Air Force Civil Engineer Center

FORMER
WILLIAMS AIR FORCE BASE

Site ST012

Former Liquid Fuel Storage Area

BCT Meeting

26 April 2019

Battle Ready…Built Right!

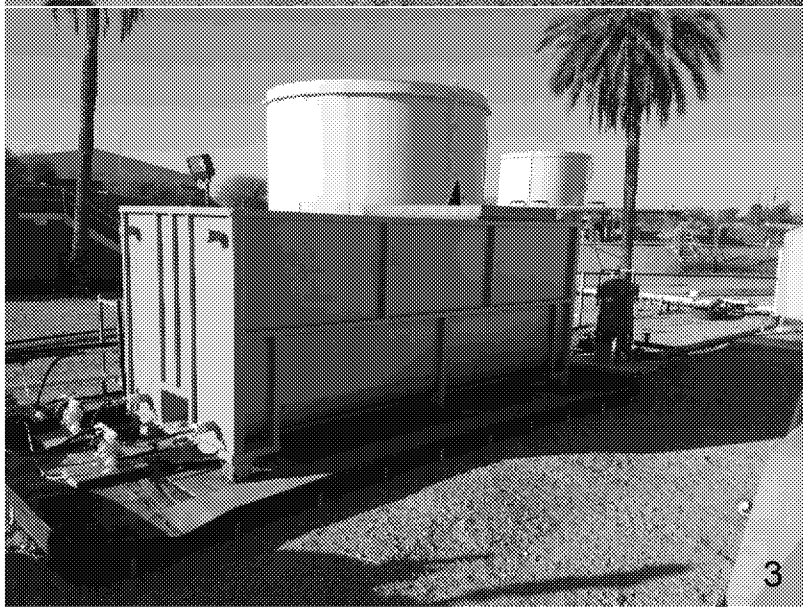
ED_005025_00010973-00001

Site ST012 Outline

- Summary of activities since March BCT call
- Update on SVE system
- LNAPL monitoring/removal update
- Pilot study groundwater sampling results
- Pilot study extraction/injection update
- Path forward

Site ST012 Activities Since March

- **Continued SVE operation**
- **Continued LNAPL screening in accessible wells**
- **Operation of Extraction and Treatment**
  - **Pump repairs**
    - UWBZ21 and UWBZ22 (pneumatic hose repairs)
    - CZ21 replacement pump installed, motor subsequently failed
  - **Catalytic Oxidizer (CAT2) optimized**
  - **Air stripper cleaned (iron and biomass fouling)**
- **Sodium sulfate injections (detail on later slides)**



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SVE Update

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Site ST012 SVE System Update

- **Jan – Mar 2019**
  - SVE ran on FlameOx until 7 Feb 2019
  - CAT2 installed in Feb 2019
  - SVE was down during final part of changeover from FlameOx to CAT2
  - After 26 Feb 2019 SVE ran on CAT2
  - CAT1 blower was down at the start of the period until 23 Jan 2019
  - Flamox was used to treat combined SVE and air stripper influent until 23 Jan 2019
  - 73.63% operational uptime FlameOx + CAT2
  - Total petroleum hydrocarbon (TPH) removed – 7,462 pounds or 1,136 gallons

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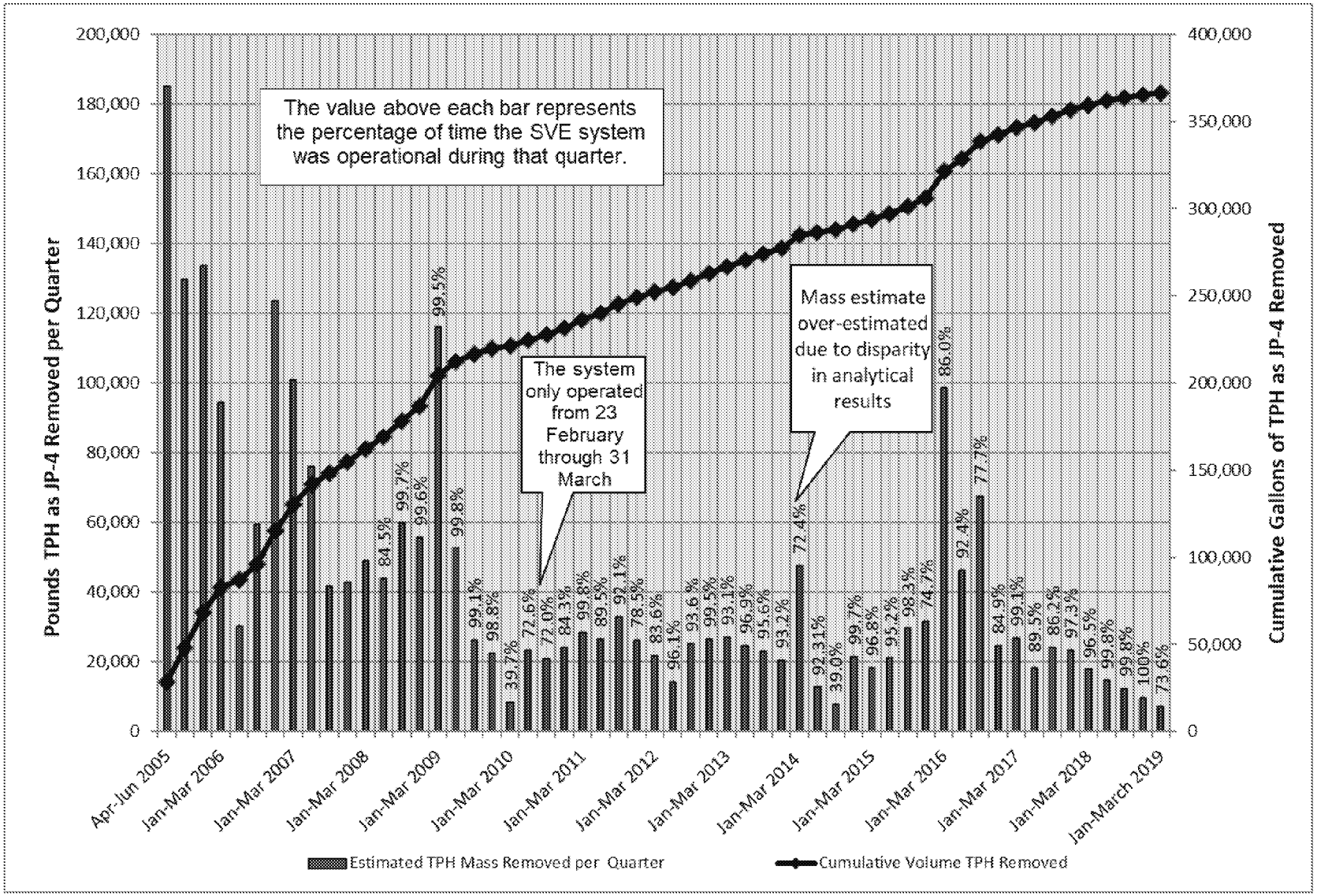
Site ST012 SVE System Performance



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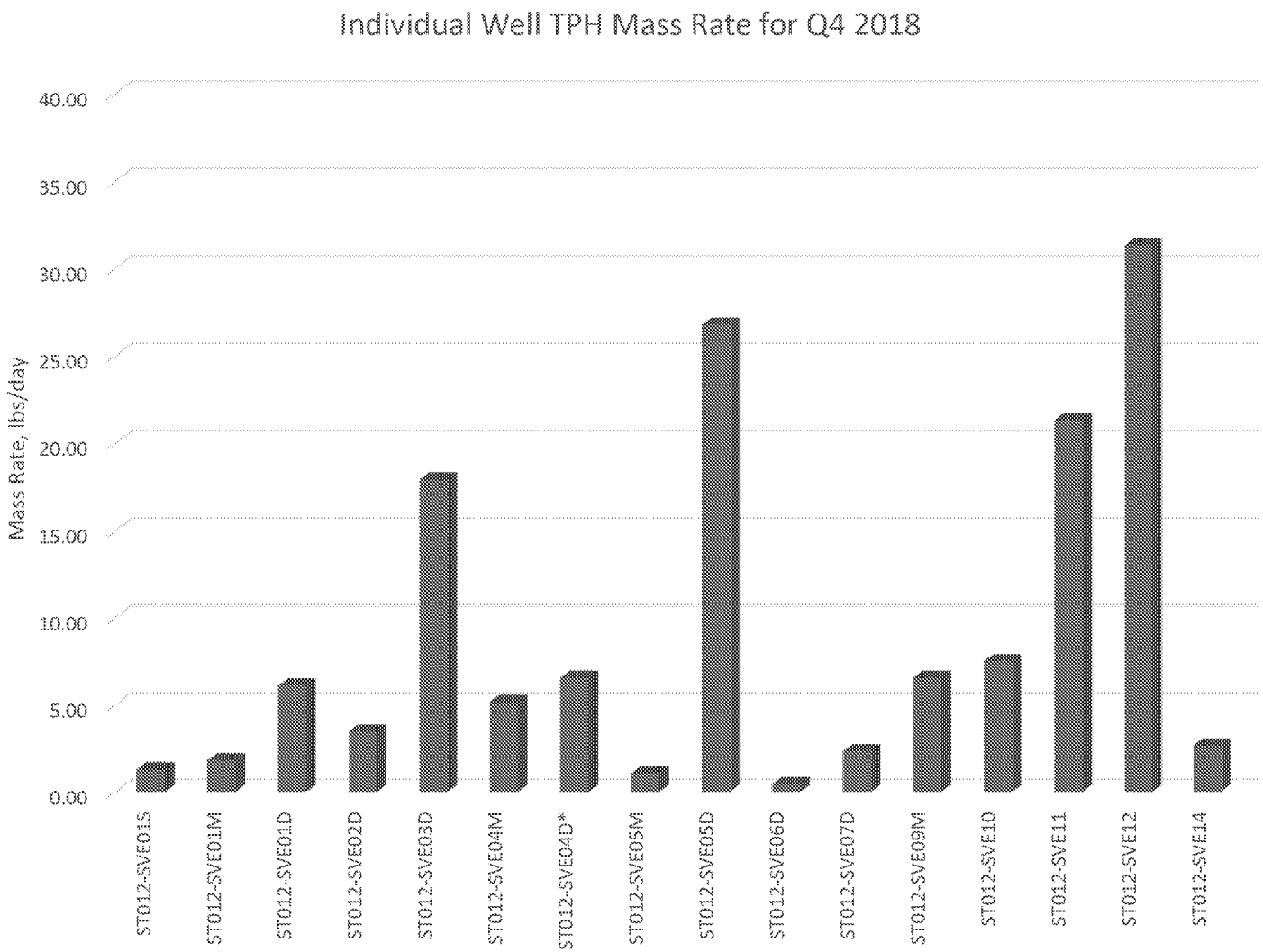
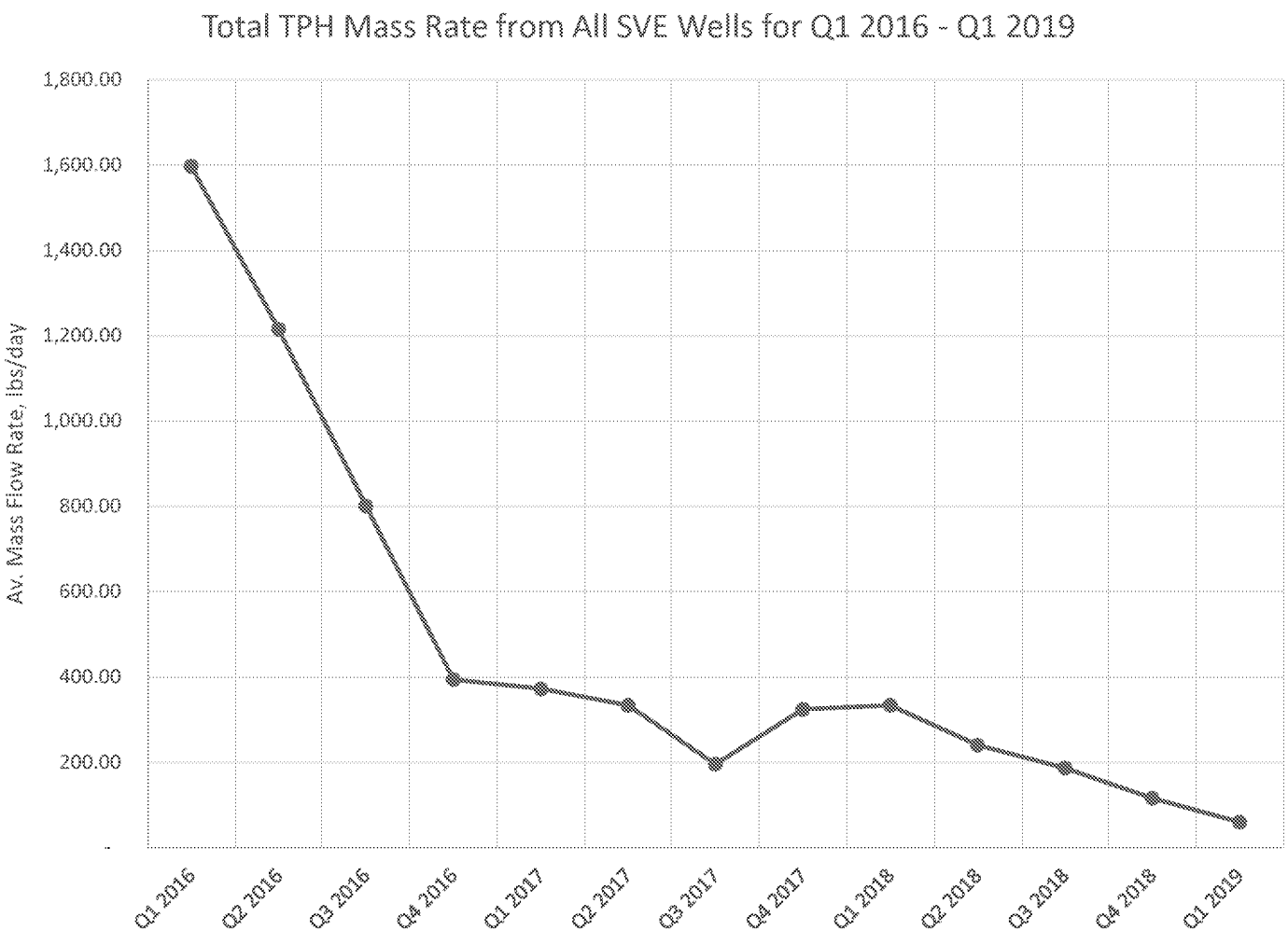
Site ST012 SVE System Performance



*Injection pipe installed in SVE04D. Flow rate averaged based on wellhead vacuum.

Site ST012 SVE System Performance



Site ST012 SVE System Performance

Mass removal rates generally highest in center of site from middle and deep intervals

Isolated high mass removal rate in close proximity to a low concentration well

X/0.76/2.36

X/0.31/2.38

2.18

5.74

X/X/X

X/2.04/X

3.45

0.00/0.70/7.81

X/X/2.58

X/2.54/11.8

X/X/4.50

9.58

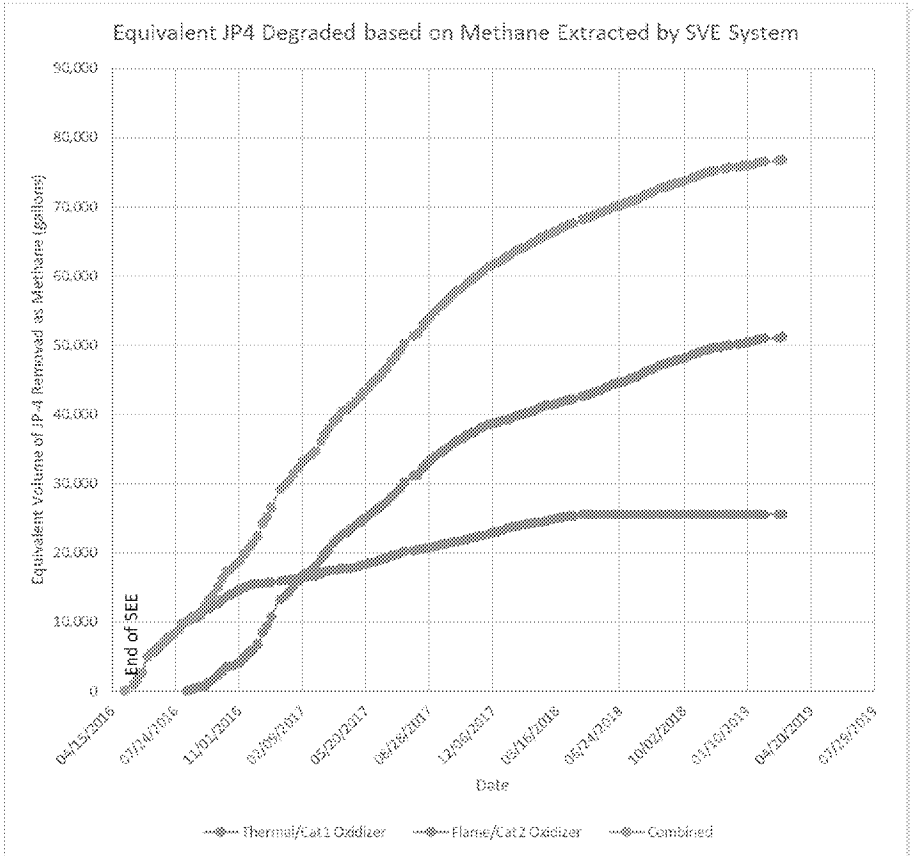
X

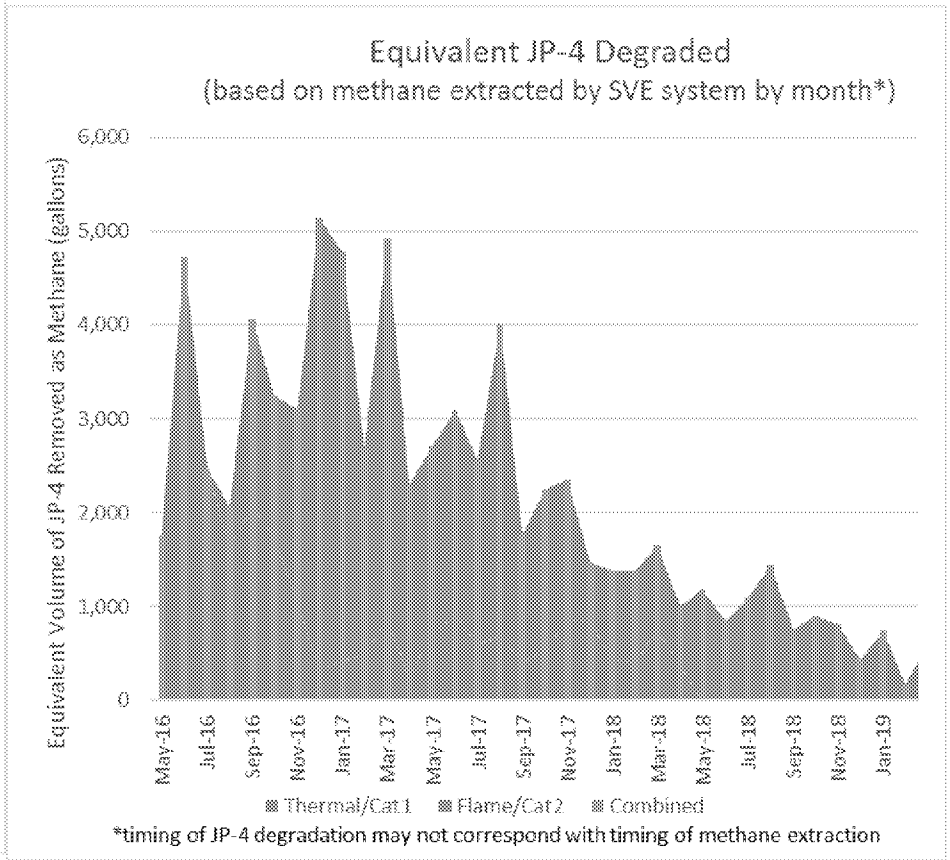
X/X/0.53

Legend

- Soil Vapor Extraction Well Location (Installed in 2013/2014)
- Nested Soil Vapor Extraction Well Location
- Decommissioned Nested Vapor Monitoring Point Location
- Groundwater Monitoring Well Location
- Decommissioned Groundwater Monitoring Well Location
- Fence Line
- ST012 Site Boundary
- S/M/D — Average Mass Flow Rate (lbs/d) in shallow/medium/deep intervals
- X — Interval Closed Throughout the Period

Site ST012 SVE System Equivalent JP-4 Degradation Based on Methane Removed





- Estimates through 11 Apr 2019
- Estimated JP-4 degradation as methane is in addition to JP-4 removal reported for SVE
- Thermal/Cat1 oxidizer changed from SVE to groundwater treatment end of Apr
- Flame oxidizer treating combined SVE and air stripper intermittently in Nov 2018 – Jan 2019
- Flame oxidizer replaced by catalytic oxidizer (Cat2) 7 Feb to 26 Feb 2019

SVE Optimization

- **Evaluated SVE wells for potential optimization by**
  - Open/Close Wells with high/low concentrations
  - Evaluate potential stagnation zones between SVE wells
  - Add atmospheric vents at select SVE wells to address stagnation zones and promote potential increased mass removal
- **Implemented piping changes to initiate venting on 5 Apr 2019**

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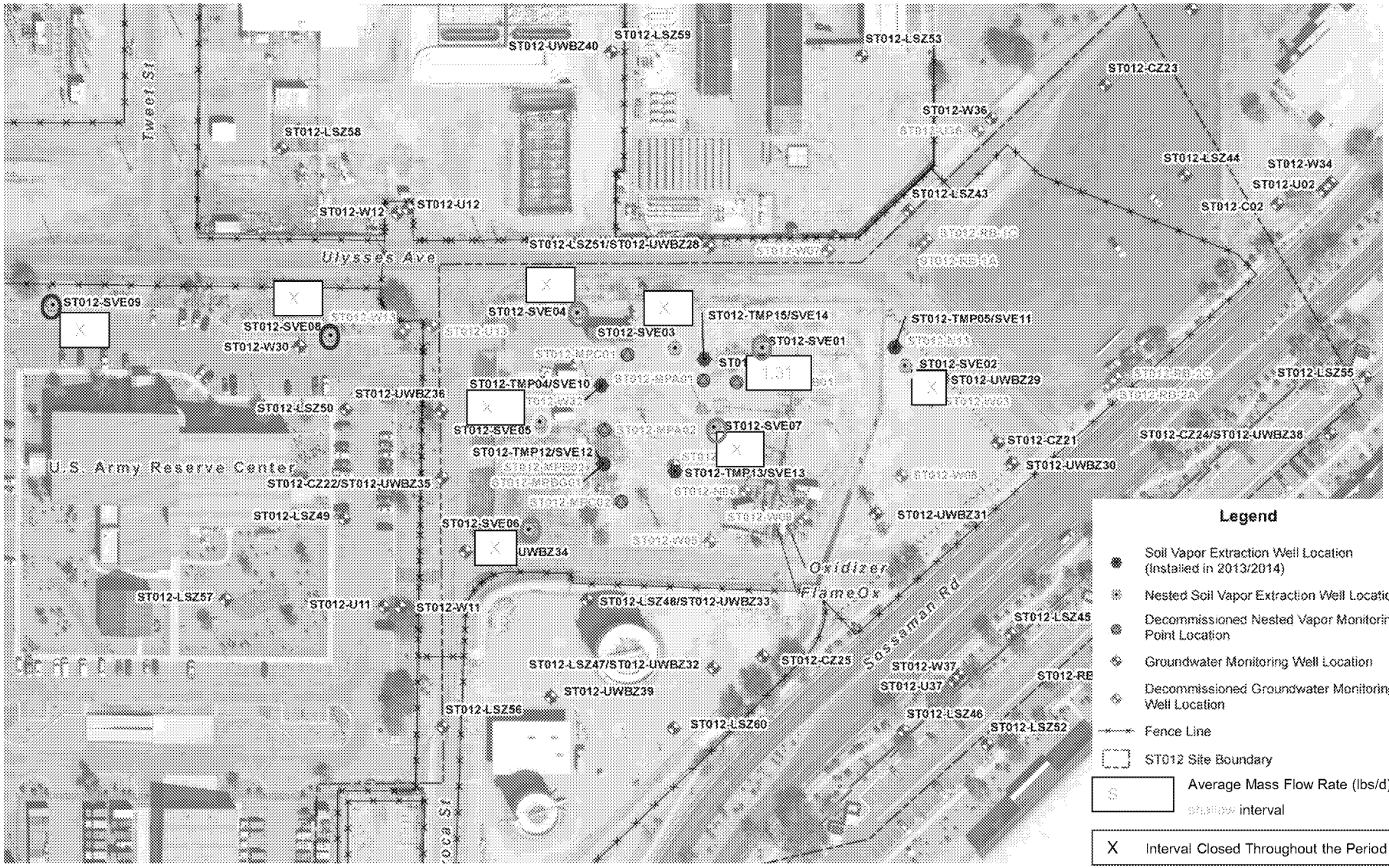
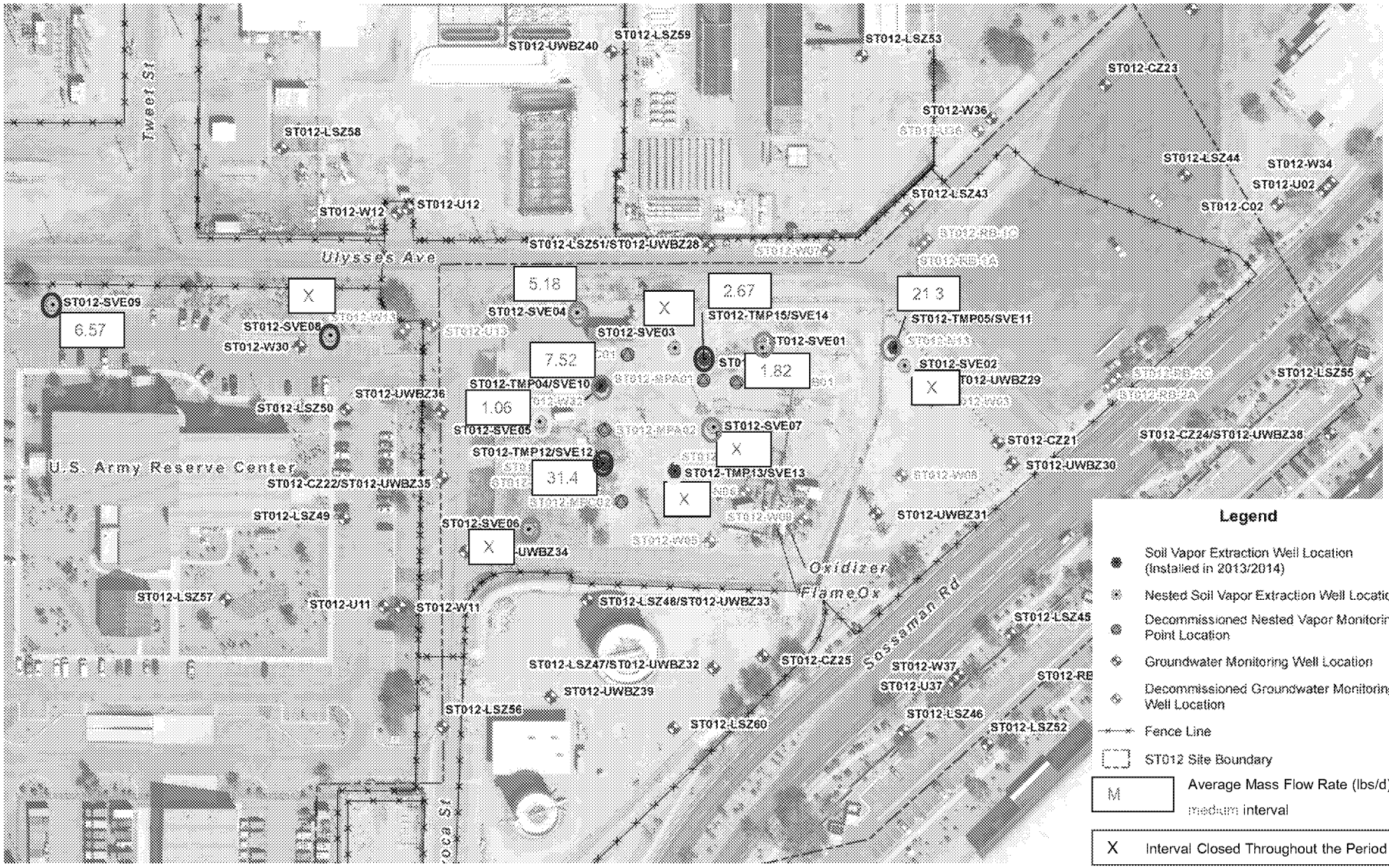
Site ST012 SVE System Optimization Shallow Zone



SVE well closed SVE well open to extraction SVE well open to venting

Site ST012 SVE System Optimization
Middle Zone



SVE well closed SVE well open to extraction SVE well open to venting

Site ST012 SVE System Optimization Deep Zone

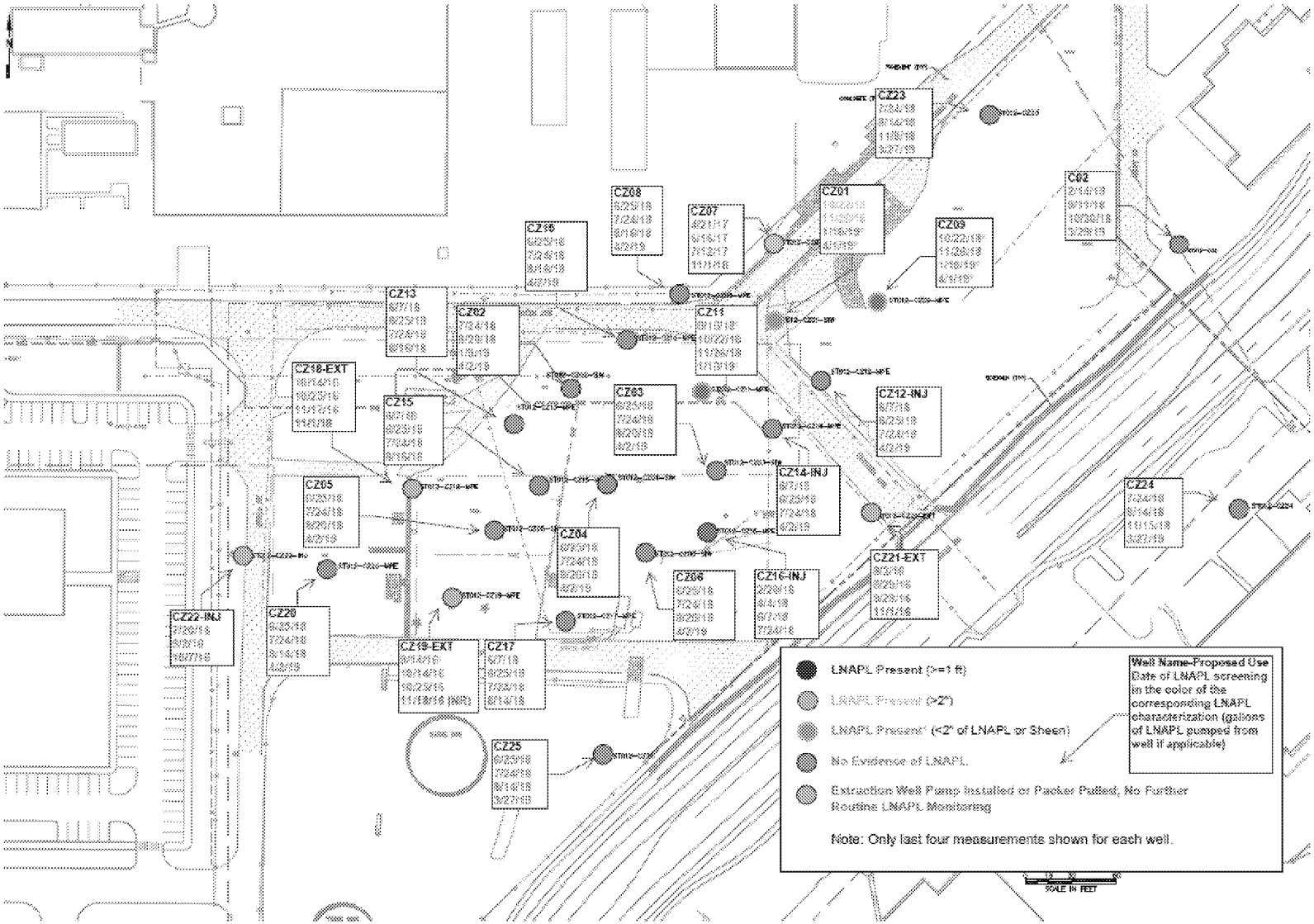
Legend

- Soil Vapor Extraction Well Location (Installed in 2013/2014)
- Nested Soil Vapor Extraction Well Location
- Decommissioned Nested Vapor Monitoring Point Location
- Groundwater Monitoring Well Location
- Decommissioned Groundwater Monitoring Well Location
- Fence Line
- ST012 Site Boundary
- S/M/D — Average Mass Flow Rate (lbs/d) in deep interval
- X — Interval Closed Throughout the Period

SVE well closed | SVE well open to extraction | SVE well open to venting

LNAPL Monitoring Update (through 10 Apr)

LNAPL Monitoring/Removal Status
Cobble Zone



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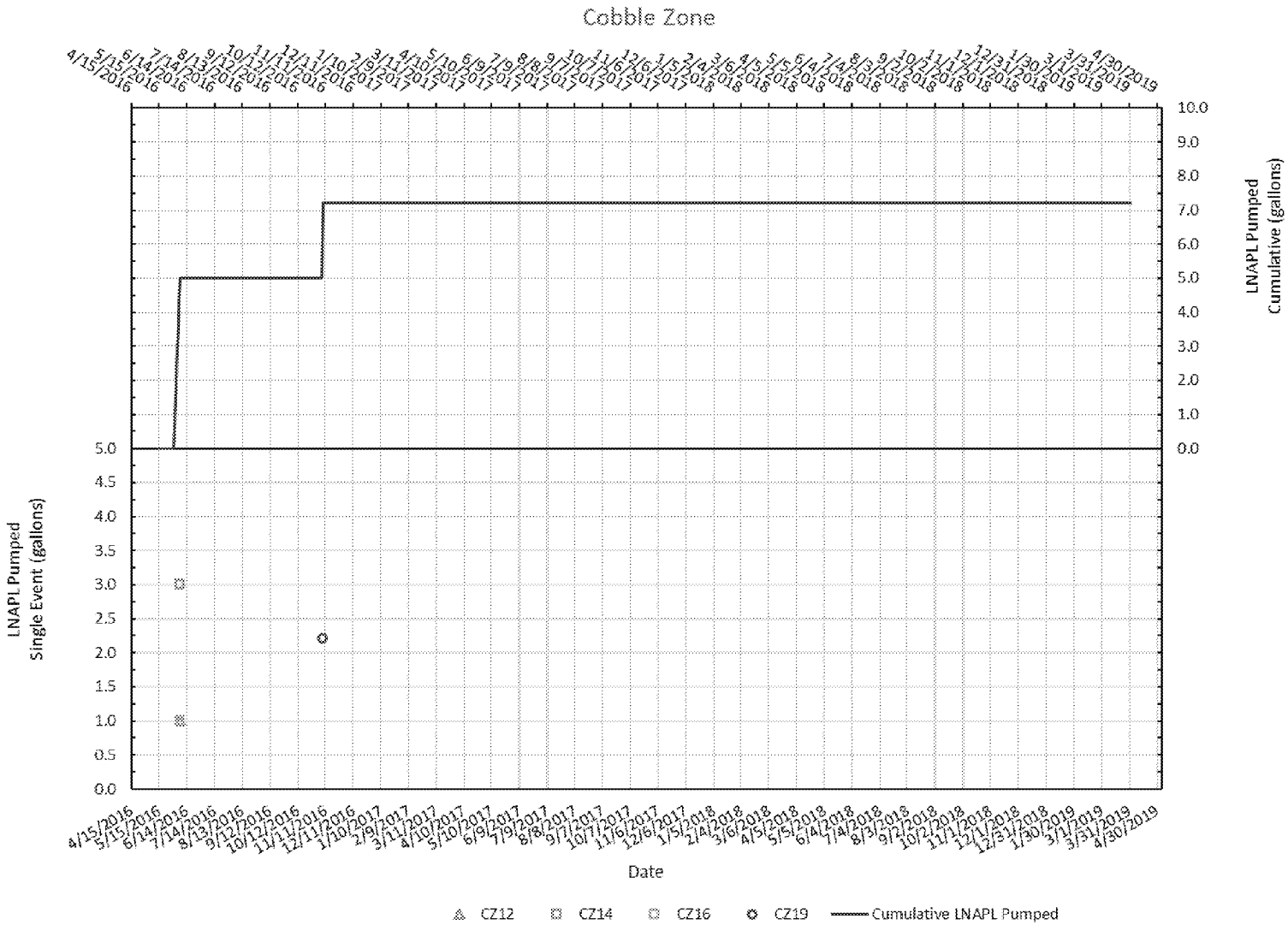
LNAPL Monitoring/Removal Status
Cobble Zone



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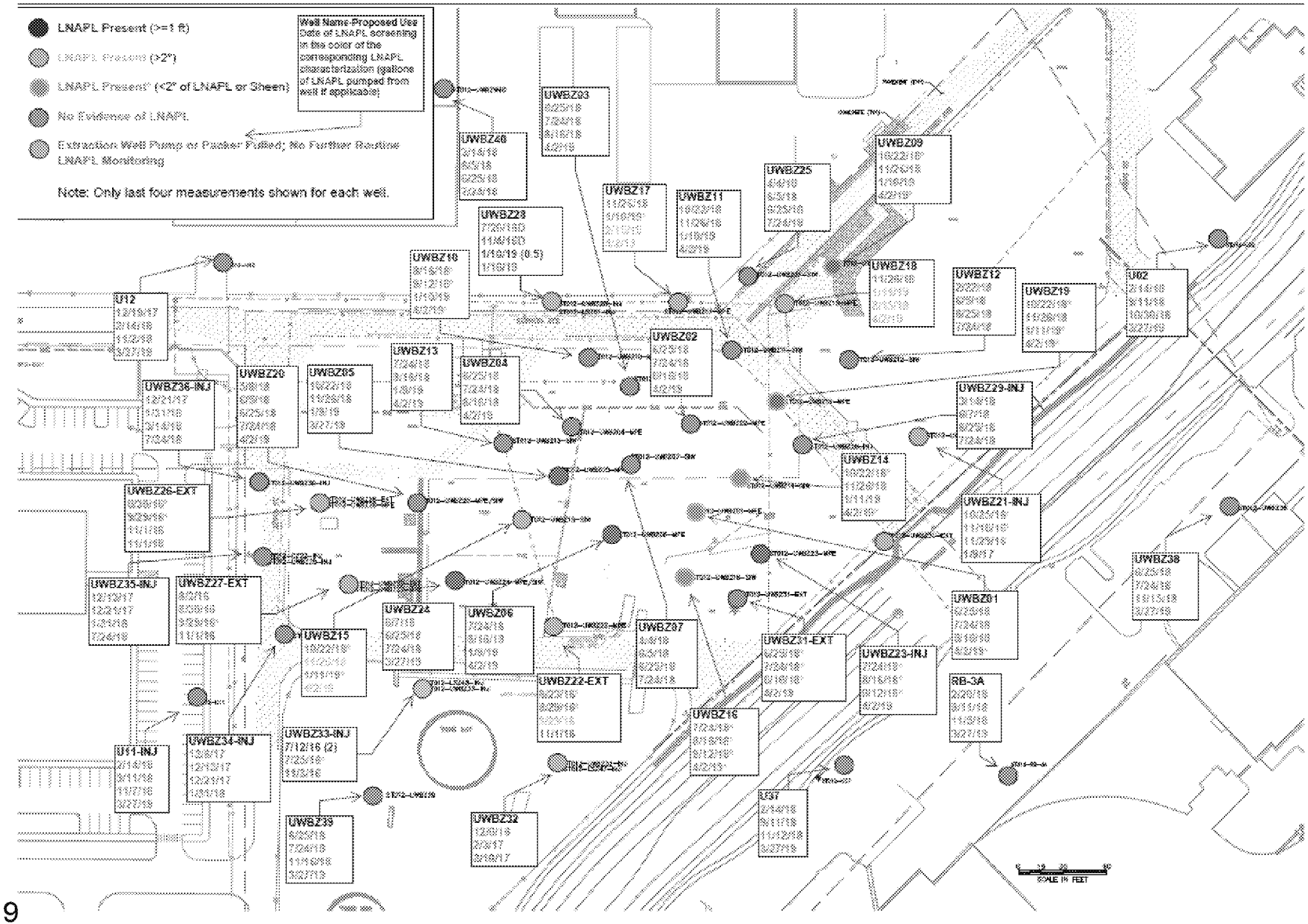
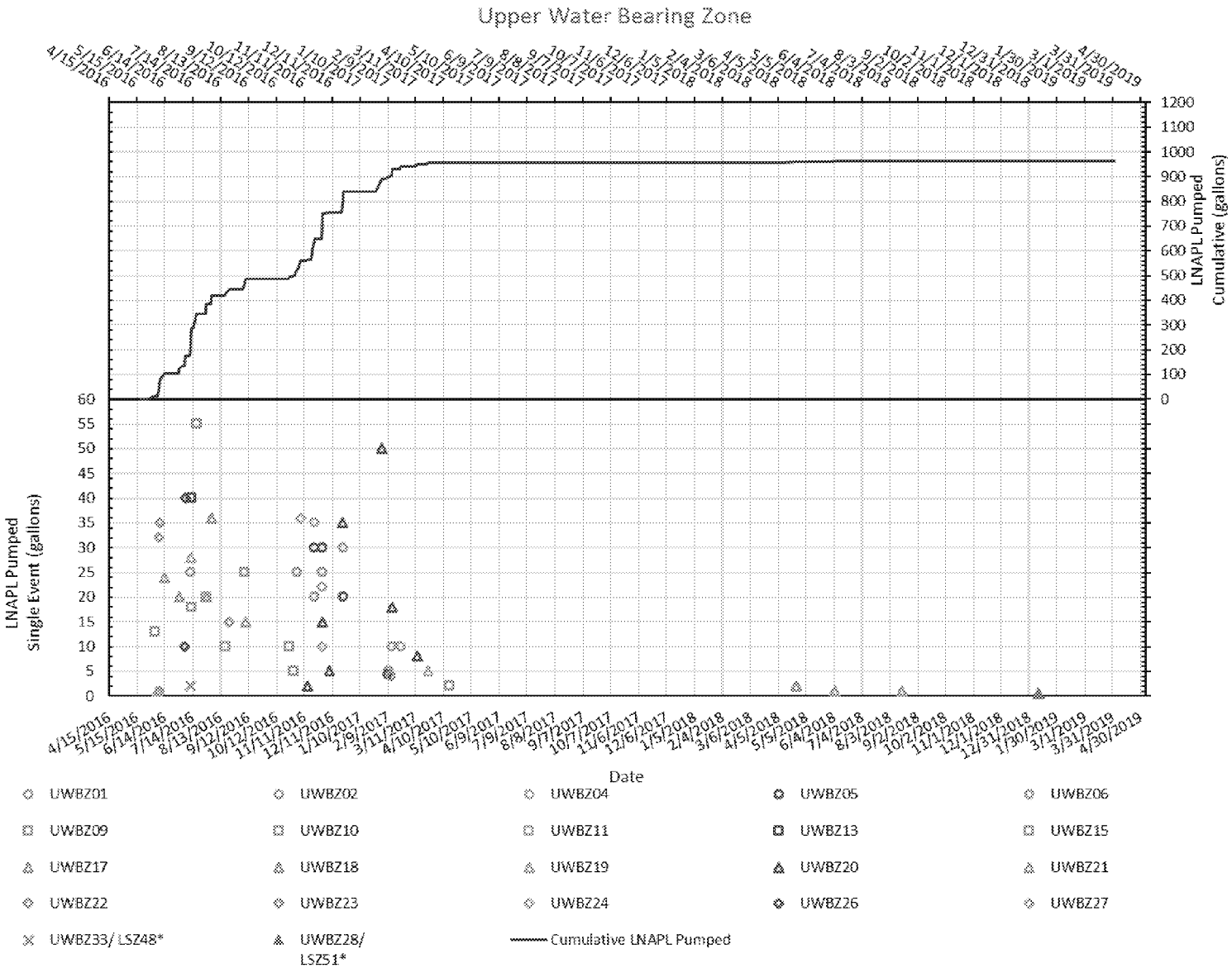
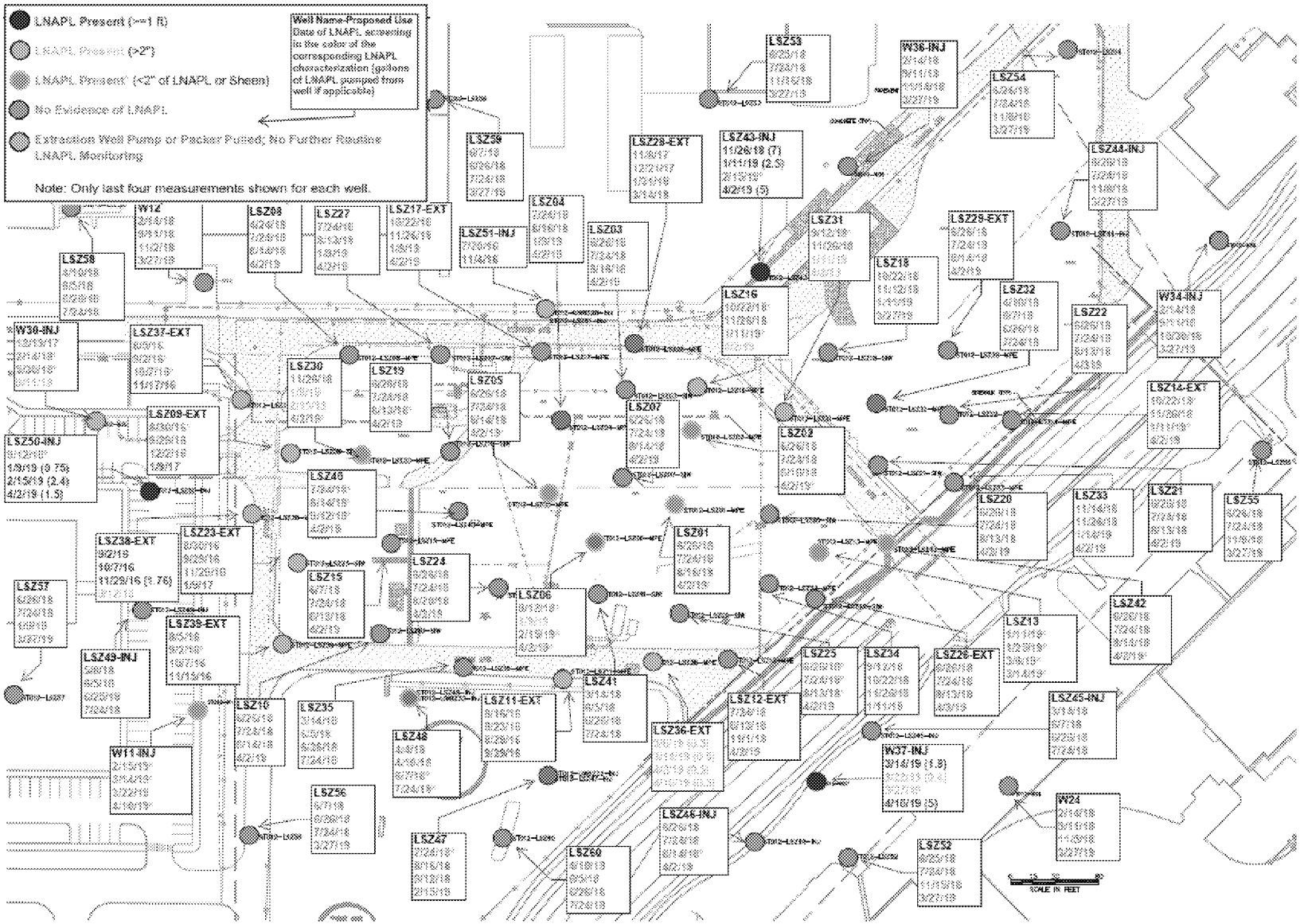
LNAPL Monitoring/Removal Status
Upper Water Bearing Zone



LNAPL Monitoring/Removal Status
Upper Water Bearing Zone



LNAPL Monitoring/Removal Status
Lower Saturated Zone



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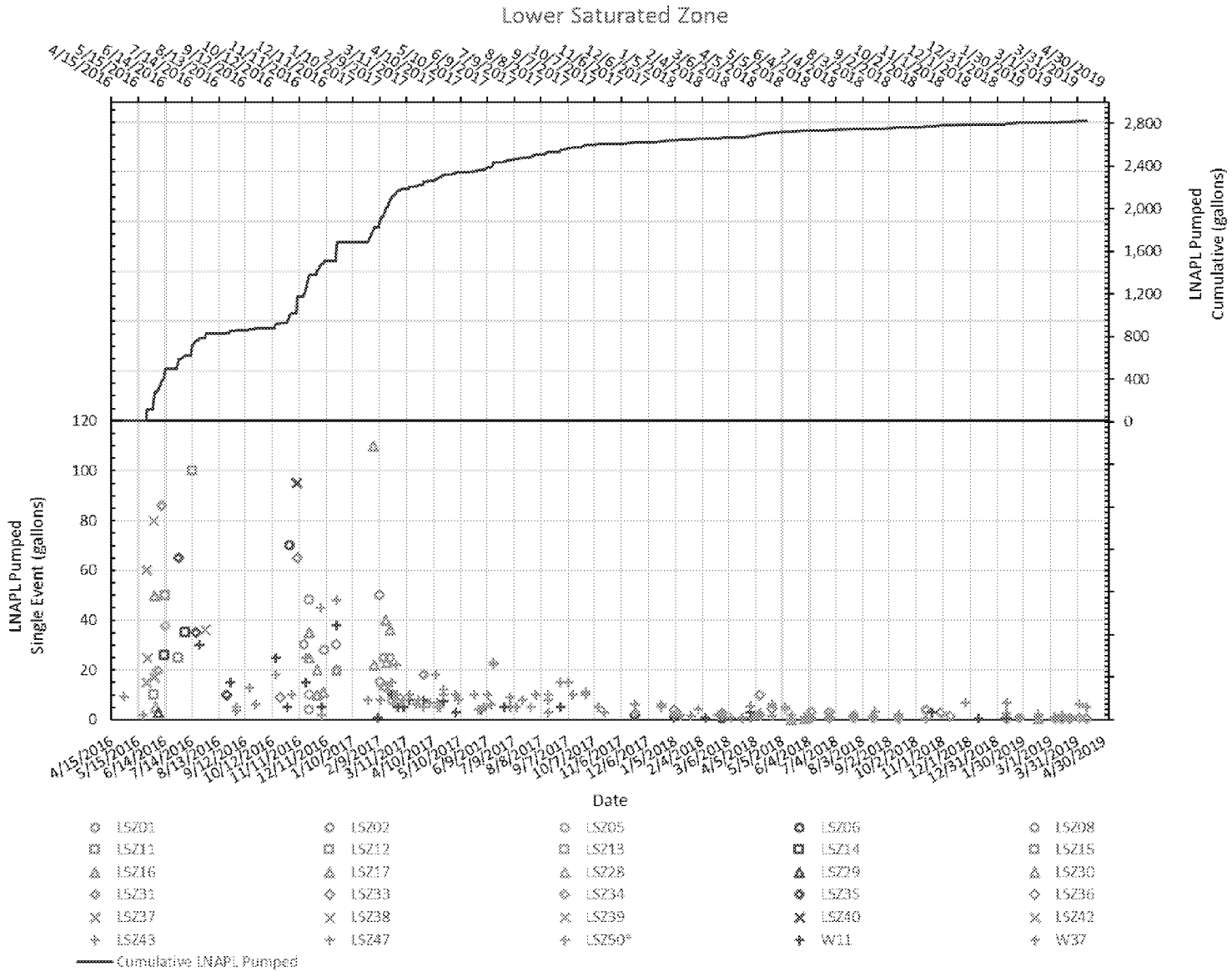
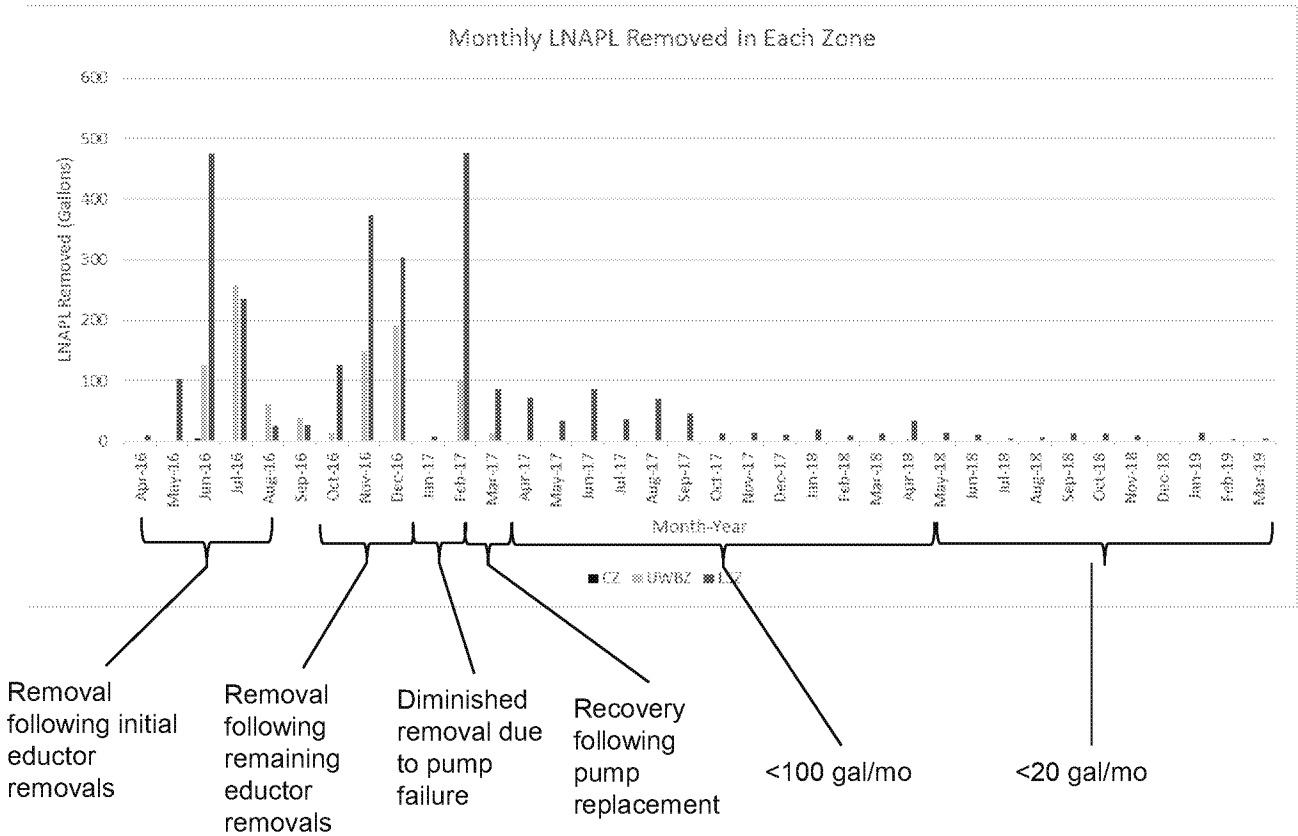
LNAPL Monitoring/Removal Status
Lower Saturated Zone



4/25/2019

ST012 LNAPL Monitoring/Removal Summary

- CZ – 7 gallons of LNAPL removed. None since Nov 2016
- UWBZ - 963 gallons of LNAPL removed. 0.5 gallons removed since Mar update (UWBZ28/LSZ51)
- LSZ - 2,826 gallons of LNAPL removed. 15 gallons removed since Mar update (W37, LSZ36, LSZ43, LSZ50).

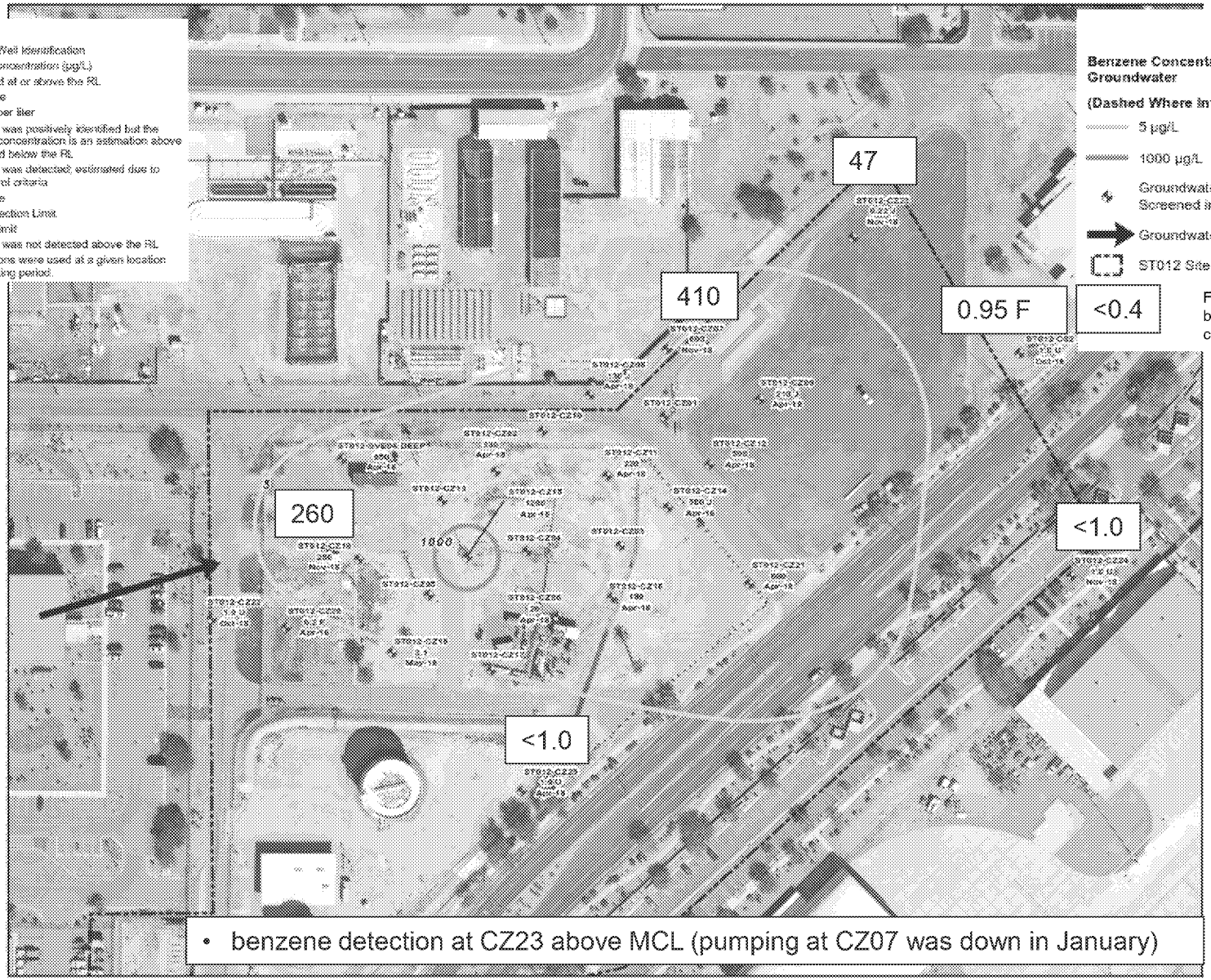


Preliminary Feb/Mar Groundwater Sampling Results

Sampling Summary

- **Sampling included:**
  - Extraction Wells
  - Injection Wells (where injections took place)
  - Monitoring Wells (in areas where injections took place)
  - Perimeter Wells
- **General Observations**
  - No change in estimated 5 µg/L benzene contours except at CZ23

Site ST012 Annual Benzene (µg/L) in CZ (previous contours for reference)



Notes:

ST012-CZ23	Monitoring Well Identification
0.22 J	Benzene Concentration (µg/L)
<1.0	Not detected at or above the RL
Nov-18	Sample Date
µg/L	Microgram per liter
F	The analyte was positively identified but the associated concentration is an estimation above the MDL and below the RL
J	The analyte was detected; estimated due to quality control criteria
CZ	Cobble Zone
MDL	Method Detection Limit
RL	Reporting Limit
U	The analyte was not detected above the RL

The most recent concentrations were used at a given location through the end of the reporting period.

Legend

Benzene Concentrations (µg/L) in Groundwater

(Dashed Where Inferred)

5 µg/L

1000 µg/L

Based on most recent data through 2018

Groundwater Monitoring Well Location Screened in the CZ

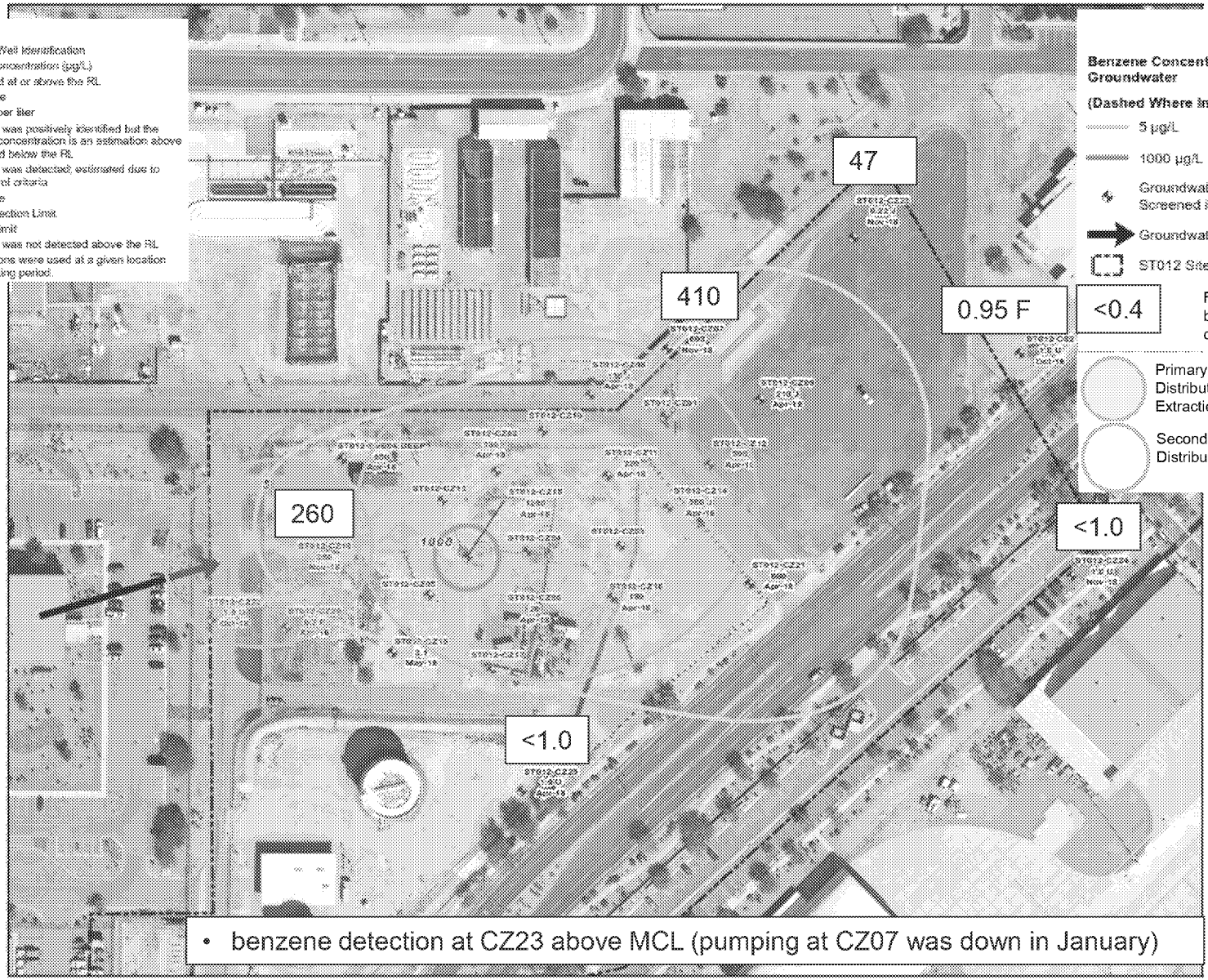
Groundwater Flow Direction

ST012 Site Boundary

Feb/Mar 2019 benzene concentration (µg/L)

- benzene detection at CZ23 above MCL (pumping at CZ07 was down in January)

Site ST012 Annual Benzene (µg/L) in CZ (previous contours for reference)



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RL	Reporting Limit
U	The analyte was not detected above the RL

The most recent concentrations were used at a given location through the end of the reporting period.

Legend

Benzene Concentrations (µg/L) in Groundwater

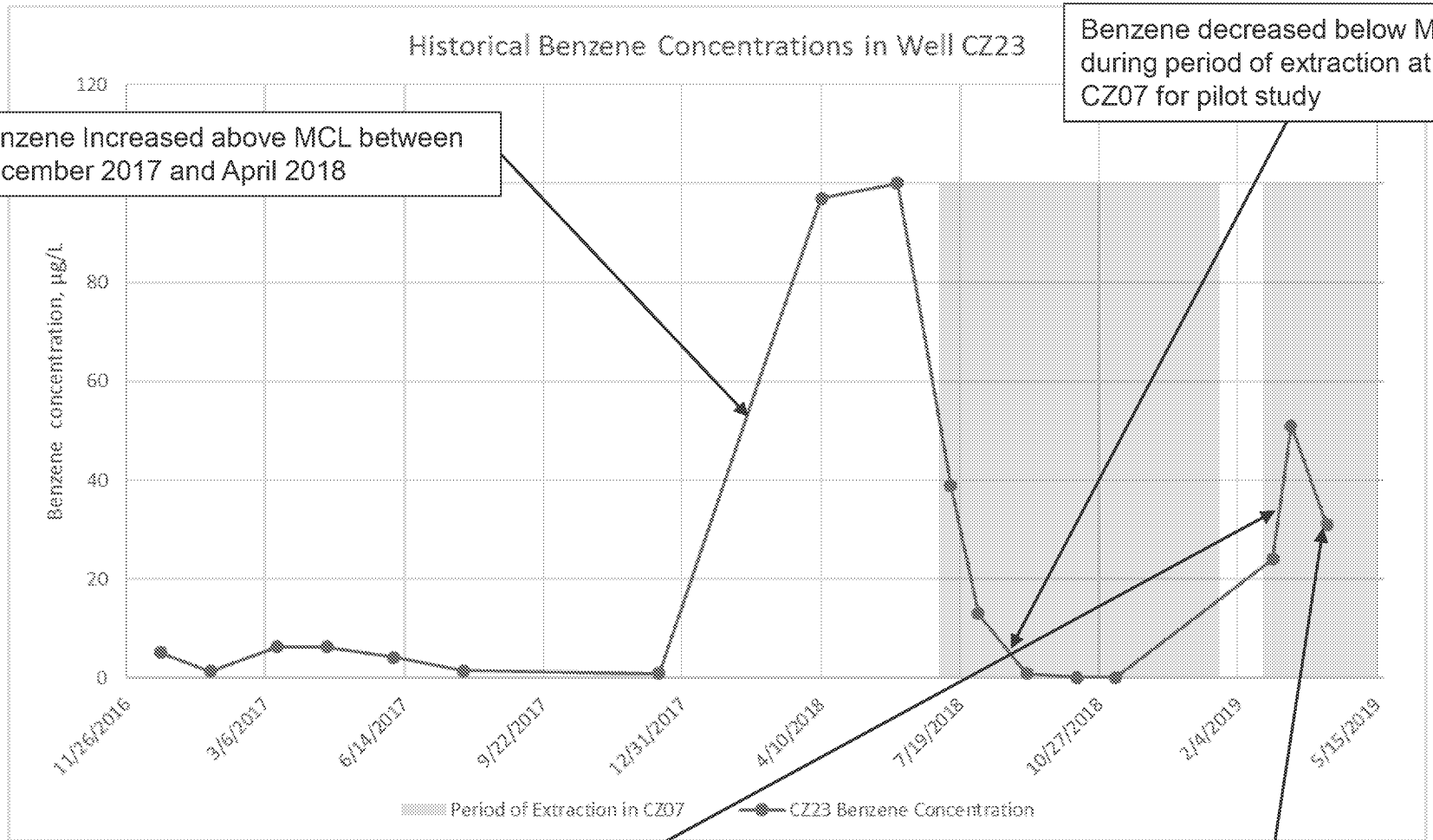
(Dashed Where Inferred)

Based on most recent data through 2018

- 5 µg/L
- 1000 µg/L
- Groundwater Monitoring Well Location Screened in the CZ
- Groundwater Flow Direction
- ST012 Site Boundary
- Feb/Mar 2019 benzene concentration (µg/L)
- Primary Target Area of Sulfate Distribution By Injection-Extraction
- Secondary Target Area of Sulfate Distribution By Extraction

- benzene detection at CZ23 above MCL (pumping at CZ07 was down in January)

CZ23 Sampling Summary



Benzene Increased above MCL between December 2017 and April 2018

Benzene decreased below MCL during period of extraction at CZ07 for pilot study

Benzene increased above MCL following period when CZ07 was down

Benzene has started to decrease following restoration of pumping from CZ07

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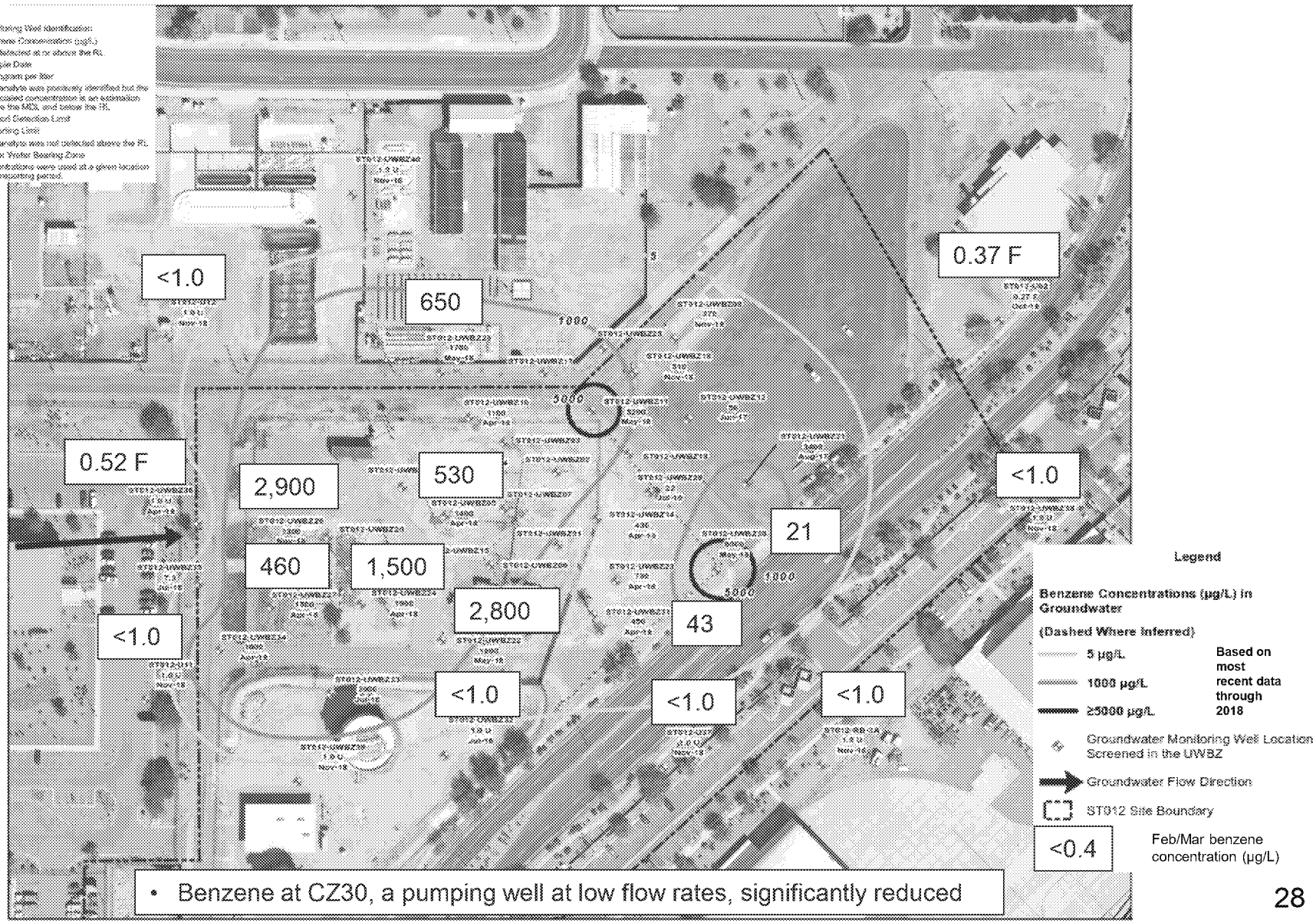
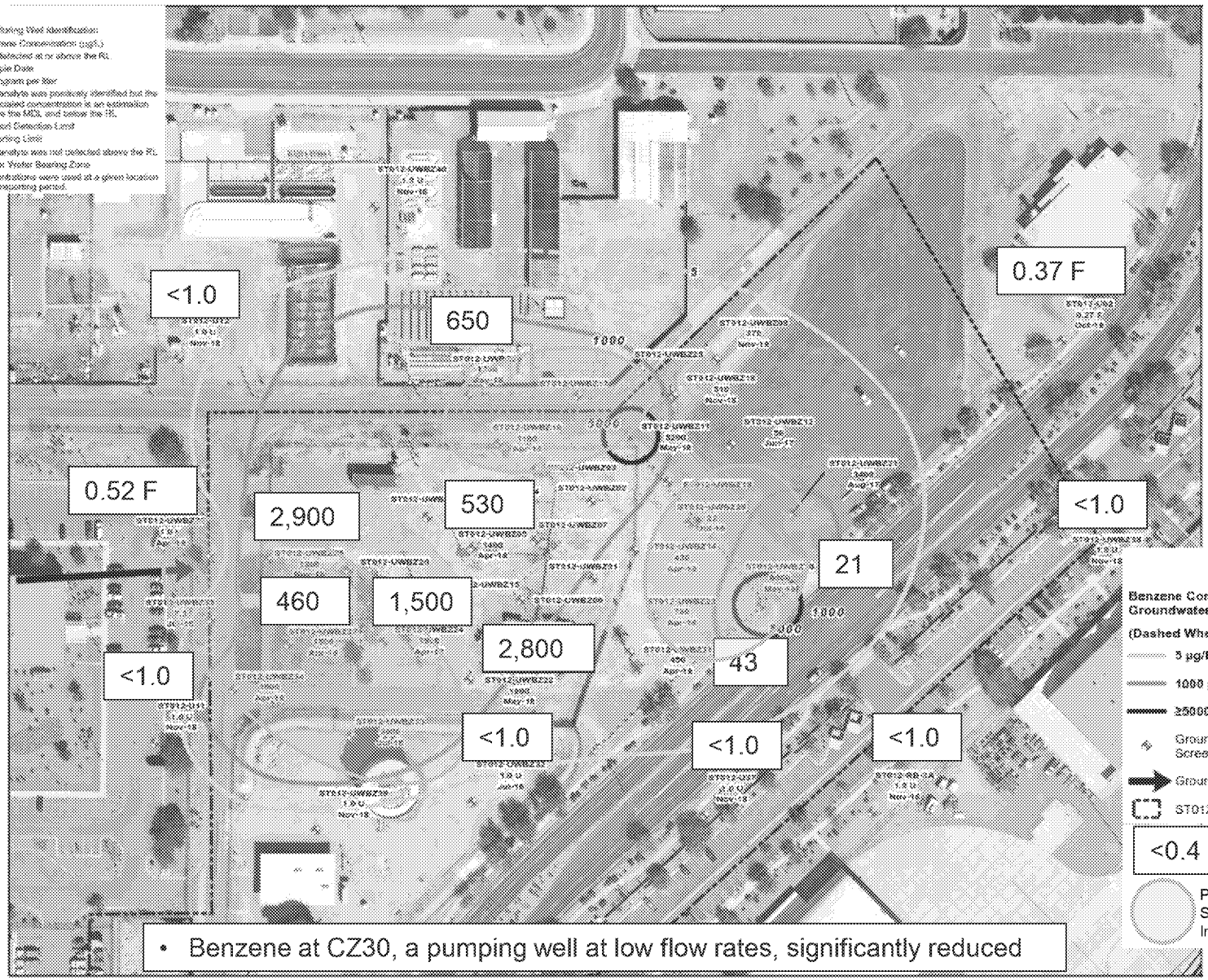
Site ST012 Annual Benzene (µg/L) in UWBZ (previous contours for reference)



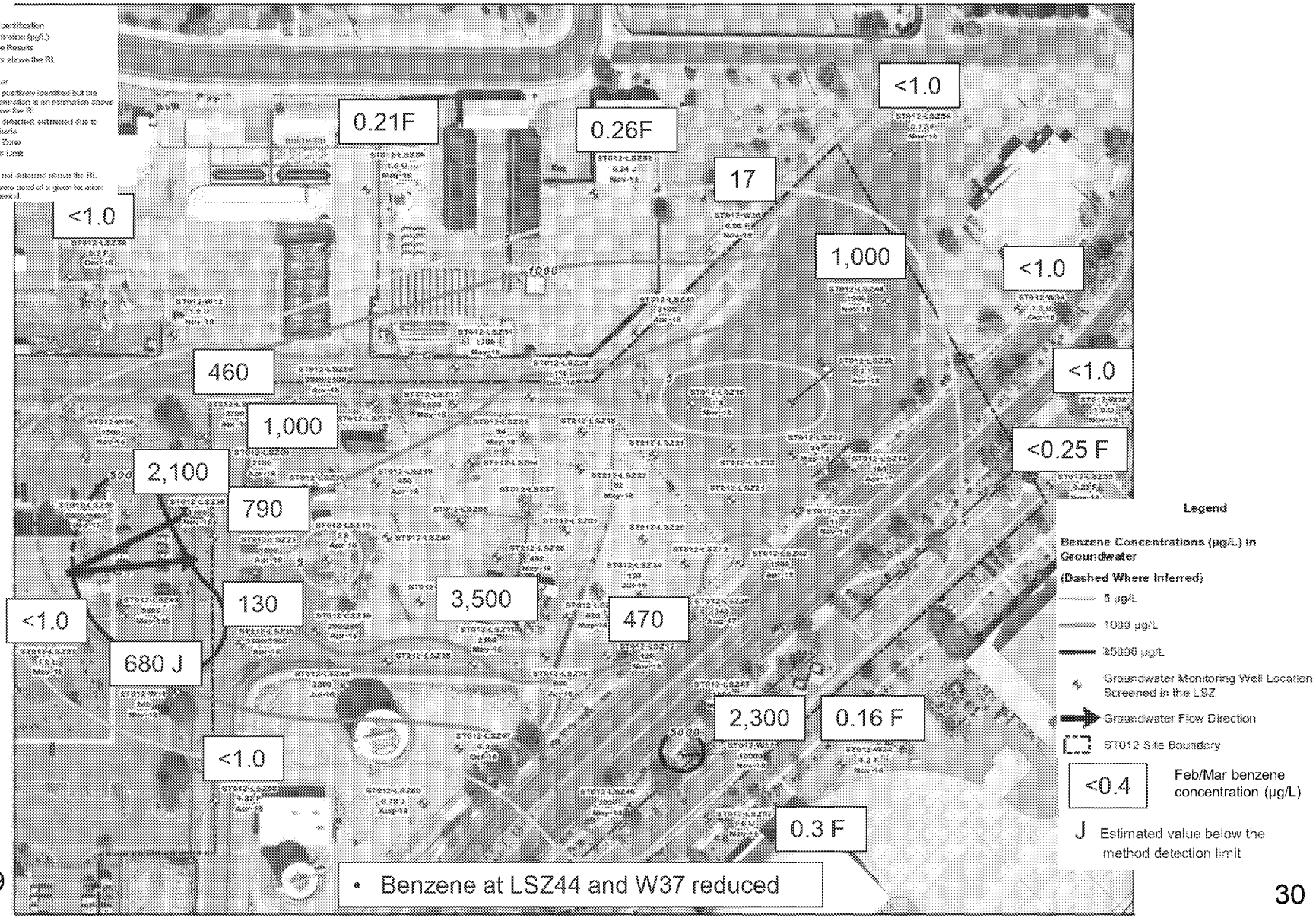
- Benzene at CZ30, a pumping well at low flow rates, significantly reduced

Site ST012 Annual Benzene (µg/L) in UWBZ (previous contours for reference)



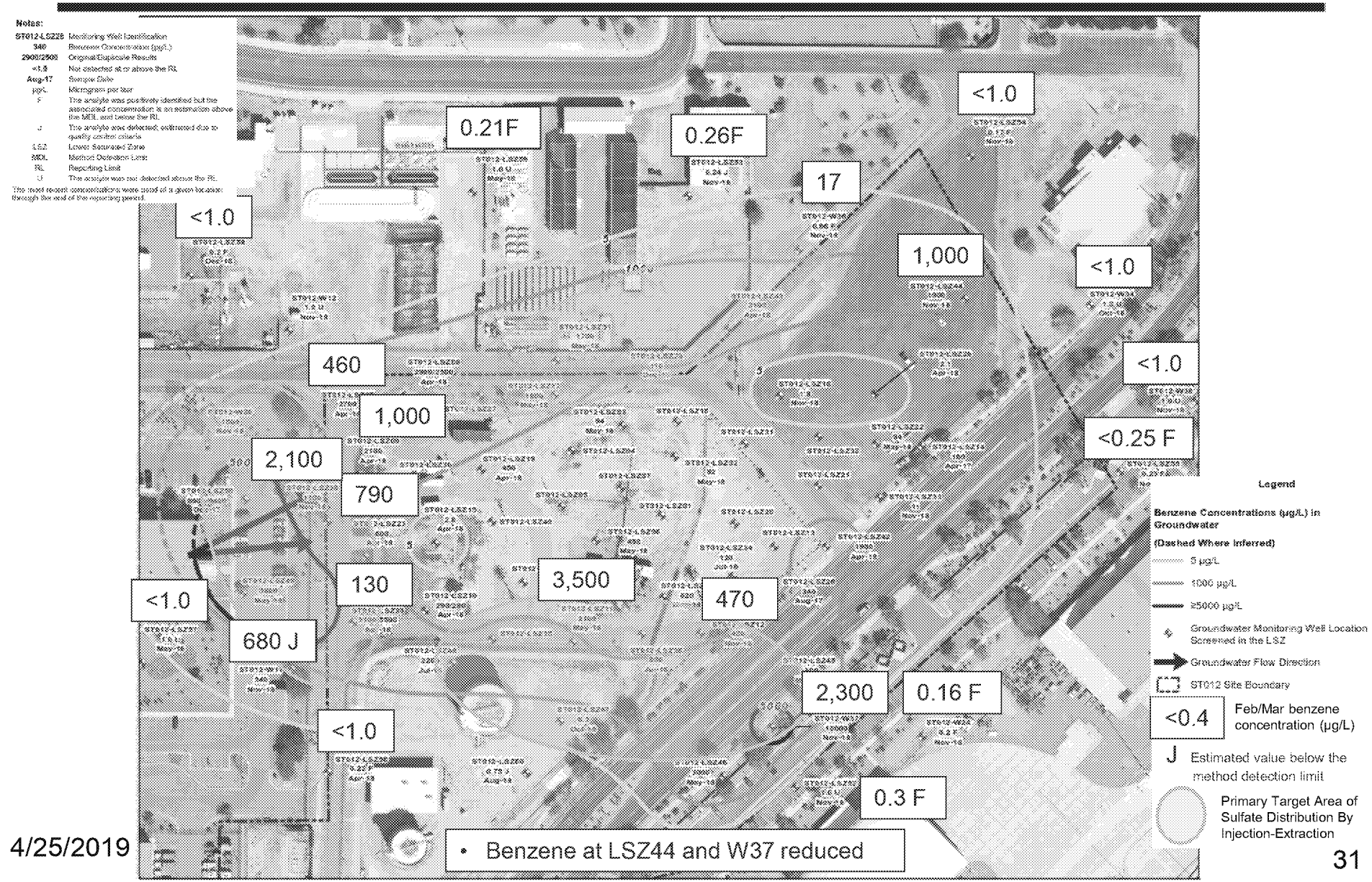
- Benzene at CZ30, a pumping well at low flow rates, significantly reduced

Site ST012 Annual Benzene (µg/L) in LSZ (previous contours for reference)



- Benzene at LSZ44 and W37 reduced

Site ST012 Annual Benzene (µg/L) in LSZ (previous contours for reference)

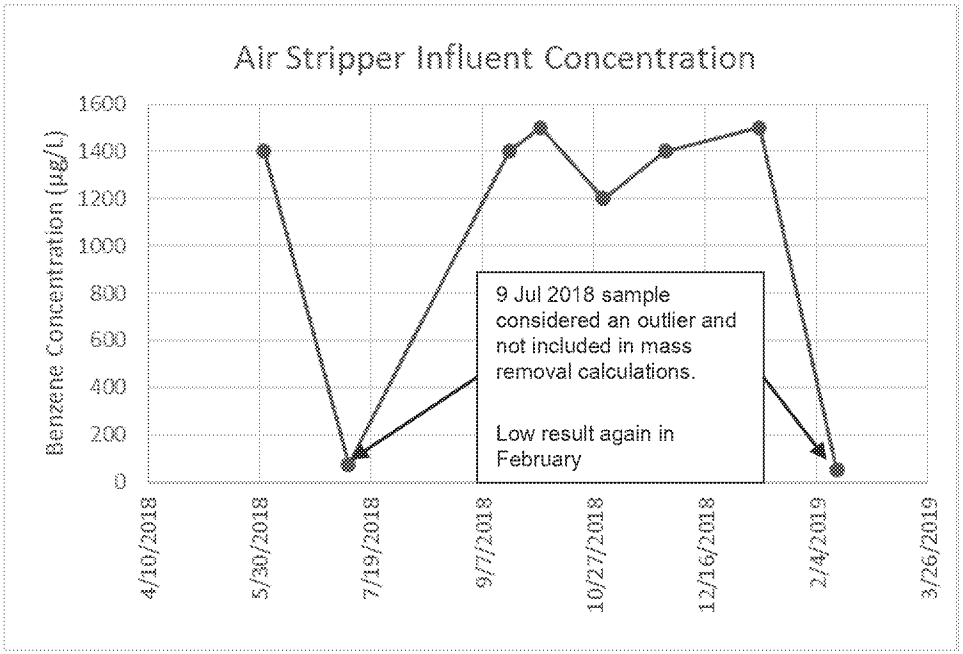


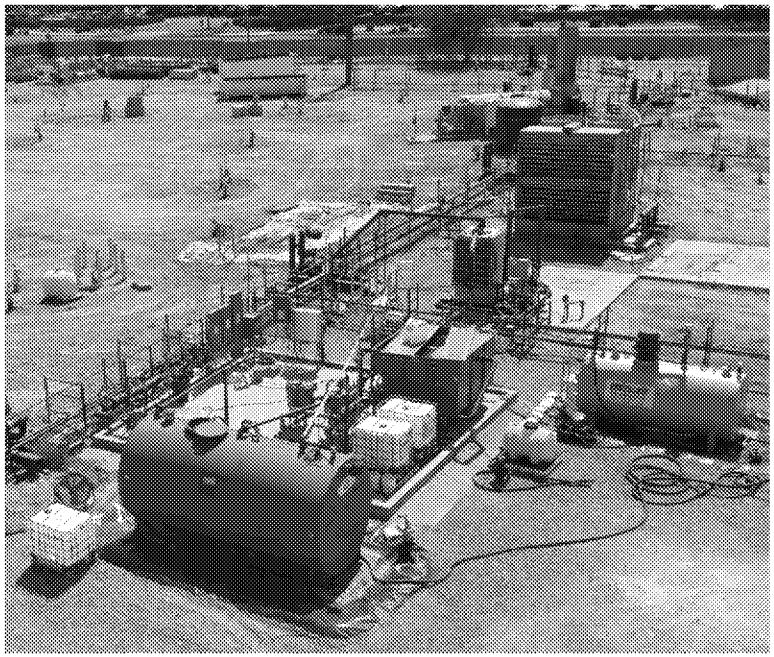
- Benzene at LSZ44 and W37 reduced

Pilot Study Injection/Extraction Update

Site ST012 Extraction System Performance

- No LNAPL has been recovered since extraction started up
- CZ18, CZ21, UWBZ21, UWBZ22 currently down (pump motor for CZ21 ordered and driller scheduled)
- Benzene air stripper influent stabilized at ~1,400 µg/L but then dropped in February sample – resampled 24 April





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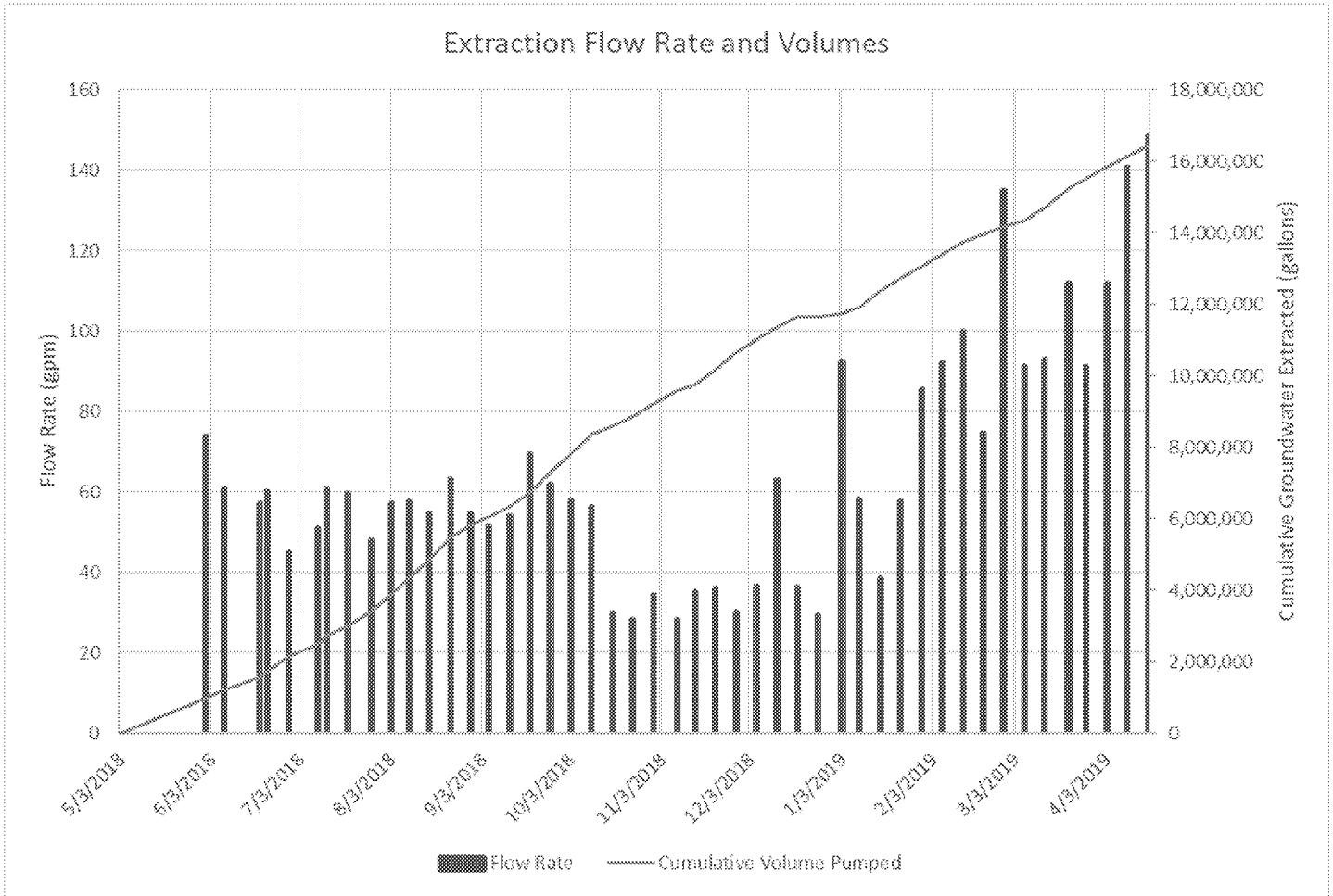
Site ST012 Extraction System Performance

- **Overall Extraction Rates and Cumulative Volume Extracted**



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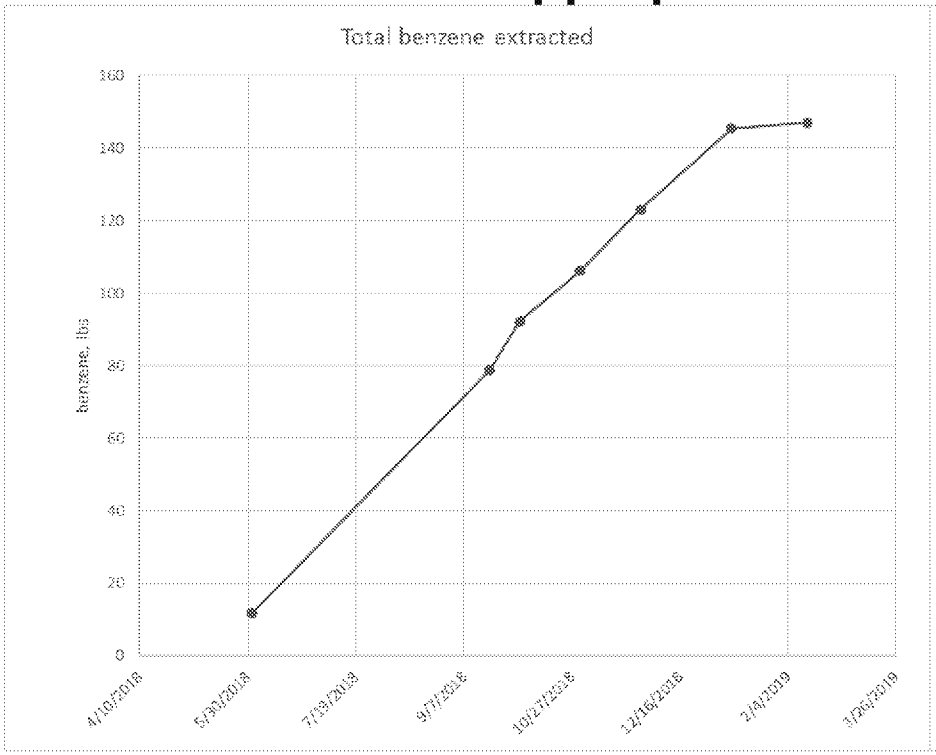
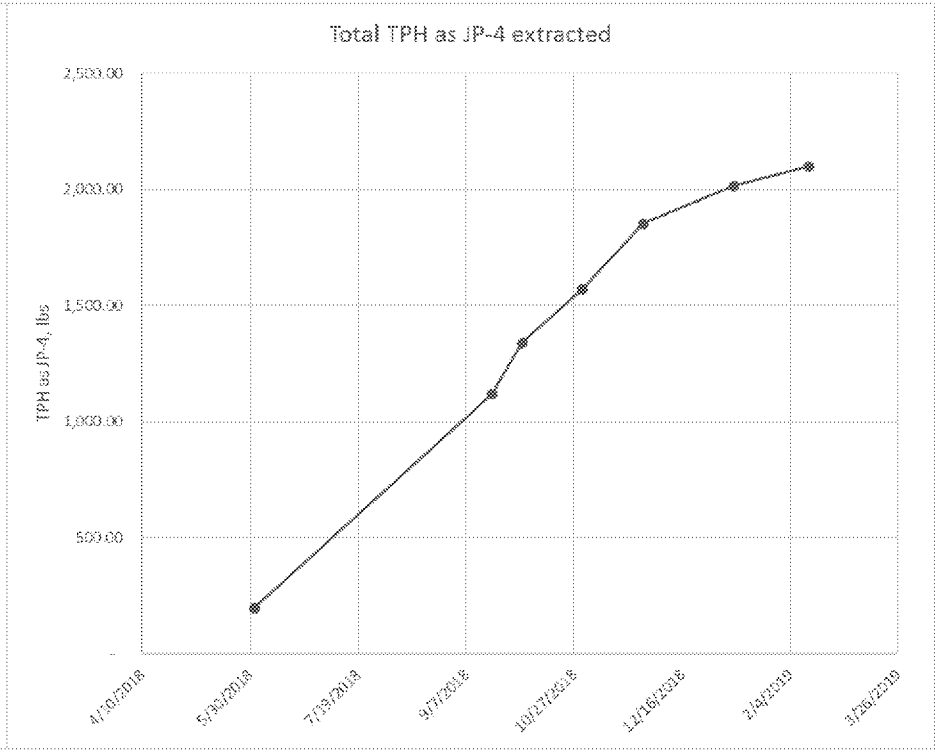
Site ST012 Extraction System Performance

- **Estimated Mass Removal by Extraction**
- **Recent lower mass extraction is due to reduced benzene influent concentration in February. February data point will be compared with future samples and may be removed from future calculations if appropriate.**





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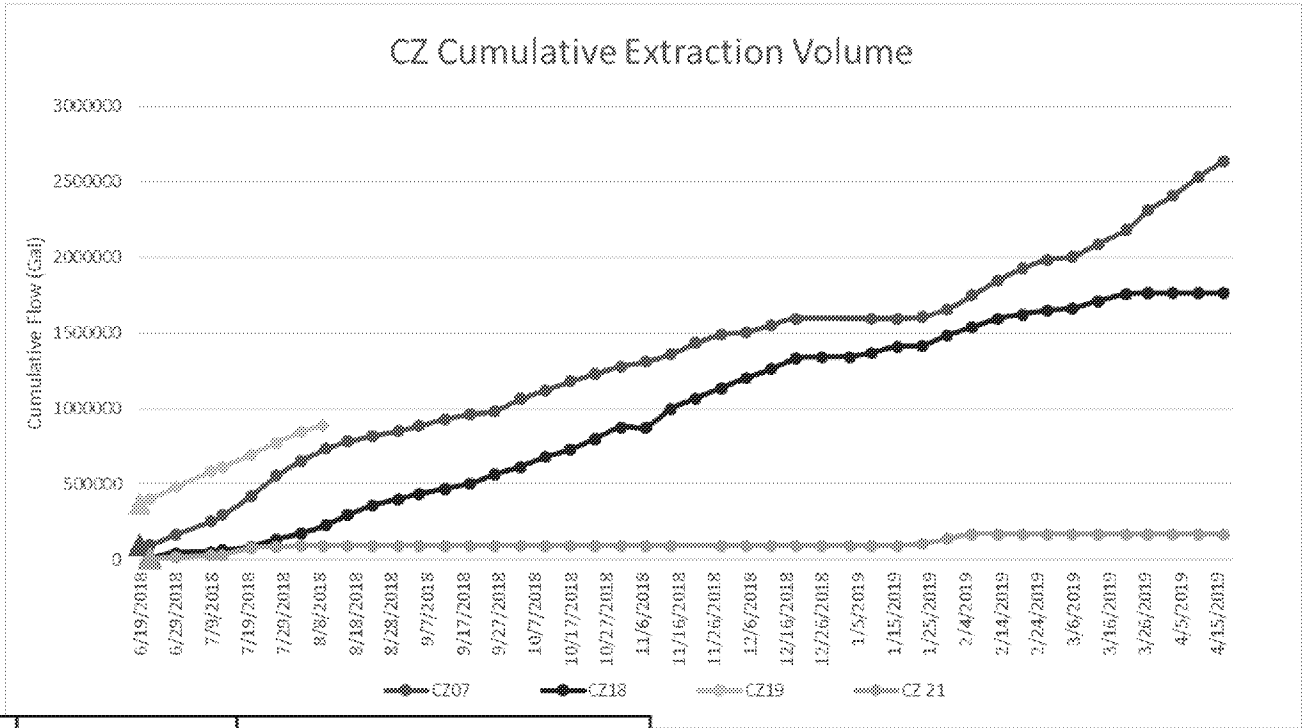
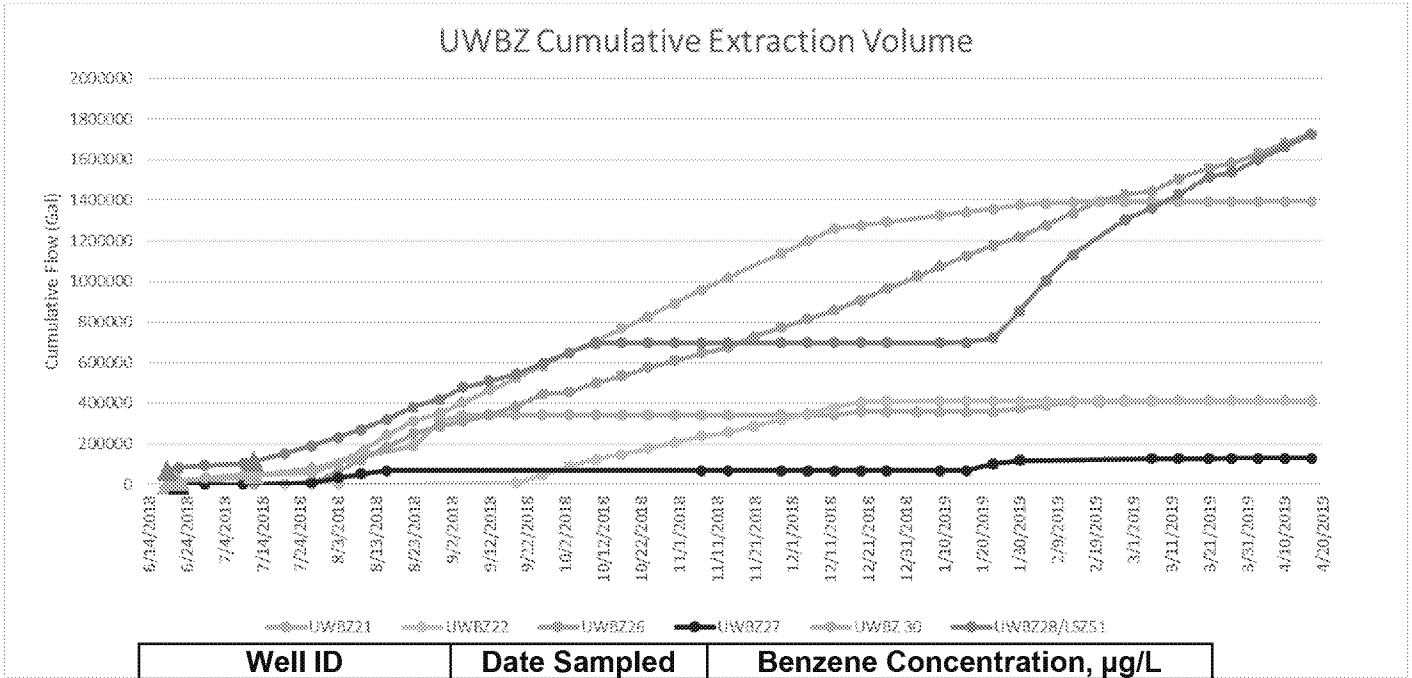
Cumulative Extraction Volume and Analytical Data by Well - Cobble Zone



Well ID	Date Sampled	Benzene Concentration, µg/L
ST012-CZ07	4/30/2018	230
	11/1/2018	600
	2/11/2019	410
ST012-CZ18	4/3/2018	1200
	11/1/2018	260
	2/11/2019	260
ST012-CZ19	5/9/2018	3.1
ST012-CZ21	4/12/2018	680

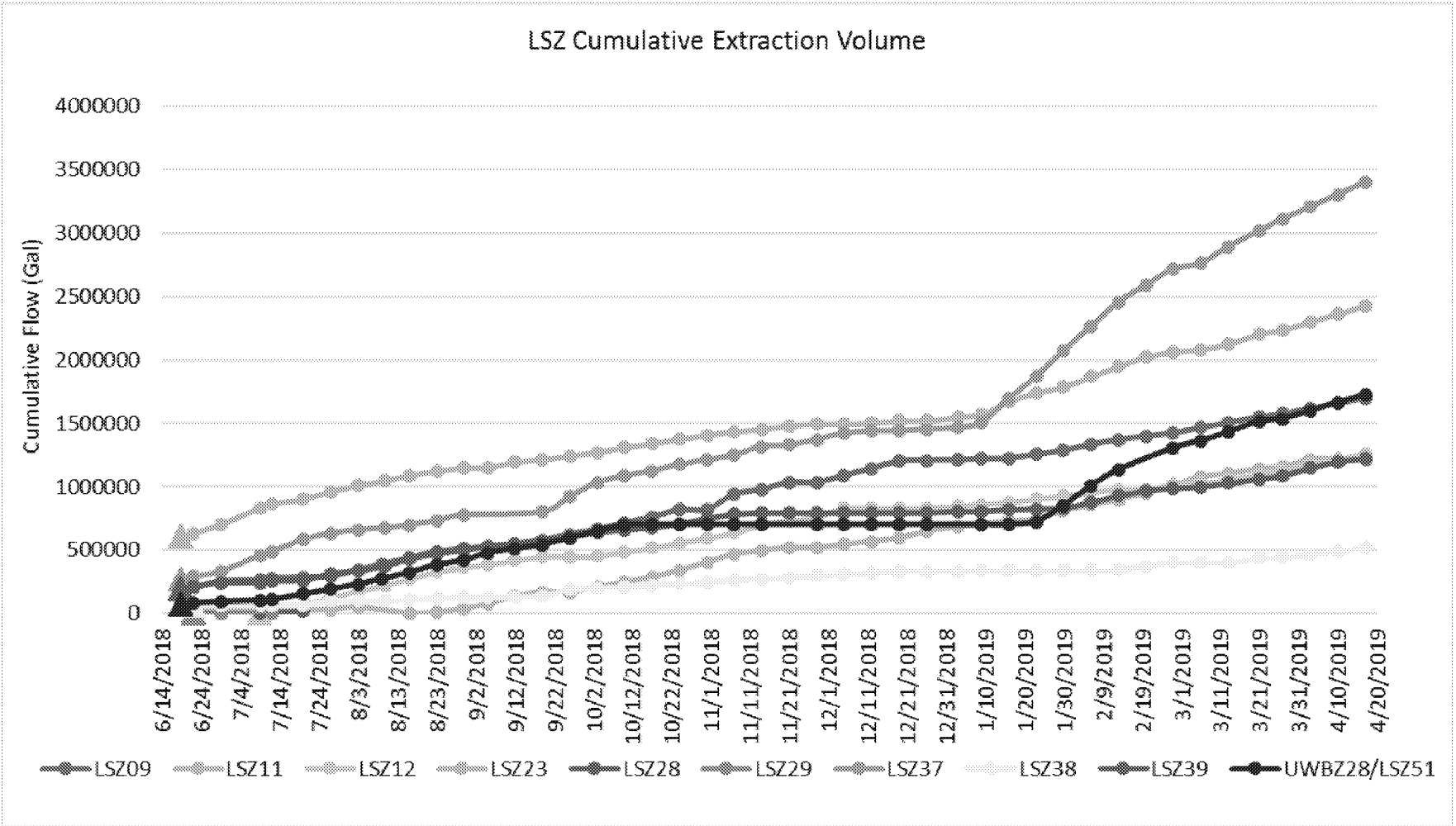
- Most recent baseline and operating (when available) benzene analytical result listed (Feb 2019 added)
- Individual well concentrations may be reduced with pumping

Cumulative Extraction Volume and Analytical Data by Well - Upper Water Bearing Zone



Well ID	Date Sampled	Benzene Concentration, µg/L
ST012-UWBZ21	8/9/2017	3400
ST012-UWBZ22	5/9/2018	1900
	2/11/2019	2800
ST012-UWBZ26	4/3/2018	3500
	4/3/2018	3700
	2/12/2019	2900
ST012-UWBZ27	4/3/2018	1500
	2/12/2019	460
ST012-UWBZ28/LSZ51	5/9/2018	1700
	3/25/2019	650
ST012-UWBZ30	5/9/2018	6000
	2/13/2019	21

Cumulative Extraction Volume by Well
Lower Saturated Zone



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Analytical Data by Extraction Well
Lower Saturated Zone

Well ID	Date Sampled	Benzene Concentration, µg/L
ST012-LSZ09	4/3/2018	2100
	2/12/2019	1000
ST012-LSZ11	5/9/2018	2100
	2/12/2019	3500
ST012-LSZ12	5/9/2018	1400
	11/1/2018	420
	2/12/2019	470
ST012-LSZ23	4/3/2018	1600
	2/12/2019	790
ST012-LSZ28	12/1/2016	110
ST012-LSZ29	4/10/2018	2.1
ST012-LSZ37	4/12/2018	2700
	2/12/2019	460
ST012-LSZ38	4/3/2018	3000
	11/1/2018	1300
	2/12/2019	2100
ST012-LSZ39	4/12/2018	3100/5500
	2/12/2019	130
ST012-UWBZ28/LSZ51	5/9/2018	1700
	3/25/2019	650

Site ST012 Injection Progress

- Injections continued in Mar-Apr
- Have been able to increase sulfate concentration with recent warmer weather to ~120 g/L of sodium sulfate (~80 g/L of sulfate)

Date	Volume (gallons)	Number of Bags of Sulfate Added	Calculated Na2SO4 Conc. g/L	Calculated SO4 Conc. g/L	Locations(% of volume if multiple locations)
3/15/2019	5,000	2	96	65	UWBZ34 (42%),W11(58%)
3/19/2019	5,000	2	96	65	UWBZ34 (42%),W11(58%)
3/20/2019	7,000	3	103	70	UWBZ34 (60%),W11(40%)
3/21/2019	5,000	2	96	65	UWBZ34 (81%),W11(19%)
3/27/2019	7,200	3	100	68	W11 (46%), UWBZ35(54%)
3/28/2019	7,500	3	96	65	UWBZ35
3/29/2019	7,400	3	97	66	UWBZ35
4/8/2019	5,000	3	144	97	UWBZ35
4/9/2019	6,000	3	120	81	UWBZ35 (33%), LSZ08 (67%)
4/10/2019	5,700	2	84	57	UWBZ35 (34%), LSZ08 (66%)
4/11/2019	9,900	5	121	82	UWBZ35 (54%), LSZ08 (46%)
4/17/2019	6,100	3	118	80	LSZ08

- Initial injections in UWBZ33, UWBZ34, UWBZ35, UWBZ36, W11 complete
- 79 tons injected through 17 Apr 2019 (of 169 tons planned for Subphase 1 – 48%)
- 34 tons injected since last update

Site ST012 Sulfate Field Screening

- **Estimated travel times (from work plan, App F figures)**
  - UWBZ33 to UWBZ22 (130 ft): up to 10 months
  - UWBZ33 to UWBZ27 (115 ft): up to 15 months
  - UWBZ36 to UWBZ26 (60 ft): 1-2 months
  - W11 to LSZ39 (60 ft): 4-7 months
- **Model predicts sulfate concentrations would increase at extraction locations for several months before decreasing**
- **Sulfate field tests completed ~weekly in wells in proximity to injections**

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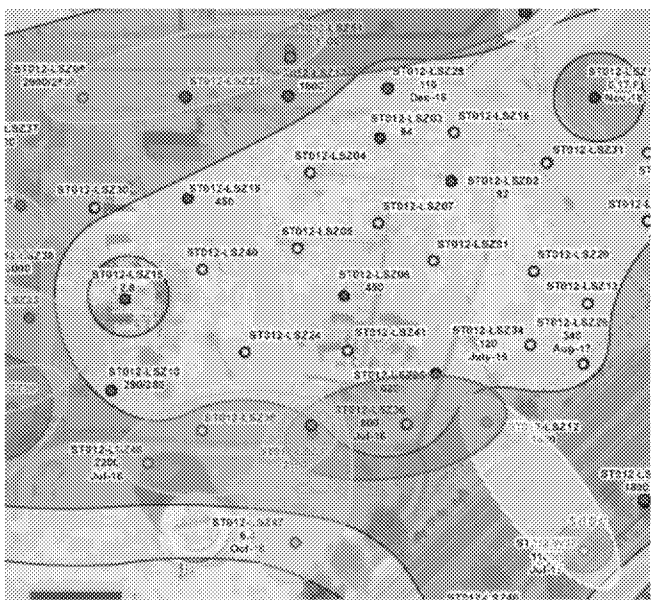
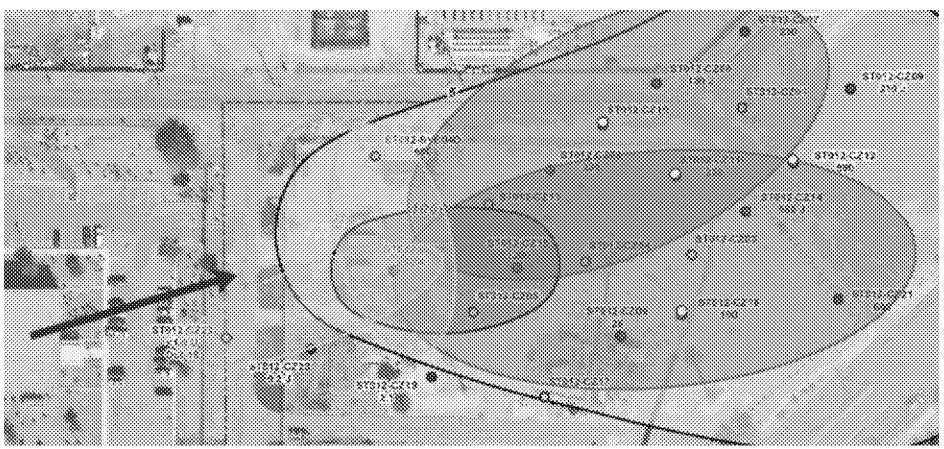
Site ST012 Sulfate Field Screening

Injection Points	Extraction Well	Date	Sulfate (mg/L)
UWBZ33	UWBZ22 (average pre-injection laboratory sulfate = 11 mg/L)	12/17/2018	*30*
		12/21/2018	*45*
		12/26/2018	146
		1/15/2019	45
		1/18/2019	40
		1/21/2019	38
		1/24/2019	41
		1/25/2019	250
		1/28/2019	10
		1/29/2019	35
		1/31/2019	89
		2/1/2019	57
		2/5/2019	37
		2/11/2019	37
		2/15/2019	36
		2/18/2019	40
		2/22/2019	pump down

Injection Points	Extraction Well	Date	Sulfate (mg/L)
UWBZ33 UWBZ34	UWBZ27 (average pre-injection laboratory sulfate = 108 mg/L)	12/17/2018	*15*
		12/21/2018	*30*
		12/26/2018	>150
		1/15/2019	71
		1/18/2019	57
		1/21/2019	66
		1/24/2019	48
		1/25/2019	50
		2/11/2019	54
		2/15/2019	48
		3/1/2019	94
		3/4/2019	112
		3/15/2019	119
		3/20/2019	97
		3/29/2019	350
		4/8/2019	297
		4/16/2019	520

Injection Points	Extraction Well	Date	Sulfate (mg/L)
UWBZ36	UWBZ26 (average pre-injection sulfate = 3.6 mg/L)	1/31/2019	22
		2/1/2019	9
		2/5/2019	25
		2/11/2019	10
		2/15/2019	12
		2/18/2019	16
		2/22/2019	22
		2/25/2019	38
		3/1/2019	66
		3/4/2019	67
		3/8/2019	104
		3/15/2019	101
		3/29/2019	99
		4/9/2019	81
		4/16/2019	150
W11	LSZ39 (average pre-injection sulfate = 132 mg/L)	3/29/2019	850
		4/9/2019	153
		4/16/2019	210

- **Increasing trends in UWBZ26 and UWBZ27.**
- **Initial high (850 g/L) measurement not sustained in LSZ39**

Site ST012 Path Forward Apr-May

- Continued SVE operation
- Continue pump repairs
- Pilot Study Implementation
  - Continue mixing sulfate batches and inject according to plan (FVM7) Apr – May
  - Next planned injection wells LSZ47 and LSZ48
  - CZ22 injections once CZ21 extraction pump repaired