Ground Water, Surface Water, and Leachate

Constructed Wetlands

Introduction:

Constructed wetlands treatment utilises natural geochemical and biological processes intrinsic in an artificial wetland ecosystem to remove metals, explosives, and other contaminants from influent waters. The process can also be employed as a filtration process.

Description:

The technology integrates key workings of wetland ecosystems; consisting of organic soils, microbial fauna, and algae. Microbial activity is accountable for the majority of the remediation that takes place.

Influent waters with elevated metal concentrations and low pH flow through the aerobic and anaerobic zones of the wetland ecosystem. Metals are removed by way of ion exchange, adsorption, absorption, and precipitation with geochemical and microbial oxidation and reduction. Ion exchange takes place as metals in the water make contact with humic or other organic materials present in the wetland. Constructed wetlands habitually have little or no soil in its place they have straw, manure or compost. Oxidation and reduction reactions catalysed by bacteria that arise in the aerobic and anaerobic zones, play a key role in precipitating metals as hydroxides and sulphides. Precipitated and adsorbed metals settle in dormant ponds or are filtered out as water filtrates through the medium or the plants.

Constructed wetland treatment is a long-term process that is expected to function constantly for years.

Applicability:

Wetlands have frequently been applied in wastewater treatment for controlling organic matter; nutrients such as nitrogen and phosphorus; and suspended sediments. The wetlands process is also appropriate for controlling trace metals, and other toxic materials. Moreover, the treatment has been exploited to treat acid mine drainage produced by metal or coal mining activities. Such wastes have high metal concentrations and are typically acidic. The process can be modified to treat neutral and basic tailing solutions.

Limitations:

This technology must be adjusted accordingly in order to consider the variation in geology, trace metal composition, and climate in the metal mining regions.

- Long-term efficiency of constructed wetlands is not well known. Aging might be a problem, which may play a role in decreasing the contaminant removal rates over time.
- The economics of constructing an artificial wetland differ significantly from project to project and may not be financially feasible for many sites.
- Temperature and variation in flow influence wetland function and can trigger a wetland to display inconsistent contaminant removal rates.
- Cold conditions slow the rate at which the wetland can break down contaminants.
- A heavy flow of incoming water can burden the removal system in a wetland, whilst a dry spell can harm plants and limit wetland function.

Data Needs:

Standard data are required.

Performance Data:

The technology was received into the Emerging Technology Program in 1988; the project was concluded in 1991. The rationale of the project was to build, operate, monitor, and assess the efficiency of constructed wetlands in treating a section of acid mine drainage from the Big Five Tunnel site in close proximity to Colorado. A few of the most favourable results from the 3 years of operation are listed:

- pH rose from 2.9 to 6.5.
- Dissolved aluminium, cadmium, chromium, copper, iron and zinc concentrations were reduced by 99 percent or more.
- Lead was reduced by 94 percent or more.
- Nickel was reduced by 84 percent or more.
- Manganese removal was low, with reduction between 9 and 44 percent.
- Bio-toxicity to fathead minnows and water fleas was reduced by factors of 4 to 20.

Due to wetland removal processes being chiefly microbial, the technology can be developed with conventional engineering approaches. Laboratory studies can signify whether remediation is likely, while bench-scale experiments can establish the loading and reactor design.

Cost:

Not currently known.