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Conducting Remedial Investigations/ Feasibility Studies for CERCLA Municipal Landfill Sites

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EXECUTIVE SUMMARY

A broad framework for the Remedial Investigation/Feasibility Study (RI/FS) and selection of remedy process has been created through the National Contingency Plan (NCP) and the *U.S. EPA RI/FS Guidance* (U.S. EPA 1988d). With this framework now in place, the Office of Emergency and Remedial Response's efforts are being focused on streamlining the RI/FS and selection of remedy process for specific classes of sites with similar characteristics. One such class of sites is the municipal landfills which compose approximately 20 percent of the sites on the Superfund Program's National Priorities List (NPL). Landfill sites currently on the NPL typically contain a combination of principally municipal and to a lesser extent hazardous waste and range in size from 1 acre to 640 acres. Potential threats to human health and the environment resulting from municipal landfills may include:

- Leachate generation and groundwater contamination
- Soil contamination
- Landfill contents
- Landfill gas
- Contamination of surface waters, sediments, and adjacent wetlands

Because these sites share similar characteristics, they lend themselves to remediation by similar technologies. The NCP contains the expectation that containment technologies will generally be appropriate remedies for wastes that pose a relatively low low-level threat or where treatment is impracticable. Containment has been identified as the most likely response action at these sites because (1) CERCLA municipal landfills are primarily composed of municipal, and to a lesser extent hazardous wastes; therefore, they often pose a low-level threat rather than a principal threat; and (2) the volume and heterogeneity of waste within CERCLA municipal landfills will often make treatment impractical. The NCP also contains an expectation that treatment should be considered for identifiable areas of highly toxic and/or mobile material (hot spots) that pose potential principal threats. Treatment of hot spots within a landfill will therefore be considered and evaluated.

With these expectations in mind, a study of municipal landfills was conducted with the intent of developing methodologies and tools to assist in streamlining the RI/FS and selection of remedy process. Streamlining may be viewed as a mechanism to enhance the efficiency and effectiveness of decision-making at these sites. The goals of this study to meet this objective include: (1) developing tools to assist in scoping the RI/FS for municipal landfill sites, (2) defining strategies for characterizing municipal landfill sites that are on the NPL, and (3) identifying practicable remedial action alternatives for addressing these types of sites.

Streamlining Scoping

The primary purpose of scoping an RI/FS is to divide the broad project goals into manageable tasks that can be performed within a reasonable period of time. The broad project goals of any Superfund site are to provide the information necessary to characterize the site, define site dynamics, define risks, and develop a remedial program to mitigate current and potential threats to human health and the environment. Scoping of municipal landfill sites can be streamlined by focusing the RI/FS tasks on just the data required to evaluate alternatives that are most practicable for municipal landfill sites. Section 2 of this document describes the activities that must take place to plan an RI/FS and provides guidelines for establishing a project's scope. To summarize, scoping of the RI/FS tasks can be streamlined by:

- Developing preliminary remedial objectives and alternatives based on the NCP expectations and focusing on alternatives successfully implemented at other sites
- Using a conceptual site model (see Figure 2-4 for a generic model devel-

oped for municipal landfill sites based on their similarities) to help define site conditions and to scope future field tasks

- Conducting limited field investigations to assist in targeting future fieldwork
- Identifying clear, concise RI objectives in the form of field tasks to ensure sufficient data are collected to adequately characterize the site, perform the necessary risk assessment(s), and evaluate the practicable remedial action alternatives
- Identifying data quality objectives (DQOs) that result in a well-defined sampling and analysis plan, ensure the quality of the data collected, and integrate the information required in the RI/FS process
- Limiting the scope of the baseline risk assessment as discussed below

Streamlining the Baseline Risk Assessment

The baseline risk assessment may be used to determine whether a site poses risks to human health and the environment that are significant enough to warrant remedial action. Because options for remedial action at municipal landfill sites are limited, it may be possible to streamline or limit the scope of the baseline risk assessment by (1) using the conceptual site model and RI-generated data to perform a qualitative risk assessment that identifies the contaminants of concern in the affected media, their concentrations, and their hazardous properties that may pose a risk through the various routes of exposure and (2) identifying pathways that are an obvious threat to human health or the environment by comparing RI-derived contaminant concentration levels to standards that are potential chemical-specific applicable or relevant and appropriate requirements (ARARs) for the action. (When potential ARARs do not exist for a specific contaminant, risk-based chemical concentrations should be used.)

Where established standards for one or more contaminants in a given medium are clearly exceeded, the basis for taking remedial action is generally warranted (quantitative assessments that consider all chemicals, their potential additive effects, or additivity of multiple exposure pathways are not necessary to initiate remedial action). In cases where standards are not clearly exceeded, a more thorough risk assessment may be necessary before initiating remedial action.

This streamlined approach may facilitate early action on the most obvious landfill problems (groundwater and leachate, landfill gas, and the landfill contents) while analysis continues on other problems such as affected wetlands and stream sediments. Dividing a site into operable units and performing early or interim actions is often desirable for these types of sites. This is because performing certain early actions (e.g., capping a landfill) can reduce the impact to other parts of a site while the RI/FS continues. Additionally, early actions must be consistent with the site's final remedy and therefore help to speed up the clean-up process.

Ultimately, it will be necessary to demonstrate that the final remedy, once implemented, will in fact address all pathways and contaminants of concern, not just those that triggered the remedial action. The approach outlined above facilitates rapid implementation of protective remedial measures for the major problems at a municipal landfill site.

Streamlining Site Characterization

Site characterization for municipal landfills can be expedited by focusing field activities on the information needed to sufficiently assess risks posed by the site, and to evaluate practicable remedial actions. Recommendations to help streamline site characterization of media typically affected by landfills are discussed in Section 3 of this report. A summary of the site characterization strategies is presented below.

Leachate/Groundwater Contamination

Characterization of a site's geology and hydrogeology will affect decisions on capping options as well as on extraction and treatment systems for leachate and groundwater. Data gathered during the hydrogeologic investigation are similar to those gathered during investigations at

other types of NPL sites. Groundwater contamination at municipal landfill sites may, however, vary in composition from that at other types of sites in that it often contains high levels of organic matter and metals.

Leachate generation is of special concern when characterizing municipal landfill sites. The main factors contributing to leachate quantity are precipitation and recharge from groundwater and surface water. Leachate is characteristically high in organic matter as measured by chemical oxygen demand (COD) or biochemical oxygen demand (BOD). In many landfills, leachate is perched within the landfill contents, above the water table. Placing a limited number of leachate wells in the landfill is an efficient means of gathering information regarding the depth, thickness, and types of the waste; the moisture content and degree of decomposition of the waste; leachate head levels and the composition of landfill leachate; and the elevation of the underlying natural soil layer. Additionally, leachate wells provide good locations for landfill gas sampling. It should be noted, however, that without the proper precautions, placing wells into the landfill contents may create health and safety risks. Also, installation of wells through the landfill base may create conduits through which leachate can migrate to lower geologic strata, and the installation of wells into landfill contents may make it difficult to ensure the reliability of the sampling locations.

Landfill Contents

Characterization of a landfill's contents is generally not necessary because containment of the landfill contents, which is often the most practicable technology, does not require such information. Certain data, however, are necessary to evaluate capping alternatives and should be collected in the field. For instance, certain landfill properties such as the fill thickness, lateral extent, and age will influence landfill settlement and gas generation rates, which will thereby have an influence on the cover type at a site. Also, characterization of a landfill's contents may provide valuable information for PRP determination. A records review can also be valuable in gathering data concerning disposal history, thus reducing the need for field sampling of contents.

Hot Spots

More extensive characterization activities and development of remedial alternatives (such as thermal treatment or stabilization) may be appropriate for hot spots. Hot spots consist of highly toxic and/or highly mobile material and present a potential principal threat to human health or the environment. Excavation or treatment of hot spots is generally practicable where the waste type or mixture of wastes is in a discrete, accessible location of a landfill. A hot spot should be large enough that its remediation would significantly reduce the risk posed by the overall site, but small enough that it is reasonable to consider removal or treatment. It may generally be appropriate to consider excavation and/or treatment of the contents of a landfill where a low to moderate volume of toxic/mobile waste (for example, 100,000 cubic yards or less) poses a principal threat to human health and the environment.

Hot spots should be characterized if documentation and/or physical evidence exists to indicate the presence and approximate location of the hot spots. Hot spots may be delineated using geophysical techniques or soil gas surveys and typically are confirmed by excavating test pits or drilling exploratory borings. When characterizing hot spots, soil samples should be collected to determine the waste characteristics; treatability or pilot testing may be required to evaluate treatment alternatives.

Landfill Gas

Several gases typically are generated by decomposition of organic materials in a landfill. The composition, quantity, and generation rates of the gases depend on such factors as refuse quantity and composition, placement characteristics, landfill depth, refuse moisture content, and amount of oxygen present. The principal gases generated (by volume) are carbon dioxide, methane, trace thiols, and occasionally, hydrogen sulfide. Volatile organic compounds may also be present in landfill gases, particularly at co-disposal facilities. Data generated during the site characterization of landfill gas should include landfill gas characteristics as well as the role of onsite and offsite surface emissions, and the geologic and hydrologic conditions of the site.

Streamlining the Development of Alternatives

Section 4 of this document describes the remedial technologies that are generally appropriate to CERCLA landfill sites. Inclusion of these technologies is based on experience at landfill sites and expectations inherent in the NCP. To streamline the development of remedial action alternatives for landfill contents, hot spots, landfill gas, contaminated groundwater. and leachate, the following points should be considered:

- The most practicable remedial alternative for landfills is containment. Such containment may be achieved by installing a cap to prevent vertical infiltration of surface water. Lateral infiltration of water or gases into the landfill can be prevented by a perimeter trench-type barrier. Caps and perimeter barriers sometimes are used in combination. The type of cap would likely be either a native soil cover, single-barrier cap, or composite-barrier cap. The appropriate type of cap to be considered will be based on remedial objectives for the site. For example, a soil cover may be sufficient if the primary objective is to prevent direct contact and minimize erosion. A single barrier or composite cap may be necessary where infiltration is also a significant concern. Similarly, the type of trench will be dependent on the nature of the contaminant to be contained. Impermeable trenches may be constructed to contain liquids while permeable trenches may be used to collect gases. Compliance with ARARs may also affect the type of containment system to be considered.

- Treatment of soils and wastes may be practicable for hot spots. Consolidation of hot spot materials under a landfill cap is a potential alternative in cases when treatment is not practicable or necessary. Consolidation-related differential settlements may be large enough to require placement of an interim cap during the consolidation phase. Once the rate of settlement is observed to decrease, then a final cap can be placed over the waste.

- Extraction and treatment of contaminated groundwater and leachate may be required to control offsite migration of wastes. Additionally, extraction and treatment of leachate from landfill contents may be required. Collection and treatment may be necessary indefinitely because of continued contaminant loadings from the landfill.

- Constructing an active landfill gas collection and treatment system should be considered where (1) existing or planned homes or buildings may be adversely affected through either explosion or inhalation hazards, (2) final use of the site includes allowing public access, (3) the landfill produces excessive odors, or (4) it is necessary to comply with ARARs. Most landfills will require at least a passive gas collection system (that is, venting) to prevent buildup of pressure below the cap and to prevent damage to the vegetative cover.

Conclusions

Evaluation and selection of appropriate remedial action alternatives for CERCLA municipal landfill sites is a function of a number of factors including:

- Sources and pathways of potential risks to human health and the environment

- Potential ARARs for the site (significant ARARs might include RCRA and/or state closure requirements, and federal or state requirements pertaining to landfill gas emissions.)

- Waste characteristics

- Site characteristics (including surrounding area)

- Regional surface water (including wetlands) and groundwater characteristics and potential uses

Because these factors are similar for many CERCLA municipal landfill sites, it is possible to focus the RI/FS and selection of remedy process. In general, the remedial actions implemented at most CERCLA municipal landfill sites include:

- Containment of landfill contents (i.e., landfill cap)
- Remediation of hot spots
- Control and treatment of contaminated groundwater and leachate
- Control and treatment of landfill gas

Other areas that may require remediation include surface waters, sediments, and adjacent wetlands.