Green Remediation Focus

Minimizing the environmental footprint of site cleanup

A Profile in Using Green Remediation Strategies

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Massachusetts Military Reservation
Cape Cod, MA

Federal Facility
Superfund NPL

Cleanup Objectives: Remediate 11 groundwater plumes across the 22,000-acre Massachusetts Military Reservation (MMR) site, including long-term operation of nine pump and treat (P&T) systems to treat approximately 14.5 million gallons of water each day. Contaminants of concern are trichloroethene, tetrachloroethene, and ethylene dibromide in groundwater at depths of 100-300 feet; other contaminants include carbon tetrachloride, vinyl chloride, 1,4-dichlorobenzene, 1,1,2,2-tetrachloroethane, RDX (CS-19), benzene, toluene, manganese, thallium, and lead.

Green Remediation Strategy: Optimize the existing systems for groundwater extraction, monitoring, and treatment; implement energy conservation techniques; deploy a renewable energy system to offset the high rates of P&T electricity consumption and associated air emissions from power plants; and employ a range of BMPs addressing all core elements of green remediation

Optimization of Groundwater Extraction

- Determine feasibility of shutting down any extraction wells no longer needed in a 100-well network that had operated since the late 1990's
- Investigate the impact of reducing pumping rates at each well or increasing extraction rates where needed
- Test efficacy of using pulse rather than continuous pumping processes at selected wells
- Packer well screens wherever warranted by changing parameters of contaminant plumes

Optimization of Groundwater and Performance Monitoring

- Convert to passive sampling techniques and identify potential adjustments to sampling locations, frequencies, and target analytes, to minimize purge water volumes and reduce a laboratory sample volume exceeding 5,000 at 3,000 locations in 2003
- Purchase a direct push rig instead of subcontracting conventional rotary drilling equipment and labor for subsurface sampling, which cost approximately $670,000 in 2003
- Convert from conventional diesel to biodiesel for powering the direct push rig and routine well maintenance vehicles such as medium-and light-duty trucks, and begin using biodegradable soy-based hydraulic fluid for all equipment

Optimization of Treatment Processes

- Conduct energy audits of all (nine) P&T systems and administrative facilities and implement the recommended energy efficiency improvements
- Begin recycling granular activated carbon (GAC) needed in all P&T systems, which in 2003 totaled a volume of 1 million pounds of virgin carbon at a cost of $800,000
- Investigate potential for beneficial reuse of treated water prior to its return to the underlying aquifer

Renewable and Passive Energy

- Install a natural gradient-driven permeable reactive barrier (PRB) containing reactive zero-valent iron along the shore of an adjacent pond to minimize phosphorus upwelling into the pond
- Install an onsite wind turbine to meet a portion of the total P&T energy demand (12,300 MWh each year), based on results of a renewable energy assessment that found optimal conditions for wind energy (including an average wind speed of 7.0 meters/second and wind shear of 0.27)
- Evaluate potential for substituting or supplementing P&T technology with in situ "polishing" technologies

such as in situ chemical oxidation or monitored natural attenuation in subareas where significant reductions in contamination concentrations have been achieved

Results:

Optimization of Groundwater Extraction

- Completed shutdown of 60 wells no longer needed for groundwater extraction due to the collapse of contaminant plumes, which was attributed to a combination of P&T operations and natural attenuation
- Optimized groundwater extraction rates in all extraction wells; for example, the flow rate for the "Ashumet Valley" P&T system was reduced from 1,200 gallons per minute (gpm) to 350 gpm, achieving an annual savings of $180,000 while continuing to meet the cleanup objectives and schedule
- Minimized extraction of clean groundwater and increased overall pumping efficiency, due to packered well screens that focus on extraction of contaminated groundwater at more discrete intervals as plumes continue to collapse

Optimization of Groundwater and Performance Monitoring

- Began monitoring a more focused hydraulic network over shorter periods (in contrast to routine monitoring of a comprehensive network, as initially needed) for an annual savings of over $34,000
- Eliminating purge water by deploying passive devices such as passive diffusion bags and hydrasleeves for groundwater sampling at over 87% (nearly 600) of the 750 monitoring wells now used, subsequently achieving an estimated savings of $200 per well that totals $400,000 over six years; in 2010, use of these sampling techniques is anticipated at 90% of the wells
- Reducing land and subsurface disturbance through direct push drilling techniques instead of using large auger or sonic rigs; these techniques also increase drilling acceptance by owners of offsite properties that need monitoring
- Reducing the need for imported equipment and associated air emissions, streamlining schedules for field activities, and saving approximately $200,000 each year due to direct purchase and in-house deployment of a direct push rig in contrast to outsourcing; a return on investment for the rig was achieved in less than one year
- Reduced use of petroleum fuel and associated air emission of particulate matter, carbon monoxide, and hydrocarbons through use of B20 fuel (20% biodiesel) for well maintenance equipment and vehicles
- Streamlined operations by eliminating hourly measurement of field parameters and automating data validation, for an annual savings of over $74,000
- Began using off-site laboratories for confirmation analysis as the monitoring well network condensed over time, saving more than $40,000 annually in laboratory costs

Optimization of Treatment Processes

- Installed energy efficiency devices based on the results of building energy audits, including high efficiency compact fluorescent lighting, occupancy sensors, programmable thermostats, and variable frequency drives for premium efficiency motors
- Eliminated booster pumps and downsized selected motors, resulting in an annual savings of more than $45,000
- Began recycling 100% of the P&T systems' spent carbon, subsequently reducing annual carbon costs by 25% due to substitution of virgin carbon media with carbon that is reactivated offsite
- Achieved longer mass transfer zones by reconfiguring the "carbon trains" to employ additional carbon vessels in series, resulting in an annual savings of $75,000
- Diverting approximately 85% of the water treated by one system for use in seasonal irrigation (at a rate of 450-500 gallons/minute) on adjoining property, which serves as a Veterans Administration cemetery; future use of treated water may include geothermal heating and cooling for onsite buildings

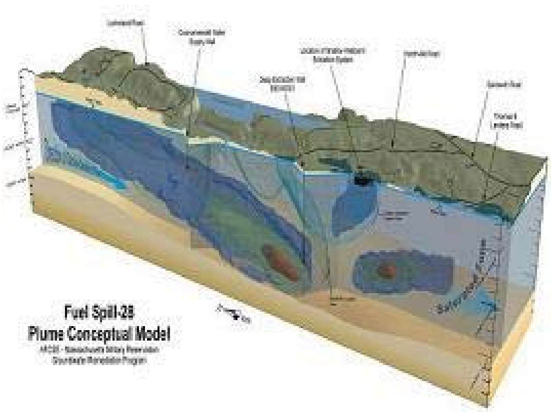
Renewable and Passive Energy

- Reducing electricity demands for pumping through use of the PRB for phosphorus upwelling protection, which requires no external energy; replenishment of the zero-valent iron reactive medium has not been needed since PRB installation in 2004
- Installed a 1.5-MW, onsite wind turbine expected to annually produce approximately 3,800 MWh of electricity; all electricity generated onsite is diverted to the utility grid under the state's net metering program, achieving nearly 100% credit at a local electricity rate of $0.167/kWh

- Reducing the total annual P&T electricity cost by an estimated 30%, compared to a $2.2 million cost in 2008
- Anticipating a six- to eight-year return on capital costs for the $4.6 million wind turbine; initial MMR expenses were reduced by a $300,000 renewable energy grant from the Massachusetts Technology Collaborative
- Offsetting estimated emissions of carbon dioxide by over 6.7 tons, nitrous oxides by 11,833 pounds, sulfur dioxide by 11,443 pounds, carbon monoxide by 1,112 pounds, and particular matter (10) by 418 pounds each year due to substitution of fossil fuel-generated energy with wind energy
- Conducting an environmental assessment on potential addition of two or three wind turbines to offset the remaining P&T electricity demand over the project life, which is expected in some cases to extend beyond 2050
- Implementing a program for ongoing optimization of the groundwater treatment systems to help reduce duration of MMR cleanup

Property End Use: Ongoing military operations

Point of Contact: Rose Forbes, Air Force Center for Engineering and the Environment



Conceptual site models were prepared and continue to be refined for each of the MMR contaminant plumes as cleanup progresses.

Prior to optimization, groundwater samples were collected from approximately 3,000 locations at MMR.

The GeoProbe 6620DT was deployed at extensive depths (up to 319 feet), eliminating the need for a larger drill rig.

Use of biodiesel (B20) instead of conventional diesel to power the direct push rig and other equipment for well maintenance reduces onsite emission of air toxics and annually saves the project $2,000.

Energy audits at MMR determined that replacement of single-speed drives with variable frequency drives (VFDs) could significantly reduce electricity consumption of each pump motor and provide more control of the water distribution processes. VFD use also is expected to reduce motor stress (and extend motor life).

Exchange of spent carbon with reactivated carbon in the groundwater treatment systems is conducted an average of four times each month, at a changeout volume averaging 80,000 pounds. As a result, MMR is investigating methods for regenerating the carbon onsite.

Sampling of nearby cranberry bogs was conducted to ensure MMR contamination did not impact the local cranberry harvest.

Construction of the wind turbine foundation began in March 2009. Approximately 600 yard^3 of 5,000 psi concrete were used to form a foundation 57 feet wide and 3-8 feet high. Placement of the turbine directly adjacent to one of the site's treatment buildings avoided the need for additional site clearing and enabled streamlining of daily monitoring and periodic maintenance activities.

Three 123-foot epoxy/fiberglass blades were shipped to MMR from a manufacturing plant in Grand Forks, ND, in July 2009.

The 73-ton nacelle (generator) was shipped from Germany to MMR via the Baltimore Port in August 2009.

The 80-meter wind turbine tower began arriving at MMR in October 2009, in four sections. Transport involved securing state and local permits and tight scheduling to accommodate police escorts and inclement weather. Navigational challenges such as overhead utilities and bridges resulted in minor dents and scrapes to one section and temporary I-81 lane closure (due to damage of a New York bridge).

Erection of the wind turbine tower required use of a 440-ton, 315-foot Manitowoc 16000 crane , which was delivered to the site on 18 flatbed trailers and assembled near the "LF-1" treatment system over four days. Construction occurred without disruption to LF-1 system operations, which include two (blue) tanks for managing backwashing water. Mobile equipment used for each P&T system includes one (red) frac tank with two carbon vessels for treating water pumped during well maintenance.

The base and sections of the wind turbine tower were set in mid October 2009.

By the end of October 2009, the turbine rotor was lifted onto the tower and all construction of the MMR wind turbine was complete.

The Air Force Center for Engineering and the Environment's "FL-1500" 1.5-MW wind turbine at MMR became operational on December 2, 2009.

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http://www.cluin.org/greenremediation/profiles/subtab_d32.cfm

United States Environmental Protection Agency
Office of Solid Waste and Emergency Response (5202P)

For more information:
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