AIR FORCE BASE CONVERSION AGENCY

Eaker Air Force Base

BIOREMEDIATION

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In backyards, all over America, bioremediation is happening every second of the day – or night. Bioremediation is one of the original natural trash disposal processes. When a lawn is mowed, but not raked, the grass clippings are naturally bioremediated. And, in the process, fertilizing the lawn. The same process takes place with other yard wastes. Some wastes take longer to bioremediate than others, but in all cases the process is the same. Gardeners value the results of bioremediation, using it to build a compost heap or transform manure into a nutritious .filler for their rose bushes and tomato plants.

Technically, the term bioremediation refers to the natural decomposition or breakdown of wastes into a less complex state. Ideally, the entire waste degrades into carbon dioxide and water as well as various other naturally occurring elements. Backyard bioremediation uses naturally recurring microbes (tiny bugs) and their "offspring" (enzymes) to achieve the desired result. Mineralization, or the process of degrading organic materials to carbon dioxide, water and other elements is the ultimate endpoint. No residues or hazardous wastes are left. Bioremediation is also called biodegradation, biorestoration, or bioreclamation.

In practice, an environment is managed to enhance and/or accelerate a natural process by which microorganisms "eat" the contaminant. The management techniques may include addition of microbes, moisture, oxygen, or acidity management.

Hazardous waste sites contaminated with hydrocarbons such as fuels and oils can be remediated using bioremediation with relative ease. The majority of the hazardous waste sites on US Air Force bases (AFB), including Eaker AFB, are contaminated with some form of fuel or other petroleum product.

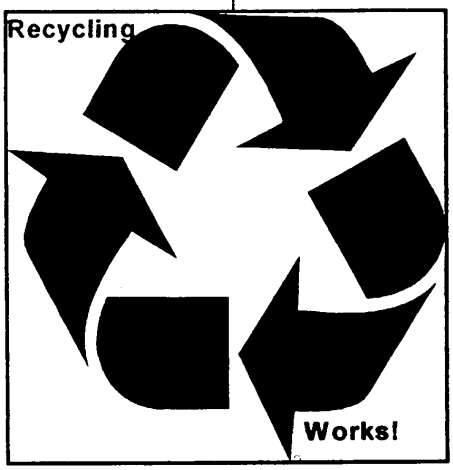
Several factors determine the usability of bioremediation at a specific hazardous waste site. They include:

- Concentration and Toxicity
- Moisture
- Temperature
- Oxygen Concentrations
- Soil Acidity (pH)
- Soil Type

Concentration, or the amount of chemical present at the site, must be considered. The contaminant may be toxic to the naturally occurring microbe. In high concentrations, it may not be possible to use bioremediation techniques without the addition of more microbes and enzymes or of different types of microbes.

Moisture is a critical factor in bioremediation. Soils must be "wet" for certain microbes and enzymes to live, function and reproduce. Moisture levels are easily manipulated in most cases.

Temperature is another important factor in bioremediation techniques. Sites, like a compost heap, must be kept within a specific range of temperatures for the microbe or enzyme to live and function. Some microbes adapted to hot climates, die in freezing conditions and vice-versa. Thus, microbes suited to the climate or time of year will be added to the site to facilitate the process.



Oxygen concentrations are also a factor in managing a bioremediation project. Microbes may be anaerobic or aerobic, meaning they require a little or a lot of oxygen. Typical methods of controlling oxygen levels include soil turning or aerating the soil; or providing other acceptable gaseous environments such as increasing nitrogen or carbon dioxide levels.

Finally, **soil type and acidity** are also elements that must be considered when designing a bioremediation project or even selecting it as the appropriate method of clean-up. Some soils, such as the clays and fatty clays found in the area of Eaker AFB, are not suited to bioremediation. Highly acid or alkaline soils may be toxic to the microbe. And, while it is possible to adjust the acidity it is difficult to modify the soil type without correspondingly high costs. Thus, another method of clean-up may be selected or other microbes introduced into the environment.

Bioremediation is, in general, an excellent method of remediating hazardous waste sites. It uses natural processes to achieve the desired result. It is an in place, or *in situ*, treatment method. Thus, soils are cleaned up where they are instead of being removed and backfilled with new or "cleaned" dirt. The resulting degradation products are non-toxic and contaminant concentrations may be reduced dramatically.

On the other hand bioremediation may be time consuming and costly depending on the site characteristics. The decision must be made on a site-by-site basis.

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