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Attachment 1

THE POTTSTOWN LANDFILL: INDEPENDENT ENVIRONMENTAL REVIEW OF CRITICAL ISSUES

Detailed Discussion and Documentation

Henry S. Cole, Ph.D.

May 2005

1.0 INTRODUCTION

1.1 Purpose. The purpose of this report is to present in outline form a summary of findings and recommendations resulting from an independent assessment of the Pottstown Landfill existing and potential releases to the environment. The principal objective is to inform the Pottstown Landfill Closure Committee on key issues that should be considered in developing the final closure plan and implementation of postclosure activities. This report is aimed at helping the Closure Committee identify and address the most important issues affecting the long-term health and safety of the community once the landfill is closed and to form its own recommendations to the Pennsylvania Department of Environmental Protection (DEP).

The report identifies a number of concerns, some dealing with present conditions and some dealing with the indefinitely long post-closure period in which the wastes in the landfill remain a threat to public health and the environment. In some cases we make specific recommendations to increase the level of protection. In other cases, we recommend additional information. Where potential problems exist, it is essential to determine their causes, to ensure that adequate surveillance and protections will be in place for many decades to come. A number of our recommendations would require measures that go beyond those contained in current closure and post-closure plans. Our principal focus is protection of public health and the environment over the many generations that the wastes in the landfill will be a threat.

1.2 Information Sources and Acknowledgements. We greatly appreciate the opportunity provided us by the members of the Pottstown Closure Committee. Funding for the project was generously provided by Montgomery and Berks Counties.

The peer review team spent approximately four days examining documents from the Pottstown Landfill docket in the PA DEP's SE Regional Office. In addition, Drs. Cole and Lee participated in several meetings with a number of DEP officials and staff including Director Joe Feola, Director of Waste Management Programs, Ron Furlan, Director of Air Programs, Francine Carlini, Sachan Shankar and Jillian Gallagher (Air Programs), James Wentzel, Jennifer Wilson (Geologist), and others. These DEP officials/staff were also helpful in providing additional information that we requested by phone and email. The increasing level of dialogue during the course of the project was especially helpful. We also acknowledge the help of John Kennedy who coordinated and facilitated DEP's response to our requests. We also thank the staff of the SE Regional Office records department for their valuable work on behalf of this project. In addition:

- The peer review team participated in a number of Pottstown Closure Meetings and gained valuable insights from Committee members, DEP staff, Tim Kyper of GAI, Waste Management officials and public participants.

- Tim Kyper of GAI was extremely helpful in providing us with documents from Waste Management files.

- We also thank Commissioner Mark Scott, Michelle Kircher, Commissioner Julie Gallisdorfer and ACE leader Donna Cuthbert for providing valuable information and insights.

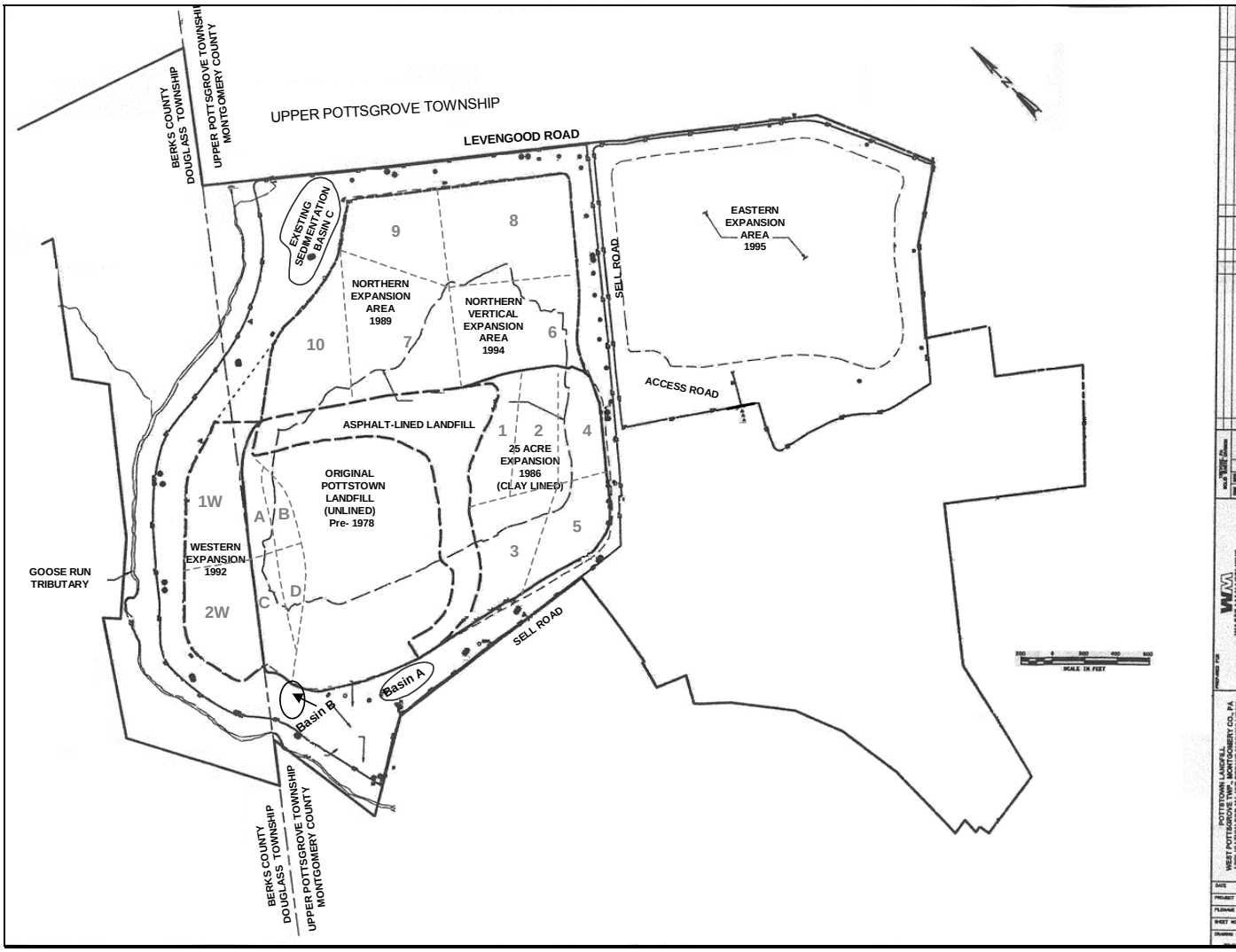
We appreciate the time, effort and knowledge from all of these people and others who we know have extremely busy schedules.

Specific sources of information are identified in footnotes.

2.0 Pottstown Landfill. A brief description of the location and history of the Pottstown Landfill is contained in the GAI report.[1] Figure 1 provides a map showing the location and principal features of the Pottstown Landfill including various parts of the closed Western Landfill and the active Eastern Expansion. The operating permit for the Eastern Expansion expires on October 2, 2005. This marks the date of closure. The landfill may not accept additional waste beyond this date. The Pennsylvania Department of Environmental Protection (DEP) has denied Waste Management's (WM) application for a vertical expansion over the current cells in the Eastern Expansion. Unless this decision is overturned, the Eastern Expansion and the landfill as a whole will stop taking waste.

The landfill currently takes both municipal and industrial waste that meets certain requirements. These wastes are likely to contain some constituents which are hazardous, (a threat to public health), even though the wastes do not meet the RCRA definition of hazardous wastes. Moreover, municipal wastes (exempt from hazardous waste regulations) often contain materials with hazardous constituents such as used solvents, paints, pesticides, household cleaners, used motor oil and radioactive materials. From the late 1940's until 1978, wastes with little control of content were dumped into the unlined portion of the Western Landfill (see Figure 1). Constituents of landfill waste that will remain hazardous for indefinitely long periods of time include metals, solvents, and pesticides. In addition, it is likely that methane will be generated for many decades following closure. The principal objective of closure is to ensure that such hazardous and deleterious materials are contained.

[1] GAI, Draft Report, p. 3


UPPER POTTSGROVE TOWNSHIP
LEVENGOOD ROAD
BERKS COUNTY
DOUGLASS TOWNSHIP
UPPER POTTSGROVE TOWNSHIP
MONTGOMERY COUNTY
EXISTING SEDIMENTATION BASIN C
NORTHERN EXPANSION AREA 1989
NORTHERN VERTICAL EXPANSION AREA 1994
EASTERN EXPANSION AREA 1995
SELL ROAD
ACCESS ROAD
ASPHALT-LINED LANDFILL
25 ACRE EXPANSION 1986 (CLAY LINED)
ORIGINAL POTTSTOWN LANDFILL (UNLINED) Pre- 1978
WESTERN EXPANSION 1992
GOOSE RUN TRIBUTARY
Basin A
Basin B
1W
2W
A
B
C
D
1
2
3
4
5
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2.1 Western Landfill (WL). The WL consists of about 150 acres of closed disposal areas. According to GAI, the site was used as a dump as early as 1932. Subsequent owners included The Rinehart family (1948-1972) and SCA (1972-1984). SCA became a subsidiary of Waste Management in 1984. The following expansions were installed by Waste Management:[2]

- The Northern Expansion (permit issued in April 1988)
- The Western Expansion (permit issued June 1992)
- The Vertical Expansion in the Northern Expansion area (July 1994)

Liner and cover conditions in the Western Landfill vary from cell to cell especially for older portions of the landfill. For example:

- Approximately 40 acres of the WL are unlined (pre-1978).
- A 15-acre asphalt and clay liner was constructed by SCA from 1972-1984[3]
- Waste Management began using an HDPE double-liner system below the waste cells and compacted clay cap for cover in 1985. In 1989 the company began using an HDPE geosynthetic-lined cap system for closures. [4]

The map in Figure 1 shows these areas.

The Western Landfill includes a leachate collection system and a groundwater extraction system to contain and treat contaminated groundwater. Western Landfill sections also utilize an active gas collection systems consisting of gas extraction wells, a collector system, several flares and turbines. Western and eastern expansion gas collection systems are now interconnected.

We have found it extremely difficult to find cohesive information in DEP files on the specific conditions existing in the different closed cells. We asked Ron Furlan of PA DEP to outline the conditions of closed cells in various parts of the WL. His description follows:

> **Portions closed prior to 1980**. "Portions of the landfill that were closed pre-SWMA (Solid Waste Management Act / pre-1980) only have to meet whatever standards were in effect at the time they ceased receiving waste. For the most part, those standards were soil covers and maybe gas venting and monitoring. A leaky clay cap of those portions still satisfies those requirements. We can not require more unless we can show that either the gas venting from the old, pre-SWMA area is causing a public nuisance or that the gas and/or leachate continuing to be generated is causing a problem for the landfill's treatment/collection systems serving post-SWMA areas (which for the most part cover the pre-act potions)." [5]
>
> **"Portions closed between 1980 and 1988**, if believed to be causing a problem, can be required to submit a closure plan pursuant to 271.113. Such a plan would have to be consistent with current final cover requirements (i.e., minimize surface water infiltration)."

[2] PA DEP, Consent Order & Agreement, Waste Management Disposal Services of PA, Inc. October 8, 1996.
[3] GAI, Draft Report, p. 3.
[4] GAI, Draft Report, p. 3
[5] Furlan, earlier memo / complete reference.

> **Post-1988** areas have to meet the current requirements for closure and post-closure care contained in Chapter 273.

According to Furlan, Chapter 75 (regulations in place before 1988) covered the requirements from 1971 to 1988. This required 2-foot soil cap with vegetation, gas venting, surface water diversion facilities, limited groundwater monitoring and leachate collection (if a manmade liner was provided). In response to our request for information on the condition of liners and covers in different parts of the Western Landfill, DEP provided the following response:

> "The condition of liners and covers would have to be determined from a performance evaluation based on data from the groundwater monitoring system and leachate flow, witness zone flow and gas flow data."[6]

The information above suggests that although all of the Western Landfill units have been closed, a number of older units have cover layers that are sufficiently permeable to allow storm water to enter the cells and produce large quantities of leachate. According to Waste Management, 65 percent of the leachate generated by the entire site originates in the Western Landfill.[7] This penetration of moisture into wastes also facilitates the continued generation of methane. (The issue of leachate generation is discussed in Section 3.)

Western Landfill Corrective Measures. In response to our inquiry on corrective measures, in December 2002, Furlan responded:

> "As stated in response to an earlier comment, we have identified ongoing leachate generation in the closed areas as a potential problem and requested WMDS to evaluate the problem."[8]

More recently, the February 7, 2005 permit on leachate storage, DEP approved certain remedial actions involving the lining of storm water channels in problematic cells. Along similar lines, Waste Management told the Closure Committee that certain remedial work is underway in the Western Landfill (e.g. repairs to storm water channels, etc.).[9] Given the large quantity of leachate generated in the Western Landfill, we have not seen documentation that convinces us that the focus on storm channels alone will bring about a substantial reduction in the infiltration of surface runoff and leachate formation. *We would therefore recommend further investigation and an upgrade of the cover layer, especially in sections that generate large quantities of leachate, contaminate leachate, and/ort have no bottom liners or have ineffective liners.*

2.2 The Eastern Expansion (EE). The Eastern Expansion was permitted in October 1995 operative in 1998. The EE consists of about 50 acres of active disposal.[10] According to GAI, the structure and construction certificates for the Eastern Expansion comply with current DEP regulations. Figure 2 shows the key features of this "modern era" landfill including the liner system and leachate control system. (The landfill gas control system is discussed in Section 5.0). As stated previously, October 2, 2005 marks the date of closure for the Eastern Expansion. We note that in May 2005, the state's Environmental Hearing Board rejected Waste Management's

[6] Furlan, email response, March 7, 2005.
[7] John Wardzinski, Waste Management, Closure Committee Meeting of February 23, 2005.
[8] Ron Furlan, SE Regional Office, PA DER, email response to questions, December 6, 2004.
[9] John Wardzinski, Waste Management, Closure Committee Meeting, February 23, 2005.
[10] GAI Report, p. 3

appeal of DEP's decision to deny the Eastern Expansion vertical expansion. Thus, the company is required to install permanent cover by October 2006.

2.2.1 EE: The "Open Face" Problem. Once a cell is filled, the best management practice is to install a permanent cover; this practice greatly reduces the infiltration of water and the release of odors and air emissions through the top of the landfill. Regulations require that this practice be followed once the waste in the cell reaches the elevation limit in the landfill's permit. Interviews with DEP officials indicate that Waste Management has delayed installing permanent cover over filled cells. The company has remained in compliance by keeping the waste volume just below the permitted capacity.

One DEP official expressed the view that Waste Management followed this practice to save the cost of installing and later removing permanent cover to construct the vertical expansion.[11] This leaves large clusters of cells with limited low-permeability cover (e.g. soil cover).

Ron Furlan (Director of Waste Management Program for DEP) stated that there are about 44 acres in an open state in the Eastern Expansion area.[12] John Wardzinski of Waste Management confirmed at the February 23, 2005, Closure Committee meeting that about 40 acres of cells in the EE remain open with 6-8 feet of remaining capacity. He added, however, that permanent cover has now been completed on the flanks of the EE. (This construction was visible on the bus tour of the landfill on October 20, 2004.)

According to Mr. Furlan, DEP has not required Waste Management to undertake additional capping in the Eastern Expansion until the site is permanently closed.

The largely open face of EE may have contributed to several problems. The lack of a cover allows infiltration of precipitation and promotes leachate generation. Thus the open face condition on more than 40 acres may be contributing to the larger than anticipated volume of leachate that has resulted in DEP actions requiring Waste Management to increase leachate storage capacity. However, both Waste Management and Furlan[13] have stated that an estimated 65 percent of the leachate is generated in the Western Landfill. (See Section 3.0 on leachate.) Moreover, the open face condition may also contribute to the odor problem detailed in Section 6.0. DEP raised the connection between "open areas," storm water infiltration, odors and gas control in its Technical Deficiency Letter of January 30, 2004.[14]

2.2.2 Eastern Expansion Closure. Conditions that now exist in the Eastern Expansion will change significantly with closing and the construction of an impermeable cover. WM will have one year to install the cap after closure, provided that the landfill closes. If the vertical expansion remains viable, portions of the Eastern Expansion may remain open for a longer period.

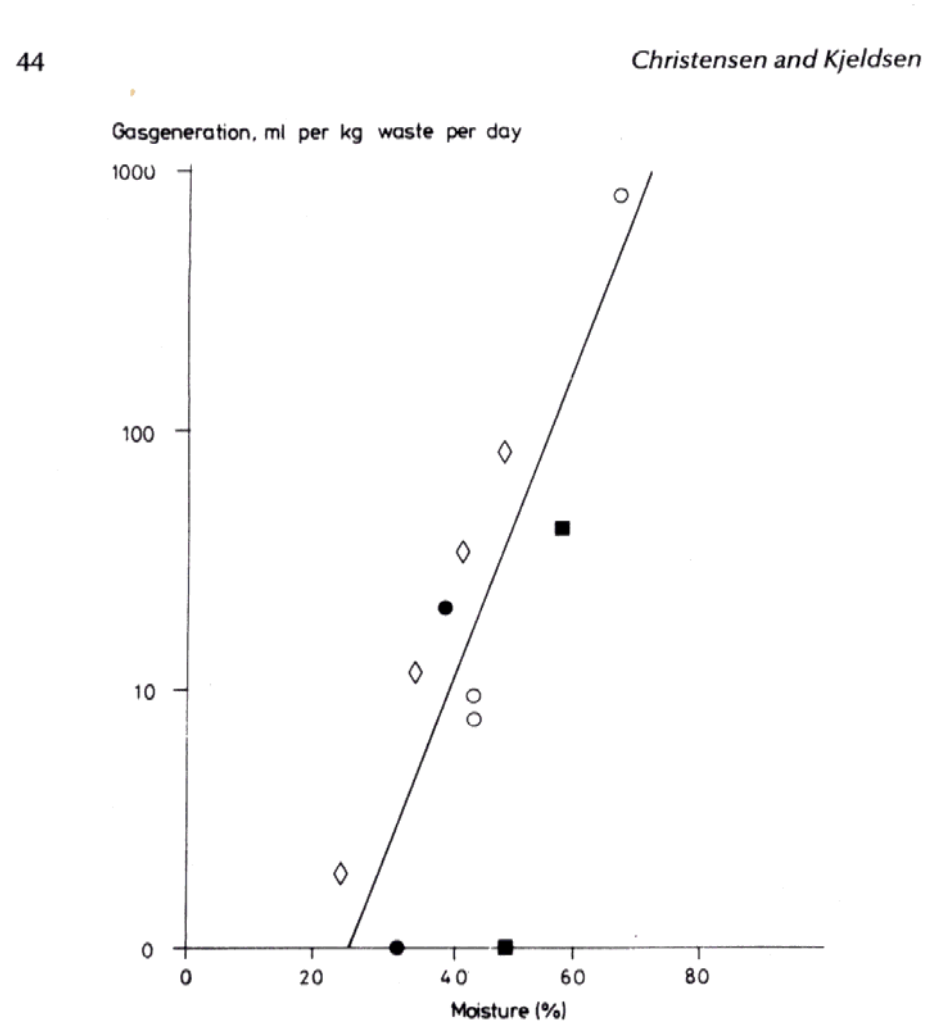
Construction of an impermeable cover in compliance with current regulations should significantly reduce the infiltration of precipitation into the Eastern Expansion. The regulations/plans for closure and post-closure are aimed at significantly reducing the amount of moisture that can enter the waste and reducing the generation of leachate and methane. It is well established that methane gas generation declines as moisture content declines and ceases

[11] The presence of an impermeable cover over the original cell would promote pooling of water in the vertically expanded cell. (Sachan Shankar, PA DEP, December 17, 2004).

[12] Ron Furlan, personal communication, December 17, 2004.
[13] Ron Furlan, personal communication, December 17, 2004
[14] James Wentzel, PA DEP, Technical Deficiency Letter to G. Von Stetina, Waste Management, January 30, 2004

completely below a level of about 20 percent (see Figure 2)[15].

Figure 2. Impact of Moisture on Landfill Gas Formation
(from Christensen and Kjeldsen, 1989)



. Gas generation rates as a function of moisture content. After Rees (1980a).

Problems with this "Dry Tomb" approach are discussed in Section 8 and detailed in Attachment 2 by Lee and Lee-Jones.

3.0 Infiltration and leachate collection. Both eastern and Western Landfills employ leachate collection systems. The leachate collected is treated in the landfill's wastewater pre-treatment

[15] Christensen, T.H. and Kjeldsen, P., "Basic Biochemical Processes in Landfills," Sanitary Landfilling: Process, Technology and Environmental Impact, Academic Press, San Diego, CA, pp. 29-49 (1989). See also Attachment 2.

system and then discharged to the Pottstown wastewater treatment plant. However, during certain periods (e.g. heavy rainfall), the quantity of leachate exceeds the capacity of the pre-treatment plant. Excess leachate during these periods is diverted to a storage tank.

In December 2004, PA DEP determined that leachate volumes are significantly greater than those projected by Waste Management. DEP ordered WM to install additional leachate storage tanks.[16] GAI has summarized DEP's position as follows: "…The Pottstown Landfill never installed the permitted 500,000 gal temporary storage tank and the Pottstown Landfill's permitted maximum required leachate storage is possibly underestimated by 3 million gallons."[17]

PA DEP requires that storage capacity be sufficient to hold water if the pre-treatment plant is not working for a 30-day period. The Department estimated that 30-day storage deficit, lacking successful remediation is about 2.5 million gallons.[18]

As a result, DEP issued a permit amendment on Feb. 7, 2005, requiring WM to (a) install a 500,000 gallon permanent storage tank (operational by Nov. 1, 2005), (b) assess the potential need for additional storage capacity from 500 K to 2.5 M gallons and (c) submit an assessment of the efficacy of surface water remediation activities by November 1, 2005.

At the February 23, 2005 Closure Committee Meeting, Waste Management stated that the current system is sufficient to collect and treat 100 percent of the leachate under all conditions.[19]

See also recommendations on closure and post-closure in Section 9.

4.0 Groundwater monitoring and release potential

4.1 Post-1984 portions of the landfill. The landfill liner system that has been constructed since Waste Management assumed ownership of the landfill in 1984 appears to be functioning to prevent detectable releases of analyzed waste-derived chemicals to the underlying groundwater system. There is greater confidence in the conclusion regarding the lack of evidence of groundwater pollution by the post-1984 landfill because there are multiple lines of evidence, including composition of the groundwater as assessed by the groundwater monitoring wells and the volume of water (fluid) in the leak detection zone underlying the composite liner for each of the landfill cells constructed since 1984. Also, there have been no reported *detected* releases of analyzed waste chemicals or analyzed transformation products to surface waters in stormwater runoff from the landfill.[20]

[16] Letter from James Wentzel, P.E., to Gary Von Stetina, Waste Management Disposal Services, Dec. 20, 2004.

[17] GAI, p. 5.

[18] Letter from James Wentzel, P.E., to Gary Von Stetina, Waste Management Disposal Services, Dec. 20, 2004, p.2.

[19] According to Wardzinski (Feb. 23, 2005), the average leachate capture per day is about 80 K gallons/day (max 120K) and limit of plant is 200 k gallons per day.

[20] Lee, G.F. and Jones-Lee, A., "Review of GAI Draft Report Devoted to Audit of Pottstown Landfill Current Releases of Waste-Derived Chemicals to Water and Recommendations for Evaluation of Closure Plan," Presented to Pottstown Landfill Closure Committee, Draft Report of G. Fred Lee & Assoc., El Macero, CA, February 2005.

However, reliable groundwater monitoring at and near the Pottstown Landfill is difficult to accomplish because of the fractured rock aquifer system underlying the Landfill. The conclusion regarding lack of detected releases of waste-derived chemicals in stormwater runoff is more tenuous because of the less-comprehensive monitoring of stormwater runoff and its impacts. Releases of waste-derived chemicals could have occurred without being detected by the existing stormwater runoff monitoring system.

4.2 Older portions of the Western Landfill. The old, unlined and asphalt-lined Pottstown Landfill that was active prior to the 1980s has contaminated groundwater to the south and southwest of the landfill. It is likely that few controls existed with regard to the kinds of waste being dumped into unlined and poorly lined areas of the landfill during this period.

It is probable that these older portions of the Western Landfill are still releasing waste-derived chemicals to groundwater below the waste cells. Continued contamination cannot be ruled out since (a) cover in some areas of the Western Landfill appears to be permeable and allowing water to infiltrate and form leachate (See Section 3.0) and (b) some older cells are unlined. Where bottom liners are absent or ineffective, contaminated leachate is likely to seep into the groundwater. However, as discussed below a groundwater pump and treat system was installed during the 1990's to address this problem.

4.2.1 Groundwater remediation. Following a series of groundwater studies, Waste Management installed a pump and treat system in 1991 to prevent the spread of contaminated groundwater. This system was modified in 1997. Review of Groundwater Extraction System Annual Assessment reports for 1997, 2002 and 2003 indicates that the system appears to be capturing the groundwater contamination plume and halting the spread of contamination.[21] [22] However, reliable groundwater monitoring at and near the Pottstown Landfill is difficult due to the fractured rock aquifer system underlying the landfill; thus we cannot rule out the possibility that some contamination migrates beyond the remedial system.

The record indicates that hydro-fracturing was needed several times to increase the flow to recovery wells due to clogging problems. The problem could reoccur and additional hydro-fracturing may be needed in the future.

4.2.2 TCE contamination along Farmington Avenue. In 2003, Montgomery County Health Department (MCHD) measured TCE (trichloroethylene) above drinking water standards in seven residential wells located along Farmington Avenue east and northeast of the Eastern Expansion. A DEP contractor conducted additional residential well sampling in the area during the first quarter of 2004. DEP's study found 44 of the 90 wells tested with TCE concentrations greater than the standard with maximum concentrations in the 200 ppb range. A second phase of the investigation included an additional 145 wells from homes and businesses in the area. A second round of sampling conducted during 2004 and 2005 showed a similar distribution of TCE levels. In all, more than 100 drinking water wells were found to have elevated TCE levels. In a May 2005 "Statement of Decision," DEP announced its decision to provide public water to 111

[21] Applied Geosciences, Inc., Pottstown Landfill Groundwater Extraction System Annual Assessment Reports for 1997, 2002, and 2003.

[22] Waste Management (with DEP) approval plans to convert monitoring well RW07 to an active recovery well in order to "more efficiently maintain removal of impacted groundwater. See Waste Management, "Pottstown Landfill Operations Closure Committee Update, March 23, 2005.

homeowners with contaminated wells.[23] However, the supply of public water will depend on adequate funding from the state's hazardous waste site cleanup program. The Statement of Decision states that the source of the TCE plume has not been determined.

Members of the public have raised the concern that the Pottstown Landfill may be the source of contamination. The authors examined this possibility but were not able to find evidence indicating the landfill as the source. The evidence summarized below suggests that the landfill is probably not the source of this contamination:

- The Eastern Expansion is the portion of the landfill closest to the contaminated zone. Little amounts of water have been found in the detection zone below the liner in the Eastern Expansion only. This means that the liner system at the present time is effectively containing leachate.[24]

- Maximum TCE concentrations in residential wells occurs along Farmington Avenue to the east of Wolf Run. Wells closer to the landfill show low or non-detectable concentrations.

- TCE concentrations at the Western Landfill perimeter measured prior to the installation of the groundwater pump and treat system (during the late 1980's) were in the low ppb (parts per billion); the levels were lower than the maximum concentrations measured along Farmington Avenue (100-200 ppb); maximum concentrations tend to be highest near the source and attenuate (diminish) in the downgradient direction due to dilution, and biodegradation.

However, additional monitoring and analysis may provide for a more definitive conclusion.

- We were unable to find a cohesive analysis of gradients and flow directions in the area between the Eastern Expansion and Farmington Avenue. There are only a limited number of monitoring wells on the eastern side of the Eastern Expansion. Moreover, these wells are not clusters with shallow and deep wells as used in the Western Landfill but appear to be intermediate wells with a longer well screening (intake) interval.

- The three-dimensional configuration of the plume has not been worked out since the residential wells sampled are at a variety of depths and the depths (and elevations) of many of the wells in DEP's database were not given.

- It is difficult to track groundwater movement in and near the landfill because of the area's fractured rock aquifer system.

Recommendation. *We recommend that additional groundwater monitoring wells be added in the areas surrounding the Eastern Expansion to better establish flow direction and water quality in the area. New wells should be clustered (installed at several depths) to examine concentrations and hydraulic pressures at various depths.*

5.0 Landfill gas and the gas control system. The decay of biodegradable wastes within a landfill over the course of several years will lead to the production of methane. Initially the decay is aerobic and the principal product is carbon dioxide; however as microbes deplete the oxygen in the cells, conditions become anaerobic and methane is produced. The generation of methane can

[23] PA DEP, Hazardous Sites Cleanup Program, "Wolf Run Site, Upper Pottsgrove Township, Montgomery Co., Statement of Decision, May 2005.
[24] Dr. G. Fred Lee, Personal Reference, May 2005, based on his analysis of monitoring data.

continue for many decades so long as there is a supply of moisture to remaining degradable wastes. Landfill gas also contains a variety of volatile organic compounds or VOCs; for example, TCE, PCE, benzene, toluene are common solvents that are present in Pottstown Landfill gas. (See Section 7).

Landfill gas control systems are needed to (a) prevent offsite migration of methane and toxic VOCs through the subsurface soil and (b) minimize the release of methane, VOCs and odors from the landfill surface and structures (e.g. leachate collection pipes) into the air.

The gas control system for the Pottstown Landfill is active rather than passive. This means that a pumping system exerts a negative pressure and draws gases from the landfill. This system consists of about 240 gas extraction wells.[25] The wells draw from screens (slotted pipe) that are located about 20 feet below the surface of the landfill. The gas collected is piped to combustion units consisting of three closed flares and two turbines. The system also consists of 4 flares and 2 turbines. Leachate also contains volatile compounds that can become airborne.

The landfill operator must carefully adjust the rate of pumping (vacuum) applied to different parts of the landfill. Insufficient draw will lead to odors, landfill emissions, and potential landfill gas migration. However, too much draw will allow air into the landfill. Air can cause fires or explosions in the landfill if the resulting gas is in the 5-15% explosive range. Required pumping rates are affected by barometric pressure and other variables: monitoring and adjustment must be conducted on a daily basis.

Federal regulations under the Clean Air Act require that landfill operators monitor gas composition and temperature within waste cells. Levels of methane, carbon dioxide, oxygen, nitrogen and temperature are measured at the gas extraction well heads. Pennsylvania regulations also require the operator to operate a series of landfill gas monitoring probes around the perimeter of the landfill to detect potential offsite gas migration problems.

In 2004, Waste Management with DEP approval constructed a pipe to interconnect gas from the Western Landfill and Eastern Expansion. According to the PA DEP, the interconnection will give the landfill operator additional flexibility in reducing odors.[26] However, Waste Management exceeded its flow limitation from Eastern Expansion to flare. As discussed below, the landfill is generating more gas than was anticipated by Waste Management (See NOV issued April 21, 2004).[27]

5.1 Gas composition and flammability. A November 3, 2004 NOV, was issued (signed by Jillian Gallagher). There were many locations in the Western Landfill where the oxygen content at gas extraction wells were > the limit of 5 %. This was based on a site inspection in August 2004 (Nov. 3, 2004 DEP Press Release).

[25] Boreholes are backfilled with gravel and capped with a bentonite seal to isolate the permeable layer from the ground surface. Each wellhead is equipped with sampling ports and a permanent temperature sensor. The wellhead also contains a valve allowing a technician to control the rate of vacuum applied to the well.

[26] SE Regional Office, PA DEP, January 26, 2004 Plan Approval PA-46-0033B; the document states that interconnect will reduce the possible impact of the Eastern Expansion flare that contains a "malfunction."

[27] This violation was also cited in DEP's NOV of July 8, 2004 which focused on exceedances of turbine and flare emission limits. "The average gas flow rate from the Eastern Expansion through the pipeline and to Flare No. 3 was 3,037 DSCMF on a combined basis." The limit contained in the pipeline interconnect approval was 1,800 DSCMF. (See NOV, Nov. 3, 2004)

- WM neglected to monitor 9 landfill gas wellheads in January 2004 and 1 in February 2004. Monitoring is required on a monthly basis.

- Company also failed to correct 45 oxygen exceedances and 1 well head temperature exceedance.[28]

A Waste Management data set provided by SE Region DEP shows that oxygen levels for many of the measurements taken in Western Landfill well heads during 2004 were on the order of 15-20 percent with methane levels within the explosive range of 5-15 percent. The dates of these measurements were from January to July of 2004. This is shown in Table 1. [29]

Gas with these levels of methane and oxygen could cause a fire or explosion if the gas comes into contact with an ignition source. According to a recent FEMA publication, the mixing of certain materials in a landfill can result in spontaneous combustion. Even in small quantities, some chemicals can ignite if exposed to one another. Also, some materials, such as oily rags, can spontaneously combust under certain conditions. Spontaneous combustion can also result from bacterial decomposition. Other ignition sources include sparks from vehicles used in the landfill (dump trucks, bulldozers, backhoes, etc.). A surface fire could also be ignited when drilling or while driving metal pipes through layers of buried waste if a hard object buried in the landfill is struck. Clearly, the best way to prevent landfill fires is to avoid combinations of oxygen (air) and methane that are combustible.[30]

Table 1: Gas measurements at well heads in Western Landfill where oxygen is greater than 5 % and methane is in 5-15 % explosive range.

Date	Well ID	Gas Temp.	Well Pressure	Oxygen %	Methane %	Carbon Dioxide

[28] A related problem concerns reporting irregularities. According to a Title V Semi-Annual Deviation Report Review Summary (Gallagher, 9/26/2004), Data for 80 wells in January 2004 are duplicative of the data entered for the same 80 wells in December 2003. "The facility is still investigating the cause of data duplication and determining whether the 2004 data is accurate."

[29] DEP Air Program (SE) provided the following information via email of April 13, 2005. ."Combustible gases are potentially explosive when mixed with air in particular concentrations; methane gas is potentially explosive for concentrations between 5 and 15% by volume with air under normal atmospheric conditions. The LEL for methane is 5% by volume. The value of 15% is the Upper Explosive Limit (UEL). In the case of methane, 25% LEL is equivalent to 1.25% by volume (i.e. 25%, or ¼, of 5% by volume). At concentrations above the upper explosive limit (UEL), theoretically explosions can not take place. However, there is a possibility that the methane concentration may become diluted with air to form an explosive concentration. Note also that the exact values for methane's LEL and UEL may vary according to the concentration of other gases such carbon dioxide and nitrogen, but for most purposes, the flammable range 5-15% (v/v) is recognized and is the basis upon which methane gas control levels have been set. In the above table the readings with the greatest hazard potential would be those with low carbon dioxide and high oxygen.

[30] Federal Emergency Management Administration (FEMA), *Landfill Fires, Their Magnitude, Characteristics, And Mitigation,* May 2002/FA–225

		°F	°C				%
2/26/2004	GW #0037	60	15.5	-24.6	13.4	5.3	6.1
1/21/2004	GW #0066	38	3.3	-1.5	11.8	12.6	9.4
3/25/2004	GW #0066	55	12.7	-9.4	14.7	7.6	6.1
6/18/2004	GW #0066	100	37.7	-1.1	17.4	8.8	6.1
6/22/2004	GW #0120	70	21.1	-1.1	16.9	7.3	7
1/23/2004	GW #0159	120	48.8	-21.6	5.5	9.7	12.9
1/30/2004	GW #034S	110	43.3	-4.1	6.5	12.8	13
2/24/2004	GW #038D	85	29.4	-0.9	13.5	7.2	5.1
4/21/2004	GW #038D	98	36.6	-1.9	15.9	6.4	8.1
2/11/2004	GW #132S	45	7.2	-3.3	12.3	6.9	7.3
7/26/2004	GW #132S	75	23.8	-2.2	16.6	5.8	4.9
1/26/2004	GW #137S	38	3.3	-0.3	12.3	7.1	3.3
1/30/2004	GW #149S	60	15.5	-0.7	14.8	6.7	3.7
2/11/2004	GW #151D	72	22.2	-10.4	14.6	11	8.5
2/13/2004	GW #174D	45	7.2	-17.3	15.4	5.4	4
4/21/2004	GW #38SA	70	21.1	0	15.2	6.5	4.8
5/6/2004	GW #38SA	65	18.3	-0.4	14.8	5.8	16
5/10/2004	GW #38SA	65	18.3	-0.4	14.8	5.8	16
5/25/2004	GW #38SA	120	48.8	-0.1	15.2	9.6	9.5
6/16/2004	GW #38SA	110	43.3	-0.5	17.4	6.1	4.7
7/20/2004	TH #0003	65	18.3	-3.3	17.7	8.4	4.7
4/22/2004	TH #0005	75	23.8	-4.8	15.6	6.8	4.9

Source: Table 2, Letter from Gary Von Stetina, Waste Management to Jillian Gallagher (PA DEP), Nov. 24, 2004.

Conditions favoring infiltration of air (oxygen) are (a) excessive pumping by gas extraction wells (indicated by large negative pressures) and (b) breaks or permeable portions of the cover layer. Less than impermeable cover can be a problem because the operator may have to increase the pumping rate in order to control odors and air emissions. Potential flaws in the landfill cap in certain areas of the Western Landfill may be contributing to oxygen exceedances as wells as excess leachate discussed previously.

Federal regulations (40 CFR Section 60.753) set limits for oxygen, nitrogen and temperature. The purpose of these regulations is to prevent the combustion of landfill gas by limiting the infiltration of air into the landfill. The regulations require that exceedances be corrected within 15 days.

Regulations at 40 CFR Section 60.75 [c] allow the landfill operator to establish a higher operating value for oxygen and for nitrogen and temperature. However, the regulations require that the operator demonstrate with supporting data that "the elevated parameter does not cause fires or significantly inhibit anaerobic decomposition by killing methanogens." According to a DEP official in the air program, Waste Management has applied to DEP and U.S. EPA for deviations that would allow the company to operate at higher oxygen and/or temperature levels. In other cases, Waste Management has asked DEP for permission to discontinue using certain extraction wells as a way to limit oxygen infiltration into the landfill. In response, DEP has asked for

additional evidence from WM that conditions within the landfill are safe in order to approve deviations.[31]

The following table demonstrates that oxygen exceedances within Western Landfill cells have been a significant problem for the past several years for which we have data.
This table covering 2001 through the first half of 2004 shows that a large number of wells had exceedances, that exceedances tended to persist for 30-70 days and that certain wells remained out of compliance for many months. Our examination revealed that wells with exceedances tend to be clustered in the northeastern portion of the Western Landfill in the "Northern Expansion Area." This is notable since this area was installed in 1994 and is a double lined landfill and was closed with a cover that should meet current regulatory standards.[32]

Table 2.

Year	Period Covered	No. Wells in exceedance	# Sampling Events with Exceedances	Avg. duration of apparent exceedance*	Maximum # days in exceedance**	Average 0_2 exceedance concentration	Source
2004	1/1/04-7/31/04	77	228	73.26	332 (well-40)	14.19	WM Response to 11/3/04 NOV. "Table 2"; WM Semi-Annual Monitoring Report, Attachments 4 & 7(2/1/05).
2003	1/1/03-4/30/03	70	82	28.23	118 (well-62)	12.40	2002 NSPS Annual Report, June 20, 2003
2002	1/1/02-4/30/03	72	157	66.2	320 (well-158)	11.00	2002 NSPS Annual Report, June 20, 2003
2001	5/1/01-4/30/02	89	109	38.7	104 (well-77)	8.69	2001 NSPS Annual Report, June 2002
	Average	**77**	**144**			**11.57**	

Complete Sampling Data Available for 2002. 2004 - All monitoring data available from 1/1-7/31/04. Only monitoring data where a gas well head had an oxygen exceedance greater than 15 days available from 8/1/-12/31/04.(See Below)

* Duration in days measured between 1st exceedance and date compliance demonstrated. Corrective dates not available for all wells. For incomplete data, end of reporting period was used as minimum possible days in exceedance.

**Data includes wells and trench heads for which a variance or abandonment had previously been requested. Deep and Shallow samples were compared separately and thus counted as different wells.

According to officials with DEP SE Region's Air Program, Waste Management has recently take steps to address the NOVs including the problem of oxygen exceedances.[33]
A recent Waste Management submittal records only 9 exceedances from the period August through December 2004. All but one of the exceedances were corrected within 15 days and the 9th was corrected in 21 days.[34] However, the NOV has not been resolved at the time of this writing.[35]

5.1.1. Recommendations. Although the problem of oxygen exceedances appears to have been resolved at present, it is essential that DEP determine the cause of this problem and to play a

[31] Sachan Shankar, Air Division, SE Region PA DEP, March 2005.
[32] Authors are in the process of confirming the location of certain gas extraction wells in the Western Landfill.

[33] Phone conference: Francine Carline and other officials with PA DEP, SE Region, and Henry S. Cole & Associates, Inc. May 9, 2005.

[34] Letter from John Wardzinski (Waste Management) to Jillian Gallagher (DEP), May 2, 2005.
[35] PA DEP News Release, May 16, 2005.

strong surveillance and enforcement role to ensure that the problem won't resurface in the short-term or long-term post-closure period. The Eastern Expansion even though it will close in October 2005, is likely to generate methane at least until a final cover excludes moisture and the waste has an opportunity to dry out. The Western Landfill may generate additional methane so long as rainfall penetrates landfill cover and degradable wastes remain; there is evidence for a slow decline in methane generation over the past 6 years.[36] We recommend the following:

- *Require that Waste Management report not only oxygen exceedances but concurrent measurements of methane and carbon dioxide as well.*

- *Advise US EPA to deny allowable oxygen or temperature deviations where methane concentrations are in the explosive range (5-15 %).*

- *Require that Waste Management implement additional measures to bring landfill cover conditions in the Western Landfill into compliance with current standards for covers.*

- *DEP and Waste Management should consider installing a computerized real time integrated control system rather than relying on monthly measurements. This would allow for operators to control conditions within the landfill with much greater precision. This kind of system is described in Appendix A of the GAI Report on the Pottstown Landfill.*[37]

These preventive actions are necessary since landfill explosions can cause serious injuries and deaths while fires can cause significant levels of air pollution in downwind neighborhoods and are extremely difficult to control. More detailed information on landfill fires and their effects are spelled out in Box 1.

Box 1 : Accidental fires associated with landfill gas control

There is a potential for fires from landfill gas control systems due to:

- Ignition of gas escaping from vents;
- Leaks in gas collection pipe work; and
- Increase in oxygen level, caused by excessive pumping rates during landfill gas extraction, creating surface and deep-seated fires.

Accidental fires can be triggered accidentally by operations through:

- Sparks from the exhaust systems of site plant or vehicles using the landfill
- Smoking on the landfill site by staff or users; and
- Uncontrolled dumping of waste materials, including hazardous substances, which can ignite when mixed.
- Sparks associated with construction activities (e.g. sparks from drilling or welding).

Spontaneous combustion of land-filled materials:

- Mixing of some materials in a landfill, or an increase in heat and oxygen level, can result in spontaneous combustion resulting in either a surface or a deep-seated fire. For example, if a small amount of hypochlorite (swimming pool chemical) comes into contact with a simple hydrocarbon oil or solvent it will spontaneously combust.

[36] Estimates from Waste Management Annual Inventory and Emission Statements: About 7 million cubic feet landfill gas per day in 1997 versus about 6 million cubic feet per day in 2003.

[37] Appendix A., GAI February 2005, Draft Environmental Audit Summary Report/Pottstown Landfill Operation and Closure. Appendix A. G Koppelmann et al. "Landfills Reach New Heights." Chemical Engineering News, January 2005.

Deep-seated fires

- Deep-seated fires are found at depth in material deposited weeks, months, or years earlier.
- Deep-seated fires can be major problems and should always be taken seriously. They have the potential to create large voids, invisible from the surface, which can cause cracking or subsidence of the landfill surface, with a risk that landfill plant and personnel may be engulfed; and
- Produce flammable and toxic gasses, for example, carbon monoxide;
- Damage leachate containment liners and collection systems and landfill gas collection systems.
- Many deep-seated fires are starved of oxygen and produce carbon monoxide as well as carbon dioxide. Carbon monoxide is a colorless, odorless gas and in combination with carbon dioxide will behave as a dense gas. Particular care must be taken in confined areas.
- Carbon monoxide is a toxic gas and is also extremely flammable when mixed with air at concentrations between 12 percent and 75 percent.
- The common cause of deep-seated fires is an increase in the oxygen level within the landfill, which increases aerobic bacterial activity causing a temperature rise. This can then ignite methane in the presence of the oxygen. Increased O2 levels are usually caused by sucking air into a landfill through over-extraction of landfill gas.

Health effects of emissions from landfill fires

- Because of the low burning temperature and incomplete combustion of burning refuse, landfill fires emit a variety of pollutants that have the potential to affect the health of people exposed to the smoke. The risk of harm depends on a variety of factors including: kinds (s) of refuse burning, concentration of pollutants in emissions; duration of exposure; and the ratio of the products of combustion in the smoke plume.
- Although there are many harmful pollutants produced in a landfill fire the pollutants of most concern are particulates, carbon monoxide, acrolein and formaldehyde. Due to the presence of chlorinated materials (e.g. PVC), it is likely that low temperature combustion will cause dioxins and furans to form.
- At about 200 meters (>600 ft) downwind of a landfill the smoke from a landfill fire can be tolerated only briefly due to aldehyde and formaldehyde causing severe difficulty in breathing, burning of eyes, nose and trachea, intense watering of the eyes and severe coughing.
- At 100 meters (300 ft.) from the fire the carbon monoxide concentrations are high enough that headaches, dizziness, weakness, confusion, nausea, disorientation and visual disturbance would be expected after a few hours of exposure. At closer distances (30-150 ft), concentrations of pollutants are so high that exposure to the plume would be intolerable without protective equipment.

Explosions. If a fire is present on a landfill site, explosions can be caused by:

- Ignition of highly inflammable material
- Ignition of landfill gas built up in enclosed spaces
- Heating up of sealed drums, cans, aerosol containers or gas bottles.
- Explosions can cause injury or death, due either to the physical force of the explosion or to flying debris and burning material.

Source: New Zealand Minister for the Environment, Landfill Guidelines Hazards Of Burning At Landfills, Dec. 1997. Source on dioxins: U.S. EPA, Dioxin Inventory.

As stated in Box 1, a smoldering landfill fire can emit dioxins and furans and other hazardous combustion products.[38] Given the disposal of radioactive materials within the landfill, smoke particles or vapors containing radionuclides may also be emitted (see Section 9). Since landfill fires are difficult to control, such emissions may continue for many weeks or months causing potentially significant cumulative exposures to a variety of hazardous pollutants.

5.2 Potential for Offsite Gas Migration. Migration of landfill gas beyond the landfill perimeter can result in offsite fires and explosions where the concentration of methane is from 5-15 percent. Such migration can occur if there is positive pressure at a landfill boundary and if there is a layer or lens of permeable soil (e.g. sandy/gravelly soil) or rock (fractured bedrock). Under such conditions landfill gas can migrate hundreds or even thousands of feet.

PA DER regulations (Section 273.292) require perimeter monitoring to ensure that significant offsite migration of landfill is not occurring through subsurface soils. The regulations also require that:

- Methane levels in perimeter probes do not reach the lower explosive level (LEL) of combustible gas (5 percent of methane).

- Combustible gas levels may not equal or exceed 25 percent of the LEL (1.25 % methane) "in an adjacent area, including buildings or structures on adjacent areas."

To evaluate potential gas migration, we examined Waste Management quarterly sampling data from gas probes located at the perimeter of the Landfill's Eastern Expansion (PE-01 through PE-14). Table 3 is a summary of quarterly probe readings from 2000 through 2004.

As the Table shows, nearly all of the probes have measured non-detectable levels of methane throughout the period. However, there have been repeated detections of methane at gas probe PE 04, including a number of readings that exceed the 5 percent limit (LEL). PE 04 is located north of the Eastern Expansion near the border of Phase 2 and Phase 3 disposal zones. The nearest offsite building is less than 200 feet from PE-04.

Table 3

Quarter - Year	Report Date	Sampling Date	Probe with detectable Methane levels	% Methane	1. Report not found to date 2. Quotations are from Waste Management Report
4th - 2004					Have not yet found report for this date
3rd - 2004	12/2/2004	9/1/2004		0.00%	"All designated points and structures recorded 0% methane levels."
2nd - 2004	7/30/2004	6/4/2004	PE-04	0.30%	"One designated point, PE-04, recorded very low methane levels. Additional monitoring was performed in the vicinity, which indicated 0% methane levels. This is in compliance with Section 273.292(e)."
1st - 2004	4/1/2004	2/25/2004	PE-11	4.00%	"One designated point, PE-11, recorded very low methane levels. Additional monitoring was performed in the vicinity, which indicated 0% methane levels. This is in compliance with Section 273.292(e)."
4th - 2003	12/3/2003	11/24/2003	PE-04	2.00%	"One designated point, PE-04, recorded very low methane levels. Additional monitoring was performed in the vicinity, which indicated 0% methane levels. This is in compliance with Section 273.292(e)."
3rd - 2003					Have not yet found report for this date
2nd - 2003	7/3/2003	5/23/2003	PE-04	**9.00%**	"One designated point, PE-04, recorded very low methane levels. Additional monitoring was performed in the vicinity, which indicated 0% methane levels. This is in compliance with Section 273.292(e)."

[38] Thorneloe, Susan, U.S. EPA, Bioreactor Landfill Technology Conference, Feb. 2003.

1st - 2003	4/17/2003	3/18/2003	PE-04	4.00%	Have not yet found report for this date
4th - 2002					Have not yet found report for this date
3rd - 2002	9/24/2002	8/26/2002	PE-04	**8.00%**	"One designated point, PE-04, recorded very low methane levels. Additional monitoring was performed in the vicinity, which indicated 0% methane levels. This is in compliance with Section 273.292(e)."
2nd - 2002					Have not yet found report for this date
1st - 2002		4/x/2002	PE-04	4.00%	Have not yet found report for this date
4th - 2001					Have not yet found report for this date
3rd - 2001	11/21/2001	8/28/2001	PE-04	**6.00%**	"One designated point, PE-04, recorded very low methane levels. Additional monitoring was performed in the vicinity, which indicated 0% methane levels. This is in compliance with Section 273.292(e)."
2nd - 2001					Have not yet found report for this date
1st - 2001	4/5/2001	3/2/2001	PE-04	**19.00%**	Have not yet found report for this date
4th - 2000	2/6/2001	11/20/2000	PE-04	0.04%	"One designated point, PE-04, recorded very low methane levels. Additional monitoring was performed in the vicinity, which indicated 0% methane levels. This is in compliance with Section 273.292(e)."
3rd - 2000	8/24/2000	8/17/2000	PE-04	**20.00%**	"One designated point, PE-04, recorded methane levels. Additional monitoring performed in the vicinity, which indicated 0% methane levels. This is in compliance with Section 273.292(e)."
2nd - 2000	6/29/2000	5/17/2000	PE-04	**5.00%**	"One designated point, PE-04, recorded 5% methane levels. Additional monitoring performed in the vicinity, which indicated 0% methane levels. This is in compliance with Section273.292(e)."
1st - 2000	4/11/2000	3/17/2000		0.00%	"All designated points and structures recorded 0% methane levels."
4th - 1999	1/14/2000	11/29/1999		0.00%	"All designated points and structures recorded 0% methane levels."
3rd - 1999	1/14/2000	8/27/1999		0.00%	"All designated points and structures recorded 0% methane levels."
2nd - 1999	1/14/2000	5/26/1999		0.00%	"All designated points and structures recorded 0% methane levels."
1st - 1999	1/14/2000	2/25/1999		0.00%	"All designated points and structures recorded 0% methane levels."

Concerns regarding the exceedances at perimeter probe PE-04 were raised in a letter from Henry S. Cole to Pottstown Closure Committee members (January 4, 2005). Dr. Cole also raised the issue at the Closure Committee of January 26, 2005. In response, Waste Management stated that supplemental measurements taken in 4 barholes 15 feet (N,S, E and W) from PE-04 showed non-detect levels and that this result demonstrated compliance. Ron Furlan of DEP agreed with this assessment at the January 26 Closure Committee meeting. Waste Management attributed methane readings at PE-04 to buried septic tank(s) or to decaying vegetation. Waste Management's arguments are detailed in a letter of February 14, 2005. To support its contention Waste Management also argued that (a) perimeter gas didn't detect VOCs that typify landfill gas and that (b) levels at PE-04 over the past year were very low to non-detect.

Peer review consultants, however, believe that the issue of exceedances at probe PE-04 has not been resolved. Our reasons are as follows:

- Although, additional barholes were installed, these barholes (which measured non-detects for methane) were limited to 5 feet in depth[39] while the PE-04 depth was 20 feet. Thus, the barhole readings may have entirely missed the level of concern. Without additional monitoring at the depth of concern, there is no assurance that extent of landfill gas migration has been determined.

- Waste Management's documentation (including the migration reports and letter of February 14, 2005 fail to provide information on the relative depths of PE-04 and adjacent waste-bearing cells. There is no discussion of the stratigraphy or potential routes of migration. At this site preferred migration pathways may include fractured bedrock as well as permeable soil layers.

- Waste Management's documentation doesn't provide precise locations of PE-04, PE-04a, barholes, the site perimeter, and adjacent waste cell(s) are not given. There is no map showing the locations of these features. It is not clear whether PE-04 or PE-04a provides a better measure of the presence of methane or offsite migration.

- Waste Management has not presented evidence showing that septic tanks existed in this area. Nor has the company shown that the layer generating gas is at a stratigraphic elevation consistent with that of a septic system from a home existing prior to the construction of the Eastern Expansion. We note that repeated methane exceedances at the site's perimeter would be of concern regardless of the source.

- To date, Waste Management has not provided a comparison of measured values of VOC constituents in landfill gas versus those in perimeter probes.

- Several readings at PE-04 in recent years were on the order of 20 percent methane. Twenty percent at the site perimeter would pose significant potential for *offsite* readings that exceed the lower explosive level (5 percent methane). Moreover, given the wide distances between adjacent probes, it is quite possible that the methane readings at PE-04 do not represent maximum concentrations along the northern boundary of the landfill.

- Although the latest readings at PE-04 and 04a were very low or non-detect, over the past 4 years, levels have shown considerable variability, at times vanishing and at times rising again to 5 percent or higher. Thus, the levels may be a function of seasonal or even daily variation. Bear in mind that readings are only measured on 4 days each year; thus the specific conditions present on sampling days may be important determinants of methane level and may mask year to year trends.

Given the hazards associated with offsite migration of landfill gas and the exceedance record at PE-04, we recommend additional field investigation sufficient to (a) understand the cause of elevated methane and (b) determine with greater certainty whether offsite migration is occurring or not. This investigation should include the questions raised above and additional measurements.

Recommendations for field investigation. Specifically, we recommend a greater number of gas probes and more frequent testing in order to delineate the horizontal and vertical limits of methane in the PE-04 perimeter area and beyond the landfill boundary. The investigation should be designed to determine whether a link exists between the elevated readings at PE-04 and nearby

[39] John Wardzinski of Waste Management (personal communication, January 26, 2005) Closure Committee Meeting,)

landfill cells. The depth of measurement is a key issue; the initial focus of sampling should be the depth at which 5 % exceedances were recorded (PE-04). I would recommend several transects of probes with samples drawn from permeable layers in the perimeter area. Focused rounds of sampling should be conducted during conditions that tend to maximize migration potential (See Box 2 below). Finally, chemical analysis of gas samples should include methane as well as a full range of volatile organic compounds (VOCs).

Box 2.

Recommended Sampling Times for perimeter gas probes:

Sampling times are almost as important as the procedure used to collect the sample. Proper monitoring of the site should include sampling at those times when landfill gas is most likely to migrate. Scientific evidence indicates that weather and soil conditions influence when gas will migrate. For these reasons sampling should be considered when:

A. Barometric pressure is low and soils are saturated; or
B. When snow cover is just beginning to melt; or
C. The ground is frozen or ice covered.

Source: Missouri DNR, *Solid Waste Management Program technical bulletin: Sampling of Landfill Gas Monitoring Wells*, July 2003.

6.0 Odors. Residents living in the vicinity of the Pottstown Landfill have complained about odors for many years.

6.1 DEP Odor Enforcement Process. Prior to discussing the record of odor violations for the Pottstown Landfill, it is useful to understand state regulations and DEP's enforcement process on odors. When DEP receives an odor complaint, the Department sends an inspector to investigate. According to Ron Furlan, the subsequent process is as follows: the incident is considered open with the possibility of further enforcement action if (a) the Department confirms the presence of odor (b) tracks the odor to its source (i.e. the landfill in this case) and (c) the odor persists. The incident is "closed" if these conditions are not met or if the problem is corrected. Furlan also provided the following description of the Department's enforcement process:

> *"The Department has enforcement discretion in assessing penalties, as well as issuing letters titled Notice of Violations. Generally if an incident of odor is not of a continued duration, no further enforcement action would be taken as long as the activity or problem generating the odor is corrected. Please be advised the nuisance regulations 25 PA Code 273.218 and 273.136 do not state that offsite odors confirmed or otherwise, are prohibited or that they are an automatic violation. Rather the regulations require that the incidence of odor generation be controlled and minimized. These regulations were modified to this format in December 2000 because it was realized that regardless of controls, there would be times that offsite odors could occur. The intensity, duration and whether the landfill operator violated their plan intentionally or for other reasons, and what corrective actions and when were they implemented, are factors used to determine whether further enforcement action is taken."*[40]

From this description, it is not clear what is done if offsite odors persist even after landfill operators have taken all measures described in Waste Management's odor minimization plan.

[40] Email from Ron Furlan to H. Cole, March 21, 2005.

6.2 Record of Complaints and Enforcement. The following information, obtained from PA DEP records, provides a chronological summary of complaints and DEP and Waste Management actions to abate odors.

- A Consent Order and Agreement (October 8, 1996) lists more than 200 odor complaints from residents during the period June 30, 1995 to September 18, 1966. DEP inspectors investigated and confirmed odors on 17 days during this period. The CO/A ordered that Waste Management to pay a fine of $72,250, submit a remediation plan, install a temporary flare and submit plans for 2 additional flares. The CO/A also stipulates penalties for additional odors and non-compliance.

- In subsequent years, numerous additional complaints from residents resulted in DEP inspections and a Notice of Violation in January 2001. The notice stated that Waste Management failed to prevent odors and harmful conditions, failure to notify, failure to properly implement its contingency plan and Air Quality Plan, etc.

- A Notice of Violation (Nov. 18, 2002) designated odors from October and November 2002 as violations. The DEP assessed civil penalties for violations of various regulations. DEP issued the NOV based on numerous confirmed odor complaints. During the 3 ½ month period (October 2002 through January 2003) DEP inspectors confirmed offsite odors on 40 days (1/3 of the days).

- A Consent Order/Agreement (CO/A) of March 6, 2003 fined Waste Management $74,000 for violations related to odors and required that the company take appropriate steps to eliminate and prevent offsite odors. The order also requires WM to initiate measures to eliminate and prevent offsite odors. The order also sets fines for additional findings of offsite odors and reserves the right to require additional remedies if violations continue. WM is required to advise DEP when corrective actions are complete.

- On May 19, 2003, the March 2003 CO/A was terminated according to its provision allowing termination with 3 or less confirmed odor complaints.

- However, there were additional odor complaints and an additional NOV issued on June 18, 2003 based on confirmed odors on May 28, 2003, just 9 days after the termination of the CO/A.

- SE Regional Office of DEP shared its frustration with the public in a public comment response document in January 2004, *"The Department does share in the public's dissatisfaction about Waste Management's inability to property control odors from the landfill site and that resulted in the Department's penalizing the Company for odors."*[41]

- DEP records for the year 2004 showed 8 odor complaints. According to Ron Furlan, these complaints "*were either not confirmed via our surveys (for example, February 17, 2004 and June 20, 2004) or found to be caused by short duration maintenance at the landfill. Unconfirmed complaints are closed*." [42]

[41] PA DEP, January 26, 2004, Public Comment Response Document on Pottstown Landfill.

[42] Email from Ron Furlan, SE Regional Office, PA DEP, to Henry Cole, March 21, 2005

6.3 Potential Causes of the Odor Problem. Peer reviewers were not able to establish whether the odors stem primarily from the Western Landfill or Eastern Expansion. Ron Furlan stated that the Department is not able to provide this information.[43] According to S. Shankar of the PA DEP Air Division most landfill odors are associated with landfill gas rather than freshly placed garbage.[44] It is possible that both Western and Eastern Landfill portions contribute to odor problems. In the case of the Eastern Expansion, more than 40 acres has remained open for an extended period without permanent cover. This condition may have allowed odors and fugitive emissions to escape from the surface of landfill. In the case of the Western Landfill areas of deficient cover including cracks and fissures facilitate the release of odors and air emissions.

6.4 Recommendations. Volatile chemicals that cause odors are likely to be present in the landfill for many decades. Thus it is critical to determine the location and cause of the odor releases and to ensure that (a) the problem will not continue to impact residents and (b) that any future problems will be corrected rapidly and effectively. Additional recommendations:

- *Respond to odor complaints rapidly and determine the portion of the landfill causing the problem.*

- *Require that Waste Management implements additional measures to bring landfill cover conditions in the Western Landfill into compliance with current standards for covers. (See Section 9 recommendations)*

7.0 Air Emissions. The Pottstown Landfill has two principal sources of air emissions: (a) stack emissions from turbines and flares and (b) fugitive emissions from the landfill surface and structures (e.g., manholes). Fugitive emissions are inadvertent losses from the landfill surface. Table 4 provides Waste Management's estimate of emissions from these sources for the year 2003.

7.1 Stack emissions. In 2004, PA DEP issued a Notice of Violation to Waste Management and substantial fine for exceedances of permit limits and violations of regulations involving (a) destruction efficiencies and emission limits of non-methane organic compounds (NMOC) for Turbines 1 and 2 and (b) exceedances of NMOC limits for flares 1 and 3.

The NOV was based on more recent measurements of stack (turbine and flare) emissions for non-methane organic emissions in May of 2004. These are much higher than those shown in Table 4. Whereas the Table shows a combined turbine/flair total of 7.97 tons per year, totals based on DEP's NOV (for 2 turbines and 2 flares) amount to 44.72 tons per year. DEP's total is more than 5 times that indicated by Waste Management. [45]

Table 4 Waste Management Estimates of Annual Emissions for 2003

A. Fugitive Emissions

[43] Email from Ron Furlan, SE Regional Office, PA DEP, to Henry Cole, March 7, 2005.

[44] Sachan Shankar, SE Regional Office PA DEP, personal communication, Dec. 17, 2004.
[45] PA DEP News Release, May 16, 2005.

	NMOC (tons/yr)	VOC* (tons/yr)	Sox (tons/yr)	Nox (tons/yr)	CO** (tons/yr)	Total HAPs (tons/ yr)	PM - 2.5 (tons/ yr)	PM-10 (tons/ yr)
Landfill (existing)	17.29	6.74	0	0	0	0.86	0	0
Landfill (eastern expansion)	7.4	2.89	0	0	0	0.54	0	0
B. Stack Emissions								
Turbines 1	1.41	0.55	3.98	17.99	14.15	0.06	0.39	0.39
Turbines 2	1.32	0.51	3.72	16.82	12.45	0.06	0.36	0.36
Flare #2	1.18	0.46	1.38	1.93	10.8	0.024	0.3	0.3
Flare #3	3	1.17	5.42	6.16	27.1	0.07	0.41	0.41
Flare #4	1.06	0.41	3	4.6	24.92	0.08	0.31	0.31

Waste Management has disputed the accuracy of DEP's measurements. According to DEP's SE Region Air Program Director Francine Carlini, the Department and Waste Management are attempting to resolve their differences with the probable resolution being retesting with a mutually agreeable test protocol.

7.2 Fugitive emissions. Estimates of fugitive emissions are from landfill surfaces (Eastern Expansion and Existing Landfill) are based on modeling. Model estimates of landfill emissions are subject to considerable uncertainty. As such they should be confirmed with actual measurements of emissions from the landfill surface.

Non-methane organic emissions (NMOC) appear to be based on 1999 data that is restricted to gas samples piped from the Western Landfill only.[46] Only 3 samples were taken of the gas were taken on a single day (April 14, 1999). This limited data may not be representative of the Eastern Expansion nor of current conditions, nor of emissions that actually escape from the landfill surface.

Table 5. Waste Management estimates of Hazardous Air Pollutants in landfill gas.

Compound	Median Pottstown Concentration (ppmv)	
	1997	1999*
1,1,1-Trichloroethane (methyl chloroform)	0.05	0.17
1,1,2,2-Tetrachloroethane	0.00	0.00 **
1,1,2-Trichloroethane	0.01	0.10
1,1-Dichloroethane (ethylidene dichloride)	10.71	0.77
1,1-Dichloroethene (vinylidene chloride)	0.15	0.13
1,2-Dichloroethane (ethylene dichloride)	0.02	0.04

[46] Waste Management Disposal Services of Pennsylvania, Inc. Pottstown Landfill and Recycling Center 2003 Annual Inventory and Emission Statement (Revised) June 7, 2004.

1,2-Dichloropropane (propylene dichloride)	0.01	0.04	
Bromomethane	NM	0.00	
Carbon tetrachloride	0.00	0.01	
Chlorobenzene	0.68	0.78	
Chloroethane (ethyl chloride)	0.03	0.94	
Chloroform	0.00	0.01	
Dichloromethane (methylene chloride)	20.54	0.71	
Ethylbenzene	10.30	1.53	
Trichloroethylene	0.56	0.69	
Vinyl Chloride	0.77	0.77	**
Acrylonitrile	0.00	0.00	**
Benzene	1.41	1.77	
1,4-Dichlorobenzene(p)	16.89	1.16	
Hexane	1.85	2.04	
Methyl chloride (Chloromethane)	20.54	0.18	
Styrene	0.51	1.02	
Toluene	38.65	9.11	
Xylene (isomers and mixtures)	25.07	6.88	
Perchloroethylene (tetrachloroethene)	1.70	1.08	
Hexachloro-1,3-butadiene		0.00	
Methyl Ethyl Ketone (2-Butanone)	8.15	8.15	**

*Average concentrations from three landfill gas samples taken by the DEP on 4/14/99
**Average concentrations from six other landfill gas sampling events
NM = Not Measured

Data Sources:
1997 Data - Waste Management Report to PADEP: *Title V Emissions Fees*, August 20, 1998
1999 Data - PADEP Bureau of Air Quality - source test report for the TO-14A sampling program conducted on April 14, 1999 at the inlet flare at the Pottstown Landfill facility.
2003 Emissions Report (Waste Management: dated 06/07/04) available but uses emissions levels from 1999.

Surface Methane Scans. Regulations under the federal Clean Air Act require that landfill operators conduct quarterly surface scans to measure landfill gas emitted from the surface of the landfill. The limit is 500 ppm methane. Methane serves as a surrogate for NMOC/VOC emissions such as those listed in the Table above. The regulations require that exceedances be re-monitored in 10 days and brought below 500 ppm within 30 days.

Cole & Associates to date has obtained data for several years of surface scan testing as described below. 2004 (4 quarterly LF transects) and results from a U.S. EPA Region III Air Compliance Inspection Report resulting from May 30, 31, 2002 inspection of the landfill.[47]

2002 Report: EPA et al. monitored 75 points, but only on the western portion[48] of the landfill. Areas tested included leachate manholes and bare spots. Exceedances are summarized as follows:

[47] Region III, U.S. EPA, Air Compliance Inspection Report for EPA's May 30-31, 2002 Inspection at Pottstown Landfill, contained in letter of July 26, 2002 from C. Pilla, EPA, Region III to Gary Von Stetina, Waste Management.

- Levels in excess of 10,000 ppm methane were detected at 6 locations, generally at gas valves and leachate manholes.

- 14 locations had exceedances of 500 ppm level.

- A number of the exceedances occurred at locations that EPA characterized as being unvegatated "bare spots" and areas affected by erosion. This finding is consistent with the hypothesis that portions of the Western Landfill have cover systems that are sufficiently permeable to allow an exchange of gases (i.e. infiltration of air and release of air emissions). The EPA report noted *that "exceedances were located in the older part of the landfill, in areas where geotextile material was not used as part of the cap. This can be an overall concern with the older portion of the landfill."* (p.7).

- Follow up testing was carried out after WM had added additional topsoil and clay and replaced the seal around manholes with silica gel. EPA report states, "… all readings at the flagged areas were below 10 ppm."

2004 Quarterly Reports: WM consultant conducts NSPS surface methane quarterly in accord with federal regulations. Findings are as follows:

- A total of 31 exceedances (measurements greater than 500 ppm methane) were observed in initial sampling of the 4 quarterly rounds.

- Typical exceedances were on the order of several thousands of ppm.

- All exceedances observed initially were corrected within the required 30-day period.

- Typical corrective actions were increasing the rate of pumping at gas extraction wells and adding layers of soil to prevent releases.

These findings indicate that Waste Management has taken necessary actions to correct exceedances once they are discovered on a quarterly basis. Although Waste Management appears to be in compliance with the surface methane scan regulation, we have several concerns:

- Are there areas between monitoring locations that may be problematic especially in older areas without geotextile material?

- Are the current efforts by Waste Management to repair limited sections of the Western Landfill sufficient to prevent exceedances and air and odor releases in the future?

- *The findings also indicate that monitoring should continue so long as there is appreciable methane within the landfill. This would argue against issuance of a final closure certificate so long as methane remains in the landfill (see Section 9).*

7.2.2 Modeled emissions. We asked DEP's Air Program to provide the most recent estimates of fugitive emissions? We received the following response. "The Department is expecting a new application from Waste Management providing us with the above information. Since the Eastern

[48] According to the EPA Region III, Compliance Report, the eastern expansion was not tested because the eastern portion was not active until 1998; thus 5 years had not elapsed.

Expansion produced more gas than the model predicted, the parameters used in the model while submitting the Eastern Expansion Plan Approval application do not appear to be valid. Waste Management chose site specific values for some of the input parameters. They are in the process of revising the site specific input parameters and to run the model. Once the Department receives the new application with revised landfill gas flow values, we would be able to calculate the fugitive emissions."[49]

7.2.3 Recommendations for plume characterization / ambient concentrations. Current estimates of fugitive emissions from the Pottstown Landfill (Table 4) are based on modeling rather than actual measurements. Such modeling is based on general emission factors for landfills. Better estimates may be obtainable via the following methods:

Flux box emission estimates with air quality modeling. In this method a box is placed over an area of landfill cover that is approximately 1 square meter. The bottom of the box is open and over a period of about 30 minutes allows landfill gas to accumulate. Samples are drawn off at various time intervals. The emission rate of methane (or other gases) is determined by calculating the rate of increase of concentrations. The emission rates are determined at a sufficient number of locations to identify hot spots (requiring cover repair or increased gas extraction) and to estimate emission rates from various parts of the landfill. These emission rates can be used in conjunction with an area source model (e.g. ISC-LT) to determine long-term concentrations in neighborhoods surrounding the landfill. A guideline from the UK Environment Agency provides a description of the flux box technique.[50]

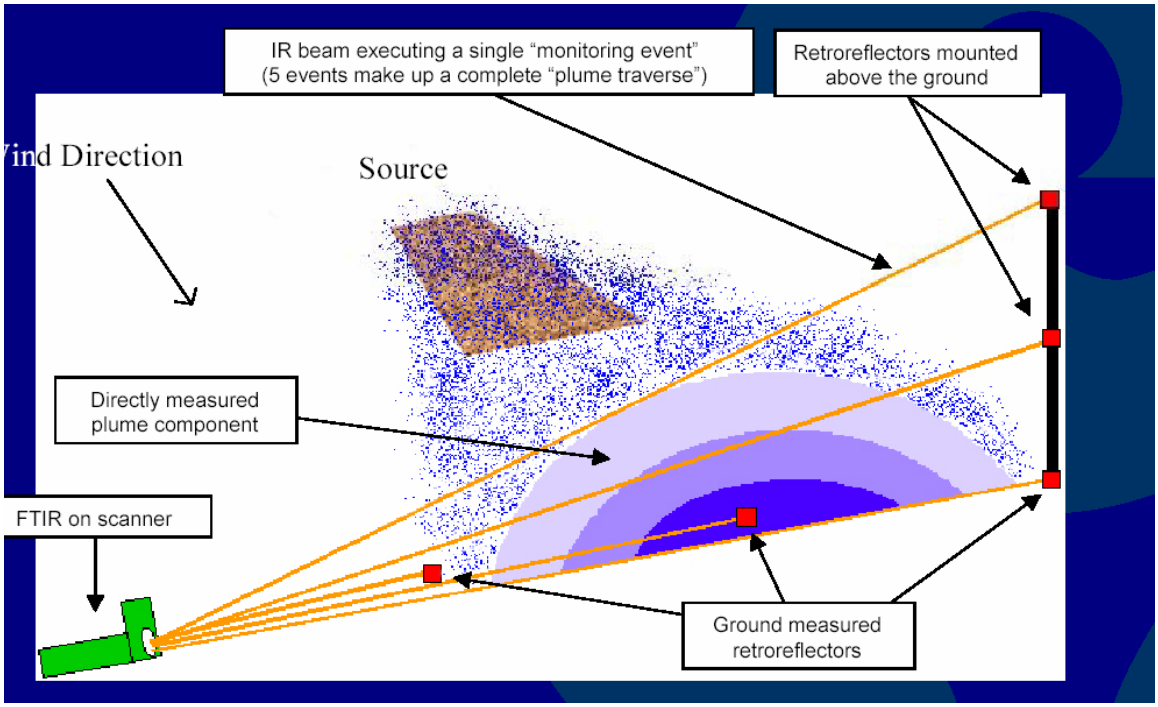
Remote plume sensing. According to a recent presentation by Susan Thorneloe, one of EPA's leading experts on landfill gases and emissions, reliable data on fugitive emissions is generally lacking. Her presentation includes a description of a remote sensing technique that could be used for the Pottstown Landfill to determine the emission rate from the surface of the landfill as well as concentrations of contaminants downwind of the landfill.[51] This technique is shown schematically in the following diagram and further described in the footnote.

Figure 3

[49] Emailed letter from Francine Carlini, DEP SE Region, April 13, 2005.

[50] United Kingdom, Environment Agency, March 2003, Draft Guidance for Monitoring Landfill Gas, Surface Emissions.

[51] Susan A. Thorneloe, U.S. EPA, "Bioreactors & Landfill Gas Emissions," US EPA Workshop on Bioreactor Landfills–Landfill Technology Conference, Feb 27-28, 2003.The technique uses remotely sensed open-path Fourier Infrared Spectroscopy (OP-FTIR) multiple beams to determine vertical and horizontal gradients. Radial scanning is used to locate potential hot spots and vertical gradient measurements used for determining mass flux (emission) rates.



7.3 Recommendation. *It is recommended that DEP and Waste Management attempt to provide more reliable estimates of landfill surface emission rates as well as ambient concentrations.* The two approaches described above could be used in conjunction with additional mobile ambient sampling. As stated previously, we recommend that closure committee consider the following recommendations for DEP:

- Require additional measures to bring landfill cover conditions in the Western Landfill into compliance with current standards. The standards require highly impermeable covers that will reduce both air and odor emissions, and cut down on the infiltration of both water and air into closed landfill cells.

- In order to minimize air emissions and odors, permanent cover should be completed within a year of closure as required by regulations.

8.0 Radioactive materials in the landfill. A number of officials on the Closure Committee and members of the public have been concerned over evidence that radioactive materials have been disposed at the Pottstown Landfill. This section summarizes the information, examines measurements of radioactive substances in leachate and gas and describes studies that would help to define the nature and extent of radioactive materials in the landfill.

8.1 Disposal of radioactive materials currently allowed. DEP regulations adopted in 2000 allow *some* radioactive *materials* to be accepted at municipal landfills including Pottstown. According to DEP, only those materials that are allowed for general public and not regulated by the federal or state government as a radioactive *waste* may be disposed of in municipal landfills *unless specifically exempted from disposal restrictions by an applicable Pennsylvania or federal*

statute or regulation.[52] We have recently asked DEP if any such exemptions were used to permit the disposal of radioactive materials at the Pottstown Landfill.

According to DEP, Materials allowed at Pottstown and other municipal landfills include:

- Naturally occurring radioactive material (e.g. soils, ores)
- Waste from nuclear medicine patients after released from treatment facilities
- Consumer products such as smoke detectors
- Natural materials that are processed including coal ash or processed metal ores.

8.2 Radiation Protection Plan. In January 2004, DEP issued a permit modification approving Waste Management's application for a "Radiation Protection Action Plan." The Action Plan includes radiation screening at the facility's entrance gate. Detection of gamma radiation sounds an alarm. Once the alarm is sounded, the operator must follow guidelines to ensure that radioactive material detected is properly characterized and managed in accord with state and federal regulations. The operator also keeps detailed records and provides an annual report to DEP.[53]

As DEP has acknowledged, prior to the installation of the radiation monitor, there was no way to determine whether "unacceptable materials" were unknowingly brought to the landfill.[54]

8.3 Disposal records. We were not able to find an organized inventory of radioactive materials that have been disposed in the Pottstown Landfill. Until recently, the landfill had no radiation monitors at its gates,[55] and therefore had no way to determine whether regulatory limits on radioactive waste disposal were being violated and the true extent to which radioactive materials were disposed of in the landfill.

Although we have not been able to detail the types and levels of radioactive substances contained in these wastes, we did find evidence to indicate that materials and wastes containing radionuclides were disposed of for at least three decades at the Pottstown Landfill. What is especially significant is that industrial wastes including those with radioactive materials brought to the landfill prior to the mid-1980's would have been buried in the oldest, unlined (original landfill) or poorly lined sections of the landfill. Thus waste constituents disposed during the

[52] PA DEP, Public Hearing Comment & Response Document (for public hearing on WM's application for a radiation protection action plan held on December 16, 2002. The Public Response Document, Jan. 2004.

[53]Further details of the radiation monitoring plan were provided by James Wentzel, DEP, SE Region (email of May 18, 2005 to Henry Cole.): "The landfill began implementing their plan in July 2004, after the monitoring equipment was installed and the construction was approved by the Department. Since then, the landfill has been required to keep a record in the daily operational record of any incident in which radioactive material was detected in waste loads. This includes loads accepted under the blanket authorizations, accepted based on specific Department approval, or rejected in accordance with the protection plan. These records are kept on site at the landfill. We do not have them or copies of them in this office. In the annual operation report, which does get submitted to the Department, the landfill is required to provide a summary record of detected radioactive materials. Since the landfill didn't start monitoring until July 2004, the first such summary record will be included in the 2004 annual operation report, which has not yet been submitted but isn't due until June 30, 2005."

[54] PA DEP, Public Hearing Comment & Response Document (for public hearing on WM's application for a radiation protection action plan held on December 16, 2002. The Public Response Document, Jan. 2004, p. 13.

[55] Abrams, Mark, Reading *Eagle Times*,2/18/96.

earlier period are more likely to reach groundwater than in later periods when disposal occurred in double-lined sections of the landfill.

Potential sources of waste containing radioactive materials are discussed below.

Cabot Corporation. According to Pa DEP, Cabot's plant in Boyertown this facility currently disposes of residual waste at the Pottstown landfill. The plant handles tantalum ore that contains naturally occurring radioactive material (uranium and thorium).[56] This residual consists of plant trash, decontaminated process equipment, packing material and filter cake. Secondly, Cabot's Revere facility sent sandblast and baghouse dust and Cesium Ore Gangue filtercake to Pottstown Landfill from 1998 to 2002.[57] DEP's characterization does not describe whether these materials and wastes contained measurable levels of radioactivity. However, an examination of regulatory documents indicates that the wastes from this facility contained a number of radionuclides including uranium and thorium.

In order to obtain DEP's approval for disposal of the filtercake at the Pottstown Landfill, Cabot obtained a letter from the Nuclear Regulatory Commission in 1988 stating that this disposal was to appropriate and consistent with federal regulations. NRC rendered this opinion based on the assumption that the filtercake contains less than 10 picocuries per gram for thorium and uranium. This understanding however appears to be based on very limited sampling (single quarterly samples). Moreover, the letter from the NRC cautions that routine precautions should be taken if disposal involves dusty conditions including the use of a dust mask.

Moreover the DEP report does not discuss the disposal of Cabot wastes at the Pottstown Landfill prior to 1998. We have reviewed a number of documents that indicate that wastes from Cabot were accepted at the Pottstown Landfill for several decades. The facility under earlier ownership or name disposed of residual sludge as early as 1973.[58] The company's 1983 generator certificate indicates that from 12,000 to 24,000 tons of treated "waste cake" was delivered to the landfill annually.[59] This waste is described as being non-hazardous, industrial, solid, wastewater treatment plant residual. As stated previously, wastes disposed of in the landfill prior to the onset of Solid Waste Act regulations went to portions of the landfill that had no liners or deficient liners by today's standards.

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[56] Tantalum concentrate Tantalum ores, often derived from pegmatites, comprise a wide variety of more than a hundred minerals, some of which contain uranium and/or thorium. Hence the mined ore and its concentrate contain both these and their decay products in their crystal lattice. Concentration of the tantalum minerals is generally by gravity methods (as with mineral sands), so the lattice-bound radioisotope impurities if present will report with the concentrate. While this has little radiological significance in the processing plant, concentrates shipped to customers sometimes exceed the Transport Code threshold of 10 kBq/kg, requiring declaration and some special documentation, labeling and handling procedures. Some reaches 75 kBq/kg. Uranium Information Centre Ltd (Australia).

[57] PA DEP, Public Hearing Comment & Response Document (for public hearing on WM's application for a radiation protection action plan held on December 16, 2002. The Public Response Document, Jan. 2004, p. 7.

[58] Pennsylvania Department of Environmental Resources, September 20, 1973, letter to Pottstown Disposal Service Inc, Re: Kawecki Berylca Industries, Sludge Disposal.

[59] Cabot Corporation, "Request for approval to treat, store or dispose of a hazardous or residual waste stream, Module 1, Nov. 8, 1993, Flow diagram for waste treated with hi-calcium lime.

Medical Waste. State and federal regulations currently in effect restrict the radiologically contaminated medical wastes that can go to a municipal landfill. Medical facilities are required to treat radioactive materials as radioactive wastes (for example, storage with decay). Patients are held at the facility until radiation levels in the body have dropped to levels that will not expose the public to levels greater than 0.5 rem. Until the patient is released, contaminated items including excreta and secretions are collected as radioactive wastes. Once a patient leaves the medical facility, bathroom wastes generally go into the sanitary sewers and other items wind up in municipal trash. The landfill does not require a license from either the state or NRC to accept these materials.[60] However, due to poor controls in the past, a variety of medical wastes containing radioactive materials may have been disposed of at the Pottstown Landfill.

Radioactive waste from Three Mile Island nuclear plant? Anthony Mitchell, an independent Philadelphia-based consultant told the Reading Eagle/Times in 1996, that the Nuclear Regulatory Commission had permitted the disposal of TMI waste at the landfill.[61] We are not able to find any documentation to substantiate this claim.

Sludge from Royersford laundry (INS). There is evidence that sludge from Interstate Nuclear Services (INS) in Royersford was shipped to the Pottstown Landfill. The sludge is a residual from the washing of garments from the Limerick Nuclear Power Plant contaminated with low-level radioactivity.

Limerick Nuclear Power Plant. Waste from the Limerick Nuclear Power Plant from radiologically controlled areas of the plant are segregated and sent to a low-level radioactive waste facility for disposal. Wastes from non-controlled areas of the plant (e.g. offices, cafeteria) are checked to ensure that there is no detectable radioactivity prior to being trucked to a transfer station and landfill. The Pottstown Landfill received this kind of waste in 1998 and 1999.[62]

However, in March 2002, Limerick's operator (Exelon) allowed 5 bags of waste to be sent for disposal *to the Pottstown Landfill* even though the bags were marked as containing radioactive material and stored in an unrestricted area. NRC designated this occurrence as an unauthorized removal in accordance with 10 CFR 20.1801. Although NRC described this violation as having very low safety significance, the incident demonstrates that what actually happens in the real world often departs from the regulatory ideal.[63]

8.1 Radiation in leachate samples. Sampling of composite leachate samples from the Eastern and Western Landfill were taken for Waste Management on October 28 and December 17, 2004.[64] The results of this sampling are shown on the following tables. Bolded values indicate an exceedance of drinking water standards.

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[60] PA DEP, Public Hearing Comment & Response Document (for public hearing on WM's application for a radiation protection action plan held on December 16, 2002. The Public Response Document, Jan. 2004, p. 9.

[61] Rippey, Gail, "Scott gets landfill test, no witness," Reading *Eagle/Times*, July 25, 1996.

[62] PA DEP, Public Hearing Comment & Response Document (for public hearing on WM's application for a radiation protection action plan held on December 16, 2002. The Public Response Document, Jan. 2004.

[63] Nuclear Regulatory Commission, Non-cited violation report Limerick Nuclear Power Plant, May 11, 2002. See also PA DEP press release, "Limerick Power Plant Waste Found at Pottstown Landfill, March 15, 2002.

[64] Moholt, Bruce, "Radiation Monitoring of Wastewater at Pottstown Landfill, March 14, 2005, memo to G. Von Stetina, Waste Management.

The DEP's 1999 radiation report David Allard states, "drinking water standards do not apply to leachate in a landfill." Although this statement is accurate from a regulatory standpoint, the high current and historical levels of tritium and gross beta are relevant given portions of the Western Landfill have no bottom liners; moreover, eventually bottom liners will develop leaks (See Section 9 and Attachment 2). It is likely that the pump and treat system in the southern portion of the Western Landfill will have to operate over

the long-term to prevent contaminated groundwater from migrating offsite and potentially reaching residential wells. The potential cumulative risks associated with drinking contaminated groundwater will be a function of all of the contaminants and their concentrations, including radionuclides.

Table 6. Composite leachate analysis for radionuclides – Pottstown Landfill

East Composite

Radionuclides	Counts	Quant. Limit	Historical Levels	US Drinking Water Standard
Gross alpha	47 +/- 74 pCi/L	130pCi/L, hence U	**250** pCi/L	15 pCi/L
Gross beta	**475** +/- 75 pCi/L	65 pCi/L	**800** pCi/L	50 pCi/L (4millirem/yr)
Tritium	**106,000 +/-** 11,000 pCi/L	400 pCi/L	**100,000** pCi/L	20,000 pCi/L

West Composite

Radionuclides	Counts	Quant. Limit	Historical Levels*	US Drinking Water Standard
Gross alpha	23 +/- 34 pCi/L	60 pCi/L, hence U	**250** pCi/L	15 pCi/L
Gross beta	278 +/- 43 pCi/L	36 pCi/L	**800 pCi/L**	50 pCi/L (4millirem/yr)
Tritium	3,750 +/- pCi/L	310 pCi/L	**100,000 pCi/L**	20,000 pCi/L

*Historical levels are from the Western Landfill since the Eastern Expansion came on line in 1997.
Source: Bruce Moholt, Memorandum on Radiation Monitoring of Wastewater at Pottstown Landfill, 14 March 2005.

Table 7. Results of Tritium Testing at Pottstown Landfill.
Results are in picocuries per liter (pCi/L)

Sample Location	DEP 1/06/97	DEP 2/27/97
Cell W-2	25,300	26,510
Cell 7	101,200	59,055
Cell 10	14,100	9,280
On-site Treatment Plant- influent	NA	14,900
On-site Treatment Plant- effluent	NA	11,500
Pottstown WWTF Discharge	NA	205
Lunchroom sink at landfill	NA	Below Detection Limits
Rt. 113 Bridge, Phila. Suburban. Water Intake	NA	Below Detection Limits

Source: Allard, D., Bureau of Radiation Protection, PA DEP, November 23, 1999, "Investigation of Radioactivity in Air Downwind of Pottstown Landfill Gas Combustion Stacks.

Note that tritium levels in Cell W-2 and Cell 7 are higher than the drinking water standard (20,000 pCi/L). According to the DEP's 1999 radiation report, the data in the table confirm the presence of tritium in the landfill. "The source of the tritium is not known but could be from the disposal of self-luminous signs." However, the report concludes that levels reaching surface water through discharge of treated leachate "are not different from levels found in PA streams in general." The report does not comment on the potential impact of tritium on groundwater.

Moreover, the results in the table are from composite samples. Composites are mixtures that average our high and low concentrations. It is likely that certain cells generate much higher than average concentrations of radionuclides. The effect of mixing is clearly shown in the results of tritium testing in leachate samples from Western Landfill Cells W-2, 7 and 10 and the on-site treatment plant influent (measuring the mixed leachate from the Western Landfill). As the preceding Table[65] shows, the maximum reading (for Cell 7) is 4 or 5 times higher than the treatment plant influent. The maximum impact on groundwater would be where high values of radionuclides such as tritium occurred in unlined or inadequately lined portions of the landfill. DEP attributes the tritium to the disposal of self-luminous signs. This hypothesis is consistent with articles in the literature. However, a report on Scottish landfills found that tritium from self-

[65] The source: Allard, D., Bureau of Radiation Protection, PA DEP, November 23, 1999, "Investigation of Radioactivity in Air Downwind of Pottstown Landfill Gas Combustion Stacks.

luminous devices is soluble and reaches leachate in significant quantities as the materials breakdown.[66]

8.4 Recommendations. We recommend that DEP require the following:

- *Monitor for tritium in the wastewater treatment and turbine buildings since tritium is contained in water vapor and methane and workers may be subject to long-term exposure.*

- *Continue leachate monitoring for tritium, gross beta and gross alpha, with cell-specific monitoring to determine maximum levels. This is especially important in older, unlined or poorly lined cells where leachate is more likely to reach groundwater.*

- *Upgrade cover systems in older portions of the Western Landfill, especially for areas that lack adequate bottom liners and also for areas where leachate contains elevated levels of radiation.*

In addition, it is possible that future generations will seek to develop or even mine the landfill. While some of the substances have short or intermediate half-lives, others have longer half-lives and will continue to be hazardous for very long periods. For this reason, we believe that it would be prudent to develop better information on the location of potential hot spots within the landfill as follows:

- *Attempt to determine which landfill cells received largest quantities of radioactive materials. This can be done to some extent using records of waste disposal (including information on cells in use during specific time periods).*

Set up an ongoing comprehensive cell-specific monitoring program for radioactivity in leachate and landfill gas.)

9.0 Critical Closure and Post-Closure Issues. Closure is defined as the date on which the landfill permanently stops accepting waste. Activities beyond closure are those necessary for post-closure care, maintenance and monitoring. As part of its applications for various parts of the landfill, Waste Management was required to submit plans for care of the landfill during the post-closure period. Post closure care includes:

- The application of a final cover
- Grading and re-vegetation
- Current plans for post-closure land use are for grass covered hill.
- Operation of the gas control system
- Continued monitoring of groundwater, surface water and gas
- Leachate collection and treatment
- Erosion control
- Abatement of pollution or degradation to the environment

[66] (Source, Hicks, T. et al. "Tritium in Scottish Landfill Sites," May 30, 2000. www.sepa.org.uk/pdf/publications/technical/TritiumInScottishLandfillSites.pdf

In addition to describing Waste Management's plans and specifications for these activities, closure and post closure plans also include financial assurances including bonds that Waste Management has set aside to finance these activities and to correct problems involving environmental releases. The terms of Waste Management's Closure Plan are spelled out in Form 28 and include requirements for post-closure care and financial assurance. DEP approved a closure plan as revised in 1994.[67]

Our analysis did not include a detailed engineering assessment of landfill components such as the permanent cover. However, we have identified certain general concerns that may be problematic after the Eastern Expansion is permanently closed. The most serious problems involve limitations in the approved closure plan coupled with containment failures that will inevitably occur many years and decades.

Western and Eastern Landfills Conditions. With regard to the permanently closed Western Landfill problems already exist. Portions of the Western Landfill continue to generate methane and leachate. These conditions appear to be related to deficiencies (breaches, cracks and/or permeable areas) of the landfill cover. Cover deficiencies may have also contributed to oxygen level exceedances within the landfill as well as odor problems. Although Waste Management with DEP oversight is taking measures to reduce infiltration, we are not able to determine whether these efforts will be sufficient to cut off the landfill's water supply. Remember also that significant portions of the Western Landfill were developed without bottom liners or with substandard liners such as sprayed asphalt. Leachate is likely to reach groundwater in these areas. We are concerned that erosive processes in the coming years and decades are likely to take a further toll on cover layers in the Western Landfill and aggravate the release of leachate into groundwater.

The Eastern Expansion and newer portions of the Western Landfill are likely to be in better shape following closure; with containment systems that meet current standards. It is likely that these systems will function properly for decades. However, many chemicals in the landfill will continue to be hazardous for an indefinitely long period. At some point in the future even the best state-of-art containment systems will fail. What is important is that there be sufficient systems in place to detect and detect and correct failures at the earliest point in time before releases reach the point where they reach nuisance levels or affect public health and the environment.

The following sections present evidence for inevitable deterioration of containment systems, discuss issues of DEP oversight and financial assurance and include recommendations aimed at increasing the levels of prevention and protection embodied in closure and post-closure plans.

9.1 Landfill Cover. A properly constructed and maintained landfill cover that includes a plastic sheeting layer can be effective in preventing moisture from entering the landfill. Under such conditions the wastes dry out and no longer generate leachate or landfill gas. In a dry tomb type landfill, this drying leads to a dormant period with respect to landfill gas and leachate generation. However, the integrity of the low permeability layer of the cover is subject to many stresses; eventually it deteriorates and allows moisture to enter the wastes which allows the renewed generation of leachate and landfill gas. This can happen in a short time after landfill closure, or be postponed for many decades after landfill closure.

Attachment 2 provides detailed evidence on the deterioration of landfill liners and covers.

[67] Waste Management, April 1994, Revised Form 28 Narrative and Bonding Sheets

Dry tomb conditions are likely to apply to portions of the landfill that were closed following the Solid Waste Management Act of 1988. Dry tomb conditions are likely in the Eastern Expansion and possible for more recent portions of the Western Landfill where landfill covers and liners are sufficiently impermeable to prevent most moisture from entering the landfill. However, we have not been able to establish which parts of the Western Landfill are currently leaking and generating significant volume of leachate.

9.2 Landfill Liner Integrity. There is a limited period of time during which the plastic sheeting upper composite liner and lower plastic sheeting secondary liner used in the Pottstown Landfill can be expected to function as designed to collect leachate and thereby prevent it from polluting groundwater. In time, the upper composite liner will fail; if the lower plastic sheeting secondary liner is still functioning without significant holes and areas of deterioration, it can indicate when the upper primary liner has failed. If the leachate that is collected in the leak detection zone is detected and action is taken to prevent water from entering the landfill through the cover, forever, the further groundwater pollution by the Pottstown Landfill can be prevented. However, if the plastic sheeting liner of the leak detection zone has significantly deteriorated, the leachate that has passed through the upper composite liner will pass through the leak detection zone into the underlying fractured rock aquifer system under the landfill and additional groundwater pollution by the Pottstown Landfill will occur. Evidence presented in Attachment 2 demonstrates that plastic liners will eventually fail due to a combination of physical and chemical processes.

Evidence in Attachment 2 further indicates that the specific kind of liners employed by Waste Management (and allowed by Pennsylvania regulations) may aggravate the problem of liner leaks. In the Pottstown Landfill, placement of geotextile between the plastic sheeting and the compacted soil layer allows leachate that penetrates through the holes, rips, tears and/or points of deterioration in the plastic sheeting liner, to pass into the geotextile space between the plastic sheeting and the compacted soil layer. It then spreads out over the compacted soil layer. This allows a larger area for leachate to pass through the compacted soil layer than would occur if the plastic sheeting and compacted soil were in intimate contact in a true composite liner design. The net effect of this problem is that the secondary liner can leak at a higher rate through holes that develop in the plastic sheeting secondary liner than would occur if a true composite liner design had been required in the secondary liner design.

9.3 Long Term Functioning of the Leachate Collection and Removal System. The leachate collection system that has been installed at the post-1991 sections of the Pottstown Landfill can be effective in collecting leachate generated in the landfill. However, over time the leachate collection and removal system at this landfill will fail to function as designed due to deterioration of the plastic sheeting layer in the upper (primary) composite liner. Leachate will pass through holes in the plastic sheeting and then penetrate through the underlying clay layer in the composite liner. It is not possible to repair the landfill liner system and the associated leachate collection and removal system as a result of the fact that they are buried under the wastes.

9.4 Groundwater Extraction/Treatment System. The groundwater extraction system in the southern portion of the Western Landfill will have to be operated so long as water collects and leachate forms in unlined or poorly lined portions of the landfill. The record indicates that hydro-fracturing was needed several times to increase the flow to recovery wells due to clogging problems. The problem could reoccur and additional hydro-fracturing may be needed in the future.

9.5 Long Term Performance of Gas Collection System. We are concerned that certain components of the system (e.g. piping) may be vulnerable to corrosive materials/conditions within the landfill cells. Collection systems must be operable so long as degradable organic wastes remain in the landfill, even if there is a potentially long dormant period in which no methane is formed since a breach of the top is likely to reinitiate methane production.

9.6 Alternate Approach to Landfill Closure – Bioreactor. A bio-reactor landfill is an alternative approach to landfill management and closure. Rather than attempting to keep out moisture and prevent leachate and methane generation, the bio-reactor approach attempts to accelerate the breakdown of wastes and shorten the period requiring post-closure care. The conversion of the Pottstown Landfill to a bioreactor landfill could potentially reduce the magnitude of the long-term threat of releases from the Landfill. However, in the short-term, such bioreactor practices as permeable cover and leachate recirculation require additional controls to ensure that leachate does not breakout or seep from the landfill.[68] This approach would not be advisable for the Western Landfill since significant portions are missing adequate bottom liners. The Western Landfill even in its closed state generates about 65 percent of the leachate of the entire landfill. The quantity of leachate produced and released to groundwater would increase if water were allowed to infiltrate freely.

It is unclear whether DEP will allow an MSW landfill such as the Pottstown Landfill to be converted from a dry tomb type landfill to a bioreactor landfill. It may take a change in DEP regulations to permit this change in mode of operation for the Pottstown Landfill. Any consideration of this approach should require an engineering study and certification that the design is capable of containing leachate and that the benefits outweigh the risks for the Pottstown Landfill. The Closure Committee may wish to discuss this alternative.

9.7 Landfill post-closure care, liability and financial assurance. This section describes DEP's regulatory framework for post-closure care. A critical question is whether these provisions are sufficient to maintain the Pottstown Landfill in an environmentally safe condition for the indefinitely period of time in which landfill chemicals continue to be hazardous. This is a tall order given the above cited evidence for the inevitable failure of critical containment systems. Clearly protection of safety and the environment will require long-term oversight/enforcement by DEP and funding for (a) operation and maintenance of landfill containment and collection systems (b) monitoring (c) corrective action such as groundwater remediation. Can the current regulatory framework meet this challenge?

9.7.1 Post Closure Care. Regulations governing post-closure require Waste Management to carry out a number of activities including leachate collection, gas collection, groundwater monitoring and perimeter gas monitoring. Waste Managements obligation for post-closure care for the Eastern Landfill are spelled out in a Closure Plan prepared in 1990 and revised in April 1994 as approved by DEP.

A key question involves requires the duration of these activities. Section 271.342 of Pennsylvania's municipal landfill regulations enables an operator to obtain a Certificate of Final Closure (CFC). Final Closure is defined as: "The date after which no further treatment, maintenance or other action is or will be necessary to ensure compliance" with the Solid Waste Management Act or municipal waste regulations.[69] In order to obtain a CFC, the operator must

[68] Shankar, S., Air Quality Program, SE Region DEP, personal communication, December 17, 2004.

[69] Presentation of James Wentzel, DEP SE Region Solid Waste Program, April 26, 2005.

demonstrate that: (a) the landfill is in compliance (b) is not causing adverse environmental effects or nuisance, and (c) all remedial activities are complete.[70]

Final closure is not tied to a particular time frame such as 30 years. According to DEP, the Department's granting of a CFC is based on site-specific and landfill performance. For example, DEP could, at its discretion, issue a final closure certificate if the landfill is in compliance and ceases to generate methane and leachate. Or it could delay issuance indefinitely based on the potential for releases.

Granting of a CFC, will not relieve Waste Management of all responsibility:

- The company is required to post a bond to cover liabilities over a 10-year period.

- Section 271.342 states that the final closure certification does not constitute a waiver or release of the bond liability or "other liability existing in law or equity for adverse environmental effects or conditions of non-compliance at the time of the notice or at a future time for which the operator remains expressly liable." This section states that the Department, following final closure, may require additional post-closure measures if it determines that measures are needed to prevent or abate adverse effects on upon the environment, public safety or welfare.

In accordance with the approved closure plan, once Waste Management obtains its final closure certificate, the company can suspend basic monitoring and maintenance operations including leachate and gas collection and treatment. The closure plan does not even commit to maintain vegetative cover or security fences following final closure. [71]

Moreover, certain activities can be suspended prior to issuance of a CFC. For example, according to DEP's presentation to the Closure Committee (April 26, 2005), "At some point between closure and final closure, gas collection and treatment, leachate collection and treatment and possibly stormwater sedimentation may cease. The timing will be based on site specific performance considerations."[72]

Although Waste Management's liability will continue following final closure, we have serious concerns.

- *Without groundwater and perimeter gas monitoring, there will be no way to determine whether a release occurs unless it is detected offsite, for example as contamination in a residential well or a fish-kill in a stream.*

- *Once a CFC is obtained, the burden of proof shifts from the operator to the DEP.[73] In other words, the DEP would have to demonstrate that the landfill has or will cause adverse impact before it can require corrective action.*

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[70] Once the Department issues a final closure certification, the operator must initiate a liability bond for the ten years following final closure.

[71] Form 28, Closure Plan Narrative, as revised 1994.

[72] Presentation of James Wentzel, DEP SE Region Solid Waste Program, April 26, 2005.

[73] Meeting of November 4, 2004 with Dr. Cole, Dr. Lee, and the following DEP officials Joe Feola (Director SE Region), Ron Furlan, Francine Carline (Manager, Air Quality Program, SE), Louise Thompson (Regional Counsel).

- *Final certification may allow an operator to walk away once the landfill enters a dormant stage (e.g. no leachate or methane being formed) and will be harder to hold accountable when containment systems breakdown perhaps decades later.*

- *It is quite possible that Waste Management will shut down or even dismantle gas and leachate collection and treatment systems once it receives a CFC. What happens if a breach in landfill cover reintroduces water into waste cells with renewed generation of leachate and landfill gas? Will DEP be able to force Waste Management to install new equipment or repair decaying equipment? Will the landfill operator challenge such orders and will such issues be tied up in hearing boards and courts?*

There is nothing to prevent Waste Management from petitioning the agency for a final closure certificate. Clearly DEP's decision on whether to grant the certificate is a weighty one.

It is our judgment that issuance of a CFC would pose serious risks to public health and the environment given that (a) hazardous constituents will endure for decades and centuries (b) landfill containment systems will deteriorate over time (c) DEP cannot guarantee the protection of public health and the environment unless monitoring, containment and collection system are maintained. *For these reasons, we strongly recommend that DEP initiate a policy that would postpone on indefinite basis the issuance of CFCs for all closed municipal waste fills in the state.*

9.8 Financial assurances and funding. There are similar problems with regulations requiring financial assurance and funding for post-closure activities.

Section 271.313 (Solid Waste Act) requires financial assurances (i.e. bonding) that will enable the landfill operator to pay for maintenance, monitoring and corrective measures. Bonding estimates are based on a 30-year estimate for the post-closure monitoring with an additional ten-year bond posted following final closure.

- *DEP's current approach is to require upfront assurance for only 30 years of funding. How will DEP and Waste management guarantee that adequate funding will be available to deal with the problems that will inevitably emerge as liners, covers and control systems deteriorate over time? The need for corrective action might occur 50, 60 or 100 years into the future. Moreover, remedial measures may need to be repeated over such periods.*

- *Assured funding is not available for all of the issues that will need attention. For example, Waste Management's financial statement provides no assured funding for replacement of the landfill cover or for remediation of contaminated groundwater.*

- *There is no assurance that funds for continued closure care or corrective measures will be available if and when Waste Management is no longer required or able to provide funding for these critical needs.*

- *The financial assurance terms are more than a decade old. Nor do they adequately cover long-term costs of corrective measures and remedial action that will inevitably be needed as deterioration of containment systems occur.*

For these reasons, we recommend that DEP attempt to renegotiate financial assurance terms with Waste Management.

9.9 Information in the post-closure era. This section deals with a major gap in closure requirements – the need for a well organized and user-friendly information system for the Pottstown Landfill. The authors found it difficult to find information in DEP files (Record Department, SE Regional Office). According to several DEP officials, many people have been through the files and documents are not necessarily returned in place. Secondly, portions of the files are in use by regulators who need them close at hand. In addition:

- The organization of the files was not always obvious (topic area/chronologically, etc.) Finally, the files were hard copies rather than electronic.

- Although DEP staff members were often helpful in overcoming these problems, it was apparent, that staff also had difficulty in locating certain documents. Moreover, staff members are extremely busy and have many responsibilities. The fragmentation of records and lack of a computerized system makes access difficult and time-consuming for all parties.

- Certain data gathered by Waste Management does not have to be submitted to DEP unless there are exceedances or the data is requested by DEP. We found several instances where DEP did not have records of follow up investigations that were or may have been conducted by Waste Management.

- We were not able to find a cohesive, well organized set of maps and diagrams that show the locations and structures of different parts of the Eastern and Western Landfills. One has to go back through a series of permit application documents to pull out this information.

- Institutional memory is a problem. The landfill has been regulated for several decades; even the Eastern Expansion has been used for seven years. We were told by several DEP staff that turnover of key staff contributes to the loss of institutional memory.

- Integration of information. A related problem is that enforcement for the landfill is carried out separately by the SE Region's Waste Management and Air Quality programs. This sometimes made it difficult.

We regard the absence of a well-organized data base on the landfill (especially for portions of the Western Landfill) as a potential obstacle to those in the future whom will need to deal with problems (e.g. releases) or who are attempting to examine development options. Fifty years from now someone may need information rapidly without having to dig through ancient and fragmentary files.

We believe that there is need for a cohesive, electronic system that would include at least the most critical information. This system should be electronic, retrievable and searchable. This system could help present day and future regulators retrieve, analyze, and map data with much greater efficiency. (See recommendations.)

10.9 Summary of recommendations on closure/ post-closure. Our recommendations are as follows:

- *DEP should require WM to implement effective corrective actions required to reduce the infiltration of water into portions of the Western Landfill. This may require installation of landfill cover that meets current standards in older portions of the landfill. DEP should discuss this issue in greater detail with the Closure Committee.*

- *A reliable landfill closure plan for the Pottstown Landfill must include monitoring of leachate and landfill gas generation as long as the wastes in the landfill have the potential to generate leachate and gas when moisture is introduced into the wastes.*

- *DEP should initiate a policy that would postpone on indefinite basis the issuance of CFCs for all closed municipal waste fills in the state.*

- *The landfill cover should be routinely inspected for areas of stressed vegetation that is indicative of landfill gas migration and air emissions through the cover. Renewed landfill gas and/or leachate generation after a dormant period (with little or no leachate generation) is an indication that moisture has been entering the landfill. Under those conditions, the landfill owner must be required to locate the area of the cover that is no longer preventing moisture from entering the landfill and repair the low permeability layer of the cover. This process will have to be repeated as needed for as long as the wastes in the landfill are a threat.*

- *Require Waste Management to maintain early-warning systems to detect the renewed presence of leachate in the collection and removal system. If leachate is detected, the operator should be required to repair the areas of the landfill cover that are allowing moisture to pass through the cover to generate leachate.*

- *DEP and Waste Management should explore the possibility of installing landfill covers with built-in leak detection system.*

- *Waste Management and DEP should provide information on the long-term performance of the gas collection and monitoring systems. The closure plan should include provisions to maintain the operability of this system and require needed repairs for the period of time in which decomposable organic wastes remain in the landfill. This requirement should continue even if the landfill is dormant with regard to methane generation since cover failures would facilitate moisture infiltration and renewed methane generation. Please note that with renewed gas generation landfill pressures in the absence of a collection system would increase as would the potential for lateral gas migration towards surrounding neighborhoods.*

- *DEP should attempt to renegotiate financial assurance terms with Waste Management to more adequately provide for long-term maintenance and monitoring and for repairs and remedial measures that will be inevitably needed. The need for financial assurances goes well beyond 30 years.*

- *As part of Closure, Waste Management should provide funds to enable PA DEP to develop a "legacy information system" on the Pottstown Landfill. This system should include critical information and should be should be electronic and should allow users to easily search and retrieve needed information. This system should also be readily accessible to the public.*