TETRA TECH

TECHNICAL MEMORANDUM

To:	**Nevada Environmental Response Trust**
Cc:	Nevada Division of Environmental Protection United States Environmental Protection Agency
From:	Dana Grady
Date:	February 9, 2024
Subject:	Las Vegas Wash ZVI-Enhanced Bioremediation Treatability Study Monthly Progress Report

At the direction of the Nevada Environmental Response Trust (NERT or Trust), Tetra Tech, Inc. (Tetra Tech) has prepared this memorandum to summarize Tetra Tech's progress during December 2023 toward successfully implementing the Las Vegas Wash Zero-Valent Iron (ZVI)-Enhanced Bioremediation Treatability Study.

Task Progress Update: December 2023

Task M18 – Las Vegas Wash ZVI-Enhanced Bioremediation Treatability Study

- Current Status –

  The Las Vegas Wash ZVI-Enhanced Bioremediation Treatability Study is being conducted to evaluate the effectiveness of ZVI-enhanced bioremediation of perchlorate-contaminated groundwater that has migrated downgradient of the NERT site toward the Las Vegas Wash. The general treatability study layout, including locations of the continuous and discontinuous ZVI walls and associated injection well and monitoring well network, is presented on Figures 1, 2a, and 2b. Well construction details are provided in Table 1. The construction phase of the treatability study was completed on April 24, 2023, and the performance monitoring phase is ongoing.

  - Performance Monitoring – The performance monitoring program included a pre-construction, baseline groundwater sampling event completed in October 2022 prior to installation of the continuous and discontinuous ZVI walls and performance monitoring network. Following construction of the ZVI walls, installation of the performance monitoring network, and injection of biological inoculum and nutrient solution, the performance monitoring program began in May 2023 and is ongoing. The performance monitoring program is being implemented in accordance with the NDEP-approved Work Plan Addendum, which includes monthly synoptic gauging events to evaluate hydrologic changes over time and groundwater sampling events approximately one month after completion of the construction phase and quarterly thereafter for a total of 16 months. The latest monthly synoptic gauging event was conducted on December 18, 2023. The Month 1 monitoring groundwater sampling event was performed from May 22 to May 30, 2023, approximately one month after completion of the construction phase of the treatability study. The

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first quarterly performance monitoring event was conducted from August 21 to August 31, 2023, which is approximately four months after completion of the construction phase. Due to a laboratory error, four monitoring wells were resampled for perchlorate on October 11, 2023, and field split samples were submitted to a separate analytical laboratory to confirm resample concentrations. Available draft groundwater analytical results from the baseline sampling event, and the subsequent monitoring events performed in May 2023 and August 2023, including the October 2023 resampling event were presented in the October 2023 monthly progress report. The second quarterly performance monitoring event was conducted from November 27 through December 6, 2023. Results from the November/December 2023 sampling event will be summarized in future reports once the laboratory data have been received.

- Monthly Synoptic Monitoring – Monthly synoptic monitoring is being performed to evaluate any changes in horizontal and vertical gradients, assess for potential groundwater mounding upgradient of the ZVI reactive zone, assess hydraulic effects of seasonal precipitation, and evaluate potential non-uniform flow. Results of the December 2023 monthly synoptic monitoring event do not indicate any significant changes to groundwater elevations in monitoring wells located upgradient, within, and downgradient of ZVI reactive zones.
- Microbial Sampling – To evaluate the microbial community present in the treatability study area, both Bio-Trap® samplers and groundwater samples were collected in August/September 2023 from 23 monitoring wells, which were located both upgradient, within, and downgradient of the continuous and discontinuous ZVI walls. Both Bio-Trap® samplers and groundwater samples were sent to microbial analytical laboratories for analysis of microbial parameters listed in the NDEP-approved Work Plan Addendum. Analytical results are provided in Table 2.

  Results from the microbial analysis show that the biomass counts indicate a robust population ranging from $2.43x10^4$ to 9.05×10^4 cells per bead in the Bio-Trap® samples collected from wells within and downgradient of the ZVI walls. The highest biomass concentrations of 9.05×10^4 was observed in the Bio-Trap® collected from ZTS-MW171, which is located within the continuous ZVI wall in Test Area 1b. Analysis of the genes encoding the perchlorate reductase enzyme (pcrA and pcrAS) indicated the presence of pcrA and/or pcrAS within or downgradient of each of the test area, with the exception of Test Area 2a. Additionally, the cld gene was detected in groundwater samples collected from seven monitoring wells, with concentrations ranging from $4.32x10^3$ to $2.55x10^5$ cells per milliliter. These results indicate the presence of microbes capable of biologically reducing perchlorate and chlorate in groundwater.

- Schedule and Progress Updates
  - Groundwater levels will be measured on a monthly basis for the duration of the treatability study. The next monthly synoptic event is scheduled for January 22 through January 24, 2024.
  - Groundwater samples will continue to be collected on a quarterly basis to generate time-series data to evaluate the effectiveness of the ZVI installations with respect to the design performance criteria. The next quarterly groundwater sampling event is planned for February 19 through 23, 2024.
- Health and Safety
  - There were no health and safety incidents related to Task M18 during December 2023.

CERTIFICATION

Las Vegas Wash ZVI-Enhanced Bioremediation 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: _____, not individually, but solely in his representative capacity as Vice President of the Nevada Environmental Response Trust Trustee

Name: Andrew W. Steinberg, not individually, but solely in his representative capacity as Vice President of the Nevada Environmental Response Trust Trustee

Title: Solely as Vice 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: 2-9-24

CERTIFICATION

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: Prepared Las Vegas Wash ZVI-Enhanced Bioremediation Treatability Study Monthly Progress Report.

February 9, 2024

Christopher Hayes, CEM
Environmental Engineer
Tetra Tech, Inc.

Date

Nevada CEM Certificate Number: EM2499
Nevada CEM Expiration Date: December 15, 2024

Figures

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Legend

- Post-Construction Monitoring Well
- Inoculum Injection Well
- Existing Injection Well
- ZVI Boring
- ZVI Trench Location

Notes:
1. Imagery Source: Drone Survey, June 2023.

DOCUMENT PATH: D:\NERT\M18\MXD\MONTHLY REPORT\POST\FIGURE 1 TREATIBILITY.MXD

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NEVADA ENVIRONMENTAL RESPONSE TRUST

LAS VEGAS WASH ZVI-ENHANCED BIOREMEDIATION TREATABILITY STUDY
HENDERSON, NEVADA

TREATABILITY STUDY LAYOUT

PROJECT NO.:	117-7502022-M18
DATE:	AUGUST 14, 2023
DESIGNED BY:	AAM

Figure No.
1

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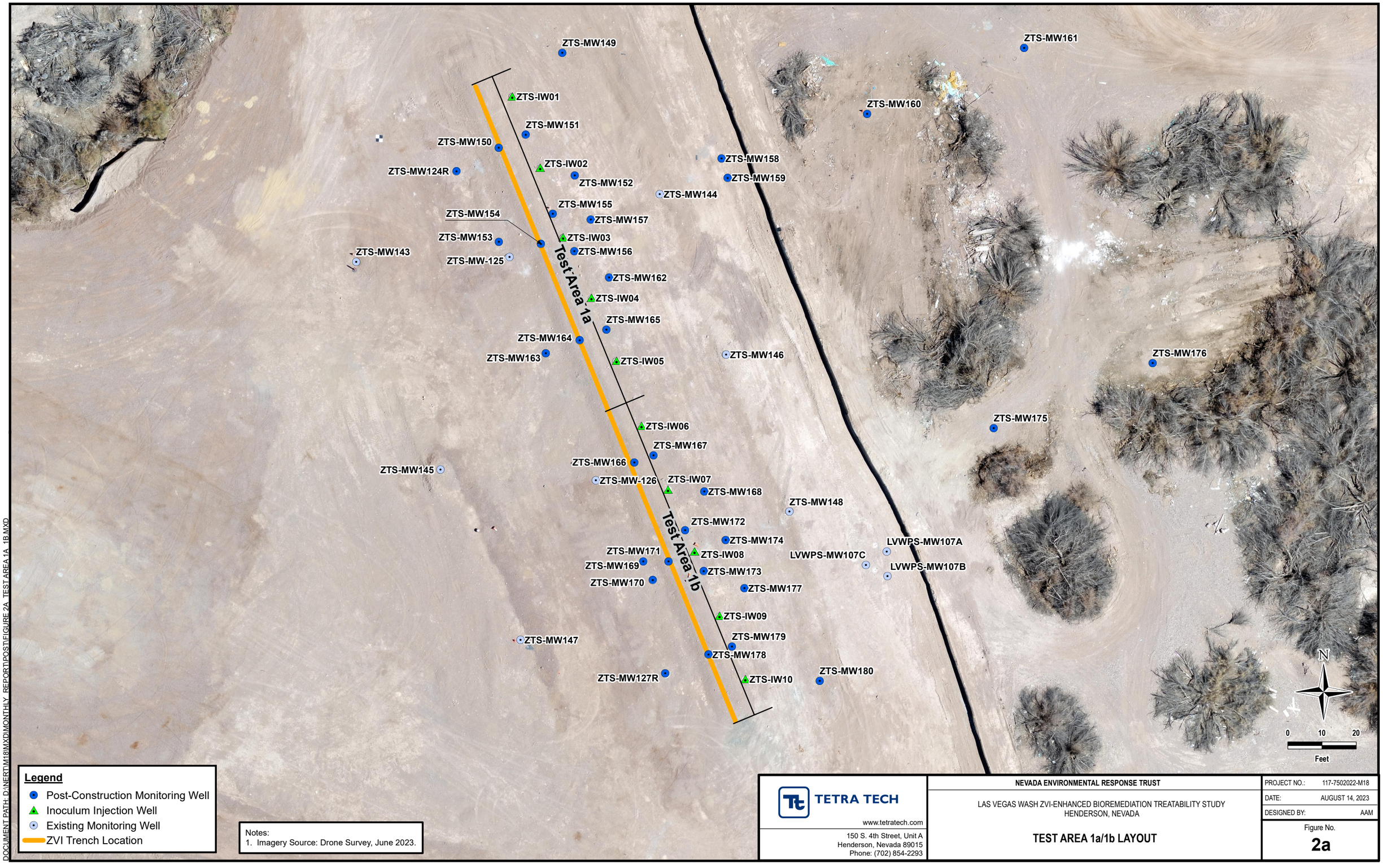

Legend

- Post-Construction Monitoring Well
- Inoculum Injection Well
- Existing Monitoring Well
- ZVI Trench Location

Notes:
1. Imagery Source: Drone Survey, June 2023.

DOCUMENT PATH: D:\NERT\M18\MXD\MONTHLY_REPORT\POST\FIGURE 2A_TEST AREA 1A_1B.MXD

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NEVADA ENVIRONMENTAL RESPONSE TRUST

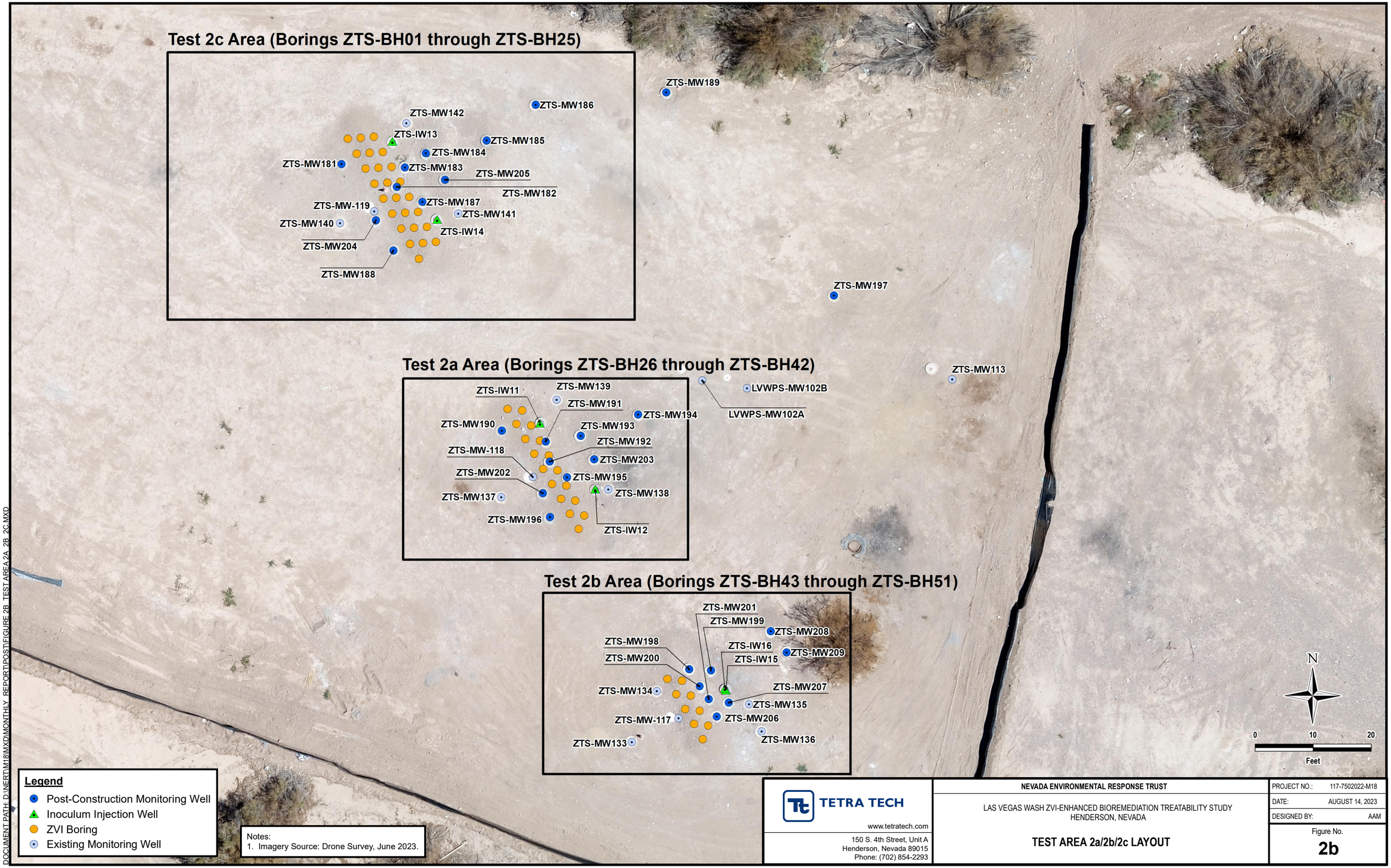
LAS VEGAS WASH ZVI-ENHANCED BIOREMEDIATION TREATABILITY STUDY
HENDERSON, NEVADA

TEST AREA 1a/1b LAYOUT

PROJECT NO.:	117-7502022-M18
DATE:	AUGUST 14, 2023
DESIGNED BY:	AAM

Figure No.
2a

DRAFT



Legend

- Post-Construction Monitoring Well
- Inoculum Injection Well
- ZVI Boring
- Existing Monitoring Well

Notes:
1. Imagery Source: Drone Survey, June 2023.

DOCUMENT PATH: D:\NERT\M18\MXD\MONTHLY REPORT\POST\FIGURE 2B_TEST AREA 2A_2B_2C.MXD

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TEST AREA 2a/2b/2c LAYOUT

PROJECT NO.:	117-7502022-M18
DATE:	AUGUST 14, 2023
DESIGNED BY:	AAM

Figure No.
2b

Tables

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Table 1
Well Construction Details
Las Vegas Wash ZVI-Enhanced Bioremediation Treatability Study

Well ID	Screened Lithology	Northing	Easting	Ground Surface Elevation	Top of Casing Elevation	Depth to Water[1]	Groundwater Elevation	Casing Material	Slot Size	Filter Pack Gradation	Nominal Borehole Diameter	Borehole Total Depth	Well Diameter	Nominal Screen Length	Well Total Depth	Bottom of Screen	Top of Screen
				feet amsl	feet amsl	ft bTOC	amsl		inches		inches	feet bgs	inches	feet	feet bgs	feet bgs	feet bgs
Test Area 1A																	
ZTS-MW124R	Alluvium	26732932.91	833021.97	1545.35	1545.24	16.94	1528.30	Schedule 40 PVC	0.020	#3	8	35.0	4	10.0	34.5	34.0	24.5
ZTS-MW125	UMCf	26732907.80	833037.00	1546.94	1546.51	17.84	1528.67	Schedule 40 PVC	0.010	#2/16	8	75	4	10	50.5	50	40
ZTS-MW143	Alluvium	26732906.40	832992.60	1545.04	1544.90	16.13	1528.77	Schedule 40 PVC	0.020	#3	6	35	2	10	33.5	33	23
ZTS-MW144	Alluvium	26732926.25	833081.32	1544.47	1544.52	16.85	1527.67	Schedule 40 PVC	0.020	#3	6	40	2	10	34.5	34	24
ZTS-MW149	Alluvium	26732967.42	833052.83	1544.31	1544.20	16.38	1527.82	Schedule 40 PVC	0.020	#3	6	35.0	2	10.0	33.5	33.0	23.3
ZTS-MW150	Alluvium	26732939.76	833034.23	1546.83	1546.74	18.70	1528.04	Schedule 40 PVC	0.020	#3	6	45.0	2	10.0	34.5	34.0	24.3
ZTS-MW151	Alluvium	26732943.59	833042.18	1545.72	1545.62	17.75	1527.87	Schedule 40 PVC	0.020	#3	6	37.5	2	10.0	34.5	34.0	24.3
ZTS-MW152	Alluvium	26732931.70	833056.48	1545.63	1545.50	17.81	1527.69	Schedule 40 PVC	0.020	#3	6	35.0	2	10.0	33.5	33.0	23.3
ZTS-MW153	Alluvium	26732912.34	833034.31	1545.73	1545.61	17.38	1528.23	Schedule 40 PVC	0.020	#3	6	40.0	2	10.0	34.5	34.0	24.3
ZTS-MW154	Alluvium	26732911.74	833046.57	1546.73	1546.62	18.72	1527.90	Schedule 40 PVC	0.020	#3	6	42.5	2	10.0	32.5	32.0	22.3
ZTS-MW155	Alluvium	26732920.46	833050.08	1545.97	1545.89	18.18	1527.71	Schedule 40 PVC	0.020	#3	6	40.0	2	15.0	35.5	35.0	20.3
ZTS-MW156	UMCf	26732909.63	833056.38	1546.34	1546.30	18.52	1527.78	Schedule 40 PVC	0.010	#2/16	6	55.0	2	10.0	54.0	53.5	43.8
ZTS-MW157	Alluvium	26732918.81	833061.15	1545.95	1545.87	18.21	1527.66	Schedule 40 PVC	0.020	#3	6	35.0	2	10.0	33.5	33.0	23.3
ZTS-MW158	Alluvium	26732936.67	833099.40	1544.15	1544.09	16.70	1527.39	Schedule 40 PVC	0.020	#3	6	35.0	2	10.0	33.5	33.0	23.3
ZTS-MW159	UMCf	26732930.97	833101.22	1544.36	1544.08	16.83	1527.25	Schedule 40 PVC	0.010	#2/16	6	50.0	48	10.0	49.0	48.5	38.8
ZTS-MW160	Alluvium	26732949.66	833141.96	1544.42	1544.11	16.86	1527.25	Schedule 40 PVC	0.020	#3	6	40.0	2	10.0	33.5	33.0	23.3
ZTS-MW161	Alluvium	26732968.87	833187.88	1544.23	1543.99	17.03	1526.96	Schedule 40 PVC	0.020	#3	6	45.0	2	10.0	34.5	34.0	24.3
ZTS-MW162	Alluvium	26732901.90	833066.48	1545.76	1545.61	17.94	1527.67	Schedule 40 PVC	0.020	#3	6	40.0	2	10.0	33.5	33.0	23.3
ZTS-MW163	Alluvium	26732879.80	833048.04	1546.23	1546.18	19.05	1527.13	Schedule 40 PVC	0.020	#3	6	40.0	2	10.0	34.5	34.0	24.3
ZTS-MW164	Alluvium	26732883.65	833057.93	1547.06	1546.96	17.90	1529.06	Schedule 40 PVC	0.020	#3	6	40.0	2	10.0	32.5	32.0	22.3
ZTS-MW165	Alluvium	26732886.70	833065.74	1545.63	1545.50	17.83	1527.67	Schedule 40 PVC	0.020	#3	6	38.0	2	10	32.5	32.0	22.3
Between Test Area 1A and Test Area 1B																	
ZTS-MW145	UMCf	26732845.93	833017.26	1547.43	1547.13	18.20	1528.93	Schedule 40 PVC	0.010	#2/16	8	50	4	10	49.5	49	39
ZTS-MW146	UMCf	26732879.40	833100.75	1548.63	1547.33	19.60	1527.73	Schedule 40 PVC	0.010	#2/16	8	55	4	10	51.5	51	41
Test Area 1B																	
ZTS-MW126	Alluvium	26732842.82	833063.07	1548.61	1548.47	19.35	1529.12	Schedule 40 PVC	0.020	#3	8	40	4	10	30.5	30	20
ZTS-MW127R	Alluvium	26732786.41	833082.92	1548.26	1548.18	19.80	1528.38	Schedule 40 PVC	0.020	#3	8	24.0	4	5.0	23.5	23.0	18.5
ZTS-MW147	Alluvium	26732796.25	833040.66	1547.65	1547.18	18.28	1528.90	Schedule 40 PVC	0.020	#3	6	35	2	10	30.0	29.5	19.5
ZTS-MW148	Alluvium	26732833.56	833119.27	1548.62	1548.41	20.49	1527.92	Schedule 40 PVC	0.020	#3	6	35	2	10	32.5	32.0	22.0
ZTS-MW166	Alluvium	26732847.93	833073.86	1548.22	1548.25	20.30	1527.95	Schedule 40 PVC	0.020	#3	6	38.0	2	10	30.0	29.5	19.8
ZTS-MW167	Alluvium	26732850.05	833079.50	1547.37	1547.33	19.43	1527.90	Schedule 40 PVC	0.020	#3	6	40.0	2	10.0	33.5	33.0	23.3
ZTS-MW168	Alluvium	26732839.48	833094.36	1547.52	1547.63	19.78	1527.85	Schedule 40 PVC	0.020	#3	6	32.0	2	10.0	30.5	30.0	20.3
ZTS-MW169	Alluvium	26732819.11	833076.48	1547.70	1547.57	19.44	1528.13	Schedule 40 PVC	0.020	#3	6	27.5	2	10.0	27.5	27.0	17.1
ZTS-MW170	UMCf	26732813.68	833079.28	1547.58	1547.45	19.32	1528.13	Schedule 40 PVC	0.010	#2/16	6	46.5	2	10.0	41.5	41.0	31.1
ZTS-MW171	Alluvium	26732819.11	833083.89	1548.61	1548.53	20.33	1528.20	Schedule 40 PVC	0.020	#3	6	35.0	2	10.0	29.5	29.0	19.3
ZTS-MW172	Alluvium	26732828.15	833088.77	1547.91	1547.74	19.77	1527.97	Schedule 40 PVC	0.020	#3	6	30.0	2	10.0	27.5	27.0	17.3
ZTS-MW173	UMCf	26732816.29	833094.22	1547.95	1547.78	19.77	1528.01	Schedule 40 PVC	0.010	#2/16	6	46.0	2	10.0	43.5	43.0	33.3
ZTS-MW174	Alluvium	26732825.33	833100.64	1548.30	1548.11	20.20	1527.91	Schedule 40 PVC	0.020	#3	6	31.5	2	10.0	30.0	29.5	19.8
ZTS-MW175	Alluvium	26732857.97	833178.91	1546.18	1546.25	19.24	1527.01	Schedule 40 PVC	0.020	#3	6	61.5	2	10.0	30.0	29.5	19.8
ZTS-MW176	Alluvium	26732876.92	833225.42	1543.90	1543.74	17.04	1526.70	Schedule 40 PVC	0.020	#3	6	32.0	2	10.0	30.0	29.5	19.8
ZTS-MW177	Alluvium	26732811.29	833106.07	1548.22	1548.12	20.17	1527.95	Schedule 40 PVC	0.020	#3	6	31.0	2	10.0	30.5	30.0	20.3
ZTS-MW178	Alluvium	26732791.95	833095.60	1549.21	1549.14	20.91	1528.23	Schedule 40 PVC	0.020	#3	6	34.0	2	10.0	28.0	27.5	17.8
ZTS-MW179	Alluvium	26732794.26	833102.47	1548.62	1548.45	20.23	1528.22	Schedule 40 PVC	0.020	#3	6	27.5	2	5.0	23.5	23.0	18.3
ZTS-MW180	Alluvium	26732784.25	833128.08	1548.42	1548.12	20.21	1527.91	Schedule 40 PVC	0.020	#3	6	25.0	2	5.0	23.0	22.5	17.8
LVWPS-MW107A	Alluvium	26732823.90	833144.18	1548.14	1547.58	19.96	1527.62	Schedule 40 PVC	0.020	#3	8	35.5	4	10	35.0	34.5	24.8
LVWPS-MW107B	UMCf	26732816.68	833144.44	1548.20	1547.82	16.61	1531.21	Schedule 40 PVC	0.010	#2/12	8	67.0	4	20	66.3	65.8	46.0
LVWPS-MW107C	UMCf (Semi-Cons)	26732819.93	833138.10	1548.33	1547.93	5.81	1542.12	Schedule 40 PVC	0.010	#2/12	6	121.0	2	20	120.5	120.0	100.3

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Table 1
Well Construction Details
Las Vegas Wash ZVI-Enhanced Bioremediation Treatability Study

Well ID	Screened Lithology	Northing	Easting	Ground Surface Elevation	Top of Casing Elevation	Depth to Water[1]	Groundwater Elevation	Casing Material	Slot Size	Filter Pack Gradation	Nominal Borehole Diameter	Borehole Total Depth	Well Diameter	Nominal Screen Length	Well Total Depth	Bottom of Screen	Top of Screen
				feet amsl	feet amsl	ft bTOC	amsl		inches		inches	feet bgs	inches	feet	feet bgs	feet bgs	feet bgs
Test Area 2A																	
ZTS-MW118	Alluvium	26732588.00	832939.61	1547.64	1547.41	16.34	1531.07	Schedule 40 PVC	0.020	#3	8	40	4	10	24	23.5	13.5
ZTS-MW137	Alluvium	26732584.41	832934.77	1547.68	1547.44	16.36	1531.08	Schedule 40 PVC	0.020	#3	6	28	2	10	24.5	24	14
ZTS-MW138	Alluvium	26732585.74	832953.21	1547.68	1547.35	16.37	1530.98	Schedule 40 PVC	0.020	#3	6	25	2	10	24.5	24	14
ZTS-MW139	Alluvium	26732601.13	832944.31	1547.36	1547.07	16.17	1530.90	Schedule 40 PVC	0.020	#3	6	30	2	10	23.5	23	13
ZTS-MW190	Alluvium	26732595.87	832934.90	1547.59	1547.32	16.32	1531.00	Schedule 40 PVC	0.020	#3	6	25.0	2	10.0	25.5	24.0	14.3
ZTS-MW191	Alluvium	26732593.97	832942.42	1548.18	1547.93	17.00	1530.93	Schedule 40 PVC	0.020	#3	6	30.0	2	10.0	25.0	24.5	14.8
ZTS-MW192	Alluvium	26732590.54	832943.15	1548.28	1548.11	17.16	1530.95	Schedule 40 PVC	0.020	#3	6	25.0	2	10.0	24.5	24.0	14.3
ZTS-MW193	Alluvium	26732594.97	832948.47	1547.64	1547.48	16.62	1530.86	Schedule 40 PVC	0.020	#3	6	25.0	2	10.0	23.8	23.3	13.6
ZTS-MW194	Alluvium	26732598.62	832958.35	1547.33	1547.38	16.65	1530.73	Schedule 40 PVC	0.020	#3	6	25.0	2	5.0	23.0	22.5	17.8
ZTS-MW195	Alluvium	26732587.81	832946.10	1548.38	1548.14	17.20	1530.94	Schedule 40 PVC	0.020	#3	6	25.0	2	10.0	24.5	24.0	14.3
ZTS-MW196	Alluvium	26732581.00	832943.16	1547.81	1547.34	16.29	1531.05	Schedule 40 PVC	0.020	#3	6	25.0	2	10.0	24.0	23.5	13.8
ZTS-MW197	Alluvium	26732619.07	832992.11	1547.27	1546.99	16.97	1530.02	Schedule 40 PVC	0.020	#3	6	25.0	2	10.0	23.0	22.5	12.8
ZTS-MW202	UMCf	26732585.08	832941.97	1547.83	1547.46	16.48	1530.98	Schedule 40 PVC	0.010	#2/16	6	40.0	2	10.0	39.0	38.5	28.8
ZTS-MW203	UMCf	26732590.95	832950.78	1547.77	1547.71	16.90	1530.81	Schedule 40 PVC	0.010	#2/16	6	45.0	2	10.0	38.5	38.0	28.3
LVWPS-MW102A	UMCf	26732606.35	832965.93	1547.23	1546.82	10.40	1536.42	Schedule 40 PVC	0.010	#2/12	6	67.5	2	20	67.1	66.6	47.0
LVWPS-MW102B	UMCf (Semi-Cons)	26732605.06	832973.68	1547.14	1546.78	4.77	1542.01	Schedule 40 PVC	0.010	#2/12	6	120.0	2	20	97.0	96.5	76.8
Test Area 2B																	
ZTS-MW117	UMCf	26732546.84	832964.21	1547.64	1547.32	14.75	1532.57	Schedule 40 PVC	0.010	#2/16	8	75	4	15	56	55.5	40.5
ZTS-MW133	UMCf	26732542.30	832957.28	1547.79	1547.51	11.11	1536.40	Schedule 40 PVC	0.010	#2/16	6	75	2	15	69.5	69	54
ZTS-MW134	UMCf	26732551.09	832961.57	1547.75	1547.54	16.31	1531.23	Schedule 40 PVC	0.010	#2/16	6	37	2	10	36.5	36	26
ZTS-MW135	UMCf	26732548.80	832977.51	1547.56	1547.42	10.76	1536.66	Schedule 40 PVC	0.010	#2/16	6	76	2	15	69.5	69	54
ZTS-MW136	UMCf	26732544.12	832979.70	1547.67	1547.29	16.01	1531.28	Schedule 40 PVC	0.010	#2/16	6	55	2	20	47.5	47	27
ZTS-MW198	UMCf	26732554.83	832967.16	1547.78	1547.69	16.64	1531.05	Schedule 40 PVC	0.010	#2/16	6	47.5	2	20.0	46.5	46.0	26.1
ZTS-MW199	UMCf	26732554.62	832970.93	1547.18	1546.84	10.53	1536.31	Schedule 40 PVC	0.010	#2/16	6	68.0	2	15.0	65.5	65.0	50.1
ZTS-MW200	UMCf	26732551.89	832968.94	1547.67	1547.57	11.41	1536.16	Schedule 40 PVC	0.010	#2/16	6	68.0	2	15.0	65.5	65.0	50.1
ZTS-MW201	UMCf	26732549.70	832970.52	1547.59	1547.29	16.03	1531.26	Schedule 40 PVC	0.010	#2/16	6	50.0	2	20.0	47.5	47.0	27.1
ZTS-MW206	UMCf	26732546.67	832971.91	1547.58	1547.61	11.34	1536.27	Schedule 40 PVC	0.010	#2/16	6	70.0	2	15.0	65.5	65.0	50.1
ZTS-MW207	UMCf	26732549.09	832973.98	1547.48	1547.43	16.33	1531.10	Schedule 40 PVC	0.010	#2/16	6	48.0	2	20.0	46.5	46.0	26.1
ZTS-MW208	UMCf	26732561.34	832981.27	1547.35	1547.21	16.41	1530.80	Schedule 40 PVC	0.010	#2/16	6	48.0	2	20.0	46.5	46.0	26.1
ZTS-MW209	UMCf	26732557.71	832983.97	1547.62	1547.30	11.00	1536.30	Schedule 40 PVC	0.010	#2/16	6	69.0	2	15.0	66.0	65.5	50.6
Test Area 2C																	
ZTS-MW119	Alluvium	26732634.25	832912.06	1547.46	1547.12	16.38	1530.74	Schedule 40 PVC	0.020	#3	8	37.5	4	10	25.5	25	15
ZTS-MW140	Alluvium	26732631.52	832907.03	1547.30	1546.73	15.94	1530.79	Schedule 40 PVC	0.020	#3	6	30	2	10	26.0	25.5	15.5
ZTS-MW141	Alluvium	26732633.15	832927.38	1547.65	1547.39	16.70	1530.69	Schedule 40 PVC	0.020	#3	6	30	2	10	25.0	24.5	14.5
ZTS-MW142	Alluvium	26732648.69	832918.45	1547.42	1546.81	16.21	1530.60	Schedule 40 PVC	0.020	#3	6	27	2	10	26.5	26	16
ZTS-MW181	Alluvium	26732641.70	832907.27	1547.62	1547.25	16.67	1530.58	Schedule 40 PVC	0.020	#3	6	27.5	2	10.0	27.5	27.0	17.3
ZTS-MW182	Alluvium	26732637.76	832916.80	1548.07	1547.79	17.17	1530.62	Schedule 40 PVC	0.020	#3	6	35.0	2	10.0	27.8	27.3	17.6
ZTS-MW183	Alluvium	26732641.13	832918.19	1547.72	1547.58	17.00	1530.58	Schedule 40 PVC	0.020	#3	6	28.0	2	10.0	27.5	27.0	17.3
ZTS-MW184	Alluvium	26732643.60	832921.80	1547.60	1547.53	17.02	1530.51	Schedule 40 PVC	0.020	#3	6	27.5	2	10.0	26.5	26.0	16.3
ZTS-MW185	Alluvium	26732645.77	832932.26	1547.59	1547.60	17.11	1530.49	Schedule 40 PVC	0.020	#3	6	27.5	2	10.0	25.5	25.0	15.3
ZTS-MW186	Alluvium	26732651.85	832940.71	1547.27	1547.26	16.87	1530.39	Schedule 40 PVC	0.020	#3	6	27.0	2	10.0	25.5	25.0	15.3
ZTS-MW187	Alluvium	26732635.16	832921.20	1547.70	1547.25	16.70	1530.55	Schedule 40 PVC	0.020	#3	6	28.0	2	10.0	25.5	25.0	15.3
ZTS-MW188	Alluvium	26732626.83	832916.22	1547.30	1546.93	16.25	1530.68	Schedule 40 PVC	0.020	#3	6	27.5	2	10.0	27.5	27.0	17.3
ZTS-MW189	Alluvium	26732654.00	832963.19	1547.16	1547.14	16.98	1530.16	Schedule 40 PVC	0.020	#3	6	27.5	2	10.0	23.5	23.0	12.8
ZTS-MW204	UMCf	26732632.00	832913.21	1547.40	1546.87	16.35	1530.52	Schedule 40 PVC	0.010	#2/16	6	42.5	2	10.0	40.5	40.0	30.3
ZTS-MW205	UMCf	26732638.98	832925.09	1547.61	1547.30	17.00	1530.30	Schedule 40 PVC	0.010	#2/16	6	42.5	2	10.0	40.5	40.0	30.3
General Vicinity																	
ZTS-MW116	UMCf	26732461.29	833014.94	1548.45	1547.92	16.31	1531.61	Schedule 40 PVC	0.010	#2/16	6	55	2	15	48.5	48	33
ZTS-MW128	UMCf	26732659.68	833137.95	1555.83	1555.41	26.67	1528.74	Schedule 40 PVC	0.010	#2/16	6	75	2	10	52.5	52	42

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Table 1
Well Construction Details
Las Vegas Wash ZVI-Enhanced Bioremediation Treatability Study

Well ID	Screened Lithology	Northing	Easting	Ground Surface Elevation	Top of Casing Elevation	Depth to Water[1]	Groundwater Elevation	Casing Material	Slot Size	Filter Pack Gradation	Nominal Borehole Diameter	Borehole Total Depth	Well Diameter	Nominal Screen Length	Well Total Depth	Bottom of Screen	Top of Screen
				feet amsl	feet amsl	ft bTOC	amsl		inches		inches	feet bgs	inches	feet	feet bgs	feet bgs	feet bgs
Injection Wells																	
ZTS-IW01	Alluvium	26732954.69	833038.19	1545.73	1545.62	NM	NM	Schedule 40 PVC	0.020	#3	6	40.0	2	15.0	36.0	35.5	20.8
ZTS-IW02	Alluvium	26732933.88	833046.37	1545.63	1545.70	NM	NM	Schedule 40 PVC	0.020	#3	6	37.5	2	15.0	35.5	35.0	20.3
ZTS-IW03	Alluvium	26732913.63	833053.06	1546.39	1546.35	NM	NM	Schedule 40 PVC	0.020	#3	6	40.0	2	15.0	36.0	35.5	20.8
ZTS-IW04	Alluvium	26732895.95	833061.35	1545.81	1545.64	NM	NM	Schedule 40 PVC	0.020	#3	6	38.0	2	15.0	36.0	35.5	20.8
ZTS-IW05	Alluvium	26732877.62	833068.66	1546.34	1546.32	NM	NM	Schedule 40 PVC	0.020	#3	6	37.5	2	15.0	36.0	35.5	20.8
ZTS-IW06	Alluvium	26732858.63	833075.96	1547.14	1546.96	NM	NM	Schedule 40 PVC	0.020	#3	6	35.0	2	15.0	35.0	34.5	19.8
ZTS-IW07	Alluvium	26732840.03	833083.70	1547.73	1547.48	NM	NM	Schedule 40 PVC	0.020	#3	6	30.0	2	5.0	27.5	27.0	22.3
ZTS-IW08	Alluvium	26732822.00	833091.44	1547.88	1547.75	NM	NM	Schedule 40 PVC	0.020	#3	6	31.0	2	5.0	27.5	27.0	22.3
ZTS-IW09	Alluvium	26732803.17	833098.78	1548.14	1548.30	NM	NM	Schedule 40 PVC	0.020	#3	6	27.0	2	5.0	26.5	26.0	21.3
ZTS-IW10	Alluvium	26732784.72	833106.32	1548.63	1548.48	NM	NM	Schedule 40 PVC	0.020	#3	6	25.0	2	5.0	25.0	24.5	19.8
ZTS-IW11	Alluvium	26732597.13	832941.47	1547.80	1547.86	NM	NM	Schedule 40 PVC	0.020	#3	6	25.0	2	5.0	23.5	23.0	18.3
ZTS-IW12	Alluvium	26732585.78	832951.00	1547.51	1547.54	NM	NM	Schedule 40 PVC	0.020	#3	6	26.0	2	5.0	25.0	24.5	19.8
ZTS-IW13	Alluvium	26732645.58	832916.08	1547.54	1547.64	NM	NM	Schedule 40 PVC	0.020	#3	6	30.0	2	10.0	29.5	29.0	19.3
ZTS-IW14	Alluvium	26732632.18	832923.75	1547.50	1547.55	NM	NM	Schedule 40 PVC	0.020	#3	6	30.0	2	10.0	27.3	26.8	17.1
ZTS-IW15	UMCf	26732551.24	832973.58	1547.33	1547.34	NM	NM	Schedule 40 PVC	0.010	#2/16	10	68.0	2	15.0	46.5	46.0	26.3
ZTS-IW16	UMCf	26732551.53	832973.34	1547.37	1547.44	NM	NM	Schedule 40 PVC	0.010	#2/16			2	20.0	67.5	67.0	52.3

Notes
amsl - above mean sea level
bgs - below ground surface
bTOC - below top of casing
NM - not measured
PVC - polyvinyl chloride
UMCf - Upper Muddy Creek formation
Semi-Cons - Semi-Consolidated
1. Depth to water collected on May 16-17, 2023.

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Table 2
Groundwater Microbial Analytical Results
Las Vegas Wash ZVI-Enhanced Bioremediation Treatability Study

Test Area	Location	Sample Date	Matrix	Location	Screened Lithology	CENSUS		PLFA									qPCR
						Perchlorate Reducing Sedimenticola	Perchlorate Reductase pcrA	Cells	Proteobacteria (Monos)	Firmicutes (Terbrsats)	Anaerobic metal reducers (BrMonos)	SRB/Actinomycetes (MidBrSats)	General (Nsats)	Eukaryotes (Polyenoics)	Slowed Growth	Decreased Permeability	Chlorite Dismutase
						cells/bead	cells/bead	cells/bead	%	%	%	%	%	%	ratio cy/cis	ratio trans/cis	cells/mL
1A	ZTS-MW124	12/12/2022	WG	Upgradient	Alluvium	< 2.50E+2	< 2.50E+2	**6.68E+4**	**68.75**	0.00	0.00	0.00	**31.26**	0.00	**1.78**	0.00	---
1A	ZTS-MW143	9/29/2023	WG	Upgradient	Alluvium	< 2.50E+2	< 2.50E+2	**5.44E+4**	**59.81**	0.00	0.00	0.00	**27.41**	**12.77**	0.00	0.00	< 2.60E+2
1A	ZTS-MW154	9/29/2023	WG	Center of Trench	Alluvium	**5.95E+1**	< 2.50E+2	**2.61E+4**	**68.50**	0.00	0.00	0.00	**31.51**	0.00	**1.05**	0.00	< 2.60E+2
1A	ZTS-MW155	9/29/2023	WG	Downgradient	Alluvium	**2.01E+1**	< 2.50E+2	**8.13E+4**	**95.51**	0.00	0.00	0.00	0.00	**4.49**	0.00	0.00	< 2.60E+2
1A	ZTS-MW157	9/29/2023	WG	Downgradient	Alluvium	< 2.50E+2	**7.15E+2**	**3.57E+4**	**79.44**	0.00	0.00	0.00	**9.67**	**10.90**	0.00	0.00	< 2.60E+2
1B	ZTS-IW08	9/29/2023	WG	Downgradient	Alluvium	**8.40E+0**	< 2.50E+2	**2.43E+4**	**72.01**	**27.98**	0.00	0.00	0.00	0.00	0.00	0.00	**1.90E+4**
1B	ZTS-MW147	9/29/2023	WG	Upgradient	Alluvium	< 2.50E+2	< 2.50E+2	**7.99E+4**	**82.28**	0.00	0.00	0.00	**13.89**	**3.82**	**4.64**	0.00	< 2.60E+2
1B	ZTS-MW171	9/29/2023	WG	Center of Trench	Alluvium	**1.67E+2**	< 2.50E+2	**9.05E+4**	**78.08**	**10.71**	0.00	0.00	**11.20**	0.00	**1.34**	0.00	< 2.60E+2
1B	ZTS-MW172	9/29/2023	WG	Downgradient	Alluvium	**7.10E+0**	< 2.50E+2	**7.04E+4**	**68.63**	**7.67**	**4.46**	0.00	**19.23**	0.00	**1.91**	0.00	< 2.60E+2
1B	ZTS-MW173	9/29/2023	WG	Downgradient	UMCf	**1.70E+1**	< 2.50E+2	**5.36E+4**	**63.36**	**21.95**	0.00	0.00	**8.01**	**6.68**	**0.84**	0.00	**2.02E+5**
1B	ZTS-MW174	9/29/2023	WG	Downgradient	Alluvium	< 2.50E+2	< 2.50E+2	**5.86E+4**	**83.98**	0.00	0.00	0.00	**10.57**	**5.45**	0.00	0.00	< 2.60E+2
2A	ZTS-MW118	12/12/2022	WG	Upgradient	Alluvium	< 2.50E+2	< 2.50E+2	**5.13E+4**	**68.89**	0.00	0.00	0.00	**31.11**	0.00	**2.96**	0.00	---
2A	ZTS-MW137	9/29/2023	WG	Upgradient	Alluvium	< 2.50E+2	< 2.50E+2	**4.67E+4**	**48.44**	**23.98**	0.00	0.00	**27.59**	0.00	**3.33**	0.00	< 2.60E+2
2A	ZTS-MW192	9/29/2023	WG	Center of Array	Alluvium	< 2.50E+2	< 2.50E+2	**6.23E+4**	**46.49**	**5.77**	0.00	0.00	**19.35**	**28.39**	**1.53**	0.00	< 2.60E+2
2A	ZTS-MW193	9/29/2023	WG	Downgradient	Alluvium	< 2.50E+2	< 2.50E+2	**6.69E+4**	**53.20**	**12.73**	0.00	0.00	**34.06**	0.00	**1.78**	0.00	< 2.60E+2
2A	ZTS-MW194	9/29/2023	WG	Downgradient	Alluvium	< 2.50E+2	< 2.50E+2	< 5.56E+4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 2.60E+2
2B	ZTS-MW133	9/29/2023	WG	Upgradient	UMCf	< 2.50E+2	< 2.50E+2	**3.50E+4**	**88.41**	0.00	0.00	0.00	**11.58**	0.00	0.00	0.00	**1.39E+5**
2B	ZTS-MW135	12/12/2022	WG	Downgradient	UMCf	< 2.50E+2	< 2.50E+2	**4.19E+4**	**75.04**	0.00	0.00	0.00	**24.96**	0.00	**2.31**	0.00	---
2B	ZTS-MW136	12/12/2022	WG	Cross Gradient	UMCf	**6.58E+1**	**1.07E+3**	**9.37E+4**	**78.98**	0.00	0.00	0.00	**21.02**	0.00	**0.63**	0.00	---
2B	ZTS-MW199	9/29/2023	WG	Downgradient	UMCf	< 2.50E+2	**3.70E+4**	**5.92E+4**	**78.37**	0.00	0.00	0.00	**13.11**	**8.53**	**0.78**	0.00	< 2.60E+2
2B	ZTS-MW200	9/29/2023	WG	Downgradient	UMCf	**1.19E+2**	**3.15E+4**	< 5.57E+4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**8.32E+3**
2B	ZTS-MW201	9/29/2023	WG	Downgradient	UMCf	**3.83E+1**	**1.38E+4**	< 5.50E+4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.55E+5**
2B	ZTS-MW207	9/29/2023	WG	Downgradient	UMCf	**4.45E+1**	< 2.50E+2	< 5.54E+4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.52E+5**
2C	ZTS-MW140	9/29/2023	WG	Upgradient	Alluvium	< 2.50E+2	< 2.50E+2	< 5.56E+4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 2.60E+2
2C	ZTS-MW182	9/29/2023	WG	Center of Array	Alluvium	**4.89E+1**	< 2.50E+2	< 5.57E+4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 2.60E+2
2C	ZTS-MW184	9/29/2023	WG	Downgradient	Alluvium	< 2.50E+2	< 2.50E+2	< 5.53E+4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 2.60E+2
2C	ZTS-MW185	9/29/2023	WG	Downgradient	Alluvium	< 2.50E+2	< 2.50E+2	< 5.56E+4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	< 2.60E+2
1A/1B	ZTS-MW145	9/29/2023	WG	Upgradient	UMCf	---	---	---	---	---	---	---	---	---	---	---	**4.32E+3**
NA	VWPS-MW10	9/29/2023	WG	NA	Qal	---	---	---	---	---	---	---	---	---	---	---	< 2.60E+2
NA	VWPS-MW10	9/29/2023	WG	NA	Qal	---	---	---	---	---	---	---	---	---	---	---	< 2.60E+2
NA	ZTS-MW116	9/29/2023	WG	NA	UMCf	---	---	---	---	---	---	---	---	---	---	---	< 2.60E+2

Notes
BrMonos - Branched Monoenoic
MidBrSats - Mid-Chained Branched Saturated
Monos - Monoenoic
Nsats - Normal Saturation
qPCR - Quantitative polymerase chain reaction
TerBrSats - Termially Branched Saturated
UMCf- Upper Muddy Creek Formation