LONG-TERM CARE FOR LANDFILLS: MORE OR LESS?

Raymond J. Dever, P.E.
Vice President, SCS Engineers
Tampa, Florida

and

James J. Walsh, P.E.
President, SCS Engineers
Cincinnati, Ohio

ABSTRACT

Some drastic potential changes to the current long-term care requirements for landfills, which could impact the financial viability of landfills in the United States, have recently been proposed. Both the U.S. EPA and the California Integrated Waste Management Board have opened discussions on this topic, and there is a major technical and policy debate on the horizon, with the outcome having long-term consequences for landfills and for integrated waste management in the U.S. This paper presents an overview of this pending debate, examines the cases on both sides of the issue, and discusses SWANA's plans for involvement in this debate, including some initial thoughts on ways to address the issue.

OVERVIEW

Since the adoption of the Subtitle D regulations for municipal solid waste (MSW) landfills in 1991, under the federal Resource Conservation and Recovery Act (RCRA), there have been critics who have expressed the opinion that lined landfills represent a flawed technology for waste disposal and that all landfill liner systems will eventually fail. More recently, this argument has been tied into the debate over the appropriate length of the long-term care period after landfill closure.

Fundamental changes in the regulatory requirements for financial assurance and long-term care have been proposed by the Grass Roots Recycling Network (GRRN) and the Sierra Club, initially in California. The basic premise of the GRRN proposal is since the liner systems of all Subtitle D landfills will eventually fail, financial assurance for all landfills needs to include significant future remediation costs and the long-term care period needs to be unlimited. Although the GRRN is open about the fact that one of their motives is to increase the cost of landfilling by these changes and to make other options like organics composting more cost-competitive, their arguments are thought-provoking and are likely to be given serious consideration.

At the same time that the case for unlimited long-term care is being made, landfill bioreactor proponents are making the case for shortening the long-term care period requirement for bioreactors, due to accelerated and more complete waste decomposition. Significant research on reducing long-term care and defining landfill stabilization, including ongoing research being funded by the Environmental Research and Education Foundation (EREF), is being conducted and has been presented in a number of venues, including previous landfill symposia sponsored by SWANA.

One final driving force behind this debate is that the end of the long-term care period for the first generation of lined landfills is not far off, and regulatory agencies will soon be faced with decisions about ending or extending long-term care for specific landfills.

LONG-TERM CARE REQUIREMENTS

The minimum long-term care and financial assurance requirements for municipal solid waste landfills, promulgated under Subtitle D of RCRA, are given in 40 CFR Part 258. These requirements state that post-closure care must be conducted for a 30-year period after formal closure of the landfill. The length of this post-closure care period may be increased if deemed necessary to protect human health and the environment, or decreased if it is demonstrated that a reduced period will still protect human health and the environment.

Associated with the long-term care requirement is a financial assurance requirement, whereby the owner or operator is required to demonstrate that they have the financial means to conduct closure and long-term care for 30 years, in order to be granted a permit to operate their landfill. The regulatory requirements for long-term care and financial assurance are the legacy of the era of highly publicized abandoned dump sites, such as Love Canal. These horror stories were one of the driving forces behind

the major environmental legislation of the 1970's, including the Clean Water Act, the Clean Air Act, the Safe Drinking Water Act, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund), and RCRA.

In practice, the cost of funding the required financial assurance mechanism becomes one of the costs of operating a landfill. If the long-term care requirements were to be significantly increased, then the associated financial assurance costs would similarly increase. These cost increases could conceivably increase the cost of landfills to the point where they would no longer be the lowest cost waste management alternative, and the relative hierarchy of integrated solid waste management options could shift significantly.

LANDFILL LONGEVITY

One of the issues at the center of the debate over the appropriate duration for long-term care is the expected service life or longevity of landfill liner systems. The question of the longevity of landfill liner systems has been examined and debated since the advent of geomembrane liners, and research on this topic continues. After some documented problems in the early days of lined landfills with the use of materials such as polyvinyl chloride (PVC) as bottom liners, the geosynthetics industry has developed a selection of more durable geomembrane products for landfill applications, principally using high density polyethylene (HDPE).

Since our experience with lined landfills has been limited to only the past 25 years or so, and actual forensic data about liner system performance is extremely limited, most of the technical literature on this topic is based on various forms of research. Unfortunately, the literature is limited and inconclusive on this topic.

Most of the research on the longevity of landfill liner systems has focused on the seamed geomembrane liner material itself and the mechanisms by which it deteriorates over time, principally the development of holes and the oxidation of the liner material. Recent research (Bonaparte, 2002; Needham, 2004) is postulating that geomembrane liners will last on the order of 750 to 1,000 years.

On the other hand, the manufacturers of geomembrane liners have significantly reduced the material warranties that they offer, compared to the warranties that were offered during the early days of lined landfills. A five-year warranty is the typical warranty now offered in the industry. A recent paper by one of the geomembrane manufacturers (Ivy, 2000) extolled a study showing that an HDPE pond liner had been in service for 20 years with little deterioration. Clearly, there is a disconnect when respected members of the landfill industry differ by almost two orders of magnitude on their perception of what the realistic service life of a landfill liner is.

A larger issue is that the life of a liner system is determined by many more factors than just the length of time that a piece of HDPE will last. The liner system obviously consists of several components including the subbase, a combination of low permeability containment layers such as HDPE, compacted clay, and/or geosynthetic clay liner (GCL), and a leachate collection and removal system consisting of some combination of pipes, geonets, drainage aggregates, and pumps. Besides the physical system itself, the effectiveness of the liner system depends on its operation and maintenance (O&M) over an extended period of time and on the institutions that support this O&M. Failure of any of these physical or institutional components can contribute to a loss of effectiveness of the landfill liner system long before the HDPE deteriorates.

THE CASE FOR MORE LONG-TERM CARE

The case for increasing landfill long-term care requirements is based on the premise that landfill liner systems will fail while the landfilled waste mass still poses a threat to human health and the environment, potentially well beyond 30 years after closure. Therefore, current requirements must be changed because they do not include sufficient time or potential remediation costs to address these future problems.

This case most recently been made by the GRRN to the California Integrated Waste Management Board in response to their request for public comments on the appropriate length of the post-closure care period for MSW landfills (Wood, 2004). In their comments, the GRRN has postulated that if an unlimited long-term care period and worst case remediation costs are included, the financial assurance for closed landfills would be two orders of magnitude greater than typical current costs.

If such changes in long-term care and financial assurance were to be implemented, then the cost of landfilling waste would in all likelihood significantly exceed the cost of alternatives, such as recycling and organics composting, which is precisely the outcome that groups such as GRRN are seeking. Since the promulgation of the Subtitle D regulations in 1991, it has been no secret that many environmental groups have hoped that increased regulation of landfills would eventually make them no longer feasible financially. While the concerns raised by these groups about the possible failure of liner systems and the adequacy of long-term care requirements are legitimate questions, it should be recognized that these groups bring a certain prejudice against landfills to this debate.

THE CASE FOR LESS LONG-TERM CARE

The most active and promising area of recent research in the landfill industry has obviously been the bioreactor landfill. With the controlled recirculation of leachate and additional liquids in a bioreactor, faster and more complete waste decomposition can be achieved than in a conventional landfill operation. In addition, the generation of landfill gas and leachate, the decomposition byproducts that pose potential threats to human health and safety and the environment, will also be reduced in duration by a bioreactor. Given this accelerated waste stabilization, a decrease in the required long-term care period has been identified as one of the most significant potential benefits of bioreactors.

Some researchers (Jones, 2000) have recognized the additional, related benefit that a bioreactor landfill would potentially be stabilized long before the liner system and other environmental controls failed. In the context of the topic of this paper, this last benefit of bioreactors may be the most significant of all. Coupled with the risk-based approach to determining an appropriate duration for long-term care at specific sites being developed in research funded by EREF (Houlihan, 2002; Morris, 2003), this accelerated waste stabilization may point the way to some solutions to the long-term care issues raised in this paper.

A NEW DESIGN APPROACH FOR LANDFILLS

One possible solution to the dilemma posed by competing calls to lengthen or shorten the required landfill long-term care period lies in our approach to designing and operating landfills. The current approach embodied in the Subtitle D regulations and the state equivalents is to design and construct a landfill following the prescriptive liner system design in the regulations, to operate and eventually close the landfill, and then to monitor the closed landfill for potential impacts on the environment. There is nothing in the current design regulations or the underlying philosophy that considers the expected and necessary life of the landfill systems when compared to the expected duration of potential environmental risks from the landfill. The duration of environmental risks is considered solely in the context of the post-closure period, long after the landfill has been designed, constructed, and operated.

If we were to take a more integrated approach to the life cycle design and operation of a landfill, then we would inevitably link the design requirements for landfill systems to the expected duration of the associated environmental risks, which are in turn linked to how the landfill is operated. If this approach were embodied in the Subtitle D regulations, then we can change from the almost unanswerable question of how long does the post-closure care period need to be, to the more appropriate question of how long do the environmental controls of the landfill need to last? When faced with the task of ensuring that the designed and constructed landfill will last the duration required to protect the environment, then landfill operational approaches like bioreactors that shorten this duration will become much more attractive to landfill designers, owners, and operators.

CONCLUSIONS

This paper has examined the debate between those who want the long-term care requirements for closed landfills increased, in anticipation of the inevitable failure of landfill liner systems, and those who want to implement bioreactor technology, which would reduce the long-term care requirements for closed landfills. Conclusions include the following:

- The issue of the appropriate length of landfill long-term care deserves attention not only because of competing views with respect to shortening or lengthening this period, but also because the first generation of landfills closed under Subtitle D is nearing the end of their long-term care periods. Regulatory agencies will soon be faced with decisions about ending or extending long-term care for specific landfills.

- An area of research that deserves continued attention is the service life of landfill liner systems. This research needs to be expanded to include all the physical and institutional components that comprise an effective containment system.

- While the proponents of increased long-term care and financial assurance for closed landfills have raised some legitimate issues, it needs to be recognized that they have an underlying agenda to eliminate the financial advantage that landfills currently have over alternative waste management methods that they prefer.

- A possible solution to the long-term care issues described in this paper is to alter the landfill design philosophy embodied in the current regulations to one that explicitly links the necessary design life of the landfill systems to the expected duration of potential environmental risks from the landfill.

- If this landfill design philosophy were adopted, the more rapid stabilization of bioreactor landfills should increase their attractiveness. In fact, this may ultimately be the most important benefit of bioreactor technology.

REFERENCES

Bonaparte, R., "Long-Term Performance of Landfills," *Proceedings of the ASCE Specialty Conference Geoenvironment 2000*, American Society of Civil Engineers, 1995

Florida Department of Environmental Protection, Chapter 62-701, Florida Administrative Code, "Solid Waste Management Facilities"

Houlihan, M.F. et al, "A Risk-Based System for Post-Closure Care – Reforming the 30-Year Time-Based System of RCRA Subtitle D," *Proceedings from SWANA's 7th Annual Landfill Symposium*, Louisville, KY, June 2002

Ivy, Nathan, "HDPE Geomembrane After 20 Years of Service", *Geotechnical Fabrics Report*, June/July, 2000

Jones, J.R., et al, "A Life-Cycle Inventory Comparison of a Bioreactor and Traditional Subtitle D Landfill," *Proceedings of WasteTech 2000*, March 2000

Lee, G. Fred and Anne Jones Lee, "Flawed Technology of Subtitle D Landfilling of Municipal Solid Waste", unpublished report, March 2005

Lee, G. Fred and Anne Jones Lee, "Overview of Subtitle D Landfill Design, Operation, Closure and Post-Closure Relative to Providing Public Health and Environmental Protection for as Long as the Wastes in the Landfill will be a Threat", unpublished report, January 2004

Lee, G. Fred, "Detecting Failure of Subtitle D Landfill Liner Systems", unpublished report, November 1999

Lee, G. F. and Jones-Lee, A., "Geosynthetic Liner Systems for Municipal Solid Waste Landfills: An Inadequate Technology for Protection of Groundwater Quality," *Waste Management & Research*, 11:354-360, 1993

Levin, S.B., "Objective Review of Bioreactor Implementation,", *Proceedings of WasteTech 2000*, March 2000

Morris, J. et al, *Performance-Based System for Post-Closure Care at MSW Landfills – A New Approach to the Current 30-Year Time-Based System of Subtitle D*, Environmental Education and Research Foundation, February 2003

Needham, A., et al, *The Likely Medium to Long-Term Generation of Defects in Geomembrane Liners*, Environment Agency, UK, January 2004

O'Brien, Jeremy, "Recent Studies Indicate Minimal Heavy Metal Releases from MSW Landfills," *MSW Management*, May/June, 2005

Shaw, P.A. and A.J. Knight, "Quantitative Analysis of Potential Savings and Earnings by Implementing a Bioreactor Landfill," *Proceedings of WasteTech 2000*, March 2000

US EPA, "Criteria for Municipal Solid Waste Landfills", 40 CFR Part 258

Wood, D.E., Grass Roots Recycling Network, and B. Magavern, Sierra Club, correspondence to California Integrated Waste Management Board, May 19, 2004