Tucson International Airport Area Superfund Site

U.S. Environmental Protection Agency • Region 9 • San Francisco, CA • March 2010

Overall Site History and Overview

In 1981, the Environmental Protection Agency (EPA) and City of Tucson sampled and analyzed the **groundwater*** from city wells and found high levels of **volatile organic compounds** (VOCs), including **trichloroethylene** (TCE). City wells in the affected area were immediately shut down and no longer used for drinking water. The site became a federal **Superfund** site in 1983, and EPA and Arizona Department of Environmental Quality (ADEQ) have been investigating and cleaning up the site ever since.

Industrial use and degreasing led to disposal of metals, chlorinated **solvents** and other wastes beginning in 1942 at the Tucson International Airport property, and large scale disposal at Air Force Plant 44 began in the 1950s. Air Force Plant 44 is the largest source of groundwater and soil contamination at this site. The main underground contaminant **plume** from Air Force Plant 44 and the airport has comingled and extended northward. The largest area of groundwater contamination flows northwest of the two facilities, and ends in the area under the Tucson Airport Remediation Project (TARP) (see Figures 1-2).

The whole Tucson International Airport Area (TIAA) Superfund Site encompasses about 10 square miles in the southeast part of Tucson. It includes 7 different project areas, the largest being Air Force Plant 44, Tucson International Airport, and Tucson Airport Remediation Project. The smaller areas are Texas Instruments, West Cap, Arizona Air National Guard Base, and West Plume B.

The main contamination plume is in the deeper regional **aquifer**. The groundwater is now treated to regulatory standards by the Tucson Airport Remediation Project before it is distributed as drinking water by the city of Tucson. Additional contamination is present in the shallow groundwater zones at Tucson International Airport and Air Force Plant 44, which then makes its way down to the regional aquifer.

There are also treatment plants in the contaminant source areas at Air Force Plant 44, Tucson International Airport, and at the Arizona Air National Guard that address the VOCs such as TCE. A new treatment plant at Air Force Plant 44 has been added to treat **1,4-dioxane**. Air Force Plant 44 and Tucson International Airport's treatment plants contain the plume and decrease the contaminants, making the water manageable for TARP to clean to drinking water standards and release to the City of Tucson's drinking water supply. Cleanup activities are at different stages at all of the sites.

Air Force Plant 44

Air Force Plant 44 is a U.S. government-owned, contractor operated facility that is currently run by Raytheon Missile Systems Company (formerly known as Hughes Missile Systems Company). In the past the facility used a variety of different chemicals in its industrial process, including TCE as a metals degreaser and **chromium** in electroplating processes. Hazardous substances generated by plant activities included the following: TCE, **dichloroethylene** (1,1-DCE), **trichloroethane** (TCA), and **1,4-dioxane**, which was a stabilizing additive to TCA formulations. Additional hazardous wastes produced were alcohols, **methyl ethyl ketone** (MEK), and other solvents; used oil and lubricants; waste paint and sludges; and industrial wastewater treatment residue containing metals such as **chromium**, **cadmium**, and **cyanide**.

A number of actions, including **capping**, excavations and off-site disposal, and **soil vapor extraction** (SVE), were performed in the 1990s to address soil contamination. A regional groundwater extraction system and treatment plant addressing the known contaminants of concern began operation in 1987. In addition, the results of on-going studies of **in-situ** (on site) **chemical oxidation** and **biodegradation** of residual soil contamination are being evaluated.

*Words in **bold** are defined in the Glossary on page 10

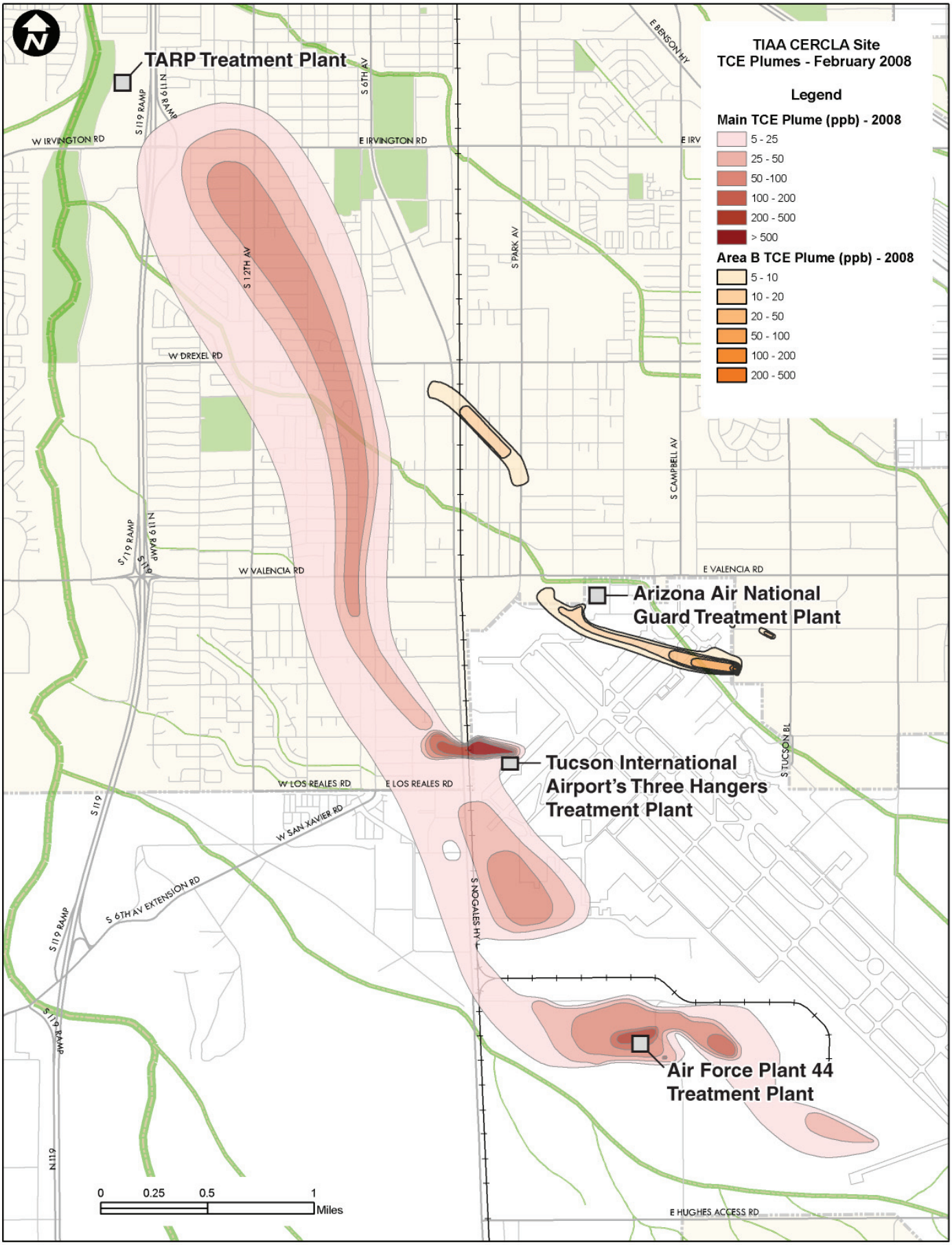

Figure 1: TCE plume map

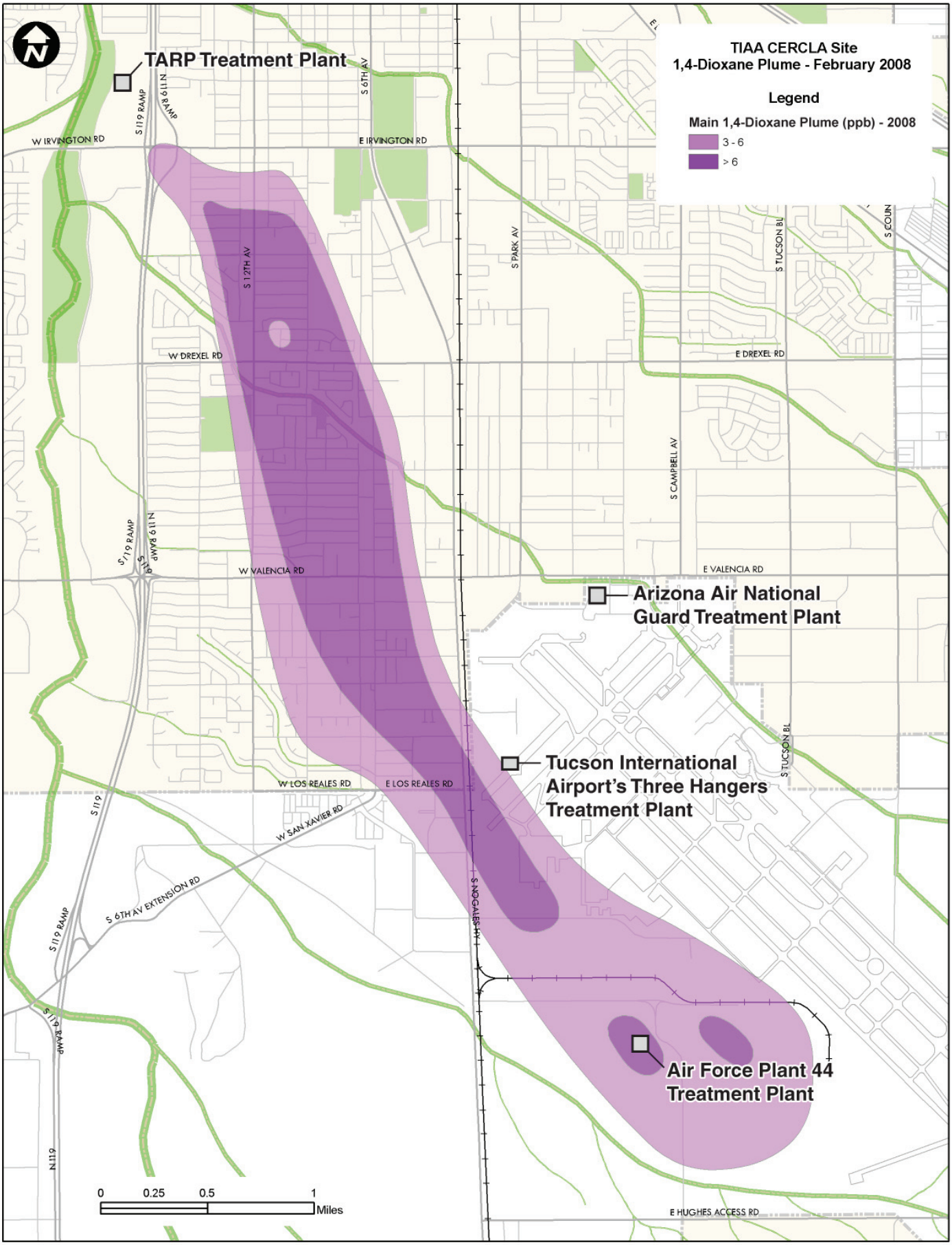

Figure 2: 1,4-Dioxane plume map

1,4 Dioxane Discovery

The treatment plant at Air Force Plant 44, however, did not address **1,4-dioxane**, which was not a known contaminant of concern until many years later. In the early 2000s, improvements in laboratory technology allowed for the detection of 1,4-dioxane down to 1 **part per billion** (ppb). After further investigations, the chemical was discovered at the Tucson Airport Remediation Project's (TARP) plant and later at Air Force Plant 44. In July 2007, the EPA ordered the Raytheon Company and the U.S. Air Force to clean up the 1,4-dioxane contaminating the groundwater at Air Force Plant 44.

Under the Order, the U.S. Air Force was required to update its groundwater treatment facility by installing and operating an advanced **oxidation** process (**AOP**) system to treat 1,4-dioxane and the other contaminants of concern. The 1,4-dioxane contamination is entering the groundwater from various sources on its 1,365-acre Air Force Plant 44 facility, which is part of and located on the southern end of the TIAA Site.

In July 2008, the U.S. Air Force began installing a new system for treating 1,4-dioxane using AOP. The AOP system injects hydrogen peroxide (H_2O_2) and ozone (O_3) at multiple points into the mixing chamber with the contaminated groundwater. The mixing of the chemicals and contaminated water allows for reactions that rid the water of 1,4-dioxane and all other contaminants of concern and converts them into nonhazardous compounds, including carbon dioxide, water, and **free chloride**.

A number of site-specific complexities led to issues with the design and delays in the installation and full-time operation of the AOP system (see box for details). All operation and maintenance issues were eventually resolved and the AOP system began full-time operations in September 2009. The AOP system will address treatment of all contaminants of concern and also reduce energy usage at the treatment facility. Following a period of operational monitoring, EPA and ADEQ in November 2009 concurred with discontinuing the use of the historic **air stripping** towers, once the primary mode of groundwater treatment. With documentation of the successful operation of the AOP system, EPA has acted to terminate the Order against Raytheon and the U.S. Air Force.

Cleaning up the Shallow Groundwater Zone

The Shallow Groundwater Zone is an area of groundwater on the western side of Air Force Plant 44 that is characterized by higher groundwater levels and contaminant concentrations. The Air Force operated a **dual-phase extraction** system in this area from 1997 to 2008 in an attempt to remove contaminant vapors and contaminated groundwater. This system was effective in removing contaminants in vapor in the **vadose zone** but was not a cost-effective cleanup option for groundwater as contaminant concentrations remained elevated well above cleanup goals after eleven years of operation. Studies to assess the impacts of contamination in the Shallow Groundwater Zone on regional groundwater quality and to evaluate the potential for **in-situ** (on site) **treatment** of contaminants in the Shallow Groundwater Zone began in late 2009.

AOP System Design Issues & Installation Delays

- Largest capacity AOP treatment plant installed to date, requiring an oxygen generator used in place of supplied O_2
- Numerous repairs were made to existing, aging treatment plant infrastructure
- Numerous repairs were made to extraction and injection wells
- Modifications to design were required due to high summertime temperatures

New AOP plant at Air Force Plant 44

Tucson Airport Remediation Project (TARP)

TARP is a treatment facility that manages a 4-mile long, 1-mile wide plume of comingled groundwater contamination from Air Force Plant 44 and the Tucson International Airport Property. TARP does not treat any type of soil contamination associated with the TIAA Site.

The treatment plant has been in operation since 1994 and utilizes **air stripping** technology and carbon filtration to remove TCE and all other VOCs from groundwater. As of August 2009, 32.75 billion gallons of water have been cleaned and about 4,000 pounds of TCE have been removed. This system provides clean drinking water to approximately 50,000 residents of Tucson (or about 9% of the municipal water supply).

1,4-Dioxane was also discovered in the groundwater at TARP. Work is underway to complete a **remedial investigation** of the 1,4-dioxane plume migrating from Air Force Plant 44 and the Tucson International Airport Property to TARP. The remedial investigation will provide the results of groundwater sampling and water-quality analyses, assess 1,4-dioxane **fate and transport** in groundwater, and determine the risks to human health from potential exposures to the contaminated groundwater at TARP. The remedial investigation is being conducted with the U.S. Air Force taking the lead, with multiple TIAA Site parties providing input in supporting roles.

Through careful monitoring and by blending with other water sources, TARP continues to meet its goal of no more than 3 ppb of 1,4-dioxane in drinking water served to the public. To date the concentrations of 1,4-dioxane in the drinking water are around 1 ppb. The health advisory for 1,4-dioxane

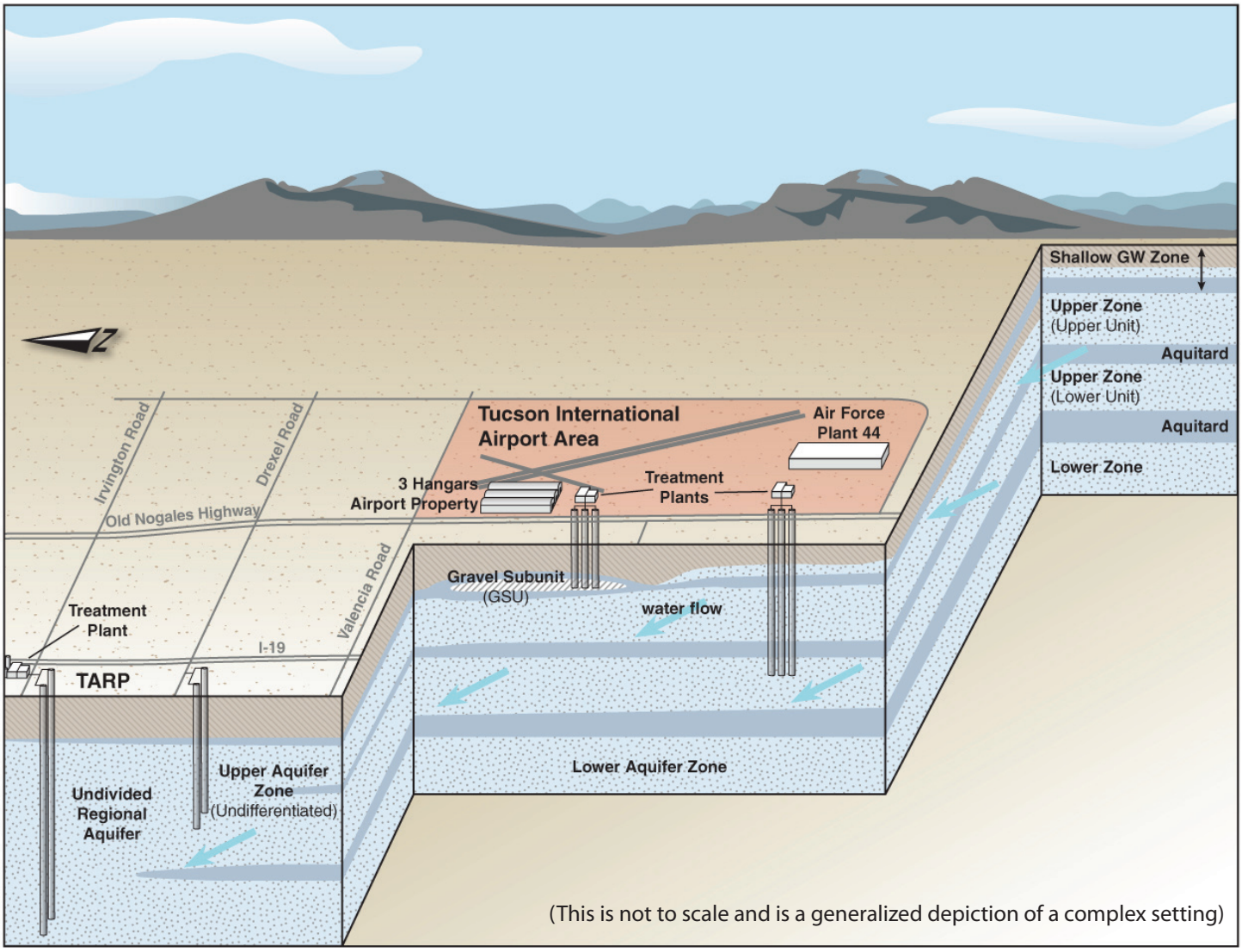

Figure 3: Simplified Representation of the Different Groundwater Zones
Complex geology has made clean up of contaminants in fine-grained layers difficult and time consuming.

is 3 ppb, so the drinking water served from TARP meets EPA safety standards. EPA is currently reviewing the toxicity of 1,4-dioxane and will share the results once they are finalized.

Tucson International Airport

At the Tucson International Airport property (specifically the Airport Three Hangars Area off South Susana St.), chemicals were used for airplane modification and engine part degreasing from 1942 to 1958. During this period, VOCs were used and disposed of on airport property. **Persistent organic chemicals**, such as **polychlorinated biphenyls (PCB's)**, were also used at the site. A Consent Decree for the cleanup of the Airport Property was signed in 2000 with the "Settling Defendants" who included the Tucson Airport Authority, the City of Tucson, General Dynamics Corporation, and McDonnell Douglas Corporation.

In November 2007, the Settling Defendants completed the fifth major treatment system for the Tucson Airport Superfund Site. The $5.5 million soil and groundwater treatment facility is located on the southern end of the Three Hangars site. The facility uses 11 extraction wells to treat approximately 34 million gallons of groundwater a year for TCE. This treatment system brings TCE levels down from over 1600 ppb to approximately 0.5 ppb. A reinjection well pumps up to 100 gallons-per-minute of treated water back into the aquifer. In addition, 7 soil vapor extraction (SVE) wells were installed that pass the extracted air through 3 continuous carbon filters (see Figure 4). As of November 2009, 10,000 pounds of contaminants have been removed by this treatment plant.

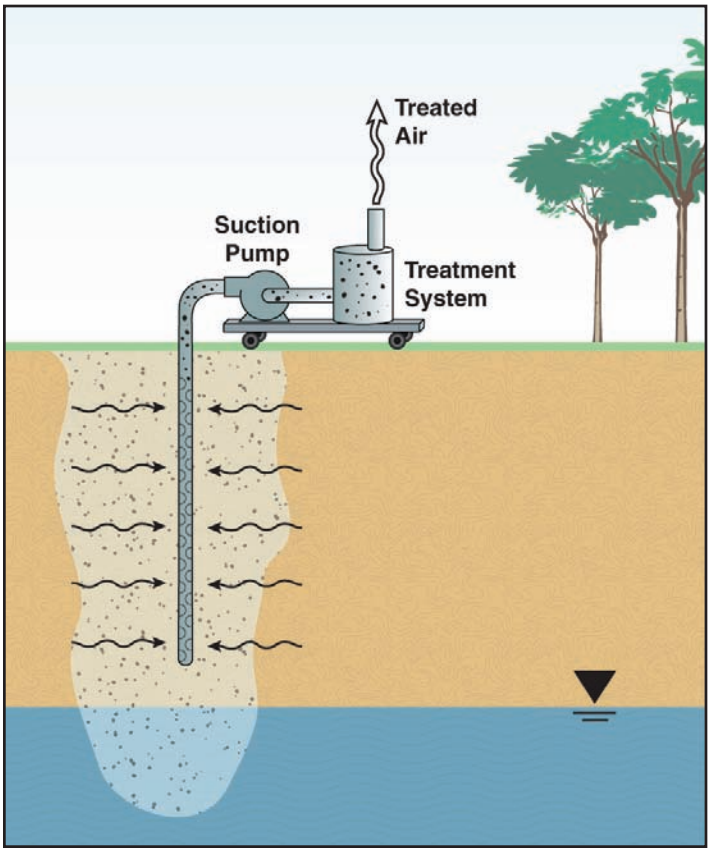

Figure 4: Conceptual diagram of SVE system
The underground pipe is connected to a suction system that moves the contaminated soil vapor out of the ground and into a treatment system.

Workers remove contaminated soil from a drain in one of the hangars.

In addition to the removal of TCE, there is a requirement to remove PCBs from the Airport Property. PCBs are not very mobile in groundwater but do accumulate in soils. Most of the PCB contamination is concentrated in drainages near and within the Three Hangars Area. Contaminated soils in the drains are being removed from the site and taken to another disposal facility as PCBs cannot be treated at the treatment plant. Work being performed on the PCB removal was moving according to schedule until the businesses leasing the hangars for storage vacated the property. When the hangars were emptied, it was discovered that there were more drains in the hangars than previously expected. The newly discovered drains were sampled and relatively high levels of PCBs were detected in some of the drains. A new work plan is being developed to address the PCB contamination found in the newly discovered drains.

The Settling Defendants for the Tucson Airport Property site were also required to close the Tucson Airport Authority solid waste landfill (see Figure 5). In 2009, EPA approved the proposed design for the closure of the landfill. However, the Settling Defendants were encountering difficulty in locating soil in the vicinity of Tucson that meets the Federal and State requirements for the landfill cover. The soil used for a landfill cover must have high clay content so that it is not easily penetrated by water. Currently the Settling Defendants are investigating mixtures of natural soils and additives that will meet the landfill cover requirements.

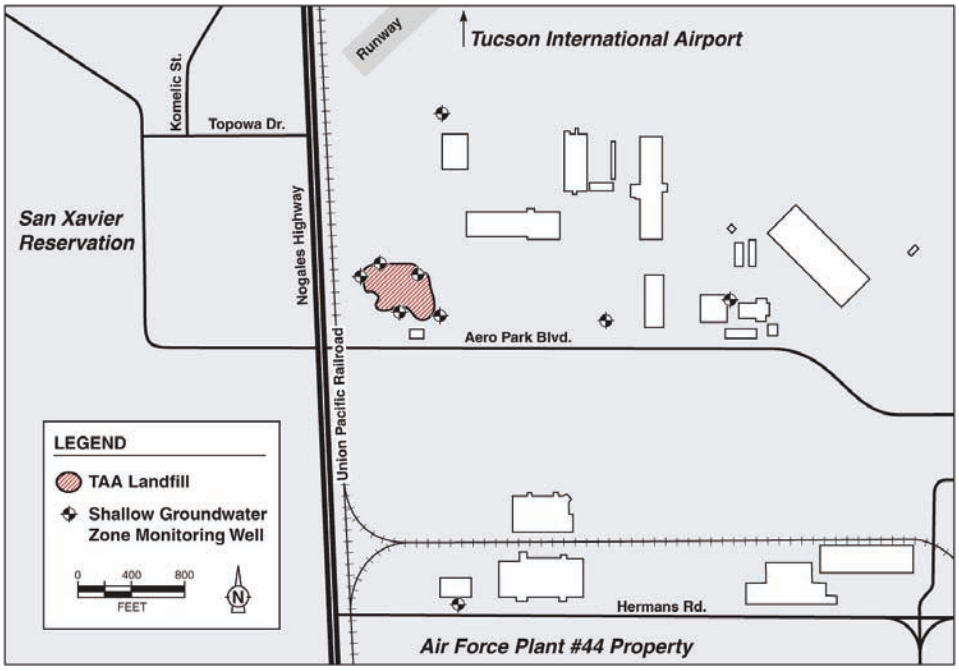

Figure 5: Location of Landfill

West Cap

The West Cap site was a former manufacturer of magnets and film capacitors that operated from the early 1960s until the early 1980s. It is believed that industrial solvents containing VOCs and other contaminants were released through floor drains and leaking drainage pipes. These disposal practices resulted in the current groundwater contamination at the West Cap **Operable Unit**. The size of the contamination plume is approximately 400 feet wide and half a mile long extending under the airport runway with total contaminant concentrations ranging from less than 5 ppb to 530 ppb.

Based on extensive well sampling, EPA has determined that the groundwater in the West Cap site is contaminated in the Upper Zone of the regional aquifer. Land use around the West Cap Operable Unit includes residential, military, aviation, industrial/commercial, undeveloped open space and washes. None of the contaminated groundwater is being served as drinking water.

A treatability study began in March 2009 to evaluate the potential of **in-situ chemical oxidation** using **potassium permanganate** to remediate the TCE and **perchloroethylene** (PCE). Potassium permanganate reacts with the TCE and PCE to form nontoxic byproducts including carbon dioxide, water, and free chloride. Currently, the contamination plume is mixing with the Arizona Air National Guard's groundwater plume and being captured by its treatment facility just northwest of the site. Using in-situ chemical oxidation will shorten the estimated time for the cleanup and will lessen the overall **carbon footprint** created by the remediation process by saving the energy that would have been required to pump the extraction wells, power the treatment plant, and operate the reinjection well. The chemical oxidation process will complete the remediation process in the subsurface with almost no power requirements. Preliminary data collected in September 2009 indicated that the potassium permanganate was delivered to the concentrated source of TCE contamination at West Cap, but more time is needed to allow for the chemical oxidation process to work.

Texas Instruments

The TCE contamination levels at the Texas Instruments site, (formerly known as Burr Brown), range from non-detectible to 15 ppb with the cleanup goal being 5 ppb. From 1992 to 2009, the contaminated water was extracted, treated, and used in the manufacturing process. In September 2009, Texas Instruments closed manufacturing operations in Tucson. With the shutdown of the plant, there was no longer a need for treated water for the manufacturing operations. This closure leaves 4 active treatment plants for the Tucson Airport Superfund site. With EPA approval, Texas Instruments initiated an in-situ chemical oxidation treatability study similar to the one at West Cap in October 2009. It is believed that it will take six months to a year to evaluate the success of the treatability study.

Arizona Air National Guard

Since 1956, the Arizona Air National Guard (AANG) 162nd Fighter Tactical Group has been used to train fighter pilots from the U.S. and from foreign countries. Operations include fueling and aircraft maintenance activities. These activities resulted in the release of hazardous waste contaminating the soil and groundwater. A soil vapor extraction system on the property was shut down in 1997 after performance goals were met. The pump and treat system is still operating with eleven extraction wells pumping 116 gallons per minute.

Since 2006, the AANG has installed eight new monitoring wells that will be used to monitor and assure that all of the contamination is being captured by the existing pump and treat system. In 2009, an in-situ chemical oxidation treatability study was implemented at the site that differed from the ones at West Cap and Texas Instruments. While the in-situ chemical oxidation studies at West Cap and Texas Instruments focus on delivering the potassium permanganate to a concentrated area of contamination, the AANG study attempted a circulation of the chemical to a broad area of groundwater. Due to unexpected changes in geology and groundwater flow, they were unable to circulate the potassium permanganate. However, there has been a drop in TCE levels observed at the site.

What's next?

Future Cleanup Goals

The EPA, ADEQ, and U.S. Air Force will sign a Federal Facilities Agreement in 2010 that will provide the framework for completion of environmental cleanup actions at Air Force Plant 44. Once the agreement is signed, the public will be notified of a 45 day comment period. Copies of the Agreement will be distributed to representatives of several community and neighborhood groups and will also be available at the library repository. It is anticipated that the Agreement will be finalized sometime in late spring and there will be an opportunity to discuss it at future Unified Community Advisory Board (UCAB) meetings (see next page for info on the UCAB).

With both the Tucson International Airport and Air Force Plant 44 treatment plants up and running, EPA's goal for 2010 is to cut off and contain these plumes into separate pockets. This would cut the source of contamination away from the TARP area, where the water is treated for drinking use. EPA will be closely monitoring the groundwater to measure the success of this goal.

School District to Implement EPA Environmental Education Funded Lessons about the Tucson Trichloroethylene Contamination and Cleanup

Marti Lindsey, a dedicated Unified Community Advisory Board (UCAB) member, has been working with an education team to put together a high school curriculum in which students will learn about the TCE contamination underground

Site Contacts

If you have questions or comments regarding the Tucson International Airport Area Superfund Site, please contact

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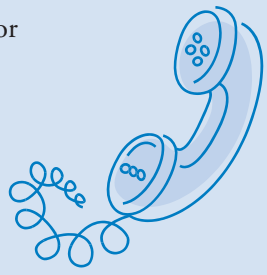

You may also call EPA's toll-free Superfund hotline and leave a message that will be forwarded to the appropriate EPA staff. The hotline number is 1-800-231-3075.

that has affected their neighborhood. The curriculum will focus on the history, health issues, chemistry, cleanup technology, and community/government cooperation relating to this important problem. Based on input from the UCAB, the Community Outreach and Education Core (COEC) (of which Marti is the Director) of the Southwest Environmental Health Sciences Center (SWEHSC) developed the TCE Contamination and Cleanup Curriculum, which was funded by an EPA Environmental Education grant.

It is the hope that these real world lessons will engage students and increase their involvement in their community. Lessons are scheduled to begin this spring, and any high schools and teachers who are interested in participating are encouraged to do so.

Marti Lindsay (far left) and the TCE curriculum team

Government agency and private sector scientists working on the Superfund site cleanup have volunteered to speak to the students about their work, either as a stand-alone or as a supplement to the curriculum. If you are interested in having someone from the Superfund Cleanup Team present to a class, please contact Leana Rosetti (contact information below).

To learn more about the curriculum contact Marti Lindsey, COEC Director, (520) 626-3692, lindsey@pharmacy.arizona.edu. The lessons are disseminated online at **http://coep.pharmacy.arizona.edu/tce**

How can I get involved?

The UCAB is a community group that was created as a result of Superfund activities. Its membership includes residents of South Tucson, health workers at the University of Arizona, high school students and teachers, and others. The UCAB provides input to the EPA and the potentially responsible parties (PRPs) on the progress of the site's cleanup. The UCAB is looking for more members if you are interested in volunteering, and anyone is welcome to simply attend and participate. The board meets every 3 months, the third Wednesday of January, April, July, and October, from 6:00-8:00 p.m., in the Activity Center at the El Pueblo Neighborhood Center on 101 W. Irvington. We are now meeting in a larger room to accommodate increased community interest.

If you are interested in having EPA do a presentation for a group, or have any questions regarding the Tucson Airport Superfund Site, please contact Leana Rosetti (contact information on page 8).

Site Repositories

El Pueblo Library
101 W. Irvington Rd.
Tucson, AZ 85714
(520) 791-4733

Hours: Mon, Tues: 9 a.m. - 6 p.m.
Wed, Thurs: 10 a.m. - 6 p.m.
Friday: 10 a.m. - 5 p.m.

EPA Superfund Records Center
95 Hawthorne St., 4th Floor
San Francisco, CA 94105
(415) 536-2000

Hours: Mon-Fri : 8 a.m. - 5 p.m.

Visit EPA's web page for the Tucson International Airport Area Site: **www.epa.gov/region09/TucsonAirport**

Glossary

1,4-dioxane: An organic chemical used as a stabilizer in solvents and for other purposes including cosmetics, detergents, and shampoos; a probable human carcinogen.

Air Stripping: A treatment system that removes volatile organic compounds (VOCs) from contaminated water by forcing a stream of air through the water, causing the compounds to evaporate.

Aquifer: An underground geologic formation containing groundwater.

Biodegradation: The process of microbes naturally breaking down chemicals into non-toxic byproducts.

Cadmium: A heavy metal that accumulates in the environment.

Capping: Placing an impermeable layer, such as concrete, over waste as a means of containing and minimizing exposure to contaminants.

Carbon Footprint: A way of calculating carbon dioxide emissions from different activities including emissions from the burning of fossil fuels for energy and from the extraction of raw materials to the final manufacturing of a product.

Chromium: A naturally occurring element found in rocks, animals, plants, soil, and in volcanic dust and gases.

Cyanide: Chemical usually used in electroplating, metallurgy, organic chemicals production, photographic developing, manufacture of plastics, fumigation of ships, and some mining processes.

Dichloroethylene (1,1-DCE): A volatile organic chemical used as a cleaning agent in chemical manufacturing.

Dual Phase Extraction: A technology that uses a high-vacuum system to remove both contaminated groundwater and soil vapor. As the water table around the well is lowered from pumping, newly drained soil is exposed. This soil is often highly contaminated, as it holds undissolved chemicals, chemicals that are lighter than water, and vapors that have escaped from the dissolved groundwater below. Contaminants in this exposed soil zone can be removed by vapor extraction. Use of dual-phase extraction can shorten the cleanup time at a site, because the drained soil is often the most contaminated area.

Fate and Transport: Chemical contaminants in the environment can undergo chemical reactions to form new substances ("fate") and can physically move to other locations in the environment ("transport") with the potential for distribution/deposition into other media (e.g., groundwater to soil).

Free chloride: Chloride ion (Cl-) that is a naturally occurring substance in water.

Groundwater: The water found beneath the Earth's surface that supplies wells and springs.

In-situ Chemical Oxidation/Treatment: The introduction of certain chemicals into the ground in order to make groundwater and/or soil contaminants less harmful.

Methyl Ethyl Ketone (MEK): A substance used in many industrial, commercial, and household products.

Operable Unit (OU): A project or project area at an EPA Superfund site.

Oxidation: The chemical addition of oxygen to break down pollutants or organic waste; e.g., destruction of chemicals such as cyanides, phenols, and organic sulfur compounds in sewage by bacterial and chemical means.

Glossary *(continued)*

Parts per Billion: Units commonly used to express contamination ratios, as in establishing the maximum permissible amount of a contaminant in water, land, or air.

Perchloroethylene (PCE): Also known as tetrachloroethylene, is a VOC used primarily as a solvent and for dry cleaning; probable human carcinogen.

Persistent Organic Chemicals: Toxic chemicals that adversely affect human health and the environment around the world and do not break down easily.

Plume: A visible or measurable discharge of a contaminant from a given point of origin, such as in groundwater.

Polychlorinated Biphenyls (PCB's): A group of toxic, persistent chemicals used in electrical transformers and capacitors for insulating purposes, and in gas pipeline systems as lubricant. The sale and new use of these chemicals, also known as PCBs, were banned by law in 1979.

Potassium Permanganate: Chemical used in in-situ chemical oxidation to clean pollutants from the water.

Remedial Investigation (RI): Under the Superfund program, an RI is an action undertaken to characterize, through sampling the environment, the full nature and extent of contamination, including the evaluation of human health and ecological risks posed by the contamination.

Soil Vapor Extraction: Suction system that removes volatile organic compounds (VOCs), such as gasoline, solvents, and other relatively volatile compounds from the soil. The basic system used to accomplish this consists of a vapor extraction well, or a pipe that extends from the surface down to a depth where the soil is contaminated, coupled with blowers or vacuum pumps, which draw air through the contaminated soil up to the surface via the pipe.

Solvent: A liquid or gas substance that is used for industrial, commercial, and household products, such as paint thinners, nail polish, dry cleaning, and detergents.

Superfund site: A contaminated site that has been placed on the National Priorities List, which is EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund law. The list is based primarily on the score a site receives from the Hazard Ranking System. EPA is required to update the NPL at least once a year and a site must be on the NPL to receive money from the Trust Fund for remedial action.

Tetrachloroethylene: See Perchloroethylene

Trichloroethane (TCA): A chemical that does not occur naturally in the environment; no longer produced in the USA because it affects the ozone layer; has many industrial and household uses.

Trichloroethylene (TCE): A VOC used primarily as a solvent to remove grease from metal parts; a probable human carcinogen.

Vadose Zone – Also termed the "unsaturated zone," the subsurface between the land surface and the top of the water table. The pores between sediments in the vadose zone contain both air and water.

Volatile Organic Compounds (VOC): Primarily solvents most commonly used in dry cleaning, machinery degreasing, and metal plating industries. They evaporate easily once exposed to air and tend to be only partially soluble in water.

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