Community Guide to Permeable Reactive Barriers

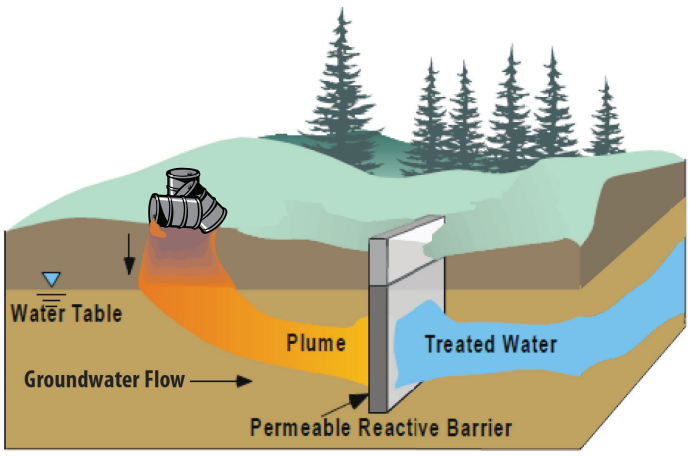
What Is A Permeable Reactive Barrier?

A permeable reactive barrier, or "PRB," is a wall created below ground to clean up contaminated groundwater. The wall is "permeable," which means that groundwater can flow through it. Water must flow through the PRB to be treated. The "reactive" materials that make up the wall either trap harmful contaminants or make them less harmful. The treated groundwater flows out the other side of the wall.

How Does It Work?

PRBs are usually built by digging a long, narrow trench in the path of contaminated groundwater flow. The trench is filled with a reactive material, such as iron, limestone, carbon or mulch, to clean up contaminants from groundwater. Due to limitations of excavation equipment, PRBs typically can be no deeper than 50 feet. However, a deeper but usually shorter PRB can be built by drilling a row of large-diameter holes or by using fracturing. (See *Community Guide to Fracturing for Site Cleanup*.) Fracturing methods connect the reactive material to deeper contaminated groundwater.

The reactive material selected for the PRB will depend on the types of contaminants present in the groundwater. The material may be mixed with sand to make the wall more permeable so that it is easier for groundwater to flow through it, rather than around it. Side walls filled with a less permeable material such as clay may be constructed at an angle to the PRB to help funnel the flow of contaminated groundwater toward the reactive materials. The filled trench is covered with soil.



PRB treats a plume of groundwater contaminants.

Depending on the reactive material, contaminants are removed through different processes:

- Contaminants ***sorb*** (stick) to the surface of the reactive material. For example, carbon particles have a surface onto which contaminants, such as petroleum products, sorb as groundwater passes through.
- Metals dissolved in groundwater ***precipitate***, which means they are removed from groundwater by forming solid particles that get trapped in the wall. For example, limestone and shell fragments can cause dissolved lead and copper to precipitate in a PRB.
- Contaminants ***react*** with the reactive material to form less harmful ones. For example, reactions between metallic iron particles in a PRB and certain industrial cleaning solvents can convert the solvents to less toxic or even harmless chemicals.
- Contaminants are ***biodegraded*** by microbes in the PRB. Microbes are very small organisms that live in soil and groundwater and eat certain contaminants. When microbes digest the contaminants, they change them into water and gases, such as carbon dioxide. (See *Community Guide to Bioremediation*.) Organic mulch frequently is used as reactive media in this type of PRB. Mulch barriers consist of plant-based materials, such as compost or wood chips, and naturally contain many different microbes. Groundwater flow through the PRB also releases organic carbon from the mulch wall, creating another reactive zone for contaminants just beyond the wall. Microbes also can make some contaminants (like arsenic and uranium) less soluble in groundwater by changing their chemical form.

Over time, PRBs can fill up with sorbed or precipitated contaminants, making them less effective at cleaning groundwater. When this occurs, the contaminated reactive material may be excavated for disposal and replaced with fresh material.

How Long Will It Take?

PRBs may take many years to clean up contaminated groundwater. The cleanup time will depend on factors that vary from site to site. For example, PRBs will take longer where:

- The source of dissolved contaminants (for instance, a leaking drum of solvent) has not been removed.
- The contaminants remain in place because they are not easily dissolved by groundwater.
- Groundwater flow is slow.
- The reactive material must be replaced frequently.

Are PRBs Safe?

The reactive materials placed in PRBs are not harmful to groundwater or people. Contaminated groundwater is cleaned up underground, so treatment does not expose workers or others onsite to contamination. Because some contaminated soil may be encountered when digging the trench, workers wear protective clothing. Workers also cover loose contaminated soil to keep dust and vapors out of the air before disposing of it. Groundwater is tested regularly to make sure the PRB is working.

How Might It Affect Me?

During construction of the PRB, you may see increased truck traffic when materials are hauled to the site, or you might hear earth-moving equipment. However, when complete, PRBs require no noisy equipment. Cleanup workers will occasionally visit the site to collect groundwater and soil samples to ensure that the PRB is working. When the reactive materials need to be replaced, the old materials will have to be excavated and hauled to a landfill.

Why Use PRBs?

PRBs are a relatively inexpensive way to clean up groundwater. No energy is needed because PRBs rely on the natural flow of groundwater. The use of some materials, such as limestone, shell fragments and mulch, can be very inexpensive, if locally available. No equipment needs to be aboveground, so the property may continue its normal use, once the PRB is installed.

Construction of a PRB in Sunnyvale, CA

PRBs have been selected for use at dozens of Superfund sites and other cleanup sites across the country.

Example

Groundwater at the Parker Sanitary Landfill Superfund site in Vermont was contaminated with solvents as a result of past disposal of industrial wastes. In 2000, a cap was placed on the landfill to keep rainfall from seeping into the wastes and causing more contaminants to enter groundwater. In 2005, a PRB was installed to treat groundwater and prevent the flow of contaminants from the site.

The 235-foot wide PRB is filled with iron particles and sand and extends 30 feet to 62 feet below the ground surface. Contaminated groundwater from a part of the landfill that received industrial waste flows through the PRB. Groundwater sampling results indicate that cleanup goals are being met by the PRB.

For More Information

- About this and other technologies in the Community Guide Series, visit: https://clu-in.org/cguides or https://clu-in.org/remediation/
- About use of cleanup technologies at a Superfund site in your community, contact the site's community involvement coordinator or remedial project manager. Select the site name from the list or map at http://www.epa.gov/superfund/sites to view their contact information.

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