Citizen's Guide Series to Cleanup Technologies

EPA's Technology Innovation and Field Services Division has developed *A Citizen's Guide Series to Cleanup Technologies* — a set of 22 guides summarizing cleanup methods used at Superfund and other sites. This 2012 series updates the guides originally released ten years ago to include information about new technologies and techniques. The one-page, double-sided guides are designed to help Remedial Project Managers and Community Involvement Coordinators explain complicated technologies to the public using basic terms in an easy-to-read style.

Each guide helps answer six questions about the cleanup method: 1) *What is it?* 2) *How does it work?* 3) *How long will it take?* 4) *Is it safe?* 5) *How might it affect me?* and 6) *Why use it?*

The following guides are available on Clu-In at http://cluin.org/products/citguide. Spanish translations of these guides will be available in 2014.

- A Citizen's Guide to Activated Carbon Treatment (EPA 542-F-12-001)
- A Citizen's Guide to Air Stripping (EPA 542-F-12-002)
- A Citizen's Guide to Bioremediation EPA 542-F-12-003)
- A Citizen's Guide to Capping (EPA 542-F-12-004)
- A Citizen's Guide to Ecological Revitalization (EPA 542-F-12-005)
- A Citizen's Guide to Evapotranspiration Covers (EPA 542-F-12-006)
- A Citizen's Guide to Excavation of Contaminated Soil (EPA 542-F-12-007)
- A Citizen's Guide to Fracturing for Site Cleanup (EPA 542-F-12-008)
- A Citizen's Guide to Greener Cleanups (EPA 542-F-12-009)
- A Citizen's Guide to Incineration (EPA 542-F-12-010)
- A Citizen's Guide to In Situ Chemical Oxidation (EPA 542-F-12-011)
- A Citizen's Guide to In Situ Chemical Reduction (EPA 542-F-12-012)
- A Citizen's Guide to In Situ Thermal Treatment (EPA 542-F-12-013)
- A Citizen's Guide to Monitored Natural Attenuation (EPA 542-F-12-014)
- A Citizen's Guide to Permeable Reactive Barriers (EPA 542-F-12-015)
- A Citizen's Guide to Phytoremediation (EPA 542-F-12-016)
- A Citizen's Guide to Pump and Treat (EPA 542-F-12-017
- A Citizen's Guide to Soil Vapor Extraction and Air Sparging (EPA 542-F-12-018)
- A Citizen's Guide to Solidification and Stabilization (EPA 542-F-12-019)
- A Citizen's Guide to Thermal Desorption (EPA 542-F-12-020)
- A Citizen's Guide to Vapor Intrusion Mitigation (EPA 542-F-12-021)
- A Citizen's Guide to Vertical Engineered Barriers (EPA 542-F-12-022)

For More Information

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

www.cluin.org/remediation
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September 2012

A Citizen's Guide to Activated Carbon Treatment

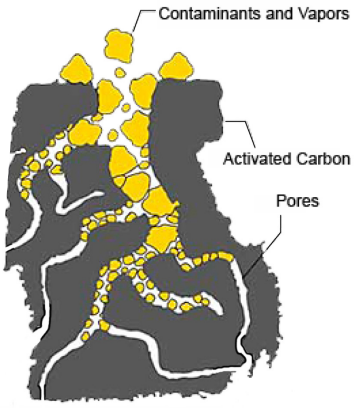
What Is Activated Carbon Treatment?

Activated carbon is a material used to filter harmful chemicals from contaminated water and air. It is composed of black granules of coal, wood, nutshells or other carbon-rich materials. As contaminated water or air flows through activated carbon, the contaminants sorb (stick) to the surface of the granules and are removed from the water or air. Granular activated carbon or "GAC" can treat a wide range of contaminant vapors including radon and contaminants dissolved in groundwater, such as fuel oil, solvents, polychlorinated biphenyls (PCBs), dioxins, and other industrial chemicals, as well as radon and other radioactive materials. It even removes low levels of some types of metals from groundwater.

How Does It Work?

Activated carbon treatment generally consists of one or more columns or tanks filled with GAC. Contaminated water or vapors are usually pumped through a column from the top down, but upward flow is possible. As the contaminated water or air flows through the GAC, the contaminants sorb to the outer and inner surfaces of the granules. The water and air exiting the container will be cleaner. Regular testing of exiting water or air is conducted to check contaminant levels. If testing shows that some contaminants remain, the water or air may need to be treated again to meet the treatment levels.

Activated carbon granules



Contaminants and vapors sorbed to activated carbon

The GAC will need to be replaced when the available surfaces on the granules are taken up by contaminants and additional contaminants can no longer sorb to them. The "spent" GAC may be replaced with fresh GAC or "regenerated" to remove the sorbed contaminants. To regenerate spent GAC, it is usually sent to an offsite facility where it is heated to very high temperatures to destroy the contaminants. If a lot of GAC needs to be regenerated, equipment to heat the GAC and remove the sorbed contaminants can be brought to the site.

Depending on the site, treated groundwater may be pumped into a nearby stream or river or back underground through injection wells or trenches. At some sites, a sprinkler system can distribute the water over the ground surface so that it seeps into soil. The water also may be discharged to the public sewer system for further treatment at a sewage treatment plant.

How Long Will It Take?

It only takes a few minutes for water or vapors to pass through an activated carbon filter. However, the time it takes to clean up a site with activated carbon treatment will depend on how long it takes to bring all the contaminated groundwater or contaminant vapors to the ground surface for treatment. This can take several months to many years. Treatment may take longer where:

- Contaminant concentrations are high or the source of dissolved contaminants has not been completely removed.
- The volume of contaminated groundwater or vapors is large.
- Treatment of groundwater or vapors involves several other cleanup methods.

These factors vary from site to site.

Is Activated Carbon Treatment Safe?

Activated carbon treatment is safe to use. Treated water is sampled and analyzed regularly to ensure that

the carbon continues to adequately sorb contaminants. If concentrations start to increase in the treated water, the carbon is reactivated or replaced. The tanks are cleaned or replaced with care to avoid releasing contaminants. Larger filters are often preferred because they do not have to be replaced as often as small ones. When treatment is complete, the used carbon may contain hazardous contaminants that require special handling and disposal at a hazardous waste facility.

How Might It Affect Me?

Activated carbon treatment generally will not disrupt the surrounding community. Initial construction of systems to extract groundwater or contaminant vapors from the ground may involve the use of heavy equipment. This may cause a temporary increase truck traffic in the neighborhood as equipment is brought to the site or when carbon tanks are exchanged. However, the treatment system itself is not particularly noisy while running. Depending on the amount of groundwater or vapors that need to be treated, tanks of activated carbon can range in size from a 55-gallon drum to a tank that is 20 feet tall and 10 feet or more in diameter.

Why Use Activated Carbon Treatment?

Activated carbon is the most commonly used approach to treating groundwater in "pump and treat" systems (See *A Citizen's Guide to Pump and Treat* [EPA 542-F-12-017]). It is also used to treat contaminant vapors removed from contaminated soil and groundwater by soil vapor extraction and other cleanup methods. (See *A Citizen's Guide to Soil Vapor Extraction* [EPA 542-F-12-018].) Activated carbon units can be brought to the site and set up relatively quickly.

Large groundwater treatment system with five tanks of activated carbon.

Small groundwater treatment system with two tanks of activated carbon.

Example

Disposal of chemical wastes at the Conservation Chemical Company Superfund site in Missouri contaminated the soil and groundwater with solvents, waste oil, PCBs, and pesticides. A pump and treat system began operating in 1991 to keep the contaminated groundwater from moving offsite. The pumped water is being treated with a series of cleanup methods. One of the last treatment steps is the use of two columns of activated carbon to remove any remaining contaminants.

Water exiting the activated carbon columns is sampled weekly for metals and quarterly for PCBs, pesticides, and other contaminants to ensure the system is working. The columns are refilled with reactivated carbon when they can no longer remove contaminants adequately. The system uses about 240,000 pounds of activated carbon each year. Sampling of groundwater continues to show that the system is protecting human health and the environment, and the treated water is discharged to the nearby Missouri River.

For More Information

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

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United States Environmental Protection Agency
Office of Solid Waste and Emergency Response (5102G)
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www.epa.gov/superfund/sites
www.cluin.org

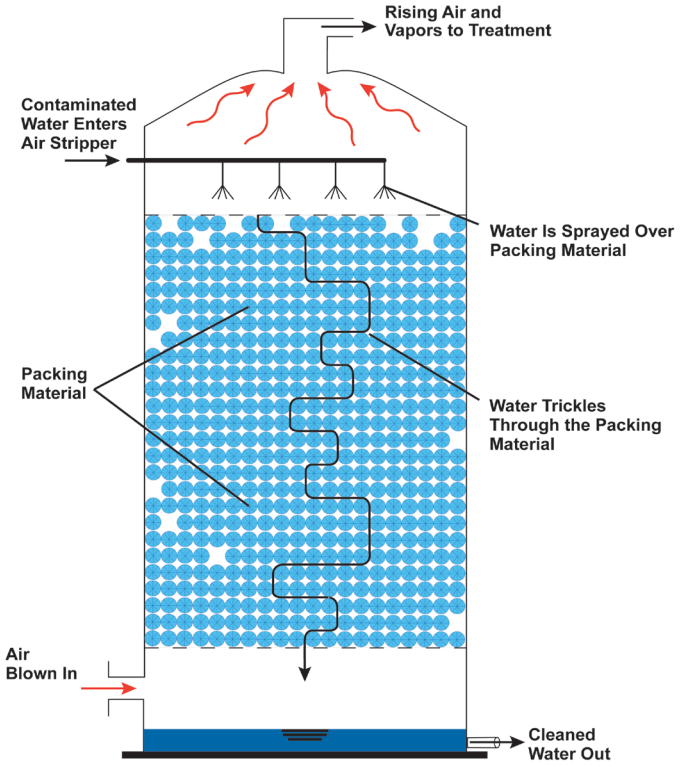
A Citizen's Guide to Air Stripping

What Is Air Stripping?

Air stripping is the process of moving air through contaminated groundwater or surface water in an above-ground treatment system. Air stripping removes chemicals called "volatile organic compounds" or "VOCs." VOCs are chemicals that easily evaporate, which means they can change from a liquid to a vapor (a gas). The air passing through contaminated water helps evaporate VOCs faster. After treating the water, the air and chemical vapors are collected, and the vapors are either removed or vented outside if VOC levels are low enough. Air stripping is commonly used to treat groundwater as part of the "pump and treat" cleanup method. (See *A Citizen's Guide to Pump and Treat* [EPA 542-12-017].)

How Does It Work?

Air stripping uses either an air stripper or aeration tank to force air through contaminated water and evaporate VOCs. The most common type of air stripper is a packed-column air stripper, which is a tall tank filled with pieces of plastic, steel, or ceramic packing material.



Packed-Column Air Stripper

Contaminated water is pumped above ground and into the top of the tank and sprayed over the top of the packing material. The water trickles downward through the spaces between the packing material, forming a thin film of water that increases its exposure to air blown in at the bottom of the tank. A sieve-tray air stripper is similar in design but contains several trays with small holes. As water flows across the trays, a fan at the bottom blows air upwards through the holes, increasing air exposure. Aeration tanks are another type of design that remove VOCs by bubbling air into a tank of contaminated water.

Rising air and vapors accumulate at the top of the air stripper or aeration tank where they are collected for release or treatment. Treated water flows to the bottom, where it is collected and tested to make sure it meets cleanup requirements. The water may be further treated, if necessary, to achieve required levels. Clean water may be pumped back underground, into local surface waters, or to the municipal wastewater treatment plant.

Aeration tanks are typically shorter than packed-column or sieve-tray air strippers. The size and type of air stripper used will depend on the types and amounts of contaminants as well as the quantity of water requiring treatment.

How Long Will It Take?

The flow of water through an air stripper or aeration tank may take only a few minutes, depending on the size of the device and the rate of water flow through it. However, cleanup of all the contaminated water at a site can take several months to years. The actual cleanup time will depend on several factors. For example, it will take longer where:

- Contaminant concentrations are high or the source of dissolved contaminants has not been completely removed.
- The amount of water requiring treatment is large.
- Groundwater cannot be pumped at a fast rate.
- Buildup of mineral deposits or algae on the packing material require frequent removal.

These factors vary from site to site.

Is Air Stripping Safe?

Air stripping is generally considered to be safe to use. Air strippers may be brought to the site so that contaminated water does not have to be transported to a cleanup facility. Contaminated water is contained throughout cleanup so that there is little chance for people to come into contact with it. The treated water usually may be returned to the groundwater or discharged to surface water. The chemical vapors produced by air stripping are treated, if necessary, to ensure unsafe levels of vapors are not released.

How Might It Affect Me?

Installation of the air stripper and treatment equipment may require use of heavy machinery, especially at large contaminated sites. Area neighborhoods may experience some increased truck traffic as the equipment is delivered. Large tanks or columns may be visible from the street and may need to operate for many years. However, care is taken to make sure the operation of air strippers is as quiet as possible.

Air stripper and treatment building

Why Use Air Stripping?

Air stripping is an effective way of removing VOCs from contaminated water and is commonly used as part of groundwater pump and treat systems at sites around the country. Air strippers can be brought to the site eliminating the need to pump contaminated water for offsite treatment.

Sample plastic packing material. (Photo from Mass Transfer, Ltd.)

Example

Air stripping is part of the treatment for four groundwater pump and treat systems operating at the North Indian Bend Wash Superfund site in Arizona. Groundwater at the site is contaminated with an industrial solvent called trichloroethene (TCE) and other VOCs. Contamination extends over an area of about 8 square miles and to depths over 100 feet.

The first pump and treat system began operating in 1994. The others were added later to improve cleanup. The packed-column air strippers remove VOC vapors, which are then treated with activated carbon and another method called "ultraviolet oxidation." Cleaned water is discharged to an area irrigation network and reservoir. As of 2011, over 40,000 pounds of TCE had been removed, and cleanup of some areas was nearly complete. The systems are expected to operate for another 40 to 70 years to clean up the entire site.

For More Information

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United States Environmental Protection Agency

Office of Solid Waste and Emergency Response (5102G)

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www.cluin.org

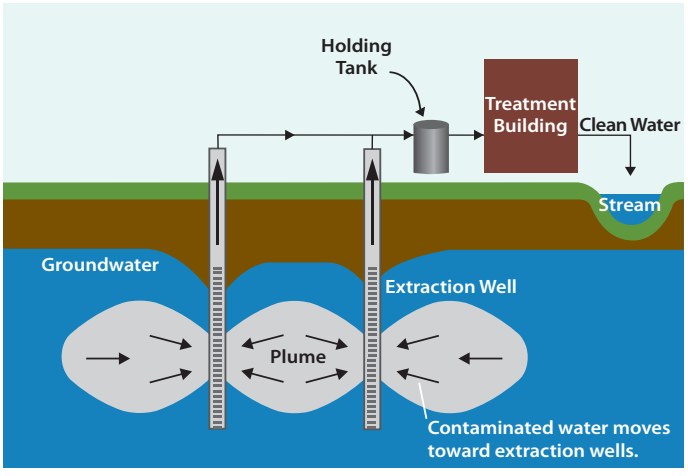
A Citizen's Guide to Pump and Treat

What Is Pump And Treat?

Pump and treat is a common method for cleaning up groundwater contaminated with dissolved chemicals, including industrial solvents, metals, and fuel oil. Groundwater is pumped from wells to an above-ground treatment system that removes the contaminants. Pump and treat systems also are used to "contain" the contaminant plume. Containment of the plume keeps it from spreading by pumping contaminated water toward the wells. This pumping helps keep contaminants from reaching drinking water wells, wetlands, streams, and other natural resources.

How Does It Work?

Pump and treat methods may involve installing one or more wells to extract the contaminated groundwater. Groundwater is pumped from these "extraction wells" to the ground surface, either directly into a treatment system or into a holding tank until treatment can begin. The treatment system may consist of a single cleanup method, such as activated carbon or air stripping, to clean the water. (See *A Citizen's Guide to Activated Carbon* [EPA 542-F-12-001] and *A Citizen's Guide to Air Stripping* [EPA 542-F-12-002].) However, treatment often requires several cleanup methods if the groundwater contains different types of contaminants or high concentrations of a single contaminant. The approach to treatment may be modified as contaminant concentrations decrease.



Example of a Pump and Treat System with Two Extraction Wells.

Once treated water meets regulatory standards, it may be discharged for disposal or further use. For example, treated water may be pumped back underground or into a nearby stream, or a sprinkler system may distribute the water over the ground surface to irrigate soil and plants. Treated water also may be discharged to the area's public sewer system for further treatment at the local wastewater treatment plant. Other wastes produced as a result of treatment, such as sludge or used filters, are disposed of properly.

Is Pump And Treat Safe?

Pump and treat is a safe way to both clean up contaminated groundwater and keep it from moving to other areas where it may affect drinking water supplies, wildlife habitats, or recreational rivers and lakes. Although pumping brings contamination to the ground surface, it does not expose people to that contamination. A pump and treat system is monitored to ensure the extraction wells and treatment units operate as designed. Also, the groundwater is sampled to ensure the plume is decreasing in concentration and is not spreading.

How Long Will It Take?

Pump and treat may last from a few years to several decades. The actual cleanup time will depend on several factors, which vary from site to site. For example, it may take longer where:

- Contaminant concentrations are high, or the contamination source has not been completely removed.
- The contaminant plume is large.
- Groundwater flow is slow, or the flow path is complex.

How Might It Affect Me?

People living or working near the site may see increased truck traffic while the system is being built as drill rigs and construction supplies arrive at the site. They also may hear the machinery used to drill wells

or construct the treatment system. Treatment systems usually are designed to minimize noise while operating. Because pump and treat cleanups can take a long time, systems can be designed so that other site activities may continue during cleanup. For example, the treatment system may be constructed in a location as far as possible from an office building or parking lot. It also may be enclosed by a fence or a shed so that it is less obvious.

Why Use Pump And Treat?

Pump and treat is used to remove a wide range of contaminants that are dissolved in groundwater. Pump and treat typically is used once the source of groundwater contamination, such as leaking drums and contaminated soil, has been treated or removed from the site. It also is used to contain plumes so that they do not move offsite or toward lakes, streams, and water supplies. Pump and treat is the most common cleanup method for groundwater. It has been selected or is being used at over 800 Superfund sites across the country.

Groundwater Pumping Wells

Groundwater Treatment Building

Indoor Treatment Facility

Outdoor Treatment Facility

Example

The Baird and McGuire Superfund site in Massachusetts was contaminated when chemicals stored in tanks leaked into the soil and groundwater. The contaminated groundwater plume flowed offsite, contaminating and closing the town's main water supply. Since 1993, a pump and treat system has been containing the plume and cleaning up groundwater.

Pump and treat began after much of the contaminated soil at the site was excavated for treatment. Eight pumping wells were installed at the site (seven still operate) typically pumping a total of about 127 gallons of groundwater per minute. The treatment plant includes a metals removal system, air strippers, and activated carbon units to remove a wide range of contaminants. It also has filters and a sludge disposal system. Treated water is pumped back underground at the site. Groundwater sampling has shown that treatment continues to protect human health and the environment by containing the plume and removing contaminants. The system is expected to operate well into the future.

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