The AquAeTerian

AquAeTer
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The President's Corner (*praeeo)*

I am pleased to introduce the inaugural edition of our technical bulletin that we will be providing to our clients and colleagues. Our intent is to feature innovative approaches to environmental management and restoration as well as showcase some of the recent activities of the company and its staff. Our professionals continue to lead the way (praeeo) in developing solutions to very complex technical problems.

The first edition of the **AquAeTerian** emphasizes two projects our experts have recently completed. First, Steve Wampler, P.E., P.G., Hydrologist and Director of Engineering for **AquAeTer**, led a team from our Centennial, Colorado office in the design and construction of an alternative evapotranspiration cap for a RCRA SWMU site in Kansas City. Steve has been working on the ITRC committee that is writing guidance to assist regulators and practitioners with alternative RCRA cap designs. Second, Dr. Jim Clarke, an **AquAeTer** Technical Director, led an environmental forensic investigation to determine potential sources for chlorinated solvents found at a dry-cleaning site in Tennessee. Dr. Clarke is a well-known expert in environmental forensics and chemical fate and transport in the environment.

We hope that you will find this information useful. Please feel free to contact Steve or Jim to learn more about specific details of their exciting work. Also, look for our next edition to be issued in the Fall where we will have descriptions of a successful biostimulation and degradation method for groundwater, and the use of GPS-linked data collection for TMDL and Mixing Zone Studies.

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$$CH_4(g)+2O_2(g) \quad CO_2(g)+H_2O(l): \Delta H^\circ_r = -890.3\ kJ/mol$$

Alternative Landfill Covers Provide Lower Cost and Maintenance

Landfill closure requirements in Federal and State solid and hazardous waste regulations include specific requirements for final covers. Final covers designed and constructed to satisfy these requirements often are called, "prescriptive covers." Prescriptive cover designs typically use compacted clay or synthetic materials (geomembranes) to achieve a low permeability to infiltrating water. However, the same regulations provide the mechanism for regulator approval of "alternate" final covers or AFCs. In order for an alternate cover to be accepted in lieu of a prescriptive final cover, the AFC components must work together to satisfy performance requirements as well as do those of the prescriptive cover.

A primary measure of any cover's performance is its capacity to limit infiltration, determined either by predictive numerical modeling or by direct measurements: inside the cover (lysimeter measurements), at the base of the waste (leachate collection), or in groundwater (monitoring well sampling). In side-by-side performance comparisons, AFCs have been shown to be at least as effective, and often more effective, in limiting infiltration than prescriptive covers. Also, experience has shown that the low permeability components of prescriptive covers can fail, perhaps as the result of damage during construction (in the case of man-made materials) or because of desiccation and cracking (in the case of soil materials).

An AFC approach that is generating considerable interest today is the evapotranspiration (ET) cover. Where prescriptive covers resist infiltration using low permeability layers, an ET cover resists infiltration by providing temporary water storage capacity within the cover and eventual water removal by evaporation and transpiration. ET cover configurations vary depending on local conditions, but typically consist of a thick, relatively porous, soil layer (perhaps three to five feet thick) capped with a thin topsoil layer. The soil cover and a diverse plant community – grasses, shrubs, and even trees – provide the necessary water storage capacity and then promote evaporation and plant transpiration to reduce infiltration into underlying waste.

With infiltration control that is as good as, or even better than, that of a prescriptive cover, other AFC advantages make the ET cover an attractive choice in many locations. These well-documented 'other' advantages include:

- Simplified design process,
- Lower cost, and usually locally available, construction materials,
- Lower construction and QC costs, and
- Lower long-term maintenance costs.

AFCs can offer additional significant advantages not provided by prescriptive covers. For example, landfill gases can accumulate beneath the low permeability layer(s) of a prescriptive cover and then migrate outward and downward to cause groundwater quality degradation.

A recently completed alternative (ET) cover over a grouping of RCRA SMWUs at a former wood treating facility in Missouri

$CH_4(g)+2O_2(g) \quad CO_2(g)+H_2O(l):\Delta H^\circ_r = -890.3$ kJ/mol

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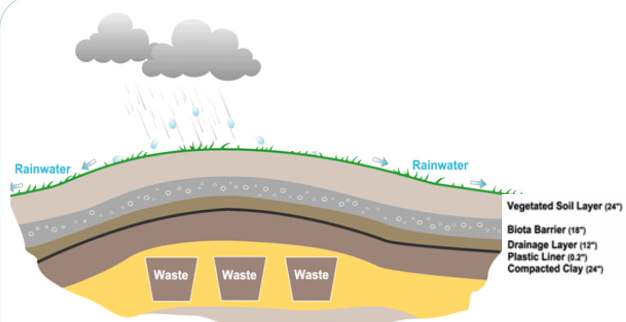
Steve Wampler is Vice President and Director of Engineering for **AquAeTer**. Based in Denver, Colorado, he works as a principal geological engineer and hydrogeologist responsible for corporate quality assurance, strategic planning, and project technical oversight and review. He has 30-years experience in engineering geology, hydrogeology, geotechnical engineering, and environmental consulting, with much of that experience dealing with the management of solid, hazardous, and radioactive waste materials and response to releases of hazardous and radioactive constituents into the environment. He has been involved with the ITRC Alternate Landfill Technologies team since the start of the team's efforts concerning alternate final covers, and has coordinated the efforts of a small group focusing on cover construction. He holds B.S. and M.S. degrees in Geological Engineering from the University of Missouri at Rolla and is a registered Professional Engineer and Professional Geologist.

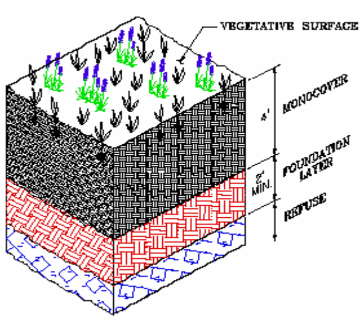
AFCs, which lack low permeability components, are less likely to cause gas accumulation. Also, promising on-going research by USEPA appears to be showing that the primary constituent of landfill gas, methane, is degraded within a permeable, vegetated AFC, reducing the likelihood of detrimental emissions to the atmosphere.

Alternate final covers can provide long-term performance consistent with regulatory requirements in most areas of the United States. Determination of the applicability of the technology to a specific site is a relatively simple evaluation of climatic conditions and available soil materials. However, regulatory acceptance is not assured even when a proposed AFC is confirmed by engineering evaluation to satisfy long-term performance requirements and offer economic advantages over a prescriptive cover. This is because the technology, while not complex, is not yet in wide-spread use and its technical basis might not be well-understood. A thorough, accurate, and convincing technical case must be developed by the facility owner and engineer to be able to take full advantage of this superior technology.



Typical Prescriptive RCRA Cover

Source: ITRC, 2003b



Typical ET Cover System Schematic

Source: ITRC, 2003a

AquAeTer is a participant (along with State and Federal regulators and industry representatives) in the Interstate Technology Regulatory Council (ITRC) Alternate Landfill Technologies team that has developed guidance documents and provides training encouraging the design and approval of innovative alternative landfill final covers. AFCs that support vegetation and promote evapotranspiration offer potential performance improvements and cost savings over the cover types prescribed by RCRA. As a leader in this technology, **AquAeTer** can be an effective advocate for its application of this technology at our client's sites.

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James H. Clarke, Ph.D. is a Technical Director for **AquAeTer** and the practice leader for the firm's work in environmental forensics. He is also a Professor of the Practice in the Department of Civil and Environmental Engineering at Vanderbilt University, where he teaches courses on Environmental Assessment, Environmental Characterization and Analysis and Contaminated Site Restoration and conducts research in long-term sustainable environmental restoration, the design and performance of contamination containment and control facilities, risked-based site remediation, and the mathematical modeling of contaminants in groundwater, surface waters, soils and sediments. Dr. Clarke is a consultant to the Department of Energy concerning the environmental restoration of former nuclear weapons sites and the use of a risk-based approach to remediation decision-making and to the Nuclear Regulatory Commission Advisory Committee on nuclear wastes for the Yucca Mountain project. He has served as an expert witness and consulting expert in several cases involving environmental liability determination, cost allocation and cost recovery for contaminated sites. He received a B.A. in Chemistry from Rockford College and a Ph.D. in Theoretical Chemical Physics from The Johns Hopkins University. You can contact Jim at 615.373.8532 or clarkejh@vuse.vanderbilt.edu.

Chemical Fingerprinting to Determine Possible Sources of Ground Water Contamination

Environmental forensics is the name given to a group of scientific and engineering techniques used to determine the sources and release timing of chemical releases into the environment. Often there are several different potential sources, since many of the common environmental chemicals were in widespread usage for similar and even different purposes. The stakes are often high, given the costs of environmental characterization and remediation, and litigation is often involved. In the example that follows, the use of a particular environmental forensic technique, chemical fingerprinting, enabled the determination of the presence of additional sources beyond the facility being investigated and also provided information about relative release times.

A former dry cleaning site located in Nashville is being investigated as a potential source of groundwater contamination. Several monitoring wells have been installed across the site and tetrachloroethylene (PCE), a common dry cleaning agent that had been used at this facility, was detected in up-gradient wells, in an off-site cross-gradient well, and in down-gradient wells. Trichloroethylene (TCE), cis and trans-1,2-dichloroethene (DCE) and vinyl chloride (VC), all well-known decay products of PCE, were also detected in most of the wells, as was chlorobenzene. Chlorobenzene has been used in the past as a dry-cleaning solution, although there was no record that it had ever been used at this particular dry cleaning operation. Other possible sources of groundwater contamination were present in the vicinity, in particular, an active staging and maintenance operation for an electric utility was located up-gradient to the dry cleaning site being investigated.

The groundwater chemical data were used to construct "fingerprints" of the contamination that was detected in each of the monitoring wells (see Figures 1 and 2). Clearly, there are two distinct chemical fingerprints in the site groundwaters. The up-gradient well MW-3, is dominated by the presence of PCE, as shown in Figure 1. Other wells, including the cross-gradient well, have this same distinct fingerprint. In each of these cases, decay products are not present or present in only very low concentrations. This PCE-dominated fingerprint is characteristic of a recent release and possibly an ongoing release. The second type of fingerprint observed is a DCE-dominated fingerprint with the traditional parent, PCE, and its decay products, TCE, DCE, and VC, as shown in Figure 2. This DCE fingerprint is representative of a historic release of PCE and can be seen when the PCE has undergone significant degradation.

Based on the chemical fingerprint analyses, the Tennessee Department of Environment and Conservation (TDEC) agreed that there were at least two possible sources of groundwater contamination and that the contamination in some of the wells was not due to the dry cleaning operation. The dry cleaning site will be required to monitor the groundwater wells on a semi-annual basis, but because of the low-risk to down-gradient areas, no further remediation will be required at the site.

FIGURE 1
PCE DOMINATED FINGERPRINT
GROUNDWATER SAMPLING RESULTS
MW-3

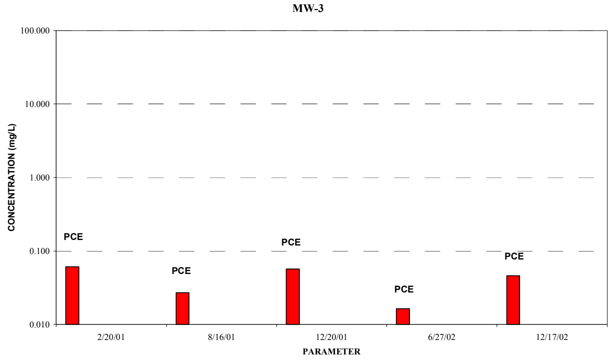

FIGURE 2
GROUNDWATER SAMPLING RESULTS
MW-7