TINKER AIR FORCE BASE

2003|Secretary of Defense Environmental Awards Program

CATEGORY|Environmental Restoration, Installation

Prairie Pond was created during capping activities of Landfill 6 in 1986. The pond was a soil borrow site transformed into a natural resource. Today the pond provides beauty, fish and wildlife habitat, and recreational opportunities.

INTRODUCTION

Tinker Air Force Base (TAFB), home of the Oklahoma City Air Logistics Center, provides worldwide technical logistics support to Air Force (AF) aerospace weapon systems while serving as a premier inter-servicing facility supporting the Air Combat Command, the Air Force Reserve Command and the Navy Strategic Communications Wing One.

Since the early 1940s, TAFB has been a vital part of the Oklahoma economy and national defense. The base comprises approximately 5,000 acres located five miles east of downtown Oklahoma City. TAFB is home to 2,261 aircraft, including the B-1, B-2, B-52, C/KC-135, E-3 and an inventory of nearly 23,000 jet engines.

With nearly 25,000 civilian and military employees and an economic impact of $2.27 billion on the six surrounding counties, TAFB is the largest single-site employer in the state.

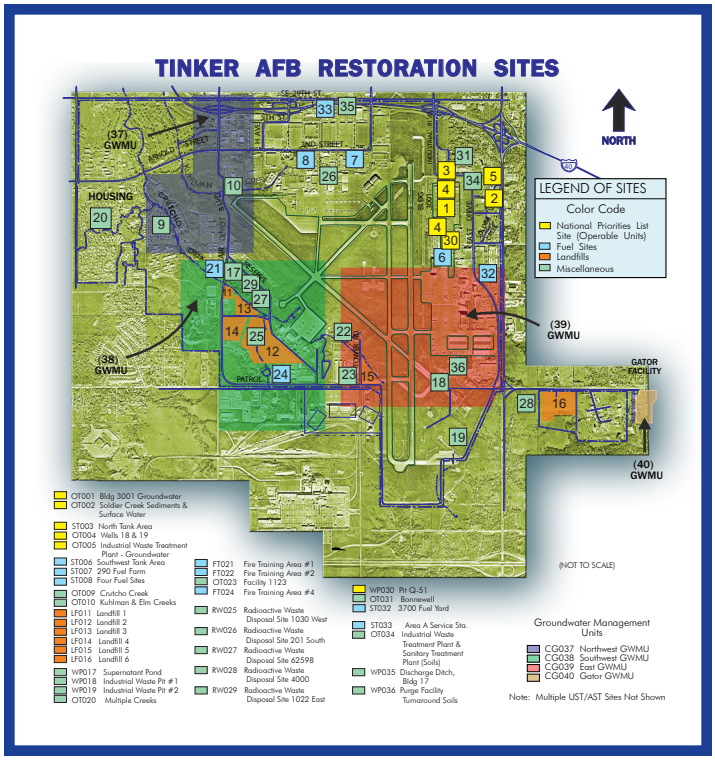
Coupled with this intense mission is the responsibility to clean up wastes associated with past operations. Restoration projects protect human health and the environment and benefits indigenous plants and wildlife as well as neighboring communities.

Restoring the environment benefits indigenous plants and wildlife as well as neighboring communities.

BACKGROUND

Meeting the Environmental Challenge

Complementing the base's dynamic defense mission that includes supporting ongoing military operations around the world, TAFB is committed to environmental restoration and protection. Tinker's complex industrial manufacturing processes, aging infrastructure and ever-changing environmental regulations present significant challenges. Striking a balance between sometimes divergent military and environmental needs requires identifying innovative solutions and partnering with stakeholders to ensure that limited cleanup dollars are effectively directed and that community concerns are taken into consideration.



Tinker has forty Installation Restoration Program sites spanning all quadrants of the base. They include National Priority List operable units, fuel sites, landfills, waste pits and fire training areas.

Maintaining a First-Rate Staff

The environmental restoration (ER) staff is a strong mix of environmental engineers, physical scientists and geologists, most of whom hold advanced degrees. Some are also adjunct professors of math, physics, geology, zoology and biology at Rose State College. In the past two years, staff members presented briefings at five conferences and symposiums and submitted three articles for publication on topics such as groundwater modeling, neural networks and the applications of seismic technology.

Implementing a Dynamic Management Approach

Tinker's environmental leadership demonstrates great confidence by empowering technical staff members to make all financial and technical decisions with regard to site cleanup and closure. The staff directly controls all aspects of sites including scheduling changes and regulatory issues. Each staff member uses this delegated authority and responsibility to implement his or her vision, while searching for continuous process improvement. Driven by accountability for cleanup progress and fund expenditure, staff members are conscientious, take a personal interest in reducing costs and continuously strive for process improvements.

The entire ER staff proactively evaluates all available data to ensure that remedial decisions are based on sound science. In one case, staff questioned groundwater modeling results at an IRP site when the model indicated that trichloroethylene (TCE) would migrate off base within 10 years, necessitating costly interim corrective measures. Millions of dollars were saved when staff determined that incorrect and inappropriate model input data had caused erroneous model results.

Involving the Community

As active members of the communities they serve, the ER staff works diligently to ensure effective two-way communication between TAFB and both the industrial (on-base) and the residential (off-base) communities. TAFB's community relations program focuses on providing ongoing updates on restoration progress to the community and media, proactively meeting with neighborhood residents one-on-one to go over topical data or specific questions and provides opportunities for the on- and off-base communities to participate in community relations activities. The Community Advisory Board (CAB), a tool used by Tinker to involve the community in every aspect of the IRP, is discussed in a separate section.

Community Initiatives
• Publish *Environmental Link* newsletter, mailed quarterly to over 350 private citizens.
• Volunteer during Earth Month each April for Eco-Motion, a mobile environmental classroom for children from disadvantaged schools.
• Provided support for the 2003 Society of American Military Engineers Texoma Regional Conference. ER staff was involved in the planning and registration committees, developing the Web site, and other support activities.
• Provide access to over 168 technical documents on the EM Web server.
• Maintain the Administrative Record, available in the local public library and on the EM Web page: http://www-ext.tinker.af.mil/em/
• Provide 12–15 tours yearly of environmental restoration sites and other EM activities
• Provide 5–8 tours yearly for off-base community, including visiting dignitaries and local high schools/universities.
• Provide 18 property owners with Off-Base Sampling and Analysis Reports for wells on their property every year.

PROGRAM SUMMARY

The ER element is responsible for conducting and managing the restoration of sites throughout the facility that were contaminated years ago when environmental awareness and pollution prevention were limited. Environmental site investigations began in 1981 and 40 sites were identified between 1991 and 1997. Tinker's restoration program goals include the following.

1. TAFB is currently on target to achieve remedy in place seven years ahead of Air Force and Department of Defense goals.
2. Plans are to close all Installation Restoration Program sites using institutional controls and risk-based cleanup levels. In August 2003, TAFB received a letter from the Oklahoma Department of Environmental Quality approving use of monitored natural attenuation with institutional controls as the remedy for site CG037. This approval set a precedent for closing remaining sites where groundwater contamination does not pose a risk to human health or the environment but is above regulatory cleanup levels.
3. The ER staff manages and protects the aquifer in order to provide a safe and adequate water

supply. In addition to evaluating and monitoring ground water and surface water interaction, Tinker has completed a wellhead protection plan for 26 active water supply wells. Groundwater contamination is controlled through remediation, pollution abatement and monitoring water supply wells.

ER staffer Scott Bowen explains cleanup activities during Environmental Awareness Day.

ACCOMPLISHMENTS

Tinker AFB's environmental restoration program demonstrated commitment to its remediation and closure schedule by cultivating and sustaining an excellent working relationship with regulators, maintaining open communications and keeping even the most challenging site schedules on track.

Significant amounts of contamination were removed, reducing potential risk to workers at the base. The chart illustrates reductions of volatile organic compound contamination in two wells. This amazing result was realized in just a few months therefore accelerating site closure.

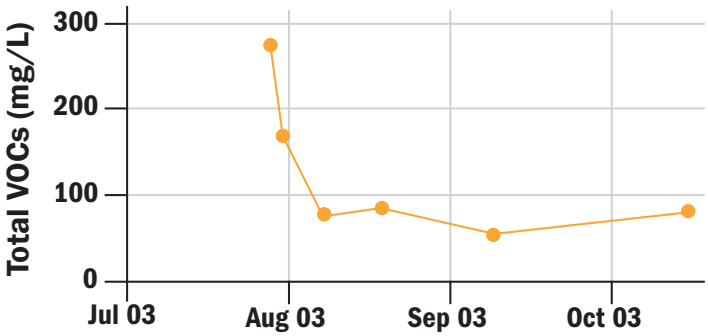
Reducing Risk to Human Health and the Environment

The mission of TAFB's environmental restoration program is to minimize potential impacts on human health and the environment through cleanup and restoration of soil, surface water and groundwater contaminated by past industrial practices. As an active base, restored land at TAFB is not transferred to the community but rather retained for ongoing military operations. Today, under the direction of the Department of Defense, the Installation Restoration Program at Tinker AFB is accomplishing restoration goals by cleaning up landfills, waste pits, waste treatment plants, low-level radioactive waste disposal sites, fuel spills, waste lines, fire training areas and vehicle and aircraft maintenance facilities on base property.

Fast-Track Clean-Up

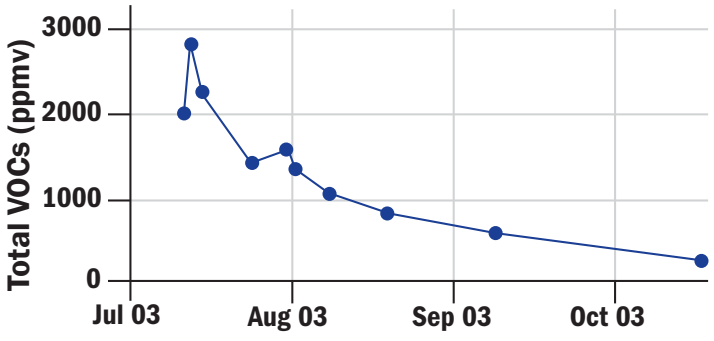
Tinker restoration managers are always looking for ways to accelerate cleanup and save taxpayer dollars. A remedial action strategy meeting in June 2003, with Environmental Protection Agency (EPA) Region 6 and the Oklahoma Department of Environmental Quality, achieved early regulatory buy-in of planned final remedies and avoided lengthy review periods. This success was due to the restoration team fostering

Well 1-70B Preliminary VOC Results



Total VOC concentrations at Well 1-70B dropped 30% in just four months, from approximately 275 mg/L in July 2003 to 81 mg/L in October 2003, using a dual-phase extraction (DPE) system.

Well HW-2 Preliminary VOC Results



Total VOC concentrations at HW-2 decreased using a soil vapor extraction (SVE) system, from over 2,700 ppmv to just over 600 ppmv in just three months.

an exceptional relationship with the regulators who were consulted throughout the remedy selection process.

Personnel teamed with state and federal regulatory agencies to plan and implement a temporary shutdown of a groundwater treatment plant at TAFB's National Priorities List site, with the potential to save $10 million in operation and maintenance costs. Data gathered will provide evidence of plume stability and support the use of monitored natural attenuation as a more cost-effective alternative to the current inefficient and costly pump-and-treat system.

As of August of 2003, a total of 288,675 pounds of VOCs have been removed at nine treatment units.

By preparing key documents and tasks in-house, reliance on contractors to complete these tasks was reduced. This industrious initiative saved the AF thousands of dollars and included risk assessments, five-year reviews, Explanation of Significant Difference document, No Further Response Action Planned documents and No Further Action letters.

Vacuum-Enhanced Pumping is a presumptive remedy technology that is now used at several TAFB sites. This method eliminates study time while the systems remove soil gas, contaminated vapor and groundwater simultaneously, processing it through separators that burn off-gas and

80% of all IRP sites have been closed or have achieved RIP, two in just the past two years, including the last of six landfills. All 40 sites will be closed or achieve RIP by FY08, seven years ahead of Air Force and DoD goals.

ER SUCCESSES

- Hosted a remedial action strategy meeting on June 17, 2003, with Environmental Protection Agency (EPA) Region 6 and ODEQ, focused on achieving regulatory buy-in of planned final remedies. Achieved early consensus because the regulators had been kept apprised throughout the remedy selection process, saving taxpayer money by reducing lengthy review periods.
- Teamed with state and federal regulatory agencies to plan and implement a temporary shutdown of a groundwater treatment plant at TAFB's National Priorities List (NPL) site, with the potential to save $10 million in operation and maintenance costs. Data gathered will provide evidence of plume stability and support the use of MNA as a more cost-effective alternative to the current inefficient and costly pump-and-treat system.
- Reduced reliance on contractors for key documents and tasks by preparing them in-house, including risk assessments, five-year reviews an Explanation of Significant Difference (ESD) document, No Further Response Action Planned (NFRAP) documents, and No Further Action (NFA) letters, saving an estimated $526,000.

Local school children tour the Eco-Motion bus during Earth Month.

remove 96 percent of contaminants. Water is then discharged into industrial wastewater or sanitary water treatment systems. This "two-fisted" approach:

- simultaneously remediates soil and groundwater;
- prevents contaminant plumes from migrating;
- shortens time needed to achieve complete site remediation by up to 15 years; and
- saves more than $2 million in long-term operation costs.

One operable unit site will close before FY10 -- well before its projected closure date in FY28 -- as a result of upgrading the existing pump-and-treat system to vacuum-enhanced pumping. Eight sites were identified as candidates for this technology since FY00. Of these, three should close out by the end of FY05.

Innovative Technologies

Tinker's dedicated restoration team constantly researches emerging and innovative technologies that will save time and money. Technologies that prove successful at test sites are then applied to other sites, contributing greatly to TAFB's ability to quickly close sites and lower program costs.

Site CG037, containing multiple groundwater plumes, was originally budgeted for a $9,575,000 clean up project. By resourcefully using monitored natural attenuation and innovative technologies the cost was reduced to $370,750 over five years.

The research and comparison of using potassium permanganate, Fenton's Reagent and bio-amendment treatment of groundwater, could result in one site being closed four years ahead of schedule and has the potential to significantly lower cleanup costs for five other sites that have a current cleanup estimated at $8 million.

This emerging technology project was carried out under the Small Business Innovative Research program. For each of the three constituents, a very low-concentration solution was injected into a separate test cell at the site to determine the lowest amount that produced effective in situ (in location) chemical oxidation. Using lower concentrations allows multiple applications while maintaining cost-effectiveness over traditional technologies. Potassium permanganate was found to be the most effective as it destroys chlorinated volatile organic compound groundwater contamination in days rather than years. In addition, focusing on "hot spots" and groundwater "preferential pathways" (the water's "path of least resistance," or the route along which added treatments tend to flow) accelerated cleanup with one site possibly achieving closure a full four years sooner than anticipated.

Another innovative technology, azimuth-controlled vertical hydraulic fracturing for permeable reactive barrier installation, will save $2 million over traditional trenching methods and will prevent further migration of contamination into an off-base neighborhood. A 100-foot deep permeable reactive barrier will be installed using injection points rather than trenches for installation. This technology allows for deeper penetration than conventional trenching, which is normally limited to 50-foot depths. Trenching would

Potassium permanganate destroys chlorinated volatile organic compound (VOC) groundwater contamination in days rather than years.

		Conventional Technologies	Innovative Technologies	
Site	Primary Contaminant	Cost	Cost	Type of Technology
CG037, Subunit 2B	TCE	$4,200,000	$671,000	Phase I & II Permanganate/ Fenton's Reagent/ Bioamendments
CG037, Subunit 1B	TCE	$2,700,000	$35,000	Electrical Resistivity Tomography (ERT)
CG037, Subunit 1B	TCE	$400,000	$50,000	Ground Penetrating Radar/ Amplitude Versus Offset (AVO) Radar/Soil Magnetic Susceptibility

cost more than $4.5 million and at deeper intervals involves safety concerns associated with placing iron filings evenly across the aquifer. ER personnel partnered with regulators and updated them on a weekly basis resulting in early buy-in on documents. Final design work is already underway. Using this technology allows funds to be redirected to other cleanup efforts.

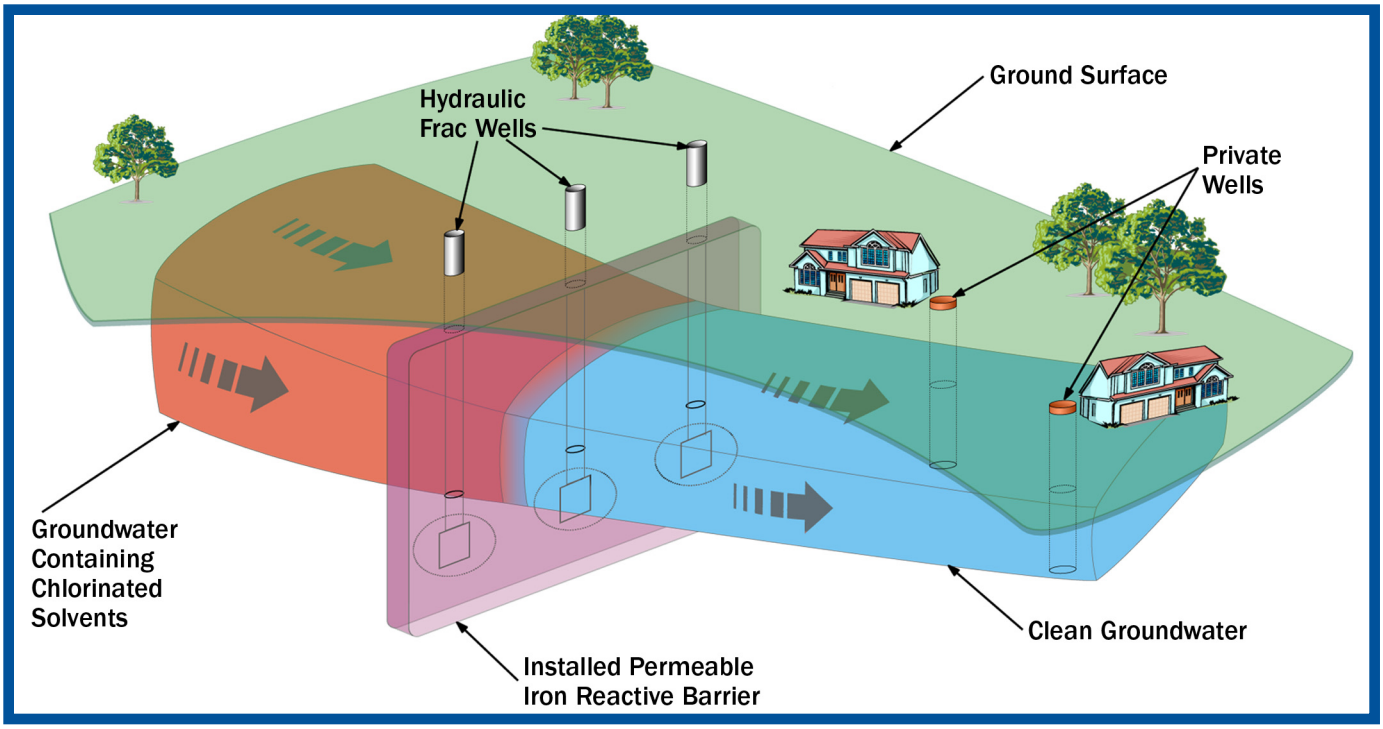
When a $20 million "dig and haul" solution was proposed to remediate an industrial waste pit, ER staff proactively researched alternatives to find a more efficient treatment technology to treat soil on-site. A less expensive thermal desorption rotary kiln — a high temperature after-burner to treat contaminated clays and residual paint sludges – was discovered at significantly reduced costs. Equipment was custom-built to meet TAFB-developed specifications to combine thermal desorption and metals stabilization. As a result, 15,000 cubic yards of hazardous waste were rendered nonhazardous thus lowering disposal costs. An additional $15 million in costs for off-site treatment of metals- and organic-contaminated soils was avoided and Air Force long-term liability for hazardous waste disposal was also limited.

Tinker AFB spearheaded an effort for the Air Force Center for Environmental Excellence's (AFCEE) Technology Transfer group to conduct an in-situ bioremediation test at no cost to TAFB. Vegetable oil was injected at Fire Training Area (FTA) 2 in the fall of 2003. Indigenous microbes in soil stimulate a chemical reaction that reduces trichloroethylene contamination. The vegetable oil serves as an inexpensive additive that promotes the growth of these microbes thereby accelerating natural biodegradation while being very cost-effective. Using this technology, the "hot spot" at FTA 2 is being remediated using AFCEE research dollars and at the same time the Air Force will acquire data and technology that can be transferred to other sites.

"The ER staff includes me as part of their team. The ER Team is the best it has ever been in the 13 years that I've been in Oklahoma. Out of the six bases where I've worked, Tinker has the best, most energetic, most dedicated ER Team."
Robert Replogle, ODEQ

Partnerships Addressing Cleanup Issues

Tinker AFB enjoys a long-standing partnership with regulators in determining restoration strategies for cleanup projects and communicating continuously throughout the restoration process. The ER team



The PRB at IRP Site CG038 will degrade chlorinated solvents in the groundwater to harmless by-products, preventing further contamination of off-base private water wells in the Tinker View Acres Subdivision.

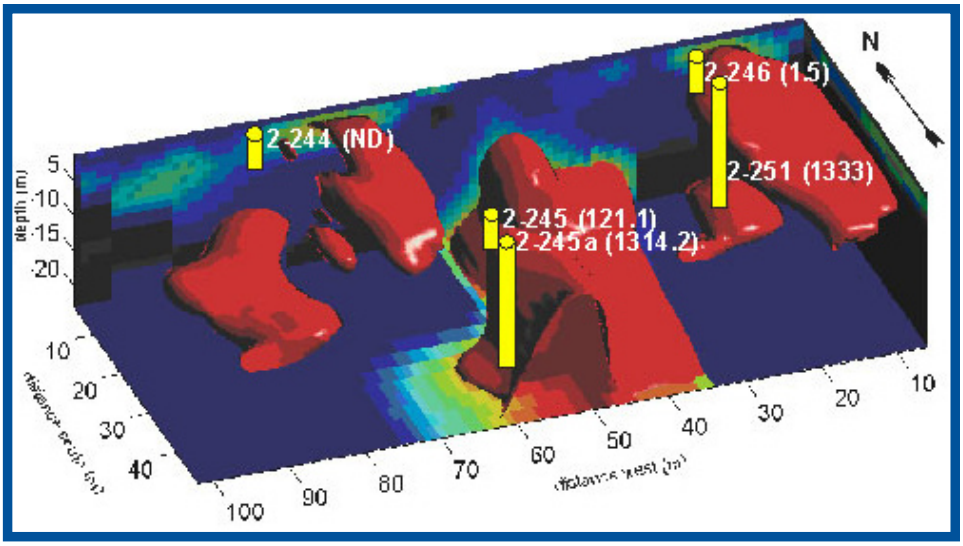
formed a key relationship with its primary contact at the Oklahoma Department of Environmental Quality who visits the site frequently and receives weekly briefings. The state is kept apprised of projects before formal reports are submitted, typically reducing regulatory review time by more than a month. For example, design of a permeable reactive barrier to treat contamination affecting the off-base Tinker View Acres subdivision was expedited as a result of early regulatory buy-in, saving time and leading to a further reduction in risk.

In addition to an ongoing partnership with key regulators, ER understands the value of partnering with outside organizations to share resources and explore new technologies.

The restoration team partnered with Oklahoma State University to conduct a noninvasive study to locate plume sources using artificial neural networks for inverse groundwater modeling. Locating contaminant sources is a significant problem throughout DoD and plumes cannot be fully remediated if the source is not found and addressed. Instead of using traditional forward modeling to estimate where the plume will go in the future, this approach uses artificial neural networks to try to identify sources by modeling backward in time, allowing remedial systems to be designed to address sources and speed cleanup. Used in conjunction with other technologies it enables a non-invasive approach to plume delineation.

Always seeking ways to save money, restoration personnel collaborated with the U.S. Environmental Protection Agency on numerous projects. TAFB makes available "host" sites with specific contaminants and geology that meet the qualifications for EPA-sponsored research projects for the Ground Water and Ecosystems Restoration Division of the National Risk Management Research Laboratory in Ada, Oklahoma. EPA conducts projects at TAFB, allowing EPA to benefit from the research and TAFB to receive the data on site without spending ER funds.

Recently, two TAFB sites were included in a study to determine relationships between species Dehalococcoides DNA in groundwater and the rates of reductive dechlorination. At no cost to the base, the data collected is being used to help determine cleanup strategies. Savings are estimated to be $75,000.



The ERT survey shows areas of contamination in a previously untested area. Well locations are shown in yellow. Numbers in parentheses are contaminant concentrations; ND denotes that no contamination was detected at that well.

By thinking "outside the box", restoration personnel discovered contamination that was previously undetected through new application of technologies. Partnering with the University of Oklahoma, personnel used electrical resistivity tomography (ERT) near the former Base Exchange gas station to accelerate site investigation and remediation. ER knew a groundwater plume existed in this area and used this technology as an inexpensive and efficient method of extending plume delineation into untested areas. The tomography survey produced a three-dimensional image of variations in subsurface electrical resistivity and depicted additional unsuspected contamination. Results were confirmed through installation of a standard monitoring well that validated the technology. Design and implementation

Contractor personnel evaluate core samples from a test boring at an ERT anomaly near Landfill 2.

Oklahoma State University researchers evaluate data from groundwater flow sensors.

of a remedial system based on incomplete plume delineation would have been both costly and ineffective, but using noninvasive investigation technologies saved $3 million. ER is now using this technology to investigate other sites, saving money over the traditional approach of drilling monitoring wells.

Flow direction variation in wells is critical to source identification and remediation system design. The Center for Aircraft Systems/Support Infrastructure sponsored a project with Oklahoma State University using innovative flow sensors in existing wells for a feasibility study. Typically, a potentiometric surface map that shows likely flow direction based on existing monitoring well data is used; however, this has limitations due to preferential pathways and site-specific hydrogeology. The flow sensors provide a more accurate vertical and horizontal groundwater flow direction and assist with determining how long monitoring may be necessary. Using these sensors ensures the final action will work as planned, optimizing system performance and minimizing unknowns.

Community Advisory Board

Including stakeholders in the community from the beginning saves time and money and fosters a unique and trusting relationship between the AF and surrounding citizens.

Proactive public meetings are an integral part of TAFB's good-neighbor policy. The Community Advisory Board is comprised of 15 community leaders from the areas surrounding the base, along with representatives from TAFB, the Environmental Protection Agency and the Oklahoma Department of Environmental Quality. Community members represent groups such as the Association of Central Oklahoma Governments, Oklahoma Toxics Campaign and Waste Management of Oklahoma. CAB meetings are based on mutual respect, are held quarterly and thoroughly involve and consult stakeholders throughout the cleanup process. The ER staff provides briefings on a myriad of issues that arise such as odors from the industrial waste treatment plant or aircraft noise, fostering open channels of communication. The CAB technical committee reviews and provides input on all restoration documents.

CAB meetings provide a forum to share information about cleanup activities and address questions and concerns from neighbors.

Small and Disadvantaged Business Opportunities

Environmental Restoration personnel at Tinker aggressively secured funding for multiple projects through DoD's Small Business Innovative Research program. Funded through Congress, this program allows the ER team to prove or disprove new technology at TAFB without spending restoration funds.

A hydrogeologic data fusion project combined many types of data into one data set to obtain a highly accurate 3-D hydrogeologic and contaminant map. Typically, information such as contaminant maps, potentiometric surface maps, geophysical logs, electric resistivity tomography data and seismic data is analyzed separately. The graphics generated from this data fusion are more accurate and immediately

depict which data types will provide the best return on investment and the quickest and most cost-effective remediation methods, thereby focusing investigative efforts and eliminating unnecessary costs.

An electrokinetics project focused on the problem of preferential pathways affecting remediation technologies that use injection, such as chemical oxidation. When applied to soils such as clay, electrokinetics act on the soil composition to make it uniformly permeable so that water and other additives do not concentrate along the paths of least resistance. This allows cleanup of the entire contaminated zone rather than primarily the preferential pathways. At site CG037, use of electrokinetics has the potential to save approximately $1.2 million with permanganate as the treatment technology.

CONCLUSION

Through open and ongoing involvement with the community and regulators, use of cutting-edge and innovative technologies, a strong commitment to the environment and a sense of responsibility for the most effective expenditure of taxpayer money, the environmental restoration team at Tinker AFB is accomplishing fast-tracked cleanup while reducing risk to human health and the environment.

Contractor personnel collect water samples from a monitoring well located in the Tinker View Acres neighborhood

Bikers enjoy Tinker's Urban Greenway.

TINKER VIEW ACRES (TVA) ISSUE RESOLVED!

In August 2000, TCE (believed to have originated in landfills on the southwest portion of the base) was discovered in private drinking water wells. TAFB acted quickly to assist residents affected by the contamination, providing them with bottled water and carbon filtration systems for drinking water until they were supplied with city water.

Residents were contacted one-on-one by the EM/Public Affairs team to gather input and ensure they were kept informed. Residents participated in decision-making and were updated with current information through informational pamphlets, the EM Web site (http://www-ext.tinker.af.mil/em/), a dedicated e-mail account, and quarterly CAB meetings. Residents continue to be informed as the design and construction of the final cleanup remedy, a PRB, continues. During construction of the PRB, ER will use injection technology (see page 5 for information on azimuth-controlled vertical hydraulic fracturing) rather than trenching, to minimize inconvenience to the residents.

The local commander was so impressed with the incident's outcome that he gave eight team members the Air Force Civilian Achievement Award. Because of TAFB's openness and responsiveness from the very beginning, a potential media nightmare was turned into a good neighbor story with a happy ending.

"The TVA incident proved that the community had confidence in the CAB. I believe the Board is serving its purpose as I've had few calls from residents and few incidents have flared up. I feel the CAB has been able to influence the ER program; Tinker has bent over backwards to provide the CAB with anything it requested."
William Janacek, CAB Community Co-Chair