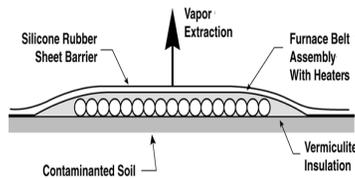


Thermal

Thermal processes use heat to increase the volatility, to burn, decompose, destroy or melt the contaminants.

Typically effective for defined areas of contamination that include organics, PCBs, solvents, pesticides, and polyaromatic hydrocarbons (PAHs).



Thermal Blanket. Targets organics, PCBs, VOCs, SVOCs and pesticides. <http://www.clu-in.org/products/newsletters/trend/view.cfm?issue=tt0298.htm>

Pros – Particularly useful for dense or light nonaqueous phase liquids (DNAPLs or LNAPLs), effective reduction/removal, short time periods (particularly for ex-situ).

Cons – Off-gas systems typically required, well network may be required, labor and energy intensive, select technologies are limited in depth and size of area.

Nanotechnology

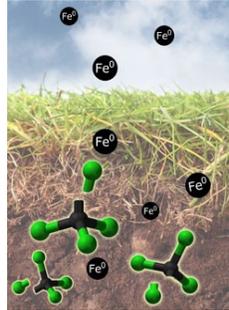
Use of nanoscale materials and taking advantage of highly reactive materials because of the large surface

area to volume ratio and the presence of a larger number of reactive sites. These properties allow for increased contact with contaminants,

Nanoscale Zero-Valent Iron.

Targets PCBs, metals, chlorinated organic and DNAPLs.

http://www.rsc.org/Publishing/ChemScience/Volume/2010/08/zero_valent_iron.asp



thereby resulting in rapid reduction of contaminant concentrations.

Research indicates that nanoscale materials such as nZVI, BNPs, and EZVI may chemically reduce the following contaminants effectively: tetrachloroethene (PCE), TCE, cis-1,2-dichloroethylene (c-DCE), vinyl chloride (VC), and 1-1-1-tetrachloroethane (TCA), polychlorinated biphenyls (PCBs), halogenated aromatics, nitroaromatics, metals such as arsenic and chromium, and nitrate, perchlorate, sulfate, and cyanide.

Soil Treatability Study

Energy Technology Engineering Center
U.S. Department of Energy

ON-SITE REMEDIATION ALTERNATIVES



On-Site Soil Remediation Technologies

Phytoremediation

Phytoremediation is the process whereby plants in take or hyperaccumulate contaminants into the plant, thereby reducing the concentrations of contaminants in the soil.

Typically effective for clean up of metals, radionuclides, PCBs, solvents, explosives, and hydrocarbons.



Helianthus annuus, the common Sunflower. Targets metals in the soil.



Populus spp., the common Poplar tree. Targets explosives, landfill contaminants and 1,4 Dioxane.

Pros – Green technology, visually appealing, low impact, passive.

Cons – Extended clean-up period, limited by depth and soil types, additional technology required for plant disposal, potential use of non-native plant species, maintenance of plants, select plants will phytorestore contaminants.

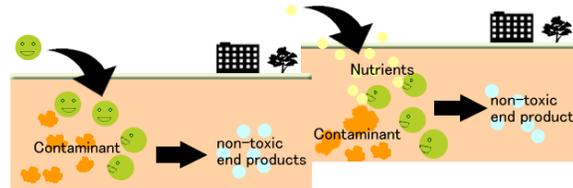
Bioremediation

Bioremediation is the use of microorganisms to enhance biodegradation or removal of contaminants; through stimulation of naturally existing species or introduction of non-natural species to enhance biodegradation.

Typically effective for clean up in low permeability soils, for petroleum hydrocarbon, solvent, metals, and radioactive contaminants.

Pros – Relatively low impact, in-situ reduction of COIs, enhancement of natural processes.

Cons – Limited by soil types, possible lack of control of stimulated microbes, introduction of bacteria.



Biostimulation & Bioaugmentation. Targets hydrocarbons, radionuclides, metals, and more.
http://www.ecocycle.co.jp/e_bioremediation/e_bioremediation.html

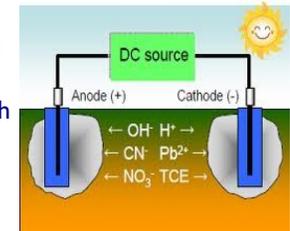
Physical/Chemical

Physical/chemical treatment uses the physical properties of the contaminants or the contaminated medium to destroy (i.e., chemically convert), separate, or contain the contamination.

Typically effective for confined areas of well-defined soils with contamination that includes solvents, hydrocarbons, organics, and metals.

Pros – Effective, faster clean up alternatives that can be completed in-situ, and required equipment is typically readily available.

Cons – Typically requires an extensive well network, treatment well involves introduction of substances in-situ, select methods sensitive to soil type, treatment residuals will require treatment or disposal, extraction fluids from soil flushing will increase the mobility of the contaminants, so provisions must be made for subsurface recovery .



Electrokinetics. Targets heavy metals, and organics.
<http://www.kankyo.yamaguchi-u.ac.jp>