative 4b

Parameter	Value	Source
Soil dry density ρ_d (g/cm^3)	1.72	Average dry density[a]
porosity n (cm^3/cm^3)	0.36	Average porosity[a]
Water filled soil porosity Θ_w (cm^3/cm^3)	0.27	Average water filled soil porosity[a]
Air filled soil porosity Θ_a (cm^3/cm^3)	0.09	$\Theta_a = n - \Theta_w$
Diffusivity in air Di (cm^2/sec)	0.12	Chemical specific[b]
Diffusivity in water Dw (cm^2/sec)	1.7E-05	Chemical specific[b]
Dimensionless Henry's Law Constant H'	1.34E-05	Chemical specific[c]
Organic carbon/water partition coefficient K_{oc} (cm^3/g)	37	Chemical specific[c]
Fraction of organic carbon in soil f_{oc} (g/g)	0.006	Standard Default[d]
Apparent Diffusivity D_a (cm^2/sec)	2.57E-06	$D_a = ((\Theta_a^{10/3} \times Di \times H' + \Theta_w^{10/3} \times Dw) / n^2)/(\rho_d \times f_{oc} \times K_{oc} + \Theta_w + \Theta_a \times H')$
Exposure interval T (sec)	9.48E+07	T = 3 (years) x 3.16E+7 (sec/year) [e]
Inverse mean concentration Q/C (g/m^2-sec per kg/m^3)	68.81	Standard Default[d]
Soil volatilization factor VFs (m^3/kg)	2.15E+04	$VFs = Q/C \times (3.14 \times D_a \times T)^{0.5} / (2 \times \rho_d \times D_a) \times 0.0001$ (m^2/cm^2)
Soil Concentration C_{soil} (mg/kg)	0.943	excavation 95% UCL[f]
Air concentration at receptor C_a (µg/m^3)	0.044	$C_a = C_{soil}$ / VFs x 1,000 µg/mg
Ambient Air PRG (µg/m^3)	0.15	

Notes

[a]Dry density, total porosity, and water filled soil porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.
[b]US EPA Region 9, 2004, PRGs Physical Chemical Data, diffusivities extrapolated from acetone and acetaldehyde based on chemical structure and property similarity.
[c]ATSDR, Formaldehyde Chemical and Physical Information, http://www.atsdr.cdc.gov/toxprofiles/tp111-c3.pdf
[d]US EPA Region 9, 2004, PRG Users Guide, VFs default parameters http://www.epa.gov/region9/waste/sfund/prg/files/04usersguide.pdf
[e]Pyhtoremediation of soil removed from DSS 3 assumed complete after three growing seasons - three years.
[f]95% UCL of formaldehyde sample results within the excavation limits shown in Figure B-7 in Appendix B

Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry	95% UCL	95 percent upper confidence limit on the mean
cm^2	square centimeters	cm^3	cubic centimeters
DSS 3	Domestic Septic System Number 3	g	grams
hr	hours	kg	kilograms
m	meters	m^2	square meters
m3	cubic meters	mg	milligrams
mg/kg	milligrams per kilogram	PRG	preliminary remediation goal
sec	seconds	USEPA	United States Environmental Protection Agency
VFs	soil volatilization factor	µg/m3	micrograms per cubic meter

Table D-3. Calculation of Ambient Air Concentration for Volatilization of Formaldehyde from Excavated Soil, Domestic Septic System Number 3, Alternative 4c

Parameter	Value	Source
Soil dry density ρ_d (g/cm^3)	1.72	Average dry density[a]
porosity n (cm^3/cm^3)	0.36	Average porosity[a]
Water filled soil porosity Θ_w (cm^3/cm^3)	0.27	Average water filled soil porosity[a]
Air filled soil porosity Θ_a (cm^3/cm^3)	0.09	$\Theta_a = n - \Theta_w$
Diffusivity in air Di (cm^2/sec)	0.12	Chemical specific[b]
Diffusivity in water Dw (cm^2/sec)	1.7E-05	Chemical specific[b]
Dimensionless Henry's Law Constant H'	1.34E-05	Chemical specific[c]
Organic carbon/water partition coefficient K_{oc} (cm^3/g)	37	Chemical specific[c]
Fraction of organic carbon in soil f_{oc} (g/g)	0.006	Standard Default[d]
Apparent Diffusivity D_a (cm^2/sec)	2.57E-06	$D_a = ((\Theta_a^{10/3} \times Di \times H' + \Theta_w^{10/3} \times Dw) / n^2)/(\rho_d \times f_{oc} \times K_{oc} + \Theta_w + \Theta_a \times H')$
Truckloads n_t	148	Estimated number truckloads to haul DSS3 soil offsite.[e]
Time to load and secure one shipment t_{ls} (hr)	3	Standard Default[f]
Exposure interval T (sec)	7.02E+06	$T = n_t \times t_{ls}$ / 8 (hr/workday) / 250 (workdays/year) x 3.16E+7 (sec/year)
Inverse mean concentration Q/C (g/m^2-sec per kg/m^3)	68.81	Standard Default[d]
Soil volatilization factor VFs (m^3/kg)	5.86E+03	$VFs = Q/C \times (3.14 \times D_a \times T)^{0.5} / (2 \times \rho_d \times D_a) \times 0.0001$ (m^2/cm^2)
Soil Concentration C_{soil} (mg/kg)	0.903	excavation 95% UCL[g]
Air concentration at receptor C_a (µg/m^3)	0.154	$C_a = C_{soil}$ / VFs x 1,000 µg/mg
Ambient Air PRG (µg/m^3)	0.15	

Notes

[a]Dry density, total porosity, and water filled soil porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.
[b]US EPA Region 9, 2004, PRGs Physical Chemical Data, diffusivities extrapolated from acetone and acetaldehyde based on chemical structure and property similarity.
[c]ATSDR, Formaldehyde Chemical and Physical Information, http://www.atsdr.cdc.gov/toxprofiles/tp111-c3.pdf
[d]US EPA Region 9, 2004, PRG Users Guide, VFs default parameters http://www.epa.gov/region9/waste/sfund/prg/files/04usersguide.pdf
[e]Estimated truckloads based on 10 cubic yard capacity and 1471 cubic yards of excavated soil.
[f]Argonne National Laboratory, 1998, Transport Storage and Disposal - Dose, Version 2.22, September.
[g]95% UCL of formaldehyde sample results within the excavation limits shown in Figure B-10 in Appendix B

Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
95% UCL	95 percent upper confidence limit on the mean
cm^2	square centimeters
cm^3	cubic centimeters
DSS 3	Domestic Septic System Number 3

Table D-3. Calculation of Ambient Air Concentration for Volatilization of Formaldehyde from Excavated Soil, Domestic Septic System Number 3, Alternative 4c (continued)

g	grams
hr	hours
kg	kilograms
m	meters
m^2	square meters
m^3	cubic meters
mg	milligrams
mg/kg	milligrams per kilogram
PRG	preliminary remediation goal
sec	seconds
USEPA	United States Environmental Protection Agency
VFs	soil volatilization factor
$\mu g/m^3$	micrograms per cubic meter

Table D-4. Calculation of Daily Intake for Volatilization of Formaldehyde from Excavated Soil, Domestic Septic System Number 3, Alternative 4a

Parameter	Value	Source
Exposure Point Concentration		
Soil dry density ρ_d (g/cm^3)	1.72	Average dry density[a]
porosity n (cm^3/cm^3)	0.36	Average porosity[a]
Water filled soil porosity Θ_w (cm^3/cm^3)	0.27	Average water filled soil porosity[a]
Air filled soil porosity Θ_a (cm^3/cm^3)	0.09	$\Theta_a = n - \Theta_w$
Diffusivity in air Di (cm^2/sec)	0.12	Chemical specific[b]
Diffusivity in water Dw (cm^2/sec)	1.7E-05	Chemical specific[b]
Dimensionless Henry's Law Constant H'	1.34E-05	Chemical specific[c]
Organic carbon/water partition coefficient K_{oc} (cm^3/g)	37	Chemical specific[c]
Fraction of organic carbon in soil f_{oc} (g/g)	0.006	Standard Default[d]
Apparent Diffusivity D_a (cm^2/sec)	2.57E-06	$D_a = ((\Theta_a^{10/3} \text{ x Di x H'} + \Theta_w^{10/3} \text{ x Dw}) / n^2)/(\rho_d \text{ x } f_{oc} \text{ x } K_{oc} + \Theta_w + \Theta_a \text{ x H'})$
Truckloads n_t	645	Estimated number truckloads to haul DSS3 soil offsite.[e]
Time to load and secure one shipment t_{ls} (hr)	3	Standard Default[f]
Exposure interval T (sec)	3.06E+07	$T = n_t \text{ x } t_{ls}$ / 8 (hr/workday) / 250 (workdays/year) x 3.16E+7 (sec/year)
Inverse mean concentration Q/C (g/m^2-sec per kg/m^3)	68.81	Standard Default[d]
Soil volatilization factor VFs (m^3/kg)	1.22E+04	$VFs = Q/C \text{ x } (3.14 \text{ x } D_a \text{ x T})^{0.5} / (2 \text{ x } \rho_d \text{ x } D_a) \text{ x } 0.0001 (m^2/cm^2)$
Soil Concentration C_{soil} (mg/kg)	0.943	excavation 95% UCL[g]
Air concentration at receptor C_a ($\mu g/m^3$)	0.0771	$C_a = C_{soil}$ / VFs x 1,000 µg/mg
Intake Calculation		
Inhalation Rate IR (m^3/day)	20	Standard Default[h]
Daily Intake (µg/day)	1.5	$I = C_a$ x IR
Prop 65 Safe Harbor Level (µg/day)	40	No Significant Risk Level (NSRL)

Notes

[a]Dry density, total porosity, and water filled soil porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.
[b]US EPA Region 9, 2004, PRGs Physical Chemical Data, diffusivities extrapolated from acetone and acetaldehyde based on chemical structure and property similarity.
[c]ATSDR, Formaldehyde Chemical and Physical Information, http://www.atsdr.cdc.gov/toxprofiles/tp111-c3.pdf
[d]US EPA Region 9, 2004, PRG Users Guide, VFs default parameters http://www.epa.gov/region9/waste/sfund/prg/files/04usersguide.pdf
[e]Estimated truckloads based on 10 cubic yard capacity and 6447 cubic yards of excavated soil in Alternative 4a.
[f]Argonne National Laboratory, 1998, Transport Storage and Disposal - Dose, Version 2.22, September.
[g]95% UCL of formaldehyde sample results within the excavation limits shown in Figure B-7 in Appendix B

Table D-4. Calculation of Daily Intake for Volatilization of Formaldehyde from Excavated Soil, Domestic Septic System Number 3, Alternative 4a (continued)

[h]USEPA. 1991a. Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual. Supplemental Guidance 'Standard Default Exposure Factors'. Office of Emergency and Remedial Response, Washington, D.C. March.

Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
95% UCL	95 percent upper confidence limit on the mean
cm^2	square centimeters
cm^3	cubic centimeters
DSS 3	Domestic Septic System Number 3
g	grams
hr	hours
kg	kilograms
m	meters
m^2	square meters
m^3	cubic meters
mg	milligrams
mg/kg	milligrams per kilogram
PRG	preliminary remediation goal
sec	seconds
USEPA	United States Environmental Protection Agency
VFs	soil volatilization factor
µg	micrograms
$\mu g/m^3$	micrograms per cubic meter

Table D-5. Calculation of Daily Intake for Volatilization of Formaldehyde from Excavated Soil, Domestic Septic System Number 3, Alternative 4b

Parameter	Value	Source
Exposure Point Concentration		
Soil dry density ρ_d (g/cm^3)	1.72	Average dry density[a]
porosity n (cm^3/cm^3)	0.36	Average porosity[a]
Water filled soil porosity Θ_w (cm^3/cm^3)	0.27	Average water filled soil porosity[a]
Air filled soil porosity Θ_a (cm^3/cm^3)	0.09	$\Theta_a = n - \Theta_w$
Diffusivity in air Di (cm^2/sec)	0.12	Chemical specific[b]
Diffusivity in water Dw (cm^2/sec)	1.7E-05	Chemical specific[b]
Dimensionless Henry's Law Constant H'	1.34E-05	Chemical specific[c]
Organic carbon/water partition coefficient K_{oc} (cm^3/g)	37	Chemical specific[c]
Fraction of organic carbon in soil f_{oc} (g/g)	0.006	Standard Default[d]
Apparent Diffusivity D_a (cm^2/sec)	2.57E-06	$D_a = ((\Theta_a^{10/3} \text{ x Di x H'} + \Theta_w^{10/3} \text{ x Dw}) / n^2)/(\rho_d \text{ x } f_{oc} \text{ x } K_{oc} + \Theta_w + \Theta_a \text{ x H'})$
Exposure interval T (sec)	9.48E+07	T = 3 (years) x 3.16E+7 (sec/year) [e]
Inverse mean concentration Q/C (g/m^2-sec per kg/m^3)	68.81	Standard Default[d]
Soil volatilization factor VFs (m^3/kg)	2.15E+04	$\text{VFs} = \text{Q/C x } (3.14 \text{ x } D_a \text{ x T})^{0.5} / (2 \text{ x } \rho_d \text{ x } D_a) \text{ x } 0.0001 \text{ (m}^2\text{/cm}^2)$
Soil Concentration C_{soil} (mg/kg)	0.943	excavation 95% UCL[f]
Air concentration at receptor C_a (µg/m^3)	0.0438	$C_a = C_{soil}$ / VFs x 1,000 µg/mg
Intake Calculation		
Inhalation Rate IR (m^3/day)	20	Standard Default[g]
Daily Intake (µg/day)	0.88	I = C_a x IR
Prop 65 Safe Harbor Level (µg/day)	40	No Significant Risk Level (NSRL)

Notes

[a]Dry density, total porosity, and water filled soil porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.
[b]US EPA Region 9, 2004, PRGs Physical Chemical Data, diffusivities extrapolated from acetone and acetaldehyde based on chemical structure and property similarity.
[c]ATSDR, Formaldehyde Chemical and Physical Information, http://www.atsdr.cdc.gov/toxprofiles/tp111-c3.pdf
[d]US EPA Region 9, 2004, PRG Users Guide, VFs default parameters http://www.epa.gov/region9/waste/sfund/prg/files/04usersguide.pdf
[e]Pyhtoremediation of soil removed from DSS 3 assumed complete after three growing seasons - three years.
[f]95% UCL of formaldehyde sample results within the excavation limits shown in Figure B-7 in Appendix B
[g]USEPA. 1991a. Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual. Supplemental Guidance 'Standard Default Exposure Factors'. Office of Emergency and Remedial Response, Washington, D.C. March.

Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
95% UCL	95 percent upper confidence limit on the mean

Table D-5. Calculation of Daily Intake for Volatilization of Formaldehyde from Excavated Soil, Domestic Septic System Number 3, Alternative 4b (continued)

cm^2	square centimeters
cm^3	cubic centimeters
DSS 3	Domestic Septic System Number 3
g	grams
hr	hours
kg	kilograms
m	meters
m^2	square meters
m^3	cubic meters
mg	milligrams
mg/kg	milligrams per kilogram
PRG	preliminary remediation goal
sec	seconds
USEPA	United States Environmental Protection Agency
VFs	soil volatilization factor
µg	micrograms
$\mu g/m^3$	micrograms per cubic meter

Table D-6. Calculation of Daily Intake for Volatilization of Formaldehyde from Excavated Soil, Domestic Septic System Number 3, Alternative 4c

Parameter	Value	Source
Exposure Point Concentration		
Soil dry density ρ_d (g/cm^3)	1.72	Average dry density[a]
porosity n (cm^3/cm^3)	0.36	Average porosity[a]
Water filled soil porosity Θ_w (cm^3/cm^3)	0.27	Average water filled soil porosity[a]
Air filled soil porosity Θ_a (cm^3/cm^3)	0.09	$\Theta_a = n - \Theta_w$
Diffusivity in air Di (cm^2/sec)	0.12	Chemical specific[b]
Diffusivity in water Dw (cm^2/sec)	1.7E-05	Chemical specific[b]
Dimensionless Henry's Law Constant H'	1.34E-05	Chemical specific[c]
Organic carbon/water partition coefficient K_{oc} (cm^3/g)	37	Chemical specific[c]
Fraction of organic carbon in soil f_{oc} (g/g)	0.006	Standard Default[d]
Apparent Diffusivity D_a (cm^2/sec)	2.57E-06	$D_a = ((\Theta_a^{10/3} \text{ x Di x H'} + \Theta_w^{10/3} \text{ x Dw}) / n^2)/(\rho_d \text{ x } f_{oc} \text{ x } K_{oc} + \Theta_w + \Theta_a \text{ x H'})$
Truckloads n_t	148	Estimated number truckloads to haul DSS3 soil offsite.[e]
Time to load and secure one shipment t_{ls} (hr)	3	Standard Default[f]
Exposure interval T (sec)	7.02E+06	$T = n_t \text{ x } t_{ls}$ / 8 (hr/workday) / 250 (workdays/year) x 3.16E+7 (sec/year)
Inverse mean concentration Q/C (g/m^2-sec per kg/m^3)	68.81	Standard Default[d]
Soil volatilization factor VFs (m^3/kg)	5.86E+03	VFs = Q/C x (3.14 x D_a x T)$^{0.5}$ / (2 x ρ_d x D_a) x 0.0001 (m^2/cm^2)
Soil Concentration C_{soil} (mg/kg)	0.903	excavation 95% UCL[g]
Air concentration at receptor C_a (µg/m^3)	0.1542	$C_a = C_{soil}$ / VFs x 1,000 µg/mg
Intake Calculation		
Inhalation Rate IR (m^3/day)	20	Standard Default[h]
Daily Intake (µg/day)	3.1	I = C_a x IR
Prop 65 Safe Harbor Level (µg/day)	40	No Significant Risk Level (NSRL)

Notes

[a]Dry density, total porosity, and water filled soil porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.
[b]US EPA Region 9, 2004, PRGs Physical Chemical Data, diffusivities extrapolated from acetone and acetaldehyde based on chemical structure and property similarity.
[c]ATSDR, Formaldehyde Chemical and Physical Information, http://www.atsdr.cdc.gov/toxprofiles/tp111-c3.pdf
[d]US EPA Region 9, 2004, PRG Users Guide, VFs default parameters http://www.epa.gov/region9/waste/sfund/prg/files/04usersguide.pdf
[e]Estimated truckloads based on 10 cubic yard capacity and 1471 cubic yards of excavated soil.
[f]Argonne National Laboratory, 1998, Transport Storage and Disposal - Dose, Version 2.22, September.
[g]95% UCL of formaldehyde sample results within the excavation limits shown in Figure B-10 in Appendix B
[h]USEPA. 1991a. Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual. Supplemental Guidance 'Standard Default Exposure Factors'. Office of Emergency and Remedial Response, Washington, D.C. March.

Table D-6. Calculation of Daily Intake for Volatilization of Formaldehyde from Excavated Soil, Domestic Septic System Number 3, Alternative 4c (continued)

Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
95% UCL	95 percent upper confidence limit on the mean
cm^2	square centimeters
cm^3	cubic centimeters
DSS 3	Domestic Septic System Number 3
g	grams
hr	hours
kg	kilograms
m	meters
m^2	square meters
m^3	cubic meters
mg	milligrams
mg/kg	milligrams per kilogram
PRG	preliminary remediation goal
sec	seconds
USEPA	United States Environmental Protection Agency
VFs	soil volatilization factor
µg	micrograms
$\mu g/m^3$	micrograms per cubic meter

APPENDIX E

CONTAMINANT LOADING ESTIMATE FOR SOIL TO GROUND WATER CONTAMINANT MIGRATION

E.1. CONTAMINANT LOADING ESTIMATE FOR SOIL TO GROUND WATER CONTAMINANT MIGRATION

Weiss calculated the area and diameter of ground water contamination that would result if all of the contamination in DOE Areas is immediately transferred into the shallowest water bearing unit. The contamination was assumed evenly distributed over an area in hydrostratographic unit 1 (HSU1) at concentrations equal to the ground water goals (California maximum contaminant level (MCL) or background concentration established in well UCD1-18). The procedures involved in this calculation included estimating the mass of contamination, contaminated volume, contaminated area and plume diameter for each constituent of ground water concern (COGWC) in each Department of Energy Area. The procedures, results and uncertainties are discussed below.

E.1.1 Mass Determination

Mass (or radiological activity) of DOE Areas contamination was determined from the concentration and volume of contaminated soil. DOE Areas soil sample data were used in the calculation of contaminated soil concentration if the data were above the background screening value. The 95 percent upper confidence limit on the mean (95% UCL) was determined from these above-background data. Maximum concentrations were used instead of the 95% UCL if the 95% UCL exceeded the maximum.

The 95% UCL of background data was used to represent the background contribution that was subtracted. For chemical constituents, half of the sample detection limit was used when background data were below the detection limit. The measured activity-concentration was used when radiological constituents were below the detection limit.

Contaminated soil volumes were based on the excavation volumes shown in Appendix B. Excavation volumes were multiplied by the fraction of above-background sample data within the excavation limits. Thus, only the contaminated volume within the excavation limits was used.

Mass of contamination was determined by subtracting the background concentration from the contaminated soil concentration and multiplying by the contaminated soil volume and soil bulk density. The soil bulk density was obtained from a study of site soil samples (D.B. Stephens, 1996). No subtraction was made for formaldehyde because its background concentration was assumed equal to zero.

E.1.2 Volume, Area and Diameter Determination

Calculations of the area and diameter of contamination were based on assuming evenly distributed contamination within HSU1 at concentrations equal to the ground water goals. The volume of contamination was determined from the contaminated mass, ground water goal, aquifer porosity, and chemical partitioning between soil and aqueous phases as shown in the equation:

$$V = M/C_{gw}/(n + K_d \text{ x } \rho_d)$$

Where M is the contamination mass, C_{gw} is the ground water goal, n is the soil porosity, K_d is the soil/water partitioning coefficient and ρ_d is the soil dry density. The volume was divided by an assumed aquifer thickness to get the area of contamination. Historical ground water elevation data were evaluated to estimate the aquifer thickness. Based on ground water elevations measured throughout the LEHR project duration, the reasonable minimum thickness of HSU1 is approximately 25 feet. Plume diameters were calculated from the area estimates based on assumed circular plume area geometry.

E.1.3 Results

The calculations are shown in Tables E-1 through E-16. As shown, most of the areas are less than one acre. Contaminated areas that exceeded one acre based on MCLs in ground water were formaldehyde at Domestic Septic System No. 3 (DSS3), nitrate at the Radium/Strontium Treatment Systems (Ra/Sr) area and nitrate at the Southwest Trenches (SWT) area. Areas larger than one acre based on background ground water goals were formaldehyde at DSS 3, silver in the Dry Wells A through E (Dry Wells) area, nitrate at the Ra/Sr area and carbon-14 at the Ra/Sr and SWT areas. The largest potential plume area was 20 acres for formaldehyde above ground water background at DSS 3.

More than half of the estimated diameters were less than 100 feet, which corresponds to approximately two tenths of an acre. The largest diameter was 1,061 feet for formaldehyde above ground water background at DSS 3. The smallest diameter was approximately 3 inches for the cesium-137 MCL at the Dry Wells area.

The area and diameter calculations indicate that formaldehyde at DSS 3, carbon-14 at the SWT area, and nitrate at the Ra/Sr and SWT areas have the greatest potential to impact ground water.

E.1.4 Uncertainty

The results of these calculations are not expected to accurately predict the area or diameter of ground water impacts. The calculations provide conservatively estimated areas and diameters. No contaminant transport attenuation processes were simulated in these calculations. Estimates of vadose zone contaminant mass were made based on sample data and all of the mass was assumed to instantly appear evenly distributed in the saturated zone at concentrations equal to the ground water goals.

The processes that will cause actual contaminated areas and diameters to be smaller are:

- Dispersion and Mass Delivery Rate – Contamination will disperse as it migrates to ground water and gradually arrives in the aquifer. In reality, a significant amount of the contamination arriving in the aquifer will disperse before all of the mass is delivered. The calculations assumed all of the mass was delivered instantaneously and none of the mass was dispersed.
- Concentration Gradients – When contamination does arrive, there will be small concentrated areas above the ground water goal and less concentrated peripheral areas below the ground water goal. The calculated areas contain all of the mass at concentrations equal to the goal, which results in the largest possible area.
- Decay – The radioactive constituents will undergo decay while the contamination migrates to ground water and within ground water.

E.1.5 References:

Daniel B. Stephens and Associates Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.

Table E-1. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Nitrate at Radium/Strontium Treatment Systems Area

Parameter	Value	Basis
MCL in Ground Water		
Bulk density ρ (g/cm^3)	1.98	Average bulk density[a]
Total contaminant mass ΣM_i (mg)	3.99E+08	Sum of mass from individual contaminated volumes (see below)
Ground water goal C_{gw} (mg/L)	10	California MCL for Nitrate
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[a]
Porosity n (unitless)	0.361	Average porosity[a]
Total Volume V (L)	1.11E+08	$V = \Sigma M_i$ (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	3.6	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	446	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Bulk density ρ (g/cm^3)	1.98	Average bulk density[a]
Total contaminant mass ΣM_i (mg)	3.99E+08	Sum of mass from individual contaminated volumes (see below)
Ground water goal C_{gw} (mg/L)	27.4	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[a]
Porosity n (unitless)	0.361	Average porosity[a]
Total Volume V (L)	4.03E+07	$V = \Sigma M_i$ (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	1.31	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	269	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Excavation	Excavation Volume[b] (ft^3)	Fraction of Samples Above Background	Factored Volume[c] V_{vz} (ft^3)	Excavation 95%UCL[d] (mg/kg)	Net Soil Concentration[e] C_{soil} (mg/kg)	Contaminant Activity[f] M (mg)
1	2513	0.857	2154	173	157.2	1.90E+07
2	106500	0.604	64344	121	105.2	3.80E+08
3	2400	0	NA	NA	NA	0.00E+00
4	9850	0	NA	NA	NA	0.00E+00
					Total Contaminant Mass $\Sigma(M_i)$	3.99E+08

Notes

[a] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.
[b] Volumes are from excavation areas shown in Figure B1.
[c] Excavation volumes were factored by the fraction of samples above background.
[d] 95% UCL calculated using above-background sample data within each excavation volume. Maximum concentration used if 95% UCL was above maximum.
[e] C_{soil} = Excavation 95% UCL - background 95% UCL (15.8 mg/kg).
[f] $M = C_{soil}$ (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)

Table E-1. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Nitrate at Radium/Strontium Treatment Systems Area (continued)

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
mg	milligrams

Table E-2. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Carbon-14 at Radium/Strontium Treatment Systems Area

Parameter	Value	Basis
MCL in Ground Water		
Bulk density ρ (g/cm^3)	1.98	Average bulk density[a]
Total contaminant activity ΣM_i (pCi)	8.44E+08	Sum of activities from individual contaminated volumes (see below)
Ground water goal C_{gw} (pCi/L)	2,000	Derived value from 4 millirroentgen equivalent man per year Federal MCL
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[a]
Porosity n (unitless)	0.361	Average porosity[a]
Total Volume V (L)	1.17E+06	$V = \Sigma M_i$ (pCi) / C_{gw} (pCi/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.038	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	46	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Bulk density ρ (g/cm^3)	1.98	Average bulk density[a]
Total contaminant activity ΣM_i (pCi)	8.44E+08	Sum of activities from individual contaminated volumes (see below)
Ground water goal C_{gw} (pCi/L)	50	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[a]
Porosity n (unitless)	0.361	Average porosity[a]
Total Volume V (L)	4.67E+07	$V = \Sigma M_i$ (pCi) / C_{gw} (pCi/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	1.5	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	290	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Excavation	Excavation Volume[b] (ft^3)	Fraction of Samples Above Background	Factored Volume[c] V_{vz} (ft^3)	Excavation 95%UCL[d] (pCi/g)	Net Soil Concentration[e] C_{soil} (pCi/g)	Contaminant Activity[f] M (pCi)
1	2513	0	NA	NA	NA	0.00E+00
2	106500	0.125	13313	0.264	0.199	1.49E+08
3	2400	1	2400	0.404	0.339	4.57E+07
4	9850	0.5	4925	2.41	2.345	6.49E+08
					Total Contaminant Activity $\Sigma(M_i)$	8.44E+08

Notes
[a] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.
[b] Volumes are from excavation areas shown in Figure B2.
[c] Excavation volumes were factored by the fraction of samples above background.
[d] 95% UCL calculated using above-background sample data within each excavation volume. Maximum concentration used if 95% UCL was above maximum.

Table E-2. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Carbon-14 at Radium/Strontium Treatment Systems Area (continued)

[e] C_{soil} 95% UCL - 1/2 background detection limit (0.065 pCi/g). All of the background samples were below the detection limit.

[f] M (C_{soil} (pCi/g) x V_{vz} (ft^3) x ρ (g/cm^3) x 28317(cm^3/ft^3))

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
pCi	picocuries

Table E-3. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Radium-226 at Radium/Strontium Treatment Systems Area

Parameter	Value	Basis
MCL in Ground Water		
Bulk density ρ (g/cm^3)	1.98	Average bulk density[a]
Total contaminant activity ΣM_i (pCi)	1.14E+09	Sum of activities from individual contaminated volumes (see below)
Ground water goal C_{gw} (pCi/L)	5	MCL for Radium-226
Soil/water partition coefficient K_d (ml/g)	450	value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[a]
Porosity n (unitless)	0.361	Average porosity[a]
Total Volume V (L)	2.96E+05	$V = \Sigma M_i$ (pCi) / C_{gw} (pCi/L) / ($n + K_d \times \rho_d$)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.010	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	23	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Bulk density ρ (g/cm^3)	1.98	Average bulk density[a]
Total contaminant activity ΣM_i (pCi)	1.14E+09	Sum of activities from individual contaminated volumes (see below)
Ground water goal C_{gw} (pCi/L)	1.14	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	450	value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[a]
Porosity n (unitless)	0.361	Average porosity[a]
Total Volume V (L)	1.30E+06	$V = \Sigma M_i$ (pCi) / C_{gw} (pCi/L) / ($n + K_d \times \rho_d$)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.042	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	48	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Excavation	Excavation Volume[b] (ft^3)	Fraction of Samples Above Background	Factored Volume[c] V_{vz} (ft^3)	Excavation 95%UCL[d] (pCi/g)	Net Soil Concentration[e] C_{soil} (pCi/g)	Contaminant Activity[f] M (pCi)
1	2513	0	NA	NA	NA	0.00E+00
2	106500	0.182	19364	1.62	1.052	1.14E+09
3	2400	0	NA	NA	NA	0.00E+00
4	9850	0.0	NA	NA	NA	0.00E+00
					Total Contaminant Activity $\Sigma(M_i)$	1.14E+09

Notes

[a] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.

Table E-3. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Radium-226 at Radium/Strontium Treatment Systems Area (continued)

[b] Volumes are from excavation areas shown in Figure B2.
[c] Excavation volumes were factored by the fraction of samples above background.
[d] 95% UCL calculated using above-background sample data within each excavation volume. Maximum concentration used if 95% UCL was above maximum.
[e] C_{soil} = Excavation 95% UCL - background 95% UCL (0.568 pCi/g).
[f] $M = (C_{soil}$ (pCi/g) x V_{vz} (ft^3) x ρ (g/cm^3) x 28317(cm^3/ft^3))

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
pCi	picocuries

Table E-4. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Formaldehyde at Domestic Septic System 3

Parameter	Value	Basis
MCL in Ground Water		
Net soil concentration C_{soil} (mg/kg)	0.943	Excavation 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	106,750	100% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	5,656,734	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.1	California State Action Level, Californa Department of Health Services
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	1.57E+08	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	5.1	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	531	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Net soil concentration C_{soil} (mg/kg)	0.943	Excavation 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	106,750	100% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	5,656,734	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.025	HSU1 ground water background concentration[c]
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	6.26E+08	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area (acres)	20	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	1061	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Notes

[a] Formaldehyde was detected in all of the samples within the excavation area (See DOE Areas Feasibility Study Figure B4).

[b] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.

[c] Background based on most recent sample (June 15, 2006) collected from Well UCD1-18. Non-detect result. 1/2 detection limit used.

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level

Table E-4. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Formaldehyde at Domestic Septic System 3 (continued)

ml	milliliters
mg/kg	milligrams per kilogram
mg/L	milligrams per liter

Table E-5. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Molybdenum at Domestic Septic System 3

Parameter	Value	Basis
MCL in Ground Water		
Net soil concentration C_{soil} (mg/kg)	2.05	Excavation 95% UCL - 1/2 background detection limit (0.13 mg/kg)
Contaminated vadose zone volume V_{vz} (ft^3)	42,700	40% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	4,918,899	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.18	EPA Region 9 PRG. No MCL available for molybdenum
Soil/water partition coefficient K_d (ml/g)	20	Superfund Chemical Data Matrix K_d value[c]
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	786,641	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.026	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	38	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Net soil concentration C_{soil} (mg/kg)	2.05	Excavation 95% UCL - 1/2 background detection limit (0.13 mg/kg)
Contaminated vadose zone volume V_{vz} (ft^3)	42,700	40% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	4,918,899	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.0149	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	20	Superfund Chemical Data Matrix K_d value[c]
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	9,503,049	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area (acres)	0.31	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	131	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Notes

[a] 40% of the samples within the excavation area (See DOE Areas Feasibility Study Figure B-5) were above background.

[b] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.

[c] 1998 Superfund Chemical Data Matrix value. Molybdenum eliminated from 2004 version because it was not considered a CERCLA hazardous substance.

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1

Table E-5. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Molybdenum at Domestic Septic System 3 (continued)

L	liters
MCL	maximum contaminant level
ml	milliliters
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
PRG	preliminary remediation goal

Table E-6. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Nitrate at Domestic Septic System 3

Parameter	Value	Basis
MCL in Ground Water		
Net soil concentration C_{soil} (mg/kg)	73.1	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	22,418	21% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	9.21E+07	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	10	California MCL for Nitrate
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	2.55E+07	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.83	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	214	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Net soil concentration C_{soil} (mg/kg)	73.1	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	22,418	21% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	9.21E+07	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	27.4	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	9.30E+06	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area (acres)	0.30	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	129	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Notes
[a] 21% of the samples within the excavation area (See DOE Areas Feasibility Study Figure B-6) were above background.
[b] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet

Table E-6. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Nitrate at Domestic Septic System 3 (continued)

ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
mg/kg	milligrams per kilogram
mg/L	milligrams per liter

Table E-7. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Selenium at Domestic Septic System 4

Parameter	Value	Basis
MCL in Ground Water		
Net soil concentration C_{soil} (mg/kg)	1.1	Site maximum - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	444	40% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	27,445	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.05	California MCL for selenium
Soil/water partition coefficient K_d (ml/g)	5.0	Superfund Chemical Data Matrix K_d value
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	61,290	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.0020	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	10	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Net soil concentration C_{soil} (mg/kg)	1.1	Site maximum - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	444	40% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	27,445	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.00567	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	5.0	Superfund Chemical Data Matrix K_d value
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	540,475	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area (acres)	0.018	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	31	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Notes

[a] 40% of the samples within the excavation area (See DOE Areas Feasibility Study Figure B8) were above background. Although not within the excavation limits, the trenches spanning below Building H-215 were added to this volume.

[b] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996.

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
mg/kg	milligrams per kilogram

Table E-7. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Selenium at Domestic Septic System 4 (continued)

mg/L	milligrams per liter

Table E-8. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Chromium at Dry Wells A through E

Parameter	Value	Basis
MCL in Ground Water		
Net soil concentration C_{soil} (mg/kg)	77.9	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	1,367	27% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	5.98E+06	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.050	California MCL for Chromium
Soil/water partition coefficient K_d (ml/g)	19	value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	3.62E+06	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.12	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	81	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Net soil concentration C_{soil} (mg/kg)	77.9	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	1,367	27% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	5.98E+06	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.025	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	19	value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	7.25E+06	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area (acres)	0.24	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	114	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Notes

a 27% of the samples within the excavation area (See DOE Areas Feasibility Study Figure B-9) were above background.

[b] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil
Samples, November 12, 1996.

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level

Table E-8. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Chromium at Dry Wells A through E (continued)

ml	milliliters
mg/kg	milligrams per kilogram
mg/L	milligrams per liter

Table E-9. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Hexavalent Chromium at Dry Wells A through E

Parameter	Value	Basis
MCL in Ground Water		
Net soil concentration C_{soil} (mg/kg)	1.274	Excavation maximum - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	354	7% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	2.54E+04	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.050	California MCL for hexavalent chromium
Soil/water partition coefficient K_d (ml/g)	19	value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	15,368	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.00050	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	5.3	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Net soil concentration C_{soil} (mg/kg)	1.274	Excavation maximum - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	354	7% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	2.54E+04	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.0394	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	19	value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	19,502	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area (acres)	0.00063	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	5.9	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Notes
[a] 7% of the samples within the excavation area (See DOE Areas Feasibility Study Figure B-10) were above background.
[b] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
mg/kg	milligrams per kilogram
mg/L	milligrams per liter

Table E-10. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Mercury at Dry Wells A through E

Parameter	Value	Basis
MCL in Ground Water		
Net soil concentration C_{soil} (mg/kg)	1.098	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	2,835	56% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	174,938	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.002	California MCL for mercury
Soil/water partition coefficient K_d (ml/g)	52	value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	974,656	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.0316	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	42	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Net soil concentration C_{soil} (mg/kg)	1.098	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	2,835	56% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	174,938	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.0001	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	52	value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	1.95E+07	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area (acres)	0.632	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	187	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Notes

[a] 56% of the samples within the excavation area (See DOE Areas Feasibility Study Figure B-11) were above background.

[b] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet

Table E-10. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Mercury at Dry Wells A through E (continued)

g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
mg/kg	milligrams per kilogram
mg/L	milligrams per liter

Table E-11. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Molybdenum at Dry Wells A through E

Parameter	Value	Basis
MCL in Ground Water		
Net soil concentration C_{soil} (mg/kg)	0.416	Excavation 95% UCL - 1/2 background detection limit (0.13 mg/kg)
Contaminated vadose zone volume V_{vz} (ft^3)	3,949	78% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	92,317	$M = C_{soil}$ (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.18	EPA Region 9 PRG. No MCL available for molybdenum
Soil/water partition coefficient K_d (ml/g)	20	Superfund Chemical Data Matrix K_d value[c]
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	14,764	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.00048	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	5.2	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Net soil concentration C_{soil} (mg/kg)	0.416	Excavation 95% UCL - 1/2 background detection limit (0.13 mg/kg)
Contaminated vadose zone volume V_{vz} (ft^3)	3,949	78% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	92,317	$M = C_{soil}$ (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.0149	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	20	Superfund Chemical Data Matrix K_d value[c]
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	178,352	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area (acres)	0.0058	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	18	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Notes
[a] 78% of the samples within the excavation area (See DOE Areas Feasibility Study Figure B-12) were above background.
[b] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996
[c] 1998 Superfund Chemical Data Matrix value. Molybdenum eliminated from 2004 version because it was not considered a CERCLA hazardous substance.

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
PRG	preliminary remediation goal

Table E-12. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Silver at Dry Wells A through E

Parameter	Value	Basis
MCL in Ground Water		
Net soil concentration C_{soil} (mg/kg)	13.2	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	3,645	72% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	2.69E+06	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.1	California MCL for silver
Soil/water partition coefficient K_d (ml/g)	8.3	Value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	1.84E+06	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.0597	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	58	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Net soil concentration C_{soil} (mg/kg)	13.2	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	3,645	72% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant mass M (mg)	2.69E+06	M = C_{soil} (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)
Ground water goal C_{gw} (mg/L)	0.005	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	8.3	Value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	3.68E+07	V = M (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area (acres)	1.19	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	257	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Notes

[a] 72% of the samples within the excavation area (See DOE Areas Feasibility Study Figure B-13) were above background.

[b] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
PRG	preliminary remediation goal

Table E-13. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Cesium-137 at Dry Wells A through E

Parameter	Value	Basis
MCL in Ground Water		
Net soil concentration C_{soil} (pCi/g)	0.0698	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	3,190	63% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant total activity M (pCi)	1.25E+07	M = (C_{soil} (pCi/g) x V_{vz} (ft^3) x ρ (g/cm^3) x 28317(cm^3/ft^3))
Ground water goal C_{gw} (pCi/L)	200	Derived value from 4 milliroentgen equivalent man per year Federal MCL
Soil/water partition coefficient K_d (ml/g)	1,000	Value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	36	V = M (pCi) / C_{gw} (pCi/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	1.18E-06	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	0.26	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Net soil concentration C_{soil} (pCi/g)	0.0698	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	3,190	63% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant total activity M (pCi)	1.25E+07	M = (C_{soil} (pCi/g) x V_{vz} (ft^3) x ρ (g/cm^3) x 28317(cm^3/ft^3))
Ground water goal C_{gw} (pCi/L)	1	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	1,000	Value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	7,277	V = M (pCi) / C_{gw} (pCi/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area (acres)	2.36E-04	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	3.6	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Notes

[a] 63% of the samples within the excavation area (See DOE Areas Feasibility Study Figure B-14) were above background.
[b] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
pCi	picocuries

Table E-14. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Strontium-90 at Dry Wells A through E

Parameter	Value	Basis
MCL in Ground Water		
Net soil concentration C_{soil} (pCi/g)	0.1070	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	2,430	48% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant total activity M (pCi)	1.46E+07	M = (C_{soil} (pCi/g) x V_{vz} (ft^3) x ρ (g/cm^3) x 28317(cm^3/ft^3))
Ground water goal C_{gw} (pCi/L)	8	MCL for Strontium-90
Soil/water partition coefficient K_d (ml/g)	35	Value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	30,180	V = M (pCi) / C_{gw} (pCi/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.00098	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	7.4	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Net soil concentration C_{soil} (pCi/g)	0.1070	Excavation 95% UCL - background 95% UCL
Contaminated vadose zone volume V_{vz} (ft^3)	2,430	48% of Feasibility Study excavation volume[a]
Bulk density ρ (g/cm^3)	1.98	Average bulk density[b]
Contaminant total activity M (pCi)	1.46E+07	M = (C_{soil} (pCi/g) x V_{vz} (ft^3) x ρ (g/cm^3) x 28317(cm^3/ft^3))
Ground water goal C_{gw} (pCi/L)	1.7	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	35	Value from Superfund Chemical Data Matrix
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[b]
Porosity n (unitless)	0.361	Average porosity[b]
Total Volume V (L)	142,021	V = M (pCi) / C_{gw} (pCi/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area (acres)	0.0046	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	16	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Notes
[a] 48% of the samples within the excavation area (See DOE Areas Feasibility Study Figure B-15) were above background.
[b] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
pCi	picocuries

Table E-15. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Nitrate at Southwest Trenches Area

Parameter	Value	Basis
MCL in Ground Water		
Bulk density ρ (g/cm^3)	1.98	Average bulk density[a]
Total contaminant mass ΣM_i (mg)	2.67E+08	Sum of mass from individual contaminated volumes (see below)
Ground water goal C_{gw} (mg/L)	10	California MCL for Nitrate
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[a]
Porosity n (unitless)	0.361	Average porosity[a]
Total Volume V (L)	7.40E+07	$V = \Sigma M_i$ (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	2.4	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	365	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Bulk density ρ (g/cm^3)	1.98	Average bulk density[a]
Total contaminant mass ΣM_i (mg)	2.67E+08	Sum of mass from individual contaminated volumes (see below)
Ground water goal C_{gw} (mg/L)	27.4	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[a]
Porosity n (unitless)	0.361	Average porosity[a]
Total Volume V (L)	2.70E+07	$V = \Sigma M_i$ (mg) / C_{gw} (mg/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.88	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	220	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Excavation	Excavation Volume[b] (ft^3)	Fraction of Samples Above Background	Factored Volume[c] V_{vz} (ft^3)	Excavation 95%UCL[d] (mg/kg)	Net Soil Concentration[e] C_{soil} (mg/kg)	Contaminant Activity[f] M (mg)
1	26260	0.154	4040	54.3	38.5	8.74E+06
2	18180	0.435	7904	168	152	6.76E+07
3	12300	0.034	424	68.9	53	1.27E+06
4	15155	0.000	NA	NA	NA	0.00E+00
5	25249	0.00	NA	NA	NA	0.00E+00
6	24284	0.586	14220	212	196	1.57E+08
7	62340	0.242	15093	51.7	36	3.04E+07
8	7700	0.103	797	75	59.2	2.65E+06
					Total Contaminant Mass $\Sigma(M_i)$	2.67E+08

Notes
[a] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996
[b] Volumes are from excavation areas shown in Figure B17.
[c] Excavation volumes were factored by the fraction of samples above background.
[d] 95% UCL calculated using above-background sample data within each excavation volume. Maximum concentration used if 95% UCL was above maximum.

Table E-15. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Nitrate at Southwest Trenches Area (continued)

[e] C_{soil} = Excavation 95% UCL - background 95% UCL (15.8 mg/kg).
[f] $M = C_{soil}$ (mg/kg) x V_{vz} (ft^3) x ρ (g/cm^3) x 0.001(kg/g) x 28317(cm^3/ft^3)

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
mg	milligrams

Table E-16. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Carbon-14 at Southwest Trenches Area

Parameter	Value	Basis
MCL in Ground Water		
Bulk density ρ (g/cm^3)	1.98	Average bulk density[a]
Total contaminant activity ΣM_i (pCi)	2.49E+09	Sum of activities from individual contaminated volumes (see below)
Ground water goal C_{gw} (pCi/L)	2,000	Derived value from 4 millirroentgen equivalent man per year Federal MCL
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[a]
Porosity n (unitless)	0.361	Average porosity[a]
Total Volume V (L)	3.44E+06	$V = \Sigma M_i$ (pCi) / C_{gw} (pCi/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	0.11	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	79	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))
Ground Water Background		
Bulk density ρ (g/cm^3)	1.98	Average bulk density[a]
Total contaminant activity ΣM_i (pCi)	2.49E+09	Sum of activities from individual contaminated volumes (see below)
Ground water goal C_{gw} (pCi/L)	50	HSU1 ground water background concentration
Soil/water partition coefficient K_d (ml/g)	0.0	100% water partitioning assumed
Dry Density ρ_d (g/cm^3)	1.72	Average dry density[a]
Porosity n (unitless)	0.361	Average porosity[a]
Total Volume V (L)	1.38E+08	$V = \Sigma M_i$ (pCi) / C_{gw} (pCi/L) / (n + K_d x ρ_d)
Aquifer thickness h (ft)	25	HSU1 reasonable minimum thickness
Affected area A (acres)	4.5	A = V (L) / h (ft) x 0.0353 (ft^3/L) x 2.296E-5(acres/ft^2)
Diameter d (ft)	498	d = 2 x square root (A (acres) / π x 43560(ft^2/acre))

Excavation	Excavation Volume[b] (ft^3)	Fraction of Samples Above Background	Factored Volume[c] V_{vz} (ft^3)	Excavation 95%UCL[d] (pCi/g)	Net Soil Concentration[e] C_{soil} (pCi/g)	Contaminant Activity[f] M (pCi)
1	26260	0.389	10212	0.216	0.1510	8.67E+07
2	18180	0	0	NA	0	0
3	12300	0.333	4100	0.494	0.429	9.88E+07
4	15155	0.833	12629	0.373	0.308	2.19E+08
5	25249	0.75	18937	2.01	1.95	2.07E+09
6	24284	0.0714	1735	0.222	0.16	1.53E+07
7	62340	0	0	NA	0	0
8	7700	0	0	NA	0	0
					Total Contaminant Activity $\Sigma(M_i)$	2.49E+09

Notes

[a] Bulk density, dry density and porosity data from Daniel B. Stephens & Associates, Inc., 1996, Hydraulic Properties of LEHR/UC Davis Soil Samples, November 12, 1996

[b] Volumes are from excavation areas shown in Figure B18.

[c] Excavation volumes were factored by the fraction of samples above background.

Table E-16. Contaminant Loading Calculation for Soil to Ground Water Contaminant Migration, Carbon-14 at Southwest Trenches Area (continued)

[d] 95% UCL calculated using above-background sample data within each excavation volume. Maximum concentration used if 95% UCL was above maximum.
[e] C_{soil} = 95% UCL - 1/2 background detection limit (0.065 pCi/g). All of the background samples were below the detection limit.
[f] $M = (C_{soil}\ (pCi/g) \times V_{vz}\ (ft^3) \times \rho\ (g/cm^3) \times 28317(cm^3/ft^3))$

Abbreviations

95% UCL	95 percent upper confidence limit on the mean
cm^3	cubic centimeters
ft	feet
ft^3	cubic feet
g	grams
HSU1	hydrostratigraphic unit 1
L	liters
MCL	maximum contaminant level
ml	milliliters
pCi	picocuries

APPENDIX F

TIME-SERIES TREND ANALYSES OF GROUND WATER CONSTITUENTS OF CONCERN

F.1. TIME-SERIES TREND ANALYSES OF GROUND WATER CONSTITUENTS OF CONCERN

This appendix contains graphs illustrating the concentrations of constituents of concern (COCs) in ground water samples through time. The COCs that are graphed are those that are evaluated in the Feasibility Study (FS) or are COPCs that will be monitored in the future (Table 1-2). The ground water samples that are presented were collected from wells that are downgradient of the United States Department of Energy (DOE) areas. Table F-1 lists the DOE areas, the monitoring wells downgradient of the DOE areas, the COCs that are being monitored for each DOE area, and the ground water COCs for each DOE area. Because the main purpose of presenting the graphs is to illustrate trends in known concentrations through time, graphs were made only if the number of detected results was at least five in that particular well. Graphs were made if there were fewer than five detected results in a well, however, if at least one of those concentrations was above the relevant regulatory threshold (i.e., maximum contaminant level, Preliminary Remediation Goal or Department of Health Services State Action Level, as applicable). The only two exceptions are nitrate at wells UCD1-005 and UCD1-006. These two wells were first sampled for nitrate in 1987, but were not sampled again until the summer of 2006. Nitrate was detected in all of those samples.

All duplicates are shown on the graphs. Non-detected results are assigned concentration values differently for radionuclides and non-radionuclides. For radionuclides, the concentrations plotted are the concentrations reported by the laboratory. For non-radionuclides, the concentration plotted is half the detection limit.

Benchmark concentrations that are relevant for interpreting constituent concentrations, such as background concentrations, maximum contaminant levels (MCL), Preliminary Remediation Goals (PRG), and California Department of Health Services State Action Levels, are represented on the graphs by horizontal lines. Background concentrations are shown on all graphs; these concentrations differ between hydrostratigraphic unit (HSU)-1 (WA, 2003) and HSU-2 (WA, 2005). MCLs are shown on all graphs for which MCLs have been determined, and are documented in the 2004 California Code of Regulations and the November 2004 California Safe Drinking Water Act and Related Laws and Regulations. PRGs (US EPA, 2004) are shown for those constituents for which MCLs have not been determined. California Department of Health Services State Action Levels are shown for formaldehyde, and are documented.

The data used to plot the graphs come from the database maintained by the University of California at Davis and ground water samples collected in June 2006 by DOE.

Simple linear trends were added to each graph to aid the reader in evaluating any increase or decrease in concentration through time. These linear trends apply to only the detected results, and are shown by the dashed line in each graph. Outliers were excluded and are noted on the relevant graphs.

REFERENCES

United States Environmental Protection Agency Region 9 (US EPA), 2004, *Preliminary Remediation Goals,* October, http://www.epa.gov/region09/waste/sfund/prg/index.html#prgtable.

Weiss Associates (WA), 2003, *DOE Areas Remedial Investigation Report, for the Laboratory for Energy-Related Health Research,* University of California, Davis, Rev. 0, September.

WA, 2005, *Site-Wide Risk Assessment, Volume I: Human Health Risk Assessment (Part B- Risk Characterization for DOE Areas)* University of California, Davis, Rev. 0, September 30.

Table F-1. Constituents of Concern Monitored in Wells Downgradient of DOE Areas

Area	**Downgradient Monitoring Well**	**Constituents of Potential Concern for Monitoring**	**Ground Water Constituents of Concern for Feasibility Study**
Domestic Septic System No. 1	None in HSU1 UCD2-007 UCD2-036	Aluminum	None
Domestic Septic System No. 3	UCD1-024 UCD2-039	Aluminum Silver	Formaldehyde Molybdenum Nitrate
Domestic Septic System No. 4	UCD1-020 UCD1-024 UCD2-039	Aluminum Chromium Nickel	Selenium
Domestic Septic System No. 5	UCD1-021 UCD2-007 UCD2-036	Aluminum	None
Domestic Septic System No. 6	UCD1-020 UCD1-021 UCD2-007	Aluminum	None
Dry Wells A-E Area	UCD1-054 UCD2-007 UCD2-036	None	Chromium Hexavalent Chromium Mercury Molybdenum Silver Cesium-137 Strontium-90
Radium/Strontium Treatment Systems	UCD1-005 UCD1-006 UCD1-021 UCD1-022 UCD2-007 UCD2-036	Americium-241	Nitrate Carbon-14 Radium-226
Southwest Trenches	UCD1-004 UCD1-023 UCD2-015 UCD2-039	Mercury Zinc	Nitrate Carbon-14
Eastern Dog Pens	UCD1-013 UCD2-039	alpha-Chlordane gamma-Chlordane Dieldrin	None

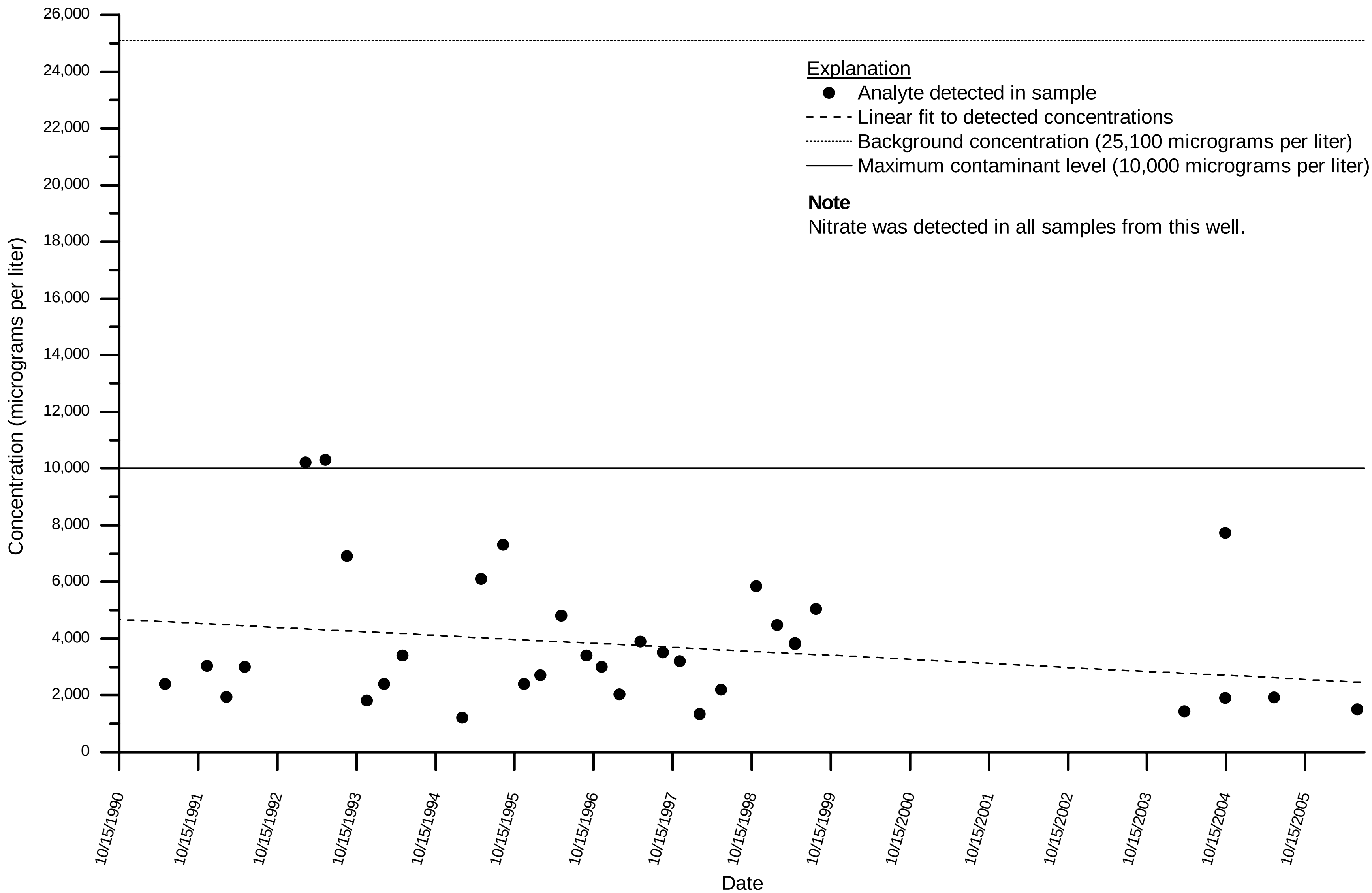

Figure F-1. Graph Showing Concentration of Nitrate Versus Time in Well UCD1-004

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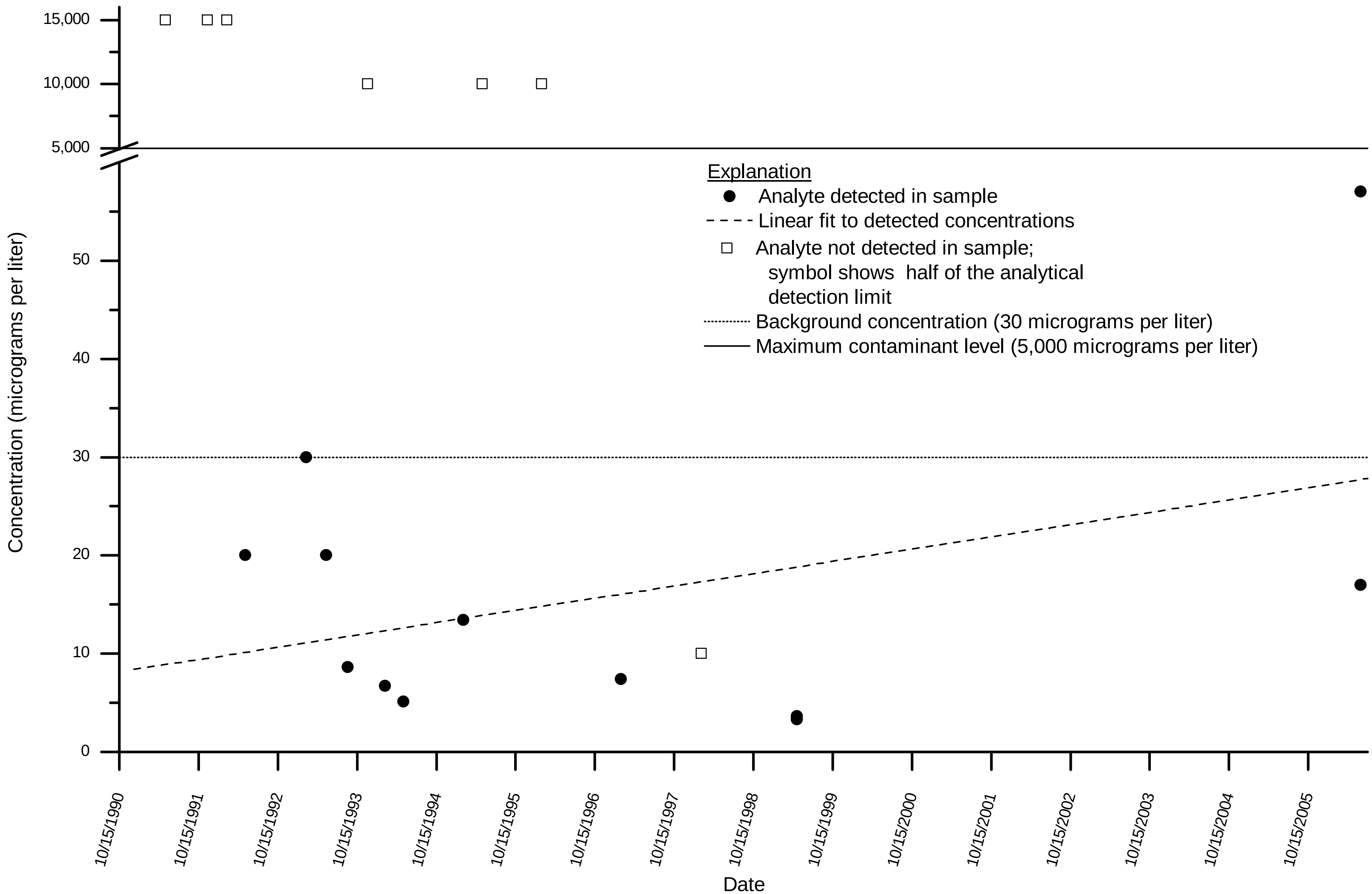

Figure F-2. Graph Showing Concentration of Zinc Versus Time in Well UCD1-004

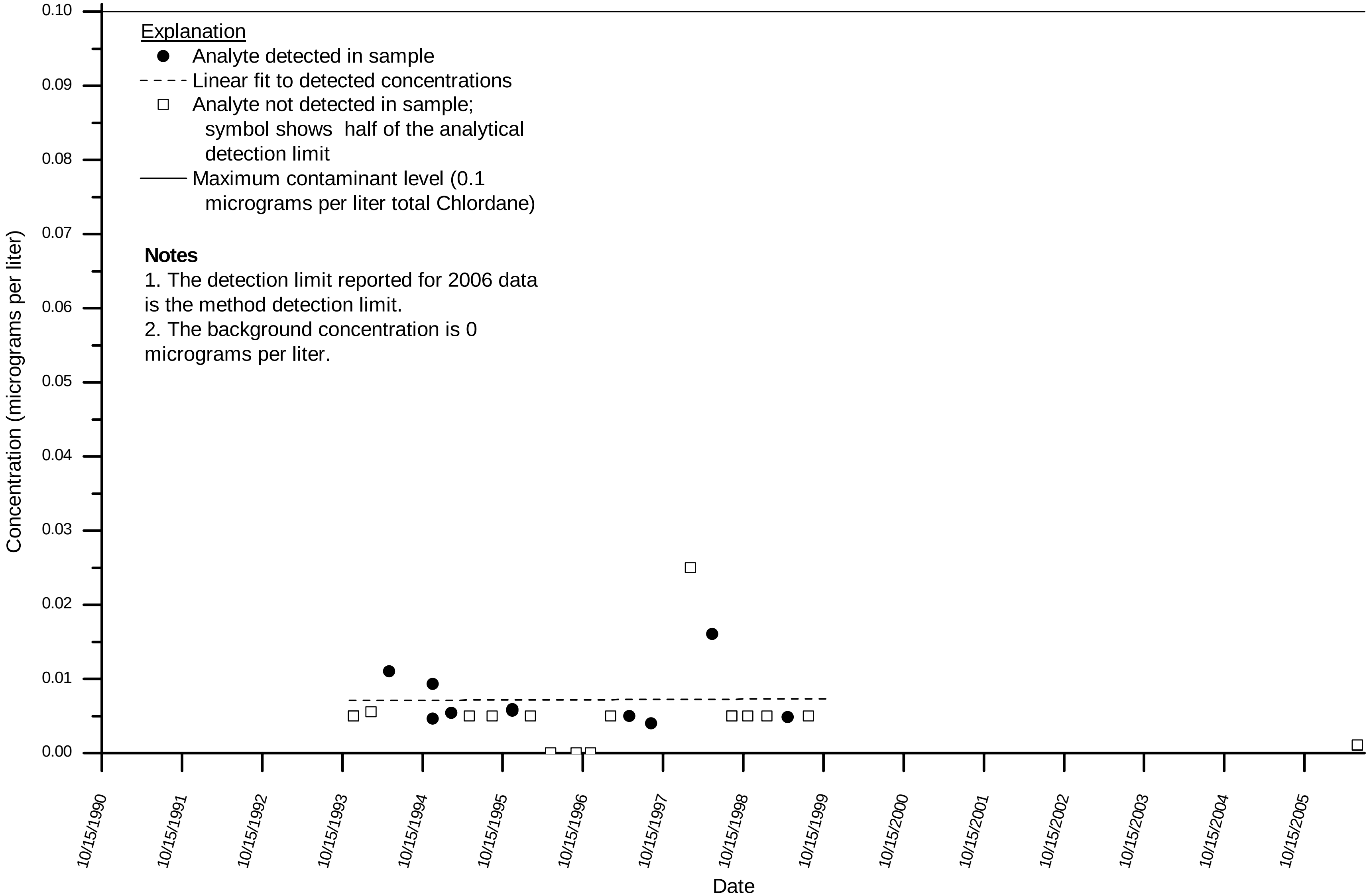

Figure F-3. Graph Showing Concentration of alpha-Chlordane Versus Time in Well UCD1-013

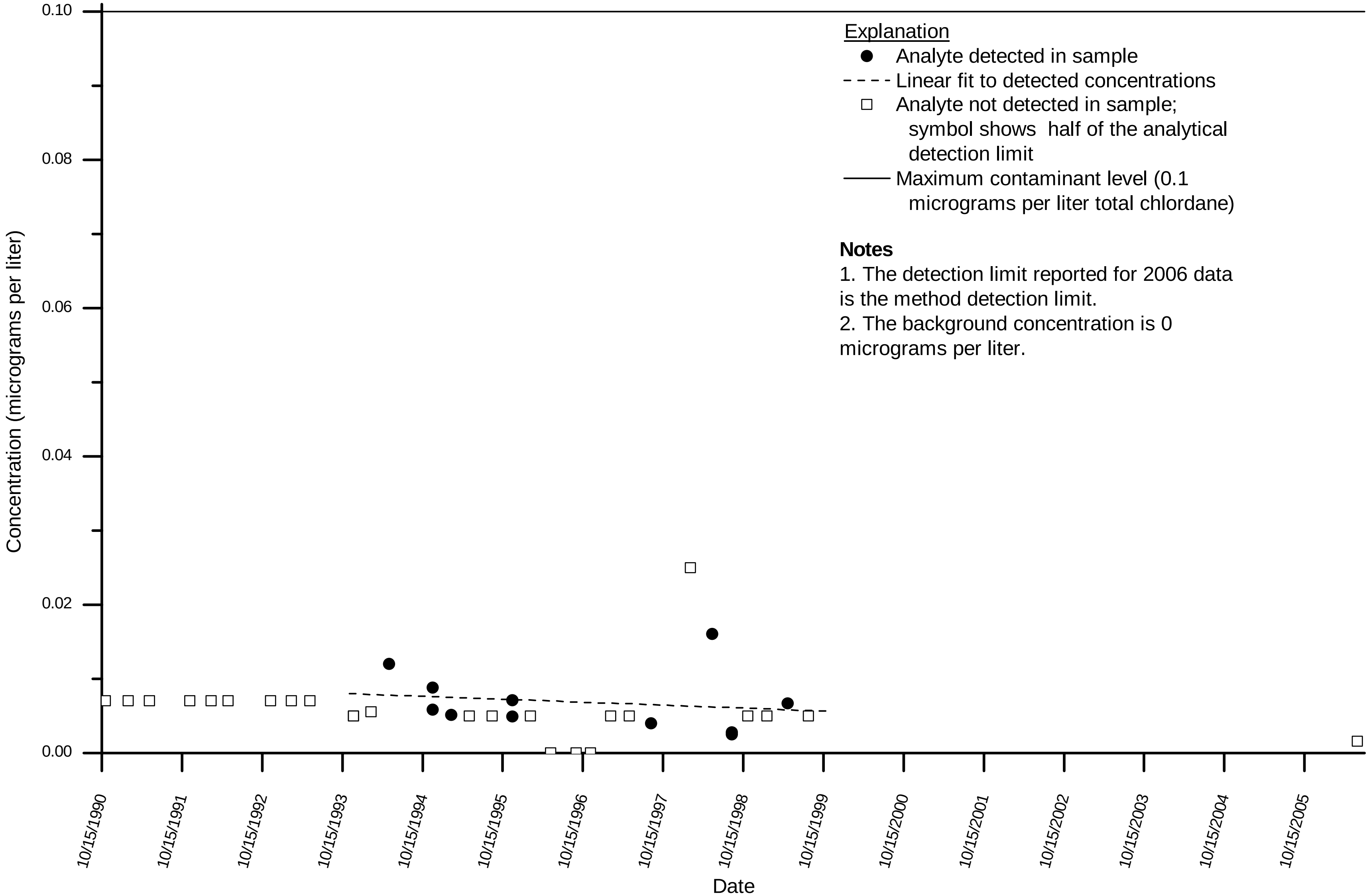

Figure F-4. Graph Showing Concentration of gamma-Chlordane Versus Time in Well UCD1-013

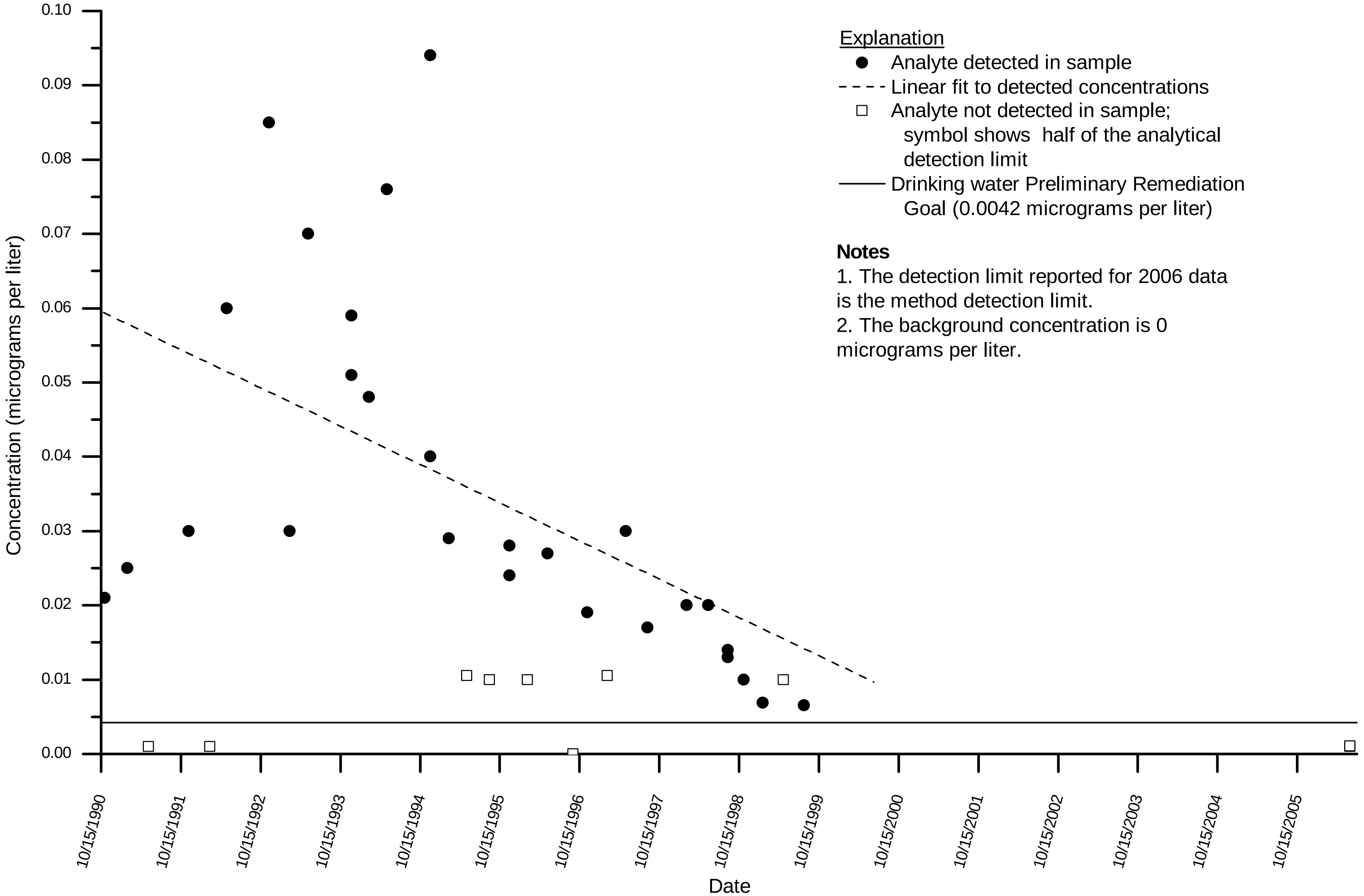

Figure F-5. Graph Showing Concentration of Dieldrin Versus Time in Well UCD1-013

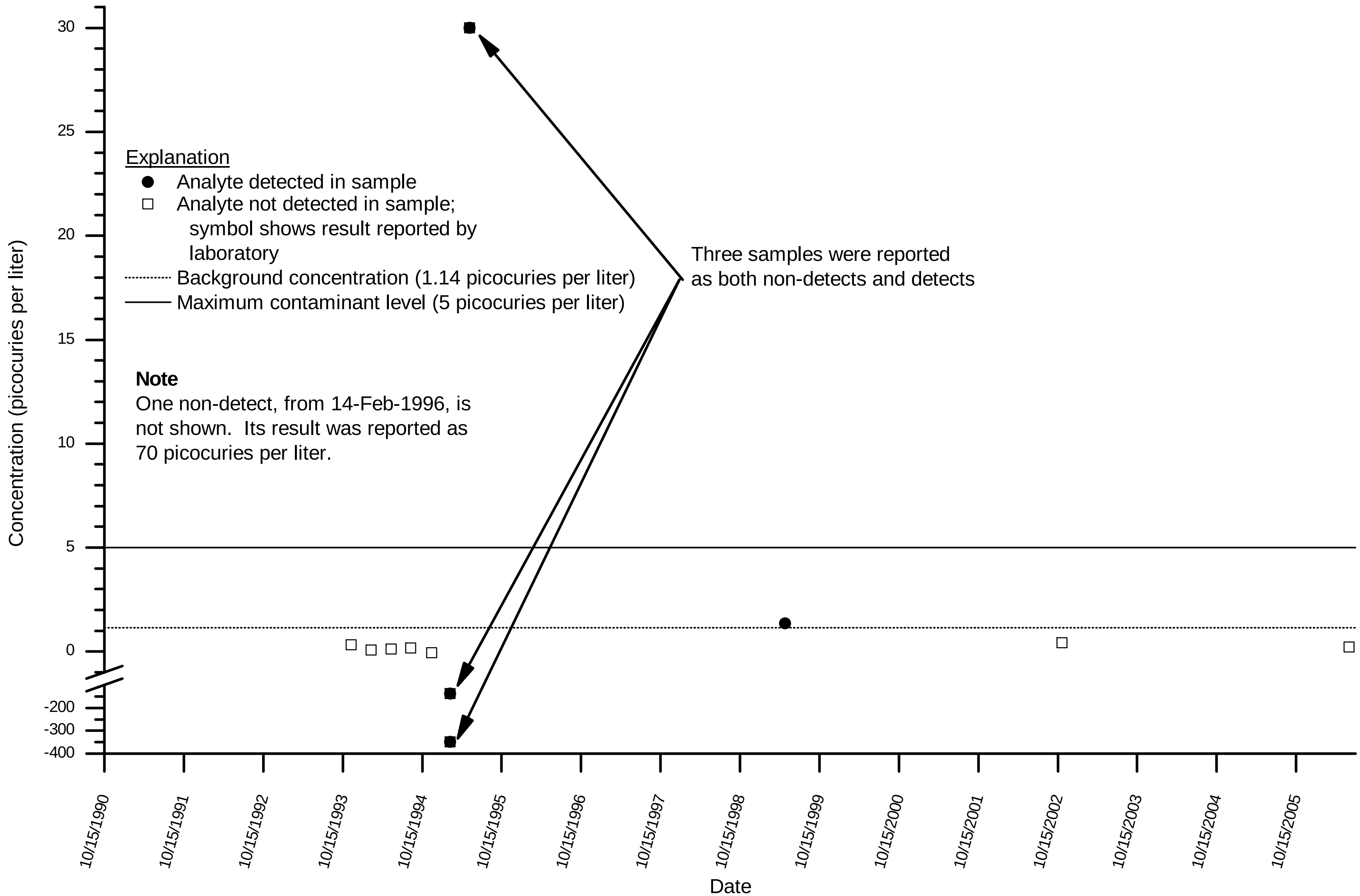

Figure F-6. Graph Showing Concentration of Radium-226 Versus Time in Well UCD1-018

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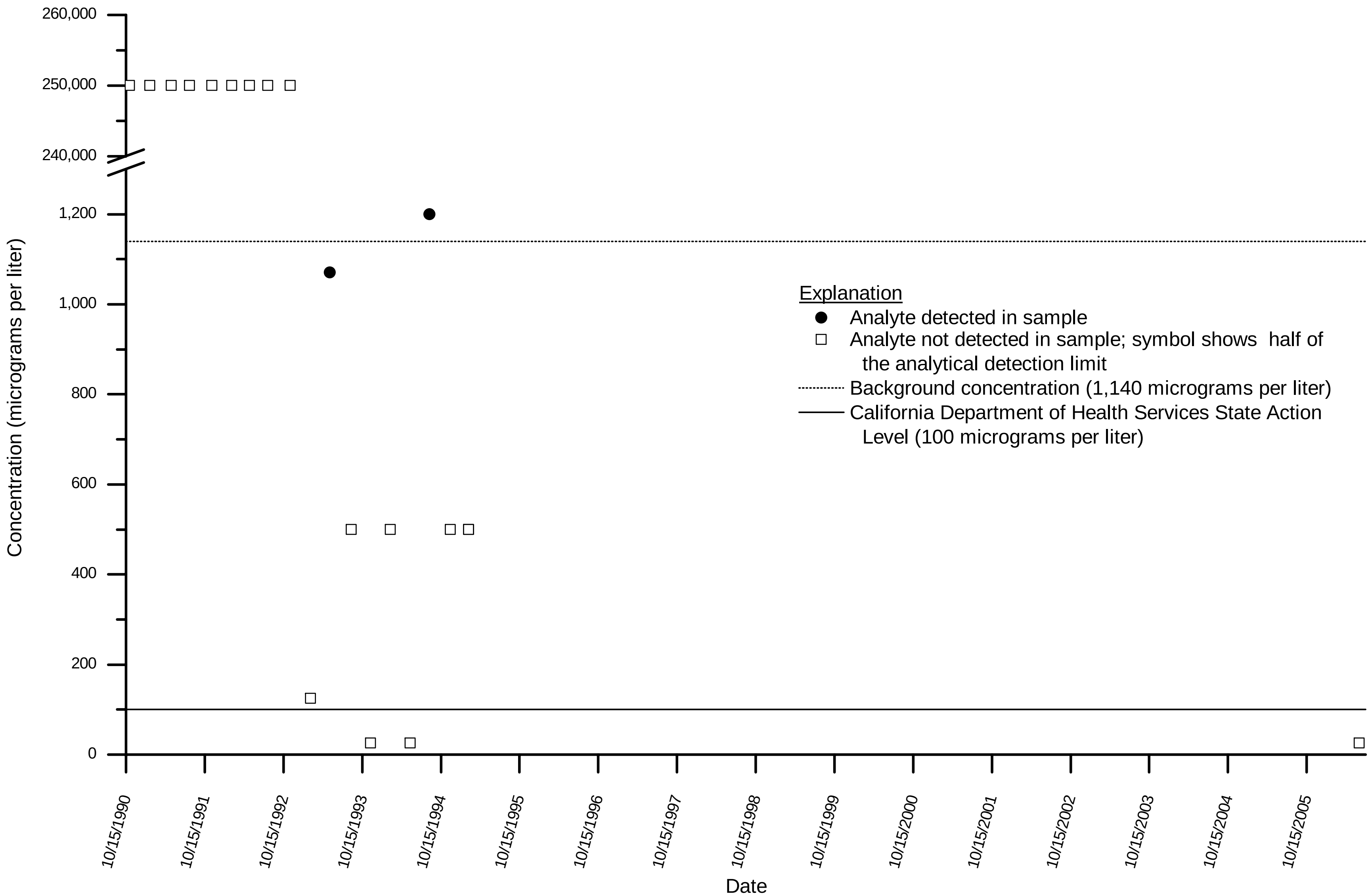

Figure F-7. Graph Showing Concentration of Formaldehyde Versus Time in Well UCD1-018

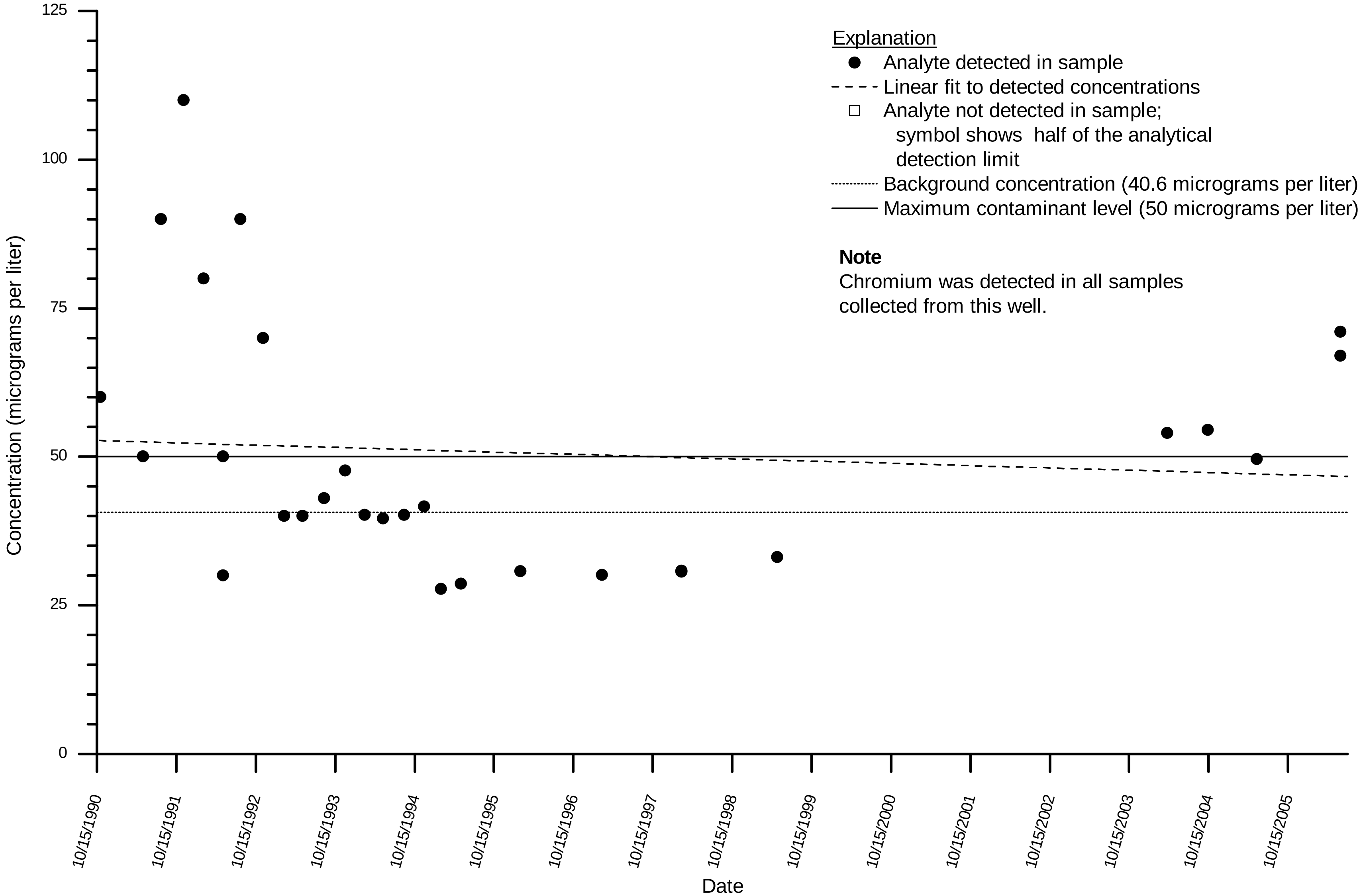

Figure F-8. Graph Showing Concentration of Chromium Versus Time in Well UCD1-020

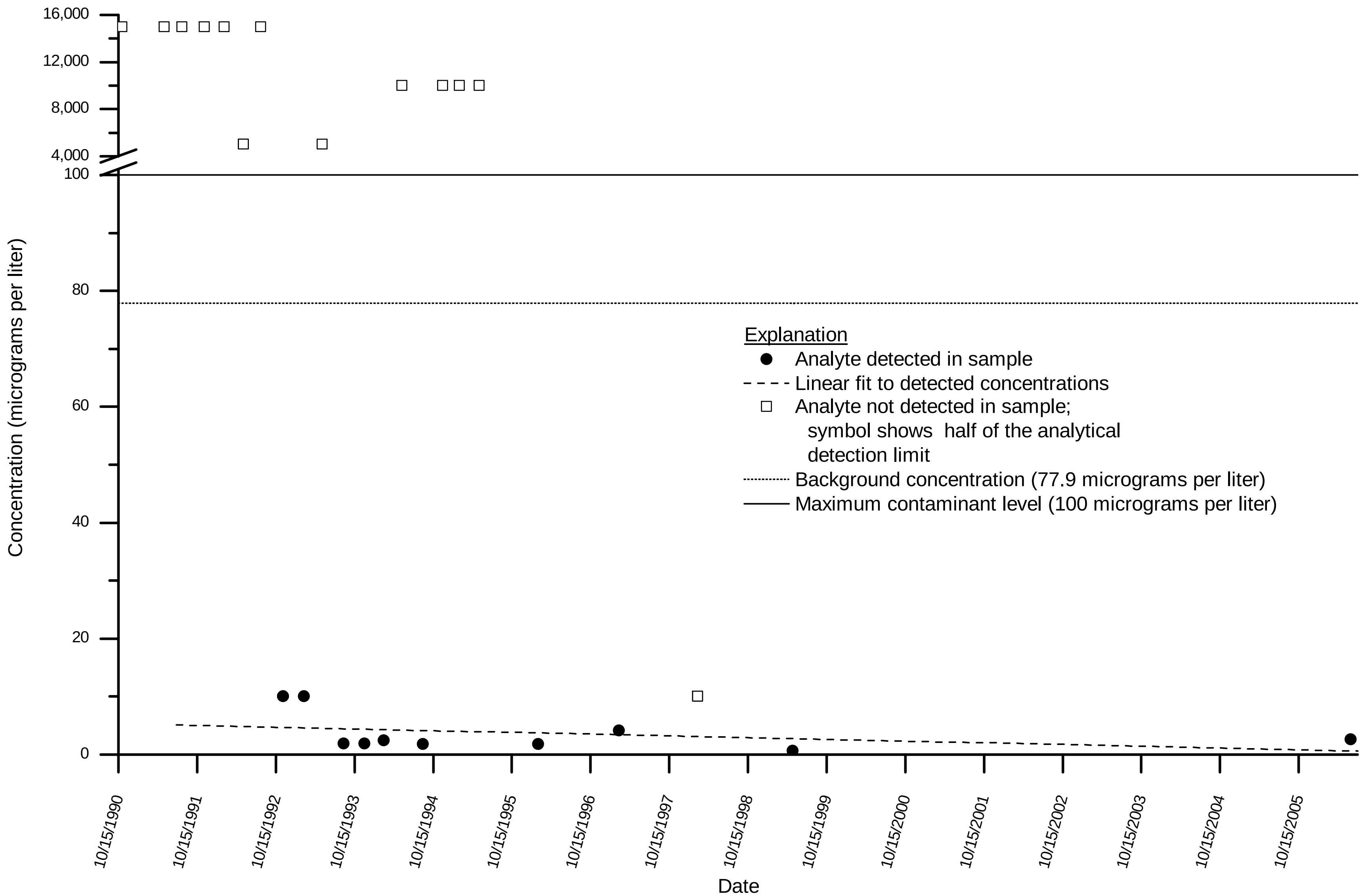

Figure F-9. Graph Showing Concentration of Nickel Versus Time in Well UCD1-020

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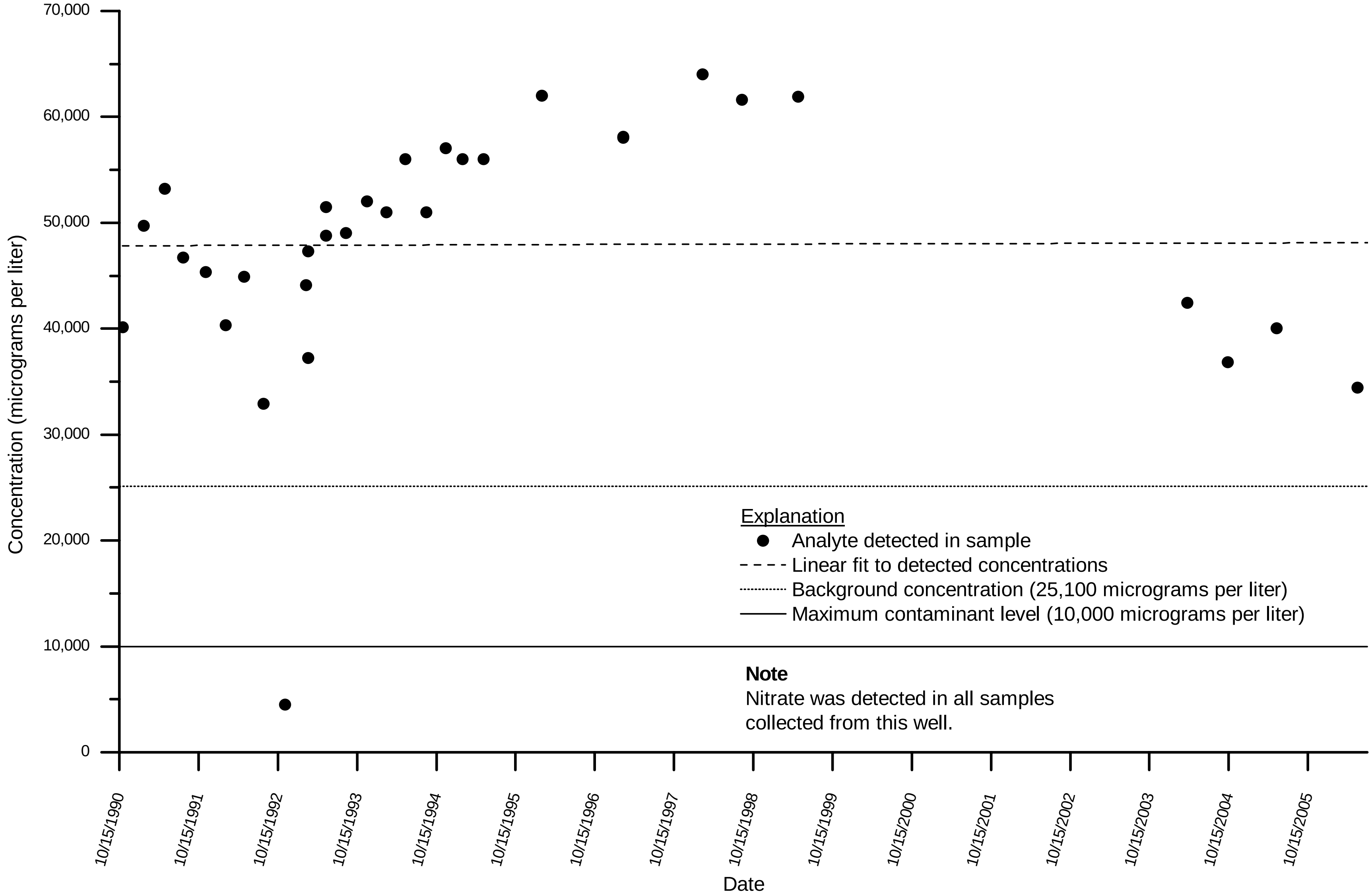

Figure F-10. Graph Showing Concentration of Nitrate Versus Time in Well UCD1-021

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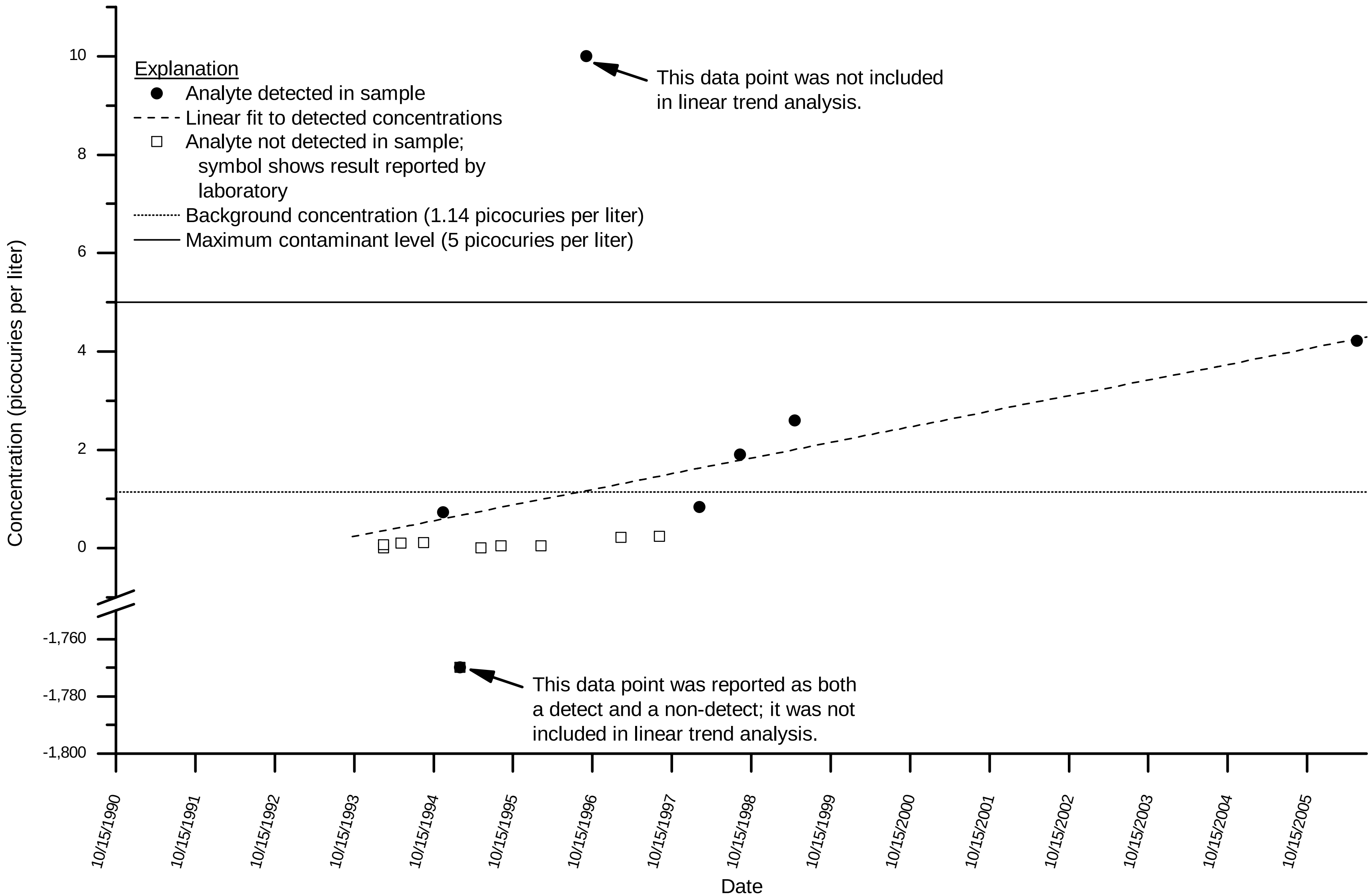

Figure F-11. Graph Showing Concentration of Radium-226 Versus Time in Well UCD1-022

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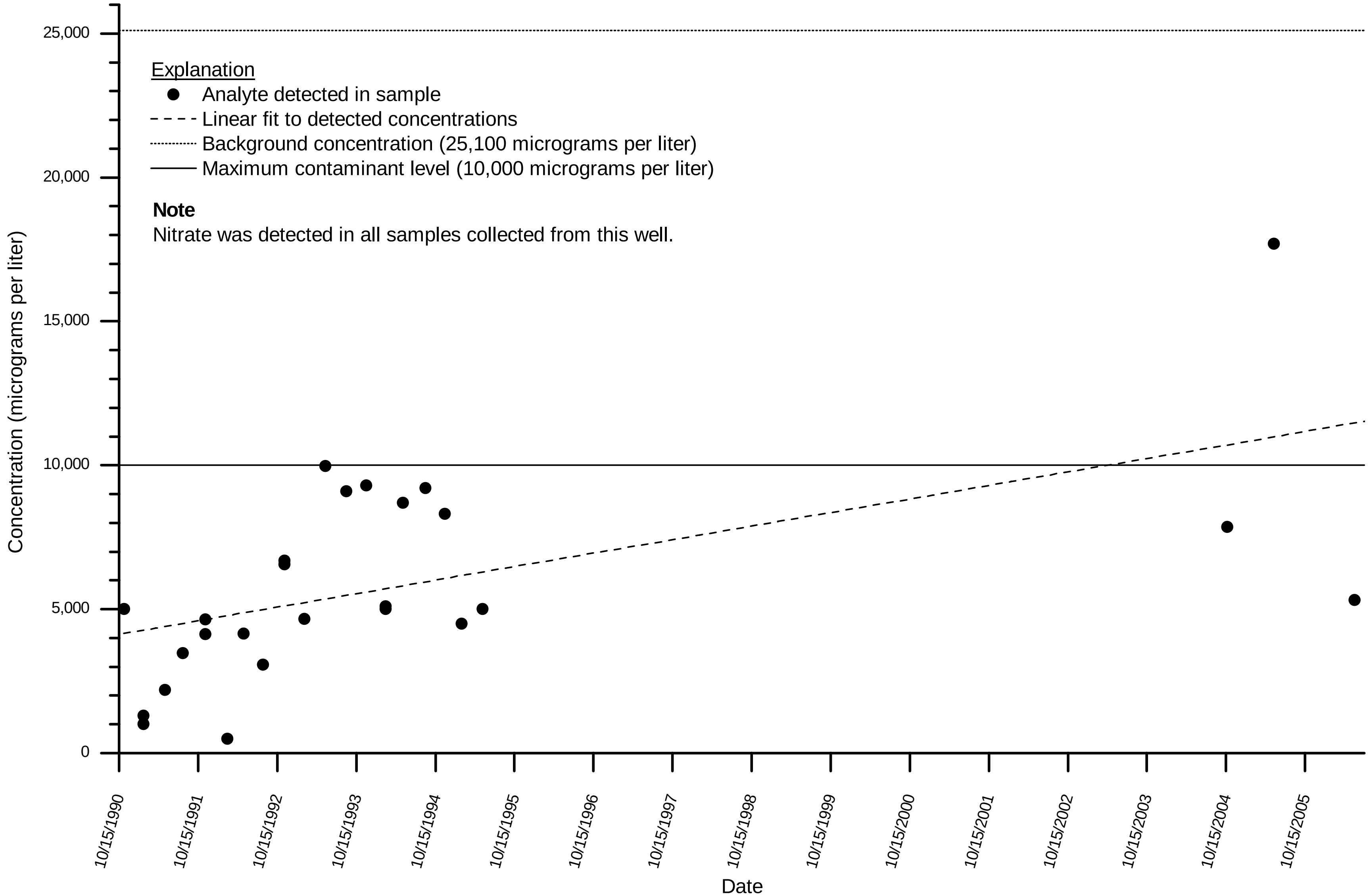

Figure F-12. Graph Showing Concentration of Nitrate Versus Time in Well UCD1-022

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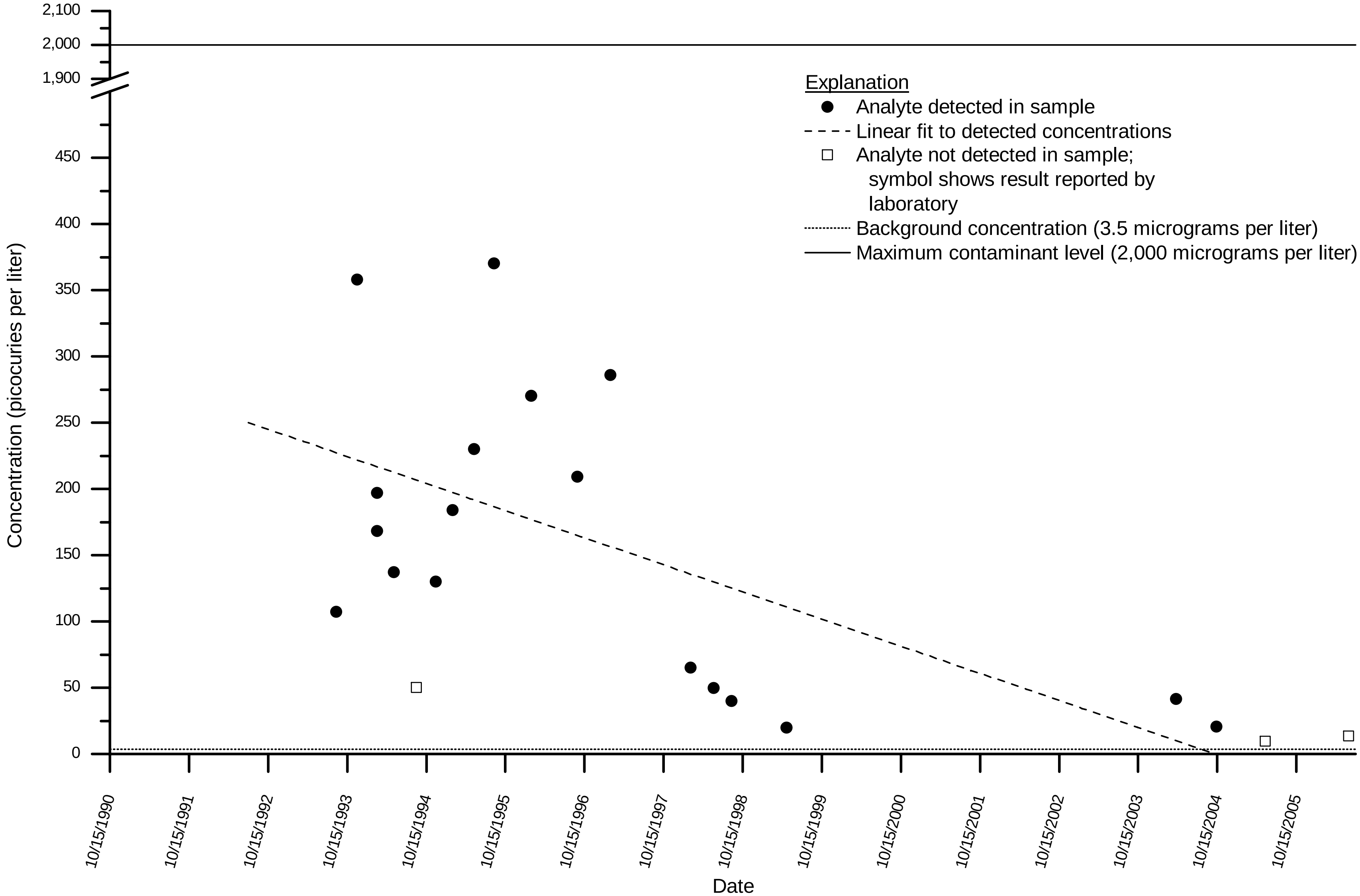

Figure F-13. Graph Showing Concentration of Carbon-14 Versus Time in Well UCD1-023

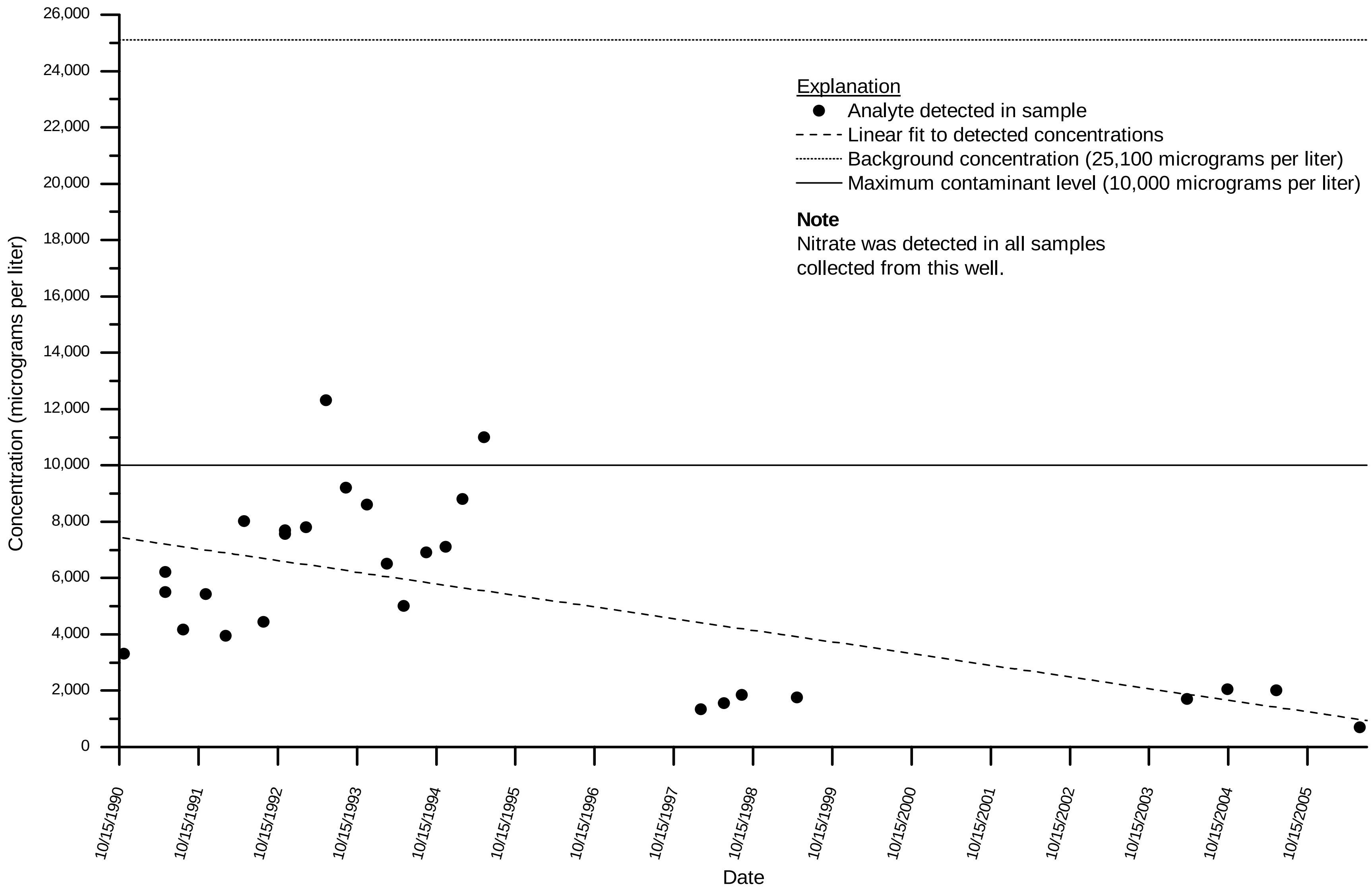

Figure F-14. Graph Showing Concentration of Nitrate Versus Time in Well UCD1-023

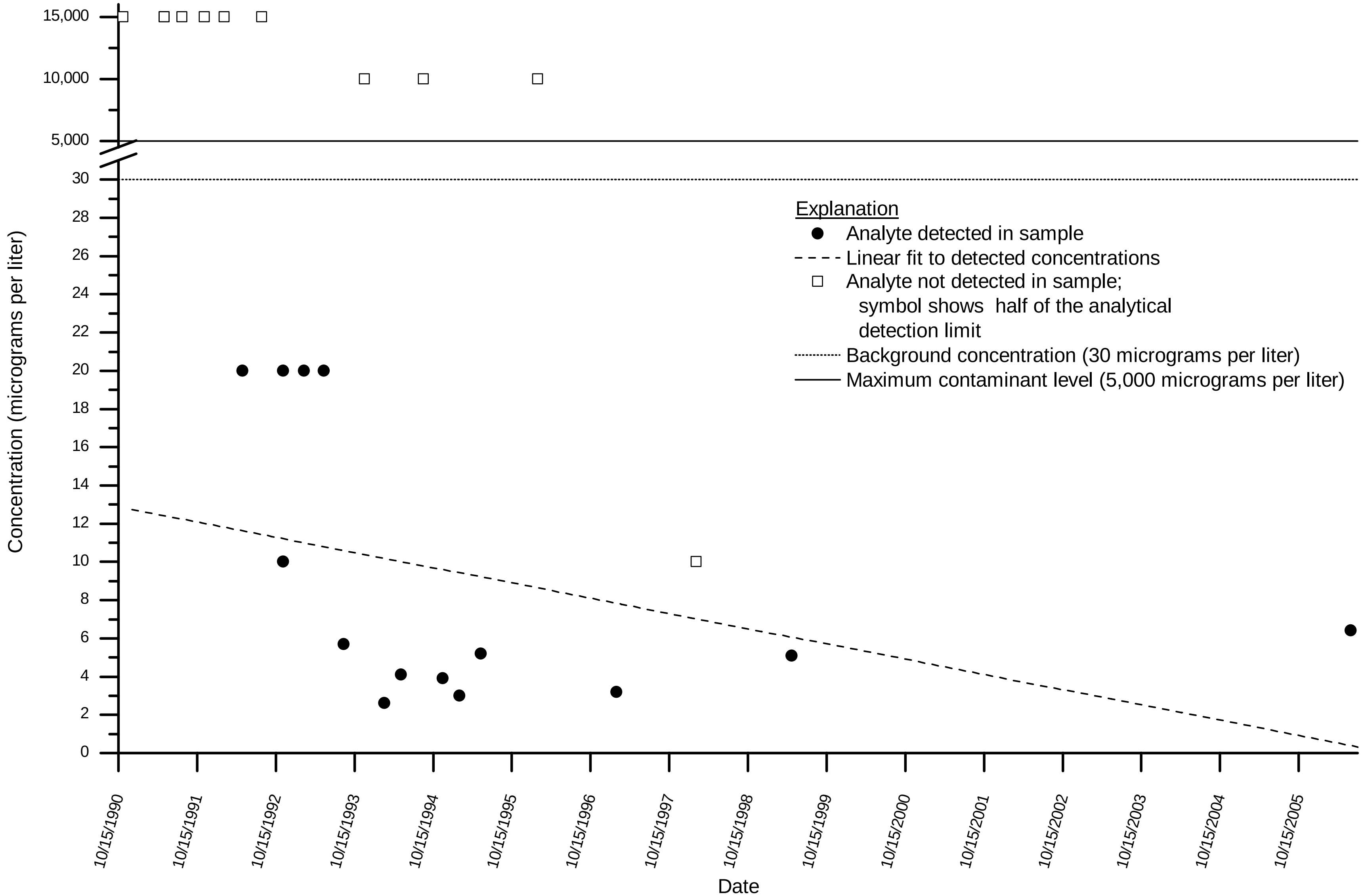

Figure F-15. Graph Showing Concentration of Zinc Versus Time in Well UCD1-023

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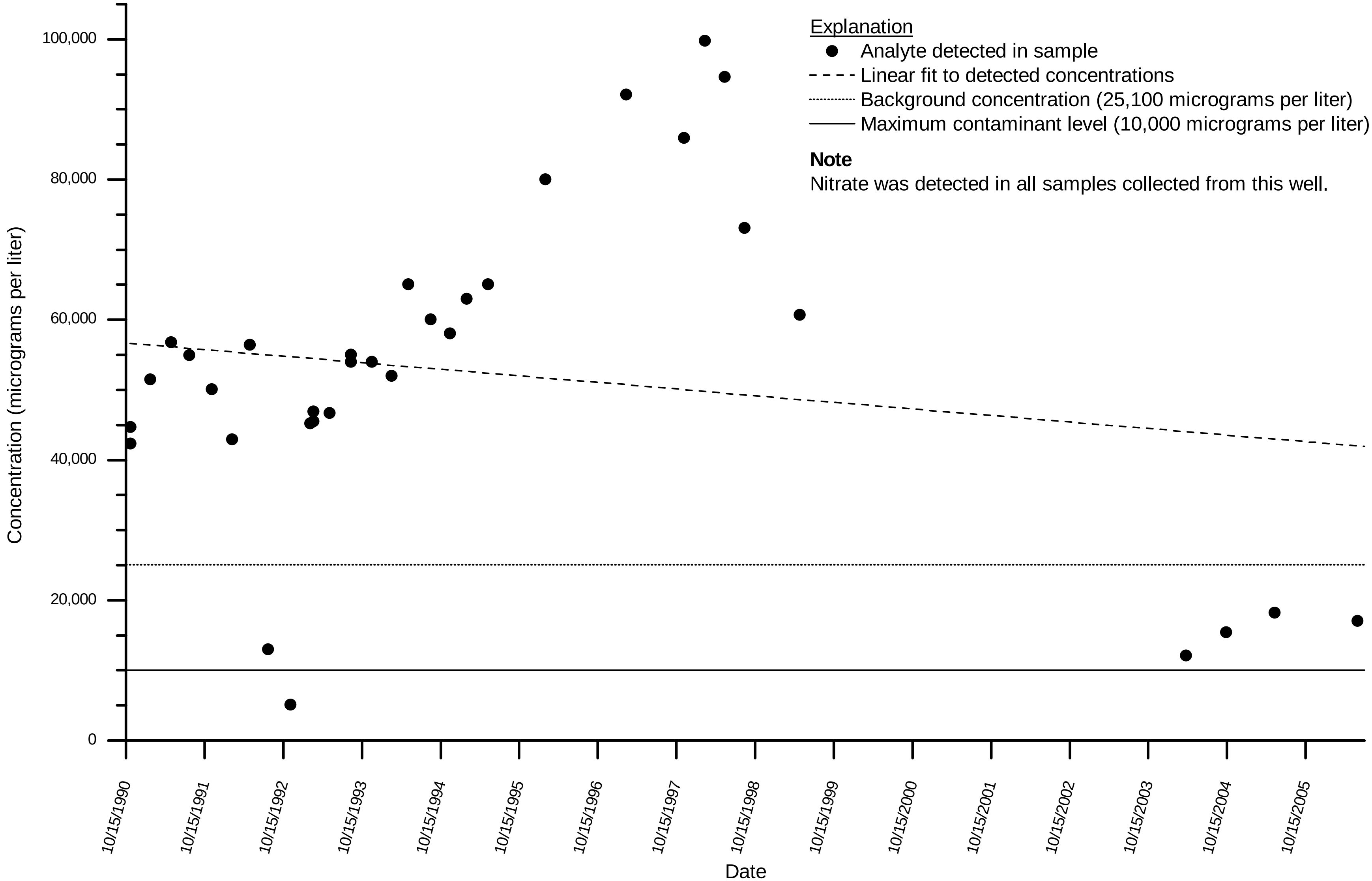

Figure F-16. Graph Showing Concentration of Nitrate Versus Time in Well UCD1-024

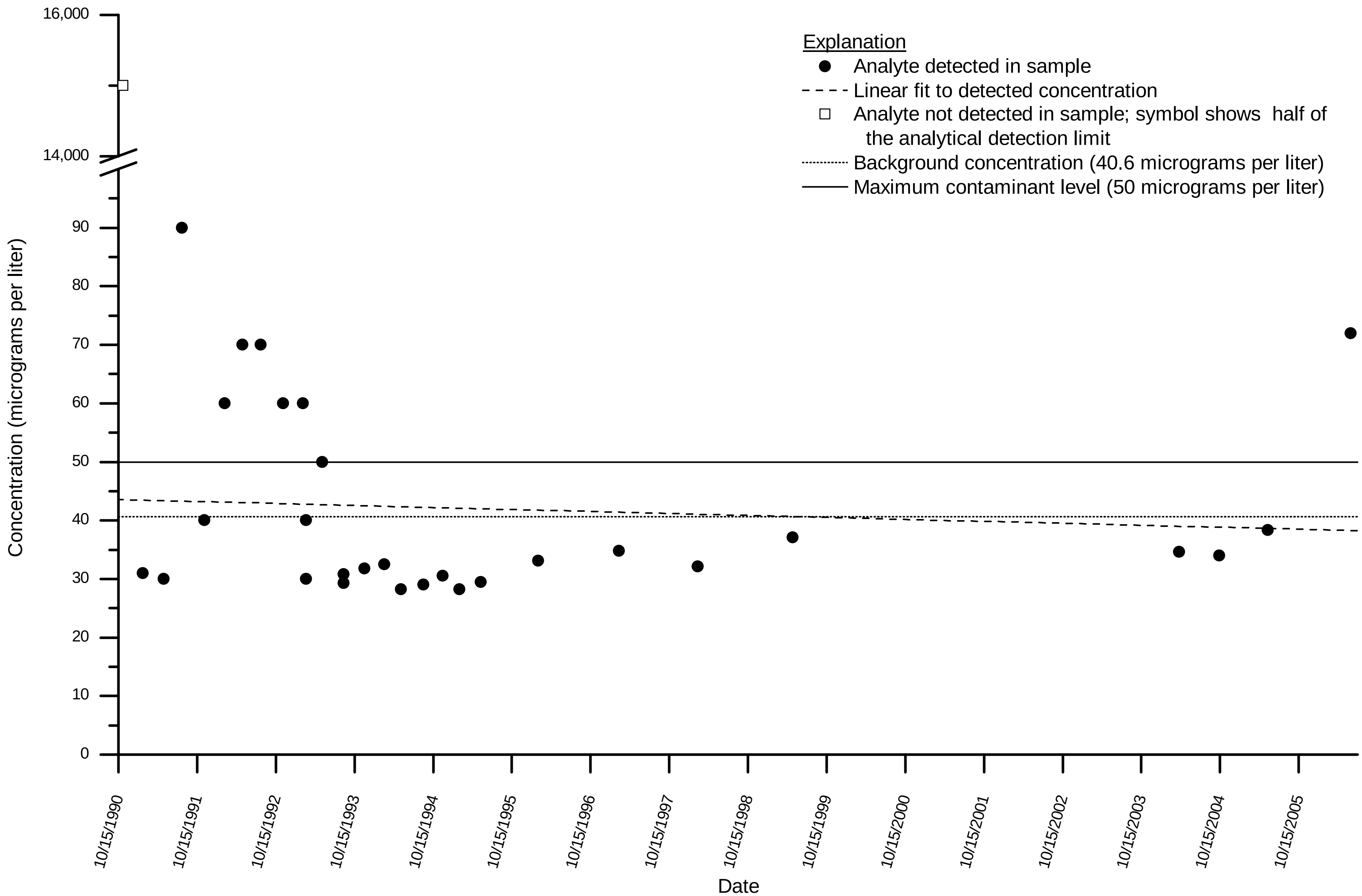

Figure F-17. Graph Showing Concentration of Chromium Versus Time in Well UCD1-024

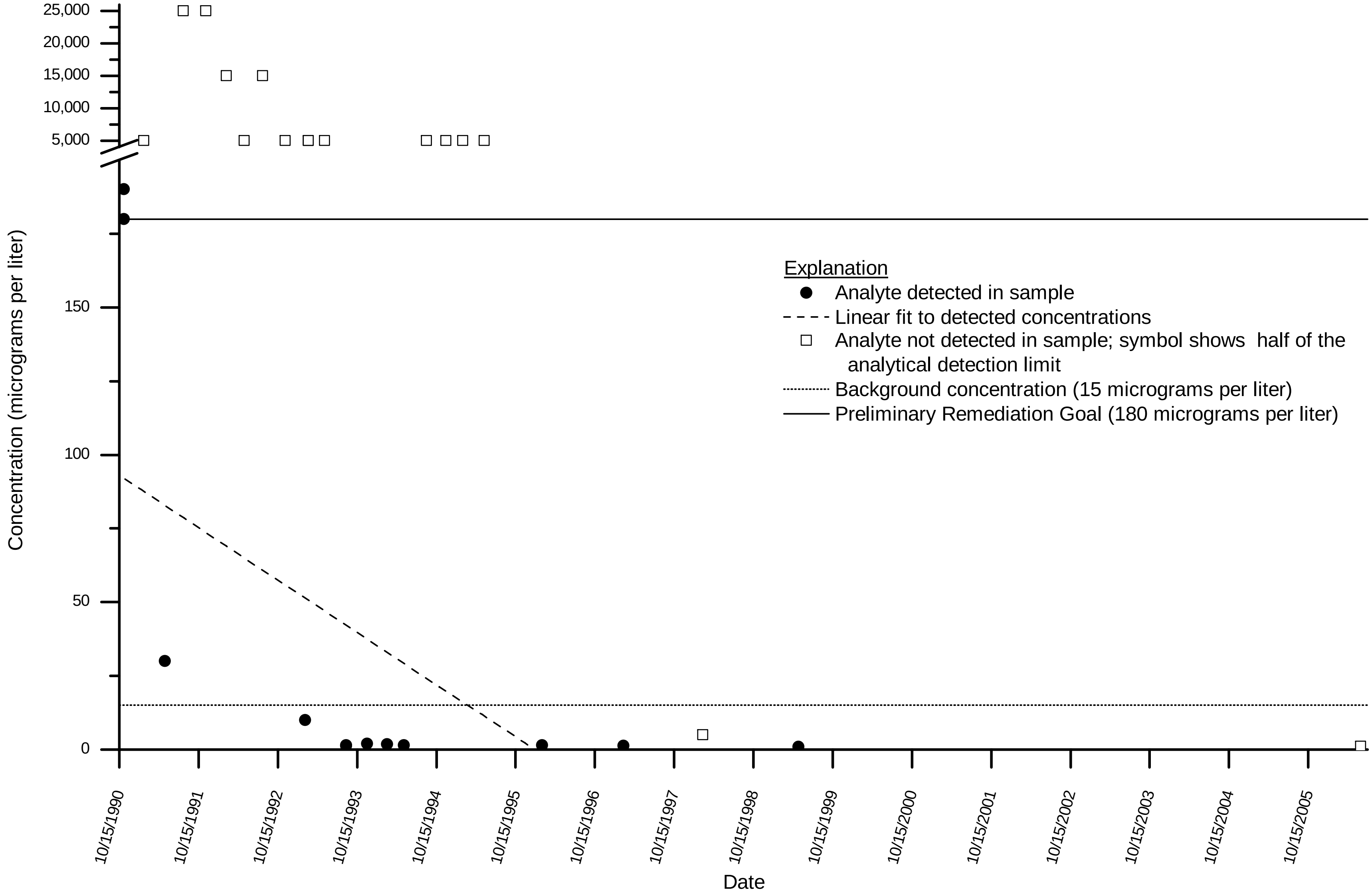

Figure F-18. Graph Showing Concentration of Molybdenum Versus Time in Well UCD1-024

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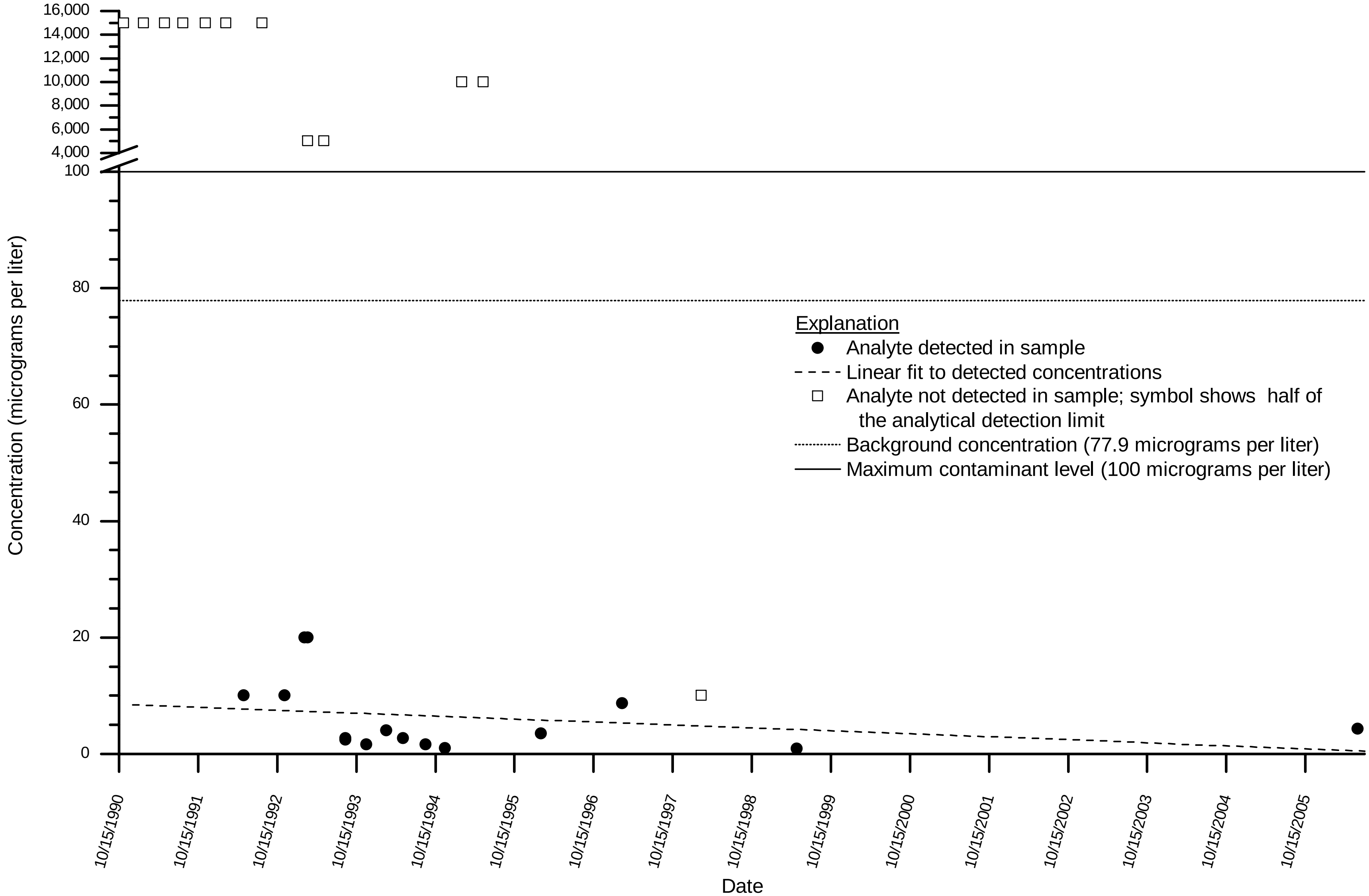

Figure F-19. Graph Showing Concentration of Nickel Versus Time in Well UCD1-024

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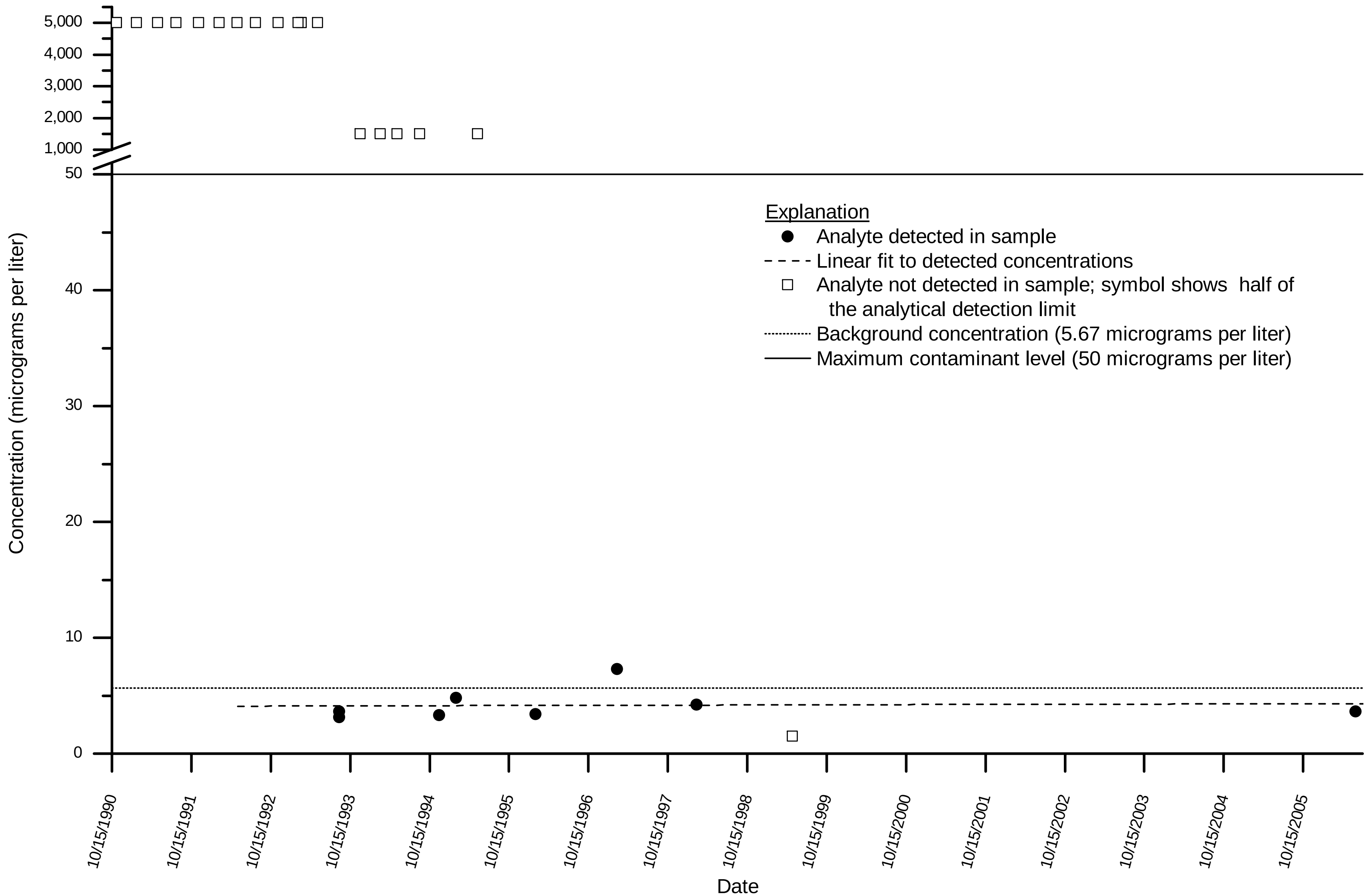

Figure F-20. Graph Showing Concentration of Selenium Versus Time in Well UCD1-024

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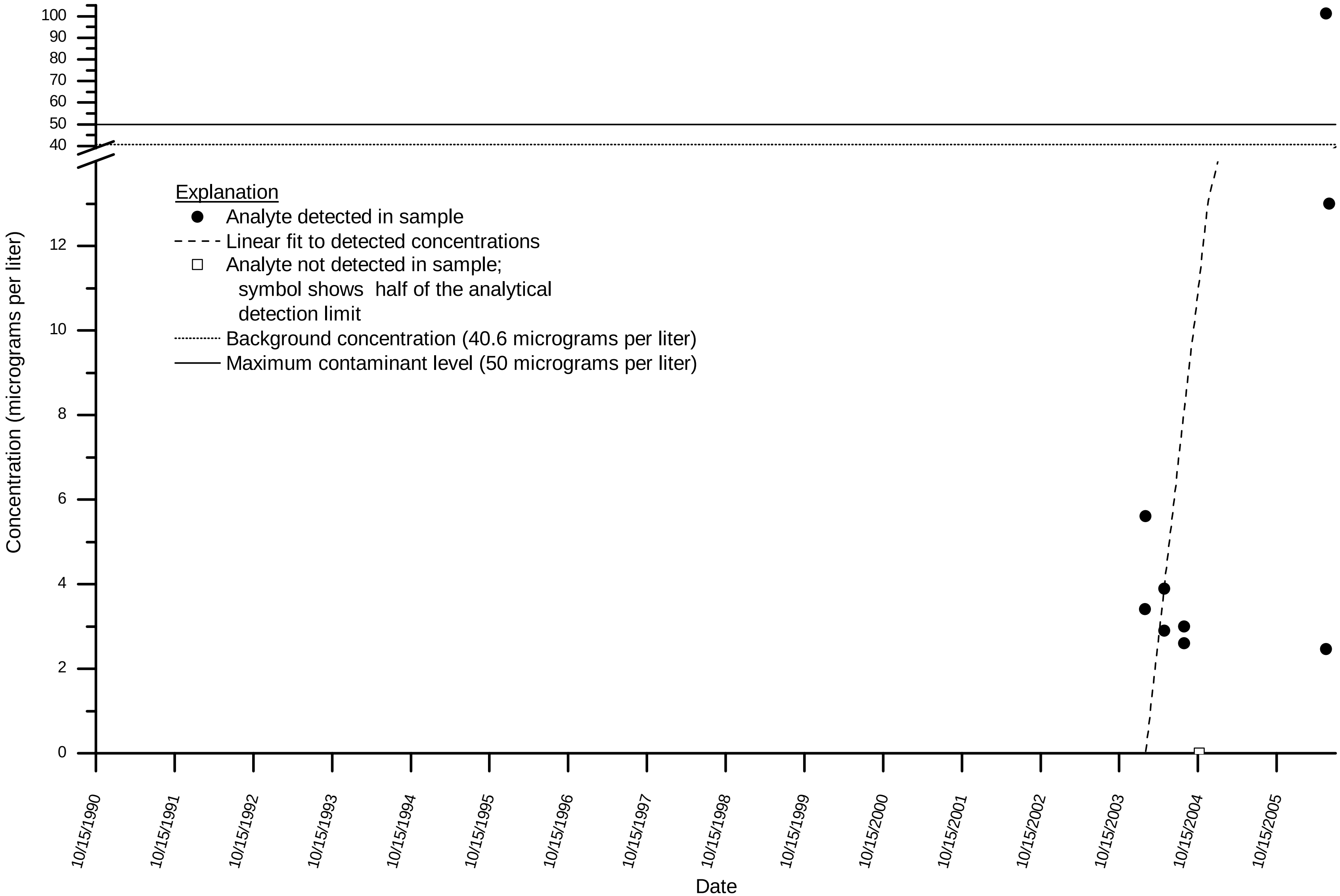

Figure F-21. Graph Showing Concentration of Chromium Versus Time in Well UCD1-054

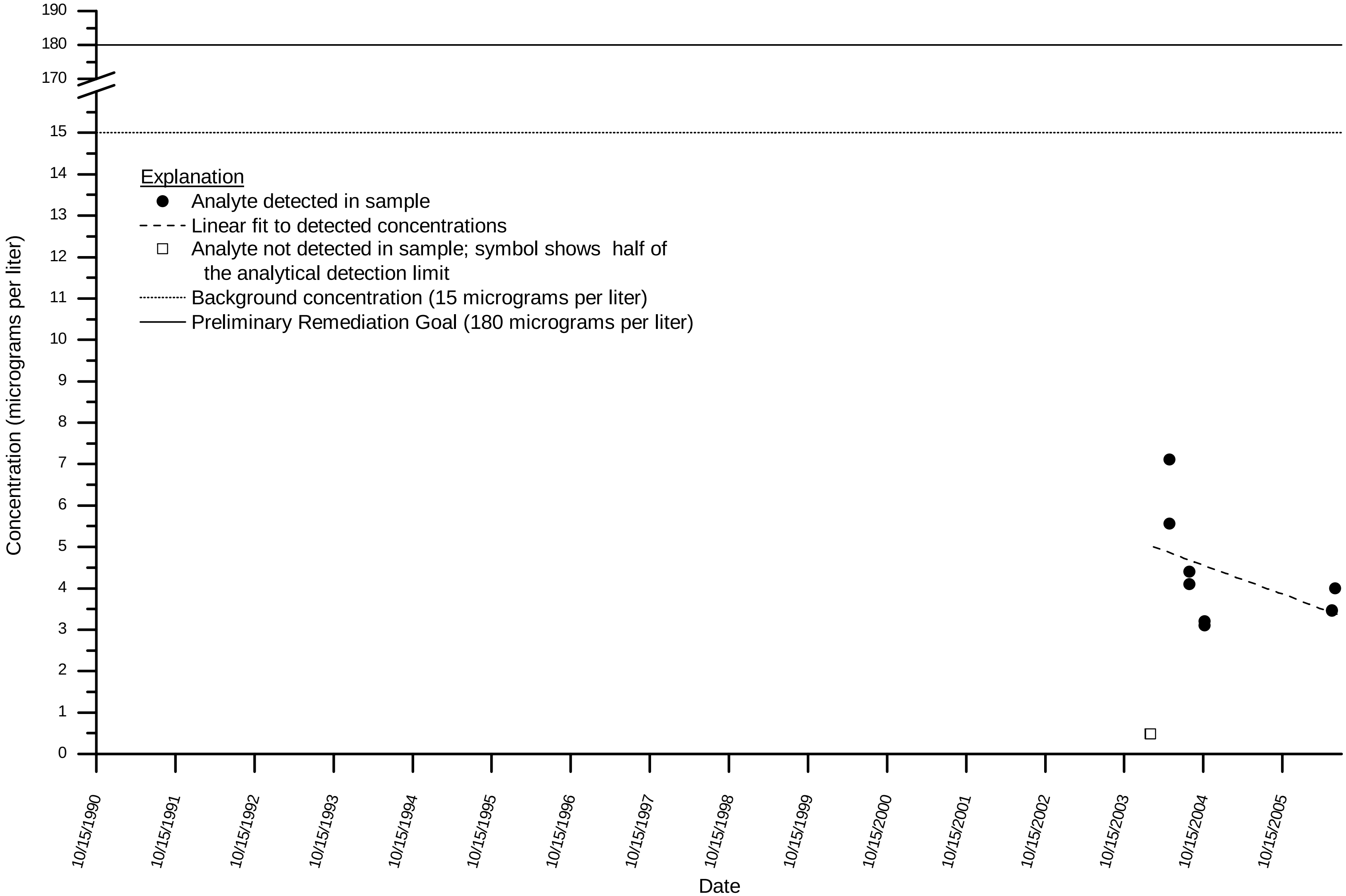

Figure F-22. Graph Showing Concentration of Molybdenum Versus Time in Well UCD1-054

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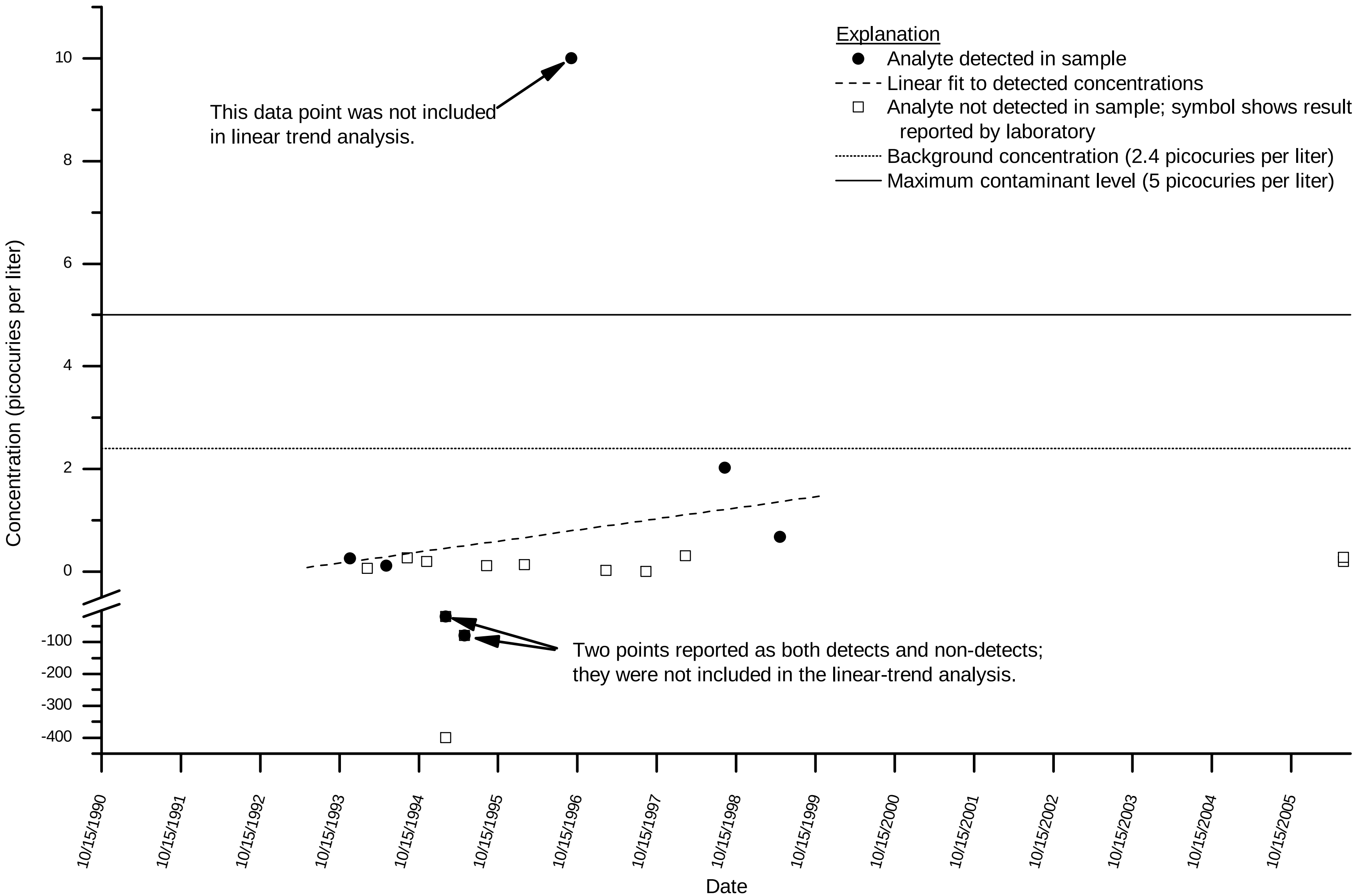

Figure F-23. Graph Showing Concentration of Radium-226 Versus Time in Well UCD2-007

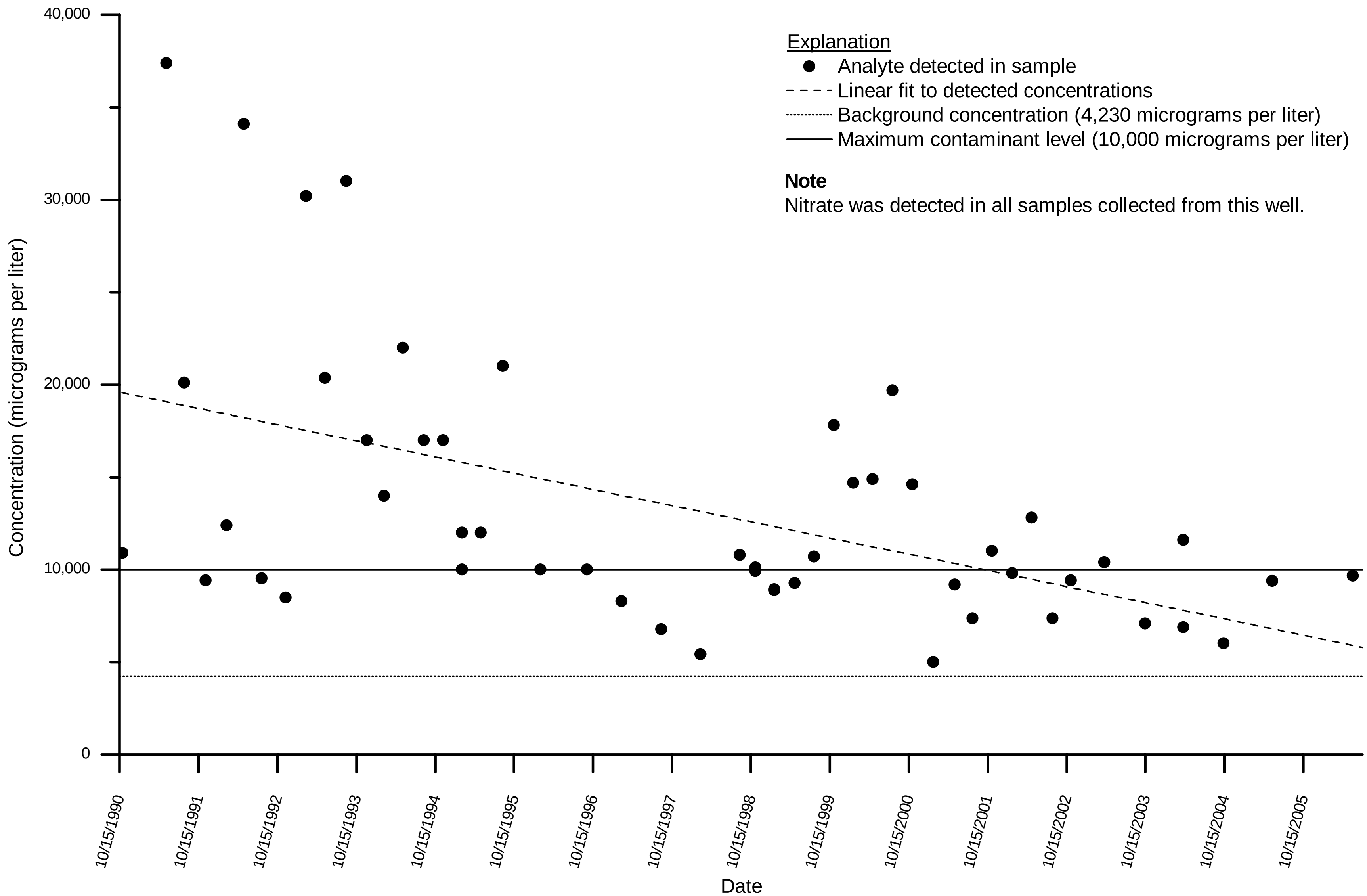

Figure F-24. Graph Showing Concentration of Nitrate Versus Time in Well UCD2-007

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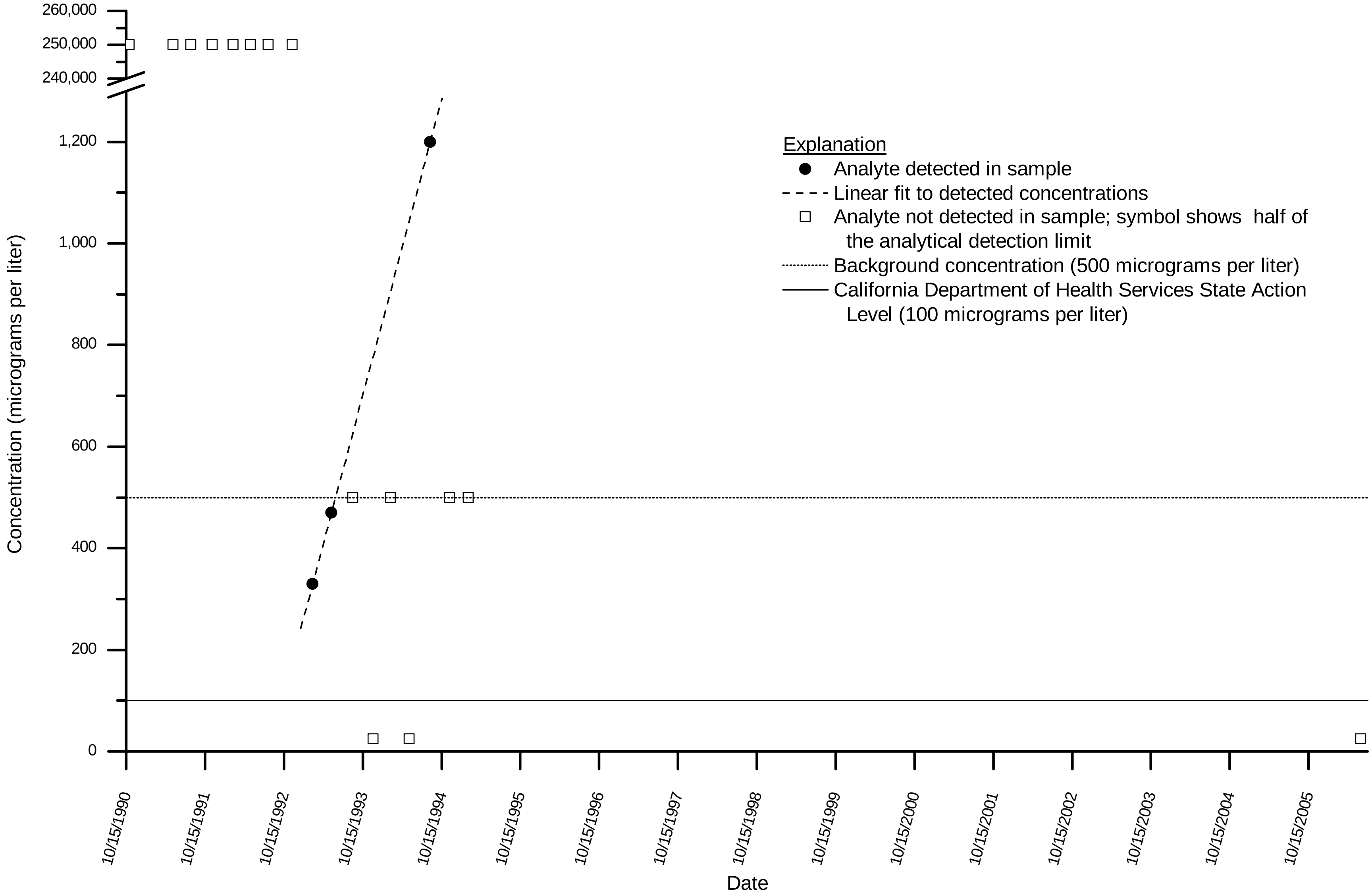

Figure F-25. Graph Showing Concentration of Formaldehyde Versus Time in Well UCD2-007

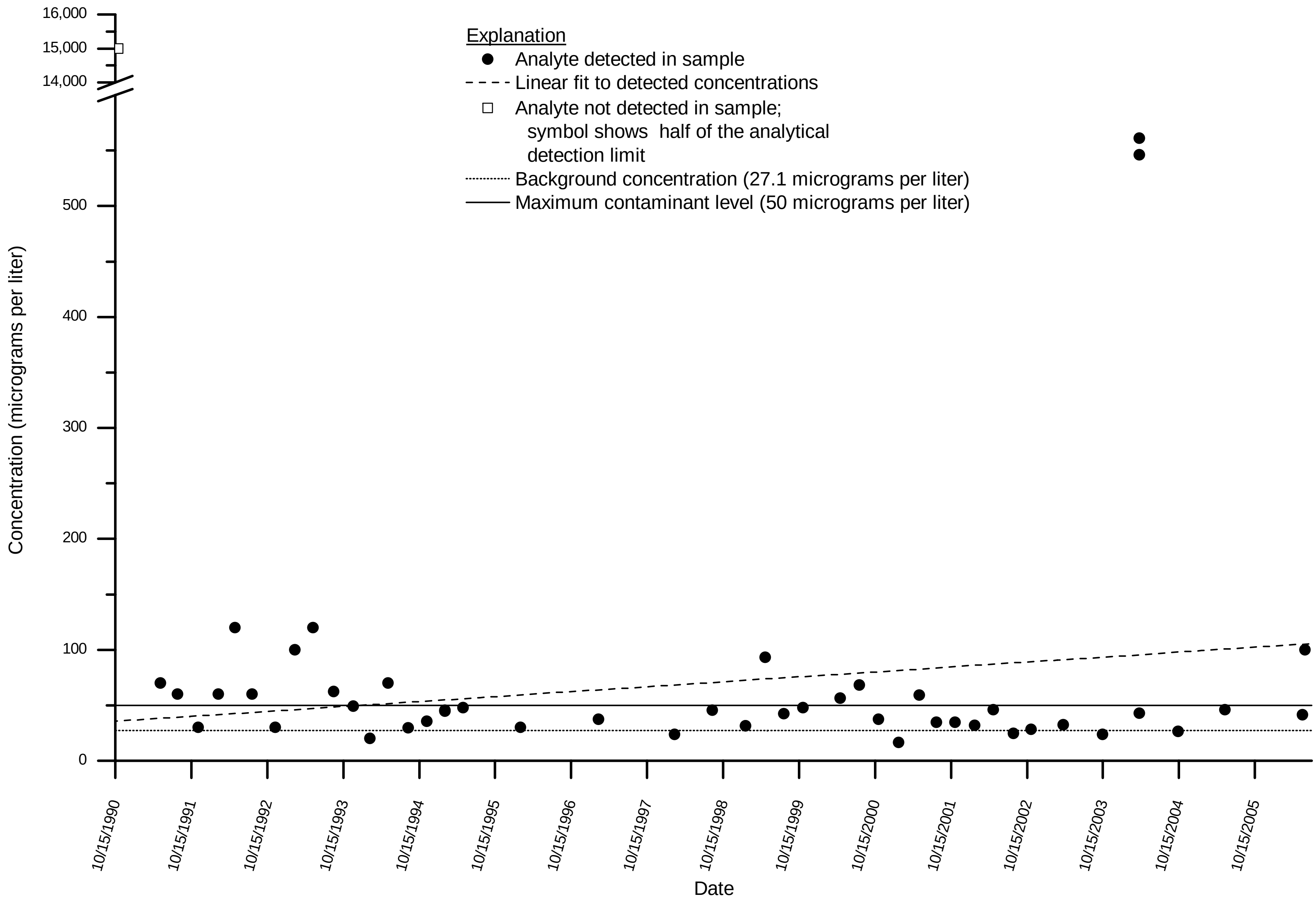

Figure F-26. Graph Showing Concentration of Chromium Versus Time in Well UCD2-007

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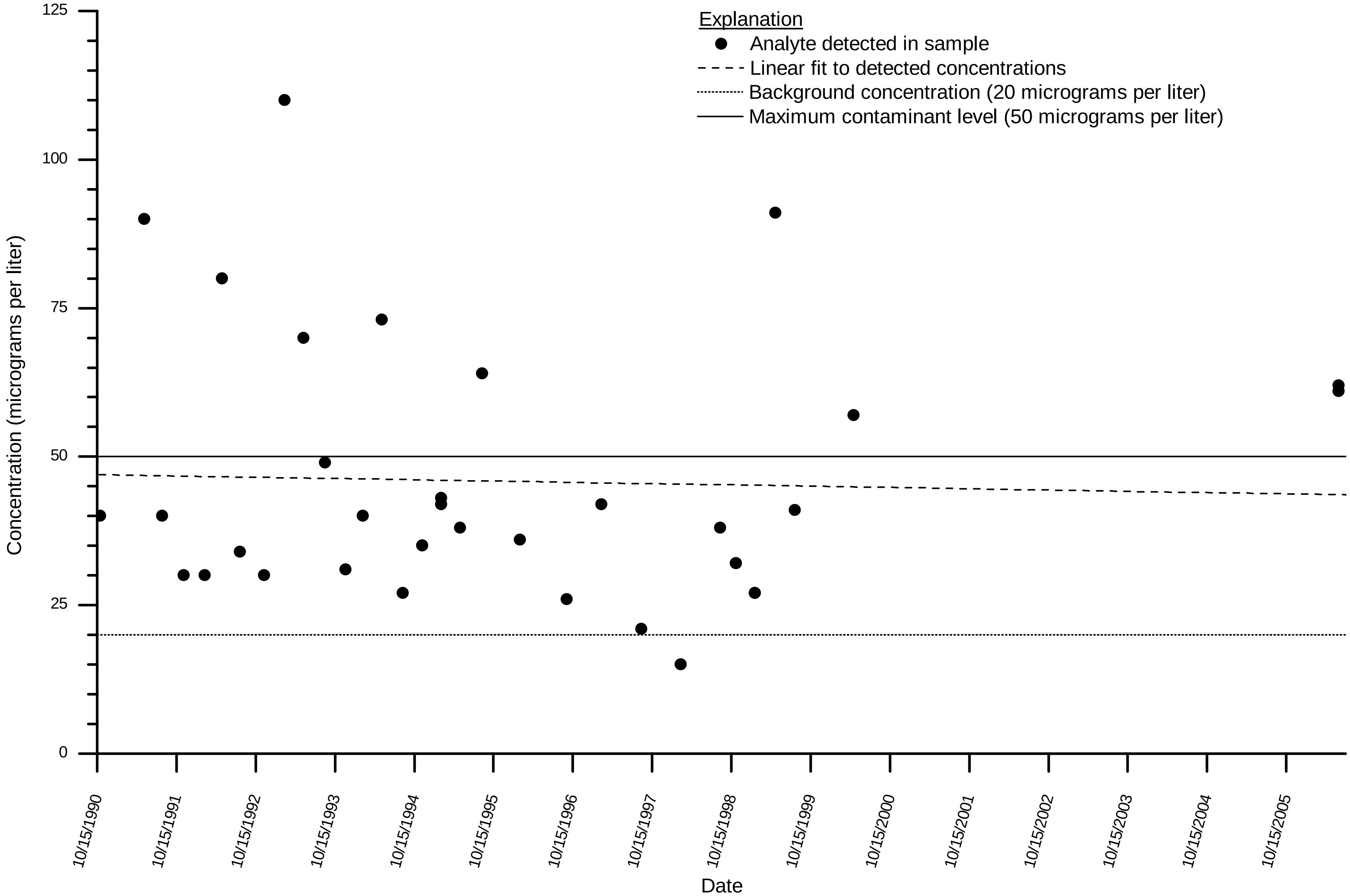

Figure F-27. Graph Showing Concentration of Hexavalent Chromium Versus Time in Well UCD2-007

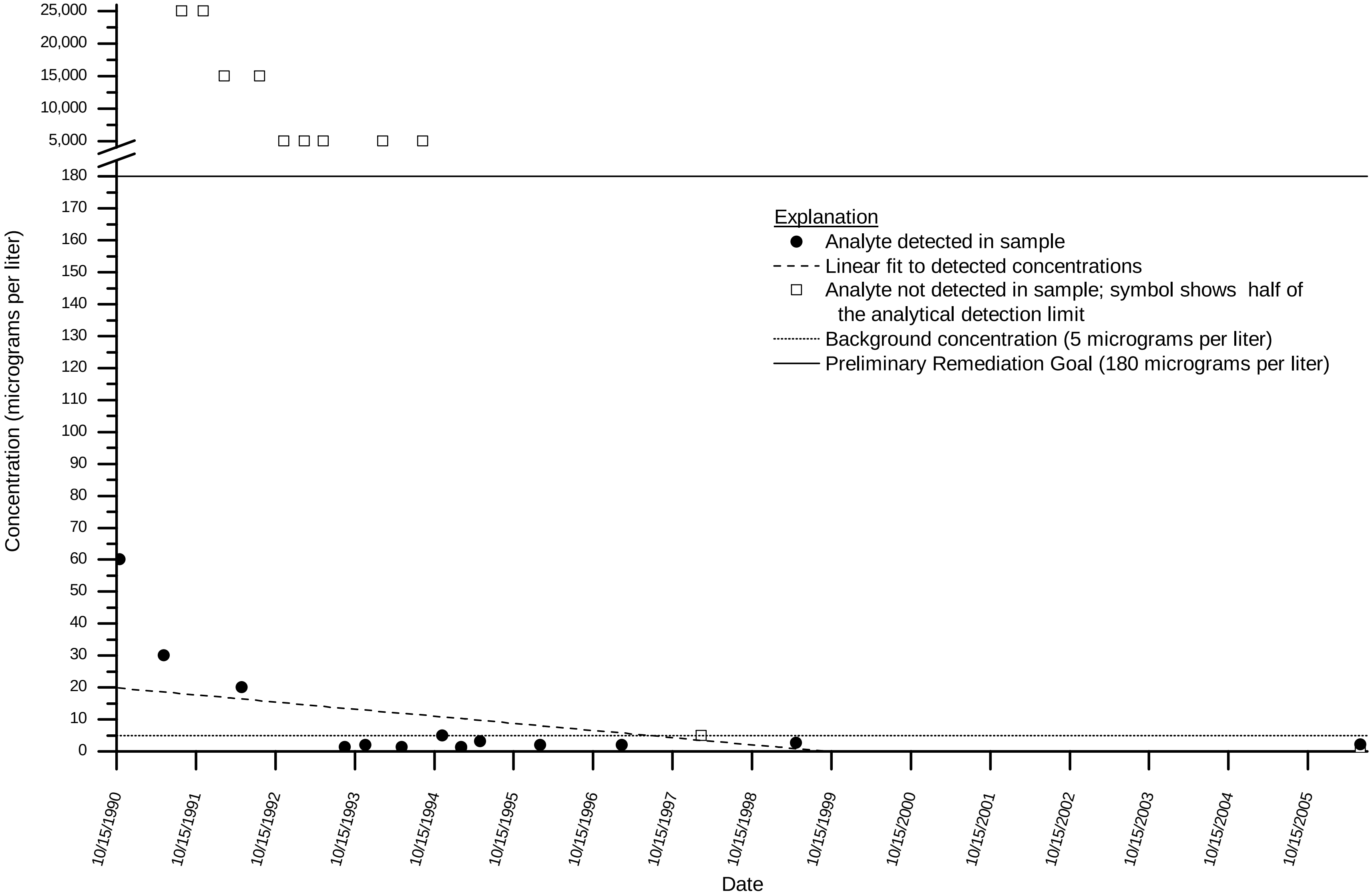

Figure F-28. Graph Showing Concentration of Molybdenum Versus Time in Well UCD2-007

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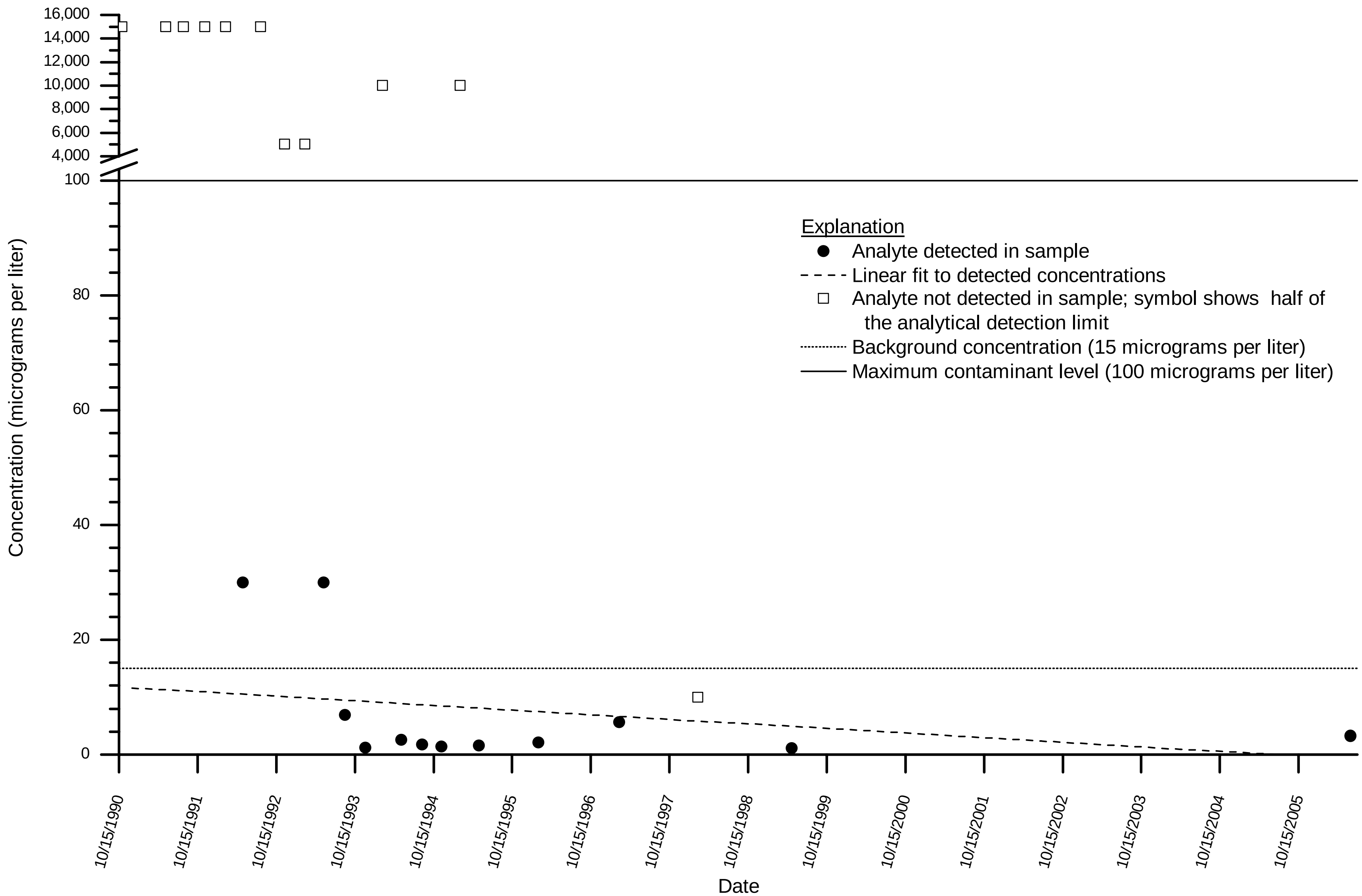

Figure F-29. Graph Showing Concentration of Nickel Versus Time in Well UCD2-007

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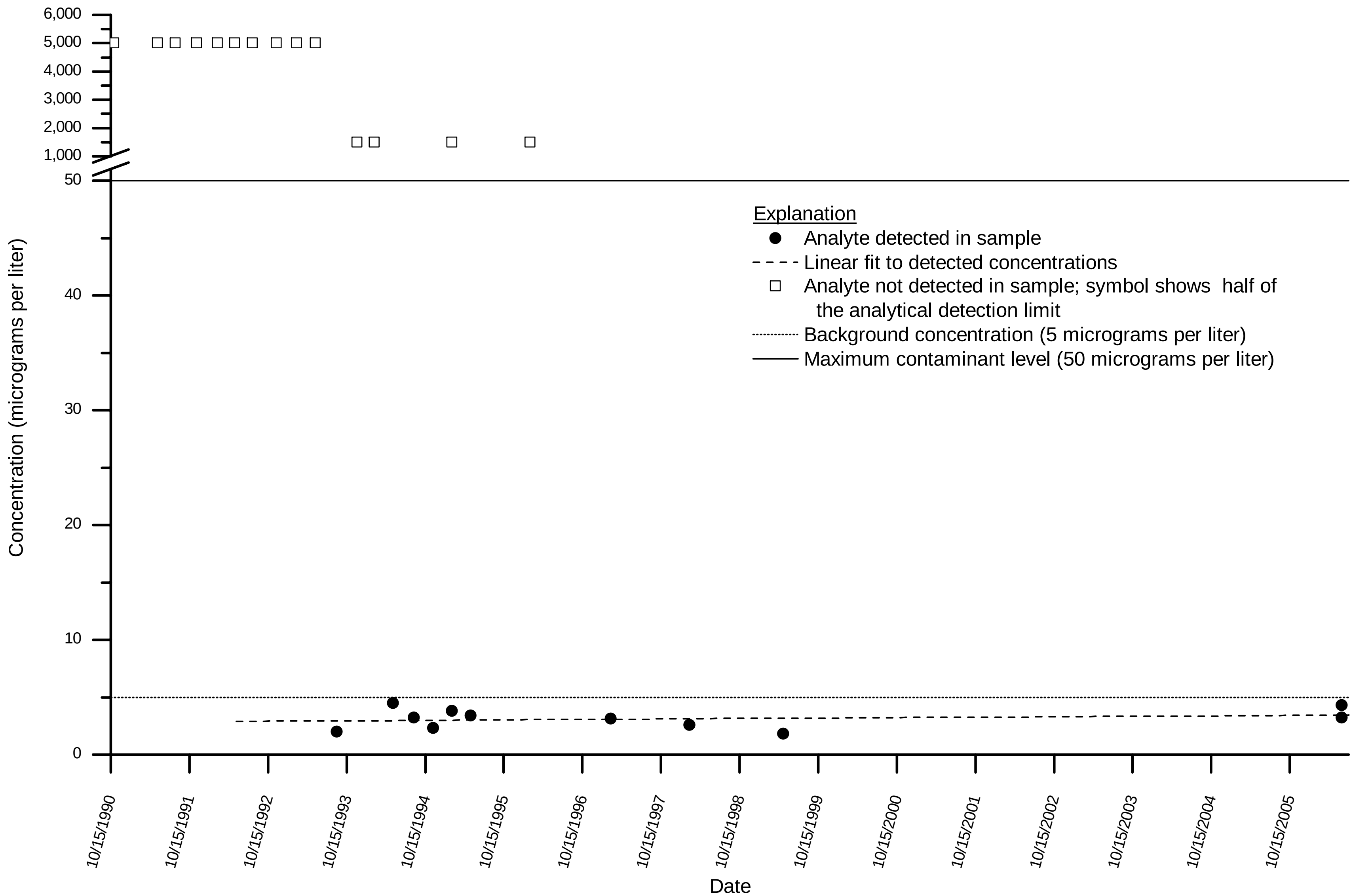

Figure F-30. Graph Showing Concentration of Selenium Versus Time in Well UCD2-007

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29-Sep-2007

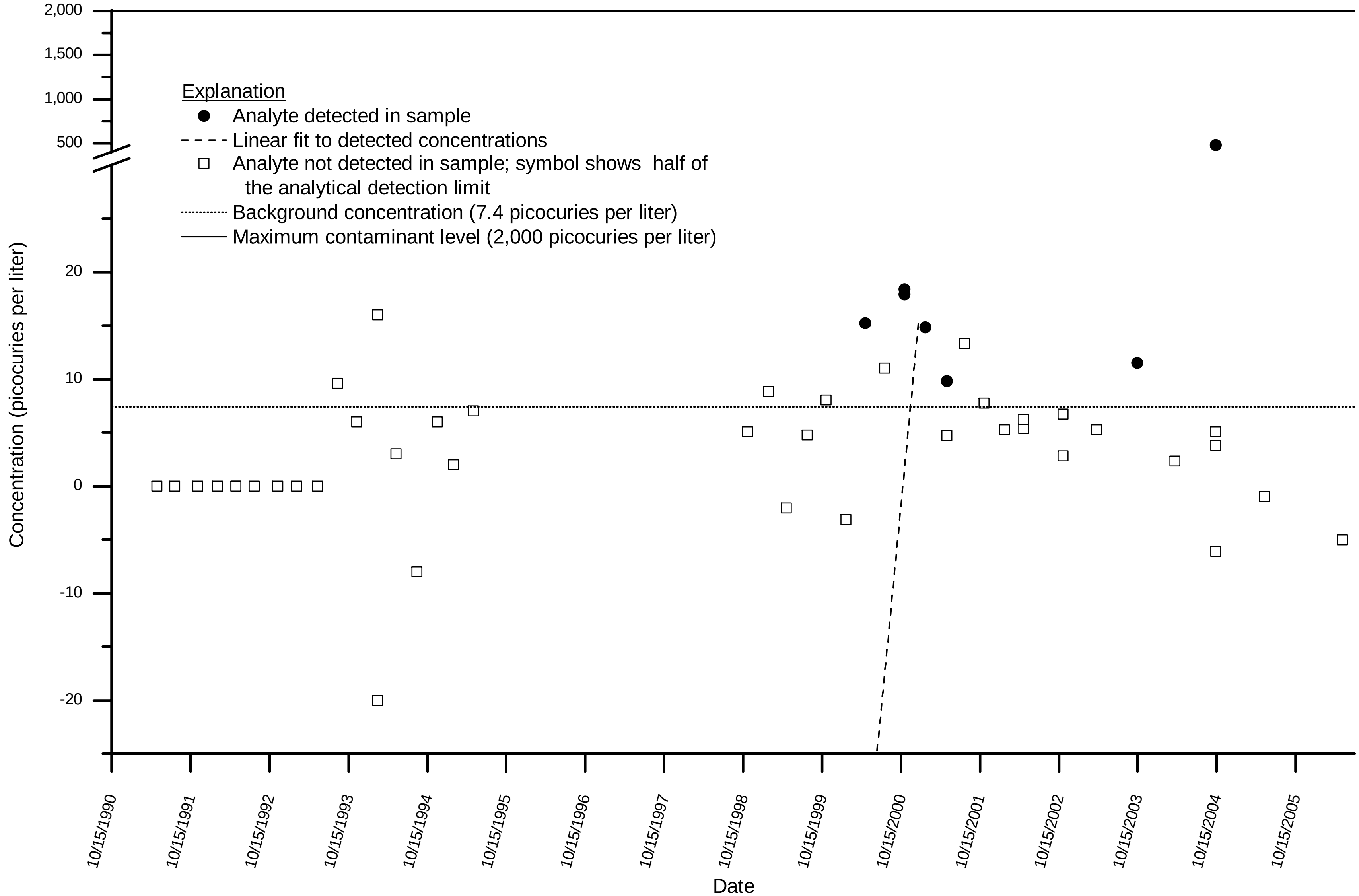

Figure F-31. Graph Showing Concentration of Carbon-14 Versus Time in Well UCD2-015

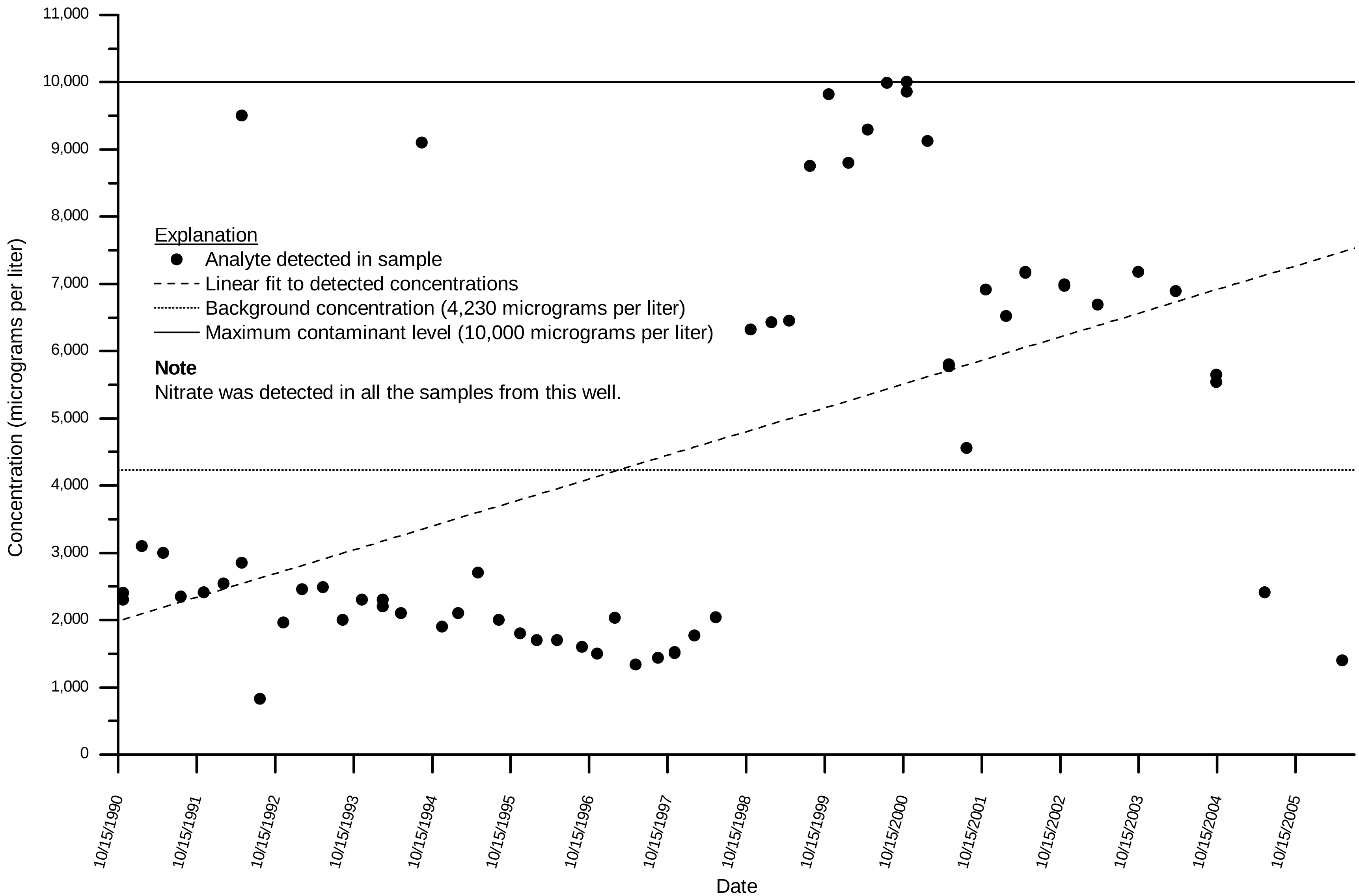

Figure F-32. Graph Showing Concentration of Nitrate Versus Time in Well UCD2-015

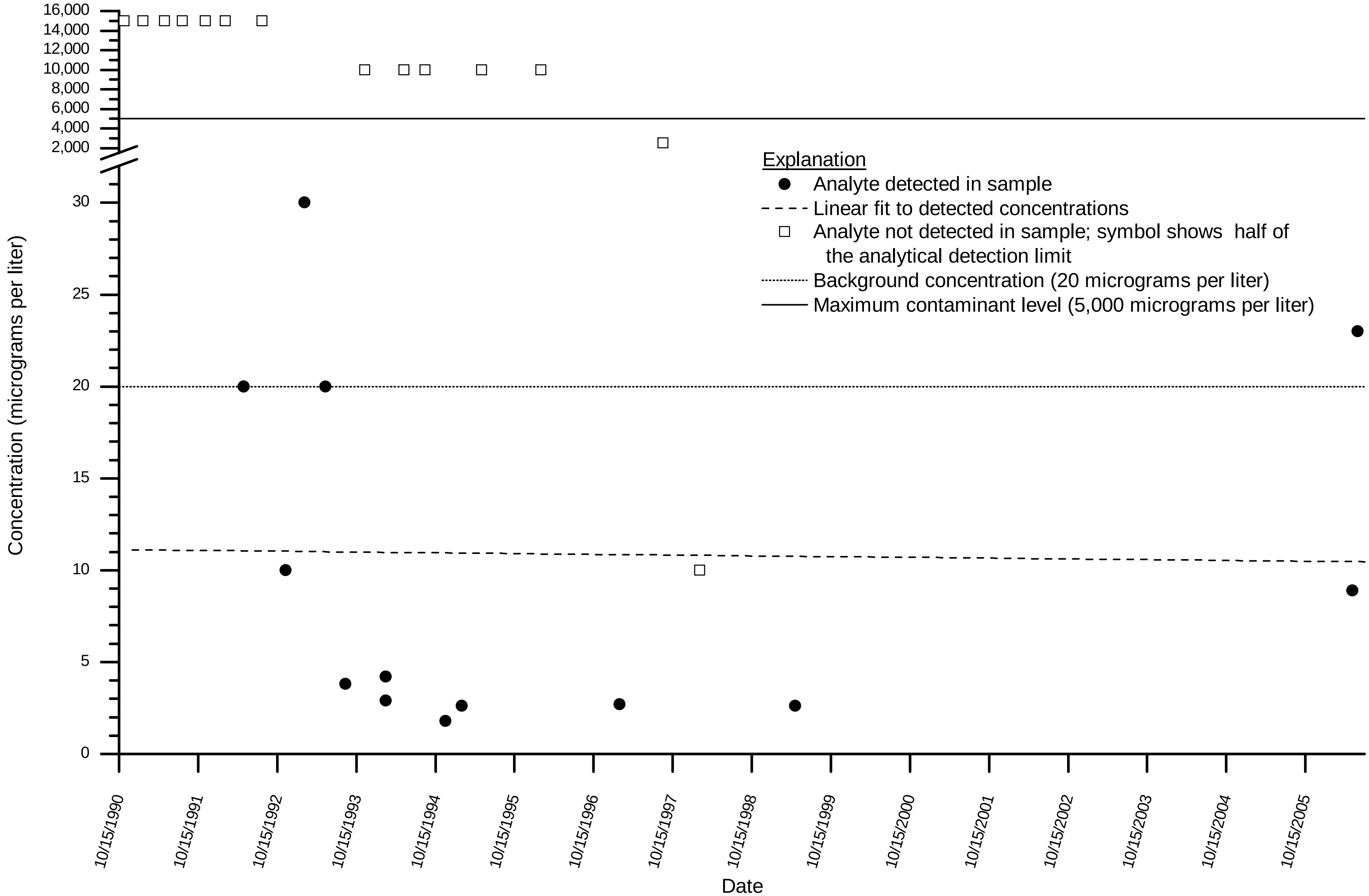

Figure F-33. Graph Showing Concentration of Zinc Versus Time in Well UCD2-015

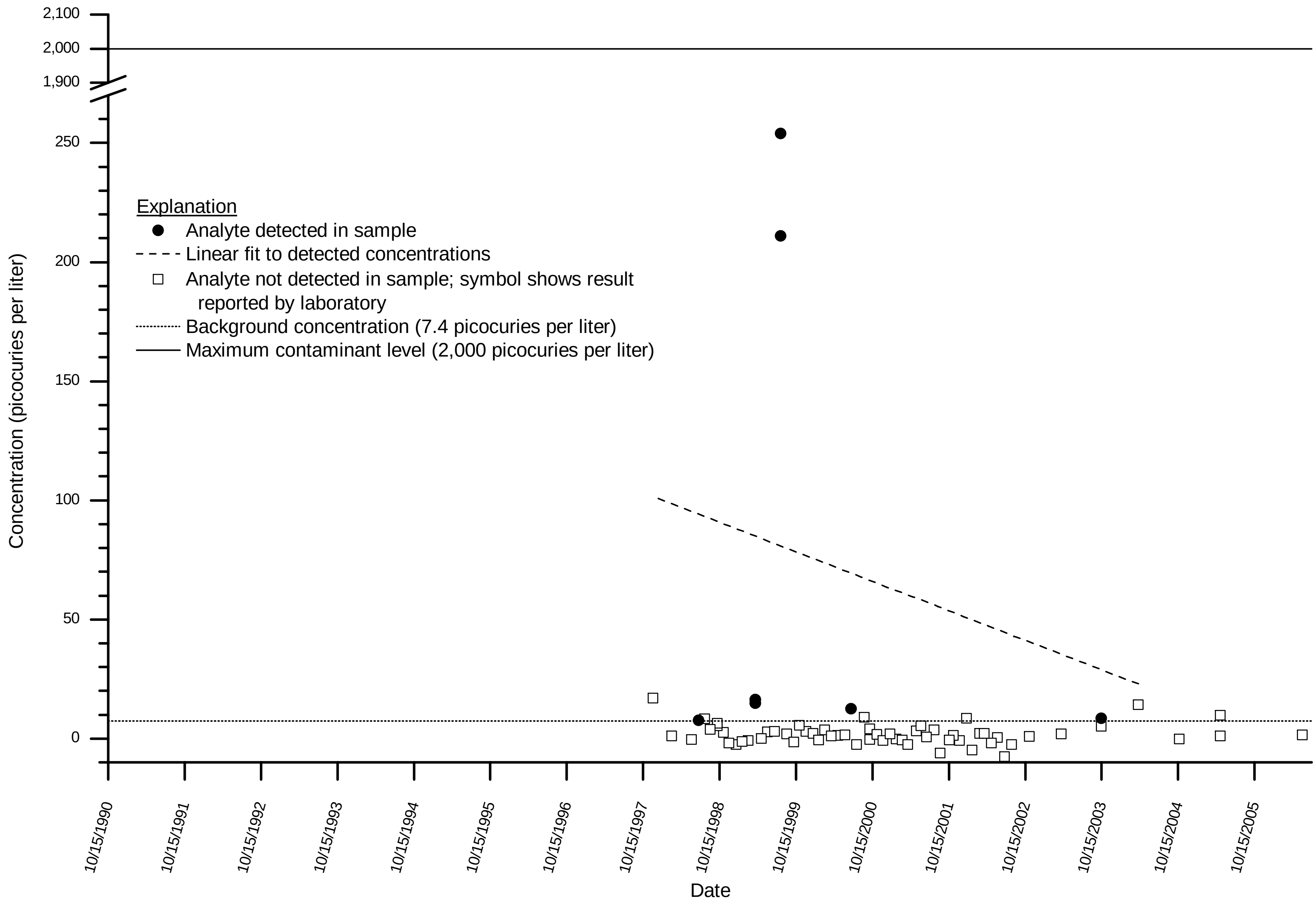

Figure F-34. Graph Showing Concentration of Carbon-14 Versus Time in Well UCD2-036

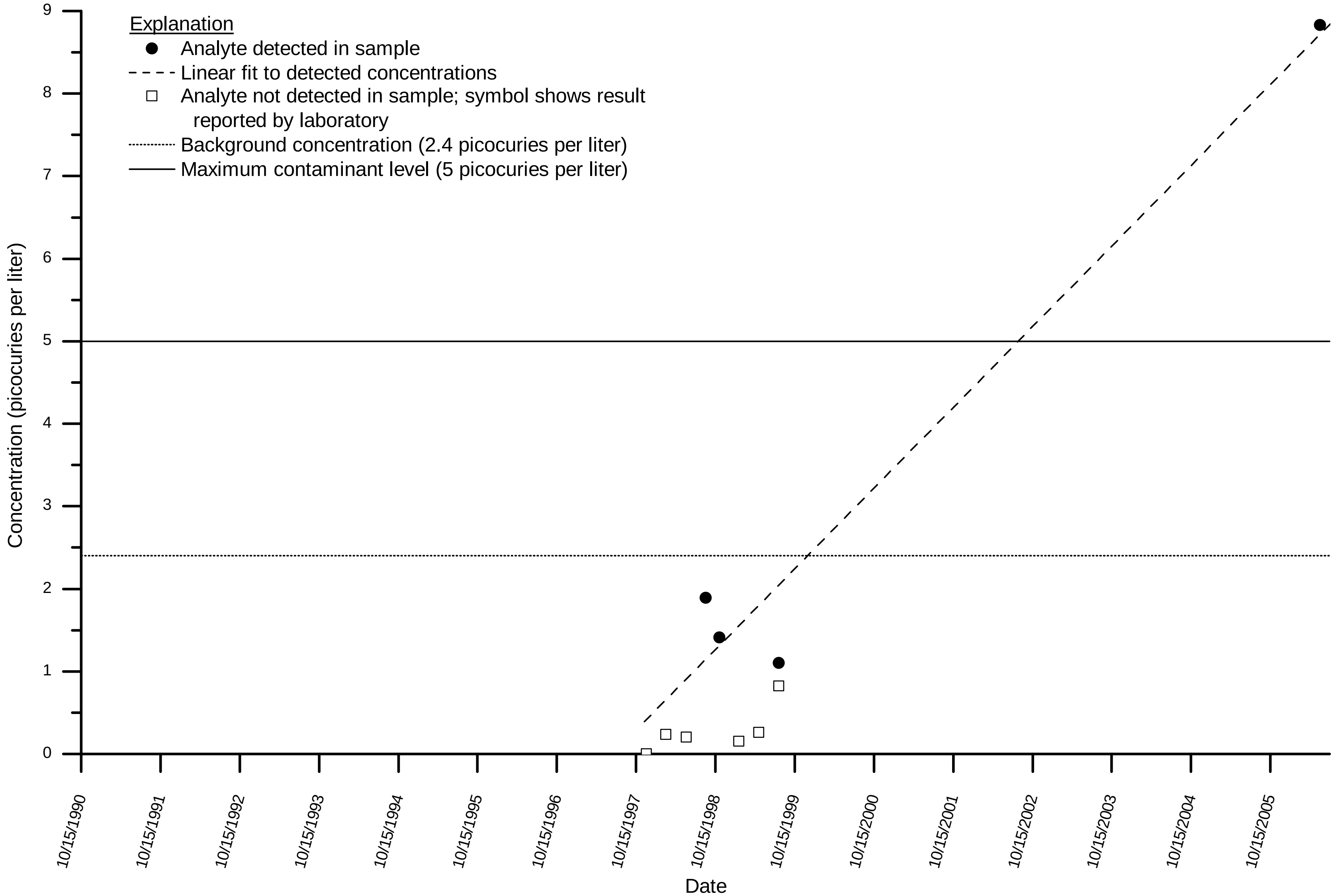

Figure F-35. Graph Showing Concentration of Radium-226 Versus Time in Well UCD2-036

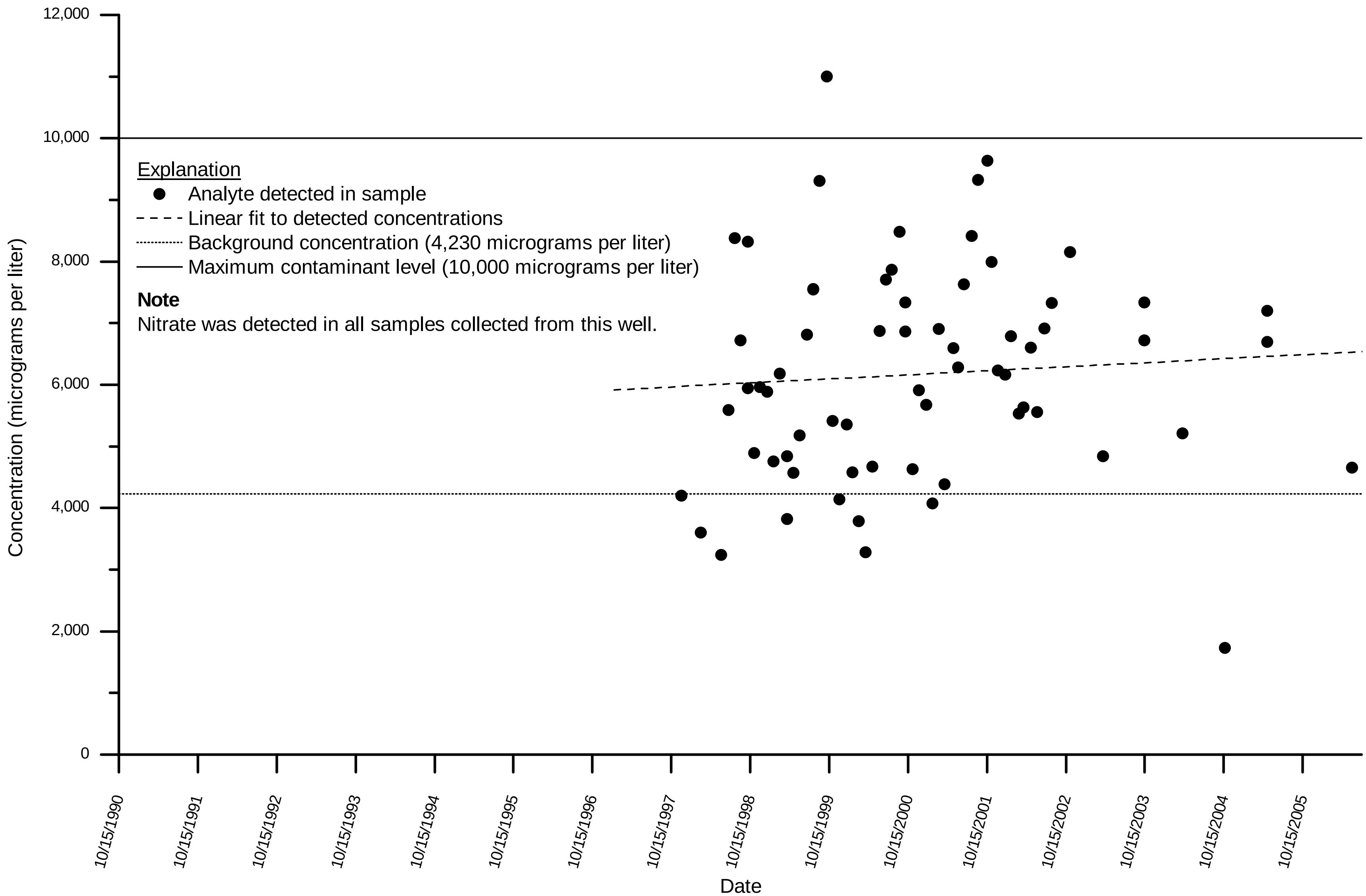

Figure F-36. Graph Showing Concentration of Nitrate Versus Time in Well UCD2-036

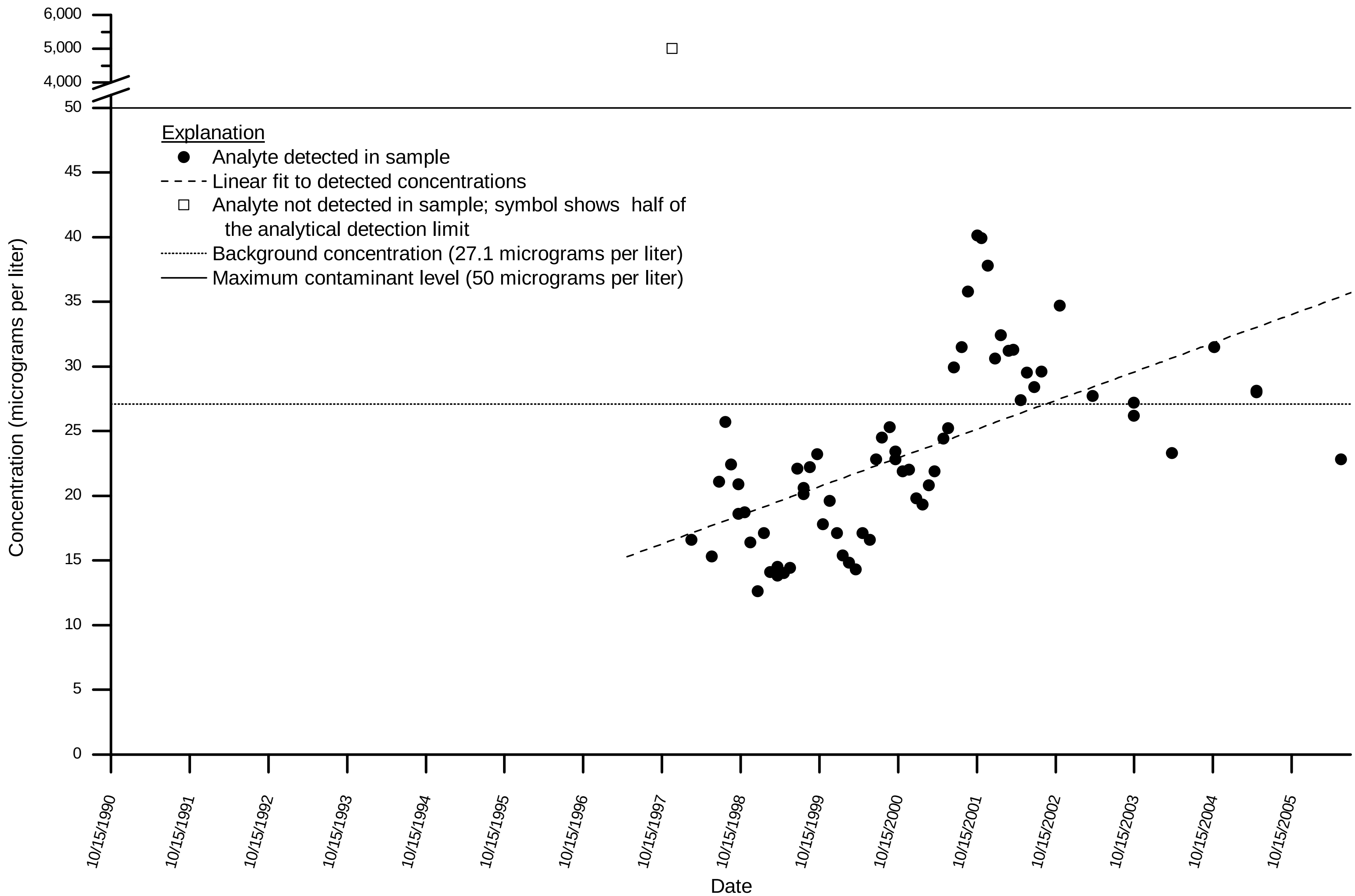

Figure F-37. Graph Showing Concentration of Chromium Versus Time in Well UCD2-036

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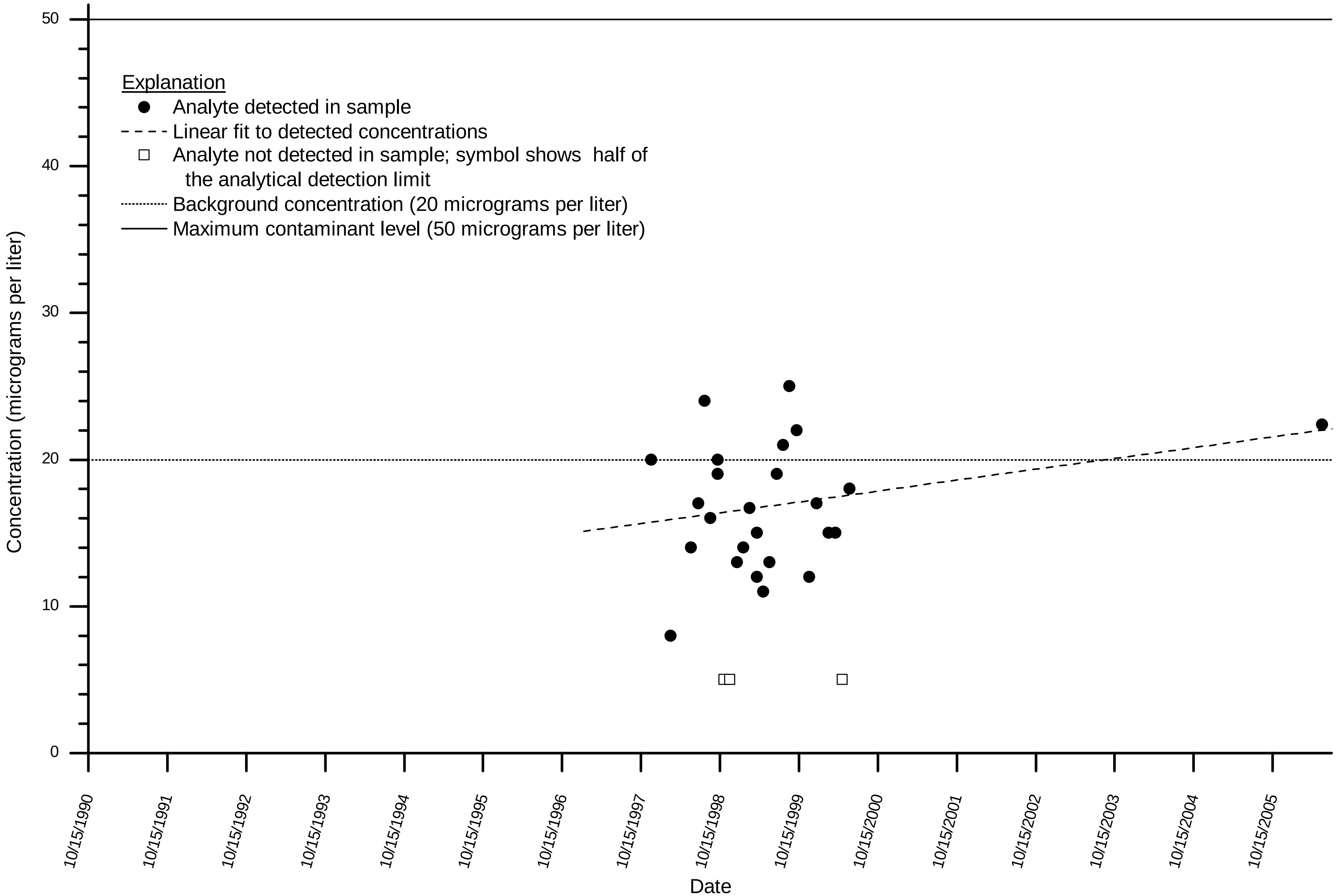

Figure F-38. Graph Showing Concentration of Hexavalent Chromium Versus Time in Well UCD2-036

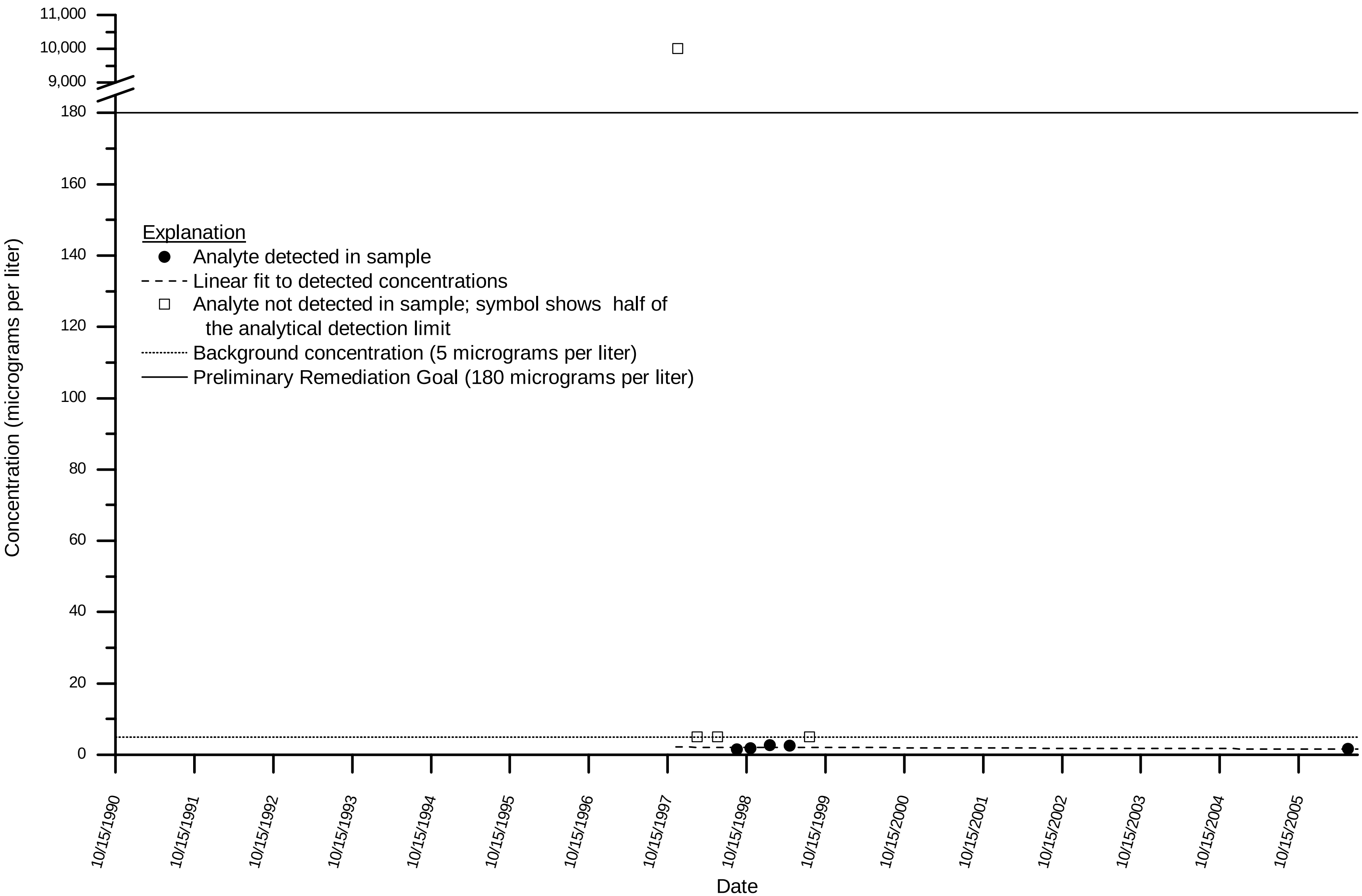

Figure F-39. Graph Showing Concentration of Molybdenum Versus Time in Well UCD2-036

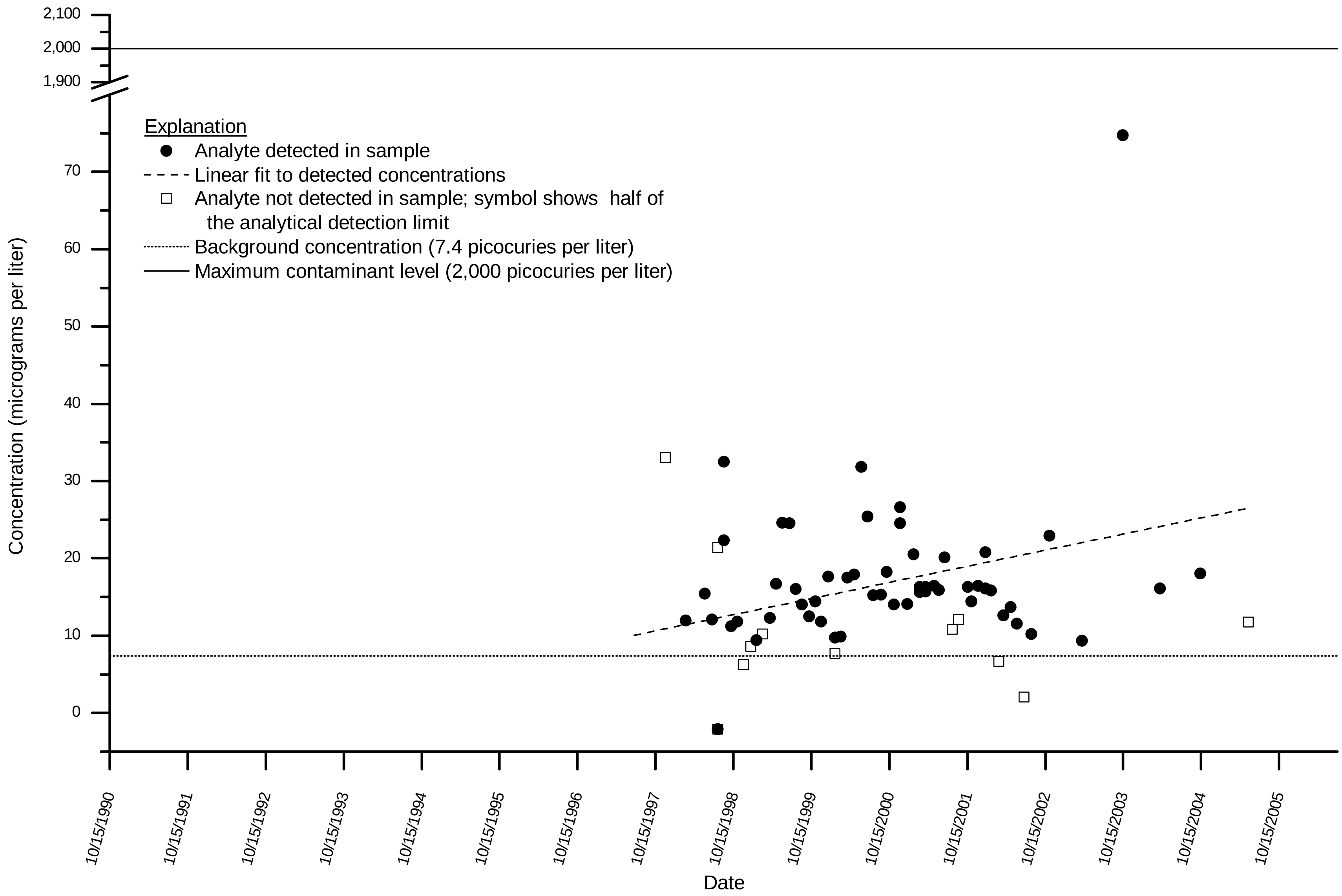

Figure F-40. Graph Showing Concentration of Carbon-14 Versus Time in Well UCD2-039

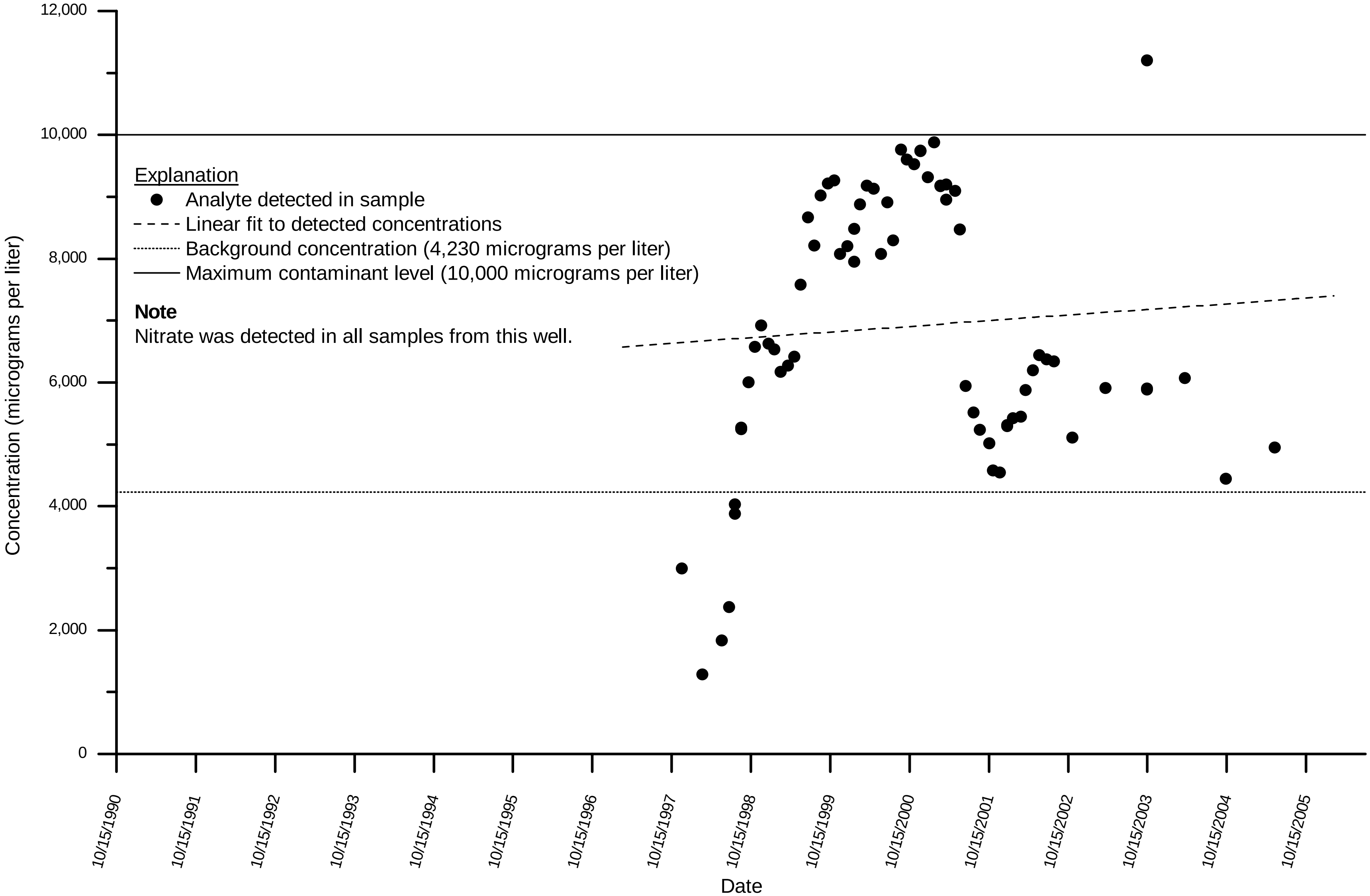

Figure F-41. Graph Showing Concentration of Nitrate Versus Time in Well UCD2-039

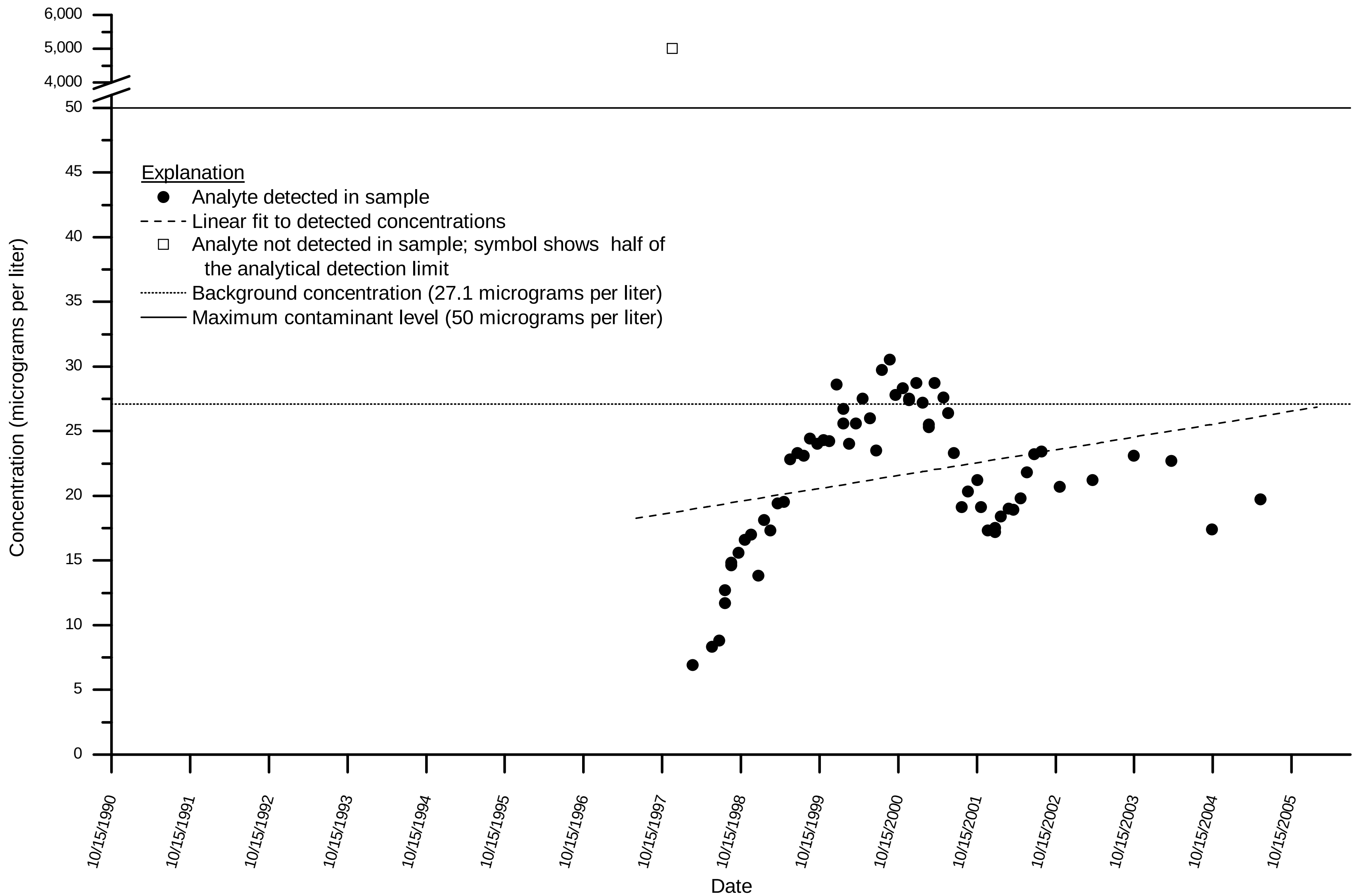

Figure F-42. Graph Showing Concentration of Chromium Versus Time in Well UCD2-039

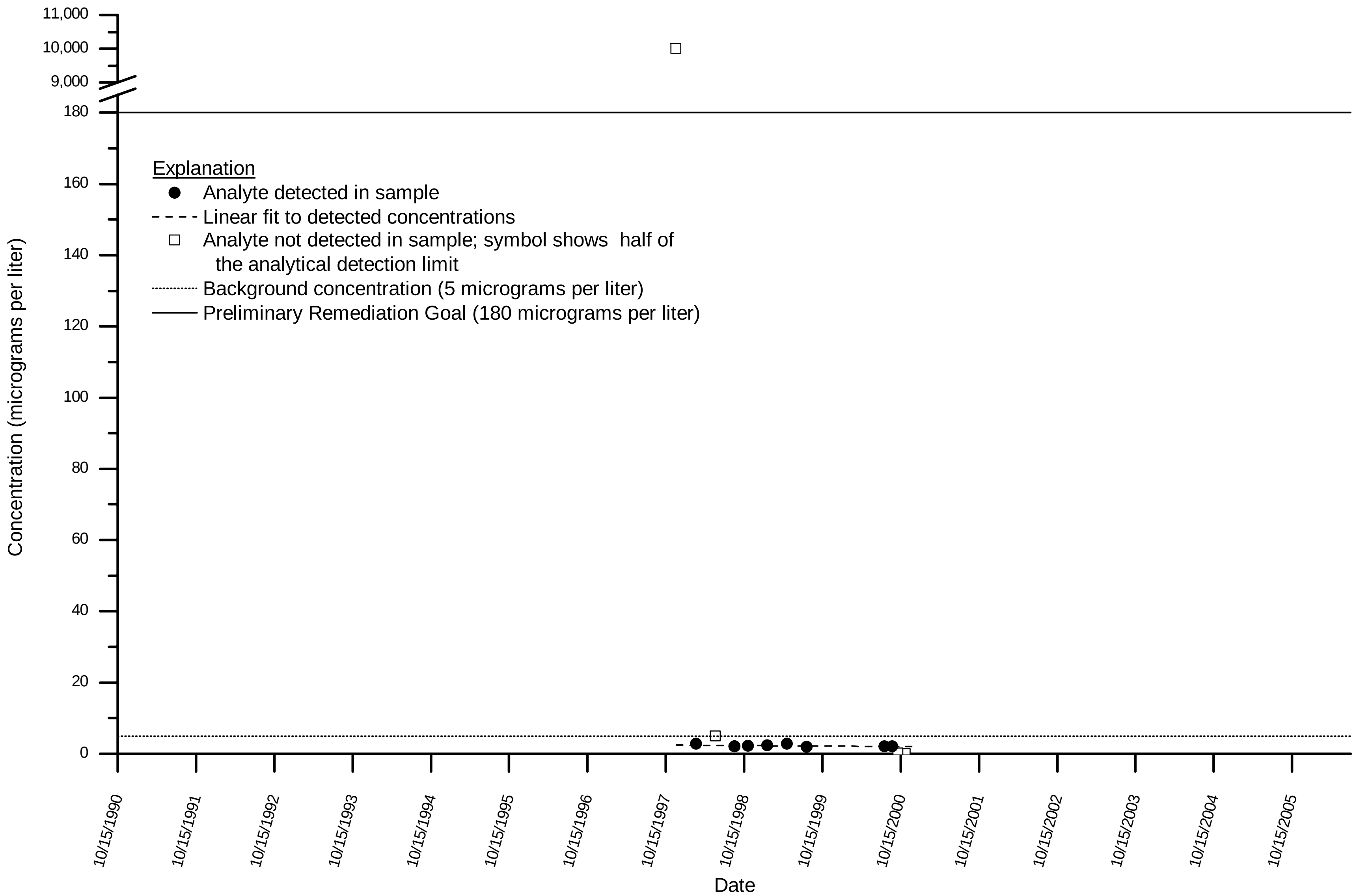

Figure F-43. Graph Showing Concentration of Molybdenum Versus Time in Well UCD2-039

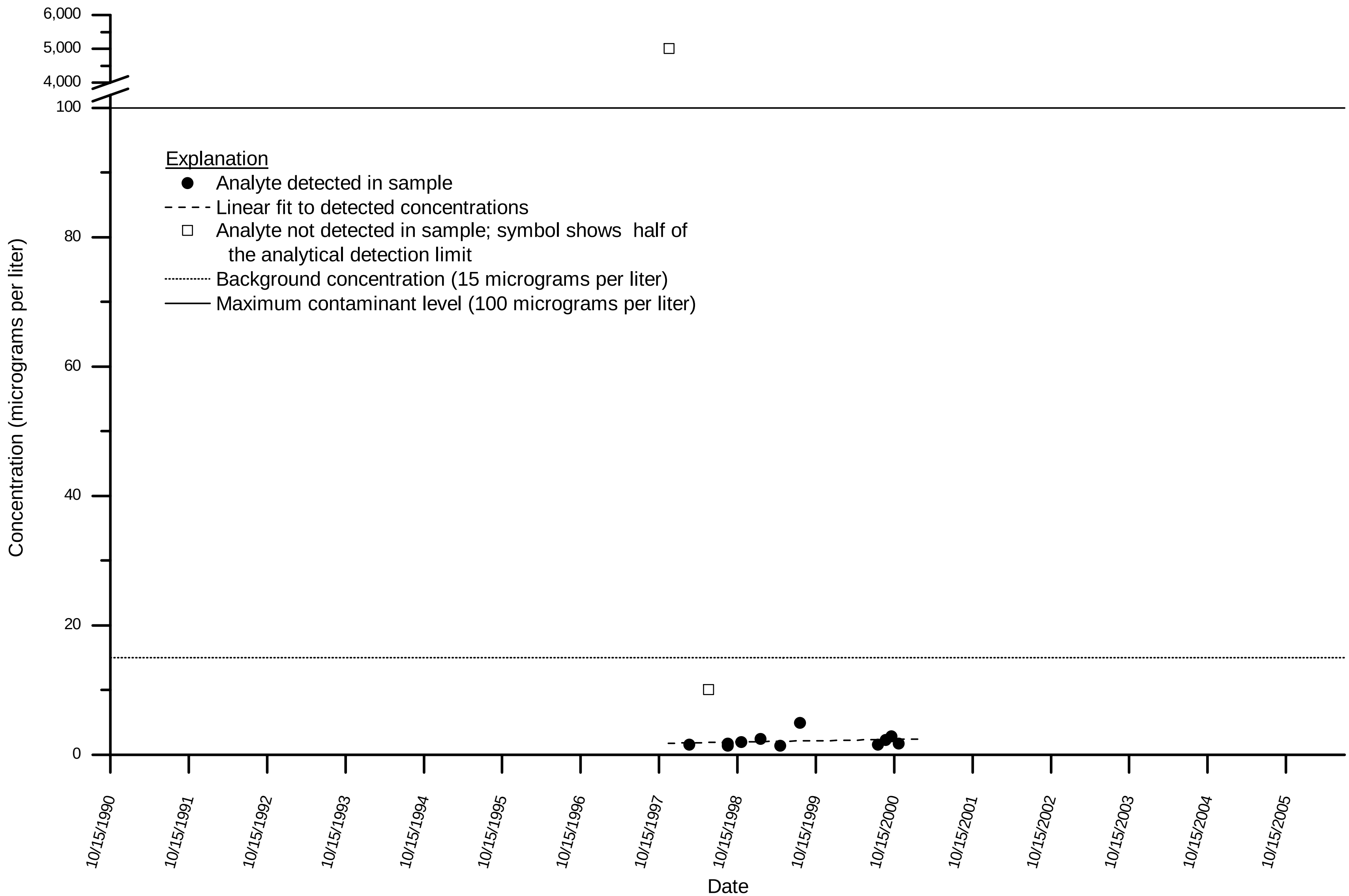

Figure F-44. Graph Showing Concentration of Nickel Versus Time in Well UCD2-039

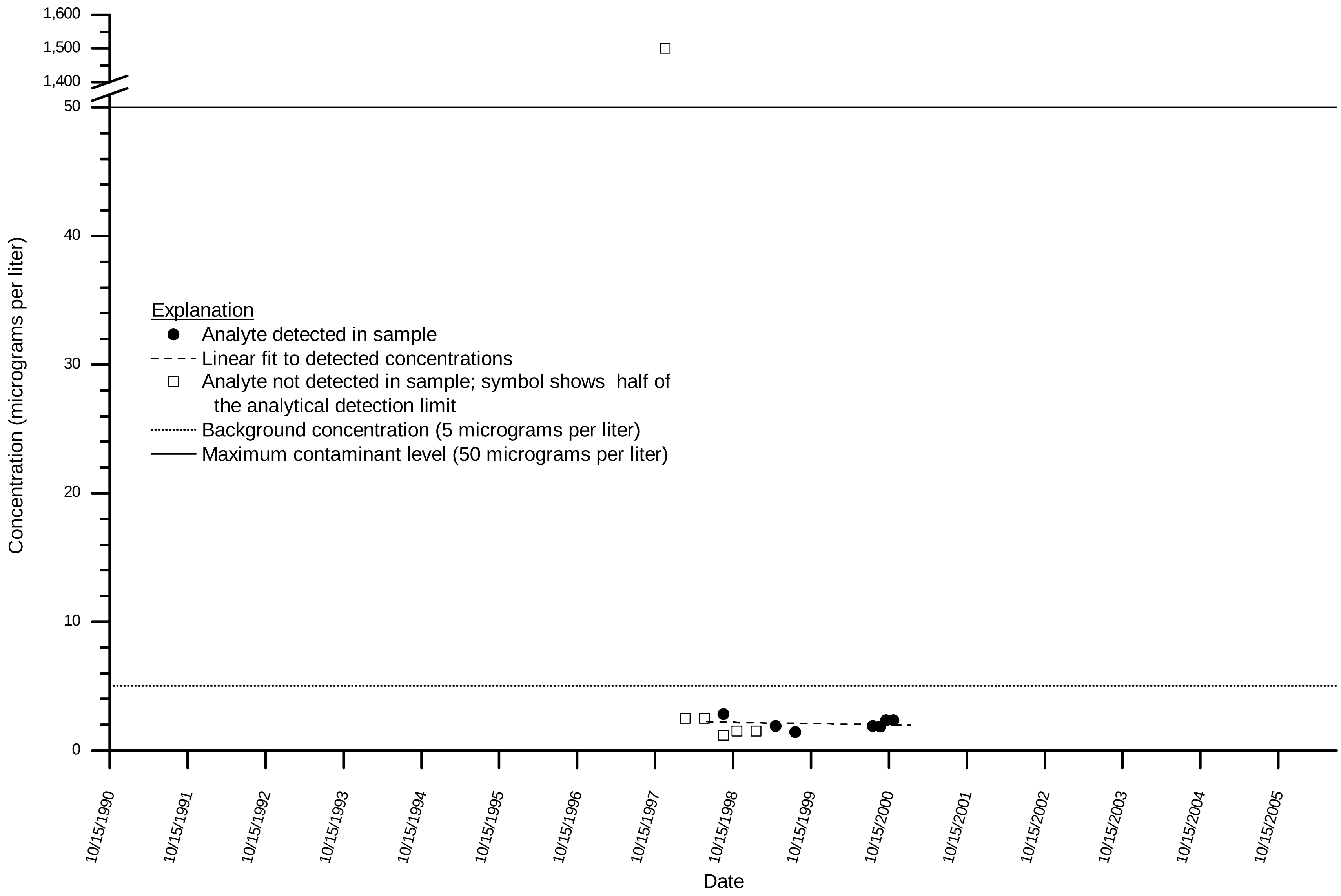

Figure F-45. Graph Showing Concentration of Selenium Versus Time in Well UCD2-039

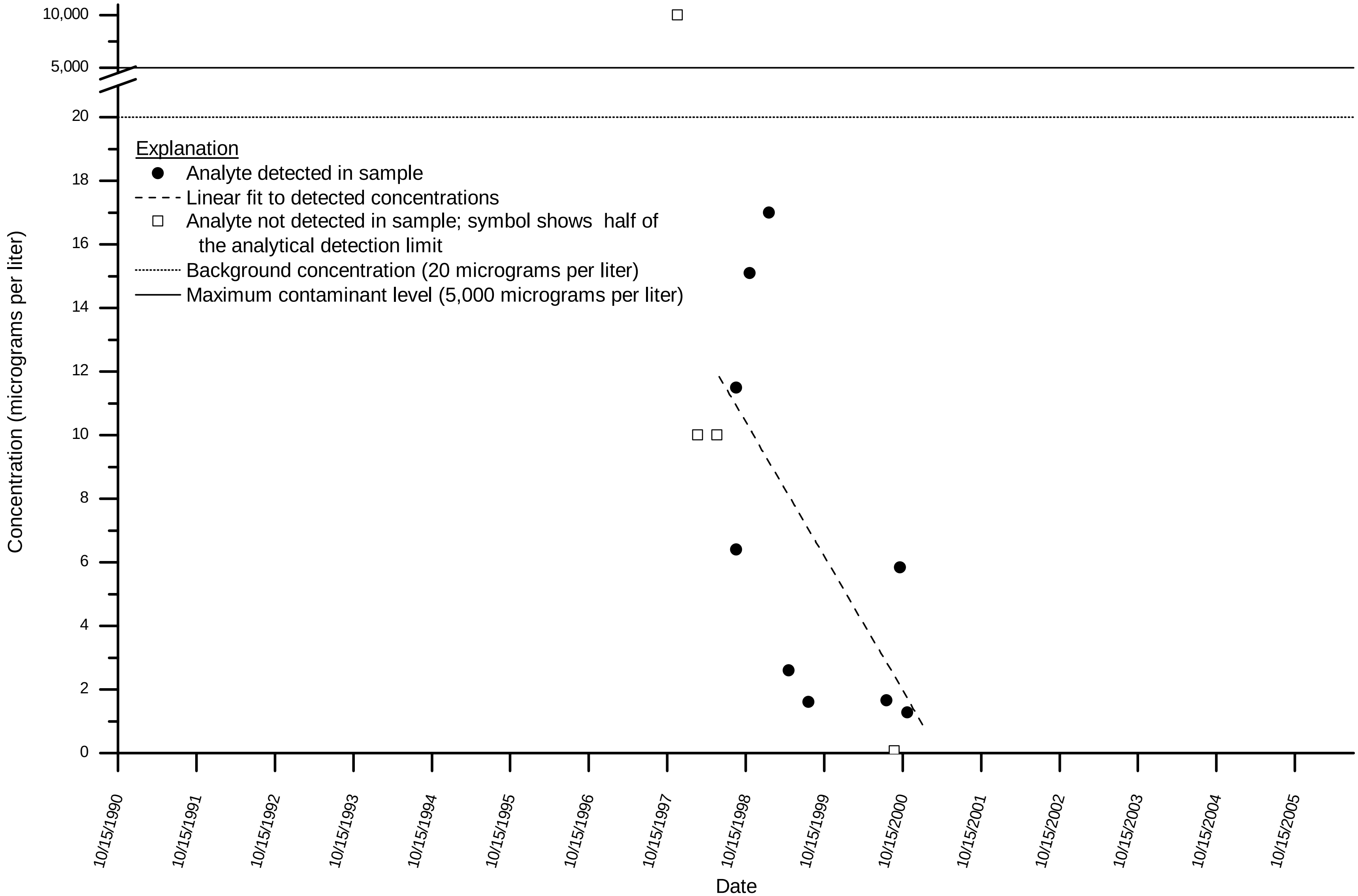

Figure F-46. Graph Showing Concentration of Zinc Versus Time in Well UCD2-039