INFORMATION
Lowry AFB was established in 1937 as a training and airfield operations facility. Activities at the base’s location were similar to other communities of the era that included coal-powered steam plant to provide heat, gas stations for fuel, landfill operations for municipal waste, and solvent parts cleaning operations. Some of these practices resulted in environmental issues that had to be addressed by current standards. The base was formally closed in September 1994.

The initial groundwater clean-up efforts were managed by the US Air Force but then privatized in 2002. The efforts were turned over to Lowry Economic Redevelopment Authority (LRA) for operation management and contract work conducted by Lowry Assumption, LLC (LAC). Groundwater cleanup activities targeted contamination stemming from releases into storm sewers from several on-base facilities including an auto shop as well as accidental spills or leaks of solvents around firing range facilities, and disposal of solvents into septic systems.

APPROACH
Early interim response actions to address trichloroethylene (TCE) impacted groundwater included a dual-phase extraction system for source area removal, a pump and treat boundary containment system that operated from 1998 until April 2005, and a demonstration scale zero-valent iron permeable reactive barrier (PRB) across a portion of the main TCE plume. Potassium permanganate was subsequently incorporated into the base-wide remediation design by LAC to aggressively treat the identified source areas and the higher concentration dissolved-phase portions of the several groundwater plumes. The imposition of a State Environmental Covenant for the on-base areas affected by the groundwater plumes requires the installation of active subslab depressurization systems for all new residential construction.

APPLICATION
RemOx® S ISCO reagent (potassium permanganate) was injected at concentrations from 3% to 4% from 2004 to 2010 at 2,181 injection points across various plume areas. The soils encountered during the injection events varied from alluvium, bedrock, and clay/silt. The main targeted areas for permanganate injection treatment included TCE sources and plumes at the Fire Training Zone (FOSET 5a/b), Main On-Base Plume, Main Off-Base Plume, and Headquarters Area Plume (FOSET 3).

RESULTS
At the conclusion of the permanganate injections, estimated mass removal was 92%, plume area reduction was 82% (below 5 µg/L, the Colorado Basic Ground Water Standard for TCE), and risk reduction was 98%. The 2010 indoor air concentrations in the off-base main plume area were at or below Colorado Department of Public Health and Environment (CDPHE) action levels. The achievement of Risk Milestones indicated that protection of human health and the environment had been accomplished. The total reduction of TCE mass in the various groundwater plumes was from greater than 300 kg to below 30 kg. Based upon diminishing return reductions of mass or areal extent following the final injection event, the determination was made that natural attenuation through abiotic destruction, dispersion/dilution, and volatilization will be instituted to achieve the final reduction to site-specific standards for TCE as approved for the site by the Colorado Water Quality Control Commission. Prior to permanganate injections, contaminant concentrations in the alluvial intervals of the TCE plumes had been recorded at concentrations as high as 600 µg/L with post-injection reductions down to below 15 µg/L.

This project is a successful example of coordinating various site remedial technologies and how Carus ISCO technologies can be utilized for site clean-up operations.

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