

Health Consultation

**EVALUATION OF INDOOR AIR MIGRATION IN BUILDING ON-SITE
AND ADJACENT TO THE OMEGA CHEMICAL SITE**

WHITTIER, LOS ANGELES COUNTY, CALIFORNIA

EPA FACILITY ID: CAD042245001

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

Department of Health Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Table of Contents

Background and Statement of Issue.....	1
Soil Gas.....	3
Indoor Air.....	4
Outdoor Air.....	6
Discussion.....	6
Comparing Outdoor Air to Indoor Air.....	6
Contaminated Soil Gas as a Source for Indoor Air Contamination.....	6
Utility Corridors Providing a Preferential Pathway for the Contamination	6
Evaluating the Indoor Air Data.....	7
An Indoor Source for Tetrachloroethylene (PCE) at Skateland	7
Exposure Pathway Evaluation	7
Public Health Implication	9
Noncancer Health Effects Evaluation.....	10
Exposure Dose Estimates.....	10
Workers and Patrons at Skateland	10
Terra Pave Workers	11
Exposure Evaluation: Skateland and Terra Pave	11
Cancer Health Effects Evaluation.....	13
Cancer Risk Estimates for Skateland and Terra Pave.....	14
ATSDR Child Health Considerations.....	16
Limitations of the Evaluation.....	16
Environmental Data	16
Exposure Assessment.....	16
Contaminant Toxicity	17
Conclusions.....	17
Public Health Recommendations and Actions.....	17
Actions Completed.....	18
Actions Planned	18
Recommendations for Further Actions	18
Preparers of Report	20
Certification	21
References.....	22
Appendix A—Table A1	26
Appendix B—Figures	31
Appendix C—Toxicological Profiles for Contaminants.....	37

Background and Statement of Issue

The Omega site is approximately 40,000 square feet in area and is located between 12504 and 12512 East Whittier Boulevard in the City of Whittier, Los Angeles County, California (Appendix B, Figure 1). There are two buildings on the Omega site: a 24,000 square foot warehouse and a 2,400 square foot administrative building. The Omega site is paved with concrete and is surrounded by a 7-foot high chain-link fence topped with razor wire (9).

Prior to 1976, the site housed several different industrial operations, including a bullet manufacturer (until 1963), a business that converted vans to ambulances (1966 to 1971), and a chemical processing facility (1971 to 1976) (9).

From 1976 to approximately 1991, the Omega Chemical Corporation and Omega Refrigerant Reclamation operated as a spent solvent and refrigerant recycling and treatment facility, handling primarily hydrocarbons and chlorofluorocarbons (10). The Omega site received and processed drums and bulk loads of waste solvents and chemicals from various industrial activities, to form commercial products that were either returned to the generators or sold in the marketplace. The hazardous wastes stored on the Omega site consist of mainly chlorinated and aromatic solvents. In June 1995, before removal activities, there were thousands of drums of hazardous waste, two roll-off bins of hardened resin material, hundreds of empty contaminated drums, numerous cylinders weighing from 15,000 to 20,000 pounds, and various other smaller containers of waste and/or hazardous waste stored on the Omega site (11). In addition, there were several hundred 55-gallon drums containing chemical products and hazardous materials stored in the warehouse on the Omega site (9).

Between 1985 and 1988, three environmental investigations were conducted at the Omega site under the oversight of the Los Angeles County Department of Health Services, Department of Public Works, and Fire Department (10). These investigations included sampling of soil gas (contaminants in soil and/or groundwater that volatilize, resulting in contaminated gases migrating upward through the soil air space), soil, and groundwater beneath the Omega site.

In 1987, Fred R. Rippy, Inc., a previous business owner and operator at the Omega site, hired the environmental consulting firm Leighton & Associates to document the removal of a 500-gallon underground storage tank (UST) and to sample the contents of the UST and surrounding soils. In 1988, two environmental investigations were conducted at the Omega site that found several volatile organic compounds (VOCs) in the subsurface soil and groundwater.

In 1995, the U.S. Environmental Protection Agency (EPA) Superfund Emergency Response Office oversaw Phase I Drum Removal Activities, during which the responsible party group removed over 4,000 steel and polyethylene 55-gallon drums from the outside storage pad, administration building, and warehouse (10, 11). These drums, as well as recovered and generated liquids and other material such as solidified resin and above-ground storage tanks, were removed to various off-site treatment, storage, and disposal facilities (TSDFs); the remaining structures were also cleaned (10).

Phase II activities began in November 1995 and included the collection and analysis of subsurface soil, groundwater, and soil gas at the Omega site by the responsible parties (10).

In September, 2006, the Skateland property was purchased by the Omega Chemical PRP Group LLC. All public access to the property has ceased and the building is scheduled for demolition (Christopher Lichens, U.S. Environmental Protection Agency, personal communication, 2006).

This health consultation evaluates the soil, groundwater, and soil gas data obtained during the Phase II activities to determine if there are current and future exposures to on-site businesses and the community in the vicinity of the Omega site. Based on the analytical results obtained during Phase II activities, contaminants detected in the subsurface soil include tetrachloroethylene (PCE), trichloroethylene (TCE), 1,1-dichloroethylene (1,1-DCE), freons and other chlorinated hydrocarbons, and metals (10). The contaminants in groundwater included PCE as well as freons and other chlorinated hydrocarbons. In addition, a groundwater plume contaminated with PCE has migrated downgradient of the Omega site, and is designated as Operable Unit One (Appendix B, Figure 2). This contamination appears to have migrated in a southwesterly direction. However, the vertical and horizontal extent of the contamination is not currently known. The contaminants detected in the soil gas include Freon 113, Freon 11, PCE, and trichloroethane (TCA) (10). Due to the significant release of hazardous substances into the groundwater, EPA proposed the site for listing on the National Priorities List (NPL) in September 1998. The site was placed on the NPL on January 19, 1999 (12). EPA is conducting an in-depth investigation of the Omega site and evaluating clean-up alternatives (9).

The land around the Omega site is used for commercial and industrial purposes. Figure 3 in Appendix B illustrates the locations of the five buildings on or near the Omega property. To the south of the site is Skateland. Skateland is a local skating rink that has been in operation since the 1950s. According to the current owner, Skateland is open for about 26 hours a week. The property is located to the south of the Omega property's site boundary line. Medlin and Son Engineering (hereafter Medlin) is a machine shop and has been located in a building northwest of the Omega Property since February 1998. Terra Pave is a construction and paving company that has been in the same location since 1992, to the east of the Omega's site boundary.

In 2003, Star City Auto Body began occupying the 24,000 square foot warehouse on the property. The Three Kings Construction company (hereafter Three Kings) began occupying the 2,400 square foot office building on the property in 2004 (13).

According to federal law, a public health assessment (PHA) must be conducted on every site nominated to the NPL. The California Department of Health Services (CDHS), under the cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR), released a PHA related to the Omega Chemical site in 2001. In that document, CDHS identified the site as posing an indeterminate public health hazard to on-site and off-site workers, who could have breathed VOCs emanating from the soil underneath buildings where they were working. In the PHA, CDHS identified four contaminants typically associated with soil gas contamination on the Omega site as contaminants of concern (COCs) for the indoor air exposure pathway: PCE, 1,1,1-TCA, freon 11, and freon 113. In the PHA, CDHS recommended more indoor air sampling and installing soil gas probes at various depths.

In 2004, EPA requested the responsible party sample the indoor air for soil gas contamination. In addition to the indoor air testing, the responsible party conducted additional soil gas sampling. In this health consultation, CDHS will review soil gas and indoor air data relating to the indoor air exposure pathway.

Soil Gas

Camp Dresser & McKee, Inc. (CDM) was hired as the responsible party's consultant and conducted soil gas sampling on and near the Omega site in April 2004 and November 2004. The sampling was focused within the site boundary (Appendix B, Figures 3 and 4). Nine soil gas samples (SG-4 through SG-12) were taken on the Omega property at depths of 6 and 12 feet below ground surface in April 2004. In November 2004, CDM sampled at deeper depths (18 and 24 feet below ground surface) at SG-7 through SG-11 on the Omega property (14). In November 2004, soil gas samples SG-13 through SG-15 (6 and 12 feet below ground surface) were taken along the southern end of the Skateland property. In November 2004, CDM collected 12 soil gas samples along two utility corridors. The samples (UC-1 through UC-12) were targeted along the sewer lines and the water lines, and ranged in depth from 2 to 11 feet below ground surface. CDHS reviewed the soil gas results from April and November 2004 (14) to see if there was contamination near buildings that could affect the indoor air quality.

Elevated concentrations of VOCs ranging from (852,000 to 4,940,000) microgram per meter cubed ($\mu\text{g}/\text{m}^3$) were found in the soil gas on and near the property. Of the nine soil gas sampling locations within the Omega site boundary, Freon 113 generally had the highest concentration. SG-10 had highest concentration of Freon 113, reaching 1,000,000 microgram per meter cubed ($\mu\text{g}/\text{m}^3$). Exceptions to this trend were SG-4, SG-10, and SG-12, where PCE was the predominant contaminant ranging from 280,000 to 1,500,000 $\mu\text{g}/\text{m}^3$. On site, PCE was the second most common contaminant in soil gas. Generally speaking, 1,1-DCE and Freon 11 are the third and fourth most common contaminants in soil gas on the Omega site (14).

Freon 113 is also the most prevalent contaminant in soil gas samples on the Skateland property, ranging in concentrations between 6,500 $\mu\text{g}/\text{m}^3$ and 1,500,000 $\mu\text{g}/\text{m}^3$. The second most prevalent contaminant in soil gas south of Skateland is 1,1-DCE. Comparing the contaminants found in SG-13 and SG-15 (Appendix B, Figure 4) shows the value for TCE ranging from 1,700 $\mu\text{g}/\text{m}^3$ to 3,500 $\mu\text{g}/\text{m}^3$. Contaminants from the Omega property are moving to the Skateland property.

The soil located near the Medlin property is also contaminated with VOCs. For example, unusually high total VOC concentrations ranging from 6,310,000 to 7,710,000 $\mu\text{g}/\text{m}^3$ were detected in soil gas samples SG-1, SG-2, and SG-3 near the Medlin property (Appendix B, Figure 4). The totals for these sampling locations are at least twice as high as the concentrations for the samples taken within the nearest site boundary sampling locations (SG-4 through SG-6). The order of the quarterly concentration levels from most prevalent to least in the soil gas around the Medlin property is: Freon 113, PCE, Freon 11, 1,1-DCE, and TCE. No soil gas samples were taken on the property (Terra Pave) west of the Omega site in April 2004 or November 2004 (soil gas samples within utility corridors along Terra Pave were taken in November 2004).

In addition to the contamination moving laterally, soil gas contamination is consistently moving vertically down into the soil. For instance, in all four sampling locations where soil gas was collected at 6, 12, 18, and 24 feet below ground surface, the concentrations of VOCs do not change. At most sampling depths and locations, the individual VOCs ranged in concentration from 100,000 $\mu\text{g}/\text{m}^3$ to 1,000,000 $\mu\text{g}/\text{m}^3$.

The high levels of VOCs in the soil gas suggest that the soil is saturated with contaminants. In addition to the saturated soils impacting the indoor air quality of nearby buildings, soil gas contamination can preferentially move along utility corridors and into buildings farther away. CDM sampled 12 locations along utility corridors and sewer and water lines, in November 2004. CDM also took real-time measurements for total VOCs at those same locations. The concentrations of VOCs in the utility corridor samples were lower than nearby soil gas samples around Skateland, indicating that chemicals can migrate via the utility corridors. (14).

Samples taken along the western end of the Star City Auto Body building above the main sewer line were high in VOCs (maximum 2,160,000 $\mu\text{g}/\text{m}^3$) and similar to the nearby soil sampling locations. High concentrations of VOCs (1,110,000 $\mu\text{g}/\text{m}^3$ and 2,860,000 $\mu\text{g}/\text{m}^3$) were also found at the two sampling locations above the water line running in front of the Terra Pave building and along Putnam Street.

Indoor Air

Of the chemicals shown in Table A1 (Appendix A), six chemicals were either detected at very low levels or not detected at all in indoor air. According to the 2001 PHA, 1,1,1-TCA was found in the groundwater and soil gas. As shown in Table A1, TCA was reported at 1.2 $\mu\text{g}/\text{m}^3$ in Skateland's boys restrooms on August 4, 2004, but after additional sampling took place, the levels fell to non-detect by September 2005. After reviewing this sampling data, CDHS removed TCA as a potential COC because it did not exceed the health comparisons values.

CDM initiated indoor air sampling in May 2004. On the basis of those findings, EPA requested additional indoor sampling, which has been conducted on a periodic basis since May 2004. As part of this health consultation, CDHS reviewed indoor air results from May 2004, August 2004, September 2004, December 2004, January 2005, and September 2005 (14).

Indoor air samples were taken in two buildings on the former Omega site (Three Kings and Star City Auto Body) and in three nearby buildings (Terra Pave, Medlin, and Skateland). As shown in Table A1, samples were taken at different buildings and different locations on each of the sampling dates. Particular attention was given to sampling inside Skateland because the highest contaminant concentrations were detected in that building. Ten locations within Skateland were sampled.

As shown in Table 1 below, high levels of VOCs were measured in all locations inside Skateland in May 2004. Freon 113 (1,300 $\mu\text{g}/\text{m}^3$) and PCE (1,100 $\mu\text{g}/\text{m}^3$) showed the highest concentrations among the five COCs for the site (14). On December 30, 2004, the concentrations for Skateland's five COCs dropped in all indoor air sampling locations. The drop in the concentrations may be due to the interim measure taken by the responsible party earlier in

December that consisted of sealing the foundation's openings and/or seasonal variation that can occur for soil gas affecting indoor air. In late December 2004, carbon filter air purifiers (Appendix B, Figure 5) were installed in the boys restroom, girls restroom, and kitchen. The purifier pulls air through the carbon filter, removing VOCs from the air and reducing indoor air concentrations. However, the results of the sampling events in mid-January 2005, and then again in September 2005, demonstrates the interim measures were not sufficient enough to continue to lower the concentrations.

CDHS compared the indoor air results from the five businesses to the data gathered as part of EPA's Building Assessment Survey and Evaluation (BASE) study (Table 1, below). The BASE study was undertaken to establish a range of concentrations for VOCs in typical office buildings. Indoor air concentrations were taken at the following buildings: Star City Auto Body, Medlin, Three Kings, and Terra Pave (Table 1). Indoor air concentrations measured in May 2004 were lower in these buildings than those measured in Skateland. Indoor air concentrations of VOCs found in soil gas decreased in Terra Pave, Medlin, and Three Kings from May 2004, compared with the second indoor air sampling event in September 2005. Since there has been no additional indoor air sampling, it is not clear if this is really a downward trend. Also, CDHS is not aware of any interim measures that would explain this decrease in concentration. Table 1 reflects the highest concentrations (in $\mu\text{g}/\text{m}^3$) for the listed structures (typical indoor concentrations in commercial buildings are shown in the bottom row) (15).

Table 1. Maximum Concentrations and Comparison Values for the Five Contaminants of Concern Measured in Indoor Air On or Near the Omega Chemical Site ($\mu\text{g}/\text{m}^3$)

Sample Location	1,1-DCE	Freon 113	Freon 11	PCE	TCE
Skateland (2004)	550*	1,300 [†]	350 [†]	1,100 ^{†‡}	270 ^{†‡}
Skateland (January 2005)	280*	1,000 [†]	210 [†]	56 ^{†‡}	14 [‡]
Skateland (September 2005)	290*	1000 [†]	280 [†]	84 ^{†‡}	37 [†]
Star City Auto Body (May 2004 and September 2005)	18	31 [†]	14	34 [‡]	6.5 [‡]
Terra Pave (May 2004 and September 2005)	20	26 [†]	7.0	110 [†]	4.4
Three Kings (September 2005)	4.9	4.2	3.8	7.6 [‡]	2.2
Medlin (May 2004 and September 2005)	10	40 [†]	12	22 [‡]	14 [‡]
EPA's Building Assessment Survey and Evaluation (BASE) study	NA	1.4-23	2.2-160	0.3-50	0.2-18
Health Comparison Value ($\mu\text{g}/\text{m}^3$)	80 (iMRL)	3,100 (PRG)	7,300 (PRG)	300 (cMRL) 1,000 (aMRL) 1.69 (CREG)	500 (iMRL) 600 (REL)

* Concentrations exceed a noncancer health comparison value. [†] Concentrations exceed the upper limit of the BASE study range.

[‡] Concentrations exceed the cancer health comparison value. aMRL: ATSDR acute duration (less than 15 days) inhalation Minimal Risk Level. cMRL: ATSDR chronic duration (more than 365 days) inhalation Minimal Risk Level. iMRL: ATSDR intermediate duration (15-365 days) inhalation Minimal Risk Level. CREG: Cancer Risk Evaluation Guide for 1 in 1,000,000 increased cancer risk. PRG: EPA Region IX Preliminary Remediation Goal.

Outdoor Air

The responsible parties took ambient air samples at the same time they took the indoor air samples. Contaminants in the ambient air samples can also affect the indoor air quality. The location of the five ambient air samples are at the Rippy Parking Lot, roof intake on Medlin, between Star City Auto Body and Three Kings, between Star City Auto Body and Medlin, and near the Former Merchants Meteorological station (Table A1, Appendix A) . These samples were all taken within the breathing zone.

All five of the COCs were detected at very low levels in the outdoor air samples (Table A1). The following is the range of levels for each of the five COCs (in $\mu\text{g}/\text{m}^3$): PCE, 0.55-1.7; TCE, 0.23-1.1; 1,1-DCE, 0.15-0.66; Freon 11, 1.6-2.0; and Freon 113, 0.73-1.8. Four of the five COCs were not detected in outdoor air sampled at Star City Auto Body (rear area of shop); Freon 11 was detected at $1.7 \mu\text{g}/\text{m}^3$. However, acetone was detected at $4,000 \mu\text{g}/\text{m}^3$ at that location (acetone is a common waste product in auto body shops). The contaminant 1,1-DCE was not detected at the Former Merchants Meteorological location.

Discussion

Comparing Outdoor Air to Indoor Air

As is typically seen, indoor air concentrations of the five COCs were higher inside than outside (Table A1). Although the outdoor air may be a small contributor to indoor air levels, there appears to be other sources influencing the indoor air, i.e., the soil gas.

Contaminated Soil Gas as a Source for Indoor Air Contamination

The California Office of Environmental Health Hazard Assessment has developed chemical-specific screening values for soil gas for two land uses: residential and commercial/industrial. These screening values are called California Human Health Screening Levels (CHHSLs). CHHSLs have been developed for TCE and PCE but not for the other three COCs. If a soil gas value is less than the CHHSL, it can be assumed that it will not pose a significant health risk. The CHHSLs for PCE and TCE are based on an excess lifetime cancer risk of one-in-a-million, assuming the person works 250 days per year for 25 years and breathes 20 m^3 of air per shift (16).

Levels of PCE and TCE in all the soil gas samples taken on or near the Omega property exceed their respective commercial/industrial CHHSL (PCE = $603 \mu\text{g}/\text{m}^3$ and TCE = $1,770 \mu\text{g}/\text{m}^3$). In most sampling locations, the soil gas levels for TCE and PCE exceed the CHHSLs by several orders of magnitude.

Utility Corridors Providing a Preferential Pathway for the Contamination

Utility corridors may play a role in the movement of VOCs within and nearby the Omega site. For instance, total VOC concentrations in the utility corridor samples nearby ranged from 3,930 to $2,860,000 \mu\text{g}/\text{m}^3$.

On the western edge of the Omega property, the utility corridors samples were similar to the VOC levels found in nearby soils. This implies that utility corridors may play a role in the contamination spreading to other locations and to indoor air.

The total VOC concentrations in the utility corridors samples taken along Putnam Street were very high; the range was between 1,110,000 to 2,860,000 $\mu\text{g}/\text{m}^3$. Recently, a soil vapor sample was taken from in front of the Terra Pave office and showed similarly high levels of total VOCs (17). The utility corridors could be contributing to the movement of the VOCs.

Evaluating the Indoor Air Data

As described above, the soil gas samples, below ground surface and near several buildings located on or near the Omega site, are highly contaminated with VOCs. The indoor air sampling indicates the largest impact is occurring at Skateland. Several of the other buildings also seem to have been impacted by the contamination to a lesser degree. The levels of Freon 113 measured in Star City Auto body and Medlin exceed the range found in the BASE study. The concentrations of Freon 113 and PCE measured in Terra Pave exceed the BASE study concentration ranges. At Skateland, all five of the COCs surpassed the concentrations listed in the BASE study.

An Indoor Source for Tetrachloroethylene (PCE) at Skateland

CDHS learned from EPA that the roller rink floor was refinished 4 weeks prior to the May 11, 2004, sampling event with a product called Tite Coat, a floor refinishing product known to contain PCE. This could be a possible reason for the high concentrations of PCE in Skateland in the May 2004 sampling event (18). Another product called Lift Off was stored in the building but was not used. Lift Off is also known to contain PCE.

Exposure Pathway Evaluation

For a receptor population to be exposed to environmental contamination, a mechanism known as an exposure pathway must connect that contamination with the target population. An exposure pathway consists of five parts: 1) a source of contamination, 2) an environmental medium and transport mechanism, 3) a point of exposure, 4) a route of exposure, and 5) a receptor population.

Exposure pathways are classified as either completed, potential, or eliminated. A completed exposure pathway is one in which all five elements of the pathway are present. A potential pathway is one in which one or more elements of the pathway are missing but might have been present or might be present later. A pathway can also be described as a potential pathway if information on one of the elements of the pathway is missing. An eliminated pathway is one in which one or more of the elements are missing and will not be complete in the future. For a population to be exposed to an environmental contaminant, a completed exposure pathway (all five elements) must be present. If any one or more of these elements are missing, then no exposure is present, though contamination could still be substantial and require remediation. This is especially true if an incomplete exposure pathway could become complete in the future.

This health consultation focuses on the inhalation of contaminants in the indoor air, from soil gas defused into the building from the contaminated soil at the Omega site. The evaluation at Skateland will include exposure to the workers as well as the patrons (Table 2, below). At the other buildings, CDHS will evaluate the exposure to the workers.

Table 2. Exposure Pathways for buildings on or near the Omega Chemical Facility

Pathway	Possible Source	Media	Exposure Point	Exposure Route	Receptor	Time	Status
Medlin	Omega property	Soil gas	Inside building located near Omega site	Inhalation	Medlin workers	Past, present, and future	Potential
Star City Auto Body	Omega property	Soil gas	Inside building located on Omega site	Inhalation	Star City Auto Body workers	Past, present, and future	Potential
Three Kings	Omega property	Soil gas	Inside buildings located on Omega site	Inhalation	Three Kings workers	Past, present, and future	Potential
Terra Pave	Omega property	Soil gas	Inside buildings located near Omega site	Inhalation	Terra Pave workers	Past, present, and future	Completed
Skateland	Omega property	Soil gas	Inside building located near Omega site	Inhalation	Skateland workers, recreational users	Past, present, and future	Completed

First, CDHS compared indoor air data to health comparison values developed for each of the COCs. This is a screening step that helps identify those pathways that need further evaluation (see Public Health Implications section). The highest concentrations of VOCs were found to be present in Skateland. The concentrations measured in indoor air in May 2004 and January 2005 exceeded both the cancer risk for TCE and PCE and the noncancer risk for 1,1-DCE. In May 2004, the level of PCE in Skateland exceeded its noncancer health comparison value. However, as described previously, the concentrations dropped in subsequent sampling rounds to levels below noncancer health comparison values. The exposures in Skateland will be evaluated further in the next section.

When the other four buildings (excluding Skateland) were tested, the concentrations of the five COCs did not exceed their noncancer health comparison values. The concentrations of PCE measured in these four buildings exceeded the cancer health comparison value; however, in Star City Auto Body, Medlin, and Three Kings, the concentrations of PCE were within the range of typical indoor air for commercial/industrial buildings (15). CDHS will evaluate the increased risk to Terra Pave employees due to the high concentrations of PCE that exceeded cancer health comparison value and the range of typical concentrations for a commercial/industrial building. Concentrations of PCE exceeded cancer health comparison values in Medlin and Star City Auto Body, but these levels are within typical levels found in commercial/industrial buildings and will not be further evaluated in this health consultation. CDHS has decided not to further evaluate the risk caused by PCE to the workers in the Medlin, Star City Auto Body, and 3 Kings Buildings because, the PCE levels fell within an acceptable risk range as defined by the BASE study;

indicating that other sources other than soil gas are contributing. Commercial products and housing components that give off PCE are beyond the scope of this health consultation.

Because there has only been limited indoor air sampling, CDHS considers indoor air exposures to workers in Star City Auto Body, Medlin, and Three kings as a potential pathway. Additional indoor air sampling is needed to ensure that the exposures do not pose a public health hazard.

Public Health Implication

As discussed in the previous section, CDHS identified two buildings (Skateland and Terra Pave) near the Omega site that may be impacted by nearby soil gas infiltrating into the indoor air; further evaluation of the health impact to the occupants of the buildings is needed. In this section, CDHS will determine the health implications of these exposures to the individuals using those buildings.

When individuals are exposed to a hazardous substance, several factors determine whether harmful health effects can potentially occur. These factors include the dose (how much), the route by which they are exposed (breathing, eating, drinking, and skin contact), other contaminants to which they may be exposed, and individual characteristics such as age, sex, nutrition, family traits, lifestyles, and general state of health. The scientific discipline that evaluates these factors and the potential for a contaminant to adversely impact health is called toxicology.

In this toxicological evaluation, CDHS determined whether cancer or noncancer health effects were likely to occur among the various groups of people for whom a completed exposure pathway exists. The affected groups are workers at Terra Pave, and workers and patrons at Skateland.

The following is a summary of what the health comparison values iMRL for 1,1-DCE and cMRL for PCE are based on. For more known information about noncancer health effects caused by 1,1-DCE and PCE, see appendix C.

1,1-DCE: ATSDR developed an intermediate MRL for breathing 1,1-DCE from a study of guinea pigs (3). When the guinea pigs breathed $20,000 \mu\text{g}/\text{m}^3$ 1,1-DCE, equivalent to 5 parts per million (ppm), for 24 hours per day for 90 days (about 1/8 their life), there were no effects seen on their liver. At 48 ppm for the same exposure time, changes in the liver could be measured in blood. The effect on the liver would not necessarily result in a symptom but could be picked up with a clinical evaluation. The lack of liver effects or other effects in other studies (see Appendix C for a summary of other studies of noncancer effects from breathing 1,1-DCE) at $20,000 \mu\text{g}/\text{m}^3$ (5 ppm), resulted in this being determined by ATSDR as no-observed-adverse-effect level (NOAEL). Thus $20,000 \mu\text{g}/\text{m}^3$ (5 ppm) was used to develop the iMRL.

Using the NOAEL of $20,000 \mu\text{g}/\text{m}^3$ (5 ppm), ATSDR applied an uncertainty factor of 100 (10 for extrapolation from animals to humans, and 10 for human variability) and a modifying factor of 3 to account for the fact that “serious” effects were seen in other studies at concentrations ranging from $40,000$ - $90,000 \mu\text{g}/\text{m}^3$ (10-25 ppm) (3, 7, 8).

Noncancer Health Effects Evaluation

The approach used to evaluate the potential for adverse health effects, other than cancer, to occur in an individual or population assumes that there is a level of exposure below which noncancer adverse health effects are unlikely to occur. That level is called the threshold level or health comparison value. Health comparison values, adjusted for the length and amount of time that a person is exposed, are derived from a threshold value with uncertainty factors. These health comparison values are estimates of daily exposure to the human population, including sensitive subgroups, below which noncancer adverse health effects are unlikely to occur. They only consider noncancer effects. Because they are based only on information currently available, some uncertainty is always associated with the health comparison value. The uncertainty factor takes into account the differences in response to toxicity for a given contaminant within human and animal populations, and between humans and animals, as well as the quality of the database and the type of toxicological effects.

PCE: ATSDR developed a chronic MRL (above 365-days exposure) for breathing PCE from a study of 60 women exposed in dry-cleaning shops (1). Compared to 30 women who worked at a cleaning plant where solvents were not used, the women exposed to solvents had changes in several tests of neurological function: simple reaction times, shape comparison-vigilance, and shape comparison-stress. The median concentration of PCE in the air was 102,000 $\mu\text{g}/\text{m}^3$ (15 ppm) and the range was 7,000-450,000 $\mu\text{g}/\text{m}^3$ (1-67 ppm).

ATSDR used 102,000 $\mu\text{g}/\text{m}^3$ (15 ppm) as the lowest-observed-adverse-effect level (LOAEL) and applied an uncertainty factor of 100 (10 for using a LOAEL and not a NOAEL and 10 for human variability). To convert from an occupational exposure to a continuous exposure, the 102,000 $\mu\text{g}/\text{m}^3$ (15 ppm) was multiplied by 8/24 hours and 5/7 days.

The greater the uncertainty in our knowledge, the greater the safety factor, and the lower the health comparison value. Exceeding a health comparison value does not imply that a contaminant represents a public health threat, but suggests that the contaminant warrants further consideration.

In order to determine whether adverse noncancer health effects are possible as a result of exposure to a contaminant, an exposure dose/concentration must be estimated for each pathway. This exposure dose concentration can then be compared with appropriate health comparison values in order to evaluate the likelihood of adverse health effects occurring. Health comparison values used to evaluate noncancer adverse health effects include ATSDR's Minimal Risk Level (MRL), USEPA's Preliminary Remediation Goal (PRG), and California EPA (CalEPA)'s Reference Exposure Level (REL). These values are estimates of daily human exposure to a contaminant below which noncancer, adverse health effects are unlikely to occur.

Exposure Dose Estimates

Workers and Patrons at Skateland

According to the Risk Assessment Guidance (19), CDHS has set the exposure duration for the Skateland worker at 25 years. The patron's exposure durations will be set at 30 years. CDHS assumes that patrons will visit Skateland for the maximum number of hours per week they are open, 26 hours/week. CDHS chose these exposure assumptions based on personal

communication with the owner and patrons of the rink (Joe Franco, Skateland owner, personal communication, 2006). These exposure assumptions are realistic based on these communications. The 30 year exposure frequency duration was chosen because CDHS assumed the chemical exposure to Skateland did not exist prior to 1976. CDHS will evaluate the exposure to both an adult and a child patron. CDHS also assumes a child begins going to Skateland at age 6 and continues into adulthood (30 years).

Terra Pave Workers

CDHS has set the Terra Pave worker's exposure durations at 14 years, since the company has been at the present location (on Putnam Street) since 1992. CDHS assumed the Terra Pave employee works 40 hours.

Exposure Evaluation: Skateland and Terra Pave

Table 3 below is a presentation of the indoor air concentrations for the five COCs adjusted for exposure frequency and exposure duration, and the health comparison values to compare them to see if further evaluation is needed. If the adjusted indoor air exposure concentration exceeds the health comparison value, then it will be evaluated further.

Exposure-adjusted concentrations for TCE, Freon 11, and Freon 113 do not exceed their corresponding noncancer chemical-specific health comparison value for workers in Terra Pave or for workers and patrons in Skateland.

Exposure-adjusted indoor air concentrations of 1,1-DCE for Skateland workers (pre- and post-remediation) and Skateland patrons (pre- and post-remediation) exceed the intermediate Minimal Risk Level (iMRL) (Table 3, below). The exposure-adjusted indoor air concentrations of PCE for Skateland workers and patrons (pre-remediation) exceed the cMRL. The exposure-adjusted indoor air concentrations of PCE for Skateland workers and patrons (post-remediation) and Terra Pave workers do not exceed the cMRL.

Table 3. Noncancer Assessment and Health Comparison Values for Buildings On or Near the Omega Site

Populations for Which Noncancer Assessment Was Performed	Indoor Air Concentrations Adjusted for Exposure Frequency and Exposure Duration ($\mu\text{g}/\text{m}^3$)					Exceed Health Comparison Value?
	TCE	PCE	1, 1-DCE	Freon 11	Freon 113	
Skateland workers (pre-remediation)	120	490*	245*	156	579	Yes: 1,1-DCE iMRL Yes: PCE cMRL
Skateland patrons (pre-remediation)	125	509*	255*	162	602	Yes: 1,1-DCE iMRL Yes: PCE cMRL
Skateland workers (post-remediation)	6.23	24.9	125*	93.5	445	Yes: 1,1-DCE iMRL
Skateland patrons (post-remediation)	6.48	25.9	130*	97.2	463	Yes: 1,1-DCE iMRL
Terra Pave workers	3.01	75.3	13.7	4.79	17.8	No
Health comparison value	500 iMRL 600 REL	300 cMRL 1,000 aMRL	80 iMRL	7,300 PRG	3,100 PRG	

*Exposure-adjusted concentration

iMRL: ATSDR intermediate duration (15-365 days) inhalation Minimal Risk Level; REL: Office of Environmental Health Hazard Assessment Reference Exposure Level; cMRL: ATSDR chronic duration (more than 15 days) inhalation Minimal Risk Level; aMRL: ATSDR acute duration (less than 15 days) inhalation Minimal Risk Level; PRG: EPA Region IX Preliminary Remediation Goal

Adjusted indoor air concentrations = $C_{\text{air}} \times \text{EF} \times \text{ED}/\text{AT}$

Where C_{air} = Concentration of contaminant in air ($\mu\text{g}/\text{m}^3$)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

AT = Averaging Time (ED x 365 days/year)

Assumptions used for calculating the dose

C_{air} is taken from Table 1 in the text; EF assumes Skateland is open 26 hours/week (or 3.25 days/week) and the individual was there that entire time and 52 weeks/year; ED for Skateland workers = 25 years (19); ED for Skateland child patron = 13 years, assuming they started skating at age 6 and continued until they became an adult (age 19); ED for Skateland adult patron = 17 years or ages 19-36, making a total of 30 years for a patron that went there as a child and then as an adult; ED for Terra Pave workers = 14 years, based on the company beginning business at that location in 1992 and on the analysis being conducted in 2006; cancer AT values for all populations = 25,550; noncancer AT values for Skateland workers = 9,125; noncancer AT values for child patron = 4,745; noncancer AT values for adult patron = 6,205; noncancer AT values for Terra Pace worker = 5,110; noncancer post-remediation AT values for all populations except Terra Pave = 574.5

As described in the box to the right, the levels at which these contaminants cause noncancer effects in animal or human studies are higher than the exposure-adjusted indoor air concentrations that represents the exposures that happened or are happening in Skateland. For instance, neurological effects occurred to women who were exposed on a long-term basis to 101,000 $\mu\text{g}/\text{m}^3$ (6,800-455,000 $\mu\text{g}/\text{m}^3$) 1,1-DCE(15), compared to the exposure-adjusted concentrations calculated for Skateland workers and patrons of 130-255 $\mu\text{g}/\text{m}^3$. Thus it seems that noncancer effects from 1,1-DCE or PCE would not be expected. However, there are data gaps in our understandings of the health effects of these compounds, which limit CDHS from completely dismissing that noncancer effects could occur at the levels measured in Skateland. For instance, similar neurological effects that were seen in dry-cleaning workers exposed to PCE have been seen in people living near dry-cleaning establishments (exposure in the range 20-1,400 $\mu\text{g}/\text{m}^3$), though the effect was not statistically significant (42). Additional studies may show this or other effects to occur at concentrations lower than we now know.

Cancer Health Effects Evaluation

Cancer health effects are evaluated in terms of a possible increased cancer risk. Cancer risk is the theoretical chance of getting cancer. In California, 41.5% of women and 45.4% of men (about 43% combined) will be diagnosed with cancer in their lifetime (20). This is referred to as the “background cancer risk.” The term “excess cancer risk” represents the risk above and beyond the background cancer risk. A one-in-a-million excess cancer risk from a given exposure to the contaminant means that if one million people are chronically exposed to a carcinogen at a certain level over a lifetime, then one cancer above the background risk may appear in those million persons from that particular

The following is a summary of the information used to determine the cancer potency factor for TCE and PCE.

The National Toxicology Program, the International Agency for Research on Cancer, EPA, and CalEPA have reviewed available information from human and/or animal studies to determine whether certain contaminants are likely to cause cancer in humans. The potential for cancer to occur in an individual or a population is evaluated by estimating the probability of an individual developing cancer over a lifetime as the result of the exposure. CalEPA has developed inhalation unit risk values/cancer slope factors for many carcinogens. A unit risk value/cancer slope factor is an estimate of a contaminant's potential for causing cancer when it is breathed. The following is a description of the derivation of California's inhalation unit risk values/cancer slope factors for TCE and PCE.

- **TCE:** the State of California has determined that TCE is carcinogenic and that it does not have a threshold for carcinogenicity (i.e., even low doses can cause cancer). The State of California made a quantitative determination on the potency of breathing TCE to cause cancer, based on four mice studies. These four studies had mixed results: one study found a statistically-increased incidence of liver cancer (4). Another study found no statistically-increased incidence of cancers in male mice but found a statistically-increased incidence of malignant lymphomas in female mice (5). Another study found a higher incidence of lung cancer in mice exposed at the two higher dose groups (at 807,000 $\mu\text{g}/\text{m}^3$, 8 cancers in 50 female animals and at 2,420,00 $\mu\text{g}/\text{m}^3$, seven cancers in 46 female animals) (6). As seen in the tumor incidence, the effect was not dose-related, i.e., there was not an increased number of cancers. The fourth study found no significant increase in cancers in female mice breathing TCE, but a statistically-significant increase in liver tumors was seen at the highest dose in males (13 tumors in 90 male mice breathing 3,230,000 $\mu\text{g}/\text{m}^3$ TCE, compared to 4 tumors in 90 animals breathing no TCE). All of these studies involved the use of TCE that is stabilized with other contaminants, some of which are known to be potent carcinogens (epichlorhydrin), further confusing the ability to understand the cancer-causing capacity of TCE.

CalEPA determined the cancer potency of breathing TCE based on these four studies is 0.007 $(\text{mg}/\text{kg}/\text{day})^{-1}$. This potency was used to calculate an increased risk from breathing TCE inside Skateland and Terra Pave.

exposure. For example, in a million people, it is expected that approximately 430,000 individuals will be diagnosed with cancer from a variety of causes. If the entire population was exposed to the carcinogen at a level associated with a one-in-a-million cancer risk, 430,001 people may get cancer, instead of the expected 430,000. Cancer risk is not a prediction that cancer will occur; it merely suggests that there is a possibility.

Cancer Risk Estimates for Skateland and Terra Pave

CDHS chose these exposure assumptions based on personal communication with the owner and patrons of the rink (Joe Franco, Skateland owner, personal communication, 2006). The 30 year exposure frequency duration was chosen because CDHS assumed the chemical exposure to Skateland did not exist prior to 1976.

The results of the indoor air samples' cancer assessment for Skateland (pre-remediation) and Terra Pave is shown below in Table 4; the table also includes the exposure parameters and assumptions used in the evaluation. The total cancer risk is derived by summing the cancer risks values for TCE and PCE. The qualitative interpretation for the Skateland male worker and patron are considered to be a moderate increased risk; the cancer risk for the Skateland female worker and child and adult patrons is a low increased risk of getting cancer at these levels. The Terra Pave female and male workers' qualitative interpretation is a very low increased risk.

In December 2004, CDM installed carbon air filters at Skateland. With the installation of the air filters completed the VOC levels dropped for many of the containments of concern. This implies that the cancer risk has dropped. However, science does not support estimating theoretical increased cancer risk for short term exposures, as these estimates may misrepresent the actual risk (21). One reason is that the cancer slope factors are developed from studies that measures exposures over a long period of time. When estimating the theoretical increased cancer risk; CDHS used recommended a 9-year minimum exposure duration (22). Since it has only been a short time since the levels dropped inside Skateland, CDHS did not calculate a cancer for that period of time.

- **PCE:** there has been one lifetime study of the carcinogenic effects of breathing PCE in animals (2). The study found a dose-dependent increase in liver tumors in mice that breathed 679,000-1,360,000 $\mu\text{g}/\text{m}^3$ PCE for 6 hours per day, 5 days per week, for 103 weeks.

The State of California has determined that tetrachloroethylene is carcinogenic, and the mice study described above was used to determine the cancer potency of breathing PCE ($0.021 \text{ mg}/\text{kg}/\text{day})^{-1}$. This potency was used to calculate an increased risk from breathing TCE inside Skateland and Terra Pave.

Table 4. Cancer Risk Assessment with Qualitative Interpretation for Buildings On and Near the Omega Property

Populations for Which Cancer Risk Was Calculated	Cancer Risk from TCE	Cancer Risk from PCE	Total Cancer Risk	Qualitative Interpretation
Skateland male worker (pre-remediation)	8.0 E-05	9.8E-04	1.1 in 1,000	Moderate increased risk
Skateland female worker (pre-remediation)	6.3E-05	7.7E-04	8.3 in 10,000	Low increased risk
Skateland male child patron (pre-remediation)	6.4E-05	7.8E-04	8.4 in 10,000	Low increased risk
Skateland female child patron (pre-remediation)	5.4E-05	6.6E-04	7.1 in 10,000	Low increased risk
Skateland adult male patron (pre-remediation)	4.3E-05	6.9E-04	7.3 in 10,000	Low increased risk
Skateland adult female patron (pre-remediation)	4.3E-05	5.4E-04	5.8 in 10,000	Low increased risk
Skateland 30-year male patron (pre-remediation)	1.1E-04	1.5E-03	1.6 in 1,000	Moderate increased risk
Skateland 30-year female patron (pre-remediation)	9.9E-05	1.2E-03	1.3 in 1,000	Moderate increased risk
Terra Pave male worker	8.9E-07	6.7E-05	6.8 in 100,000	Very low increased risk
Terra Pave female worker	7.8E-07	5.9E-05	5.9 in 100,000	Very low increased risk

Cancer risk = SF x Cair x (BR/BW) x 0.001 x A x EF x ED/AT

Where SF = Slope Factor. Derived from the Office of Environmental Health Hazard Assessment inhalation unit risk (mg/kg/day)⁻¹

Cair = Concentration of contaminant in air (µg/m³)

BR = Breathing Rate (m³/day)

BW = Body Weight (kg)

0.001 = conversion factor (mg/µg)

A = Inhalation Absorption Factor (unitless). Used if the cancer potency factor itself includes a correction for absorption across the lung (23)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

AT = Averaging time; time period over which exposure is averaged (days)

Assumptions used for calculating the dose

Cair is taken from Table 1 in the text; BR for adult and child is the time weighted averaging of breathing rates for grouped ages for both females and males taken from Table 5-11 of Exposure Factors Handbook Volume 1 (24); BW for adult and child is the time weighted average of body weights for grouped ages for both females and males taken from Table 7-3 of Exposure Factors Handbook Volume 1 (24); EF assumes Skateland is open 26 hours/week (or 3.25 days/week) and the individual was there that entire time and 52 weeks/year; ED for Skateland workers = 25 years (19); ED for Skateland child patron = 13 years, assuming they started skating at age 6 and continued until they became an adult (age 19); ED for Skateland adult patron = 17 years or ages 19-36, making a total of 30 years for a patron that went there as a child and then as an adult; ED for Terra Pave workers = 14 years, based on the company beginning business at that location in 1992 and on the analysis being conducted in 2006; cancer AT values for all populations = 25,550; noncancer AT values for Skateland workers = 9,125; noncancer AT values for child patron = 4,745; noncancer AT values for adult patron = 6,205; noncancer AT values for Terra Pace worker = 5,110; noncancer post-remediation AT values for all populations except Terra Pave = 574.5

ATSDR Child Health Considerations

ATSDR recognizes that infants and children may be more sensitive to exposures, depending on substance and the exposure situation, than adults in communities with contamination of their water, soil, air, and/or food. This sensitivity is a result of several factors: 1) Children may have greater exposures to environmental toxicants than adults because pound for pound of body weight, children drink more water, eat more food, and breathe more air than adults; 2) Children play outdoors close to the ground which increases their exposure to toxicants in dust, soil, surface water, and in the ambient air; 3) Children have a tendency to stick their hands in their mouths while playing without washing their hands, thus, they may come into contact with, and ingest, potentially contaminated soil particles at higher rates than adults (also, some children possess a behavior trait known as "pica" which causes them to ingest non-food items, such as soil); 4) Children are shorter than adults, which means they can breathe dust, soil, and any vapors close to the ground; 5) Children's bodies are rapidly growing and developing; thus they can sustain permanent damage if toxic exposures occur during critical growth stages; and 6) Children and teenagers may disregard no trespassing signs and wander onto restricted locations. Because children depend completely on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests at sites such as the Omega site as part of the ATSDR Child Health Considerations.

CDHS has attempted to identify places (e.g., parks, schools, recreational facilities) in the vicinity of the Omega site where children spend time (i.e., live, play, or go to school). The location closest to the Omega site where children may spend time is at a skating rink that abuts the Omega site to the south (less than 100 feet away).

Limitations of the Evaluation

The identification and analysis of environmental exposure is difficult and inexact. This health consultation was prepared using different sources of information. There are varying degrees of uncertainty associated with each source of information. The following describes four broad areas where uncertainties may be found and provides examples of some of these uncertainties.

Environmental Data

CDHS assumes that adequate quality control measures were followed with regard to chain of custody, laboratory procedures, and data reporting. The validity of the analyses and conclusions reported in this health consultation depends on the completeness and reliability of the referenced information. As stated previously, there are data gaps in understanding past exposures which can no longer be filled. We have recommended sampling that can help fill data gaps in understanding current or future exposure.

Exposure Assessment

Exposure assumptions were used to estimate exposure doses. The exposure assumptions used in the health consult are meant to provide conservative (health protective) results for the exposure estimates.

Contaminant Toxicity

Toxicity information for the COCs was generated mostly from animal studies at high doses and in some cases, epidemiological studies of adult worker populations. For most contaminants, we really do not know what effects will result from low level exposure to humans.

Conclusions

On the basis of soil gas and indoor air data collected at the Omega site, it appears the contaminants found in the soil gas are impacting the indoor air quality at Skateland.

Indoor air samples were collected in Skateland, Medlin, Star City Auto Body, Three Kings, and Terra Pave. PCE (before December 2005) and 1,1-DCE exceed the health comparison values for noncancer adverse health effects in Skateland. When taking into account the amount of time that workers and patrons would have been breathing the air inside Skateland, the levels of PCE are several orders of magnitude lower than the levels at which health effects are known to have affected individuals. However, there are data gaps in our understandings of the health effects of these contaminants that limit CDHS from completely dismissing that noncancer effects (changes in liver function tests for 1,1-DCE and changes in tests of neurological function for PCE) could occur at the levels of 1,1-DCE and PCE in Skateland.

CDHS also evaluated the potential for carcinogenic effects of PCE and TCE in the indoor air at Skateland and Terra Pave (the other COCs are not considered carcinogenic). A moderate increased cancer risk exists to Skateland workers and patrons for a 25-year exposure. Since the air filters were installed in December 2004, it is not possible for CDHS to make an assumption on the post installation cancer risk levels for such a short exposure period. The exposure scenarios and calculations for the Skateland workers and patrons were developed when Skateland was fully operational. However, during the final drafts of the Health Consult preparation, Skateland was closed to the public thus removing the current and future exposure pathways. The Terra Pave workers cancer risk is considered a very low increased risk. During the final drafts of this health consultation, the Skateland property was purchased by the Omega Chemical PRP Group LLC in September 2006. All public access to the property has ceased and the building is scheduled for demolition.

In conclusion, on the basis on available data, CDHS and ATSDR classify the Omega site as posing no apparent public health hazard from the indoor air concentrations at the current time. The Omega site posed a public health hazard to the workers and patrons of Skateland Park prior to it being closed in the fall 2006.

Public Health Recommendations and Actions

The Public Health Recommendations and Action Plan (PHRAP) for this site contain a description of actions taken, to be taken, or under consideration by ATSDR and CDHS, at and near the site. The purpose of the PHRAP is to ensure that this health consultation 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. CDHS and ATSDR will follow up on this plan to ensure that actions are carried out.

Actions Completed

- Contractors for the responsible parties have completed the Phase I investigation that involved the removal of drums, containers, and debris from the Omega site.
- Contractors for the responsible parties have completed the Phase II investigation that involved the collection and analysis of soil gas, soil, and groundwater on the Omega site.
- Contractors for the responsible parties collected additional data that is described in a "Revised Report Addendum for Additional Data Collection in the Phase 1a Area," completed in March 2005
- Weston completed an updated well survey of all potential groundwater wells downgradient of the Omega site.
- Contractors for the responsible parties conducted indoor air monitoring for on-site buildings at the Omega site. CDHS has evaluated this data to assess the public health implications of this pathway.
- Contractors for the responsible party installed carbon air filters in Skateland's restrooms and kitchen in December 2004 and sealed its foundation.
- The Omega Chemical PRP Group closed its purchase of the Skateland Property on September 21, 2006 and will demolish the building as soon as reasonably possible.

Actions Planned

- Contractors for the responsible parties are currently designing an interim groundwater pump and treatment system.
- EPA will conduct a site-wide risk assessment after Operable Unit Two data collection is complete.
- CDM will conduct a risk assessment based on the Operable Unit One data, the large groundwater contaminant plume.
- Contractors for the potentially responsible party group, under an EPA order, are currently installing downgradient groundwater monitoring wells (Operable Unit Two). Subsequent to that work, EPA will install additional wells. The wells will be used to characterize the nature and extent of the contamination.
- EPA will be conducting a site-wide Remedial Investigation/Feasibility Study that will include the downgradient (Operable Unit Two) area.

Recommendations for Further Actions

On the basis of the available data, CDHS and ATSDR recommend that:

- USEPA remediate the soil at the following hot spots: near Medlin and near the northwest corner of the property.
- USEPA further investigate the utility corridors in the northwest corner of the property as a possible entry route into the buildings.

USEPA should conduct additional indoor air sampling at Terra Pave, Star City Auto Body, Medlin and Three Kings in order to ensure that the COC's concentrations at these buildings continue to decrease and any exposures do not present a public health hazard.

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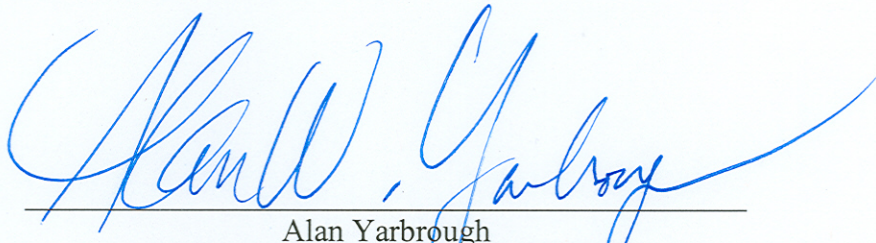
Certification

The health consultation The Omega Chemical site located in Whittier, Los Angeles County was prepared by the California Department of Health Services under a cooperative agreement with the federal 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 prepared. Editorial Review was completed by cooperative agreement partner.



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



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References

1. Ferroni C, Selis L, Mutti A, et al. Neurobehavioral and neuroendocrine effects of occupational exposure to perchloroethylene. *NeuroToxicology* 1992;13:243-47.
2. National Toxicology Program (1986). Technical report series no. 311. Toxicology and carcinogenesis studies of tetrachloroethylene (perchloroethylene) (CAS no. 127-18-4) in F344/N rats and B6C3F1 mice (inhalation studies). Research Triangle Park, NC: Department of Health and Human Services, Public Health Services, National Institutes of Health, NIH publication no. 86-2567.
3. Prendergast JA, Jones RA, Jenkins LJ, et al. Effects on experimental animals of long-term inhalation of trichloroethylene, carbon tetrachloride, 1,1,1-trichloroethane, dichlorodifluoromethane, and 1,1-dichloroethylene. *Toxicol Appl Pharmacol* 1967;10:270-89.
4. Bell ZG, Olson KJ, Benya TJ (1978). Final report of audit findings of the manufacturing chemists association (MCA): Administered trichloroethylene (TCE) chronic inhalation study at Industrial Bio-Test Laboratories, Inc., Decatur, IL. Unpublished study reported in U.S. Environmental Protection Agency (1985).
5. Henschler DH, Romen W, Elsasser HM, et al. Carcinogenicity study of trichloroethylene by longterm inhalation in three animal species. *Arch Toxicol* 1980;43:237-48.
6. Fukuda K, Takemoto K, Tsuruta H. Inhalation carcinogenicity of trichloroethylene in mice and rats. *Ind Health* 1983;21:243-54.
7. Short RD, Winston JM, Minor JL, et al. Toxicity of vinylidene chloride in mice and rats and its alteration by various treatments. *J Toxicol Environ Health* 1977d;3:913-21.
8. Reitz RH, Watanabe PG, McKenna MJ, et al. Effects of vinylidene chloride on DNA synthesis and DNA repair in the rat and mouse: A comparative study with dimethylnitrosamine. *Toxicol Appl Pharmacol* 1980;52:357-70.
9. California Department of Health Services. Public health assessment for Omega Chemical Site, Whittier, Los Angeles County, California. Atlanta: U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry; 2001 Sep 05.
10. England & Associates, Inc. and Hargis & Associates, Inc. Phase II close out report, volume I of II. Prepared for Omega Chemical site potentially responsible party organized group; 1996 Oct 01. Available to the public at: California Department of Health Services, Richmond (CA).
11. U.S. Environmental Protection Agency. National priority list for Omega Chemical Corporation. Washington D.C.: 1998 Sep.
12. U.S. Environmental Protection Agency. Omega Chemical Corporation. 2006 May 09. Available at: <http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/4b229bb0820cb8b888256f0000092946/00664a6e0727ce2788257007005e93f1!OpenDocument>. Last accessed: 2006 May 12.
13. U.S. Environmental Protection Agency. Email from Chris Lichens to William Warren concerning background information related to the buildings on and near the Omega site. Washington, D.C. March 29, 2006.
14. Camp Dresser & McKee, Inc. Memorandum from John Eisenbeis to Chris Lichens concerning the preliminary evaluation of soil gas results from November 2004. Irvine, California. February 03, 2005.

15. Girman JR, Hadwen GE, Burton LE, et al. Individual volatile organic compound prevalence and concentrations in 56 buildings of the Building Assessment Survey and Evaluation (BASE) study. 1999.
16. California Environmental Protection Agency. Use of California Human Health Screening Levels (CHHSLs) in evaluation of contaminated properties. Sacramento: 2005 Jan.
17. Camp Dresser & McKee, Inc. Memorandum from Sharon Wallin and Dave Chamberlin to Chris Lichens concerning the summary of additional findings from soil vapor and MIP sampling. Irvine, California. 2006 Apr 14.
18. U.S. Environmental Protection Agency. Email from Chris Lichens to Marilyn Underwood concerning refinishing products used at Skateland. Washington, D.C. 2006 Apr 10.
19. U.S. Environmental Protection Agency. Risk assessment guidance for Superfund, volume 1, human health evaluation manual, supplemental guidance, standard default exposure factors (SDEF), interim final, OSWER directive n° 9285.6-03. Washington D.C.: 1991 Mar 25.
20. California Cancer Registry. Cancer in California, 2000: A decade of cancer surveillance. Sacramento: 2000 Jun.
21. Hames N, Roberts S, Tolson J, et al. Reevaluating cancer risk estimates from short-term exposures scenarios. *Toxicological Sciences* 2000;58:32-42.
22. Office of Environmental Health Hazard Assessment. Technical support document for exposure assessment and stochastic analysis. Oakland: California Environmental Protection Agency. 2000 Sep.
23. Office of Environmental Health Hazard Assessment. Air toxics hot spots program, risk assessment guidelines (Part IV). Oakland: California Environmental Protection Agency. 2000 Sep.
24. Office of Research and Development. Exposure factors handbook (Volume I). Washington: U.S. Environmental Protection Agency. 1997 May.
25. Agency for Toxic Substances and Disease Registry. Toxicological profile for 1,1-dichloroethylene. Atlanta: U.S. Department of Health and Human Services; 1994.
26. Agency for Toxic Substances and Disease Registry. Toxicological profile for tetrachloroethylene Atlanta: U.S. Department of Health and Human Services; 1997.
27. Agency for Toxic Substances and Disease Registry. Toxicological profile for trichloroethylene. Atlanta: U.S. Department of Health and Human Services; 1997.
28. Rampy LW, Quast JF, Humiston CG, et al. Interim results of two-year toxicological studies in rats of vinylidene chloride incorporated in the drinking water or administered by repeated inhalation. *Environ Health Perspect* 1977;21:33-43.
29. U.S. Environmental Protection Agency (1976). Summary characteristics of selected chemicals of near-term interest. Publication n° EPA-56014-76-004. Washington D.C.: U.S. Environmental Protection Agency.
30. Murray FJ, Nitschke KD, Rampy LW, et al. Embryotoxicity and fetotoxicity of inhaled or ingested vinylidene chloride in rats and rabbits. *Toxicol Appl Pharmacol* 1979;48:189-202.
31. Short RD, Minor JL, Winston JM, et al. (1977). Toxicity studies of selected chemicals: Task II. The Developmental toxicity of vinylidene chloride inhaled by rats and mice during gestation. Washington D.C.: U.S. Environmental Protection Agency. Publication n° EPA-560/9-77-022.

32. Gennari P, Naldi M, Motta R, et al. Gamma-glutamyltransferase isoenzyme pattern in workers exposed to tetrachloroethylene. *Am J Ind Med* 1992;21:661-71.
33. Brodtkin CA, Daniell W, Checkoway H, et al. Hepatic ultrasonic changes in workers exposed to perchloroethylene. *Occup Environ Med* 1995;52:679-85.
34. Lauwerys R, Herbrand J, Buchet JP, et al. Health surveillance of workers exposed to tetrachloroethylene in dry-cleaning shops. *Int Arch Occup Environ Health* 1983;52:69-77.
35. Cai S-X, Huang M-Y, Chen Z, et al. Subjective symptom increase among dry-cleaning workers exposed to tetrachloroethylene vapor. *Industrial Health* 1991;29:111-21.
36. Stewart RD, Hake CL, Wu A, et al. (1977). Effects of perchloroethylene/drug interaction on behavior and neurological function. Final report. Washington D.C.: National Institute for Occupational Safety and Health. Publication n° PB83-17460.
37. Stewart RD, Hake CL, Forster HV, et al. (1981). Tetrachloroethylene: Development of a biologic standard for the industrial worker by breath analysis. Cincinnati, OH: National Institute for Occupational Safety and Health. Contract n° HSM 99-72-84. Publication n° PB82-152166.
38. Franchini I, Cavotorta A, Falzoi M, et al. Early indicators of renal damage in workers exposed to organic solvents. *Int Arch Occup Environ Health* 1983;52:1-9.
39. Price RG, Taylor SA, Crutcher E, et al. The assay of laminin fragments in serum and urine as an indicator of renal damage induced by toxins. *Toxicol Lett* 1995;77:313-18.
40. Bundschuh I, Herbort c, Fels LM, et al. Renal fibronectin excretion as a marker for renal environmental toxins. *Contrib Nephrol* 1993;101:177-84.
41. Solet D, Robins TG. Renal function in dry-cleaning workers exposed to perchloroethylene. *Am J Ind Med* 1991;20:601-14.
42. Mutti A, Alinovi R, Bergamaschi E, et al. Nephropathies and exposure to perchloroethylene in dry-cleaners. *Lancet* 1992;340(8813):189-93.
43. Stewart RD, Baretta ED, Dodd HC, et al. Experimental human exposure to tetrachloroethylene. *Arch Environ Health* 1970;20:224-29.
44. Altmann L, Wiegand H, Bottger A, et al. Neurobehavioral and neurophysiological outcomes of acute repeated perchloroethylene exposure. *Applied Psychology: An International Review* 1992;41(3):269-79.
45. Echeverria D, White RF, Sampaio C. A behavioral evaluation of PCE exposure in patients and dry cleaners: A possible relationship between clinical and preclinical effects. *J Occup Environ Med* 1995;37(6):667-80.
46. Nakatsuka H, Watanabe T, Takeuchi Y, et al. Absence of blue-yellow color vision loss among workers exposed to toluene or tetrachloroethylene, mostly at levels below occupational exposure limits. *Int Arch Occup Environ Health* 1992;64:113-17.
47. Cavalleri A, Gobba F, Paltrinieri M, et al. Perchloroethylene exposure can induce colour vision loss. *Neurosci Lett* 1994;179:162-66.
48. Ahlborg GJ. Pregnancy outcome among women working in laundries and dry-cleaning shops using tetrachloroethylene. *Am J Ind Med* 1990;17:567-75.
49. Kyyronen P, Taskinen H, Lindbohm ML, et al. Spontaneous abortions and congenital malformations among women exposed to tetrachloroethylene in dry cleaning. *J Epidemiol Community Health* 1989;43:68-69.
50. Windham GC, Shusterman D, Swan S, et al. Exposure to organic solvents and adverse pregnancy outcome. *Am J Ind Med* 1991;20:241-59.

51. McDonald AD, Armstrong B, Cherry NM, et al. Spontaneous abortion and occupation. *J Occup Med* 1986;28:1323-238.
52. Eskenazi B, Fenster L, Hudes M, et al. A study of the effect of perchloroethylene exposure on the reproductive outcomes of wives of dry-cleaning workers. *Am J Ind Med* 1991a;20:593-600.
53. Lagakos SW, Wessen BJ, Zelen M, et al. An analysis of contaminated well water and health effects in Woburn, Massachusetts. *Journal of the American Statistical Association* 1986;81:583-614.
54. Bove FJ, Fulcomer MC, Klotz JB. Public drinking water contamination and birth outcomes. *Am J Epidemiol* 1995;141:850-62.
55. Schwetz BA, Leong BKJ, Gehring PJ. The effect of maternally inhaled trichloroethylene, perchloroethylene, methyl chloroform, and methylene chloride on embryonal and fetal development in mice and rats. *Toxicol Appl Pharmacol* 1975;32:84-96.
56. Brown DP, Kaplan SD. Retrospective cohort mortality study of dry-cleaning workers using perchloroethylene. *J Occup Med* 1987;29:535-41.
57. Blair A, Decoufle P, Grauman D. Causes of death among laundry and dry-cleaning workers. *Am J Public Health* 1979;69:508-11.
58. Duh RW, Asal NR. Mortality among laundry and dry-cleaning workers in Oklahoma. *Am J Public Health* 1984;74:1278-80.
59. Katz RM, Jowett D. Female laundry and dry-cleaning workers in Wisconsin. A mortality analysis. *Am J Public Health* 1981;71:305-07.
60. Spirtas R, Stewart PA, Lee JS, et al. Retrospective cohort mortality study of workers at an aircraft maintenance facility: I. Epidemiological results. *Br J Ind Med* 1991:515-30.
61. Hardell L, Eriksson M, Degerman A. Exposure to phenoyacetic acids, chlorophenols, or organic solvents in relation to histopathology, stage, and anatomical localization of non-Hodgkin's lymphoma. *Cancer Res* 1994;54:2386-89.
62. Axelson O, Selden A, Andersson K, et al. Updated and expanded Swedish cohort study on trichloroethylene and cancer risk. *J Occup Med* 1994;36:556-62.
63. Antilla A, Pukkala E, Sallmén M, et al. Cancer incidence among Finnish workers exposed to halogenated hydrocarbons. *J Occup Environ Med* 1995;37(797-806).
64. Henschler D, Vamvakas S, Lammert M, et al. Increased incidence of renal cell tumors in a cohort of cardboard workers exposed to trichloroethene. *Arch Toxicol* 1995(291-299).
65. Paddle GM. Incidence of liver cancer and trichloroethylene manufacture: Joint study by industry and a cancer registry. *Br Med J* 1983;286:846.
66. Novotna E, David A, Malek B. [An epidemiological study of hepatic tumor incidence in subjects working with trichloroethylene. I. Negative result of retrospective investigations in subjects with primary liver cancer]. *Prac Lek* 1979;31:121-23. (Czech).

Appendix A—Table A1

Table A1. Volatile Organic Compounds Analytical Summary; Indoor Air Analytical Results
(Source: Camp Dresser & McKee, Inc., September 30, 2005)

Sample Location	Sample Date	Sample Type	PCE	TCE	1,1,2,2-PCA	1,1,1-TCA	1,1-DCE	CTC	CFM	MC	1,2-DCB	1,4-DCB	Freon 11	Freon 113	Freon 12	Acetone	Benzene	Toluene	Ethyl benzene	m,p-Xylenes	o-Xylene
Terra Pave																					
First floor office area																					
	05/11/04	ORIG	110	4.4	0.25 U	0.45	23	0.56	0.24	1.5	0.22 U	0.23	7	26	2.9	41	1.3	10	1.6	5.4	2.1
	09/14/05	ORIG	39	1.6	0.22 U	0.17 U	5.5	0.67	0.21	1.2	0.19 U	0.27	3.4	6.3	2	22	1.1	6.9	0.93	3.5	1
Second floor office area																					
	05/11/04	ORIG	100	4	0.25 U	0.49	21	0.62	0.23	1.4	0.22 U	0.22 U	6.9	26	2.6	43	1.4	8.7	1.5	5.5	2.1
	09/14/05	ORIG	45	1.7	0.25 U	0.2 U	6	0.63	0.21	1.3	0.22 U	0.22 U	3.4	6.8	1.5	37	1.2	6.5	0.95	3.3	0.96
Star City Auto Body																					
Main work area																					
	05/11/04	ORIG	16	3.5	0.94 U	0.74 U	17	0.86 U	0.67 U	4.7 U	0.82 U	0.82 U	13	30	2.3	1100 E	2.6	420	8.6	46	13
	05/11/04	DUP	17	3.6	0.94 U	0.74 U	18	0.86 U	0.67 U	4.8	0.82 U	0.82 U	14	31	2.7	1200 E	3.2	440	9.2	49	14
	09/14/05	ORIG	34	6.5	0.25 U	0.33	16	0.67	0.19	1.5	0.22 U	0.22 U	11	18	1.9	350 E	5.3	38	4.6	21	5.1
	09/14/05	DUP	33	5.5	0.24 U	0.32	16	0.66	0.19	1.5	0.21 U	0.21 U	11	17	2.1	330 E	5	36	4.8	22	5.4
Rear area of shop																					
	05/11/04	ORIG	6	3.9 U	5 U	4 U	1.6	4.6 U	3.6 U	25 U	4.4 U	4.4 U	4.1 U	5.6 J	3.6 U	5400 E	5.8 U	2400	48	270	78
	09/14/05	ORIG	23 U	18 U	23 U	18 U	6.7 U	21 U	16 U	120 U	20 U	20 U	19 U	26 U	17 U	6000	27 U	74	14 U	29 U	14 U
Skateland																					
Boys Restroom																					
	08/04/04	ORIG	770	270	1.3 U	1.2	550	1.2 U	0.93 U	6.6 U	1.1 U	1.1 U	350	880	5.4 J	90	3.4	6.9	1.5	4.2	1.6
	12/30/04	ORIG	77	9	0.23 U	0.24	55	0.55	0.25	2.1	0.2 U	0.57	28	98	3	40	3.7	29	6.8	32	12
	12/30/04	DUP	76	8.8	0.22 U	0.27	54	0.54	0.27	2.4	0.2 U	0.63	28	96	3.1	44	3.8	43	7.5	33	12
	01/12/05	ORIG	33	11	0.18 U	0.26	78	0.62	0.3	5.1	0.16 U	0.31	45	170	3	29	3.3	25	3.2	12	4 J
	01/12/05	DUP	38	12	0.22 U	0.37	95	0.63	0.32	6	0.19 U	0.29	52	210	2.8	25	3	28	2.8	10	3.4 J
	09/14/05	ORIG	83	37	0.44 U	0.35 U	100	0.56	0.31 U	2.2 U	0.39 U	0.39 U	78	220	3.1	93	0.75	3.4	0.47	1.3	0.36
Center of Rink																					
	05/11/04	ORIG	1100	16	1.2 U	0.97 U	130	1.1 U	0.87 U	6.2 U	1.1 U	1.1 U	120	350	4	21	1.4 U	12	2.1	6.7	2
	05/11/04	DUP	880	14	1.1 U	0.91 U	120	1 U	0.81 U	5.8 U	1 U	1 U	100	310	3.4	20	1.3 U	10	2	6.5	2
	08/04/04	ORIG	300	36	0.76 U	0.8	290	0.7 U	0.54 U	3.9 U	0.67 U	0.67 U	190	720	5.7 J	43	2.5	18	1.4	3.8	1.5
	08/04/04	DUP	320	38	0.98 U	0.9	300	0.9 U	0.69 U	4.9 U	0.86 U	0.86 U	210	740	5.7 J	79	2.9	6.8	1.3	3.4	1.3
	12/29/04	EPA	94.9	11.3 J	13 U	10.4 U	63.4	11.9 U	9.27 U	6.59 U	11.4 U	11.4 U	33.1	115	9.39 U		6.07 U	35.4	8.25 U	29.1 J	11.3 J

Table A1 Continued. Volatile Organic Compounds Analytical Summary; Indoor Air Analytical Results
 (Source: Camp Dresser & McKee, Inc., September 30, 2005)

Sample Location	Sample Date	Sample Type	PCE	TCE	1,1,2,2-PCA	1,1,1-TCA	1,1-DCE	CTC	CFM	MC	1,2-DCB	1,4-DCB	Freon 11	Freon 113	Freon 12	Acetone	Benzene	Toluene	Ethyl benzene	m,p-Xylenes	o-Xylene
	12/30/04	ORIG	80	8.5	0.23 U	0.26	56	0.55	0.24	2.3	0.2 U	0.56	28	100	3	39	3.8	28	6.6	30	11
	01/12/05	ORIG	56	14	0.28 U	0.4	130	0.64	0.23	5.5	0.24 U	0.3	74	260	3.4	33	3.8	31	3.2	11	3.6 J
	01/12/05	EPA	88.1	24.2 J	15.8 U	12.5 U	170	14.5 U	11.2 U	7.98 U	13.8 U	13.8 U	118	391	11.4 U	--	7.34 U	16.2 J	9.99 U	20 U	9.99 U
	09/14/05	ORIG	86	24	0.25 U	0.32	120	0.67	0.22	1.3	0.22 U	0.22 U	86	280	2.4	20	0.83	4.3	0.55	1.6	0.52
	09/14/05	DUP	84	23	0.31 U	0.33	120	0.68	0.22 J	1.6 U	0.28 U	0.28 U	86	280	2.7	19	0.8	4.1	0.51	1.4	0.4
Dance Floor																					
	08/04/04	ORIG	160	24	1.2 U	0.99 U	320	1.1 U	0.89 U	6.3 U	1.1 U	1.1 U	260	1000	7.2	29	3.1	6.9	1.2	2.9	1.1
Exterior Location - adjacent to front door																					
	08/04/04	ORIG	1.2	0.26	0.23 U	0.19 U	0.58	0.72	0.17 U	1.5	1.8	0.22	2.1	2.6	3.4 J	61	1.6	5.7		3.6	1.8
Exterior Location - adjacent to sewer manhole																					
	08/04/04	ORIG	1.7	0.22	0.26 U	0.2 U	0.89	0.61	0.18 U	1.8	0.22 U	0.22 U	2	1.8	3.5 J	34	1.7	5.3	0.85	2.2	0.9
Girls Restroom																					
	12/30/04	ORIG	65	7.5	0.37 U	0.3 U	45	0.53	0.4	3.4	0.33 U	0.63	24	81	3.2	44	4.5	150	10	33	12
	01/12/05	ORIG	43	14	0.23 U	0.26	100	0.71	0.36	2.8	0.2 U	0.32	59	220	3	50	3.1	12	1.9	8	2.6 J
	09/14/05	ORIG	59	18	0.23 U	0.39	88	0.63	0.29	1.3	0.2 U	0.2 U	66	210	2.4	95 E	0.75	3.7	0.59	1.6	0.52
Kitchen																					
	08/04/04	ORIG	160	38	1.4 U	1.1 U	340	1.3 U	1 U	7.2 U	1.2 U	1.2 U	310	1300	11 J	44	3.5	6	1.1	2.8	1.1
	12/30/04	ORIG	83	9.2	0.24 U	0.26	87	0.55	0.32	2.1	0.21 U	0.6	46	170	3.4	42	4.7	32	6.2	27	9.5
	01/12/05	ORIG	44	14	1.3 U	1 U	280	1.2 U	0.93 U	12	1.2	1.8	210	1000	5.2	29	27	140	36	130	44 J
	09/14/05	ORIG	69	27	2.2 U	1.7 U	290	2 U	1.5 U	11 U	1.9 U	1.9 U	280	1000	6.5	32	2.5 U	3.3	1.4 U	2.7 U	1.4 U
Office																					
	08/04/04	ORIG	9.5	1	0.26 U	0.26	3.6	0.64	0.18 U	1.6	0.22 U	0.27	4.5	10	3.4 J	41	1.6	5.1	0.84	2.1	0.8
	12/29/04	EPA	29.1	8.6 U	11 U	8.73 U	17.4	10.1 U	7.81 U	5.55 U	9.62 U	9.62 U	11.2 J	33.7	7.91 U		5.11 U	26.4	6.95 U	18.7 J	6.95 J
	01/12/05	EPA	10.2 U	8.06 U	10.3 U	8.18 U	12.7	9.43 U	7.32 U	5.21 U	9.01 U	9.01 U	10.7 J	34.5	7.41 U		4.79 U	12.8	6.51 U	13 U	6.51 U
Rear Interior Corner by Storage Room																					
	08/04/04	ORIG	270	25	0.64 U	0.87	250	0.64	0.45 U	3.4	0.56 U	0.56 U	170	600	5.2 J	44	2.2	7.2		3	1.1
Skate Rental Counter (by window)																					
	05/11/04	ORIG	950	19	0.98 U	0.78 U	160	0.9 U	0.69 U	4.9 U	0.86 U	0.86 U	140	480	4.2	35	1.1 U	10	2	6.8	1.9
	08/04/04	ORIG	180	31	0.61 U	0.48 U	170	0.94	0.43 U	3.1 U	0.54 U	0.54 U	140	560	5.4 J	75	2.1	6.7	1.1	2.9	1.1

Table A1 Continued. Volatile Organic Compounds Analytical Summary; Indoor Air Analytical Results
(Source: Camp Dresser & McKee, Inc., September 30, 2005)

Sample Location	Sample Date	Sample Type	PCE	TCE	1,1,2,2-PCA	1,1,1-TCA	1,1-DCE	CTC	CFM	MC	1,2-DCB	1,4-DCB	Freon 11	Freon 113	Freon 12	Acetone	Benzene	Toluene	Ethyl benzene	m,p-Xylenes	o-Xylene
	12/29/04	EPA	88.1	11.3	6.86 U	5.45 U	63.4	6.29 U	4.88 U	4.17 J	6.01 U	6.01 U	35.4	123	4.94 U	9.26	5.43 J	32.8	6.51 J	26.5	9.99
	01/12/05	EPA	34.6	12.4 J	15.1 U	12 U	151	13.8 U	10.7 U	7.64 U	13.2 U	13.2 U	118	498	10.9 U		7.02 U	13.2 J	9.55 U	19.1 U	9.55 U
Rippy Parking Lot																					
Ambient - upwind																					
	05/11/04	ORIG	0.86	0.48	0.26 U	0.2 U	0.16	0.5	0.18 U	1.3 U	0.22 U	0.22 U	1.7	1.1	2.7	19	1.3	6.7	1.4	5	1.9
	05/11/04	DUP	0.57	0.42	0.2 U	0.16 U	0.12	0.6	0.14 U	1 U	0.18 U	0.18 U	1.8	1.1	2.9	14	0.9	3.3	0.47	1.5	0.52
	09/14/05	ORIG	0.84	0.42	0.25 U	0.2 U	0.13	0.63	0.18 U	1.3 U	0.22 U	0.22 U	1.8	1.4	2	14	0.99	3.7	0.45	1.3	0.45
On-Site Ambient																					
Ambient - between Star City and 3 Kings																					
	05/11/04	ORIG	1.3 U	1 U	1.3 U	1 U	0.37 U	1.2 U	0.91 U	6.5 U	1.1 U	1.1 U	1.7	1.4 U	2.4	4000 E	1.5 U	6	0.79 J	2.8	1.2
Ambient - between Star City and Medlin & Son																					
	05/11/04	ORIG	1.2	1.1	0.37 U	1.1	0.66	0.5	0.27 U	1.9 U	0.33 U	0.33 U	1.7	1.8	2.6	28	0.82	7.8	0.63	2	0.77
	09/14/05	ORIG	1.7	0.4	0.26 U	0.2 U	0.45	0.62	0.18 U	1.3 U	0.22 U	0.22 U	2	1.5	1.8	46	0.86	4.6	0.63	2	0.51
Medlin & Son																					
Ambient - roof intake																					
	05/11/04	ORIG	0.55	0.2 U	0.25 U	0.2 U	0.15	0.59	0.18 U	2.1	0.22 U	0.22 U	1.9	1.3	3.4	19	0.91	5.5	0.79	2.1	0.8
Front office area																					
	05/11/04	ORIG	4.3	2.7	0.59 U	0.46 U	5.1	0.67	0.42 U	3.9	0.51 U	0.95	8.7	40	2.6 J	3400 E		5.3	0.79	2.2	0.87
	09/14/05	ORIG	22	14	0.22 U	0.18 U	10	0.84	0.27	1.7	0.19 U	0.2	12	34	1.8	530 E		7.4	0.72	2.5	0.9
Production area																					
	05/11/04	ORIG	6.2	2.6	0.24 U	0.21	6.6	0.8	0.2	5.1	0.21 U	0.21 U	8.9	36	3.3	39	1.1	7.3	0.85	2.7	1
	09/14/05	ORIG	4.6	2.3	0.25 U	0.2 U	2.9	1.3	0.32	1.3 U	0.22 U	0.22 U	5.4	17	1.2	22	0.91	4.8	0.79	2.7	0.98
Former Merchants Met																					
Ambient - upwind																					
	05/11/04	ORIG	0.6	0.23	0.4	0.2 U	0.074 U	0.58	0.18 U	1.3 U	0.3	0.4	1.6	0.73	2.6	15		5.1	0.78	2.3	0.87
3 Kings Construction																					
Interior office area																					
	05/11/04	ORIG	3.2	0.92	0.23 U	0.22	2.7	0.58	0.25	2.1	0.2 U	0.2 U	3	4.1	2.6	28	6	40	4.4	20	5.6
	09/14/05	ORIG	7.6	2.2	0.26 U	0.2 U	4.9	0.57	0.18 U	49	0.22 U	0.22 U	3.8	4.2	1.4	24	2.8	36	3.2	14	2.9

Table A1 Continued. Volatile Organic Compounds Analytical Summary; Indoor Air Analytical Results
(Source: Camp Dresser & McKee, Inc., September 30, 2005)

Sample Location	Sample Date	Sample Type	PCE	TCE	1,1,2,2-PCA	1,1,1-TCA	1,1-DCE	CTC	CFM	MC	1,2-DCB	1,4-DCB	Freon 11	Freon 113	Freon 12	Acetone	Benzene	Toluene	Ethyl benzene	m,p-Xylenes	o-Xylene
Storage and work area																					
	05/11/04	ORIG	1	0.25	0.23 U	0.21	0.7	0.59	0.16 U	1.8	0.2 U	0.2 U	2	1.6	2.7	37	5.1	34	3.8	18	5
	09/14/05	ORIG	13	3.3	0.64 U	0.51 U	9.2	0.65	0.46 U	260	0.56 U	0.56 U	5.9	6.8	3.1	50	11	170	16	82	17

Notes:

Concentrations are reported in micrograms per cubic meter (ug/m3)

Concentrations for EPA samples are reported in ug/m3, which were calculated from ppb (v/v) results and then rounded to the appropriate number of significant figures.

Only compounds detected in one or more air samples more than once are shown.

VOCs analyzed by EPA Method TO-15 SIM.

U = Not detected at a concentration greater than the reporting limit shown.

J = Detected at an estimated concentration between the laboratory reporting and method detection limits.

E = Estimated concentration - exceeds upper calibration range of instrument.

-- = Analyte not reported.

PCE = Tetrachloroethene; TCE = Trichloroethene; PCA = Tetrachloroethane; TCA = Trichloroethane; DCE = Dichloroethene; CTC = Carbon tetrachloride; CFM = Chloroform; MC = Methylene chloride; DCB = Dichlorobenzene; Freon 11 = Trichlorofluoromethane; Freon 113 = 1,1,2-Trihaloro-1,2,2-trifluoroethane; Freon 12 = Dichlorodifluoromethane.

Sample Type:

ORIG = Original sample

DUP = Duplicate sample

EPA = Sample collected by EPA

Appendix B—Figures

Figure 1. Location of Former Omega Property, Omega Chemical Site, Whittier, Los Angeles County, California

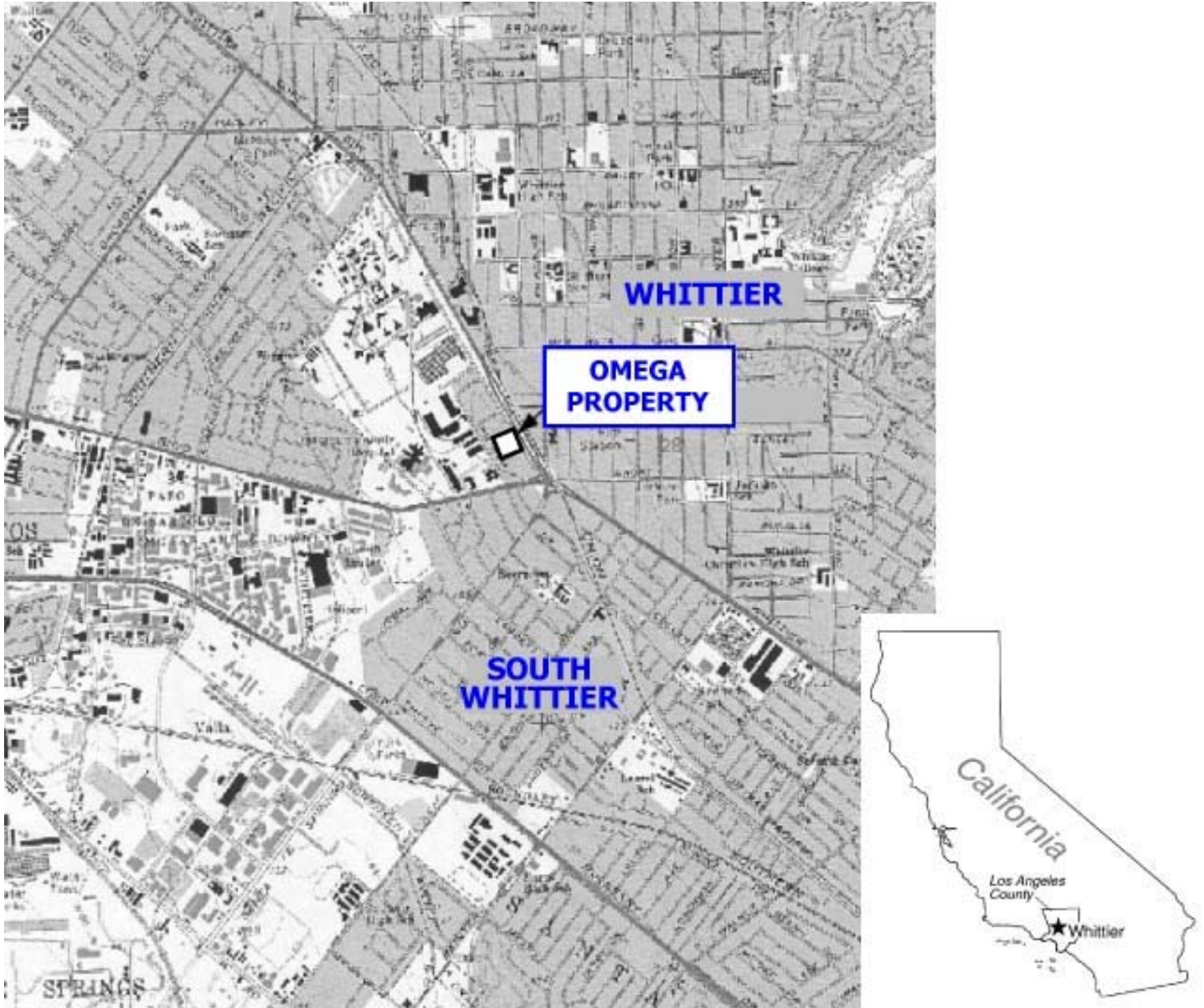


Figure 2. Location of Operable Unit One, Omega Chemical Site, Whittier, Los Angeles County, California (Source: England & Associates, October 1996)



Figure 3. Utility Corridors and Skateland Soil Gas Sampling Locations, November 2004, Omega Chemical Site, Whittier, Los Angeles County, California (Source: Camp Dresser & McKee, Inc., December 2, 2004)

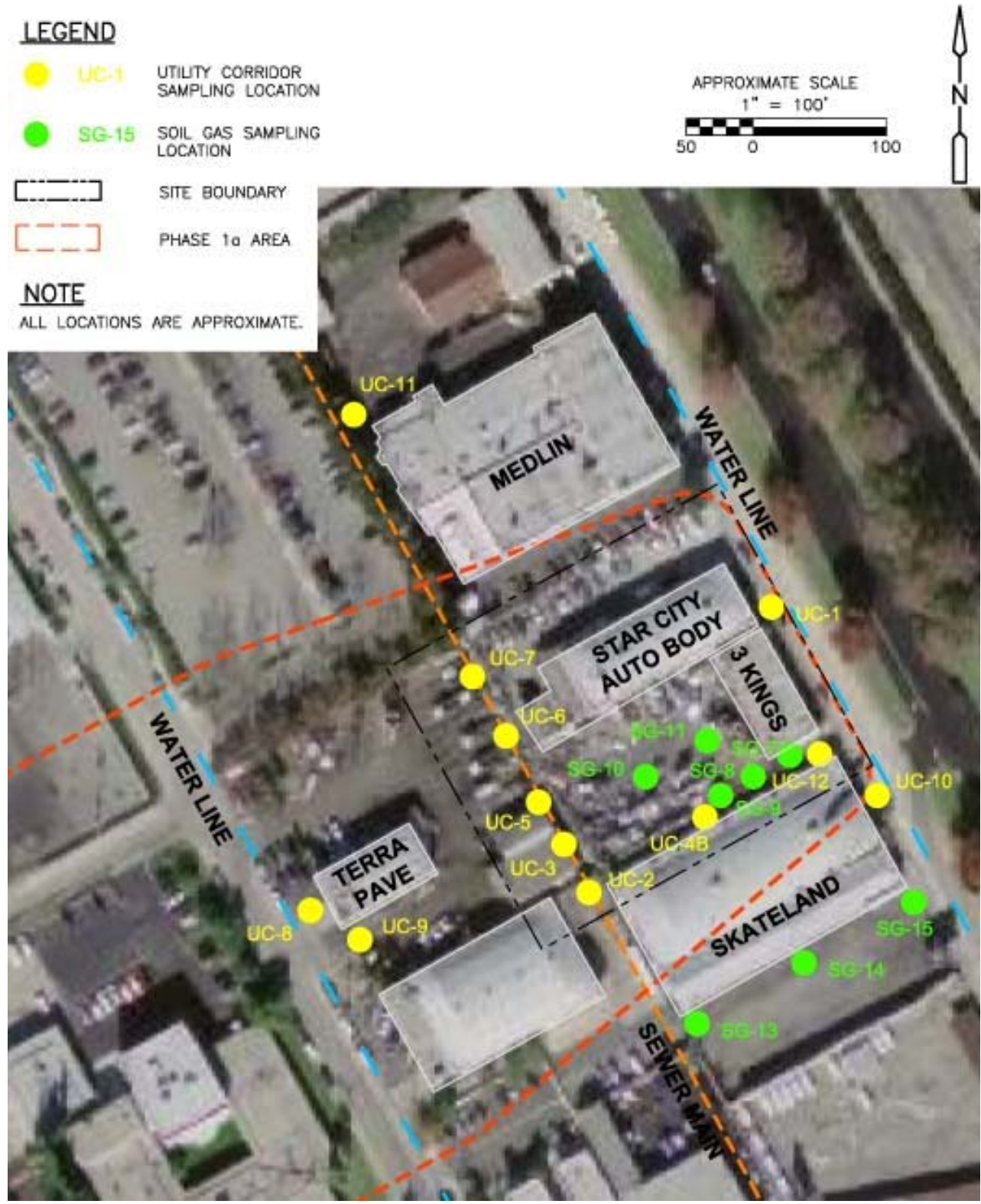


Figure 4. Sampling Locations, Omega Chemical Site, Whittier, Los Angeles County, California
 (Source: Camp Dresser & McKee, Inc., May 11, 2004)



LEGEND

- Leray Crandall Soil Boring (1985)
- ENSR Soil Boring (1988)
- ⊙ ENSR Groundwater Monitoring Well (1988)
- ⊙ England/Hargis Soil Boring (January 1996)
- ▲ England/Hargis Soil Gas Sample (December 1995)
- ⊕ England/Hargis Monitoring Well (June 1996)
- ⊙ England/Hargis Hydropunch (March 1996)
- ⊙ England/Hargis Soil Boring (March 1996)
- ⊕ ERT Soil Gas Sample (1988)
- Feature Removed

- ▲ Systematic Surface Soil Sample (SS)
- ▼ Purposive Surface Soil Sample (SS)
- Soil Gas Sample (SG)
- Deep Soil Boring (GP)

NOTE

1. Samples analyzed for physical characteristics are designated by a black circle around the symbol.
2. SG1 through SG3 located on the Medlin & San property

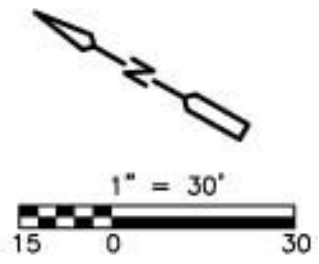


Figure 5. Carbon filter air purifier installed in December 2004 at Skateland, Omega Chemical Site, Whittier, Los Angeles County, California



Appendix C—Toxicological Profiles for Contaminants

This appendix summarizes background information from toxicological profiles published by ATSDR. It highlights the toxicological effects of the contaminants of concern detected in the indoor air, ambient air, or soil, in and around the Omega Property.

1,1-Dichloroethylene (1,1-DCE) (25)

- Synthetic chemical, most commonly used to make other products.
- Colorless liquid that evaporated quickly at room temperature; evaporates very quickly from soil and water.
- Breaks down quickly in the air, slowly in water.
- Found at very low concentrations in indoor and outdoor air, therefore, the potential for exposure in the environment is extremely low. The amounts are somewhat higher near some factories that make or use 1,1-DCE (those that make food-packaging films, adhesives, flame-retardant coatings for fiber and carpet backing, piping, and coating for steel pipes).
- Can enter body through inhalation, ingestion, or possibly dermal contact, most commonly from products containing this chemical.
- Adverse health effects due to chronic inhalation include neurological effects, and possible kidney and liver damage.
- Chronic oral Minimal Risk Level = 0.009 mg/kg/day (liver effects in rats).
- Carcinogenicity classification
U.S. Environmental Protection Agency: probable human carcinogen
Department of Health and Human Services: not classified
International Agency for Research on Cancer: not classifiable as human carcinogen

Freon 12 (Dichlorodifluoromethane)

- Colorless, volatile liquid or a gas at 75 degrees Fahrenheit.
- Used as a refrigerant, solvent, and in making fire extinguishers.
- Can irritate skin and eyes. Repeated exposure can cause dryness and cracking of the skin. Breathing Freon 12 can irritate the lungs, causing coughing and/or shortness of breath. Overexposure can cause lightheadedness and dizziness. High exposure can cause irregular heart beat and can be fatal.
- Chronic oral reference dose = 0.2 mg/kg/day.
- Carcinogenicity classification
U.S. Environmental Protection Agency: not classified
International Agency for Research on Cancer: not classified

Freon 113 (1,1,2-Trichlorotrifluoroethane)

- Colorless, volatile liquid or a gas at 75 degrees Fahrenheit.
- Used as a refrigerant, dry-cleaning solvent, foam blowing agent, and in making fire extinguishers.
- Can irritate skin and eyes. Repeated exposure can cause dryness and cracking of the skin. Breathing Freon 113 can irritate the lungs, causing coughing and/or shortness of breath. Overexposure can cause lightheadedness and dizziness. High exposure can cause irregular heart beat and can be fatal.

- Chronic oral reference dose = 30 mg/kg/day.
- Carcinogenicity classification
U.S. Environmental Protection Agency: not classified
International Agency for Research on Cancer: not classified

Tetrachloroethylene (PCE) (26)

- Synthetic chemical used as a dry-cleaning fluid, a degreaser, and as a starting material for other products.
- Evaporates quickly, but breaks down very slowly.
- Can travel easily through soils to reach groundwater.
- Inhalation most common way to enter body, also ingestion if drinking water is contaminated
- Adverse health effects due to chronic inhalation exposure possibly include reproductive effects in women.
- Higher concentrations of exposure in animals may cause liver and kidney damage.
- Chronic oral reference dose = 0.01 mg/kg/day (hepatotoxicity in mice and weight gain in rats).
- Carcinogenicity classification
International Agency for Research on Cancer: probable human carcinogen

Trichloroethylene (TCE) (27)

- Synthetic chemical, liquid at room temperature; most commonly used as a degreaser, also used in some household products.
- Evaporates readily from surface soil, water; breaks down in air to form phosgene, a lung irritant; breaks down more slowly from deep soils, groundwater.
- Can enter body through inhalation, ingestion, or dermal absorption.
- Adverse health effects due to chronic exposure possibly include childhood leukemia, heart defects, and other birth defects.
- Acute inhalation Minimal Risk Level = 2,000 parts per billion (10,700 $\mu\text{g}/\text{m}^3$) (neurological effects in humans).
- Intermediate inhalation Minimal Risk Level = 100 parts per billion (540 $\mu\text{g}/\text{m}^3$) (neurological effects in rats).
- Acute oral Minimal Risk Level = 0.2 mg/kg/day (developmental effects in mice).
- Carcinogenicity classification
U.S. Environmental Protection Agency: probable human carcinogen (inadequate human, sufficient animal evidence)
Department of Health and Human Services: may reasonably be anticipated to be a human carcinogen
International Agency for Research on Cancer: probable human carcinogen (limited human, sufficient animal evidence)

Appendix D—Toxicological Descriptions

1,1-Dichloroethylene (DCE)

There are very few human studies available to help us understand the health effects of breathing 1,1-DCE. Several studies conducted in the 1960s and 1970s studied the effects of mice, rats, hamsters, dog, guinea pig, and monkey breathing 1,1-DCE (3, 28). Animal studies are designed to see effects in a small group of exposed animals, thus the exposure doses are typically fairly high. The effects seen in animals breathing 1,1-DCE include changes in kidney and liver function and structure. These effects were seen at levels of 1,1-DCE exceeding 25 parts per million (99,200 $\mu\text{g}/\text{m}^3$). In several studies, they have seen that these effects on the liver were made worse if the animal was not eating (fasting). In one study, they ceased the exposure after 18 months and looked at the effects on the animals 6 months later. They found the effects on the liver no longer existed. The effects went away after the exposure ceased.

Effects on the liver were seen in workers exposed to 1,1-DCE for 6 years or less in a 1,1-DCE polymerization plant. Liver scans and measurements of liver enzymes revealed 50% or greater loss in liver function in 27 (59%) of the 46 exposed workers (29).

CDHS focused on health studies where the effects were observed after inhalation of 1,1-DCE rather than the ingestion route. However, though most sensitive organ for the ingestion exposure of 1,1,1-DCE is also the kidney and the liver.

Several animal studies also have looked at the developmental effects of 1,1-DCE (30, 31). In these studies, the pregnant females were exposed and the success of the pregnancy (pups/litter) and structural and functional changes in the offspring were examined. The critical issue in developmental studies is to see an effect on the offspring at doses where there is no effect on the mother, thus demonstrating that it is not stress on the mother that is causing a secondary effect on the offspring. Many of the dosing groups in the developmental animal studies saw effects on the mothers, thus are not helpful to determining developmental effects. In one study, the pregnant mice inhaled 59,200 $\mu\text{g}/\text{m}^3$ 1,1-DCE (31). There were no maternal effects; however, there was an increase in mean number of fetuses per litter with structural abnormalities like cleft palate. Because this increase was not found to be statistically significant—they might be within the range of what is typically found for unexposed animals—it is not clear that 1,1-DCE is a developmental toxicant.

There were no studies found which evaluated the immunological or reproductive effects from breathing 1,1-DCE in animals or humans. There was a three-generation study of 1,1-DCE conducted in rats.

Tetrachloroethylene (PCE)

Noncancer Health Effects

In the 1980s and 1990s, several studies of the long-term health effects of breathing PCE have been conducted on workers in the dry-cleaning industry. There have also been several studies using people who volunteered to breathe PCE for short periods of time. The main parts of the body these studies focused on the health effects were the kidney, liver, and the nervous system.

Changes in serum markers of liver health (average exposure concentration of 11.3 parts per million or $76,700 \mu\text{g}/\text{m}^3$) (32) and structural changes to the liver seen by non-invasive imaging (average exposure of 15.8 parts per million or $107,300 \mu\text{g}/\text{m}^3$) (33) have been observed in dry-cleaning workers. At least two other studies of dry-cleaning workers exposed to similarly high levels of PCE did not find changes in the serum markers of liver damage (34, 35). In two studies with volunteers, there were no changes in liver health markers when comparing the levels before and after exposure (e.g., 20 parts per million or $136,000 \mu\text{g}/\text{m}^3$ and 100 parts per million or $679,000 \mu\text{g}/\text{m}^3$ PCE for an 11-week period of intermittent exposure) (36, 37).

Increases in certain proteins and other compounds associated with kidney health have been measured in urine of dry-cleaning workers exposed to a level above 10 parts per million or $67,900 \mu\text{g}/\text{m}^3$ PCE (38-40). However, the compound that has been affected has not been consistent from study to study, and some studies have not shown any affect on markers of kidney health (34, 35, 41). The most comprehensive study of kidney health found changes in several urinary markers from dry-cleaning workers exposed to 85 parts per million or $577,00 \mu\text{g}/\text{m}^3$ PCE compared to control subjects (42). In two studies with volunteers, there were no changes in kidney health markers when comparing the levels before and after exposure (e.g., 20 parts per million or $136,000 \mu\text{g}/\text{m}^3$ and 100 parts per million or $679,000 \mu\text{g}/\text{m}^3$ PCE for an 11-week period of intermittent exposure) (36, 37).

Volunteer studies dating back to the 1950s and 60s have demonstrated that short-term high levels (100 parts per million or $679,000 \mu\text{g}/\text{m}^3$ for 7 hours) cause obvious effects like headache, dizziness, difficulty speaking, and sleepiness (43). More recent studies using volunteers have examined more subtle effects on the nervous system, some of which have been affected by short-term exposure to PCE. In one study, a couple of the neurological endpoints (vigilance and eye-hand coordination) were seemingly affected when the volunteers breathed 50 parts per million $339,000 \mu\text{g}/\text{m}^3$ PCE for 4 hours per day for 4 days, but not in a group of volunteers that breathed 10 parts per million or $68,000 \mu\text{g}/\text{m}^3$ (44). A study of neurological effects in chronically-exposed dry-cleaning workers saw similar effects: vigilance was significantly affected, as was stress and simple reaction times, in 60 women exposed to a median concentration of 15 parts per million or $101,000 \mu\text{g}/\text{m}^3$ for an average of 10 years (1). Other neurological studies of dry-cleaning workers have seen effects on short-term memory for visual designs and showed deficits in the high-exposure group ($277,000 \mu\text{g}/\text{m}^3$) relative to the lower-exposure group ($76,000 \mu\text{g}/\text{m}^3$) (45). One study of dry-cleaning workers showed an effect on color vision in the blue/yellow range (46), while another did not (47).

A human study of neurological effects of PCE was conducted of 14 persons living above or next to dry-cleaning facilities for 1 to 30 years, relative to 23 controls where the exposed breathed 20 to $1,400 \mu\text{g}/\text{m}^3$ when they were at their apartments (44). The researchers found an increased response time in the continuous performance test and simple reaction time, and a smaller number of stimuli were identified. The effect on these neurological functions was altered from their controls but was not statistically significantly different.

Reproductive effects have also been studied in humans. In dry-cleaning female workers, there have been several studies suggesting an increased risk of spontaneous abortion (48-50). Other

studies have not seen such effects (51, 52). A study of dry-cleaning male workers found that a higher percentage of abnormal sperm was similar to those of unexposed laundry workers, though the changes tended to be different (52). These studies lacked exposure measurement data.

There have been no human studies of the developmental effects of breathing PCE. Studies where drinking water systems were contaminated with PCE suggest there could be an association with birth defects, in particular cleft palate (53, 54). In those studies, people using the contaminated water for showering and cooking would have breathed and ingested PCE. When pregnant mice and rats breathed 204,000 $\mu\text{g}/\text{m}^3$ PCE, there was a decrease in fetal weight and delayed bone hardening (55).

Cancer Health Effects

A number of different cancers have been associated with breathing PCE in one human study or another but never very consistently across all studies. In the one study where only PCE exposure had occurred in the workplace, no excess cancer deaths of any kind was found in 615 workers from dry-cleaning shops where only PCE was used (56). Several other studies of cancer incidence or cancer death where the workers were exposed to PCE along with some other chemicals such as petroleum products and TCE, have shown a variety of cancers such as lung, cervix, esophagus, kidney, skin, lymphatic/hematopoietic system, and colon (57-59). Levels of exposure were not described in these studies.

There has been one lifetime study of the carcinogenic effects of breathing PCE in animals (2). This study found dose-dependent increased amount of mononuclear cell leukemia in rats that breathed 1,360,000 $\mu\text{g}/\text{m}^3$ to 2,700,000 $\mu\text{g}/\text{m}^3$ PCE for 6 hours per day, 5 days per week, for 103 weeks. The study found a dose-dependent increase in liver tumors in mice that breathed 679,000 $\mu\text{g}/\text{m}^3$ to 1,360,000 $\mu\text{g}/\text{m}^3$ PCE for the same period. Because both mononuclear cell leukemia and hepatic tumors are common in rats and mice respectively, the relevance of these tumors to humans is not clear. Brain glioma (a rare tumor in the brain) was observed in one male control rat and four male rats that were exposed to 400 parts per million PCE. This increase was not statistical. However, this type of tumor is not typical in rats.

The State of California has determined that PCE is carcinogenic, and the mouse study described above was used to determine the cancer potency of breathing PCE $(0.021 \text{ mg}/\text{kg}/\text{day})^{-1}$.

Trichloroethylene (TCE)—Cancer Health Effects

Several occupational studies have examined the cancer effects of breathing TCE and have found different results. In most of these studies, the worker was exposed to several chemicals including TCE. For instance, a study of 14,457 aircraft maintenance workers found increases in multiple melanomas in white women, non-Hodgkin's lymphoma in white women, and cancer of the biliary passages and liver in white men dying after 1980 (60). When only those exposed to TCE (6,929) were examined, no significant associations between several measures of TCE exposure and excess cancer risk were observed. Other occupational studies have also seen increased risk for non-Hodgkin's lymphoma (61, 62) and liver (63). In addition, other cancers have been

implicated in one study or another: stomach and prostate (63) and kidney (64). In two studies focused on liver cancer, no association with TCE exposure was seen (65, 66).

The State of California has determined that TCE is carcinogenic and that it does not have a threshold for carcinogenicity (i.e., even low doses can cause cancer). The State of California made a quantitative determination on the potency of breathing TCE to cause cancer, based on four mice studies. These four studies had mixed results: one study found a statistically-increased incidence of liver cancer (4). Another study found no statistically-increased incidence of cancers in male mice, but found a statistically-increased incidence of malignant lymphoma in female mice (64). Another study found a higher amount of lung cancer in mice exposed at the two higher dose groups (807,000 $\mu\text{g}/\text{m}^3$, 8 cancers in 50 female animals; 2,420,00 $\mu\text{g}/\text{m}^3$, 7 cancers in 46 female animals) (6). As seen in the tumor incidence, the effect was not dose-related, i.e., there was not an increased number of cancers. The fourth study found no significant increase in cancers in female mice breathing TCE but a statistically-significant increase in liver tumors was seen at the highest dose in males (13 tumors in 90 male mice breathing 3,230,000 $\mu\text{g}/\text{m}^3$ TCE, compared to 4 tumors in 90 animals breathing no TCE). All of these studies involved the use of TCE that is stabilized with other contaminants, some of which are known to be potent carcinogens (epichlorhydrin), further confusing the ability to understand the cancer-causing capacity of TCE.

The California Environmental Protection Agency determined the cancer potency of breathing TCE based on these four studies is $0.007 \text{ (mg/kg/day)}^{-1}$. This potency was used to calculate an increased risk from breathing TCE inside Skateland and Terra Pave.