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Tuesday 23 October

Energy, Emissions, and Air Quality

Diesel Exhaust Risk Assessment in California
Lanny Schmidt – Union Pacific

The 2005 MOU between the BNSF, UPRR and California Air Resources Control Board (CARB) required completion of Health Risk Assessments (HRAs) for several locations over a 2 year period. Once the HRAs are finalized, the Railroads are required to meet with CARB, the Local Air District, and community member representatives to discuss concerns of the community, new alternative practices, or other feasible actions that have been implemented to reduce emissions. This presentation will describe one approach to that process.

Project Implementation and Air Quality Conformity Issues for Nonattainment Status Transitions
John Morton and Edward Liebsch – HDR
David Seep – BNSF Railway

This presentation will provide a summary of air quality issues related to project implementation in areas potentially undergoing a change in status from “attainment” to “nonattainment” with respect to National Ambient Air Quality Standards (NAAQS). In nonattainment and “maintenance” (former nonattainment) areas, projects that will obtain federal licensing or funding may be subject to regulatory requirements of Transportation Conformity rules (40 CFR 93, Subpart A) and/or General Conformity rules (40 CFR 93, Subpart B).

The purpose of these conformity rules is to ensure that federal actions do not impede a state or local, EPA-approved plan to bring areas into attainment, or to maintain attainment, with NAAQS. Due to significant tightening of both the fine particulate matter (PM2.5) and ozone NAAQS in recent years, a significant number of areas nationwide now need to deal with conformity issues. Given the possibility of further standard revisions, even more areas may need to deal with conformity in the future. It is important when planning a project to anticipate potential transitions to nonattainment status, as the timing of these transitions can significantly impact the ability to obtain federal funding or approval of actions that are critical to successful project implementation.

Exhaust Emissions from a EMD SD60M Locomotive Equipped with a Diesel Oxidation Catalyst
Dustin Osborne and Steve Fritz
Southwest Research Institute
Mike Iden - Union Pacific
Don Newbury - MIRATECH Corporation

This presentation describes the test results of a program to apply an experimental diesel oxidation catalyst (DOC) to a 2,850 kW freight locomotive. Locomotive emissions and fuel consumption measurements were performed on an Electro-Motive Diesel (EMD) model SD60M locomotive, owned by Union Pacific Railroad company, that had been recently rebuilt to EPA Tier 0 exhaust emission certification levels. Emission testing was performed at the Southwest Research Institute (SwRI) Locomotive Exhaust Emissions Test Center in San Antonio, Texas. US EPA-regulated emission levels of hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOX), and particulate (PM) were measured using U.S. EPA locomotive certification test procedures in three configurations; first a baseline with a relatively high sulfur diesel fuel (2,913 ppm sulfur) meeting EPA locomotive certification test specifications, and another baseline using ultra-low sulfur diesel fuel (ULDS), and finally a test using ULSD after the installation of a diesel oxidation catalyst designed and manufactured by MIRATECH Corporation (patent pending). The DOC was applied pre-turbine, within the exhaust manifold due to both space and exhaust temperature considerations. This paper describes the design of the DOC-equipped exhaust manifold, and reports the changes in the regulated exhaust emission levels between the baseline tests and after installation of the DOC. Also described is a locomotive on-board monitoring system used to monitor DOC performance during ongoing revenue service field testing.

An Overview of Greenhouse Gas Activities in the U.S.
Connie Sasala, Ken Rose, Jeff Caton, and Susan Ellis - Cameron-Cole, LLC

The landscape of greenhouse gas-related initiatives, pending federal legislation and state regulation is changing rapidly. The purpose of this presentation is to provide an overview of leading protocols, programs and key bills covering the mandatory and voluntary management of greenhouse gases in the U.S., and how they relate to the railroad industry. This overview will include (but is not limited to) the following: WRI/WBCSD GHG Protocol; ISO 14064 (1-3); DOE 1605(b) Program; Climate VISION; U.S. EPA Climate Leaders; the California Climate Action Registry (the Registry); the Regional Greenhouse Gas Initiative (RGGI); “The Climate Registry” (also known as the multi-state registry); the Chicago Climate Exchange (CCX); California AB 32 (Global Warming Solutions Act of 2006); and several leading bills in Congress.

Particular emphasis will be placed on California’s progress in developing the implementing regulations for AB 32, and the role of the California Climate Action Registry in shaping those regulations. These actions represent the leading edge of mandatory controls in the U.S., and warrant closer examination, as they may be used as a model for federal controls.
Overview of EPA’s Proposed Tier 3 and Tier 4 Locomotive Exhaust Emission Regulations
Steve Fritz – Southwest Research Institute

EPA proposed new locomotive exhaust emission regulations on June 29, 2006. A Final Rule is expected by the end of this year. This presentation will briefly cover the following areas; Timeline of EPA locomotive exhaust emission regulations; locomotive diesel fuel regulations; Proposed Regulations for both New locomotives (Tier 3 & Tier 4) and changes for Existing locomotives (T0, T1, & T2); new rules for Switcher locomotives, new Idle Restrictions, and proposed test procedure changes.

Energy, Emissions, and Air Quality Technology Panel
Moving Forward by Looking Back – How GE Transportation Develops Fuel Saving & Emissions Reduction Products for the Installed Base of Locomotives
Joseph Dougherty - GE

Our objective: At this conference we plan to address our multi-generational approach to product develop as it pertains to fuel savings and emissions reduction on Aftermarket locomotives by using two case studies, one existing product and one potential new product.

Problem statement: The majority of the installed base locomotives were designed and manufactured prior to either the EPA’s Tier standards or the substantial rise in diesel fuel prices. Further, the seeming dichotomy of reducing both fuel and emissions, especially as it pertains to NOx and particulate matter, presents a unique challenge for all stakeholders: operators, regulators, the public, and suppliers. As a technology-driven company and a supplier of GE and EMD parts and services, GE Transportation is in a position to help operators find a balance of the right types and levels of investment for fuel and emissions products on the aging locomotive fleets.

Interest to audience members: In every product we develop for the aftermarket, we quantify what we consider a win-win scenario of emissions reduction balanced with fuel savings.

Consider the macro-level example found below:

- 350,000 Gallons per year per road locomotive
- 17,500 Road locomotives in U.S.
- 9.5 Tier 0 NOx (gr/bhp-hr)
- 0.2 Tier 0 PM (gr/bhp-hr)

1% Fuel improvement
- 61,250,000 Annual gallons saved
- 46,500,000 Tons NOx reduced
- 3,000,000 Tons PM reduced

In addition to providing emissions reduction and fuel savings products, GE Transportation views the data collection and off-boarding processes as of emerging importance with respect to asset management and regulatory reporting requirements.

Fuelcell Locomotives for Zero-Emissions Urban Rail
Arnold Miller - Vehicle Projects

Fuelcell power for locomotives combines the environmental benefits of a catenary-electric locomotive with the higher overall energy efficiency and lower infrastructure costs of a diesel-electric. Catenary-electric locomotives – when viewed as only one component of a distributed machine that includes an electricity generating plant, transformers, and transmission lines – are the least energy-efficient and most costly locomotive type. Diesel-electric locomotives, while collectively worse as sources of air pollution than an equal number of catenary-electric locomotives driven by a coal-fired powerplant, are more energy efficient and have a less expensive energy infrastructure. Fuelcell locomotives will be more energy efficient than diesel locomotives and have similar fuel infrastructure costs. Elimination of high catenary-electric infrastructure costs by fuelcell locomotives is the key to economic viability of electric trains in low population density regions such as the western USA.

Zero-emission, hydrogen-fueled fuelcell locomotives can help resolve the related issues of urban air quality and national energy security affecting the US rail industry and transportation sector as a whole. The issues are related by the fact that about 97% of the energy for the transport sector is based on oil, and more than 60% is imported. Besides being the source of conventional air pollution, the burning of fossil fuels and consequent atmospheric release of carbon dioxide is probably a factor in global climate change. Energy security is impacted because world oil reserves are diminishing, demand is increasing, and political instability threatens supply disruptions.

Furthermore, a need exists for large vehicles that serve, in addition to conveyance, as mobile backup power sources for critical infrastructure. Power-to-grid applications include military bases and civilian disaster-relief operations. Indeed, following Hurricane Katrina, a makeshift jail in New Orleans was powered by an Amtrak diesel-electric locomotive.

A North American consortium (see Table 1), a public-private partnership, is developing a prototype hydrogen-fueled fuelcell-battery hybrid switcher locomotive (see Figure 1) for urban and military-base rail applications leading to commercial locomotives that will: (1) reduce air pollution in urban railyards, particularly yards associated with seaports, (2) increase energy security of the rail transport system by using a
fuel (hydrogen) independent of imported oil, (3) reduce atmospheric greenhouse-gas emissions, and (4) serve as a mobile backup power source ("power-to-grid") for critical infrastructure on military bases and for civilian disaster relief efforts.

At 127 tonne (280,000 lb), continuous power of 250 kW from its PEM (proton exchange membrane) fuelcell powerplant, and transient power well in excess of 1 MW, the hybrid locomotive will be the heaviest and most powerful fuelcell land vehicle yet. The schedule for this fast-paced project calls for completion of the vehicle in early 2008. Contributing to the fast pace are: (1) the platform of the fuelcell-hybrid locomotive is based on a commercially available diesel-battery hybrid switcher (Green GoatTM) and (2) both the fuelcell powerplant and roof-mounted lightweight compressed-hydrogen storage system (see Figure 2) are derived from the CitaroTM fuelcell transit bus. Citaro fuelcell buses, widely used in European cities, have a combined operating experience of more than 1.5 million kilometers.

Several design and integration challenges arise when implementing such a large hydrogen fuelcell vehicle. Harsh operating conditions, especially shock loads during coupling to railcars, require component mounting systems capable of absorbing high energy. Additionally, system design must address railway-industry regulations governing safety and such events as derailment, side impact from yard traffic, refueling, and maintenance.

Available and Developing Technologies to Meet Emission Standards
Karen Dzienkowski - MotivePower, Inc.

With EPA's proposed rulemaking on Part 92, railroads need to identify compliant remanufacture options for their existing fleet as well as develop a strategy for air quality compliance into the future. MotivePower, Inc. (MotivePower) proposes to present several environmental solutions for locomotives operating in both freight and passenger service. These product solutions include

1. Multi-engine switcher locomotives
   These locomotives offer 1400 or 2100 hp, depending on the model, and use ultra-clean Tier 3 nonroad engines for power. They offer nearly 90% reduction in NOx and nearly 80% reduction in PM from uncontrolled levels. Fuel savings for these locomotives is estimated at 25-40%, depending on duty cycle, and greenhouse gas emissions reductions are in direct proportion to fuel savings. The fuel savings are achieved by the locomotive’s integrated start/stop control, which operates in cold and warm weather alike, and by bringing engines online only as additional power is needed. The locomotive has a modular design that allows for in-field maintenance and engine change-outs, resulting in higher availability and lower maintenance costs.

2. T2R engine upgrade package
   The T2R engine upgrade package converts an existing uncontrolled or Tier 0 locomotive to a locomotive that emits at Tier 2 emission levels, generating as much as 60% reduction in NOx and 40% reduction in PM. The complete upgrade package includes:
   - Electronic fuel injection,
   - Enhanced cooling system,
   - New fuel injectors, and;
   - Diesel oxidation catalyst module

Depending on the customer’s needs, all or pieces of this package can be applied to reach as high as Tier 2 emission levels or the new remanufactured engine levels for Tier 0 and Tier 1 locomotives in EPA's proposed rulemaking. Currently this product is developed for the 16-645F3B engine, a 3600 hp turbocharged engine commonly used in passenger service. Minimal modifications are needed to apply the technology to the 16-645EB engine commonly used in the freight market. Similar packages for other engines will be developed according to customer demand.

3. Diesel oxidation catalyst (DOC) module
   MotivePower's DOC has been tested in its emissions lab and based on these data reduces PM emissions by about 25%. It can be applied to both high and low-horsepower locomotives, but depending on the duty cycle, may require an automatic engine start/stop device with microprocessor control. The module replaces the existing silencer and does not modify the locomotive's existing profile. Because the module bolts to the turbo exhaust flange, maintenance access is straightforward and quick. A field demonstration project is planned and MotivePower is pursuing ARB/EPA technology verification for the module.

4. Diesel particulate filter (DPF) module
   MotivePower is currently installing a DPF on a 2000 hp MTU engine. DPFs have also been installed on two EMD switcher locomotives in California. Additionally, some customers are interested in DPF on multiengine locomotives. A DPF module may reduce PM emissions by as much or more than 80%. Because the filter housing is rather large, DPFs are best suited to low-horsepower locomotives that do not need to meet tunnel clearances.

5. Emissions test lab facilities.
   MotivePower develops emission reducing technologies and obtains certifications using data from its emissions test lab. It is one of only four (4) test labs in North America that is equipped to perform EPA's locomotive Federal Test Procedures (FTP). MotivePower also offers in-use testing services to locomotive manufacturers and certification and component verification testing for rail or emission technology clients.

The presentation will explore the emissions and energy benefits of these technologies as well as their maintenance and operating advantages. Finally, the presentation will discuss emissions reductions and cost-effectiveness estimates for potential projects as well as identify possible funding sources.
California’s Locomotive Emission Control and Carl Moyer Programs
Harold Holmes - California Air Resource Board

The California Air Resources Board has historically recognized federal preemption of state’s authority to regulate new and remanufactured locomotive emissions. In spite of federal preemptions, California has worked cooperatively with the Union Pacific and BNSF railroads over the past decade to forge voluntary agreements that reduce both oxides of nitrogen and particulate matter locomotive emissions beyond those provided under existing U.S. EPA locomotive regulations. California recently commented on U.S. EPA’s proposed locomotive rulemaking, with support for many of the key elements, but also stressing the need to strengthen and accelerate some of those elements. California’s 2007 State Implementation Plans have highlighted a need for earlier and greater emission reductions from locomotives and railyards, beyond those proposed in the recent federal locomotive rulemaking, to achieve both PM2.5 and ozone ambient air quality standards by specified dates.

This presentation will provide an overview of California’s locomotive and railyard emission control programs including the 1998 Locomotive Fleet Average Agreement for the South Coast Air Basin and the 2005 Statewide Railyard Agreement. The presentation will include a discussion of California’s research efforts to develop aftertreatment applications for existing locomotives and California’s locomotive remote sensing pilot program. An overview will be provided on California’s position on U.S. EPA’s proposed locomotive rulemaking, and California’s need for additional locomotive emission reductions beyond the proposed rulemaking. The presentation will also describe the Carl Moyer and Proposition 1B incentive programs that are being used to fund a number of emission reduction strategies, including advanced technology locomotives in California.

Noise and Vibration

Evaluating Noise From Intermodal and Transloading Operations
Timothy Casey – HDR

American consumption of foreign goods and materials continues to increase each year, creating congestion at international ports on the West Coast and a corresponding increase in demand for intermodal transport of these goods and materials. The freight railroad industry is growing and expanding to meet these increasing demands. However, siting new or expanding existing intermodal yards typically requires a lengthy approvals process. Potential conflicts arise when noise-sensitive land uses exist in close proximity to the proposed project site. Options to assess noise from proposed intermodal or auto transloading facilities include spreadsheet-based models and commercially-available acoustical modeling software. This presentation provides an overview of those two methods, briefly discussing the pros and cons.

Can You Hear ME NOW? - Acoustical Barriers
Stuart Boykin – CSX Transportation
Britt Luther, Donnie Seward, Fang Yang, and
Leo Thorbecke – Earth Tech

Those who have visited or worked around Hump Yards can attest to the discomfort of the high pitched squeal that the main and secondary retarders emit as the cars are sent to the distribution yard. To work around the retarders or in the general vicinity of such equipment requires hearing protection. Buildings adjacent to the hump and at the head of the distribution yard are impacted as well. As the nation continues to build acoustical barriers along our highways to abate the drum of noise pollution, the railroad industry is looking at a similar means of mitigating problems associated with noise that may be a nuisance, but more importantly, a possible health risk.

In order to develop an understanding of the noise-related problems at two CSX Transportation Hump Yards, Earth Tech developed sound models of the facilities to measure acoustical parameters that accounted for topography, location, the source, frequency, and the presence of existing or proposed structures. Field noise measurements were obtained using Brul & Kjaer Investigator 2260H and Quest 1900 meters and performed the sound modeling using SoundPLAN. Unlike highway noise the industrial modeling of retarders substantially differs in its use of the algorithms to produce an accurate model that is capable of being manipulated to easily change the desired parameters to measure statistical differences in time including weighted averages. Various designs can be assessed and manipulated by the engineer allowing the final design and configuration to be optimized.

Noise barrier abatement analyses was conducted at both Hump Yards to determine the existing ambient noise conditions around the humps and evaluate effective barrier design options in abating noise from retarder operations to protect workers’ hearing environment, particularly at outdoor activity areas. Subsequently there were the design and construction management of the installation of sound barriers at the selected facilities. The noise barrier abatement analyses consisted of identifying the characteristics of the hump retarder-generated noise, measuring ambient noise levels at areas where workers face potential retarder-generated noise, developing a noise model to predict noise contours around the hump, predicting noise contours from various barrier design options, and recommending feasible and effective barrier design options to improve the workers’ hearing environment.
Wrestling with Rapanos (v. United States)
Matt Pillard – HDR

The June 2006 U.S. Supreme Court ruling in Rapanos v. United States has presented new interpretations of jurisdictional waters of the U.S. defined under the Clean Water Act. This decision is important to all railroads as they embark on projects that involve crossings of potentially jurisdictional waters of the U.S.

Based on this U.S. Supreme Court decision, there are two tests for jurisdictional waters of the U.S. (i.e. waters that are subject to regulation under the Clean Water Act): 1) the Scalia plurality – in essence, a hydrographic test in which “only those relatively permanent, standing or continuously flowing bodies of water ‘forming geographic features’ that are described in ordinary parlance as ‘streams, oceans, rivers and lakes’”; and 2) the Kennedy concurrence – “a water or wetland [that] possesses ‘a significant nexus’ to waters that are navigable in fact or that could reasonably be so made . . . .”

At the time this abstract is being submitted, guidance from the U.S. Army Corps of Engineers is pending and is expected to be released “at any time.” A summary of this guidance will be provided in this presentation, followed by examples of how the guidance is being implemented in various U.S. Army Corps of Engineers districts. This presentation will also examine the implications of this decision on Section 404 of the Clean Water Act and, specifically, the tests for determining jurisdictional waters of the U.S. The audience will gain an understanding of the intent of the decision, the guidance that has been offered, and what this means to railroad activities subject to Section 404 of the Clean Water Act. As an alternative if the guidance is not forthcoming, current practical applications by various U.S. Army Corps of Engineers will be reviewed.

Wastewater Treatment at Railyards: What Equipment and Instrumentation Do You Really Use?
Ken Rose and Wayne Frank – Cameron-Cole, LLC
Glenn Thomas – Union Pacific

Wastewater treatment plants at railyards typically receive wastewater generated from locomotive maintenance, fueling operations, locomotive/railcar cleaning operations and contact stormwater. Wastewater composition commonly consists of light-end petroleum hydrocarbons, oil and grease, detergents, suspended solids, and dissolved solids. The relative composition of influent streams varies between and within railyards based on shift and daily activities. Oil/water separator units that discharge to publicly owned treatment works (POTW) are the most common treatment processes currently in use.

Existing treatment plants are under pressure to provide improved performance due to regulatory changes. Additional treatment equipment and improved process control is required to ensure compliance with POTW discharge permits. Instrumentation, such as sensors and remote telemetry, results in a “smart” treatment plant with improved operational control coupled with remote monitoring and control.

In this presentation, we will discuss equipment and instrumentation that has been successfully used to improve treatment plant operations and provide increased automation. Examples from active railyard wastewater treatment plants will be presented.

Flow Dependent Wastewater Treatment Facility Upgrades
Kevin Hauschildt – Norfolk Southern
Stephanie Knight - ENSR Corporation

The Norfolk Southern Railway Company (NSRC) operates a wastewater treatment facility (WWTF) at the Brosnan Yard in Macon, Georgia. The facility receives wastewater generated from the engine fueling platform, as well as from other smaller sources. The volume and quality of the wastewater that the facility receives is highly dependent on the duration and intensity of the precipitation generating contact storm water runoff.

Several years ago, NSRC installed organo-clay filters (OCF) as secondary treatment downstream of a dual channel API separator. Although the OCF has added to the reliability in meeting the NPDES permit limits, flow rates to the treatment system periodically exceed the OCF flow capacity. Because of the reliability of these units, NSRC desired to keep these units in the WWTF upgrades, while adding diffused air flotation (DAF), to further increase the reliability of the system during high flow conditions.

The wastewater treatment system was modified to provide effective treatment under all flow conditions. Depending on the flow rate into the WWTF, the water could either flow through the API and then through the DAF and OCF, or nearly any combination of these individual processes. Therefore, this flexible treatment system design makes it possible to achieve regulatory discharge criteria in spite of highly variable flow conditions.

This design resulted in a significant cost savings over increasing the size of both the existing OCF and the proposed DAF. This presentation will discuss the design process, the control loops, and specific retrofit features of these processes in the Brosnan Yard engine fueling platform wastewater treatment facility.
Storm Sewer Installation and Repair Dos and Don’ts
John Hasterlo – Union Pacific
Christopher Harvey – TRC

Many railroad yards experience integrity problems in their aging storm water and industrial wastewater sewers causing environmental issues. Also, it was common for railroads to build storm sewers with traditional methods/materials in hydrocarbon-impacted subsurface conditions. The materials, sealants and gaskets may be incompatible with hydrocarbon-impacted groundwater, and often contaminated groundwater infiltrates storm sewers. This presentation provides several potential solutions to this situation using an actual railroad yard case study in Illinois. We will present the challenges encountered in the existing sewer of a large railyard, and the approaches that were considered and selected to successfully address them. This yard had a 30-year old storm sewer constructed of corrugated metal pipe to convey storm water through an active fixed fueling area. Subsurface impact consisting of free-phase hydrocarbon product infiltrated the storm sewer. The Illinois Environmental Protection Agency issued a notice of violation for the storm water discharge. The railroad replaced and rehabilitated the sewer using slip lining, sewer replacement, WEKO-SEALs, and patching and grouting. We will share the dos and don’ts from our experiences working at this yard.

Navigating the Stormwater Fee Assessment Program
Dillon Magers – BNSF Railway
Raghu Chatrathi – EMR

Railroads with land holdings in several urban locations are assessed storm water fees based on impervious area calculations. The success of intermodal operations is changing the urban railyard landscape from predominantly tracks to large portions being converted to paved areas for container parking (impervious areas). A large mid-south metropolitan city (City) initiated a Storm Water Fee Assessment Program (Program) in 2006 with fees being assessed starting in May 2006. The Program developed an Adjustments and Credits Manual (Manual) that property owners can follow to reduce the fee.

A Class I Railroad owns several parcels in the City and the Program identified 42 parcels of various sizes that were targeted for the fee. Based on an aerial survey of the properties the City estimated a $5,200 monthly storm water fee. The Railroad wanted to use the Manual to identify adjustments and credits that could be used to reduce the fee. Publicly available and private databases were used with aerial photographs to synchronize information and determine the accuracy of the City data. This paper presents the railroads’ experience with the Program and the steps being taken to minimize the fee assessed by the City.

TSS in Moffat Tunnel Discharge Waters
Oscar Sorensen - CH2M Hill
Mark Ross - Union Pacific

The Moffat Tunnel, with its West Portal located in Winter Park, Colorado and its East Portal located approximately 7 miles west of Rollinsville, Colorado is just over 6.2 miles long and penetrates James Peak through the continental divide. At an elevation of 9,239 feet above sea level, the Moffat Tunnel is one of the highest railroad tunnels in the United States.

Groundwater infiltrates into the Moffat Tunnel bore at several locations along its length. This seepage discharges from the West Portal at approximately 300 gallons per minute (gpm) and from the East Portal at approximately 60 gpm. High total suspended solids (TSS) in the discharge waters resulted in an Individual Industrial Wastewater Permit (IIWP) being issued from the State of Colorado requiring a reduction in TSS prior to discharging the water to South Boulder Creek at the East Portal and the Fraser River at the West Portal.

An evaluation was conducted of the site conditions that cause the elevated concentrations of total suspended solids (TSS) to be discharged. Included in this evaluation were temporal grain size and TSS/turbidity analyses in addition to thorough geochemical analyses on discharge and receiving waters. Parshall Flumes with in-line turbidity probes were installed at each Portal to continuously monitor discharge and turbidity. Based on the results of the analyses, a number of potential remedies were evaluated, including: media filtration, microfiltration, natural treatment (wetlands), chemical/polymer coagulation, and electrocoagulation. In order to achieve IIWP compliance, a treatment system was selected that was both cost effective and would operate well in the harsh conditions observed at the location.

Private Cost Recovery Actions under Superfund - Back to the Future
Michael Meloy - Manko, Gold, Katcher & Fox, LLP

In June of this year, the United States Supreme Court issued a unanimous decision in United States v. Atlantic Research Corp., holding that the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA or Superfund), authorizes private parties to bring cost recovery actions to recover response costs that they have incurred even where there has been no governmental enforcement activity. The decision significantly enhances the ability of private parties to seek the costs of cleanup that they perform from other entities which may meet the broad liability standards under CERCLA. The decision dramatically alters the judicial landscape with respect to the risks private parties must manage and provides new opportunities for private parties to recover cleanup costs that they have expended. These changing dynamics will have ramifications for the railroads in many contexts, ranging from transactions to remediation strategies.
**Wednesday 24 October**

**Environmental Response**

**Fate and Transport of Ethanol in the Environment**  
Jim Holland – Pinnacle Engineering

The following is a brief summary of Pinnacle’s activities relating to the Balaton, MN train derailment, where ethanol and soybean oil were released to the environment.

**Initial Incident**

On the morning of 7-28-04, Pinnacle was requested to respond to a train derailment in Balaton, Minnesota, to represent the DM & E Railroad as their Environmental Team on the Site, to coordinate the post emergency response activities. Emergency response actions, including were in progress, under the supervision of the Minnesota Pollution Control Agency, the Balaton Fire Department, and the DM & E. The initial concern was to secure the area and eliminate immediate health and safety concerns.

**Soil Excavation**

Pinnacle office personnel prepared a Site Safety Plan and Workplan for use in the subsequent soil excavation and soil and groundwater investigations. Once the area was stabilized, an initial soil excavation was conducted to remove/stockpile the heavily impacted soils in the immediate spill area. Test pits were advanced to determine the extent of soil impacts in and around the spill area. Once the train cars and other debris were removed from the Site, a more extensive excavation was completed to remove the grossly impacted surficial soils from the release area, and from the ditch that flowed to Lake Yankton. The excavated areas were refilled with clean, imported fill. The ditch was excavated to a depth of approximately 18-inches, and the surface was covered with packed clay, the area was seeded, and erosion control was installed.

The excavated soils were stockpiled on the Site and characterized for treatment/disposal. The treatment method approved by the MPCA consisted of landfarming, which was done on two local farms that had been pre-approved for landfarming. Approximately 2,100 cubic yards of impacted soil were excavated from the Site.

**Wastewater Treatment**

Ethanol and soybean oil from the spill flowed to a ditch extending to Lake Yankton. As part of the emergency response, a dike was established across the ditch to contain the spill. Additional ethanol and oil were washed into the holding area behind the dike after the spill area was flooded with water to dilute and remove the spilled liquids. The impacted water was subsequently pumped to a nearby sewer on site, which flowed to the City of Balaton wastewater treatment plant. Water was also pumped into trucks and transported directly to the Balaton primary wastewater treatment pond.

On August 2, 2004, Pinnacle received call from the City of Balaton concerning the status of the wastewater pond. The pond had a dissolved oxygen (DO) reading of 0 and required immediate attention. Pinnacle staff subsequently prepared a plans to remedy the condition of the wastewater pond and to prevent further issues/problems.

It was decided to install turbo aerators in the southeast corner of the pond. In addition, three, 6-inch diameter pumps were installed in the other corners of the pond to aid in water circulation and aeration. Oil was also skimmed from the pond surface and placed in a storage tank located at pond.

A small boat was mobilized to the Site to allow the collection of DO readings across the pond to monitor the effectiveness of the aeration system. The microbial activity was enhanced by adding “seeded” water from the Marshall wastewater pond on several occasions. The aeration system was started on August 3rd, and the aeration was discontinued on August 17th, 2004, after DO readings were consistently elevated and sufficient microbial activity was established. Monitoring of the DO concentrations and microbial activity continued through August 20, 2004, and was discontinued, as the pond had stabilized.

The MPCA established discharge parameters for stormwater contained in the ditch impoundment. On several occasions, the impoundment was filled with stormwater that was impacted with ethanol as it flowed over impacted soil in the drainage ditch. It was required that the stormwater be pumped from the impoundment to the wastewater treatment system to prevent flowage into Lake Yankton. This was continued through August 15, 2004, when analytical readings of the impounded water showed the ethanol concentrations were below regulatory limits. The dike was subsequently breached.

**Indoor Air Quality Investigation**

On August 31, 2004, the owner of an unused grain elevator immediately adjacent to the spill contacted Pinnacle with concerns that ethanol from the spill may have entered the elevator basement. It was also asked if electricity could be safely restored to the elevator. On September 2, 2004, Pinnacle conducted an indoor air quality (IAQ) assessment of the elevator. A Mini-Rae photo ionization detector (PID) and a Mini-Rae four-gas meter were utilized for the IAQ assessment (the PID measures organic vapors, and the four gas meter measures explosive vapors, oxygen level,
hydrogen sulfide, and carbon monoxide). No abnormal readings were noted on either instrument on the ground floor, the basement, or in a crawl space adjacent to the railroad tracks. No visual or olfactory evidence of ethanol or petroleum infiltration was noted.

Subsurface Investigation

A workplan for a follow-up subsurface investigation was prepared by Pinnacle and approved by the MPCA. In September, 2004, Pinnacle conducted the investigation to document remaining soil and groundwater impacts to the Site. The investigation consisted of advancing eleven push probe borings to assess the soil and groundwater impacts following the completion of response actions at the Site. In addition, Pinnacle evaluated the potential for impacts to receptors in the vicinity of the release.

Concentrations of ethanol in the drainage ditch were shown to decrease with distance from the source area. The analytical results from borings advanced on the north side of Highway 14 between the drainage ditch and Lake Yankton indicated that the extent of impact from the ethanol release was limited to the northeast, and the likelihood of impact to Lake Yankton through groundwater discharge was determined to be low.

It was found that residual pockets of impacted soil were present after the excavation of grossly contaminated soil in the source area and drainage ditch. The majority of the remaining soil impacts occurred at the water table, which ranged from 5 to 11.5 feet below the surface in the immediate vicinity of the source area. Post-excavation PID readings from shallower soils were considerably less than at the water table, suggesting that soil cleanup that had been conducted was sufficient. The silt and clay soils in the area will likely minimize the lateral migration of these residual impacts.

The primary receptors that have the potential for impact from the ethanol release at the site are drinking water wells and utility backfill. In order to evaluate the potential for impact to drinking water wells in the vicinity of the release area, Pinnacle recommended additional groundwater investigation, including the installation of groundwater monitoring wells and additional push probes. It was also recommended that pumping tests of a municipal well near the release be conducted to determine the potential for impacts to the municipal water supply.

Brooks, Kentucky Derailment January 16, 2007 - A Series of Fortunate Events
Paul Kurzansi – CSX Transportation
Denis Balcer and Hadley Stamm – ARCADIS

On January 16 at approximately 8:51 a.m., 25 railcars derailed immediately south of the community of Brooks, Kentucky. Seven of the 12 derailed hazardous material cars leaked, breached and/or burned. Spilled material included butadiene, methyl ethyl ketone and cyclohexane. The resulting fire burned for 48 hours. Community outreach plus environmental and hazardous assessments began immediately.

As a result of a rapid coordinated response, the USEPA demobilized from the site in three weeks. Evacuated families began returning to their homes within one week, and the environmental restoration of the incident was minimized within one month, with remaining environmental concerns limited to less than 1,000 feet of the derailment. What factors contributed to this success when initial assessments put the USEPA on-site for a year or more, the spill from the derailment occurred in a residential area of private well supply, and the area topography was ringed with surface-water drainage ways in typical Kentucky limestone strata?

The answer: CSXT’s rapid, aggressive response and a few fortunate factors reduced the initial catastrophe into a manageable, short-term and localized cleanup. Aggressive response activities included a focused community outreach/public communication plan; coordinated rapid source removal of residues, impacted soil, sediments and surface water; and restoration of infrastructure. Special circumstances included the time and season of the derailment, subsurface geology, physiochemical properties of the spilled materials, duration of the fire, location of the derailment (20 miles south of Louisville, Kentucky), and the availability of usable real estate. Finally, CSXT focused on and developed a workable synergy between the public, the regulatory community and itself based on open communication, an aggressive plan of action and follow-through on promises.

The combination of all of these factors resulted in one of the greatest success stories from one of the worst derailments in CSXT history.

Mass Balance Calculations of the Fate of Hydrocarbon Spills
André Pelletier – CN
Hélène Richer-Berard, Robert Noel de Tilly, Eric Bergeron, and François Beaudoin – Golder Associates

In June 2006 a CN train carrying both diesel and gasoline derailed just north east of Montreal, Quebec, Canada. The derailment occurred near a river in sandy soil. An estimated total of 232,836 liters of hydrocarbons were released to the environment. This paper presents the processes by which the hydrocarbons traveled through the environment as well as the mass balance calculations of the fate of the spilled product in the environment for:
- Liquid phase (free product hydrocarbons on the water table);
- Dissolved phase in both groundwater and surface water;
- Adsorbed hydrocarbons on the soils; and
- Volatilization calculations to estimate the loss of product from the ground surface and the river. Calculation methodologies for each process and the inherent uncertainties are presented. Finally recommendations concerning data acquisition during the initial 48 hours of a spill are given.
Environmental Management Systems

Web-Based Environmental Management System
Chuck Mason – Gannett Fleming

This abstract will show that Gannett Fleming’s (GF) unique and effective Web EMS application can help railroads: 1) Better organize and manage environmental risks, 2) Improve tracking of compliance and EMS requirements, 3) Better organize documents, records, and the EMS training program.

Introduction
GF has developed an easy to use, intuitive web-based EMS application. It is designed to allow large organizations, such as railroads and others with significant environmental risks, better manage their EMS. GF has clients with multiple facilities across the county, similar to many railroads, successfully using Web EMS on a national scale to better manage their program. Specific features of Web EMS are:

ISO 14001 Based: Web EMS is designed specifically to manage all of the requirements of the ISO 14001 standard and contains tabs for each major ISO 14001 element, allowing the user to easily organize and manage its EMS. For example, the application contains a tab with information related to objectives, targets, and environmental management programs. This allows the user to track the status of various objectives and targets to ensure that they remain on schedule.

Manage Compliance: Web EMS allows the user to track inspection requirements, sample results, and other tasks to demonstrate environmental compliance across its entire organization. The compliance calendar feature enables the user to see compliance requirements at a glance, and also understand what tasks are behind schedule and what results are out of compliance.

Training Management: Web EMS allows the user to view training requirements for anyone within its organization, and also determine who is behind on meeting training requirements. The application also allows training records to be easily updated.

Document and Records Management: Web EMS allows the user to manage and organize EMS documents and records. The user can post and update documents and records as they are developed for use across the organization, which will enhance document management, security, and accessibility.

Permission Levels: Web EMS allows the user to define permission and access levels to enhance security and ease of use. Therefore, “Superusers” can have the ability to view and modify all EMS information, whereas others may only have read-only access on a regional or facility basis.

Conclusion
GF’s Web EMS is an effective tool that allows railroads, which have many environmental risks across large geographic areas, to effectively manage these risks and improve performance by using the power of the Web.
GF suggests that our presentation be part of a panel of railroad EMS managers discussing how railroads manage their EMS compared with other industrial EMS management systems in use today.

An Environmental Management System (EMS) Designed to Meet the Facility’s Needs
Lyle Staley – BNSF Railway
Mick Bilney – TEC, Inc.

A simple, flexible, three-part, performance-based approach to establishing an EMS has proven effective for shop personnel at a major American railroad. The EMS was designed to be a straightforward and useful tool for facility personnel to help them improve their environmental performance and shrink the facility’s environmental footprint.

This presentation will show how the EMS is structured and how it has significantly reduced the amount of time operating personnel need to participate in EMS meetings, internal audits and other activities. The presenters will describe the separate EMS segments and the unique way devised to communicate performance expectations that is immediately understood and helps gain acceptance on the shop floor. The presenters will also describe the evidence of wide support the EMS has achieved among operating personnel. They will discuss how the EMS is designed to meet the needs of facility personnel for effective solutions first, before any efforts at detailed documentation or conformance. Additionally, the presentation will demonstrate how the EMS helped simplify and ease the integration of the Responsible Care Management System (RCMS) elements for a successful outcome at Headquarters and the facilities.

Tools developed to support the needs of the facility personnel and ease the EMS implementation and integration effort are described. Numerous examples of money saved, performance improved and other benefits achieved are provided.

Workflow Automation in Environmental Data Management: New Advancements Lead to Greater Efficiencies in Data Monitoring and Management.
Arnold Gray and Mitchell Beard – EarthSoft

As the volume of soil and groundwater contamination data increases for known and suspected contaminated sites, many environmental agencies,
industrial firms, and environmental consulting groups seek to automate large parts of the environmental data management workflow. While it is necessary to build ad hoc queries and look at data in different ways, it is also possible to build automated systems and sub-systems that operate on the data in a highly automated and fixed manner. Automated systems for data loading and data reporting in response to specific “triggers” in the data have been developed and are being implemented widely using EQuIS, by EarthSoft.

System automation carries with it some basic requirements. Automating the loading of data requires some standardization of data formats. This leads almost immediately to the opposing desires of automation versus flexibility. For automation to be successful we must employ the principles of Total Quality Management, which guide us to improve quality by limiting choices. With a standardized format for incoming Electronic Data Deliverables (EDDs) in place, incoming EDDs can be automatically screened for correctness and completeness by software and loaded into EQuIS. Upon a ‘pass’, the submitter receives an email acknowledging the completed data submission and the data are loaded into EQuIS. Upon a failed EDD, an email is returned with the error log and the data are not loaded.

With the loading of data complete, it becomes possible to automate the delivery of reports, graphs, graphics, or other exports by screening the data against fixed regulatory limits. Designated reports can then be ‘pushed’ to the prospective user based on a clearly defined triggering event or time requirement. Whether for environmental chemistry, geology, limnology or geotechnical data, the EQuIS Environmental Information Agents (i.e., ‘push’ reports) provide environmental professionals with the capability for real-time data monitoring and decision support.

These new systems allow large organizations to manage large amounts of data most inexpensively and efficiently.

BNSF’s Environmental Metrics Program
Lyle Staley – BNSF Railway
Lori Upgren, Stefanie Young, and Chris Carleo - ENSR Corporation

Five years ago, BNSF Railway embarked on a process to enhance our environmental metrics program. Our goals were to improve the timeliness, relevance, and quality of the information used to assess the effectiveness of our Environmental Programs and to develop our internal and external Environmental Reports. This presentation will describe the methodology used to organize our metrics program and the challenges that we encountered and the successes that we achieved.

To initiate the metrics program a series of breakout group discussions were conducted to gather information on important areas of the railroad’s operations that should be addressed in the metrics program. Meetings were completed with all staff that had responsibility for the collection of data related to those programs to learn about the types of data available, frequency of collection and reporting, and methods to gain access to the data. We developed an overall organizational structure for the program by gathering the metrics into one of four “Themes”.

BNSF developed an overall report format that charts the data and provides text discussions of initiatives undertaken, and trends observed in the data. The metrics project also includes use of an information technology tool to automate the creation of the report. At this point the metrics program involves the development of quarterly and annual reports that are used to assess the effectiveness of BNSF’s Environmental Programs and report to management on progress, as well as analyze the gaps to identify opportunities for additional improvements.

Compliance

Environmental Issues Affecting the North American Railroads
Robert Fronczak – Association of American Railroads

The Association of American Railroads (AAR) represents the freight railroads in North America. AAR members include the railroads that operate 76 percent of the line-haul mileage, employ 93 percent of the workers, and account for 95 percent of the freight revenue of all railroads in the United States; and passenger railroads that operate intercity passenger trains and provide commuter rail service. AAR also represents the Canadian railroads through the Railway Association of Canada, and two Mexican railroads including Ferromex, and KCS DeMexico. This presentation will discuss current regulatory, legislative, environmental awareness, and pollution prevention initiatives at AAR. Regulatory activities include EPA's notice of proposed rulemaking on locomotive and marine diesel engines, developments in the area of spill prevention control and countermeasure plans, changes in the group multi-sector stormwater permit, creosote re-registration, and an effort by EPA to publish a risk assessment on naphthalene. EPA released a notice of proposed rulemaking in March which will have significant impact on the locomotives the industry purchases and rebuilds and will be phased in, in the next 10 years. Voluntary programs include the SmartWay program, a voluntary program designed to improve fuel efficiency and reduce emissions.

Development of an Environmental Chapter for the AREMA Manual
Kevin Keller
Melissa Godlewski - Kennedy/Jenks
Donald Girard – BNSF Railway

At a recent Committee 13 meeting, the members elected to develop a Chapter 13 (Environmental) for the AREMA Manual for Railway Engineering. In the past, Committee 13 had been reluctant to author a chapter on environmental due to the changing nature of the various federal, state, and local regulations. However, due to recent critical regulatory changes in the areas of the Clean Water Act and the Clean Air Act, and their potential substantial impacts to the rail industry, the committee feels that a chapter that at least presents the fundamentals of appropriate
environmental regulations is warranted.

The new environmental chapter will be loosely based on the Environmental Screening Checklist and Workbook for Short Line Railroads, published by the U.S. Environmental Protection Agency in July 2000. Environmental Best Management Practices (BMPs) from other Class I Railroads will also be integrated into the chapter. This presentation will provide an outline of the major sections of the new chapter, as well as discuss some of the more critical regulatory areas that face the rail industry today. A draft version of the chapter is anticipated to be completed by the 2007 Annual Conference.

Guidance on Accounting for Environmental Retirement Obligations for Railroad Assets per FIN-47
Doug Blakeley and Jim Redwine
Shaw Environmental & Infrastructure, Inc.
Jeffrey Davidson – Wilmer-Hale

To support their operations, AAR members have a need to maintain physical facilities to house, store, and protect their employees, equipment and material. A significant amount of these assets are owned by AAR members who are also part of public corporations or are otherwise responsible to an investing community. The Financial Accounting Standards Board (FASB) has developed standards for properly accounting for those assets, including retirement obligations. One of the more recent (and controversial) standards is FASB Standard 143, “Accounting for Asset Retirement Obligations” (2001) and its complementary document, “Interpretation No. 147, “Accounting for Conditional Asset Retirement Obligations: An Interpretation of FASB Statement No. 143” (2005). The outcome of these standards is an obligation by an investor-owned company who has adopted these standards in its accounting principles to identify its retirement obligations and properly account for them. Adoption of the FASB standards is generally consistent with Sarbanes-Oxley compliance.

This paper and presentation will provide guidance for the identification of assets that have conditional retirement obligations, how to estimate the value of the liability, the reporting of that liability on the company’s financial statements, and the considerations throughout this process.

First, applicable companies need to define what assets (structures, equipment, etc.) have items with applicable environmental regulatory closure, decontamination and/or disposal requirements that may need to be accounted for as liabilities in the company’s financial statements. In the railroad industry, these assets may include, but are not limited to:

- Bulk Storage of Petroleum (aboveground and underground storage)
- Asbestos and Potentially-Asbestos Containing Materials
- Polychlorinated Bi-Phenyl (PCB) containing equipment and/or contaminated building materials
- Lead-painted or containing materials that cannot be disposed of as solid waste in the routine demolition process
- Creosote-treated railroad ties

Once identified, there are several estimating methods, including ASTM 2137-E. Proper selection of an estimating method to determine Fair Value is important and will depend upon the information readily available to the company. Following the estimate, the reporting of this information on the balance sheet and therefore to the company’s investors needs to be managed.

Lastly, the paper will pose some issues for future consideration:

- If inventory reveals previously unknown assets and /or non-compliant conditions, what do you do?
- What happens if the company discovers other similar assets after the initial financial correction?
- What if the company acquires an asset that has not prepared such a CARO estimate?

Special International Presentation

Railways and Environment: An International Perspective
Raimondo Orsini - International Union of Railways

Risk Management

CSXT Leased Land & Track Risk Reduction Program
Paul Kurzanski, Carl Gerhardstein, and
Mark Gennette - CSX Transportation
Pat Harrison - AMEC Earth & Environmental, Inc.

This presentation describes the current program being used by CSX Transportation, Inc. (CSXT) to implement an enterprise-wide initiative designed to evaluate and reduce potential liabilities associated with property which has been leased to outside parties or may be leased to outside parties in the future.

The presentation describes CSXT’s analysis of leased property as it relates to contingent liability reserves, and the program subsequently developed by the Environmental Department to elevate discussion of the issue and raise awareness with various internal stakeholders.
These efforts lead to consolidation of the Company’s approach regarding both current and future lease transactions, as well other related programs, including …

- An evaluation of the effects of lease claims against the Company’s environmental reserve
- Formation of an enterprise-wide team of stakeholders to develop guidelines for leases (including restrictions and prohibitions) for the use of property
- Development and implementation of multi-level awareness training regarding the guidelines and the potential risks to CSXT associated with leases
- Development and implementation of an in-field program for the evaluation of current lease conditions and ensuring, to the degree possible, correction of any items by the lessee
- A process for internal assessment of certain properties for potential sale
- Tracking of the program through the PS&E-MS, an internal database

The presentation will provide a summary analysis of metrics to-date related to the field evaluation and follow-up program.

**Development of a Railroad Environmental Crimes Unit**

H.R. (Skip) Elliott, Keith Brinker,
Special Agent Steve Purvis - CSX Transportation
Glenn Millner and Michael Feehamster
Center for Toxicology and Environmental Health
Lisa McKenna - Phoenix EHS Consultants

Environmental crimes on railroad property, principally illegal dumping, whether by internal or external sources, are a significant and growing problem in the railroad industry. In field year 2006, CSXT experienced >200 incidents of illegal dumping with >15 from hazardous waste. Illegal dumping not only causes undue risks to the railroad in terms of environmental liability, employee safety, and operations, it is also very costly.

CSX Transportation, Inc. (CSXT) recognized the importance of investigating and prosecuting these crimes as a deterrent from further or more serious acts and to protect its interests in terms of liability and cost. In 2006, CSXT initiated their Environmental Crimes Unit (ECU) consisting of a cross section of its internal Special Agents, environmental managers, and specialized consultant partners. Specialized training has been presented and continues to be developed to equip the ECU to deal with environmental crimes from discovery through prosecution and remediation. The mission of the ECU is to investigate and prosecute environmental crimes under a number of environmental statutes including RCRA, CERCLA, CWA, CAA, etc.

CSXT believes the ECU helps foster a corporate culture of environmental compliance and one of support with the regulatory community while at the same time protecting railroad property. Finally, the program raises public awareness and perception of railroad operations within the community and enhances public safety and timeliness of railroad transportation.

**Development of an Environmental Consequence Model for Hazardous Materials Transportation**

Charles Werth, Hongkyu Yoon, David Schaeffer, Neha Hridaya, and Chris Barkan - University of Illinois at Urbana-Champaign

Although light nonaqueous phase liquid (LNAPL) spills due to railroad tank car accidents are not common, they often create human and environmental risks, and result in costly cleanups. A quantitative environmental risk analysis is used to determine the cost-effectiveness of replacing the current tank cars with alternate design cars. In the risk analysis, the environmental consequence is the cleanup costs for hazardous material spills. In order to assess environmental risks due to railroad tank car accidents, there is a strong need to develop an environmental model whose results serve as an input for the risk analysis. This study presents the development of the environmental screening model to assess NAPL dissolution and groundwater transport module was then used to simulate the effects of chemical properties, excavation, and free NAPL removal on NAPL redistribution and cleanup time. Implications of remediation efforts, cleanup times, and cleanup costs are discussed. Implementation of free product removal (i.e. removal of NAPL) and air sparging processes will also be discussed.
**Remediation**

**Completion of in-situ Thermal Remediation of PAHs, PCP and Dioxins at a Former Wood Treatment Facility**  
**Ralph Baker - TerraTherm, Inc.**

The largest in-situ thermal conduction heating project ever undertaken at a wood treatment site was completed in March 2006. The site was a former utility pole treatment facility that Southern California Edison (SCE) operated from 1921 to 1957. Former site facilities included pole immersion pits; boiler house; storage tanks; pipelines and railroad spurs. The subsurface soils were contaminated primarily with polycyclic aromatic hydrocarbons (PAHs), pentachlorophenol (PCP), dioxins and furans, with soil treatment standards of 0.065 mg/kg benzo(a)pyrene Toxic Equivalents (TEQ), 25 mg/kg PCP, and 1.0 µg/kg dioxin, expressed as 2,3,7,8-tetrachlorodibenzo-dioxin (TCDD) TEQ. A feasibility study led to the selection of TerraTherm's patented In-Situ Thermal Destruction (ISTD) technology, which utilizes simultaneous application of thermal conduction heating and vacuum to treat contaminated soil without excavation. The applied heat volatilizes organic contaminants within the soil, enabling them to be carried in the vapor stream toward heater-vacuum wells. Subsurface temperature monitoring tracked the progress of heating. A heating goal for inter-well temperatures to 325°C (620°F) was achieved. Approximately 12,600 m³ (16,500 CY) of predominantly silty soil was treated to a maximum depth of 32 m (105 ft). TerraTherm installed 785 thermal wells, comprised of 654 heater-only and 131 heater-vacuum wells, in a hexagonal pattern at 2.1 m (7.0 ft) inter-well spacing.

Over the course of the project, TerraTherm reduced mean B(a)P and TEQ concentrations in soil from 30,600 µg/kg and 18 µg/kg (pre-treatment) to 59 µg/kg and 0.11 µg/kg (post-treatment), respectively; thereby meeting the remedial goals. Attainment of such stringent soil treatment goals with an in-situ technology is unprecedented. Dioxin emissions based on four source tests performed by an independent stack testing firm averaged 0.0084 ng TEQ/dsm³, compared to the standard of 0.2 ng TEQ/dsm³. It is estimated that over 395,000 kg (869,000 lb) of contaminant expressed as naphthalene was removed from the subsurface over the two phases of the project, not including the mass that was pyrolyzed in-situ, which could not be quantified. Based on the completion of this project, and the lessons learned presented herein, it is estimated that the turnkey cost of ISTD for a wood treatment site with a similar soil volume would be approximately $500/m³ ($383/cy).

**In-situ Hydrogen Production for Bioremediation**  
**Hugh Russell – AR Environmental Services**

The BioLance™ System is a patent-pending design that uses electrodes completed into an aquifer system for the generation of hydrogen. The hydrogen is subsequently used for microbial mediated reductive dechlorination of chlorinated solvents, such as Perchloroethene (PCE) and Trichloroethene (TCE). The System has been installed and tested over the past four years at a site in the Northeastern United States, impacted with PCE.

In 2003, a Field Pilot Test System (FPTS) was installed and monitored as a proof of concept and field validation study. The FPTS was installed at the edge of the plume to assure that movement down gradient and off site did not occur. During both the installation and operation of the FPTS, several important lessons were learned in regard to design, installation and operation.

The System was monitored by sampling five (5) wells on a monthly basis for about a year. Data analysis showed a loss of PCE that could be linked to the production of hydrogen and microbial activity. Hydrogen concentrations as high as 16 nanomoles per liter were detected in monitoring wells. As a result, the technology was field validated.

Once the technology had been proven to the State, a second System (System 2) was installed upgradient of the initial System 1. System 2 incorporated design and installation changes or “lessons learned” from System 1. The purpose of the second system was to treat the aquifer impacted by the middle of the plume. Evaluation of the data from the wells monitoring the second system showed that this “System 2” was more efficient at removal of PCE than the FPTS system. Hydrogen concentrations as high as 160 nanomoles per liter were detected in monitoring wells. Evaluation of the data from System 2 provided evidence that this new design was more efficient at removal of contaminants from the aquifer.

To remediate the Site, a third system (System 3) was installed at the very up gradient edge of the plume. The three Systems then treat the entire plume across the property. Only one monitoring point was required for this System. Approximately six (6) months after the system was installed, there was a sustained observable loss of PCE. The loss of PCE coincided with a transient increase in DCE.

The required clean up goals for the Site are 1 ppb for PCE and TCE and 70 ppb for Dichloroethene (DCE). There are eleven (11) wells monitoring that Site that must meet these standards for site closure. Five (5) of the wells monitor System1, five (5) monitor System 2 and One (1) monitors System 3. As of January 17, 2007 there are three (3) wells above standards for PCE and TCE (1 ppb). All three of the wells are associated with System 1 (original designed system). Of these three wells, two are within an order of magnitude of the required clean up goals (approx. 9 ppb) and the third is within two orders (110 ppb). The well with the highest current concentration of chlorinated solvents is TMP-1, which is the furthermore down gradient monitoring location. The wells monitoring both System 2 and System 3 are currently below 1 ppb for PCE, TCE and DCE.

This would indicate that this part of the aquifer has been completely remediated in regard to chlorinated solvents. The area is devoid of chlorinated solvents, both progenitor and daugther products. Table 1.0 presents data from the various systems and the percent removal rate for PCE. As shown,
the only well with less than a 96% removal rate for PCE is TMP-1, the furthestmost down gradient well associated with System 1. All of the wells with greater than 98% removal of PCE are below required site clean-up goals for all constituents of interest. The 1.2 ppb results for most wells represent the sample detection limit. Within these wells, PCE was not detected at 1.2 ppb. Except for two small areas in the vicinity of System 1, the aquifer appears to have been remediated. The wells monitoring System 2 have been below required clean up goals for the past seven (7) months.

Application of Permeable Adsorptive Barriers for In-situ Remediation of Petroleum Hydrocarbon at Limited Access Railroad Sites

Mark Leece – CH2M Hill

A diesel spill occurred as a result of a derailment along a mainline Union Pacific Railroad track adjacent to a stream in the Blue Mountains of Oregon. The spill occurred when diesel tanks from 9 refrigerator cars were damaged during the derailment. Emergency response activities were immediately implemented. Response activities in the adjacent stream included deployment of absorbent boom and pads. Within 24 hours following the derailment, sheen was observed in the stream. State and Federal agencies requested additional action to address the sheen in the stream. A test pit investigation was completed in the derailment area between the railroad track and the stream. A hydrocarbon sheen was observation on the shallow water table in the test pits however no recoverable product was present, precluding traditional recovery methods. Based on the fuel inventory and the volume of recovered fuel, up to 900 gallons of diesel fuel (est. 6,600 pounds) may have been present in the subsurface that could potentially migrate to the stream.

Implementation of a remedial technology that would be constructed in-situ, constructed in a limited area and utilize minimal operation and maintenance was necessary to limit sheen impacts to the stream. A permeable adsorptive barrier was installed, using a sand/organoclay mixture, along the area of concern to adsorb residual diesel in the subsurface before impacting the stream. Construction was completed using conventional equipment without disruption to mainline operation. Using an adsorption capacity of 0.5 lbs of diesel per 1 lb of organoclay, a minimum of 13,200 lbs of organoclay was required. The organoclay was incorporated into a target zone at the water table (e.g. 5 to 10 feet below ground surface (ft bgs) with the groundwater table about 8 ft bgs. The total barrier length was approximately 200 linear feet.

Within several days of installation, observation of an ongoing sheen in the stream had been addressed. Use of an organoclay adsorption material was a cost effective method of remediating residual petroleum hydrocarbons from a relatively small spill in a shallow aquifer adjacent to a stream.

Overview of Groundwater Issues for Ethanol in Fuels

Bruce Bauman - American Petroleum Institute

Conventional gasoline (CG) and Reformulated Gasoline (RFG) are the two basic types of gasoline used in the United States to meet federal and state regulatory requirements. There has been a virtual national phase-out of MTBE from all US gasoline over the last several years, and EPA no longer requires a minimum oxygen content in RFG. However, federal and some state regulations require the use of ethanol in gasoline, and currently about 50% of the gasoline blended in the US contains ethanol, usually at 10% volume. Domestic production and use of ethanol is predicted to double within the next several years from its current (2007 estimate) of over 6 billion gallons, and EPA is currently developing regulations to implement the Bush administration “20 in 10” initiative that would replace 20% of US gasoline (~30 billion gallons) with alternative fuels within 10 years. Language in current US Senate 2007 federal Energy Bill legislation would require 36 billion gallons of alternative fuels by 2022, so it is highly likely that ethanol gasolines of varying blends will become even more prevalent. Except for specialty fuels like E85 (~81% ethanol), EPA regulations prohibit >10% ethanol in gasoline, but there are also initiatives to allow ethanol blends of 11-20% for use in all gasoline motor vehicles. Also, since about 70% of denatured ethanol (E95) is transported by railcar, rail accidents can result in large volume releases of fuel with 95% ethanol. API has been studying E95 releases in the lab and field and for over two years. E85 blends are already widely available in the Midwest and heavily promoted by US auto makers. This broad-scale transition means that all parts of the US are likely to have ethanol present in gasoline, and all spill response personnel will need to develop a thorough understanding of how releases of these fuels might behave differently than gasolines without ethanol. It will become necessary to catalog all known release scenarios (e.g., small chronic releases, sudden large releases) and receptors (e.g., ground water, surface water, utilities) for these different types of gasolines. Existing conceptual models for spill response and corrective action require should be reviewed to determine if any modifications might be helpful to fully account for all important direct and indirect effects. API research has been developing some of this information over the last several years, and will continue to focus on key fate and transport issues as well as corrective action technologies.

Characterization of a Petroleum Hydrocarbon Release by Laser-Induced Fluorescence and its Use in Guiding Remedial Strategy

Brian Martinke - Cameron-Cole, LLC

The occurrence of separate phase hydrocarbons (SPH) in vadose zone and saturated zone soils at release sites can dominate the groundwater environment through the perpetuation of dissolved phase contamination. As such, treatment or removal of the SPH at a hydrocarbon release site is typically a prerequisite for successful remediation. Often it is difficult to determine precisely where the SPH resides in the formation so that remediation technologies can target the contamination effectively. Laser-induced fluorescence (LIF) is a rapid screening technology that can provide sensitive and high resolution delineation of subsurface SPH contamination. LIF technology provides detection of hydrocarbons due to their fluorescence emitted in response to specific wavelengths of ultraviolet light delivered by a laser. Subsurface measurements are achieved by fitting the laser to a downhole tool (typically a cone penetrometer [CPT]). Utilized in this manner, a detailed vertical profile of approximately 12 readings per foot and 300 feet per day can be achieved.

A case history of the use of LIF technology at a former petroleum refinery site is presented. The lateral extent of SPH in a sand aquifer overlain by
A silt-clay layer was previously well defined at the site by an extensive network of monitoring wells. However, little was known about the vertical distribution of SPH. The prevailing conceptual model was that SPH occurred predominantly in the smear zone across upper silt-clay layer with the lower more permeable sand impacted by a dissolved plume. LIF data was collected at 28 locations within the center and margins of the impacted area, providing detailed vertical profiling of the occurrence of SPH throughout the vadose zone and saturated zones. The data showed that the SPH occurred throughout the vertical extent of the sand aquifer well below the water table. The results of the LIF investigation significantly altered the conceptual model and shifted the focus of remediation from the silt-clay layer to the more readily treatable sand where the majority of the SPH resided.

Characterization and Remediation of a TCE Source Area Using Electrical Resistance Heating (ERH) - Glendive, Montana
Ross Dunning and John Norris – Kennedy/Jenks

Trichloroethylene (TCE) was detected in shallow perched groundwater at the BNSF Glendive Fuelling and Maintenance Facility in the late 1990’s. A zero-valent iron permeable reactive barrier (PRB) wall was subsequently constructed to remediate dissolved TCE in groundwater. The TCE source area was identified and characterized using membrane interface probe (MIP) technology as well as conventional environmental sampling and analysis methods.

Based on site characteristics and technology screening, soil vapor extraction (SVE) enhanced by electrical resistance heating (ERH) was selected for use and employed in early November 2006. The application of this technology resulted in successful removal of TCE from soil and groundwater in the source area. Treatment posed unique challenges due to the presence of TCE in soil and groundwater directly beneath a concrete loading dock situated between two active rail lines.

The treatment area encompassed approximately 1,600 square feet and extended to approximately 22 feet below ground surface (bgs). Soil consists of finely layered silt and clayey sands underlain by stiff clay present between approximately 14 and 25 ft bgs. The depth to groundwater ranges seasonally between approximately 2 and 6 feet bgs. Pre-treatment TCE concentrations detected in the source area groundwater ranged as high as 50 mg/L.

The selected technology employed electrical resistance to heat soil and groundwater, and vaporize TCE which was then extracted using SVE. A total of 12 ERH electrodes and co-located vapor and steam recovery wells operated continuously for approximately 11 weeks. The extracted soil vapor stream was treated ex situ using granular activated carbon (GAC).

Post-treatment soil samples indicated TCE concentrations below detection limits and target treatment levels. The PRB downgradient of the ERH treatment area will continue to treat the residual downgradient dissolved TCE concentrations in groundwater.

Use of Innovative In-Well Technology to Treat TCE in Groundwater
Jeffrey McDermott – Union Pacific
Brian Symons and Robert Kick – The Forrester Group, Inc.

Accelerated Remediation Technologies, LLC (“ART”) has developed and patented a remedial technology that combines proven technologies (in-situ air stripping, air sparging/soil vapor extraction and enhanced bioremediation) in an innovative wellhead system. The ART System consists of several components including: a submerged pump placed at the bottom of the well to which discharges water through a spray head inside the top of the well (i.e., air stripping); recirculate water to the top of the well for downward discharge through a spray head, similar to the effect occurring in an air stripping tower; an air sparge injection placed at the bottom of the well; and a vacuum extraction applied at the top of the well to extract vapors from theremove subsurface vapors. All of these components are installed in a 4-inch or 6-inch groundwater well.

This combination of air sparging, groundwater pumping, and groundwater spraying and vacuum extraction creates a circulation zone surrounding the well that further enhances groundwater remediation. cleanup as impacted water enters the well at the base of the screened interval and remediated water exits near the top. If the chemical of concern is amenable to aerobic degradation, then the ART system also supplies atmospheric oxygen and so promotes bioremediation.

All of these components are installed in a 4-inch or 6-inch groundwater well.

Union Pacific Railroad Company voluntarily implemented an ART evaluation at a Kansas site in the fall of 2004, which was later expanded in the winter of 2006. The source area was impacted by TCE present in soil and groundwater. The ART system was selected because constituents were volatile, formation permeability was deemed sufficient to promote groundwater flow to and from the well, and because only TCE vapors would be generated which can be emitted to the atmosphere without a permit. A total of five ART remediation wells and eight additional observation wells were installed in the area of highest TCE mass. The purpose of the ART evaluation was to remove as much mass as possible and to provide treatability information to support the Feasibility Study for the overall site. During the first 3 months of system operation, only a single remediation well was operated. During the next nine months two wells were operated and for the past year the current five-well ART system has been operating. The results of the entire operational period are presented in this paper.

Air effluent and groundwater samples were collected to monitoring ART system performance. Average mass removal estimates of TCE based upon air effluent data indicate approximately 2301,623 pounds of TCE has been removed from December 2004 to April 2007, representing 29 months of overall operation. was removed during the two year period of operation. Monitoring wells located downstream of the source areas showed a consistent decline in TCE concentrations while wells closer to the source area continue to show elevated and fluctuating concentrations.
These results indicate that the ART system is effective in the source area; however secondary TCE sources, such as residual adsorbed product, may be present and may prolong the need for continuing system operation.

Use of LIF, Hydroexcavation, and Temporary Retaining Structures for Precision Excavation Near an Active Mainline
Scott Carney – ERM
Michael Woolridge and Gregory Jeffries – BNSF Railway

A Laser Induced Fluorescence (LIF) investigation of diesel impacted soil showed an area of mobile, Non-Aqueous Phase Liquids (NAPL) measuring 300 feet by 75 feet located between an active Mainline and the Yard Office at an active railroad facility. LIF results were successfully used to define the limits of the mobile NAPL in the investigation phase. The subsequent Corrective Action Design (CAD) recommended excavation due to a high capillary bond of the NAPL to the silty-clay soils and a small radius of influence of other in situ remedies. Excavation limits were selected and implemented on LIF results alone, and confirmed with DRO analysis.

The area targeted for excavation was the operational heart of the active railroad facility, averaging 50-100 trains per day. Utilities within the excavation included high and low voltage electricity, multiple telecommunication fiber optic cables, track signal cables, and water and industrial sewer services. Approximately 720 feet of temporary retaining wall was constructed in order to complete the excavation. The temporary retaining wall was constructed using soldier-pile and lagging techniques and incorporated a strut and whaler structure to provide additional wall strength in a critical portion of the excavation. Portions of the retaining wall were within 15 feet of the mainline. Hydro-excavation was used to remove approximately 36,000 gallons of soil and water to expose the conflicting utilities.

Soil-type-specific NAPL saturation values from American Petroleum Institute (API) Publication 1628, was used with existing DRO data to determine intervals with NAPL saturation. The NAPL saturation intervals were then compared with LIF responses to draw empirical estimates of mobile NAPL. An LIF response of 50% was proposed and approved by the regulating agency to serve as the threshold between soils with mobile NAPL (>50% response) and those with residual NAPL (>50% response). The excavation was successful in removing approximately 4,100 cubic yard of mobile NAPL-containing soils without damage to property or incidents of health and safety. The deepest extent of mobile NAPL occurrence varied between 7 and 14 feet bgs.

LNAPL Mobility Analysis at a Railroad Maintenance Facility
Wade Bishop – Norfolk Southern
Stephanie Knight and Gaylen Brubaker - ENSR Corporation

The operation of a locomotive and rail car maintenance facility has resulted in the release of petroleum products to the subsurface. Initial site investigations determined that, although dissolved constituent impacts to groundwater were minimal, light non-aqueous phase liquids (LNAPLs) would accumulate in shallow wells with thicknesses of 6 feet or more. Despite the significant thicknesses of LNAPL in individual wells, the investigation data indicated that the LNAPL did not exist as a large, continuous plume but, instead, was present as relatively small, isolated accumulations resulting from numerous small releases.

In 1998, the Norfolk Southern Railway Company (NSRC) initiated dual phase extraction (DPE) activities to remove LNAPL from the subsurface. The DPE system was decommissioned after approximately two years, as the LNAPL recovery rate had decreased significantly and the LNAPL thicknesses in monitoring wells had decreased to 0.02 to 0.06 feet. A total of 2,237 gallons of LNAPL was removed from the subsurface as a result of DPE operations. The state regulatory agency, however, requires continued monthly LNAPL gauging and removal activities at the facility until thicknesses decrease to less than 0.01 feet, "unless continued recovery efforts cannot attain this minimum and more aggressive recovery methods are not warranted based upon lack of receptors or other considerations including the lack of product mobility”.

RETEC conducted a site-specific analysis to evaluate conditions affecting LNAPL mobility and recoverability. The results of this analysis refined the site conceptual model and demonstrated that LNAPL recovery operations could be ceased at the railroad maintenance facility while still being protective of groundwater and downgradient receptors. The regulatory agency was amenable to discussing these results, but did not fully grasp the concepts that were presented. Following a meeting with the agency, where a basic review of NAPL migration principles were presented, as well as the site specific modeling using the API LNAPL mobility model, the agency accepted this argument and has issued a no further action letter for this site. NSRC has closed the remaining monitoring wells and recognizes a significant cost savings and reduction in liability for this site. This presentation discusses the parameters, sample collection techniques and analyses required for development of a site-specific LNAPL mobility analysis.

Risk-Based Approach to LNAPL Remediation
Tim Wippold - ARCADIS
Rob Werner - BNSF Railway

Many States have developed guidelines regarding the extent that LNAPL should be cleaned up. These guidelines generally range from a sheen to a quarter inch LNAPL thickness. For many years we have known that these clean-up guidelines are not practicable; however, recent studies have shown that these levels are also not necessary from a risk perspective. This presentation will discuss (a) recent studies in LNAPL mobility; (b) the work ASTM has done in using these studies to develop a risk-based approach to LNAPL remediation; and, (c) how the ASTM standard can be applied to a BNSF site.
Poster Presentations

Energy, Emissions, and Air Quality

Assessment Regarding a Complaint of Staining Deposited on a Residential Deck Due to Diesel Fuel Soot From a Locomotive in St. Clair, Michigan

Erin Busby, Nicole Heller, and Michael Harris - AMEC
Paul Kurzanski - CSX Transportation

A residential homeowner located in St. Clair, Michigan lodged a complaint with CSX Transportation, Inc. (CSXT) that he believed black material deposited on his deck was caused by locomotive soot from the CSXT St. Clair Yard. CSXT visited the site to investigate the report in November 2006 and indicated the complainant should call local or state environmental departments. The complainant was not satisfied with this response and AMEC was then retained by CSXT to collect additional data.

In December 2006, AMEC performed a site visit to observe the deck to identify other potential sources of the spotting. AMEC observed spotting on the deck in areas that were not covered (i.e. received sun light). AMEC also determined that the deck material (floor only) is a composite material supplied by Lowe's Companies, Inc. (Lowe's). The composite material is made of recycled consumer products such as milk cartons and saw dust. The railings and other surfaces are composed of natural wood that has been painted. The black spots were observed on the composite deck and not on natural wood (painted surfaces). AMEC collected tape samples from the deck surfaces that were submitted to MicroLab Northwest in Redmond, Washington (MicroLab) for microscopic particle identification.

Land use in the vicinity was noted to contain numerous residential and light commercial properties, including plastics manufacturing, chemical processing, automotive parts manufacturing, fuel storage, and tool manufacturing. In addition, AMEC noted that the site is located 6 miles south of major fuel refineries and chemical plants and just north of two coal fired power plants located in St. Clair, Michigan. AMEC also contacted the Michigan State University/Michigan Climatological Resource Program (MCRP) to obtain data regarding the prevailing wind direction in the area. The closest available data was from the Mount Clemens, Michigan area at Selfridge Air National Guard (SANG) base, which is approximately 35 miles southwest of the site. Arithmetic mean calculations of MCRP data over monthly periods indicate the prevailing winds from the southwest.

MicroLab’s analysis of the tape samples revealed that the samples contained: plant fiber; binder; hyphae; quartz; calcite; spores; fungal mats; cenospheres; fly ash; mite debris; glass fiber; starch; skin flakes; natural minerals; charred wood; and tire wear. The MicroLab report indicates the primary source of material in the spotting is fungal material. Additional materials in the sample that would appear to be black are cenospheres, the result of burning fuels. According to the laboratory report, the cenospheres are large and not indicative of cenospheres observed from burning diesel fuel (which are smaller in size). AMEC then conducted internet searches to determine if other composite deck consumers have had similar problems. It appears that decks made with consumer recycled goods and sawdust can have mold and mildew problems (i.e., spotting) if not cleaned often and with the correct chemicals. AMEC concluded that the spotting on the residential deck was not caused by locomotives on CSXT’s property, but is caused predominantly by fungi growing on the composite deck.


David Read - US EPA

Various studies have been conducted on the potential recovery of dynamic brake energy from diesel-electric locomotives in North American freight service. These studies have generally concluded that the potential fuel savings obtainable are insufficient to warrant the construction and implementation of devices to capture dynamic brake energy from freight trains. However, these studies have not considered hydraulic energy storage devices as a potential cost-effective alternative for recovery of dynamic brake energy.

In the automotive field, for heavy vehicles, hydraulic energy storage has recently been found to be significantly more cost-effective as a means for energy storage than electric batteries or other competing energy storage devices, particularly for heavy duty vehicles that require high power density for efficient energy storage. State of the art high pressure hydraulic accumulators on prototype hydraulic hybrid vehicles handle power rates at about 3 kilowatts per kilogram of accumulator weight, equivalent to state of the art ultracapacitors but at much less cost. At projected accumulator costs of $10 per kilogram (i.e., 300 watts per dollar), accumulators provide a potentially cost-effective storage device for handling the high power levels involved in dynamic braking of a freight train.

It is proposed that a hydraulic energy storage car could cost-effectively be substituted into a locomotive consist in the place of one of the multiple locomotives in the consist. The hydraulic energy storage car would be “charged” through dynamic braking and/or by the engine of a remaining locomotive in the consist. The charged storage car could match the power output of the removed locomotive as needed (albeit for time periods limited by the energy storage capacity in the car before being recharged, which is projected to be sufficient for normal launching and accelerations but not for extended grades). The energy storage car is projected to cost less than a locomotive it replaces, and would thus generate significant cost savings for rail companies in terms of reducing their needs to purchase additional locomotives to handle business growth or attrition of old locomotives. Significant fuel savings and emissions reductions would also result. One of multiple additional strategies (also explained herein) could be employed for energy recovery and power supplementation at locations with extended grades.
Physical and Chemical Characterization of Emission Gas
Exhausted from Diesel Locomotive Engines
Youngmin Cho, Duck-Shin Park, and Soon-Bark Kwon
Korean Railroad Research Institute
In-Gwon Lim - CATech, Inc.

Though the railroad is known to be one of the most environment-friendly transportation, the air pollutant emission from the railroad diesel locomotive is still a significant environmental concern in many countries. Especially, the fine particulate matter and gaseous pollutant emission is serious environmental concern because these pollutants may be hazardous to human. In our study, we carried out physical and chemical characterization of the emission gases exhausted from the large diesel locomotive engine (2-cycle, 16-cylinder, and 3,000-horsepower) under various engine-rating conditions. A scanning mobility particle sizer (SMPS) and a dust spectrometer were used to investigate the particle size distribution and concentration of particulate matters present in the emission gas. The diameter (DP) of particulate matters was observed to be ranged over 0.007 ~ 0.304 μm. As the engine loads increased, the size of particulate matters also increased. The size distribution showed a bimodal mode that consists of the nuclei mode (DP < 50 nm) and the accumulation mode (50 nm < DP < 1,000 nm). As for the gaseous pollutants, a gas stack sampler was used to measure the concentration of CO, CO₂, NO, and NO₂. The concentration of CO₂ increased upon the increase of engine load that consists of the nuclei mode (DP < 50 nm) and the accumulation mode (50 nm < DP < 1,000 nm). As for NO and NO₂, they were produced more actively upon higher engine load because of the thermal reaction of nitrogen gases. The concentration of CO initially decreased upon the increase of engine load but it increased at further increase of engine load.

Improvement of Indoor Air Quality in Railroad Passenger Cabins by Cyclone, Carbon Dioxide Trap, and Roll-filter Technologies
Youngmin Cho, Duck-Shin Park, and Soon-Bark Kwon
Korean Railroad Research Institute

The indoor air pollution by particulate matters and carbon dioxide in the railroad passenger cabin has been serious environmental concern. In order to relieve this problem, we developed a new system for railroad passenger cabin by introducing some state-of-the-art technologies. First, we introduced a cyclone dust separator to remove the coarse particulate matters contained in the fresh air. We could see that more than 99 wt% of the coarse particulate matters from the supply air by using the cyclone. In addition, we introduced a carbon dioxide trap to lower the carbon dioxide level of the passenger cabin. The simple ventilation for control of carbon dioxide level of indoor air is not always appropriate choice, because the ventilation in summer or winter season requires large amount of additional cooling or heating energy. By using the carbon dioxide trap, we could maintain the carbon dioxide level of 1,500 ppm. More than two sets were installed in the passenger cabin, and used trap was designed to automatically be regenerated continually. We also introduced a roll filter system to remove the fine particulate matters of the passenger cabin. Roll type of polypropylene filters with meshes were used to use the filter more than 6 months without filter substitution. Our new air cleaning system for passenger cabin will be very effective for the management of indoor air quality in the railroad passenger cabin.

Energy Audits: Spend a Little...Save a Lot!
Rita Meyer - EMR

Are railroad energy dollars going into thin air? We will review the potential natural gas savings for a diesel shop's annual boiler tune-up, hot water reset controls, reduce heating of concrete, carbon dioxide based ventilation, reduce make-up air to the shop, thermostat controls for unit heaters and infrared switch heaters. Let's look at a state that passed legislation banning electronics from the landfills. The law states they should be recycled, but now they end up on the roadside. The sand, the sun, the sea, the squallor -- our oceans are sending back what we dump in – water bottles, milk crates, netting, plastic buoys and a fine confetti of broken-up plastic chips. We’ll wrap it up with some good, old fashioned trashy statistics.

Environmental Response

Comparison of Two Derailment Sites in Agricultural Areas and Remedial Considerations
Andy Pennington, Stephen Vasas, Kevin Peterburs, and Sid Glenn
ARCADIS
Paul Kurzanski - CSX Transportation

Derailment releases in agricultural areas have unique considerations that are not evaluated in standard residential and industrial/commercial settings. These unique considerations were applied to two derailment release sites in agricultural areas of central and southern Illinois.

The first site involved a release of approximately 20,700 gallons of hydrochloric acid into a farm field. During emergency response, lime was used to neutralize the acid. Upon completion of emergency response activities, it was determined that site soils and groundwater did not contain any residual constituents that posed a risk to human health. However, chloride concentrations in the soil were elevated, corresponding to a risk of increased soil salinity and adverse agricultural effects.

The second site involved a release of 200,000 pounds of granular ammonium nitrate into a 1.9 acre farm field. During emergency response, released ammonium nitrate was stockpiled and removed, but residual nitrate impacts remained onsite. Preexisting nitrate impacts were identified in residential potable wells from the historical use of nitrate fertilizer in the area. Synthetic Precipitation Leaching Procedure (SPLP) nitrate concentrations in the surface soil were above background concentrations and above the maximum contaminant level (MCL) of 10 mg/L for

20
nitrates.

In both cases, the constituent of potential concern was a plant nutrient typically found in agricultural areas. Chlorides serve as a micronutrient and are necessary for plant growth and development, and nitrates are a primary ingredient of most fertilizers. The presence of these compounds at typical background levels is important for agricultural production. At both sites, the risks associated with agricultural production from the excavation and backfilling of impacted soils were greater than risks associated with leaving the nutrient-rich soils in situ.

In both cases, in situ remedial activities consisted of tilling the soil using conventional farming methods and allowing the nutrient-rich soils to be mixed with unimpacted soil from surrounding areas and diluted. In addition, natural attenuation of these constituents as a result of weather and farming activities would occur rapidly, and concentrations would be expected to return to area background levels.

At the first site, technical requirements for a return to compliance have been satisfied; at the second site, the remedial approach has received regulatory approval and remedial action is underway. The selected remedial action at both sites minimizes the disruption of the agricultural properties’ prior use. Labor, transportation, and disposal costs typically associated with soil excavation and removal were eliminated, and both projects realized significant cost savings.

**Pest Control**

**The Snail that Didn’t Eat Detroit**
Paul Kurzanski - CSX Transportation
Neil Ferrone - Conrail
Terri Rubis and R. Bruce Rust - ARCADIS

What do you do when your yard is infested with an exotic snail? In 2001 and 2004, the United States Department of Agriculture (USDA) discovered an infestation of exotic snail known as Xerolenta obvia on CSX Transportation, Inc. and Conrail properties in Detroit, Michigan. Xerolenta obvia is a pest of feed corps in Germany; contaminated fruits and vegetables exported to European countries from Italy and Bulgaria; transmits spores of Altermaria sp., Fusarium sp., Phytophthora sp., and Rust; and is a vector of sheep lungworm, cestode, and trematode. The infestation populations of the snail destroy farming and harvesting equipment. As the major function of the Detroit railyards is to export automobiles and automotive parts across our nation an infestation at these yards presents the risk of transporting the snails across the country with the potential of reaching farming areas of the United States, where their impacts would be devastating.

USDA conducted eradication efforts at the properties in 2001 however Xerolenta obvia proved difficult to eliminate due the ability to survive on most types of vegetation and the ability to rapidly adapt to new conditions. In 2006 the USDA required treatment or remedial measures to control the exotic snail under Sections 411, 412 and 414 of the Animal Protection Act (7 USC 7711, 7712, and 7714) and Sections 10404 through 10407 of the Animal Health Protection Act (7 USX 8303). CSXT and Conrail assessed several remedial options, including: engineering, chemical, fire, and physical methods, even suggesting dousing the snails with beer! A combination of complete habitat modification and pesticide use was selected to insure eradication without transporting material (soil, vegetation etc.) off site. In addition, the life cycle of the snail was taken into consideration and all activities would have to be conducted at the adult point of the cycle to ensure all snails were active and had not started the egg lying cycle.

To execute the eradication plan, CSXT and Conrail completely overturned the 15 acres of the infected properties, down to 6 inches, to remove the root base and physically crush the snails. All debris found during this activity (tires, drums and concrete) was sent for proper offsite disposal after isolation and thorough inspection to ensure it was free of the snails. Trees and large shrubs were used to fill low areas and the site was graded ensuring complete coverage of vegetation. Areas near the rail or high traffic areas were capped with black top millings. The USDA agreed to provide bait laced with Deadline Bullets® molluscid (hazardous ingredient: Metaldehyde). This bait was applied as the second component of the eradication effort. Follow-up inspections by the USDA determined the Xerolenta obvia to be eliminated from the infected properties. The USDA will continue to bait and monitor the yards for 3 years.

With today’s Global Economy now more than ever the biohazards of far away places become biohazards in our own backyards.

**Remediation**

Use of ASTM Risk Based Corrective Action Standards by Committee E 50 on Environmental Assessment With Innovative Management Approaches to Achieve Timely Site Closures
Zdenek Hejzlar and Thomas Stungis - Engineering Systems, Inc.

The ASTM Environmental Committee E50 has developed a number of standards for Risk Based Corrective Action. A presentation regarding these and perhaps an option for a training session would be good for the October 2007 Railroad Environmental Conference.

**TapRoot™ Technology: Non-Invasive Plume Delineation**
Jeffrey Mc Dermott - Union Pacific
Matt Shurtliff, Mike Mason, Joel Burken - The Forrester Group, Inc.

The science of tree coring to detect the uptake of chemicals of environmental concern has matured significantly in recent years and tree coring is
now being deployed for rapid, precise contaminant source and plume delineation.

By combining tree core analysis with highly accurate GPS mapping of trees on-site, The Forrester Group and Union Pacific Railroad can now generate solvent plume maps at a fraction of the cost of conventional investigation techniques. The spatial resolution that can be achieved leads to maps that can precisely locate plume boundaries and source areas in a single mobilization for sites of multiple acres in scale. Maps can be provided within days, compared to the weeks or months required for conventional investigative techniques. Groundwater contaminant delineation can also be accomplished at difficult locations that are inaccessible to direct push or drilling rigs, with minimal mobilization costs.

Case studies and methodologies will be presented to show how The Forrester Group’s TapRoot™ Technology has been used at railroad sites, and what information can be gained. Limitation of the methods, including compounds that can be analyzed and site characteristics that can be limiting to application, will be discussed and overviewed.

Implementation and Analysis of Comparative LNAPL Removal
Pilot Tests at a Redeveloped Rail Yard in Kentucky
Shane Holunga, Robert Singer, Michael Devir, Aaron Benson, and Evan Barman - AMEC
Paul Kurzanski - CSX Transportation

CSX Transportation, Inc. (CSXT) retained long-term environmental liability of a Former Rail Yard following major redevelopment. An extensive light non-aqueous phase liquid (LNAPL) plume has been delineated across the Site. CSXT has been conducting LNAPL recovery activities at the former rail yard in Kentucky since 1993. Since 2002 LNAPL recovery efforts have consisted of extracting accumulated LNAPL from 61 wells at the Site on a monthly basis using a vacuum-extraction truck. This method has removed an average of 820 gallons of LNAPL per year since 2002.

In consideration of the size of the LNAPL plume, low permeability subsurface conditions, and the relatively low recovery rate, CSXT contracted AMEC to propose and evaluate a series of technologies that could be used as part of a focused long-term solution for enhancing LNAPL recovery and mass reduction at the site.

In June 2006, AMEC performed an initial screening of six specific technologies with respect to effectiveness, feasibility, additional data needs, and order of magnitude costs. The technologies evaluated included: monthly vacuum extraction, in situ chemical oxidation, skimming, bioslurping/multiphase extraction (BS/MPE), in situ thermal conduction heating and extraction, and surfactant flushing. Based on this screening, CSXT contracted AMEC to conduct two concurrent pilot tests for skimming and BS/MPE, and compare the relative effectiveness of each technology as part of a long-term, focused approach for LNAPL recovery at the site. AMEC selected two isolated areas of the plume on CSXT-owned property for the pilot tests and designed, installed, and operated the systems.

The skimming system consisted of two 4-inch wells equipped with density specific floating inlet skimmer pumps. The compressor and LNAPL collection tanks were housed in a shed within the active rail corridor. The BS/MPE system consisted of a 6-inch extraction well, five 1-inch monitoring points, a mobile trailer equipped with a liquid ring pump and separator, automated control system generator for power, and LNAPL collection tanks.

The skimming system ran for 27 days and recovered 103 gallons of LNAPL from two wells, with less than 10 gallons of groundwater recovered. The BS/MPE system ran for approximately 16 days and recovered approximately 32 gallons of LNAPL and 7,100 gallons of groundwater from a single well.

The proposed poster, will detail the implementation of the two pilot tests, discuss the collected data, and compare the relative effectiveness of the two technologies as they relate to the site.

Service Without Interruption: Minimizing Interference with Railway Operations When Remediating Hydrocarbon Releases
Stefan Dorman, Stacy Dowell, Simon Walshe - Talon/LPE

Disruption of service to one or more rail lines due to fuel spills and product releases can be detrimental to the overall operations of a rail yard. When these releases occur, and the subsurface soil directly surrounding the spill area and beneath the tracks are impacted, there can be a reasonable solution to remediate the affected areas while allowing the operation of a major switchyard to continue. In addition, geotechnical integrity problems to the rail beds may also be avoided. In response to a release at the Clovis Rail Yard, in Clovis, New Mexico, environmental assessment and remediation methods for alleviating the commodities of time, space, and economics worked in tandem to demonstrate their intended effectiveness while correlating with the minimal disturbance of daily operations to the rail yard.

The proper design and installation of a linear French drain system between tracks can effectively collect released free product, as well as dissolved-phase product, which can then be removed from the remedial drains using a mobile high-vacuum unit. Flushing the surface with large volumes of fresh water while simultaneously vacuuming the drain will facilitate the movement of the released product into the collection system. Concurrently, water samples can be collected from the drain and analyzed for the constituents of concern and in turn, progress can be quantified over time. Upon completion of activities with the confirmation of soil and drain fluid samples, the installed piping can be easily removed or left in place in the event that a similar release occurs in the future.

Microbial bioremediation agents can be applied to impacted sub-surface soil in order to reduce or eliminate the regulated constituents within hydrocarbon based products such as benzene, toluene, xylene, ethyl-benzene, and poly-aromatic hydrocarbons (PAH) to identify a few. Following
the application of a bioremedial agent, effectiveness can be appropriately quantified which can diminish the scope or need for excavation in conditions where it is impractical or unfavorable, such as beneath or directly adjacent to a rail line. The microbial agent is cost effective when compared to heavy equipment excavation and waste hauling activities and uncomplicated in application methodologies. Its residual byproduct is a final biodegradable compound making it a safe remedial technology while considerably reducing the disruption of rail service.

When confirming that a site has been remediated to previous conditions it is often necessary to collect soil samples from varying depths within the sub-strata. Additionally, groundwater should be assessed before product percolation into the lithology occurs creating a need for long term groundwater impact remediation. While small excavation equipment could complete the job it is not cost effective and can be extremely disruptive to rail operations. Skid-steer mounted geoprobe drilling equipment can be used in place of larger equipment for sampling purposes. This direct-push technology can install borings/wells, while maintaining the required safety distance, between two tracks and permits normal rail services to continue. Additionally, the geoprobe unit makes a boring of less than four inches in diameter causing almost no disturbance to the ground surface. Samples can be collected at any desired depth without difficulty.

This presentation will discuss, in detail, the advantages of remediation through the use of microbial bioremedial agents, linear French drain systems, and collecting subsurface soil/groundwater samples by means of a skid-steer mounted geoprobe, all in conjunction, to address the aspects of limited interruption to continental main line switch operations.

How Clean is Closure? TPH Fingerprinting and Environmental Forensics
Paul Kurzanski - CSX Transportation
Eric Cherry and Hadley Stamm - ARCADIS

On June 21, 2003, 39 railcars buckled and derailed approximately 8 miles south of Buffalo, New York. Seven derailed refrigerated railcars leaked an estimated 2,800 gallons of diesel fuel between 500 feet of three mainline tracks.

Emergency response activities recovered 350 gallons of spilled diesel fuel. Direct removal of residual diesel fuel within the remaining ballast and underlying soils would risk undermining the integrity of three active mainline tracks. Therefore, applications of a water-based biosurfactant and nutrient mix (Bio-Solve 3% solution) were completed to the spill areas on July 2, July 3, and August 22, 2003. In November 2004, 45 2.5-foot-long temporary introduction sumps were installed in the spill area between the active tracks. The sumps were placed into the ballast to direct Microblaze® into the subsurface. Microblaze® introductions were conducted in November 2004 and May and October 2005.

After each of the introduction events, soil confirmation sampling was performed in the spill area and the railcar staging areas. Soils were sampled for volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method 8021 and polynuclear aromatic hydrocarbons (PAHs) by USEPA Method 8270. Analytical results continued to exceed the New York State Department of Environmental Conservation (NYSDEC) Recommended Soil Cleanup Objectives for VOCs and PAHs. Only PAHs concentrations were above the standards during October 2005 and July 2006.

The elimination of the VOCs and the decrease of PAHs positioned the project team to investigate if the continued PAH detections were related to the spilled diesel. An environmental forensic evaluation was conducted to evaluate PAH fingerprints from the five areas, with the distributions being compared to background soil samples. In addition, statistical comparisons to other known PAH source materials were performed. PAH components were detected in both background and spill area samples, and the relative proportions of these compounds were similar. A statistical and graphical evaluation of PAH concentrations from historical spill area sample data, railcar staging area samples, and background sample data from 29 samples was also completed to identify the origin of the PAHs in the soils. The evaluation included a comparison of analytical results for homogeneity, comparisons to PAH profiles, homolog ratios and cross-plots of common PAH-containing materials published in the peer-reviewed literature.

This evaluation concluded all three sample groups (spill area samples, railcar staging area samples, and background samples) had a similar distribution of PAH compounds, consistent with coal or coal combustion related materials. It was further concluded that the PAHs were not consistent with creosote, coal tar, waste oil or petroleum combustion sources. The PAHs present were not from the spilled diesel fuel but were from a coal dust and coal combustion origin, not uncommon in railroad base materials containing cinders. Therefore the cleanup related to the 2003 incident was complete. This conclusion was presented to the NYSDEC, and the site was granted a No Further Work designation and a status of Inactive.

A Tier 3 Assessment Based on Impractical Remediation of Free-Phase Hydrocarbons at a Railroad Yard
Stephen Vasas, Michele Gurgas, and Sid Glenn - ARCADIS
Paul Kurzanski - CSX Transportation

Residual free-phase hydrocarbons are occasionally encountered at a site in south suburban Chicago that has been an operating railroad yard for 85 years. The area of interest in the railroad yard consists of various railroad service buildings of which a diesel fuel pumping facility is the main source of historical hydrocarbon releases. Free-phase hydrocarbons have been reported in this area since 1990. Aggressive free product removal activities began in 1995 and consisted of a recovery trench system that was operational until September 2000. Additional free product was removed by excavating a 15’x 15’ x 8’ area and pumping liquids out of the excavation. The excavation was backfilled with clean ballast. Various other extraction methods related to recovery wells have been incorporated to address the residual free product that remains at the site. The two
areas of residual free product impact total approximately 1500 square feet.

Site geology consists of a 3-foot thick discontinuous gravel ballast fill at the surface that is only present beneath the railroad yard. A 1 to 4 foot thick slag fill layer underlies the ballast material and also appears to be discontinuous. Native soil beneath the fill material consists of clays and silty clays. The clay is continuous through the area and is encountered to a depth of at least 46 feet, the maximum depth investigated. Hydraulic conductivities at the site range from 3.71 x 10^-4 cm/sec (in the ballast fill material and slag fill) to 1.24 x 10^-6 cm/sec in the native clay soil.

Diesel fuel related hydrocarbons (BTEX and PNAs) have been detected in site soils (adsorbed phase) and site groundwater (dissolved phase). Free product is contained primarily within the ballast layer, and downward migration of impacts has not been observed. Site impacts are limited to the railroad yard and have been adequately delineated and characterized using twenty-five (25) monitoring wells and forty-nine (49) additional soil borings. Soil impacts onsite are at least 95 feet away from the nearest property boundary, and groundwater impacts have been defined at least 100 feet away from the nearest property boundary.

Using the site geology and hydrogeology, the characterization of the residual hydrocarbons, and the impracticability of further remediation along with fate and transport groundwater modeling, a Tier 3 free-phase hydrocarbon remediation objective has been developed. The Tier 3 remediation objective replaces the default Illinois Remediation Objective of no observable free product. The ASTM E-1739-95(2002) steady-state attenuation equation was used to perform fate and transport models. This is a conservative model because it assumes a constant source and does not account for adsorption. In addition, it assumes that no change occurs in groundwater flow direction and velocity, although changes have been observed at this site. Constituent solubilities were assumed to be the source area groundwater concentrations in the groundwater model. Results of modeling indicated that groundwater remediation objectives would be met at the property boundary. A groundwater use restriction will be obtained for the property, and closure is anticipated after observed free product levels are below the Tier 3 objective for four consecutive quarters.

Use of Passive Diffusion Samplers to Reduce Groundwater
Sampling Costs and Improve Data Quality
Jeffrey McDermott - Union Pacific
Robert Kick - The Forrester Group, Inc.

Use of the Passive Diffusion Bag (“PDB”) sampling technology, developed and patented by the U.S. Geological Survey, sampling device represents a simplified method by which groundwater samples can be collected from wells for volatile organic compound (“VOC”) analysis. Consisting of a low-density polyethylene (“LDPE”) tubular bag filled with laboratory grade deionized water, the PDB is placed at a specified depth within the screen of a monitoring well. Over time, typically requiring a minimum of two weeks, VOCs diffuse from groundwater through the LDPE membrane and into the water within the PDB sampler until chemical equilibrium is reached. The PDB is then removed from the well and water is discharged through a tube or port into standard 40-milliliter sample containers. Subsequent sample management and analytical procedures are the same as for traditional sampling methods.

Advantages of PDB samplers include: reduced sampling time and cost compared to low-flow sampling; easy to deploy and retrieve; no purge water to dispose; minimal equipment decontamination; can help discern vertical contaminant stratification in moderate to high permeability formations; not impacted by turbidity or alkalinity-contributing solutes; and practical for busy locations.

Disadvantages include: not suitable for all VOCs; not suitable for natural attenuation parameters such as pH, temperature, redox, iron and other ions; not suitable for low permeability formations; not suitable for formations with short temporal variations in groundwater chemistry; and not suited for wells with vertical flow.

A case study from a recent railroad project illustrates the advantages of this sampling technique.

Investigation and Bioremediation of PCP Soil
Contamination from Wood Treating Operations
P. Steven Finn, Michael Borda, Andrew Joslyn, and Heather Lin
Golder Associates
LeeAnn Thomas - Canadian Pacific Railway

Soils at a rail facility in Minnesota were impacted by pentachlorophenol from historic wood treating operations. This paper describes key aspects of the investigation and remediation program completed by Canadian Pacific Railway (CPR) with oversight from the Minnesota Department of Agriculture (MDA). Main topics include:
- Application of immunoassay field testing for “real time” delineation of impacted areas;
- Evaluation of dioxin and furans, taking into consideration urban background and other anthropogenic sources;
- Evaluation of clean-up goals and alternatives leading to selection of on-site bioremediation;
- Excavation and biopile construction, including air monitoring for worker and community health and safety
- Biopile operations and performance;
- Community relations.
This project was accomplished on a fast track schedule with the cooperation of MDA, the Minnesota Department of Health, and the local community.
Stormwater and Wastewater

Keeping on the Right Track: Oil/Water Separators and Advanced Filtration Systems for the Railroad Industry
Gregory Aymong - Highland Tank

The public’s increasing interest is the conservation of the nation’s water resources, which has directly affected many railroad facilities. Railroads are now facing increasingly more stringent regulations covering the treatment and discharge of oily wastewater and now risk costly penalties resulting from public pressure for the government to control harmful oil spills and pollutant discharges.

While the basis for the requirements is the federal law, state and local governments may have more stringent compliance requirements. These can take the form of stricter limits for pollutant discharges than required by federal law or stiffer penalties for noncompliance.

This paper outlines traditional primary and secondary water treatment technologies and relative inefficiencies with hydrocarbon contaminated water. Recent technology developments are discussed, specifically patented Corella® Coalescing Plate Technology and Advanced Filtration Systems™.

Drainage collection and oil/water separator treatment systems are presented for railroad vehicle and equipment maintenance and cleaning locations with:
- Washing
- Fueling
- Outdoor vehicle storage
- Aboveground fuel storage and dispensing

Additionally, advanced filtration options are presented which rapidly remove dilute hydrocarbons from water with insignificant pressure drop and minimal contact time. Several applications are reviewed including: industrial wastewater, storm water treatment and re-use/recovery, condensate polishing, ground water remediation, and locomotive coolant recovery.

Stormwater Treatment Plant Upgrade at a Coal Dock Facility
Kevin Hauschildt - NS
Molly Page and Foster McMasters - Metcalf and Eddy

Stormwater treatment plant (SWTP) improvements are being implemented to address changes in the water quality received for treatment at the Norfolk Southern Ashtabula Ohio coal dock/transfer facility SWTP. The improvements incorporate operational flexibility to allow the operator to effectively deal with changes in water quality coming to the SWTP for treatment prior to discharge to Lake Erie. Operational training and standard operating procedures are provided to be sure the facility maintains compliance at the lowest possible cost. This paper discusses the water quality changes being experienced at the site and the improvements implemented to address those changes.

Norfolk Southern operates a 107-acre coal dock/transfer facility on the south shore of Lake Erie at Ashtabula, Ohio. A stormwater treatment plant (SWTP) is required to treat the coal pile runoff water to meet NPDES permit requirements for discharge to Lake Erie. The runoff is from both rainwater and the water used to spray the coal piles stored at the site. The treatment process was designed to raise the pH and remove heavy metals and total suspended solids (TSS) from the runoff water utilizing a lamella gravity separator prior to discharge.

The SWTP performance began to be unacceptably close to the discharge limits when the transfer facility started receiving coal from a different source which caused the influent pH to drop. When influent concentrations of TSS were high, the original SWTP had difficulty meeting discharge limits in the NPDES permit.

A study was conducted to evaluate the current SWTP and determine alternatives that would allow the system to remain in compliance under the varying conditions being experienced. The study consisted of an initial characterization of influent water; an evaluation of existing flow and treatment data; on-site treatability (jar) testing; and development of treatment alternatives.

After evaluating the options, installing a continuous backwash sand filter following the existing system was selected to increase system efficiency over a wider range of influent conditions with low maintenance requirements. The sand filters act as a polishing step to further reduce the TSS in the effluent water prior to discharge. Another advantage was that this alternative, under most conditions, limited the amount of chemical handling required since lime addition would not be required.

Once the alternative was selected, a full design was prepared and contractor selected.

Prior to the start of construction a second change in stormwater influent conditions occurred, characterized by a further drop in the pH of the influent water along with an increase in the iron concentration. The existing SWTP was unable to efficiently operate at these conditions. Additional treatability testing was conducted to evaluate the need for oxidation or additional alkalinity, along with changes in flow rates and chemical feed (caustic and polymer). A different polymer was identified that decreased the settling time and allowed for the system to operate within compliance. It was confirmed that the sand filters would still be feasible and additional facility improvements were not required by these further changes in influent characteristics.