
CINDER PILE REMEDIAL DESIGN STUDY REPORT

*BN Livingston Shop Complex Facility,
Livingston, Montana*

Prepared for:

Livingston Restoration Group

Livingston, MT

Prepared by:



Moonlight Professional Building
480 East Park Street, Suite 200
Butte, MT 59701

July 2015, Revised March 2021

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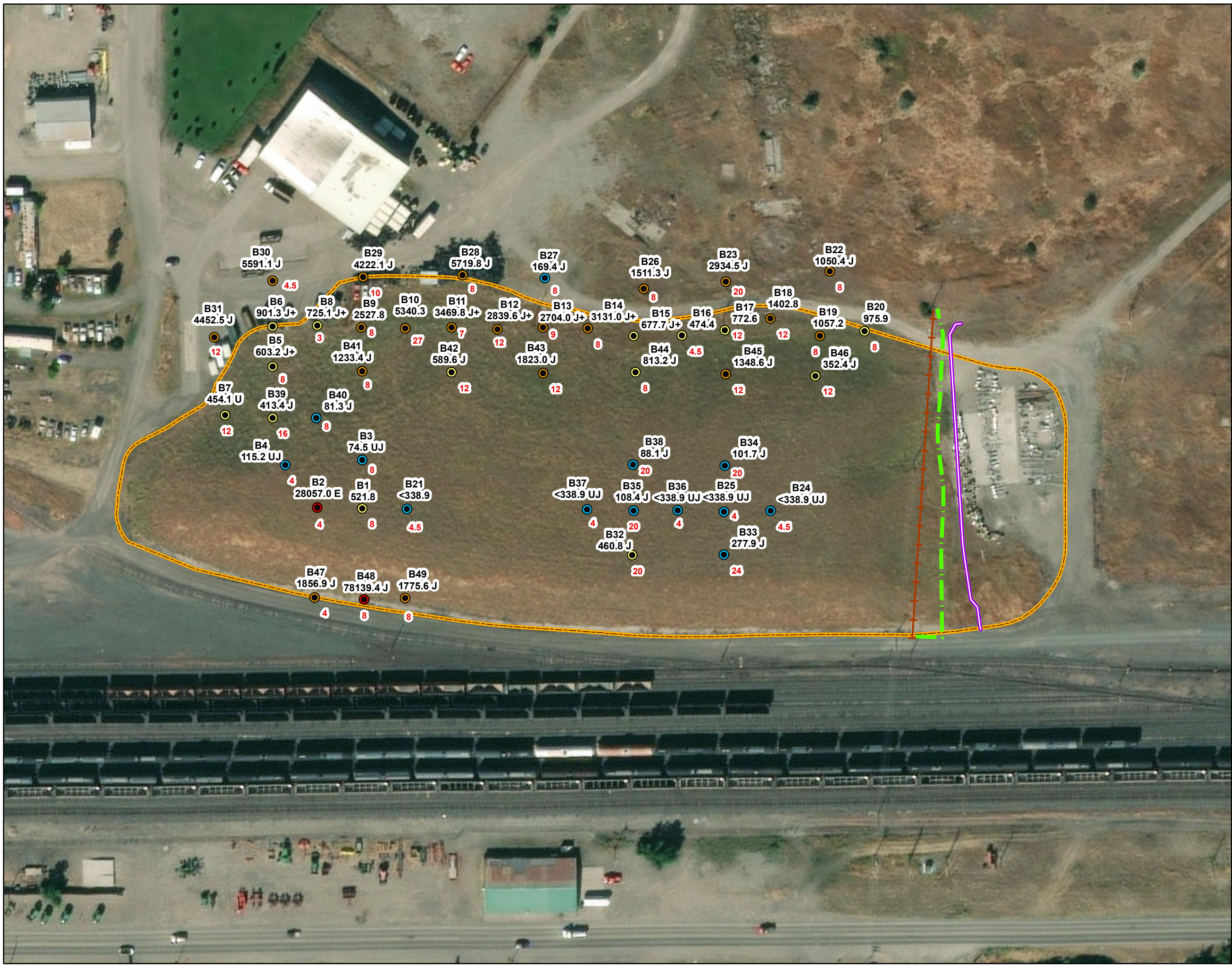
List of Acronyms

ACM	asbestos-containing material
Air Toxics	Eurofins Air Toxics, Inc.
API	American Petroleum Institute
bgs	below ground surface
BNSF	BNSF Railway Company
CECRA	Comprehensive Environmental Cleanup and Responsibility Act
DEQ	Montana Department of Environmental Quality
Energy	Energy Laboratories
EPA	United States Environmental Protection Agency
GWIC	Ground Water Information Center
in. Hg	inches of mercury
LCS	laboratory control sample
LRG	Livingston Restoration Group
$\mu\text{g}/\text{m}^3$	microgram per cubic meter
mL/min	milliliter per minute
MS	matrix spike
MSD	matrix spike duplicate
NAPL	non-aqueous phase liquid
NAVD88	North American Vertical Datum of 1988
OIS	OIL-IN-SOIL™
PCE	tetrachloroethene
PID	photoionization detector
ppbv	parts per billion by volume
ppm	parts per million
PVC	polyvinyl chloride
RPD	relative percent difference
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RD	remedial design
ROD	Record of Decision
SAP	Sampling and Analysis Plan
TCE	trichloroethene
VOC	volatile organic compound

WET
WWTP

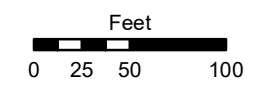
Water and Environmental Technologies, PC
wastewater treatment plant

FIGURES



Legend

- Estimated or Non-Detect
- 100.1 - 1,000 ug/m³
- 1,000.1 - 10,000 ug/m³
- <10,000 ug/m³
- 12 = Sample Depth in feet
- Fiber Optic Conduit
- Overhead Power
- - - Underground Telephone
- Cinder Pile Footprint



BORING LOCATION WITH PEAK PCE CONCENTRATIONS & SAMPLE DEPTH

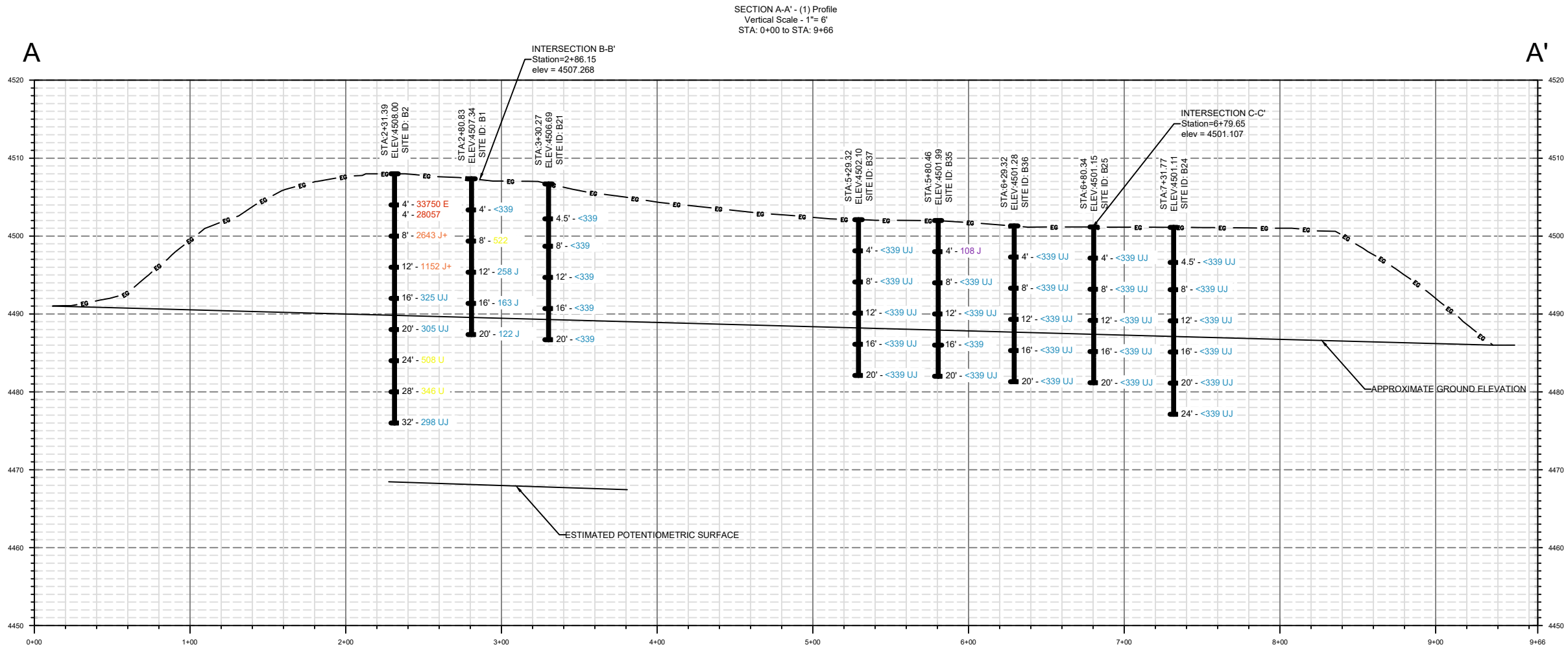
Burlington Northern Livingston Shop Complex

Job#: LRGM01 Task 3
Date: 2/4/2021

FIGURE 5

Path: M:\LRGM01\Task3\Fig5_Borings_PCE.mxd, Author: jhulla

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LEGEND	
LIGHT BLUE TEXT	CONCENTRATIONS = NON DETECT
PURPLE TEXT	CONCENTRATIONS = 10-100 µg/m³
YELLOW TEXT	CONCENTRATIONS = 100.1 - 1,000 µg/m³
ORANGE TEXT	CONCENTRATIONS = 1,000.1-10,000 µg/m³
RED TEXT	CONCENTRATIONS = >10,000 µg/m³
BLUE TEXT	GROUND WATER RESULTS
PINK TEXT	SOIL DATA RESULTS

No.	Description	Date	Drawn By

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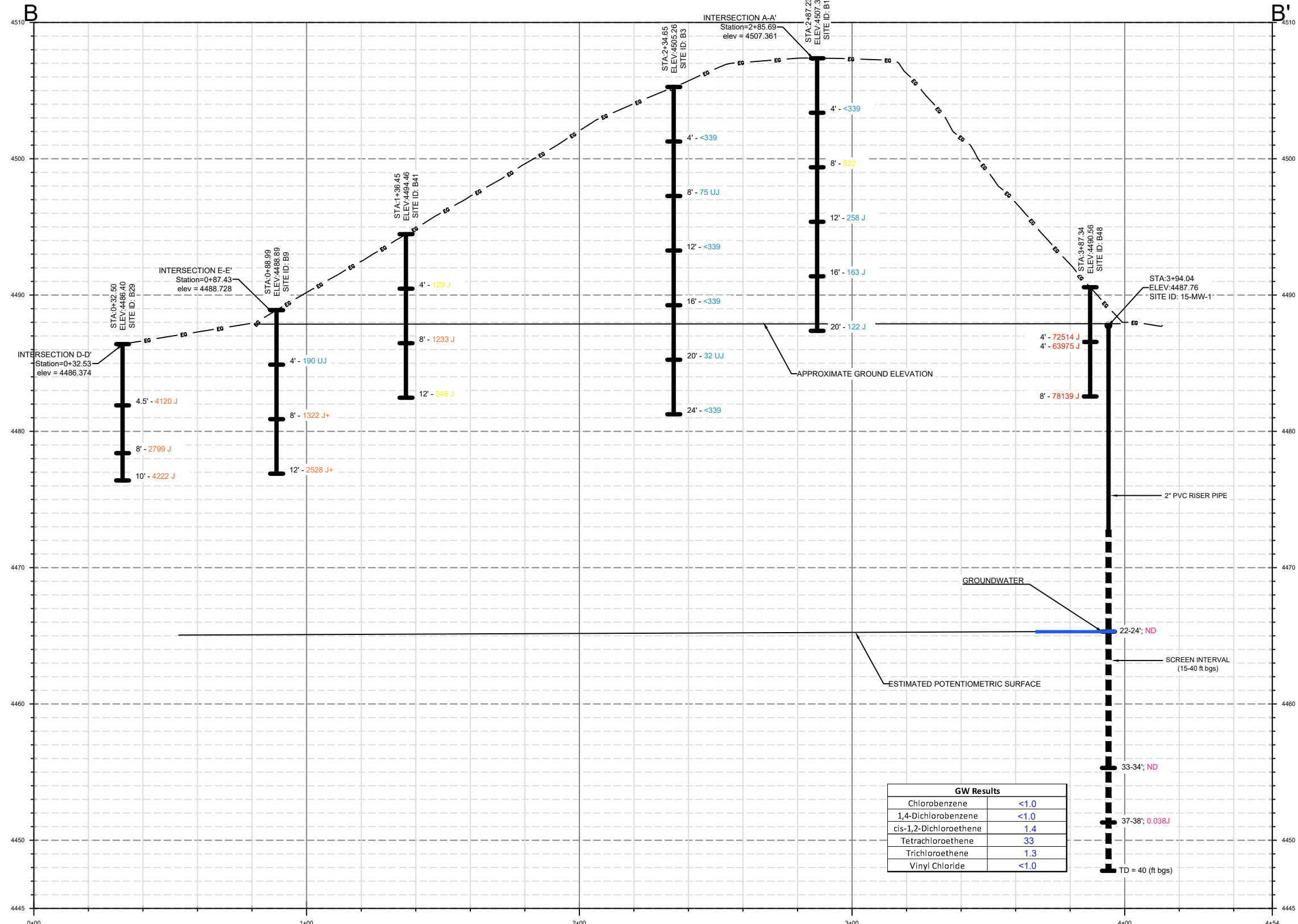
**SECTION A-A' BORING LOCATIONS WITH PCE
CONCENTRATIONS IN SOIL GAS & SAMPLE DEPTH**

PROJECT NAME: BURLINGTON NORTHERN LIVINGSTON CINDER PILE
LOCATION: LIVINGSTON, MT
FILE NO.: MC-BM01-LRGM01-03.dwg

JOB NO.: LRGM01-T3
DATE: 10/29/20
DRAFTER: JH
CHECKED BY: SN

SHEET
F7

SECTION B-B' Profile
Vertical Scale - 1" = 6'
STA: 0+00 to STA: 4+54



LEGEND	
LIGHT BLUE TEXT	CONCENTRATIONS = NON DETECT
PURPLE TEXT	CONCENTRATIONS = 10-100 µg/m³
YELLOW TEXT	CONCENTRATIONS = 100.1 - 1,000 µg/m³
ORANGE TEXT	CONCENTRATIONS = 1,000.1-10,000 µg/m³
RED TEXT	CONCENTRATIONS = >10,000 µg/m³
BLUE TEXT	GROUND WATER RESULTS
PINK TEXT	SOIL DATA RESULTS

GW Results	
Chlorobenzene	<1.0
1,4-Dichlorobenzene	<1.0
cis-1,2-Dichloroethene	1.4
Tetrachloroethene	33
Trichloroethene	1.3
Vinyl Chloride	<1.0

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**SECTION B-B' BORING LOCATIONS WITH PCE
CONCENTRATIONS IN SOIL GAS & SAMPLE DEPTH**

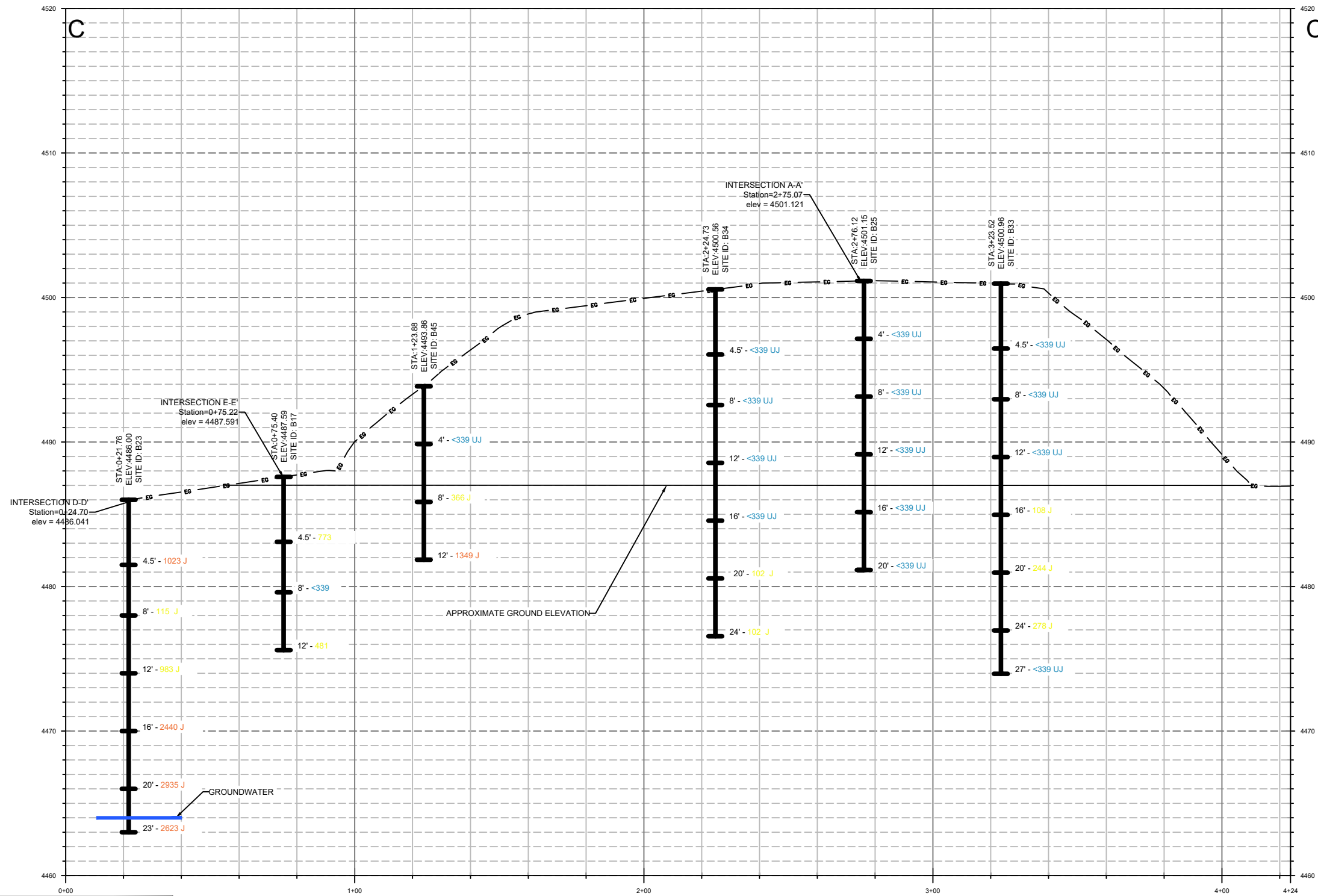
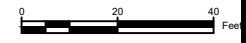
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LOCATION: LIVINGSTON, VT
FILE NO.: MC-BM01-LRGM01-03.dwg

JOB NO.: LRGM01-T3
DATE: 11/2/20
DRAFTER: JH
CHECKED BY: SN

SHEET
F8

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SECTION C-C' Profile
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 STA: 0+00 to STA: 4+24



LEGEND	
LIGHT BLUE TEXT	CONCENTRATIONS = NON DETECT
PURPLE TEXT	CONCENTRATIONS = 10-100 µg/m³
YELLOW TEXT	CONCENTRATIONS = 100.1 - 1,000 µg/m³
ORANGE TEXT	CONCENTRATIONS = 1,000.1-10,000 µg/m³
RED TEXT	CONCENTRATIONS = >10,000 µg/m³
BLUE TEXT	GROUND WATER RESULTS
PINK TEXT	SOIL DATA RESULTS

No.	Description	Date	Drawn By

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**SECTION C-C' BORING LOCATIONS WITH PCE
 CONCENTRATIONS IN SOIL GAS & SAMPLE DEPTH**

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 LOCATION: LIVINGSTON, MT
 FILE NO.: MC-BM01-LRGM01-03.dwg

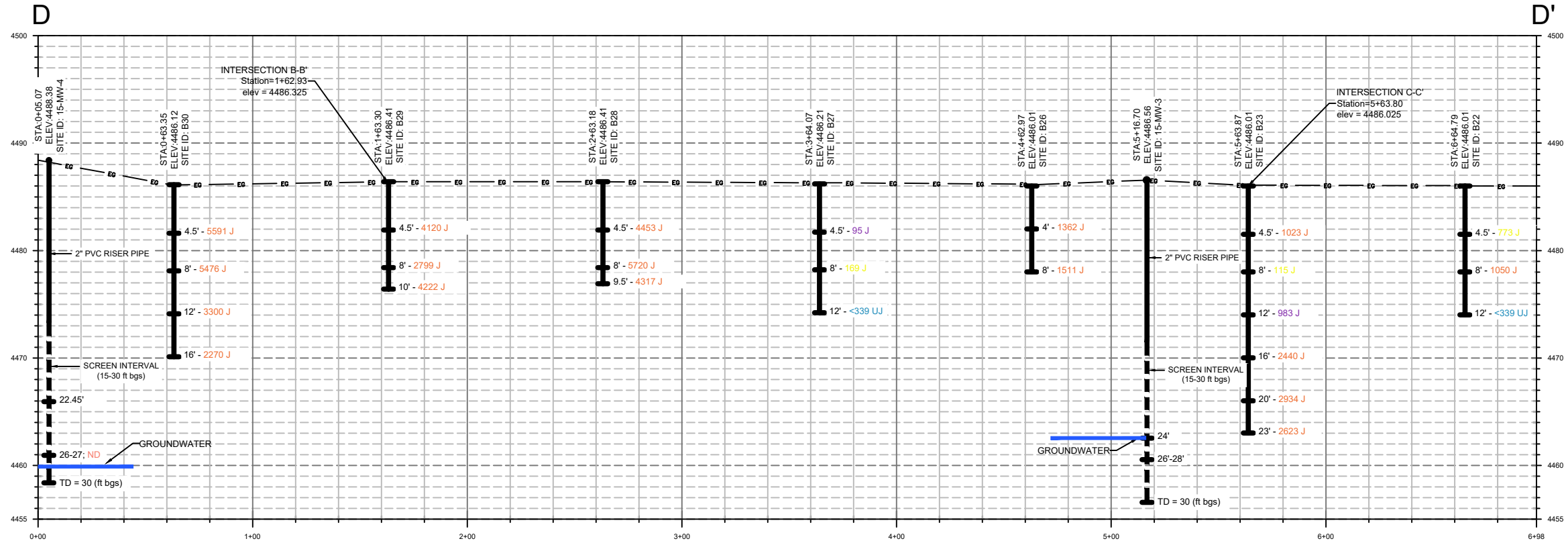
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 DATE: 2/4/21
 DRAFTER: JH
 CHECKED BY: SN

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SECTION D-D' Profile
Vertical Scale - 1" = 6'
STA: 0+00 to STA: 6+98



GW Results	
Chlorobenzene	<1.0
1,4-Dichlorobenzene	<1.0
cis-1,2-Dichloroethene	0.21J
Tetrachloroethene	16
Trichloroethene	0.72J
Viny Chloride	<1.0

Groundwater Results (µg/L)	
Chlorobenzene	<1.0
1,4-Dichlorobenzene	<1.0
cis-1,2-Dichloroethene	1.5
Tetrachloroethene	11
Trichloroethene	1.1
Vinyl Chloride	<1.0

LEGEND	
LIGHT BLUE TEXT	CONCENTRATIONS = NON DETECT
PURPLE TEXT	CONCENTRATIONS = 10-100 µg/m³
YELLOW TEXT	CONCENTRATIONS = 100.1 - 1,000 µg/m³
ORANGE TEXT	CONCENTRATIONS = 1,000.1-10,000 µg/m³
RED TEXT	CONCENTRATIONS = >10,000 µg/m³
BLUE TEXT	GROUND WATER RESULTS
PINK TEXT	SOIL DATA RESULTS



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SECTION D-D' BORING LOCATIONS WITH PCE CONCENTRATIONS IN SOIL GAS & SAMPLE DEPTH
PROJECT NAME: BURLINGTON NORTHERN LIVINGSTON CINDER PILE
LOCATION: LIVINGSTON, MT
FILE NO. MC-BM01-LRGM01-03.dwg

JOB NO: LRGM01-T3
DATE: 2/4/21
DRAFTER: JH
CHECKED BY: SN

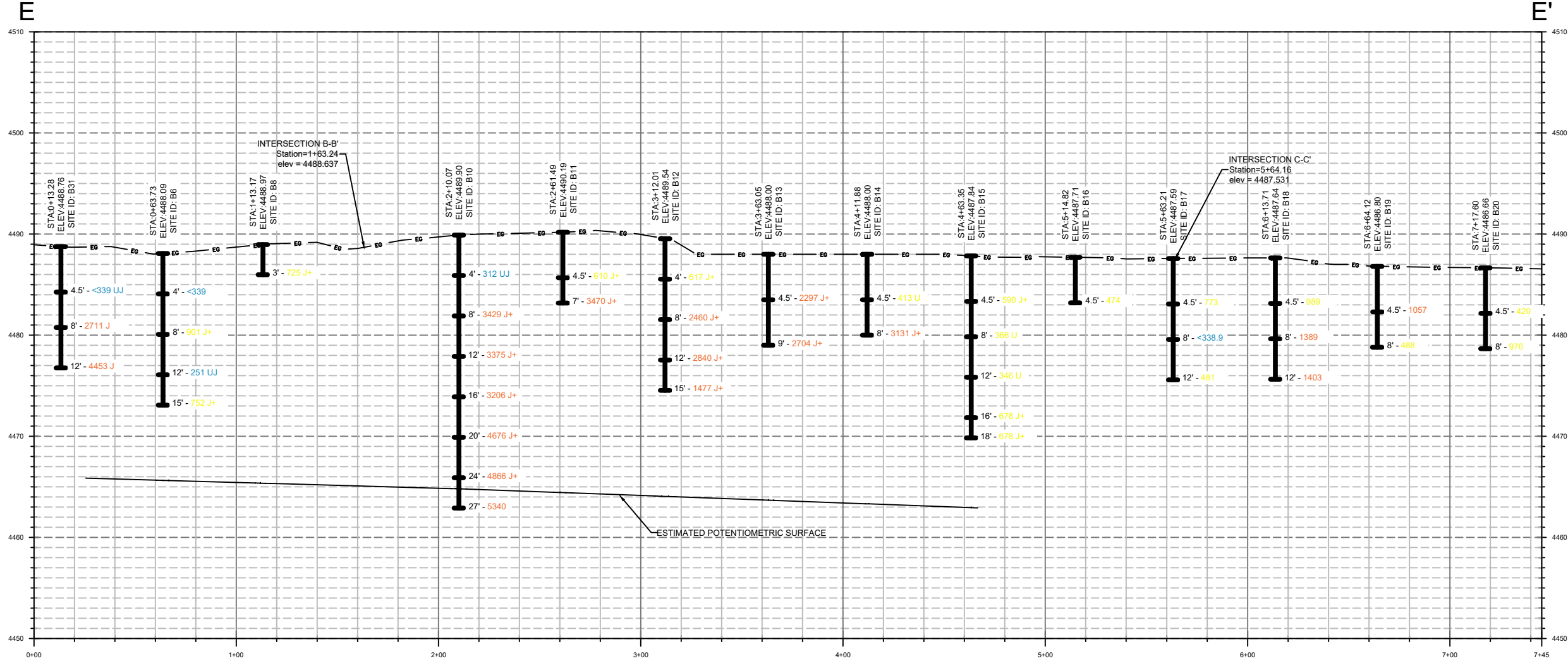
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NOTE:
B9 IS ON CROSS-SECTION B-B'
SEE SHEET F8

SECTION E-E' Profile
Vertical Scale - 1"= 6'
STA: 0+00 to STA: 7+45



LEGEND	
LIGHT BLUE TEXT	CONCENTRATIONS = NON DETECT
PURPLE TEXT	CONCENTRATIONS = 10-100 µg/m³
YELLOW TEXT	CONCENTRATIONS = 100.1 - 1,000 µg/m³
ORANGE TEXT	CONCENTRATIONS = 1,000.1-10,000 µg/m³
RED TEXT	CONCENTRATIONS = >10,000 µg/m³
BLUE TEXT	GROUND WATER RESULTS
PINK TEXT	SOIL DATA RESULTS

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SECTION E-E' BORING LOCATIONS WITH PCE
CONCENTRATIONS IN SOIL GAS & SAMPLE DEPTH

PROJECT NAME: BURLINGTON NORTHERN LIVINGSTON CINDER PILE
LOCATION: LIVINGSTON, MT
FILE NO. MC-BM01-LRGM01-03.dwg

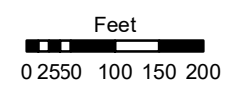
JOB NO:	LRGM01-T3
DATE:	2/4/21
DRAFTER:	JH
CHECKED BY:	SN
SHEET	F11



Legend

- Well ID with PCE Concentration
- Groundwater Elevation Contour - 1/2 foot
- Fiber Optic Conduit
- Overhead Power
- Underground Telephone
- Cinder Pile Footprint

Notes:
 * - Laboratory analytical data provided by Kennedy/Jenks for routine Facility groundwater sample collected on March 9, 2015.
 PCE - Tetrachloroethene
 ug/L - Micrograms per Liter
 NS - Not Sampled During Period
 Datum NAVD 88



Area Groundwater PCE Concentrations	
Burlington Northern Livingston Shop Complex	
Job#: LRGM01	FIGURE 12
Date: 4/8/2020	
<small>Path: M:\LRGM01\Task3\Fig12_WellsGWData.mxd, Author: caggenberger</small>	

TABLES

Table 1. Volatile Organic Compounds (VOCs) in Soil Gas

Site ID	Sample ID (boring ID - depth (ft bgs))	Raw File ID	Sample Date	Benzene			Trichloroethene			Tetrachloroethene			Ethylbenzene			Sample Depth (ft bgs)
				ppbv*	µg/m³	Q	ppbv*	µg/m³	Q	ppbv*	µg/m³	Q	ppbv*	µg/m³	Q	
B1	B1-4	20140902_006	9/2/2014	<50	<160		<50	<268		<50	<339		<50	<217		4
B1	B1-4R	20140903_003	9/3/2014	<50	<160		<50	<268		413	2799		<50	<217		4
B1	B1-8	20140903_005	9/3/2014	<50	<160		<50	<268		77	522		<50	<217		8
B1	B1-12	20140903_006	9/3/2014	<50	<160		<50	<268		38	258	J	<50	<217		12
B1	B1-16	20140904_003	9/4/2014	<50	<160		<50	<268		14	95	J	<50	<217		16
B1	B1-20	20140904_004	9/4/2014	<50	<160		<50	<268		18	122	J	<50	<217		20
B2	B2-4	20140904_007	9/4/2014	<50	<160		<50	<268		4980	33750	E	<50	<217		4
B2	B2-4	20140904_009	9/4/2014	<1000	<3190		<1000	<5368		4140	28057	E	<1000	<4338		4
B2	B2-8	20140904_011	9/4/2014	<50	<160		<50	<268		390	2643	J+	<50	<217		8
B2	B2-12	20140904_012	9/4/2014	<50	<160		<50	<268		170	1152	J+	<50	<217		12
B2	B2-16	20140904_013	9/4/2014	<50	<160		18	97	J	48	325	UJ	<50	<217		16
B2	B2-20	20140904_010	9/4/2014	<50	<160		<50	<268		45	305	UJ	<50	<217		20
B2	B2-24	20140904_015	9/4/2014	<50	<160		<50	<268		75	508	U	<50	<217		24
B2	B2-28	20140904_016	9/4/2014	<50	<160		46	247	J	51	346	U	<50	<217		28
B2	B2-32	20140904_017	9/4/2014	<50	<160		45	242	J	44	298	UJ	<50	<217		32
B3	B3-4	20140904_019	9/4/2014	<50	<160		<50	<268		<50	<339		<50	<217		4
B3	B3-8	20140904_020	9/4/2014	<50	<160		<50	<268		11	75	UJ	<50	<217		8
B3	B3-12	20140904_021	9/4/2014	<50	<160		<50	<268		<50	<339		<50	<217		12
B3	B3-16	20140904_022	9/4/2014	<50	<160		<50	<268		<50	<339		<50	<217		16
B3	B3-20	20140904_023	9/4/2014	<50	<160		<50	<268		4.7	32	UJ	<50	<217		20
B3	B3-24	20140904_024	9/4/2014	33	105	J	<50	<268		<50	<339		<50	<217		24
B4	B4-4	20140905_001	9/5/2014	<50	<160		82	440		17	115	UJ	<50**	<217		4
B4	B4-8	20140905_002	9/5/2014	<50	<160		<50	<268		<50	<339		<50**	<217		8
B4	B4-12	20140905_003	9/5/2014	<50	<160		<50	<268		<50	<339		<50**	<217		12
B4	B4-16	20140905_004	9/5/2014	<50**	<160		<50	<268		<50	<339		<50**	<217		16
B4	B4-20	20140905_005	9/5/2014	<50	<160		<50	<268		<50	<339		<50**	<217		20
B4	B4-24	20140905_006	9/5/2014	<50**	<160		<50	<268		<50	<339		<50**	<217		24
B5	B5-4	20140905_011	9/5/2014	<50	<160		<50	<268		<50**	<339		<50**	<217		4
B5	B5-8	20140905_009	9/5/2014	<50**	<160		<50	<268		89	603	J+	<50**	<217		8
B5	B5-12	20140905_008	9/5/2014	<50**	<160		<50	<268		<50	<339		<50**	<217		12
B5	B5-16	20140905_007	9/5/2014	<50**	<160		<50	<268		<50	<339		<50**	<217		16
B6	B6-4	20140905_012	9/5/2014	<50	<160		<50	<268		<50	<339		<50**	<217		4
B6	B6-8	20140905_013	9/5/2014	<50**	<160		17	91	J	133	901	J+	<50**	<217		8
B6	B6-12	20140905_014	9/5/2014	10	32	J	12	64	J	37	251	UJ	17	74	UJ	12
B6	B6-15	20140905_015	9/5/2014	<50**	<160		17	91	J	111	752	J+	12	52	UJ	15
B7	B7-4	20140905_016	9/5/2014	<50	<160		<50	<268		<50**	<339		11	48	UJ	4
B7	B7-8	20140905_017	9/5/2014	<50	<160		<50	<268		<50	<339		<50**	<217		8
B7	B7-12	20140905_018	9/5/2014	<50**	<160		<50	<268		67	454	U	<50**	<217		12
B7	B7-16	20140905_019	9/5/2014	13	41	J	<50	<268		<50	<339		16	69	UJ	16
B7	B7-20	20140905_020	9/5/2014	<50**	<160		<50	<268		<50	<339		17	74	UJ	20
B7	B7-24	20140905_021	9/5/2014	<50**	<160		<50	<268		<50	<339		18	78	UJ	24
B8	B8-3	20140906_003	9/6/2014	<50	<160		<50	<268		107	725	J+	<50**	<217		3
B9	B9-4	20140906_005	9/6/2014	<50	<160		<50	<268		28	190	UJ	16	69	UJ	4
B9	B9-8	20140906_006	9/6/2014	<50**	<160		<50	<268		195	1322	J+	<50**	<217		8
B9	B9-12	20140906_008	9/6/2014	11	35	J	10	54	J	373	2528	J+	<50**	<217		12
B10	B10-4	20140906_010	9/6/2014	<50	<160		<50	<268		46	312	UJ	<50**	<217		4
B10	B10-8	20140906_011	9/6/2014	<50**	<160		18	97	J	506	3429	J+	<50	<217		8
B10	B10-12	20140906_012	9/6/2014	20	64	J	21	113	J	498	3375	J+	<50**	<217		12
B10	B10-16	20140906_009	9/6/2014	10	32	J	18	97	J	473	3206	J+	<50**	<217		16
B10	B10-20	20140906_014	9/6/2014	<50	<160		28	150	J	690	4676	J+	<50**	<217		20
B10	B10-24	20140906_015	9/6/2014	<50	<160		24	129	J	718	4866	J+	<50**	<217		24
B10	B10-27	20140906_016	9/6/2014	<50	<160		26	140	J	788	5340		<50**	<217		27
B11	B11-4.5	20140906_017	9/6/2014	<50**	<160		<50	<268		90	610	J+	<50**	<217		4.5
B11	B11-7	20140906_018	9/6/2014	<50**	<160		18	97	J	512	3470	J+	<50**	<217		7
B12	B12-4	20140907_003	9/7/2014	<50	<160		<50	<268		91	617	J+	<50**	<217		4
B12	B12-8	20140907_004	9/7/2014	<50	<160		<50**	<268		363	2460	J+	<50**	<217		8
B12	B12-12	20140907_006	9/7/2014	<50**	<160		21	113	J	419	2840	J+	12	52	UJ	12
B12	B12-15	20140907_007	9/7/2014	18	57	J	12	64	J	218	1477	J+	76	330		15
B13	B13-4.5	20140907_008	9/7/2014	10	32	J	<50	<268		339	2297	J+	<50**	<217		4.5
B13	B13-9	20140907_009	9/7/2014	<50	<160		14	75	J	399	2704	J+	<50**	<217		9
B14	B14-4.5	20140907_010	9/7/2014	<50	<160		<50	<268		61	413	U	<50**	<217		4.5
B14	B14-8	20140907_011	9/7/2014	<50**	<160		21	113	J	462	3131	J+	<50**	<217		8
B15	B15-4.5	07SEP20140907_001	9/7/2014	<50	<160		<50	<268		87	590	J+	<50	<217		4.5
B15	B15-8	07SEP20140907_002	9/7/2014	<50**	<160		<50	<268		54	366	U	14	61	UJ	8
B15	B15-12	07SEP20140907_003	9/7/2014	<50**	<160		<50	<268		51	346	U	18	78	UJ	12
B15	B15-16	07SEP20140907_004	9/7/2014	<50**	<160		13	70	J	100	678	J+	<50**	<217		16
B15	B15-18	07SEP20140907_005	9/7/2014	<50**	<160		13	70	J	100	678	J+	<50**	<217		18
B16	B16-4.5	07SEP20140907_006	9/7/2014	<50	<160		<50	<268		70	474		<50	<217		4.5
B17	B17-4.5	07SEP20140907_007	9/7/2014	<50	<160		<50	<268		114	773		<50	<217		4.5

Table 1. Volatile Organic Compounds (VOCs) in Soil Gas

Site ID	Sample ID (boring ID - depth (ft bgs))	Raw File ID	Sample Date	Benzene			Trichloroethene			Tetrachloroethene			Ethylbenzene			Sample Depth (ft bgs)
				ppbv*	µg/m³	Q	ppbv*	µg/m³	Q	ppbv*	µg/m³	Q	ppbv*	µg/m³	Q	
B17	B17-8	07SEP20140907 008	9/7/2014	<50	<160		<50	<268		<50**	<339		<50**	<217		8
B17	B17-12	07SEP20140907 009	9/7/2014	<50	<160		<50	<268		71	481		<50**	<217		12
B18	B18-4.5	20140909 002	9/9/2014	<50	<160		<50	<268		146	989		<50**	<217		4.5
B18	B18-8	20140909 003	9/9/2014	<50**	<160		12	64	J	205	1389		<50**	<217		8
B18	B18-12	20140909 004	9/9/2014	<50	<160		18	97	J	207	1403		<50**	<217		12
B19	B19-4.5	20140909 006	9/9/2014	13	41	J	<50**	<268		156	1057		<50**	<217		4.5
B19	B19-8	20140909 007	9/9/2014	16	51	J	10	54	J	72	488		<50**	<217		8
B20	B20-4.5	20140909 008	9/9/2014	<50**	<160		<50	<268		62	420		<50**	<217		4.5
B20	B20-8	20140909 009	9/9/2014	<50	<160		16	86	J	144	976		<50**	<217		8
B21	B21-4.5	20140909 011	9/9/2014	<50	<160		<50	<268		<50	<339		<50	<217		4.5
B21	B21-8	20140909 012	9/9/2014	<50	<160		<50	<268		<50	<339		<50**	<217		8
B21	B21-12	20140909 013	9/9/2014	<50**	<160		<50	<268		<50	<339		<50	<217		12
B21	B21-16	20140909 014	9/9/2014	<50	<160		<50	<268		<50	<339		<50**	<217		16
B21	B21-20	20140909 015	9/9/2014	<50	<160		<50	<268	UJ	<50	<339		<50**	<217		20
B22	B22-4.5	20140910 003	9/10/2014	<50	<160		<50	<268	UJ	114	773	J	<50	<217		4.5
B22	B22-8	20140910 004	9/10/2014	<50**	<160		<50	<268	UJ	155	1050	J	<50**	<217		8
B22	B22-12	20140910 006	9/10/2014	<50**	<160		<50	<268	UJ	<50	<339	UJ	<50**	<217		12
B23	B23-4.5	20140910 007	9/10/2014	<50	<160		<50	<268	UJ	151	1023	J	<50**	<217		4.5
B23	B23-8	20140910 008	9/10/2014	18	57	J	<50	<268	UJ	17	115	J	<50**	<217		8
B23	B23-12	20140910 010	9/10/2014	<50	<160		10	54	J	145	983	J	<50**	<217		12
B23	B23-16	20140910 012	9/10/2014	<50	<160		22	118	J	360	2440	J	<50**	<217		16
B23	B23-20	20140910 011	9/10/2014	<50	<160		25	134	J	433	2934	J	<50**	<217		20
B23	B23-23	20140910 013	9/10/2014	<50	<160		21	113	J	387	2623	J	<50**	<217		23
B24	B24-4.5	20140910 015	9/10/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50**	<217		4.5
B24	B24-8	20140910 016	9/10/2014	10	32	J	<50	<268	UJ	<50	<339	UJ	17	74	J	8
B24	B24-12	20140910 017	9/10/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50**	<217		12
B24	B24-16	20140910 018	9/10/2014	<50**	<160		<50	<268	UJ	<50	<339	UJ	10	43	J	16
B24	B24-20	20140910 019	9/10/2014	11	35	J	<50	<268	UJ	<50	<339	UJ	10	43	J	20
B24	B24-24	20140910 020	9/10/2014	<50**	<160		<50	<268	UJ	<50**	<339	UJ	20	87	J	24
B25	B25-4	20140910 021	9/10/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		4
B25	B25-8	20140910 022	9/10/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		8
B25	B25-12	20140910 023	9/10/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		12
B25	B25-16	20140910 024	9/10/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		16
B25	B25-20	20140910 025	9/10/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		20
B26	B26-4	20140911 003	9/11/2014	<50	<160		<50	<268	UJ	201	1362	J	<50	<217		4
B26	B26-8	20140911 004	9/11/2014	<50**	<160		<50	<268	UJ	223	1511	J	<50**	<217		8
B27	B27-4.5	20140911 012	9/11/2014	<50	<160		<50	<268	UJ	14	95	J	<50	<217		4.5
B27	B27-8	20140911 014	9/11/2014	10	32	J	<50	<268	UJ	25	169	J	<50**	<217		8
B27	B27-12	20140911 015	9/11/2014	12	38	J	<50	<268	UJ	<50**	<339	UJ	<50**	<217		12
B28	B28-4.5	20140911 021	9/11/2014	<50	<160		<50**	<268		657	4453	J	<50**	<217		4.5
B28	B28-8	20140911 022	9/11/2014	<50	<160		19	102	J	844	5720	J	<50**	<217		8
B28	B28-9.5	20140911 023	9/11/2014	<50**	<160		20	107	J	637	4317	J	<50**	<217		9.5
B29	B29-4.5	20140911 029	9/11/2014	<50**	<160		<50	<268		608	4120	J	<50**	<217		4.5
B29	B29-8	20140911 030	9/11/2014	<50**	<160		<50**	<268		413	2799	J	10	43	J	8
B29	B29-10	20140911 032	9/11/2014	<50	<160		11	59	J	623	4222	J	<50**	<217		10
B30	B30-4.5	20140912 003	9/12/2014	<50	<160		<50	<268		825	5591	J	<50	<217		4.5
B30	B30-8	20140912 004	9/12/2014	<50	<160		<50	<268		808	5476	J	<50	<217		8
B30	B30-12	20140912 005	9/12/2014	<50**	<160		<50	<268		487	3300	J	<50**	<217		12
B30	B30-16	20140912 007	9/12/2014	<50**	<160		13	70	J	335	2270	J	<50**	<217		16
B31	B31-4.5	20140912 012	9/12/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		4.5
B31	B31-8	20140912 013	9/12/2014	<50	<160		<50	<268		400	2711	J	<50	<217		8
B31	B31-12	20140912 014	9/12/2014	<50	<160		<50	<268		657	4453	J	<50	<217		12
B32	B32-4.5	20140917 010	9/17/2014	<50	<160		10	54	J	<50	<339	UJ	<50	<217		4.5
B32	B32-8	20140917 011	9/17/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		8
B32	B32-12	20140917 012	9/17/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		12
B32	B32-16	20140917 013	9/17/2014	<50	<160		<50	<268		<50**	<339	UJ	<50	<217		16
B32	B32-20	20140917 014	9/17/2014	<50	<160		18	97	J	68	461	J	<50	<217		20
B32	B32-24	20140917 015	9/17/2014	<50	<160		<50	<268		10	68	J	<50	<217		24
B32	B32-28	20140917 016	9/17/2014	11	35	J	<50	<268		14	95	J	<50**	<217		28
B32	B32-32	20140917 017	9/17/2014	<50	<160		12	64	J	36	244	J	<50	<217		32
B32	B32-36	20140917 018	9/17/2014	<50	<160		17	91	J	62	420	J	<50	<217		36
B33	B33-4.5	20140917 027	9/17/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		4.5
B33	B33-8	20140917 032	9/17/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		8
B33	B33-12	20140917 028	9/17/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		12
B33	B33-16	20140917 029	9/17/2014	<50	<160		15	81	J	16	108	J	<50	<217		16
B33	B33-20	20140917 030	9/17/2014	<50	<160		23	123	J	36	244	J	<50	<217		20
B33	B33-24	20140917 031	9/17/2014	<50	<160		15	81	J	41	278	J	<50	<217		24
B33	B33-27	20140917 033	9/17/2014	<50**	<160		<50	<268	UJ	<50	<339	UJ	<50**	<217		27
B34	B34-4.5	20140917 007 5MIN	9/17/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		4.5

Table 1. Volatile Organic Compounds (VOCs) in Soil Gas

Site ID	Sample ID (boring ID - depth (ft bgs))	Raw File ID	Sample Date	Benzene			Trichloroethene			Tetrachloroethene			Ethylbenzene			Sample Depth (ft bgs)
				ppbv*	µg/m³	Q	ppbv*	µg/m³	Q	ppbv*	µg/m³	Q	ppbv*	µg/m³	Q	
B34	B34-8	20140917_009 5MIN	9/17/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		8
B34	B34-12	20140917_010 5MIN	9/17/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		12
B34	B34-16	20140917_011 5MIN	9/17/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		16
B34	B34-20	20140917_012 5MIN	9/17/2014	<50	<160		<50	<268	UJ	15	102	J	<50	<217		20
B34	B34-24	20140917_013 5MIN	9/17/2014	<50	<160		<50	<268	UJ	15	102	J	<50	<217		24
B35	B35-4	20140911_006	9/11/2014	<50	<160		1584	8502	J	16	108	J	<50	<217		4
B35	B35-8	20140911_008	9/11/2014	<50	<160		1046	5615	J	<50**	<339	UJ	<50	<217		8
B35	B35-12	20140911_009	9/11/2014	<50	<160		237	1272	J	<50	<339	UJ	<50	<217		12
B35	B35-16	20140911_010	9/11/2014	<50	<160		48	258	J	<50	<339		<50	<217		16
B35	B35-20	20140911_011	9/11/2014	11	35	J	62	333	J	<50	<339	UJ	<50	<217		20
B36	B36-4	20140911_016	9/11/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		4
B36	B36-8	20140911_017	9/11/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		8
B36	B36-12	20140911_018	9/11/2014	<50**	<160		<50	<268		<50	<339	UJ	<50	<217		12
B36	B36-16	20140911_019	9/11/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		16
B36	B36-20	20140911_020	9/11/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		20
B37	B37-4	20140911_024	9/11/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		4
B37	B37-8	20140911_025	9/11/2014	<50**	<160		<50	<268		<50	<339	UJ	<50**	<217		8
B37	B37-12	20140911_026	9/11/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		12
B37	B37-16	20140911_027	9/11/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		16
B37	B37-20	20140911_028	9/11/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		20
B38	B38-4	20140911_034	9/11/2014	<50	<160		<50	<268		11	75	J	<50	<217		4
B38	B38-8	20140911_035	9/11/2014	<50	<160		<50	<268		<50**	<339	UJ	<50	<217		8
B38	B38-12	20140911_037	9/11/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		12
B38	B38-16	20140911_038	9/11/2014	<50**	<160		<50	<268		<50**	<339	UJ	<50	<217		16
B38	B38-20	20140911_039	9/11/2014	<50	<160		<50	<268		13	88	J	<50	<217		20
B39	B39-4	20140912_008	9/12/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		4
B39	B39-8	20140912_009	9/12/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		8
B39	B39-12	20140912_010	9/12/2014	<50	<160		<50	<268		43	291	J	<50	<217		12
B39	B39-16	20140912_011	9/12/2014	<50	<160		<50	<268		61	413	J	<50	<217		16
B40	B40-4	20140912_015	9/12/2014	<50	<160		<50	<268		<50**	<339	UJ	<50	<217		4
B40	B40-8	20140912_016	9/12/2014	<50	<160		<50	<268		12	81	J	<50	<217		8
B40	B40-12	20140912_017	9/12/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		12
B40	B40-16	20140912_018	9/12/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		16
B41	B41-4	20140917_005	9/17/2014	<50	<160		<50	<268		19	129	J	<50	<217		4
B41	B41-8	20140917_007	9/17/2014	<50	<160		<50	<268		182	1233	J	<50	<217		8
B41	B41-12	20140917_009	9/17/2014	<50	<160		<50	<268		51	346	J	<50	<217		12
B42	B42-4	20140917_019	9/17/2014	<50	<160		<50	<268		<50	<339	UJ	<50	<217		4
B42	B42-8	20140917_020	9/17/2014	<50	<160		<50	<268		<50**	<339	UJ	<50	<217		8
B42	B42-12	20140917_021	9/17/2014	<50	<160		<50	<268		87	590	J	<50	<217		12
B43	B43-4	20140917_022	9/17/2014	<50	<160		<50	<268		12	81	J	<50	<217		4
B43	B43-8	20140917_023	9/17/2014	<50	<160		<50	<268		186	1261	J	<50	<217		8
B43	B43-12	20140917_024	9/17/2014	<50	<160		<50**	<268		269	1823	J	<50	<217		12
B44	B44-4	20140917_026	9/17/2014	<50	<160		<50	<268		86	583	J	<50	<217		4
B44	B44-8	20140917_034	9/17/2014	<50	<160		<50	<268	UJ	120	813	J	<50	<217		8
B45	B45-4	20140917_001 5MIN	9/17/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		4
B45	B45-8	20140917_002 5MIN	9/17/2014	<50	<160		<50	<268	UJ	54	366	J	<50	<217		8
B45	B45-12	20140917_003 5MIN	9/17/2014	<50	<160		<50	<268	UJ	199	1349	J	<50	<217		12
B46	B46-4	20140917_004 5MIN	9/17/2014	<50	<160		<50	<268	UJ	<50**	<339	UJ	<50	<217		4
B46	B46-8	20140917_005 5MIN	9/17/2014	<50	<160		<50	<268	UJ	<50	<339	UJ	<50	<217		8
B46	B46-12	20140917_006 5MIN	9/17/2014	<50	<160		<50	<268	UJ	52	352	J	<50	<217		12
B47	B47-4	20140918_003	9/18/2014	<50	<160		<50	<268	UJ	274	1857	J	<50	<217		4
B48	B48-4	20140918_005	9/18/2014	<50	<160		43	231	J	10700	72514	J	<50	<217		4
B48	B48-8	20140918_011	9/18/2014	<500	<1595		<500	<2684	UJ	9440	63975	J	<500	<2169		4
B48	B48-8	20140918_016	9/18/2014	<500	<1595	UJ	<500	<2684	UJ	11530	78139	J	<500	<2169	UJ	8
B49	B49-4	20140918_007	9/18/2014	<50	<160		<50	<268	UJ	171	1159	J	<50**	<217		4
B49	B49-8	20140918_008	9/18/2014	<50	<160		<50	<268	UJ	262	1776	J	<50**	<217		8

Notes: HAPSITE results were reported in the field in parts per billion per volume (ppbv) (See Appendix C) and have been converted to micrograms per cubic meter (µg/m³). Multiplier calculation is as follows:

$$\frac{(\text{molecular weight} * \text{standard atmospheric pressure})}{(\text{standard temperature} * \text{ideal gas law constant})}$$

standard atmospheric pressure = 760, standard temp = 298.15
ideal gas law constant = 62.4

* A low-point calibration standard of 100 ppbv was used for initial calibration on 9/2/14 per the SOP (Appendix C1: KD Analytical Soil Gas Analysis by Field-Portable GC/MS SOP, Section 8.0). However, the instrument's response to analyte peaks at or below 50 ppbv guided the analyst to include a 50 ppbv standard as the low-point for the 9/5/14 and 9/9/14 calibrations, as well as assigned a reporting limit of 50 ppbv to samples analyzed between 9/2 and 9/5. This professional judgement is supported by the SOP (Appendix C1, Section 7.0). Based on the analyst's professional judgement, a method detection limit of 10 ppbv was assigned to samples analyzed during investigation.

Table 1. Volatile Organic Compounds (VOCs) in Soil Gas

Site ID	Sample ID (boring ID - depth (ft bgs))	Raw File ID	Sample Date	Benzene			Trichloroethene			Tetrachloroethene			Ethylbenzene			Sample Depth (ft bgs)
				ppbv*	µg/m ³	Q	ppbv*	µg/m ³	Q	ppbv*	µg/m ³	Q	ppbv*	µg/m ³	Q	

** Non-detect samples were reported as non-detect (<50 ppbv) when review of the chromatograph showed non-identifiable peaks. When a peak was identified on the chromatograph, but at a concentration greater than the associated method blank but less than the 50 ppbv reporting limit, the compound was reported at an estimated ("J" flagged) value.

BOLD indicates a detection.

Q - Data validation qualifier:

- E exceeds curve, but within range of instrument
- J is estimated
- J+ is overestimated
- UJ is estimated as a non-detect
- U is detected at or below the quantitation limit

Table 2. Volatile Organic Compounds (VOCs) in Soil, mg/kg^(a)

Sample ID	ROD Cleanup Level ^(b)	LRG-MW1-22-24-S	LRG-MW1-33-34-S	LRG-MW1-37-38-S	LRG-MW2-26-27-S	LRG-MW3-26-28-S	LRG-MW4-26-27-S	D1-SB-1-17-15*
Date Sampled		1/15/2015	1/16/2015	1/16/2015	1/16/2015	1/16/2015	1/17/2015	1/17/2015
PID Field Screening Result, ppm		5.6	10.4	0.2	5.4	1.8	2.2	2.2
Benzene	-- ^(c)	<0.20 ^(d)	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Bromobenzene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Bromochloromethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Bromodichloromethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Bromoform	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Bromomethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Carbon tetrachloride	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorobenzene	124	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chloroethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
2-Chloroethyl vinyl ether	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chloroform	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chloromethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-Dibromoethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
2-Chlorotoluene	--	0.25	0.060 J ^(e)	<0.20	<0.20	<0.20	<0.20	<0.20
4-Chlorotoluene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorodibromomethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Dibromomethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-Dichlorobenzene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,3-Dichlorobenzene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,4-Dichlorobenzene	264	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Dichlorodifluoromethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1-Dichloroethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-Dichloroethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1-Dichloroethene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cis-1,2-Dichloroethene	14	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
trans-1,2-Dichloroethene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-Dichloropropane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,3-Dichloropropane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
2,2-Dichloropropane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1-Dichloropropene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
cis-1,3-Dichloropropene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
trans-1,3-Dichloropropene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ethylbenzene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Methyl ethyl ketone	--	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Methyl tert-butyl ether (MTBE)	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Methylene chloride	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Styrene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1,1,2-Tetrachloroethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

Table 2. Volatile Organic Compounds (VOCs) in Soil, mg/kg^(a)

Sample ID	ROD Cleanup Level ^(b)	LRG-MW1-22-24-S	LRG-MW1-33-34-S	LRG-MW1-37-38-S	LRG-MW2-26-27-S	LRG-MW3-26-28-S	LRG-MW4-26-27-S	D1-SB-1-17-15*
Date Sampled		1/15/2015	1/16/2015	1/16/2015	1/16/2015	1/16/2015	1/17/2015	1/17/2015
1,1,2,2-Tetrachloroethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Tetrachloroethene	4	<0.20	<0.20	0.038 J	0.61	<0.20	<0.20	<0.20
Toluene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1,1-Trichloroethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,1,2-Trichloroethane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Trichloroethene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Trichlorofluoromethane	2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2,3-Trichloropropane	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Vinyl chloride	0.02	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
m+p-Xylenes	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
o-Xylene	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Xylenes, Total	--	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

Notes:

- (a) Soil samples analyzed for volatile organic compounds (VOCs) using EPA Method 8260.
- (b) Cleanup levels from Record of Decision, Burlington Northern Livingston Shop Complex (ROD) [Montana Department of Environmental Quality (DEQ) 2001].
- (c) "--" denotes a ROD cleanup level not established.
- (d) "<" denotes analyte was not detected at the indicated method reporting limit.
- (e) "J" indicates estimated value. The analyte is present but at a concentration less than the limit of quantitation.

* - Duplicate of LRG-MW4-26-27-S.

Detected values shown in bold.

mg/kg - milligrams per kilogram

Detection exceeds ROD screening level.