Checklist of MSW Landfill Groundwater and Environmental Protection Issues

Developed by
G. Fred Lee, PhD, PE, BCEE, F.ASCE Anne Jones-Lee, PhD
G. Fred Lee & Associates
El Macero, California
gfredlee33@gmail.com www.gfredlee.com
April 2012

Listed below are issues that need to be evaluated in developing MSW landfills to improve protection of groundwater and environmental quality.

- Siting Issues
  - US EPA Subtitle D location criteria – Landfills should not be located:
    - near an airport runway
    - in a floodplain
    - within 200 ft of a fault
    - in a wetland
    - in a seismic impact zone
    - in a geological unstable area
  - Need to also consider
    - Where there is natural protection of groundwater protection, avoid fractured rock, cavernous limestone, and sandy lens areas
    - Areas with high water table where groundwater can enter the wastes are unsuitable for landfills. Artificial lowering of water table with under-landfill drains and/or by pumping is not reliable for preventing entrance of groundwater into landfill wastes
    - Areas that periodically flood due to intense rainfall runoff through the area should be avoided as sites for landfills since the construction of dikes to divert stormwater run on and runoff can alter the downstream hydrology and cause flooding in areas that do not normally flood. Also dikes require long term post post closure maintenance.
    - Deep water table does not ensure protection, only delays when pollution occurs.
    - Adequate separation of water table and the bottom of the wastes
    - Cracks in clay layers
    - Adequate buffer zone between waste deposition and adjacent property lines. Sufficient buffer lands should be included on the landfill property to adequately control the operational impacts of the landfill that lead to justified "Not in My Backyard" (NIMBY) concerns including:
      - offsite odors, adverse view of landfill area from adjacent properties through the use of screening (tree line), fugitive windblown paper and other wastes, offsite noise, offsite light pollution by operation at night, mud on the public streets, lines of garbage trucks waiting to enter the landfill on public roads, roadside dumping of garbage near the landfill by the public, circling birds that in flight defecate on adjacent properties, significant nearby property value decrease. Often a mile of landfill owned buffer needed to dissipate releases on landfill property

        - Where groundwater discharges to surface waters
        - Maximum rate of transport to offsite groundwater not the geometric mean should be used
        - Impacts of sea level rise on the landfill
- Liner Design
    - Single composite liner not reliable. Use double-composite liner with leak detection layer between composite liners
    - Use presence of leachate in leachate collection area as an indication of landfill cover failure
    - GLC liner not a longterm reliable substitute for compacted clay liner
    - Landfill liners will leak at locations other than just under the sump
- Groundwater Monitoring
    - Should be based on detecting leachate in the leak detection layer between the two composite liners. If leachate is found in that layer, the upper composite liner has failed to prevent leachate from passing through it. If that occurs, the landfill cover is no longer effective in preventing penetration of water and the plastic sheeting layer in the cover needs to be repaired.
    - If a single-composite liner is used, the groundwater monitoring should be conducted with vertical monitoring wells that are spaced sufficiently close together to ensure a 95% probability that leachate-polluted groundwater is detected when it first reaches the point of compliance for groundwater monitoring, for leaks in the liner that occur at the down groundwater gradient edge of the landfill. To achieve that level of reliability a site-specific evaluation of the spread/pluming of leachate-polluted groundwater that is expected to occur at the site.
    - Must be able to reliably predict the rate and extent of migration of landfill-derived pollutants in the aquifer system(s) that could be anticipated to be polluted by the failure of the landfill liners.
    - An evaluation should be made of the potential for new offsite production wells to change the direction of pollutant migration in the offsite areas.
    - The monitoring parameters should include not only the constituents for which there are drinking water MCLs but also all chemical parameters that have the potential to impair the use of the groundwater for domestic purposes, including taste and odors. If groundwater enters surface water use aquatic life criteria as critical concentrations.
    - In planning the ongoing groundwater and leachate monitoring programs consideration needs to be given to currently unrecognized pollutants that can be in leachate that will become recognized as pollutants in the future.
    - Since some of the US EPA drinking water MCLS have been set based on factors other than impacts on public health, before an MCL is used for evaluating potential impacts of the chemical the MCL should be examine to see if meeting it provides protection of human health. If it does not, the risk-based concentration of the chemical parameter should be used to evaluate the pollution of groundwater by landfill leachate.
    - Water supply wells located on adjacent and nearby properties that could be polluted by landfill leachate should be monitored to determine if any chemical parameters or pathogenic organisms associated with landfill leachate and has reached the well; this should include so-called “non-hazardous” constituents as those parameters would signal potential contamination of the well water by potentially hazardous/deleterious

constituents that are not included in the analytical regimen. Offsite monitoring well monitoring should be funded by landfill owner and conducted by independent third party reporting to the property owners/users and the regulatory agencies.

- Surface Water Issues
  - Dikes constructed to divert stormwater run-on and runoff can alter the downstream hydrology and cause flooding in areas that do not normally flood
  - Stormwater runoff from the landfill area must be monitored for the presence of pollutants
  - Landfill leachate should not be used as dust suppressant because of stormwater runoff pollution.
  - Evaluate the impact of constructing a landfill near a wetland on the quality of the groundwater and surface water that supply the wetland
  - Evaluate the surface waters that stand to be impacted by leachate-polluted groundwater or runoff from the landfill. Some contaminants are hazardous to aquatic life in concentrations below those that adversely affect human health.
- Landfill Closure
  - Leak-detectable covers should be installed, and operated and maintained for as long as the wastes are a threat to generate leachate when contact by water
  - If a conventional Subtitle D cover is used, funds should be set aside for rigorous inspection and searches for areas of deterioration of the plastic sheeting layer; this will be difficult because that layer is beneath cover soil and vegetation. The generation of leachate after landfill closure with a low-permeability cover is an indication that the integrity of the cover has been compromised and should trigger the repair/replacement of the cover. Repair will be difficult because there is little ability to isolate the specific area of the cover that has been breached.
  - The integrity of the landfill cover should be assessed based on monitoring for the presence of leachate in the leachate collection sump.
  - The US EPA HELP model not reliable for estimating water penetration through the cover or leachate generation rates over the period during which the wastes in the landfill will be a threat.
  - Where consideration is given to the use of an alternative landfill cover, such as an evaporative cover in an arid environment, the rainfall history at the site should be carefully reviewed to determine whether rainfall events that have occurred or could occur at the site could cause penetration of moisture through the cover into the wastes. A low average precipitation does not preclude the occurrence of penetrating rains.
  - Covered landfill should not be re-used for any activity that could compromise integrity of cover or increase the potential for water infiltration, such as a golf course.
- Gas Collection/Management issues
  - Landfill gas is a public health threat due to odors and hazardous chemicals
  - Offsite odors should not be allowed; they are hazardous to public health
    - Odor masking agents should not be used because they do not control the hazardous chemicals in landfill gas releases
  - Active and effective gas collection systems with adequate vacuum must be used in the landfill and in the leachate collection system for as long as the wastes in the landfill can generate leachate. Gas removal pipes should be installed in the leachate collection system to remove landfill gas that enters this area. The gas collection systems should be

designed to last, and should be maintained, for as long as the wastes in the landfill can generate landfill gas when exposed to water.
    - The US EPA LandGem model does not reliably estimate landfill gas generation rate over the period during which the wastes in a dry-tomb landfill will be a threat.
    - Landfill gas can lead to groundwater pollution when it migrates through the landfill liner system, "up-groundwater-gradient" as well as "down-groundwater-gradient."
- Leachate generation
    - Leachate can be generated as long as there are materials in the landfill that can leach contaminants when exposed to water. The more effective the cover is in keeping water out of the wastes, the longer leachate generation can be postponed.
    - The presence of bagged wastes prolongs the period over which leachate and gas can be generated because the plastic can shield otherwise fermentable/leachable wastes from moisture. Even with significant moisture breach into a landfill, some wastes will not be exposed to the liquid until the plastic decomposes.
- Operations
    - Prevent the disposal of MSW in plastic, non-degradable or slowly degradable plastic bags
        - If plastic-bagged MSW is allowed to be deposited the landfill, the MSW should be shredded prior to deposition.
    - Sufficient daily cover should be used to control offsite odors, and scavenging by rodents, birds and other animals
    - If a cloth or plastic cover, rather than an earthen cover, is used for daily cover, it should be managed in such a way so as to prevent the release of odors offsite when the daily cover is removed.
    - Operations checklist:
        - Pick up all windblown litter, roadside dumping of garbage, mud of the public roads, circling birds, each day.
        - Prevent garbage trucks waiting to enter the landfill from queuing up on public roads.
        - Sufficient daily cover should be used to control offsite odors, animals' scavenging.
        - Have contingency plans in place to assess and mitigate impacts of large stormwater runoff events such as can occur after a 24-hr 100-yr storm.
        - Routinely and actively monitor for offsite impacts of landfilling operation such as noise, odors, view/aesthetic disruption. Complaints should not have to be registered before action is taken for such problems.
- Landfill Maintenance
    - Maintenance of all landfill systems, including the landfill cover, monitoring system, and gas collection system, should be conducted for as long as the wastes in the landfill will be a threat.
        - The maintenance program should be sufficiently rigorous and complete to provide a high degree of certainty that weakness and incipient failures of landfill containment and monitoring systems will be detected and expediently repaired.
    - After major precipitation events the landfill cover and stormwater drainage ways should be inspected for erosion damage and repaired for as long as he wastes in the landfill can generate leachate when in contact with water.
    - A contingency plan should be in place to address potential additional onsite and offsite impacts caused by a storm greater than the 24-hr 100-yr event.

- Landfill Postclosure Funding
  - The US EPA RCRA-prescribed 30-year postclosure period of assured funding is a small portion of the time during which the wastes in a dry-tomb landfill will be a threat.
  - Realistic provisions for funding closure, postclosure monitoring, maintenance, and groundwater remediation should be established at the time the landfill is developed, and to be derived from disposal fees collected. Those fees should be of sufficient magnitude so that when they are maintained in a dedicated trust fund will generate enough resources to address plausible worst-case scenario failures for as long as the wastes in the landfill will be a threat, essentially *ad infinitum*.
  - The period of postclosure funding should extend for as long as the wastes in the landfill can generate leachate and/or landfill gas when contacted by water. For planning purposes, the postclosure funding period should be assumed to be at least 100 years.
- Alternative Domestic Water Supply for Offsite Polluted Groundwater
  - Postclosure funding should include funding to provide for an alternate domestic water supply if the offsite groundwaters are polluted by landfill leachate.
  - Existing water supply wells should be monitored for the presence of leachate-derived chemicals
- Fermentation–Leaching Landfills
  - A fermentation/leaching landfill of the type described by Lee and Jones-Lee would, if properly developed, operated, and monitored, offer a conceptually and fundamentally greater likelihood of long-term protection of public health and environmental quality than dry-tomb-type landfills.