PUBLIC HEALTH ASSESSMENT

Groundwater Contamination in West Plume B North of Valencia Road

Tucson International Airport Area Superfund Site
Tucson, Arizona

CERCLIS #AZ0980737530

Prepared by

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Executive Summary

This public health assessment evaluates the potential public health hazard from exposure to contaminated groundwater in the vicinity of the Tucson International Airport. The Tucson International Airport Area (TIAA) superfund site consists of a main plume of contaminated groundwater and three smaller areas of groundwater contamination east of the main plume. This report focuses on one of these areas of contamination called Plume B and evaluates the public health hazard posed by Plume B to residents of the area of south Tucson bounded by Valencia Road, Campbell Avenue, Irvington Road, and 6th Avenue.

This assessment addresses potential ***current and future*** exposures to contaminated groundwater from private wells in the area of concern. Because insufficient data are available to evaluate potential past exposures, this document does not address past exposure. This document is part of a series of health consultations and health assessments evaluating all aspects of the TIAA site. Other areas of contamination and community concern have been or will be addressed by other documents.

For this evaluation, Arizona Department of Health Services, Office of Environmental Health (ADHS), considered 24 private wells which had been identified in the study area. Five of the wells were either non-operational or were not sampled by request of the owners, leaving a total of 19 private wells. Of the 19 private wells evaluated in this report, 12 were private drinking water wells and 7 were irrigation wells.

ADHS found that none of the drinking water wells exceeded appropriate comparison values while three of the irrigation wells were found to exceed USEPA's Maximum Contaminant Levels for Trichloroethylene (TCE). ADHS considered the specific use of these three wells for irrigation water and found that the TCE levels present were not of public health concern for irrigation purposes (because only incidental ingestion and contact was likely for adults or children who may come into contact with the water on a limited basis).

Therefore, ADHS found that the groundwater *currently poses no public health hazard.* However, ADHS noted that there is nothing currently in place to preclude residents from turning an irrigation well into a drinking water well or installing new drinking water wells in the area of the plume. ADHS also notes that the plume is still being characterized and that chemical concentrations in some existing wells may increase beyond current levels. Because of these possibilities, ADHS has concluded that a *future potential public health hazard may exist.*

1.0 Background

The United States Environmental Protection Agency (USEPA) asked the Arizona Department of Health Services (ADHS), Office of Environmental Health, to determine whether contaminated groundwater north of the Tucson International Airport Area (TIAA) has the potential to adversely affect human health in exposed persons. The USEPA asked that recent data contained in a 1998 private well study, conducted by the Pima County Department of Environmental Quality (PCDEQ), and the 1998 monitoring well data, obtained by the Arizona Department of Environmental Quality (ADEQ), be used to determine if adverse health effects would result from the use of private wells that have been identified near Plume B north of Valencia Blvd. The objective of this public health assessment is to evaluate if a public health hazard exists to residents who use the currently identified private wells over or near Plume B.

1.1 Site Description and History

In 1981, contaminants were detected in several City of Tucson drinking water wells near the Tucson International Airport. Subsequently, the Tucson International Airport Area (TIAA) Superfund Site was officially added to the National Priorities List (NPL) in 1983. Figure 1 in the Appendix shows location of the TIAA.

The TIAA site consists of one main contaminated groundwater plume with three smaller areas of groundwater contamination located directly eastward. The three smaller areas of groundwater contamination will be referred to in this report by their approximate locations: one plume located at the Air National Guard facility, a plume associated with the Burr-Brown and West-Cap facilities, and Plume B, which is located just north of the Air National Guard facility and Valencia Road (ADEQ 1998). The groundwater in Plume B has been contaminated with the industrial solvent trichloroethylene (TCE) and chromium (ADEQ 1998). The source of the plume has not yet been determined. Possible sources have included the Air National Guard, the former West-Cap facility, and General Electric. Figure 2 in the Appendix shows the location of the larger and smaller contaminated groundwater plumes at the TIAA.

1.2 Site Visit

ADHS conducted site visits on November 18 and 19, 1998, and on January 20, 1999. Activities included visiting the West-Cap site, the Air National Guard, and the surrounding residential area near Plume B. The following observations were made:

- The residential area of concern begins approximately one-half mile north of the Air National Guard, and north of Valencia Blvd. There are several trailer parks, houses, one elementary school, and a few businesses located in this area. The elementary school is located on Drexel and is on the public water system.

- The area directly west of the residential area where Plume B is located is undeveloped

and has little vegetation.

In addition to site visits, ADHS also obtained information about the area from the PCDEQ, ADEQ, USEPA, and from residents who attended a community meeting on Wednesday, November 18, 1998. Additional groundwater data were obtained from the TCE library located at the El Pueblo Clinic in South Tucson. The TCE library collects data and information that are provided by various governmental and community sources relating to the larger TIAA Superfund Site. This information is available to the public at the TCE Library located at 101 W. Irvington, Tucson, Arizona.

1.3 Demographics, Land Use, Natural Resources

Demographics

The area of groundwater contamination is within the TIAA Superfund Site, just north of Valencia Road. A residential area, which includes several trailer parks, small houses, an elementary school, and businesses, is located directly over the contaminated groundwater plume. The USEPA is continuing to install monitoring wells in the area to better define the plume boundaries. For purposes of this health assessment, boundaries have been chosen that will include the residential area located directly over the plume and an area extending beyond the current plume boundaries. The boundaries of the area considered for this report include Valencia Road to the south, Campbell Ave. to the east, Irvington Road on the north, and 6th Avenue to the west. Figure 1 shows these boundaries in relation to the TIAA site area.

Land Use and Natural Resources

Most of the residential community obtains their drinking and irrigation water from the City of Tucson municipal water system. However, there are some residences in the study area which still use private wells for drinking and/or irrigation purposes.

Geology

The upper 200 feet of sedimentary material within the area show a general coarsening trend from east to west. East of the Nogales Highway where the West Cap site is located, predominately fine-grained material is interbedded with layers and lenses of sand and gravel in a complex manner (ADEQ/USEPA 1998).

General Hydrogeology

The regional aquifer system at the TIAA site is hydogeologically complex due to lateral and vertical lithologic changes. Three units of the regional aquifer system (the upper zone, lower zone, and undivided regional aquifer) are present within the boundaries of the TIAA Site. The middle aquitard divides the regional aquifer into upper and lower zones under most of the TIAA Site.

Transport and fate of groundwater contamination has been associated mainly with the upper zone regional aquifer because the vertical extent of contamination has been limited by the presence of

the middle aquitard. In this area, the upper zone regional aquifer is about 70 - 100 feet thick, extending from the water table, which occurs at depths of about 85 - 100 feet bgs, to the top of the middle aquitard at a depth of about 175 feet bgs. As a consequence of the heterogeneous, layered geology, including lateral sedimentary facies changes, and local and regional groundwater pumpage, the depth to groundwater, nature of the aquifer system (unconfined versus confined), and direction of groundwater flow vary within the area depending on location and depth, making it difficult to characterize this groundwater plume (ADEQ 1998).

1.4 Health Outcome Data

Several health studies have been conducted over the past 15 years to determine the health effects to residents in the TIAA area from exposures to trichloroethylene (TCE) in drinking water Although these studies focus on exposures to TCE in drinking water primarily from the larger Main Plume, they are also applicable to Plume B since it also is contaminated with TCE and chromium similar to the Main Plume (ADHS 1996; ATSDR 1994). These studies are as follows:

1. Mortality Rates on Tucson's Southside. Caldwell G. ADHS. 1986.
The objective of the study was to determine if an increase in mortality rates existed in certain census tracts in Tucson, Arizona. A 12-year review of all deaths in certain census tracts suspected to have unusual levels of serious illness (as reported by the press) was carried out in Tucson, Arizona. The number of deaths in census tracts 37, 38, and 39 (contaminated water area) were compiled by cause of death, sex, and age from computerized vital statistics death records.

Statistically significant excess crude mortality rates were found for the following diseases when compared to annual state or county rates: influenza/pneumonia in 1977; diseases of early infancy in 1973, 1975, 1976, 1980 and 1981; accidents in 1976; and homicide in 1978. Overall crude rates were not significantly different. No significant excess deaths were seen when compared to census tracts 24 and 25. With age-adjusted data, only 13 out of 84 comparisons were statistically significant. Of these, none were considered directly related to the trichloroethylene contamination. When compared to census tracts 24 and 25, no statistically significant mortality was apparent in census tracts 37, 38, and 39. No specific tests have been done to compare census tracts. *(The report concludes that no pattern of mortality consistent with a marked increase in death is apparent and attributes the few excesses seen to behavior or chance rather than an environmental exposure).*

2. An Association of Human Congenital Cardiac Malformations and Drinking Water Contamination Goldberg SJ, Lebowitz MD, Graver EJ, Hicks S. Journal of the American College of Cardiology. 1990; 16;1:155-164.

The authors state that the investigation was designed to test the hypothesis that the

proportion of offspring with congenital heart disease (CHD) is greater for parents who had contact with the contaminated water in the TIAA area before and through the first trimester of pregnancy than for parents who never had contact with the contaminated water area. The hypothesis is stated as if the study is a cohort study.

This is a registry-based case-control study investigating exposure to contaminated water among parents of children with certain types of CHD in Tucson, Arizona. The main contaminant was trichloroethylene, but dichloroethylene, chromium, and trace levels of other solvents were also present in the water supply. Seven hundred and seven families with children diagnosed with CHD were interviewed and compared to three different control groups. The authors conclude that the data show a significant association but no causality between parental exposure to the contaminated water and an increased proportion of CHD.

3. Maricopa and Pima County Birth Defects Study. ADHS. 1987.

The objectives of this study were to determine if : 1) the observed differences in the birth defect rates between Pima County (Tucson) and Maricopa County (Phoenix) were real; 2) to compare the 2 county rates to the national and state rates; and 3) to determine if there were any unusual geographic distributions in either county.

A 5-year study of birth defects was conducted in Maricopa and Pima counties of Arizona. No consistent statistically significant differences in occurrence of birth defects was found between the two counties. The trend analysis, however, did show significant differences in the patterns of occurrence from defect to defect and between counties, but no evidence of a consistent county differential.

Of the 21 birth defect groups, none was found to be statistically significantly elevated, when compared either internally or externally to the Metropolitan Atlanta Birth Defects Registry. Only 11 of 282 census tracts were found to have a statistically significant excess in one or more defect groups, when 14 might have been expected by chance alone. Only one of these tracts was in Pima County. These data indicate that previously reported data may have resulted from reporting differences on birth certificates rather than real differences in the frequency of defects. Further surveillance and study are warranted for those tracts and birth defect groups where excesses were observed.

4. A Comparison of Homebound Program Admission Rates in the Tucson Unified and Sunnyside School Districts. K. Komatsu, ADHS. 1986.

The purpose of the study was to examine the number and type of Homebound program admissions in the Sunnyside (close to the TCE-contaminated area) and Tucson Unified (unexposed) school districts to determine if there were significant differences which might be suggestive of a public health problem.

Results showed that: 1) Sunnyside Homebound admission rates were significantly higher for several diagnostic categories and specific diagnoses including overall number of cases, trauma, pregnancy, and infectious diseases. Rates for cancer, mononucleosis, Valley fever, and seizures did not differ significantly; 2) Among specific cancer diagnoses, there were no clusters, unexpected types, or unusual patterns of distribution in either district.

5. Historical Prospective Mortality Study of Hughes Aircraft Employees at Air Force Plant #44. ENSR. 1990.

This report describes a cohort mortality study of 20,535 Hughes Aircraft employees. The observed mortality of the cohort, by cause, was compared with the expected based on U.S. mortality rates. For the entire cohort, mortality from all causes was 71.5% of that expected, a deficit that was statistically significant. In addition, a significantly lower mortality was found for all cancer combined, cancers of buccal cavity, pharynx, digestive system, larynx, female genital organs, circulatory system and several other nonmalignant disease. Though a significant increase in asthma mortality was observed when compared with U. S. mortality rates, there was no increase when compared with Pima County, Arizona rates.

6. The Incidence of Childhood Leukemia and Testicular Cancer in Pima County, 1970-1986. ADHS. 1990*.*

This incidence study was conducted in *1990* to investigate the findings of the *1986* mortality study. It was designed to compare the incidence rates of childhood leukemia in the *0-19* age group and testicular cancer in males of all ages in the TIAA to the rest of Pima County during the years from *1970* through *1986.* The incidence rates for childhood leukemia, testicular cancer, brain/CNS cancer and lymphoma, and other childhood cancers in the TIAA were not statistically elevated in comparison to the remainder of Pima County during the years from *1970* to 1986. The incidence rates were comparable to rates in other states and cities participating in the National Cancer Institute Surveillance Epidemiology End Results (SEER) Program.

7. Effects on Neurobehavioral Performance of Chronic Exposure to Chemically Contaminated Well Water. Kilburn KH, Warshaw RH, University of Southern California, Los Angeles, CA. 1994.

This study was designed to determine whether there were adverse health effects, specifically neurobehavioral impairment, from living within an area served by wells known to have been contaminated with TCE and other chemicals for 25 years.

This is a study comparing neurophysiological (NPH) and neuropsychological (NPS) tests of 170 TCE- exposed residents of Tucson with two groups of subjects who had been

studied for similar investigations. The NPH battery consisted of body balance, eye closure and blink reflex, simple and choice reaction time, and finger pad number recognition. The NPS battery consisted of immediate recall of stories, visual spatial memory, intelligence, attention span, psychomotor speed, dexterity, and affective status. Exposed subjects were significantly impaired compared to referents for both NPH and NPS tests.

8. Prevalence of Symptoms of Systemic Lupus Erythematosus (SLE) and of Fluorescent Antinuclear Antibodies Associated with Chronic Exposure to Trichloroethylene and other Chemicals in Well Water: Kilburn KH, Warshaw RH. Environmental Research. 1992; 57:1-9.

This study was designed to determine whether there was an increased prevalence of systemic lupus erythematosus (SLE) in the Tucson residents group who had been exposed to TCE. Results showed that the frequencies of each of 10 Antinuclear Antibodies (ANA) symptoms were higher in "exposed" subjects than in any comparison group, except those with clinical SLE. The prevalence of subjects with four or more symptoms was double in "exposed" group women and men compared to referent women and men.

2.0 Community Health Concerns

The overall mission of ADHS and the ATSDR is to address the public health concerns of the residents who live near hazardous waste sites, such as the TIAA. Identifying and addressing public health concerns of the community near a Superfund site is crucial if the public health assessment is to satisfy its purpose of helping the public and health professionals understand the health risks posed by a site. This section describes the various concerns voiced by the community residents who live near the TIAA site.

Groundwater contamination in southwest Tucson has been a concern of the residents living near the TIAA site for many years. The community is made of residents who understand the history of the site, the exposure scenarios, and what is happening with the remediation activities as well as those who believe that the drinking water is still contaminated. Many residents do not trust Tucson City Water, or any governmental official. Much of the fear that residents have at this site is fueled from on-going problems created by the largest plume of contamination in the area and perceived lies told to community residents by various state, county, and city organizations and governmental personnel. Therefore, any news of a new plume tends to fuel the mistrust of Tucson Water and government officials.

PCDEQ conducted a private well study in 1994 and 1998 to identify the private wells in the TIAA area. During these investigations, PCDEQ employees informed all private well owners in the TIAA including the Plume B area of the groundwater contamination. They encouraged residents who had private wells to hook up to Tucson Water. While some residents have switched over to City water, a few believe that drinking water out of a contaminated private well

is safer than drinking the "contaminated Tucson Water" and will not hook up to city water.

According to PCDEQ, there is currently a mild level of concern among the residents living near the Plume B area. However, in the past, residents in southwest Tucson have expressed concerns to ATSDR about the prevalence of congenital heart disease, lupus, and, cancer in their community that they associate with exposure to the contaminated groundwater. Several studies have been conducted to address these concerns, as described previously in Section 1.4, "Health Outcome Data."

3.0 Environmental Contamination and Other Hazards

This section presents the environmental data on private wells in the Plume B area. Section 5.0 "Public Health Implications" presents a discussion of these data and their relevance to public health. For reference purposes and to provide the reader with a convenient frame of reference, the data are presented here alongside the USEPA's maximum contaminant levels (MCLs), which are legal standards for public drinking water supplies. The differences between MCLs and other health guidelines is presented in the Comparison Values section of the Appendix.

3.1 Contamination of Private Wells

The most recent monitoring well data suggest that a groundwater plume that has been contaminated with TCE and chromium has migrated in a northwest direction from Valencia Road near the AANG to Drexel Road. The total size of the contaminated groundwater plume is approximately 2 miles long and one-half mile wide. Since Plume B is migrating in a northwesterly direction, it has the potential to affect private drinking water wells and irrigation wells in nearby residential areas. Figure 3 in the Appendix shows the approximate extent of Plume B.

In 1994, a private well inventory was conducted by the PCDEQ to determine the extent of contamination in private wells throughout the larger TIAA Superfund Site and surrounding residential areas that might have been affected by the larger groundwater plume. This study included a portion of the residential area near Plume B with the exception of the far most western and northwestern portions. In 1998, a second follow-up private well study was conducted by PCDEQ which extended beyond the 1994 study boundaries to include the area north and northwest of the Plume B area (PCDEQ 1998).

ADHS selected the private wells that are ***currently being used*** in the area east of 6th Avenue and north of Valencia Road to be evaluated. In total, 24 private wells were identified in the area east of 6th Avenue. Five of these wells, three of which are located near the corner of 6th Avenue and Valencia, have either been shut down or were not sampled at the request of the owners, leaving a total of 19 private wells to be evaluated in this health assessment.

Samples were analyzed at the USEPA Regional Laboratory in Richmond, California, using USEPA Method 524.2 for VOCs, and USEPA Method 200.7 for Total Chromium. Turner Laboratories, located in Tucson, Arizona, was used to analyze the Hexavalent Chromium samples using Method SM 17-3500 CR (PCDEQ 1994, 1998).

In 1994, the highest concentrations of chromium and TCE were found in one well at 160.0 µg/L and 120 µg/L, respectively. This well has been shut down. In the 1998 study, the levels of chromium and TCE ranged from non-detect to 9.9 µg/L and 50 µg/L, respectively, for the private wells currently in operation in the Plume B area. Figure 4 in the Appendix shows the location of the private wells in the ADHS study area. Table 1, below, lists the private wells in the study area that are currently used for drinking, bathing, and cooking purposes, and the highest TCE and chromium contaminant levels that have been detected from either the 1994 or 1998 private well studies.

Table 1: Maximum Contaminant Concentrations in the 12 Private Drinking Wells and Comparison to Corresponding MCLs*.

Well ID #	Present Status	TCE† MCL=5 µg/L‡	Chromium MCL=100 µg/L	Above MCL?
25	Cemetery	N.D.§	N.D.	NO
28	Private residence	N.D.	N.D.	NO
29	Private residence	N.D.	N.D.	NO
3	Private residence	N.D.	2.2	NO
12	Mobile Home Park	N.D.	6.3 **	NO
9	Private residence	N.D.	3.0 **	NO
18	Private residence	N.D.	5.6 **	NO
21	Private residence	N.D.	5.8 **	NO
17	Private residence	N.D.	1.2 **	NO
7	Private residence	4 **	N.D.	NO
13	Mobile Home Park	3.6	5	NO
15	Private residence	3 **	6.3 **	NO

* MCLs = maximum contaminant levels; † TCE = trichloroethylene; ‡ µg/L = micrograms per liter; § N.D. = non-detect;
** Indicates an increase in contaminant level from 1994 samples to 1998 samples.

Table 2 lists the private wells that are used for irrigation purposes. The highest detected level is listed whether it was from the 1994 or 1998 private well studies.

Table 2: Maximum Contaminant Concentrations of the 7 Private Irrigation Wells and Comparison to Corresponding MCLs*.

Well ID	Location	TCE† MCL=5 µg/L ‡	Above MCL	Chromium MCL=100 µg/L	Above MCL
26	Cemetery	ND§	NO	17.5	NO
24	Private residence	ND	NO	ND	NO
27	Elementary school	ND	NO	ND	NO
10	Private residence	ND	NO	2.8 **	NO
14	**Private residence**	**50.0 ****	**YES**	9.9 **	NO
2	**Private residence**	**16.0 ****	**YES**	ND	NO
23	Private residence	**7.0**	**YES**	4.8	NO

* MCLs=maximum contaminant levels; † TCE=trichloroethylene; ‡ µg/L= micrograms per liter; § ND = non-detect;

** Indicates an increase in contaminant level from 1994 to 1998.

As seen from Table 2, there are three private irrigation wells that had TCE levels above the MCL. Additionally, chromium and TCE concentrations both increased in one well, chromium increased in another well, and the TCE level increased in a third well from the 1994 sampling to the 1998 sampling. These changes indicate, as previously mentioned, that characterization of the plume is ongoing. Table 3, below, provides a summary of all the private wells in the ADHS Plume B study area.

Table 3: Summary of the Maximum Contaminant Concentrations and Comparison to Corresponding MCLs*.

Chemical	Concentration Range (µg/L†)	Comparison Value		Exceed MCL	# Wells Above MCL
		µg/L	Source		
TCE‡	ND§ - 50.0	5.0	MCL	YES	3
Chromium	ND - 9.9	100	MCL	NO	0

* MCLs= maximum contaminant levels; † µg/L = micrograms per liter ‡ TCE = trichloroethylene; § ND = non-detect

TCE was detected in excess of the MCL in three irrigation wells. Concentrations of chromium in the irrigation wells were below the MCL of 100 µg/L (PCDEQ 1994, 1998).

3.1.1 Monitoring Well Data

In addition to the available data from private wells, ADHS located data collected from a number of monitoring wells installed by USEPA while characterizing the extent of Plume B. Thirteen monitoring wells have been installed and sampled between 1997 and 1999. Monitoring well sample results available to ADHS indicate a scenario quite similar to that displayed by the private well data. As discussed previously, sampling data results from the 19 private wells show most wells have TCE concentrations below the MCL of 5.0 µg/L and three of the 19 wells exceed the MCL. The three wells that exceeded the 5.0 µg/L MCL had maximum TCE concentrations of 7, 16, and 50 µg/L. The results of TCE analyses on the 13 monitoring wells installed by USEPA show that five of the 13 wells had maximum TCE levels that exceeded the MCL (ERMWest 2000). The maximum TCE levels in these five wells ranged from 8 µg/L to 30 µg/L, very similar to the levels observed in the private wells.

ADHS has not yet thoroughly evaluated the data from these monitoring wells, however it seems appropriate for the purposes of this document to confirm the consistency with the private well data reviewed in this report. ADHS notes that the 13 monitoring wells are open to the aquifer at depths ranging from about 70 to 125 feet below the ground surface. Although ADHS does not have detailed information about the construction of the private wells, ADHS believes it is likely that those wells would be less than 200 feet deep and would most likely be open to the aquifer at depths ranging from about 70 feet below ground surface (roughly the depth to water in the aquifer) to the total depth of each well. In summary, the 13 monitoring wells appear to be encountering very similar portions of the aquifer as the 19 private wells, with the 13 monitoring wells providing more specific information on discrete screen-opening zones and lengths. The chemical results of TCE concentrations also support this conclusion, with the results from the 13 monitoring wells being very similar to the data from the 19 private wells. Together, this data indicates an aquifer contaminated over a sizable area with TCE, but with only a limited number of wells which contain more than 5 µg/L of TCE.

3.2 Physical and Other Hazards

No physical hazards that would be considered unusual were identified during the site visits. Children's toys were seen in the streets throughout the trailer park areas. Old cars were also seen around the neighborhoods.

4.0 Pathway Analyses

In order to determine if residents are being exposed to TCE or chromium at levels of public health concern in drinking or irrigation wells near the TIAA site, exposure pathways are identified to determine if and how residents might be exposed to the contaminants. This health assessment reviews the current and future potential pathways from the private wells in the Plume B area. The lack of past environmental sampling data precludes evaluation of potential past exposures.

4.1 Completed Current Exposure Pathways

The currently completed exposure pathway identified is residential exposure to contaminated groundwater by use of private wells for irrigation purposes. This includes inhalation, limited ingestion, and dermal exposures from irrigation wells.

Groundwater Pathway

Current exposure pathways may result from people using the water from their wells either for irrigation or drinking purposes or both. Typical residential well exposures to TCE include dermal and inhalation exposures from bathing and showering, and ingestion exposures from drinking and using water for cooking. Since the wells of concern are irrigation wells, only limited dermal, inhalation, and ingestion exposures could occur to anyone who comes in contact with the contaminated water. This would include exposures to adults while they are watering the lawn or gardens, children playing in yards that are irrigated with contaminated private well water, or anyone who eats garden vegetables that are irrigated with contaminated water and which accumulate the contaminants.

Table 4 identifies the estimated population that currently is being exposed to chromium or TCE through the use of contaminated private irrigation wells.

Table 4: Summary of Complete Current Exposure Pathways

Type of Private Well	EXPOSURE PATHWAY ELEMENTS					Time
	Media	Point of Exposure	Route of Exposure	Exposed Pop.*	COC†	
Irrigation Well	Groundwater	yards, gardens	Ingestion Dermal Inhalation	9 Residents	TCE	Current

* Pop. = population. This assumes 3 persons per residence. † COC = chemical of concern; ‡ TCE = trichloroethylene.

4.2 Potential Future Exposure Pathways

ADEQ is still in the process of characterizing the boundaries of the plume due to the difficult hydrology of the area. Since the plume is slowly migrating northward, and has not been completely delineated, it is possible that uncontaminated wells could become contaminated in the future. In addition, exposure could occur in the future if abandoned wells are repaired and used for drinking or irrigation purposes, if a citizen decides to drill a private well in the area, or if an irrigation well is changed into a drinking water well. Because there are currently no ordinances in place in the site area to prevent this, these are all possibilities for potential future exposure pathways to occur.

ADEQ and PCDEQ are currently investigating the area to identify additional private wells that have been abandoned or were not previously identified in the 1998 Private Well study. There are 3 private drinking water wells and 2 irrigation wells that currently have no detection of chromium or TCE. Since these wells are close to other private wells that have detection of

chromium or TCE, they are considered in this health assessment to have a slight potential of being contaminated in the future. These include drinking water wells at a cemetery and 2 private residences, and irrigation wells at a private residence and an elementary school. The elementary school well is located directly east of the known Plume B boundaries.

Some of the wells that are furthest away from the known boundaries of Plume B have low detections of chromium. Because other plumes exist in the area, this contamination may not be directly related to Plume B. However, since traces of chromium and/or TCE have been detected in these wells, the wells are considered to be at risk for further contamination. Table 5 below provides a description of the potential future exposure pathways that have been identified for the ADHS Plume B study area and the estimated population that could be affected. It includes only those wells with current detections of TCE and/or chromium. Because chromium has generally been detected at levels well below the MCL, potential increases in levels of TCE are considered to pose the greatest potential future risk. The wells that have no detection of TCE and/or chromium should be re-evaluated as work continues at the site to determine if the wells remain outside the plume.

Table 5: Summary of Future Potential Exposure Pathways.

Type of Private Well	EXPOSURE PATHWAY ELEMENTS					Time
	Media	Point of Exposure	Route of Exposure	Exposed Pop.*	COC†	
Drinking Water Wells	Groundwater	Residences: tap	Ingestion Dermal Inhalation	130 residents	TCE ‡	Future
Irrigation Wells	Groundwater	Residences: yards, gardens	Ingestion Dermal Inhalation	9 residents	TCE	Future

* Pop. = population. This assumes 3 persons per residence and 50 persons for each mobile home park; † COC = chemical of concern; ‡ TCE = trichloroethylene.

There are approximately 145 residents whose private wells have levels of TCE and/or chromium below the corresponding MCL. If the contamination increases in these wells to above the respective MCLs, these people are at risk of being exposed to elevated levels of TCE and/or chromium.

5.0 Public Health Implications

5.1 Toxicological Evaluation

This section reviews the potential for adverse health effects in persons exposed to specific contaminants through current or future exposure pathways. ADHS has analyzed the exposure scenarios to determine what, if any, public health hazard exists from exposure to contaminated groundwater in Plume B through the use of private wells. The analysis determined that some residents are currently being exposed to TCE and chromium through ingestion, inhalation, and dermal exposures from the use of contaminated private wells for irrigation purposes. Concentrations of chromium were found in both irrigation and drinking wells but were not above the chromium MCL. Three private irrigation wells had concentrations of TCE (at 50 µg/L, 16 µg/L, and 7 µg/L) which are above the MCL of 5 µg/L. The highest concentration of TCE (50 ug/l) was detected in a private well (rather than one of the 13 monitoring wells in the Plume B area), so ADHS focused our evaluation on these private wells. Therefore, TCE is considered the only chemical of concern (COC) in the ADHS study area.

5.1.1 Methods

ADHS assesses a site by evaluating the level of exposure in potential or completed pathways. An exposure pathway is the way chemicals may enter a person's body to cause a health effect. The evaluation includes use of comparison values, which are screening tools used with environmental data relevant to the exposure pathways. Comparison values are concentrations of chemicals that can reasonably and conservatively be regarded as harmless to public health based on the available scientific data. These comparison values are used for screening contaminants at a site to select which substances warrant more detailed evaluation by health assessors. The development of a comparison value includes conservative exposure assumptions which typically result in values much lower than those concentrations which have been observed to cause adverse health effects. If public exposure concentrations related to a site are below the appropriate comparison value, then the exposures are not of public health concern and no further analysis of the pathway is conducted. However, while concentrations below the comparison value are not expected to lead to any observable adverse health effect, it should not be inferred that a concentration greater than the comparison value will necessarily lead to adverse health effects. Depending on site- specific environmental exposure factors (for example, duration and amount of exposure) and individual human factors (such as: personal habits, occupation, overall health), exposure to levels above the comparison value may or may not lead to a health effect. Therefore, ADHS' comparison values should not be used to predict the occurrence of adverse health effects. Further information on comparison values and a description of some of the scientific terms and related health risk terminology (such as EPA's MCLs) is located in the Appendix section titled "Comparison Values."

ADHS acknowledges uncertainty exists in characterizing health effects from chemicals through various exposure pathways. Much of the toxicological information is based on dose-response relationships observed, primarily, in experimental animals, and typically extrapolated from high chemical doses in small animal populations to estimate low-dose responses. There often are also differences between animals and humans in metabolic response to a chemical, and chemical toxicity values are usually developed singly and responses may differ when complex mixtures are present. ADHS has considered these variables in the development and application of comparison

values.

For the West Plume B area of the Tucson International Airport Area Superfund site, ADHS has used Human Health Based Guidance Levels (HBGLs) as the appropriate comparison values with which to evaluate the available environmental data on potential exposures to TCE.

5.1.2 Comparison to HBGLs

To further evaluate the human exposures that could occur from someone using a contaminated irrigation well, the ADHS developed and used a model that analyzes a chronic daily intake from multiple exposure pathways when using contaminated water for irrigation purposes. The ADHS calculated Human Health-based Guidance Levels (HBGLs) as comparison values that would incorporate all the various exposure pathways to the contaminated water via incidental ingestion and dermal contact, and inhalation pathways under irrigation scenarios.

HBGLs are used to help evaluate the health hazard from the cumulative inhalation, ingestion, and dermal contact with contaminants in groundwater. They are calculated using a human health-based approach that is generally consistent with risk assessment methodologies recommended by ATSDR, USEPA, and the ADHS. They use standard assumptions regarding daily intake of drinking water, air breathed, etc. when possible. Where standard assumptions were not available, the ADHS has made conservative assumptions based upon research of the particular exposure scenario and professional judgement. Equations used to quantify exposures were based upon generally accepted methods, models, toxicity values, and assumptions developed by the USEPA. The equations and assumptions used to calculate HBGLs are conservative and well documented (ADHS 1997a). The HBGL calculations for TCE in irrigation water, along with the standard assumptions used, are presented in the Appendix (Tables A1- A19).

A residential exposure scenario for flood irrigation was calculated which consists of residents who periodically irrigate their lawn with contaminated irrigation water or come in contact with water that is used to maintain neighborhood parks. This exposure scenario conservatively assumes that adults and children are exposed to the contaminated irrigation water via inhalation, ingestion, and dermal contact during periodic maintenance or play activities.

A child exposure scenario was also calculated for a child who is assumed to play in the irrigation water for 4 hours per day, 350 days per year (COP 1998), for six years. Finally, an occupational exposure scenario was calculated for an adult maintenance worker exposed via inhalation of contaminants escaping from the flood irrigation waters for the 4 hours that the water is assumed to be standing in the property. The adult maintenance worker involved in flood irrigation duties is assumed to have incidental ingestion, inhalation and dermal contact with the flood irrigation water for eight hours per day, 250 days per year, for 25 years (ADHS 1997b).

The adult and child HBGL for residential use is 397µg/L and 87µg/L, respectively. The occupational HBGL is 100 µg/L. As seen in Table 7, estimated exposure doses from ingestion of contaminated private well water are below the respective HBGL.

Table 7: Comparison of TCE* Concentrations to the HBGLs†.

Chemical Found in Private Well	Exposure Pathway	Usage of Private Well	Comparison of Exposure Intake to HBGL		
			Values	HBGL	Exceeds HBGL?
TCE	3 Private Wells	Irrigation	7 µg/L‡ 16 µg/L 50 µg/L	Adult: 397 µg/L Child: 87 µg/L Occupational:100 µg/L	NO NO NO

* TCE = trichloroethylene; † HBGLs = Health-based Guidance Levels. Assume that adults and children are exposed to the contaminated irrigation water 350 days per year; ‡ µg/L = micrograms per liter.

Table 7 shows that all three wells of concern had TCE levels below both the respective residential and occupational HBGLs. Therefore, the level of TCE in the irrigation wells does not represent a current public health hazard. However, owners of the wells have been notified that their wells have levels of TCE above the MCL, and have been given the option to change over to Tucson Water.

Edible Plants

After conducting an extensive literature search, ADHS has concluded that there are insufficient data to identify the possible health hazard related to the ingestion of edible plants grown with the use of contaminated groundwater. While much of the present research has focused on the uptake of pesticides into plants, the research on the uptake of industrial pollutants by plants and food crops is rudimentary. Available data suggest that the uptake of organic contaminants by plants is dependent on the various properties of the compound, the plant, and its environment. Until these variables can be determined and identified, any health hazard to humans due to the consumption of food grown with TCE contaminated groundwater cannot be determined.

Summary of Toxicological Data

A brief summary of toxicological information on TCE and chromium is provided in the Appendix for reference. Each chemical is summarized with regard to use, interactions with other chemicals, exposure routes, toxicokinetics, toxic (health) effects, carcinogenicity, and regulatory status. Much of this information is available in greater detail in the *Toxicological Profiles* published by ATSDR. A copy of ATSDR's Toxicological Profile for TCE can be viewed at the TCE Library at 101 W. Irvington in Tucson.

5.2 Health Outcome Data Evaluation

ATSDR has reviewed eight of the ten studies presented in Section 1.4. The comments are provided in the "*Review of Health Studies Related to TCE Contamination at Tucson Superfund Site, Tucson Arizona,*" presented in the Appendix. Numerous and significant limitations exist in the eight studies. These limitations prevent definitive conclusions on the causal relationship between exposure and health outcomes. Almost no exposure information is available besides that

of residence in the contaminated census tract or work. This is a poor surrogate for exposure, since the contamination plume does not occupy the whole census tract. Using the tract level for analysis rather than block level is likely to lead to exposure misclassification resulting in an underestimation of the outcome effect. It is recommended that any further studies use block level analysis of morbidity and mortality data.

No statistically significant results were found for the following outcomes studied: a) homebound program admission rates in the Tucson Unified and Sunnyside school districts, b) mortality rates of Hughes aircraft employees and, c) childhood leukemia and testicular cancer incidence in Pima County.

In the reviewed studies, the reported results were suggestive for the following outcomes: a) congenital heart disease, b) musculoskeletal birth defects (county-year interactions) c) mortality due to asthma, d) neuro-behavioral performance and, e) prevalence of systemic lupus erythematosus.

Although a number of serious limitations exist in the above studies, it is recommended that the outcomes for which results were suggestive be included in any future studies of the Tucson TCE contamination problem when possible. It is also recommended that a trend analysis be done to determine if the elevations in specific birth defects or other outcomes were persistent after public water supply sources were used.

5.3 Community Health Concerns Evaluation

Water issues have been a concern of community residents in South Tucson for many years. The community must be made more aware of the situation with the private wells in the Plume B area. For instance, managers of one mobile park were ready to fix the two private wells on the property and use them instead of being on Tucson Water, since it was cheaper. After speaking with them, they most likely will stay on Tucson Water. However, this indicates that other residents in the area may be motivated to use private wells since it appears less expensive than being hooked up to Tucson Water.

Previous Health Assessments

In 1988, ATSDR conducted a health assessment for the larger Main Plume at the TIAA site to address the community concerns. The assessment indicated that soil and groundwater in the Main Plume had been contaminated by chromium and volatile organic compounds such as TCE and DCE. The findings of the public health assessment for the Main Plume found that it is unlikely that exposure to the concentrations of TCE detected in the Tucson public water supply would result in non-carcinogenic toxicity to the liver, central nervous system or other organs. Additionally, no congenital heart disease or other teratogenic effects would be expected to result from exposures to water from the public water supply.

Sampling of private wells for TCE from 1981 through 1994 identified both drinking and

irrigation private wells in and near the TIAA (primarily the larger groundwater plume known as the Main Plume) with the contaminant levels ranging from non-detect to 120 µg/L. One of the private irrigation wells (#14) had concentrations of TCE of 49 µg/L which has subsequently increased to 50 µg/L. ATSDR determined that the exposure to the TCE in irrigation well #14 was not a public health concern. However, some of the private drinking water wells presented a health concern, since the concentrations were high and durations of exposure were greater than 10 years. It was also determined that the cancer risk from exposures to water from contaminated private drinking water wells was slightly increased. More information on TCE is provided in the Appendix.

5.4 ATSDR's Child Health Initiative

ADHS has prepared this public health assessment under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ADHS has included the following information in accordance with ATSDR's Child Health Initiative.

Sub-populations of concern are sensitive receptor populations who may be particularly susceptible to chemical exposure. This can include infants, the elderly, or individuals with respiratory problems, depending on the chemicals of concern and the nature of the exposures. Children are more likely to be exposed because they are shorter than adults, which means they breathe dust, soil, and heavy vapors close to the ground which can result in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Child- specific HBGLs were calculated in this health assessment to identify any health hazard that may exist for children near the Plume B area. The following results were found:

- ❑ The level of the TCE in the private drinking water wells was below the MCL indicating the water to be safe to drink for children.

- ❑ The water in three of the irrigation wells was above the MCL. Further analysis was conducted in the health assessment to determine if the detected TCE concentrations in these wells could present a health hazard to children who might play in the irrigation water. ADHS concludes that the level of TCE in the irrigation wells would not be considered a health hazard to children who would play with the water.

In summary, the concentrations of TCE detected in the monitoring, drinking, and irrigation wells do not pose a public health hazard to sensitive populations in the area, such as children and older adults.

Conclusions

Given the current data, ADHS concludes that no current public health hazard exists for residents as a result of ingestion, dermal, or inhalation exposures to the contaminated groundwater in

Plume B. However, potential future exposure to the groundwater contamination presents a viable public health hazard and needs to be addressed in order to prevent future human exposures.

Private wells in the residential areas near Plume B have been impacted with TCE and chromium from the contaminated groundwater plume. Twelve private drinking water wells, seven irrigation wells, and 13 monitoring wells were included in the ADHS Plume B study area. A quantitative analysis of exposures was conducted. Results showed the following:

1. Public drinking water supply wells in the area present no public health hazard.

2. Three private wells used for irrigation purposes were found to contain levels of TCE above the MCL of 5 µg/L. However, quantitative analysis shows the level of TCE is not at a level that would be expected to cause adverse health effects for residents through inhalation, ingestion, or dermal exposures.

3. Seven private drinking wells and 4 private irrigation wells, including some of the wells furthest from the Plume B boundaries, were found to have low levels of chromium. The highest level of chromium found was 17.5 µg/L, which is far below the screening level of 100 µg/L. The level of chromium found in these wells is not at levels that would be expected to cause adverse health effects for residents through inhalation, ingestion, or dermal exposures. The chromium contamination in the furthest wells may not be due to contaminated groundwater from Plume B.

4. Potential future exposure to groundwater contamination cannot be ruled out. Monitoring wells also show that TCE contamination is present in the aquifer at levels above public drinking water standards and contaminated groundwater containment has not been achieved yet. Abandoned wells have been identified in the ADHS Plume B Study Area and these could potentially be fixed and made into irrigation or drinking water wells and could be contaminated from the Plume. There are no current laws to prevent any resident from turning an irrigation well into a drinking well or installing new wells.

Recommendations

This public health assessment has determined that, given the data provided by the PCDEQ in the 1998 private well study, no current health hazard exists to those residents whose private wells were identified in the ADHS Plume B Study Area. However, future exposures to the contaminated groundwater presents a viable public health hazard to the community living near Plume B. Therefore, ADHS makes the following recommendations:

1. Further investigation is needed to identify additional private wells and their accurate locations, particularly in the Tucson Water parcel areas. It is estimated that this will include

around 2000 residences. If additional private wells are found during this investigation, those wells need to be sampled and results sent to the ADHS for further evaluation.

2. ADEQ has recently identified some abandoned wells near the Plume B area. It is important that a long-term management protocol be developed to address the following:

- That abandoned wells in the area are not converted into working irrigation or drinking water wells;
- That irrigation wells are not converted into drinking water wells and vice versa without proper approval and knowledge by ADEQ and EPA project managers;
- That development of a comprehensive database which identifies all private wells in the Plume B area, their use, location address, and other pertinent information would assist project managers from the various agencies involved.

3. As a precaution, private wells near the path of the plume should be sampled on a regular basis to see that no additional contamination occurs from possible future migration of the groundwater plume. If any additional contamination is found in private wells as a result of future investigations, an ATSDR Health Consultation should be conducted to evaluate the hazard to public health.

4. Since the area of Plume B is not yet fully characterized, it would be beneficial to all concerned residents in the area to be routinely informed of the status of the plume investigation and its effect on any private wells in the area. These could be mailed to private well owners, supplied to the TCE library, and made available to community meetings held at the El Pueblo Clinic.

Public Health Action Plan

The Public Health Action Plan (PHAP) for the Plume B Site contains a description of actions taken, to be taken, or under consideration by ATSDR and ADHS at and near the site. The purpose of the PHAP is to ensure that this public health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. ADHS and ATSDR will follow up on this plan to ensure that actions are carried out.

Actions Completed

From 1993 - 1995, ADHS staff conducted many workshops in Tucson to address the health concerns of the community. These included workshops on exposures to TCE and it's health effects, lupus, cancer, environmental pollution, and other issues of concern.

From 1993 - 1995, ADHS staff conducted many physician education training seminars in Tucson on TCE and it's health effects, and other environmental issues that they may need to know in order to address the concerns of their patients.

ADHS attended a public meeting at the Tucson UCAB (Unified Community Action Board) in February 1998 to announce the public health assessment for the Plume B Site.

In January 1999, ADHS staff met with the Pima County Department of Environmental Quality (PCDEQ) to discuss the upcoming health assessment and to gather data on the private wells in the area. Staff also went to the TCE Library to gather data on the various sites where health assessments would be conducted. This also included attending the monthly UCAB meeting.

In March 1999, ADHS staff attended the UCAB meeting in Tucson to discuss concerns about the Plume B area. One full day was spent driving around the site, identifying the private wells in the area, taking pictures, and talking with residents to identify their concerns.

In April 1999, ADHS met with EPA, PCDEQ, ADEQ, and other parties in San Francisco for 2 days to discuss the West Cap and Plume B situation in Tucson. Plans were put in place to better characterize the site, determine the source of the contamination, and further the clean up of West Cap.

In August, 1999 a teleconference was held between ADHS, PCDEQ, and ADEQ staff to discuss the Plume B site. Discussion included plans to reduce future exposures to contaminated water, prevent residents from turning abandoned wells and irrigation wells into drinking wells, and developing a GIS database that can provide information for any new person that gets involved in the site.

In September, ADHS staff attended the UCAB meeting and presented the results of the health assessment and other health assessments being conducted on the Tucson site.

Actions Proposed

ADHS will continue to meet with the community residents at the UCAB meetings on a regular basis to communicate the ADHS activities being conducted at the Tucson site. Specific goals are to increase the understanding of the technical aspects of the area contaminants and their fate and transport, and to educate the community on ways to minimize their exposures to site-related contaminants and physical hazards.

ADHS will continue to work with EPA, ADEQ, PCDEQ, and consulting companies to address additional health concerns about exposures at the Plume B Site.

Public Comment Period

ATSDR provided an opportunity in the final draft stage of this document for the general public to comment on Agency findings or proposed activities. This comment period lasted from July 6, 2000 through September 30, 2000. During that time no comments were received.

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APPENDIX

Figure 1: Location map of the Tucson International Airport Superfund Site

Figure 2: Location of Larger Plume A and Smaller Plume B

Figure 3: Close-up Map of Plume B

Figure 4: Results of 1994 and 1998 Private Well Studies Conducted by Pima County Department of Environmental Quality

Table A1: Results of Calculations for the Flood Irrigation Scenarios

Table A2-A19: Equations for Exposure Calculations for the Flood Irrigation Scenarios

ATSDR Review of Eight TIAA Health Studies Related to Trichloroethylene (TCE) Contamination

ADHS Toxicological Profile for TCE

Comparison Values

Listed below are some of the comparison values used by ADHS to select chemicals which merit detailed site specific evaluation. In addition, other non-ADHS values are listed which are sometimes used to provide a meaningful frame of reference for environmental chemical data. For convenience, the list also includes some of the common abbreviations used for common units of measure. Following the list is a brief description of each value.

CREG = Cancer Risk Evaluation Guide
MRL = Minimal Risk Level
EMEG = Environmental Media Evaluation Guide
RMEG = Reference Dose Media Evaluation Guide
RfD = Reference Dose
RfC = Reference Dose Concentration
RBC = Risk Based Concentration
DWEL = Drinking Water Equivalent Level
LTHA = Lifetime Health Advisory
MCL = Maximum Contaminant Level
HBGL = Human Health Based Guidance Level
PRG = Permissible Remediation Goal (Action Level)
PEL = Permissible Exposure Limit
TLV = Threshold Limit Value
ppm = parts per million
ppb = parts per billion

kg = kilogram (1000 grams)
mg = milligram (0.001 grams)
ug = microgram (0.000001 grams)
L = liter
m^3 = cubic meter (referring to 1000 liters of air)

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations expected to cause no more than one excess cancer in one million persons exposed over a lifetime. CREGs are calculated from USEPA's cancer slope factors or cancer potency factors using standard assumptions for exposure rates. These cancer estimates are commonly used because low-dose chemical exposure lab studies typically are not in the scientific literature and the true risk is unknown (and may be as low as zero).

Minimal Risk Levels (MRLs) are estimates of daily human exposure to a chemical (usually in terms of milligrams chemical per kilogram of body weight per day) that are unlikely to be associated with any appreciable risk of adverse noncancer effects over a specified duration of exposure. MRLs are calculated using data from human and animal studies and are usually reported for one of three time frames: acute (up to 14 days exposure), intermediate (15 - 364 days exposure), and chronic (1 year or more of exposure). MRLs are developed by the federal Agency for Toxic Substances and Disease Registry (ATSDR) and are published in ATSDR's Toxicological Profiles.

Environmental Media Evaluation Guides (EMEGs) are media-specific concentrations of chemicals calculated from ATSDR minimal risk levels using standard body weight and ingestion assumptions. EMEGs may be developed for specific timeframes of exposure duration such as acute, intermediate, or chronic (see MRLs). Chemical amounts below an EMEG are considered to be harmless to public health while amounts above an EMEG require detailed site-specific evaluation.

Reference Dose Media Evaluation Guide (RMEG) is the concentration of a contaminant in air, water, or soil that corresponds to USEPA's RfD for that contaminant when standard assumptions of body weight and intake rates are taken into account.

Reference Dose (RfD) is USEPA's estimate of the daily exposure to a contaminant unlikely to cause noncarcinogenic adverse health effects. Like the ATSDR MRL, the RfD is a dose expressed in mg/kg/day.

Reference Concentration (RfC) is a concentration of a substance in air which USEPA considers unlikely to cause non-cancer adverse health effects over a lifetime of exposure.

Risk-Based Concentrations (RBCs) are media-specific concentrations calculated from RfDs, RfCs, or USEPA's Cancer Slope Factors. They represent concentrations of a contaminant that are considered unlikely to cause adverse health effects over a lifetime of chronic exposure.

Drinking Water Equivalent Levels (DWELs) are based on USEPA's oral RfD and represent corresponding concentrations of a substance in drinking water that are estimated to have negligible deleterious effects in humans at an intake rate of 2 liters per day for life, assuming that drinking water is the sole source of exposure.

Lifetime Health Advisories (LTHA) are calculated from the DWEL and represent the concentration of a substance in drinking water estimated to have a negligible deleterious effect in humans over a lifetime of 70 years, assuming 2 liters per day consumption for a 70 kilogram adult, and taking into account other probable sources of exposure. In the absence of chemical specific data, the assumed fraction of total intake from drinking water is 20%. Lifetime health advisories are not derived for compounds considered potentially carcinogenic for humans.

Maximum Contaminant Levels (MCLs) are legally enforcible contaminant concentrations in drinking water that USEPA deems protective of public health (considering the availability and economics of water treatment technology) over a 70 year lifetime at an exposure rate of 2 liters of water per day.

Health Based Guidance Levels (HBGLs) are calculated by ADHS to limit excess lifetime cancer risk to one-in-one million (10^{-6}) for known human carcinogens and to one-in-one-hundred-thousand (10^{-5}) for possible and probable human carcinogens. HBGLs are considered individually protective of human health, including sensitive groups, over a lifetime. Chemical concentrations that exceed the applicable HBGL may not necessarily represent a health hazard. Rather, when contaminant concentrations exceed the HBGL, further evaluation may be necessary to determine whether a contaminant poses an unacceptable health hazard to humans.

Permissible Remediation Goals (PRGs), or Action Levels, are chemical- and media- specific levels of contamination which, when exceeded, automatically trigger a regulatory response or remedial action of some kind.

Permissible Exposure Limit (PEL) is an 8-hour time-weighted average concentration of a substance in workplace air designed by the Occupational Safety and Health Administration (OSHA) to provide that, to the extent feasible, chemical exposures in the workplace do not impair the health or functional capacity of workers throughout their working life. The PEL may be exceeded for brief periods, but the sum of the exposure levels averaged over 8 hours is not to exceed to PEL.

Threshold Limit Value (TLV), developed by the American Conference of Governmental Industrial Hygienists (ACGIH), is "the time-weighted average concentrations for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect." Many of ACGIH's TLVs were adopted by OSHA for use as PELs. Note that TLVs and PELs, which were designed to protect healthy workers, are usually much higher than the public health based values of ATSDR and USEPA, which were designed to protect the health of the general population, including subgroups such as the very young and the elderly.

Glossary

aquifer a permeable rock stratum below the earth's surface through which groundwater moves; generally capable of producing water for a well.

chemicals of concern
chemicals whose concentrations are above the appropriate screening level.

detection limit the minimum concentrations that must be accurately and precisely measured by the laboratory and/or specified in the quality assurance plan.

dose the amount of a contamination that is absorbed or deposited in the body of an exposed organism for an increment of time. A total dose is the sum of doses received by a person from a contaminant in a given interval resulting from interaction with all environmental media that contain the contaminant. Units of dose and total dose are often converted to units of mass per volume of physiological fluid or mass of tissue.

exposure an event that occurs when there is contact at a boundary between a human being and the environment with a contaminant for a specific concentration for an interval of time: the units of exposure are concentration multiplied by time.

exposure pathway
the process by which an individual is exposed to contaminants that originate from some source of contamination and are categorized as inhalation, dermal, and/or ingestion exposures.

latency the period between stimulus application and response onset.

parts per million
a common basis of reporting water analysis. One part per million (ppm) equals 1 pound per million pounds of water.

public health assessment an evaluation of relevant environmental data, health outcome data, and community concerns associated with a site where hazardous substances have been released.

route of exposure
means by which the contaminant actually enters or contacts the body, such as ingestion, inhalation, dermal contact, and dermal absorption.

volatile compounds

	compounds amenable to analysis by the purge and trap techniques. Used synonymously with purgable compounds.
volatilization	the conversion of a liquid or solid into vapors.

LIST OF ACRONYMS AND ABBREVIATIONS

ADHS	Arizona Department of Health Services
ADEQ	Arizona Department of Environmental Quality
AMC	American Cancer Society
ATSDR	Agency for Toxic Substances and Disease Registry
COC	chemical of concern
HBGL	Health-based Guidance Levels
MCL	maximum contaminant level
MRL	minimum risk level
NA	not applicable
ND	non-detect
NS	not sampled
PCDEQ	Pima County Department of Environmental Quality
ppm	parts per million
SLE	Systemic Lupus Erythematosus
TCE	trichloroethylene
TIAA	Tucson International Airport Area
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
µg/L	micrograms per liter