# Comments on the CIWMB Staff Efforts to Gain Assured Postclosure Funding for Landfills for as Long as the Wastes in the Landfill Are a Threat to Public Health and the Environment

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The California Integrated Waste Management Board (CIWMB 2006) is in the process of developing a regulatory approach to ensure that landfill postclosure monitoring and maintenance funding will be available as needed for as long as the wastes in a landfill are a threat. We strongly support this effort.

The state of California landfilling regulations, originally adopted as Subchapter 15 in the 1970s and reaffirmed in 1984 by the State Water Resources Control Board (SWRCB), require that postclosure funding of landfills be provided for monitoring and maintenance for as long as the wastes in the landfill are a threat to public health and the environment. In the early to mid-1980s, I worked as a consultant to the SWRCB staff (Gil Torres) on the development of SWRCB Chapter 15 landfilling regulations where this postclosure funding requirement was set forth. These regulations were subsequently combined with the California Integrated Waste Management Board's regulations governing landfilling, into California Code of Regulations Title 27. The original requirements of Chapter 15 have been maintained, including Section 2540, which is now Title 27 Environmental Protection; Division 2 Solid Waste; Chapter 3 Criteria for All Waste Management Units, Facilities, and Disposal Sites; Subchapter 2 Siting and Design; Article 4 SWRCB - Waste Management Unit Construction Standards; Section 20310 SWRCB - General Construction Criteria.

Paragraph (c) of Section 20310 states,

> *"Class III landfills shall have containment structures which are capable of preventing degradation of waters of the state as a result of waste discharges to the landfills if site characteristics are inadequate."*
> (http://www.ciwmb.ca.gov/Regulations/Title27/ch3sb2c.htm#Article4)

Class III landfills are municipal solid waste (MSW) landfills.

Subchapter 5 Closure and Post-Closure Maintenance; Article 1 General Standards For All Waste Management Units; Section 20950 SWRCB - General Closure and Post-Closure Maintenance Standards Applicable to Waste Management Units (Units) for Solid Waste (C15: Section 2580); Paragraph (a) General (1) Applicability states,

> *"Classified Units shall be closed according to an approved closure and post closure maintenance plan which provides for continued compliance with the applicable SWRCB-promulgated standards for waste containment and precipitation and drainage controls in Article 4, Subchapter 2, Chapter 3 of this subdivision (section 20310 et seq.), and the monitoring program requirements in Article 5, Subchapter 2, Chapter 3 of this subdivision (section 20380 et seq.), throughout the closure period and the post closure maintenance period. Relative to the applicable SWRCB-promulgated requirements of this title, the post closure maintenance period shall extend* ***as long as the wastes pose a threat to water quality****;"* [emphasis added]
> (http://www.ciwmb.ca.gov/Regulations/Title27/ch3sb5.htm#Article2)

We strongly support the requirement to ensure that the landfill active-life owner provide the funds that will be needed for postclosure monitoring and maintenance for as long as there is a potential for the landfilled wastes to release waste-derived chemicals to groundwaters and the environment.

At the time the Subchapter 15 postclosure funding requirements were developed in the mid-1970s, the classical sanitary landfills being used allowed moisture (water) to enter the closed landfill through the cover of the landfill. It is well-established that the key to waste degradation and elimination of the long-term threat posed by the waste in a closed landfill is the interaction between the waste components and water, leading to fermentation of the biodegradable organics to form landfill gas and, through leaching of the wastes, leachate. It is the chemicals in landfill gas and leachate that lead to adverse impacts on groundwater quality and the area (atmosphere) near the landfill. Ultimately, a classical sanitary landfill in which water enters the landfill through the cover tends, over a long period of time, to reduce the long-term threat that the waste residues in the landfill pose to public health and the environment, albeit with attendant groundwater pollution having taken place. These issues have been discussed in Lee and Jones-Lee (2006).

While, in a classical sanitary landfill, landfill gas production can typically occur over decades, leachate production that is a threat to cause groundwater pollution can occur over a much longer period of time. As Lee and Jones-Lee have discussed in their writings over the years (including Lee and Jones-Lee 2006), classical sanitary landfills, where there is no attempt to prevent moisture from entering the wastes, have been found to generate leachate for thousands of years. In the book, Groundwater, Freeze and Cherry (1979) of the University of British Columbia and the University of Waterloo, Ontario, Canada, discussed the finding that landfills developed in the Roman Empire about 2,000 years ago are still producing leachate. Belevi and Baccini (1989), two Swiss scientists who have examined the expected contaminating lifespan of Swiss MSW landfills, have estimated that waste in Swiss landfills will leach lead in concentrations above drinking water standards for over 2,000 years.

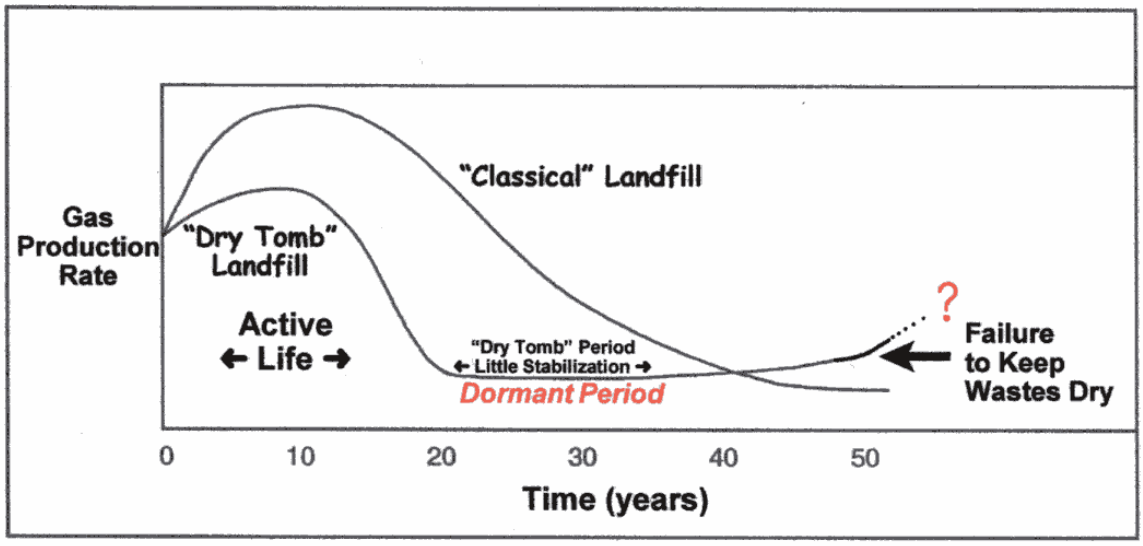
**Dry Tomb Landfill Failure Scenario**

In the mid-1980s, the US Congress mandated that the US EPA develop "dry tomb"-type landfills in which the landfilled wastes are to be enclosed in plastic sheeting and

compacted clay liners and covers in an effort to keep the wastes dry. While dry wastes do not produce landfill gas and leachate, the approach that the US EPA has adopted of relying on plastic sheeting and compacted clay liners and covers to protect groundwater, has significant technical long-term problems in keeping the landfilled wastes dry. Of particular concern is that, while it is possible to construct plastic sheeting and compacted clay liners and covers that are effective in significantly reducing the amount of water entering the landfilled wastes, thereby effectively shutting off the moisture supply to the landfill (i.e., the landfill will become dormant with respect to gas and leachate production), over time these liner and cover materials will deteriorate and lead to delayed, renewed production of landfill gas and leachate.

This scenario is represented in Figure 1 and has been discussed by Lee and Jones-Lee (2006). A relationship similar to that shown in Figure 1 has been developed by the California Integrated Waste Management Board (CIWMB 2004). Once a "dry tomb" landfill is closed with a low-permeability cover, the rate of landfill gas generation and leachate production will decline and eventually stop if the landfill cover is effective in preventing moisture from entering the landfill. This is because both leachate generation and landfill gas production are dependent on there being moisture in the wastes.

**Figure 1. Comparison of Pattern of Landfill Gas Generation over Time at Classical Sanitary Landfill and "Dry Tomb" Landfill**




(from Lee and Jones, 1991)

During the "dormant period" the wastes in the landfill remain in an essentially unaltered state. However, when they come in contact with water at some future time, however far in the future, they will resume production of landfill gas and leachate. At that time, if the gas collection system is not functioning effectively, landfill gas will escape from the landfill and be a threat to cause explosions and expose nearby humans and wildlife to hazardous chemicals. Landfill gas can also lead to groundwater pollution. Landfill gas

can be highly odorous and in some locations be detected at distances up to a mile or so from the landfill.

As moisture enters the landfill through an ineffectively maintained cover after the landfill has been dormant, leachate will also again be generated. If the leachate collection and removal system (LCRS) is no longer functioning to collect and remove from the landfill all the leachate generated, and/or the landfill owner is no longer operating/maintaining the LCRS, the leachate will accumulate in the landfill, leading to increased potential for leachate to penetrate through the liner and potentially begin to pollute groundwaters. If the landfill is a US EPA Subtitle D minimum design landfill with a single composite liner and vertical monitoring wells at the point of compliance for groundwater monitoring spaced hundreds or more feet apart, the failure of the landfill liner system may not be detected until offsite production wells are polluted. This failure scenario could occur a few years after landfill closure, especially if the construction of the landfill containment system was of inadequate quality and/or if the placement of the wastes near the liner damaged the liner. This failure scenario could also be delayed by decades to hundreds of years after landfill closure.

This failure scenario serves as the technical basis for the current CIWMB efforts to develop assured funding for postclosure care and remediation of polluted groundwater for as long as the wastes in the landfill can release pollutants that are a threat to public health and/or the environment. The CIWMB current effort to develop assured postclosure funding is especially important for privately owned landfills and for publicly owned landfills that are owned by communities that may have limited ability to obtain funding from their constituent base.

**How Long Will Dry Tomb Landfilled Wastes Be a Threat?**

It is a common misconception that the passage of time for wastes in a "dry tomb" landfill detoxifies wastes and renders them benign. This misconception has contributed to the myth that a finite, several-decade period of postclosure care protects groundwater quality from adverse effects of landfilled wastes. These misconceptions evolved from inappropriate extrapolations from the fermentation and leaching that can occur in a homogeneous wet environment, to a "dry tomb" environment, as well as from wishful thinking and liability management.

As discussed by Lee and Jones-Lee (2006) and summarized above, the passage of time during a landfill's "dormant period" does not render the buried residues non-hazardous or no longer deleterious to the environment. The wastes represent a threat at the time of closure and remain a threat until the wastes are thoroughly reacted and leached. This reaction and leaching will take place eventually – either in a controlled, engineered fashion or *de facto* when landfill maintenance and monitoring become inadequate. The period of time during which the wastes will be a threat is actually prolonged by high-quality maintenance of the integrity of the "dry tomb" cover. The duration of the "dormant period" is determined by how long the landfill cover is adequately maintained to prevent the addition of water to the landfilled wastes, and the gas and leachate

monitoring and control systems are effective in preventing the escape of waste-derived chemicals into the environment.

Once the cover has been breached sufficiently to allow moisture into a conventional "dry tomb" landfill and the failure of the cover is not immediately detected and repaired, protection of groundwater quality will rely on the integrity and operation of the leachate collection and removal system. How long that system will function properly will depend on several factors. The effectiveness of the leachate collection and removal system is dependent on the integrity of the plastic sheeting layer which serves as its base. Lee and Jones-Lee (2006) reviewed the variety of factors that influence the ultimate failure of landfill liner systems and leachate collection and removal systems, which can lead to groundwater pollution.

Assuming that the leachate collection and removal system is operating as intended, how long it will need to function to protect groundwater quality depends on the nature of the buried wastes themselves, and the nature of fermentation and leaching, which is the mechanism by which hazardous and otherwise deleterious materials will be removed from the landfill. Much of the waste placed in MSW landfills is, or becomes, compressed, making the interaction of the fermentable components with moisture more difficult and prolonging the period of fermentation and leaching.

Further, much of the household and commercial waste put in an MSW landfill is in plastic bags which are crushed, but not shredded, as part of the landfilling. These plastic bags will tend to hide some of the MSW from moisture that may enter the landfill during the period of time when the landfilled wastes are open to the atmosphere, as well as when the low-permeability cover has deteriorated to the point of no longer being effective in keeping the wastes dry. As discussed by Lee and Jones-Lee (2006), the rate of degradation of polyethylene plastic bags typically used for disposal of household and some commercial wastes is not known, but it is expected to be long – possibly on the order of decades. As the plastic bags degrade, the "hidden" wastes in the crushed bags will be a source of fermentable organic wastes and wastes with leachable components that can interact with water that enters the landfill, leading to releases of landfill gas and leachate that can potentially be a threat to public health and the environment. This situation can significantly prolong the period of time that the wastes in a dry tomb type landfill will be a threat.

Thus, how long wastes in a "dry tomb" landfill will remain a threat is a complex issue that is landfill-specific. It depends on a variety of factors that can change over time, such as the quality/effectiveness of the landfill gas and leachate collection systems and the rate of deterioration of the effectiveness of the landfill cover and liner, as well as the nature of the buried wastes themselves. Therefore, true "postclosure care" includes vigilant maintenance for as long as the landfill containment materials used can be maintained and repaired, as well as attending to the fermentation, leaching, and leachate treatment following the dormant period, until the waste residues are rendered truly non-hazardous/deleterious. Until that point is reached, the wastes in the landfill will be a threat.

In summary, there is no way to reliably predict, *a priori,* how long the wastes in a dry tomb landfill will be a threat. In order to be protective, in compliance with current regulatory requirements, it should be assumed that a plausible worst-case scenario applies to a particular landfill with respect to the period of time that postclosure funding will be needed; i.e., unless appropriately demonstrated otherwise, it should be assumed that the wastes in a landfill will be a threat for as long as representative samples of the wastes taken from the landfill can produce landfill gas and/or leachate upon contact with water. In examining the potential for leachate developed from landfilled wastes to be adverse to public health and the environment, it is appropriate to include the potential for the leachate to adversely impact groundwater quality, including such issues as total salts, the production of tastes and odors, etc. This level of protection is required by the California Porter-Cologne Water Quality Control Act.

**Funding of Postclosure Care**

An issue that has been raised in CIWMB deliberations on developing assured postclosure funding for as long as the landfilled wastes are a threat to impair the beneficial uses of groundwaters (in accordance with Chapter 15, now Title 27), is how additional funding can be obtained as part of "tipping fees" for currently active landfills, as well as for those that have been closed. Several of those who commented at the CIWMB workshop indicated that it would be difficult to get those who currently contribute wastes to an active landfill or have contributed wastes to a closed landfill to provide the additional funds needed to develop a trust fund and insurance of sufficient magnitude to address the needed additional funding.

The issue of adequately funding MSW landfilling, including funding for postclosure care for as long as the wastes are a threat, has been of concern since the late 1980s. Lee and Jones-Lee (2006), in their "Flawed Technology" review, have presented information on this issue as discussed by others in the literature. An excerpt from their report is presented in Appendix A. As presented in Appendix A, postclosure care funding issues have been discussed by Hickman (1992, 1995, 1997, 1998), Skinner (2001), the US EPA (1991), GAO (1990), Cochran (1992) and others. One thing universally recognized is that current landfilling tipping fees are low compared to the funds needed to comply with California requirements of postclosure care (funding) for as long as the wastes in the landfill are a threat.

As Lee has repeatedly pointed out beginning in the late 1980s when the US EPA first proposed Subtitle D landfilling regulations – in his writings (see www.gfredlee.com); lectures for American Chemical Society local sections; and short-courses offered by American Society of Civil Engineering, American Water Resources Association, National Groundwater Association, University of California Extensions, and others – the current landfilling approach will, by default, pass part of the true cost of landfilling on to future generations. This could include the cost of "Superfund"-like remediation of polluted groundwater caused by landfills allowed under these regulations, which are inadequately monitored and maintained. There are some, including the authors, who feel that those who generate the wastes should pay the true cost of waste management,

including fully funding postclosure care. That this approach will not be to the liking of waste management firms/agencies or to the people who generate wastes is certain. Equally certain, however, is that the existing problem will not go away, and that society continues to generate and bury massive amounts of wastes that will need adequate postclosure funding until such time as they are no longer a threat to generate landfill gas and/or cause groundwater pollution.

In order to address the issue of the acquisition of additional funding, the CIWMB, the SWRCB and the Regional Water Boards should initiate a major effort to inform all landfill owners in California that the current tipping fees for MSW management should be increased to cover the deficiencies in funds available to cover postclosure monitoring and maintenance for all landfills that have received wastes from a political jurisdiction waste management area. CIWMB/SWRCB should develop guidance on how a political jurisdiction that provides solid waste management in an area should develop the funding to address the legacy of inadequately funded postclosure monitoring and maintenance, and develop a funding mechanism for current landfilling operations that includes sufficient assured funds for postclosure monitoring and maintenance for as long as the wastes are a threat.

**Pottstown Landfill Closure Issues**

Appended to these comments as Appendix B is a discussion of the landfill closure issues that have developed at the Pottstown Landfill located in Pottstown, Pennsylvania. The city of Pottstown, several local jurisdictions and two counties that are impacted by the Pottstown Landfill developed the Pottstown Landfill Closure Committee. This committee consisted of elected officials from the political jurisdictions affected by the landfill. As part of the closure of the landfill, which was scheduled to take place in 2005, the committee hired Drs. H. Cole and G. F. Lee to assist the committee in reviewing the adequacy of the proposed closure of this landfill, as well as postclosure care (monitoring and maintenance). Drs. Cole and Lee developed several reports for the committee, which discuss issues that need to be considered in closing a landfill and providing postclosure monitoring and maintenance for as long as the wastes in the landfill are a threat to public health and the environment. Many of these same issues will be faced by political jurisdictions throughout California (and, for that matter, nationally) as Subtitle D landfills begin to close.

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# Appendix A
# Information from the Literature on Need for Adequate Postclosure Funding

(Excerpts from Lee and Jones-Lee 2006)

**Inadequate Postclosure Monitoring and Maintenance**

The 30-year funding period for postclosure monitoring and maintenance of Resource Conservation and Recovery Act Subtitle C and D landfills that was specified by Congress was one of the most significant errors made in developing RCRA Subtitle C and D landfilling regulations. Those who were responsible for developing this approach did not have an understanding of how waste-associated constituents would degrade/transform in a dry tomb landfill. The US Congress General Accounting (now Accountability) Office (GAO, 1990), in the Executive Summary of its report "Funding of Postclosure Liabilities Remains Uncertain," under a section labeled "Funding Mechanisms Questionable," concluded that,

> *"Owners/operators are liable for any postclosure costs that may occur. However, few funding assurances exist for postclosure liabilities. EPA only requires funding assurances for maintenance and monitoring costs for 30 years after closure and corrective action costs once a problem is identified. No financial assurances exist for potential but unknown corrective actions, off-site damages, or other liabilities that may occur after the established postclosure period."*

Further, the US EPA Inspector General (US EPA, 2001) in a report, "RCRA Financial Assurance for Closure and Post-Closure," developed similar conclusions:

> *"There is insufficient assurance that funds will be available in all cases to cover the full period of landfill post-closure monitoring and maintenance. Regulations require postclosure activities and financial assurance for 30 years after landfill closure, and a state agency may require additional years of care if needed. We were told by several state officials that many landfills may need more than 30 years of post-closure care. However, most of the state agencies in our sample had not developed a policy and process to determine whether post-closure care should be extended beyond 30 years, and there is no EPA guidance on determining the appropriate length of post-closure care. Some facilities have submitted cost estimates that were too low, and state officials have expressed concerns that the cost estimates are difficult to review."*

As noted by John Skinner, Executive Director of the Solid Waste Association of North America (SWANA) and former US EPA official in the Office of Solid Waste and Emergency Response, on pg.16 of the July/August 2001 *MSW Management* Journal,

> *"The problem with the dry-tomb approach to landfill design is that it leaves the waste in an active state for a very long period of time. If in the*

> *future there is a breach in the cap or a break in the liner and liquids enter the landfill, degradation would start and leachate and gas would be generated. Therefore, dry-tomb landfills need to be monitored and maintained for very long periods of time (some say perpetually), and someone needs to be responsible for stepping in and taking corrective action when a problem is detected. The federal Subtitle D rules require only 30 years of post-closure monitoring by the landfill operator, however, and do not require the operator to set aside funds for future corrective action. Given the many difficulties of ensuring and funding perpetual care by the landfill operator, the responsibility of responding to long-term problems at dry-tomb landfills will fall on future generations, and the funding requirements could quite likely fall on state and local governments."*

Typically those developing a landfill propose to only be responsible for providing the financial assurance for: closure; postclosure and corrective action for the 30-year minimum period. Hickman (1992, 1995, 1997, 1998), in a series of articles ("Financial Assurance-Will the Check Bounce?", "Ticking Time Bombs?", "No Guarantee," "A Broken Promise Reversing 35 Years of Progress"), has discussed the inadequate approaches for postclosure funding under Subtitle D regulations. Lee and Jones (1992), Lee and Jones-Lee (1992, 1993, 2004) and Lee (2003) have published a number of reviews on the need for longer-term postclosure care, as well as the use of more reliable financial instruments to provide funding during the postclosure care period than is typically provided today.

The issue of the long-term financial stability of garbage companies, including Waste Management, was discussed by Cochran (1992) in *Barron's*. There it was stated,

> *"Legal liability in this* [solid waste management] *field is significant and uninsurable. Illustrating the risks, WMX* [Waste Management Inc.] *has agreed to pay WMII* [Waste Management International] *$285 million over 50 years for 'certain environmental costs and liabilities which may be suffered by the Company' because of past practices, and which are 'both probable of incurrence and capable of reasonable estimation.' The amount for known problems exceeds WMII's total earnings for its corporate history."*

Lee and Jones-Lee (2004) have discussed the unreliable information that some private landfill owners and their consultants are foisting on regulatory agencies where they claim that it is possible to predict, based on landfill monitoring, the duration of postclosure care. This is an attempt to try to limit the long-term liability of landfill owners for postclosure care. As discussed by Lee and Jones-Lee (2004), such claims ignore the processes that will take place in a dry tomb type landfill. Figure 1 (see text) provides a diagram of the expected situation with respect to landfill gas formation and leachate generation in a closed dry tomb landfill.

**References for Appendix A**

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# Appendix B
# Pottstown Landfill Closure Issues

In 2004 Drs. Henry S. Cole and G. Fred Lee were appointed advisors to the Pottstown Landfill Closure Committee to assist this committee in understanding landfill closure and postclosure issues and to raise issues that the committee should consider in working with the Pennsylvania Department of Environmental Protection (DEP) in closing the Pottstown Landfill. They were also charged with the responsibility of advising the committee on developing adequate postclosure monitoring and maintenance of this landfill that will protect public health and the environment from landfill releases for as long as the wastes in this landfill will be a threat.

The Pottstown Landfill was originally started as an open dump that evolved into a classical sanitary landfill. In the 1980s, associated with DEP developing updated landfilling regulations, plastic sheeting and clay liners were added to new sections of the landfill to develop a dry tomb type landfill. The Pottstown Landfill is an approximately 200-acre municipal solid waste (MSW) landfill owned/operated by Waste Management of Pennsylvania, which was scheduled to close (stop accepting wastes) in 2005. The Pottstown Landfill Closure Committee consisted of elected officials of Pottstown and several neighboring communities and two counties that are impacted by the landfill.

Cole and Lee reviewed the design of the landfill, its hydrogeological setting, and operating records that were in the DEP files on this landfill. They prepared a series of draft reports that were made available to the committee, DEP, Waste Management and others interested, for review and comments. These reports were finalized based on comments received. The final reports and copies of PowerPoint presentations to the committee are available on www.gfredlee.com in the Landfills-Groundwater section, Examples of Specific Landfill Studies subsection, at

http://www.gfredlee.com/plandfil2.htm#examples.

These reports include a detailed review of the expected performance of the Pottstown Landfill containment (liner and cover) and monitoring systems (Lee and Jones-Lee 2005a,b). Of particular importance is the discussion of the expected performance of the landfill liners, leak detection system and groundwater and landfill gas monitoring systems over the time that the wastes in the Pottstown Landfill would be expected to be a threat to release chemicals to the environment. While these discussions are specific to the Pottstown Landfill situation, they have application to many MSW dry tomb landfills that are closed in accordance with US EPA Subtitle D requirements.

The current DEP landfilling regulations were developed in the 1980s prior to the promulgation/adoption of Subtitle D in the late 1980s to early 1990s. As reviewed by Lee and Jones-Lee (2006), Subtitle D regulations evolved out of a litigation settlement and included the Executive Office of Manpower and Budget requirement of not increasing the near-term cost of MSW landfilling, understanding that the landfill liner/cover systems will ultimately fail to prevent escape of waste-derived chemicals to

the environment. One of the most significant deficiencies in Subtitle D regulations is the failure of the US Congress/US EPA to provide assured postclosure monitoring and maintenance funding for as long as the MSW waste in a dry tomb landfill will be a threat – i.e., effectively forever.

The developers of Pennsylvania DEP landfilling regulations, who were not constrained by the politics of Subtitle D, had considerable foresight in landfill design, liner leakage detection and assured postclosure funding requirements, with the result that these regulations are far more protective than Subtitle D and potentially, with full implementation, more protective than most, if not all, state MSW landfilling regulations in the US. The Pennsylvania DEP landfilling requirements include a single composite liner that is underlain by a leak detection zone consisting of a geonet layer and a plastic sheeting HDPE liner that can enable leachate that penetrates the composite liner to be transported to a sump where the amount and chemical composition can be assessed. This system is especially important for the Pottstown Landfill since this landfill is underlain by a fractured rock hydrogeology with a high water table. The vertical monitoring wells spaced hundreds of feet apart around the perimeter of the landfill are grossly inadequate to reliably detect landfill liner leakage before offsite groundwater pollution occurs. However, if operated properly, the leak detection zone will serve as the primary basis for determining when the composite liner fails to prevent leachate from passing through it. The detection of leachate in the leak detection zone will be an indication that the low-permeability layer in the landfill cover is no longer effective in preventing moisture from entering the wastes and, therefore, needs to be repaired.

Another highly important feature of the Pennsylvania DEP MSW landfilling regulations is the requirement that a landfill owner provide for postclosure funding for as long as the wastes in a landfill represent a threat to release chemicals to the environment. When Cole and Lee first became involved with the Pottstown Landfill Closure Committee, they found that Waste Management had developed some propaganda that it made available to the committee claiming that it was only obligated to provide postclosure funding for 30 years after closure. Review of this issue with DEP staff confirmed that this assessment is incorrect. The DEP regulations do not contain the RCRA Subtitle D 30-year minimum postclosure funding period. Pennsylvania DEP works with a landfill owner to periodically update the amount of reserve funding that is available for postclosure monitoring and landfill maintenance. There is no time limit on the process.

While the Pennsylvania DEP landfilling regulations approach for postclosure funding, in principle, can accomplish the desired goal of the CIWMB's current efforts to develop assured postclosure funding for as long as the wastes are a threat, the key to the effectiveness of this approach is its implementation by the regulatory agencies. In order to ensure adequate implementation, a landfill closure committee should work closely with the regulatory agency to provide independent oversight throughout the postclosure period.

Waste Management has had chronic problems with inadequate control of gaseous emissions from the Pottstown Landfill, as evidenced by severe offsite odors. Cole

(2005a,b), in reviewing the physical characteristics of the landfill gas management system, found significant deficiencies in Waste Management's construction/maintenance of the low-permeability cover over those sections of the landfill that had previously been closed. An adequately constructed and maintained low-permeability cover should curtail the amount of moisture entering the closed cells of a landfill so that little or no leachate and landfill gas production occurs. However, the cells of the Pottstown Landfill that had been closed a number of years ago with a low-permeability cover were still producing leachate and gas at a high rate, clearly indicating that the low-permeability cover over these cells was not functioning as it should to adequately limit moisture from entering the landfill.

One of the problems that occurs at some landfills is that the landfill regulatory agency is inadequately funded to hire qualified staff to critically review the operating/monitoring records that are submitted to the regulatory agency by the landfill owner/operator. This situation can be especially acute for closed landfills, since agency staff would likely place greater regulatory attention on active landfills, especially those which are causing releases to the environment that are of concern to the public. In order to address this issue, Lee and Jones-Lee (2005a,b; 2006) recommended that, in addition to oversight by the regulatory agency, third-party, independent monitoring of the landfill that reports to a landfill closure committee be developed that is funded by the landfill owner as part of the landfill closure/postclosure costs.

Cole (2005a,b) concluded that the Pottstown Landfill gas migration monitoring system based on vertical monitoring wells was inadequate to have a high certainty of detecting subsurface gas migration before it trespasses under adjacent properties. The reliable monitoring of landfill gas emissions is an area that needs far greater attention than it is receiving today at the Pottstown Landfill and typically receives at other landfills.

The Cole and Lee experience in reviewing the closure and postclosure issues for the Pottstown Landfill provides valuable insight into a number of the issues that essentially all Subtitle D landfills will encounter. A major difference is that minimum design Subtitle D landfills will not have leak detection zones that can indicate when the landfill liner system has failed and groundwater pollution is occurring that may not be detected by the typical groundwater monitoring well arrays located at the point of compliance for groundwater monitoring. Further, minimum design Subtitle D landfills will not have regulations in place that require that the regulatory agency periodically review the adequacy of postclosure funding throughout the postclosure period, for as long as the wastes in the landfill are a threat to release chemicals to the environment.

It will be important that those potentially impacted by a closed landfill develop a landfill closure committee that can actively work with the regulatory agencies in reviewing the adequacy of closure of the landfill and the funding for monitoring and maintenance during the postclosure period – i.e., for as long as the wastes represent a threat.

**References for Appendix B**

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