Health Consultation

Indoor Air Quality Assessment of a Residential Neighborhood
Overlying a Tetrachloroethylene (PCE) Groundwater Plume

A1 STOP LAUNDRY AND DRY CLEANERS

LAKEWOOD, JEFFERSON COUNTY, COLORADO

EPA FACILITY ID: COD980962518

FEBRUARY 20, 2007

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

Colorado Department of Public Health and Environment
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Foreword

The Colorado Department of Public Health and Environment's (CDPHE) Environmental Epidemiology Section has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the US Department of Health and Human Services and is the principal federal public health agency responsible for the health issues related to hazardous waste. This health consultation was prepared in accordance with the methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on health issues associated with specific exposures so that the state or local department of public health can respond quickly to requests from concerned citizens or agencies regarding health information on hazardous substances. The Environmental Epidemiology Section (EES) evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur in the future, reports any potential harmful effects, and then recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time this health consultation was conducted and should not necessarily be relied upon if site conditions or land use changes in the future.

For additional information or questions regarding the contents of this health consultation or the Environmental Epidemiology Section, please contact the authors of this document:

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Summary and Statement of Issues

In April 2006, the Colorado Department of Public Health and Environment's (CDPHE) Hazardous Waste and Waste Management Division requested that the ATSDR Cooperative Agreement Program, housed within the Environmental Epidemiology Section at CDPHE, review the available indoor air data collected from residential homes overlying the plume to determine any potential public health impacts associated with PCE and its degradation products. The purpose of this document is to identify any potential public health implications resulting from current and future exposures to the A1 plume contaminants and recommend actions to reduce the exposure, if necessary.

The A1 Stop Dry Cleaners site (A1) is a former dry cleaning establishment located in Lakewood, CO, a western suburb of Denver. In 2005, the CDPHE's Hazardous Waste and Waste Management Division (HWWMD) determined that A1 was the source of a tetrachloroethene plume, which extends south from the A1 property on West Colfax Avenue to approximately West 12th Avenue between Simms and Union Streets in Lakewood (Figure 1). Tetrachloroethene, or perchloroethene (PCE), is an organic solvent that is commonly associated with the dry cleaning and manufacturing industries. PCE is a volatile organic compound, which has the ability to migrate from a subsurface source, such as an aquifer, through soil, and into the indoor air spaces of overlying buildings. This phenomenon is known as vapor intrusion.

After a through review of the available indoor air data down gradient of the A1 Stop Cleaners site, it is concluded that the indoor air in residential homes above the PCE plume represents no apparent public health hazard for current and future exposure scenarios. One residence in the area had theoretical cancer risks above the CDPHE risk management action level during the first round of sampling. When this property was resampled, the contaminant levels in indoor air had dropped by 73% and did not represent an immediate health hazard. Therefore, this property is considered to represent an indeterminate public health hazard until further indoor air sampling has been conducted to verify the safety of the indoor air at this property.

Background

A1 Stop Dry Cleaners site (A1) is located in Lakewood near the intersection of W. Colfax Avenue and Simms Street in Jefferson County, CO. The site was built in 1960 and was purchased by the current owner in 1973. The complete history of the site is unknown. However over the past several years, the property has been leased to dry-cleaning operators. The following material describes the preliminary events leading up to the discovery of the PCE plume.

In August 1995, PCE was detected in ground water monitoring wells installed at the U-Pump-It gas station and a neighboring property located on Colfax Avenue. U-Pump-It gas station is located across Colfax Avenue to the southeast and down gradient of A1

Stop Dry Cleaners (Figure 1). The monitoring wells at the U-Pump-It site had been installed for an underground storage tank assessment and remediation of petroleum related contaminants. The Colorado Department of Labor and Employment's Division of Oil and Public Safety (OPS) notified the Resource Conservation and Recovery Act (RCRA) Unit at CDPHE that Volatile Organic Compounds (VOCs) were infiltrating ground water at the U-Pump-It site by an up-gradient source (CDPHE 2006). The RCRA team investigated the A-1 Stop Dry Cleaning facility in 1997 and found no RCRA violations or apparent releases to ground water and soil. Therefore, no further investigation into the source of the ground water contamination was appropriate at that time. However, a water well survey was conducted to determine if domestic-use wells were present in the neighborhood down gradient of the known area of contamination. No domestic-use wells were identified within the plume area and no further action was taken at this time.

In 1999, the RCRA program identified that PCE and trichloroethene (TCE) were migrating onto the Quality Metals corrective action site. Quality Metals is another site in the area that was under investigation for a VOC plume originating on that property (See Figure 1). At the time, increasing levels of PCE and TCE were being detected in monitoring wells located up gradient of the Quality Metals site, indicating that the site was being impacted by another offsite source. This information was sent to the Preliminary Assessment and Site Inspection (PA/SI) Unit at CDPHE who initially ranked the site's impact on public health as negligible due to the fact that no domestic drinking water wells were in use in the area of known contamination. However, recent interest in the health impacts from vapor intrusion into buildings and homes overlying contaminated ground water and soils prompted the PA/SI Unit to conduct a Combined Assessment (CA) aimed at identifying the source of contamination and defining the extent of the plume.

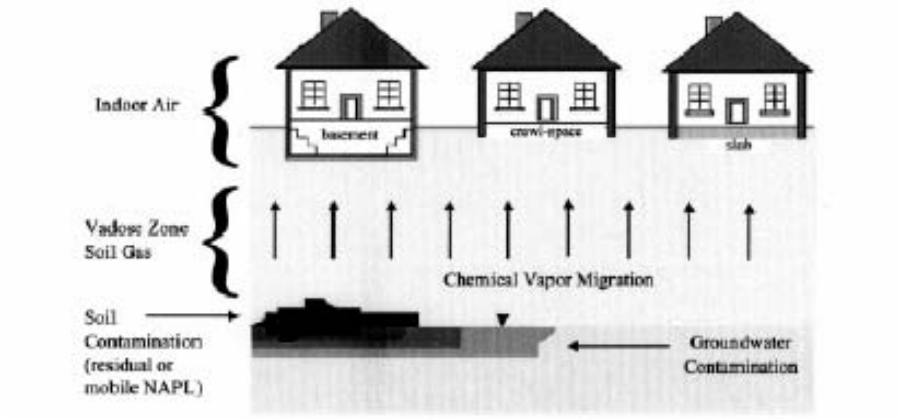
The CA, conducted in 2005-2006, concluded the source of PCE and TCE contamination was A1 Stop Dry Cleaners. Subsequently, A1 Stop Dry Cleaners entered into a corrective action agreement with CDPHE and additional sampling, including the analysis of indoor air samples from homes overlying the plume, was conducted as per the Corrective Action Plan. Sampling conducted during the CA also allowed CDPHE to map the plume boundaries with isopleths, or areas of similar concentrations of PCE. The indoor air samples in this assessment were collected from homes within the boundaries of the plume as mapped by CDPHE.

Volatile Organic Compounds—Vapor intrusion pathway

PCE and its degradation products belong to a class of organic compounds called volatile organic compounds or VOCs. VOCs have high vapor pressures, which enables their vapors to readily enter the atmosphere. Vapor intrusion refers to the migration of VOC vapors from a subsurface source, through the vadose zone (subsurface area over the source), and into homes and buildings where people can be exposed. Subsurface sources may include contaminated groundwater and/or soils. Typically, vapors are released from

the subsurface source; migrate through soils, and into indoor air spaces of overlying buildings. The figure below is a generalized schematic of the vapor intrusion pathway (EPA 2002).

It should also be noted that environmental contamination is not the only source of VOCs in indoor air. VOCs do not occur in a natural environment. However, a number of VOCs are present in many household sources including building materials, cleaners, furniture treatments, paint, plastics, sealants, and cosmetics. In fact, studies have found that the levels of VOCs in indoor air may be as high as five times the levels found in outdoor air regardless of if the building was located in industrialized, urban areas or rural settings (EPA 2006b). The contribution of VOCs from household sources to the overall indoor air concentration of VOCs introduces a level of uncertainty to the analysis of indoor air samples since it is often difficult to define the contribution of VOCs from each source.



(Source: EPA 2002)

Community Health Concerns

Prior to indoor air sampling, residents were contacted by ERO Resources Corporation for potential participation in the sampling event. A total of 73 property owners were contacted in an attempt to gain access agreements to conduct sampling. At this time, an informational fact sheet was distributed throughout the neighborhood overlying the contamination. A few community members voiced concern about the need for indoor air sampling and potential health effects resulting from exposure to PCE contaminated indoor air. No specific health concerns were noted and overall community interest appeared to be low. After the completion of indoor air sampling and analysis, an additional fact sheet was distributed to community members, which discussed the levels of PCE in indoor air. No other recent community involvement activities or community concerns have been reported since the distribution of the second fact sheet.

Discussion

Data Used

The samples used in this health consultation were collected by ERO Resources Corporation (ERO) in accordance with the Corrective Action Work Plan and sent to Severn Trent Laboratory in California for analysis by EPA Method TO-15 with standard sensitivity detection methodology (SCAN) and selective ion monitoring (SIM) methodology. A total of 18 indoor samples and 1 outdoor sample were collected from 16 homes that were willing to participate in the assessment. Air sampling occurred in two phases with an initial phase of sampling in April 2006 (13 homes) and a second phase in June 2006 (3 homes). Survey forms were completed to determine applicable background information on the homes, to document building occupancy at the time of sampling, and to document the use and/or presence of chemicals, building materials, and other occupant activities that have the potential to affect the analytical results (ERO 2006). Six-Liter Summa canisters were then placed in the lowest habitable level of the homes and were equipped with regulators to collect airflow for a 24-hour period. One duplicate and 1 ambient (outdoor) air sample were also collected for quality control during the initial phase of sampling. The results of the sampling analysis and summary statistics are shown in Table 1.

Exposure Evaluation

The initial steps of the assessment process involve screening the available environmental data for contaminants and then comparing this information to conservative, health-based environmental guidelines. Exposures to contaminated sources below the environmental guidelines are not expected to result in adverse or harmful health effects. If the concentration of a particular contaminant is above the chosen environmental guideline, the contaminant is normally retained for further analysis as a contaminant of potential concern (COPC). However, exceeding the screening value does not necessarily mean that the contaminant poses a public health hazard, only that further evaluation may be necessary. ATSDR and Environmental Epidemiology Section also consider sampling location, data quality, exposure probability, frequency and duration; and community health concerns in determining which contaminants to evaluate further.

If the contaminant is selected for extended evaluation, the next step is to identify pathways of probable exposure that could pose a hazard. Simply having the substance present in the environment does not necessarily mean that people will come into contact with it and subsequently experience adverse health effects. An exposure pathway consists of five primary elements: a source, a contaminated environmental medium, and transport mechanism, a point of exposure, a route of exposure, and a receptor population. Exposure pathways are classified as either complete, potential, or eliminated. Only complete exposure pathways can be fully evaluated and characterized to determine the public

health implications. Site-specific contaminants of concern and completed exposure pathways are discussed further in the section below.

COPC Selection

PCE degrades into 4 different compounds via the reductive dechlorination pathway thought to be occurring in the A1 plume. In this case, reductive dechlorination occurs by dehalogenating bacteria, which reduce the chlorinated ethenes by exchanging chlorine atoms with hydrogen atoms. The resulting compounds from reductive chlorination of PCE include trichloroethene, dichloroethene, vinyl chloride, and ethene. Ethene is harmless gas, which is also emitted by fruits to hasten ripening. Ethene will not be considered further in this assessment and PCE, trichlorethene, dichloroethene (DCE), and vinyl chloride were retained as the target compounds of potential concern.

The screening values utilized in this assessment are the Environmental Protection Agency's Region 3 Risk-Based Concentration (RBCs) and ATSDR's Chronic and Intermediate Duration Comparison Values (CVs). Region 3 RBCs for carcinogenic compounds in ambient air are based on an age-adjusted exposure covering 30 yrs. from the time of birth to the age of 30 with an exposure frequency of 350 days per year. The inhalation RBCs for carcinogenic contaminants indicate that no more than 1 theoretical excess cancer case out of one million would be expected from exposures to this concentration in air. ATSDR's CVs for non-carcinogenic health effects are based upon chronic and intermediate-duration inhalation exposures.

The maximum detected concentrations of PCE and its degradation products found in the indoor air samples during sampling at the A1 Stop Cleaners Site are well below ATSDR CVs for non-carcinogenic health effects and no non-carcinogenic COPCs (e.g., DCE) were retained. Therefore, non-carcinogenic health effects are not likely to occur from exposures to the levels of contaminants in indoor air encountered during this assessment. However, PCE, trichloroethene, and vinyl chloride are retained as COPCs for carcinogenic health effects since they exceed EPA Region 3 RBCs for carcinogenic health effects (Table 1).

Conceptual Site Model

The exposure scenario under consideration involves PCE contaminated groundwater that has the potential to contaminate the indoor air of houses above the contaminant plume. This is the only complete exposure pathway because all of the houses receive municipal water and no domestic-use wells were identified within the plume area.

Demographics

The area down gradient of A1 Stop Dry Cleaners is a mixture of businesses and residential dwellings, primarily single-family homes. Approximately 330 individuals live within the area of the contaminant plume according to Census 2000 data. Ten percent of this population is over the age of 65 years and 7.4 % is under the age of 5 years (U.S.

Census 2000). In comparison to national averages, the number of adults over the age of 65 is less than the national average (national = 12.4%) and the number of children under the age of 5 is slightly greater than the national average (national = 6.8%). The median age of the site population by census block ranges from 30-45.5 years old. In addition, the majority of the site population appears to be English speaking.

Health Assessment

PCE and some of its biodegradation products appear to be infiltrating indoor air spaces of residential homes overlying the A1 Stop Cleaners contaminant plume. PCE was detected in 13 of 18 indoor air samples collected during the Indoor Air Quality Assessment with a concentration range of 1.1-20 $\mu g/m^3$ (ERO 2006). Each of these samples exceeded the health-based environmental screening value for PCE in air. PCE was not detected in the indoor air of 5 residences or the outdoor ambient air sample. The maximum value detected from all samples was 20 $\mu g/m^3$, which exceeds the CDPHE action level of 15.5 $\mu g/m^3$. This property was resampled in June 2006 and the indoor air concentration had dropped below a level of immediate concern at 5.5 $\mu g/m^3$. This property is currently being re-sampled.

Trichloroethene (TCE) was detected in 15.8% (3/19) of all samples and vinyl chloride (VC) was detected in 21% (4/19) of all samples. The TCE concentration exceeded the health-based environmental screening value in all three samples in which it was detected and only 1 out of 4 samples exceeded the health-based environmental screening value for VC in air. PCE is considered the primary contaminant of concern and any risk from the other degradation products is added to the theoretical cancer risk for PCE.

To calculate theoretical cancer risks for the indoor air pathway, the inhalation dose of contaminants in the indoor air samples is multiplied by the cancer slope factor (or health guideline) in accordance with the EPA Region 3 Risk-Based Concentrations methodology. The available toxicity values (or health guidelines) utilized here to evaluate the likelihood of possible harmful cancer and noncancer effects are discussed in Appendix B. The results of health risk calculations are presented in Table 3. In summary, theoretical cancer risk totals for the neighborhood south of A1 Stop Cleaners ranged from $4.17 * 10^{-6} – 6.45 * 10^{-5}$, which means that no more than 4.17 to 64.5 excess cancer cases out of one million individuals would be expected from the indoor air exposures occurring in the homes that were sampled for this assessment. These estimates are not likely to represent significant risk of cancer. As stated previously, non-cancer adverse health effects are not likely to occur from exposure to the levels of contaminated indoor air encountered in this assessment.

In general, CDPHE strives to achieve a target cancer risk level of $1 * 10^{-6}$ or no more than 1 excess cancer case out of a million people for all site-related environmental exposures. The USEPA considers a risk level of $1* 10^{-6}$ to $1* 10^{-4}$as the acceptable range of risk. All measured indoor air concentrations in this assessment, with the exception of sample IAQ-11831-IA, are below the CDPHE risk management action level of $5*10^{-5}$ for PCE and

TCE, as well as the action level of $1*10^{-5}$ for VC. Overall, the currently available data used in this assessment does not appear to represent a significant theoretical potential carcinogenic health risks because remedial action to remove the source of contamination began in December 2006. This will reduce the timeframe of exposure and, subsequently, the potential to experience adverse health effects.

As mentioned earlier, there may be some uncertainty associated with the amount of VOCs in indoor air, which are attributable to domestic sources. Background levels of PCE, for example, have been established through indoor air sampling at two sites in Colorado (Redfield Rifle Scopes site and CDOT's Materials Testing Laboratory). The mean background concentration of PCE found in residential homes near these sites after vapor mitigation systems were installed was 1.12 and 1.62 $\mu g/m^3$ with a 95% Upper Confidence Limit (UCL) of the mean of 2.22 and 2.23 $\mu g/m^3$, respectively (Kurtz and Folkes, 2002). In comparison, the mean concentration of PCE found in the properties in this assessment is 3.03 $\mu g/m^3$ with a 95% UCL of the mean of 5.37 $\mu g/m^3$. It appears that contaminated groundwater beneath the residences is affecting indoor air quality.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

The health effects of PCE and its degradation products on young children are generally thought to be similar to the effects on adults. However, children could be more vulnerable to those exposures of VOCs that are heavier than air (e.g., PCE, TCE) and occur near the floor because they breathe air that is closer to the ground than adults. PCE, TCE, and VC have also been shown to collect in breast milk and can be transferred to infants during breast-feeding. Additionally, PCE, TCE, and VC can also cross the placenta. Therefore, the developing fetus and infants are of special concern when considering exposures to PCE, TCE, and VC.

The unique susceptibility of children to adverse health effects from PCE, TCE, and vinyl chloride exposures was considered in this assessment. The Risk-Based Concentrations that were utilized to calculate risk levels account for time-weighted early life exposures

(0-6 years) through the age of 30 for PCE and TCE. Additionally, EPA has recently concluded that cancer risk of mutagenic carcinogens such as vinyl chloride is generally higher from early-life exposures than from similar exposure durations later in life. This early-life susceptibility for vinyl chloride was addressed in this assessment by using the Risk-Based Concentration derived in accordance with the EPA methodology for early-life exposures only without averaging over a lifetime of 70 years (EPA Region 3, 2006a). Overall, children's health does not appear to be at an increased risk for adverse effects when compared to adults in this assessment.

Conclusions

Overall, the A1 Stop Cleaners site is considered to represent no apparent health hazard based on the low levels of contamination found in indoor air and the imminent remediation of the groundwater PCE plume. One exception exists to this conclusion for the property, which initially tested above the acceptable health-based levels of concern and when resampled was below a level of immediate health concern. Some uncertainty exists as to the actual concentration of PCE and its degradation products since the levels had decreased by 73% over a period of 4 months. Until this property can be resampled, it is concluded that this residence constitutes an indeterminate public health hazard.

Recommendations

In order to reduce exposures to PCE and its biodegradation products at the A1 site, the EES has made the following recommendations:

- CDPHE HWWMD should conduct additional sampling at the property that had highly variable results, one of which was above the CDPHE risk management action level.

- CDPHE and the property owner should continue with the remediation as planned in the Corrective Action Plan.

- Residents living in the neighborhood south of the former A1 Stop Dry Cleaners should exercise good practices to reduce exposure to PCE from household sources. This may include proper ventilation, removing known sources of VOCs from the home, and not storing newly dry-cleaned clothes in plastic bags.

Public Health Action Plan

The public health action plan describes the actions designed to mitigate or prevent adverse human health effects that might result from exposure to hazardous substances associated with site-related contamination. Overall, this health consultation supports the ongoing remedial actions at this site by the HMWMD of CDPHE. These remedial actions include raising the building, removing the contaminated soil and concrete, and injecting potassium permanganate into the surficial aquifer to degrade the chlorinated solvents. The EES commits to do the following public health actions related to indoor air exposures at the A1 site:

- Follow up on the additional sampling at the residence, which exceeded the CDPHE action level.
- Disseminate this information to all concerned community members.
- The EES will conduct community outreach and health education activities on an as needed basis dependent upon community interest and needs.
- By request, the EES will review any additional data collected at the A1 site.

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Tables and Figures

Table 1. A1 Stop Cleaners Indoor Air Assessment Data (ERO 2006)

Sample Number	Tetrachloroethene	Trichloroethene (SIM)	Vinyl Chloride (SIM)
IAQ-11770-IA	1.7	ND	ND
IAQ-11825-IA	1.2	ND	ND
IAQ-11830-IA	1.2	ND	ND
IAQ-11830-IA-D[1]	1.1	ND	ND
IAQ-11831-IA (April 2006)	20	ND	ND
IAQ-11831-IA (June 2006)	5.5[3]	0.38	0.15
IAQ-11831-IA-AM[2]	ND	ND	ND
IAQ-11835-IA	1.7	ND	ND
IAQ-11850-IA	7.5[3]	0.38	ND
IAQ-11745-14A	2.7[3]	ND	ND
IAQ-11770-14A	ND	0.67	ND
IAQ-11855-14A	1.5[3]	ND	0.022
IAQ-11660-SA	ND	ND	ND
IAQ-11684-SA	1.4	ND	0.03
IAQ-11725-SA	9.1	ND	ND
IAQ-11735-SA	ND	ND	ND
IAQ-11766-SA	3.0[3]	ND	ND
IAQ-11845-13A	ND	ND	0.03
IAQ-11690-PA	ND	ND	ND
Maximum Values	**20**	**0.67**	**0.15**
95% UCL on the mean	**5.73**		
EPA Region 3 Risk-Based Concentrations (RBC)	0.31	0.016	0.072
ATSDR Non-cancer Comparison Values (CVs)	234.4	464.36	66.27

Note: Dichloroethene was not retained for further evaluation as a COC because the maximum concentration of 0.094 ug/m3 is well below the CDPHE non-cancer screening level of 5 ug/m3

*All Values are reported in µg/m^3
Values in red indicate samples that exceeded screening levels
No Value = Not detected above reporting limit
SIM = Selective Ion Monitoring Method
[1] Duplicate Sample
[2] Outdoor (Ambient) Sample
[3] SIM method

Table 2. Summary of Theoretical Cancer Risks to Residents by individual Indoor Air Sample (A1 Stop Cleaners Site)

Sample Number	PCE CRL	TCE (SIM) CRL	VC (SIM) CRL	CRL Totals
IAQ-11770-IA	5.48E-06	NA	NA	5.48E-06
IAQ-11825-IA	3.87E-06	NA	NA	3.87E-06
IAQ-11830-IA	3.87E-06	NA	NA	3.87E-06
IAQ-11830-IA-D	3.55E-06	NA	NA	3.55E-06
IAQ-11831-IA	6.45E-05	NA	NA	**6.45E-05**
IAQ-11831-IA	1.77E-05	2.38E-05	2.08E-06	4.36E-05
IAQ-11831-IA-AM	NA	NA	NA	NA
IAQ-11835-IA	5.48E-06	NA	NA	5.48E-06
IAQ-11850-IA	2.42E-05	2.38E-05	NA	4.79E-05
IAQ-11745-14A	8.71E-06	NA	NA	8.71E-06
IAQ-11770-14A	NA	4.19E-05	NA	4.19E-05
IAQ-11855-14A	4.84E-06	NA	3.06E-07	5.14E-06
IAQ-11660-SA	NA	NA	NA	NA
IAQ-11684-SA	4.52E-06	NA	4.17E-07	4.93E-06
IAQ-11725-SA	2.94E-05	NA	NA	2.94E-05
IAQ-11735-SA	NA	NA	NA	NA
IAQ-11766-SA	9.68E-06	NA	NA	9.68E-06
IAQ-11845-13A	NA	NA	4.17E-07	4.17E-07
IAQ-11690-PA	NA	NA	NA	NA

Note: the concentration of contaminants in the indoor air samples are divided by the EPA Region 3 Risk-Based Concentrations for that contaminant and then multiplied by $1*10^{-6}$ (i.e. 20 / 0.31 * $1*10^{-6}$)

Value in red exceeded CDPHE's risk management action level
SIM = Selective Ion Monitoring Method
CRL = Theoretical Cancer Risk Level

Figure 1. A-1 Stop Cleaners Site Location Map (Source: ERO 2006)

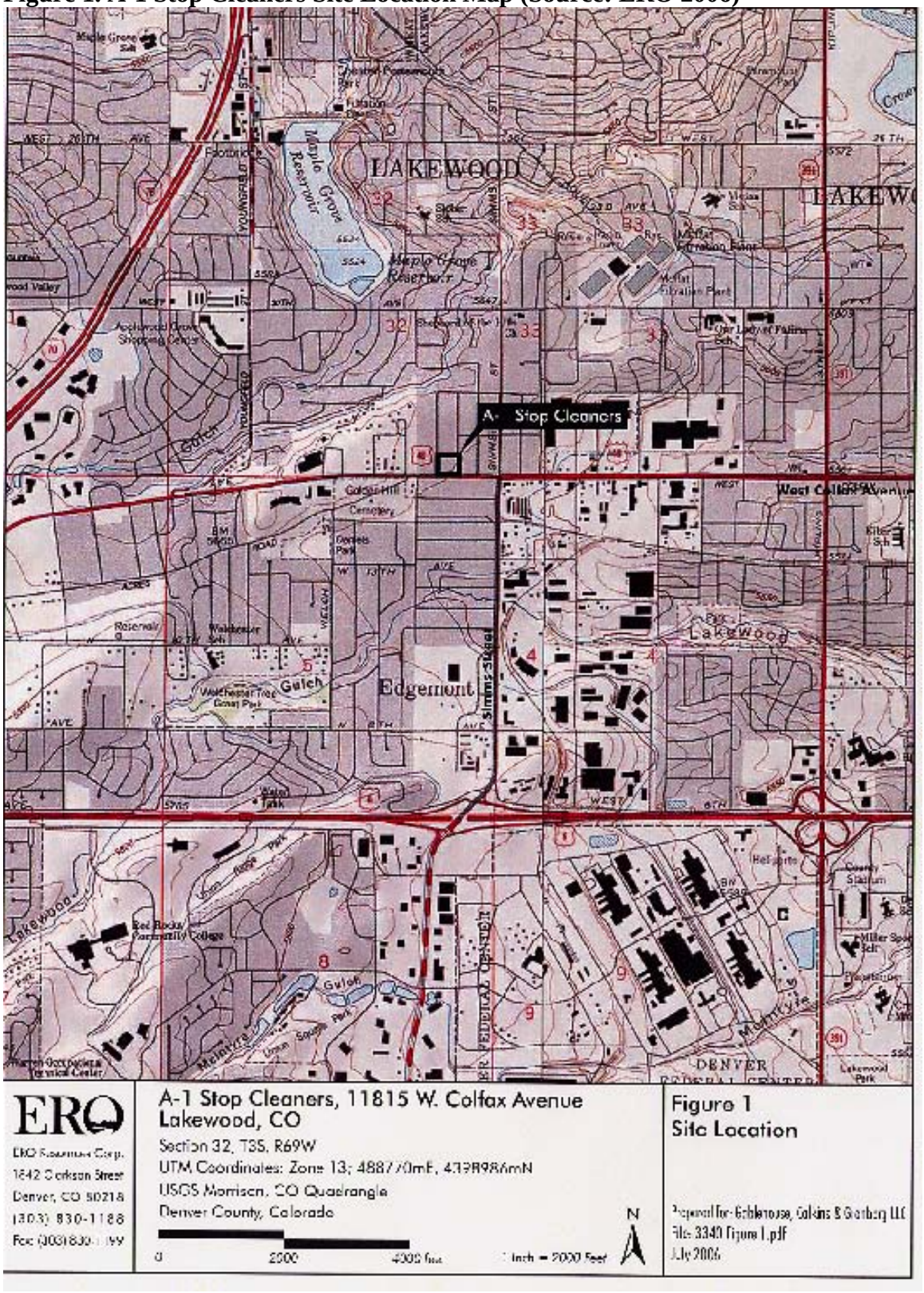
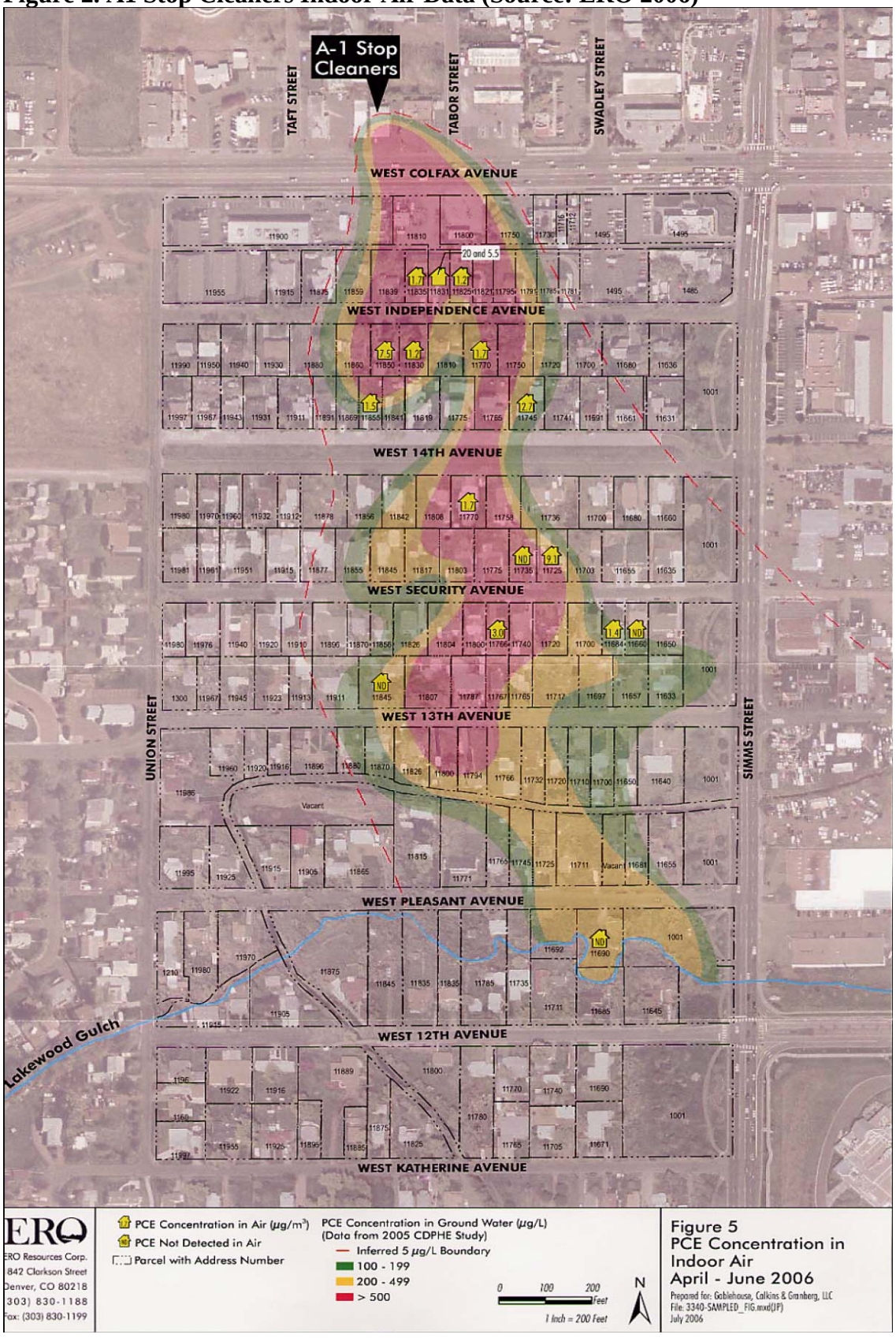


Figure 2. A1 Stop Cleaners Indoor Air Data (Source: ERO 2006)



Appendices

Appendix A: ATSDR Public Health Hazard Categories

Category / Definition	Data Sufficiency	Criteria
A. Urgent Public Health Hazard This category is used for sites where short-term exposures (< 1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.	This determination represents a professional judgment based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicates that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards.
B. Public Health Hazard This category is used for sites that pose a public health hazard due to the existence of long-term exposures (> 1 yr) to hazardous substance or conditions that could result in adverse health effects.	This determination represents a professional judgment based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	**Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.**
C. Indeterminate Public Health Hazard **This category is used for sites in which "*critical*" data are *insufficient* with regard to extent of exposure and/or toxicologic properties at estimated exposure levels.**	This determination represents a professional judgment that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.	**The health assessor must determine, using professional judgment, the "criticality" of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.**
D. No Apparent Public Health Hazard This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.	This determination represents a professional judgment based on critical data which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.
E: No Public Health Hazard **This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.**	**Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future**	

Appendix B: Toxicological Evaluation

The basic objective of a toxicological evaluation is to identify what adverse health effects a chemical causes, and how the appearance of these adverse effects is dependant on dose. The toxic effects of a chemical frequently depend on the route of exposure (oral, inhalation, dermal) and the duration of exposure (acute, subchronic, chronic or lifetime). In general, acute and chronic neurological changes, and liver and kidney toxicity, have been observed in humans and animals exposed to PCE (See Appendix C for PCE health effect fact sheet). It is important to note that estimates of human health risks may be based on evidence of health effects in humans and/or animals depending upon the availability of data.

At the current time, the International Agency for Cancer Research (IARC) has classified PCE as a Group 2a carcinogen (IARC 1995). The USEPA has not established an inhalation reference concentration or a carcinogenicity assessment for lifetime exposures to PCE in the EPA Integrated Risk Information System (IRIS). In the absence of relevant values in IRIS, the USEPA Office of Solid Waste and Emergency Response (OSWER) recommends using the California EPA's carcinogenic inhalation cancer slope factor or toxicity factor per mg/kg/day of PCE (EPA, 2003, OSWER Directive No. 9285.7-75). CDPHE's Hazardous Waste and Waste Management Division also adopted the Cal EPA inhalation cancer slope factor, which results in RBC of 0.31 $\mu g/m^3$ as a screening value to guide remedial action in 2006.

The resulting RBC used in this assessment is based on age-adjusted theoretical cancer risks spanning 30 years from the time of birth to the age of 30. It accounts for exposure to PCE, TCE, and VC vapors for 350 days per year over the thirty-year time period and lower body weights and early-life susceptibility (for VC) of children. Exposure to PCE at this duration and frequency of exposure is expected to result in no more than 1 theoretical cancer case per 1,000,000 people.

Noncancer health guidelines for PCE, TCE, and VC are available from ATSDR, EPA draft risk assessment for TCE, and EPA Integrated Risk Information System (IRIS). These values are not discussed further here because the concentrations of these contaminants in indoor air are significantly below the health guidelines.

Appendix C: ATSDR Tetrachloroethylene Public Health Statement

Public Health Statement for Tetrachloroethylene

CAS# 127-18-4

This Public Health Statement is the summary chapter from the Toxicological Profile for tetrachloroethylene. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™, is also available. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-888-422-8737.

This public health statement tells you about tetrachloroethylene and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup. Tetrachloroethylene has been found in at least 771 of the 1,430 current or former NPL sites. However, it's unknown how many NPL sites have been evaluated for this substance. As more sites are evaluated, the sites with tetrachloroethylene may increase. This is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact.

If you are exposed to tetrachloroethylene, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

What is tetrachloroethylene?

Tetrachloroethylene is a synthetic chemical that is widely used for dry cleaning of fabrics and for metal-degreasing operations. It is also used as a starting material (building block) for making other chemicals and is used in some consumer products. Other names for tetrachloroethylene include perchloroethylene, PCE, perc, tetrachloroethene, perclene, and perchlor. It is a nonflammable liquid at room temperature. It evaporates easily into the air and has a sharp, sweet odor. Most people can smell tetrachloroethylene when it is present in the air at a level of 1 part in 1 million parts of air (ppm) or more. In an experiment, some people could smell tetrachloroethylene in water at a level of 0.3 ppm.

What happens to tetrachloroethylene when it enters the environment?

Tetrachloroethylene enters the environment mostly by evaporating into the air during use. It can also get into water supplies and the soil during disposal of sewage sludge and factory waste and when leaking from underground storage tanks. Tetrachloroethylene may also get into the air, soil, or water by leaking or evaporating from storage and waste sites. It can stay in the air for several months before it is broken down into other chemicals or is brought back down to the soil and water by rain.

Much of the tetrachloroethylene that gets into water and soil will evaporate into the air. However, because tetrachloroethylene can travel through soils quite easily, it can get into underground drinking water supplies. If it gets into underground water, it may stay there for many months without being broken down. If conditions are right, bacteria will break down some of it and some of the chemicals formed may also be harmful. Under some conditions, tetrachloroethylene may stick to the soil and stay there. It does not seem to build up in animals that live in water, such as fish, clams, and oysters. We do not know if it builds up in plants grown on land.

How might I be exposed to tetrachloroethylene?

People can be exposed to tetrachloroethylene from environmental and occupational sources and from consumer products. Common environmental levels of tetrachloroethylene (called background levels) are several thousand times lower than levels found in some workplaces. Background levels are found in the air we breathe, in the water we drink, and in the food we eat. The chemical is found most frequently in air and, less often, in water. Tetrachloroethylene gets into air by evaporation from industrial or dry cleaning operations. It is also released from areas where chemical wastes containing it are stored. It is frequently found in water. For example, tetrachloroethylene was found in 38% of 9,232 surface water sampling sites throughout the United States. There is no similar information on how often the chemical is found in air samples, but we know it is widespread. We do not know how often it is found in soil, but in one study, it was found in 5% of 359 sediment samples.

In general, tetrachloroethylene levels in air are higher in cities or industrial areas where it is in use more than in more rural or remote areas. You can smell it at levels of 1 ppm in air. However, the background level of tetrachloroethylene in air is usually less than 1 part in 1 billion parts of air (ppb). The air close to dry cleaning shops and chemical waste

sites has levels of tetrachloroethylene higher than background levels. These levels are usually less than 1 ppm, the level at which you can smell it. Water, both above and below ground, may contain tetrachloroethylene. Levels in water are also usually less than 1 ppb. Levels in contaminated water near disposal sites are higher than levels in water far away from those sites. Water polluted with this chemical may have levels greater than 1 ppm. In soil, background levels are probably 100–1,000 times lower than 1 ppm.

You can also be exposed to tetrachloroethylene by using certain consumer products. Products that may contain it include water repellents, silicone lubricants, fabric finishers, spot removers, adhesives, and wood cleaners. Although uncommon, small amounts of tetrachloroethylene have been found in food, especially food prepared near a dry cleaning shop. When you bring clothes home from the dry cleaners, the clothes may release small amounts of tetrachloroethylene into the air. The full significance to human health of these exposures to small amounts of tetrachloroethylene is unknown, but to date, they appear to be relatively harmless. Tetrachloroethylene can also be found in the breast milk of mothers who have been exposed to the chemical.

The people with the greatest chance of exposure to tetrachloroethylene are those who work with it. According to estimates from a survey conducted by the National Institute for Occupational Safety and Health (NIOSH), more than 650,000 U.S. workers may be exposed.

For the general population, the estimated amount that a person might breathe per day ranges from 0.08 to 0.2 milligrams. The estimated amount that most people might drink in water ranges from 0.0001 to 0.002 milligrams per day. These are very small amounts.

How can tetrachloroethylene enter and leave my body?

Tetrachloroethylene can enter your body when you breathe air containing it. How much enters your body in this way depends on how much of the chemical is in the air, how fast and deeply you are breathing, and how long you are exposed to it. Tetrachloroethylene may also enter your body when you drink water or eat food containing the chemical. How much enters your body in this way depends on how much of the chemical you drink or eat. These two exposure routes are the most likely ways people will take in tetrachloroethylene. These are also the most likely ways that people living near areas polluted with the chemical, such as hazardous waste sites, might be exposed to it. If tetrachloroethylene is trapped against your skin, a small amount of it can pass through into your body. Very little tetrachloroethylene in the air can pass through your skin into your body.

Most tetrachloroethylene leaves your body from your lungs when you breathe out. This is true whether you take in the chemical by breathing, drinking, eating, or touching it. A small amount of the tetrachloroethylene is changed by your body (especially your liver) into other chemicals that are removed from your body in urine. Most of the changed tetrachloroethylene leaves your body in a few days. Some of it that you take in is found in your blood and other tissues, especially body fat. Part of the tetrachloroethylene that is

stored in fat may stay in your body for several days or weeks before it is eliminated.

How can tetrachloroethylene affect my health?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Tetrachloroethylene has been used safely as a general anesthetic agent, so at high concentrations, it is known to produce loss of consciousness. When concentrations in air are high—particularly in closed, poorly ventilated areas—single exposures can cause dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. Irritation may result from repeated or extended skin contact with the chemical. As you might expect, these symptoms occur almost entirely in work (or hobby) environments when individuals have been accidentally exposed to high concentrations or have intentionally abused tetrachloroethylene to get a "high." In industry, most workers are exposed to levels lower than those causing dizziness, sleepiness, and other nervous system effects. The health effects of breathing in air or drinking water with low levels of tetrachloroethylene are not definitely known. However, at levels found in the ambient air or drinking water, risk of adverse health effects is minimal. The effects of exposing babies to tetrachloroethylene through breast milk are unknown. Results from some studies suggest that women who work in dry cleaning industries where exposures to tetrachloroethylene can be quite high may have more menstrual problems and spontaneous abortions than women who are not exposed. However, it is not known for sure if tetrachloroethylene was responsible for these problems because other possible causes were not considered.

Results of animal studies, conducted with amounts much higher than those that most people are exposed to, show that tetrachloroethylene can cause liver and kidney damage and liver and kidney cancers even though the relevance to people is unclear. Although it has not been shown to cause cancer in people, the U.S. Department of Health and Human Services has determined that tetrachloroethylene may reasonably be anticipated to be a human carcinogen. The International Agency for Research on Cancer (IARC) has determined that tetrachloroethylene is probably carcinogenic to humans. Exposure to very high levels of tetrachloroethylene can be toxic to the unborn pups of pregnant rats and mice. Changes in behavior were observed in the offspring of rats that breathed high levels of the chemical while they were pregnant. Rats that were given oral doses of tetrachloroethylene when they were very young, when their brains were still developing, were hyperactive when they became adults. How tetrachloroethylene may affect the

developing brain in human babies is not known.

Is there a medical test to determine whether I have been exposed to tetrachloroethylene?

One way of testing for tetrachloroethylene exposure is to measure the amount of the chemical in the breath, much the same way breath alcohol measurements are used to determine the amount of alcohol in the blood. This test has been used to measure levels of the chemical in people living in areas where the air is contaminated with tetrachloroethylene or those exposed to the chemical through their work. Because it is stored in the body's fat and is slowly released into the bloodstream, it can be detected in the breath for weeks following a heavy exposure. Tetrachloroethylene can be detected in the blood. Also, breakdown products of the chemical can be detected in the blood and urine of people exposed to tetrachloroethylene. Trichloroacetic acid (TCA), a breakdown product of tetrachloroethylene can be detected for several days after exposure. These tests are relatively simple to perform. The breath, blood, or urine must be collected in special containers and then sent to a laboratory for testing. Because exposure to other chemicals can produce the same breakdown products in the urine and blood, the tests for breakdown products cannot determine if you have been exposed only to tetrachloroethylene.

What recommendations has the federal government made to protect human health?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and NIOSH.

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for tetrachloroethylene include the following:

The EPA maximum contaminant level for the amount of tetrachloroethylene that can be in drinking water is 0.005 milligrams tetrachloroethylene per liter of water (mg/L) (0.005 ppm).

EPA has established regulations and procedures for dealing with tetrachloroethylene, which it considers a hazardous waste. Many regulations govern its disposal. If amounts greater than 100 pounds are released to the environment, the National Response Center of the federal government must be told immediately.

OSHA limits the amount of tetrachloroethylene that can be present in workroom air. This amount is limited to 100 ppm for an 8-hour workday over a 40-hour workweek. NIOSH recommends that tetrachloroethylene be handled as a chemical that might potentially cause cancer and states that levels of the chemical in workplace air should be as low as possible.

1.8 Where can I get more information?

For additional information on tetrachloroethylene, refer to the ATSDR Toxicological Profile at: http://www.atsdr.cdc.gov/toxprofiles/tp18.html

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1997. Toxicological profile for tetrachloroethylene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

CERTIFICATION

This A-1 Stop Cleaners health consultation was prepared by the Colorado Department of Public Health and Environment under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was conducted. Editorial review was completed by the Cooperative Agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation, and concurs with its findings.

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