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Memorandum

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Subject	**August and November 2019 SWMU 1 Landfill Gas Monitoring Technical Memorandum, Former Hampshire Chemical Corp. Facility, Waterloo, New York**
Attention	Former Hampshire Chemical Corp.
From	Jacobs Engineering Group Inc.
Date	February 2020
Project Number	DWWAT002

1. Introduction

This technical memorandum reports the results of landfill gas monitoring conducted at the Former Hampshire Chemical Corp. (HCC) Facility Solid Waste Management Unit 1 (SWMU 1) in Waterloo, New York (site). Two additional rounds of landfill gas monitoring activities were performed in August and November 2019 using four shallow landfill gas monitoring wells and six groundwater monitoring wells per the New York State Department of Environmental Conservation (NYSDEC) request in the approval letter for the *Technical Memorandum – February 2018 to January 2019 SWUM1 Landfill Gas Monitoring* dated October 4, 2019.

This investigation was conducted as a supplement to SWMU 1 corrective measures completed in November 2016. This investigation was conducted to evaluate whether methane and other common landfill gases are present at the boundary of and within the subsurface of the former landfill. The findings of this investigation will be used to evaluate the need for further methane monitoring, mitigation, and/or corrective measures at SWMU 1.

The site is regulated under Title 6 of the New York Code of Rules and Regulations (NYCRR) Part 373 and the Resource Conservation and Recovery Act (RCRA), with NYSDEC as the lead agency. RCRA facility investigations (RFIs) have been performed at the facility since 1993 to evaluate the nature and extent of releases to the environment.

2. Background

The site is located at 228 East Main Street in Waterloo, New York, on property currently occupied by Evans Chemetics, which operates a chemical manufacturing facility. Figure 1 shows the site location relative to New York State and the Village of Waterloo. SWMU 1 is in the southwestern corner of the facility property; bounded to the east by the facility, to the south by the Seneca-Cayuga Canal (canal), to the west by East Water Street, and to the north by the Seneca-Cayuga Canal Raceway (raceway). An asphalt road accesses the facility on the western side near East Water Street and crosses over SWMU 1. Figure 2 shows the location features within and surrounding SWMU 1, including roads, the canal, the raceway, monitoring wells, and the area of concern boundary.

Sanborn fire insurance maps of the site indicate the area along the western side of SWMU 1 and near some of the historical raceways was identified as the Village of Waterloo Dump as early as October 1918. The RCRA Facility Assessment Report (A.T. Kearney 1993) indicates the former Village of Waterloo

Dump was probably in operation at the western edge of the site until 1951 (O'Brien and Gere Engineers, Inc. 2003). This suggests an operating period for the dump of at least 33 years, during which the Village of Waterloo placed debris, soil, and refuse in this area.

The 1964 Sanborn map for the facility shows that the canal and raceways were filled to the western edge of the old lock, and the area is identified as the Village of Waterloo Dump (O'Brien and Gere Engineers, Inc. 2003). As indicated by facility personnel, additional material was placed over the filled former raceways in the early 1980s that was derived from soil excavated during facility construction projects, mainly the wastewater treatment plant at the site.

3. Previous Investigations and Corrective Measures

Test pitting conducted during previous environmental investigations at SWMU 1 have identified various municipal waste fill, including glass and plastic fragments, scrap metal, ash, ceramics, shoes, brake pads, copper wire, and vehicle tires. Construction debris, including cobbles, bricks, wood, and metal scrap, also was identified in the test pitting. Intact bottles, both empty and containing liquids, also have been identified in test pits located near the access roadway as well as down along the right-of-way near the canal (CH2M HILL Engineers, Inc. [CH2M] 2006, 2009). The results of the test pit excavations show that fill materials extend onto the canal right-of-way in the area. From that investigation, it has been estimated that approximately 2,500 cubic yards of fill material are present within the canal right-of-way (CH2M 2009).

A soil vapor investigation was conducted within the vicinity of SWMU 1 in December 2007 as part of the RFI Addendum (CH2M 2008). Soil vapor data collected at two locations, SGP-9 and SGP-10, and within the boundary of SWMU 1 were compared to historical SWMU 1 soil and groundwater data to evaluate if the reported soil vapor volatile organic compounds (VOCs) were related to site activities and a subsurface release. The constituents detected in the soil vapor samples historically were not detected in nearby monitoring wells. Based on data evaluation and a review of multiple lines of evidence, it was concluded that none of the reported VOCs in SWMU 1 soil vapor is likely to present a vapor intrusion concern; however, methane was not analyzed during the 2007 soil vapor investigation.

A survey of methane concentrations in six SWMU 1 groundwater monitoring wells was conducted in October and November 2012 (CH2M 2013). Methane was not detected at levels above 0.1% by volume (Vol%) during the 2012 survey.

Between September and November 2016, corrective measures were undertaken by HCC at SWMU 1. These activities are detailed in the *SWMU 1 Corrective Measures Construction Completion Report* (CH2M 2017) and included the construction of an engineered landfill cap, decommissioning of some groundwater monitoring wells, paving, and site restoration activities.

Beginning in December 2016, elevated concentrations of methane were detected in SWMU 1 monitoring wells MW-17 and TW-01 during wellhead screening conducted as part of a long-term groundwater monitoring event depth-to-water survey. The New Jersey Department of Environmental Protection was notified and four shallow landfill gas monitoring probes were installed in February 2018 (Jacobs Engineering Group Inc. [Jacobs] 2019). Eight landfill gas monitoring events were conducted at SWMU 1 gas probes (GP-01 to GP-04) and groundwater monitoring wells (MW-16I, MW-17, MW-18, MW-26, and TW-01) (Jacobs 2019).

Further details regarding previous environmental and geotechnical investigations conducted at SWMU 1 are in the RFI and RFI Addendum and technical memorandums (CH2M 2006, 2008, 2009, 2012).

4. Landfill Gases

Landfill gas, if present, will be mostly comprised of methane and carbon dioxide by volume, but also can consist of smaller amounts of other gases. Three principal subsurface processes can create landfill gases, including bacterial decomposition, volatilization, and chemical reactions. Waste characteristics

and composition and other environmental factors will influence the rate and volume of landfill gas (Agency for Toxic Substances and Disease Registry [ATSDR] 2001). In general, the more organic material that is buried in a covered SWMU, the more landfill gas will be produced by bacterial decomposition. Organic landfill waste will decompose by bacteria through phases as the subsurface transitions from aerobic to anaerobic conditions. Methane is only produced in the subsurface when oxygen is no longer present since methanogenic bacteria (methane producing) are generally only active under anaerobic conditions (ATSDR 2001).

In addition, the age of the buried waste material also will affect landfill gas production. Waste that has been buried more recently (less than 10 years) generally will produce more landfill gases than waste that is older (buried more than 10 years) (ATSDR 2001). Maximum gas production for organic waste materials through bacterial decomposition, volatilization, or chemical reactions is generally 5 to 7 years after the waste has been buried. Based upon documentation of when waste materials were last disposed in SWMU 1 (early 1950s according to the RCRA Facility Assessment Report [A.T. Kearney 1993]), the waste has been buried for more than 60 years. Additionally, during the 2012 survey, methane sampling found concentrations of 0.1 Vol%.

5. Screening Criteria

The lower explosive limit (LEL) for methane is 5% (methane by volume in air at standard temperature and pressure). Following the requirements discussed in Title 6, NYCRR Section 360-2.17(f), the concentration of methane at the property boundary of a sanitary landfill is not to exceed the LEL. Therefore, the LEL of 5% (methane by volume) was used for the screening criteria for the survey.

6. Field Activities

During August and November 2019, the concentrations of landfill gases were monitored at four landfill gas monitoring probes and five groundwater monitoring wells associated with SWMU 1 (Figure 2). Headspace field screening logs are included in Attachment 1. This section discusses the investigative methods used during this effort.

6.1 Well Headspace Differential Pressure Measurements

The first measurement collected from the landfill gas monitoring wells was the pressure differential between the atmosphere and well headspace (differential pressure). Differential pressure measurements were made using an Alnor EBT730 micromanometer attached to the instrument quick-connect fitting by a short length of low-density polyethylene (LDPE) tubing. Table 1 lists the differential pressure ranges.

6.2 Well Headspace Volume Determination

The headspace volume of each landfill gas monitoring point was calculated to determine the volume of gas to purge before recording screening measurements. For the shallow landfill gas monitoring probes (GP-01 to GP-04), the headspace volume was fixed and did not vary between monitoring events; however, the headspace volume of the groundwater monitoring wells fluctuated with changes in groundwater elevations. Table 2 lists the headspace volume calculations and depth-to-water measurements for SWMU 1 groundwater monitoring wells. Figure 3 presents hydrographs of groundwater elevations at the five groundwater monitoring wells, and Table 3 summarizes the well construction information for the SWMU 1 groundwater monitoring wells.

6.3 Landfill Gas Measurements

Measurements of carbon monoxide (parts per million), carbon dioxide (Vol%), hydrogen sulfide (parts per million), the LEL (Vol% calibrated to methane), and methane (Vol%) were made using a Landtec GEM 2000 Plus or GEM 5000 landfill gas meter. The landfill gas meter's sample inlet port was attached to the instrument quick-connect fitting by a short length of vinyl tubing. Gas samples began flowing to the

landfill gas meter when the instrument quick-connect fitting was attached to the headspace sampling valve.

In general, the landfill gas probes (GP-01 to GP-04) were purged using the landfill gas meter's internal pump at a rate of approximately 0.5 liter per minute, and the groundwater monitoring wells (MW-16I, MW-17, MW-18, MW-26, and TW-01) were purged using standalone air sampling pumps at a rate of 0.5 to 1.0 liter per minute (Table 2). Initial measurements from the landfill gas meter were recorded when concentrations stabilized for approximately 1 minute. Next, the landfill gas meter was disconnected, and a MiniRAE 3000 photoionization detector was attached to the well sampling valve by a short length of LDPE tubing to measure total VOC concentrations. Finally, a MultiRAE was attached to the well sampling valve to measure sulfur dioxide concentrations. Table 1 presents the initial landfill gas screening results.

Final measurements of landfill gas concentrations were recorded after approximately one volume of headspace gas was purged from the monitoring locations. Measurements were collected using the same instruments and methods as described above. The final gas concentrations are shown in Table 1. Tables 2 and 4 contain the headspace purge data.

All instruments were calibrated daily according to the manufacturer's instructions, with calibration information recorded on data sheets.

7. Results and Discussion

Screening of landfill gas concentrations was conducted at nine monitoring points associated with SWMU 1 in August and November 2019. Table 1 summarizes the screening data. Methane was detected in headspace samples from four SWMU 1 monitoring locations (GP-04, MW-17, MW-18, and TW-01) at concentrations up to 5.5 Vol% (MW-17) (Table 1, Figures 4 and 5). Methane was detected at the following concentrations during the reporting period:

- At MW-18 and TW-01, methane was detected at concentrations above the GEM's detection limit (0.1 Vol%) and below 1 Vol%.
- At GP-04, methane was detected at concentrations between 1 and 5 Vol%.
- At MW-17, the screening limit for methane of 5 Vol% (100% of the LEL for methane) was exceeded during both monitoring events (Figure 6).
- At GP-01, GP-02, MW-16I, and MW-26, methane was not detected during the reporting period.

Carbon dioxide and oxygen measurements are plotted on Figures 7 and 8, respectively. In general, methane concentrations appear to correlate positively with carbon dioxide concentrations and have an inverse relationship to oxygen concentrations.

Table 1 lists the concentrations of total VOCs, carbon monoxide, hydrogen sulfide, and sulfur dioxide. These gases were not detected at significant levels from the SWMU 1 landfill gas monitoring locations during the reporting period.

Groundwater elevations observed at the SWMU 1 monitoring wells (MW-16I, MW-17, MW-18, MW-26, and TW-01) are plotted along with methane concentrations and well screen intervals on Figure 9. There is no apparent relationship between changes in groundwater elevations and methane concentrations during the reporting period, except for MW-16I, the observed groundwater elevations were generally within the screened intervals of the monitoring wells, such that a portion of the perforated casing was unsaturated and exposed to formation gases. However, it should be noted that both MW-17 and TW-01 have the longest screened interval (10 feet) with the most consistently unwetted surface area of the landfill gas monitoring points (Figure 9), and they have the highest observed methane concentrations.

Figure 10 shows methane concentrations at SWMU 1 plotted against daily minimum and maximum ambient air temperatures. Ambient air temperature data were collected at the Geneva Research Farm

weather station (Global Historical Climatology Network station ID USC00303184) (National Oceanic and Atmospheric Administration 2020) approximately 9 miles west of the site in Geneva, New York. A positive correlation between ambient air temperature and methane concentrations may exist for GP-04 and MW-17. The effects of air temperature on methane concentrations, if any, are less apparent for other locations.

8. Conclusions

The following conclusions are based on the results of the August and November 2019 monitoring:

- The presence of methane in SWMU 1 groundwater monitoring wells was not identified before December 2016 so the presence may indicate methane is accumulating beneath the SWMU 1 landfill cap.
- The concentrations of methane at shallow landfill gas monitoring probes (GP-01, GP-02, and GP-03) along the eastern and western boundary of SWMU 1 are below the LEL or below instrument detection limits for the last two rounds. Prior detections of methane in these monitoring points were rare and when present ranged from 0.1% to 0.2%. Methane at GP-04 (positioned in a potential preferential flow area) has ranged from 0.1% to 2.7% but has consistently remained below 5% LEL screening criteria.
- Concentrations of methane above 1 Vol% were detected at monitoring locations in the southwestern area of SWMU 1 historically (MW-17, TW-01 and MW-17); only MW-17 exceeded the 5% LEL screening criteria in the last two rounds of monitoring (5.1% and 5.5%, respectively). Wells MW-16I and MW-26 rarely detect methane and when they do it has ranged from 0.1% to 0.2%.
- The nearest potential methane receptors along the western site boundary are occupied structures located west of East Water Street. Based on data collected to date, there appears to be no risk to offsite receptors west of SWMU 1, given that methane concentrations do not exceed screening levels (the 5% LEL for methane) along the western landfill boundary.
- No identified potential methane receptors are along the southern landfill boundary. Features present south of SWMU 1 include the canal and unoccupied land owned by HCC. Based on data collected to date, there appears to be no risk to offsite receptors south of SWMU 1.

9. Recommendations

Methane along the western boundary of SWMU 1 is well below the 5% LEL screening criteria, (suggesting low risk to occupied offsite buildings), concentrations of methane are stable or declining, and methane generation is expected to decrease with time as is typical for landfills. Based on the observations over the last 2 years, no additional monitoring is proposed except at GP-04. As a conservative measure, HCC will monitor GP-04 annually for an additional two years.

10. References

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Tables

Table 1. Screening Measurements for SWMU 1 Landfill Gas Monitoring Locations
August and November 2019 SWMU 1 Landfill Gas Monitoring Report
Former Hampshire Chemical Corp. Facility, Waterloo, New York

Monitoring Date	Location	Differential Pressure Range	VOC (ppm)	Methane (%vol)	LEL (%)	Carbon Monoxide (ppm)	Hydrogen Sulfide (ppm)	Carbon Dioxide (%)	Oxygen (%)	Sulfur Dioxide (ppm)
8/16/2019	GP-01	-0.011 - -0.009	0.0	0.0	0	0	0	0.0	1.7	0
	GP-02	-0.015 - -0.002	40.2	0.0	0	0	0	11.4	0.1	0
	GP-03	-0.009 - -0.008	0.0	0.0	0	0.0	0	13.6	8.4	0
	GP-04	-0.008 - -0.004	0.0	2.7	54	0	0	12.7	0.0	0
	MW-16I	0.017 - 0.021	0.0	0.0	0	0	0	0.0	20.5	0
	MW-17	-0.010 - -0.008	0.7	**5.1**	>100	0	0	11.5	0.0	0
	MW-18	-0.011 - -0.014	0.0	0.0	0	0	0	11.5	4.0	0
	MW-26	-0.006 - -0.004	2.8	0.0	0	0	0	12.6	3.8	0
	TW-01	-0.014 - -0.010	0.0	0.0	0	0	0	0.1	20.4	0
11/18/2019	GP-01	-0.004 - 0.439	0.0	0.0	0	0	0	12.0	3.2	0
	GP-02	-0.009 - 0.220	0.0	0.0	0	0	0	0.0	21.4	0
	GP-03	-0.003 - 0.804	0.0	0.0	0	0	0	8.6	12.0	0
	GP-04	-0.003 - 0.620	0.0	0.2	5	0	0	10.6	0.4	0
	MW-16I	0.007 - 1.700	0.0	0.0	0	0	0	0.1	21.0	0
	MW-17	0.020 - 0.050	0.0	**5.5**	>100	0	0	12.1	0.8	0
	MW-18	0.000 - 1.010	0.0	0.5	11	0	0	7.1	0.5	0
	MW-26	NM[a]	0.0	0.0	0	0	0	7.0	12.3	0
	TW-01	0.002 - 1.040	0.0	0.9	19	0	0	2.5	17.9	0

Notes
a) Unable to measure differential pressure because well plug was not completely sealed at arrival.
>100 - greater than LEL
%vol - percent by volume
LEL - lower explosive limit
NM - not measured (see note "a")
VOC - volatile organic compound
ppm - parts per million
5 bold and shaded results are greater than or equal to 5% methane by volume (100% of the lower explosive limit).

Table 2. Purging Data for SWMU 1 Landfill Gas Measurements
August and November 2019 SWMU 1 Landfill Gas Monitoring Report
Former Hampshire Chemical Corp. Facility, Waterloo, New York

Monitoring Date	Location	Well Screen Interval (feet bgs)	Casing Diameter (inches)	Headspace Length/Depth to Water[a] (feet)	Headspace Volume (liters)	Purge Time (minutes)	Purge Rate (mL/min)	Volume Purged (liters)	Purge Method	Notes
				D	*0.17D*	*T*	*R*	*TR*		
8/16/2019	GP-01	5 -7	1	8.3	1.4	5.0	500	2.5	GEM 2000+	
	GP-02			7.0	1.2	17.0	500	8.5	GEM 2000+	
	GP-03			7.0	1.2	5.0	500	2.5	GEM 2000+	
	GP-04			8.3	1.4	5.0	500	2.5	GEM 2000+	
	MW-16I	30.5 - 35.5	2	25.64	16.9	55.0	500	27.5	air sampling pump	
	MW-17	15.6 - 25.6		21.94	14.5	29.0	500	14.5	air sampling pump	
	MW-18	6.1 - 12.1		12.19	8.0	20.0	500	10.0	air sampling pump	
	MW-26	4.2 - 14.2		11.26	7.4	16.0	500	8.0	air sampling pump	
	TW-01	9.4 - 19.9		17.33	11.4	25.0	500	12.5	air sampling pump	
11/18/2019	GP-01	5 -7	1	8.3	1.4	14.0	1000	14.0	air sampling pump	
	GP-02			7.0	1.2	8.0	500	4.0	GEM 2000+	
	GP-03			7.0	1.2	9.0	500	4.5	GEM 2000+	
	GP-04			8.3	1.4	8.0	1000	8.0	air sampling pump	
	MW-16I	30.5 - 35.5	2	25.70	17.0	15.0	1000	15.0	air sampling pump	
	MW-17	15.6 - 25.6		21.22	14.0	14.0	1000	14.0	air sampling pump	
	MW-18	6.1 - 12.1		11.82	7.8	18.0	1000	18.0	air sampling pump	
	MW-26	4.2 - 14.2		10.56	7.0	11.0	1000	11.0	air sampling pump	
	TW-01	9.4 - 19.9		17.60	11.6	16.0	1000	16.0	air sampling pump	

Notes
"--" - not measured or not applicable
bgs = below ground surface
mL/min = milliliters per minute
a) For monitoring well locations, the headspace length measurement is the unwetted well volume (i.e., the depth to water from the top of casing). For landfill gas probe locations, the headspace length measurement is equal to the total well length.

Table 3. SWMU 1 Monitoring Well Construction Data

August and November 2019 SWMU 1 Landfill Gas Monitoring Report

Former Hampshire Chemical Corp. Facility, Waterloo, New York

Location	Well Diameter (inches)	Well Material	Ground Elevation (feet amsl)	Top of Casing Elevation (feet amsl)	Total Well Depth (feet bgs)	Screen Slot (inches)	Screen Interval (feet bgs)	Screen Interval (feet amsl)
MW-16I	2	Schedule 40 PVC	454.27	455.99	35.53	0.01	30.5 - 35.5	423.7 - 418.7
MW-17	2	Schedule 40 PVC	449.92	452.13	14.50	0.01	15.3 - 25.3	434.6 - 424.6
MW-18	2	Schedule 40 PVC	440.04	442.07	12.32	0.01	6.3 - 12.3	433.7 - 427.7
MW-26	2	Schedule 40 PVC	439.29	441.76	16.00	0.01	7.5 - 17.5	431.8 - 421.8
TW-01	2	Schedule 40 PVC	447.33	449.01	17.50	0.01	10.3 - 20.8	437.0 - 426.5

Notes

amsl = above mean sea level

bgs = below ground surface

PVC = polyvinyl chloride

Figures

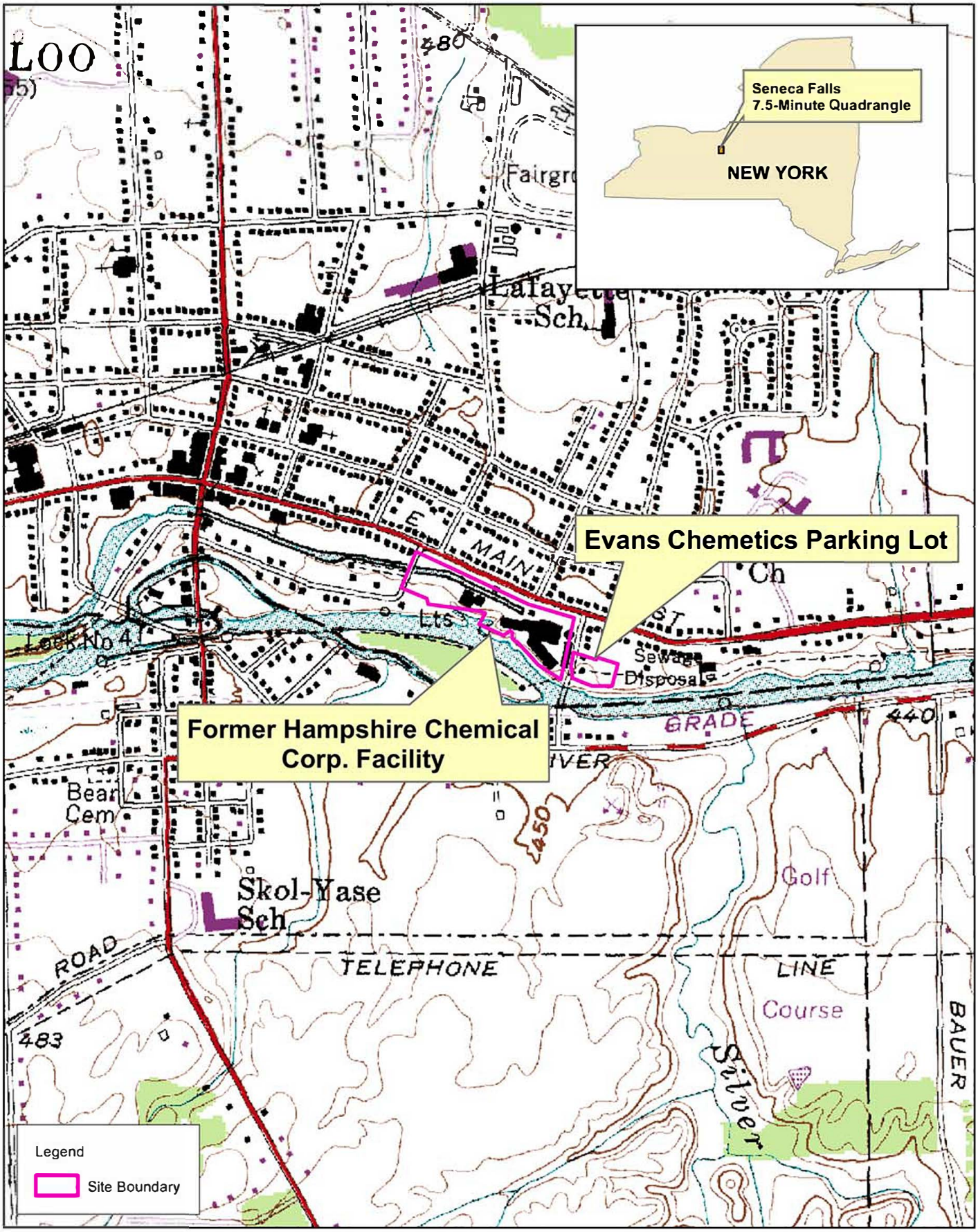

Figure 1. Site Location
Former Hampshire Chemical Corp. Facility, Waterloo, NY

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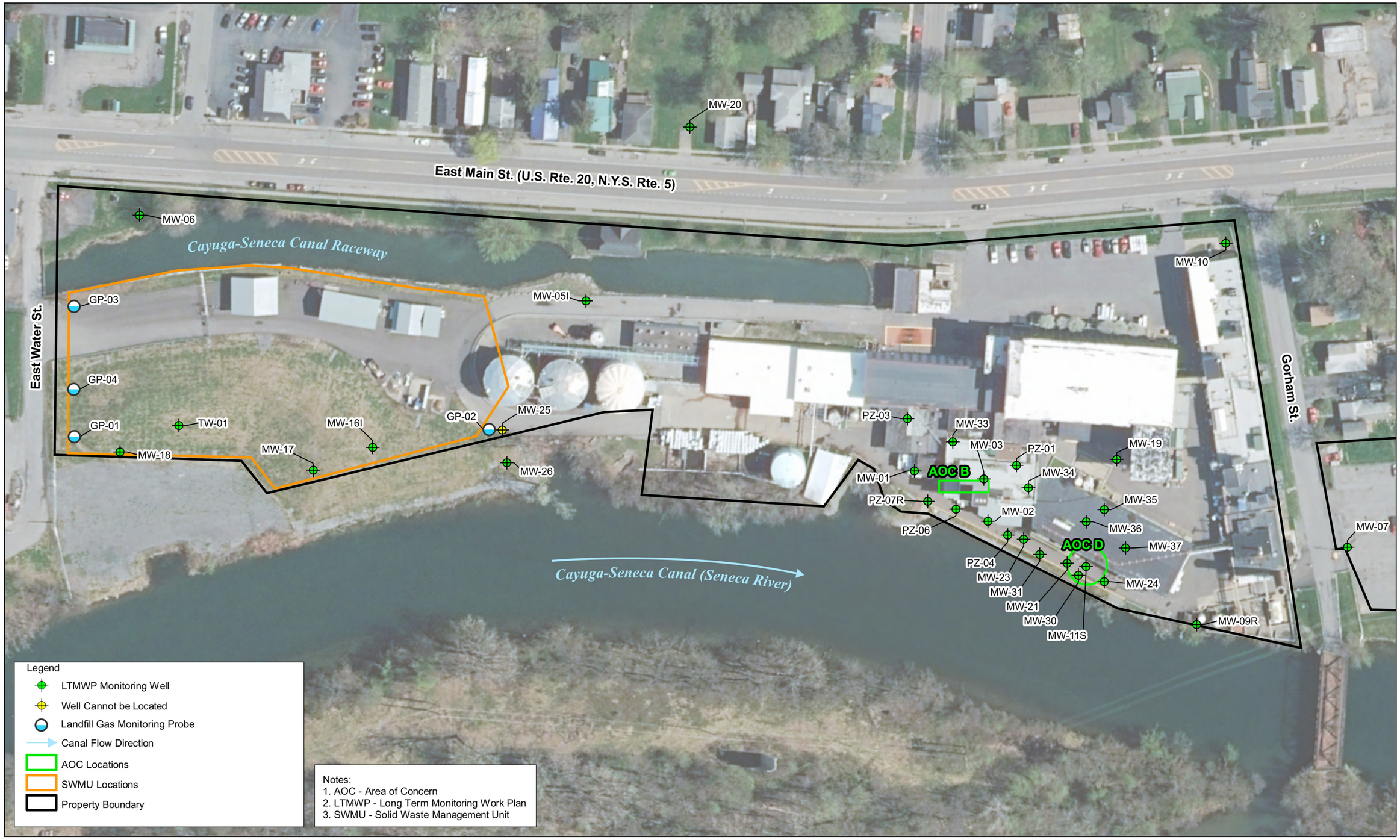

FIGURE 2
Site Layout Map
SWMU 1 Landfill Gas Monitoring Report
Former Hampshire Chemical Corporation
Waterloo, New York

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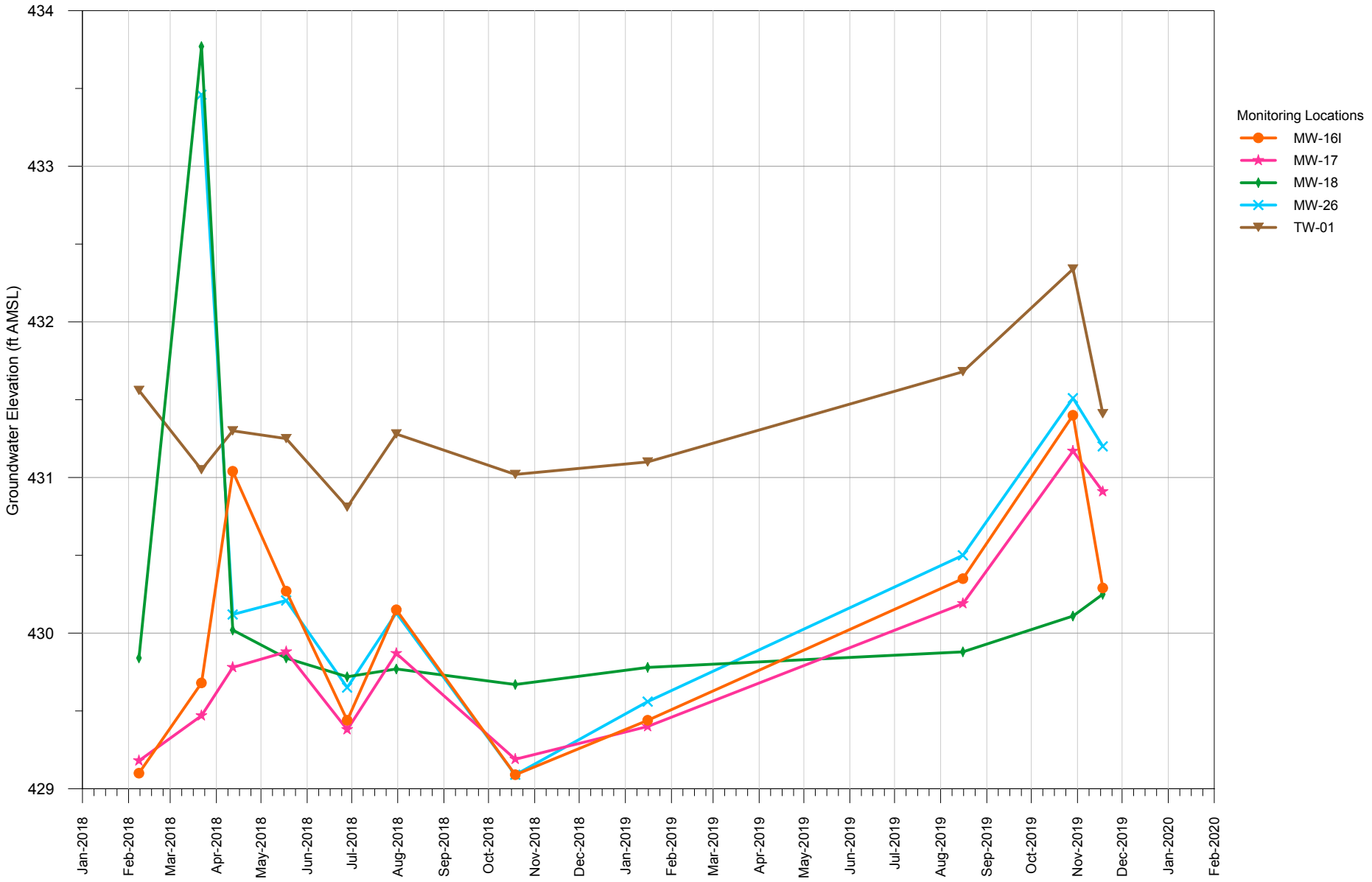

Notes
1) ft AMSL - feet above mean sea level
2) SWMU - solid waste management unit

Figure 3
Groundwater Elevations at SWMU 1 Monitoring Wells
Former Hampshire Chemical Corp. Facility
Waterloo, New York

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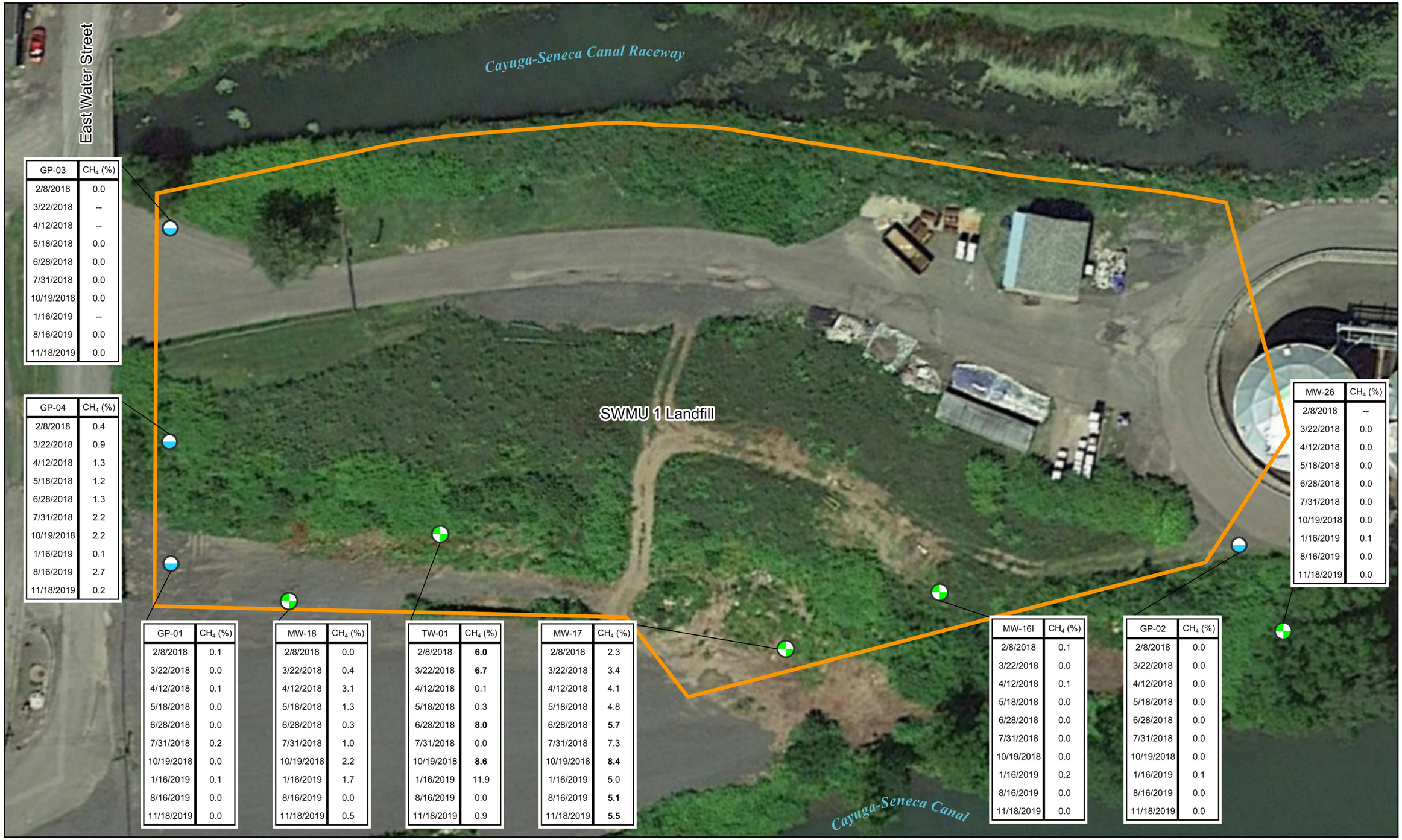

GP-03	CH_4 (%)
2/8/2018	0.0
3/22/2018	--
4/12/2018	--
5/18/2018	0.0
6/28/2018	0.0
7/31/2018	0.0
10/19/2018	0.0
1/16/2019	--
8/16/2019	0.0
11/18/2019	0.0

GP-04	CH_4 (%)
2/8/2018	0.4
3/22/2018	0.9
4/12/2018	1.3
5/18/2018	1.2
6/28/2018	1.3
7/31/2018	2.2
10/19/2018	2.2
1/16/2019	0.1
8/16/2019	2.7
11/18/2019	0.2

MW-26	CH_4 (%)
2/8/2018	--
3/22/2018	0.0
4/12/2018	0.0
5/18/2018	0.0
6/28/2018	0.0
7/31/2018	0.0
10/19/2018	0.0
1/16/2019	0.1
8/16/2019	0.0
11/18/2019	0.0

GP-01	CH_4 (%)
2/8/2018	0.1
3/22/2018	0.0
4/12/2018	0.1
5/18/2018	0.0
6/28/2018	0.0
7/31/2018	0.2
10/19/2018	0.0
1/16/2019	0.1
8/16/2019	0.0
11/18/2019	0.0

MW-18	CH_4 (%)
2/8/2018	0.0
3/22/2018	0.4
4/12/2018	3.1
5/18/2018	1.3
6/28/2018	0.3
7/31/2018	1.0
10/19/2018	2.2
1/16/2019	1.7
8/16/2019	0.0
11/18/2019	0.5

TW-01	CH_4 (%)
2/8/2018	**6.0**
3/22/2018	**6.7**
4/12/2018	0.1
5/18/2018	0.3
6/28/2018	**8.0**
7/31/2018	0.0
10/19/2018	**8.6**
1/16/2019	11.9
8/16/2019	0.0
11/18/2019	0.9

MW-17	CH_4 (%)
2/8/2018	2.3
3/22/2018	3.4
4/12/2018	4.1
5/18/2018	4.8
6/28/2018	**5.7**
7/31/2018	7.3
10/19/2018	**8.4**
1/16/2019	5.0
8/16/2019	**5.1**
11/18/2019	**5.5**

MW-16I	CH_4 (%)
2/8/2018	0.1
3/22/2018	0.0
4/12/2018	0.1
5/18/2018	0.0
6/28/2018	0.0
7/31/2018	0.0
10/19/2018	0.0
1/16/2019	0.2
8/16/2019	0.0
11/18/2019	0.0

GP-02	CH_4 (%)
2/8/2018	0.0
3/22/2018	0.0
4/12/2018	0.0
5/18/2018	0.0
6/28/2018	0.0
7/31/2018	0.0
10/19/2018	0.0
1/16/2019	0.1
8/16/2019	0.0
11/18/2019	0.0

N

0 100
Feet

Legend

- LTMWP monitoring well
- Landfill gas monitoring probe
- SWMU 1 boundary

Notes:
1) CH_4 (%) - percent of methane by volume
2) LEL - lower explosive limit
3) LTMWP - long-term monitoring work plan
4) SWMU - solid waste management unit
5) Results are bold where methane concentrations are greater than or equal to the lower explosive limit (5% by volume).

FIGURE 4
Methane Screening Results
February 2018 to November 2019 SWMU 1 Landfill Gas Monitoring Report
Former Hampshire Chemical Corporation
Waterloo, New York

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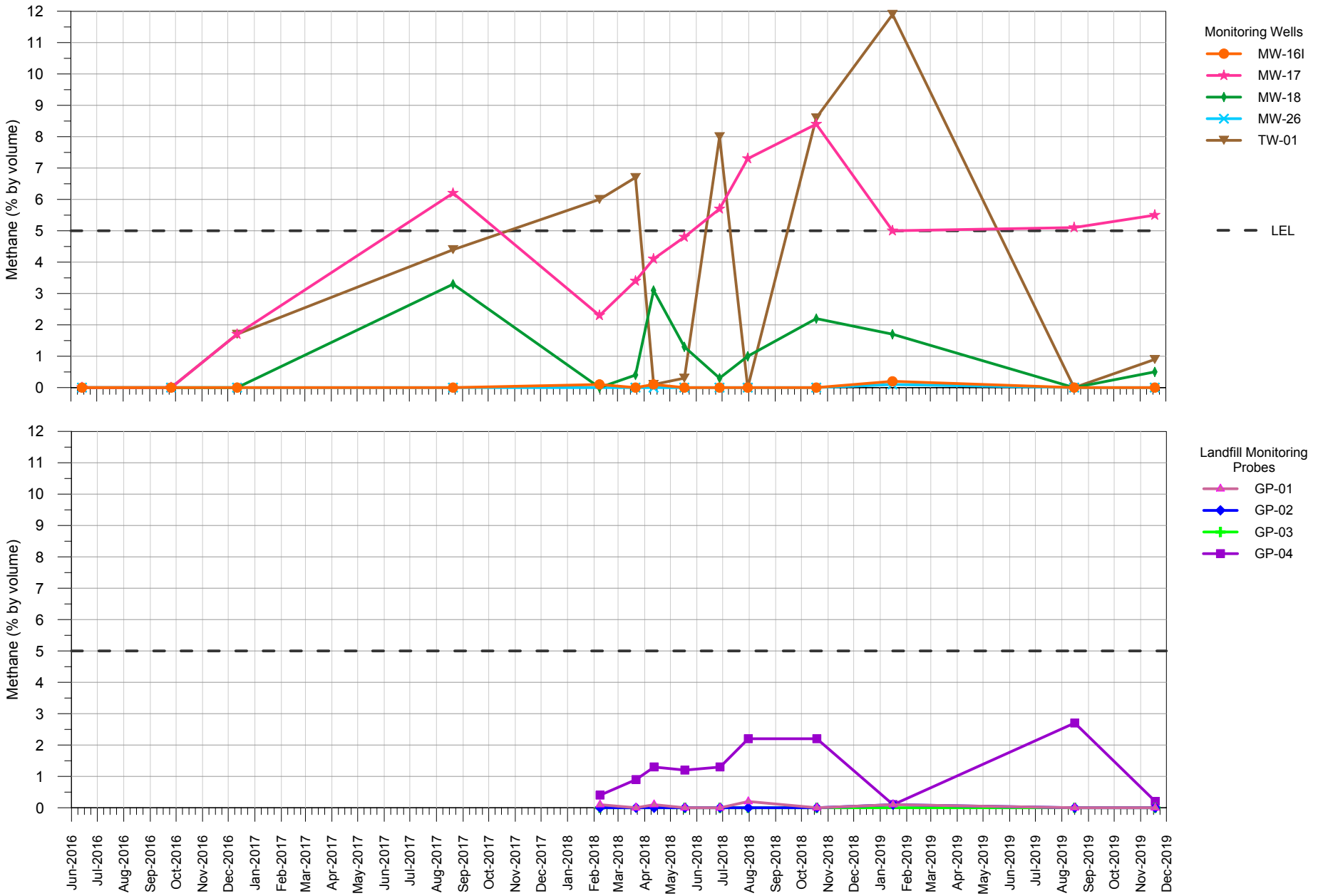

Notes
1) LEL - lower explosive limit
2) SWMU - solid waste management unit

Figure 5
Methane Concentrations at SWMU 1 Landfill Gas Monitoring Points
Former Hampshire Chemical Corp. Facility
Waterloo, New York

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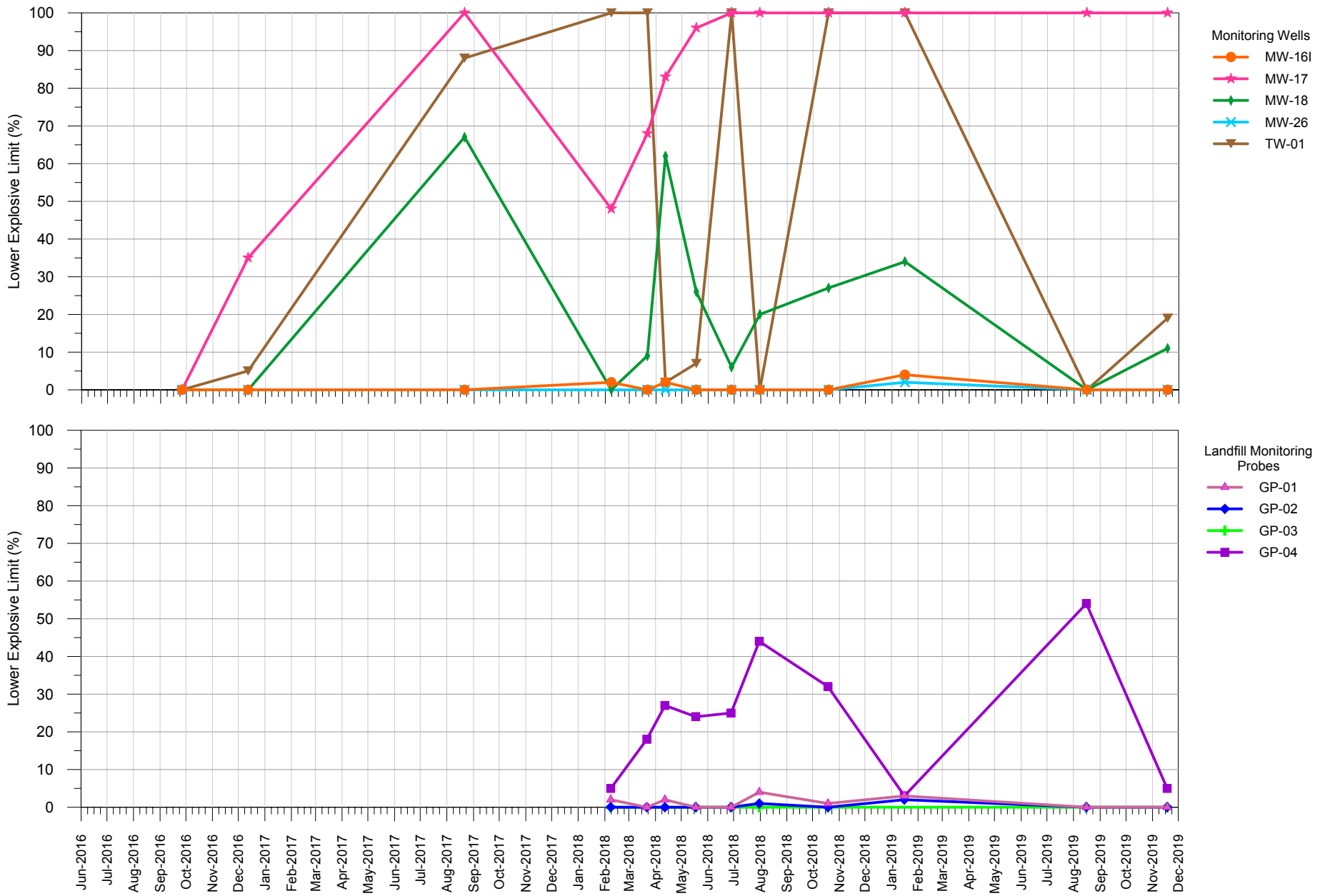

Notes
1) SWMU - solid waste management unit
2) LEL - lower explosive limit
3) Measurements greater than 100% of the LEL plotted as 100%

Figure 6
LEL Measurements at SWMU 1 Landfill Gas Monitoring Points
Former Hampshire Chemical Corp. Facility
Waterloo, New York

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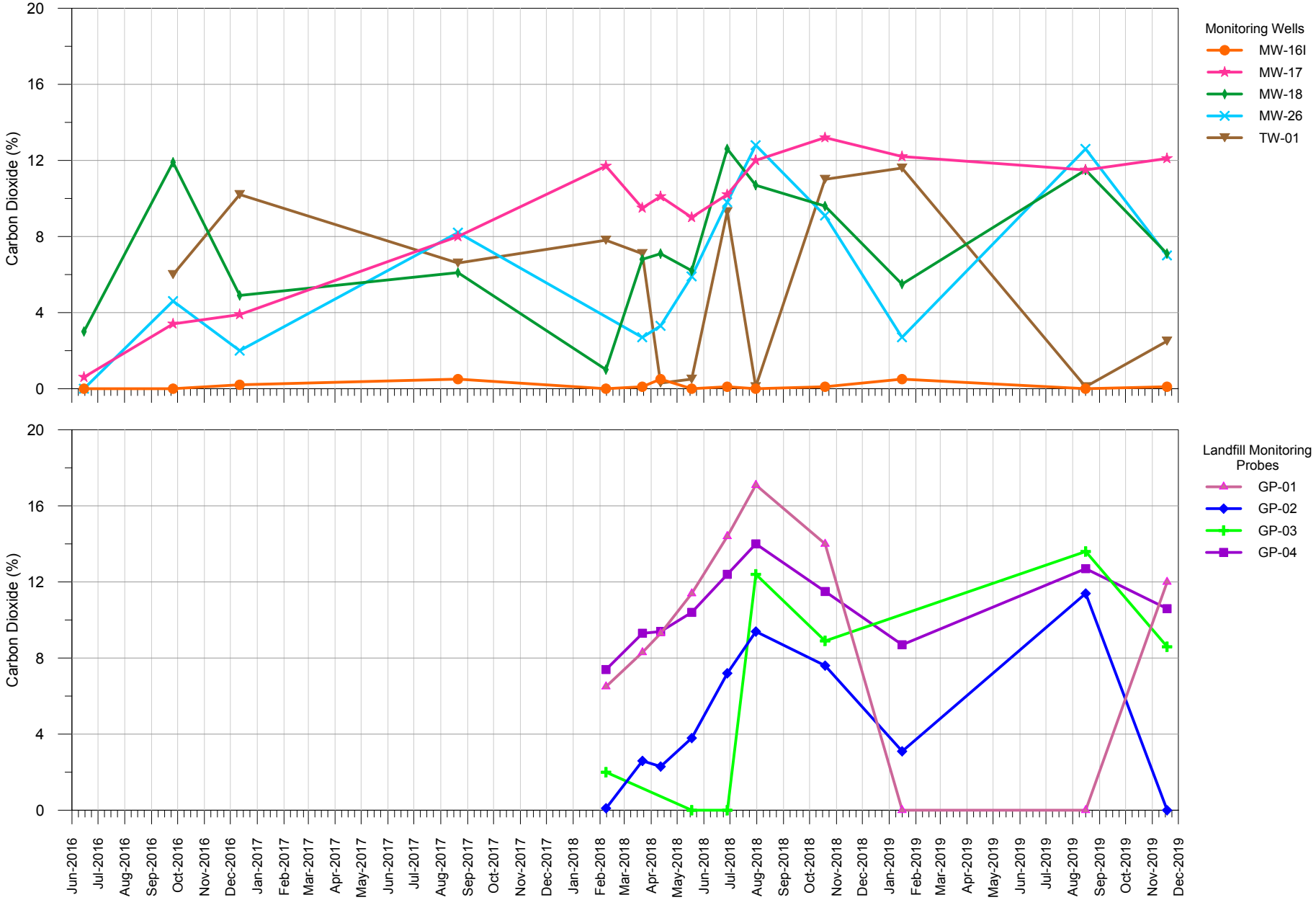

Notes
1) SWMU - solid waste management unit

Figure 7
Carbon Dioxide Concentrations at SWMU 1 Landfill Gas Monitoring Points
Former Hampshire Chemical Corp. Facility
Waterloo, New York

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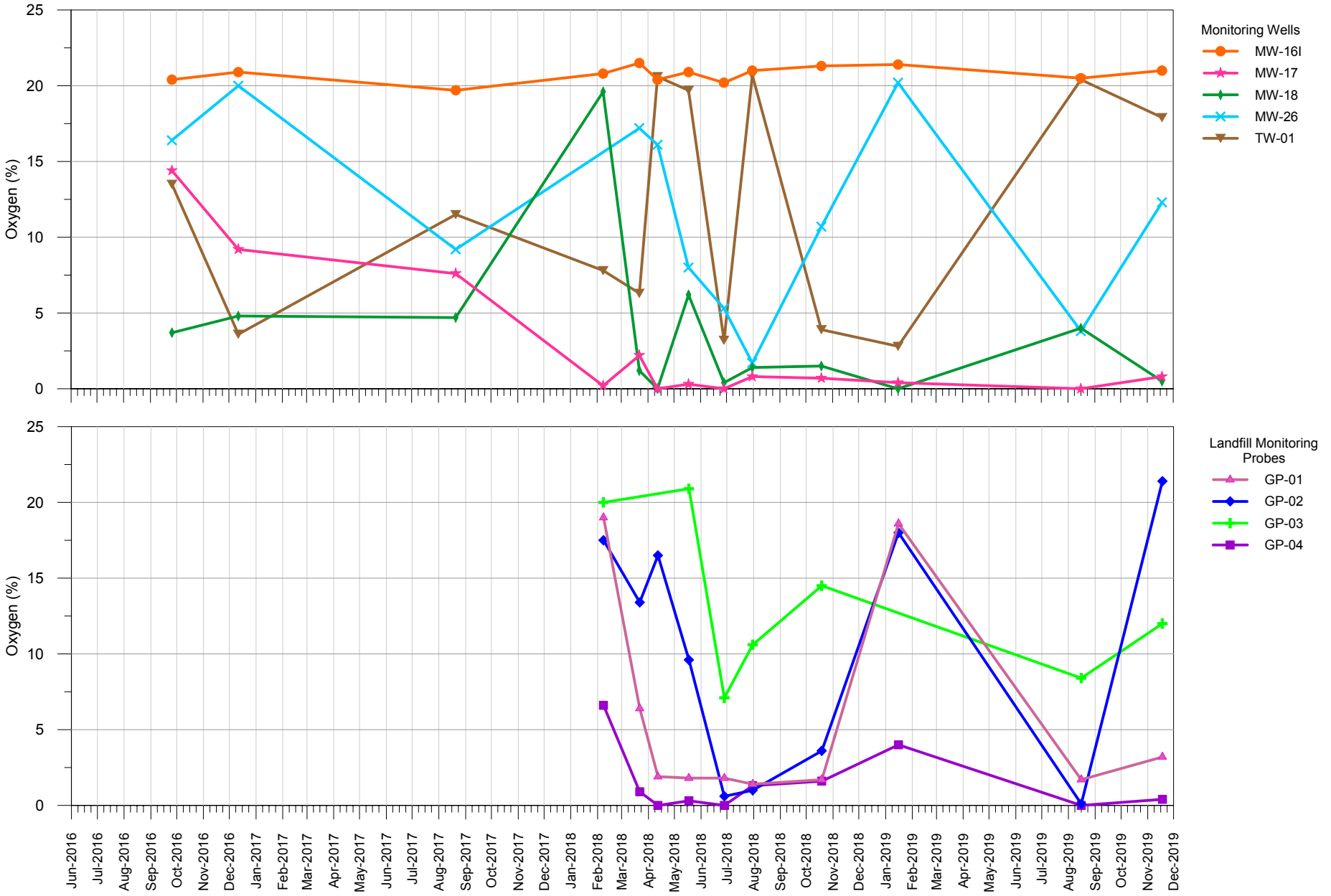

Notes
1) SWMU - solid waste management unit

Figure 8
Oxygen Concentrations at SWMU 1 Landfill Gas Monitoring Points
Former Hampshire Chemical Corp. Facility
Waterloo, New York

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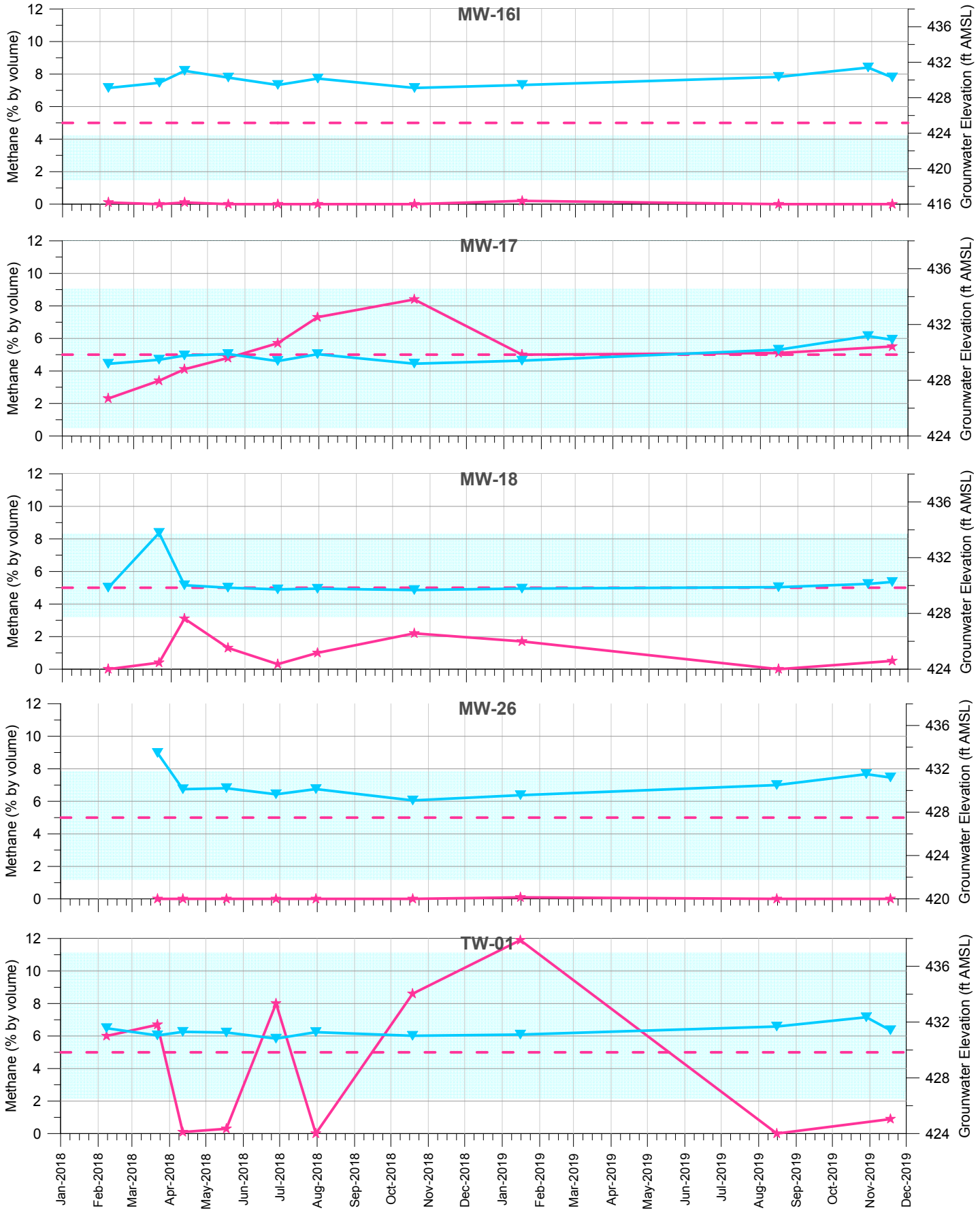

Notes
1) LEL - lower explosive limit
2) SWMU - solid waste management unit

Figure 9
Methane Concentrations and Groundwater Elevations at SWMU 1 Groundwater Monitoring Wells
Former Hampshire Chemical Corp. Facility
Waterloo, New York

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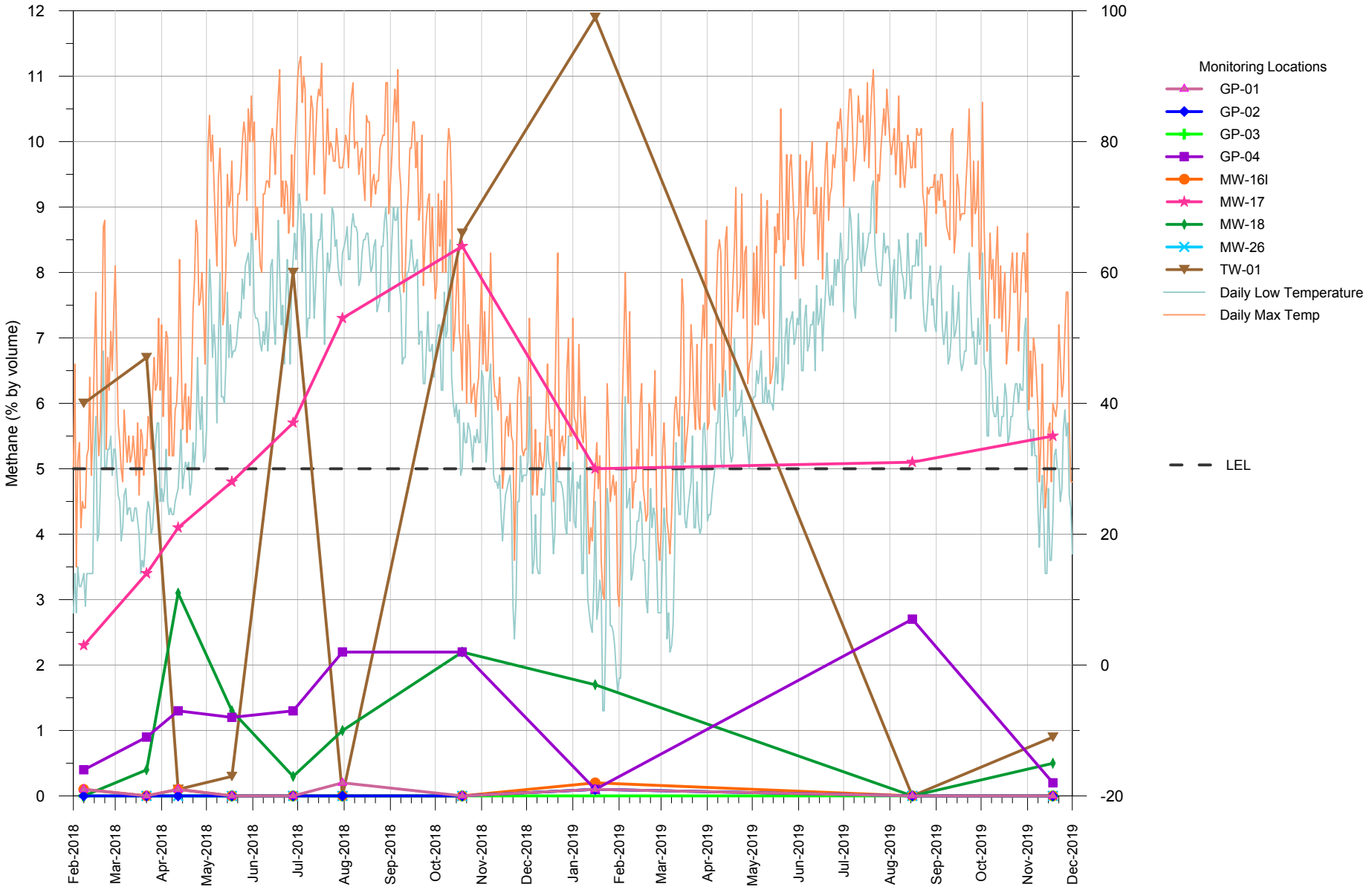

Notes
1) LEL - lower explosive limit
2) SWMU - solid waste management unit
3) Air temperature data was collected at the Geneva Research Farm weather station (Global Historical Climatology Network station ID USC00303184)

Figure 10
Methane Concentrations and Daily Temperatures at SWMU 1 Landfill Gas Monitoring Points
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Attachment 1
Wellhead Screening Logs

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Date: 8/16/19
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		❶ Field Pressure Data	Probe Information		Purge Vol.	❸ Field Purge Data			Notes
		Diff. Pressure (inch WC)	Screen Interval (ft bgs)	D = Probe Length (feet)	Volume (liters) = 0.17 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	Purge start 1157 →
GP-01	Hi	-0.009							
	Lo	-0.011	5 - 7	8.30	1.4	45	500	2.5	

		Gas Concentration Field Measurements								
		VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)	
❷	Initial	0	0	0	1	0	15.5	2.7	0	
❹	Stable	0	0	0	16.2	0	0	1.7	0	

		❶ Field Pressure Data	Probe Information		Purge Vol.	❸ Field Purge Data			Notes
		Diff. Pressure (inch WC)	Screen Interval (ft bgs)	D = Probe Length (feet)	Volume (liters) = 0.17 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	Purge 10:19 → 10:36
GP-02	Hi	-0.015							Bump check PID w/ 100ppm
	Lo	-0.002	5 - 7	7.00	1.2	17	500	8.5	isobutylene — ok @ 96.2ppm

		Gas Concentration Field Measurements								
		VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)	
❷	Initial	54.3	0	0	0	0	11.2	0.1	0	
❹	Stable	40.2	0	0	0	0	11.4	0.1	0	

0.55

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	❶ Field Pressure Data		Probe Information		Purge Vol.	❸ Field Purge Data			Notes
	Diff. Pressure (inch WC)		**Screen Interval** (ft bgs)	*D* = **Probe Length** (feet)	**Volume** (liters) = 0.17 * *D*	*T* = **Purge Time** (minutes)	*R* = **Purge Rate** (ml/min)	**Actual Volume Purged** (liters) = T * R	Well buried under a pile of dirt. Fetched shovel & dug around for well.
GP-03	Hi	-0.009							
	Lo	-0.008	5 - 7	7.00	1.2	5	500	2.5	
	Gas Concentration Field Measurements								Well just south of westernmost small tree near at edge of pavement
	VOC (ppm)	**CH_4** (% vol.)	**LEL CH_4** (%)	**CO** (ppm)	**H_2S** (ppm)	**CO_2** (%)	**O_2** (%)	**SO_2** (ppm)	
❷ Initial	0	0	0	0	0	13.2	8.6	0	
❹ Stable	0	0	0	0	0	13.6	8.4	0	Purge 1245 → 1250

	❶ Field Pressure Data		Probe Information		Purge Vol.	❸ Field Purge Data			Notes
	Diff. Pressure (inch WC)		**Screen Interval** (ft bgs)	*D* = **Probe Length** (feet)	**Volume** (liters) = 0.17 * *D*	*T* = **Purge Time** (minutes)	*R* = **Purge Rate** (ml/min)	**Actual Volume Purged** (liters) = T * R	Purge time 1214 → 1219
GP-04	Hi	-0.004							
	Lo	-0.008	5 - 7	8.60	1.5	5	500	2.5	
	Gas Concentration Field Measurements								
	VOC (ppm)	**CH_4** (% vol.)	**LEL CH_4** (%)	**CO** (ppm)	**H_2S** (ppm)	**CO_2** (%)	**O_2** (%)	**SO_2** (ppm)	
❷ Initial	0	3.1	63	1	0	12.1	0.6	0	
❹ Stable	0	2.7	54	0	0	12.7	0.0	0	

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	❶ Field Pressure Data		❸ Probe Information		❹ Purge Vol.	❺ Field Purge Data			Notes
	Diff. Pressure (inch WC)		Screen Interval (ft bgs)	D = Depth to Water (ft BTOC)	Volume (liters) = 0.66 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	Purge 1059 → 1128
MW17 ~~MW-16I~~	Hi	-0.008							
	Lo	-0.010	30.5 - 35.5	21.94	14.48	29	500	14.5	
	Gas Concentration Field Measurements								
	VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)	
❷ Initial	6.4	~~5.0~~	>100	1	0	11.1	0.0	0	
❻ Stable	0.7	5.1	>100	0	0	11.5	0.0	0	

	❶ Field Pressure Data		❸ Probe Information		❹ Purge Vol.	❺ Field Purge Data			Notes
	Diff. Pressure (inch WC)		Screen Interval (ft bgs)	D = Depth to Water (ft BTOC)	Volume (liters) = 0.66 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	Purge 1045 → 1140
MW16I ~~MW-17~~	Hi	0.017							
	Lo	0.021	15.6 - 25.6	25.64	16.92	~~55~~	~~500~~	27.5	
	Gas Concentration Field Measurements								
	VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)	
❷ Initial	6.4	0	0	0	0	0.4	20.0	0	
❻ Stable	0	0	0	0	0	0	20.5	0	

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	❶ Field Pressure Data		❸ Probe Information		❹ Purge Vol.	❺ Field Purge Data			Notes
	Diff. Pressure (inch WC)		Screen Interval (ft bgs)	D = Depth to Water (ft BTOC)	Volume (liters) = 0.66 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	hi diff pressure -0.014
MW-18	Hi	~~-2.126~~ ~~-1.602~~				~~20~~ ~~10~~			lo diff pressure -0.011
	Lo	~~-1.883~~	6.1 - 12.1	12.19	8.5	~~25~~	500	~~12.5~~ 10.0	Purge 1148 → ~~1213~~ 1208
	Gas Concentration Field Measurements								
	VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)	
❷ Initial	0	0	0	0	0	11.1	3.2	0	
❻ Stable	0	0	0	0	0	11.5	4.0	0	

	❶ Field Pressure Data		❸ Probe Information		❹ Purge Vol.	❺ Field Purge Data			Notes
	Diff. Pressure (inch WC)		Screen Interval (ft bgs)	D = Depth to Water (ft BTOC)	Volume (liters) = 0.66 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	Purge start 10:35 → 1051
MW-26	Hi	-0.004							
	Lo	-0.006	4.2 - 14.2	11.26	7.43	16	500	8	
	Gas Concentration Field Measurements								
	VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)	
❷ Initial	12.8	0	0	0	0	10.9	6.7	0	
❻ Stable	2.8	0	0	0	0	12.6	3.8	0	

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		❶ Field Pressure Data	❸ Probe Information		❹ Purge Vol.	❺ Field Purge Data			Notes
		Diff. Pressure (inch WC)	**Screen Interval** (ft bgs)	*D* = **Depth to Water** (ft BTOC)	**Volume** (liters) = 0.66 * *D*	*T* = **Purge Time** (minutes)	*R* = **Purge Rate** (ml/min)	**Actual Volume Purged** (liters) = T * R	Purge time 11:40 → 1205
TW-01	Hi	-0.010							
	Lo	-0.014	9.4 - 19.9	17.33	11.4	25	500	12.5	
		Gas Concentration Field Measurements							
		VOC (ppm)	**CH_4** (% vol.)	**LEL CH_4** (%)	**CO** (ppm)	**H_2S** (ppm)	**CO_2** (%)	**O_2** (%)	**SO_2** (ppm)
❷	Initial	0	0	1	2	0	3.9	15.6	0
❻	Stable	0	0	0	0	0	0.1	20.4	0

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GP02 ~~GP-01~~

❶ Field Pressure Data		Probe Information		Purge Vol.	❸ Field Purge Data			Notes
Diff. Pressure (inch WC)		Screen Interval (ft bgs)	D = Probe Length (feet)	Volume (liters) = 0.17 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	stable Δp ≈ 0.0
Hi	+0.22							
Lo	-0.009	5 - 7	8.30	1.4	8	500	4	

Gas Concentration Field Measurements								
	VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)
❷ Initial	0	~~0.2~~ 0	~~4~~ 0	0	0	~~4.7~~ 0	~~21~~.9	0
❹ Stable	0	0	0	0	0	0	21.4	0

Notes: Recorded because of elevated/sustained CH_4

GP01 ~~GP-02~~

❶ Field Pressure Data		Probe Information		Purge Vol.	❸ Field Purge Data			Notes
Diff. Pressure (inch WC)		Screen Interval (ft bgs)	D = Probe Length (feet)	Volume (liters) = 0.17 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	
Hi	0.439							
Lo	- 0.004	5 - 7	7.00	1.2	14	1	14	

Gas Concentration Field Measurements								
	VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)
❷ Initial	0	0.0	1	0	0	10.6	6.5	0
❹ Stable	0	0.0	0	0	0	12.0	3.2	0

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GP-03

❶ Field Pressure Data		Probe Information		Purge Vol.	❸ Field Purge Data			Notes
Diff. Pressure (inch WC)		Screen Interval (ft bgs)	D = Probe Length (feet)	Volume (liters) = 0.17 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	* STABLE
Hi	+ 0.804							
Lo	− 0.003 *	5 - 7	7.00	1.2	9	500	4.5	

Gas Concentration Field Measurements								
	VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)
❷ Initial	0	0.0	0	0	0	8.7	11.8	0
❹ Stable	0	0.0	0	0	0	8.6	12.0	0

GP-04

❶ Field Pressure Data		Probe Information		Purge Vol.	❸ Field Purge Data			Notes
Diff. Pressure (inch WC)		Screen Interval (ft bgs)	D = Probe Length (feet)	Volume (liters) = 0.17 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	STABLE *
Hi	0.620							
Lo	− 0.003 *	5 - 7	8.60	1.5	8	1000	8	

Gas Concentration Field Measurements								
	VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)
❷ Initial	0.0	0.2	5	0	0	11.4	0.0	0
❹ Stable	0.0	0.2	5	0	0	10.6	0.4	0

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Date: 11/15/19
Project #: DWWAT002

MW-16I

❶ Field Pressure Data		❸ Probe Information		❹ Purge Vol.	❺ Field Purge Data			Notes
	Diff. Pressure (inch WC)	Screen Interval (ft bgs)	D = Depth to Water (ft BTOC)	Volume (liters) = 0.66 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	* stable
Hi	+1.70							
Lo	+0.007 *	30.5 - 35.5	25.70		15	1000	15	

Gas Concentration Field Measurements

	VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)
❷ Initial	ϕ	ϕ.1	3	ϕ	ϕ	ϕ.9	2ϕ.1	ϕ
❻ Stable	0	0.0	0	0	0	0.1	21.0	0

MW-17

❶ Field Pressure Data		❸ Probe Information		❹ Purge Vol.	❺ Field Purge Data			Notes
	Diff. Pressure (inch WC)	Screen Interval (ft bgs)	D = Depth to Water (ft BTOC)	Volume (liters) = 0.66 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	
Hi	+0.050							
Lo	+0.020	15.6 - 25.6	21.22		14	1000	14	

Gas Concentration Field Measurements

	VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)
❷ Initial	0	6.1	>100	0	0	12.1	0.6	ϕ
❻ Stable	0	5.5	over	0	0	12.1	0.8	0

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Date: 11/18/19
Project #: DWWAT002

		❶ Field Pressure Data		❸ Probe Information		❹ Purge Vol.	❺ Field Purge Data			Notes
		Diff. Pressure (inch WC)		Screen Interval (ft bgs)	D = Depth to Water (ft BTOC)	Volume (liters) = 0.66 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	
MW-18	Hi	1.010								
	Lo	0.000		6.1 - 12.1	11.82		18	1100	19.8	
		Gas Concentration Field Measurements								
		VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)	
❷	Initial	0	0.3	7	0	0	7.6	0.0	0	
❻	Stable	0	0.5	11	0	0	7.1	0.5	0	

		❶ Field Pressure Data		❸ Probe Information		❹ Purge Vol.	❺ Field Purge Data			Notes
		Diff. Pressure (inch WC)		Screen Interval (ft bgs)	D = Depth to Water (ft BTOC)	Volume (liters) = 0.66 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	plug loose - diff pressure no good
MW-26	Hi	ϕ								
	Lo	see notes		4.2 - 14.2	10.56	6.97	11	1,000	1000	
		Gas Concentration Field Measurements								
		VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)	
❷	Initial	0.2	0	0	0	0	0	18.3	0	
❻	Stable	0	0	0	0	0	7	12.3	0	

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Date:

Project #: DWWAT002

		❶ Field Pressure Data	❸ Probe Information		❹ Purge Vol.	❺ Field Purge Data			Notes
		Diff. Pressure (inch WC)	Screen Interval (ft bgs)	D = Depth to Water (ft BTOC)	Volume (liters) = 0.66 * D	T = Purge Time (minutes)	R = Purge Rate (ml/min)	Actual Volume Purged (liters) = T * R	* STABLE
TW-01	Hi	1.04							
	Lo	0.002 *	9.4 - 19.9	17.60		16	1000	16	

		Gas Concentration Field Measurements								
		VOC (ppm)	CH_4 (% vol.)	LEL CH_4 (%)	CO (ppm)	H_2S (ppm)	CO_2 (%)	O_2 (%)	SO_2 (ppm)	
❷	Initial	0.0	6.2	OVER	0	0	12.3	3.1	0	
❻	Stable	0	0.9	19	0	0	2.5	17.9	0	