A Citizen's Guide to In Situ Thermal Treatment

What is In Situ Thermal Treatment?

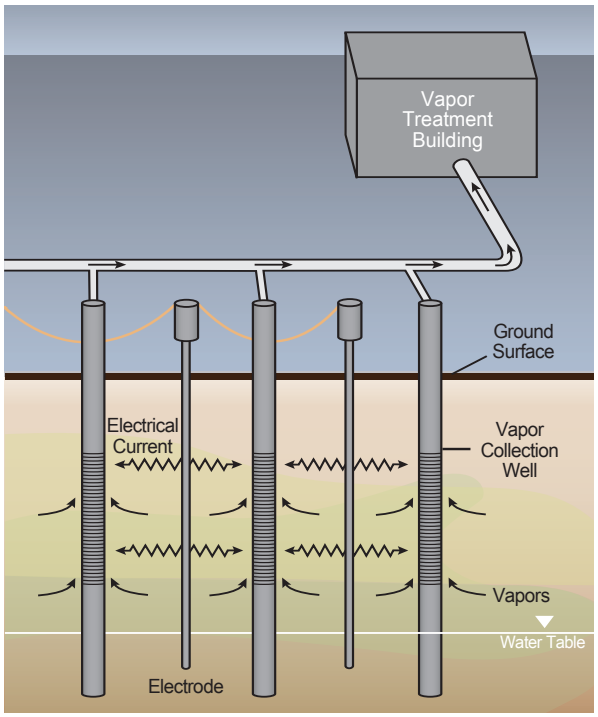
In situ thermal treatment methods move or "mobilize" harmful chemicals in soil and groundwater using heat. The chemicals move through soil and groundwater toward wells where they are collected and piped to the ground surface to be treated using other cleanup methods. Some chemicals are destroyed underground during the heating process. Thermal treatment is described as "in situ" because the heat is applied underground directly to the contaminated area. It can be particularly useful for chemicals called "non-aqueous phase liquids" or "NAPLs," which do not dissolve readily in groundwater and can be a source of groundwater contamination for a long time if not treated. Examples of NAPLs include solvents, petroleum, and creosote (a wood preservative).

How Does It Work?

In situ thermal treatment methods heat contaminated soil, and sometimes nearby groundwater, to very high temperatures. The heat vaporizes (evaporates) the chemicals and water changing them into gases. These gases, also referred to as "vapors," can move more easily through soil. The heating process can make it easier to remove NAPLs from both soil and groundwater. High temperatures also can destroy some chemicals in the area being heated.

In situ thermal methods generate heat in different ways:

- **Electrical resistance heating (ERH)** delivers an electrical current between metal rods called "electrodes" installed underground. The heat generated as movement of the current meets resistance from soil converts groundwater and water in soil into steam, vaporizing contaminants.
- **Steam enhanced extraction (SEE)** injects steam underground by pumping it through wells drilled in the contaminated area. The steam heats the area and mobilizes and evaporates contaminants.
- **Thermal conduction heating (TCH)** uses heaters placed in underground steel pipes. TCH can heat the contaminated area hot enough to destroy some chemicals.



The chemical and water vapors are pulled to collection wells and brought to the ground surface by applying a vacuum. (See *A Citizen's Guide to Soil Vapor Extraction and Air Sparging* [EPA 542-12-018] for information on how this is done.) The vapors are then treated above ground using one of several cleanup methods available. Or, if concentrations are high, the vapors can be condensed back to liquid chemicals and reused.

How Long Will It Take?

In situ thermal treatment might take a few months to a few years to clean up a site. The actual cleanup time will depend on several factors. For example, it might take longer where:

- Contaminant concentrations are high.
- The contaminated area is large or deep.
- A variety of soil types are present, causing the ground to heat unevenly.
- The soil has a lot of organic matter, which causes chemicals to stick to the soil and not evaporate easily.

These factors vary from site to site.

Are In Situ Thermal Treatment Methods Safe?

In situ thermal treatment methods do not pose a threat to site workers or the community when properly operated. For instance, when using ERH, the electrical current is prevented from traveling outside of the treatment area or to aboveground structures by using common electrical grounding techniques. A thermal treatment area is usually covered with an impermeable surface cover (such as concrete, asphalt, or a heavy-duty tarp) to keep the heat and steam underground. Such seals also help prevent the release of chemical vapors to the air. In addition, workers test air samples to make sure that vapors are being captured.

How Might It Affect Me?

In situ thermal treatment requires the use of drilling equipment and other heavy machinery to install wells or electrodes and to collect and treat vapors. Neighborhoods near the site may experience some increased truck traffic as the equipment is delivered and later removed. Nearby residents and businesses also may hear operating equipment.

Why Use In Situ Thermal Treatment?

In situ thermal treatment methods speed the cleanup of many types of chemicals, and are among the few in situ methods that can clean up NAPLs. Thermal treatment can be used in silty or clayey soil where other cleanup methods do not perform well. They also can reach contamination deep underground or beneath buildings, which would otherwise be difficult or costly to dig up to treat above ground. In situ thermal treatment has been selected or is being used in cleanups of at least 12 Superfund sites as well as dozens of other sites across the country.

ERH system cleans up contaminated soil and groundwater.

Example

SEE was used to speed clean up of the Southern California Edison Co., Visalia Pole Yard Superfund site in California. Use of chemicals to treat wooden utility poles contaminated soil and groundwater at the facility. Conventional "pump and treat," begun in 1984, did not show much progress in meeting cleanup objectives. In 1997, 14 steam injection wells were installed around the contaminated area. Steam was injected into the ground at depths of 80-100 feet, vaporizing the chemicals and forcing them toward the collection wells.

Initially, about 13,000 pounds of contaminants were pumped from the collection wells every day. SEE was stopped after three years when the wells began collecting less than 4 pounds per day, indicating that most of the chemicals had been removed. The pump and treat system was turned off in 2004. Overall, about 1.3 million pounds of contaminants were removed, and groundwater contaminant concentrations were reduced to below drinking water standards. By using SEE as part of the cleanup effort, the overall site cleanup was reduced from an estimated 120 years to 20 years.

For More Information

For more information about this and other technologies in the Citizen's Guide Series, visit:

www.cluin.org/remediation
www.cluin.org/products/citguide
www.cluin.org/products/Thermal In

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