Health Consultation

DOWNTOWN SCHOOL MEMPHIS CITY SCHOOLS
(a/k/a STATE OF TENNESSEE DCERP SITE #79-212)

MEMPHIS, SHELBY COUNTY, TENNESSEE

JANUARY 2, 2003

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

Health Consultation: A Note of Explanation

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

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

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HEALTH CONSULTATION

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MEMPHIS, SHELBY COUNTY, TENNESSEE

Prepared by:

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

BACKGROUND AND STATEMENT OF ISSUES

In November 2002, the Tennessee Department of Environment and Conservation (TDEC) Division of Superfund (DSF) requested the Tennessee Department of Health (TDH), Communicable and Environmental Disease Services (CEDS), Environmental Health Studies and Services (EHSS) review a report on the Downtown School Vapor Monitoring Program (Pickering 2002). The report detailed air sampling results performed outside and inside the building. Superfund wanted to know, "If the measured vapor concentrations would be a health hazard to children who will attend the new Downtown School in fall semester 2003?"

The process of drycleaning is not truly dry, but it uses so little water that it has come to be known as drycleaning. Instead of water, other solvents are used in the cleaning process. The process of drycleaning has been utilized for more than a century (Cowan 2002a). Regulations on the chemical processes and wastes associated with drycleaning have only recently been developed. Without regulation, the solvents used in drycleaning were often discarded improperly and many drycleaner sites are now known to be sources of pollution from the solvents used.

In 1992, the U.S. Environmental Protection Agency (EPA) created the Design for the Environment Garment and Textile Care Partnership with the dry cleaning industry to reduce exposures to solvents (2002a).

The Tennessee legislature passed law in 1996 that created the Drycleaner Environmental Response Program (DCERP). This program was established to create a fund that could be used for investigation and cleanup of sites where drycleaning solvents have been released to the environment. The program is primarily funded by registration fees and surcharges on the purchase of drycleaning solvents that are paid by Tennessee drycleaner operators throughout the state.

On August 12, 1998, DCERP entered into an agreement with Nations Bank to perform a voluntary cleanup of the 10 North Fourth Street property they owned. The property was the former site of Henry Loeb and Company Laundry and Memphis Steam Laundry Stable. A map dated 1907 details these structures. By the 1990s, the laundry and cleaners had been removed and an asphalt parking lot was in place. The property was later sold to the City of Memphis to be used as the site for a new elementary school.

The 10 North Fourth Street property, future home of the City of Memphis Downtown School, was investigated for contamination from its past use a laundry. A series of investigations determined that soils contained tetrachloroethylene (PCE) and total petroleum hydrocarbons (TPH). Analysis of shallow groundwater detected contamination of tetrachloroethylene (PCE), trichloroethylene (TCE), total petroleum hydrocarbons (TPH), cis-1,2-dichloroethene (1,2-DCE), and vinyl chloride (VC).

In 1999, contaminated soil was removed from the site. Two (2) 15 feet x 15 feet x 16 feet deep pits were excavated and hauled away. In 2001, another (1) pit measuring 300 feet x 300 feet x 20 feet deep was dug and soil removed. Limestone fill was used to geotechnically improve the

future building's footprint. A horizontal piping collection system was installed 20 feet below grade that feeds a vertical recovery well. This pump-and-treat system was designed to extract and reduce pollutants in the groundwater located 4 to 10 feet below grade. The Downtown (elementary) School building (Figures 1 and 2) was then constructed on the site (Figure 3). The Downtown School building is not scheduled for classroom use until the fall semester 2003.

From June 28, 2002 to July 1, 2002, Pickering Environmental Consultants, Inc., under the authorization of TDEC DCERP, performed a vapor monitoring study at the site. In November 2002, TDH EHSS was asked to review the report in a written health consultation.

On December 10, 2002, representatives from Memphis City Schools, Pickering Environmental Consultants, Inc., TDEC DCERP, Memphis-Shelby County Health Department, and TDH EHSS met. The purpose was for Pickering to present results of the vapor monitoring study conducted at the Downtown School June-July 2002 to an executive committee of the Memphis City School Board. State government environment and health officials attended to answer questions and provide assistance.

DISCUSSION

Environmental Sampling

After the Downtown School building was erected, but prior to completion, Memphis City Schools contracted Pickering Environmental Consultants, Inc. to investigate whether or not vapors from the contaminated groundwater were present outside or inside the building. Pickering collected samples in 7 SUMMA canisters (Figure 4) and 36 Emflux "traps" (Figures 5, 6, and 7) between June 28 and July 1, 2002.

The sampling apparatus were placed throughout the Downtown School. Seven (7) chemicals of concern (COC) were investigated: 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, tetrachloroethylene, trichloroethene, and vinyl chloride. None of the 7 SUMMA canisters detected any COC. The practical quantitation limit (PQL) of the SUMMA canisters for PCE is 6.78 $\mu g/m^3$ (micrograms per cubic meter) and for DCE is 3.96 $\mu g/m^3$. Since SUMMA canisters are frequently used to measure chlorinated solvent vapors and no vapors were detected, SUMMA-only studies would have reported non-detect vapor levels. The addition of Emflux "traps" to the Vapor Monitoring Program (Pickering 2002) enabled the detection of some chemicals at levels below the SUMMA canister PQL.

Four (4) of the 36 Emflux samples detected tetrachloroethylene (PCE) up to a maximum flux rate of 161 nanograms per square meter per minute (ng/m^2-min). Seventeen (17) of the 36 Emflux detected 1,1-dichloroethene (DCE) to a maximum flux rate of 92 nanograms per square meter per minute (ng/m^2-min). A flux rate is the amount of a chemical passing through a known area over time. In this case, flux rate is the amount of gaseous PCE passing through the concrete building foundation into the Emflux apparatus during the sampling event. Only 2 of the 36 traps detected both PCE and DCE in the same location (Pickering 2002).

To error on the side of caution, the maximum measured flux rates of PCE and DCE were used in evaluating the possible risk to human health. Furthermore, Pickering Environmental Consultants, Inc. calculated the flux rates to concentrations at a conservative ceiling height of only 5 feet (ft) which adjusts for chemical concentrations at breathing height. Converting the measurements into the more commonly used units of micrograms of chemical per cubic meter of air ($\mu g/m^3$) and parts per billion (ppb), provides a maximum PCE level of 0.63 $\mu g/m^3$ or 0.093 ppb and maximum DCE level of 1.18 $\mu g/m^3$ or 0.297 ppb. (Note these Emflux values are indeed below afore mentioned SUMMA canister PQLs for both PCE and DCE.)

Because only 2 of 7 chemicals of concern were detected in the summer 2002 sampling event, only PCE and DCE will be investigated for human health concerns in this publication.

Tetrachloroethylene (PCE) $Cl_2C=CCl_2$

Tetrachloroethylene (PCE) is also commonly called perchloroethylene (PCE or PERC). Tetrachloroethylene is a clear, colorless liquid said to produce a sharp, sweet smell. It is nonflammable and evaporates very readily at room temperature. Tetrachloroethylene is a synthetic chemical and is often used as a starting point for the manufacture of other chemicals (ATSDR 1997).

If PCE pollutes surface water or surface soil, it will mostly evaporate into the air and disperse. Tetrachloroethylene can travel through soil easily. If PCE gets into underground water, it can remain there for many months or years without breakdown.

People can detect the smell of PCE in the air at 1 part per million (ppm) or more. Background concentration of PCE in outdoor air is usually less than 1 part per billion (ppb). Tetrachlorethylene is used in certain consumer products including repellents, silicone lubricants, fabric finishers, spot removers, adhesives, and wood cleaners. Tetrachloroethylene has been widely used in the drycleaning industry for decades. Clothes brought home from drycleaners may release small amounts of PCE into the air. The significance of exposure to small amounts of PCE is unknown, but to date, they appear to be relatively harmless (ATSDR 1997).

After exposure to PCE, whether through breathing, drinking, eating, or touching, most PCE leaves the body from the lungs during exhalation. A small amount of PCE will be changed by the body, mainly in the liver, to other chemicals and removed from the body via urination. Tetrachloroethylene or changed PCE products can found in the blood or stored in body tissues, especially fat. Body burden of PCE after repeated exposure has been shown to increase. Storage of PCE in body fat can range from days to weeks prior to elimination.

The health effects of breathing air with low levels of PCE are not known. Most industry workers with known PCE exposures had symptoms of dizziness, sleepiness, and other nervous system effects (ATSDR 1997). Laboratory studies of mice and rats suggest that the liver and kidneys are the target organs of PCE.

Tetrachloroethylene can cross the placenta and distribute to the fetus and amniotic fluid. Tetrachloroethylene has been found in the breast milk of mothers exposed to PCE. The effects

of exposing babies to PCE through breast milk are unknown. As of 1997, ATSDR reported finding no studies describing developmental effects of PCE inhalation (ATSDR 1997).

The cancer-causing potential of PCE has been extensively studied. In laboratory rats and mice, PCE has been shown to cause cancer when ingested or inhaled in large amounts. With many workers in the drycleaning industry, several studies provide evidence for a causal association between PCE and elevated risks of certain types of cancer (EPA 2002a). Tetrachloroethylene is listed by the International Agency for Research on Cancer (IARC) as a probable human carcinogen. The National Toxicology Program (NTP) agrees listing PCE as reasonably anticipated to be a human carcinogen (ATSDR 2002).

Tetrachloroethylene is commonly called perchloroethylene or PERC in the drycleaning industry. Introduced in the 1930s (Cowan 2002a), PERC is the solvent, or cleaning agent, most often used by professional drycleaners. PERC removes stains and dirt from all common types of fabric. PERC does not usually cause clothes to shrink or dyes to bleed. PERC is not flammable unlike many other common solvents. Additionally, PERC can be reclaimed after the drycleaning process and reused, helping to make it a cost-effective professional cleaner.

1,1-Dichloroethene (DCE) $CH_2=CCl_2$

Also called vinylidene chloride (VDC), 1,1-dichloroethene (DCE), is a clear, colorless liquid that evaporates readily at room temperature. 1,1-dichloroethene has mild, sweet, chloroform-like odor and burns readily. DCE is a synthetic chemical that is used in the manufacture of certain plastics including packing materials and flexible films. The DCE reported in this consultation is thought to be a product of PCE breakdown. PCE was known to have been used in drycleaning at the site.

In surface soils DCE readily evaporates into the air and disperses. 1,1-dichloroethlene is broken down by reactive compounds formed by sunlight and lasts about 4 days in air. If in surface water, DCE either evaporates into the air or percolates through soil with rainwater into underground water.

1,1-dichloroethene can enter the body through inhalation of polluted air. Low to moderate levels of DCE will be excreted in urine from the body in 1-2 days as breakdown products. Some DCE breakdown products such as dithioglycolic acid are more harmful than DCE. In low concentration, DCE is not stored very much in the body (ATSDR 1994).

Limited animal laboratory studies of the effects of DCE have suggested that its target organs are the liver and kidneys. 1,1-dichloroethene is not known to cause cancer (ATSDR 2002).

Outdoor versus Indoor Air

Tetrachloroethylene has been known to pollute both outdoor and indoor air. Furthermore, elevated levels of PCE vapors have been measured in the air above known soil and groundwater contaminated sites. At the Downtown School site, the pollutant plume is known to extend under

the school building but is not under the playground area. Vapors would be expected in higher concentrations closest to the plume.

Studies have shown that outdoor vapor concentrations are normally several times less than indoor vapor concentrations. This result is not surprising as PCE evaporates quickly and can leave breathable air heights where wind mixing can readily take place. Therefore, the real concern of exposure to PCE or DCE vapors at the Downtown School is inside the building.

Comparing Indoor Air Chemical Concentrations

Some federal guidelines are available for concentrations of PCE and DCE in air. The calculated maximum vapor concentrations for both PCE and DCE are lower than ATSDR MRLs (minimal risk levels) and EPA Region 9 PRGs (preliminary remediation goals).

Chemical	**Maximum Calculated Vapor Concentration**	**ATSDR-MRL Inhalation**		**EPA Region 9 PRG Ambient Air**
	$\mu g/m^3$	ppb	$\mu g/m^3$	$\mu g/m^3$
Tetrachloroethylene	0.63	40 C	271 C	0.67 ca
1,1-dichloroethene	1.18	20 I	79.3 I	520 nc
MRL = Minimal Risk Level is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. These substance-specific estimates, which are intended to serve as screening levels, are used to identify contaminants and potential health effects (ATSDR 2002a).				
PRG = Preliminary Remediation Goals are risk-based tools that are intended to assist in initial screening-level evaluations of environmental measures. PRGs should be viewed as guidelines, not legally enforceable standards. PRGs are helpful in providing long-term targets to use during analysis of remedial activities (EPA 2002b).				
C = Chronic exposure greater than 1 year; I = Intermediate duration exposure up to 1 year ca = cancer value; nc = noncancer value				

Several studies have been conducted to collect ambient air concentrations of PCE. These studies detail what can be considered background levels of PCE in everyday air (ATSDR 1997).

Maximum tetrachloroethylene (PCE) Vapor Concentration	**Comparision Value**	**Origin of Comparison Value**
0.63 µg/m^3 **or** **0.093 ppb** (Pickering 2002)	0.16 ppb rural & remote areas 0.79 ppb urban & suburban 1.3 ppb near emission sources	Compilation of U.S. ambient air monitoring data prior to 1981
	0 ppb Grand Canyon 31 ppb New Jersey	Compilation of listed measured average concentrations
	0.03 - 0.73 ppb urban 0.03 - 0.06 ppb rural	Canadian ambient air monitoring studies
	0.058 – 0.31 ppb	Portland, OR 1984 ambient air monitoring studies
	0.77 ppb	Philadelphia, PA 1983-84 ambient air monitoring studies
	0.24 – 0.46 ppb	samples from 3 NJ cities in summer 1981 and winter 1982
	0.29 – 0.59 ppb	ambient air samples from seven major U.S. cities
	0.035 – 1.33 ppb	EPA Total Exposure Assessment Methodology studies of three industrialized areas

Several studies were conducted to collect ambient air concentrations of DCE. These studies detail what can be considered background levels of DCE in air (ATSDR 1994).

Maximum 1,1-dichloroethene (DCE) Vapor Concentration	**Comparison Value**	**Origin of Comparison Value**
1.18 µg/m^3 **or** **0.297 ppb** (Pickering 2002)	4.6 ppb	National Ambient Volatile Organic Compound Database ambient daily average
	47.3 ppb in summer 7.1 ppb in winter	Research Triangle Park, North Carolina indoor air survey of 26 home and apartments
	3 to 14 µg/m^3	EPA Total Exposure Assessment Measurement studies of 1,085 personal air samples collected over three seasons from 350 New Jersey residents
	0.005-0.03 ppb	on-site field data collection of seven U.S. cities
	0.84 ppb	79 air samples from Kanawha Valley, WV; Los Angeles, CA; Houston, TX
	0.38 ppb	35 air samples from Newark, NJ
	0.35 ppb	34 air samples from Elizabeth, NJ
	0.36 ppb	30 air samples from Camden, NJ

Based on a literature review, the maximum calculated concentrations of PCE and DCE inside Downtown School are less than or comparable to data gathered for both outdoor and indoor urban locations across the U.S. and Canada.

Need for Additional Data

The data collected by SUMMA canisters and Emflux in June-July 2002, demonstrates levels of PCE and DCE that are below guidelines from ATSDR and EPA Region 9. Furthermore, the measured vapor levels are in-line with ambient air measurements across the United States. These data are encouraging, especially since the pumped-and-treat remediation of the groundwater pollution plume has yet to begin.

Literature indicates that PCE vapor concentrations are higher in fall/winter and DCE vapor concentrations are higher in spring/summer due to varying degradation rates (ATSDR 1997). The single summer data sampling event is insufficient for evaluating the current risk to students. Additional samples collected over various seasons are needed to fully characterize potential exposures to elementary students attending the Downtown School.

Additional sampling is encouraged prior to student arrival. Furthermore, EHSS agrees with the proposed need for annual sampling of the indoor air at Downtown School to ensure that past drycleaner activities do not affect student health until the groundwater plume is verifiably removed.

ATSDR Child Health Initiative

In 1996, the Agency for Toxic Substances and Disease Registry (ATSDR) launched an initiative to place a special agency-wide emphasis on environmental hazards to children's health and to emphasize child health in all agency programs and activities. The initiative was begun because of the special vulnerabilities of children when they are exposed to hazardous substances (ATSDR 1997, 1998).

Children six years old or younger are more sensitive to the effects of pollutants than adults. Children generally have lower body weights, breath air closer to the ground, and are more often in contact with the ground than adults. At low levels of exposure a child's mental and physical growth may be affected. TDH used the potential exposure of young children to the PCE or DCE found in the air outside or inside in assessing the risks for the Downtown (elementary) School as school children often are the more susceptible population than the adult employees.

CONCLUSIONS

1. The single air sampling event is not sufficient to rule out a health hazard; therefore, an indeterminate public health hazard is indicated for DCERP site #79-212 until additional data is available for review.
2. The maximum measured flux rate of tetrachloroethylene (PCE) was 161 ng/m^2-min; the maximum calculated air concentration was 0.63 $\mu g/m^3$ or 0.093 ppb.
3. The maximum measured flux rate of 1,1-dichloroethene (DCE) was 92 ng/m^2-min; the maximum calculated air concentration was 1.18 $\mu g/m^3$ or 0.297 ppb.
4. Literature indicates that seasonal variability in the measured PCE vapor concentrations is higher in winter and DCE vapor concentrations are higher in summer.
5. The future use of DCERP site #79-212 as an elementary school brings a sensitive population of mentally and physically developing children below age 6 to the site.
6. Literature indicates that the June-July 2002 calculated PCE and DCE concentrations at Downtown School, Memphis, Tennessee, are in-line with or below both outdoor and indoor ambient air monitoring data.

RECOMMENDATIONS

1. Collect additional indoor air quality data, preferably in winter.
2. Periodically monitor the Downtown School indoor air quality to ensure no public health hazard develops over time.
3. Implement a monitoring plan, consistent to what Pickering Environmental Consultants, Inc. (2002), suggestion for sampling during remediation start-up and in-process.

PUBLIC HEALTH ACTION PLAN

1. TDH & TDEC provided Memphis City School Board contact information for further health or environmental assistance, if needed.
2. Pickering Environmental Consultants, Inc. has been approved by the TDEC DCERP to perform winter sampling with both SUMMA canisters and Emflux “traps” from December 27-30, 2002.
3. On December 31, 2002, Pickering Environmental Consultants, Inc. informed both TDEC DCERP and TDH EHSS that SUMMA and Emflux samples had been collected and sent to a laboratory for analysis.

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FIGURE 1
Downtown School Main Entrance
Memphis, Shelby County, Tennessee
(Photo credit: David Borowski, TDH)

FIGURE 2
Downtown School looking south down Fourth Street
Memphis, Shelby County, Tennessee
(Photo credit: David Borowski, TDH)

FIGURE 3
Site diagram of Downtown School
Memphis, Shelby County, Tennessee
(Pickering 2002) (Mapquest.com)

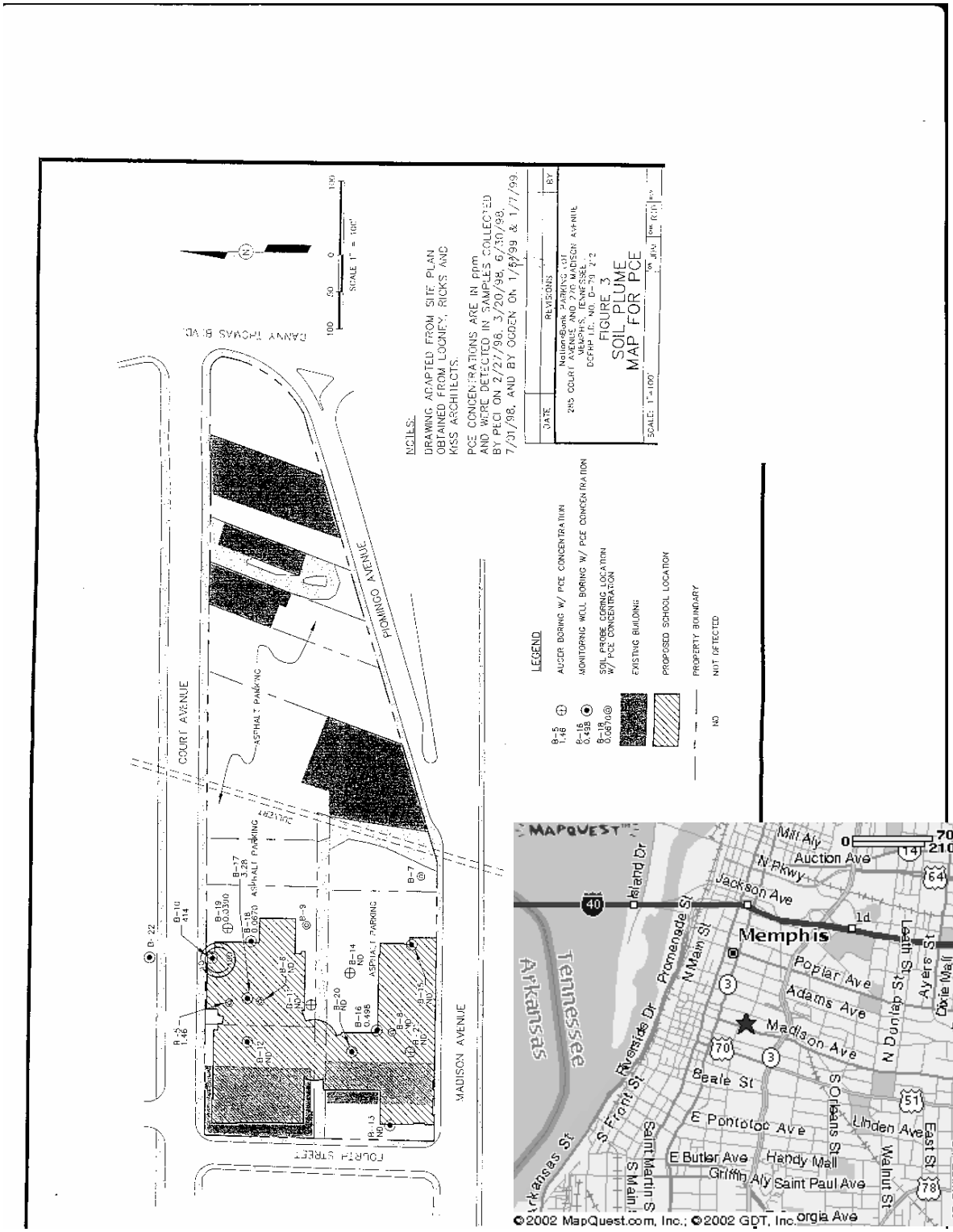

FIGURE 4
Photo of SUMMA canister sampling at Downtown School
Memphis, Shelby County, Tennessee
(Photo credit: Shanna Davis, PECI)

FIGURE 5
Photo of Emflux sampling over concrete floor at Downtown School
Memphis, Shelby County, Tennessee
(Photo credit: Shanna Davis, PECI)

FIGURE 6
Photo of Emflux sampling over patched concrete floor at Downtown School
Memphis, Shelby County, Tennessee
(Photo credit: Shanna Davis, PECI)

FIGURE 7
Photo of Emflux sampling near tiled-floor at Downtown School
Memphis, Shelby County, Tennessee
(Photo credit: Shanna Davis, PECI)

CERTIFICATION

This Memphis City Schools Health Consultation was prepared by the Tennessee Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

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

Roberta Erlwein

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