

OBG

**BOYERTOWN SANITARY LANDFILL
SUMMARY OF FINDINGS AND RECOMMENDATIONS**

**Boyertown Sanitary Landfill Site
300 Merkel Road
Gilbertsville, Pennsylvania**

Boyertown Sanitary Landfill Site Coalition

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1. INTRODUCTION

O'Brien & Gere (OBG) conducted an evaluation of the facilities and operations at the Boyertown Sanitary Landfill located in Gilbertsville, Pennsylvania. The evaluation was conducted on behalf of the Boyertown Sanitary Landfill Site Coalition (Coalition), and included a review of historical documentation regarding landfill construction and operations, site visits to review the landfill facilities and operations, interviews of the landfill operator (Warren Frame) and select investigations of the landfill systems/infrastructure. The objectives of the landfill operations evaluation include the following:

- Provide an understanding of the current landfill operations and condition of the existing facilities
- Develop recommendations for the repair/restoration and/or replacement of the landfill infrastructure (if needed), to the extent necessary to bring the landfill into compliance with the landfill's closure plan approved by the Pennsylvania Department of Environmental Protection (PADEP)
- Provide recommendations for the establishment of landfill operations and maintenance program consistent with the landfill's PADEP-approved operations and plan

This report presents the landfill operations evaluation by OBG, including the activities and investigations conducted, key evaluation findings, and recommendations regarding repairs/restoration of the existing landfill systems and future operations and maintenance as appropriate.

1.1. BACKGROUND

The Boyertown Sanitary Landfill is located on an approximately 60-acre property in Douglass Township, Montgomery County at 300 Merkel Road, Gilbertsville, Pennsylvania (see [Figure 1](#)). An aerial photo of the landfill property and surrounding features, together with approximate parcel boundaries obtained from Montgomery County tax map information, is included as [Figure 2](#). The landfill footprint is approximately 30 acres, and is surrounded by support facilities including raw and pre-treated leachate storage lagoons, buildings housing leachate pre-treatment facilities, and stormwater management basins and swales. Two gravel-covered areas, covering approximately 2.5 acres, are located near the northern corner of the property and are rented to third parties as storage areas.

The landfill reportedly stopped accepting solid wastes on or about 1985 and the final cap was installed in 1987. The predominant waste accepted at the landfill was municipal waste or municipal-like residual wastes, including office trash and construction and demolition debris. The landfill also accepted significant quantities of municipal sewage treatment plant sludge, treatment plant solids, and certain industrial wastes.

The property is bounded on the northeast by Merkel Road and Minister Creek. A portion of the creek passes through the northeast section of the property. A residential neighborhood is located beyond Minister Creek to the northeast, and another residential neighborhood (Greenbrier housing development) is located adjacent to the southwest property boundary. The northwest side of the landfill property is bordered by an approximately 25-acre largely undeveloped property owned by Warren Frame. One of the parcels adjacent to the northwestern access road into the landfill includes a maintenance garage that Mr. Frame reportedly leases to tenant businesses. Other portions of the Frame property along the western side of the landfill have been used to stage fill, stone, wood chips and associated tree debris, and another portion is occupied by a commercial cell tower.

The landfill is currently owned and operated by the Boyertown Sanitary Disposal Co., which is owned by Warren Frame. According to the PADEP-approved closure plan and associated documentation provided by PADEP, the landfill includes the following components/systems:

- Landfill cap/cover, stormwater drainage, and site access/security
- Leachate conveyance and storage

- Leachate pre-treatment
- Landfill gas management

The above-noted systems are further described in the following sections of this report.

2. LANDFILL SYSTEMS AND INVESTIGATION FINDINGS

2.1. SUMMARY OF INVESTIGATIONS

OBG conducted investigations of the landfill's systems and equipment from 2015 to 2016, including the following:

- Review of PADEP historical files/documentation regarding the landfill, including documentation of past groundwater monitoring, leachate sampling, miscellaneous correspondence, PADEP enforcement activities, completed closure activities, and PADEP response actions under the Hazardous Sites Cleanup Act (HSCA). Additional information on landfill construction, leachate collection and treatment was obtained from interviews with the landfill owner/operator, Warren Frame. Mr. Frame also provided copies of selected drawings of the leachate collection system features, Closure Plan drawings for the landfill, and construction plans for the site's leachate pre-treatment system.
- Site visits and inspections conducted in 2015-2016, which included discussions with the landfill owner, Mr. Frame. Site visits included review of the general landfill facilities, and inspection and maintenance activities (e.g., vegetation removal) regarding specific features to facilitate investigations and groundwater sampling. Inspections were also conducted by qualified operations personnel to identify the existing condition and potential rehabilitation measures required for specific landfill systems and equipment (e.g., flare equipment, PADEP landfill gas/leachate collection trench, leachate pre-treatment system equipment)
- Cleaning and camera inspection of selected leachate collection piping in May 2016.
- Field/camera inspection of landfill perimeter gas vents in May 2016.

More recent investigation activities conducted at the site in October 2016 consisted of the following:

- Measurement of leachate/liquid flows from the landfill's central leachate collection manhole during a month-long testing period, with weekly analytical sampling for applicable Berks-Montgomery Municipal Authority (BMMA) discharge permit parameters and other general chemistry parameters.
- Measurements at landfill gas vents to evaluate the presence of methane and liquid levels.

Following are descriptions of the landfill systems and their general condition based on the documentation review and site inspections/investigation findings.

2.2. LANDFILL CAP/COVER, STORMWATER DRAINAGE, AND SITE ACCESS

2.2.1. Landfill Cap/Cover and Lining Systems

As described in Section 2.1, historic reports and other documents regarding the landfill were obtained from PADEP and other sources and reviewed. The following documents provided details regarding the landfill cap, cover, and liner systems constructed at the Site:

- *Closure Plan for Boyertown Sanitary Disposal, Co. Sanitary Landfill*, Applied Geotechnical and Environmental Service Corp. (AGES), August 1983 (Closure Plan)
- *Application for Permit Amendment, Boyertown Sanitary Disposal Co. Sanitary Landfill*, AGES, February 1984 (Application for Permit Amendment)
- *Certification of Construction for DER Approved Closure of Existing Fill Area*, AGES, December 3, 1987 (Certification of Construction)
- *Summary of Costs for Closure and Post-Closure Maintenance of Existing Fill Area at Boyertown Sanitary Landfill*, AGES, August 1986, revised February 1988 (Summary of Costs)

Based on these documents, the landfill footprint is reported to be approximately 30 acres. Of that, approximately 11 acres comprising the oldest portions of the landfill are unlined. The other 19 acres, filled more recently, are lined with asphalt or PVC lining systems (approximately 14 acres and 5 acres, respectively).

Approximately 9.2 acres of the landfill are capped with two feet of low permeability ($<10^{-7}$ cm/sec) clay, covered by two feet of cover soil and topsoil to sustain vegetative growth. The clay cap is reported to have been constructed on 9.2 acres encompassing the highest portion of the landfill, which reportedly covers portions of the unlined, PVC-lined, and asphalt-lined areas (the approximate limits of the clay cap are shown on [Figure 2](#)). The remaining 21 acres encompassing the lower portions of the landfill are reportedly furnished with two feet of cover soil and topsoil to sustain vegetative growth.

As observed during the site visits and inspections, the landfill cap/cover and surrounding areas are generally well vegetated and maintained by mowing. No significant indications of erosion (e.g., erosion gullies, bald spots) were noted on the cap slopes. On the top of the landfill there is an area of topographic depression (estimated at approximately 1 to 1.5 acres in size) that may be due to landfill materials settlement. Also reportedly, Mr. Frame had opened a portion of the cap in the 1990s or early 2000s to re-circulate leachate, a process PADEP ordered him to discontinue. It appears that portions of this area have not been mowed due to wetness in the surface soils caused by the lack of positive drainage. The area of topographic depression appears to be located within the clay-capped portion of the landfill. A good management practice for this area would be to backfill the topographic depression area through the import and placement of additional low permeability materials/soil cover (consistent with the existing cap), as required to re-establish positive drainage and a healthy vegetative cover.

2.2.2. Stormwater Drainage/Runoff Management

Based on observations during the Site visit, surface water runoff from the landfill flows radially down the slopes of the cover until captured in a network of drainage channels. There appear to be no constructed stormwater management (i.e., detention) facilities at the base of the landfill slopes along the northwest and southwest sides of the landfill, and stormwater runoff in these areas appears to disperse and infiltrate into the surrounding subsurface soils. On the southeast and northeast sides of the landfill, surface runoff is collected in vegetated swales on the landfill slopes and directed to a sedimentation basin in the northeast corner of the landfill, with discharge to Minister Creek before it leaves the property near its northeast corner. The Closure Plan and Application for Permit Amendment (refer to Section 2.2.1) indicate that the stormwater management facilities were sized to accommodate the 25-year, 24-hour storm, which is consistent with current PADEP Solid Waste regulations.

The landfill slopes appeared well vegetated, with little erosion present. Stormwater drainage channels are presently in good condition (i.e., no significant erosion), with the exception of the downstream reach of a channel (approximately 425 feet in length) that flows northeast and drains into the sedimentation basin located along the northeast side of the landfill. This channel segment steepens in grade as it approaches the sedimentation basin and erosion (i.e., a head cut) is present in the area of steepened grading. It is anticipated that the head cut erosion in this area will progress upslope/upstream along the channel over time, unless the condition is addressed and it is recommended that the channel erosion be corrected through the installation of surface reinforcement materials (e.g., rip rap, turf reinforcement mat) and/or grade controls.

2.2.3. Site Access/Security

Security fencing currently limits access to the leachate pre-treatment system building and equipment, and to the raw leachate storage basin and pre-treated effluent storage basins (refer to [Figure 2](#)). Vehicle access to the property is obtained via an entrance along Merkel Road. Other businesses reportedly utilize portions of the property owned by the Boyertown Sanitary Disposal Company, and adjoining parcels owned by Warren Frame.

As noted in Section 1.1, a residential neighborhood is located adjacent to the landfill's southwest property boundary. The Closure Plan indicates that a fence is present to the west and south of the landfill to limit access to the property in this area; however, limited fencing was observed along the southwest property boundary as part of the site visits/inspections. Indications of minor trespass onto the landfill property (e.g., deposits of yard waste such as grass clippings) were observed during site visits/inspections along the southwest property line. On the southeast side of the landfill there are remnant portions of a tall fence, which was reportedly constructed to contain blowing trash during landfill operations. A number of breaches in this fence were observed, but no indications of frequent trespass (e.g., worn footpaths, recreational vehicle paths) were noted.

Based on observations during the site visits and inspections, the landfill perimeter access road along the southeast and southwest property boundary is overgrown and heavily rutted, such that access (even with four-wheel drive vehicles) is difficult.

2.3. LEACHATE COLLECTION SYSTEM

2.3.1. Leachate Collection System Layout

Information obtained during the file reviews and from Warren Frame regarding details of the leachate collection system construction includes the following:

- *Closure Plan* design drawings
- Mast Engineering leachate collection piping design drawings

The available documentation, supported by Warren Frame's descriptions, indicates that there are two primary leachate collection systems in the landfill. The west leachate collection system (refer to [Figure 2](#) for an approximate collection pipe layout) collects leachate from the perimeter of the approximately 11-acre oldest, unlined portion of the landfill and consists of a single perimeter pipe that follows the edge of this portion of the landfill. The pipe extends west along the northern edge of the landfill and then turns south to follow the west edge of the cell, terminating approximately midway along the landfill's west edge. There are no cleanouts or other visual evidence of the pipe's location on the surface or other means of access besides its drainage termination point in the central leachate collection manhole, located at the northern end of the landfill. Mr. Frame is aware of the pipe's general location/alignment along the western boundary of the landfill, and field-located the pipe in March 2016 during exploratory excavation work used to select a location for a new monitoring well.

The east leachate collection system (refer to [Figure 2](#) for an approximate collection piping layout) is a dendritic network of collection piping at the bottom of the 19-acre lined portion of the landfill, extending from the central leachate collection manhole at the northern end of the landfill eastward and southward into the lined portion of the landfill. The level of detail and alignment of the leachate collection piping shown on the above-referenced *Closure Plan* drawings and Mast Engineering drawings are different, so the leachate piping configuration and alignment shown on [Figure 2](#) should be considered approximate. Photos of the liner system construction produced by Warren Frame appear to support the general construction details and piping configuration depicted on the above-referenced drawings. The photos also show that the leachate collection piping and landfill liner were covered with what appears to be a layer of relatively fine aggregate.

The primary collection pipes of the east and west leachate collection systems drain to a central leachate collection manhole located near the north end of the landfill adjacent to the leachate pre-treatment system, as shown on [Figure 2](#). The manhole was installed as part of the leachate treatment system circa 1984. Based on field observations, the inside diameter of the manhole is approximately four (4) feet, and the manhole floor is located at approximately 7 feet below ground surface (bgs). A 4-inch diameter PVC pipe that drains leachate from the west system enters the manhole at 1-2 inches above the manhole floor, and a 4-inch diameter PVC pipe that drains leachate from the east system enters the manhole on the opposite side at approximately the same elevation. A submersible pump installed in the manhole pumps collected liquids through a buried 2-inch diameter HDPE discharge line to the raw leachate storage basin. Based on the limited manhole depth, the bottom several feet of the manhole serve as the wet well for the pump, with the "pump-on" level float activated when the liquid depth in the manhole reaches approximately 4 feet above the floor, and the "pump-off" level float activated when the liquid depth in the manhole reaches approximately 6 inches to 1 foot above the floor. As a result, the two 4-inch diameter west and east system leachate collection pipes are submerged under normal operating conditions. The submergence of these pipes inhibits free draining of the collection system piping, which promotes reduced flow velocities in portions of the collection system and resultant settling/accumulation of sediment/solids in the collection piping. Review of historical design drawings/*Closure Plan* information for the landfill indicates that a 6-inch diameter drainage line previously allowed leachate to freely drain from the manhole to the on-site raw leachate storage basin. However, current site observations and discussions with Warren Frame indicate that the 6-inch drain line was previously closed/sealed. It is recommended that the

existing manhole be replaced with a deeper manhole to provide a “wet well” for collection of leachate below the elevations of the east and west leachate collection lines, to allow leachate to freely drain from the east and west collection lines, consistent with the original design/Closure Plan documentation.

2.3.2. Cleanout and Camera Inspection of Selected Collection System Piping (May 2016)

O'Brien & Gere performed cleanout of selected reaches of the east and west collection system piping on May 23, 2016. To perform cleaning of the collection piping, the leachate in the collection manhole was pumped down to reveal the collection pipes. A flow of relatively clear liquid was observed entering the collection manhole from both the east and west collection systems prior to and following the cleaning effort. The cleaning effort did not result in a noticeable change in the observed flow rates from the leachate collection systems.

West Collection System

Cleaning was accomplished using water jetting equipment for approximately 165 feet in the west line, beginning from the leachate collection manhole. Oily sediment and some other debris (stones, grit, etc.) was removed from the pipe during the cleaning activities. Following pipe cleaning, a camera was advanced along the west collection pipe to the limit of the cleaned section (approximately 165 feet). Sediment and debris was encountered in the collection pipe just beyond the cleaning limits, preventing further advancement of the camera.

Observations from the camera work indicated that the pipe appeared to be in sound condition for the entire length inspected. No bends in the pipe, or other pipes branching from the line, were observed, and this is consistent with the information presented in historical design drawings reviewed for the west collection system (refer to Section 2.3.1). Leachate drained from the pipe to the collection manhole at similar rates prior to and after the cleaning.

East Collection System

Cleaning of the east collection piping was accomplished for approximately 350 feet in the east line, beginning from the collection manhole. Following the cleaning/jetting, the camera was advanced 237 feet east into the pipe.

Camera inspection work commenced at the leachate collection manhole and proceeded southeast along the east leachate collection line. The pipe was observed to be of solid wall (non-perforated) PVC construction. A 30 or 45-degree bend to the right (turning southward) was encountered at 85 feet from the manhole, and a second 30 or 45-degree bend to the left was encountered at approximately 100 feet from the manhole, bringing the pipe back to the original direction/line as shown on the historic drawings. These pipe bends are not specifically identified on the historic drawings reviewed (refer to Section 2.3.1), and may have been field-installed based on conditions encountered during construction. At approximately 86 feet from the manhole (shortly after the first bend noted above at 85 feet along the pipe), a tee/pipe junction was encountered and a stronger flow of clear liquid entered from the left (eastern) branch of the junction. Based on review of the Mast Engineering drawings (refer to Section 2.3.1), the left branch is thought to join with a second main leachate collection line from the eastern section of the landfill. However, the water jetting and camera equipment could only proceed straight through the tee/junction. There was less liquid flow in the pipe that the camera followed past the tee.

Beyond 100 feet from the manhole (i.e., past the second pipe bend noted above), the leachate collection piping was observed to be perforated, with two holes in its bottom half. As noted above, less liquid flow was observed in the pipe beyond the tee/junction, and eventually no flow was observed in the pipe as the camera continued to advance. The camera could not be advanced past approximately 237 feet from the manhole, due to sediment and debris within the pipe.

Observations from the camera work indicated that the piping appeared to be in sound condition for the entire length inspected, with no breaks, cracking, or open joints observed. The approximate collection piping layout shown on [Figure 2](#) reflects the findings from the camera work.

2.3.3. Leachate Collection System Flow Evaluation (October 2016)

Historically, leachate has been pre-treated at the Site (refer to Section 2.4 for additional details) and discharged to the Berks-Montgomery Municipal Authority (BMMA) under an existing Industrial User Permit (Permit No. 01-11). A summary of annual pre-treatment facility discharge flow records obtained from BMMA is as follows:

Year	Annual Discharge in Gallons	Annual Rainfall ¹ (inches)
2001	1,125,978	32.15
2002	1,346,369	42.21
2003	1,683,323	58.80
2004	1,897,300	54.40
2005	N/A	41.55
2006	826,700	52.07
2007	677,100	41.83
2008	862,700	46.01
2009	900,400	47.54
2010	750,600	39.00
2011	647,700	52.74
2012	159,800	38.71
2013	0	43.37
2014	0	43.49
2015	0	36.93

N/A - Flow data not available

¹Rainfall data from Weather Underground for the Pottstown Limerick rain gauge:

https://www.wunderground.com/history/airport/KPTW/2016/11/09/DailyHistory.html?req_city=Gilbertsville&req_state=PA&reqdb.zip=19525&reqdb.magic=1&reqdb.wmo=99999

Comparison of the above-noted flow information to landfill design information included in the Closure Plan indicates that the BMMA annual discharge flow data for the 2001-2004 time period are within the range of anticipated leachate flow rates that would be expected from the landfill (i.e., in the range of 1.5 MG/year, based on an average annual rainfall of 40 inches/year and a clay/soil cover type), and also considering variations in annual rainfall during the 2001-2004 time period. However, commencing in 2006 and thereafter, BMMA annual flow records show a significant reduction in discharges from the landfill pre-treatment facility. Since 2012, the flow records indicate that no liquids have been discharged to BMMA from the leachate pre-treatment facility.

Discussions with the current landfill operator (Warren Frame) and observations during OBG's site visits/inspections indicate that pre-treated effluent leachate from the on-site leachate pre-treatment facilities is being recirculated from the pre-treated leachate/effluent storage basins back to the influent (raw) leachate storage basin, possibly in an effort to minimize discharges from the site to BMMA (and the associated discharge fees). It is unclear how long this recirculation practice has been in effect. Review of the BMMA annual discharge flow data in the table above suggests that the practice of recirculating pre-treated leachate effluent back to the influent (raw) leachate storage basin may have been in effect as early as 2006. However, given the significant reduction in flows from the pre-treatment system recorded from approximately 2006 and more recently, OBG conducted a field study to evaluate whether current liquid flow rates from the landfill's leachate collection piping system are within the range of expected values based on historical flow data (as noted above) and based on landfill design documentation.

Temporary pumping equipment was installed in the central leachate collection manhole on October 14, 2016 and operated for a one-month period during the flow study. Pumping equipment level floats were set to maintain the liquid level in the manhole as low as possible (approximately 6-inches to 1-foot above the manhole floor), to allow leachate from the landfill collection piping to freely drain to the manhole to the degree practical. Pumping operations commenced on October 14, 2016, and continued for approximately one-month. The temporary pumping equipment was removed on November 11, 2016.

Flow metering equipment was installed on the temporary pump's discharge line to allow for measurement of liquid discharges from the manhole to the raw leachate storage basin. The flow meter was inspected twice a week to confirm proper operation and to record totalized flow readings. Flow readings from the inspections are presented in [Table 1](#), along with calculated daily and annualized flow rates. Based on the data collected during the testing period, the annualized leachate flow rates range from approximately 1.1 million gallons (MG) to 1.3 MG. This range in collection manhole discharge flow rates is generally consistent with historical BMMA flow records for the pre-treatment facility prior to 2006. For example, the BMMA flow record of approximately 1.1 MG/year in 2001 (when the annual precipitation was recorded at approximately 32 inches for the year), closely matches the 1.1-1.3 MG annualized flow range estimated through the leachate collection system flow study in 2016 (when the annual total precipitation through November is recorded at approximately 26.17 inches). In addition, the measured leachate flow rates during the October/November 2016 flow study are within the general range of anticipated leachate flow rates that would be expected from the landfill, based on Closure Plan design information, as described above.

Liquid level and methane measurements were also obtained from the landfill's perimeter gas vents during the October/November 2016 flow testing work, and are discussed in Section 2.5.3 below.

2.4. LEACHATE STORAGE AND PRE-TREATMENT FACILITIES

OBG's evaluation of the landfill's leachate treatment facilities is based on limited visual inspection of the existing pre-treatment equipment, review of available design documentation (e.g., copies of as-built drawings for the leachate pre-treatment system provided by Warren Frame), review of BMMA/sampling information and discussions with BMMA personnel, and discussions with the current landfill operator (Warren Frame). In addition, a trade magazine article describing the leachate storage and pre-treatment facilities is included as [Appendix A](#).

The landfill is authorized to discharge pre-treated leachate via Industrial User Permit (Permit No. 01-11) with BMMA. The User Permit was re-issued in July 2016. Pre-treated leachate is discharged to a local sanitary sewer, which drains to a POTW facility operated by BMMA. The landfill's existing leachate storage and pre-treatment features are written into the Special Conditions (Part 4) of the BMMA permit, and are summarized as follows:

- Raw (i.e., untreated) leachate storage lagoon/basin having 345,000 gallon working capacity (650,000 gallon maximum capacity)
- A fixed film reactor intended to contain a biomass acclimated to treat the leachate with an accompanying clarifier
- An air stripping tower
- Two liquid-phase carbon adsorption columns in series
- Intermediate vessels for acid/base neutralization, pH adjustment or other modification, as needed
- Two 100,000 gallon working capacity pre-treated leachate/effluent storage basins

BMMA maintains a lock on a valve in the discharge line from the pre-treatment facility to the BMMA system, which is unlocked when a discharge is warranted in accordance with conditions outlined in the BMMA permit.

The following sections provide additional details regarding the existing leachate storage and pre-treatment facilities (including an assessment of their current condition). In addition, a treatability evaluation of the current pre-treatment facilities with respect to BMMA discharge parameters compliance is presented, considering both historical and more recent leachate sampling data.

2.4.1. Leachate Storage

Raw Leachate Storage Lagoon

The approximately 345,000-gallon working capacity raw leachate storage lagoon is a hypalon-lined basin approximately 16,000 square feet in surface area and 7 feet deep, with a primary liner, a secondary liner and a leakage witness layer as detailed in the treatment system as-built drawings. Constructed in approximately 1985, the lining system is over 30 years old. The lagoon is observed to have a number of open seams and vegetation growing through some seams, particularly in the east end. An investigation of the condition of the raw leachate storage basin (as well as the two treated leachate storage basins) was reportedly conducted circa 2000-2001, and no leakage was clearly identified from the raw leachate basin at that time. However, the deteriorated condition of the lining system is visually evident based on OBG's recent observations. Based on the above, the basin liner system would require replacement in order to support future landfill operations.

Treated Leachate Lagoons

The two pre-treated leachate/effluent storage basins (each 100,000-gallons working capacity) are approximately the same age as the raw leachate basin and of similar construction (i.e., each furnished with a primary liner, a secondary liner, and a leakage witness layer), but appear to be in somewhat better condition based on OBG's recent observations. However, reports from the above-noted investigation in 2000-2001 indicate that leakage from the primary liners in these basins was occurring at that time. Repairs attempted to stop the leakage were reportedly unsuccessful. Based on the above, the effluent basin liner systems would require replacement in order to support future landfill operations.

2.4.2. Leachate Pre-Treatment System – Preliminary Treatability Evaluation

Historical Sampling Data

OBG conducted a review of selected historical sampling data regarding the leachate pre-treatment system discharges to BMMA, to provide an indication of the pre-treatment facility's ability to treat the landfill leachate sufficient to comply with BMMA discharge criteria. OBG also contacted BMMA to discuss the discharge permit compliance history for the leachate pre-treatment system, and BMMA personnel indicated that the pre-treatment system discharges have complied with the Industrial User Permit discharge criteria in the past (BMMA noted that discharges have not been received from the pre-treatment system since 2012 – refer to Section 2.3.3 above).

OBG obtained selected historical influent/effluent sampling results for the pre-treatment system, and these results are included as [Appendix B](#). Pre-treatment system effluent sampling results for 2009-2015 are shown in [Table B-1](#), and compared with BMMA permit discharge criteria, which include biological oxygen demand, pH, total dissolved solids (TDS), oil & grease, ammonia nitrogen (NH₃-N), phosphorus, color, and selected metals (in accordance with the permit conditions, effluent samples are taken from a sampling port between the two carbon vessels). As shown on the table, the effluent sampling results generally demonstrate compliance with the BMMA permit discharge criteria, with the exception of ammonia and color exceedances for effluent samples collected from 2011-2015 (it is noted that the BMMA permit allows for the payment of surcharges for exceedances of certain parameters, including TDS, color, phosphorus and NH₃-N, at the BMMA's discretion).

In addition to the above-noted parameters, the BMMA permit includes discharge criteria for priority pollutants as follows:

Priority Pollutant	Sum of Detected Compound Values
Volatiles (excluding acrolein and acrylonitrile)	100 µg/L
Acid extractable compounds	100 µg/L
Pesticides & PCBs	100 µg/L
Acrolein and acrylonitrile	50 µg/L
Gamma-BHC	0.5 µg/L

The current BMMA permit also restricts the concentration of any parameter not on the above list to no more than 20 µg/L above its respective method detection limit (MDL). The permit also contains a requirement to remove a minimum of 85% of the total concentration of the priority pollutants identified in the raw leachate.

Historical pre-treatment system effluent sampling results for priority pollutants and metals from 1986-1995 are shown in **Table B-2**, and compared with the above-noted BMMA permit discharge criteria. As shown on the table, the discharge sampling results generally demonstrate compliance with the BMMA discharge criteria (possibly with a few minor exceptions, such as naphthalene in a February 1986 effluent sample).

Table B-2 also includes pre-treatment system influent sampling results for priority pollutants and metals from 2009-2015. These results show low levels (in the range of 10 ug/L or less) for various priority pollutants, generally demonstrating compliance with the BMMA permit criteria.

Recent Leachate Collection System Sampling (October 2016)

As described in Section 2.3.3, review of BMMA flow records indicates a significant reduction in annual discharges from the landfill pre-treatment system from approximately 2006 onward, and no discharges from the pre-treatment facility to BMMA have occurred since 2012. In addition, discussions with the current landfill operator (Warren Frame) and observations during OBG's site visits/inspections indicate that pre-treated effluent leachate from the on-site leachate pre-treatment facilities is being recirculated from the pre-treated leachate/effluent storage basins back to the influent (raw) leachate storage basin, in order to minimize discharges from the site to BMMA (and the associated discharge fees). It is unclear how long this recirculation practice has been in effect. However, based on review of the BMMA annual discharge flow data in the table above, it is reasonable to conclude that the practice of recirculating pre-treated leachate effluent back to the influent (raw) leachate storage basin may have been in effect as early as 2006. It is also reasonable to conclude that the more recent (i.e., 2009-2015) BMMA influent/effluent sampling results reviewed above may reflect the recirculation operational practices, and therefore these influent/effluent testing results may not necessarily be representative of typical pre-treatment system operations (i.e., normal treatment and discharge to BMMA).

As detailed in Section 2.3.3, OBG conducted a field study in October-November 2016 to evaluate liquid flow rates from the landfill's leachate collection piping system, via the installation of temporary pumping equipment in the landfill's central leachate collection manhole and operation of the pumping equipment for a one-month period. As part of this field study, OBG also collected discrete/grab analytical samples of the raw leachate from the collection manhole on a weekly basis during the pumping operations. The first sample was collected on October 21, 2016, after one week of pumping operations, and the last sample was collected on November 11, 2016, after 4 weeks of pumping operations. The sampling was conducted with the objective of obtaining recent, representative samples of influent/raw leachate from the landfill. Samples were analyzed for BMMA discharge parameters and other general chemistry parameters.

The raw leachate analytical results obtained during the field study are included as **Table 2**, and compared with applicable BMMA permit discharge criteria. Following is a summary of the field study results for selected BMMA discharge parameters, a summary of historical BMMA sampling results, and potential treatability considerations as applicable:

5-Day Biochemical Oxygen Demand (BOD-5)

- **BMMA Limits:** The permit has a limit of 150 mg/L, with potential surcharges for effluent concentrations at or above 200 mg/L.
- **October/November 2016 Sampling:** BOD-5 in the raw leachate ranged from 17.9 to 62.7 mg/L.
- **2009-2015 Effluent Monitoring Results (**Table B-1**):** BOD-5 was measured between 2.5 to 47 mg/L, which is in the same general concentration range as BOD-5 in the 2016 raw leachate results.
- **Pre-treatment Requirements:** Based on the 2016 raw leachate data, pre-treatment for BOD-5 (via the fixed film reactor/clarifier) may not be required since the raw leachate results are below the permit limit.

However, operation of the fixed film reactor/clarifier may be beneficial in addressing other leachate constituents (e.g., ammonia, priority pollutants), provided that the reactor biomass can be properly acclimated to the landfill leachate constituents. Based on the relatively low BOD-5 in the raw leachate, the fixed film reactor may require a supplemental carbonaceous food source for proper operation.

Total Dissolved Solids (TDS)

- **BMMA Limits:** The permit has a limit of 3500 mg/L, with potential surcharges for effluent concentrations at or above 500 mg/L.
- **October/November 2016 Sampling:** TDS concentrations in the raw leachate ranged from 3,990 to 5,650 mg/L.
- **2009-2015 Effluent Monitoring Results (Table B-1):** TDS was measured between 170 to 2,190 mg/L.
- **Pre-treatment Requirements:** Based on the 2016 raw leachate data, pre-treatment for TDS would be required to meet the BMMA limits. The pre-treatment system does not currently include processes designed to address TDS, and treatment processes that would address TDS (e.g., reverse osmosis) are typically costly to construct and operate. It is also noted that the caustic addition used with the air stripping process to address ammonia (refer to ammonia discussion below) may add additional TDS to the pre-treated leachate stream. Therefore, it may be beneficial to discuss modification of the current BMMA permit limit and payment of applicable surcharges for excess TDS, in lieu of providing additional treatment processes for this parameter.

Ammonia (NH₃-N)

- **BMMA Limits:** The permit has a limit of 25 mg/L, with potential surcharges for effluent concentrations above this value.
- **October/November 2016 Sampling:** Ammonia (NH₃-N) concentrations in the raw leachate ranged from 276 to 382 mg/L.
- **2009-2015 Effluent Monitoring Results (Table B-1):** Ammonia (NH₃-N) concentrations ranged from 0.1 to 57.3 mg/L.
- **Pretreatment Requirements:** Based on the 2016 raw leachate data, pre-treatment for ammonia would be required to meet the BMMA limits. The pre-treatment system currently includes processes designed to address ammonia (primarily pH adjustment using caustic, followed by air stripping through an existing stripper tower). However, based on review of the ammonia concentrations in the raw leachate (in the range of 300 to 400 mg/L, as noted above), the current air stripper system may not be able to provide ammonia removal sufficient to meet the BMMA permit limit of 25 mg/L. Therefore, it may be beneficial to discuss modification of the current BMMA permit limit and payment of applicable surcharges for excess ammonia. Alternatively, a replacement air stripper treatment process could be considered for addressing ammonia; however, the design, installation, and operation of replacement air stripper equipment would be anticipated to involve additional capital/operating costs.

Color

- **BMMA Limits:** The permit has a limit of 150 platinum-cobalt (Pt. cobalt) units, with potential surcharges for effluent concentrations above 100 Pt. cobalt units.
- **October/November 2016 Sampling:** Color ranged from 500 to 750 Pt. cobalt units.
- **2009-2015 Effluent Monitoring Results (Table B-1):** Color ranged from 25 to 275 Pt. cobalt units.
- **Pretreatment Requirements:** Based on the 2016 raw leachate data, pre-treatment for color would be required to meet the BMMA limits. The pre-treatment system currently includes processes designed to address color in part (primarily the lead-lag liquid-phase granular activated carbon adsorption vessels). However, based on review of the color values for the raw leachate (in the range of 500 to 750 Pt. cobalt units, as noted above), it is anticipated that significant quantities of carbon media would be required to

provide color removal sufficient to meet the BMMA permit limit/surcharge limits of 150/100 Pt. cobalt units. In addition, alternative treatment processes that would address color (e.g., reverse osmosis) are typically costly to construct and operate. Therefore, it may be beneficial to discuss modification of the current BMMA permit limit and payment of applicable surcharges for excess color.

Priority Pollutants/Organic Constituents

- **BMMA Limits:** The BMMA permit has various discharge limits for priority pollutants as described above under “Historical Sampling Data”.
- **October/November 2016 Sampling and Historical Effluent Monitoring Results:** Organic constituent concentrations in the 2016 raw leachate samples were generally higher than those identified based on historical pre-treatment system influent sampling results for priority pollutants from 2009-2015 (refer to [Table B-2](#) and the associated discussion under “Historical Sampling Data” above).
- **Concentrations of selected organic constituents** (e.g., benzene, chlorobenzene, 1,4-dichlorobenzene, ethylbenzene, xylenes) were generally in the range of 10 to 50 ug/L, and concentrations of 1,4-dioxane were detected in the general range of 100 to 200 ug/L.
- **Pretreatment Requirements:** Based on the 2016 raw leachate data, pre-treatment for priority pollutants/organics would be required to meet the BMMA limits (typical permit limits for individual organic constituents are no more than 20 ug/L above each constituent’s respective method detection limit). The pre-treatment equipment currently includes processes designed to address organic constituents (e.g., fixed film reactor/clarifier, the air stripping process, and liquid-phase granular activated carbon adsorption vessels), and it is anticipated that the pre-treatment system would be able to comply with the specific BMMA limits for most priority pollutants/organic constituents (selected constituents may merit further review/treatability testing). However, based on the relatively low aggregate concentrations of priority pollutants/organic constituents (i.e., total concentrations in the ug/L range), it may be challenging to meet the BMMA permit limit regarding the removal of a minimum of 85% of the total concentration of the priority pollutants identified in the raw leachate (refer to the discussion under “Historical Sampling Data” above). Therefore, it may be beneficial to discuss modification of this current BMMA permit limit.

Summary of Findings

Based on review of the raw leachate analytical sampling results obtained in October-November 2016 and the preliminary treatability evaluation presented above, the leachate pre-treatment system would not be expected to meet the current BMMA permit discharge limits as currently designed and operated. OBG contacted BMMA to discuss the potential for modification of selected discharge permit criteria (e.g., TDS, ammonia, color), and BMMA personnel indicated that they would potentially entertain the possibility for modifications in these parameters. It is recommended that further discussions/negotiations be conducted with BMMA toward modification of the permit limits for the leachate pre-treatment system. Based on preliminary conversations with the Coalition, BMMA has indicated that it would consider accepting raw leachate into its system if discharged in batches which could be pre-screened. Further discussions with BMMA and PADEP would be necessary to further evaluate the efficacy of this approach. If the batch discharge of raw leachate is not approved, but some modification of discharge limitations can be, the following section describes the anticipated rehabilitation/restoration measures toward resuming the pre-treatment system operations.

2.4.3. Leachate Pre-Treatment System – Equipment Operability/Restoration Evaluation

The following sections provide recommendations for the rehabilitation/restoration of the existing pre-treatment system equipment. The pre-treatment system was installed circa 1984, based on historical design drawings provided by the current system operator (Warren Frame). The recommendations are based on OBG’s site inspections and preliminary observations regarding the treatment system equipment conditions, prior experience with similar systems and equipment, and discussions with Mr. Frame regarding the system operations and maintenance history.

Fixed Film Reactor and Clarifier

The first pre-treatment process receiving influent flows from the raw leachate storage basin is the fixed film biological reactor, followed by a clarifier for removal of solids. These units are below-grade concrete tanks, each with a 20-foot by 20-foot footprint, and approximately 6-8 feet in depth. Historical design drawings indicate that the tanks each have a cone-shaped or sloped bottom, to promote the settling of solids from the biological and settling processes and allow their periodic removal as needed. Historical design drawings indicate that the fixed film reactor contains a network of submerged aeration piping, reportedly of PVC and carbon steel construction, as well as a carbon steel screen that serves as the fixed film media to promote uniform biomass development throughout the reactor volume. The clarifier is reportedly furnished with internal wooden baffle boards. The tanks are open on top to permit routine inspection and maintenance, and a fabricated roof structure (with wooden framing and corrugated plastic panel cladding) is installed over the tanks for weather protection and to limit access to the tanks and equipment. The equipment within the tanks (i.e., aeration piping and screens) is primarily submerged during normal operating conditions, limiting the ability to observe and inspect the equipment condition without shutting down and draining the tanks. However, limited observation of the equipment operation (i.e., agitation of the water surface) indicates that the aeration piping appears to be providing irregular air flow through the tank, suggesting that submerged aeration piping may be fouled or otherwise in deteriorated condition, and potentially inhibiting proper unit operation. In addition, limited discussions with Mr. Frame indicate that solids have not been removed from the fixed film reactor or the clarifier in some time. Based on OBG's observations of the equipment, and considering the equipment's age/duration of operations (30+ years), the following general activities are recommended for rehabilitation and restoration of the equipment operations:

- Temporarily shut down the reactor/clarifier units, drain the tanks, and remove accumulated solids (with disposition/management of solids/liquids as appropriate)
- Cleaning, inspection, and repair of the tank floors and concrete surfaces, with repair/re-coating of the surfaces as necessary
- Replacement of the aeration/diffuser piping and fixed film media in the reactor, and replacement of the internal baffles in the clarifier

Caustic/Acid Feed Systems, Mixing Equipment and Stripping Tower

As described above, the leachate pre-treatment system currently includes processes designed to address ammonia (primarily pH adjustment using caustic, followed by air stripping through an existing stripper tower). An acid feed system is used following air stripping to return the leachate/liquids to neutral pH conditions. Based on OBG's limited inspection of the equipment, the equipment appeared to be unmaintained, and reportedly has not been in use for some time (e.g., the caustic mix tank was dry/not in operation, and was coated with what appeared to be residual caustic solids). Based on OBG's observations of the equipment, and considering the equipment's age/duration of operations (30+ years), the following general activities are recommended for rehabilitation and restoration of the equipment operations:

- Temporarily shut down the stripper tower, replace the tower media, and clean the interior (using mechanical means) to remove accumulated scale/solids
- Replacement of the stripper system blower and motor
- Replace the caustic/acid feed systems and mixers/tanks

Carbon Adsorption

The pre-treatment process includes liquid-phase carbon adsorption (primarily for final polishing of organics, and removal of color). Based on OBG's inspection of the equipment, the equipment appeared to be unmaintained, and reportedly the carbon media has not been changed in some time. Based on OBG's observations of the equipment, and considering the equipment's age/duration of operations (30+ years), the following general activities are recommended for rehabilitation and restoration of the equipment operations:

- Remove and dispose of the carbon within the vessels (the carbon has reportedly not been replaced in the vessels for some time). Although re-use of the vessels may be further evaluated based on inspection of their condition during carbon media removal, based on the age of the vessels and duration of their operations it is recommended that the vessels and carbon media be replaced at this time.

System Start-Up and Testing

Following replacement/rehabilitation of the pre-treatment process equipment as described above, the flow of leachate would be resumed through the system, and start-up and testing would be conducted to confirm equipment functionality and operations, with calibration and testing of chemical feed systems and dosages. Following confirmation of overall system and individual equipment functionality, influent/effluent testing and sampling are recommended to confirm treatment efficacy/effluent characterization between the various unit processes and for the final pre-treatment system effluent, prior to resuming permitted discharges.

Significant long term O&M cost savings could be obtained with a direct or batch discharge of raw leachate. Such an arrangement would require other plumbing and structural changes at the landfill which have not been evaluated here.

2.5. LANDFILL GAS MANAGEMENT

According to the *Summary of Costs* historical documentation, twelve (12) gas vents were located along the southwest perimeter of the landfill and eleven (11) gas vents were located along the southeast perimeter of the landfill. The *Closure Plan* describes these vents as vertical extensions connected to the lateral leachate collection lines within the landfill (refer to Section 2.3 for a discussion of the leachate collection system layout). The vents were constructed by extending 4-inch PVC piping through the soil landfill cover to the ground surface. The reported intent of these vents is to vent landfill gas off the free surface of leachate in the collection system. As documented in the *Summary of Costs*, a gas flaring unit located near the northeast corner of the landfill (“Flare 1” – refer to **Figure 2**) was installed to burn the gas emitted from the southeastern vents. No other gas collection facilities are reported to have been installed at the time of closure.

In September 2000, gas quality testing was performed on the twelve (12) gas vents located to the southwest of the landfill as described in the *Final Report on Work Plan Status, Boyertown Sanitary Disposal Company* (Martin and Martin, Incorporated, March 29, 2001). Eleven (11) of the vents indicated methane concentrations above 60%. It was determined that eight (8) of these eleven (11) vents would sustain a continuing flame. Two candle flares (“Flare 2” and “Flare 3” – refer to **Figure 2**) were installed, and vents were connected to these flares. While these flares initially sustained a flame, after approximately a day of operation, the flares were no longer able to sustain an ongoing flame. It was recommended that these flares be operated periodically and additional testing be performed to determine the frequency.

Based on a review of the inspection reports from 2000-2013, the three flares operated intermittently through 2004 and the two candle flares (Flares 2 and 3) installed in 2000, were removed following installation and operation of the leachate and gas collection trench/system in 2004 (see Section 2.5.1 below). Remnants of these three flares (Flares 1 through 3) were observed during the OBG 2015-2016 site visits/inspections.

2.5.1. PADEP Leachate and Gas Collection Trench

In response to what was presumed to be landfill leachate migrating across the landfill’s south property line and emerging as a seep on the adjacent residential property (under construction) in April 2001, PADEP performed an investigation leading to the construction of a combination leachate and landfill gas (e.g., methane) collection trench along the southwest boundary of the site between the edge of the landfill footprint and the site’s perimeter access road. The investigation, design, and construction are documented in the following reports:

- *Summary Report for Initial Investigation*, IT Corporation, September 2001 (2001 Summary Report)
- *Boyertown Sanitary Landfill, Landfill Leachate and Methane Migration Control System Design Plan*, Shaw Environmental and Infrastructure, Inc., November 21, 2002 (2002 Design Plan)

- *End-Of-Project Summary Report, Boyertown Landfill*, Shaw Environmental, Inc., February 2005 (2005 Summary Report)

As described in the above reports, a soil gas survey was conducted in August 2001 and consisted of the installation of 34 PVC monitoring probes to sample landfill gas (via field and laboratory analysis) along the southwest boundary of the landfill, between the landfill footprint and the adjacent property. The soil gas survey results indicated methane concentrations ranging from 0 to 59.9%. A second round of soil gas surveying was conducted in August 2002. The results for the second round indicated one location with a methane concentration of 3% and methane concentrations of 0% at all other monitoring points.

Based on the results of PADEP's investigation, in June/July 2003 a trench was constructed to a depth of approximately 12 feet for a length of 450 feet along the southwest boundary of the landfill, between the landfill footprint and the adjacent property. The trench consists of a membrane liner on the bottom and down-gradient sidewall, a six-inch diameter perforated pipe for leachate collection and another perforated pipe for landfill gas collection. The leachate collection piping is connected to a leachate and gas condensate collection sump constructed at the middle of the trench. Documentation indicates that collected leachate/condensate was pumped from the sump to one of the landfill's leachate system/landfill gas vents to be conveyed through the landfill's leachate collection system to the leachate treatment facility. The trench gas collection piping is connected to a vacuum blower and flare equipment at the west end of the trench ("Utility Flare" – refer to [Figure 2](#)). Startup for the flare system occurred in July 2004. Testing during startup showed that the trench collected gas slowly and that when operated, the collected gas could support the flare's flame for less than five minutes. The system was therefore set up on a timer to activate the system once a day for a ten-minute period. The historical trench inspection/operations reports reviewed do not indicate the volumes/flow rates of the liquids historically discharged from the PADEP trench during operations.

An additional soil gas survey was conducted in August 2004, following startup of the flare system. The survey was conducted consistent with the approach used during the August 2001 and 2002 soil gas surveys described above. Results from the August 2004 survey were consistent with results from the August 2002 survey; one soil gas survey location had a methane concentration of 0.7% and all other monitoring locations had methane concentrations of 0%.

Contractors working for PADEP determined in 2010 that the trench system was not working. Repairs were reportedly made in 2011 and 2012, but available information supports that the flare and trench systems have not operated since that time. Interviews with the current landfill operator (Warren Frame) indicate that a blockage is thought to be present within the landfill's gas vent/leachate collection piping system that serves as the connection/discharge point for the PADEP trench pump. The exact location of this connection point is not known based on the site inspections and documentation reviewed to-date.

OBG inspected the PADEP flare and leachate/gas collection trench systems in 2015 and found them to be inoperable. The insides of the main electrical panels feeding the flare and trench pumping equipment were found to be deteriorated/rusted due to weather exposure, likely because the panels were left open and exposed to the elements. New panels and associated equipment with appropriate exposure ratings and fittings would be needed to restore power supply for the two systems. The power panels located on the flare equipment skid would also require significant maintenance/repairs, and replacement power conduits and thermocouple equipment would also be required. Preliminary field testing indicated that the flare stack requires inspection/cleanout, and other flare components also appear to be in deteriorated condition, requiring inspection/repairs.

2.5.2. Landfill Gas Vents Camera Inspection and Site Observations (May 2016)

OBG identified 20 leachate collection system gas vents along the landfill's southeastern and southwestern boundary (LC-1 through LC-20 as shown on [Figure 2](#)) as part of landfill inspection activities, and in May 2016 camera inspections were performed to evaluate the vent conditions.

During the vent inspections, it was observed that a number of the 4-inch PVC vent pipes are broken off at or slightly below the ground surface (possibly due to damage from mowing equipment operating on the landfill

cover). Obstructions (in a number of cases due to the presence of solids/debris) were encountered in each of the vent pipes inspected during the camera work, and standing liquid was observed in the pipes at various levels. Observations regarding the vent conditions during the May 2016 inspections and camera work are included on [Table 3](#). Methane measurements were also recorded in the vents, with methane readings ranging from 0% to 71%; the methane measurements are included in [Table 4](#).

In addition, methane measurements were also recorded at each of the vent/riser pipes for the PADEP leachate/gas collection trench (labeled as HDPE 1 through HDPE 6 on [Figure 2](#)), and these measurements are also included in [Table 4](#). The methane measurements for HDPE 1 through HDPE 6 indicated no presence of methane within the collection trench vent piping.

Limited sections of buried PVC piping (4-inch diameter) were also identified near the vents during the inspections, and the piping is thought to be gas collection header piping that would have conveyed collected gas from the vents to the flares that previously operated at the landfill (refer to Section 2.5 discussion above). The condition and alignment of the underground PVC collection piping is unknown.

As part of the May 2016 vent inspections, the length of vent pipe from the ground surface/top of vent to encountered standing liquid and/or obstruction was measured. When possible, the type of obstruction was noted. Since as-built plans and profiles of the leachate collection system and gas vents are not available, the approximate locations of the vents were recorded using GPS measurements, and approximate elevations of the standing water surface and/or obstructions in the vents were estimated using ground surface elevations estimated from LiDAR data and an estimated 45-degree angle of the vent riser pipe. The estimated vent ground surface elevations and standing liquid/obstruction elevations from the May 2016 inspections are included on [Table 5](#).

2.5.3. Landfill Gas Vents Inspection (October/November 2016)

As a part of the leachate flow measurement investigation (refer to Section 2.3.3), OBG collected measurements of methane and liquid levels in the leachate collection system gas vents to further evaluate the presence of methane in the vents, and to evaluate the potential responses in vent liquid levels to the modified pumping operations at the leachate collection manhole during the October/November 2016 leachate pumping operations. The October/November 2016 methane measurements for the vents are included in [Table 4](#), and the estimated vent liquid levels (elevations estimated using methods as described above for the May 2016 vent inspections/measurements) included in [Table 5](#). As shown on [Table 5](#), liquid levels in most of the vents showed little correlation with/response to the October/November 2016 leachate pumping operations. The general range in methane percentages obtained at the landfill vents from the October/November 2016 methane measurements (0 to 67%) is consistent with the May 2016 methane measurements, as shown on [Table 4](#).

In addition, a round of methane measurements was also recorded at each of the vent/riser pipes for the PADEP leachate/gas collection trench (labeled as HDPE 1 through HDPE 6 on [Figure 2](#)) during the October/November 2016 field study, and these measurements are included in [Table 4](#). The methane measurements for HDPE 1 through HDPE 6 during the October/November 2016 field study indicated no presence of methane within the collection trench vent piping, consistent with the May 2016 measurements (as discussed in Section 2.5.2).

2.5.4. Summary of Findings

The following summarizes the findings based on the review of information and investigations of the landfill's gas management system, as described above:

- Review of historical information regarding the PADEP leachate and gas collection trench indicates that it was installed in response to reported leachate seeps (and associated methane detections) from the landfill on neighboring residential property in 2001, along the southwestern landfill property boundary. PADEP soil gas survey investigations completed along the southwestern landfill property boundary in August 2001 indicated elevated methane readings at several locations; however, additional soil gas readings conducted at these locations approximately one year later (August 2002) indicated significantly lower methane readings. The PADEP trench was installed in 2003 (together with a flare system for the destruction of collected methane gas from the trench), and review of operations data for the trench/flare system indicates that the flare

operations have been intermittent/minimal (i.e., only a few minutes each day during operations). An additional soil gas survey conducted in August 2004 following the trench start-up indicated very low methane results along the landfill's southwest property boundary, consistent with the 2002 survey. OBG site investigations in 2016 indicate that the PADEP trench/flare systems are currently inoperable, and appear to have been inoperable for some time. In addition, landfill gas measurements in the PADEP trench vent pipes do not indicate the presence of methane.

- Review of the PADEP-approved Closure Plan indicates that methane measurements along the property boundary are included as part of the landfill post-closure operations. Based on the landfill gas management system investigations and findings presented above, the following actions are recommended:
 - » Based on the blockages identified in the landfill's perimeter gas vents, cleaning of the gas vents is recommended to remove the blockages as practicable. The gas vents should also be repaired to address the noted damage to them, and protective measures should be installed to protect the vents from future damage.
 - » The operations of the leachate/gas condensate collection sump in the PADEP trench should be restored to allow for future collection of liquids if needed. Based on the blockage thought to be present within the landfill's gas vent/piping system that serves as the connection/discharge point for the PADEP trench pump, and based on the blockages observed in the other landfill collection vents, at this time it is recommended that a discharge line be installed along the landfill perimeter to allow the sump to discharge to the central leachate collection manhole along the northeast edge of the landfill. Alternatively, if a clear/unobstructed vent is identified through the above gas vent cleaning efforts, a connection/discharge point for the sump could be established at one of these locations.
 - » Based on the low methane readings from soil gas measurements along the landfill's southwest property identified prior to and following the PADEP trench installation and operations, the minimal gas flare operations noted during the trench operations, and the 2016 measurements indicating no presence of methane within the trench vent/riser pipes, restoration of the PADEP trench gas collection and flare operations is not recommended at this time. The cleaned gas vents along the perimeter of the landfill can be measured for the presence of methane, and a series of solar-operated candlestick flare units can be installed at selected vents as needed, to burn off methane if it is detected at sufficient concentrations. In addition, methane measurements can also continue to be collected within the vent/riser pipes of the PADEP leachate/gas collection trench (HDPE 1 through HDPE 6, refer to [Figure 2](#)) between the landfill and the southwest property boundary, to evaluate the potential for migration of methane beyond the landfill footprint in this area.

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3. FINDINGS AND RECOMMENDATIONS

The following summarizes the findings and recommendations regarding repair/rehabilitation of the landfill's infrastructure, based on the activities and investigations conducted to assess the current landfill systems and operations as described in Section 2. A summary of preliminary cost estimates for design, permitting/approvals, bidding, and construction for the landfill systems repair/rehabilitation based on the recommendations below is included as [Table 6](#), and the cost estimate details are included in [Appendix C](#).

LANDFILL CAP/COVER, DRAINAGE, AND ACCESS

- As observed during the site visits and inspections, the landfill cap/cover and surrounding areas are generally well vegetated and maintained by mowing. On the top of the landfill there is an area of topographic depression (estimated at approximately one to 1.5 acres in size) that may be due to landfill materials settlement, or other historic activities of the landfill operator, and accumulation of water on the cap in this area is inhibiting routine maintenance (i.e., mowing) in some areas. It is recommended that this topographic depression area be corrected through the import and placement of additional low permeability materials with appropriate soil cover, and re-establishment of positive drainage and the vegetative cover (refer to Section 2.2.1).
- Based on site inspections, the landfill slopes appear well vegetated, with little erosion present. Stormwater drainage channels are generally in good condition (i.e., no significant erosion), with the exception of the downstream reach of a channel (approximately 425 feet in length) that flows northeast and drains into the sedimentation basin located along the northeast side of the landfill. This channel segment steepens in grade as it approaches the sedimentation basin and erosion (i.e., a head cut) is present in the area of steepened grading. It is recommended that the channel erosion be corrected through the installation of surface reinforcement materials (e.g., rip rap, turf reinforcement mat) and/or grade controls (refer to Section 2.2.2).
- Based on observations during the site visits and inspections, the landfill perimeter access road along the southeast and southwest property boundary is overgrown and heavily rutted, such that access to conduct maintenance and repairs for the landfill infrastructure in these areas (e.g., PADEP trench, landfill gas collection vents) is difficult, and it is recommended that the road be graded to remove the rutting and furnished with crushed stone to facilitate access to these areas (refer to Section 2.2.3).

LEACHATE COLLECTION SYSTEM AND STORAGE BASINS

- Based on the data collected during the leachate collection system flow testing in October/November 2016, the annualized leachate flow rates ranged from approximately 1.1 million gallons (MG) to 1.3 MG. This range in collection manhole discharge flow rates is generally consistent with historical BMMA flow records for the pre-treatment facility prior to 2006, and is also within the general range of anticipated leachate flow rates that would be expected from the landfill, based on Closure Plan design information (refer to Section 2.3.3).
- It is recommended that the existing central leachate collection manhole be replaced with a deeper manhole to provide a "wet well" for collection of leachate below the elevations of the east and west leachate collection lines, to allow leachate to freely drain from the east and west collection lines (and thereby mitigate the potential for solids/sediment build-up and possible clogging of the lines), consistent with the original design/Closure Plan documentation (refer to Section 2.3.1).
- The lining systems for the raw leachate storage basin and treated leachate/effluent storage basins require replacement to support future landfill operations, based on their age (30+ years), review of historical documentation regarding leakage, and observations from site inspections (refer to Section 2.4.1).

LEACHATE PRE-TREATMENT SYSTEM

- Based on review of the raw leachate analytical sampling results obtained during the October/November 2016 leachate flow testing program, and the preliminary treatability evaluation presented in Section 2.4.2, the leachate pre-treatment system would not be expected to meet the current BMMA permit discharge limits as currently designed and operated. OBG contacted BMMA to discuss the potential for modification of selected discharge permit criteria (e.g., TDS, ammonia, color), and BMMA personnel indicated that they would potentially entertain the possibility for modifications in these parameters. It is recommended that further discussions/negotiations be conducted with BMMA toward modification of the permit limits for the leachate pre-treatment system (refer to Section 2.4.2).
- Based on review/inspection of the existing leachate pre-treatment system equipment and facilities, rehabilitation/restoration measures for the system include the following (refer to Section 2.4.3):
 - » Shut down and draining of the fixed film reactor/clarifier units, with removal and disposal of accumulated solids. Cleaning, inspection, and repair/coating of the tank floors and concrete surfaces is recommended, with replacement of the reactor aeration/diffuser piping and fixed film media, and replacement of the clarifier baffles
 - » Shut down of the stripper tower, replacement of the tower media, and cleaning of the interior (using mechanical means) to remove accumulated scale/solids, and rehabilitation/replacement of the stripper system blower and motor
 - » Replacement of the caustic/acid feed systems and mixers/tanks, and replacement of the carbon adsorption system units
 - » Start-up and testing for resuming system operations to confirm systems/equipment operability, chemical feed rates, etc. In addition, influent/effluent testing and sampling are recommended to confirm treatment efficacy/effluent characterization between the various unit processes and for the final pre-treatment system effluent, prior to resuming permitted discharges.
 - » The rehabilitation/restoration measures described above are based on the inspections and system observations to-date; additional rehabilitation/restoration requirements may be identified during the completion of the restoration measures, start-up and testing activities, and/or treatment efficacy/effluent characterization testing work. In addition, treatability testing/process design work would be required prior to selection of replacement equipment, to confirm equipment sizing/suitability and chemical feed rates (caustic, acid, etc.) based on the raw leachate characteristics, and the design activities would be dependent in part upon the outcome of BMMA negotiations regarding potential revisions to the BMMA discharge permit criteria.
- Significant long term cost savings could be achieved if the landfill can move to a direct or batch discharge of raw leachate. Further discussions with BMMA and PADEP would be necessary to further evaluate the efficacy of this approach.

LANDFILL GAS MANAGEMENT

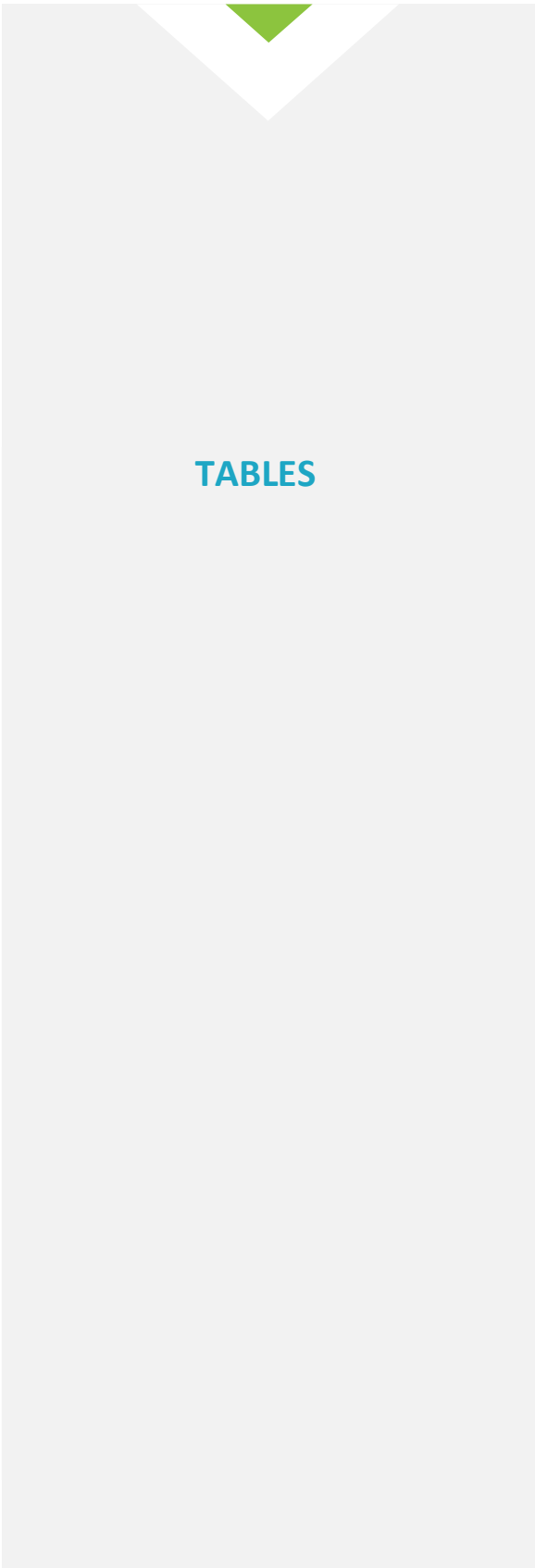
- Based on the solids/accumulated liquids identified in the landfill's perimeter gas vents, cleaning of the gas vents is recommended to remove the blockages as practicable. The gas vents should also be repaired to address the noted damage to them, and protective measures should be installed to protect the vents from future damage (refer to Section 2.5).
- The operations of the leachate/condensate collection sump in the PADEP trench should be restored to allow for future collection of liquids if needed. Based on the blockage thought to be present within the landfill's gas vent/piping system that serves as the connection/discharge point for the PADEP trench pump, and based on the blockages observed in the other landfill collection vents, at this time it is recommended that a discharge line be installed along the landfill perimeter to allow the sump to discharge to the central leachate collection manhole along the northeast edge of the landfill. Alternatively, if a clear/unobstructed vent is identified

through the above gas vent cleaning efforts, a connection/discharge point for the sump could be established at one of these locations (refer to Section 2.5).

- To provide for landfill gas/methane monitoring along the landfill perimeter, the cleaned gas vents along the perimeter of the landfill can be measured for the presence of methane, and a series of solar-operated candlestick flare units can be installed at selected vents as needed, to burn off methane if it is detected at sufficient concentrations. In addition, methane measurements can also continue to be collected within the vent/riser pipes of the PADEP leachate/gas collection trench (HDPE 1 through HDPE 6, refer to [Figure 2](#)) between the landfill and the southwest property boundary, to evaluate the potential for migration of methane beyond the landfill footprint in this area (refer to Section 2.5.4).

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TABLES



Boyertown Landfill				
Leachate Collection System Flow Measurements				
Date & Time	Days Pumped	Cumulative Flow (gal)	Daily Flow Rate (gal/day)	Annualized Flow Rate (gal/year)
10/14/16 12:00	Began pumping at 12:00 PM			
10/18/16 12:00	4.0	14,384	3,596	1,312,540
10/21/16 12:00	7.0	22,911	3,273	1,194,645
10/25/16 9:00	10.9	33,846	3,112	1,135,981
10/28/16 8:15	13.8	41,250	2,980	1,087,585
11/1/16 9:08	17.9	52,549	2,939	1,072,695
11/4/16 9:47	20.9	60,086	2,874	1,048,965
11/8/16 9:02	24.9	69,351	2,788	1,017,556
11/11/16 11:19	28.0	77,832	2,783	1,015,628



BOYERTOWN SANITARY LANDFILL SUMMARY OF FINDINGS AND RECOMMENDATIONS | TABLE 2

Boyertown Landfill														
October/November 2016 Raw Leachate Analytical Sampling Results														
Sample ID			COLLECTION MANHOLE 102116	COLLECTION MANHOLE 102116	COLLECTION MANHOLE 102116	COLLECTION MANHOLE 102816	COLLECTION MANHOLE 102816	COLLECTION MANHOLE 110416	COLLECTION MANHOLE 110416	COLLECTION MANHOLE 111116	COLLECTION MANHOLE 111116			
Sample Date	Units		JC30209-1	JC30209-1F	JC30209-1R	JC30672-1	JC30672-1F	JC31100-1	JC31100-1F	JC31602-1	JC31602-1F			
Sample Type			10/21/2016	10/21/2016	10/21/2016	10/28/2016	10/28/2016	11/4/2016	11/4/2016	11/11/2016	11/11/2016			
Matrix			GW	GW FILTERED	GW	GW	GW FILTERED	GW	GW FILTERED	GW	GW			
Unit			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L			
Volatile Organic Compounds (VOCs)														
Acetone	ug/l	50	8.1	-	-	12.2	-	8.2	-	6.5	-			
Acrolein	ug/l		ND (1.3)	-	-	ND (1.3)	-	ND (1.3)	-	ND (1.3)	-			
Acrylonitrile	ug/l		ND (1.2)	-	-	ND (1.2)	-	ND (1.2)	-	ND (1.2)	-			
Benzene	ug/l		11.5	-	-	7.9	-	16	-	15.3	-			
Bromochloromethane	ug/l		ND (0.20)	-	-	ND (0.20)	-	ND (0.20)	-	ND (0.20)	-			
Bromodichloromethane	ug/l	ND (0.14)	-	-	ND (0.14)	-	ND (0.14)	-	ND (0.14)	-				
Bromoform	ug/l	ND (0.15)	-	-	ND (0.15)	-	ND (0.15)	-	ND (0.15)	-				
Bromomethane	ug/l	ND (0.20)	-	-	ND (0.20)	-	ND (0.20)	-	ND (0.20)	-				
2-Butanone (MEK)	ug/l	ND (1.9)	-	-	11.4	-	ND (1.9)	-	ND (1.9)	-				
Carbon disulfide	ug/l	ND (0.12)	-	-	ND (0.12)	-	ND (0.12)	-	ND (0.12)	-				
Carbon tetrachloride	ug/l	ND (0.19)	-	-	ND (0.19)	-	ND (0.19)	-	ND (0.19)	-				
Chlorobenzene	ug/l	30.4	-	-	22.2	-	34.2	-	36.2	-				
Chloroethane	ug/l	1	-	-	0.77	J	2	-	1.5	-				
2-Chloroethyl vinyl ether	ug/l	ND (0.73)	-	-	ND (0.73)	-	ND (0.73)	-	ND (0.73)	-				
Chloroform	ug/l	ND (0.11)	-	-	ND (0.11)	-	ND (0.11)	-	ND (0.11)	-				
Chloromethane	ug/l	ND (0.22)	-	-	ND (0.22)	-	ND (0.22)	-	ND (0.22)	-				
Cumene	ug/l	4.6	-	-	3	-	3.2	-	2.4	-				
Cyclohexane	ug/l	ND (0.45)	-	-	ND (0.45)	-	0.95	J	0.78	J	-			
Dibromochloromethane	ug/l	ND (0.22)	-	-	ND (0.22)	-	ND (0.22)	-	ND (0.22)	-				
1,2-Dibromoethane	ug/l	ND (0.19)	-	-	ND (0.19)	-	ND (0.19)	-	ND (0.19)	-				
1,2-Dibromo-3-chloropropane	ug/l	ND (0.60)	-	-	ND (0.60)	-	ND (0.60)	-	ND (0.60)	-				
1,2-Dichlorobenzene	ug/l	3.6	-	-	2.4	-	4.5	-	4.5	-				
1,3-Dichlorobenzene	ug/l	0.41	J	-	0.32	J	0.55	J	0.48	J	-			
1,4-Dichlorobenzene	ug/l	12	-	-	9.1	-	15.1	-	13.5	-				
Dichlorodifluoromethane	ug/l	ND (0.54)	-	-	ND (0.54)	-	ND (0.54)	-	ND (0.54)	-				
1,1-Dichloroethane	ug/l	ND (0.16)	-	-	ND (0.16)	-	0.24	J	ND (0.16)	-				
1,2-Dichloroethane	ug/l	ND (0.21)	-	-	ND (0.21)	-	ND (0.21)	-	ND (0.21)	-				
1,1-Dichloroethene	ug/l	ND (0.22)	-	-	ND (0.22)	-	ND (0.22)	-	ND (0.22)	-				
cis-1,2-Dichloroethene	ug/l	ND (0.30)	-	-	ND (0.30)	-	ND (0.30)	-	ND (0.30)	-				
trans-1,2-Dichloroethene	ug/l	ND (0.14)	-	-	ND (0.14)	-	ND (0.14)	-	ND (0.14)	-				
1,2-Dichloropropane	ug/l	ND (0.17)	-	-	ND (0.17)	-	ND (0.17)	-	ND (0.17)	-				
cis-1,3-Dichloropropene	ug/l	ND (0.16)	-	-	ND (0.16)	-	ND (0.16)	-	ND (0.16)	-				
trans-1,3-Dichloropropene	ug/l	ND (0.17)	-	-	ND (0.17)	-	ND (0.17)	-	ND (0.17)	-				
Ethylbenzene	ug/l	12.7	-	-	4.6	-	9.8	-	13.8	-				
Freon 113	ug/l	ND (0.53)	-	-	ND (0.53)	-	ND (0.53)	-	ND (0.53)	-				
2-Hexanone	ug/l	ND (1.7)	-	-	ND (1.7)	-	ND (1.7)	-	ND (1.7)	-				
Methyl Tert Butyl Ether	ug/l	0.7	J	-	0.6	J	0.84	J	0.85	J	-			
4-Methyl-2-pentanone(MIBK)	ug/l	ND (1.1)	-	-	ND (1.1)	-	ND (1.1)	-	ND (1.1)	-				
Methylene chloride	ug/l	ND (0.16)	-	-	ND (0.16)	-	ND (0.16)	-	ND (0.16)	-				
Methyl Acetate	ug/l	ND (2.0)	-	-	ND (2.0)	-	ND (2.0)	-	ND (2.0)	-				
Methylcyclohexane	ug/l	ND (0.40)	-	-	ND (0.40)	-	ND (0.40)	-	0.42	J	-			
Styrene	ug/l	ND (0.17)	-	-	ND (0.17)	-	ND (0.17)	-	ND (0.17)	-				
1,1,2,2-Tetrachloroethane	ug/l	ND (0.18)	-	-	ND (0.18)	-	ND (0.18)	-	ND (0.18)	-				
Tetrachloroethene	ug/l	ND (0.17)	-	-	ND (0.17)	-	ND (0.17)	-	ND (0.17)	-				
Toluene	ug/l	4.3	-	-	1.4	-	2.8	-	5.5	-				
1,2,4-Trichlorobenzene	ug/l	ND (0.15)	-	-	ND (0.15)	-	ND (0.15)	-	ND (0.15)	-				
1,2,3-Trichlorobenzene	ug/l	ND (0.18)	-	-	ND (0.18)	-	ND (0.18)	-	ND (0.18)	-				
1,1,1-Trichloroethane	ug/l	ND (0.17)	-	-	ND (0.17)	-	ND (0.17)	-	ND (0.17)	-				
1,1,2-Trichloroethane	ug/l	ND (0.18)	-	-	ND (0.18)	-	ND (0.18)	-	ND (0.18)	-				
Trichloroethene	ug/l	ND (0.16)	-	-	ND (0.16)	-	ND (0.16)	-	ND (0.16)	-				
Trichlorofluoromethane	ug/l	ND (0.55)	-	-	ND (0.55)	-	ND (0.55)	-	ND (0.55)	-				
Vinyl chloride	ug/l	ND (0.19)	-	-	ND (0.19)	-	ND (0.19)	-	ND (0.19)	-				
m,p-Xylene	ug/l	22.2	-	-	10	-	31	-	37.2	-				
o-Xylene	ug/l	8.9	-	-	4.4	-	11.5	-	13.5	-				
Xylenes (total)	ug/l	31.1	-	-	14.4	-	42.5	-	50.7	-				
Total VOCs	ug/l	100	120.41			90.29		140.88		152.43				
Semi Volatile Organic Compounds (SVOCs) (EPA 625)														
2-Chlorophenol	ug/l		ND (0.82)	-	-	ND (0.82)	-	ND (0.82)	-	ND (0.82)	-			
4-Chloro-3-methyl phenol	ug/l		ND (0.89)	-	-	ND (0.89)	-	ND (0.89)	-	ND (0.89)	-			
2,4-Dichlorophenol	ug/l		ND (1.3)	-	-	ND (1.3)	-	ND (1.3)	-	ND (1.3)	-			
2,4-Dimethylphenol	ug/l		6.6	-	-	ND (2.4)	-	3.2	J	5.5	-			
2,4-Dinitrophenol	ug/l		ND (1.6)	-	-	ND (1.6)	-	ND (1.6)	-	ND (1.6)	-			
4,6-Dinitro-o-cresol	ug/l		ND (1.3)	-	-	ND (1.3)	-	ND (1.3)	-	ND (1.3)	-			
2-Methylphenol	ug/l		ND (0.89)	-	-	ND (0.89)	-	ND (0.89)	-	ND (0.89)	-			
3&4-Methylphenol	ug/l		ND (0.88)	-	-	ND (0.88)	-	ND (0.88)	-	ND (0.88)	-			
2-Nitrophenol	ug/l		ND (0.96)	-	-	ND (0.96)	-	ND (0.96)	-	ND (0.96)	-			
4-Nitrophenol	ug/l		ND (1.2)	-	-	ND (1.2) ^a	-	ND (1.2) ^a	-	ND (1.2)	-			
Pentachlorophenol	ug/l		ND (1.4)	-	-	ND (1.4) ^a	-	ND (1.4) ^a	-	ND (1.4)	-			
Phenol	ug/l		ND (0.39)	-	-	ND (0.39)	-	ND (0.39)	-	ND (0.39)	-			
2,3,4,6-Tetrachlorophenol	ug/l		ND (1.5)	-	-	ND (1.5)	-	ND (1.5)	-	ND (1.5)	-			
2,4,5-Trichlorophenol	ug/l		ND (1.3)	-	-	ND (1.3)	-	ND (1.3)	-	ND (1.3)	-			
2,4,6-Trichlorophenol	ug/l		ND (0.92)	-	-	ND (0.92)	-	ND (0.92)	-	ND (0.92)	-			
Acenaphthene	ug/l		1.1	-	-	0.85	J	1.2	-	1.2	-			
Acenaphthylene	ug/l		ND (0.14)	-	-	ND (0.14)	-	ND (0.14)	-	ND (0.14)	-			
Acetophenone	ug/l		ND (0.21)	-	-	ND (0.21)	-	ND (0.21)	-	ND (0.21)	-			
Anthracene	ug/l		0.71	J	-	ND (0.21)	-	ND (0.21)	-	0.46	J	-		
Atrazine	ug/l		ND (0.45)	-	-	ND (0.45)	-	ND (0.45)	-	ND (0.45)	-			
Benzidine	ug/l		ND (0.90)	-	-	ND (0.90)	-	ND (0.90) ^a	-	ND (0.90)	-			
Benzaldehyde	ug/l		ND (0.29)	-	-	ND (0.29)	-	ND (0.29)	-	ND (0.29)	-			
Benzo(a)anthracene	ug/l		ND (0.20)	-	-	ND (0.20)	-	ND (0.20)	-	ND (0.20)	-			
Benzo(a)pyrene	ug/l		ND (0.21)	-	-	ND (0.21)	-							

Sample ID		COLLECTION MANHOLE 102116	COLLECTION MANHOLE 102116	COLLECTION MANHOLE 102116	COLLECTION MANHOLE 102816	COLLECTION MANHOLE 102816	COLLECTION MANHOLE 110416	COLLECTION MANHOLE 110416	COLLECTION MANHOLE 111116	COLLECTION MANHOLE 111116
Sample Date	Units	JC30209-1	JC30209-1F	JC30209-1R	JC30672-1	JC30672-1F	JC31100-1	JC31100-1F	JC31602-1	JC31602-1F
Sample Type		10/21/2016	10/21/2016	10/21/2016	10/28/2016	10/28/2016	11/4/2016	11/4/2016	11/11/2016	11/11/2016
Matrix		GW	GW FILTERED	GW	GW	GW FILTERED	GW	GW FILTERED	GW	GW FILTERED
Unit		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
2-Nitroaniline	ug/l	ND (0.28)	-	-	ND (0.28)	-	ND (0.28)	-	ND (0.28)	-
3-Nitroaniline	ug/l	ND (0.39)	-	-	ND (0.39)	-	ND (0.39)	-	ND (0.39)	-
4-Nitroaniline	ug/l	ND (0.44)	-	-	ND (0.44)	-	ND (0.44)	-	ND (0.44)	-
Naphthalene	ug/l	36.3	-	-	14.6	-	29.8	-	28	-
Nitrobenzene	ug/l	ND (0.64)	-	-	ND (0.64)	-	ND (0.64)	-	ND (0.64)	-
n-Nitrosodimethylamine	ug/l	ND (0.82)	-	-	ND (0.82)	-	ND (0.82)	-	ND (0.82)	-
N-Nitroso-di-n-propylamine	ug/l	ND (0.48)	-	-	ND (0.48)	-	ND (0.48)	-	ND (0.48)	-
N-Nitrosodiphenylamine	ug/l	2.4 J	-	-	1.7 J	-	1.9 J	-	2.2 J	-
Phenanthrene	ug/l	2.1	-	-	1.5	-	2.3	-	1.7	-
Pyrene	ug/l	ND (0.22)	-	-	ND (0.22)	-	ND (0.22)	-	ND (0.22)	-
1,2,4,5-Tetrachlorobenzene	ug/l	ND (0.37)	-	-	ND (0.37)	-	ND (0.37)	-	ND (0.37)	-
Total SVOCs	ug/l	220.2	-	-	145.28	-	204.7	-	297.76	-
Semi Volatile Organic Compounds (SVOCs) (EPA 608)										
Aldrin	ug/l	ND (0.0031)	-	-	ND (0.0030)	-	ND (0.0030)	-	ND (0.0030)	-
alpha-BHC	ug/l	ND (0.0030)	-	-	ND (0.0030)	-	ND (0.0030)	-	ND (0.0030)	-
beta-BHC	ug/l	ND (0.0029)	-	-	ND (0.0028)	-	ND (0.0028)	-	ND (0.0028)	-
delta-BHC	ug/l	ND (0.0023)	-	-	ND (0.0023)	-	ND (0.0023)	-	ND (0.0023)	-
gamma-BHC (Lindane)	ug/l	0.5	-	-	ND (0.0014)	-	ND (0.0014)	-	ND (0.0014)	-
alpha-Chlordane	ug/l	ND (0.0023)	-	-	ND (0.0023)	-	ND (0.0023)	-	ND (0.0023)	-
gamma-Chlordane	ug/l	ND (0.0023)	-	-	ND (0.0023)	-	ND (0.0023)	-	ND (0.0023)	-
Dieldrin	ug/l	ND (0.0018)	-	-	ND (0.0018)	-	ND (0.0018)	-	ND (0.0018)	-
4,4'-DDD	ug/l	ND (0.0019)	-	-	ND (0.0019)	-	ND (0.0019)	-	ND (0.0019)	-
4,4'-DDE	ug/l	ND (0.0031)	-	-	ND (0.0031)	-	ND (0.0031)	-	ND (0.0031)	-
4,4'-DDT	ug/l	ND (0.0025)	-	-	ND (0.0025)	-	ND (0.0025)	-	ND (0.0025)	-
Endrin	ug/l	ND (0.0025)	-	-	ND (0.0025)	-	ND (0.0025)	-	ND (0.0025)	-
Endosulfan sulfate	ug/l	ND (0.0027)	-	-	ND (0.0026)	-	ND (0.0026)	-	ND (0.0026)	-
Endrin aldehyde	ug/l	ND (0.0026)	-	-	ND (0.0026)	-	ND (0.0026)	-	ND (0.0026)	-
Endrin ketone	ug/l	ND (0.0026)	-	-	ND (0.0025)	-	ND (0.0025)	-	ND (0.0025)	-
Endosulfan-I	ug/l	ND (0.0025)	-	-	ND (0.0025)	-	ND (0.0025)	-	ND (0.0025)	-
Endosulfan-II	ug/l	ND (0.0022)	-	-	ND (0.0021)	-	ND (0.0021)	-	ND (0.0021)	-
Heptachlor	ug/l	ND (0.0019)	-	-	ND (0.0019)	-	ND (0.0019)	-	ND (0.0019)	-
Heptachlor epoxide	ug/l	ND (0.0033)	-	-	ND (0.0033)	-	ND (0.0033)	-	ND (0.0033)	-
Methoxychlor	ug/l	ND (0.0029)	-	-	ND (0.0028)	-	ND (0.0028)	-	ND (0.0028)	-
Toxaphene	ug/l	ND (0.093)	-	-	ND (0.092)	-	ND (0.092)	-	ND (0.092)	-
Aroclor 1016	ug/l	ND (0.17)	-	-	ND (0.17)	-	ND (0.17)	-	ND (0.17)	-
Aroclor 1221	ug/l	ND (0.15)	-	-	ND (0.15)	-	ND (0.15)	-	ND (0.15)	-
Aroclor 1232	ug/l	ND (0.10)	-	-	ND (0.10)	-	ND (0.10)	-	ND (0.10)	-
Aroclor 1242	ug/l	ND (0.14)	-	-	ND (0.14)	-	ND (0.14)	-	ND (0.14)	-
Aroclor 1248	ug/l	ND (0.13)	-	-	ND (0.13)	-	ND (0.13)	-	ND (0.13)	-
Aroclor 1254	ug/l	ND (0.17)	-	-	ND (0.17)	-	ND (0.17)	-	ND (0.17)	-
Aroclor 1260	ug/l	ND (0.14)	-	-	ND (0.14)	-	ND (0.14)	-	ND (0.14)	-
Aroclor 1262	ug/l	ND (0.12)	-	-	ND (0.12)	-	ND (0.12)	-	ND (0.12)	-
Aroclor 1268	ug/l	ND (0.12)	-	-	ND (0.12)	-	ND (0.12)	-	ND (0.12)	-
Metals										
Aluminum	ug/l	1000	<200	<200	-	<200	<200	<400 ^c	<200	<400 ^c
Antimony	ug/l		<6.0	<6.0	-	<6.0	<6.0	<12 ^c	<6.0	<12 ^c
Arsenic	ug/l		6.6	3.7	-	15.2	10.8	23.2 ^c	19.1	27.6 ^c
Barium	ug/l		3260	2370	-	2290	1610	3750 ^c	2890	4710 ^c
Beryllium	ug/l		<1.0	<1.0	-	<1.0	<1.0	<2.0 ^c	<1.0	<2.0 ^c
Cadmium	ug/l		<3.0	<3.0	-	<3.0	<3.0	<6.0 ^c	<3.0	<6.0 ^c
Calcium	ug/l		155000	142000	-	136000	128000	163000 ^c	154000	175000 ^c
Chromium	ug/l		31.6	26.7	-	22	19.6	28.6 ^c	25.1	39.8 ^c
Cobalt	ug/l		<50	<50	-	<50	<50	<100 ^c	<50	<100 ^c
Copper	ug/l	1590	<10	<10	-	<10	<10	<20 ^c	<10	<20 ^c
Iron	ug/l		16200	1200	-	16300	724	13700 ^c	2200	17300 ^c
Lead	ug/l	1090	<3.0	<3.0	-	<3.0	<3.0	<6.0 ^c	<3.0	<6.0 ^c
Magnesium	ug/l		284000	262000	-	173000	168000	324000 ^c	308000	395000
Manganese	ug/l		2220	2050	-	2860	2640	1900 ^c	1770	1930 ^c
Mercury	ug/l	2	<0.40 ^c	<0.20	-	<0.20	<0.20	<0.60 ^c	<0.40 ^c	<0.60 ^c
Nickel	ug/l	4280	182	173	-	104	101	197 ^c	188	267 ^c
Potassium	ug/l		266000	244000	-	195000	187000	246000 ^c	236000	323000
Selenium	ug/l		<10	<10	-	<10	<10	<20 ^c	<10	<20 ^c
Silver	ug/l	1530	<10	<10	-	<10	<10	<20 ^c	<10	<20 ^c
Sodium	ug/l		1050000	986000	-	732000	701000	1170000	1080000	1340000
Thallium	ug/l		<2.0	<2.0	-	<2.0	<2.0	<4.0 ^c	<2.0	<4.0 ^c
Vanadium	ug/l		<50	<50	-	<50	<50	<100 ^c	<50	<100 ^c
Zinc	ug/l	1750	<20	<20	-	<20	<20	<40 ^c	<20	<40 ^c
General Chemistry										
Alkalinity, Total as CaCO3	mg/l		1920	-	-	2160	-	2540	-	3440
BOD, 5 Day	mg/l	150/200*	62.7	-	-	17.9	-	60.5	-	42.6 ^e
Chemical Oxygen Demand	mg/l		886	-	-	1100	-	1000	-	1560
Chloride	mg/l		1730	-	-	1450	-	2320	-	2770
Color, Apparent	CU	150/100*	500	-	-	750	-	750	-	750
Cyanide	mg/l		<0.010	-	-	<0.010	-	0.015	-	<0.010
Cyanide, After Chlorination	mg/l		-	-	<0.010	<0.010	-	<0.010	-	<0.010
Cyanide, Amenable	mg/l		-	-	<0.020 ^f	<0.020 ^f	-	<0.020 ^f	-	<0.020 ^f
Fluoride	mg/l		1.6 ^g	-	-	1.3 ^g	-	1.7 ^g	-	1.8 ^g
HEM Oil and Grease	mg/l	25	<5.1	-	-	<5.0	-	<5.0	-	<5.0
Nitrogen, Ammonia	mg/l	25/25*	320	-	-	276	-	344	-	382
Nitrogen, Nitrate	mg/l		2.9 ^h	-	-	1.5 ^h	-	<0.11 ^h	-	<0.11 ^h
Nitrogen, Nitrate + Nitrite	mg/l		2.9	-	-	1.6	-	<0.10	-	<0.10
Nitrogen, Nitrite	mg/l		0.02	-	-	0.15	-	<0.010	-	<0.010
Phenols	mg/l		<0.20	-	-	<0.20	-	<0.20	-	<0.20
Phosphorus, Total	mg/l	25/10*	0.83	-	-	0.88	-	0.88	-	12.2
Solids, Total Dissolved	mg/l	3500/500*	4270	-	-	3990	-	5550	-	5650
Solids, Total Suspended	mg/l	300*	47.3	-	-	59	-	72	-	63
Specific Conductivity	umhos/cm		6360	-	-	5820	-	6750	-	7280
Sulfate	mg/l		<10	-	-	<10	-	<10	-	<10
Total Organic Carbon	mg/l		203	-	-	113	-	196	-	234
pH	su	6-9	6.94 ⁱ	-	-	6.71 ⁱ	-	6.77 ⁱ	-	6.71 ⁱ

Notes:

ND, < Not Detected Above Detection Limits

-- Not Sampled

Green bolded value indicates a detection that exceeds surcharge criteria, but is below permit criteria

Red bolded value indicates a detection that exceeds permit and surcharge criteria

* First number indicates discharge permit limit; second number indicates BMMA may apply surcharges above the value noted

^a This compound in ICV is outside in house QC limits bias high.

^b This compound in ICV is outside in house QC limits bias low.

^c Elevated sample detection limit due to difficult sample matrix.

^d Elevated detection limit due to dilution required for matrix interference (indicated by failing internal standard on original analysis).

^e Glucose spike recovery indicates possible low bias.

^f Calculated as: (Cyanide) - (Cyanide, After Chlorination)

^g Peak shape indicates matrix interference and possible positive bias.

^h Calculated as: (Nitrogen, Nitrate + Nitrite) - (Nitrogen, Nitrite)

ⁱ Sample received out of holding time for pH analysis.



Boyertown Landfill	
May 2016 Landfill Gas Vents Camera Inspection Findings	
Leachate Collection Vent	Notes
LC-1	Camera obstructed by debris; Liquid appeared clear
LC-2	Camera obstructed by debris; Liquid appeared dark brown with small debris
LC-3	Obstruction could not be identified; Liquid was thick and dark
LC-4	Camera obstructed by pipe joint; Liquid was light brown in appearance
LC-5	Obstruction could not be identified; Liquid becomes very thick and black; Heavy landfill gas odor from the well at the ground surface
LC-6	Camera obstructed by a pipe joint; Very thick brown and black liquid
LC-7	Obstruction could not be identified; Thick dark brown liquid
LC-8	Camera obstructed by an upward bend in the pipe; Liquid was dark brown with fungus
LC-9	Camera obstructed by a pipe joint; Red liquid was at the ground surface
LC-10	Camera obstructed by heavy debris; Liquid was light brown with small debris
LC-11	Camera obstructed by heavy debris; Liquid was dark brown
LC-12	Camera obstructed by debris; Liquid was thick and brown; Strong landfill gas odor from the well at the ground surface
LC-13	Obstruction could not be identified; Liquid was thick brown to black
LC-14	Pipe was completely filled with soil at a depth of 2.4 feet
LC-15	Camera obstructed by thick liquid and debris; Liquid was thick and brown
LC-16	Consisted of a cut piece of corrugated pipe embedded 2 feet into the ground
LC-17	Camera obstructed by debris; Liquid was dark brown
LC-18	Obstruction could not be identified; Liquid was thick and black; Strong landfill gas odor at the ground surface
LC-19	OBG personnel did not open the cap; Liquid with a sheen was leaching out from the cap; Strong landfill gas odor present at the ground surface
LC-20	Camera obstructed by a pipe joint; Liquid was light brown

Boyertown Landfill									
May and October/November 2016 Landfill Gas Vents Methane Measurements									
	5/23/2016	10/18/16	10/21/16	10/25/16	10/28/16	11/1/16	11/4/16	11/8/16	11/11/16
LC-1	68.0	NM	NM	NM	9.0	46.2	44.8	42.1	23.4
LC-2	62.5	NM	NM	NM	44.4	58.6	59.1	58.0	42.6
LC-3	NM	NM	NM	NM	7.0	5.0	7.1	6.8	49.4
LC-4	65.0	NM	NM	NM	7.3	59.1	60.0	60.3	66.0
LC-5	0.0	NM	NM	NM	0.0	0.0	0.0	0.0	0.0
LC-6	0.3	NM	NM	NM	62.9	63.6	61.2	57.7	63.1
LC-7	24.0	NM	NM	NM	64.9	66.9	65.8	61.3	58.2
LC-8	71.0	NM	NM	NM	10.0	9.7	10.1	9.1	7.6
LC-9	70.0	NM	NM	NM	NM*	NM*	NM*	NM*	NM*
LC-10	20.0	NM	NM	NM	28.3	53.1	60.3	57.5	57.4
LC-11	66.0	NM	NM	NM	48.7	59.9	61.4	58.3	59.2
LC-12	67.0	NM	NM	NM	33.3	59.0	58.1	53.8	50.7
LC-13	40.0	NM	NM	NM	0.0	49.7	41.2	40.6	16.7
LC-14	38.0	NM	NM	NM	26.1	61.1	58.5	57.3	60.8
LC-15	65.0	NM	NM	NM	59.7	59.4	60.3	56.5	58.8
LC-16	NM	NM	NM	NM	NM	NM	37.7	37.9	47.9
LC-17	NM	NM	NM	NM	42.1	55.5	56.7	54.1	52.2
LC-18	NM	NM	NM	NM	56.1	62.1	60.3	58.9	61.2
LC-19	64.0	NM	NM	NM	62.6	41.0	40.3	41.0	38.7
LC-20	25.0	NM	NM	NM	NM	NM	NM	NM	NM
HDPE-1	0.0	NM	NM	NM	NM	NM	NM	NM	0.0
HDPE-2	0.0	NM	NM	NM	NM	NM	NM	NM	0.0
HDPE-3	0.0	NM	NM	NM	NM	NM	NM	NM	0.0
HDPE-4	0.0	NM	NM	NM	NM	NM	NM	NM	0.0
HDPE-5	0.0	NM	NM	NM	NM	NM	NM	NM	0.0
HDPE-6	0.0	NM	NM	NM	NM	NM	NM	NM	0.0

Notes:

Methane measurements shown in % by volume

Methane LEL is 5%

NM - Not measured

*Pipe filled with water

Boyertown Landfill										
May and October/November 2016 Landfill Gas Vents Estimated Liquid Level Measurements										
Rain Gauge ¹	Estimated Ground Elevation	5/23/2016	10/18/16	10/21/16	10/25/16	10/28/16	11/1/16	11/4/16	11/8/16	11/11/16
Rainfall ²		-	-	0.00	0.15	0.23	0.30	0.00	0.00	0.03
		-	-	0.03	0.24	0.33	0.31	0.02	0.00	0.00
LC-1	322.5	287.5	270.3	269.3	269.7	269.1	269.1	269.3	269.2	269.3
LC-2	322.6	291.1	271.5	271.9	271.7	271.7	271.6	271.7	271.7	271.7
LC-3	323.0	298.6	288.3	287.4	287.4	287.4	287.4	287.4	287.4	287.4
LC-4	325.7	308.8	301.6	317.0	316.4	316.4	316.4	316.4	289.8	289.8
LC-5	326.3	322.4	320.1	320.1	320.3	320.3	320.3	320.3	320.3	320.3
LC-6	328.7	324.0	325.9	325.9	325.9	325.9	325.9	325.9	325.9	325.9
LC-7	330.6	318.9	327.1	327.1	327.1	327.1	327.1	327.1	327.1	327.1
LC-8	336.2	304.0	331.1	334.6	334.5	334.4	334.8	334.8	335.0	335.0
LC-9	338.3	338.3	338.3	338.3	338.3	338.3	338.3	338.3	338.3	338.3
LC-10	341.3	327.2	333.5	333.6	333.6	334.1	334.1	334.1	334.1	334.2
LC-11	343.2	316.0	316.4	316.6	316.4	316.5	316.5	316.5	316.5	316.5
LC-12	343.7	299.8	313.4	311.7	311.8	311.7	311.7	311.7	311.7	311.7
LC-13	344.4	330.6	318.1	308.5	308.5	308.5	308.5	308.5	308.5	308.5
LC-14	346.3	343.9	325.1	325.0	324.9	324.9	324.9	324.9	324.9	324.9
LC-15	353.1	323.1	315.6	315.6	315.6	315.6	315.6	315.6	315.6	315.6
LC-16	353.0	NM	NM	NM	NM	NM	NM	325.1	325.1	325.1
LC-17	353.8	329.6	323.4	323.4	323.4	323.4	323.4	324.1	324.1	324.2
LC-18	353.8	304.5	326.1	326.2	327.0	327.1	327.1	327.1	327.0	327.0
LC-19	355.6	355.6	311.7	311.7	311.8	311.8	311.8	311.8	311.8	340.7
LC-20	359.1	347.4	NM	NM	NM	NM	NM	NM	NM	NM

Notes:

Estimated Ground Elevation shown in feet above mean sea level (amsl)

Measurements shown are estimated elevations based on the estimated ground elevations and an assumed 45 degree angle of the riser pipe

NM - Not measured, could not locate in the field

Red text indicates well was blocked or a dry well at depths shown

Rain data presented in inches since previous sampling event

¹Rain Gauge data from rain gauge on-site

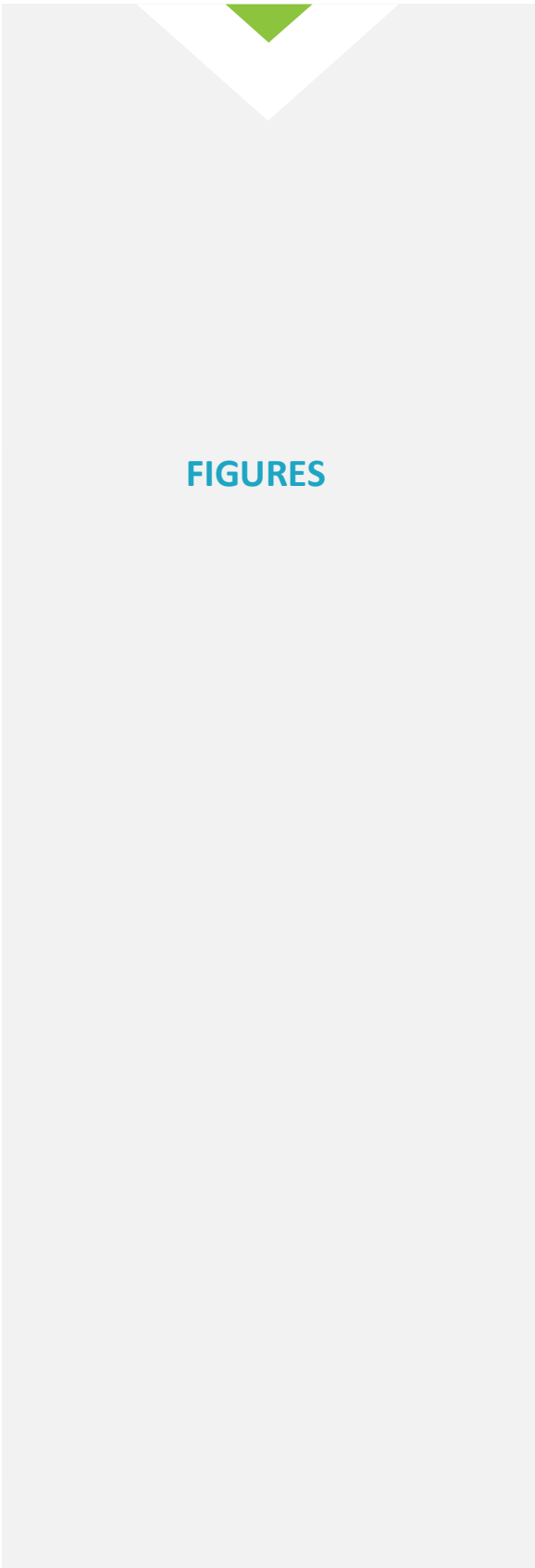
²Rainfall data from Weather Underground for the Pottstown Limerick rain gauge:

https://www.wunderground.com/history/airport/KPTW/2016/11/09/DailyHistory.html?req_city=Gilbertsville&req_state=PA&reqdb.zip=19525&reqdb.magic=1&reqdb.wmo=99999

Summary of Preliminary Cost Estimates

Cost Item	Cost
Landfill Cap and Cover	1,373,000
Fill/regrade the low area on top of the landfill (approx. 1.5 acres)	
Regrade/stabilize the north end of the east side drainage channel (approx. 425 LF)	
Restore landfill perimeter road (approx. 2,500 LF)	
Install piping and electrical conduit for operation of PADEP sump pump	
Leachate Collection and Storage	1,428,000
Upgrade leachate collection manhole	
Repair raw leachate lagoon	
Repair the two treated effluent storage lagoons	
Leachate Treatment	
(a) Repair existing air stripper tower	1,179,000
(b) Replace with new air stripper tower	1,359,000
Clean/reline the clarifier and fixed film reactor (including replacement of baffles, aeration piping, and fixed film media)	
Replace caustic and neutralization mix tanks and feeds	
Address the stripping tower system in one of two ways:	
(a) Repair existing air stripper tower	
(b) Replace with new air stripper tower	
Replace carbon units	
Clean system piping	
System start-up and testing	
Landfill Gas Management	376,000
Clean leachate collection gas vents	
Repair landfill collection gas vent piping at the surface	
Install candlestick flares on up to 10 of the 20 leachate collection gas vents	
Capital Costs Total (a)	4,356,000
Capital Costs Total (b)	4,536,000

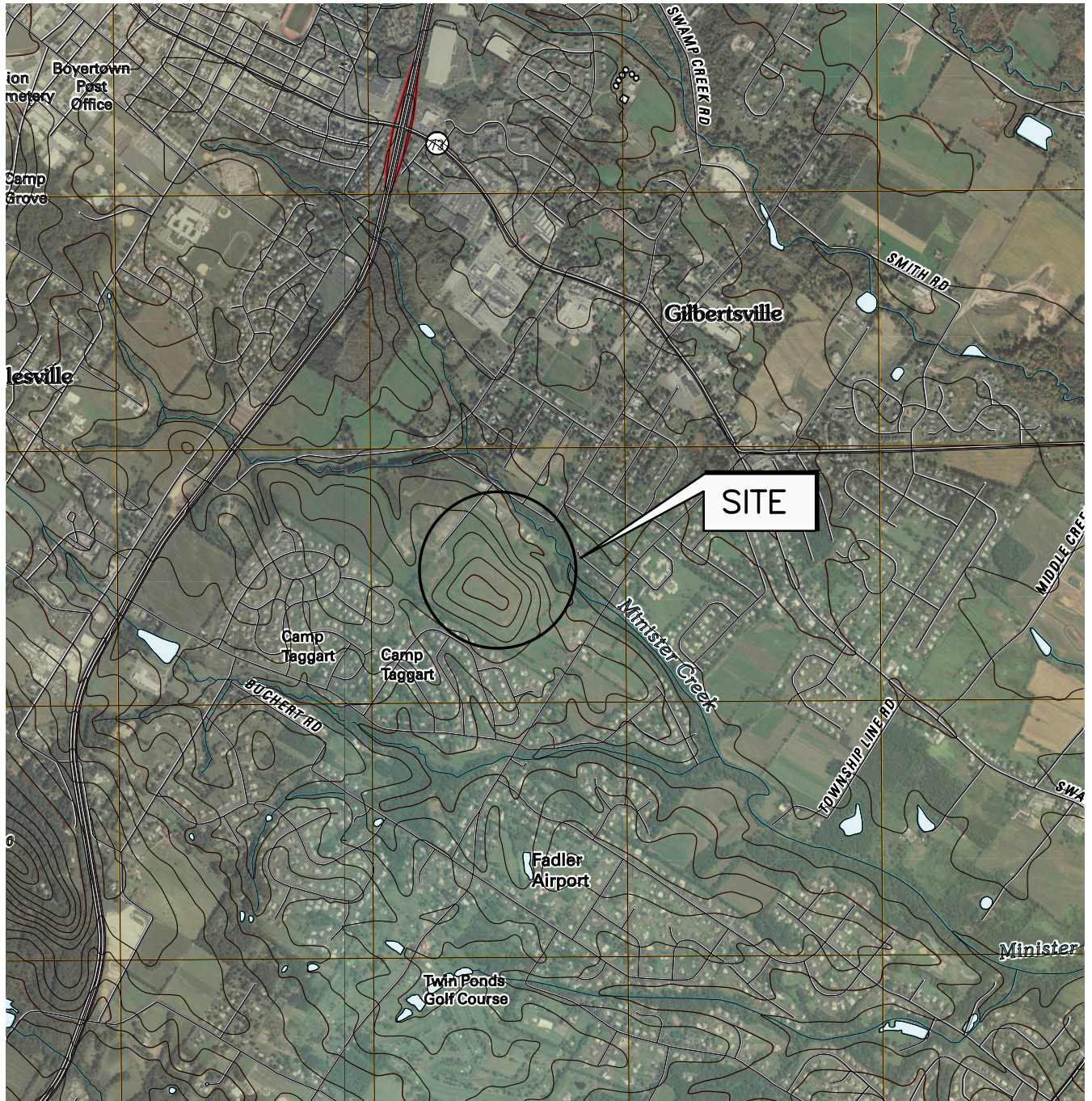




FIGURES

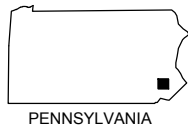


FIGURE 1



ADAPTED FROM: SASSAMANSVILLE AND BOYERTOWN, PA. U.S.G.S. 7.5 MIN. QUAD

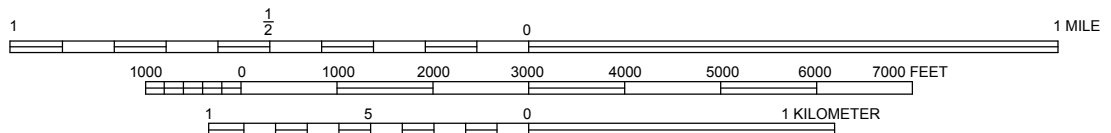
BOYERTOWN SANITARY LANDFILL SITE COALITION
BOYERTOWN SANITARY LANDFILL
DOUGLASS TOWNSHIP, PENNSYLVANIA



PENNSYLVANIA

SITE LOCATION MAP

QUADRANGLE LOCATION



FILE NO. 24918.60128-004
SEPTEMBER 2017

SCALE: 1:24000



9/5/2017 11:39 AM

I:\Boyertown_24918\60128 Boyertown-Saniti\Docs\DWG\Sheets\60128-006-NOV 2016.dwg



LEGEND

- APPROX. PROPERTY BOUNDARY (REFER TO NOTE 9)
- PROPOSED AREA FOR CLAY CAP REGRADING/REPAIRS
- APPROX. LOCATION OF EXISTING CLAY CAP
- APPROX. LAYOUT OF EXISTING LEACHATE COLLECTION SYSTEM (REFER TO NOTE 6)
- APPROX. LOCATION OF EXISTING LINED (I.E., PVC OR ASPHALT) LANDFILL AREAS (REFER TO NOTE 5)
- EXISTING LEACHATE COLLECTION SYSTEM GAS VENTS (REFER TO NOTE 4)
- EXISTING GROUNDWATER MONITORING WELL (REFER TO NOTE 3)

BOYERTOWN SANITARY LANDFILL SITE COALITION

- NOTES:
- AERIAL IMAGERY BASE WAS OBTAINED FROM U.S. GEOLOGICAL SURVEY HIGH RESOLUTION ORTHOIMAGES OF PENNSYLVANIA, 2010.
 - CONTOUR DATA OBTAINED FROM THE PAMAP PROGRAM TOPOGRAPHIC CONTOURS OF PENNSYLVANIA, PA DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES. CONTOURS WERE DERIVED FROM PAMAP LIDAR DATA COLLECTED IN 2008. FOR THE PURPOSES OF CLARITY, ONLY 10 FOOT INTERVAL CONTOURS ARE SHOWN ON THIS MAP.
 - MONITORING WELL LOCATIONS SHOWN ON THIS PLAN WERE FIELD SURVEYED BY BARRY ISETT & ASSOCIATES ON APRIL 26, 2016.
 - LEACHATE COLLECTION SYSTEM GAS VENT LOCATIONS SHOWN ON THIS PLAN WERE LOCATED IN THE FIELD USING GPS BY O'BRIEN & GERE.
 - PVC AND ASPHALT LINED AREAS OF THE LANDFILL SHOWN ARE APPROXIMATE AND ARE BASED ON THE LINER PERIMETERS SHOWN ON THE 'CLOSURE PLAN FOR BOYERTOWN SANITARY DISPOSAL, CO. SANITARY LANDFILL' (CLOSURE PLAN) DRAWINGS PREPARED BY AGES, DATED AUGUST 1983.
 - LEACHATE COLLECTION SYSTEM PIPING LAYOUTS SHOWN ARE APPROXIMATE AND ARE BASED ON THE CLOSURE PLAN DRAWINGS AND THE MOST ENGINEERING LEACHATE COLLECTION PIPING DESIGN DRAWINGS.
 - LOCATION OF THE MIGRATION COLLECTION TRENCH AND APPURTENANCES ARE APPROXIMATE AND WERE OBTAINED FROM PLANS TITLED 'METHANE MIGRATION CONTROL SYSTEM, PLAN VIEW, BOYERTOWN SANITARY LANDFILL' PREPARED BY SHAW & E.I. INC., DATED AUGUST 8, 2002 AND LAST REVISED NOVEMBER 21, 2002.
 - LOCATION OF THE CLAY CAP SHOWN IS APPROXIMATE AND IS BASED ON THE CLOSURE PLAN AND 'CERTIFICATION OF CONSTRUCTION FOR DER APPROVED CLOSURE OF EXISTING FILL AREA' PREPARED BY AGES, DATED DECEMBER 3, 1987.
 - PROPERTY BOUNDARIES SHOWN ON THIS PLAN ARE APPROXIMATE ONLY. PROPERTY INFORMATION WAS OBTAINED FROM THE MONTGOMERY COUNTY ASSESSMENT OFFICE PROPERTY RECORDS DATABASE.



SITE PLAN

24918.60128-006
SEPTEMBER 2017



APPENDIX A
BSL Leachate Treatment
System Article



Leachate treatment system removes organic constituents from industrial landfill site

CONNIE WICKERSHAM
Philadelphia Regional Editor

DAVID A. TOY
Associate Editor

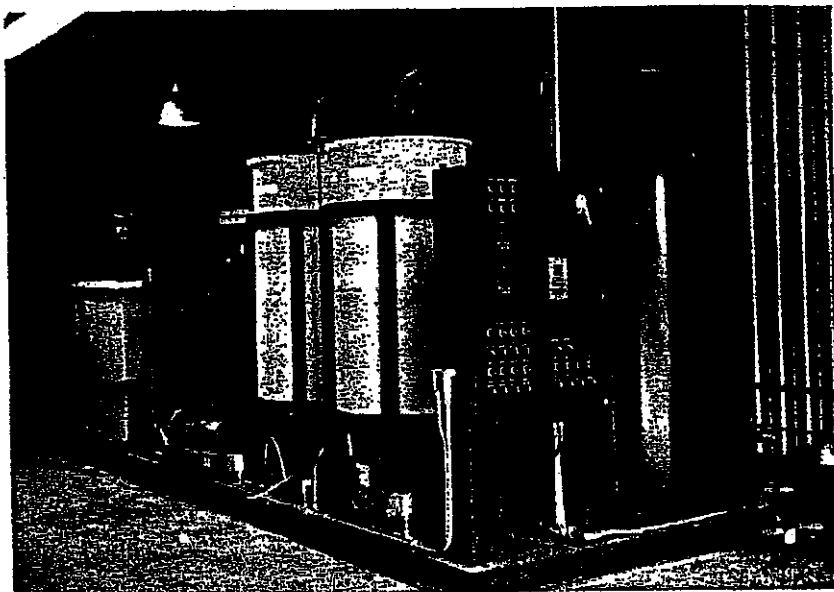
New Solutions to Plant Problems

Problem: Since opening in 1962, an East Coast landfill has catered to the disposal of industrial waste, manufacturing debris, demolition wastes, and other institutional wastes. The landfill had been granted status as an interim hazardous waste site. Storm water generated from rainfall would permeate the surface, percolate through the landfill, and become contaminated. The resulting leachate could not be discharged directly to the municipal sewer system because of the increased concentration of organics.

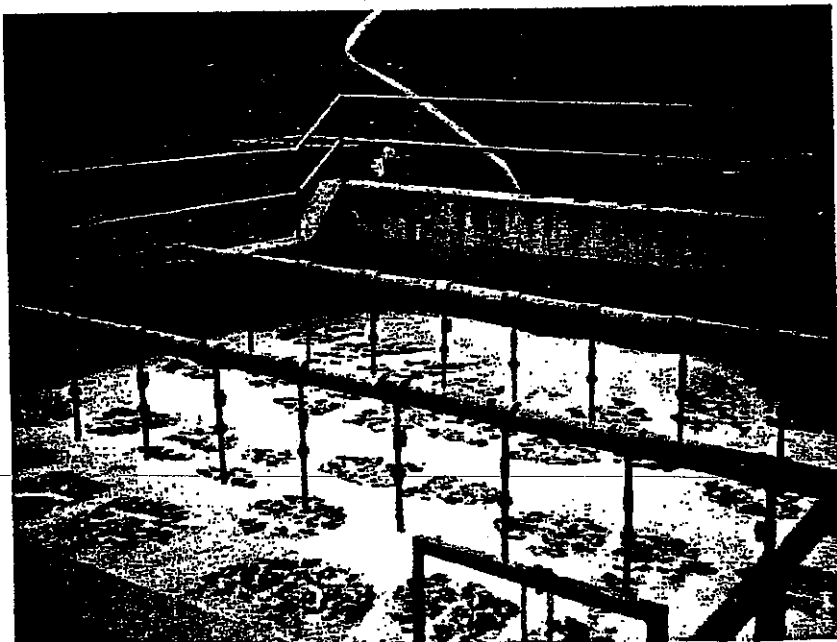
As the landfill grew, a leachate collection system was designed and implemented. The earliest system consisted solely of perimeter trenches and a collection pond. Later an aeration step was added, and finally, an air stripping sequence was instituted for the removal of ammonia.

Little, if anything, was known about the exact composition of landfill leachate in the early days of landfill operation. With the advent of tighter regulatory control, the raw leachate was sampled and analyzed by an independent testing laboratory in accordance with EPA guidelines.

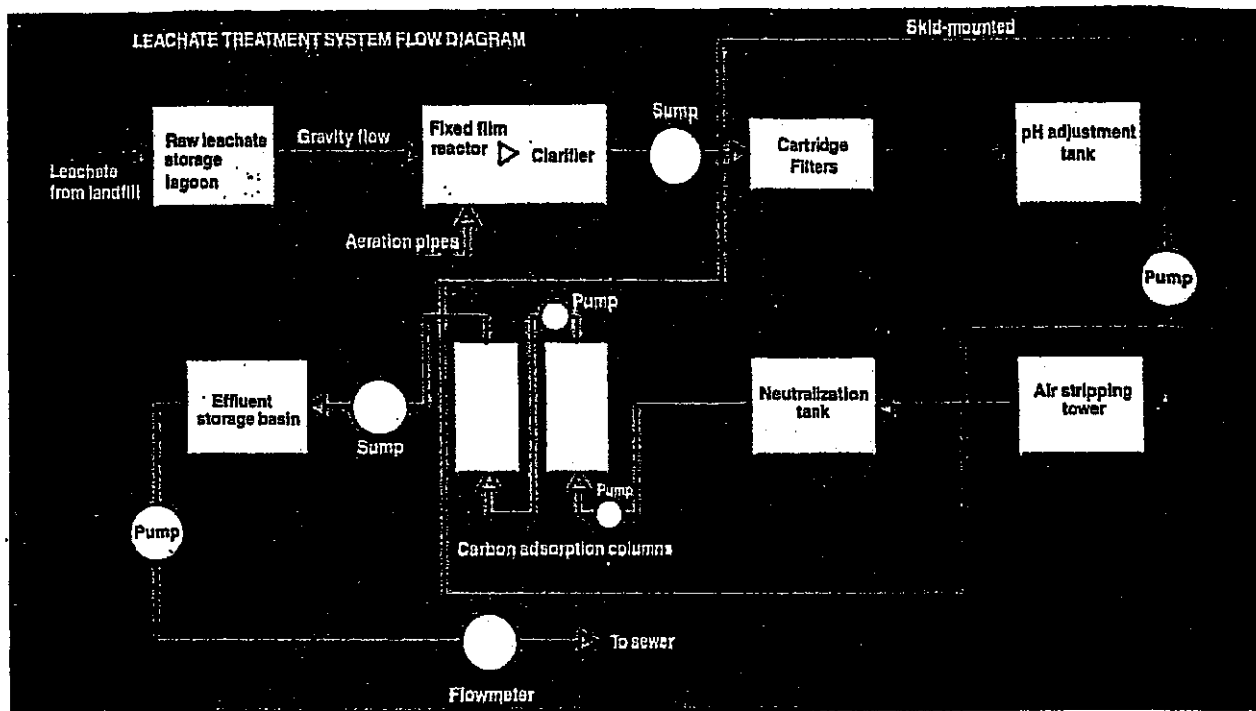
Analysis by gas chromatography and flame ionization detection techniques yielded a breakdown of individual chemical components and concentrations. Raw leachate was profiled for a period of eighteen months. Test results identified the waste as a combination of organics ranging from barely detectable to 6000 ppm. The waste profile aided in the determination of an appropriate treatment scheme—a method primarily geared towards removal of organics such as methylene chloride, dichloroethylene,



Skid-mounted unit contains cartridge filters, pH adjustment and neutralization tanks, chemical feed tanks, and carbon adsorption columns (blue cylinders to right), complete with pumps, piping, and controls



Aeration within the fixed film reactor enhances biological reduction of the raw leachate



toluene, phenols, and benzene. Although heavy metals, total dissolved solids, and total suspended solids were present in the leachate, their removal was not the focus of the treatment plant design.

Solution: To effectively treat the leachate from the landfill, a physical/chemical treatment method preceded by a biological step was designed according to requirements for reducing the concentration of organics by 85%. Treatment phases include:

- aeration and biological reduction of raw leachate via a fixed film reactor
- clarification
- cartridge filtration
- flash mixing and pH adjustment
- ammonia stripping
- pH neutralization
- organics removal by carbon adsorption
- storage and sampling
- final effluent filtration.

The plan incorporated a number of pieces of existing equipment and minimized the need for additional equipment.

Leachate from the landfill is collected in a 250,000 gal leachate storage/equalization lagoon. The lagoon is double-lined with a 50 mil chlorinated polyethylene primary liner over a 20 mil PVC layer. Controlled gravity flow from the storage lagoon maintains steady flow to the leachate treatment system.

An existing set of two connected concrete tanks (each 20' x 20') was adapted for both the aeration/biological reduction and clarification phases. Aeration in a

fixed film reactor (or submerged trickling filter) provides a more uniform composition. Biological media is suspended in the reactor atop a coated iron grating and, together with the aeration, significantly reduces BOD and TOC levels.

Effluent from the fixed film reactor flows into a baffled clarifier via a broad crest weir on the common wall of the two concrete tanks. A sump station collects the discharge from the clarifier and pumps the waste to the next treatment phase.

Filtration by 100 micron cartridge filters removes suspended particles. Cartridge filtration has been tried on an experimental basis to determine its effectiveness and suitability for this type of application. In test runs at 4-6 gpm, the filters performed for 80 hours before replacement.

Flash mixing and adjustment to pH 10.5 require a retention time of at least 60 seconds. A high speed mixer assures complete contact of the pH adjustment chemicals (caustic) with the leachate to aid in ammonia reduction. Chemical dosage is ratioed to influent flowrate but can be manually adjusted, as required, without interrupting process flow. A centrifugal transfer pump feeds an existing air stripping tower with the pretreated leachate.

The stripping tower has a 15' deep packed bed and operates at a minimum 10:1 air-to-water ratio. Stripping is utilized for ammonia and volatile organics removal.

After stripping, a neutralization tank

is used to readjust the pH of the leachate. Acid is added by a metering pump until the pH reaches 7.0.

Two feed pumps route the neutralized leachate to a pair of air fluidized upflow granular carbon adsorption columns in series. The columns employ a bituminous coal-based activated carbon with high surface area to remove any remaining organic contaminants. Each column measures eight feet in height and four feet in diameter, with an actual carbon bed length of four feet.

The carbon adsorption columns, neutralization tank, pH adjustment tank, cartridge filters, pumps, and controls are skid-mounted. The package was pre-wired and pre-piped to facilitate transport and quick installation. The system was designed for unattended operation; operators need only check makeup chemical levels and equipment daily.

A sump collects effluent from the carbon columns before it is pumped to one of two 100,000 gal effluent storage basins. Construction materials for the effluent basins are a 30 mil synthetic rubber primary layer over a 20 mil PVC barrier. The treated leachate is sampled and analyzed to ensure that treatment has been performing up to specification.

To assure that the storage basins do not leak (effluent and raw leachate basins), a witness system has been employed. A pipe is inserted between the two layers of the basin liners to collect any liquid that might leak through the synthetic rubber primary liner. The method provides early warning for liner damage (the same sys-

Effluent basins are double-lined with a primary 30 mil layer of synthetic rubber over a 20 mil PVC sheet



tem is also employed in the raw leachate storage/equalization lagoon).

A variable-speed pump draws treated leachate from the storage basin. A rotor-type flowmeter monitors liquid volume before discharge to sewer. The inexpensive unit provides accuracy to within $\pm 1\%$ and repeatability of $\pm 0.5\%$.

Results: The leachate treatment system was installed in February, 1984 and test run initially in October, 1984. The system was specifically designed to remove contaminants so that the effluent could be discharged to stream.

Testing and laboratory analyses of the treated effluent confirmed the effectiveness of the system. Species such as methylene chloride, dichloroethylene, toluene, phenols, and benzene in concentrations up to 1000 ppm were removed with an overall system removal yield of 100% (85% had been required to meet local regulations)—no volatile organics were detected at the ppm level. Qualitatively, the results can be seen from a color comparison. Raw leachate in the storage lagoon is virtually black; after biological reduction, the leachate is greenish; after stripping, it is yellow; and discharged water is clear.

According to local environmental requirements, the pH adjustment tank and neutralization tank were included to improve ammonia removal efficiency in the stripping tower. Since the site now discharges to sewer (instead of to stream) and the sewer authority permits a higher ammonia level, the pH adjustment and neutralization tanks are not in use pres-

ently. However, if the site ever decides to or is forced to discharge to stream, it has the capability. ■

Skid-mounted leachate treatment system including Fybroc centrifugal transfer pumps, pH adjustment tank, neutralization tank, and carbon adsorption columns supplied by Systems Div., Met-Pro Corp., 160 Cassell Rd., Box 144, Harleysville, PA 19438.

Laboratory analyses of leachate and effluent performed by Applied Geotechnical & Environmental Services (AGES) Corp., 1151 Trooper Rd., Norristown, PA 19403.

Design of complete leachate treatment facility also performed by AGES Corp.

Leachate witness system also designed by AGES Corp.

BIOdek® filter media used in the fixed film reactor supplied by The Munters Corp., 1205 Sixth St., SE, Box 6428, Ft. Myers, FL 33911.

Cartridge filters are products of Tate Engineering Inc., 370 Turner Industrial Way, Aston, PA 19014.

Air stripping tower is a custom design fabricated by Ground Water Associates, Hydro Group, Box 280, Westerville, OH 43081.

Filtersorb® 300 granular activated carbon provided by Calgon Carbon Corp., Box 717, Pittsburgh, PA 15230.

Chlorinated polyethylene (CPE) used in the raw leachate storage lagoon supplied by the Plastics Dept., Dow Chemical USA, 2020 Dow Center, Midland, MI 48640.

Hypalon® synthetic rubber is a product of the Elastomers Dept., Du Pont Co., Wilmington, DE 19898.

CPE and PVC liner sheets for the leachate storage lagoon fabricated by Watersaver Co. Inc., Box 16465, Denver, CO 80216.

Hypalon and PVC liner sheets for the effluent storage basins supplied by Staff Industries Inc., 240 Chene St., Detroit, MI 48207.

Rotor-X® flowsensor is a product of Signet Scientific Co., 3401 Aerojet Ave., El Monte, CA 91734.

APPENDIX B
**Historical Pre-Treatment
System Sampling Data**

TABLE B-1: PRE-TREATMENT SYSTEM EFFLUENT SAMPLING RESULTS

Water Quality Parameters	2011	7/23/2009	11/13/2009	5/15/2010	12/14/2010	4/18/2011	11/10/2011	1/4/2013	3/20/2014	12/16/2015
	Permit									
BOD-5 (mg/L)	150/200*	11.8	7.87	10.3	42.6	2.52	24.6	47	44.1	33.5
pH (s.u.)	6-9	7.48	7.20	7.22	7.14	6.91	6.58	6.17	7.64	7.46
Total Dissolved Solids (mg/L)	3500/500*	2190	1640	2140	1910	1380	1890	1630	1160	170
Oil & Grease (mg/L)	25	ND	ND	ND	ND	ND	0.8	ND	ND	ND
NH3-N (mg/L)	25/25*	0.1	18.9	34.6	28.9	0.19	54.8	57.3	52.8	47.0
Phosphorus as P (mg/L)	25/10*	0.214	0.142	0.261	0.357	ND	0.198	0.305	0.128	0.05
Color (Pt. cobalt units)	150/100*	90	100	100	25	55	175	275	70	250
Metals										
Aluminum, total (mg/L)	1.00	ND	0.0059	0.0053	ND	ND	ND	0.046	ND	ND
Chromium, total (mg/L)	6.78	0.0057	0.005	0.0068	0.0082	0.0009	0.0058	0.0056	0.006	ND
Copper, total (mg/L)	1.59	0.0024	0.0024	0.0062	0.0025	0.0053	0.0045	0.0123	0.0023	0.0207
Lead, total (mg/L)	1.09	ND	0.000289	0.000794	ND	ND	ND	ND	ND	0.0052
Mercury, total (mg/L)	0.002	ND	ND	ND	ND	ND	ND	0.000078	ND	ND
Nickel, total (mg/L)	4.28	0.041	0.0359	0.0489	0.0443	0.0233	0.0441	0.0383	0.0342	0.0555
Silver, total (mg/L)	1.53	ND	ND	ND	0.0030	0.0017	0.0031	0.0027	ND	ND
Zinc ,total (mg/L)	1.75	0.0151	0.0207	0.0298	0.0247	0.0191	0.0193	0.0145	0.0193	0.0721

*First number indicates discharge permit limit; second number indicates BMMA may apply surcharges above the value noted.
Note: Highlighted cells indicate analyte was measured at a value that exceeds either a permit limit or the proposed pretreatment limit or both.

Table B-2: Pre-Treatment System Priority Pollutant Sampling Results

	Date Lab ID Influent/Effluent	2011 Permit	1/6/1986 NA Effluent	2/3/1986 NA Effluent	10/2/1987 NA Effluent	10/12/1987 NA Effluent	10/23/1987 NA Effluent	3/13/1995 NA Effluent	8/7/1995 NA Effluent	11/13/2009 L3174835-2 Influent	12/14/2010 L3596224-2 Influent	11/10/2011 L3966665-2 Influent	1/4/2013 L4002355-2 Influent	3/20/2014 L4869898-2 Influent	12/16/15 JC10802-1 Influent
Metals (mg/L)															
Aluminum, total		1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Antimony		NS	ND	0.002	0.003	0.001	ND	ND	ND	< 0.0022	NA	< 0.0023	< 0.0044	< 0.02	< 0.006
Arsenic total		NS	0.003	0.008	0.044	0.016	0.02	0.006	0.0094	< 0.0013	NA	0.0096	0.0186	< 0.02	0.0078
Barium total		NS	1.4	0.81	2.9	1.45	2.19	0.000693	0.000584	NA	NA	NA	NA	NA	NA
Beryllium, total		NS	ND	ND	ND	ND	ND	NA	NA	< 0.000028	NA	0.000177 B	< 0.000024	< 0.02	< 0.001
Cadmium total		NS	ND	ND	ND	ND	ND	ND	ND	< 0.00013	NA	< 0.000111	< 0.000159	< 0.02	< 0.003
Chromium, total		6.78	0.045	0.034	0.06	0.045	0.056	NA	NA	0.0081	NA	0.0082	0.0068	< 0.02	< 0.01
Chromium, hexavalent		NS	ND	ND	0.003	0.001	0.004	ND	ND	NA	NA	NA	NA	NA	NA
Copper, total		1.59	0.006	0.004	0.012	0.002	0.04	ND	ND	0.0022 B	NA	0.0023	0.0078	< 0.02	< 0.01
Iron, total		NS	15.7	18.7	94.2	16.9	13.8	8.24	3.4	NA	NA	NA	NA	NA	NA
Lead, total		1.09	0.004	ND	0.011	ND	0.006	ND	0.00556	< 0.0018	NA	< 0.0018	< 0.002	< 0.02	< 0.003
Manganese, total		NS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury, total		0.002	ND	ND	ND	ND	ND	0.0009	< 0.000035	NA	NA	< 0.000047	0.000063 B	< 0.0002	< 0.0002
Nickel, total		4.28	ND	0.08	0.09	0.09	0.31	0.02	0.05	0.0379	NA	0.0471	0.0418	0.0359	0.0513
Selenium, total		NS	0.014	0.014	0.018	0.024	0.027	ND	ND	< 0.0074	NA	< 0.0052	< 0.008	< 0.02	< 0.01
Silver, total		1.53	0.002	ND	ND	ND	0.016	ND	ND	< 0.00051	NA	0.0029	0.0026	< 0.02	< 0.01
Thallium, total		NS	<0.05	ND	ND	ND	7.5	NA	NA	< 0.002	NA	< 0.0032	< 0.0046	< 0.02	< 0.002
Zinc ,total		1.75	0.11	ND	0.09	0.04	0.03	0.011	ND	0.14	NA	0.0193	0.0139	<0.05	< 0.02
Priority Pollutant Groups (ug/L)															
Volatiles (other than acrolein and acrylonitrile)		100	50.9	0	16	0	0	0	0	2.31	8.55	3.1	10.36	15.57	1.5
Acid Compounds		100	ND	ND	NA	ND	NA	ND	ND	NA	NA	NA	NA	NA	NA
Pesticides & PCBs		100	ND	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA
alpha BHC		NS	NA	NA	NA	NA	NA	NA	NA	< 0.0018	< 0.0036	< 0.0018	< 0.0018	< 0.04	0.019
delta BHC		NS	NA	NA	NA	NA	NA	NA	NA	< 0.0022	< 0.0044	< 0.0022	< 0.0022	< 0.04	0.011
Acrolein and Acrylonitrile		50	ND	ND	ND	ND	NA	ND	ND	NA	NA	NA	NA	NA	< 10
Gamma - BHC		0.5	ND	ND	NA	ND	NA	NA	NA	< 0.002	< 0.004	< 0.002	< 0.002	< 0.04	< 0.011
Priority Pollutant Volatiles (ug/L)															
Benzene		NS	2	ND	3	ND	NA	ND	ND	1.3	1.6	< 0.32	3.01	3.36	0.74 J
Chlorobenzene		NS	NA	NA	NA	NA	NA	NA	NA	NA	4.22	3.1	6.36	8.37	1.5
Chloroform		NS	ND	ND	13	ND	NA	ND	ND	< 0.39	< 0.22	< 0.29	< 0.12	< 1	< 1
1,1-Dichloroethane		NS	ND	ND	ND	ND	NA	ND	ND	< 0.38	< 0.22	< 0.32	< 0.14	< 1	< 1
1,2-Dichloroethane		NS	ND	ND	ND	ND	NA	ND	ND	< 0.31	< 0.25	< 0.26	< 0.16	< 1	< 1
1,1-Dichloroethylene		NS	ND	ND	ND	ND	NA	ND	ND	< 0.68	< 0.29	< 0.32	< 0.15	< 1	< 1
Ethylbenzene		NS	20.7	ND	ND	ND	NA	ND	ND	1.01	1.08	< 0.26	< 0.12	1.87	< 1
Methylene Chloride		NS	ND	ND	ND	ND	NA	ND	ND	< 0.79	< 0.5	< 0.5	< 0.5	< 1	< 1
Tetrachloroethylene		NS	ND	ND	ND	ND	NA	ND	ND	< 0.64	< 0.3	< 0.31	< 0.11	< 1	< 1
Toluene		NS	28	ND	ND	ND	NA	ND	ND	< 0.61	1.65	< 0.23	0.99	1.97	< 1
1,2-Trans-dichloroethylene		NS	ND	ND	ND	ND	NA	ND	ND	< 0.6	< 0.23	< 0.29	< 0.16	< 1	< 1
1,1,1-Trichloroethane		NS	ND	ND	ND	ND	NA	ND	ND	< 0.7	< 0.26	< 0.26	< 0.13	< 1	< 1
Trichloroethylene		NS	0.2	ND	ND	ND	NA	ND	ND	< 0.78	< 0.31	< 0.34	< 0.08	< 1	< 1
Bromodichloromethane		NS	ND	ND	2	ND	NA	ND	ND	< 0.36	< 0.24	< 0.26	< 0.13	< 1	< 1
Priority Pollutant Acid Extractables (ug/L)															
Total phenols		NS	ND	ND	NA	ND	NA	ND	ND	< 1.23	< 0.99	0.36 J	< 0.33	< 5	< 200
2,4-Dichlorophenol		NS	ND	ND	NA	ND	NA	ND	ND	< 1.84	< 1.71	< 0.57	< 0.57	< 5	< 5
Priority Pollutant Base/Neutrals (ug/L)															
Acenaphthylene		NS	ND	ND	ND	ND	ND	ND	ND	< 0.52	< 1.92	< 0.64	< 0.64	< 5	< 1
Bis (2-Chloroethoxyl) Methane		NS	ND	ND	ND	ND	ND	ND	ND	< 0.6	< 2.28	< 0.76	< 0.76	< 5	< 2
Bis (2-Chloroethyl) Ether		NS	ND	ND	ND	ND	ND	ND	ND	< 0.61	< 2.52	< 0.84	< 0.66	< 5	< 2
Bis (2-Chloroisopropyl) Ether		NS	ND	ND	ND	ND	ND	ND	ND	< 0.52	< 2.28	< 0.76	< 0.76	< 5	< 2
Bis (2-Ethylhexyl) Phthalate		NS	12	54	ND	12	ND/21	ND	2.7	< 2.37	9.72 J	1.22 JB	1.49 J	< 5	< 2
1,2-Dichlorobenzene		NS	ND	ND	ND	ND	ND	ND	ND	< 0.32	0.74 J	1.06	1.02	1.35	0.37 J
Diethyl Phthalate		NS	6.4	ND	ND	ND	ND	ND	ND	< 0.76	< 3.6	< 1.2	< 0.69	< 5	< 2
Dimethyl Phthalate		NS	ND	ND	ND	ND	ND	ND	ND	< 1.08	< 2.88	< 0.96	< 1.3	< 5	< 2
Di-N-Butyl Phthalate		NS	ND	ND	ND	ND	ND	ND	ND	3.24 J	< 14.7	1.36 JB	0.81 J	< 5	< 2
Fluorene		NS	ND	ND	ND	ND	ND	ND	ND	< 0.59	< 1.98	< 0.66	< 0.66	< 5	< 1
Isophorone		NS	ND	ND	ND	ND	ND	ND	ND	< 0.49	< 2.31	< 0.77	< 0.77	< 5	< 2
Nitrobenzene		NS	ND	ND	ND	ND	ND	ND	ND	< 0.58	< 2.43	< 0.81	< 0.81	< 5	< 2
Chlorobenzene		NS	2.2	ND	ND	ND	ND	ND	ND	< 0.45	4.22	3.1	6.36	8.37	< 2
1,4-Dichlorobenzene		NS	ND	11	ND	ND	ND	ND	ND	< 0.58	3.56	5.37	4.94	4.9	1.9
Naphthalene		NS	ND	40	ND	ND	ND	ND	ND	< 0.52	< 2.4	< 0.8	< 0.8	< 5	< 1
1,3-Dichlorobenzene		NS	ND	ND	ND	ND	ND	4.1/3.2	ND	< 0.56	< 0.18	< 0.29	< 0.14	< 1	< 2

Notes:
NA - Data not available
NS - No standard
194 Analyte exceeds a permit limit
12 Volatile or Semi-volatile detected; no standard
J - Estimated Value
B - Reported value is greater than the Method Detection Limit but less than the Reporting Limit





APPENDIX C

Preliminary Cost Estimate Details

Estimate 1
Preliminary Cost Estimate: Repairs to Landfill Cap/Cover, Drainage Systems, and Access Roadways
Boyertown Sanitary Landfill

DESCRIPTION: Scope of work consists of the filling and regrading of a topographic depression area on the top of the landfill to promote positive drainage and allow for maintenance mowing. This will also mitigate surface water infiltration and the development of undesirable vegetation. In addition, the north end of the east side stormwater drainage channel requires regrading and stabilization to address existing surface erosion along the channel length and mitigate the potential for future erosion. The landfill perimeter road would also be leveled and provided with a crushed stone surface to facilitate access/future O&M activities as part of this alternative. Repairs also include the installation of a discharge line from the PADEP Trench leachate collection sump to the central leachate collection manhole.

Item No.	Item	Quantity	Quantity Rounded	Unit	Unit Cost (\$)	Extended/ Rounded Cost (\$)	Total Cost (\$)
CONSTRUCTION							
1	Mobilization	1	1	LS	\$ 20,000	\$ 20,000	\$ 20,000
	Temporary Facilities (inc. sanitary, staging areas, storage facilities)	1	1	LS	\$ 10,000	\$ 10,000	\$ 10,000
2	General Dimensions						
	Landfill Cap						
	- Area (total repair area)	60,000	60,000	SF			
	- Avg. depth to raise cap grades in repair area	3.0	3	ft			
	- Volume of additional cap in repair area	6,666.7	6,700	cyd			
	- Approx. perimeter (repair area with 10' offset)	1,000	1,000	LF			
	Northeast Stormwater Channel						
	- Length of channel	425	425	ft			
	- Width of channel	30	30	ft			
	- Area of channel reconstruction	12,750	12,750	SF			
	- Volume of topsoil (assume 0.5 ft of topsoil along bottom of channel)	236.1	240.0	cyd			
	- Approx. perimeter (repair area with 10' offset)	1,000.0	1,000	LF			
	Road Repairs (along southeastern and southwestern landfill border)						
	- Length of road	2,500	2,500	ft			
	- Width of road	12	12	ft			
	- Average area of road	30,000	30,000	SF			
	- Average depth of additional crushed stone for road base	1	1	ft			
	- Volume of crushed stone required	1,111.1	1,120	cyd			
	- Length of leachate conveyance piping	2,500	2,500	LF			
	- Length of electrical conduit piping	2,500	2,500	LF			
3	Site surveys/control (by licensed surveyor)						\$ 28,000
	Initial control survey/monuments	1	1	LS	\$ 8,000	\$ 8,000	
	Progress control surveys	1	1	LS	\$ 10,000	\$ 10,000	
	Final "as-built" survey	1	1	LS	\$ 10,000	\$ 10,000	
4	Soil Erosion & Sediment Controls						\$ 33,800
	Tracking pads, installed cost	2	2	each	\$ 3,000	\$ 6,000	
	Silt fence	2,600	2,600	LF	\$ 3.00	\$ 7,800	
	Installation, assumes 1 week	1	1	wk	\$ 20,000	\$ 20,000	
5	Site Clearing/Grubbing						\$ 7,280
	- Area required for clearing/grubbing	72,750	72,800	SF			
	Site clearing/grubbing,vegetation removal, and on-site chipping/mulching and/or staging	72,750	72,800	SF	\$ 0.10	\$ 7,280	
6	Repair Landfill Cap/Cover¹						\$ 576,100
	Stripping/staging of topsoil (assume 0.5 foot layer)	1,111	1,200	cyd	\$ 12	\$ 14,400	
	Stripping/staging of cover soils (assume 1 foot layer)	2,222	2,300	cyd	\$ 15	\$ 34,500	
	Import cap materials (3 ft certified clean low permeability soil/clay) - 1.5 ton/CY	10,000	10,000	ton	\$ 35	\$ 350,000	
	Backfill/compact clay materials (incl. geotechnical testing)	6,667	6,700	cyd	\$ 16	\$ 107,200	
	Backfill/compact cover soils (incl. geotechnical testing)	2,222	2,300	cyd	\$ 20	\$ 46,000	
	Topsoil placement	1,111	1,200	cyd	\$ 10	\$ 12,000	
	Seeding/mulching cap surface	60,000	60,000	SF	\$ 0.20	\$ 12,000	
7	Reconstruct Northeast Stormwater Channel						\$ 47,070
	Stripping of topsoil (assume 0.5 foot layer of topsoil)	236	240	cyd	\$ 20	\$ 4,800	
	Excavation and regrading subbase in preparation for liner placement (assume removal of 0.5 foot layer of soils)	236	240	cyd	\$ 20	\$ 4,800	
	Transportation & Disposal of channel soils - assume non-hazardous: 1.5 tons/CY	354	360	ton	\$ 50	\$ 18,000	
	Furnish and install turf reinforcement mat (assume across 20-foot wide channel)	8,500	8,500	SF	\$ 1.50	\$ 12,750	
	Topsoil placement	236	240	cyd	\$ 12	\$ 2,880	
	Seeding/mulching channel	12,750	12,800	SF	\$ 0.30	\$ 3,840	
8	Road Repairs						\$ 93,500
	Regrade/prepare existing subgrade surface along roadway alignment	6	6	day	\$ 4,000	\$ 24,000	
	Geotextile/road stabilization fabric installation	30,000	30,000	SF	\$ 0.30	\$ 9,000	
	Import crushed stone for road base 1.6 tons/CY	1,778	1,780	ton	\$ 20	\$ 35,600	
	Furnish road drainage pipe (as needed)	1	1	LS	\$ 2,500	\$ 2,500	
	Place and compact new crushed stone road base	1,111.1	1,120	cyd	\$ 20	\$ 22,400	
9	Leachate Conveyance Line from PADEP Trench to Leachate Manhole²						\$ 69,560
	Replacement of trench liquid sump pump and control pane	1	1	EA	\$ 8,500.00	\$ 8,500	
	Trench/backfill for conveyance line	6	6	day	\$ 4,000	\$ 24,000	
	Import pipe bedding materials (assume 1 foot depth)	278	278	cyd	\$ 20	\$ 5,560	
	Furnish and install piping (assume 1" HDPE discharge line)	2,500	2,500	LF	\$ 4.00	\$ 10,000	
	Furnish and install 1" PVC electrical conduit for power and control:	2,500	2,500	LF	\$ 3.00	\$ 7,500	
	Power/control wiring installation	2,500	2,500	LF	\$ 3.00	\$ 7,500	
	Furnish and install electrical handhole boxes (assume one per 300 LF and every bend)	12	13	EA	\$ 500.00	\$ 6,500	
10	Demobilization	1	1	LS	\$ 25,000	\$ 25,000	\$ 25,000
Construction Cost Subtotal:							\$ 910,310
Contingency (20%)							\$ 182,062
Total Construction Cost:							\$ 1,093,000

Estimate 1

Preliminary Cost Estimate: Repairs to Landfill Cap/Cover, Drainage Systems, and Access Roadways

Boyertown Sanitary Landfill

DESCRIPTION: Scope of work consists of the filling and regrading of a topographic depression area on the top of the landfill to promote positive drainage and allow for maintenance mowing. This will also mitigate surface water infiltration and the development of undesirable vegetation. In addition, the north end of the east side stormwater drainage channel requires regrading and stabilization to address existing surface erosion along the channel length and mitigate the potential for future erosion. The landfill perimeter road would also be leveled and provided with a crushed stone surface to facilitate access/future O&M activities as part of this alternative. Repairs also include the installation of a discharge line from the PADEP Trench leachate collection sump to the central leachate collection manhole.

Item No.	Item	Quantity	Quantity Rounded	Unit	Unit Cost (\$)	Extended/ Rounded Cost (\$)	Total Cost (\$)
DESIGN/PERMITTING/BIDDING/ENG. OVERSIGHT							
	Estimated construction duration:	3		month			
	Pre-Design Investigations (e.g., site topographic/features survey for design)	1	1	LS	\$ 30,000	\$ 30,000	
	Design	1	1	LS	\$ 40,000	\$ 40,000	
	Bid/Contract Documents	1	1	LS	\$ 30,000	\$ 30,000	
	PADEP Approvals/Submittals	1	1	LS	\$ 25,000	\$ 25,000	
	Env. Permits (soil erosion and sediment control)	1	1	LS	\$ 10,000	\$ 10,000	
	Contract bidding	1	1	LS	\$ 20,000	\$ 20,000	
	Engineering oversight						
	- Construction inspection/oversight (1 inspector)	3	month	month	\$ 25,000	\$ 75,000	
	- Office eng./contract admin.	3	month	month	\$ 5,000	\$ 15,000	
	Engineering Certification Report/As-Builts	1	1	LS	\$ 30,000	\$ 30,000	
Total Design/Permitting/Bidding/Eng. Oversight:						\$ 280,000	
						Program Cost Total:	\$ 1,373,000

Notes:

1. The cap repairs would be completed within the assumed area of low permeability clay cover (based on historic documents/design reports). Therefore, the fill imported to raise grades in this repair area would consist of clay (or other low permeability materials) similar to the existing compacted clay cover, overlaid with a layer of cover soils and topsoil capable of sustaining vegetative growth and consistent with the original cap design. An estimated average thickness of 3 feet of additional low permeability materials across a 60,000 square foot area is assumed for the purpose of this conceptual cost estimate, based on preliminary site observations - a topographic survey would be required to confirm the actual quantity of materials required. Costs assume no off-site disposal of soils/cap materials is required.

2. Alternatively, if a clear/unobstructed perimeter gas vent is identified through the gas vent cleaning efforts, a connection/discharge point for the sump could be established at one of those locations. In addition, another alternative may be the establishment of a leachate collection frac tank near the PADEP trench, with periodic liquids removal via vac truck and off-site disposal at a permitted facility.

Estimate 2

Preliminary Cost Estimate: Repairs to Leachate Collection and Storage

Boyetown Sanitary Landfill

DESCRIPTION: Scope of work consists of the repairs to the leachate storage lagoons (pre- and post- treatment). Repairs include excavation to expose lagoon liners, removal of torn and degraded liners, regrading of subbase materials, and replacement of liners. The scope of work also includes replacement of the central leachate collection manhole.

Item No.	Item	Quantity	Quantity Rounded	Unit	Unit Cost (\$)	Extended/ Rounded Cost (\$)	Total Cost (\$)
CONSTRUCTION							
1	Mobilization	1	1	LS	\$ 25,000	\$ 25,000	\$ 25,000
	Temporary Facilities (inc. sanitary, staging areas, storage facilities)	1	1	LS	\$ 10,000	\$ 10,000	\$ 10,000
2	General Dimensions						
	Treated Effluent Lagoon A						
	- Area (plan area with 5' extension for anchor trench)	5,105	5,200	SF			
	- Area (incl side slopes for liner)	6,212	6,300	SF			
	- Avg. depth of lagoon	10	10	ft			
	- Volume of lagoon	624	600	cyd			
	- Avg. depth of sludge at bottom of lagoon	0.15	0.20	ft			
	- Volume of sludge at bottom of lagoon	34.5	30	cyd			
	- Storage capacity of lagoon	126,121.5	126,100	gal			
	- Approx. perimeter - see below	-	-	LF			
	Treated Effluent Lagoon B						
	- Area (plan area with 5' extension for anchor trench)	5,786	5,800	SF			
	- Area (incl side slopes for liner)	6,828	6,800	SF			
	- Avg. depth of lagoon	10	10	ft			
	- Volume of lagoon	680	700	cyd			
	- Avg. depth of sludge at bottom of lagoon	0.15	0.20	ft			
	- Volume of sludge at bottom of lagoon	37.9	40	cyd			
	- Storage capacity of lagoon	137,367.3	137,400	gal			
	- Approx. perimeter of lagoons #1 and #2 (with 10' offset)	405.0	410	LF			
	Raw Leachate Storage Lagoon						
	- Area (plan area with 5' extension for anchor trench)	21,364	21,400	SF			
	- Area (incl side slopes for liner)	24,662	24,700	SF			
	- Avg. depth of lagoon	7	7	ft			
	- Volume of lagoon	3,286	3,300	cyd			
	- Avg. depth of sludge at bottom of lagoon	0.15	0.20	ft			
	- Volume of sludge at bottom of lagoon	137.0	140	cyd			
	- Storage capacity of lagoon	663,761.4	663,800.0	gal			
	- Approx. perimeter (with 10' offset)	670.0	700	LF			
3	Site surveys/control (by licensed surveyor)						\$ 28,000
	Initial control survey	1	1	LS	\$ 8,000	\$ 8,000	
	Progress control surveys	1	1	LS	\$ 10,000	\$ 10,000	
	Final "as-built" survey	1	1	LS	\$ 10,000	\$ 10,000	
4	Soil Erosion & Sediment Controls						\$ 36,200
	Tracking pads, installed cost	2	2	each	\$ 3,000	\$ 6,000	
	Decon pad	2	2	each	\$ 3,000	\$ 6,000	
	Silt fence	1,398	1,400	LF	\$ 3.00	\$ 4,200	
	Installation, assumes 1 week	1	1	wk	\$ 20,000	\$ 20,000	
5	Replace Leachate Collection Manhole						\$ 84,000
	Excavate around the existing leachate collection manhole	1	1	LS	\$ 20,000	\$ 20,000	
	Waste classification sampling ¹	0.01	1	smpl	\$ 2,000	\$ 2,000	
	Transportation & Disposal of concrete manhole materials - assume non-hazardous	10	10	ton	\$ 100	\$ 1,000	
	Dewater excavation						
	Pumping equipment (pumps and hoses)	1	1	LS	\$ 500	\$ 500	
	Drop-off/pickup of 21,000 gallon frac tank	1	1	each	\$ 1,200	\$ 1,200	
	Rental of 21,000 gallon frac tank (for temp. constr. water storage)	1	1	month	\$ 1,200	\$ 1,200	
	Leachate T&D (assumes 2 frac tanks, non haz. liquids, incl. waste characterization) ²	42,000	42,000	gal	\$ -	\$ -	
	New manhole materials	1	1	LS	\$ 10,000	\$ 10,000	
	Installation of new manhole	1	1	LS	\$ 22,000	\$ 22,000	
	Assumes excavation into bedrock					\$ -	
	Assumes 12-14 feet deep, 5-foot inside diameter					\$ -	
	Procure and install simplex pump system	1	1	LS	\$ 26,000	\$ 26,000	
	Incl. rail-mounted pump, control panel, visual alarm, flow meter, conveyence line, meter pit						
6	Repair Treated Effluent Lagoon A						\$ 123,000
	Dewatering (assume lagoon is half-full, sent to BMMA directly)	63,061	63,100	gal	\$ 0.02	\$ 1,261	
	Removal of sludge	35	40	cyd	\$ 20	\$ 800	
	Waste classification sampling ¹	0.1	1	smpl	\$ 2,000	\$ 2,000	
	Transportation & Disposal of sludge - assume non-hazardous (includes. adder for dewater.)	51.77	60	ton	\$ 100	\$ 6,000	
	Removal, transportation & disposal of primary and secondary liners (assume non-hazardous)	12,425	12,430	SF	\$ 2	\$ 24,860	
	Removal of 1-ft drainage layer between primary and secondary liners	189	200	cyd	\$ 20	\$ 4,000	
	Off-site disposal of 1-ft drainage layer between primary and secondary liners	284	300	ton	\$ 100	\$ 30,000	
	Regrading subbase in preparation for liner placement (assume regrading top foot)	230	300	cyd	\$ 20	\$ 6,000	
	Secondary liner procurement and installation	6,212	6,300	SF	\$ 2.00	\$ 12,600	
	Purchase of new drainage layer material for placement between primary and secondary liners	284	300	ton	\$ 20	\$ 6,000	
	Placement/compaction of new drainage layer material	189	200	cyd	\$ 20.00	\$ 4,000	
	Furnish and install of geocomposite layer between primary and secondary liner	5,105	5,200	SF	\$ 1.00	\$ 5,200	
	Primary liner procurement and installation	6,212	6,300	SF	\$ 2.00	\$ 12,600	
	Witness manhole, cover, and piping	1	1	LS	\$ 8,000	\$ 8,000	
7	Repair Treated Effluent Lagoon B						\$ 145,000
	Dewatering (assume lagoon is half-full, sent to BMMA directly)	68,684	68,700	gal	\$ 0.02	\$ 1,374	
	Removal of sludge	38	40	cyd	\$ 20	\$ 800	
	Waste classification sampling ¹	0.1	1	smpl	\$ 2,000	\$ 2,000	
	Transportation & Disposal of sludge - assume non-hazardous (includes. adder for dewater.)	56.90	60	ton	\$ 100	\$ 6,000	
	Removal, transportation & disposal of primary and secondary liners (assume non-hazardous)	13,657	13,660	SF	\$ 2	\$ 27,320	
	Removal of 1-ft drainage layer between primary and secondary liners	214	300	cyd	\$ 20	\$ 6,000	
	Off-site disposal of 1-ft drainage layer between primary and secondary liners	321	400	ton	\$ 100	\$ 40,000	
	Regrading subbase in preparation for liner placement (assume regrading top foot)	253	300	cyd	\$ 20	\$ 6,000	
	Secondary liner procurement and installation	6,828	6,900	SF	\$ 2.00	\$ 13,800	
	Purchase of new drainage layer material for placement between primary and secondary liners	321	400	ton	\$ 20	\$ 8,000	
	Placement/compaction of new drainage layer material	214	300	cyd	\$ 20.00	\$ 6,000	
	Furnish and install of geocomposite layer between primary and secondary liner	5,786	5,800	SF	\$ 1.00	\$ 5,800	
	Primary liner procurement and installation	6,828	6,900	SF	\$ 2.00	\$ 13,800	
	Witness manhole, cover, and piping	1	1	LS	\$ 8,000	\$ 8,000	

Estimate 2

Preliminary Cost Estimate: Repairs to Leachate Collection and Storage

Boyetown Sanitary Landfill

DESCRIPTION: Scope of work consists of the repairs to the leachate storage lagoons (pre- and post- treatment). Repairs include excavation to expose lagoon liners, removal of torn and degraded liners, regrading of subbase materials, and replacement of liners. The scope of work also includes replacement of the central leachate collection manhole.

Item No.	Item	Quantity	Quantity Rounded	Unit	Unit Cost (\$)	Extended/ Rounded Cost (\$)	Total Cost (\$)
8	Repair Raw Leachate Storage Lagoon						\$ 455,000
	Dewatering (assume lagoon is half filled, sent to BMMA directly)	331,881	331,900	gal	\$ 0.02	\$ 6,638	
	Removal of sludge	137	140	cyd	\$ 20	\$ 2,800	
	Waste classification sampling ¹	0.3	1	smpl	\$ 2,000	\$ 2,000	
	Transportation & Disposal of sludge - assume non-hazardous (includes. adder for dewater.)	205.52	210	ton	\$ 100	\$ 21,000	
	Removal, transportation & disposal of primary and secondary liners (assume non-hazardous)	49,324	49,330	SF	\$ 2	\$ 98,660	
	Removal of 1-ft drainage layer between primary and secondary liners	791	800	cyd	\$ 20	\$ 16,000	
	Off-site disposal of 1-ft drainage layer between primary and secondary liners	1,187	1,200	ton	\$ 100	\$ 120,000	
	Regrading subbase in preparation for liner placement (assume regrading top foot)	913	1,000	cyd	\$ 20	\$ 20,000	
	Secondary liner procurement and installation	24,662	24,700	SF	\$ 2.00	\$ 49,400	
	Purchase of new drainage layer material for placement between primary and secondary liners	1,187	1,200	ton	\$ 20	\$ 24,000	
	Placement/compaction of new drainage layer material	791	800	cyd	\$ 20.00	\$ 16,000	
	Furnish and install of geocomposite layer between primary and secondary liner	21,364	21,400	SF	\$ 1.00	\$ 21,400	
	Primary liner procurement and installation	24,662	24,700	SF	\$ 2.00	\$ 49,400	
	Witness manhole, cover, and piping	1	1	LS	\$ 8,000	\$ 8,000	
9	Construction Water Management						\$ 18,490
	Pumping equipment (high capacity trash pumps)	1	1	LS	\$ 5,000	\$ 5,000	
	Drop-off/pickup of 21,000 gallon baker tank	1	1	each	\$ 1,200	\$ 1,200	
	Rental of 21,000 gallon baker tank (for temp. constr. water storage)	4	4	month	\$ 2,400	\$ 9,600	
	Construction water T&D assumed rainfall/month (in): 4 Assumes non haz. liquids, can be sent to BMMA, incl. waste characterization	6,720	6,700	gal	\$ 0.40	\$ 2,688	
10	Restoration						\$ 6,530
	Seeding/mulching disturbed soil areas	21,780	21,780	SF	\$ 0.3	\$ 6,534	
11	Demobilization	1	1	LS	\$ 25,000	\$ 25,000	\$ 25,000
Construction Cost Subtotal:							\$ 956,220
Contingency (20%)							\$ 191,244
Total Construction Cost:							\$ 1,148,000
DESIGN/PERMITTING/BIDDING/ENG. OVERSIGHT							
	Estimated construction duration:	4 month					
	PDI (e.g., geotech borings/testing)	0	0	LS	\$ -	\$ -	
	Design	1	1	LS	\$ 40,000	\$ 40,000	
	Bid/Contract Documents	1	1	LS	\$ 30,000	\$ 30,000	
	PADEP Approvals/Submittals	1	1	LS	\$ 25,000	\$ 25,000	
	Env. Permits (soil erosion and sediment control)	1	1	LS	\$ 10,000	\$ 10,000	
	Contract bidding	1	1	LS	\$ 20,000	\$ 20,000	
	Engineering oversight						
	- Construction inspection/oversight (1 inspector)	4	month	month	\$ 25,000	\$ 100,000	
	- Office eng./contract admin.	4	month	month	\$ 5,000	\$ 20,000	
	Engineering Certification Report/As-Built	1	1	LS	\$ 30,000	\$ 30,000	
Total Design/Permitting/Bidding/Eng. Oversight:							\$ 280,000
Program Cost Total:							\$ 1,428,000

Notes:

1. Costs assume collection and analysis (e.g., VOCs, SVOCs, metals, RCRA parameters) of 1 composite sample for every 500 cyd of materials.

2. Costs assume that any groundwater/leachate generated during manhole replacement can be discharged to the on-site equalization raw leachate storage basin, and therefore, no off-site T&D costs are included.

Estimate 3								
Preliminary Cost Estimate: <u>Leachate Treatment System Rehabilitation/Restoration</u>								
Boyetown Sanitary Landfill								
DESCRIPTION: Scope of work consists of rehabilitation/restoration of the leachate pre-treatment system.								
Item No.	Item	Quantity	Quantity Rounded	Unit	Unit Cost (\$)	Extended/ Rounded Cost (\$)	Total Cost (\$)	
CONSTRUCTION								
1	Mobilization	1	1	LS	\$ 20,000	\$ 20,000	\$	20,000
	Temporary Facilities (inc. sanitary,staging areas, storage facilities)	1	1	LS	\$ 10,000	\$ 10,000	\$	10,000
2	General Dimensions							
	Clarifier/Fixed Film Reactor							
	- Inside Surface Area	1,301	1,300	SF				
	- Avg. total depth (of each tank)	9.0	9	ft				
	- Avg. depth until "rectangular" section (rectangular portion above pyramid section)	6.0	6	ft				
	- Avg. depth of "pyramid" section (where sides begin to slant inwards)	3.0	3	ft				
	- Width (of each tank)	20.0	20	ft				
	- Total volume (of each tank)	105	110	cyd				
	- Total volume of "rectangular" section (rectangular portion above pyramid section)	89	90	cyd				
	- Total volume of "pyramid" section (where sides begin to slant inwards)	16	20	cyd				
3	Clarifier/Fixed Film Reactor						\$	220,000
	Vac truck to remove and store sludge materials (assume pyramid section is filled in both tanks)	2	2	day	\$ 4,500	\$ 9,000		
	Waste classification sampling(assume one per tank)	2	2	smpl	\$ 2,000	\$ 4,000		
	Transportation & Disposal of sludge/fixed film - assume non-hazardous	1	1	LS	\$ 20,000	\$ 20,000		
	Clean/wash concrete tank (both clarifier and fixed film reactor)	1	1	LS	\$ 29,000	\$ 29,000		
	Furnish and install baffles (clarifier)	1	1	LS	\$ 18,000	\$ 18,000		
	Furnish and install aeration piping (fixed film reactor)	1	1	LS	\$ 25,000	\$ 25,000		
	Furnish and install fixed film media (i.e., screen/grating)	1	1	LS	\$ 30,000	\$ 30,000		
	Tank re-lining (both clarifier and fixed film reactor)	1	1	LS	\$ 85,000	\$ 85,000		
4	Caustic Mix Tank and Feed						\$	15,000
	Furnish and install new tanks including metering pump and feed line, and flash mix tanks	1	1	LS	\$ 15,000	\$ 15,000		
5	Stripping Tower						(a) \$	40,000
							(b) \$	190,000
(a)	Maint./rehab of existing stripper system (blowers testing/balancing, stripper tower cleaning)	1	1	LS	\$ 40,000	\$ 40,000		
(b)	Replace existing stripping tower with new stripper system (if needed) ⁸	1	1	LS	\$ 190,000	\$ 190,000		
6	Neutralization Chamber and Feed						\$	15,000
	Furnish and install new tanks including metering pump and feed line, and flash mix tanks	1	1	LS	\$ 15,000	\$ 15,000		
7	Carbon Adsorbers						\$	49,000
	Furnish carbon units (assume 1,000 lb cans)	3	3	each	\$ 8,500	\$ 25,500		
	Furnish carbon (assume 1,000 lb per unit)	3	3	each	\$ 2,500	\$ 7,500		
	Misc. materials (e.g., pipe fittings)	1	1	LS	\$ 8,000	\$ 8,000		
	Install carbon units	1	1	LS	\$ 8,000	\$ 8,000		
8	Treatment System Piping						\$	30,000
	Cleaning of above-grade piping (assumes no cleaning required for below-grade piping)	1	1	LS	\$ 15,000	\$ 15,000		
	Replacement of pipes (i.e., inside building, no excavation required)	1	1	LS	\$ 15,000	\$ 15,000		
	Replacement of pumps (assumes no replacement required)	0	0	LS	\$ -	\$ -		
9	Disposal of Existing Equipment						\$	25,000
	Remove and dispose of existing equipment	1	1	LS	\$ 25,000	\$ 25,000		
10	System Start-Up and Testing						\$	75,000
	System start-up and testing, including basic equipment operations checks, system fill-up, effluent testing, and field oversight	1	1	LS	\$ 75,000	\$ 75,000		
11	Demobilization	1	1	LS	\$ 25,000	\$ 25,000	\$	25,000
						Construction Cost Subtotal (a):	\$	524,000
						Construction Cost Subtotal (b):	\$	674,000
						Contingency (20%) (a)	\$	104,800
						Contingency (20%) (b)	\$	134,800
						Total Construction Cost (a):	\$	629,000
						Total Construction Cost (b):	\$	809,000
DESIGN/PERMITTING/BIDDING/ENG. OVERSIGHT								
	Estimated construction duration:	4 month						
	Bench scale/laboratory treatability testing	1	1	LS	\$ 90,000	\$ 90,000		
	Design	1	1	LS	\$ 130,000	\$ 130,000		
	Bid/Contract Documents	1	1	LS	\$ 40,000	\$ 40,000		
	PADEP Approvals/Submittals	1	1	LS	\$ 60,000	\$ 60,000		
	BMMA Permit Negotiations	1	1	LS	\$ 40,000	\$ 40,000		
	Env. permits (e.g., air emissions) ³	0	0	LS	\$ -	\$ -		
	Contract bidding	1	1	LS	\$ 30,000	\$ 30,000		
	Engineering oversight							
	- Construction inspection/oversight (1 inspector)	4	month	month	\$ 25,000	\$ 100,000		
	- Office eng./contract admin.	4	month	month	\$ 5,000	\$ 20,000		
	Engineering Certification Report/As-Builts	1	1	LS	\$ 40,000	\$ 40,000		
						Total Design/Permitting/Bidding/Eng. Oversight:	\$	550,000
						Program Cost Total (a):	\$	1,179,000
						Program Cost Total (b):	\$	1,359,000
Notes:								
1. All costs assume that new/modified equipment will fit within existing structures. No new structures/buildings are included								
2. Costs are not included for rehab/repairs/restoration of buried piping.								
3. Costs assume no air emissions permits are required.								
4. Costs assume existing power supply to treatment building is sufficient for all new/modified equipment.								
5. Costs assume no new centralized instrumentation, controls, and monitoring alarm/remote notification systems								
6. Costs assumes that modification of current BMMA discharge permit criteria would be negotiated for selected parameters (e.g., ammonia, color, TDS) - refer to report for details								
7. System costs assume that liquid phase carbon will be suitable for treatment of all organic constituents in leachate. Further treatability testing/evaluation will be required as part of detailed design								
8. Optional costs for replacement of air stripper if needed to address ammonia.								

Estimate 4 Preliminary Cost Estimate: <u>Upgrade Gas Collection and Treatment</u>								
DESCRIPTION: Scope of work consists of cleaning the existing landfill gas collection piping and installing candlestick flares on selected landfill gas vents.								
Item No.	Item	Quantity	Quantity Rounded	Unit	Unit Cost (\$)	Extended/ Rounded Cost (\$)	Total Cost (\$)	
	CONSTRUCTION							
1	Mobilization	1	1	LS	\$ 10,000	\$ 10,000	\$	10,000
	Temporary Facilities (inc. sanitary, staging areas, storage facilities)	1	1	LS	\$ 5,000	\$ 5,000	\$	5,000
2	Site surveys/control (by licensed surveyor)						\$	5,000
	Initial control survey	1	1	LS	\$ 2,500	\$ 2,500		
	Final "as-built" survey	1	1	LS	\$ 2,500	\$ 2,500		
3	Repair Landfill Gas Vents						\$	80,000
	Cleaning of collection/vent piping							
	Water delivery (20,000 gal and tank)	3	3	LS	\$ 2,000	\$ 6,000		
	Line jetting service	1	1	LS	\$ 17,100	\$ 17,100		
	Vac truck to clean manhole (incl. disposal)	1	1	day	\$ 4,500	\$ 4,500		
	Frac tank for materials removed from manhole	1	1	each	\$ 2,400	\$ 2,400		
	Repair piping at surface and installation of protective measures	20	20	each	\$ 2,500	\$ 50,000		
4	Install Candlestick Flares						\$	95,000
	Candlestick flares	10	10	each	\$ 5,500	\$ 55,000		
	Guy wire kits	10	10	each	\$ 300	\$ 3,000		
	Bollards or other protection	10	10	each	\$ 600	\$ 6,000		
	Miscellaneous equipment	1	1	LS	\$ 1,000	\$ 1,000		
	Install candlestick flares	10	10	each	\$ 3,000	\$ 30,000		
5	Demobilization	1	1	LS	\$ 10,000	\$ 10,000	\$	10,000
						Construction Cost Subtotal:	\$	205,000
						Contingency (20%)	\$	41,000
						Total Construction Cost:	\$	246,000
	DESIGN/PERMITTING/BIDDING/ENG. OVERSIGHT							
	Estimated construction duration:	1 month						
	PDI (e.g., geotech borings/testing)	0	0	LS	\$ -	\$ -		
	Design	1	1	LS	\$ 20,000	\$ 20,000		
	Bid/Contract Documents	1	1	LS	\$ 20,000	\$ 20,000		
	PADEP Approvals/Submittals	1	1	LS	\$ 15,000	\$ 15,000		
	Env. Permits (soil erosion and sediment control)	1	1	LS	\$ -	\$ -		
	Contract bidding	1	1	LS	\$ 20,000	\$ 20,000		
	Engineering oversight							
	- Construction inspection/oversight (1 inspector)	1	month	month	\$ 25,000	\$ 25,000		
	- Office eng./contract admin.	1	month	month	\$ 5,000	\$ 5,000		
	Engineering Certification Report/As-Builts	1	1	LS	\$ 20,000	\$ 20,000		
						Total Design/Permitting/Bidding/Eng. Oversight:	\$	130,000
						Program Cost Total:	\$	376,000
Notes:								