

## **Monitoring the Impacts of Landfills during their Active Life<sup>1</sup>**

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Municipal solid waste landfills are notorious for having adverse impacts on those within their sphere of influence during the active life of the landfill (the period of time that wastes are received by the landfill). This situation leads to a justified NIMBY (“not in my backyard”) attitude on the part of the public. Lee and Jones-Lee (2005), in their “flawed technology” review of US EPA Subtitle D landfilling of municipal solid waste, discuss the issues that lead to justified NIMBY. Presented herein is a discussion of the characteristics of the monitoring program that should be conducted during the active life of a landfill in order to obtain the information needed to possibly address many of the adverse impacts of the landfill on the health, welfare and interests of those potentially impacted by the landfill.

Lee and Jones-Lee (2005) present a list of the adverse impacts that can occur for today’s Subtitle D municipal solid waste landfills. This list is presented in Table 1.

**Table 1**  
**Adverse Impacts of “Dry Tomb” Landfills on Adjacent/Nearby**  
**Property Owners/Users**

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- public health, economic and aesthetic aspects of groundwater and surface water quality
  - methane and VOC migration - public health hazards, explosions and toxicity to plants
  - illegal roadside dumping and litter near landfill
  - truck traffic
  - noise
  - dust and wind-blown litter
  - odors
  - vectors, insects, rodents, birds
  - condemnation of adjacent property for future land uses
  - decrease in property values
  - impaired view
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From Lee et al. (1994)

In order to better protect the interests of those potentially impacted by a landfill, each of these potential adverse impacts should be evaluated by a third-party (independent) monitoring program.

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<sup>1</sup> Reference as Lee, G. F., and Jones-Lee, “Monitoring the Impacts of Landfills during their Active Life,” report of G. Fred Lee & Associates, El Macero, CA (2005)

### **Organizing the Monitoring Program**

In order to achieve the required operations of a municipal solid waste (MSW) landfill while minimizing/eliminating the adverse impacts on those within the sphere of influence of the landfill, there is need for third-party monitoring of the landfill operations. Those concerned about the potential impact of a landfill should organize a landfill monitoring committee (Committee) that would be responsible for developing and implementing this program. This Committee should work with the local regulatory agency(s) for the landfill in detecting and then minimizing/controlling the adverse impacts of the landfill. A cooperative approach on the part of the landfill owner/operator can greatly facilitate minimizing the adverse impacts of the landfill on those within the sphere of influence of it. An attempt should be made to gain the cooperation of the landfill owner/operator in organizing and implementing the monitoring program.

Normally the Committee will need technical assistance from one or more individuals who can conduct the monitoring and interpret the results of the monitoring program. It can be expected that from \$50,000 to \$100,000 per year will be needed to fund a credible active-life-impact monitoring program that is designed to protect the interests of those potentially impacted by the landfill. Ideally, the landfill owner/operator will provide the Committee with the funds needed to support the technical assistance that the Committee needs. If this is not possible, then the Committee will have to support the monitoring from other sources. It may be possible, as part of obtaining a permit to develop or expand a landfill, to include financial support from the landfill owner/operator for the independent third-party monitoring.

The third-party independent monitoring should not in any way reduce the need for monitoring by the landfill owner/operator as well as regulatory agencies. The additional monitoring is designed to provide those who will be potentially impacted by the landfill with some assurance that the landfill owner/operator is adequately and reliably carrying out its monitoring responsibilities, and that the regulatory agency staff are properly and adequately inspecting the landfill for compliance with regulatory requirements and critically reviewing the monitoring that is provided by the landfill owner/operator. While the owner/operator may claim that there is no need for such monitoring, in fact there are numerous examples where landfill owners/operators are inadequately or unreliably conducting the required monitoring. Further, with ever-decreasing funding, the regulatory agencies are finding it more and more difficult to fully carry out their mandated responsibilities for monitoring of a landfill's operations.

Those conducting third-party monitoring should periodically, at no less than quarterly intervals, provide summary reports of their findings to the Committee and the regulatory agency(s). Further, a comprehensive annual monitoring report should be prepared in which all of the data and other information collected during the year is presented and discussed.

### **Permitting of the Landfill**

If possible, the Committee should be actively involved in working with the regulatory agencies in establishing landfill operating permit conditions. It should be made clear to the landfill owner/operator and the regulatory agencies that the past operation of landfills, where adjacent properties are used to dissipate releases and other adverse impacts of the landfill, will not be allowed. Each of the potential adverse impacts of a landfill need to be reviewed in order to work toward achieving operating permit conditions that will clearly limit the releases from the landfill

that are adverse to the adjacent and nearby property owners/users at the property line. The overall approach should be that of making sure that others can use the adjacent property at the property line without adverse impacts of the landfill. Establishing permit conditions that can be monitored and enforced by regulatory agencies if violations occur is instrumental in developing a monitoring program that can be protective of the interests of those potentially impacted by the landfill.

Whenever possible, the monitoring program should be initiated at least one year, or preferably several years, prior to the initiation of the landfill operation in order to gain background data on the conditions that exist in the area of the landfill.

### **Monitoring of Waste Receipt**

A monitoring program should be developed to evaluate whether the landfill owner/operator is conforming to the landfill permit conditions in terms of the amounts of wastes received each day and the types of waste received. The monitoring should include unannounced reviews of the amount of waste received during a period. This monitoring could include assessing the number of trucks and their loads of wastes received during a day.

Each landfill owner/operator must periodically check for illegal wastes (such as “hazardous” waste) in the waste received at the landfill. The monitoring should include a review of how the landfill owner/operator evaluates whether hazardous wastes and other inappropriate wastes are being received at the landfill.

### **Monitoring of Offsite Odors**

One of the most important adverse impacts of landfills during their active life is release of odors that trespass onto adjacent properties. Landfill owners/operators (and, unfortunately, some regulatory agencies) allow landfills to be developed without sufficient buffer lands between where the wastes are deposited and the property lines of adjacent properties. This is a recipe for highly offensive odors emitted from a municipal solid waste landfill to lead to justified NIMBY. It is the experience of the authors that at least one mile, and in some cases several miles, of property owned by the landfill owner/operator must exist between where wastes are deposited and adjacent property lines.

A number of landfills conduct composting at the landfill site. Such composting can be a significant additional source of odors that are derived from the landfill area. There are numerous examples of composting operations having to be closed because of the inability of those responsible for conducting the composting to control offsite odors. It is important that composting operations be conducted in such a way as to control odorous emissions so that they do not trespass onto adjacent properties.

One of the primary areas of activity of the Committee should be to establish an odor monitoring program to reliably document when odorous conditions exist at an adjacent property line. In addition to recording the presence of landfill odors, information should be obtained on the odor intensity and the distance from the landfill where the odor is present. The Committee should work with the regulatory agencies to establish the amount and type of documentation that is

needed in order to have the regulatory agencies strictly enforce the permit conditions regarding trespass of landfill odors onto adjacent properties.

If the landfill owner/operator tries to control offsite odors with odor-control chemicals, the monitoring should include evaluation of the potential for the odor control to introduce other odors that mask the landfill odor but do not prevent offsite odorous conditions at the property lines. As discussed by Lee and Jones-Lee (2005), offsite odors are an indication of the presence of airborne hazardous chemicals released from the landfill that, even if not odorous, can readily be a threat to those experiencing the odors or the masked odors.

### **Dust**

Many landfill operators experience problems with controlling dust emissions that can be a serious nuisance and health threat to adjacent property owners/users. Dust is derived from truck traffic, waste dumping and the deposition and manipulation of the daily cover. Landfill owners/operators should be required to control dust emissions so that there is no increase in dust at the adjacent property owners' property line. Monitoring should include an evaluation of whether the landfill operator is adequately controlling dust emissions from the landfill.

Some regulatory agencies will allow landfill operators to use leachate for dust control, where it is spread on the surface where dust is being generated. This approach should not be allowed, since leachate contains a variety of pollutants that can become airborne and/or can be associated with stormwater runoff from the landfill property. If the landfill operator attempts to use chemical dust suppressants, the monitoring program should include an evaluation of whether the dust suppressants represent a potential threat to public health and the environment, either associated with airborne dust or stormwater runoff.

### **Active Face Issues**

The size of the active face where daily wastes are deposited can be a significant problem area that can lead to offsite impacts. Many landfill owners/operators will claim that they will limit the size of the active face as part of an effort to reduce offsite odors and other adverse impacts of the landfill. Some regulatory agency landfill operating permit conditions restrict the size of the active face. It will be important to periodically check to see if the requirements imposed on a particular landfill operator regarding the size of the active face are being achieved. This should be part of the landfill monitoring program.

**Daily cover.** One of the frequent problem areas with landfills is the failure of the operator to provide adequate cover of the wastes deposited during a day. Typically a landfill operating permit will specify that a certain thickness of daily cover, typically soil, must be deposited on each day's wastes. Periodic monitoring of the thickness of the daily cover and the adequacy of its placement should be part of the landfill monitoring program.

An area of concern is the use of alternative daily cover approaches such as tarpaulins that cover the day's wastes. The removal of the tarp the next morning can result in offsite odors.

**Bird problems.** Gulls, crows and other birds can be a significant source of problems for those who live or use properties near landfills. Landfill owners/operators have claimed that they will

control bird populations that attempt to gain access to the active face of the landfill. In some cases large populations of birds will circle the landfill, and their droppings can become a nuisance/threat to those on adjacent properties. Monitoring needs to be done to determine whether the landfill operator is in fact effectively controlling the bird populations on the active face as well as those that circle the landfill.

***Insects, Rodents and Vermin.*** Periodic inspection of the landfill should be conducted to determine if flies (and other insects), rodents and other vermin are making use of the active face area of the landfill. Some landfills have severe problems with allowing flies to develop in the solid wastes which then become a nuisance and health hazard to those on adjacent properties. The monitoring program should include periodic review of these issues.

***Fugitive Wastes.*** A common problem at municipal solid waste landfills is windblown waste components. Under windy conditions substantial amounts of garbage components can become airborne, where they will be carried onto adjacent properties. Landfill owners/operators are typically required to install a trash fence to collect the windborne trash before it trespasses onto adjacent properties. The monitoring of the landfill operation should include determination of whether windborne trash is being transported to adjacent properties. When this does occur, a report that includes photographs should be filed with the regulatory agencies in an effort to try to force the landfill owner/operator to more effectively control the windborne solid waste components derived from the active face that are carried to adjacent properties.

### **Truck Traffic**

In addition to monitoring the number and size of trucks that bring garbage to the landfill, the Committee should monitor truck traffic to determine if the trucks are adverse to vehicular traffic through blocking the road, excessive speed and/or deposition of wastes along the roadway. Leaking trucks and inadequate waste cover are other potential problems that should be monitored. The monitoring program should include a review of these issues, where apparent violations should be reported to the appropriate authorities. In the reports, violations should be carefully documented to provide a written record of reporting.

During wet weather conditions, garbage trucks can carry large amounts of mud from the landfill property onto public streets and highways. This situation is a violation of many landfill operating permits and should not be allowed. The monitoring program should determine if the landfill operator is allowing mud to be tracked onto public streets/highways, through inspection of the areas during and following periods of rainfall. A photographic record of the conditions should be made in order to gain cooperation of the regulatory agency in enforcing permit requirements regarding mud on the streets/highways. It may become necessary to wash the mud from the garbage trucks before they leave the landfill area.

### **Roadside Litter**

Another common problem with municipal solid waste landfills is that individuals will deposit bags of garbage along the road near the landfill. As part of permitting a landfill, the regulatory agency should require that the landfill operator pick up any garbage that is deposited near the landfill. This should be done daily, usually the first thing in the morning. The monitoring

program should ensure that the landfill operator does this each day, through periodic inspection of the roadsides for litter.

### **Stormwater Runoff Water Quality Impacts**

Stormwater runoff from the landfill area should be monitored for pollutants. This is required by some regulatory agencies. It should be required by the appropriate regulatory agency for water pollution control. The Committee should review the results of the monitoring of stormwater runoff to determine if waste components/chemicals are present in the stormwater runoff. This will likely require acquiring technical assistance of an expert in water quality evaluation.

An issue of particular concern is the occurrence of leachate spills due to handling problems and/or breaks in leachate transfer pipes. Landfill operators are normally required to report such spills. The Committee should review how well the landfill operator cleans up spilled leachate.

Stormwater runoff water quality management programs typically include sediment ponds to trap sediment eroded from the landfill. The monitoring should include determining whether the landfill operator is adequately maintaining the pond depth by periodic cleaning. The disposition of the solids collected in the stormwater runoff ponds should be evaluated, since they can be polluted by waste-derived constituents.

Landfills are typically designed to prevent stormwater from flowing onto the landfill property. This can lead to changes in stormwater flow patterns for that area which can lead to flooding in offsite areas that did not experience flooding prior to the construction of the landfill, or to a worsening of previously existing flooding conditions. The stormwater flow patterns near the landfill should be monitored to determine if the landfill causes additional flooding problems in the area.

### **Leachate Management**

The adequacy of leachate management needs to be evaluated with respect to the potential for releases of hazardous and detrimental chemicals that can affect public health and the environment. In addition to spills associated with handling of leachate, there is concern that leachate ponds that are used at some landfills can be a source of groundwater pollution. Regulatory agencies allow some landfills to be developed with HDPE plastic sheeting lined ponds. Studies have shown that these lined ponds can begin to fail to contain the leachate within a few years. All leachate ponds should have a double composite liner system with a leak detection layer between the two composite liners. The composition of the liquid that is found in the leak detection layer should be reviewed by the Committee to determine if it contains leachate-derived components.

If single plastic sheeting or clay lined ponds are used, then a groundwater monitoring program should be required in order to determine when the pond liners fail.

### **Groundwater Monitoring**

One of the most significant adverse impacts of landfills is the pollution of groundwaters by landfill leachate. The US EPA Subtitle D regulations allow the construction of municipal solid waste landfills with a single composite liner. With proper quality construction, and appropriate

initial waste placement in the landfill, this landfill liner system can prevent groundwater pollution for decades. Even if there is inadequate quality control in the construction of the plastic sheeting part of the composite liner, the pollution of groundwater by landfill leachate may not be detected for many decades because of the unreliability of the groundwater monitoring programs that are allowed by regulatory agencies. The typical groundwater monitoring well array that is allowed, in which vertical monitoring wells are placed hundreds of feet apart at the point of compliance for groundwater monitoring, can be highly unreliable for detecting leachate-polluted groundwater when it first reaches the point of compliance for groundwater monitoring. The initial leakage through the plastic sheeting liner can form finger-like plumes that will only be a few feet wide at the point of groundwater monitoring. These finger plumes can pass the point of compliance without being detected by the monitoring wells.

An evaluation should be made of the ability of the groundwater monitoring system that is used to detect leachate-polluted groundwaters when they first reach the point of compliance for groundwater monitoring. This evaluation will require an assessment of the characteristics of the leachate-polluted groundwater plumes at the point of compliance, with particular consideration as to whether the monitoring well spacing is adequate to reliably detect leachate-polluted groundwaters when they first reach the point of compliance for groundwater monitoring. Ideally, the monitoring well spacing should be such that the capture zone about a monitoring well that is created by sampling of the well will have a 95 percent or greater probability of detecting leachate-polluted groundwaters that arise from a small leak through the liner system which occurs at any location in the liner.

It should be understood that, even if the plastic sheeting liner has holes in it when it first begins to be used, it may take two or more decades for the leachate-polluted groundwater to pass through the compacted clay liner and be transported to the point of compliance for monitoring where it can possibly be detected by the monitoring wells. The net result is that the groundwater monitoring data generated for the landfill may not show groundwater pollution even though the landfill liner may not be collecting all the leachate that is generated in the landfill and some of it is polluting groundwater under the landfill.

### **Landfill Gas Monitoring**

An area of particular concern is the migration of landfill gas (principally methane and carbon dioxide) to adjacent properties. This gas, when mixed with air (oxygen), can lead to explosions in confined structures. In addition, landfill gas contains other gases that are highly odorous, and contains hazardous chemicals that can cause cancer in those who are exposed to the gas for extended periods. The Committee's monitoring program should include an evaluation of the adequacy of the landfill gas monitoring program to detect landfill gas migration in the near-ground surface air and in the subsurface soils. Of particular concern is the potential for preferential gas flow pathways in the subsurface soils. Further, the landfill operator's gas monitoring data that are submitted to the regulatory agencies should be reviewed by the Committee to be sure that the agency staff is critically reviewing the data as they are submitted.

The amount of landfill gas and leachate that is generated/developed in those sections of the landfill that have been closed with a low permeability cover should be monitored. An effective landfill cover can severely limit the amount of landfill gas/leachate that is generated in the closed

sections of the landfill. If a closed landfill area is still generating substantial amounts of landfill gas/leachate several years after closure, then the landfill cover was not adequately constructed or is not being adequately maintained by the landfill operator.

### **Monitoring Data Review**

Each of the landfill cells' leachate production rate and composition, leak detection fluid generation rate and composition, groundwater composition as sampled by the monitoring wells, landfill cell gas production rate and composition should be reported in tables of data and presented in quality control charts. These charts will help the Committee review the monitoring data. These charts are useful in detecting changes in the monitored parameters that need attention. For example, if a landfill cell starts producing more leachate and/or landfill gas than it has in the past, there is need to repair the landfill low permeability cover. Information on quality control charts is available at <http://www.statsoft.com/textbook/stquacon.html>.

### **Viewshed Shield**

Landfill owners are often required to develop berms or shrubbery lines to try to shield the view of the landfill from offsite property. The monitoring should include evaluating the adequacy of the landfill operator's maintenance of this shield.

### **Property Values**

The Committee should track the impacts of the development of the landfill on nearby property values. In addition to determining the impact of the landfill on property values, the undeveloped nearby properties will have restrictions as to how they can be developed given their proximity to the landfill, which will limit their value. These restrictions would not exist if the landfill were not present.

### **Request for Addition Information**

The authors request that those who are experiencing the impacts of a landfill bring additional information on the issues discussed herein and any other relevant issues to our attention so that they can be incorporated into revisions of this write-up.

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