ORANGE COUNTY GOVERNMENT
FLORIDA
Environmental Protection Division

Remediation System Optimization

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System Optimization

- Ensuring the RA system is most effectively treating contamination
- Utilize data collected from O&M events to determine effectiveness
- Can be evaluated and applied at different stages of remediation
    - System Design
    - Startup
    - Throughout system operation

Why Optimize?

Uncertainty of where to target after system treating the target area

- Soil heterogeneity can cause contamination pockets that may be difficult to reach.
- Some areas may be receptive to the remedial approach, while others appear unaffected.

a.) Modify System?

b.) Change the remediation approach?

Potential savings on costs associated with O&M and sampling

The subsurface dynamics change with the implementation of remediation systems

RA System Evaluation

The facility status will vary when the site manager receives a site.

- Involvement with SAR and RAP phases
- Received at RAC/RA Startup
- Received during the continuation of O&M
- Currently in NAM/PARM with apparent contaminant rebounding of recalcitrant compounds

O&M Reports

Things to consider when reviewing submitted O&M Reports

- O&M Reports provide the information needed to evaluate the effectiveness of the remediation system
- Tracks the progress of remediation
- Illustrates the influence that the remediation system has on COCs in the subsurface
  - Can be different than the RAP

O&M Reports

Important information found in O&M Reports

- Reading/analyzing groundwater analytical data
  - Influence the Remedial system has in the subsurface at key monitoring wells
- Current system configuration
  - Operational Parameters
- Location of contaminant plume
  - Comprehensive annual sampling
- System run time

Reading/analyzing influence data for key wells

- Dissolved Oxygen
- Pressure/vacuum measurements
- Groundwater elevation levels
- Location and levels of dissolved contaminant concentrations

O&M Reports

Things to consider when evaluating the performance of the remediation system

- Check to see if the treatment points are addressing the impacted zone
- Are the contaminant concentrations at key monitoring wells reducing at an acceptable rate
- Contaminant plume migration
- Groundwater contaminant rebound

Performance Control

Ways to optimize AS/VE system performance

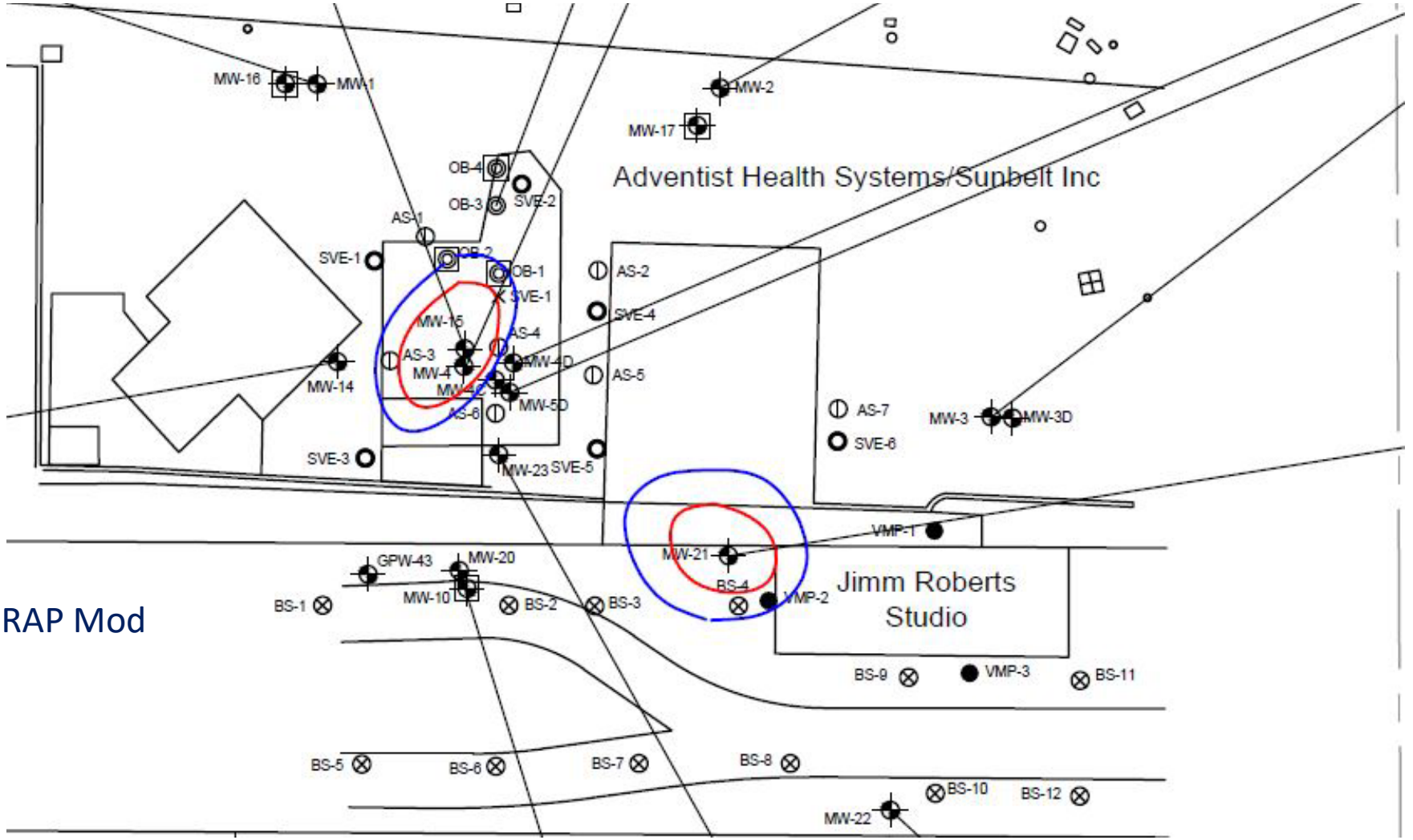
- Applied vacuums to the VE wells and sparge pressures for AS wells
- Well configuration where the vacuums/pressures are applied
- Is influence seen at the target plume area?

Example

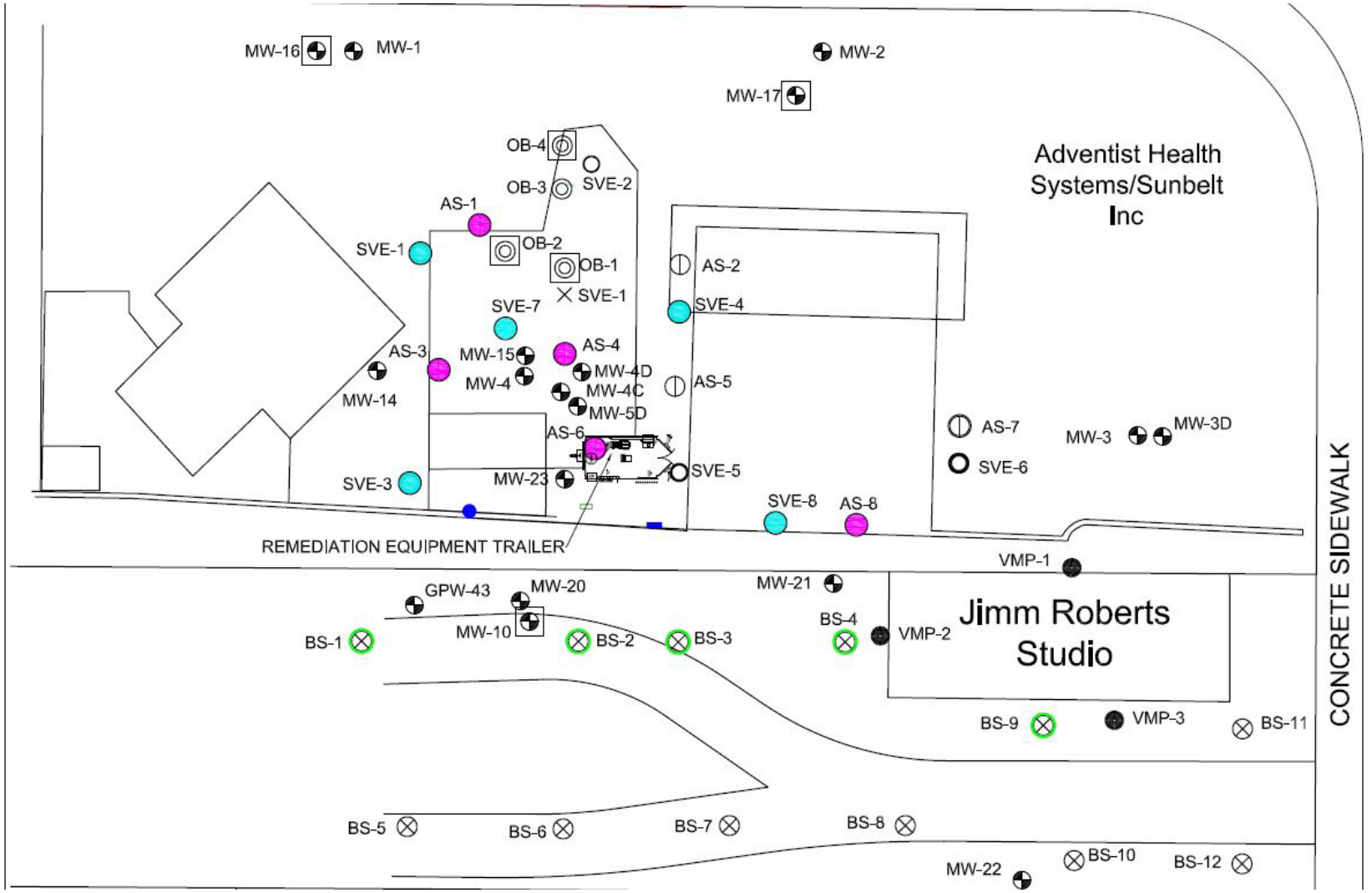
A Brief Site History

- Site received during NAM sampling
- AS/SVE system operational for 4 yrs. and moved to NAM
- COC rebound occurred and RAP Mod approved for AS/BS/SVE
- Currently operating for approx. 1 yr.

GW Plume Prior to RAP Mod



AS/BS/SVE System



Analytical Results = µg/l

B= Base Line
K= Key Well

			NADC	100	400	300	200	NA	200	2	150	140	280	280	50000
			GCTL	1	40	30	20	NA	20	0.02	15	14	28	28	5000
Location	Screen Interval	Date	DTW	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Total VOAs	MTBE	EDB	Total Lead	Naphthalene	1-Methyl Naphthalene	2-Methyl Naphthalene	TRPH
		10/23/06	13.91	0.5 U	**660**	**1200**	**4700**	6560	0.44 U	NA	NA	**220**	**98**	**170**	**12000**
		01/20/10	NM	**14.80**	8.20	255	**1230**	1508	6.80	NA	NA	0.39 U	0.9	0.2 U	3200
		07/21/10	13.35	**3.52**	**266**	**567**	**2360**	3197	1.0 U	NA	NA	**78.2**	24	**36.3**	**5730**
		10/26/10	14.15	**32.00**	**336**	**607**	**3100**	4075	38.60	0.71 U	NA	**47**	19	24.0	NA
		01/24/11	16.16	**20.50**	**365.00**	**177**	**2260**	2830	10 U	0.72 U	NA	**66.2**	25	**38.4**	3980
Active		04/26/11	15.95	0.5 U	**141 L**	**303 L**	**960**	1104	1.0 U	0.69 U	NA	**15.8**	18.8	13.6	4580
		08/09/11	14.45	**20.10**	**154.00**	**427**	**2100**	2701	20.10	1.3 U	NA	**166 J**	**90.8 J**	**153 J**	4260
Remediation		01/10/12	NM	**12.10**	**137 L**	**124 L**	**1120**	1393	1.0 U	0.60 U	NA	**22.8**	19.9	**29.6**	4640
		04/12/12	17.63	**12.50**	**144.00**	**198**	**1960**	2315	10.00	NA	NA	**52.6**	**41.0**	**66.5**	**6190**
		07/23/12	15.71	**13.60**	**113 L**	**422 L**	**2860**	2874	7.27	NA	NA	**63.4**	16.5	26.0	3,850 L
		10/22/12	13.30	**1.35**	5.33	14.90	**104**	126	1.0 U	NA	NA	4.2	1.8	2.5	329
		01/16/13	16.28	0.71 U	**51.00**	**110**	**600**	895	0.60 U	NA	NA	**17.0**	7.3	11.0	1100
		06/07/13	15.52	0.71 U	22.00	**97.00**	**780**	900	0.60 U	NA	NA	**15.0**	16.0	22.0	1000
MW-15	10.5 - 20.50	09/06/13	12.65	0.71 U	2.90	20.00	**130**	154	0.60 U	NA	NA	6.8	8.9	12.0	370
		12/06/13	15.00	0.71 U	1.60	22.00	**160**	184	0.60 U	NA	NA	9.2	12.0	17.0	630
		01/21/15	13.59	0.20 U	0.41	13.20	**70**	84	0.30 U	NA	NA	4.8	10.6	15.8	838
		07/28/15	15.73	0.50 U	0.51 U	**91.00**	**300**	391	0.44 U	NA	NA	**43.0**	**29.0**	**35.0**	3400
		03/22/16	14.79	0.50 U	0.51 U	**140**	**790**	830	0.44 U	NA	NA	**71.0**	**37.0**	**55.0**	NS
		05/27/16	15.61	1.0 U	1.40	**200**	**1300**	1501	0.88 U	NA	NA	NA	NA	NA	NA
		09/26/16	14.04	0.50 U	0.51 U	**140**	**590**	730	0.44 U	NA	NA	**45**	28	**44**	2000
		01/09/18	14.39	0.25 U	0.24 U	**95**	**280**	375	0.44 U	NA	NA	**37**	24	**35**	1300
		04/08/19	15.14	0.25 U	0.24 U	**110**	**310**	420	0.44 U	NA	NA	**52**	**56**	**86**	NA
		12/06/21	14.13	0.25 U	0.24 U	30	**48**	78	0.44 U	NA	NA	13	**36**	**56**	1800
Active		01/30/23	12.95	0.71 U	0.72 U	19	**68**	87	0.60 U	NA	NA	11	**39**	**61**	3,900 U
		04/19/23	15.52	0.71 U	0.72 U	22	**52**	74	0.60 U	NA	NA	**16**	**71**	**110**	3,900 U
Remediation		07/13/23	14.40	0.71 U	0.72 U	23	**54**	77	0.60 U	NA	NA	**33**	**120**	**190**	NA
		10/18/23	12.68	0.71 U	0.72 U	5.7	15	20.7	0.60 U	NA	NA	3.7	13	21	NA

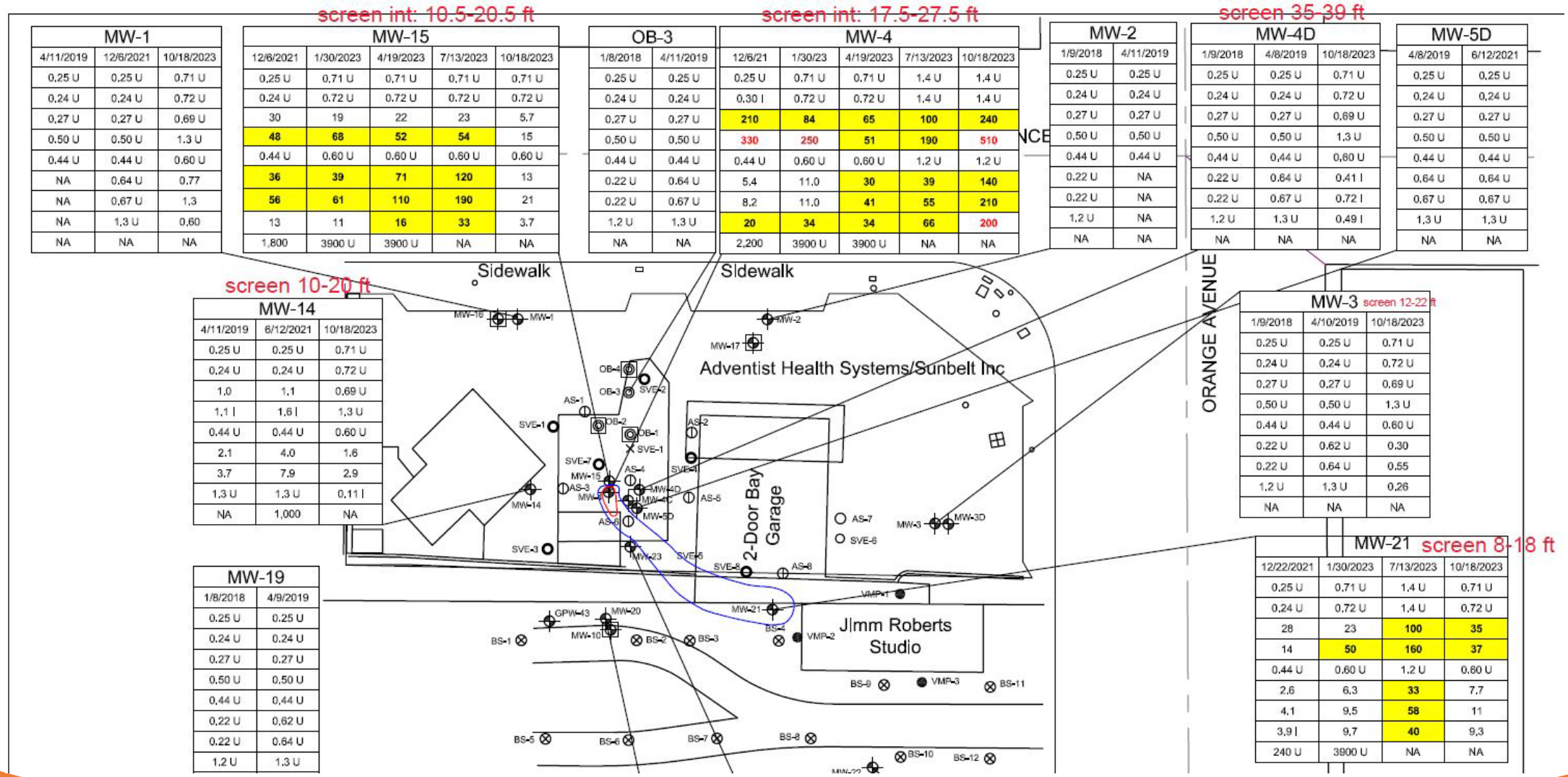
- BTEX & naphthalene compounds for key well MW-15 have been reduced to below their respective GCTLs

Analytical Results = µg/l

B= Base Line
K= Key Well

			NADC	100	400	300	200	NA	200	2	150	140	280	280	50000
			GCTL	1	40	30	20	NA	20	0.02	15	14	28	28	5000
Location	Screen Interval	Date	DTW	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Total VOAs	MTBE	EDB	Total Lead	Naphthalene	1-Methyl Naphthalene	2-Methyl Naphthalene	TRPH
MW-21	8 - 18.00	06/26/17	13.94	1.0 U	1.0 U	**300.0**	**800**	1100.0	0.88 U	NA	NA	**41**	19	27	1,900
		01/08/18	12.20	0.50 U	0.48 U	**180.0**	**1000**	1180.0	0.88 U	NA	NA	**56**	**30**	**54**	1,100
		04/09/19	NM	0.25 U	0.24 U	**95.0**	**350**	445.0	0.44 U	NA	NA	**27**	18	28	NA
		12/22/21	12.25	0.25 U	0.24 U	28	14	42	0.44 U	NA	NA	3.9 I	2.6	4.1	240 U
		01/30/23	11.74	0.71 U	0.72 U	23	**50**	73	0.60 U	NA	NA	9.7	6.3	9.5	3,900 U
		07/13/23	12.14	1.4 U	1.4 U	**100**	**160**	260	1.2 U	NA	NA	**40.0**	**33.0**	**58.0**	NA
		10/18/23	10.68	0.71 U	0.72 U	**35**	**37**	72	0.60 U	NA	NA	9.3	7.7	11	NA
MW-4	17.5 - 27.50	06/09/94	NM	**1260**	**22000.0**	**2100**	**16720**	42080.0	1000 U	0.02 U	24	**1140**	**260**	**550**	36000
		04/12/05	13.60	10 U	**2300 J**	**1000**	**3500**	6800.0	10 U	0.02 U	NA	**320**	74	120	1000
		10/19/05	11.92	NA	NA	NA	NA	NA	NA	NA	0.079	NA	NA	NA	NA
		09/26/16	14.30	0.50 U	1.1	**190**	**600**	791.1	0.44 U	NA	NA	24	7.3	10	1100
		01/09/18	14.65	0.50 U	0.63 I	**360**	**840**	1200.0	0.88 U	NA	NA	**94**	27	30	1500
		04/08/19	15.41	0.50 U	0.48 U	**400**	**600**	1000.0	0.88 U	NA	NA	**93**	20	27	NA
		12/06/21	14.42	0.25 U	0.30 I	**210**	**330**	540.3	0.44 U	NA	NA	20	5.4	8.2	2200
Active		01/30/23	13.21	0.71 U	0.72 U	**84**	**250**	334	0.60 U	NA	NA	**34**	11	11	3,900 U
		04/19/23	15.89	0.71 U	0.72 U	**65**	**51**	116	0.60 U	NA	NA	**34**	**30**	**41**	3,900 U
		07/13/23	14.67	1.4 U	1.4 U	**100**	**190**	290	1.2 U	NA	NA	**66**	**38**	**55**	NA
Remediation		10/18/23	12.99	1.4 U	1.4 U	**240**	**510**	750	1.2 U	NA	NA	**200**	**140**	**210**	NA

- MW-4 was not being sampled during the operation of the previous remedial system.
- GW COCs are not reducing as consistently as MW-15 (notice the screen interval of MW-4 is different than that of MW-15).



MW-1		
4/11/2019	12/6/2021	10/18/2023
0.25 U	0.25 U	0.71 U
0.24 U	0.24 U	0.72 U
0.27 U	0.27 U	0.69 U
0.50 U	0.50 U	1.3 U
0.44 U	0.44 U	0.60 U
NA	0.64 U	0.77
NA	0.67 U	1.3
NA	1.3 U	0.60
NA	NA	NA

MW-15				
12/6/2021	1/30/2023	4/19/2023	7/13/2023	10/18/2023
0.25 U	0.71 U	0.71 U	0.71 U	0.71 U
0.24 U	0.72 U	0.72 U	0.72 U	0.72 U
30	19	22	23	5.7
48	68	52	54	15
0.44 U	0.60 U	0.60 U	0.60 U	0.60 U
36	39	71	120	13
56	61	110	190	21
13	11	16	33	3.7
1,800	3900 U	3900 U	NA	NA

OB-3	
1/8/2018	4/11/2019
0.25 U	0.25 U
0.24 U	0.24 U
0.27 U	0.27 U
0.50 U	0.50 U
0.44 U	0.44 U
0.22 U	0.64 U
0.22 U	0.67 U
1.2 U	1.3 U
NA	NA

MW-4				
12/6/21	1/30/23	4/19/2023	7/13/2023	10/18/2023
0.25 U	0.71 U	0.71 U	1.4 U	1.4 U
0.30 I	0.72 U	0.72 U	1.4 U	1.4 U
210	84	65	100	240
330	250	51	190	510
0.44 U	0.60 U	0.60 U	1.2 U	1.2 U
5.4	11.0	30	39	140
8.2	11.0	41	55	210
20	34	34	66	200
2,200	3900 U	3900 U	NA	NA

MW-2	
1/9/2018	4/11/2019
0.25 U	0.25 U
0.24 U	0.24 U
0.27 U	0.27 U
0.50 U	0.50 U
0.44 U	0.44 U
0.22 U	NA
0.22 U	NA
1.2 U	NA
NA	NA

MW-4D		
1/9/2018	4/8/2019	10/18/2023
0.25 U	0.25 U	0.71 U
0.24 U	0.24 U	0.72 U
0.27 U	0.27 U	0.69 U
0.50 U	0.50 U	1.3 U
0.44 U	0.44 U	0.60 U
0.22 U	0.64 U	0.41 I
0.22 U	0.67 U	0.72 I
1.2 U	1.3 U	0.49 I
NA	NA	NA

MW-5D	
4/8/2019	6/12/2021
0.25 U	0.25 U
0.24 U	0.24 U
0.27 U	0.27 U
0.50 U	0.50 U
0.44 U	0.44 U
0.64 U	0.64 U
0.67 U	0.67 U
1.3 U	1.3 U
NA	NA

MW-14		
4/11/2019	6/12/2021	10/18/2023
0.25 U	0.25 U	0.71 U
0.24 U	0.24 U	0.72 U
1.0	1.1	0.69 U
1.1 I	1.6 I	1.3 U
0.44 U	0.44 U	0.60 U
2.1	4.0	1.6
3.7	7.9	2.9
1.3 U	1.3 U	0.11 I
NA	1,000	NA

MW-19	
1/8/2018	4/9/2019
0.25 U	0.25 U
0.24 U	0.24 U
0.27 U	0.27 U
0.50 U	0.50 U
0.44 U	0.44 U
0.22 U	0.62 U
0.22 U	0.64 U
1.2 U	1.3 U

MW-3 screen 12-22 ft		
1/9/2018	4/10/2019	10/18/2023
0.25 U	0.25 U	0.71 U
0.24 U	0.24 U	0.72 U
0.27 U	0.27 U	0.69 U
0.50 U	0.50 U	1.3 U
0.44 U	0.44 U	0.60 U
0.22 U	0.62 U	0.30
0.22 U	0.64 U	0.55
1.2 U	1.3 U	0.26
NA	NA	NA

MW-21 screen 8-18 ft			
12/22/2021	1/30/2023	7/13/2023	10/18/2023
0.25 U	0.71 U	1.4 U	0.71 U
0.24 U	0.72 U	1.4 U	0.72 U
28	23	100	35
14	50	160	37
0.44 U	0.60 U	1.2 U	0.60 U
2.6	6.3	33	7.7
4.1	9.5	58	11
3.9 I	9.7	40	9.3
240 U	3900 U	NA	NA

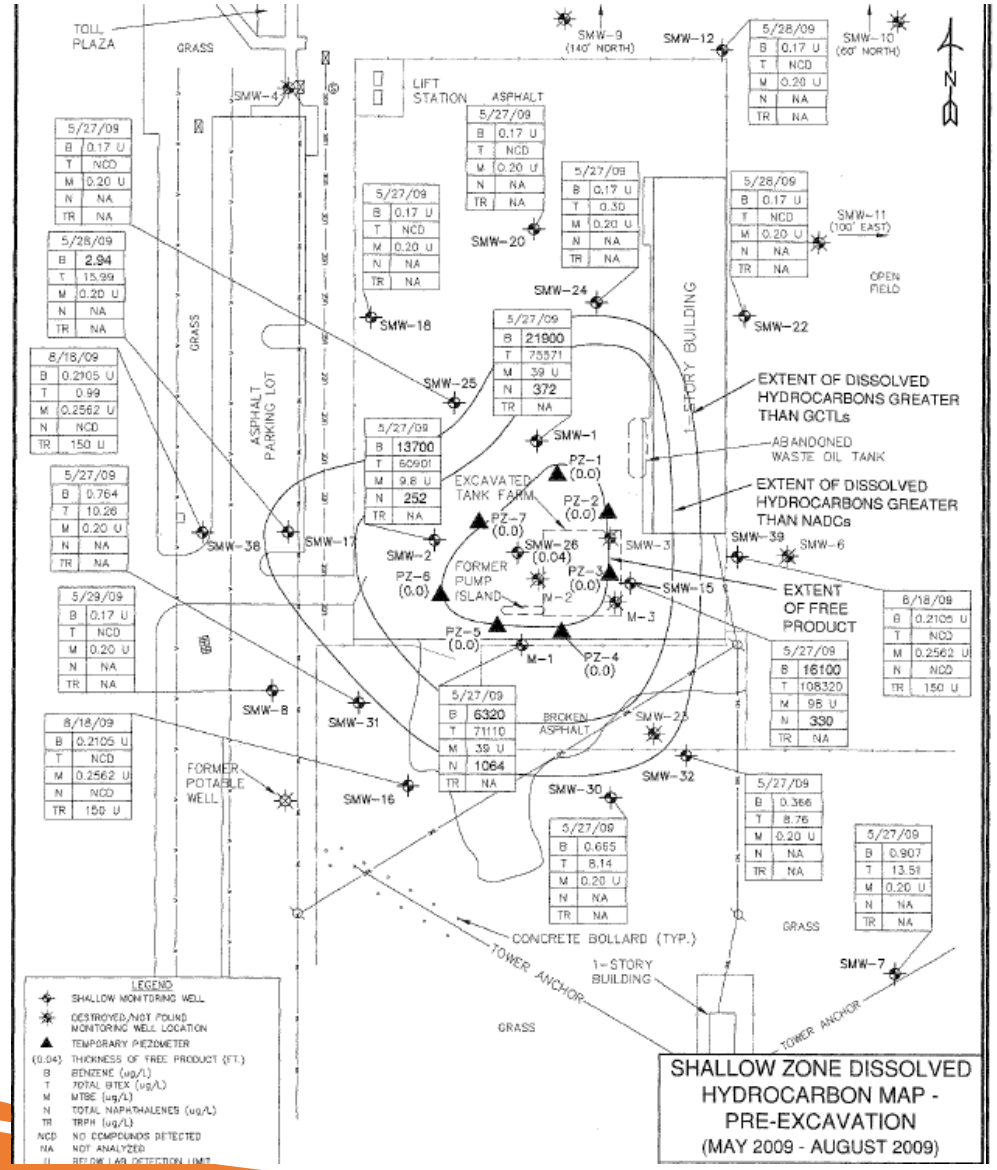
Observations

- Current RA System appears to effectively treat key MWs intersecting the water table (MW-15 & MW-21)
- Focus remedial efforts on the COCs in depth of the screen interval of MW-4 (17-27 ft BLS)
- Determine if additional AS wells need to be installed deeper (currently screened at 28-30 ft BLS)

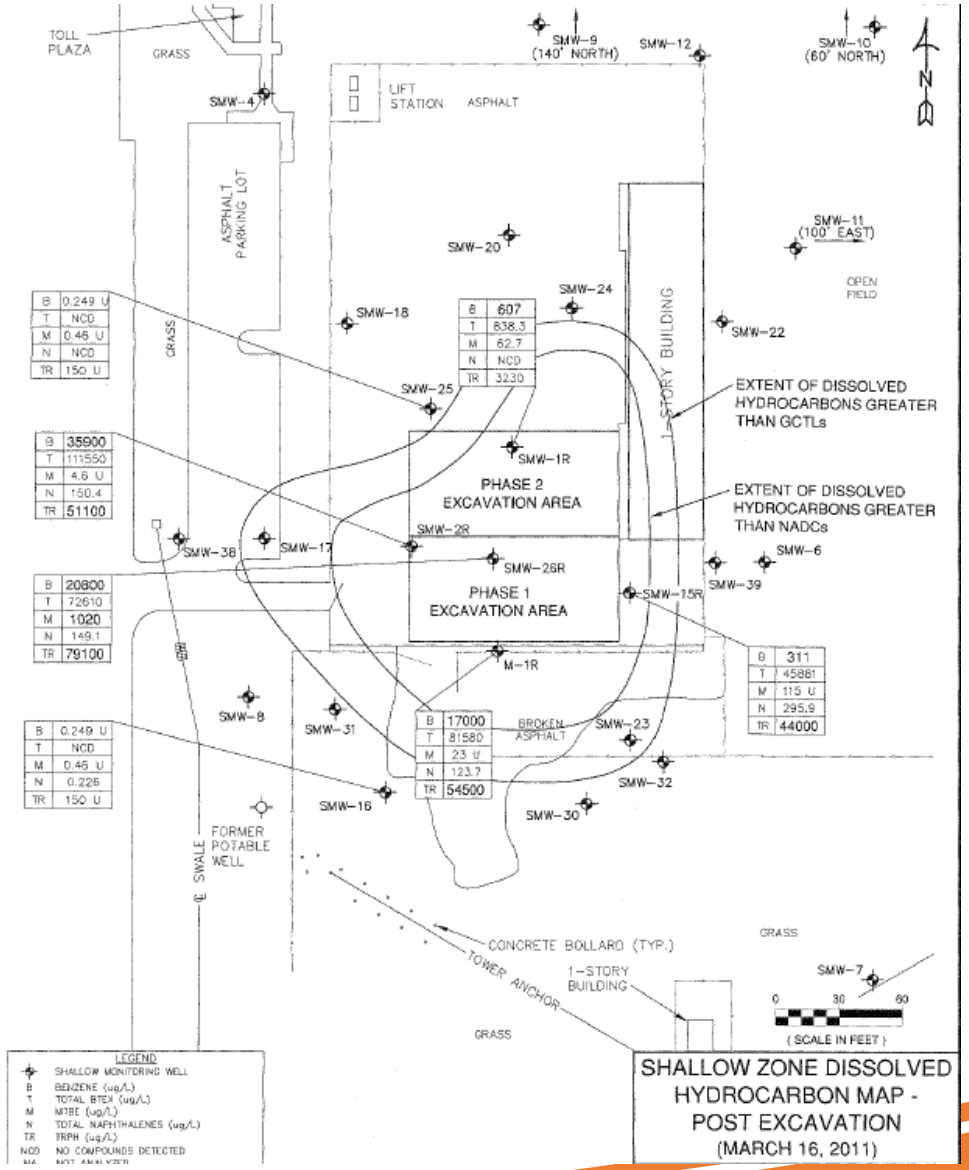
Example

A Brief Site History

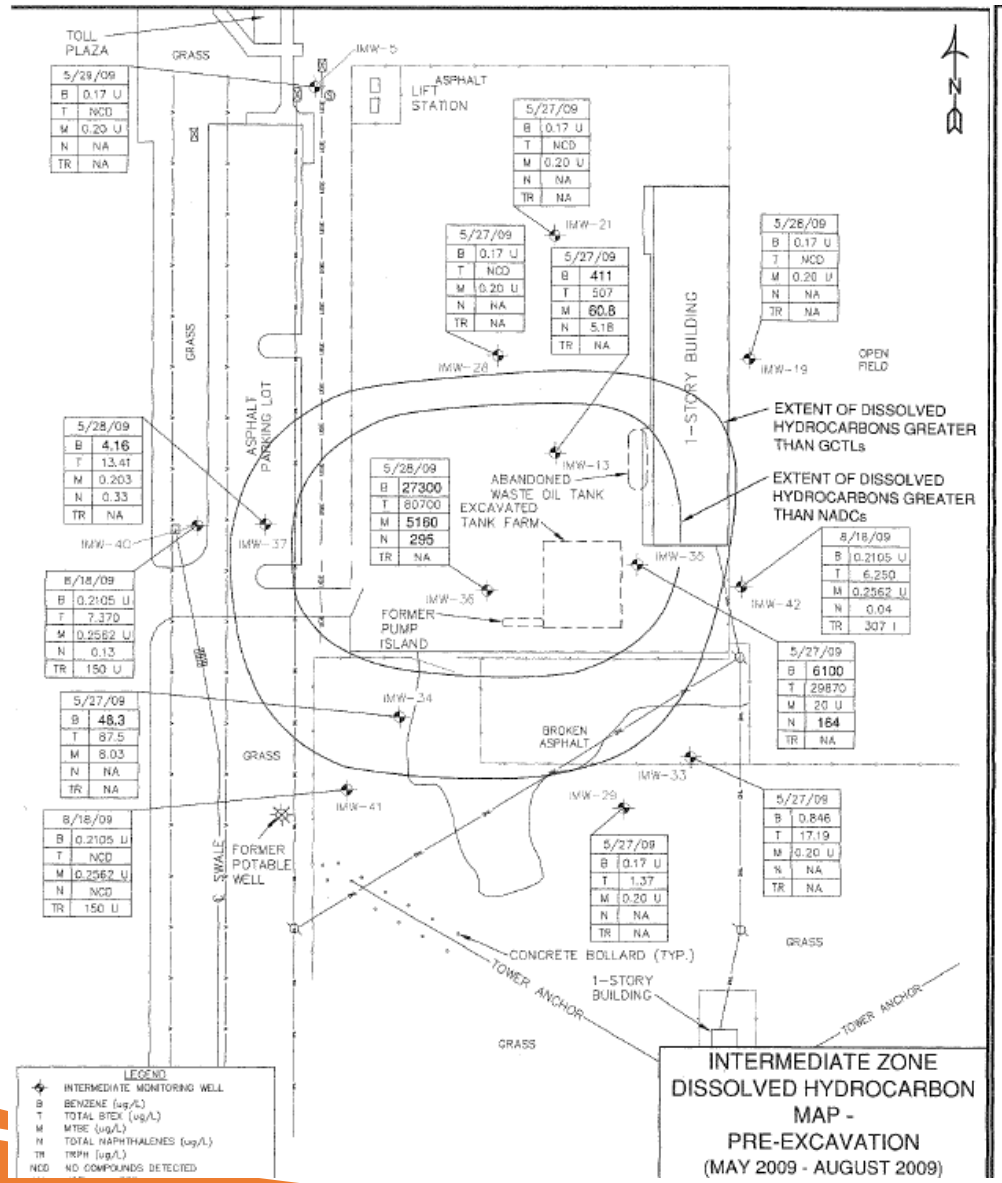
- SAR Approved in 2010
- Source Removal conducted in 2010
- Approx. 8,000 tons impacted soil removed
- RAP Approved for AS/SVE in 2011



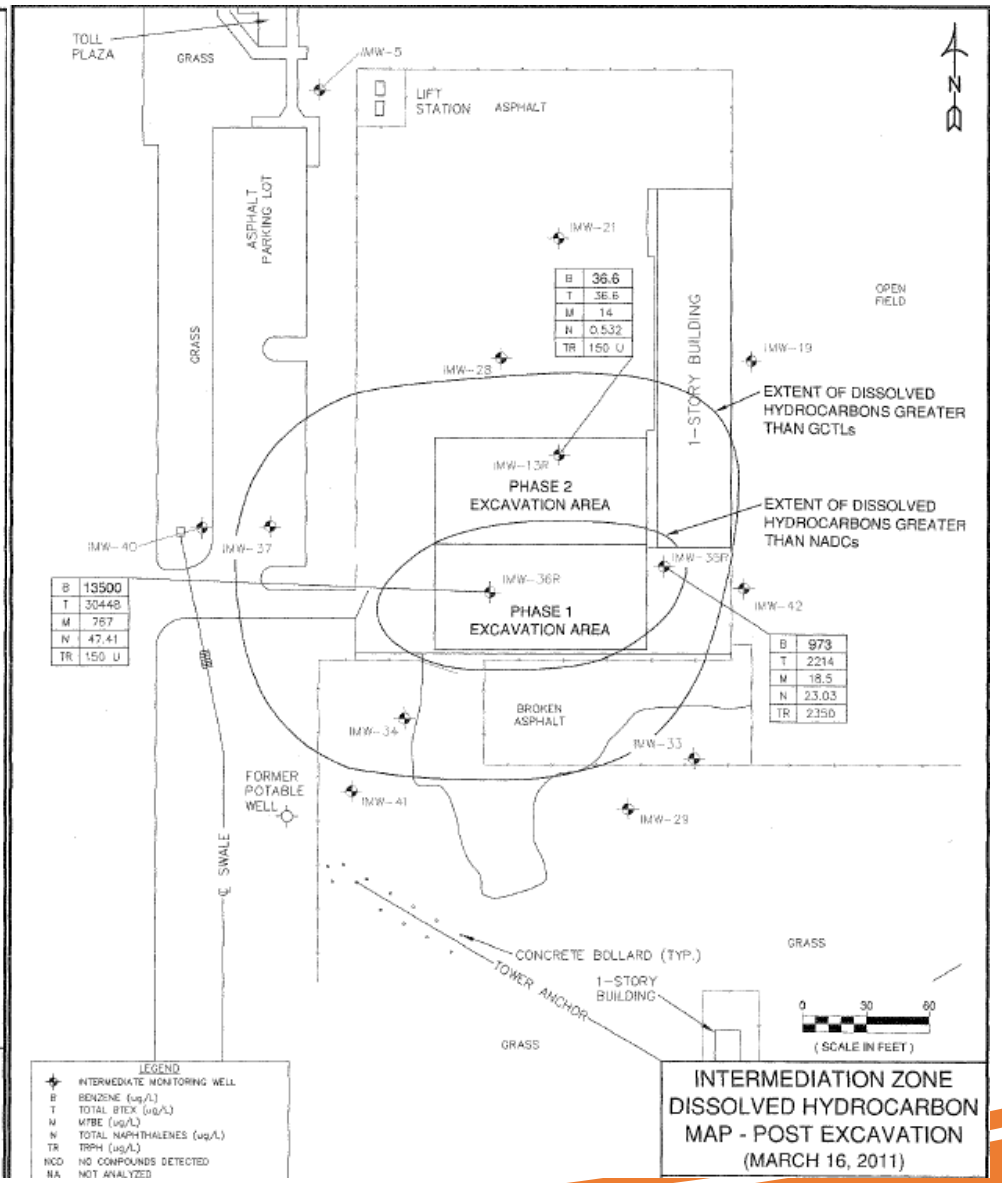
SHALLOW ZONE DISSOLVED HYDROCARBON MAP - PRE-EXCAVATION
(MAY 2009 - AUGUST 2009)



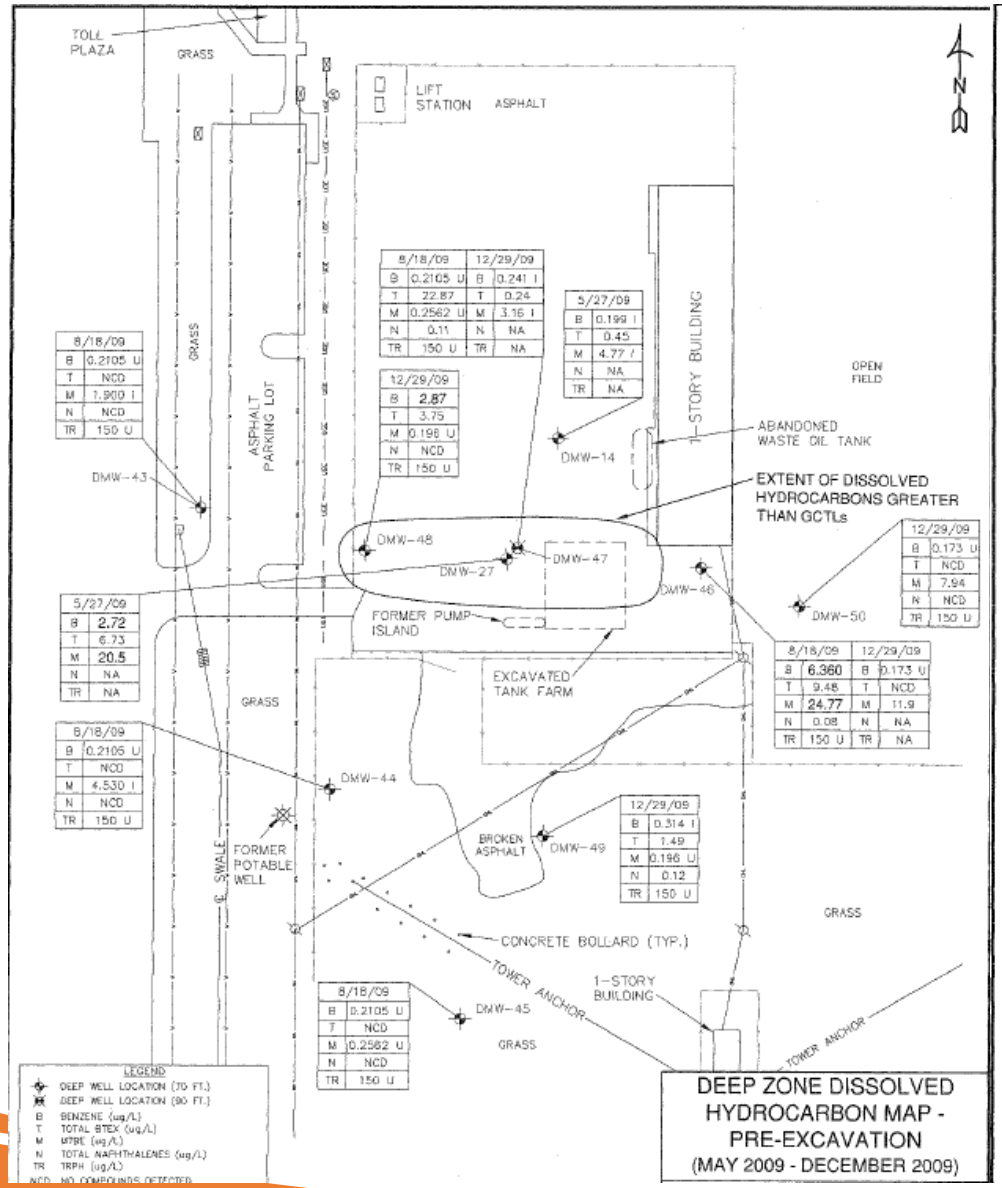
SHALLOW ZONE DISSOLVED HYDROCARBON MAP - POST EXCAVATION
(MARCH 16, 2011)

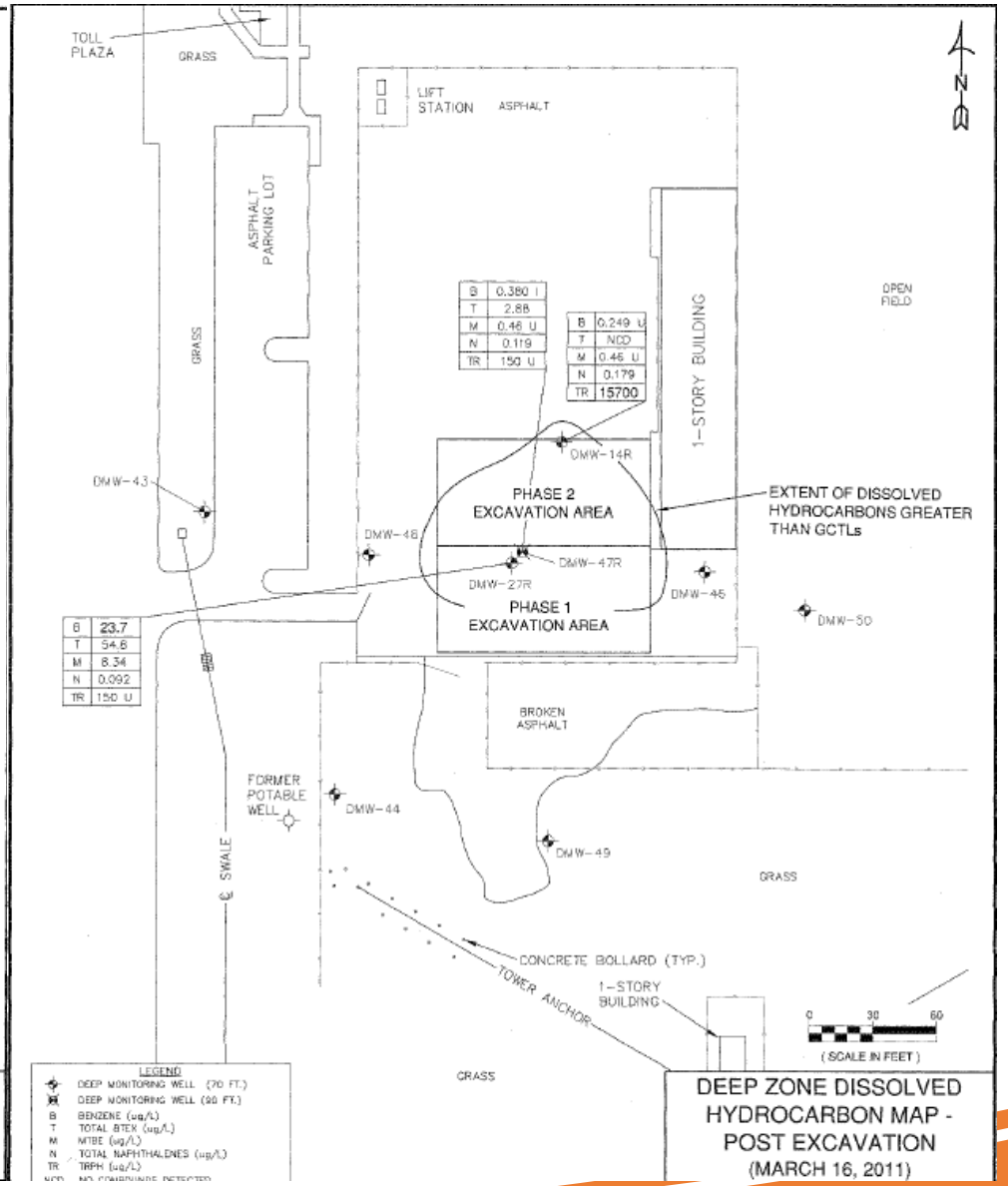


INTERMEDIATE ZONE DISSOLVED HYDROCARBON MAP - PRE-EXCAVATION (MAY 2009 - AUGUST 2009)



INTERMEDIATION ZONE DISSOLVED HYDROCARBON MAP - POST EXCAVATION (MARCH 16, 2011)


TOLL PLAZA
GRASS
LIFT STATION
ASPHALT
ASPHALT PARKING LOT
1-STORY BUILDING
OPEN FIELD
ABANDONED WASTE OIL TANK
EXTENT OF DISSOLVED HYDROCARBONS GREATER THAN GCTLs
FORMER PUMP ISLAND
EXCAVATED TANK FARM
FORMER POTABLE WELL
BROKEN ASPHALT
CONCRETE BOLLARD (TYP.)
TOWER ANCHOR
1-STORY BUILDING
TOWER ANCHOR
DMW-43
DMW-48
DMW-27
DMW-47
DMW-46
DMW-14
DMW-50
DMW-44
DMW-49
DMW-45
8/18/09
B 0.2105 U
T NCD
M 1.900 I
N NCD
TR 150 U
8/18/09 12/29/09
B 0.2105 U B 0.241 I
T 22.87 T 0.24
M 0.2562 U M 3.16 I
N 0.11 N NA
TR 150 U TR NA
5/27/09
B 0.199 I
T 0.45
M 4.77 /
N NA
TR NA
12/29/09
B 2.87
T 3.75
M 0.196 U
N NCD
TR 150 U
5/27/09
B 2.72
T 6.73
M 20.5
N NA
TR NA
8/18/09 12/29/09
B 6.360 B 0.173 U
T 9.48 T NCD
M 24.77 M 11.9
N 0.08 N NA
TR 150 U TR NA
12/29/09
B 0.173 U
T NCD
M 7.94
N NCD
TR 150 U
8/18/09
B 0.2105 U
T NCD
M 4.530 I
N NCD
TR 150 U
12/29/09
B 0.314 I
T 1.49
M 0.196 U
N 0.12
TR 150 U
8/18/09
B 0.2105 U
T NCD
M 0.2562 U
N NCD
TR 150 U
LEGEND
DEEP WELL LOCATION (70 FT.)
DEEP WELL LOCATION (90 FT.)
B BENZENE (ug/L)
T TOTAL BTEX (ug/L)
M MTBE (ug/L)
N TOTAL NAPHTHALENES (ug/L)
TR TRPH (ug/L)
NCD NO COMPOUNDS DETECTED
DEEP ZONE DISSOLVED HYDROCARBON MAP - PRE-EXCAVATION
(MAY 2009 - DECEMBER 2009)

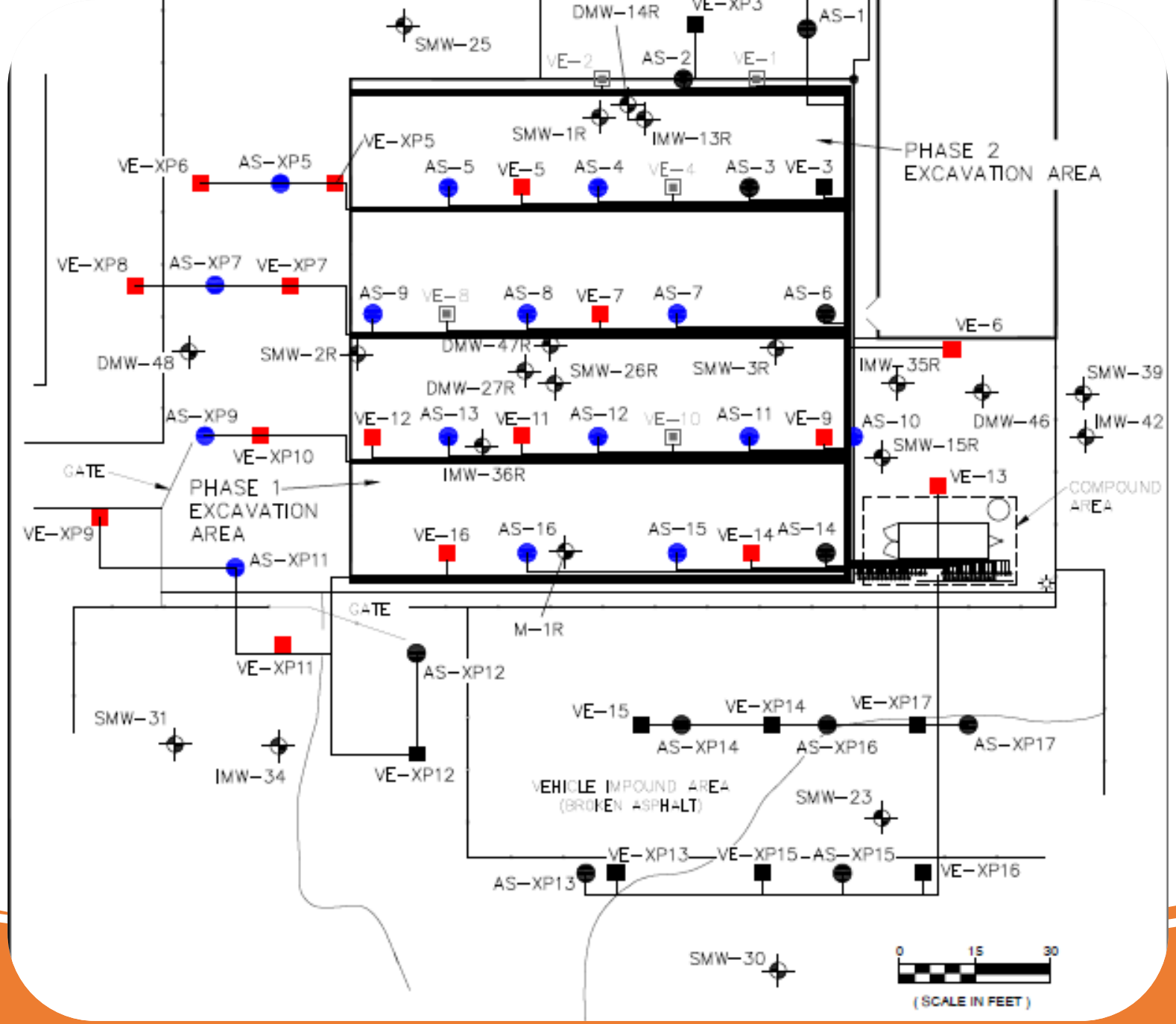

TOLL PLAZA
GRASS
LIFT STATION
ASPHALT
ASPHALT PARKING LOT
1-STORY BUILDING
OPEN FIELD
PHASE 2 EXCAVATION AREA
PHASE 1 EXCAVATION AREA
EXTENT OF DISSOLVED HYDROCARBONS GREATER THAN GCTLs
BROKEN ASPHALT
FORMER POTABLE WELL
CONCRETE BOLLARD (TYP.)
TOWER ANCHOR
1-STORY BUILDING
DMW-43
DMW-48
DMW-27R
DMW-47R
DMW-14R
DMW-46
DMW-45
DMW-50
DMW-44
DMW-49
B 0.380 I
T 2.88
M 0.46 U
N 0.119
TR 150 U
B 0.249 U
T NCD
M 0.46 U
N 0.179
TR 15700
B 23.7
T 54.6
M 8.34
N 0.092
TR 150 U
0 30 60
(SCALE IN FEET)
LEGEND
DEEP MONITORING WELL (70 FT.)
DEEP MONITORING WELL (90 FT.)
B BENZENE (ug/L)
T TOTAL BTEX (ug/L)
M MTBE (ug/L)
N TOTAL NAPHTHALENES (ug/L)
TR TRPH (ug/L)
DEEP ZONE DISSOLVED HYDROCARBON MAP - POST EXCAVATION
(MARCH 16, 2011)

Brief O&M Summary

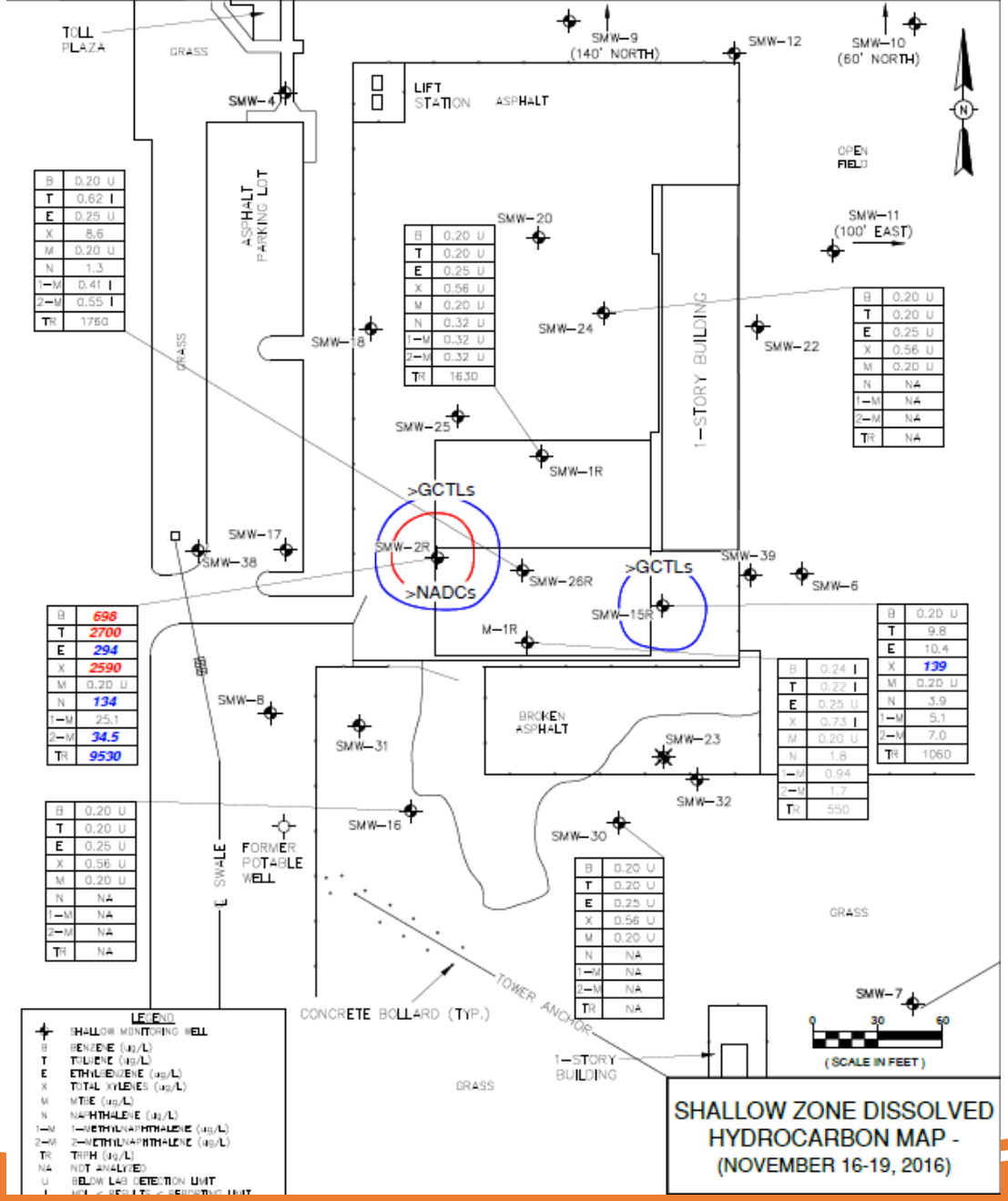
- AS/SVE system operational since 2012
- Most of the dissolved GW contamination has been reduced to the shallow zone of the surficial aquifer
- Remediation system effective in reducing COCs to localized zones

SVE Wells

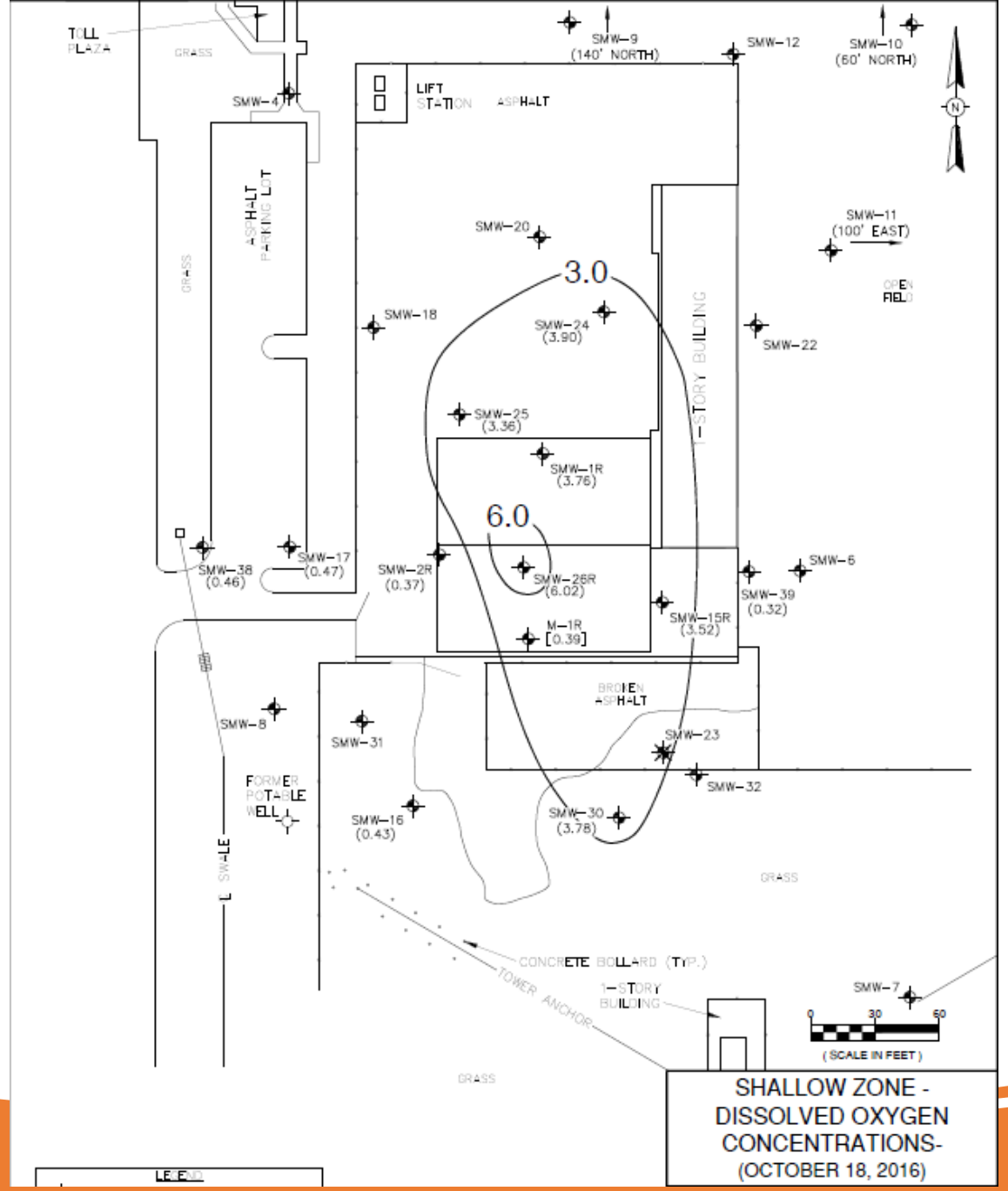
AS Wells



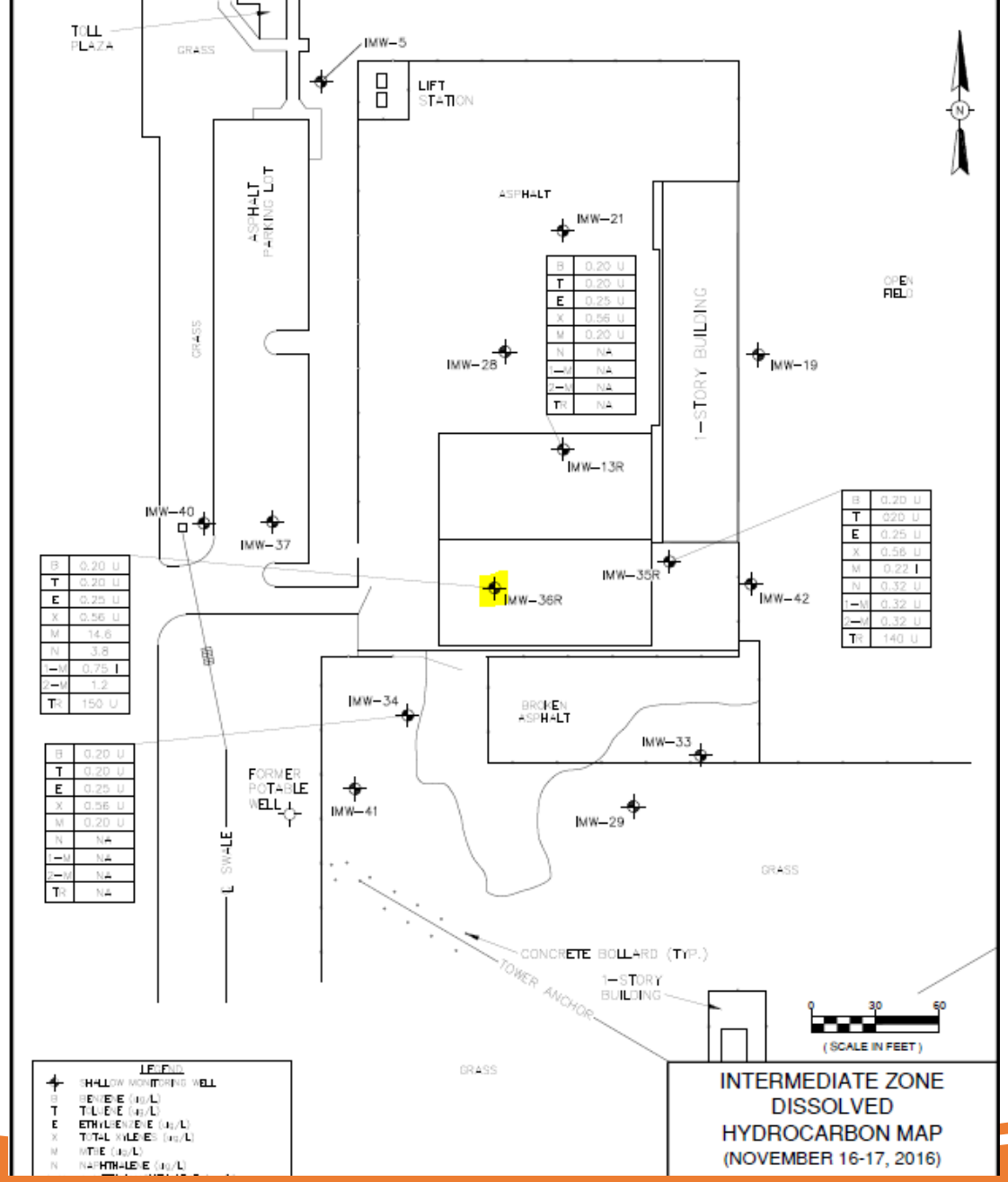
- When the site was received, COCs were limited to two MWs in the Shallow zone (SMW-2R & SMW-15R).
- The intermediate and deeper zones of the surficial aquifer appeared to have been remediated



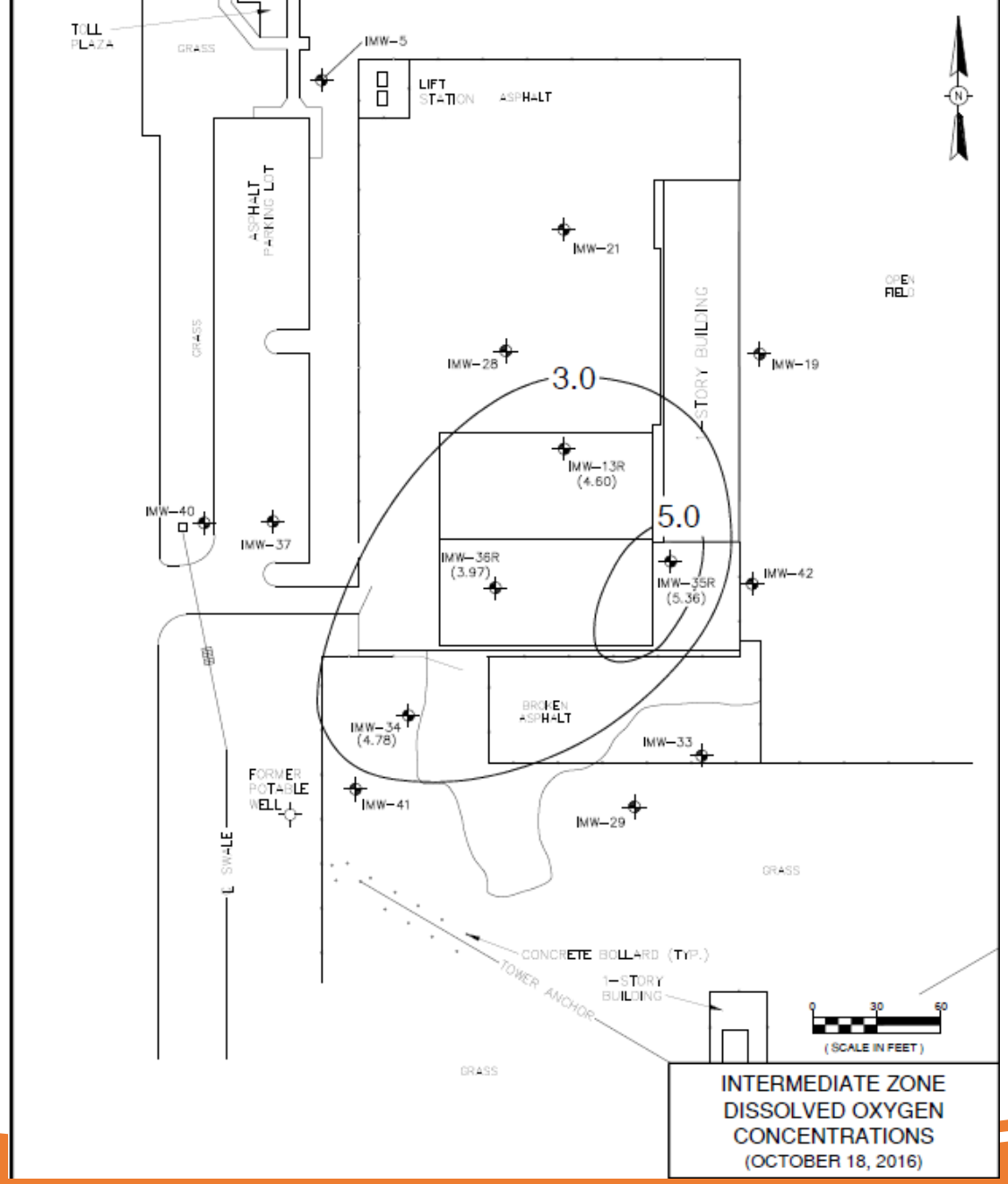
- DO concentrations were measured at 0.37 mg/L for SMW-2R and 3.52 mg/L for SMW-15R.
- Time to evaluate the treatment well array to see if influence can be reached for SMW-2R.



- Intermediate zone appears to have been remediated
- IMW-36R has been highlighted.



- Figure depicting the dissolved oxygen concentrations for the intermediate zone.



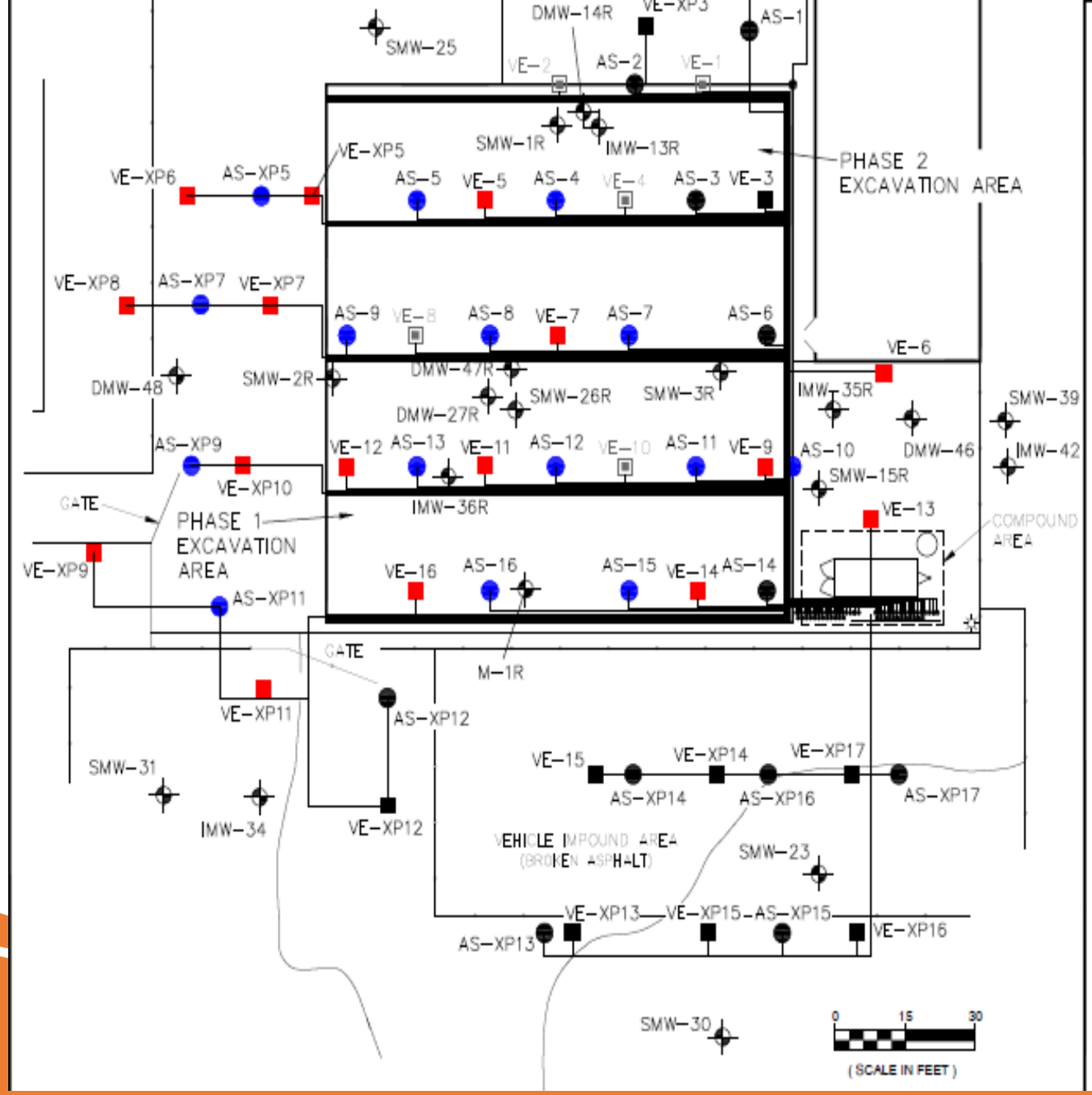
SMW-2	6-16 / 7-17	10/29/1987	NM	48000	72000	4800	28000	152800	--	0.0023	6				--
		2/23/1988	NM	--	--	--	--	--	--	--	50 U				
		5/31/2005	10.35	13400 D	18900 D	1160 D	13360	46820	41.6	0.063	11	395 D	85.9 D	190 D	19,900 D
		4/10/2007	13.32	7634	8380	457	13958	30429	30.67	--	--	292	125	333	--
		5/27/2009	11.05	13700	22000	301	24900	60901	9.8 U	--	--	135	43.8	73.1	--
SMW-2R		3/16/2011	13.41	35900 D	62300 D	3350 D	10000 D	111550	4.6 U	--	--	107 D	15.1 D	28.3 D	51,100 D
	Baseline	6/13/2012	NM	1.3 ft of free product											
		11/7/2012	11.25	29000	53800	3580	17600	103980	210 U	--	--	509	101	224	37,300
		2/11/2013	13.22	15400	41900	4590	25700	87590	110 U	--	--	338	54.8	96.5	34,800
		5/6/2013	12.97	6150	21400	3080	22500	53130	53 U	--	--	1260	154	440	19,900
		8/19/2013	12.30	1610	4910	569	5700	12789	11 U	--	--	225	88.7	127	16,200
		2/6/2014	14.88	968	7050	852	6560	15430	0.20 U	--	--	155	47.9	57.4	12,100
		5/7/2014	13.83	379	4660	548	4420	10007	0.20 U	--	--	101	27.8	46.2	10,900
		8/14/2014	12.02	389	3910	524	3780	8603	10 U	--	--	107	20.5	15.2	10,200
		11/20/2014	13.21	666	4170	390	3600	8826	10 U	--	--	127	32.2	48.7	10,200
		2/17/2015	11.13	109	909	146	1340	2504	3.0 U	--	--	38.7	10.4	16.1	6,480
B= Base Line			NADC	100	400	300	200	NA	200	2	150	140	280	280	50,000
K= Key Well			GCTL'S	1**	40**	30**	20**	NA	20	0.02**	15**	14	28	28	5,000

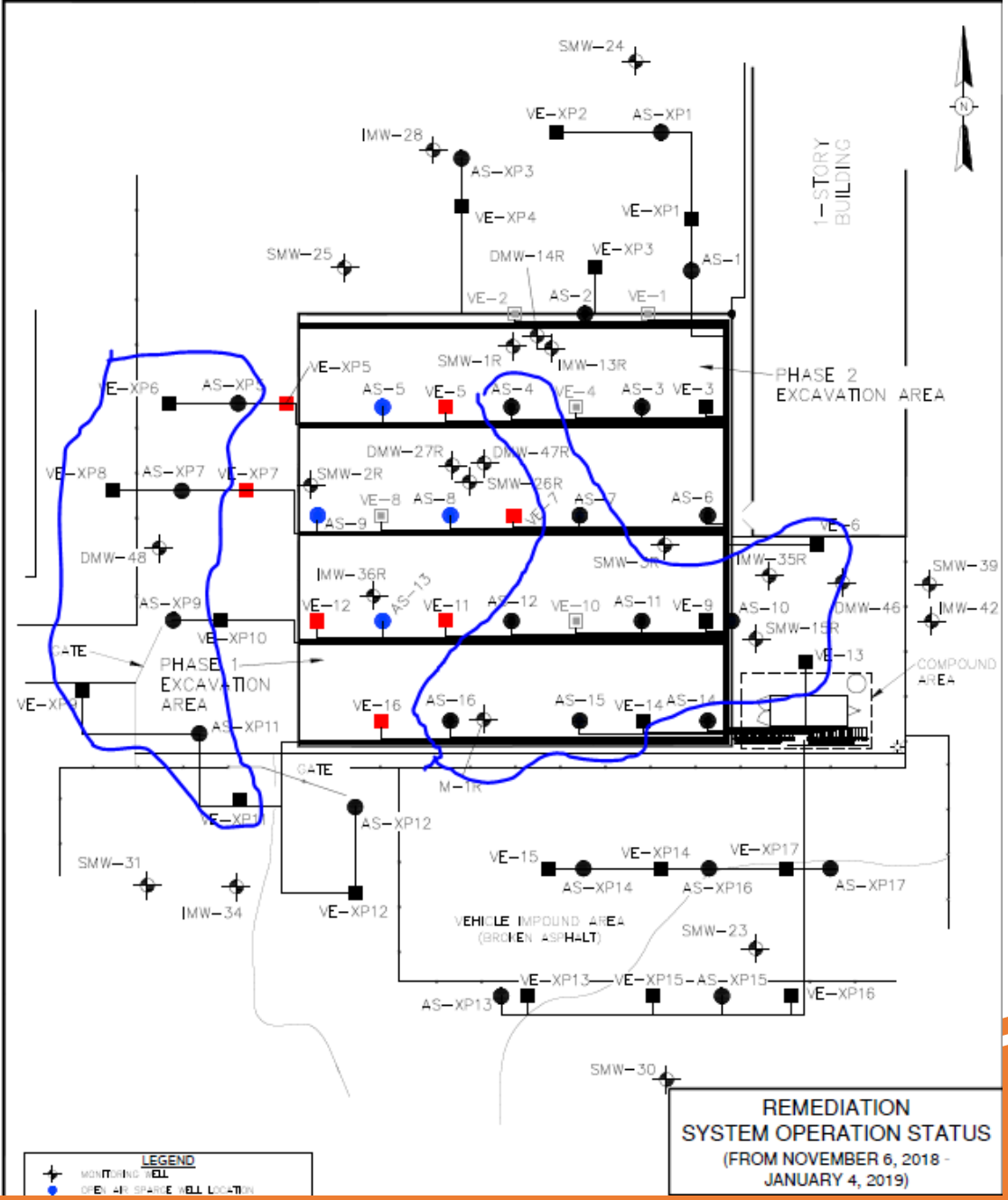
Location	Screen Int.	Date	DTW	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Total VOA	MTBE	EDB	Total Lead	Naptha-lene	Methyl nap. 1	Methyl nap. 2	TRPH
SMW-2R		5/18/2015	14.63	123	533	64.8	531	1251.8	3.0 U	--	--	5.6	0.98	0.99	3,590
Cont.		8/19/2015	10.55	41.8	341	28.7	410	821.5	1.5 U	--	--	11.4	2.6	3.5	4,840
		11/23/2015	10.95	169	854	127	1070	2220	1.5 U	--	--	53.9	10.9	17.0	6,590
		2/18/2016	10.85	53.8	241	45.4	513	853.2	0.50 U	--	--	19	3.5	4.8	2,600
		5/24/2016	13.06	83.9	339	27.4	434	884.3	0.20 U	--	--	3.4	1.3 U	1.3 U	5,400
		8/26/2016	14.23	31.9	74.9	12.4	130	249.2	0.20 U	--	--	8.6	2.5	2.1	3,390
		11/17/2016	12.41	698	2700	294	2590	6282	0.20 U	--	--	134	21.5	34.5	9,530

IMW-36	31-36 / 35-40	5/12/2006	11.14	5670	2170	533	2394	10767	1030	0.089	--	54.8	9.80	22.5	2,702
		4/10/2007	13.26	15530	11150	1294	8163	36137	1408	--	--	87.1	23.2	47.4	--
		5/28/2009	12.60	27300	33800	3300	16300	80700	5160	--	--	214	28.3 I	52.2	--
IMW-36R		3/16/2011	13.74	13500 D	10800 D	948 D	5200 D	30448	767 D	--	--	33.1 D	5.29	9.02	150 U
	Baseline	6/13/2012	15.82	5900	5000	658	3530	15088	78.7 I	--	--	51.8	9.8	16.3	6,090
		11/7/2012	11.55	5420	2260	725	3910	12315	62.3 I	--	--	79	10.6	18	5,580
		2/11/2013	13.58	95.1	21.2	4.5	19.1	139.9	86.3	--	--	0.67 I	0.38 U	0.38 U	769
		5/6/2013	12.86	18.4	1.2	1.1	2.1 I	22.8	25.8	--	--	0.43 I	0.39 U	0.39 U	140 U
		8/19/2013	12.65	12.3	0.51 I	0.55 I	0.95 I	14.31	18.5	--	--	0.76 I	0.38 U	0.38 U	140 U
		2/6/2014	15.10	4.3	0.20 U	0.38 I	0.66 U	4.68	32.9	--	--	0.38 U	0.38 U	0.38 U	140 U
		5/7/2014	13.81	4.8	0.20 U	0.28 U	0.66 U	4.8	28.3	--	--	0.38 U	0.38 U	0.38 U	140 U
		8/14/2014	12.31	3.5	0.20 U	0.28 U	0.66 U	3.5	10.2	--	--	0.32 U	0.32 U	0.32 U	140 U
		11/20/2014	13.49	1.0	0.20 U	0.28 U	0.66 U	1.0	18.9	--	--	0.32 U	0.32 U	0.32 U	140 U
		2/17/2015	11.33	2.4	0.40 U	0.20 U	0.51 U	2.4	26.7	--	--	0.33 U	0.33 U	0.33 U	140 U
		5/18/2015	19.24	0.58 I	0.40 U	0.20 U	0.51 U	0.58 I	23.7	--	--	1.3	0.31 U	0.31 U	140 U
		8/19/2015	10.41	0.20 U	0.40 U	0.20 U	0.51 U	NCD	2.1	--	--	0.32 U	0.32 U	0.32 U	140 U
		11/24/2015	11.31	0.20 U	0.40 U	0.20 U	0.51 U	NCD	44.5	--	--	0.54 I	0.32 U	0.32 U	140 U
		2/18/2016	10.91	2.3	0.20 U	0.25 U	0.56 U	2.3	34.4	--	--	0.38 I	0.32 U	0.32 U	140 U
B= Base Line			NADC	100	400	300	200	NA	200	2	150	140	280	280	50,000
K= Key Well			GCTL'S	1**	40**	30**	20**	NA	20	0.02**	15**	14	28	28	5,000
Location	Screen Int.	Date	DTW	Benzene	Toluene	Ethyl Benzene	Total Xylenes	Total VOA	MTBE	EDB	Total Lead	Naptha-lene	Methyl nap, 1	Methyl nap, 2	TRPH
IMW-36R Cont.		5/24/2016	13.16	0.52 I	0.20 U	0.25 U	0.56 U	0.52	31.3	--	--	0.42 I	0.32 U	0.32 U	140 U
		8/26/2016	14.41	0.51 I	0.20 U	0.25 U	0.56 U	0.51	43.4	--	--	0.32 U	0.32 U	0.32 U	140 U
		11/17/2016	12.79	0.20 U	0.20 U	0.25 U	0.56 U	NCD	14.6	--	--	3.8	0.75 I	1.2	150 U

Adjusting treatment point operation

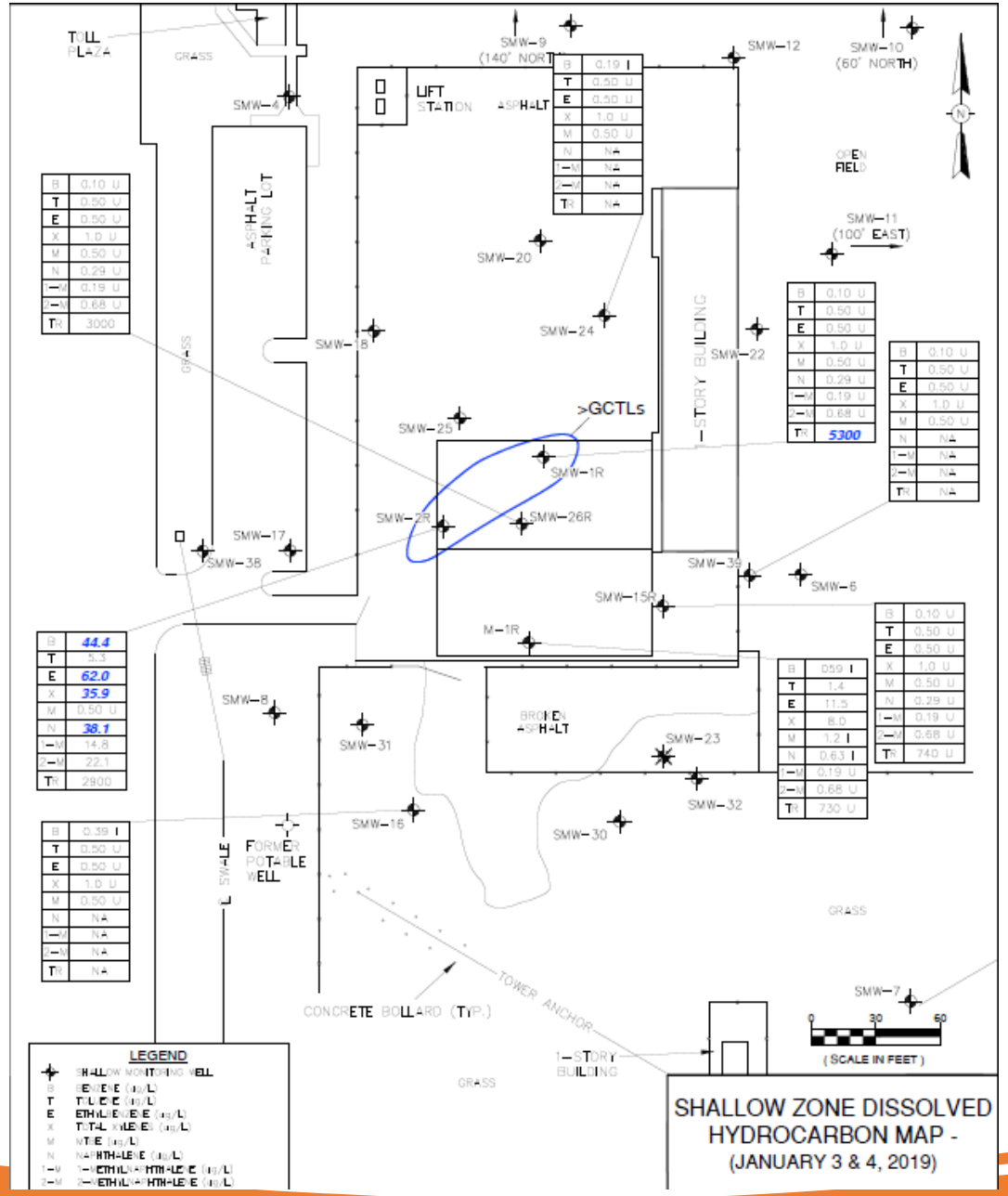
- The number of treatment points of the remediation system were reduced to target the area of residual contamination located at monitoring well SMW-2R



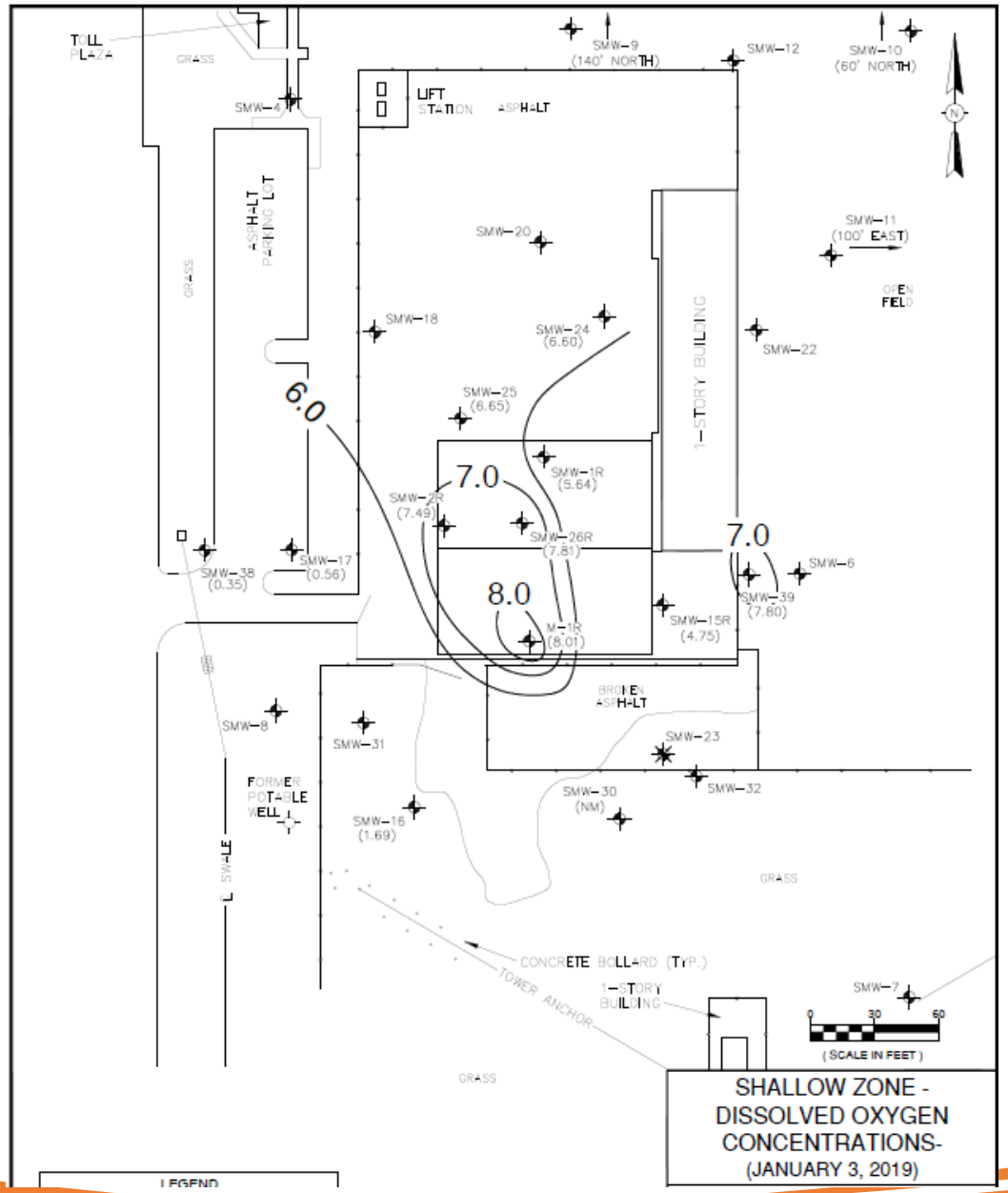


- Remedial System prior to optimization
- Remedial System after optimization

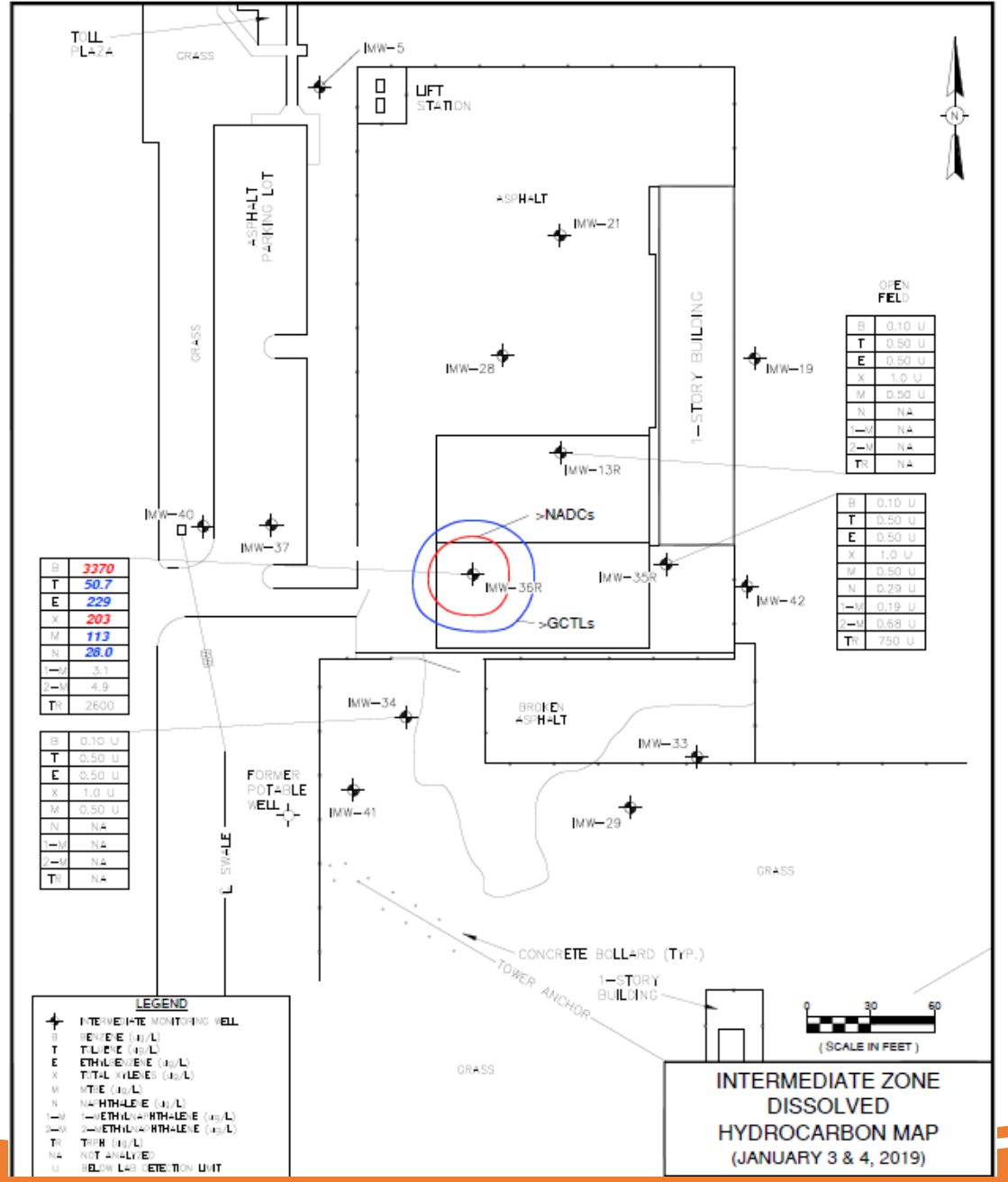
- The contaminant concentrations in the vicinity of monitoring well SMW-2R were reduced to below their respective NADCs



- DO concentrations have improved in the vicinity of monitoring well SMW-2R
- Figure illustrates DO conc. of 7.49 mg/L in SMW-2R

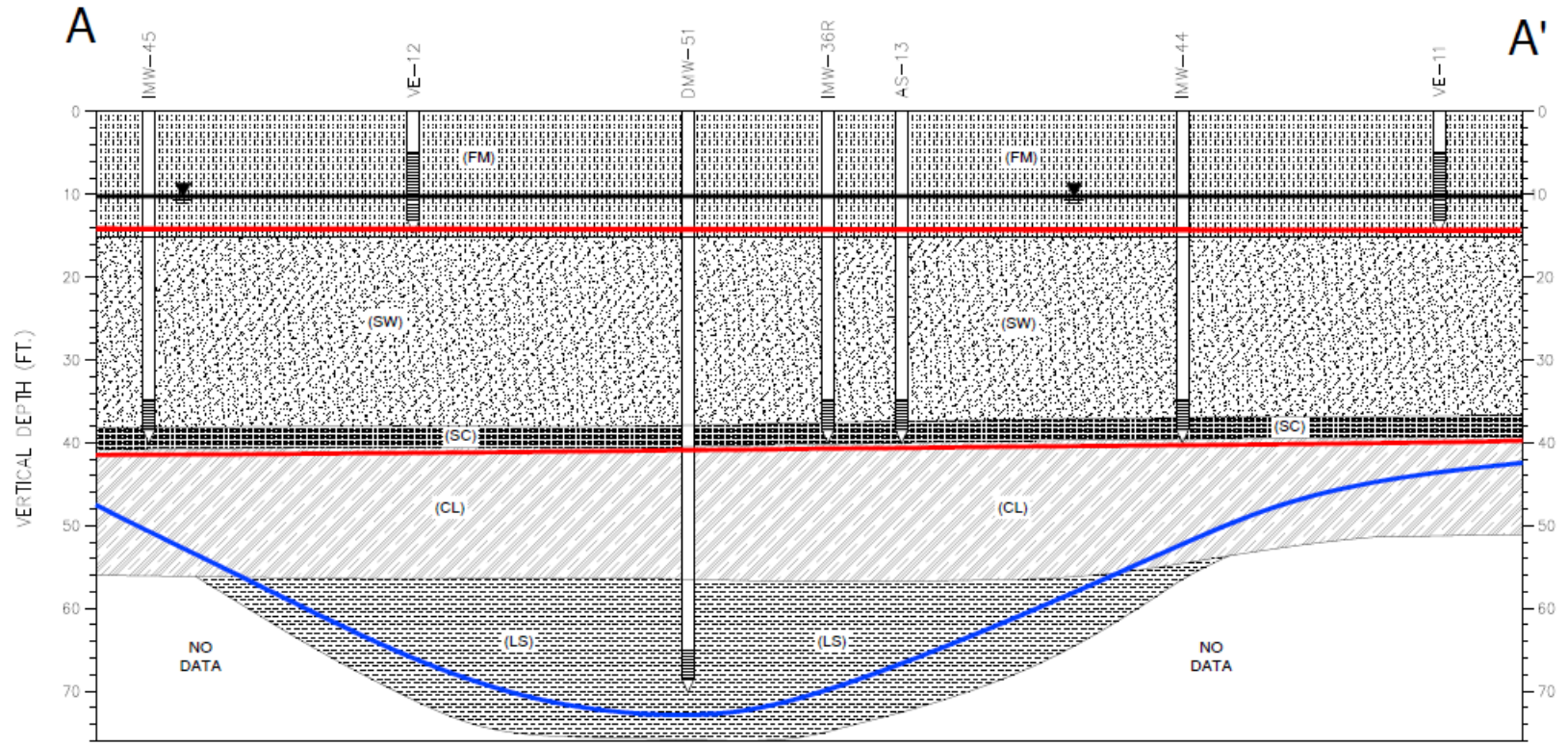


- Apparent rebounding occurred in intermediate monitoring well IMW-36R



Additional Assessment

- Rebounding in monitoring well IMW-36R
- Seven additional intermediate monitoring wells were installed to an approximate depth of 40 ft BLS
- One deep monitoring well installed to a depth of 70 ft BLS for vertical delineation
- The additional assessment gave a more accurate depiction of the current groundwater contamination due to the rebounding. Also provided the new target area to focus remedial efforts

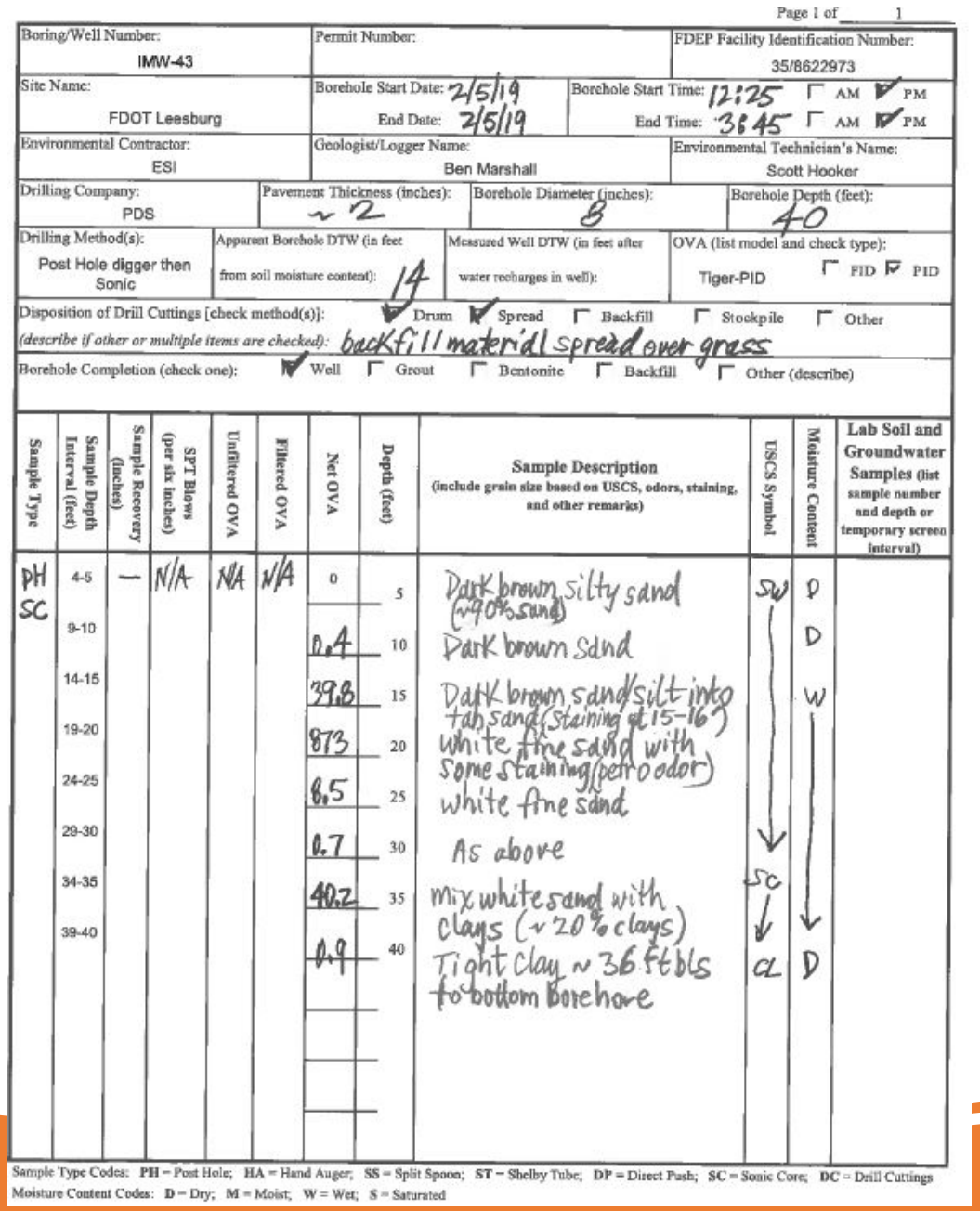


LEGEND

- FILL MATERIAL (DARK BROWN SANDY SILT) (FM)
- SANDS (OCCSIONALLY TRACE CLAY) (SW)
- SANDY CLAY (SC)
- CLAY (OCCASIONALLY ~10% SAND) (CL)
- LIMESTONE (LS)
- ESTIMATED EXTENT OF GCTL EXCEEDANCE
- ESTIMATED EXTENT OF NADC EXCEEDANCE

LITHOLOGIC CROSS SECTION A-A'

- IMW-43 boring log indicates OVA spile around 15-20’ bls and around 35 bls
- Clay found at 36’ bls to end of boring



Page 1 of 1

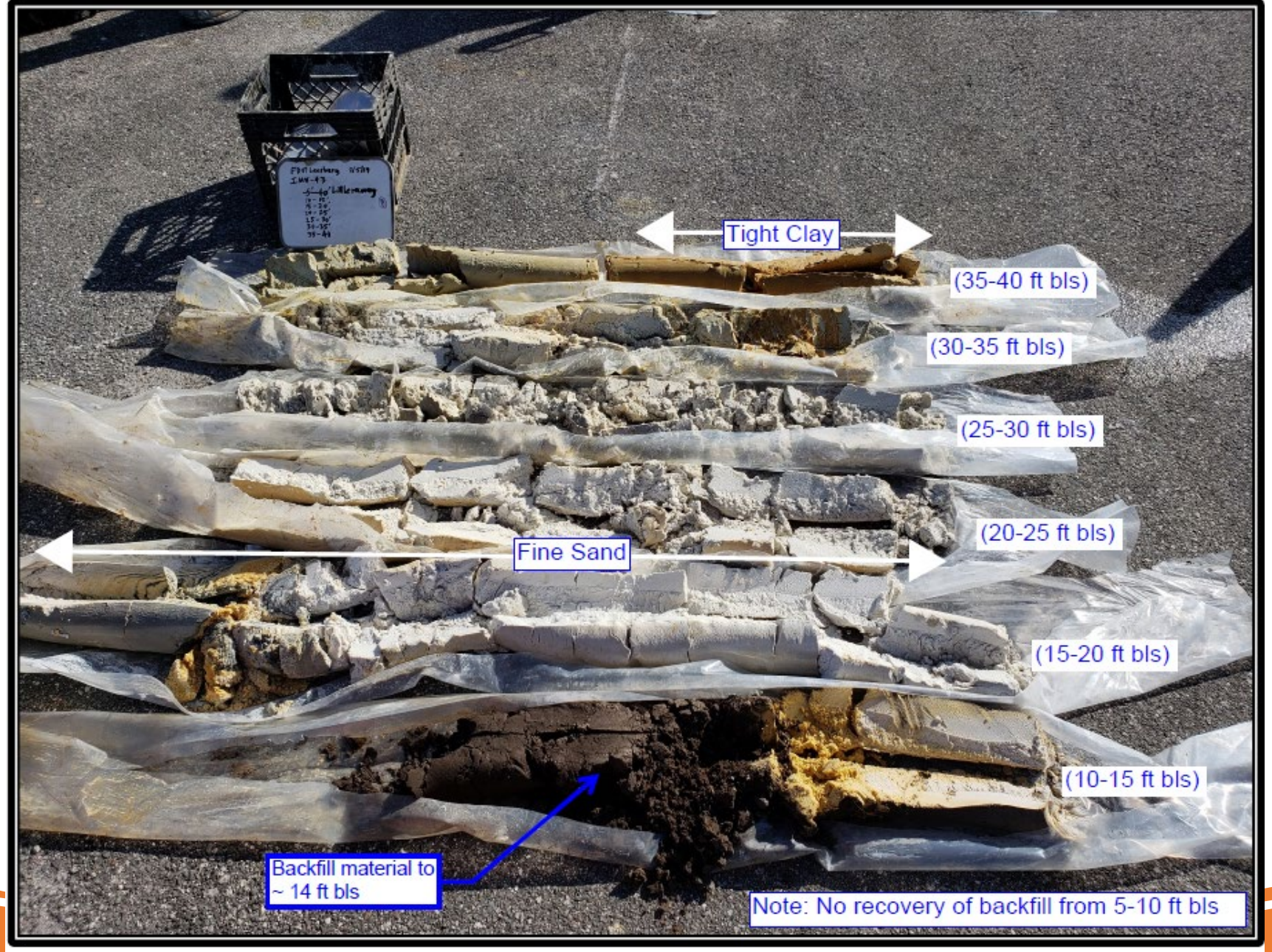
Boring/Well Number: IMW-43	Permit Number:	FDEP Facility Identification Number: 35/8622973
Site Name: FDOT Leesburg	Borehole Start Date: 2/5/19 End Date: 2/5/19	Borehole Start Time: 12:25 ☐ AM ☑ PM End Time: 3:45 ☐ AM ☑ PM
Environmental Contractor: ESI	Geologist/Logger Name: Ben Marshall	Environmental Technician's Name: Scott Hooker
Drilling Company: PDS	Pavement Thickness (inches): ~2	Borehole Diameter (inches): 8 / Borehole Depth (feet): 40
Drilling Method(s): Post Hole digger then Sonic	Apparent Borehole DTW (in feet from soil moisture content): 14 / Measured Well DTW (in feet after water recharges in well):	OVA (list model and check type): Tiger-PID ☐ FID ☑ PID

Disposition of Drill Cuttings [check method(s)]: ☑ Drum ☑ Spread ☐ Backfill ☐ Stockpile ☐ Other
(describe if other or multiple items are checked): backfill material spread over grass

Borehole Completion (check one): ☑ Well ☐ Grout ☐ Bentonite ☐ Backfill ☐ Other (describe)

Sample Type	Sample Depth Interval (feet)	Sample Recovery (inches)	SPT Blows (per six inches)	Unfiltered OVA	Filtered OVA	Net OVA	Depth (feet)	Sample Description (include grain size based on USCS, odors, staining, and other remarks)	USCS Symbol	Moisture Content	Lab Soil and Groundwater Samples (list sample number and depth or temporary screen interval)
PH SC	4-5	—	N/A	N/A	N/A	0	5	Dark brown silty sand (~90% sand)	SW	D	
	9-10					0.4	10	Dark brown sand		D	
	14-15					39.8	15	Dark brown sand/silt into tan sand (staining at 15-16')		W	
	19-20					873	20	white fine sand with some staining (petro odor)			
	24-25					8.5	25	white fine sand			
	29-30					0.7	30	As above			
	34-35					40.2	35	mix white sand with clays (~20% clays)	SC		
	39-40					0.9	40	Tight Clay ~36 ft bls to bottom Borehole	CL	D	

Sample Type Codes: PH = Post Hole; HA = Hand Auger; SS = Split Spoon; ST = Shelby Tube; DP = Direct Push; SC = Sonic Core; DC = Drill Cuttings
Moisture Content Codes: D = Dry; M = Moist; W = Wet; S = Saturated



IMW-43 Soil Cores (taken 2/5/19)

IMW-43 Soil Staining at 15-16 ft bls (taken 2/5/19)

Boring/Well Number:	Permit Number:	FDEP Facility Identification Number:
DMW-51		35/8622973

Facility Name:	Borehole Start Date: 2/4/19	Borehole Start Time: 1000 ☐ AM ☐ PM
FDOT Leesburg	End Date: 2/4/19	End Time: 1510 ☐ AM ☐ PM

Environmental Contractor:	Geologist's Name:	Environmental Technician's Name:
Earth Systems	Brian Dinning	Scott Hooker

Drilling Company:	Pavement Thickness (inches):	Borehole Diameter (inches):	Borehole Depth (feet):
Preferred Drilling	+2	8	70

Drilling Method(s):	Apparent Borehole DTW (in feet from soil moisture content):	Measured Well DTW (in feet after water recharges in well):	OVA (list model and check type):
PH/SC	15		Tiger PID ☑ PID

Disposition of Drill Cuttings [check method(s)]: ☑ Drum ☑ Spread ☐ Backfill ☐ Stockpile ☐ Other

(describe if other or multiple items are checked): backfill spread over grass

Borehole Completion (check one): ☑ Well ☐ Grout ☐ Bentonite ☐ Backfill ☐ Other (describe)

Sample Type	Sample Depth Interval (feet)	Sample Recovery (inches)	SPT Blows (per six inches)	Unfiltered OVA	Filtered OVA	Net OVA	Depth (feet)	Sample Description (include grain size based on USCS, odors, staining, and other remarks)	USCS Symbol	Moisture Content	Lab Soil and Groundwater Samples (list sample number and depth or temporary screen interval)
PH	4-5	12	NA	NA	NA	ϕ	5	Dark brown fine sand	SW	D	
SC	9-10					ϕ	10	Dark brown medium-fine sand	SW	D	
	14-15					ϕ	15	Dark brown medium fine sand w/ trace fine gravel	SP	W	
	19-20					ϕ	20	White fine sand	SW	W	
	24-25					ϕ	25	White fine sand w/ trace clay	SC	W	
	29-30					21.2	30	As above	SC	W	
	34-35					66.2	35	Light gray medium fine sand w/ some clay, odor	SC	W	
	39-40					63.1	40	As above	SC	W	
	44-45					17.8	45	Orange + gray clay w/ some fine sand	CL	W	
	49-50					93.8	50	As above	CL	W	
	54-55					27.3	55	Orange clay w/ some fine sand + trace limestone	CL	W	
	59-60					1.1	60	Limestone			

Sample Type Codes: PH = Post Hole; HA = Hand Auger; SS = Split Spoon; ST = Shelby Tube; DP = Direct Push; SC = Sonic Core; DC = Drill Cuttings
Moisture Content Codes: D = Dry; M = Moist; W = Wet; S = Saturated

Boring/Well Number:	FDEP Facility Identification Number:	Site Name:	Borehole Start Date:
DMW-51	35/8622973	FDOT Leesburg	End Date:

Sample Type	Sample Depth Interval (feet)	Sample Recovery (inches)	SPT Blows (per six inches)	Unfiltered OVA	Filtered OVA	Net OVA	Depth (feet)	Sample Description (include grain size based on USCS, odors, staining, and other remarks)	USCS Symbol	Moisture Content	Lab Soil and Groundwater Samples (list sample number and depth or temporary screen interval)
SC	64-65					ϕ	65	Limestone		W	
	69-70					ϕ	70	Limestone		W	

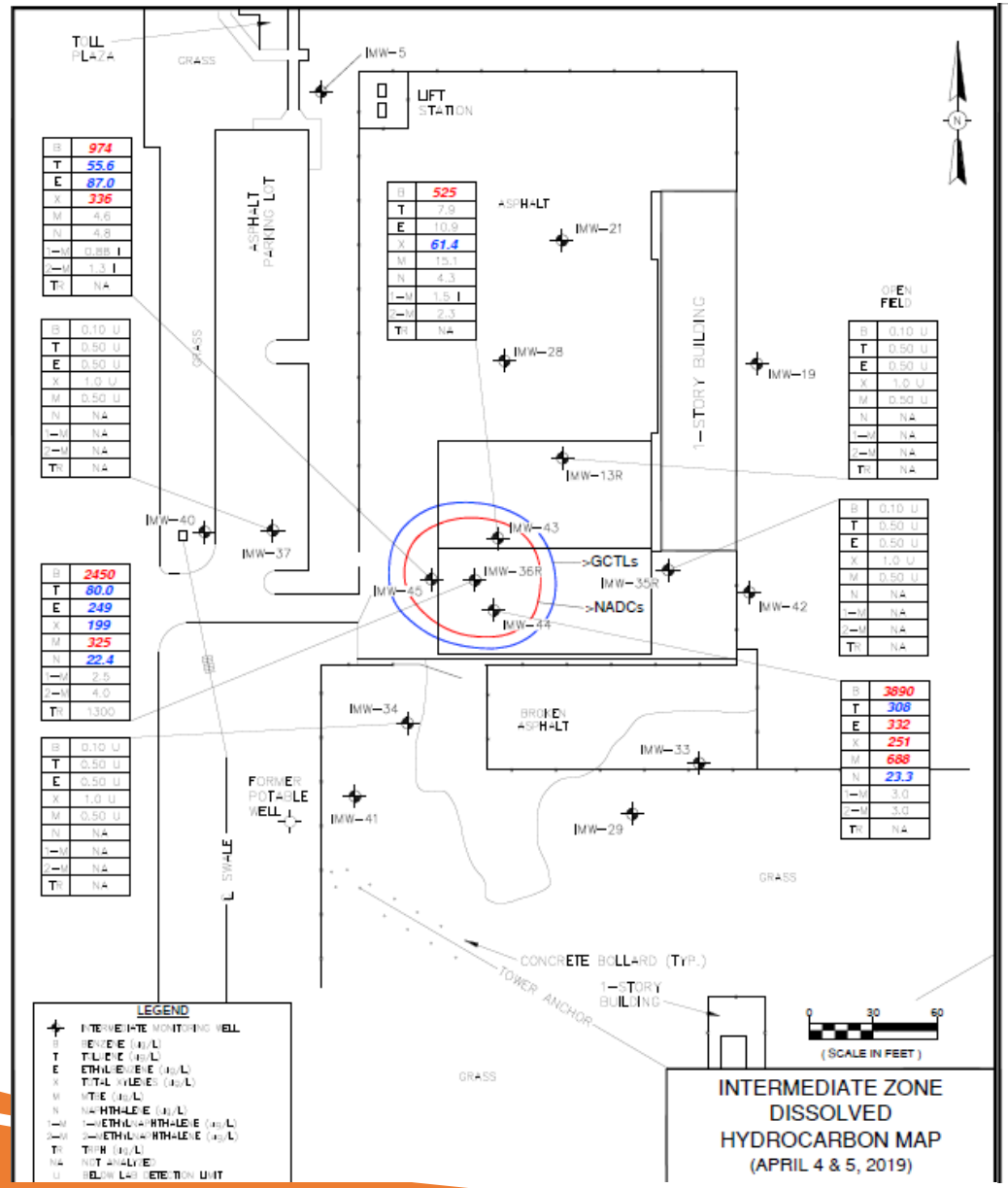
Sample Type Codes: PH = Post Hole; HA = Hand Auger; SS = Split Spoon; ST = Shelby Tube; DP = Direct Push; SC = Sonic Core; DC = Drill Cuttings
Moisture Content Codes: D = Dry; M = Moist; W = Wet; S = Saturated

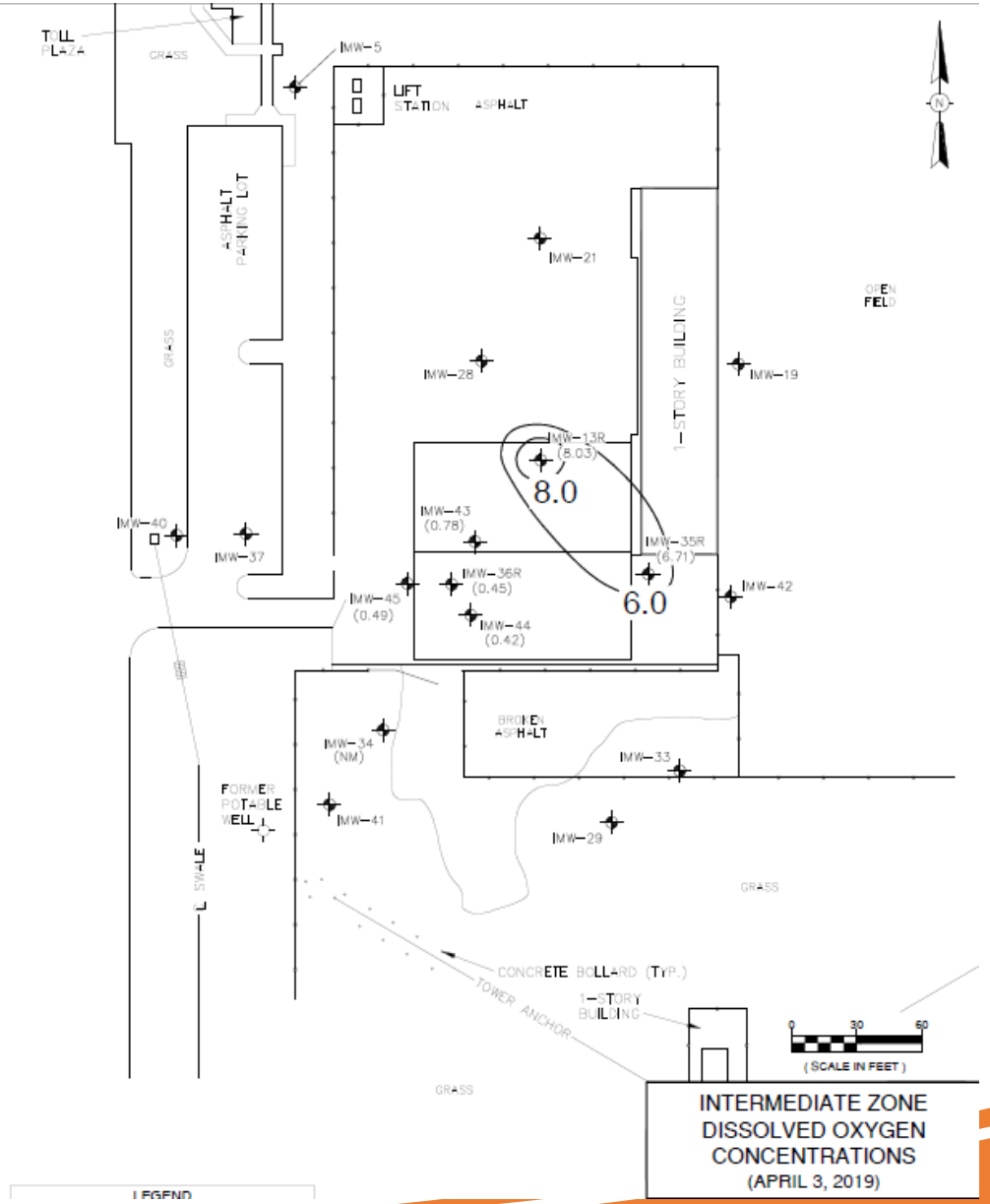
DMW-51 (55-60 ft bls)

DMW-51 (60-65 ft bls)

DMW-51 (65-70 ft bls)

DMW-51 Soil Cores (taken 2/4/19)





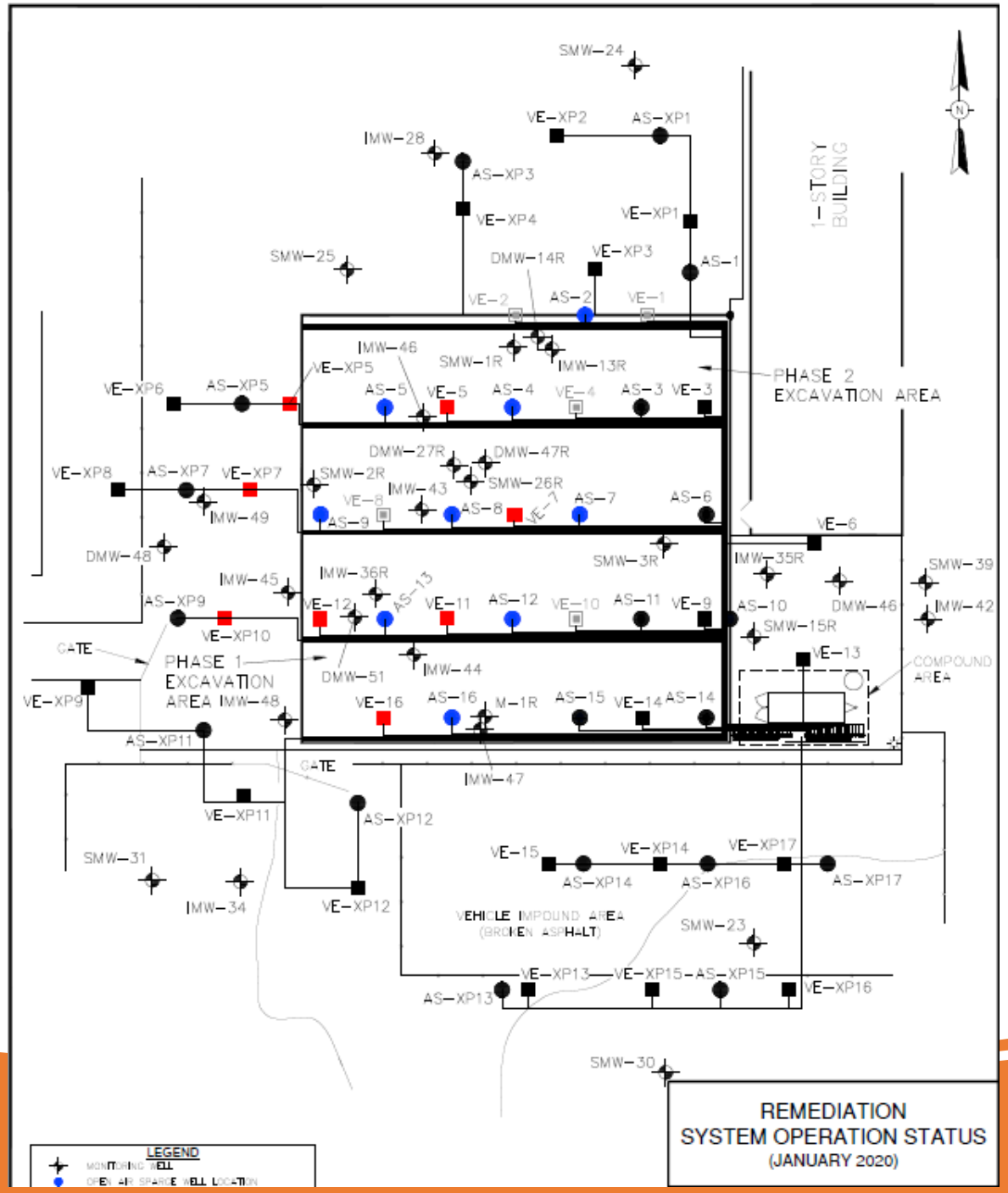
GW NADC plume defined in the intermediate zone

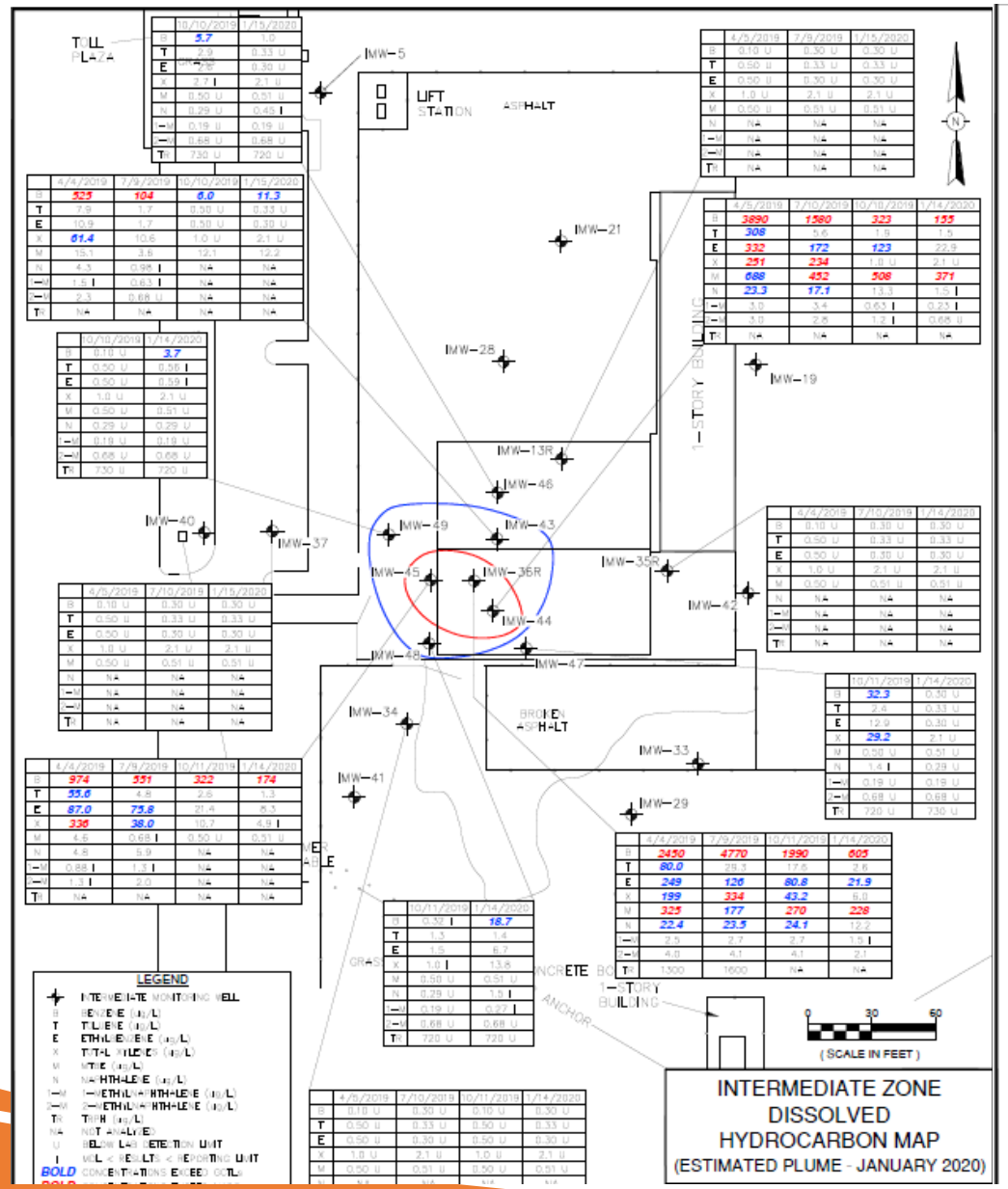
DO influence less than 1 mg/L in target area

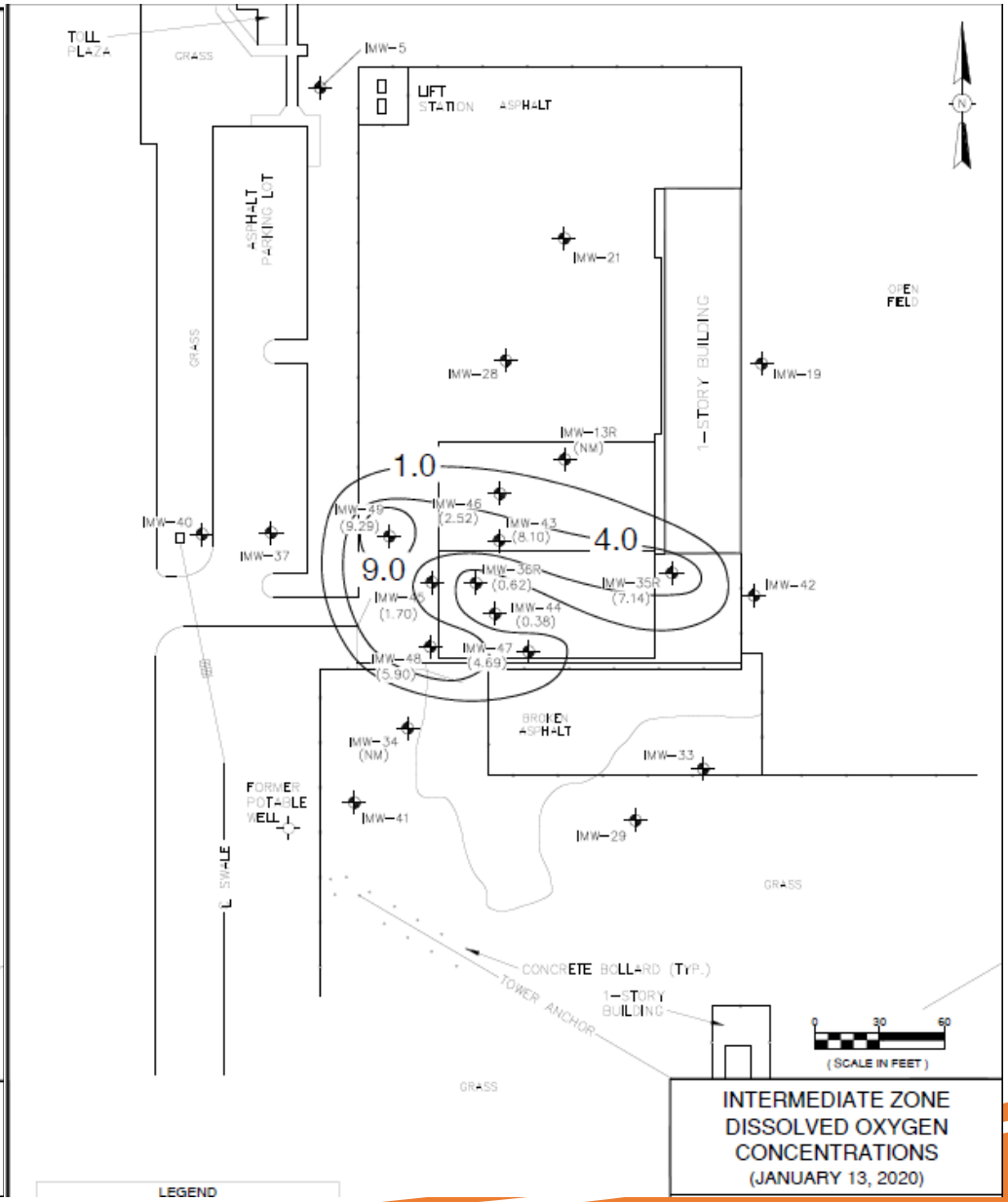
RA System Adjustments

- Additional monitoring points have been included in the AS/SVE well array to further remediate the contamination discovered in the intermediate zone of the surficial aquifer
- A RAP Mod Scope of Work was generated for the potential addition of sparge points to address the areas in the subsurface that are not receiving influence from the current treatment network

- The AS/SVE well array was increased to further remediate GW contamination discovered In the intermediate zone of the surficial aquifer




TOLL PLAZA
LIFT STATION
ASPHALT
1-STORY BUILDING
GRASS
BROKEN ASPHALT
CONCRETE BOLLARD (TYP.)
TOWER ANCHOR
1-STORY BUILDING
0 30 60
(SCALE IN FEET)
LEGEND
INTERMEDIATE MONITORING WELL
BOLD CONCENTRATIONS EXCEED CTL
INTERMEDIATE ZONE DISSOLVED HYDROCARBON MAP
(ESTIMATED PLUME - JANUARY 2020)


TOLL PLAZA
LIFT STATION
ASPHALT
ASPHALT PARKING LOT
1-STORY BUILDING
OPEN FIELD
GRASS
BROKEN ASPHALT
FORMER PORTABLE WELL
CONCRETE BOLLARD (TYP.)
TOWER ANCHOR
1-STORY BUILDING
1.0
4.0
9.0
0 30 60
(SCALE IN FEET)
LEGEND
INTERMEDIATE ZONE DISSOLVED OXYGEN CONCENTRATIONS
(JANUARY 13, 2020)

System Optimization

Takeaways

- Evaluating the effectiveness a remediation system has on subsurface contamination is a dynamic process
- It is important to utilize the information received from O&M reports to make changes needed for system optimization
- Ask questions