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AquAeTer

optimizing resources | water, air, earth

The AquAeTerian

In This Issue:

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Hot Topics

Christy Lewis received a recent award from Belmont University for Outstanding Student in the Professional Bachelor's of Business Administration Program for 2009. Christy graduated cum laude from Belmont's Adult Studies program in December.

Christopher Green is participating in the Nashville Chapter of the Society of Military Engineers with their Joint Readiness Committee. This committee is helping coordinate resources for the Tennessee Emergency Management Association for emergency response to natural disasters.

The President's Corner

"quando titanes progrediunt ad caelites"
When Titans go to the Gods

In 1973, I entered Vanderbilt as a graduate student in Environmental and Water Resources Engineering. At Vanderbilt, I had one of the most fantastic group of professors in the environmental field including Wes Eckenfelder, Peter Krenkel and my advisor, Frank Parker. I later worked with Wes Eckenfelder at AWARE from 1980 to 1985 and during the last five years, Wes worked at **AquAeTer**. He was a great mentor for our young and old engineers and scientists. On March 28, 2010 Wes passed away.

Wes came to me a few years ago and urged me to hire Jim Clarke, who was at the time at Brown and Caldwell (formerly Eckenfelder, Inc.). I hired Jim and he has been with **AquAeTer** for 10 years now. Jim also became a Professor at Vanderbilt in the Civil and Environmental Engineering Department. Later, Jim came to me and said that we should hire Wes. Wes came to **AquAeTer** in 2004 after my exceptional sales pitch.

I first met Wes in his wastewater engineering class at Vanderbilt where he was, first and foremost, a teacher of the profession. His passion for sharing knowledge and working with people to solve wastewater problems was unsurpassed. True to form, when Wes came to **AquAeTer**, he continued his work creating workshops and technical presentations. Wes found time to mentor several of our chemical and environmental engineers while solving industrial wastewater treatment problems for our clients. He always enjoyed the give and take with our engineers who liked to challenge Wes in order to pull from the great reservoir of knowledge very few people possess.

Wes's typical work schedule at **AquAeTer** was a ½ day, 3 days per week. We would end his work day at lunch over a glass of Chardonnay. Wes was always actively thinking up new ways to treat wastewater. His last major projects included wastewater consulting for two petroleum refineries, a pulp and paper mill where he agreed to install solar aerators, addition of nutrients to biologically treat contaminated water, and a nitrification-denitrification treatment system for a high-strength ammonia wastestream. We will miss Wes at **AquAeTer**, but more importantly, we were privileged to have Wes work with us if only for a short period.

Jim Clarke, Wes Eckenfelder, and Mike Corn at AquAeTer in 2004

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END-OF-LIFE EVALUATION: CREOSOTE-TREATED RAILROAD TIES

Introduction

Steve Smith and Chris Bolin recently completed an article to be published in the CrossTies magazine of the Railway Tie Association. A synopsis of the article is provided in this newsletter.

The full life cycle of creosote-treated railroad ties includes: the growth of trees on forested land; harvest of logs; milling to create ties and lumber; treatment of ties with creosote; use of the ties by the railroads as part of the railroad bed; and, at the end of their use-lives, disposal or use as an energy source. End-of-life alternatives include: recycling ties to produce useful energy, disposing ties in landfills, and legacy ties along the railroad's right-of-way.

Description of Creosote-Treated Ties

Ties are treated by pressure impregnation of creosote preservative. The actual U.S. average creosote retention in ties is in the range of 5 to 6 pounds per cubic foot (pcf). 5.5 pcf is assumed in this evaluation.

The composition of a treated tie changes from initial treatment through the use-life such that it is different at the end of life. Ties spend their use-life in an extreme environment: placed horizontally, the top surface fully exposed to sun and weather, the sides and bottom embedded in ballast rock, repeatedly heated, cooled, wetted, and dried, in varying climates, while being subjected to repeated compression and bending stresses as they support the transport of millions of tons of freight each year. A portion of the creosote is lost due to volatilization, biological degradation, and photo-chemical degradation that takes place on the surface of the ties and to a lesser extent in surrounding ballast. The estimated "average" composition of ties at life stages of untreated, newly treated, and end-of-use are shown in Table 1.

Table 1. Composition of Ties by Life Stage

Tie Components	Untreated	Treated	Loss or change in use	Used ties
	(lb/tie)	(lb/tie)		(lb/tie)
Wood (dry mass)	148	148	5%	141
Water (% of dry mass)	70%	40%		20%
Water mass	104	59		28
Creosote mass	0	20	35%	13
Whole tie	252	228		182

Impact Indicators

Each end-of-life option has consequences. The following indicators of potential impacts (consequences) are evaluated for each end-of-life option.

• Fossil Energy Use – Fossil energy is a non-renewable resource. Use of fossil energy is a measure of resource depletion. When renewable resources, such as wood products, are beneficially used, they offset fossil fuel use and reduce resource depletion.

• Greenhouse Gas (GHG) – Carbon dioxide (CO_2) is the reference compound used to assess warming impact. Methane emissions are considered in the calculation of GHG and are estimated to have 21 times the CO_2-equivalents (CO_2-eq.) of carbon dioxide on a mass basis. Wood is biogenic, and its use for fuel does not increase GHG emissions.

• Acidification – Combustion of fuel results in emissions that contribute to acidification. Factors have been applied to standard emission rates for natural gas, wood, and coal combustion boilers to evaluate the potential acidification impacts.

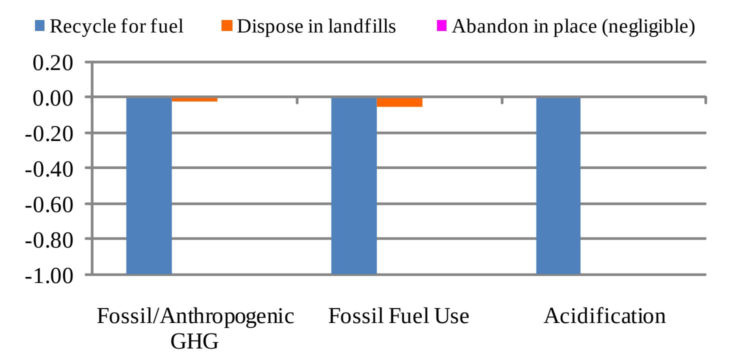
Tie Impact Indicators Prior to End-of-Life

The wood in each tie contains 71 pounds of carbon, equal to the removal of 260 pounds of carbon dioxide during tree growth. Each tie also contains 13 pounds of fossil carbon as creosote. Thus, treated ties begin with negative 260 pounds of CO_2 and this value increases through manufacture, use, and disposal life cycles as the fossil components decay or are combusted. While in use, 5 percent of the wood and 35 percent of the creosote are converted to carbon dioxide, raising the GHG emissions by 34 pounds for a net of negative 226 pounds.

Comparison of End-of Life Alternatives

Comparison of all impact indicators for the complete life cycle is shown in Figure 1. Rather than indicating actual indicator values, these have been normalized to show the recycle option as a negative 1, since all indicators for this option are negative. Values for disposal in a landfill and abandonment are relative to the recycle option. Negative values mean that releases causing the indicator are reduced by implementing the disposal option. Positive values indicate the disposal method increases the impact indicator values.

Figure 1
Used Tie Impacts by End-of-Life Alternative



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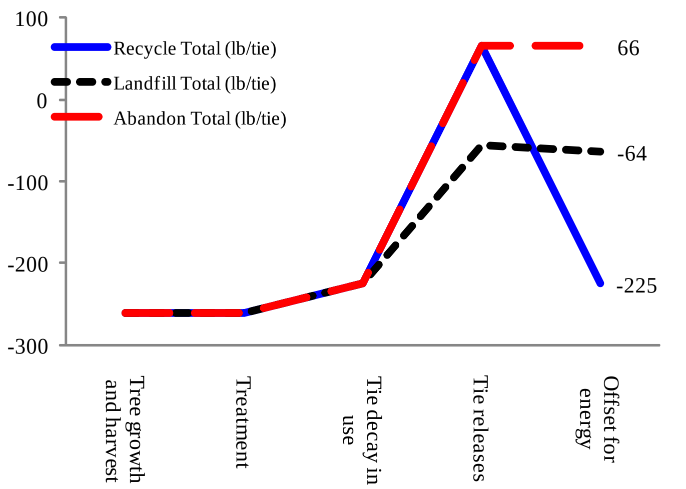
Another way to consider the full life cycle is to consider the flux of GHG interchange with the atmosphere as depicted in Figure 2. The flux begins at negative 260 pounds of CO_2-eq. due to the CO_2 removed from the atmosphere and stored in the tie wood and remains unchanged as the tie is treated. Injection of creosote does not result in a change since it is not released as CO_2 or methane. During the tie's use, the GHG value increases due to decay (creosote and wood loss).

Figure 2
GHG (CO2-Eq) Flux by Life Stage



Values for the three alternatives diverge at the end-of-life stage. The recycle for energy and abandon alternatives increase because all carbon remaining in the ties is converted by combustion or decay, respectively, to carbon dioxide. The landfill option results in less CO_2 emissions, but includes methane emissions (with CO_2-eq. at 21 times those of CO_2), raising the landfill alternative GHG total. As a final analysis at the end-of-life, offsets to fossil fuel use are applied. Abandoned ties have no offset. Recycled ties have a large offset that brings the final CO_2-eq. per tie value to a negative 225 pounds. Landfilled ties have a small offset, due to methane capture and energy recovery, bringing the final to negative 64 pounds of CO_2-eq. per tie.

Conclusions

Recycling wood ties for energy recovery provides clear and significant benefits of conserving fossil fuel resources, reducing greenhouse gas levels in the atmosphere, and reducing emissions that lead to acid precipitation.

The fuel offset gained by recycling creosote-treated ties for energy recovery is 20 times greater than energy recovery from landfill disposal. Offsets result in a significant decrease in GHG emissions when ties are recycled for energy compared to a slight increase in GHG emissions when landfilled. If ties are abandoned, no change results to fossil fuel use or acidification and GHG emissions are increased approximately one-third as much as by landfill disposal.

If all ties replaced annually in the U.S. (approximately 20 million) were recycled for energy, the offset of energy would eliminate GHG and fossil fuel use equivalent to the requirements of a city of nearly 100,000 people.

STEPHEN T. SMITH, P.E.

Steve Smith is a technical consultant to **AquAeTer**, providing engineering and environmental consulting in oil, gas, and other natural resources, forestry, wood preserving, agriculture, and manufacturing sectors. Mr. Smith has extensive experience in plant engineering and problem solving, life-cycle assessment, environmental management, environmental assessments, permitting of facilities for process wastewater, storm water, and air media, operations, project management, risk assessment, site investigation and cleanup, boilers and combustion systems, advocacy, and regulatory affairs.

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CHRISTOPHER A. BOLIN

Mr. Bolin is the Operations Manager for the Centennial, Colorado office and a technical director over **AquAeTer's** sustainability and Life Cycle Assessment projects. One of Mr. Bolin's focus areas is services to the treated wood industry. He has conducted investigations at over 20 treated wood facilities and has experience with both water- and oil-borne preservatives. He has performed numerous property transaction assessments and due diligence reviews of industrial and manufacturing properties. He has successfully negotiated risk-based closures at several industrial facilities with environmental media impacts. Currently, Mr. Bolin is overseeing the preparation of five Life Cycle Assessments for the Forest Products Industry. Mr. Bolin's multidisciplinary education includes training in geology, geochemistry, hydrogeology, environmental science and engineering, and chemistry.

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Bill Jernigan is a Sr. Technical Consultant to **AquAeTer**, providing direction and management for projects involving wastewater treatment, flexible discharge permitting and compliance strategies, surface water utilization, pollution prevention/control plans for process spills and storm runoff, auditing facility compliance status, implementing an effective environmental management program, assessing environmental risk potential in a facility purchase or sale, and negotiating permitting and compliance schedules or agreements with regulatory agencies. Mr. Jernigan has over 42 years of experience in environmental engineering which includes nearly 30 years of coordinating multi-media compliance programs at pulp and paper, corrugated packaging, and wood products facilities.

A Review of Metro Atlanta Storm Water Management

The development and implementation of Total Maximum Daily Loads (TMDLs) for receiving streams is creating a heightened awareness of the need to mimic natural predevelopment hydrology and hydrogeological conditions. This will result in increasing focus on infiltration, storage, and flow control-related technologies. It is also expected that we will see additional emphasis on education, new or revised regulations, permit requirements, and an increase in agency inspections and enforcement.

The recent heavy rains and extensive flooding experienced in the metro Atlanta area resulted in an in-depth review by the news media. Stream gauge data from the U. S. Geological Survey for 10 years and state storm water reports from 15 metro governments were utilized. This study showed that rapid development over the last decade overwhelmed the efforts to control runoff.

One finding was the amount of impervious surface area, parking lots, asphalt streets, buildings, etc. had grown by 91,000 acres, the equivalent of nearly 69,000 football fields. However, the tipping point was determined to be when the impervious surface covered 30 percent of the land in a watershed. A comparison for one small creek showed a rise of just less than 2 inches in the first hour of rain in a single day in June 2002, while a similar storm in March 2009, after development exceeded the tipping point, had a rise of 5 inches in the first hour and kept climbing. In theory, the change in the rate and volume of runoff from development sites would be modulated by installation of detention facilities which would control the "flashiness" of the stream. However, in some cases these facilities were not adequately installed or had been ignored for any maintenance or upkeep after being turned over to the site owner or homeowners association. One of the hardest hit areas with home flooding was the Austell community located at the junction of five creeks that has exceeded the tipping point.

The findings also indicated that maintenance of storm water infrastructure such as drains and detention ponds had fallen well below regulatory requirements. Maintenance of detention ponds has become a hot potato being tossed back and forth between government and the property owners. As a result, the removal of accumulated trash and volunteer trees and plants has mostly gone undone since installation. One approach being considered in the City of Atlanta is creation of a storm water "utility" which charges property owners fees based on square footage of impervious surface. However, the current hard economic times will certainly generate opposition. One city on the south side and one county on the east side of the area have established storm water utilities within the last couple of years to help fund upgrades to their systems.

TMDLs are addressing the water quality impact of storm water discharges on the receiving stream. In an effort to address the cause, runoff volume and flow are being targeted as surrogate pollutants. Developing cost effective Best Management Practices (BMPs), retrofit strategies or other ways to manage existing areas will require a creative approach. A cultural change that integrates a storm water management solution into the project rather than an "end-of-the-drain" add-on is developing. Among the improvements being considered are:

- New laws requiring local governments to study their flood plains;
- New laws to require developers to better control runoff downstream;
- Laws requiring that more water be captured and retained on site;
- Laws requiring use of trees and other plants to soak up rainwater on site;
- Growing use of storm water utilities;
- Extensive use of porous pavement; and
- Using plants on rooftops to absorb rain.

Some of these ideas have recently been implemented in other parts of the country and are being investigated by metro area officials. Several years ago, Philadelphia implemented a requirement for any disturbance of over 15,000 square feet, about the size of a chain drugstore, that made on site retention of the first inch of rain the owners responsibility. They could use grassy areas, plants on the roof, porous pavement or other means to make it stay on site. My alma mater, the Georgia Institute of Technology, is utilizing underground cisterns to collect roof drainage and air conditioning condensate to supply water for the building's landscape irrigation system. At the Atlanta City Hall, they have installed a model rooftop garden.

Not only in Atlanta, but throughout this country, there is an awareness that storm water management could have been done better in the past. I'm optimistic that as a result we're coming together for a better future. For more information on stormwater issues, you can contact Bill Jernigan at bjernigan@aquaeter.com.