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Project Summary

Leachate Generation and Migration at Subtitle D Facilities: A Summary and Review of Processes and Mathematical Models

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The U.S. Environmental Protection Agency (EPA) recently promulgated revisions to the Solid Waste Disposal Facility Criteria under Subtitle D of the Resource Conservation and Recovery Act (RCRA). These revisions create a need for tools for predicting the performance of facilities regulated under Subtitle D. Mathematical models, based on site-specific data, provide a means of estimating the effects of a variety of designs and hydrogeologic conditions on the generation and migration of leachate at Subtitle D facilities.

Leachate generation and migration are influenced by numerous interrelated physical, chemical, and biological processes that can occur during the lifetime of a waste disposal facility. Many of these processes are discussed in this report. Some processes are already well understood and easily described by mathematical models. The mathematical representation of other processes is the subject of current research. This report focuses on the state-of-the-art in modeling leachate generation and migration. Issues related to selection of models for application to specific scenarios are discussed.

This Project Summary was developed by EPA's Environmental Research Laboratory, Athens, GA, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Overview

Subtitle D of RCRA requires the EPA to develop criteria for controlling solid waste management practices. Subtitle D covers land disposal of all nonhazardous waste, household hazardous waste, and hazardous waste from small quantity generators in landfills, surface impoundments, land application units, and waste piles. New criteria for Subtitle D municipal landfills provide a need for computer models in designing the facility and in monitoring its performance.

The need for computer models appears at two different stages of landfill development and operation. During the design stage, models will be needed to show that an alternative design meets the performance standards specified in the criteria and to show that a facility located in a wetland will not degrade the wetland environment. During the monitoring stage, the use of models will be required of any operator requesting a suspension of the groundwater monitoring requirements. In addition, models can be used to determine the most effective remediation options at facilities where contamination of the environment has occurred.

In anticipation of the need for a suite of EPA-approved models for use in comply-

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ing with current and future criteria, this report discusses the potential for contamination of groundwater from the four main types of Subtitle D facilities and addresses issues related to modeling contamination at these sites. Tables characterizing some currently available models are provided.

Three issues are important in determining the effect, if any, of land-based Subtitle D facilities on the subsurface environment: the quantity of leachate generated, the composition of the leachate generated, and the migration of the leachate from the facility. The report summarizes a number of the complex, interrelated factors that affect leachate generation and migration.

No one model can handle all aspects of the complex problems that arise at Subtitle D facilities. For many sites, it will be necessary to link a series of leachate generation, geochemical, hydrologic, and pollutant transport models that have been selected to correspond to specific site conditions. The report discusses the modeling of leachate quality and quantity, facility design, chemical and microbial transport, biodegradation, geochemical reactions, and flow (e.g., fracture, karst, multiphase). Available models are summarized and the application of specific models is addressed. Topics include the selection, verification and validation of models.

Conclusions

- Many physical, chemical, and biological processes can occur during the lifetime of a waste disposal facility. These processes influence the generation and migration of leachate. Some of the processes are relatively easy to describe and predict; others are poorly understood.
- Because of the wide variety of wastes placed in Subtitle D facilities and because of differences in other factors, such as the operation, design, and age of a facility, it is very difficult to predict the release rate of leachate generated at a particular disposal facility. Release rate estimation requires the determination of both the contaminant concentration in the leachate and the volumetric flux of leachate.
- Once released to the subsurface, leachate migration depends on factors such as the liquid nature of the waste, the chemical properties of the leachate constituents, the loading rate, the climate, and the subsurface hydrogeologic properties. Complex interactions among physical, chemical, and biological processes control migration.
- Revisions to the Solid Waste Disposal Facility Criteria create a need for modeling tools to predict the performance of facilities. The models will be used primarily to demonstrate that alternative designs will satisfy performance standards and to show that a particular design or hydrogeologic setting ensures that there will be no potential for migration of contaminants from the facility to the uppermost aquifer during the active life of the unit.
- Numerous existing models could be applied to the simulation of leachate generation and migration. These models represent a wide range in complexity, from simple analytical solutions that can be solved with a calculator to complex numerical models that require a large computer.
- Mathematical models can provide a useful means of understanding and predicting the effects of waste disposal facilities on the subsurface environment. No individual model exists, however, that can simulate all of the processes affecting leachate generation and migration. In some cases, it is beneficial to link or couple "stand-alone" codes to produce more accurate representation of a specific facility.
- The use of mathematical models requires simplified representations of reality. Errors are introduced because of the use of assumptions and simplifications, a lack of data, and a poor understanding of some processes influencing the transport and transformation of contaminants. Normally, it is difficult to quantify the effects of these errors.
- It is impossible to develop a set of discrete "scenarios" from which a modeler could confidently select when applying a model to a specific site. Each site must be described individually. Many factors must be considered when characterizing a site.
- Calibration, verification and validation are critical aspects of the development and application of models. They are particularly important for site-specific studies.

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The complete report, entitled "Leachate Generation and Migration at Subtitle D Facilities: A Summary and Review of Processes and Mathematical Models," (Order No. PB93-217784AS; Cost: $27.00; subject to change) will be available only from:

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