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Technical Memorandum

Date:	31 October 2017
To:	Kirk Wills, Waste Connections, Inc.
Reviewed By:	Kwasi Badu-Tweneboah, Ph.D., P.E., Geosyntec Consultants
From:	Matthew Wissler, P.G., Craig Browne, P.E., Warren Brady, Geosyntec
Subject:	Landfill Gas and Groundwater Benzene Evaluation J.E.D. Solid Waste Management Facility Omni Waste of Osceola County, LLC Geosyntec Project No.: FR3090

On 10 March 2017, following a meeting with the Florida Department of Environmental Protection (FDEP), Omni Waste of Osceola County, LLC (Omni), a wholly owned subsidiary of Waste Connections, Inc. (WCI), contracted Geosyntec Consultants Inc. (Geosyntec) to evaluate benzene concentrations in groundwater and landfill gas (LFG) migration at the J.E.D. Solid Waste Management facility (JED facility), a Class I landfill located in Osceola County, Florida. Specifically, FDEP requested that WCI solicit a 3rd party engineering consultant to evaluate groundwater and LFG detections at the JED Facility. The scope of work to perform this evaluation consisted of the following:

- Site History and Major Activities Review – compilation of a site history for construction, groundwater and LFG monitoring, and closure activities;

- Conceptual Site Model – provides a description of LFG management and benzene migration;

- Data Compilation – describes the organization and compilation of period-of-record groundwater and LFG monitoring results;

- Data Analysis – comparison of groundwater and LFG results with timeline of events to identify changes in site operations that may have effected groundwater quality and LFG migration; and

- Conclusions – provides a summary of the source and distribution of LFG and groundwater benzene adjacent to the landfill.

These work components are described further in the following sections of this document. This technical memorandum has been prepared by Matt Wissler, P.G., Craig Browne, P.E., and Warren Brady, P.G. and reviewed by Kwasi Badu-Tweneboah, Ph.D., P.E., all of Geosyntec.

SITE HISTORY AND MAJOR ACTIVITIES SUMMARY

The following subsections provide a summary of the site history with regards to cell development and waste placement, LFG monitoring and evaluation, groundwater monitoring, and the construction and expansion of the Gas Collection and Control System (GCCS) and associated components including the soil vapor extraction (SVE) pilot test where vertical and horizontal wells were installed and connected to the GCCS. **Table 1** provides a chronological summary of major activities. **Figure 1** identifies the landfill cells and their status (closed, active, etc.), the soil gas and water quality monitoring network, and other relevant site features (e.g., wetlands, borrow pit).

Cell Construction Summary

Cell construction activities for Cells 1A, 1B, 2, 3, 4, and 5 were completed between January 2004 and October 2007. Dewatering at the borrow pit to the west was initiated in approximately November/December 2005. In March 2009 waste filling activities began in Cell 6 with partial closure of Cells 1 through 4 taking place in December 2009. Cell 7 construction activities were completed in November 2010 and waste began to be placed in the cell in November 2011. In November 2012, the second partial closure of Cells 1 through 4 and dewatering of the borrow pit were completed. Cells 9, 10, 11 and 13 were constructed and became operational between 2013 and 2016. Recirculation of leachate was previously performed and was discontinued in January 2016.

Landfill Gas Monitoring and Evaluation

The initial installation of permanent gas monitoring probes (GPs) was completed in April and May of 2008 (GP-7 through GP-22) and elevated methane was reported in select GPs during the initial monitoring event. Golder (2010[1]) performed a methane gas migration investigation that included monthly monitoring of permanent and temporary GPs (TGPs) and 18 temporary barhole probes installed approximately 10 to 20 feet away from GPs and TGPs. The investigation concluded that LFG migration from the waste footprint may be contributing to some of the methane detected in gas monitoring probes. However, an alternative source from naturally-occurring gas in the surrounding wetland areas was also identified as a potential source for methane.

Geosyntec (2011[2]) performed total organic carbon (TOC) sampling in November 2010 to identify organic-rich soil horizons in excavated trenches adjacent to gas probes within the former wetland areas, which may be providing a source of methane to gas probes. These results indicated that TOC levels ranged from 450 to 1,500 milligrams per kilogram (mg/kg), potentially providing a viable alternative methane source.

Temporary gas probes TGP-4 through TGP-13 were installed by Geosyntec in August of 2010. Geosyntec performed the first round of gas probe readings for percent methane instead of percent lower explosive limit (LEL) in October 2010 (WSI, 2010[3]). Temporary gas probes TGP-1 through TGP-3 were installed in July 2009.

In March of 2011 methane measurements from the headspace of monitoring wells MW-1A through MW-13A, MW-16, MW-17A, and MW-23A were collected. Methane was detected in the headspace of 10 of the 16 wells measured with the highest reported methane concentration from monitoring well MW-1A (55.6%), MW-9A (46.6%), and MW-23A (42.8%) (WSI, 2011[4]).

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[1] Golder. 2010. Methane Gas Migration Investigation – J.E.D. Solid Waste Management Facility. Submitted to the FDEP on 17 June 2010.

[2] Geosyntec. 2011. Summary of Total Organic Carbon Soil Sampling – J.E.D. Solid Waste Management Facility. Submitted to WSI on 14 January 2011.

[3] WSI.2010. Status Report of Methane Gas Migration Investigation – J.E.D. Solid Waste Management Facility. Submitted to the FDEP by WSI on 14 November 2010.

[4] WSI. 2011. Status Report of Methane Gas Migration Investigation and Remediation – J.E.D. Solid Waste Management Facility. Submitted to FDEP on 14 April 2011.

In June 2012 gas probes GP-7 through GP-22 were replaced with GP-7R through GP-22R as the original gas monitoring probes were installed at depths where the screened intervals were frequently submerged. The replacement gas probes (GP-7R through GP-22R) were installed with the bottom of the 5-ft screened interval placed at approximate elevation 77.5-ft (NGVD, 1929) (EPS, 2011[5]). These gas probes have been monitored quarterly from July 2012 to present.

In December 2013, Geosyntec performed an assessment of volatile organic compounds (VOCs) in groundwater, leachate, and LFG (Geosyntec, 2013[6]). The benzene concentrations in groundwater were attributed to an LFG effect based on: i) the consistently low and steady groundwater benzene trends (concentrations did not substantially increase), which do not support a leachate source; ii) a comparison of predicted groundwater benzene concentrations based on LFG data applied to the Henry's law partitioning calculation compared to actual groundwater benzene data; and iii) a comparison of the JED groundwater benzene data to the typical range of groundwater benzene concentrations reported for other landfills with known LFG effects on groundwater.

Groundwater Monitoring

Monitoring wells have been installed as the landfill footprint has expanded with groundwater monitoring beginning as early as 2004 (monitoring wells MW-1A through MW-15A) adjacent to the initial landfill cell (Cell 1) and have been sampled semi-annually. Monitoring wells MW-16A through MW-23A were constructed as part of the Phases 2 and 3 developments in September 2007. Monitoring wells MW-24A through MW-31A have been sampled semi-annually from November 2014 to November 2016, when installed. The upper surficial or A-zone monitoring wells are constructed across the water table with screened sections extending up into the landfill berm at several locations. The A-zone wells are screened across the water table with up to 9 feet of well screen exposed to the vadose zone which can serve as a mechanism for LFG migration/accumulation through/within the wells screen above the water table.

[5] EPS. 2011. Replacement of Perimeter Gas Monitoring Probes Installation Report – J.E.D. Solid Waste Management Facility. Submitted to WSI on 30 August 2011.
[6] Geosyntec. 2013. Groundwater Contamination and Landfill Gas Migration Investigation and Assessment – Benzene. Submitted to WSI on 27 December 2013.

GCCS Construction and Expansion

In December of 2008, the Phase 1 GCCS was completed and the flare became operational. The Phase 1 Sequence 3A component of the GCCS was completed in September 2010. The GCCS was connected to leachate sump manholes and leachate risers for Cells 1 through 6 in December of 2010. An SVE pilot test system utilizing vertical wells near the Cell 5 sump area and a horizontal SVE system along the west side of Cell 1 was constructed in March 2012 (HDR, 2012[7]) with the wells connected to the GCCS in April 2012. Five additional gas extraction wells were installed near the Cell 5 sump area in December 2012 and March 2013 to expand the pilot SVE system. The SVE pilot system was removed in October 2013. The “2015” GCCS Expansion was completed in February 2016 and included installation and replacement of gas extraction wells in the Cells 1-8 areas. In March 2017, the “2016-2017” GCCS Expansion was completed, which included additional gas extraction wells and horizontal gas collectors in Cells 3, 4, 5, 6, 9, and 10.

CONCEPTUAL SITE MODEL

LFG is generally composed of methane and carbon dioxide with small concentrations of VOCs (e.g. benzene) that can migrate from the waste via gaseous diffusion outward. The preferred pathway for LFG migration is upward. The direction, speed, and distance LFG will migrate away from the waste is dictated by the following:

- Landfill cover type – LFG will move vertically upward through permeable cover material and laterally if the cover is impermeable;
- Conduits – drains, trenches, utilities, and other potential conduits provide pathways of least resistance for LFG to move upward;
- Lithology – the soil material, stratigraphy and type/permeability adjacent to the landfill will impact how quickly and to what extent gas is able to migrate laterally (e.g., LFG within a confining layer would tend to migrate further laterally to a more permeable zone to escape vertically to the atmosphere);
- Moisture – wet soil conditions (e.g. perched water table overlying layer with LFG) may prevent LFG from migrating upward, moisture moving into pore spaces within a landfill can push gas out of these spaces, a rising water table can also push LFG upward;

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[7] HDR. 2012. Installation and Initial Operation Report – Soil Vapor Extraction Pilot Test Study – J.E.D. Solid Waste Management Facility. Submitted to the FDEP on 17 October 2012.

- Temperature – increases in temperature stimulate gas particle movement and increase diffusion and thus LFG may spread more quickly in warmer conditions; and
- Pressure – migration of LFG can be induced through build-up of gas pressure (e.g., lack of appropriate GCCS coverage) and tendency of LFG to flow from areas of higher pressure to areas of lower pressure, which can also be influenced by barometric pressure.

The distance LFG will migrate in the subsurface outside of a landfill cell will be strongly influenced by lithology, and will seek conduits and/or more permeable material to diffuse upward. Benzene is anticipated to migrate in a similar manner and partition to groundwater, as noted by Geosyntec (2013[8]). At the JED facility, the soils underlying and immediately adjacent to the disposal footprint consist primarily of sands and silty sand materials. The absence of clayey materials (i.e., confining layers) within the subsurface suggests that lateral gas migration from the disposal area would be limited with the natural tendency of methane to migrate upwards through the subsurface.

The Conceptual Site Model (CSM) for LFG transport at the JED facility is affected by: i) the status of closure/capping of existing cells; ii) the localized geology and hydrogeology that affect LFG's laterally or vertically upward mobility; iii) operation of the GCCS system; and iv) waste filling operations that may result in conditions that enhance vertical transport upward (e.g. conduits to the surface) or laterally (e.g. compacted layers of waste and daily cover soils or moisture from leachate recirculation that may enhance lateral transport). Differentiation of LFG impacts from natural methane production in wetland areas as proposed by Golder (2010[9]) and Geosyntec (2011[10]) complicates evaluating the migration of methane in the subsurface as there appears to be a background source.

DATA COMPILATION

Benzene groundwater concentration data from monitoring wells MW-1A through MW- 31A, and compliance wells CW-1A, CW-2A, and CW-3A were compiled for the period of record for each

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[8] Geosyntec. 2013. Groundwater Contamination and Landfill Gas Migration Investigation and Assessment – Benzene. Submitted to WSI on 27 December 2013.
[9] Golder. 2010. Methane Gas Migration Investigation – J.E.D. Solid Waste Management Facility. Submitted to the FDEP on 17 June 2010.
[10] Geosyntec. 2011. Summary of Total Organic Carbon Soil Sampling – J.E.D. Solid Waste Management Facility. Submitted to WSI on 14 January 2011.

well from groundwater monitoring reports previously submitted to the FDEP. Methane data from the TGPs and GPs over the period of record were also compiled to further evaluate LFG and benzene effects on groundwater. The methane concentration in the headspace of monitoring wells MW-1A through MW-13A, MW-16A, MW-17A, and MW-23A were measured during the March 2011 event. These gas monitoring data were compiled from previous quarterly methane monitoring reports provided to the FDEP and WSI.

The monitoring wells, TGPs, and GPs were grouped into 19 clusters by area as summarized on **Figure 1**. Concentration over time figures for benzene and methane were generated for each cluster and are presented in **Attachment A**. The primary Y axis (i.e., left of figure) on each figure contains the concentration of benzene reported in micrograms per liter (μg/L). The reported methane concentration in the TGPs and GPs is presented in % on the secondary Y axis. Additionally, major site activities are identified by date to aid in determining if operational changes may have affected LFG migration.

DATA ANALYSIS

Attachment A provides graphs depicting the concentration trends over time for benzene in groundwater and methane in TGP and GPs over the period of record for each cluster (**Figure 1**). It is noted that prior to October 2010, methane readings in the GP's were artificially limited to 5% methane (volume/volume) due to reporting in terms of % LEL. In addition, major facility activities in the area of each cluster (e.g. GCCS expansion, when waste was placed in cells, and closure) are identified as major timeline considerations for each graph. The major findings of these graphs are as follows:

- There is no evidence of LFG migration, based on the result of methane gas and groundwater benzene monitoring, at Clusters 2, 17, and 18.
- LEL monitoring prior to October 2010, with an assumed 5% methane concentration, identified methane at all clusters but 2, 17, and 18.
- Several of the clusters (e.g., Clusters 1, 3, 14, 15, and 17) contained methane in the TGP or GP prior to the placement of waste in the adjacent cell.
- Benzene detections in groundwater were observed *after* detections of methane, which supports the CSM observation that groundwater benzene is from a LFG source. Note that groundwater monitoring began at MW-1 through MW-15 prior to Cell 1 construction and gas monitoring commenced after groundwater monitoring and waste placement.

- Methane has not been detected in the replacement GPs or TGPs at multiple locations (Clusters 2, 4, 8, 9, 11, 12, and 15).
- Several of the replacement GPs, which are located farther from the waste, have not detected methane though TGPs within the same cluster have contained elevated methane concentrations suggesting that lateral LFG migration is limited (Clusters 6, 13, and 14).
- For clusters with sporadic methane detections in replacement GPs, an extended period of record demonstrates that these detections were not repeatable and suggest that the completion of the GCCS may have improved gas collection (Clusters 1, 3, 5, 7, 10).
- The variability of methane levels in replacement GP-21R (Cluster 16), located within Cluster 16, is likely associated with the organic material documented during the Geosyntec 2011[11] investigation since methane was detected 4 years prior to adjacent landfill cell construction (Cells 9 and 10). The GCCS was only recently expanded into this area (March 2017).
- As noted above, methane was detected in the headspace of 10 of the 15 monitoring wells sampled in March 2011, these results are not surprising as the monitoring wells are generally the same distance from waste as the TGPs and some of the wells were installed in the area of the former wetlands (**Figure 1**).
- Though benzene was detected in monitoring wells from Clusters 5, 11, and 12, the downgradient compliance wells in these clusters yielded non-detect groundwater benzene concentrations. These compliance wells are located further from the waste than the GP, TGP, or monitoring wells.

In summary, the presence of methane in GPs prior to waste placement suggests an alternative source (e.g., wetland) for some of the methane detected during the initial GP monitoring in May 2008. The presence of methane in the original GPs and the monitoring well headspace measurements reported during the March 2011 event suggests that LFG-derived methane was elevated close to the limits of waste. The migration of methane (and benzene) may have been higher during periods of dewatering along the western property boundary resulting from a lower water table and higher gradients. The increase and subsequent decrease in benzene groundwater concentrations at Clusters 4, 5 and 6 may be indicative of influences from dewatering. Additionally, the discontinued use of leachate recirculation in January 2016 may have facilitated enhanced LFG capture. The trend graphs in **Attachment A** demonstrate that with the construction

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[11] Geosyntec. 2011. Summary of Total Organic Carbon Soil Sampling – J.E.D. Solid Waste Management Facility. Submitted to WSI on 14 January 2011.

and expansion of the GCCS and the other factors discussed above (e.g., discontinued leachate recirculation and dewatering), the frequency and magnitude of methane detections in GPs has decreased over time. **Table 2** provides a summary of the most recent methane detections greater than 5% in replacement GPs from March 2012 to May 2017. These data indicate that methane migration is limited to the immediate area of the waste and, over time with cell closures and GCCS expansion, has had less frequent detections.

The effect of elevated methane levels on groundwater benzene levels supports the argument that LFG is the source of benzene in groundwater. Similar to methane, benzene groundwater detections appear to be laterally limited and delineated by the compliance wells.

CONCLUSIONS

The data analysis presented herein indicates limited LFG migration from the limits of waste as evidenced by the rapid attenuation of methane concentrations with distance from waste. Quarterly methane monitoring is required to demonstrate that recent methane detections over 5% in select well clusters (Cluster 16 and 19) in the area of the recent GCCS expansion, and other areas, are meeting regulatory requirements.

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Enclosures:

Table 1 – History of Major JED Facility Construction Activities and Gas Monitoring, Collection and Treatment Activities.
Table 2 – Summary of Recent (2012 to 2017) Methane Results in GPs
Figure 1 – Soil Gas and Water Quality Monitoring Network
Attachment A – Period of Record Data Plots

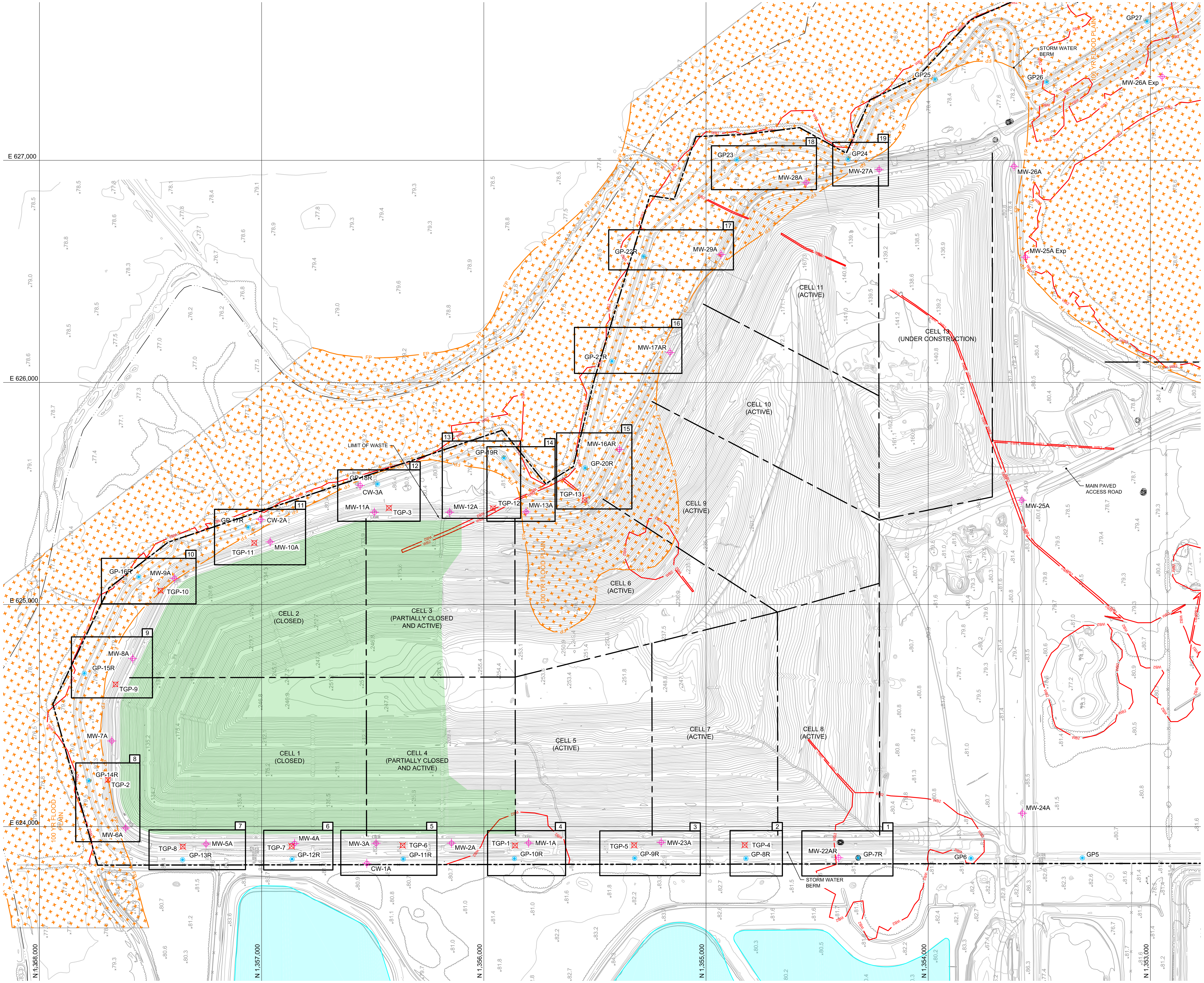
Table 1
History of Major JED Facility Construction Activities and Gas Monitoring, Collection, and Treatment Activities

Date	Major Landfill Construction Activities	Gas Monitoring, Collection, and/or Treatment Activities
Jan-04	Cell 1A Construction Complete	
Apr-04	Cell 1B Construction Complete	
May-05	Cell 4 Construction Complete	
Dec-05	Dewatering at borrow pit initiated	
Apr-06	Cell 2 Construction Complete	
Oct-06	Cell 3 Construction Complete	
Oct-07	Cell 5 Construction Complete	
Apr/May - 2008		Initial Installation of Boundary Gas Probes
Jul-08	Cell 6 Construction Complete	
Dec-08		Phase I GCCS Completed (Cells 1-4) & Flare Startup
Mar-09	Cell 6 Waste Filling Began	
Dec-09	Partial Closure (Cells 1-4 - Event 1) Complete	
Aug-10		Temporary Gas Monitoring Probes TGP-4 thru -13 installed
Sep-10		GCCS Phase I Sequence 3A Completed (Cells 1-4)
Oct-10		First round of gas probe readings with %CH_4 reported (instead of %LEL)
Nov-10	Cell 7 Construction Complete & FA Cost Estimate Approved	TOC Sampling and Temporary Gas Monitoring Probes TGP-1 thru -3 Installed
Dec-10		GCCS Connected to Leachate Sump Manholes and LC Risers (Cells 1-6)
Nov-11	Cell 7 Waste Filling Began	
Apr-12		SVE System installed and connected to GCCS
Jun-12	Cell 8 Waste Filling Began	Gas Probes GP-7 thru GP-22 were replaced (GP-7R thru GP-22R)
Nov-12	Dewatering at borrow pit complete, and Partial Closure (Cells 1-4 - Event 2) Complete	
Dec-12		Two additional Gas Extraction Wells for the SVE System installed near the Cell 5 sump Area
Mar-13		Three additional Gas Extraction Wells installed near the Cell 5 sump Area
Oct-13	Cell 9 Construction Complete	Removal of SVE System
Nov-13	Cell 9 Waste Filling Began	
Sep-14	Cell 10 Certification of Construction Completion (FDEP approval)	
Oct-15	Cell 11 Waste Filling Began	
Jan-16	Leachate Recirculation stopped	
Feb-16		Completion of the "2015" GCCS Expansion (Cells 1-8)
Jun-16	Cell 13 Construction Complete	
Oct-16	Cell 13 Waste Filling Began	
Mar-17		Completion of the "2016-2017" GCCS Expansion (Cells 3-6,9, and 10)

Table 2
Summary of Recent (2012 to 2017) Methane Results in GPs

Gas Probe	Cluster	Most Recent Detection of > 5% methane	Reported Methane %	Notes
GP-7R	1	Sep-14	8.5	Methane not detected above 5% from January 2014 to present.
GP-8R	2	NA	NA	Methane not detected above 5%.
GP-9R	3	Sep-15	16.6	Single methane detection over period of record.
GP-10R	4	NA	NA	Methane not detected above 5%.
GP-11R	5	Jul-12	28.5	Methane not detected from January 2013 to present.
GP-12R	6	NA	NA	Methane not detected above 5%. Over 50% methane reported in TGP over same period.
GP-13R	7	Sep-14	35.4	Single methane detection over 5% over period of record.
GP-14R	8	NA	NA	Methane not detected above 5%.
GP-15R	9	NA	NA	Methane not detected above 5%.
GP-16R	10	Mar-15	6.4	Single methane detection over period of record.
GP-17R	11	NA	NA	Methane not detected above 5%.
GP-18R	12	NA	NA	Methane not detected above 5%.
GP-19R	13/14	NA	NA	Methane not detected above 5%.
GP-20R	15	NA	NA	Methane not detected above 5%.
GP-21R	16	Dec-16	8.0	GCCS expansion to this area in March 2017
GP-22R	17	NA	NA	Methane not detected above 5%.
GP-23	18	NA	NA	Methane not detected above 5%.
GP-24	19	Dec-16	16.0	Methane not detected above 5% from February 2017 to present.

Notes
NA - not applicable, methane not detected above 5%



NORTH

0 200' 400'

SCALE IN FEET

LEGEND

- PROPERTY BOUNDARY
- LIMIT OF WASTE
- APPROXIMATE LOCATION OF INTERMITTENT STREAM
- EXISTING GROUND ELEVATION (FEET) (NOTES 2 AND 4)
- EXISTING FENCE LINE
- EXISTING TOPOGRAPHY SPOT ELEVATION (FEET)
- TREE LINE
- GP-17R GAS MONITORING PROBE
- MW-26A GROUNDWATER MONITORING WELL
- TGP-13 TEMPORARY GAS MONITORING PROBE
- EXISTING PARTIAL CLOSURE AREA
- WETLAND BOUNDARY BY PHOTO INTERPRETATION BY BRA (NOTE 8)
- WETLAND BOUNDARY PER BRA FLAGGING AND SURVEY BY JOHNSTON SURVEYING INC. (NOTE 8)
- 100-YEAR FLOODPLAIN (NOTE 9)
- APPROXIMATE LIMIT OF BORROW AREA (NOTE 10)

NOTES:

1. NORTHING AND EASTING COORDINATES SHOWN REPRESENT FLORIDA STATE PLANE EAST ZONE NORTH AMERICAN DATUM OF 1983 (NAD83)
2. THE ELEVATIONS SHOWN REPRESENT NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29)(FEET).
3. THE PROPERTY BOUNDARY IS BASED ON A COMPOSITE BOUNDARY SURVEY PROVIDED BY JOHNSTON SURVEYING INC., KISSIMMEE FLORIDA, DATED AUGUST 12, 1999.
4. TOPOGRAPHIC INFORMATION SHOWN ON THIS DRAWING WAS PROVIDED BY METROPOLITAN AERIAL SURVEYS BASED ON AN AERIAL PHOTOGRAPH TAKEN ON 10 MAY 2017.
5. THE TOPOGRAPHIC INFORMATION PROVIDED DOES NOT NECESSARILY REPRESENT CURRENT CONDITIONS. THE CONTRACTOR SHALL UNDERSTAND CURRENT CONDITIONS BASED ON FIELD RECONNAISSANCE AND/OR ADDITIONAL TOPOGRAPHIC SURVEYS AT THEIR EXPENSE.
6. GAS INFORMATION IS BASED ON A DRAWING TITLED "ASBUILT SURVEY - GAS PROBES 2015" SURVEY DATE 16 JUNE 2015 AND A DRAWING TITLED "SPECIFIC PURPOSE SURVEY" SURVEY DATE 13 JULY 2011 PROVIDED BY PEAVEY & ASSOCIATES SURVEYING & MAPPING PA.
7. TEMPORARY GAS MONITORING PROBES IS BASED ON A DRAWING TITLED " PROBE LOCATION MAP" CREATED 11 NOVEMBER 2010 PROVIDED BY GOLDER ASSOCIATES. THE LOCATIONS FOR THE TEMPORARY GAS MONITORING PROBES ARE APPROXIMATE AND SHOULD ONLY BE USED FOR GENERAL REFERENCE.
8. THE WETLAND BOUNDARY INFORMATION SHOWN IS BASED ON A FIELD SURVEY DATED MAY 15, 2002 BY JOHNSTON SURVEYING INC. OF WETLANDS BOUNDARIES FLAGGED BY BIOLOGICAL RESEARCH ASSOCIATES, INC., TAMPA, FLORIDA (BRA), AND JDS PERMIT, COMBINED WITH A PHOTO INTERPRETATION OF WETLAND BOUNDARIES BY BRA IN AREAS OF THE SITE OUTSIDE THE LIMITS OF CONSTRUCTION.
9. THE 100-YEAR FLOODPLAIN BOUNDARY SHOWN WAS PROVIDED BY THE OSCEOLA COUNTY GIS DEPARTMENT ON JANUARY 9, 2002.
10. APPROXIMATE LIMIT OF BORROW AREA IS DIGITIZED FROM A DRAWING TITLED "BORROW AREA "B" GEOMETRY & EXCAVATION PHASING PLAN" PROVIDED BY RHPA, REVISION 2 DATED 04 MAY 2004.

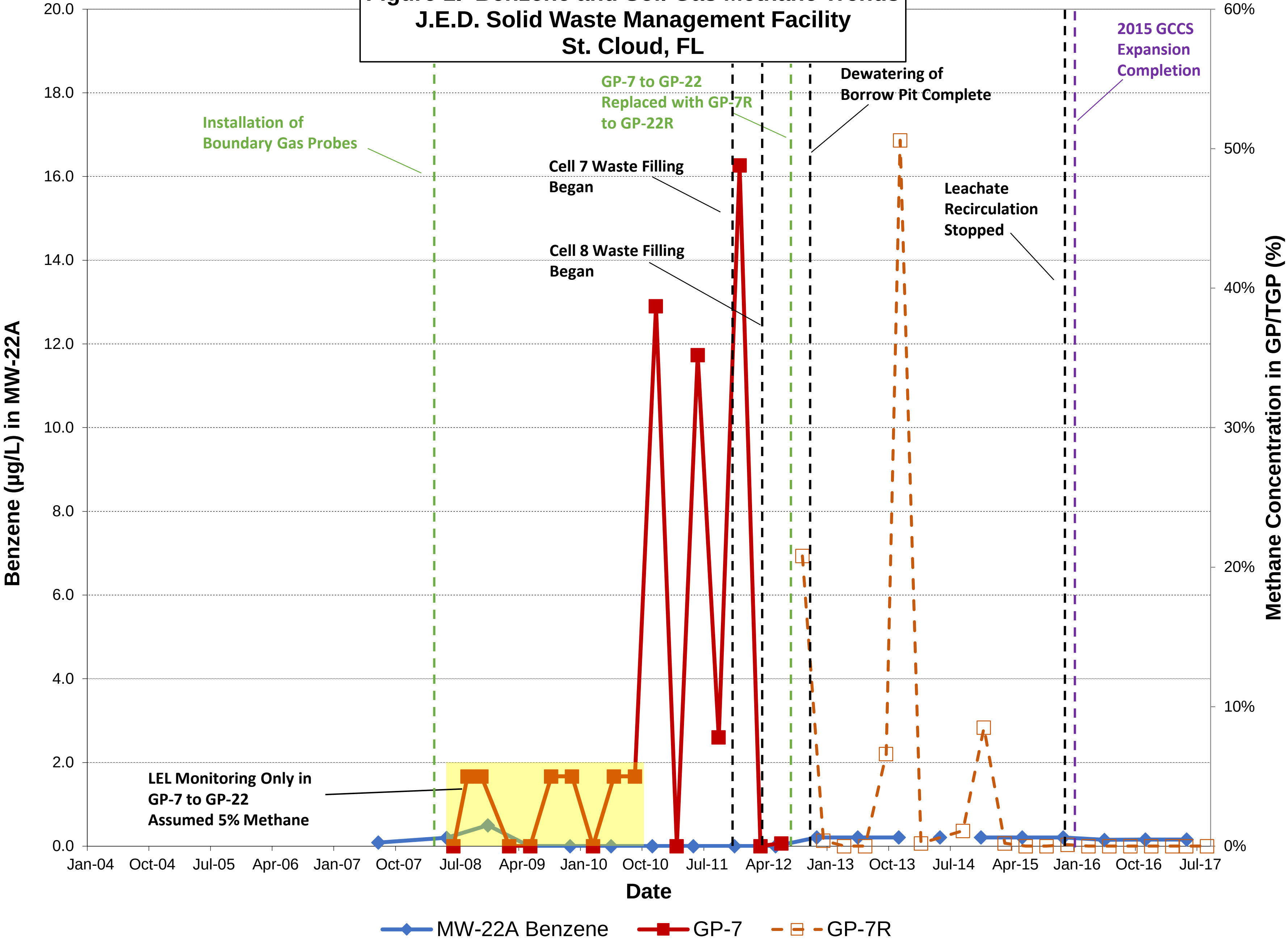
SOIL GAS AND WATER QUALITY MONITORING NETWORK
JED SOLID WASTE MANAGEMENT FACILITY

Geosyntec consultants

PROJECT NO: FL3090.01 | AUGUST 2017

FIGURE 1

Figure 1. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL



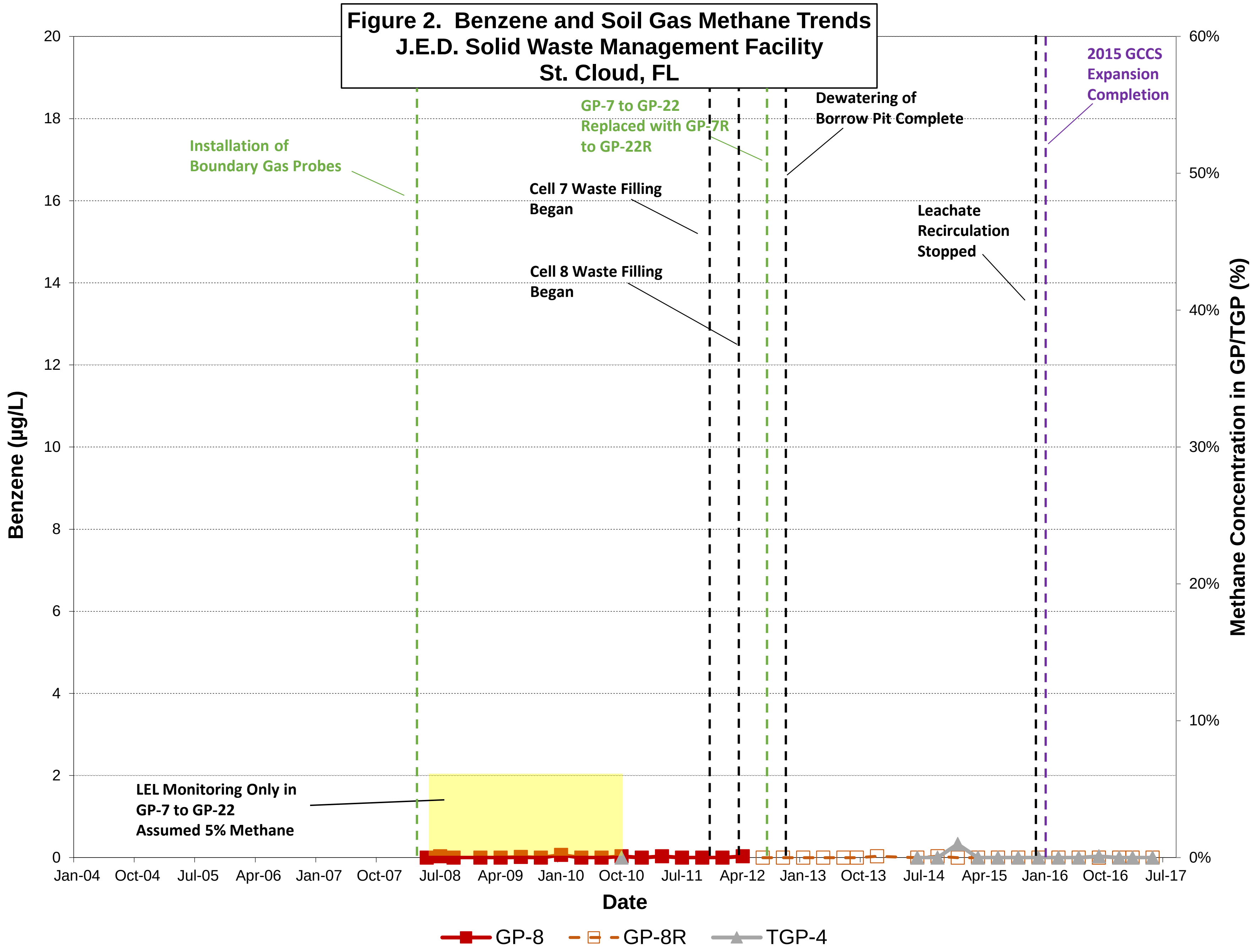


Figure 2. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Installation of Boundary Gas Probes
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
2015 GCCS Expansion Completion
Cell 7 Waste Filling Began
Cell 8 Waste Filling Began
Leachate Recirculation Stopped
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
Benzene (µg/L)
Methane Concentration in GP/TGP (%)
Date
20
18
16
14
12
10
8
6
4
2
0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
GP-8
GP-8R
TGP-4

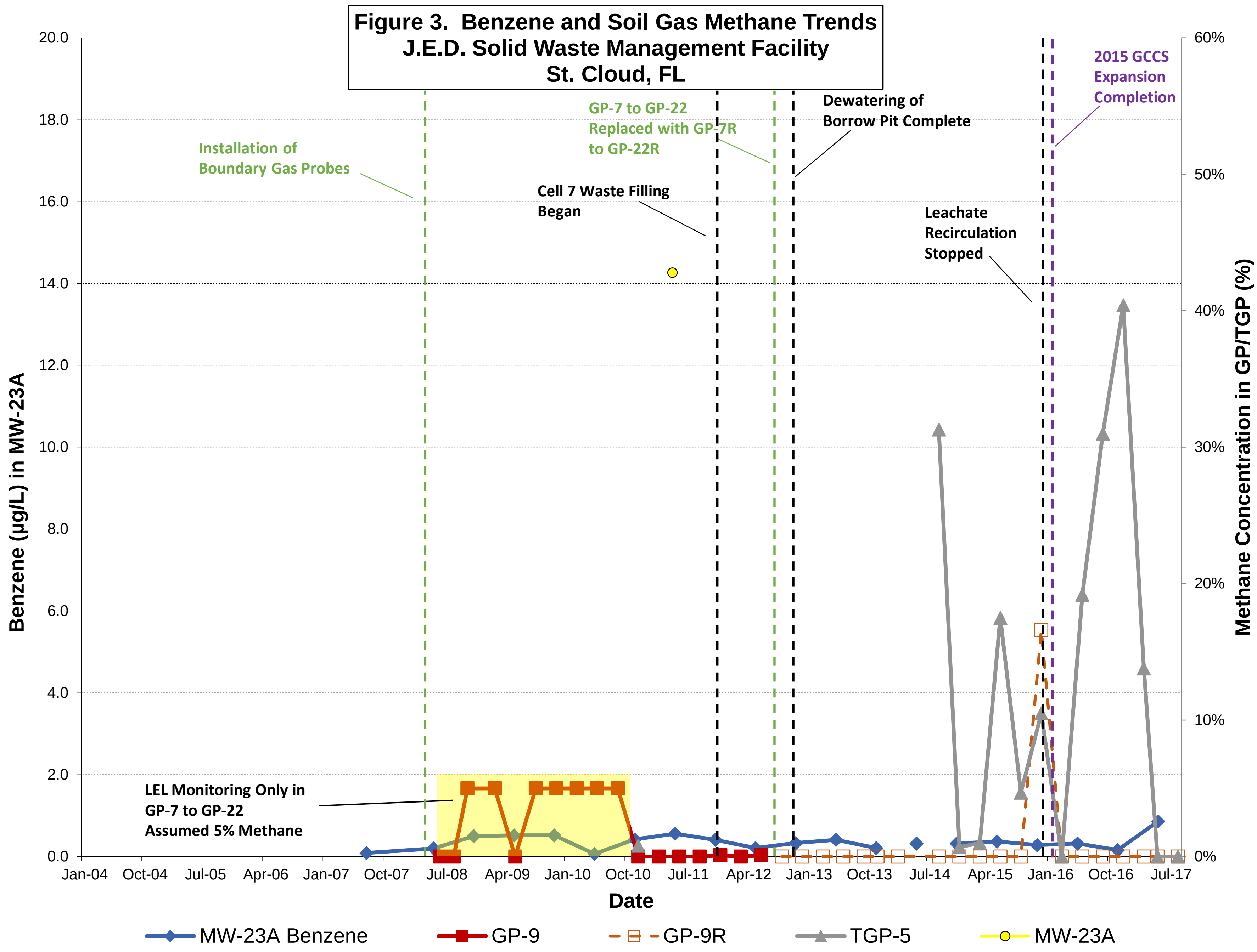
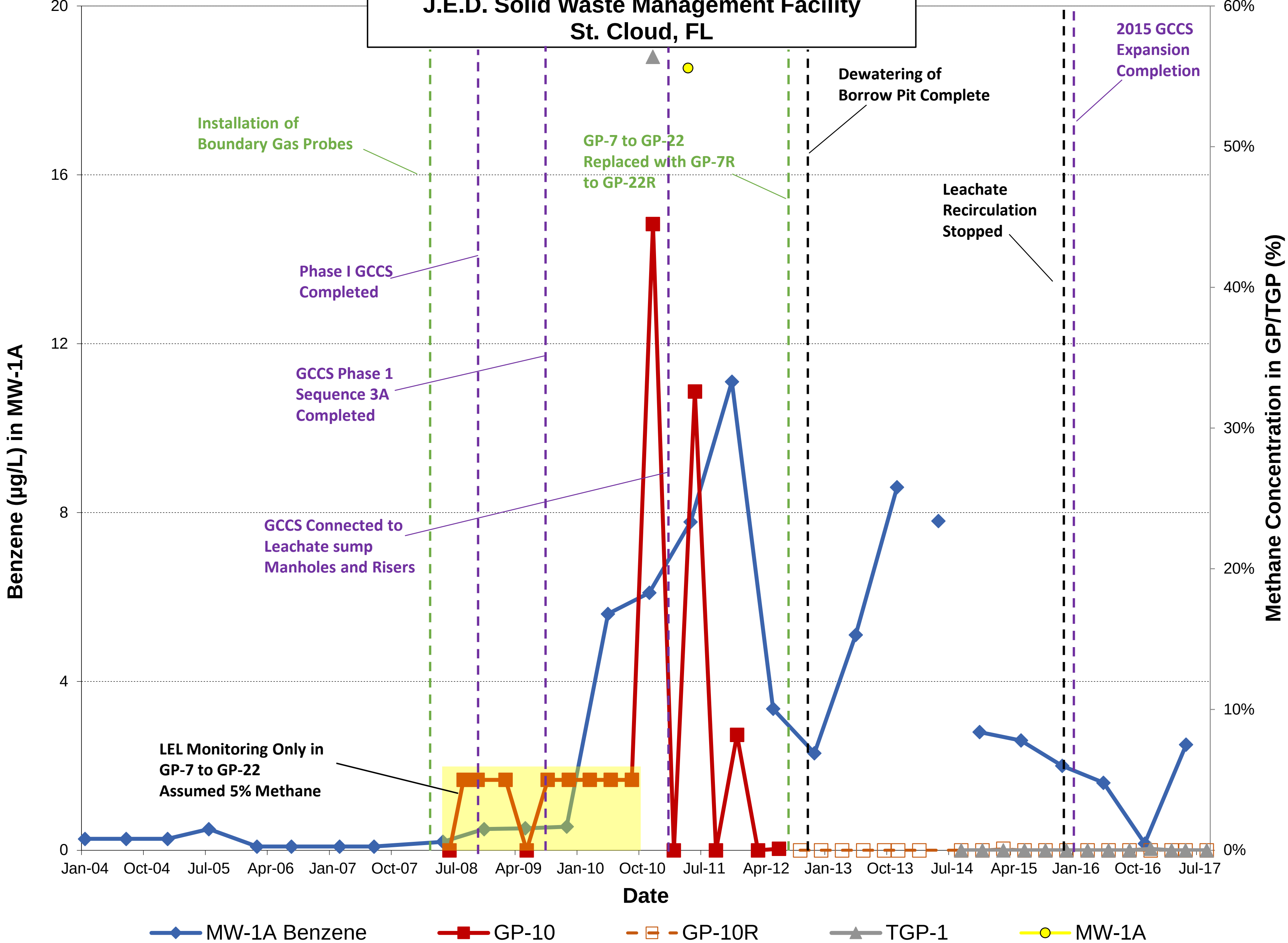


Figure 3. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Installation of Boundary Gas Probes
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Cell 7 Waste Filling Began
Dewatering of Borrow Pit Complete
Leachate Recirculation Stopped
2015 GCCS Expansion Completion
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
Benzene (µg/L) in MW-23A
Methane Concentration in GP/TGP (%)
Date
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
0%
10%
20%
30%
40%
50%
60%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
MW-23A Benzene
GP-9
GP-9R
TGP-5
MW-23A

Figure 4. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL



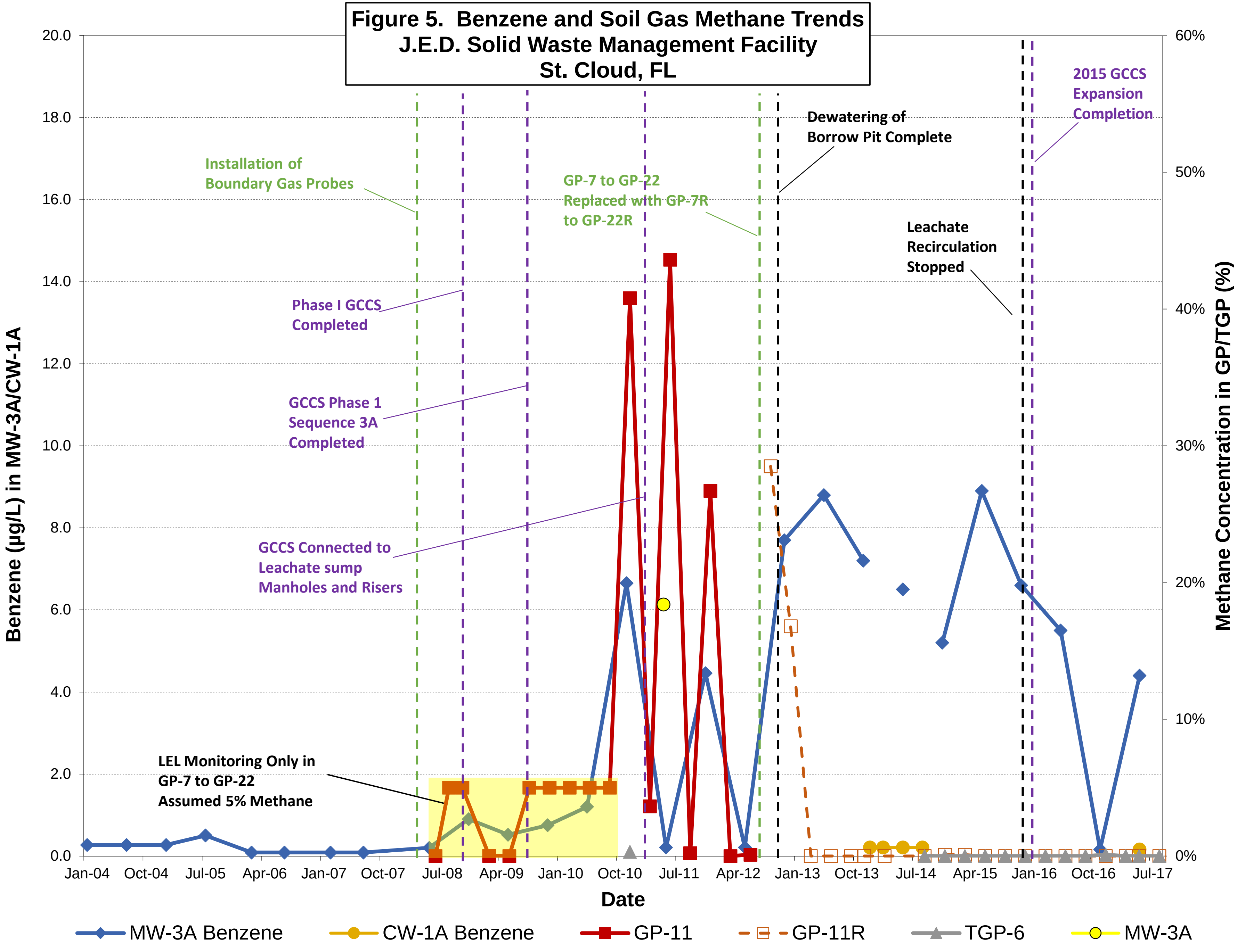


Figure 5. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Benzene (µg/L) in MW-3A/CW-1A
Methane Concentration in GP/TGP (%)
Date
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
Installation of Boundary Gas Probes
Phase I GCCS Completed
GCCS Phase 1 Sequence 3A Completed
GCCS Connected to Leachate sump Manholes and Risers
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
Leachate Recirculation Stopped
2015 GCCS Expansion Completion
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
MW-3A Benzene
CW-1A Benzene
GP-11
GP-11R
TGP-6
MW-3A

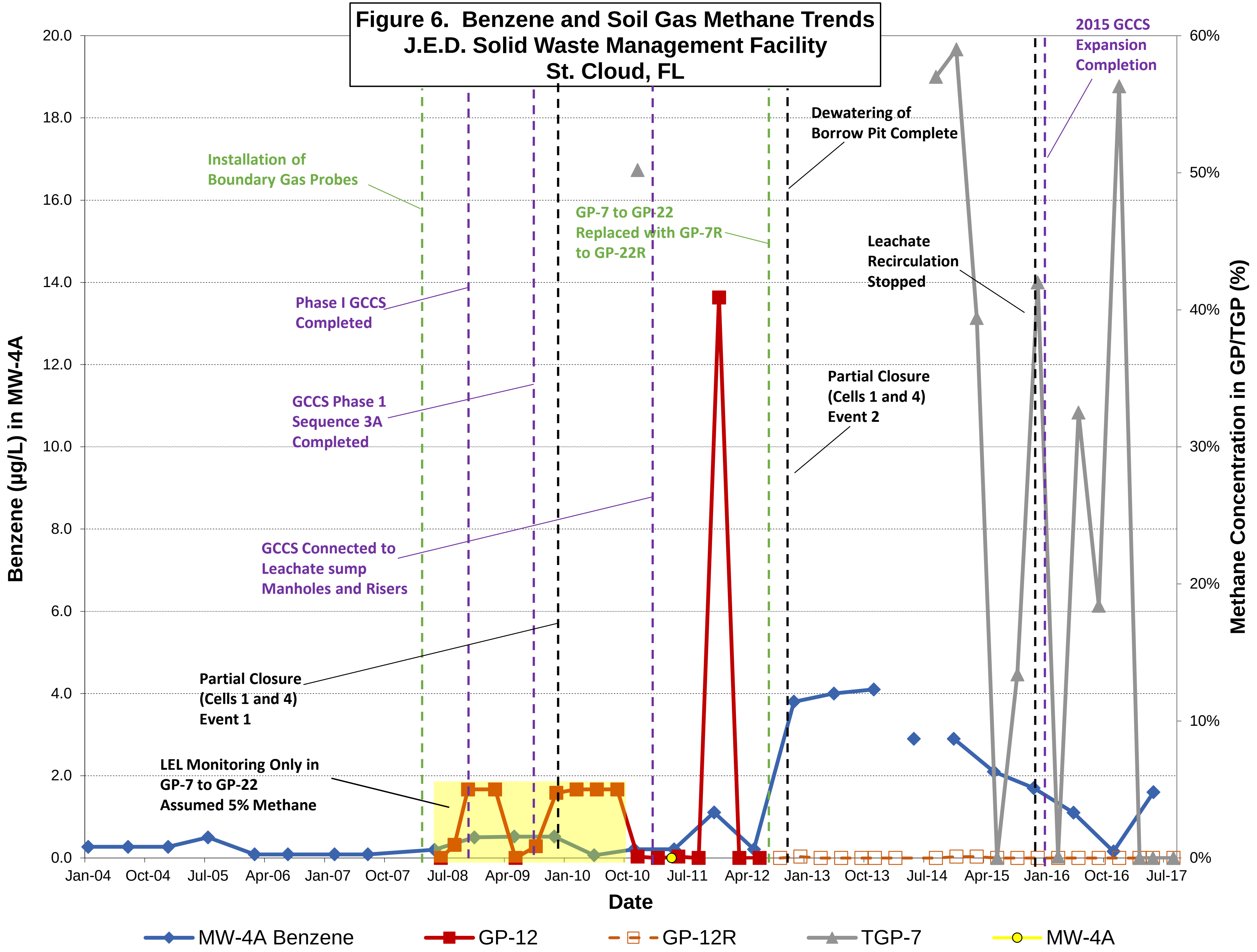


Figure 6. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Benzene (µg/L) in MW-4A
Methane Concentration in GP/TGP (%)
Date
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
Installation of Boundary Gas Probes
Phase I GCCS Completed
GCCS Phase 1 Sequence 3A Completed
GCCS Connected to Leachate sump Manholes and Risers
Partial Closure (Cells 1 and 4) Event 1
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
Leachate Recirculation Stopped
Partial Closure (Cells 1 and 4) Event 2
2015 GCCS Expansion Completion
MW-4A Benzene
GP-12
GP-12R
TGP-7
MW-4A

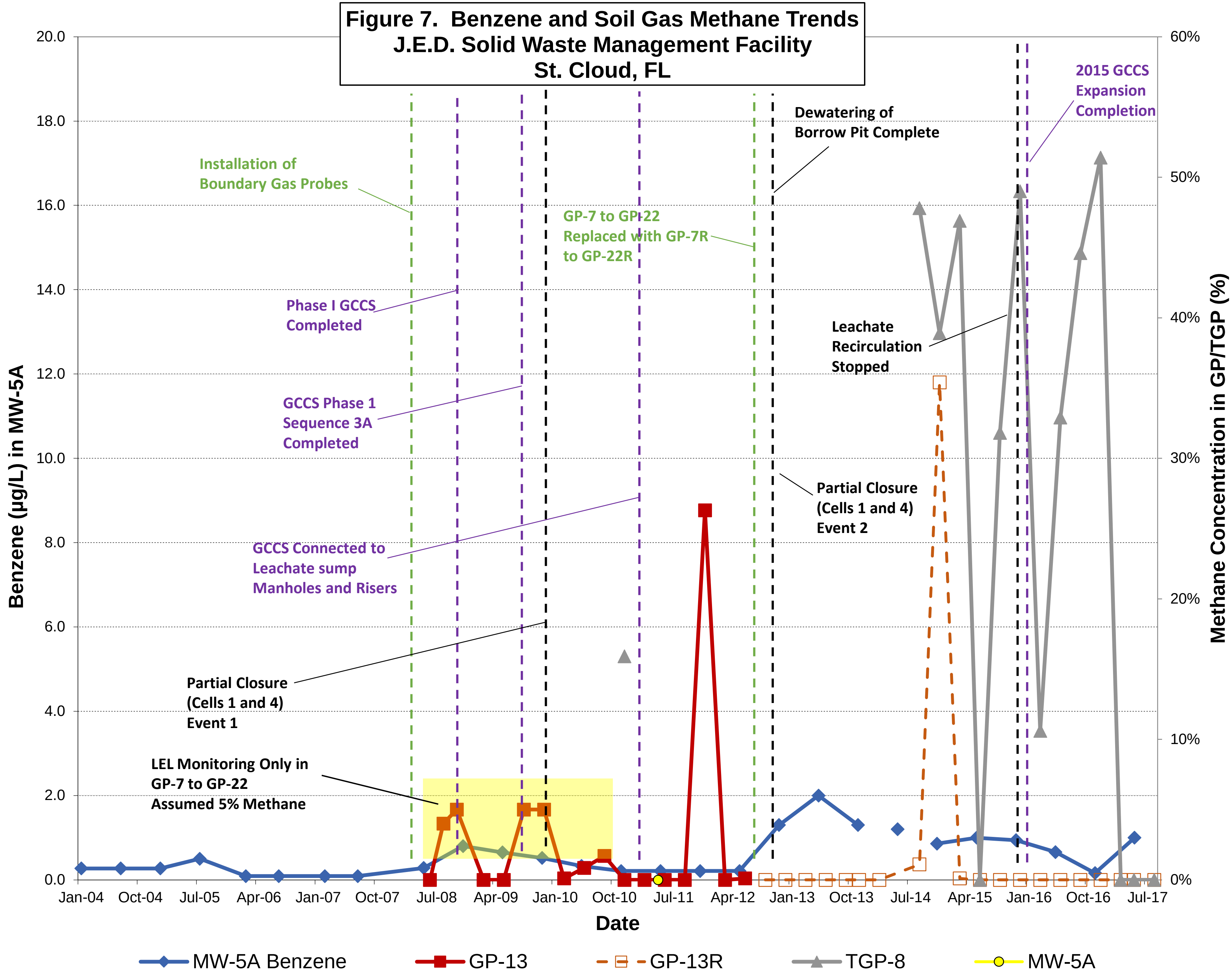


Figure 7. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Installation of Boundary Gas Probes
Phase I GCCS Completed
GCCS Phase 1 Sequence 3A Completed
GCCS Connected to Leachate sump Manholes and Risers
Partial Closure (Cells 1 and 4) Event 1
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
Partial Closure (Cells 1 and 4) Event 2
Leachate Recirculation Stopped
2015 GCCS Expansion Completion
Benzene (µg/L) in MW-5A
Methane Concentration in GP/TGP (%)
Date
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
MW-5A Benzene
GP-13
GP-13R
TGP-8
MW-5A

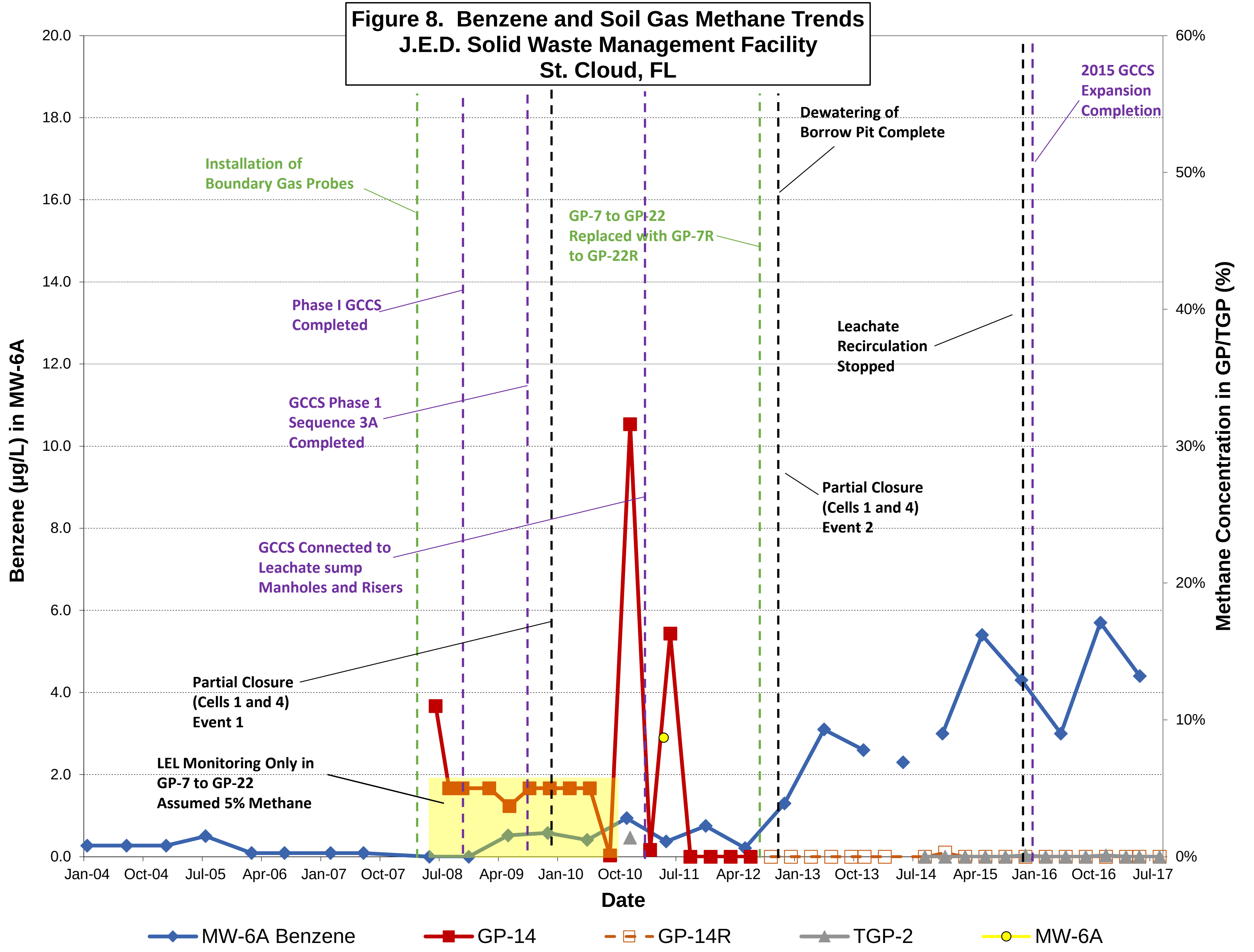


Figure 8. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Benzene (µg/L) in MW-6A
Methane Concentration in GP/TGP (%)
Date
Installation of Boundary Gas Probes
Phase I GCCS Completed
GCCS Phase 1 Sequence 3A Completed
GCCS Connected to Leachate sump Manholes and Risers
Partial Closure (Cells 1 and 4) Event 1
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
Leachate Recirculation Stopped
Partial Closure (Cells 1 and 4) Event 2
2015 GCCS Expansion Completion
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
MW-6A Benzene
GP-14
GP-14R
TGP-2
MW-6A

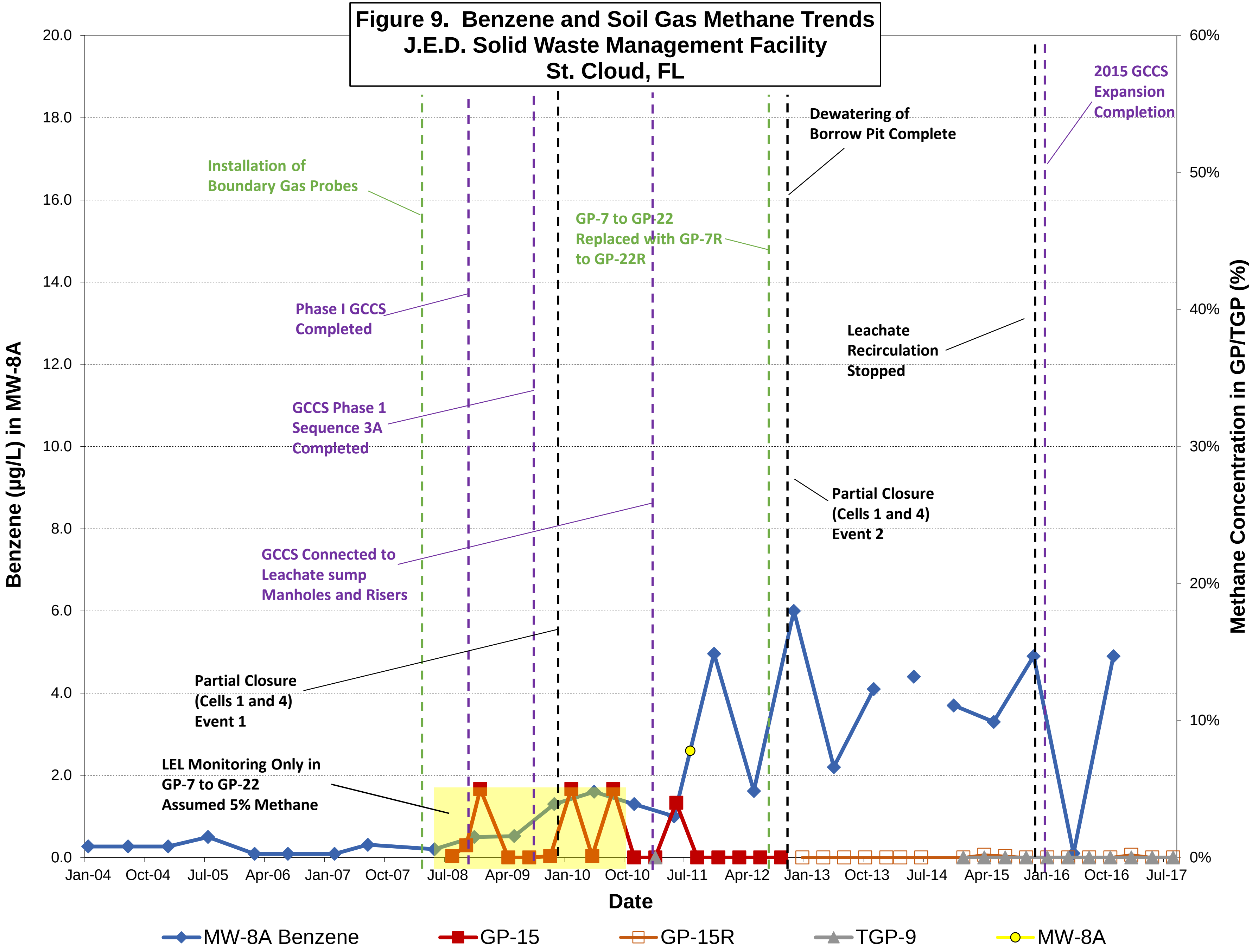


Figure 9. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Installation of Boundary Gas Probes
Phase I GCCS Completed
GCCS Phase 1 Sequence 3A Completed
GCCS Connected to Leachate sump Manholes and Risers
Partial Closure (Cells 1 and 4) Event 1
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
Leachate Recirculation Stopped
Partial Closure (Cells 1 and 4) Event 2
2015 GCCS Expansion Completion
Benzene (µg/L) in MW-8A
Methane Concentration in GP/TGP (%)
Date
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
MW-8A Benzene
GP-15
GP-15R
TGP-9
MW-8A

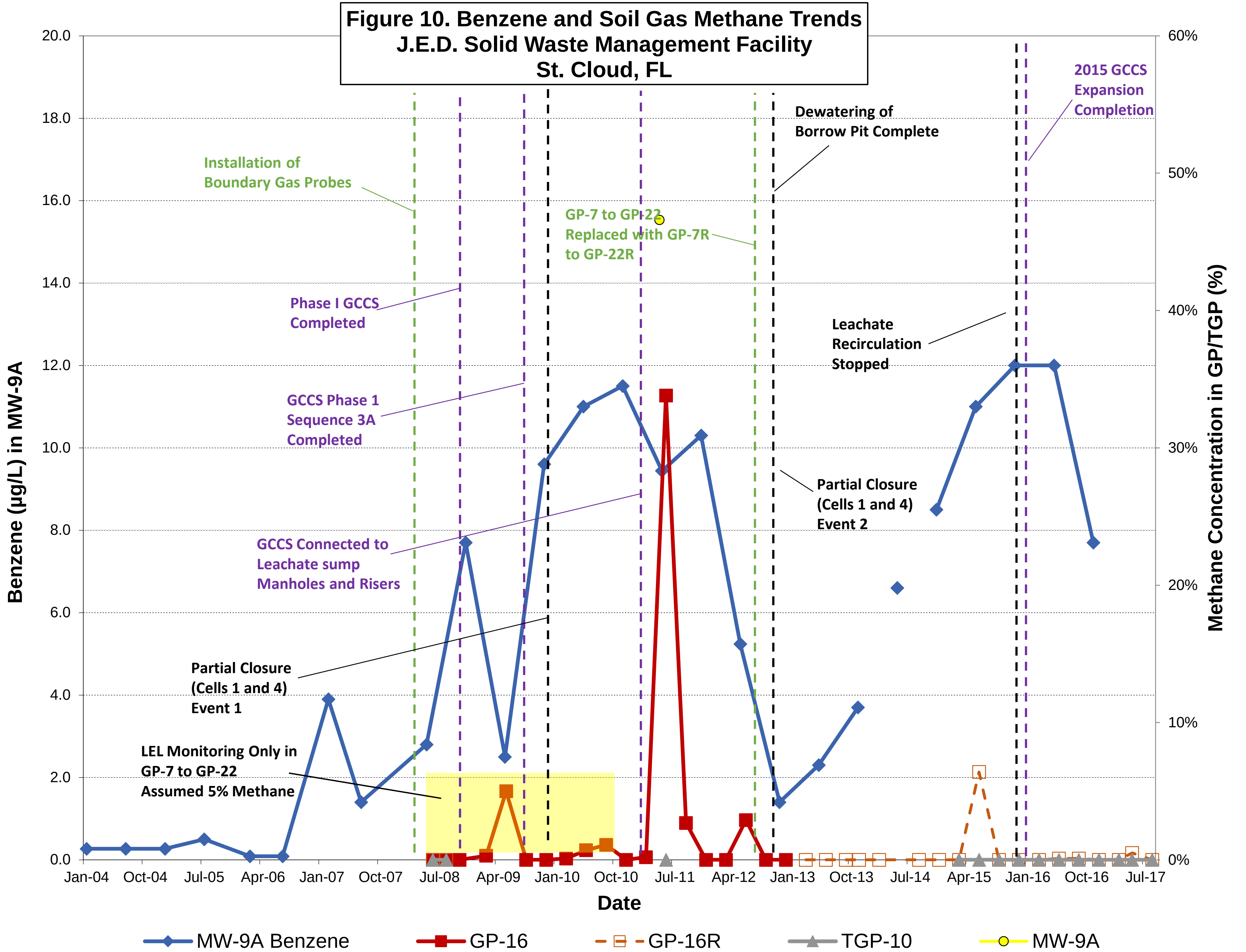


Figure 10. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Benzene (µg/L) in MW-9A
Methane Concentration in GP/TGP (%)
Date
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
Installation of Boundary Gas Probes
Phase I GCCS Completed
GCCS Phase 1 Sequence 3A Completed
GCCS Connected to Leachate sump Manholes and Risers
Partial Closure (Cells 1 and 4) Event 1
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
Partial Closure (Cells 1 and 4) Event 2
Leachate Recirculation Stopped
2015 GCCS Expansion Completion
MW-9A Benzene
GP-16
GP-16R
TGP-10
MW-9A

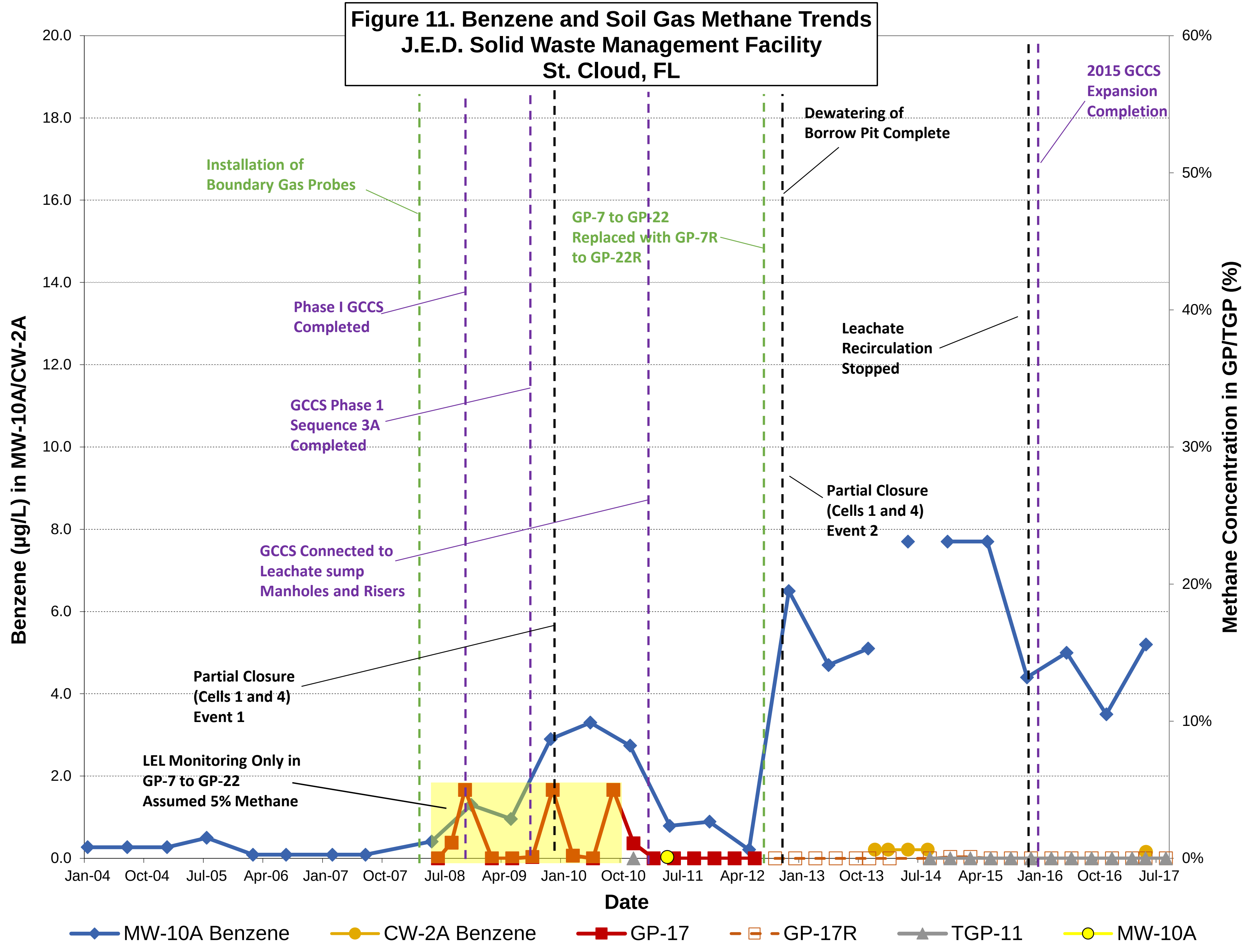


Figure 11. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Benzene (µg/L) in MW-10A/CW-2A
Methane Concentration in GP/TGP (%)
Date
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
Installation of Boundary Gas Probes
Phase I GCCS Completed
GCCS Phase 1 Sequence 3A Completed
GCCS Connected to Leachate sump Manholes and Risers
Partial Closure (Cells 1 and 4) Event 1
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
Leachate Recirculation Stopped
Partial Closure (Cells 1 and 4) Event 2
2015 GCCS Expansion Completion
MW-10A Benzene
CW-2A Benzene
GP-17
GP-17R
TGP-11
MW-10A

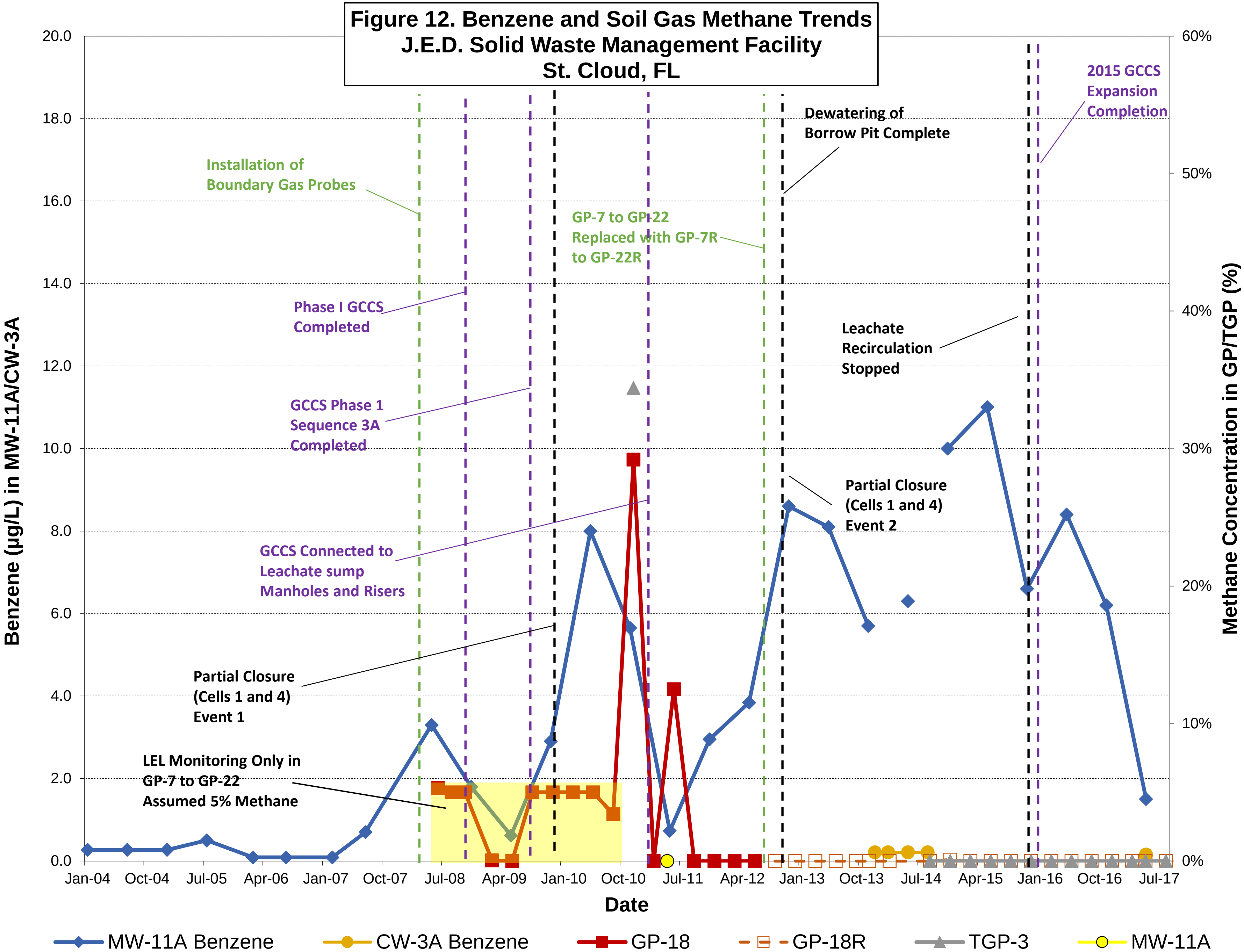
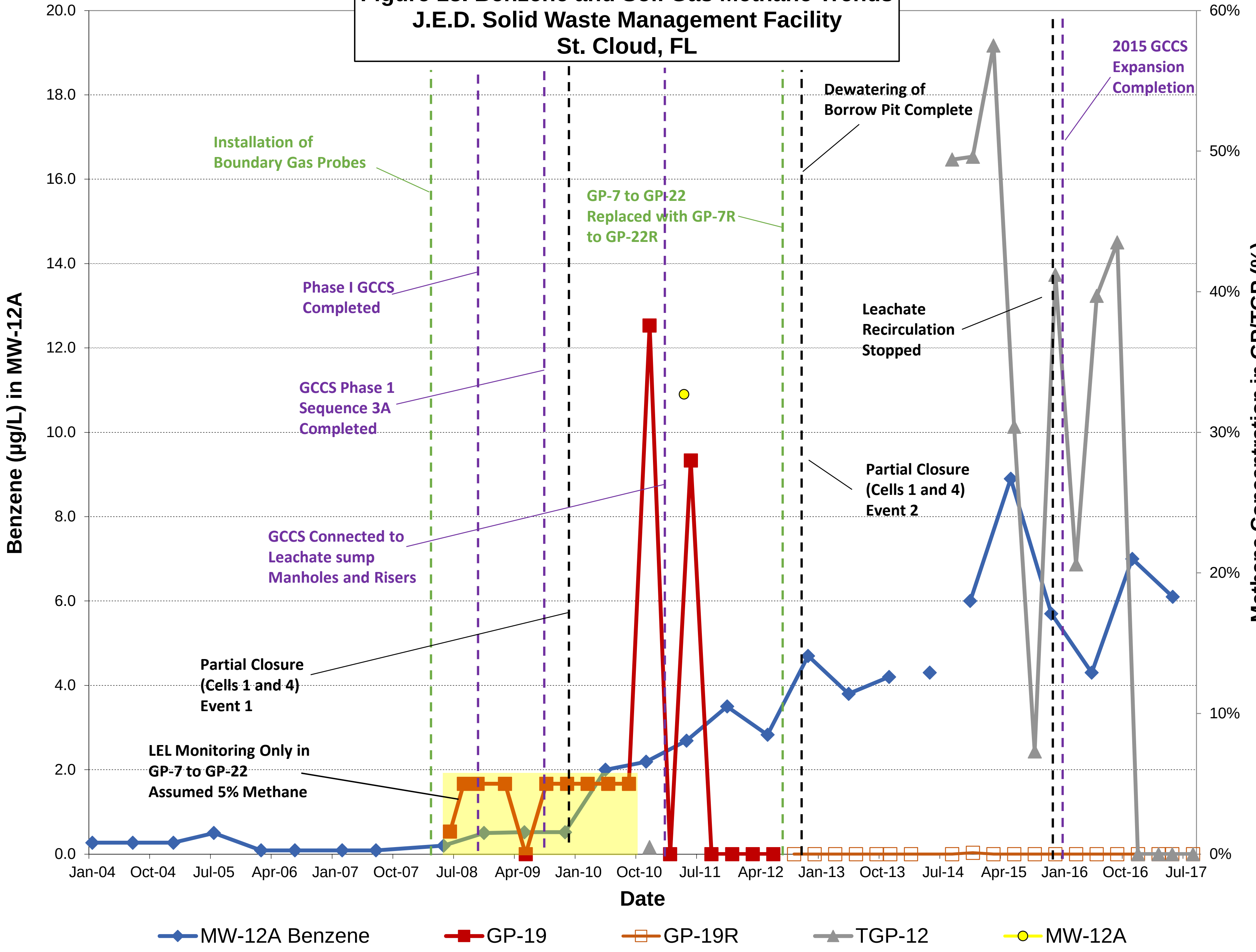


Figure 12. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Benzene (µg/L) in MW-11A/CW-3A
Methane Concentration in GP/TGP (%)
Date
Installation of Boundary Gas Probes
Phase I GCCS Completed
GCCS Phase 1 Sequence 3A Completed
GCCS Connected to Leachate sump Manholes and Risers
Partial Closure (Cells 1 and 4) Event 1
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
Leachate Recirculation Stopped
Partial Closure (Cells 1 and 4) Event 2
2015 GCCS Expansion Completion
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
MW-11A Benzene
CW-3A Benzene
GP-18
GP-18R
TGP-3
MW-11A

Figure 13. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL



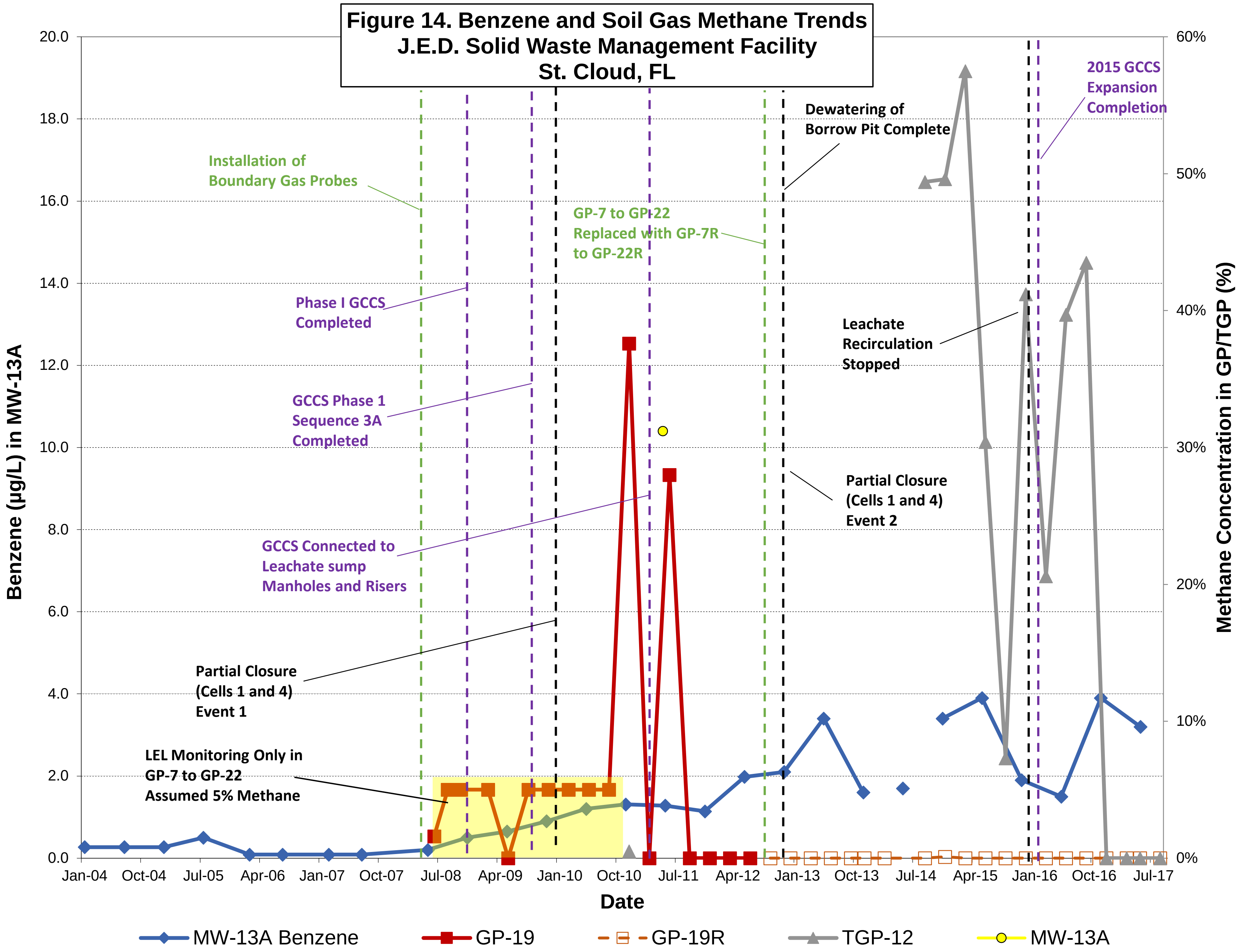


Figure 14. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Benzene (µg/L) in MW-13A
Methane Concentration in GP/TGP (%)
Date
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
Installation of Boundary Gas Probes
Phase I GCCS Completed
GCCS Phase 1 Sequence 3A Completed
GCCS Connected to Leachate sump Manholes and Risers
Partial Closure (Cells 1 and 4) Event 1
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
Leachate Recirculation Stopped
Partial Closure (Cells 1 and 4) Event 2
2015 GCCS Expansion Completion
MW-13A Benzene
GP-19
GP-19R
TGP-12
MW-13A

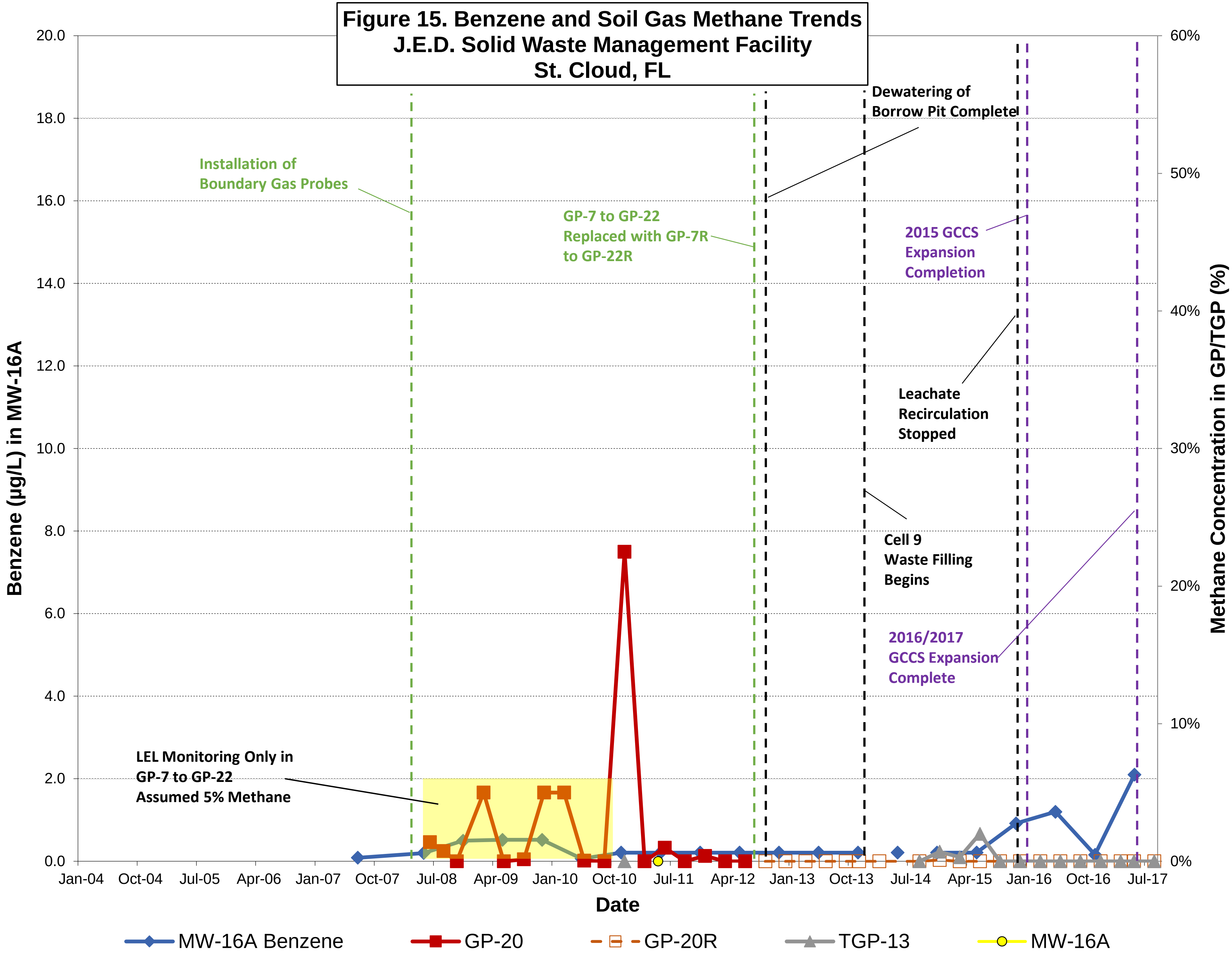


Figure 15. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Benzene (µg/L) in MW-16A
Methane Concentration in GP/TGP (%)
Date
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
Installation of Boundary Gas Probes
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
2015 GCCS Expansion Completion
Leachate Recirculation Stopped
Cell 9 Waste Filling Begins
2016/2017 GCCS Expansion Complete
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
MW-16A Benzene
GP-20
GP-20R
TGP-13
MW-16A

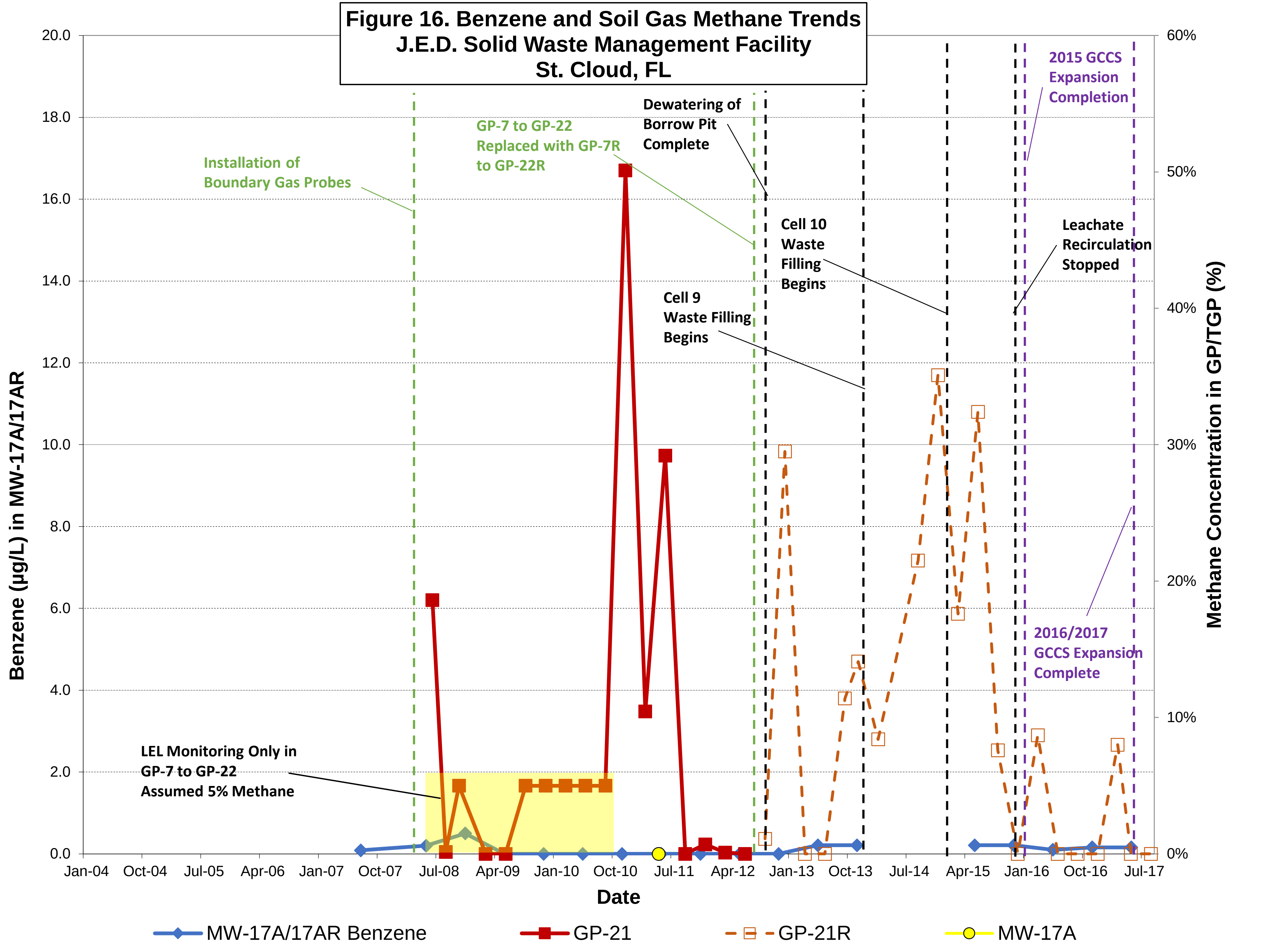


Figure 16. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Installation of Boundary Gas Probes
GP-7 to GP-22 Replaced with GP-7R to GP-22R
Dewatering of Borrow Pit Complete
Cell 10 Waste Filling Begins
Cell 9 Waste Filling Begins
2015 GCCS Expansion Completion
Leachate Recirculation Stopped
2016/2017 GCCS Expansion Complete
LEL Monitoring Only in GP-7 to GP-22 Assumed 5% Methane
Benzene (µg/L) in MW-17A/17AR
Methane Concentration in GP/TGP (%)
Date
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
60%
50%
40%
30%
20%
10%
0%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
MW-17A/17AR Benzene
GP-21
GP-21R
MW-17A

Figure 17. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL

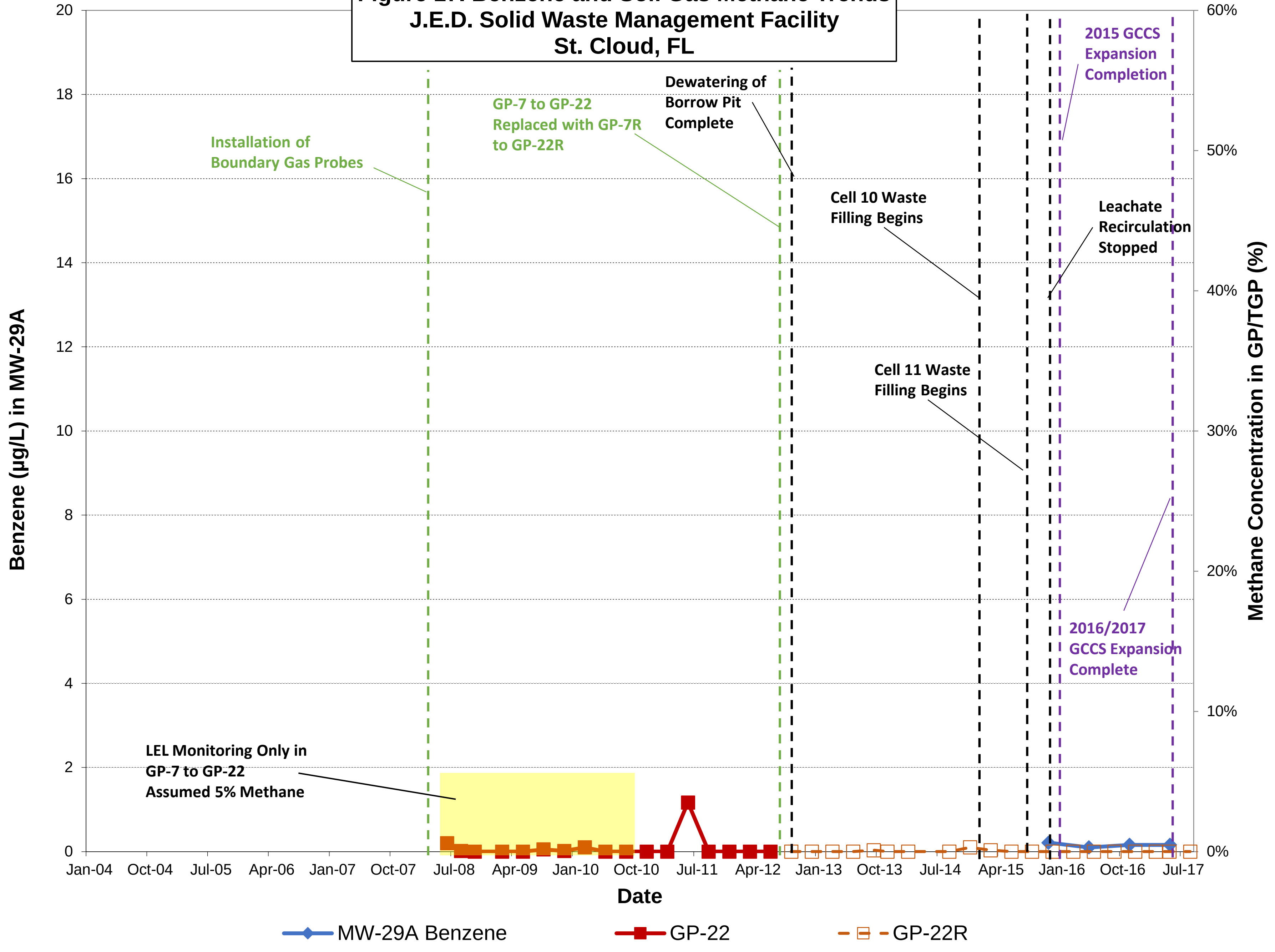
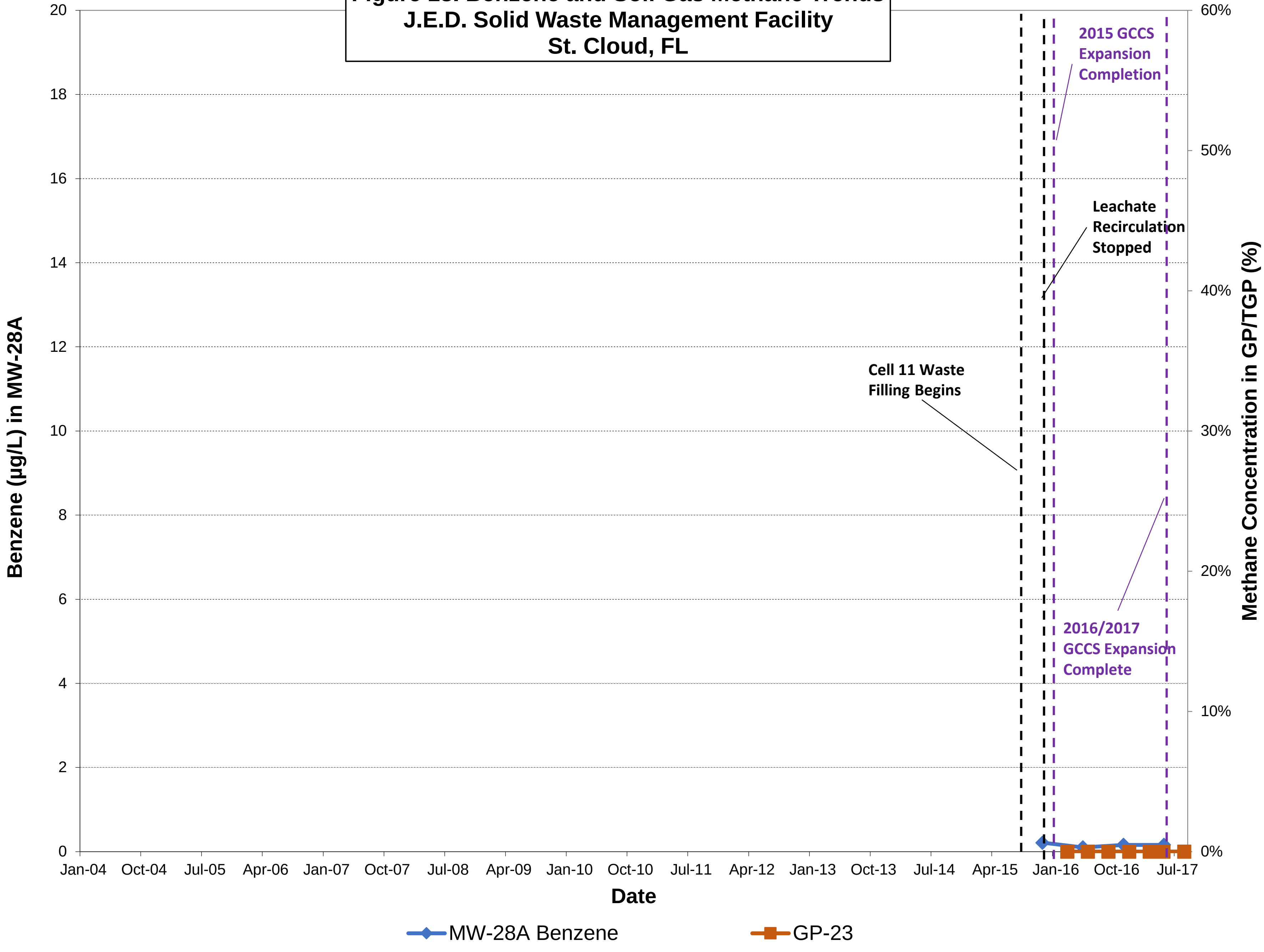


Figure 18. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL



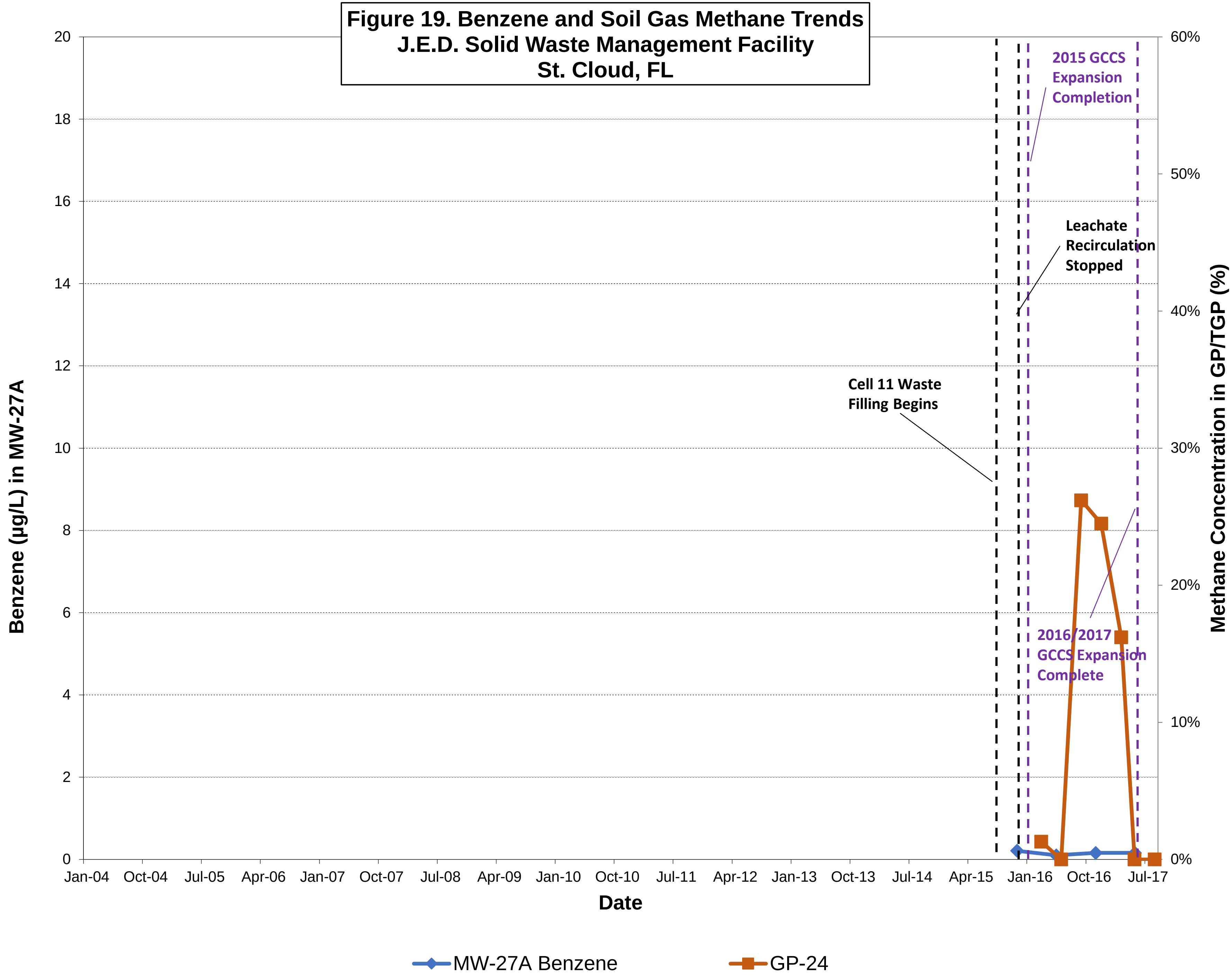


Figure 19. Benzene and Soil Gas Methane Trends
J.E.D. Solid Waste Management Facility
St. Cloud, FL
Benzene (µg/L) in MW-27A
Methane Concentration in GP/TGP (%)
Date
0
2
4
6
8
10
12
14
16
18
20
0%
10%
20%
30%
40%
50%
60%
Jan-04
Oct-04
Jul-05
Apr-06
Jan-07
Oct-07
Jul-08
Apr-09
Jan-10
Oct-10
Jul-11
Apr-12
Jan-13
Oct-13
Jul-14
Apr-15
Jan-16
Oct-16
Jul-17
Cell 11 Waste Filling Begins
Leachate Recirculation Stopped
2015 GCCS Expansion Completion
2016/2017 GCCS Expansion Complete
MW-27A Benzene
GP-24