By Camille Atrache

Remediation techniques for contaminated soils

Currently, many remedial techniques are being used for cleanup of contaminated soils. Soils remediation techniques address the Vadose Zone (the region extending from the ground surface to the upper surface of the principal water-bearing formation) and situations where the saturated zone is engineered to become unsaturated, e.g., when ground water is pumped to create an unsaturated zone.

The most efficient, permanent and fastest remedial method is the Dig and Haul method whereby the contaminated soil is excavated and hauled to remote disposal facility for the particular contaminants. The soil is then replaced with clean soil to restore the site.

In the Prepared Bed Treatment method: the contaminated soil may be either:

- physically moved from its original site to a newly prepared areas, which has been designed to enhance treatment and/or to prevent transport of contaminants from site; or
- removed from the site to a storage area while the original location is prepared for use, then returned to the bed, where treatment is accomplished.

Preparation of the bed may include placement of clay or plastic liner to retard transport of contaminants from the site or addition of uncontaminated soil to provide additional treatment medium. Treatment may be enhanced with biological and/or physical/chemical methods, as with in situ systems.

In Situ Techniques include:

- soil vacuum washing;
- bioremediation;
- immobilization; and
- mobilization.

Soil vacuum extraction (SVE) is also known as forced air venting, or in situ air stripping. This technique involves extraction of air and contaminants from unsaturated soil. Clean air is injected or passively flows into the unsaturated zone. Volatile partition from soil water into soil air, and the vapour-laden air is removed using vacuum extraction wells. Typically, components of SVE consist of vacuum extraction wells, air inlet wells, and vapour monitoring wells distributed across a contaminated site, and blowers to control air flow. Extraction wells may be placed vertically or horizontally, although vertical alignment is typical for deeper contamination zones and for residues in radial flow.

In situ biological remediation (Bioremediation) of contaminated soils with organic chemicals is also an alternative treatment technology for achieving a permanent cleanup remedy at hazardous waste sites. This method involves the use of naturally occurring micro-organisms to degrade and/or detoxify hazardous constituents in the soil at a contaminated site to protect public health and the environment. Components of soil bioremediation systems generally include:

- delivery systems – such as injection nozzles, plows, and irrigation systems – deliver water, nutrients, oxygen, organic matter, specialized micro-organisms, and/or other amendments, as required;
- and run-on and run-off controls for moisture control and waste containment.

Immobilization: constituents in situ systems are generally immobilized through sorption, ion exchange, and/or precipitation reactions. These techniques reduce the rate of contaminant release from the soil environment so that concentrations along exposure pathways are held within acceptable limits. (These are also used in Prepared Bed Treatment systems).

Solidification and stabilization are additional immobilization techniques that are applicable to in situ and prepared bed systems. These techniques are designed to accomplish one or more of the following:

- production of solid from a liquid or semisolid waste;
- reduction of contaminant volubility; and/or
- a decrease in the exposed surface area across which transfer may occur.

Solidification may involve encapsulation of fine waste particles (microencapsulation) or large blocks of waste (macroencapsulation). Stabilization refers to the process of reducing the hazardous potential of waste materials by converting contaminants into their least soluble, mobile, or toxic from. Systems for delivering reagents to the contaminated area include: injection systems; soil surface applicators; and /or delivery and application of electrical energy for melting soils and rock that contain hazardous materials.

Mobilization of organic and/or inorganic contaminants from soil may be accomplished using soil flushing and recovery and treatment of the elutriate. Flushing solutions generally include water, acidic and basic solutions, surfactants, and solvents. The solutions partition a contaminant into the liquid phase through the volume of added liquid or by decreasing the distribution coefficient between the soil and the flushing phase. Components consist of (1) the flushing solution, and (2) delivery and recovery systems, which may include injection and recovery wells, equipment for surface applications, and holding tanks for sorting elutriate for reapplication. B

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