# Pennsylvania Avenue Landfill
# Brooklyn, New York
# NYSDEC Site No. 224002

# Annual Post-Closure Operation, Maintenance and Monitoring Report
# January 2016 through December 2016

## March 2017

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# Table of Contents

## List of Figures

## List of Tables

## Section 1- Introduction

This Post-Closure Annual Summary Report (Report) has been prepared by the New York City Department of Environmental Protection (NYCDEP) to fulfill the reporting requirements contained in the Pennsylvania Avenue Landfill (PAL) Operation and Maintenance (O&M) Manual, the PAL Monitoring Plan, and 6NYCRR Part 360. This Report documents the operation, maintenance and monitoring activities performed during the PAL eighth annual post-closure reporting period from January 1 through December 31, 2016.

## Section 2 - Site Background

The PAL inactive hazardous waste disposal site (Site) is located on 110 acres at the southern end of Pennsylvania Avenue in Brooklyn, New York. It is bounded by the Belt Parkway, Jamaica Bay, Hendrix Creek and Fresh Creek. A site location map is provided in Figure 1.

In 1956, the Site was opened to receive residential and commercial wastes, including construction and demolition (C&D) residuals and waste oil. In 1962, land-filling activities shifted to the Fountain Avenue Landfill (FAL). The PAL was reopened for disposal of C&D wastes in 1968. It is reported that, between 1974 and 1980, illegal dumping of hazardous wastes occurred at the Site. Disposal of all wastes stopped by 1980, and the Site was added to the Registry of Inactive Hazardous Waste Disposal Sites requiring surveillance. In 1983, the Site was reclassified to a Class 3, which is a site considered not to pose a significant threat, and for which action can be deferred. After an oil inventory and product recovery feasibility study conducted in 1984, the Site was reclassified to a Class 2, a site which poses a significant threat to public health or the environment.

On December 16, 1985, and again on April 17, 1990, the New York State Department of Environmental Conservation (NYSDEC) executed Orders on Consent with the New York City Department of Sanitation (DOS) to close and remediate the Site. On April 7, 1992, the DEP entered into a Consent Order with the NYSDEC to perform a remedial program at the Site.

In response to this, DEP conducted a Remedial Investigation/Feasibility Study (RI/FS) to determine the nature and extent of contamination. The Final RI/FS, dated May 1994, revealed that certain areas and media at the Site required remediation; a summary of these results follows:

- Surface soil and sediment samples exhibited varying levels of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, pesticides and PCBs contamination.
- It was determined that a floating product (i.e., separate-phase petroleum) plume beneath the Site contaminated the groundwater in the leachate mound and the surface water in Fresh Creek. Tests indicated that the waste oils with the capacity to migrate to the shoreline had already done so, and the remaining oils are stationary. In addition to the VOC and SVOC levels associated with residual petroleum contamination, the waste oil contained PCB levels that classify it as a hazardous waste.

- Groundwater in the leachate mound (U wells – fill aquifer) was somewhat contaminated with VOCs, SVOCs and PCBs, and it was more so in the areas where it was in contact with the floating oil plume. The shallow and deep Upper Glacial Aquifer (S & D wells) did not require remediation because they did not exhibit significant levels of contamination.

By the Order on Consent, Interim Remedial Measures (IRMs) were implemented. An interim cover was placed to prevent casual contact with exposed waste and minimize emissions. Rip-rap was installed for shoreline protection. Construction of a passive waste oil interceptor trench was completed in January 1994. The purpose of the trench is to capture waste oil before it reaches Fresh Creek; however, to date actual oil migration to the trench has been minimal.

The goals for the remediation program were set to eliminate or minimize the threats to the public health and the environment, by addressing the contamination of subsurface soils and waste disposal areas; by protecting surface waters through eradication of run-off and erosion from contaminated substrates and the migration of leachate into surrounding waters; by minimizing the impact of contaminated groundwater; by reducing soil and sediment contamination levels and removing the possibility of human or animal contact; and, by controlling and containing landfill gas emissions.

The Final Feasibility Study Report, dated September 1994, detailed the selection process and the remedial alternative chosen. The option selected included a 6NYCRR Part 360 cap, leachate collection along Fresh Creek, limited sediment excavation, active gas control, and long term monitoring of site media.

The Record of Decision (ROD), dated February 1995, presented the remedial action. In accordance with the ROD, the Site was remediated under construction Contracts Nos. LF-PAL-G2/E2 and LF-PAL-G3. The main elements of this action included:

- Remediation of approximately 30,000 cubic yards of sediment along the Fresh Creek shoreline.
- Installation of a groundwater/leachate (GW/L) management system consisting of a 750-feet-long interceptor trench, two pumping stations, a force-main and an enclosed leachate pre-treatment system with subsequent disposal to the 26$^{th}$ Ward Wastewater Treatment Plant (WWTP).
- Regrading of the Site to provide proper drainage and minimize erosion.
- Installation of a stormwater collection, conveyance and outfall system.
- Installation of an actively vented impermeable final cover consisting, from top to bottom, of a vegetated top soil layer (6" minimum), a soil barrier protection layer (12"), a Type 2 cover double-sided geocomposite drainage layer or a Type 1 cover cushion geotextile, an LLPDE geomembrane liner (40 mil thick), and a sub-base grading fill layer.
- Planting of warm season grasses and approximately 13,000 shrubs and trees
- Installation of an active landfill gas (LFG) collection system and flaring station.

The ROD called for a pre-approved Post-Closure Monitoring, Sampling and Analysis Plan (the Monitoring Plan, the Plan) to commence within one month of DEP's receipt of NYSDEC's written approval of the Final Engineering Report (FER) for the Site. The FER acceptance letter was dated

March 26, 2009, and the first monitoring round was initiated within a month of its receipt and performed in accordance with the Monitoring Plan requirements. Subsequently, the ground-water portion of the Monitoring Plan was revised to allow the low-flow purging and sampling method to be used to collect groundwater samples for the analysis of both the inorganic and organic parameters. These revised Monitoring Plan requirements were utilized commencing with the second Post-Closure monitoring event. Based on the results of one year of quarterly post-closure monitoring, the frequency of ground water monitoring was reduced from quarterly to annually in rotating calendar quarters (i.e., once every five quarters), and the list of parameters required to be monitored was reduced. The 2011 annual monitoring round was performed during the first quarter of 2011, the 2012 annual monitoring round was performed during the second quarter of 2012, the 2013 annual monitoring round was performed during the third quarter of 2013, the 2014 annual monitoring round was performed during the fourth quarter, and the 2016 annual monitoring round was performed during the first quarter. The next monitoring round will be performed during the second quarter of 2017. Soil gas quality readings are taken from the five gas monitoring wells located beyond the perimeter of the cap, parallel to the Belt Parkway quarterly.

Prior to approval of the FER, a preliminary groundwater sampling and analysis round was conducted in July 2007. Since their installation in May 2008, the perimeter soil gas wells are monitored as needed, and at least quarterly as mandated by the Monitoring Plan.

In July 2012, the NYSDEC changed the classification of the PAL site from a Class 2 to a Class 4 site on the Registry of Inactive Hazardous Waste Disposal Sites since it was properly remediated and requires site management.

# Section 3 – Annual Summary

This Report covers the eighth annual post-closure reporting period from January 1 through December 31, 2016.

## 3.1 Groundwater/Leachate Management System

The groundwater/leachate (GW/L) management system represents one of the components of the selected remedy in the Site's ROD**.** The ROD stipulated the construction of an active leachate collection trench in the area of the waste oil outbreak along Fresh Creek and pumping the leachate to an on-site facility for pre-treatment prior to discharge to the 26$^{th}$ Ward WWTP.

The GW/L collection, pre-treatment and disposal system was designed to prevent migration of GW/L containing oil and dissolved contaminants to Fresh Creek and to produce a treated effluent acceptable for discharge. The main components of the GW/L management system consist of a stone-filled interceptor trench with two pump stations; a 3-inch diameter HDPE leachate force main carrier pipe in a 6-inch diameter HDPE casing pipe; a pre-treatment facility and a 4-inch diameter HDPE pretreated leachate force main pipe ultimately discharging to a junction manhole at the 26$^{th}$ Ward WWTP. The GW/L pre-treatment facility was designed to treat up to 30 gpm. The facility's components include oil-water separation with citric acid conditioning, bag filtration and carbon adsorption.

The effluent was originally regulated under DEP's Industrial Wastewater Discharge (IWD) Permit No. 07-P3145-2, effective from August 27, 2007 to August 26, 2012. Based on the historical sampling data indicating that the groundwater/leachate quality in the interceptor trench met the plant's Industrial Pre-Treatment Permit discharge limits prior to pre-treatment, the DEP received approval in 2011 to install diversion piping within the PAL GW/L Pre-Treatment Plant to divert the influent directly to the plant effluent piping. Figure 2 shows the current Pre-Treatment System Schematic, which includes the diversion-related modifications. The programmable logic control (PLC) was also reprogrammed to accommodate this second mode of operation. The facility has operated in Pre-Treatment Plant Diversion Mode since November 1, 2011. The Pre-Treatment Plant equipment within the building has been, and shall continue to be properly maintained so that if the GW/L water quality degrades, the Pre-Treatment Plant can be put back into operation in accordance with the PAL O&M Manual.

A new IWD Permit No. 11-P3145-1, reflecting the relocated M-1 sampling location was issued on November 11, 2011 and expired on November 10, 2016. The effluent is now currently regulated under IWD Permit No. 16-P3145-1 until October 18, 2021. Monthly M-1 sampling continues to be performed under the new permit and is reported quarterly in the Self Monitoring Reports submitted to the IIPS. Appendix B of the 2016 Quarterly Reports contains the results of the laboratory analyses as well as the Self-Monitoring Reports.

Examination of the M-1 sampling data for the 2016 annual reporting period, summarized in Table 1, indicates that the concentration of each detected parameter in the M-1 samples is lower than its respective IWD permit discharge limit. To document that operation of interceptor trench collection system is still warranted, the M-1 sample results were also compared to the NYSDEC 6NYCRR Part 703 standards and guidance values for Class SA (Saline) surface waters. Based on that comparison, in 2016, the concentrations of both chlorobenzene and the total dichlorobenzenes in the interceptor trench water exceeded the 5-ug/L guidance value for protection of saltwater fish propagation in the 1$^{st}$ and 2$^{nd}$ quarter, with chlorobenzene also exceeding in the 3$^{rd}$ quarter. In addition, the lead concentrations of the interceptor trench water exceeded the 8-ug/L standard for protection of saltwater fish propagation in the 1$^{st}$ quarter. Finally, the zinc concentrations of the interceptor trench water exceeded the 0.066-mg/L standard for protection of saltwater fish propagation in the 2$^{nd}$ quarter. Therefore, operation of the interceptor trench collection system is still warranted.

Although the system is in diversion mode, the interceptor trench continues to be inspected daily for the presence of product (separate-phase petroleum) and to verify water levels. There was no indication of separate-phase petroleum in the trench and no off-site leachate migration during this annual reporting period.

During this annual reporting period, 8,091,313 gallons were discharged to the WWTP from the interceptor trench. The system had one interruption, from January 23$^{rd}$ to February 2$^{nd}$, when the power transformer failed and needed to be replaced. The interceptor trench water level was monitored and there was no off-site leachate discharge. The following table summarizes the flow data for the twelve-month period.

| | Total Flow (Gallons) | Average Flow (GPM) | Average Daily Flow (GPD) | Maximum Daily Flow (GPD) | Number of days in service | Percent of time in service |
|---|---|---|---|---|---|---|
| **Jan-16** | 576,728 | 18.1 | 26,067 | 29,530 | 22.1 | 71.4% |
| **Feb-16** | 955,600 | 24.6 | 35,393 | 43,660 | 27 | 93.1% |
| **Mar-16** | 810,770 | 18.2 | 26,154 | 33,300 | 31 | 100% |
| **Apr-16** | 695,567 | 16.1 | 23,186 | 28,380 | 30 | 100% |
| **May-16** | 683,283 | 15.3 | 22,041 | 25,700 | 31 | 100% |
| **Jun-16** | 630,510 | 14.6 | 21,017 | 23,800 | 30 | 100% |
| **Jul-16** | 608,230 | 13.6 | 19,620 | 24,630 | 31 | 100% |
| **Aug-16** | 600,750 | 13.5 | 19,379 | 22,240 | 31 | 100% |
| **Sep-16** | 573,763 | 13.3 | 19,125 | 24,490 | 30 | 100% |
| **Oct-16** | 598,517 | 13.4 | 19,307 | 22,310 | 31 | 100% |
| **Nov-16** | 584,920 | 13.5 | 19,497 | 24,960 | 30 | 100% |
| **Dec-16** | 772,675 | 17.3 | 24,925 | 27,140 | 31 | 100% |
| **Average** | 674,276 | **15.9** | **22,976** | NA | N**A** | **97.0%** |
| **Maximum** | 955,600 | **24.6** | NA | **43,660** | NA | NA |
| **Total** | **8,091,313** | NA | NA | NA | **355.1** | NA |

Inspection and monitoring of the GW/L pre-treatment system was conducted following the O&M Manual procedures. Daily Operations, bi-weekly (GWL-1), monthly (GWL-2), quarterly (GWL-3), and annual (GWL-5) inspections were performed. Another form, DP-1, "Description of Deficiencies and Problems," was used to highlight specific problems requiring timely attention. While many of the deficiencies caused by the impact of the Hurricane Sandy surge were addressed previously, certain repairs were performed during the first quarter under a hurricane damage priority repair work order. These repairs included installing road material and regrading the access road to Pump Station No.1, repairing the embankment adjacent to the road and removing sand/road material from the valve vault at Pump Station No.1. The remaining recommended operational equipment components that were impacted by the Hurricane Sandy surge and designated for replacement should be replaced when the remaining Hurricane Sandy repairs are performed. Other equipment components exposed to the Hurricane Sandy surge that are currently operational will continue to be monitored and assessed over time and may be replaced in the future, if necessary.

No separate-phase petroleum has ever been detected at the leachate pump stations. However, as a precautionary measure, the replacement of the scavenger pumps was examined but determined not to be necessary at this time. The pump stations will continue to be inspected on a daily basis and the water quality will continue to be sampled on a monthly basis in accordance with the Discharge Permit requirements. Should separate-phase petroleum be observed, mitigation measures will be taken at that time to ensure they are appropriate to the actual conditions encountered. The replacement of the OWS influent filter casing and the petroscreen coalescer baskets has been placed on hold since the treatment system can be placed back on line without these items, thereby, allowing for their replacement when, and if, the pre-treatment system is placed back on-line. At

the commencement of the diversion mode operation, the pre-treatment plant equipment and piping that was being circumvented, was power-washed and prepared in accordance with manufacturer's recommendations to remain in a standby condition. The equipment continues to be inspected as required to ensure that they remain in good operating condition and ready to return to service if needed. Copies of the inspection reports were provided in Appendix A of the 2016 Quarterly Reports.

## 3.2 Landfill Gas Management System

The landfill gas (LFG) management system represents one of the elements of the selected remedy in the Site's ROD. The ROD required the selected remedy "to ensure full collection and control of landfill gas". This system must also meet the requirements of 6NYCRR Part 360 to limit off-site gas migration to the lower explosive limit (LEL) at the property line (i.e., 5% gas in air) and 25% of the LEL in structures (i.e., 1.25% gas in air). The LFG management system operates in accordance with an Air Facility Registration Certificate # 2-6105-00762/00001 issued by the NYSDEC.

The system features 46 gas extraction wells (EWs), a below grade polyethylene collection header piping network with isolation valves, two 375-scfm centrifugal blowers (Blower 301 and Blower 302), condensate collection system, an enclosed flare system, process instrumentation and controls, a PLC management system, a fire alarm system and an emergency condition alarm autodialer phone system. A plan of the overall LFG management system is shown on Figure 3 illustrating the location of the extraction wells, header pipe and flare facility. All 46 gas EWs were inspected and monitored for gas content (percent $CH_4$, $CO_2$ and $O_2$), temperature and vacuum pressure each month. Deficiencies such as missing signage, track cleaning or sampling port repair are corrected at the time of the inspection, work orders are issued for other work. The LFG-3 inspection reports are included in Appendix C of the 2016 Quarterly Reports.

The four main headers that convey the landfill gas are connected to a condensate drain line at their low point located adjacent to the flare station. This condensate drain line and the condensate drain lines from the two blower demisters (knock out pots) empty into the 2,500 gallon condensate tank located at the flare station. At the end of the 2016 annual post-closure period, the condensate tank contained approximately 496 gallons.

Main piping on the vacuum side of the blowers contains an 8-inch butterfly valve with an electric actuator. This automatically adjusts the valve position according to the vacuum transmitter readings in order to control the landfill vacuum. This is followed by an 8-inch electro-pneumatic butterfly valve which operates with a compressed nitrogen cylinder. This valve automatically closes in the event of a system failure or shutdown. The gas flare system is designed to operate with one blower in service and one as redundant standby. Although designed to collect up to 375 scfm of landfill gas, the system averaged 90.4 scfm during the 2016 annual post-closure period. Process gas temperature and pressure readings from the vacuum and discharge side are recorded daily in the LFG-1 inspection log. The monthly summary report of the LFG-1 daily inspections is included in Appendix C of the 2016 Quarterly Reports.

Landfill gas is discharged from the blowers through an 8-inch header and flame arrestor into the enclosed flare. The flare pilot is fired using natural gas from the utility company. The natural gas is also used as auxiliary fuel to supplement the recovery of landfill gas. During the 2016 annual post-closure period, 96,952 SCF of natural gas was consumed for the pilot and to help bring system to temperature after start ups. The flare support system includes a purge air blower, two manual and two automatic dampers, temperature control with three thermocouples. The flare operation is on automatic control using the middle thermocouple at a target temperature of 1,500 $^{o}$F.

During the 2016 annual post-closure period, the landfill gas flaring system processed 44,450,063 SCF of landfill gas. The flare ran for 89.1% of the time. The Annual FDNY inspection of the flare station was held on Friday, October 28, 2016. During that inspection, the FDNY noted the need to repair the alarm/trouble bells and verify that central station is monitoring any potential battery problems. These issues were addressed, the FDNY conducted a follow up inspection on December 28th and the FDNY approval was received. This process did not impede the continuous operation of the flare station. In addition, a controlled shutdown by the electrician, Autodialer phone line failure, routine equipment inspection, replacement, calibration and maintenance, severe weather conditions, frozen equipment, poor gas quality, and condensate issues accounted for 957.7 hours or 10.9% of the 2016 annual post-closure period. In an effort to alleviate condensate issues, condensate withdrawal events from the headers were conducted on February 1st, 4th, 20th, March 4th, 21st, 23rd, 29th, April 4th, 13th, and 25th. Although there is no increase in the condensate tank inventory, condensate displacement results in improved operations. The landfill gas flare flow meter was calibrated on December 1st. Flow and process gas content data is summarized in the table that follows.

| **Pennsylvania Avenue Landfill** | | | |
|---|---|---|---|
| **Flare Operation - 2016** | | | |
| **Month** | **$CH_4$** (% by Volume) | **Time in service (Hours)** | **Flow (SCF)** |
| January-16 | 17.2% | 680.5 | 3,387,110 |
| February-16 | 16.9% | 527.9 | 3,248,923 |
| March-16 | 17.2% | 605.8 | 3,649,281 |
| April-16 | 18.9% | 639.5 | 4,238,547 |
| May-16 | 16.8% | 598 | 3,777,119 |
| June-16 | 16.8% | 699.1 | 3,826,439 |
| July-16 | 15.8% | 613.5 | 3,459,607 |
| August-16 | 16.3% | 738.5 | 3,560,092 |
| September-16 | 17.0% | 644.0 | 3,383,495 |
| October-16 | 16.5% | 674.0 | 3,648,998 |
| November-16 | 18.1% | 675.0 | 3,953,003 |
| December-16 | 17.8% | 730.5 | 4,317,449 |
| **Average** | **17.1%** | | **3,704,172** |
| **Total** | | **7,826.3** | **44,450,063** |

Bi-weekly (LFG-2) and quarterly (LFG-4) inspections were conducted, and copies are included in Appendix C of the 2016 Quarterly Reports. The system was inspected by the FDNY on Friday, October 28, 2016th; and as result, the alarm bell and trouble bell were replaced. Deficiencies identified at the flare and blower station during scheduled inspections, and still pending are the condensate monitoring system float and probe. The recommended operational equipment components that were impacted by the Hurricane Sandy surge and designated for replacement should be replaced when the remaining Hurricane Sandy repairs are performed. Other equipment components exposed to the Hurricane Sandy surge that are currently operational but not designated for replacement will continue to be monitored and assessed over time and may be replaced in the future, if necessary. There were no other significant deficiencies pending at the end of this annual reporting period.

### 3.3 Final Cover System

The landfill final cover system (FCS) prevents stormwater infiltration into the landfill and landfill gas migration into the atmosphere. The ROD stipulated the construction of a 6NYCRR Part 360 landfill cap. According to the O&M Manual, the cover is comprised of a vegetative topsoil layer with a minimum thickness of 6 inches; a 12-inch thick soil barrier protection layer; a Type 2 cover system double-sided geocomposite drainage layer (areas with less than 5% slope); a Type 1 cover system cushion geotextile layer (areas with slopes greater than 5%); a 40-mil thick LLDPE (linear low density polyethylene) geomembrane liner; and 6-inch thick Type II cover soil.

The O&M Manual requires the final cover system be inspected on a monthly basis and after each major rainfall event equal to or exceeding the 2-year 24-hour precipitation event (3.5 inches in 24 hours). The surface of the landfill was divided into 17 inspection zones. All 17 inspection zones are shown in Figure 4 which is utilized to identify the system components. This figure is also utilized to identify the components of the stormwater and ancillary systems. A record of the final cover system inspection is summarized on a Monthly Checklist Form FCS-1, with deficiencies noted on the Deficiency and Problems Form (DP-1). The monthly inspection reports can be found in Appendix D of the 2016 Quarterly Reports. The final cover system is inspected for surface cracking, vegetative growth, vector penetration, settlement, erosion, slope stability, seepage, and vandalism. The inspection is performed by walking up and down the side slopes and across each zone several times. The deficiencies remaining at the end of this reporting period are erosion in inspection Zone 4 stabilized by vegetative cover, and ponding in inspection Zones 1, 2, 5, 16, and 17.

### 3.4 Stormwater Management System

The stormwater management system (SWM) is an integral part of the capping and closure system required under the 6NYCRR Part 360 regulations to protect the landfill final cover system. The system was designed to collect, transport and discharge stormwater to the surface waters surrounding the PAL in order to prevent stormwater ponding and erosion damage to the final cover system.

The stormwater management system consists of several components which require monitoring, inspection, and periodic maintenance. The system has been divided into three subsystems (SWM-

1, SWM-2 and SWM-3) for ease of inspection and reporting. These subsystems include:

- SWM-1: Geocomposite drain pipes and stormwater drainage swales,
- SWM-2: Outlets, culverts, rip rap inlet and outlet protection and revetment area, and
- SWM-3: HDPE downchute pipes, manholes, pipe trenches and energy dissipation structures.

The O&M Manual requires that the stormwater management systems SWM-1, SWM-2 and SWM-3 be inspected on a monthly basis and after each major rainfall event equal to or exceeding the 2-year 24-hour precipitation event (3.5 inches in 24 hours). A record of the inspection is summarized on Monthly Checklist Forms SWM-1, SWM-2, SWM-3 and DP-1 (for SWM-1, SWM-2 and SWM-3) for each system in accordance with the requirements of the O&M Manual. A Deficiency and Problems Form DP-1 is completed to summarize the items marked not satisfactory (NS) in the stormwater system checklist forms.

Deficiencies identified during the 2016 annual post-closure period do not necessarily affect the efficient performance of this system. Inspection of the System during and after storm events, indicate that it is working properly. The swales and culverts were mowed, weed-wacked, and excessive vegetative growth and debris was removed when observed during inspections. The monthly inspection reports and DP-1 Forms can be found in Appendix D of the 2016 Quarterly Reports.

## 3.5 Ancillary Systems

The ancillary systems (ANS) are those support systems at the PAL that are used for site access and security. The ancillary systems include five (5) access roads (A, B, C, D and E) and two (2) nature trails (East & West), along with fences, gates, and locks. The roadways are integral in providing access to perform required inspection, monitoring and maintenance activities. In addition, since the selected remedy resulted in leaving waste on-site, the security fences and gates provide important institutional controls to prevent site access to unauthorized individuals.

The O&M Manual requires that the ANS be inspected on a monthly basis. A record of the inspection is summarized on Monthly Checklist Forms ANS-1 and DP-1 (for ANS-1) in accordance with the requirements of the O&M Manual. The instructions for the checklists further require inspections after each major rainfall event equal to or exceeding the 2-year 24-hour precipitation event (3.5 inches in 24 hours). These are incorporated into the monthly inspections reports found in Appendix D of the 2016 Quarterly Reports.

Damage and wear are inherent in unpaved roads and nature trails. Potholes on the access roads and nature trails are recurring and are filled in as part of routine maintenance.

Holes in the perimeter fence are repaired as soon as possible after they are found during each monthly inspection and/or the weekly inspections conducted during fair weather. Locks are inspected and lubricated quarterly and as needed. Safety inspections are performed monthly.

Damaged and missing "No Trespassing", "Confined Space" and "Hazard" signs were also replaced.

## 3.6 Post-Closure Environmental Monitoring

The Monitoring Plan for the PAL went into effect when the FER was approved by NYSDEC at the end of March 2009. The Plan addresses the performance evaluation of the effectiveness of the cap and/or landfill gas collection system in controlling leachate and landfill gas migration. It requires monitoring of the groundwater elevation and quality at ten wells (HP wells) located around the perimeter, outside the limits of the closure cap, and soil gas quality in five perimeter gas monitoring wells (GMW wells) located outside the limits of the cap parallel to the Belt Parkway as shown in Figure 5. Monitoring for landfill gas is also performed on a monthly basis inside the groundwater/leachate treatment facility building, as per 6 NYCRR Part 360 requirements (minimum quarterly frequency). Additionally, the landfill surface is monitored semi-annually for potential landfill gas emissions, although this is not a regulatory requirement at this site.

### 3.6.1 Gas Monitoring Program

Perimeter soil gas readings at the five perimeter gas monitoring wells were taken quarterly, on March 18th, June 21st, September 23rd and December 7th, and to confirm the absence of off-site gas migration after intermittent extended flare outages on February 1st, 16th, 18th, 19th, March 21st, May 16th, July 27th, and November 1st. Figure 5 shows the locations of the perimeter gas wells. Table 2 contains a summary of the perimeter gas monitoring well results during the 2016 annual post-closure period.

Methane readings were consistently 0.0% except on December 7th where methane readings were 0.3% at GMW-1, GMW-2 and GMW-3, and 0.2% at GMW-4 and GMW-5. Accordingly, methane levels at all five gas monitoring wells were less than the lower explosive limit (i.e., 5% gas in air) at the property line and thus meet the 6NYCRR Part 360 requirements.

Methane readings within the GW/L pre-treatment facility building were obtained on a monthly basis and were consistently 0.0% throughout the facility. These readings were taken on January 5th, February 10th, March 2nd, April 5th, May 4th, June 2nd, July 13th, August 3rd, September 13th, October 13th, November 14th and December 12th. The data is summarized in Table 3 of this Report. Accordingly, methane levels within the building were less than 25% of the LEL (i.e., 1.25% gas in air) and therefore meet 6NYCRR Part 360 requirements.

On March 15th and September 27th, landfill surface gas readings were taken, with no detections observed throughout the landfill. Although the O&M Manual does not require surface emission monitoring since the landfill does not meet the applicability requirements of 6NYCRR Part 208, the DEP has included this task in the OM&M Contract. Under 6NYCRR Part 208.4, landfill gas collection systems are required to be operated so that methane concentrations are less than 500 ppm above background at the landfill surface. The landfill surface gas monitoring performed during this reporting period meet the requirements stipulated under 6NYCRR Part 208.4. Sample

locations are shown in Figure 6, and results are included in Appendix E of the First and Third Quarter 2016 Reports, respectively.

Based on the results of the post-closure landfill-gas monitoring performed during this annual reporting period, methane levels measured were less than the 6NYCRR Part 360 limits, and indicate that landfill gas being generated by the PAL is being contained by the collection and treatment system and preventing off-site methane migration. It is expected that landfill gas concentrations will continue to decrease over time as the landfill ages.

### 3.6.2 Groundwater Monitoring Program

In the NYSDEC letter of March 2, 2011 to DEP, the NYSDEC approved the DEP's request to reduce the frequency of ground-water monitoring from quarterly, to annually in rotating quarters (i.e., once every five quarters), and to reduce the frequency of monitoring for pesticides and PCBs to once every five years. The first quarter 2016 ground water-monitoring round served as the annual monitoring round for the period covered by this Report. The next annual ground water-monitoring round will be performed during the second quarter of 2017.

Water-levels were collected in nine of the ten ground water-monitoring wells and samples were collected from all ten wells (see Figure 5) on January 14th and 19th. The groundwater monitoring wells are designated by zone as follows:

- U for fill aquifer (saturated zone above the tidal marsh deposit (TMD)),
- S for upper portion of the upper glacial aquifer (10-20 feet below the bottom of the TMD)
- D for lower portion of the upper glacial aquifer (45-55 feet below the bottom of the TMD)

The ground water beneath the PAL is influenced by the tide cycle. However, a prior hydraulic analysis determined that while the tide cycle causes pressure fluctuations in the wells, it does not significantly influence ground-water flow beneath the site. Accordingly, monitoring rounds are conducted independently of the tide cycle. Moreover, the water-level data are used for informational purposes only, and not to determine ground water-flow directions or gradients.

Well HP-101S could not be gauged due to a partially-restricted casing. This is not a significant data gap because the water-level data are not used to prepare groundwater-flow maps, and the results for the other wells are consistent with previous results. While groundwater samples were collected from all ten monitoring wells, Well HP-101S was sampled using a peristaltic pump and dedicated tubing rather than with a submersible pump due to its partially-restricted casing. Well HP-318 was also sampled with a peristaltic pump and dedicated tubing. This modification does not impact the results for these wells because the low-flow purging and sampling techniques was still used for these wells.

The samples were analyzed for all required annual parameters, specifically: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), leachate indicators, and inorganic parameters (Metals) by an ELAP-certified environmental laboratory. The next round of monitoring

for pesticides and PCBs will be performed during the third quarter of 2018 monitoring round, which will be last monitoring round of the current five-year review period.

The laboratory results were validated by an independent data validator. The validated results are summarized and compared to the State's Class GA potable ground-water standards and guidance values in Tables 4 through 7, respectively. The water-level elevation data, sample collection field logs and Data Usability Summary Report, which contains the validated laboratory data, were included in the 2016 First Quarter Report, Appendix F.

Overall, the results of the 2016 annual ground water-monitoring round are consistent with previous results, and continue to indicate that the PAL is not a significant source of releases of hazardous or toxic substances to ground water. It should be noted that the ground water beneath the Site is naturally saline and therefore non-potable. The results are compared to the potable water standards and guidance values because there are no standards or guidance values for saline ground water. Accordingly, an exceedance of a potable ground-water standard or guidance value does not necessarily indicate a significant concern for this Site.

Note that five of the ground water-monitoring wells (Wells HP-101U, HP-407U, HP-104A, HP-318 and HP-603) are screened in the Fill Aquifer (i.e., the saturated fill zone above the tidal marsh deposit), two wells (Wells HP-101S and HP-407S) are screened in the upper portion of the Upper Glacial Aquifer (UGA) which lies under the tidal marsh deposit, and the other three wells (Wells HP-101D, HP-407D and HP-103D) are screened in the lower portion of the UGA.

The specific results for each analyte group are summarized below. A detailed comparison to previous results, including a trend analysis, will be provided in the next five-year review report.

VOCs – The results of the 2016 annual ground water-monitoring round continue to indicate that the PAL is not a significant source of VOC impacts to ground water. Specifically, although each ground-water sample was analyzed for 47 target VOCs, only two VOCs (acetone and chlorobenzene) were actually detected. Moreover, as shown in Table 4, acetone was only detected in one well at a relatively low concentration; and chlorobenzene was only detected in four wells at low, estimated concentrations. All of the VOC detections were lower than the Class GA potable ground-water standards and guidance values.

All of the VOC detections occurred in wells screened in Fill Aquifer wells, which indicates that the tidal marsh deposit is continuing to serve as a hydraulic barrier to vertical migration of ground water from the Fill Aquifer into the underlying UGA.

SVOCs - The results of the 2016 annual ground water-monitoring round indicate that the PAL also continues to not be a significant source of SVOC impacts to ground water. Specifically, although each ground-water sample was analyzed for 64 target SVOCs, only one SVOC was actually detected. Moreover, as shown in Table 5, detections were limited to a very low concentration of acenaphthene in Well HP-318. This one SVOC detection was also much lower than the Class GA guidance value for acenaphthene. As noted above, Well HP-318 is screened in the Fill Aquifer so the SVOC results also indicate that the tidal marsh deposit is continuing to serve as a hydraulic barrier to vertical migration of ground water from the Fill Aquifer into the underlying UGA.

Leachate Indicators – The 2016 leachate indicator parameter results are consistent with the PAL being an old, closed and capped municipal landfill that is underlain by saline ground water. Specifically, as shown in Table 6, most of these parameters were detected in nearly every well; except for BOD and cyanide, which typically do not occur naturally at significant concentrations in saline ground water; and nitrate, which is metabolized by bacteria in the ground water.

Moreover, the concentrations of the parameters known to occur naturally in seawater, such as bromide, chloride, hardness, sulfate, and total dissolved solids, are highest in the wells screened in the lower portion of the UGA, where the ground water is expected to be the most saline. Other parameters, such as alkalinity, ammonia, color and phenols, appear to be Site-related because they are detected only, or at significantly higher concentrations, in wells screened in the Fill Aquifer.

The concentrations of a number of parameters exceeded their Class GA potable ground-water standards and guidance values. However, it should be noted that most of the exceedances were for parameters related to the naturally saline ground water beneath the Site. The exceedances for the Site-related parameters, such as ammonia and phenols, are not a significant concern because the ground water is non-potable. Moreover, ammonia occurs naturally in seawater and is not persistent in the environment; and the standard for phenols is aesthetics-based rather than health-based.

Inorganic Parameters – The 2016 inorganic parameter results continue to indicate that the PAL is not a significant source of metals-related impacts to ground water. Specifically, as shown in Table 7, most of the target analytes, including the more toxic RCRA metals, were either not detected or were only detected sporadically and/or at low concentrations. The concentrations of the frequently-detected parameters, such as iron, magnesium, potassium and sodium, are generally higher in the wells screened in the UGA than in the wells screened in the Fill Aquifers. This pattern indicates that they are primarily attributed to the naturally saline ground-water beneath the Site.

The concentrations of certain metals exceeded their Class GA potable ground-water standards and guidance values. However, it should be noted that most of these exceedances, and the highest-magnitude exceedances, were for parameters that are related to the naturally saline ground water beneath the Site. No exceedances for heavy metals occurred during the 2016 monitoring round.

## Section 4 – Conclusions and Recommendations

Based on the results of the post-closure activities performed during this annual reporting period, the PAL engineering controls and associated institutional controls are in place, performing properly and remain effective. The PAL remedy continues to be protective of public health and the environment and is compliant with the PAL ROD. The activities associated with the O&M Manual and the Post-Closure Monitoring Plan (as approved by the NYSDEC) continue to be implemented.

Routine system maintenance and repair of each of the remediation systems should continue in compliance with the requirements of the PAL O&M Manual. In general, it is recommended that

areas of the Site affected by Hurricane Sandy should be restored to their existing condition prior to the storm event.

Specific conclusions and recommendations for each of the remediation systems are identified in the following paragraphs.

### 4.1 Groundwater/Leachate Management System

The GW/L management system continued to be operational and prevent off-site leachate migration during this annual reporting period. Since November 1, 2011, the GW/L management system has been operating in plant diversion mode. In this mode, the treatment system processes are being circumvented since the quality of the interceptor trench water being collected meets the permit discharge limits without pre-treatment. During this reporting period, the untreated discharge continued to meet the required permit limits. The interceptor trench discharge monthly monitoring for permit-required parameters will be continued in accordance with the permit requirements. Should it be necessary in the future for the treatment processes to be brought back online, it would be recommended that monthly influent/effluent water quality sampling be reinstated.

While the Monthly M-1 sample results during this reporting period continue to meet the required permit discharge limits without pre-treatment, the concentrations of certain parameters in the influent continue to exceed the NYSDEC limits for saline surface water. Therefore, operation of the interceptor trench is still warranted.

As previously recommended in prior Post-Closure Reports, since no separate-phase petroleum has ever been detected at the leachate pump stations, the replacement of the scavenger pumps was examined and determined not to be necessary. The pump stations should continue to be inspected on a daily basis and the water quality should continue to be sampled on a monthly basis in accordance with the Discharge Permit requirements. Should separate-phase petroleum be observed, mitigation measures should be taken at that time to ensure they are appropriate to the actual conditions encountered. Based on the results of the monitoring and inspection activities performed during this reporting period, this recommendation remains in effect.

The remaining recommended operational equipment components that were impacted by the Hurricane Sandy surge and designated for replacement should be replaced when the remaining Hurricane Sandy repairs are performed. Other equipment components exposed to the Hurricane Sandy surge that are currently operational but not designated for replacement should continue to be monitored and assessed over time and may be replaced in the future, if necessary.

In general, it is recommended that individual pieces of equipment that are not in use be maintained in good working condition and ready to be placed back on-line, if necessary. The interceptor trench pump stations and related equipment will continue to be operated and maintained. If deficiencies are noted they will be repaired and/or replaced in a timely manner to minimize system down time. Specifically, the recommended corrective actions listed in Form DP-1, Leachate Pre-Treatment System, Descriptions of Deficiencies and Problems, in Appendix A of the Quarterly Reports should be implemented.

## 4.2 Landfill Gas Management System

The LFG management system continues to be operational and prevent off-site gas migration. As the landfill ages, the methane quality and quantity of gas generated by the landfill will continue to decline. The LFG management system should continue to be operated to maximize methane quality at the flare in order to minimize the use of supplemental gas. The recommendations made by the DEP oversight consultant to improve system performance should continue to be implemented. The LFG management system performance should continue to be monitored to determine if adjustments and/or modifications to the system are necessary as the landfill gas quality and quantity diminishes in the future.

The remaining recommended operational equipment components that were impacted by the Hurricane Sandy surge and designated for replacement should be replaced when the remaining Hurricane Sandy repairs are performed. Other equipment components exposed to the Hurricane Sandy surge that are currently operational but not designated for replacement should continue to be monitored and assessed over time and may be replaced in the future, if necessary. In addition, the recommended corrective actions listed in Form DP-1, Landfill Gas System, Descriptions of Deficiencies and Problems, in Appendix C of the quarterly reports should be implemented.

## 4.3 Final Cover System

Overall the landfill final cover system is in good condition and protecting landfill cap beneath it as intended. Conditions found were typical of those encountered during the landfill post-closure period, with only a few deficiencies noted. In general, it is recommended that routine maintenance continue to be performed to prevent problem areas from expanding and worsening. This would include filling ruts caused by erosion, reseeding areas where necessary and maintaining landfill surface slope to promote stormwater runoff. The perimeter areas of the final cover system affected by Hurricane Sandy should be restored to their existing condition prior to the storm event. In addition, the recommended corrective actions listed in Form DP-1, FCS-1, Descriptions of Deficiencies and Problems, in Appendix D of the Quarterly Reports should be implemented.

## 4.4 Stormwater Management System

The stormwater management system continues to convey stormwater runoff to its outfall locations. Conditions found were typical of those encountered during the landfill post-closure period, with a few deficiencies noted. In general, it is recommended that silt and vegetation in drainage swales continue to be periodically removed and sediment be removed from other portions of the drainage system. Specifically, the recommended corrective actions listed in Form DP-1 (SWM-1, SWM-2 SWM-3), Descriptions of Deficiencies and Problems, in Appendix D of the Quarterly Reports should be implemented as deemed appropriate.

## 4.5 Ancillary Systems

The roads and nature trails of the ancillary systems continue to provide access throughout the Site while the fencing and gates continue to allow for controlled site access. Conditions found were typical of those encountered during the landfill post-closure period, with a few deficiencies noted.

In general, it is recommended that routine maintenance continue to be performed to prevent problem areas from expanding and worsening. This would include filling ruts and depressions in roads and trails and repairing site fencing and gates when necessary. Areas of the ancillary systems affected by Hurricane Sandy should be restored to their existing condition prior to the storm event. In addition, the recommended corrective actions listed in Form DP-1, ANS-1, Descriptions of Deficiencies and Problems, in Appendix D of the Quarterly Reports should be implemented.

### 4.6 Post-Closure Environmental Monitoring

In summary, taken as a whole, the results from 2016 annual ground water-monitoring event indicate that the PAL is not a significant source of toxic or hazardous substance releases to ground water, and that ground water-quality conditions beneath the Site are stable or improving over time in response to the remediation. The results also confirm that the reductions in the scope and frequency of post-closure ground-water monitoring were justified, and that further reductions (e.g., reducing the frequency of monitoring for VOCs and SVOCs to once every five years) may be warranted in the future. Specifically, VOC and SVOC detections continued to be limited to low concentrations of one or two compounds in Fill Aquifer wells only, and there were no exceedances of the Class GA potable ground-water standards or guidance values for these parameters in 2016.

Based on the results of the post-closure landfill-gas monitoring performed during this annual reporting period, methane levels measured met the 6NYCRR Part 360 requirements indicating that the landfill gas being generated by the PAL is being contained by the collection and treatment system and preventing off-site methane migration. It is expected that landfill gas concentrations will continue to decrease over time as the landfill ages.

Recommendations for post-closure monitoring are to continue to monitor ground water and gas in accordance with the current modified Monitoring Plan, including the reduction in the frequency of ground-water monitoring to annually, in rotating quarters (i.e., once every five quarters) and the reduction in the frequency of ground-water monitoring for pesticides and PCBs to once every five years to coincide with the five-year review periods. This schedule has been approved by NYSDEC so that monitoring will not be conducted in consecutive quarters and annual ground-water monitoring will be performed once in each calendar quarter during each five-year reporting period.

# Figures

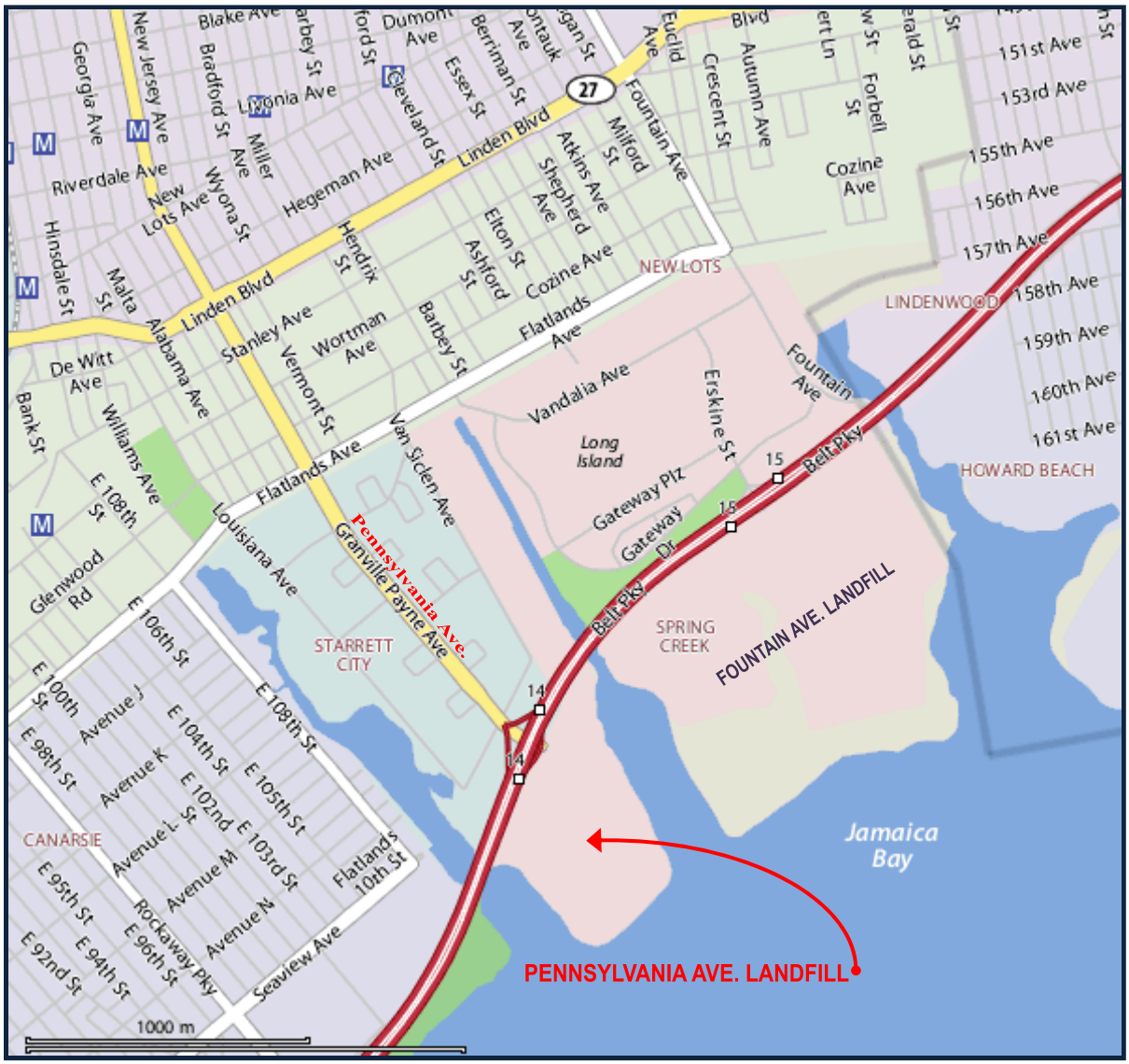
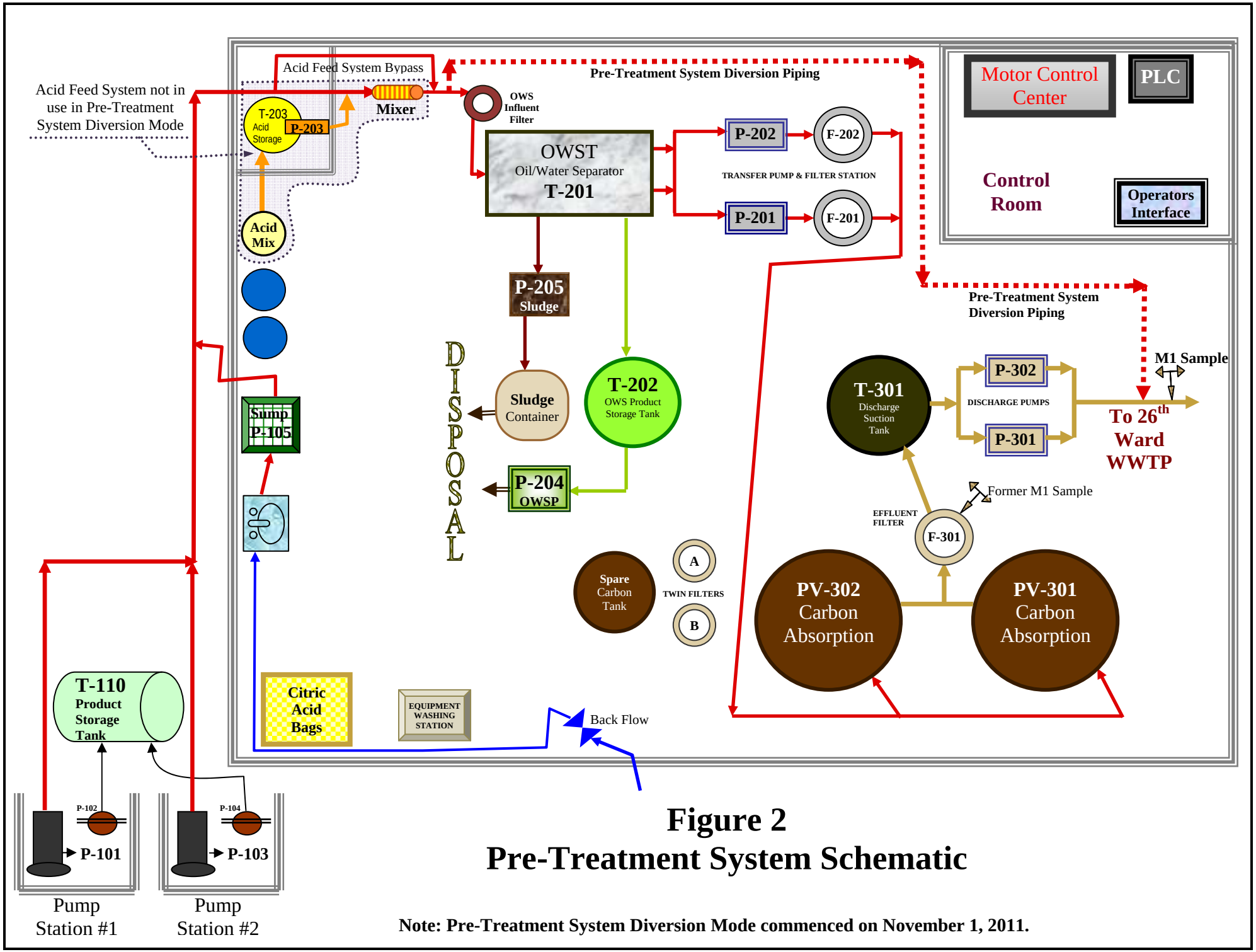




FIGURE 1
SITE LOCATION MAP




# Figure 2
# Pre-Treatment System Schematic

**Note: Pre-Treatment System Diversion Mode commenced on November 1, 2011.**

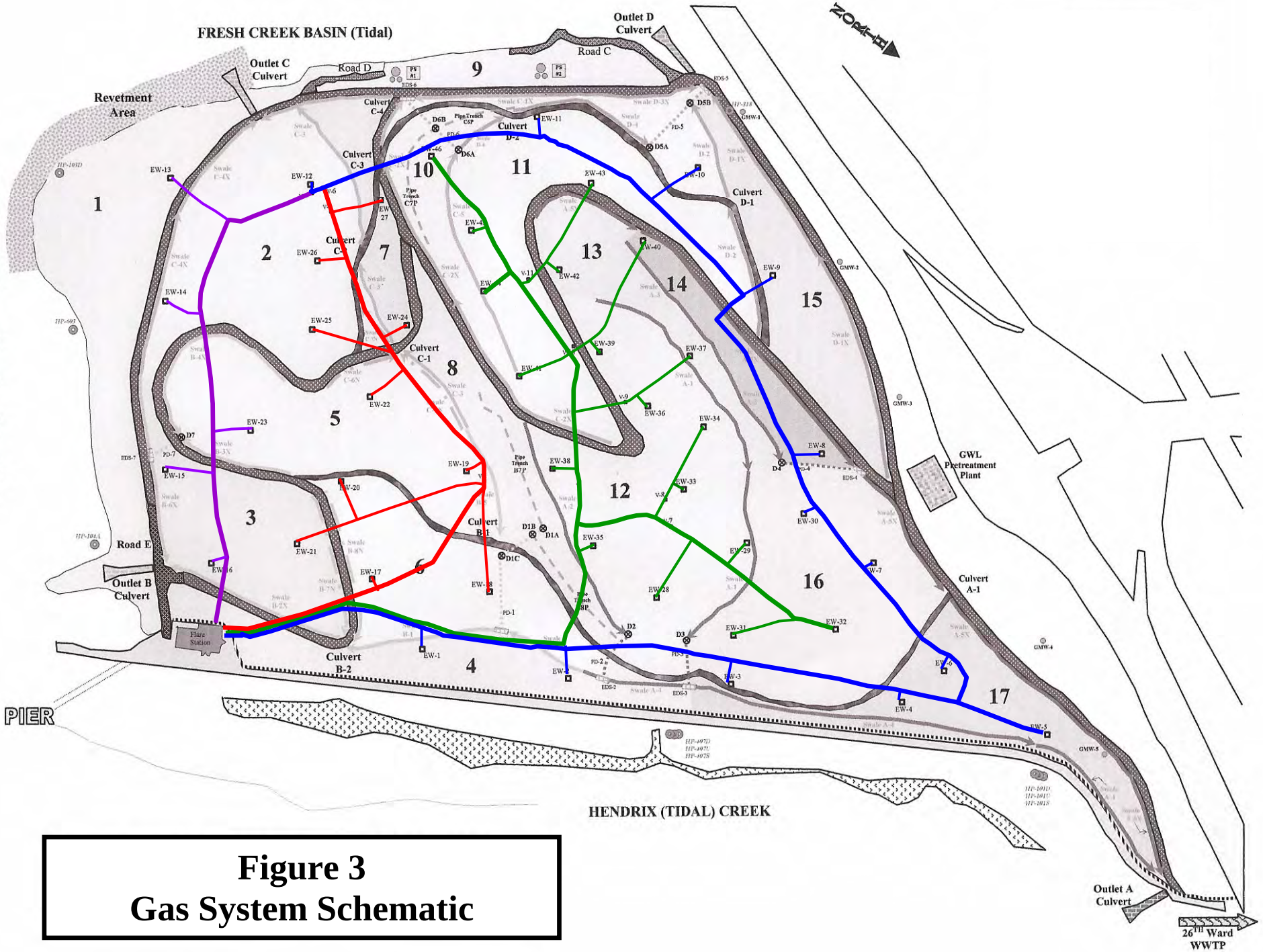



**Figure 3**
**Gas System Schematic**

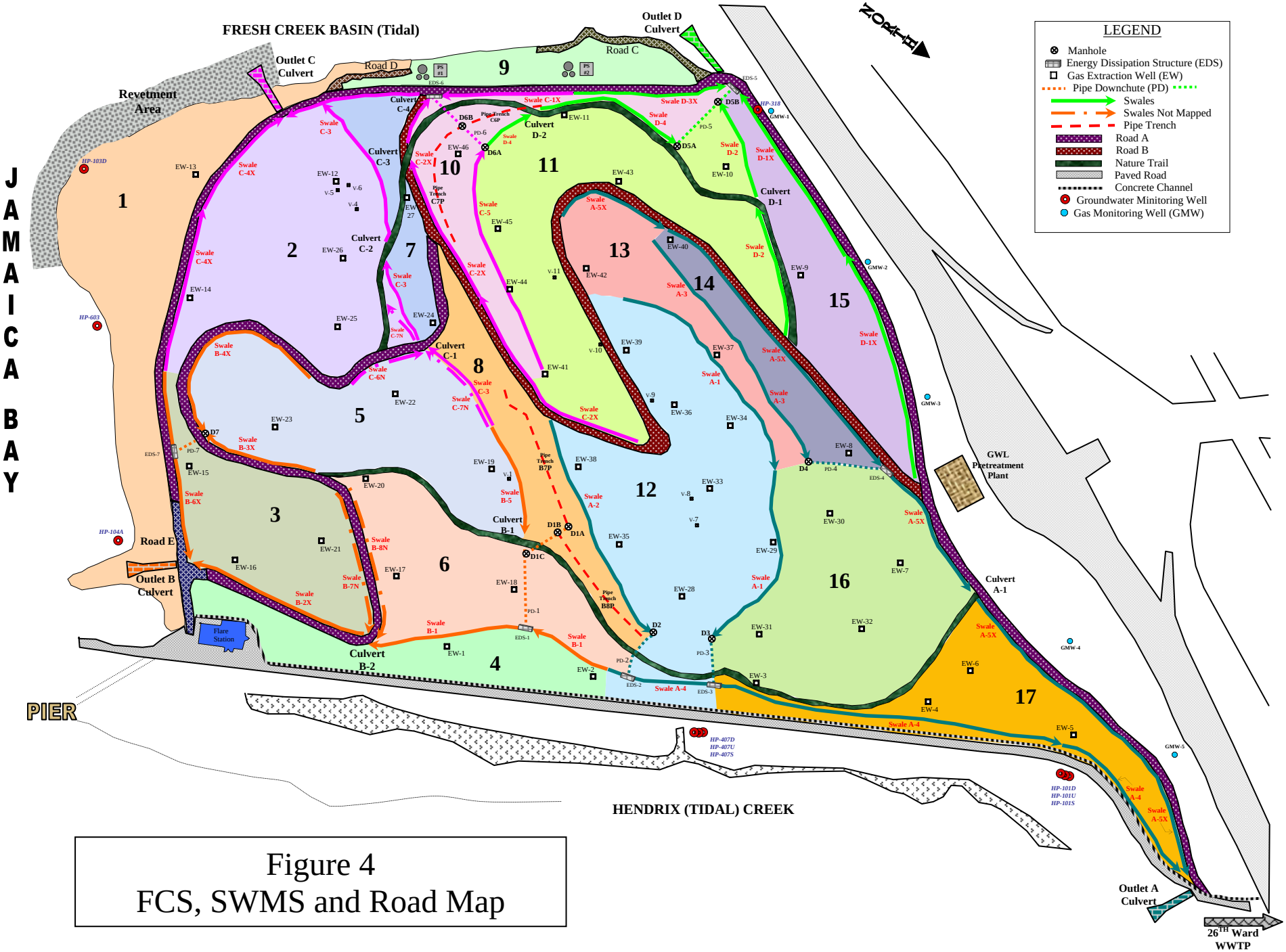



Figure 4
FCS, SWMS and Road Map

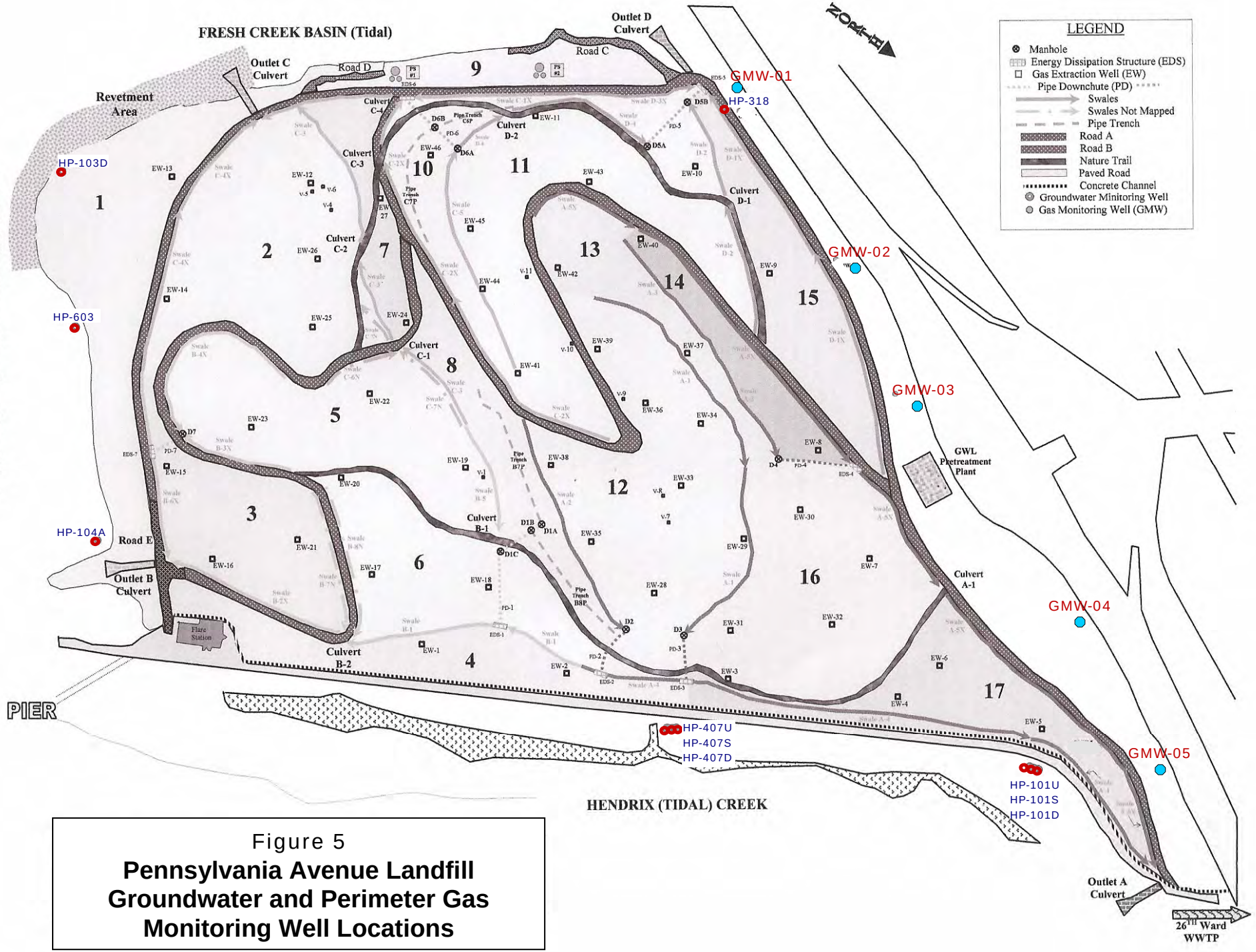



Figure 5

**Pennsylvania Avenue Landfill Groundwater and Perimeter Gas Monitoring Well Locations**

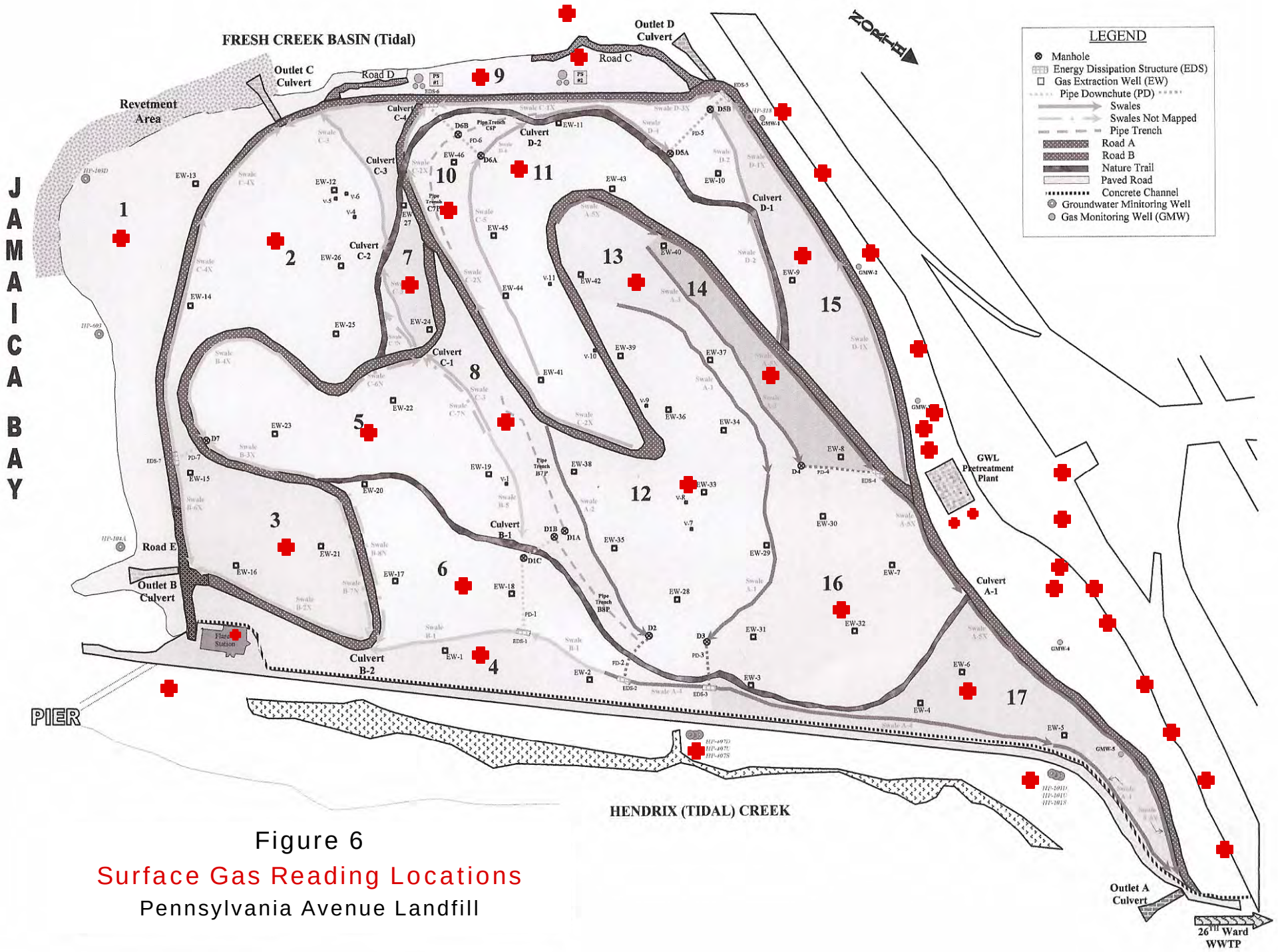



Figure 6

Surface Gas Reading Locations

Pennsylvania Avenue Landfill

# Tables

# Table 1 - Parameters Detected in the Groundwater Leachate Pre-Treatment System Discharge

| Analyte | Units | Permit Max. Conc. | Permit Daily Limit | Permit Monthly Limit | TOGS SA Fish Propagation Standards | M1 Discharge Sample Results 01/05/16 | 02/10/16 | 03/02/16 | 04/05/16 | 05/04/16 | 06/02/16 | 07/13/16 | 08/03/16 | 09/13/16 | 10/13/16 | 11/14/16 | 12/12/16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lead | ug/L | 2000 | | | 8 | **31** | **17** | <5.0 | 7.1 | 7.8 | 7.6 | < 5.0 | < 5.0 | < 5.0 | <5.0 | <5.0 | <5.0 |
| Zinc | mg/L | 5.0 | | | 0.066 | <0.020 | <0.020 | <0.020 | **0.099** | 0.038 | 0.02 | <0.020 | <0.020 | <0.020 | <0.020 | <0.020 H | <0.020 |
| Carbonaceous Biological Oxygen Demand | mg/L | | | | | 5 | <2 | <4 | <4 | <4 | <4 | <4 | <4 | <4 | <4.0 H | <4.0 | <4.0 |
| Chloride | mg/L | | | | | 2,610 D | 2730 D | 1,610 D | 1,700 D | 2,900 D | 2,790 D | 3,000 D | 4,270 D | 4,470 D | 5060 | 4770 | 4310 |
| Nitrate as N | mg/L | | | | | 0.63 | 0.52 | 0.64 | 0.77 | 0.1 | <0.10 | 0.4 | <0.10 | 0.19 | 0.21 | 0.23 | 0.11 |
| Nitrogen, Kjeldahl, Total | mg/L | | | | | 30.9 D | 32.7 D | 172 D | 35.9 D | 49.4 D | 39.7 D | 37.1 D | 45.1 D | 39.9 D | 48.5 | 44.4 | 31.1 |
| Nitrogen, Total | mg/L | | | | | 31.5 | 33.2 | 172 | 36.7 | 49.5 | 39.7 | 37.5 | 45.1 | 40.1 | 48.7 | 44.6 | 31.2 |
| Suspended Solids (Residue, Non-Filterable) | mg/L | 350 | | | | 17 | <10 | 12 | <10.0 | 15 | <10.0 | 11 | 21 | 12 | 20 | 15 | <10.0 |
| Suspended Solids (Residue, Non-Filterable) | mg/L | ↓ | | | | 14 | <10 | <10 | <10.0 | <10.0 | <10.0 | <10.0 | 14 | 13 | 19 | 25 | <10.0 |
| Suspended Solids (Residue, Non-Filterable) | mg/L | ↓ | | | | 13 | 11 | <10 | <10.0 | <10.0 | <10.0 | <10.0 | 11 | 11 | 12 | 17 | 14 |
| Suspended Solids (Residue, Non-Filterable) | mg/L | ↓ | | | | 14 | <10 | <10 | <10.0 | <10.0 | <10.0 | 16 | 23 | 17 | 21 | 19 | 12 |
| **pH** (*Lab pH Qualifier* H) | | | | | | | | | | | | | | | | | |
| pH Grab 1 (Field/Lab) | SU | 5.0 - 11.0 | | | | 7.33 / 7.0 | 7.16 / 6.9 | 7.61 / 7.0 | 7.7/ 7.8 | 6.8/ 6.9 | 6.7/ 7.0 | 6.84 / 6.9 | 6.84/7.0 | 6.84/7.0 | 6.84 / 7.0 | 7.12 / 6.9 | 6.98 / 6.8 |
| pH Grab 2 (Field/Lab) | SU | Standard Units | | | | 7.34 / 7.0 | 7.18 / 6.9 | 7.55 / 6.4 | 7.1/ 7.8 | 6.8/ 7.0 | 6.8/ 7.0 | 6.80 / 6.9 | 6.78/7.1 | 6.81/7.0 | 6.81 / 7.3 | 6.72 / 7.1 | 6.86 / 7.0 |
| pH Grab 3 (Field/Lab) | SU | | | | | 7.34 / 7.0 | 7.15 / 6.9 | 7.50 / 6.9 | 7.0/ 7.8 | 6.8/ 7.0 | 6.8/ 7.0 | 6.80 / 6.9 | 6.82/7.0 | 6.80/7.0 | 6.93 / 7.6 | 6.76 / 7.0 | 6.83 / 7.2 |
| pH Grab 4 (Field/Lab) | SU | | | | | 7.33 / 7.0 | 7.12 / 6.9 | 7.51 / 6.4 | 7.0/ 7.9 | 6.8/ 7.0 | 6.9/ 7.3 | 6.80 / 6.9 | 6.78/7.0 | 6.86/7.0 | 6.93 / 7.3 | 6.56 / 7.3 | 6.85 / 7.1 |
| **PCBs** | | | | | | | | | | | | | | | | | |
| Aroclor 1016 | µg/L | 1 (Total PCBs) | | | | <0.065 | <0.065 | <0.065 | <0.065 | <0.065 | <0.065 | <0.065 | <0.065 | <0.065 | <0.065 | <0.065 | <0.065 |
| **VOCs** | | | | | | | | | | | | | | | | | |
| 1,2-Dichlorobenzene | µg/L | | | | | 1.6 | 3.1 | 2 | 1.7 | 1.7 | 1.3 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 1,3-Dichlorobenzene | µg/L | | | | | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 C | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 1,4-Dichlorobenzene | µg/L | | | | | 3 | 3.4 | 2.6 | 3 | 3.5 | 2.8 | 1.5 | 1.7 | 1.5 | 1.5 | 1.5 | 1.6 |
| Sum of Dichlorobenzenes | µg/L | | | | 5 (GV) | 4.6 | **6.5** | 4.6 | 4.7 | **5.2** | 4.1 | 1.5 | 1.7 | 1.5 | 1.5 | 1.5 | 1.6 |
| 2-Butanone | µg/L | | | | | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| Acetone | µg/L | | | | | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | 14 | <5.0 | <5.0 | <5.0 |
| Benzene | µg/L | | 134 | 57 | 190 (GV) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Chlorobenzene | µg/L | | | | 5 (GV) | **8.6** | **9.8** | **16** | **16** | **17** | **9.8** | **6.6** | **5.2** | **5.6** | <1.0 | 4.1 | 4.3 |
| Ethylbenzene | µg/L | | 380 | 142 | 4.5 (GV) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| m,p-Xylene | µg/L | | | | | <1.0 | <1.0 | <1.0 | 1.2 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Xylene (total) | µg/L | | 74 | 28 | | <1.0 | 1.1 | <1.0 | 1.9 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| **SVOs** | | | | | | | | | | | | | | | | | |
| Acenaphthene | µg/L | | | | | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | 1.3 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Bis(2-ethylhexyl)phthalate | µg/L | | | | | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| Di-n-butyl phthalate | µg/L | | | | | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| N-Nitrosodiphenylamine | µg/L | | | | | 3.5 | 3.9 | 4.2 | 3.7 | 4.3 | 4.3 | 4.6 | 3.6 | 3.5 | 3.5 | 2.5 | 3.7 |

*Qualifiers:*

*D = Result for dilution*

*B = Found in blank*

*c = Calibration acceptability criteria exceeded for this sample*

*S = Recovery exceeded control limit for this sample*

*H = Received/analyzed outside of analytical holding time*

*GV = Guidance Value only, not a standard*

*Bold font indicates exceedance of Class GA standard or guidance value.*

## Table 2
## Summary of Perimeter Gas Monitoring Well Results
### Pennsylvania Avenue Landfill, Brooklyn, NY

| Quarterly Monitoring Round | Date | GMW-1 | GMW-2 | GMW-3 | GMW-4 | GMW-5 |
|---|---|---|---|---|---|---|
| | | **Methane** (% by volume) | | | | |
| 1Q16 | 1-Feb | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 16-Feb | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 18-Feb | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 19-Feb | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 18-Mar | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 21-Mar | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2Q16 | 16-May | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 21-Jun | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3Q16 | 27-Jul | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 23-Sep | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4Q16 | 1-Nov | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | 7-Dec | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 |
| | | **Carbon Dioxide** (% by volume) | | | | |
| 1Q16 | 1-Feb | 3.2 | 2.8 | 2.7 | 11.2 | 1.0 |
| | 16-Feb | 3.0 | 1.6 | 1.2 | 11.4 | 0.8 |
| | 18-Feb | 2.4 | 1.1 | 1.9 | 7.3 | 0.5 |
| | 19-Feb | 2.6 | 1.5 | 0.8 | 9.7 | 1.1 |
| | 18-Mar | 2.7 | 1.3 | 1.1 | 8.4 | 1.2 |
| | 21-Mar | 2.3 | 1.5 | 0.9 | 7.6 | 1.2 |
| 2Q16 | 16-May | 0.8 | 1.7 | 2.9 | 9.9 | 1.6 |
| | 21-Jun | 2.6 | 1.5 | 1.3 | 8.2 | 1.1 |
| 3Q16 | 27-Jul | 2.8 | 1.9 | 1.1 | 9.4 | 1.1 |
| | 23-Sep | 1.5 | 1.7 | 1.8 | 8.4 | 1.5 |
| 4Q16 | 1-Nov | 6.3 | 3.1 | 8.2 | 13.1 | 1.4 |
| | 7-Dec | 1.5 | 1.9 | 4.8 | 11.7 | 1.1 |
| | | **Oxygen** (% by volume) | | | | |
| 1Q16 | 1-Feb | 7.8 | 13.3 | 17.6 | 7.4 | 20.1 |
| | 16-Feb | 8.8 | 17.1 | 19.9 | 6.4 | 20.0 |
| | 18-Feb | 8.4 | 20.5 | 20.3 | 13.4 | 20.1 |
| | 19-Feb | 8.1 | 14.1 | 19.6 | 9.9 | 19.1 |
| | 18-Mar | 8.9 | 19.3 | 19.5 | 11.6 | 19.6 |
| | 21-Mar | 8.1 | 19.1 | 19.5 | 12.1 | 19.3 |
| 2Q16 | 16-May | 18.3 | 17.2 | 16.1 | 10.8 | 19.4 |
| | 21-Jun | 8.2 | 18.6 | 19.8 | 11.7 | 19.2 |
| 3Q16 | 27-Jul | 8.1 | 18.3 | 19.3 | 10.6 | 19.3 |
| | 23-Sep | 11.3 | 17.6 | 18.2 | 11.1 | 19.2 |
| 4Q16 | 1-Nov | 8.6 | 10.9 | 9.6 | 9.2 | 19.7 |
| | 7-Dec | 20.1 | 20.2 | 17.6 | 9.8 | 19.2 |

**Note:** The quarterly rounds were conducted on March 18th, June 21st, September 23rd and December 7th. Monitoring was performed to confirm the absence of off-site gas migration after intermittent extended flare outage on all other dates.

## Table 3:
## Summary of Gas Monitoring Results within the Groundwater/Leachate Pre-Treatment Building

### Pennsylvania Avenue Landfill
**Brooklyn, NY**

| | Date | Leachate Treatment Building Methane (% by Volume) |
|---|---|---|
| **1Q16** | 1/5/16 | 0.0 |
| | 2/10/16 | 0.0 |
| | 3/2/16 | 0.0 |
| **2Q16** | 4/5/16 | 0.0 |
| | 5/4/16 | 0.0 |
| | 6/2/16 | 0.0 |
| **3Q16** | 7/13/16 | 0.0 |
| | 8/3/16 | 0.0 |
| | 9/13/16 | 0.0 |
| **4Q16** | 10/13/16 | 0.0 |
| | 11/14/16 | 0.0 |
| | 12/12/16 | 0.0 |

Table 4 - Volatile Organic Compounds Detected in Pennsylvania Avenue Landfill Monitoring Wells During 2016 Monitoring Round

| VOCs Detected In Ground-Water Samples | Class GA Standard | Well Number and Result, in ug/L | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HP-101U | HP-101S | HP-101S Dup. | HP-101D | HP-103D | HP-104A | HP-318 | HP-407U | HP-407S | HP-407D | HP-603 |
| Acetone | 50[GV] | <5 | <5 | <5 | <5 | <5 | <5 | <5 | 21 | <7 | <5 | <6 |
| Chlorobenzene | 5 | <5 | <5 | <5 | <5 | <5 | 3 J | 4 J | 1 J | <7 | <5 | 2 J |

Notes: J = Estimated concentration.
GV = Guidance value.
Bold font indicates exceedance of Class GA standard or guidance value.

Table 5 - Semivolatile Organic Compounds Detected in Pennsylvania Avenue Landfill Monitoring Wells During 2016 Monitoring Round

| SVOCs Detected In Ground-Water Samples | Class GA Standard | Well Number and Result, in ug/L | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HP-101U | HP-101S | HP-101S Dup. | HP-101D | HP-103D | HP-104A | HP-318 | HP-407U | HP-407S | HP-407D | HP-603 |
| Acenaphthene | 20[GV] | <1 | <1 | <1 | <1 | <1 J | <1 | 1 | <1 | <1 | <1 | <1 |

Notes: J = Estimated concentration.
GV = Guidance value.
Bold font indicates exceedance of Class GA standard or guidance value.

Table 6 - Leachate Indicator Parameter Results for 2016 Pennsylvania Avenue Landfill Ground-Water Samples

| Leachate Indicator Parameter | Class GA Standard | Well Number and Result, in mg/L* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HP-101U | HP-101S | HP-101S Dup. | HP-101D | HP-103D | HP-104A | HP-318 | HP-407U | HP-407S | HP-407D | HP-603 |
| Alkalinity | No Std. | 395 | 873 | 885 | 428 | 219 | 467 | 302 | 1,430 | 563 | 183 | 559 |
| Bromide | 2[GV] | <0.50 | **2.11** | 1.06 | **36.7 J** | **44.1** | <0.50 | 0.53 | **2.28** | **21.1** | **26.8** | 0.61 |
| Chloride | 250 | **530** | **3,620 J** | **2,460 J** | **14,300** | **19,200** | 66.1 | **576** | 243 | **6,870** | **8,540** | 128 |
| Sulfate | 250 | 85.2 | <5.00 | <5.00 | **1,400** | **1,620** | 144 | 247 | 6.36 | **594** | **1,120** | 117 |
| BOD | No Std. | <7 | <7 | <7 | <7 | <7 | <7 | <7 | 10 | <4 | <4 | <7 |
| COD | No Std. | 21.5 | 41.9 | 42.8 | 205 J | 156 | 35.9 | 27.1 | 217 | 131 | 114 | 57.8 |
| Color (Units) | 15 | **300** | **50.0** | <50.0 | **100** | **200** | **750** | **50.0** | **200** | **250** | **150** | **150** |
| Cyanide | 0.2 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| Hardness | No Std. | 450 | 500 J | 1,000 J | 3,700 | 4,500 | 580 | 640 | 620 | 2,650 | 2,450 | 1,000 |
| Ammonia | 2 | **7.53** | **6.64** | **6.77** | **6.46** | **6.82** | **5.90** | **11.1** | **91.7** | **31.2** | 1.79 | **10.6** |
| Nitrate | 10 | 0.41 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 | 4.26 | <0.10 | <0.10 | <0.10 | 1.33 |
| Phenols | 0.001 | **0.0143** | **0.0101** | <0.005 | **0.0062** | **0.0095** | **0.0108** | **0.0151** | **0.0184** | **0.0151** | **0.0112** | **0.0135** |
| TDS | 500 | **5,280** | **5,050** | **4,150** | **25,100** | **31,100** | **732** | **1,240** | **1,500** | **12,000** | **15,600** | **954** |
| TKN | No Std. | 7.16 | 6.98 | 6.86 | 6.00 | 5.98 | 6.29 | 11.4 | 88.4 | 29.8 | 1.55 | 11.3 |
| TOC | No Std. | 7.2 | 9.2 | 9.3 | 2.8 | 1.6 | 8.4 | 10.9 | 91 | 5.7 | 1.6 | 17.2 |

Notes: J = Estimated concentration.
GV = Guidance value.
* = Except for Color, which is in Color Units.
Bold font indicates exceedance of Class GA standard or guidance value.

Table 7 - Inorganic Parameter Results for 2016 Pennsylvania Avenue Landfill Ground-Water Samples

| Inorganic Parameter | Class GA Standard | Well Number and Result, in ug/L | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HP-101U | HP-101S | HP-101S Dup. | HP-101D | HP-103D | HP-104A | HP-318 | HP-407U | HP-407S | HP-407D | HP-603 |
| Aluminum | No Std. | <200 | <200 | <200 | <200 | <200 | <200 | <221 | <200 | <200 | <200 | <200 |
| Antimony | 3 | **4.5 J** | <60 | **3.8 J** | **7.0 J** | **4.5 J** | **5.4 J** | <60 | <60 | **6.0 J** | <60 | <60 |
| Arsenic* | 10* | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Barium* | 1,000 | 72.3 J | 42.8 J | 42.3 J | 106 J | 94.7 J | 276 | 41.8 J | 647 | 205 | 55.6 J | 76.5 J |
| Beryllium | 3[GV] | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| Boron | 1,000 | 285 | **1,060** | **1,050** | **2,560** | **3,180** | 262 | 249 | **2,280** | **1,640** | **1,740** | 607 |
| Cadmium* | 5 | <0.20 J | <2.5 | 0.20 J | 1.6 J | <2.5 | <2.5 | <2.5 | <2.5 | <2.5 | 0.60 J | <2.5 |
| Calcium | No Std. | 147,000 J | 56,000 J | 55,300 J | 282,000 | 351,000 J | 187,000 J | 184,000 J | 118,000 J | 218,000 J | 282,000 J | 211,000 J |
| Chromium, Total* | 50 | 3.3 J | 5.9 J | 6.2 J | 21.9 | 4.0 J | 8.2 J | 2.4 J | 11.0 | 18.0 | 13.7 | 2.9 J |
| Chromium, Hexavalent | 50 | <20 | <20 | <20 | <20 | <20 | <20 | <20 | <20 | <20 | <20 | <20 |
| Cobalt | No Std. | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 |
| Copper | 200 | <25 | <25 | <25 | <25 | <25 | <25 | <25 | <25 | <25 | <25 | <25 |
| Iron | 300 | **12,700 J** | <980 | <995 | **19,700 J** | **8,050 J** | **36,000 J** | <2,230 | <1,740 | **10,700 J** | **20,600 J** | **7,300 J** |
| Iron and Manganese | 500 | **12,953 J** | 57.7 | 57.6 | **20,108 J** | **9,270 J** | **36,521 J** | 258 | 335 | **11,061 J** | **21,325 J** | **8,400 J** |
| Lead* | 25 | 1.4 J | 2.3 J | 1.3 J | <5.0 | <5.0 | <5.0 | 5.0 J | 0.99 J | 3.5 J | <5.0 | 1.2 J |
| Magnesium | 35,000[GV] | 27,200 | **122,000** | **122,000** | **847,000** | **1,070,000** | **41,400** | **49,200** | **105,000** | **508,000** | **672,000** | **56,500** |
| Manganese | 300 | 253 | 57.7 | 57.6 | **408** | **1,220** | **521** | 258 | **335** | **361** | **725** | **1,100** |
| Mercury* | 0.7 | <0.20 | <0.20 | <0.20 J | <0.20 | <0.20 | 0.18 J | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| Nickel | 100 | 7.4 J | <40 | <40 | 32.9 J | 51.2 | 3.3 J | 2.8 J | 7.9 J | 68.8 | 38.4 J | 10.0 J |
| Potassium | No Std. | 12,900 J | 77,700 J | 82,100 J | 272,000 J | 333,000 J | 13,600 J | 17,600 J | 64,300 J | 208,000 J | 217,000 J | 12,100 J |
| Selenium* | 10 | <10 J | <10 J | <10 J | <10 J | <10 J | <10 J | <10 J | <10 J | <10 J | <10 J | <10 J |
| Silver* | 50 | 3.2 J | <10 | <10 | 3.6 J | <10 | 4.7 J | <10 | <10 | 3.1 J | 2.1 J | <10 |
| Sodium | 20,000 | **383,000 J** | **392,000 J** | **638,000 J** | **292,000 J** | **304,000 J** | **<48,800 J** | **297,000 J** | **368,000 J** | **477,000 J** | **498,000 J** | **121,000 J** |
| Thallium | 0.5[GV] | <10 | **2.2 J** | **3.1 J** | <10 | **2.0 J** | **2.1 J** | **2.4 J** | <10 | **1.9 J** | <10 | <10 |
| Vanadium | No Std. | <50 | 10.4 J | 12.4 J | 3.6 J | 3.6 J | <50 | 4.2 J | 10.6 J | 4.4 J | <50 | <50 |
| Zinc | 2,000[GV] | <67.0 | <20 | <20 | <20 | <20 | <20 | <20.6 | <20 | <20 | <20 | <20 |

Notes: J = Estimated concentration.
GV = Guidance value.
Bold font indicates exceedance of Class GA standard or guidance value.
* = RCRA metal.