A Groundwater Protection Strategy for Lined Landfills

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EPA's groundwater monitoring program, ostensibly designed to detect failure of landfill liners for Subtitle C (hazardous waste) and Subtitle D (municipal solid waste) waste management facilities, does not support reliable early detection of groundwater pollution. A significantly different approach is needed to address the fundamental flaws in the design of the EPA program, which is being adopted by states to detect leakage from lined landfills. This strategy would utilize a leak detection system within the landfill liner and would require a reliable source of funds for the inevitable need for exhumation of landfill wastes once a leak is detected.

As shown in Figure 1, the nature of incipient leakage from a lined landfill is significantly different from that from an unlined landfill. The groundwater monitoring programs used today for lined landfills presume that the leachate plume develops across the landfill and moves in a wide front in the groundwater. However, initial leakage from a lined landfill will be from point sources--holes, tears, imperfections--in the liner system. Those point sources will produce leachate-contaminated groundwater plumes that move as fairly narrow "fingers" with limited lateral spread in the distance between the landfill and the point of compliance for groundwater monitoring (1). Because of the limited zone of capture of conventional vertical monitoring wells (about 1 ft), their wide spacing, and the nature of incipient leakage, the current practice of groundwater monitoring at lined landfills is cosmetic and of little utility in protecting groundwater resources from pollution by leachate.

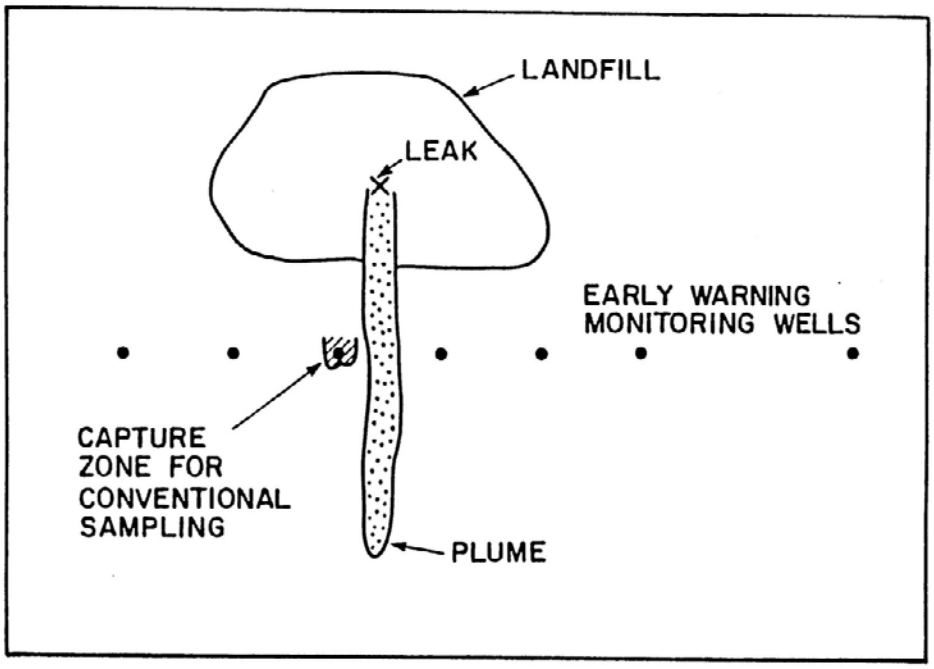
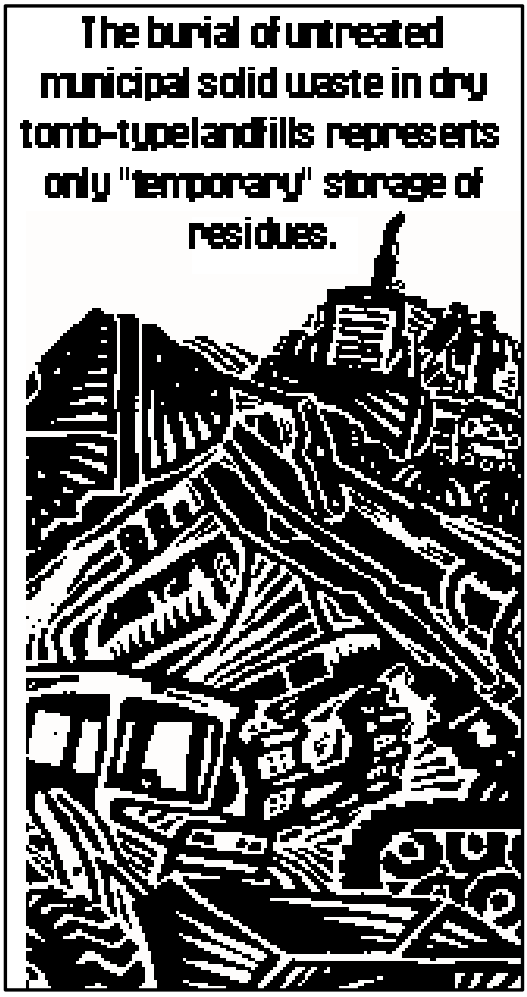


Figure 1. Pattern of Landfill Leakage from Lined Landfills (after Cherry, 1990)

A reasonable requirement for a groundwater monitoring system is that it demonstrate at least a 95% probability of detecting the incipient presence of leachate-polluted groundwaters at the point of compliance for the monitoring system. Although it is technically feasible to implement that performance requirement with a "picket fence" of vertical monitoring wells spaced a few feet apart along the downgradient, the cost would be high.

A Permanent Threat

Hazardous waste and municipal solid waste dry-tomb landfills represent an ongoing threat to groundwater quality. Because the plastic sheeting used in the composite liners in Subtitle C and D landfills will eventually deteriorate, and because there is virtually no possibility that landfill covers of the type being constructed today will keep moisture out of the landfill for as long as the wastes represent a threat--that is, forever--it is inevitable that leachate will migrate through the liner to pollute the underlying groundwater.



At best, groundwater monitoring detects leachate pollution after the fact. In areas where groundwater could be used for domestic or any other purposes, the presence of Subtitle C and D landfills represents a continuing threat unless an approach is implemented and maintained to provide appropriate intervention before leachate can reach the groundwater. Thus, instead of relying on groundwater monitoring to detect liner failure, we suggest the practice of direct monitoring for failure of the uppermost composite liner in a Subtitle C landfill or the composite liner in a Subtitle D landfill.

We propose (2) the use of a pan lysimeter monitoring system that would underlie the full landfill area. This approach would include a double-composite liner system in which the lower composite liner would be used for leak detection. Such a system would reveal when leachate has leaked through the upper composite liner to a sufficient extent to pollute the groundwater under the landfill and render it unusable for domestic water supply purposes. Although Subtitle C landfills (and, in a number of states, Subtitle D landfills) incorporate double composite liner systems, the lower liner is simply relied upon as an additional barrier to leachate migration. In our system, however, the function of the lower liner is not the last level of containment but rather the first line of leak detection.

Action Plan and Funding

A pan lysimeter leak detection system that underlies the full landfill area offers the possibility of determining, with a high degree of reliability, leakage through the upper composite liner before widespread groundwater pollution occurs. However, simply detecting a leak in the upper composite liner will not necessarily protect groundwater resources (2). With the current approach to landfill design, it is not possible to locate and repair a leak without waste exhumation, and the liner may be buried under hundreds of feet of solid waste.

We suggest that an integral part of any landfill liner leak detection system be an action program with a dedicated source of funding for as long as the wastes represent a threat. Potential action programs might include improving the efficacy of the cover so as to reduce the entrance of moisture into the landfill, which leads to leachate generation, or exhumation of the wastes from the dry-tomb landfill, proper treatment to remove the pollution potential of the waste constituents, and reburial of the nonrecyclable treated residues. This approach recognizes that the burial of untreated and treated hazardous waste as is now being practiced, and of untreated municipal solid waste in dry-tomb-type landfills, represents only "temporary" storage of residues.

This approach further recognizes that those residues will ultimate have to be exhumed and properly managed if groundwater quality is to be protected in accord with the overall performance standards contained in EPA and many states' landfill regulations. Regulations for protection of groundwater quality typically do not set a limit on the period during which such protection is to be achieved. Rather, they imply or even explicitly state--as in the case of California--that protection is to be achieved for as long as the wastes are a threat, which almost certainly will be forever for municipal solid waste, treated hazardous waste, and virtually all "nonhazardous" industrial waste in monofills (2, 3).

The approach currently being used by the EPA and many states to provide for only 30 years of post-closure care funding is inadequate (3, 4); municipal solid wastes and treated hazardous waste residues will be a threat to groundwater quality as long as they are in the dry-tomb landfill. Furthermore, many of the financial instruments being used for post-closure funding have limited reliability for ensuring that sufficient funds in fact will be available when needed to address not only routine maintenance and monitoring but also the inevitable failure of the liner systems.

A dedicated trust generated as part of disposal fees provides a mechanism by which funds can be made available to meet post-closure needs (5). The interest generated from the monitoring and maintenance trust funds has to be sufficient to provide a perpetual, self-generating funding base for cover maintenance and for eventual waste exhumation and appropriate treatment and management of the treated residues.

Although the proposed approach for operation and monitoring of dry-tomb type landfills will initially cost somewhat more for those who generate the wastes, it will be less costly in the long term and the costs will be paid by those using the facility. Future generations will not be required to endure the ramifications of leachate-polluted groundwater and to spend funds to stop the spread of groundwater pollution arising from the inadequacies of a dry-tomb landfilling approach that uses plastic sheeting, compacted clay liners, and groundwater monitoring programs to detect leachate leakage.

References

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