

# TECHNICAL MEMORANDUM

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**To:** Nevada Environmental Response Trust

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**Cc:** Nevada Division of Environmental Protection  
United States Environmental Protection Agency

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**From:** Arul Ayyaswami and Dan Pastor

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**Date:** June 8, 2018

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**Subject:** Vacuum Enhanced Recovery Treatability Study Monthly Progress Report

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At the direction of the Nevada Environmental Response Trust (NERT or Trust), Tetra Tech, Inc. (Tetra Tech) has prepared this memorandum that summarizes Tetra Tech's progress made through April 2018 toward successfully implementing the Vacuum Enhanced Recovery (VER) Treatability Study as outlined in the VER Treatability Study Work Plan (Work Plan). The location of the proposed and final well locations associated with the VER Treatability Study are depicted on Figures 1 and 2, respectively.

## Task Progress Update: April 2018

### Task M16 – Vacuum Enhanced Recovery Treatability Study

- Task Leader – Arul Ayyaswami
- Current Status
  - No field activities associated with the VER Treatability Study were conducted in April 2018.
- Schedule and Progress Updates
  - The VER Treatability Study Results Report is under development and will be submitted to the Nevada Division of Environmental Protection in June 2018. Draft summary data tables of the well construction details, soil sampling results, baseline groundwater monitoring results, groundwater monitoring results during the VER test, and drawdown are provided in the attached tables. A brief summary of the analytical data, groundwater drawdown results, and groundwater extraction rates obtained from the VER testing is provided below. The VER Treatability Study Results Report to be submitted in June will provide detailed descriptions and interpretation of the treatability study data.
    - The highest concentrations of perchlorate, chlorate, and hexavalent chromium in soil and groundwater were encountered between 25 and 70 feet bgs. Perchlorate, chlorate, and hexavalent chromium concentrations decreased below 50 feet bgs in soil and below 70 feet bgs in groundwater.

- The highest concentrations of perchlorate (830 mg/kg), chlorate (3,600 mg/kg), and hexavalent chromium (20 mg/kg) in soil were detected in samples collected from 50 feet bgs.
  - During the intermediate zone VER test, perchlorate concentrations in the extracted groundwater from VER-01I generally remained stable ranging from 1,100 to 1,300 mg/L, chlorate concentrations remained within a range of 2,900 to 3,400 mg/L, and hexavalent chromium concentrations increased from 7.7 to 13 mg/L.
  - During the deep VER test, perchlorate concentrations in the extracted groundwater from well VER-01D decreased from 2.0 to 0.57 mg/L, chlorate concentrations decreased from 4.4 to 1.7 mg/L, and hexavalent chromium concentrations remained relatively stable between 0.018 and 0.025 mg/L.
  - Based on pressure transducer data collected during the intermediate VER test, drawdown of 4.94 feet was observed in the performance monitoring well M-221, located 66 feet from pumping well VER-01I.
  - Based on pressure transducer data collected during the deep VER test, drawdown greater than 10 feet was observed in the performance monitoring well VMW-02D, located 55 feet from pumping well VER-01D.
  - During the intermediate zone VER test, the average groundwater extraction rate using conventional pumping over a period of 8 hours was 3.12 gpm. The average groundwater extraction rate over the first 8 hours with applied vacuum was 4.05 gpm, an approximate 30 percent increase in the groundwater extraction rate over the comparable time period. The average groundwater extraction rate with applied vacuum for the entire 70 hours of the test was approximately 3.83 gpm
  - During the deep zone VER test, the average groundwater extraction rate using conventional pumping over a period of 12 hours was 0.53 gpm. The average groundwater extraction rate over the first 12 hours with applied vacuum was 0.64 gpm, an approximate 21 percent increase in the groundwater extraction rate over the comparable time period. The average groundwater extraction rate with applied vacuum for the entire 84 hours of the test was approximately 0.59 gpm
- Health and Safety
    - There were no health and safety incidents related to Task M16 through April 2018.

## CERTIFICATION

### Vacuum Enhanced Recovery Treatability Study Monthly Progress Report

**Nevada Environmental Response Trust Site  
(Former Tronox LLC Site)  
Henderson, Nevada**

#### **Nevada Environmental Response Trust (NERT) Representative Certification**

I certify that this document and all attachments submitted to the Division were prepared at the request of, or under the direction or supervision of NERT. Based on my own involvement and/or my inquiry of the person or persons who manage the systems(s) or those directly responsible for gathering the information or preparing the document, or the immediate supervisor of such person(s), the information submitted and provided herein is, to the best of my knowledge and belief, true, accurate, and complete in all material respects.

Office of the Nevada Environmental Response Trust

Le Petomane XXVII, not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

**Signature:** Jay A. Steinberg, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

**Name:** Jay A. Steinberg, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

**Title:** Solely as President and not individually

**Company:** Le Petomane XXVII, Inc., not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

**Date:** 6/8/18

## CERTIFICATION

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I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been prepared in a manner consistent with the current standards of the profession, and to the best of my knowledge, comply with all applicable federal, state, and local statutes, regulations, and ordinances. I hereby certify that all laboratory analytical data was generated by a laboratory certified by the NDEP for each constituent and media presented herein.

**Description of Services Provided:** Vacuum Enhanced Recovery Treatability Study Progress Report, Nevada Environmental Response Trust Site, Henderson, Nevada



June 8, 2018

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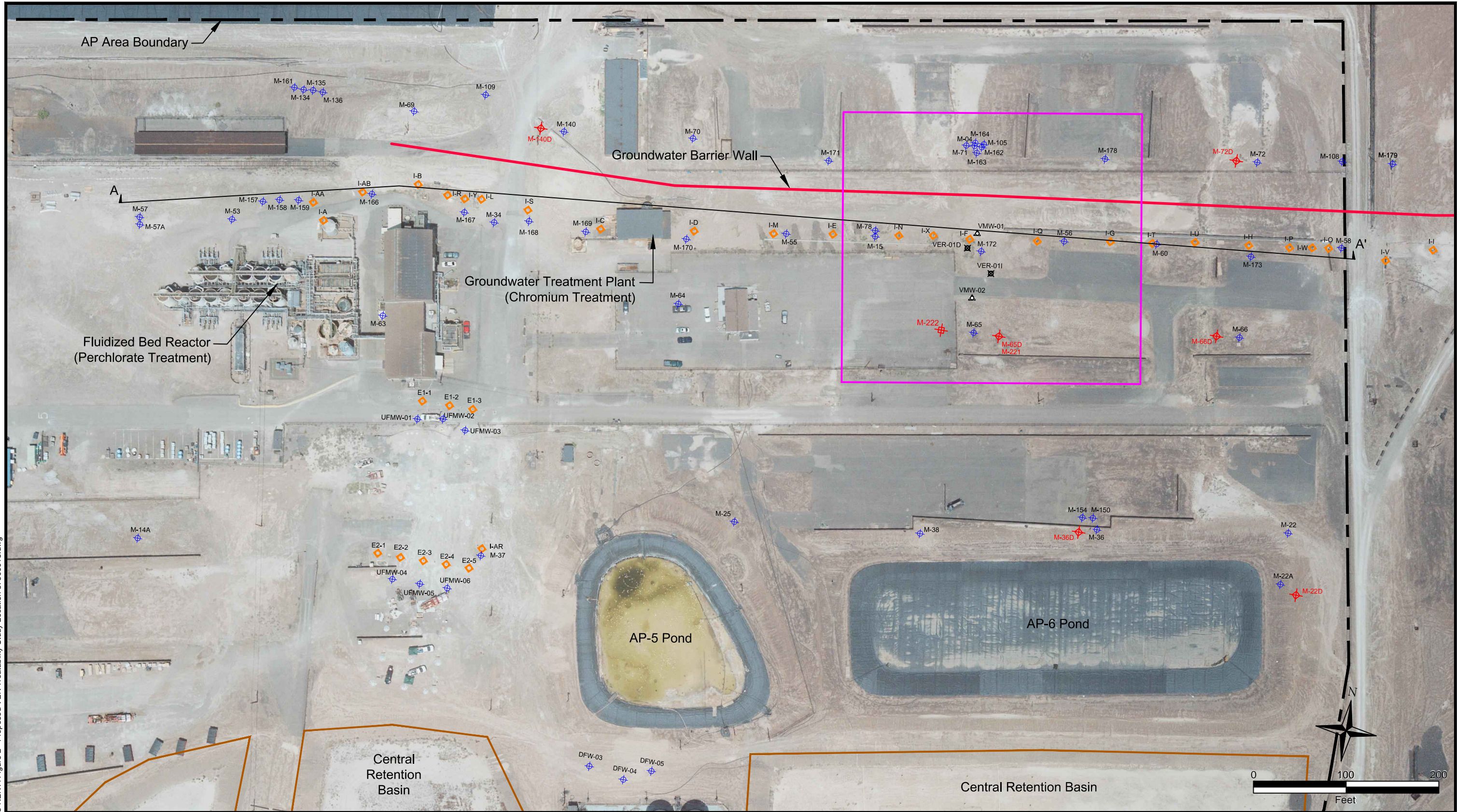
**Kyle Hansen, CEM**  
Field Operations Manager/Geologist  
Tetra Tech, Inc.

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Date

Nevada CEM Certificate Number: 2167  
Nevada CEM Expiration Date: September 18, 2018

# Figures



\\fs318fs1.t.t.local\ces1\87600015-NERT\Figure 2 - Proposed VER Treatability Study Location 87600015.dwg

Legend	
	M-55 Monitoring Well
	I-M Extraction Well
	MW-22D Planned Deeper Shallow WBZ Well (Ramboll)
	MW-222 Planned Middle WBZ Well (Ramboll)
	Proposed VER Treatability Study Area
	VER-011 Proposed Intermediate VER Well Location (Tt)
	VER-01D Proposed Deep VER Well Location (Tt)
	VMW-01 Proposed Middle WBZ Well (Tt)
	A-A' Cross Section Line

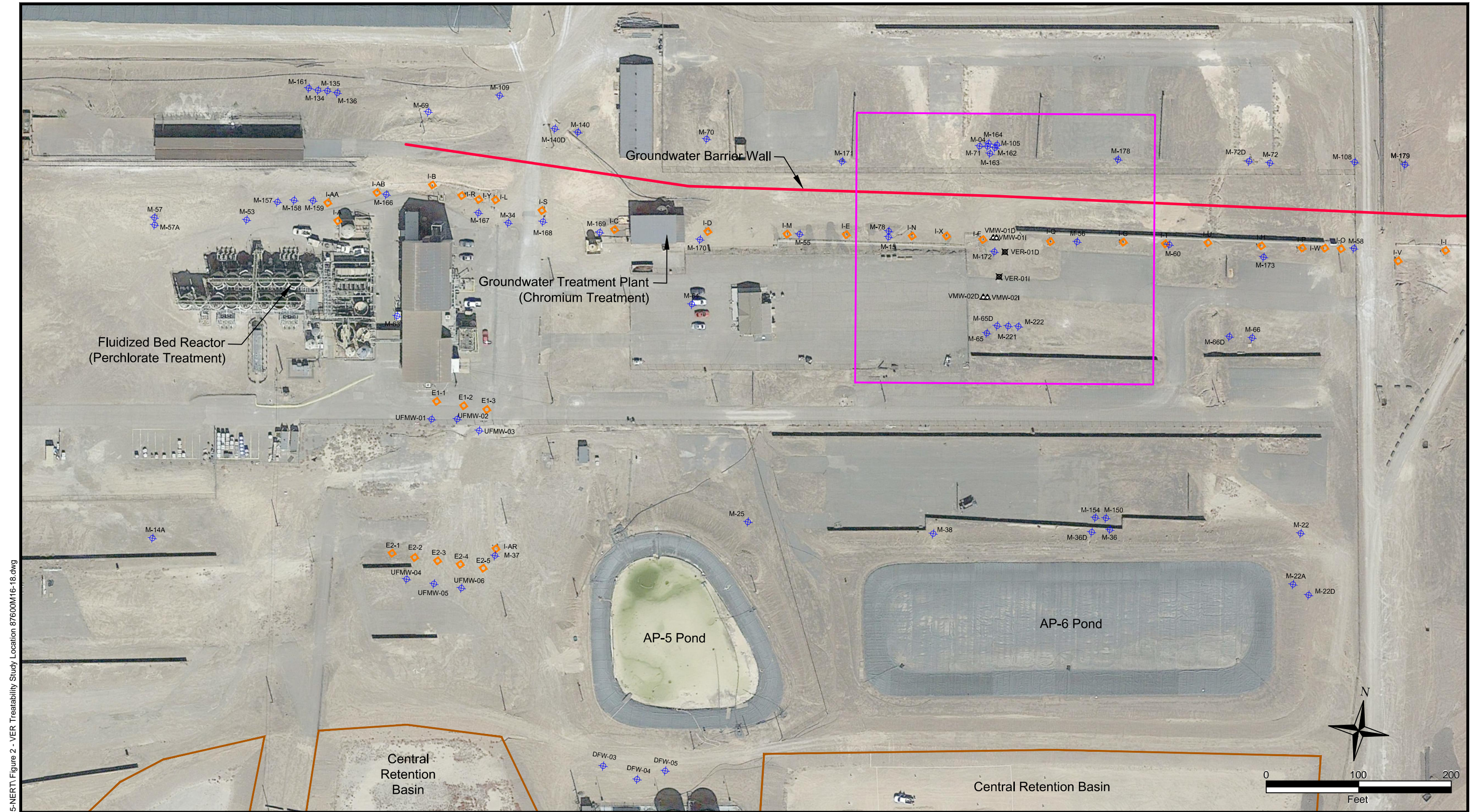
**Notes:**  
 1. Imagery Source: Aerotech Mapping, August 2016.  
 2. Monitoring well, extraction well, and groundwater barrier wall locations based on Figures 1A/B and Plates 1, 2, 6, 7, and 8 in 2015-2016 Annual Performance Report (Ramboll Environ, 2016).

**TETRA TECH**

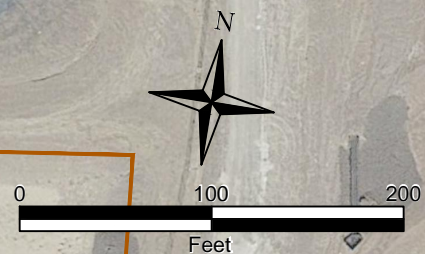
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 Henderson, Nevada 89015  
 Phone: (702) 854-2293

NEVADA ENVIRONMENTAL RESPONSE TRUST SITE	
VACUUM ENHANCED RECOVERY TREATABILITY STUDY	
<b>PROPOSED VER TREATABILITY STUDY LOCATION</b>	

Project No:	87600015
Date:	AUGUST 23, 2017
Designed By:	CL
Figure No.	<b>1</b>



\\tss318f51\1\local\ces\87600015-NERT\Figure 2 - VER Treatability Study Location 87600M16-18.dwg



Legend	
◆ M-55	Monitoring Well
◆ I-M	Extraction Well
□	VER Treatability Study Area
⊠ VER-011	Intermediate VER Well Location
⊠ VER-01D	Deep VER Well Location
▲ VMW-011	Intermediate VER Monitoring Well
▲ VMW-01D	Deep VER Monitoring Well

Notes:  
 1. Imagery Source: Aeratech Mapping, August 2016.  
 2. Monitoring well, extraction well, and groundwater barrier wall locations based on Figure 1 and Plate 1 in 2016-2017 Annual Performance Report (Ramboll Environ, 2017), Figure 7-1b in RI Data Evaluation Tech Memo (Ramboll Environ, 2016), and field observations.


**TETRA TECH**  
  
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NEVADA ENVIRONMENTAL RESPONSE TRUST SITE

VACUUM ENHANCED RECOVERY TREATABILITY STUDY RESULTS REPORT  
 HENDERSON, NEVADA

**VER TREATABILITY STUDY LOCATION**

Project No:	117-7502018
Date:	MAY 9, 2018
Designed By:	DVK
Figure No.	<b>2</b>

# Tables



**DRAFT**

**Table 1 - Well Construction Details**  
Vacuum Enhanced Recovery Treatability Study

Well ID	Northing (feet)	Easting (feet)	Latitude	Longitude	Borehole Size (inches)	Well Diameter (inches)	Well Material (blank casing)	Well Vault	Filter Pack Material	Screen Material	Screen Interval (feet bgs)	Screen Top (feet bgs)	Screen Bottom (feet bgs)	Screen Length (feet)	Total Depth of Borehole (feet bgs)	Total Depth of Well (feet bgs)	TOC Elevation (feet amsl)	Ground Surface Elevation (feet amsl)
VMW-01I	26719849.476	827893.530	N36°02'55.20944"	W115°00'08.61921"	8	2	Sch. 80 PVC	8-in. Diameter Round	#2/16 Sand	2-in. PVC 0.010"	55-70	70	55	15	71	70.5	1,748.90	1,749.29
VMW-01D	26719849.103	827890.040	N36°02'55.20596"	W115°00'08.66175"	8	2	Sch. 80 PVC	8-in. Diameter Round	#2/16 Sand	2-in. PVC 0.010"	90-110	110	90	20	111	110.5	1,748.97	1,749.17
VMW-02I	26719784.504	827894.140	N36°02'54.56687"	W115°00'08.61651"	8	2	Sch. 80 PVC	8-in. Diameter Round	#2/16 Sand	2-in. PVC 0.010"	55-70	70	55	15	71	70.5	1,751.82	1,752.15
VMW-02D	26719783.955	827889.784	N36°02'54.56169"	W115°00'08.66959"	8	2	Sch. 80 PVC	8-in. Diameter Round	#2/16 Sand	2-in. PVC 0.010"	90-110	110	90	20	111	110.5	1,751.80	1,752.15
VER-01I	26719808.757	827903.116	N36°02'54.80619"	W115°00'08.50544"	10	4	Sch. 80 PVC	12-in. Diameter Round	#2/16 Sand	4-in. Stainless Steel 0.010"	55-70	70	55	15	75.5	75	1,751.38	1,751.84
VER-01D	26719836.149	827905.071	N36°02'55.07696"	W115°00'08.47963"	10	4	Sch. 80 PVC	12-in. Diameter Round	#2/16 Sand	4-in. Stainless Steel 0.010"	90-110	110	90	20	115.5	115	1,750.11	1,750.56

- Notes:**
- amsl Above mean sea level
  - bgs Below ground surface
  - btoc Below top of casing
  - GW Groundwater
  - PVC Polyvinyl Chloride
  - TOC Top of Casing
  - in Inches

**Table 2 - Summary of Soil Analytical Results**  
Vacuum Enhanced Recovery Treatability Study

Boring Location	Sample Depth (ft bgs)	Sample ID	Sample Date	Chlorate by USEPA Method 300.1B (µg/kg)	Chlorite by USEPA Method 300.1B (µg/kg)	Perchlorate by USEPA Method 314.0 (mg/kg)	Hexavalent Chromium by USEPA Method 7199 (mg/kg)	Total Chromium by USEPA Method 6010B (mg/kg)
VMW-01D	5.0	VMW-01D-5.0-20170928	09/28/17	1500 J-	<43	210	<0.16	17
	10.0	VMW-01D-10.0-20170928	09/28/17	100 J	<44	19	<0.17	18
	15.0	VMW-01D-15.0-20170928	09/28/17	720	<43	7.6	<0.16	11
	20.0	VMW-01D-20.0-20170928	09/28/17	2,700	<43	6.5	<0.16	16
	25.0	VMW-01D-25.0-20170928	09/28/17	26,000	<48	33	0.26 J	65
	30.0	VMW-01D-30.0-20170928	09/28/17	660,000	<500	240	8.1	25
	40.0	VMW-01D-40.0-20170928	09/28/17	2,700,000	<650	570	11	48
	50.0	VMW-01D-50.0-20170928	09/28/17	3,600,000	<740	830	19	45
	60.0	VMW-01D-60.0-20170928	09/28/17	1,000,000	<55	310	0.87	17
	70.0	VMW-01D-70.0-20170928	09/28/17	40,000	<66	7.1	<0.25	21
	80.0	VMW-01D-80.0-20170928	09/28/17	3,700	<65	0.78	<0.24	49
	90.0	VMW-01D-90.0-20170928	09/28/17	11,000	<54	6.4	<0.20	41
100.0	VMW-01D-100.0-20170928	09/28/17	2,600	<53	0.85	<0.20	12	
110.0	VMW-01D-110.0-20170929	09/28/17	3,000	<64	1.3	0.31 J	48	
110.0	VMW-01D-110.0-20170929-FD	09/28/17	2,500	<63	1.0	<0.24	38	
VMW-02D	5.0	VMW-02D-5.0-20171018	10/18/17	68 J	<43	0.31 J	<0.16	17
	5.0	VMW-02D-5.0-20171018-FD	10/18/17	87 J	<43	1.8 J	<0.16	20
	10.0	VMW-02D-10.0-20171018	10/18/17	<56	<44	0.22	<0.17	28
	15.0	VMW-02D-15.0-20171018	10/18/17	190 J	<44	1.2	<0.16	16
	20.0	VMW-02D-20.0-20171018	10/18/17	1,100	<43	26 J	<0.16 UJ	18
	25.0	VMW-02D-25.0-20171018	10/18/17	54,000	<47	260	<0.18	16
	30.0	VMW-02D-30.0-20171018	10/18/17	860,000	<48	260	3.1	22
	40.0	VMW-02D-40.0-20171018	10/18/17	1,900,000	<62	430	9.3	34
	50.0	VMW-02D-50.0-20171018	10/18/17	1,200,000	<75	530	1.1	33
	60.0	VMW-02D-60.0-20171018	10/18/17	35,000	<79	30	<0.30	35
	70.0	VMW-02D-70.0-20171018	10/18/17	3,000	<76	2.3	<0.29	42
	80.0	VMW-02D-80.0-20171018	10/18/17	560	<55	0.18	<0.21	21
90.0	VMW-02D-90.0-20171018	10/18/17	710	<53	0.11	<0.20	33	
100.0	VMW-02D-100.0-20171018	10/18/17	150 J	<53	0.032 J	<0.20	21	
110.0	VMW-02D-110.0-20171018	10/18/17	<86	<69	0.027 J	<0.26	55	
VER-01I	5.0	VER-01I-5.0-20171019	10/19/17	1,200	<43	37 J	<0.16	18
	5.0	VER-01I-5.0-20171019-FD	10/19/17	1,200	<43	21 J	0.30 J	18
	10.0	VER-01I-10.0-20171019	10/19/17	69 J	<44	0.21 J-	<0.17	20
	15.0	VER-01I-15.0-20171019	10/19/17	<55	<44	0.094	<0.17	16
	20.0	VER-01I-20.0-20171019	10/19/17	<53	<42	3.0	<0.16	11
	25.0	VER-01I-25.0-20171019	10/19/17	7,500	<430	16	0.19 J	8.8
	30.0	VER-01I-30.0-20171019	10/19/17	1,800,000	<130	270	7.8	50
	40.0	VER-01I-40.0-20171019	10/19/17	980,000	<120	230	4.7	28
	50.0	VER-01I-50.0-20171019	10/19/17	1,800,000	<110	310	5.6	24
	60.0	VER-01I-60.0-20171019	10/19/17	77,000	<55 UJ	54	<0.21	15
70.0	VER-01I-70.0-20171019	10/19/17	17,000	<66	5.6 J	<0.25	24	
70.0	VER-01I-70.0-20171019-FD	10/19/17	18,000	<66	13 J	<0.24	27	
VER-01D	5.0	VER-01D-5.0-20171020	10/20/17	4,500	<45	76	<0.17	18
	10.0	VER-01D-10.0-20171020	10/20/17	6,100	<45	49	<0.17	35
	10.0	VER-01D-10.0-20171020-FD	10/20/17	6,000	<44	55	<0.16	21
	15.0	VER-01D-15.0-20171020	10/20/17	4,200	<43	23	<0.16	13
	20.0	VER-01D-20.0-20171020	10/20/17	960 J+	<45	24	<0.17	13
	25.0	VER-01D-25.0-20171020	10/20/17	11,000	<440	11	<0.16	14
	30.0	VER-01D-30.0-20171020	10/20/17	1,700,000	<62	400	6.2	44
	40.0	VER-01D-40.0-20171020	10/20/17	2,300,000	<68	450	9.3	41
	50.0	VER-01D-50.0-20171020	10/20/17	2,400,000	<81	550	20	30
	60.0	VER-01D-60.0-20171020	10/20/17	1,100,000	<50	260	0.80	14
	70.0	VER-01D-70.0-20171020	10/20/17	130,000	<66	15	<0.25	36
	80.0	VER-01D-80.0-20171020	10/20/17	15,000	<59	1.8	<0.22	37
	90.0	VER-01D-90.0-20171020	10/20/17	6,900	<54	2.6	<0.20	26
	100.0	VER-01D-100.0-20171020	10/20/17	3,200	<51	0.34	<0.19	23
110.0	VER-01D-110.0-20171020	10/20/17	1,300	<68	0.15 J	<0.25	52 J	
110.0	VER-01D-110.0-20171020-FD	10/20/17	1,400	<74	0.22 J	<0.28	110 J	

**Notes:**

- USEPA United States Environmental Protection Agency
- ft bgs Feet below ground surface
- mg/kg Milligram per kilogram
- < The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
- J- The result is an estimated quantity, but the result may be biased low.
- J The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
- J+ The result is an estimated quantity, but the result may be biased high.
- UJ The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
- Not Analyzed

**DRAFT**

**Table 3 - Summary of Baseline Groundwater Analytical Results**  
Vacuum Enhanced Recovery Treatability Study

Well Location	Sample ID	Sample Date	Week	Date Gauged	Time	Screen Interval (feet bgs)	TOC Elevation (feet amsl)	Depth to Water (feet btoc)	GW Elevation (feet amsl)	Perchlorate by USEPA Method 314.0 (µg/L)	Hexavalent Chromium by USEPA Method 7199 (µg/L)	Total Chromium by USEPA Method 7199 (mg/L)	Chlorate by USEPA Method 300.1B (µg/L)	Chlorite by USEPA Method 300.1B (µg/L)	Detected VOCs by USEPA Method 8260B (µg/L)							
															Bromodichloromethane	Bromoform	Carbon Tetrachloride	Chloroform	Dibromochloromethane	1,2-Dichlorobenzene	1,4-Dichlorobenzene	Trichloroethene
VMW-01I	VMW-01I-20171107	11/07/17	Baseline	11/07/17	7:47	55-70	1,751.82	30.38	1,721.44	1,000,000	6,900	6.6	2,000,000	<1000	0.61	1.7	<0.25	280	0.31 J	3.0	0.62	0.43 J
VMW-01D	VMW-01D-20171107	11/07/17	Baseline	11/07/17	7:45	90-110	1,751.80	23.82	1,727.98	7,900	21	0.25	21,000	<1000	<0.25	<0.40	<0.25	2.1	<0.25	<0.25	<0.25	<0.25
	VMW-01D-20171107-FD	11/07/17	Baseline							7,400	21	0.28	21,000	<1000	<0.25	<0.40	<0.25	2.2	<0.25	<0.25	<0.25	<0.25
VMW-02I	VMW-02I-20171108	11/08/17	Baseline	11/07/17	7:51	55-70	1,751.38	31.81	1,719.57	320,000	1,000	1.2	470,000	<500	<0.25	<0.40	0.31 J	69	<0.25	<0.25	<0.25	<0.25
VMW-02D	VMW-02D-20171108	11/08/17	Baseline	11/07/17	7:49	90-110	1,750.11	26.11	1,724.00	280	22	0.028	500	<500	<0.25	<0.40	<0.25	0.45 J	<0.25	<0.25	<0.25	<0.25
VER-01I	VER-01I-20171108	11/08/17	Baseline	11/07/17	7:53	55-70	1,748.90	31.87	1,717.03	300,000	2,200	2.5	680,000	<200	<0.25	<0.40	<0.25	110	<0.25	<0.25	<0.25	<0.25
VER-01D	VER-01D-20171107	11/07/17	Baseline	11/07/17	7:55	90-10	1,748.97	24.97	1,724.00	53,000	40	0.17	140,000	<1000	<0.25	<0.40	<0.25	29	<0.25	<0.25	<0.25	<0.25

**Notes:**  
 USEPA United States Environmental Protection Agency  
 °C Celsius  
 µg/L Micrograms per liter  
 mg/L Milligrams per liter  
 mV Millivolt  
 VOCs Volatile Organic Compounds  
 < The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.  
 J The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.  
 - Not Analyzed

**Table 4 - Groundwater Sample Analytical Results for the Intermediate VER Test**  
Vacuum Enhanced Recovery Treatability Study

Parameter	Concentration (milligrams per liter)							
Sampling Event	0 hr	12 hr	24 hr	36 hr	48 hr	60 hr	72 hr	78 hr
Perchlorate	1,200	1,100	1,200	1,100 J+	1,200	1,200	1,300	1,200 J
Chlorate	3,000	3,100	3,100	3,300 J	2,900	3,400	3,300	3,100 J
Hexavalent Chromium	7.7	12	11	13 J-	12	13 J-	12	12 J-
Total Chromium	8.7 J-	12 J-	12	12 J-	11 J-	12	13 B J-	12 B J+
Chloroform	0.470	0.710	0.700	0.730	0.630	0.670	0.640	0.620

**Notes:**

- B Compound was found in the blank and the sample.
  - hr hour
  - J The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
  - J- The result is an estimated quantity, but the result may be biased low.
  - J+ The result is an estimated quantity, but the result may be biased high.
1. Samples were collected from a sampling port on the extracted groundwater pipeline.
  2. Chlorite was not detected at a concentration above the level of the reported sample quantitation limit in the groundwater samples collected during the intermediate VER test.

**Table 5 - Groundwater Sample Analytical Results for the Deep VER Test**  
 Vacuum Enhanced Recovery Treatability Study

Parameter	Concentration (milligrams per liter)								
	0 hr	12 hr	24 hr	36 hr	48 hr	60 hr	72 hr	84 hr	96 hr
Perchlorate	2.0	0.980	1.1	0.830	0.800	0.720	0.660	0.670	0.570
Chlorate	4.4	3.7	2.9	2.4 J-	2.2	2.0	1.8 J-	1.8 J-	1.7 J-
Hexavalent Chromium	0.018	0.026	0.026	0.026	0.025	0.026	0.025	0.025	0.025
Total Chromium	0.028	0.028	0.028 B U	0.028 B U	0.028 B U	0.027 B U	0.030	0.028	0.028
Chloroform	0.0012	0.00066	0.00046 J	0.00044 J	0.00033 J	0.00030 J	0.00029 J	0.00027 J	0.00026 J

**Notes:**

- B Compound was found in the blank and the sample.
- hr hour
- J The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
- J- The result is an estimated quantity, but the result may be biased low.
- U The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.

1. Samples were collected from a sampling port on the extracted groundwater pipeline.
2. Chlorite was not detected at a concentration above the level of the reported sample quantitation limit in the baseline groundwater samples.

**Table 6 - Relative Groundwater Drawdown During the Intermediate Constant-Rate Pumping Test**  
Vacuum Enhanced Recovery Treatability Study

Well ID (Screened Interval - feet below ground surface)	Distance from Extraction Well (feet)	Depth to Water at Start of Test	Depth to Water at Maximum Drawdown	Maximum Relative Drawdown Observed (feet)
VER-01I (55-70)	0	34.11	54.79	20.68
VMW-02I (55-70)	26	32.37	37.14	4.77
VMW-02D (90-110)	26	26.07	26.15	0.08
M-172 (26.1-36.9)	28	33.37	33.56	0.19
VMW-01I (55-70)	42	31.38	35.51	4.13
VMW-01D (90-110)	42	23.86	23.9	0.04
I-F (11.8-41.8)	44	32.94	34.51	1.57
M-65 (14.4-39.0)	62	32.77	32.95	0.18
M-65D (15.1-40.0)	66	33.56	35.58	2.02
M-221 (75-85)	66	32.71	35.1	2.39
M-56 (15.1-40.0)	92	30.98	31.2	0.22
M-78 (21.5-41.5)	129	32.72	32.76	0.04
M-164 (60-70)	145	34.99	35.36	0.37

**Notes:**

1. Depth to water at maximum relative drawdown did not consistently correspond to the end of the constant-rate pumping test.
2. Screen interval is presented in feet below ground surface (feet bgs).
3. I-F is an active IWF extraction well.
4. Drawdown directly attributable to the intermediate constant-rate pumping test was not observed in IWF pumping wells, I-G, I-Q, and I-X.

**Table 7a - Relative Groundwater Drawdown During the Intermediate VER Test (Prior to Vacuum)**  
 Vacuum Enhanced Recovery Treatability Study

Well ID (Screened Interval - feet below ground surface)	Distance from Extraction Well (feet)	Depth to Water at Start of Test	Depth to Water at Maximum Drawdown	Maximum Relative Drawdown Observed (feet)
VER-011 (55-70)	0	34.17	70	35.83
VMW-02I (55-70)	26	32.36	36.95	4.59
VMW-02D (90-110)	26	26.16	26.16	0
M-172 (26.1-36.9)	28	33.41	33.51	0.1
VMW-01I (55-70)	42	31.56	35.89	4.33
VMW-01D (90-110)	42	23.88	23.89	0.01
I-F (11.8-41.8)	44	33.53	33.87	0.34
M-65 (14.4-39.0)	62	32.78	32.82	0.04
M-65D (15.1-40.0)	66	33.55	34.3	0.75
M-221 (75-85)	66	33.05	34.04	0.99
M-56 (15.1-40.0)	92	31.02	31.1	0.08
M-78 (21.5-41.5)	129	32.75	32.75	0
M-164 (60-70)	145	35	35.03	0.03

**Notes:**

1. To estimate the depth to water at maximum relative drawdown prior to applying vacuum to VER-011, depth to water measurements collected between 03:30 and 10:30 on January 15, 2018, were compared to the depth to water at the start of the test.
2. I-F was an active IWF pumping well.

**Table 7b - Relative Groundwater Drawdown During the Intermediate VER Test (After Vacuum)**  
 Vacuum Enhanced Recovery Treatability Study

Well ID (Screened Interval - feet below ground surface)	Distance from Extraction Well (feet)	Depth to Water at Start of Test	Maximum Relative Drawdown Observed (feet)
VMW-02I (55-70)	26	38.03	3.72
VMW-02D (90-110)	26	26.17	0.07
VMW-01I (55-70)	42	36.45	3.54
M-65D (15.1-40.0)	66	35.27	1.89
M-221 (75-85)	66	34.63	4.94

**Notes:**

1. Depth to water at start of test and relative drawdown were estimated from pressure transducer measurements of pressure in wells during the VER test.

**Table 8 - Relative Groundwater Drawdown During the Deep Constant-Rate Pumping Test**  
Vacuum Enhanced Recovery Treatability Study

Well ID (Screened Interval - feet below ground surface)	Distance from Extraction Well (feet)	Depth to Water at Start of Test	Depth to Water at Maximum Drawdown	Maximum Relative Drawdown Observed (feet)
VER-01D (90-110)	0	29.69	86.02	56.33
M-172 (26.1-36.9)	13	33.25	33.15	-0.1
VMW-01I (55-70)	18	31.4	31.19	-0.21
VMW-01D (90-110)	20	26.17	39.42	13.25
I-F (11.8-41.8)	28	33.12	32.8	-0.32
VMW-02I (55-70)	52	32.2	32.06	-0.14
VMW-02D (90-110)	55	27.85	32.1	4.25
M-56 (15.1-40.0)	78	30.98	30.81	-0.17
M-65 (14.4-39.0)	89	32.58	32.47	-0.11
M-65D (15.1-40.0)	92	32.34	33.35	1.01
M-221 (75-85)	92	32.98	32.73	-0.25
M-222 (100-110)	101	28.57	30.48	1.91
M-163 (80-90)	108	28.71	29.64	0.93
M-162 (100-110)	113	24.29	26.85	2.56
M-164 (60-70)	120	34.91	34.78	0.13
M-78 (21.5-41.5)	128	32.5	32.4	-0.1

**Notes:**

1. Depth to water at maximum relative drawdown did not consistently correspond to the end of the deep constant-rate pumping test.
2. I-F is an active IWF pumping well.
3. Drawdown directly attributable to the deep constant-rate pumping test was not observed in IWF pumping wells, I-G, I-Q, and I-X



**Table 9a - Relative Groundwater Drawdown During the Deep VER Test (Prior to Vacuum)**  
Vacuum Enhanced Recovery Treatability Study

Well ID (Screened Interval - feet below ground surface)	Distance from Extraction Well (feet)	Depth to Water at Start of Test	Depth to Water at Maximum Drawdown	Maximum Relative Drawdown Observed (feet)
VER-01D (90-110)	0	26.8	110	83.2
M-172 (26.1-36.9)	13	32.61	32.57	-0.04
VMW-01I (55-70)	18	30.57	30.6	-0.03
VMW-01D (90-110)	20	24.18	39.25	15.07
I-F (11.8-41.8)	28	31.95	31.82	-0.13
VMW-02I (55-70)	52	31.63	31.56	-0.07
VMW-02D (90-110)	55	26.39	28.05	1.66
M-56 (15.1-40.0)	78	30.38	30.36	-0.02
M-65 (14.4-39.0)	89	32.14	32.17	0.03
M-65D (15.1-40.0)	92	32.93	32.91	-0.02
M-221 (75-85)	92	32.46	32.41	-0.05
M-222 (100-110)	101	28.54	28.58	0.04
M-163 (80-90)	108	28.33	28.34	0.01
M-162 (100-110)	113	23.78	24.63	0.85
M-164 (60-70)	120	34.6	34.56	-0.04
M-78 (21.5-41.5)	128	31.82	31.77	-0.05

**Notes:**

1. To estimate the depth to water at maximum relative drawdown prior to applying vacuum to VER-01D, depth to water measurements collected between 03:30 and 15:30 on February 5, 2018, were compared to the depth to water at the start of the test.
2. I-F was an active IWF pumping well.

**Table 9b - Relative Groundwater Drawdown During the Deep VER Test (After Vacuum)**  
Vacuum Enhanced Recovery Treatability Study

Well ID (Screened Interval - feet below ground surface)	Distance from Extraction Well (feet)	Depth to Water at Start of Test	Maximum Relative Drawdown Observed (feet)
VMW-01I (55-70)	18	30.52	-0.01
VMW-01D (90-110)	20	36.19	14.61
VMW-02I (55-70)	52	31.62	0.02
VMW-02D (90-110)	55	26.59	11.91
M-222 (100-110)	101	28.52	5.96

**Notes:**

1. Depth to water at start of test and relative drawdown were estimated from pressure transducer measurements of pressure in wells during the VER test.