Chapter 2
Municipal Landfills & Illegal Dumps

Introduction

By definition, a municipal solid waste landfill is a discrete area of land or an excavation that receives household waste, and that is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined in law. Household waste includes any solid waste, including garbage, trash, and septic tank waste, derived from houses, apartments, hotels, motels, campgrounds, and picnic grounds. Subtitle D of RCRA defines other types of wastes a municipal solid waste landfill may accept, such as commercial solid waste, nonhazardous sludge, small quantity generator waste, and industrial solid waste. (EPA ,1993)

Landfills come in all shapes and sizes and can impact the environment in many different ways. Some dump sites may be as small as a few barrels of waste oil, while the largest industrial waste landfill may cover 100 acres or more. The range of effects that dump sites and landfills can manifest upon the environment are just as diverse as the various forms the sites may take. This chapter will frequently characterize solid waste contaminated brownfields and outline typical remediation strategies that can be used to redevelop these sites.

Landfills and Open Dumps in America

The modern day American landfill was preceded by the open and unregulated town dump. In these dumps wastes were left uncovered and untreated, leaving the refuse open to the full effects of the elements. Often, neither the existence nor the use of the dump was authorized, and there was no supervision. There was little or no effort made to compact or cover the waste and no regard was given to pollution control measures or aesthetics. Frequently, these open dumps were also burning dumps. Fire could occur spontaneously, but more often, the fire was purposely set in an attempt to reduce the volume at a dump or destroy the food that attracts rodents and insects. The most common air pollution resulting from burning dumps was highly visible clouds of particulate matter and incompletely burned gases, as well as the smell of smoldering garbage (EPA, 1971).

Sanitary landfills began to emerge in the 1930s with systematic deposition, compaction, and burial of refuse, but open dumps still persisted into the 1960s and 1970s (US Army, 1978). The primary difference between a dump and a sanitary landfill was that a sanitary landfill was covered with several inches of soil every evening. The purpose of the soil was to reduce odors and reduce the access of vermin to the waste. It was not until 1993 and Subtitle D of the Resource Conservation and Recovery Act (RCRA) that there were federal regulations governing the construction and operation of sanitary landfills.

Cape Charles, Virginia
A Brownfields Success Story:

Cape Charles' Sustainable Technology Park Authority in conjunction with a grant from EPA's Brownfield Assessment Pilot assessed an abandoned 25-acre town dump in the middle of a planned eco-industrial park in the heart of Cape Charles. The overall site will contain a conference and training center. Two businesses are locating on the site: Energy to Recovery, a research and development company that plans to hire 50 local residents and Solar Building Systems, Inc., a company that assembles solar panels and has already hired 30 local residents. One half of the land is natural habitat and will eventually have walkways and trails.

In the example just given, and in many other examples from Brownfields Pilot sites, it has been shown that the redevelopment of a dump site can be very positive for the community. The developer must consider however, the variety of situations which may be encountered when such a site is under redevelopment. Il

Landfill and Dump Site Characteristics

There are two major sources of contaminants in municipal landfills and dumpsites; leachate and landfill gas (LFG). Each is composed of different contaminants and each poses its own set of management burdens for the development of a brownfield. Taken together, they can affect the soils, ground and surface waters, and air in and around the sites of the landfills, many times years after the landfill has been closed. In addition to these, there are buried materials which may also contribute to contamination.

Leachate

Leachate is the liquid that results from rain, snow, dew, and natural moisture which percolates through the waste in a landfill or dump. While migrating through the waste, the liquid dissolves salts, picks up organic constituents, and leaches heavy metals, such as iron, mercury, lead, and zinc from cans, batteries, paints, pesticides, cleaning fluids, and inks. The organic strength of landfill leachate can be greater than 20 to 100 times the strength of raw sewage. This "landfill liquor" is potentially a potent polluter of soil and groundwater. The majority of open dumps and old sanitary landfills do not have liners or proper drainage systems to divert the leachate. Both pose the problem that the leached material could be absorbed into the ground and then possibly move into groundwater, surface water, or aquifer systems. (Heimlich, Undated)

A 1977 EPA study looked at three municipal landfill sites to determine the effects of the disposal facilities on surrounding soils and groundwater. Groundwater samples from up and down the groundwater flow gradient and below the landfill were taken. At all three of the sites, changes in chemical composition of the groundwater could be related to the position of the borings with respect to the landfill. Water quality below and down the groundwater flow gradients from the landfills showed elevated nitrate, total organic carbon, and cyanide levels. The percolation of the leachate did not alter the permeability of the soil beneath the refuse, nor was there evidence that the sub-landfill soils sealed themselves. Borings directly below the landfill showed decreasing constituents as sample depth increased; therefore, the source of the contamination may be the refuse and leachate from the landfill.

Landfill Gases

Methane (CH_4) is the principal gas produced from the decomposition of the organic solid waste (about 50% by volume) with carbon dioxide, nitrogen, andoxygen, and "non-methane organic compounds" (NMOCs) making up the remainder. (Ewall, 1999) Landfill gases are released either by aerobic and anaerobic decomposition of refuse or by the volatilization of existing compounds.

Initially, there is a high percentage of carbon dioxide as a result of aerobic decomposition. Aerobic decomposition continues to occur until the oxygen in the air initially present in the compacted waste is depleted. From that point on, anaerobic decomposition will occur.

Methane emissions result from the anaerobic decomposition of organic landfill materials such as yard waste, household garbage, food waste, and paper. Landfills are the largest anthropogenic source of methane, and municipal solid waste landfills account for approximately 93 percent of total landfill emissions. (EPA 1999) Methane production typically begins one or two years after waste placement in a landfill and may last from ten to sixty years. Explosions and fires at old dumps and landfills are often the result of methane build-up at a building on or adjacent to the landfill property. (Heimlich, Undated) In many cases, the use of landfill gas as an energy source is not economically feasible because of the low quality of the methane gas and its rate of production when compared with natural pipeline gas. (Lee and Jones-Lee, Undated)

The "landfill smell" that many people recognize from older dump sites is the result of landfill gases. Emissions of potentially carcinogenic organic chemicals have been detected from landfills. Benzene and vinyl chloride have been detected at landfills sites in California, Wisconsin, and New Jersey. Problems in sampling procedures make it difficult to determine if there is evidence of migration of the VOCs off-site into the ambient air. (Tchobanoglous et al, 1977)

Landfill and Dump Site Remediation Strategies

Site Investigation

The first step in any successful brownfield remediation is an accurate assessment of the character and scope of the problem. The following technologies are ones typically used to assess the state of contamination in and around landfills and dump sites:

- **Direct Push and Drilling Techniques**

  This sampling technique involves the use of drills and hydraulic presses to remove core samples of soil in and around landfills and dump sites. These samples are then brought to off-site laboratories for analysis. Labs can test for the presence of contaminants in the soil. This technique, whereby soil is analyzed off-site rather than on, provides much greater accuracy and provides managers with much more accurate information on the extent of site contamination.

- **Groundwater Sampling**

  Groundwater sampling is a very important aspect of the initial site investigation. The large majority of compliance and pollution problems associated with landfill brownfields have to do with contaminated groundwater. Contaminated groundwater is an especially dangerous problem in rural areas where most people rely on wells for their drinking water. Site managers should plan on carrying out extensive groundwater sampling before any development can commence.

- **Fugitive Gas Sampling**

  This investigative technique involves the use of gas sampling devices to determine the volume and type of landfill gas emissions at potential brownfields. This is very important for sites where building of any significance is to take place, as fugitive gas emissions are most dangerous in situations where the former landfill will be disturbed by excavation.

Site Remediation

Remediation of former landfill sites is somewhat different from remediation at other contaminated brownfields. For one, landfills differ from other brownfields in the sheer volume of contamination. No other brownfield has as much TOTAL contamination as a former landfill does, whether measured by volume or area. Also, site contamination is almost always spread throughout the entire site and cannot be remediated economically with most treatment technologies (i.e., you cannot possibly treat all of the contaminated soil at a municipal landfill). The final remediation strategy for a site will depend mostly then on the size of the landfill or dump site and the costs of the proposed remediation strategies.

- **Landfill Capping**

  Landfill capping is by far the most common method of site remediation. There are many types of landfill caps on the market, ranging from the ultra-sophisticated, ultra-expensive to the simplest coverings of plastic and canvas. Landfill caps are designed to do just what their name says, they 'cap' the landfill so that contaminants contained within are not released into the environment. They are most effective when the landfill or dump site in question has a viable bedliner that is still functioning and where most of the waste is above the water table.(CPEO, 2000) In these situations, a cap functions to keep water from entering the waste matrix, thus reducing leachate contamination. Caps usually are formed of a combination of compacted clay and soil in combination with a semi-permeable membrane (either plastic or some other composite). The most sophisticated caps are called RCRA "C" or "D" caps, but caps of all types can be created by contractors with the unique needs of each site in mind. It is estimated that C-type caps cost around 175 thousand dollars per acre while D-type caps cost as much as 225 thousand dollars per acre. (FRTR, 2000)

- **Landfill Gas Collection**

This type of pollution control actually evolved as a means to make money off of omnipresent landfill gas. Scientists learned early on that LFG was over 50% methane, the main component of natural gas. Today, the technology exists to 'harvest' the gas and (after filtering and cleaning it) burn that gas to make electricity. A side effect of this process is that landfill gas that once was released directly into the atmosphere, can now be collected, lessening the environmental and aesthetic impact of the gas.(EREN, 2000) A number of successful electric utilities have already been constructed on retired and active landfills throughout the US. (Ewall, 1999)

Conclusion

Landfills and illegal dump sites pose a significant risk to human and environmental health. Simply based on the number of sites throughout the country, landfills are one of the largest sources of potential pollution in communities of all types. Yet as pressure for new land rises, especially in urban and suburban areas, these landfill 'brownfields' are becoming valuable parcels of land and cost-effective and safe remediation of any contaminants on-site becomes a first priority. This chapter outlines the history of landfills and illegal dump sites, describes probable contaminants associated with these sites, and offers suggestions for successful remediation programs, with the ultimate purpose being to educate developers and community planners on the most important aspects of brownfield redevelopment.