

**Agency for Toxic
Substances and
Disease Registry**

Division of Health Studies

FINAL REPORT

**Site-Specific Surveillance Project at
the Koppers Company, Inc.
National Priorities List Site
Texarkana, Texas**

Texas Department of Health

March 1994



**U.S. DEPARTMENT OF HEALTH
AND HUMAN SERVICES**

Public Health Service
Agency for Toxic Substances
and Disease Registry
Atlanta, Georgia 30333

In 1980, Congress created the Agency for Toxic Substances and Disease Registry (ATSDR) to implement health-related sections of laws that protect the public from hazardous wastes and environmental spills of hazardous substances. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), commonly known as the "Superfund" Act, designated ATSDR as the lead agency within the U.S. Public Health Service to help prevent or reduce further exposure to hazardous substances and the adverse health effects that result from such exposures, and also to expand the knowledge base about such effects.

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**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY
ATLANTA, GEORGIA**

**SITE-SPECIFIC SURVEILLANCE PROJECT AT
THE KOPPERS COMPANY, INC.
NATIONAL PRIORITIES LIST SITE
TEXARKANA, TEXAS**

TEXAS DEPARTMENT OF HEALTH

March 1994

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CONTENTS

	<u>Page</u>
DISCLAIMER	ii
ABSTRACT	1
INTRODUCTION	3
Objectives	3
BACKGROUND	5
History	5
Site Description	5
Site Characterization	6
Soil	6
Groundwater	6
Surface Water and Sediments	6
Air	7
Municipal Water System	7
Human Exposure	7
METHODS	9
Study Design	9
Target Community	9
Comparison Community	9
Sample Selection	9
Study Instrument	10
Interviewing	10
Household Contact	11
Environmental Samples	11
Biological Monitoring	11
Privacy and Notification	12
Informed Consent	12
Data Protection and Privacy	12
Community Notification	12
Data Analyses	12
RESULTS	15
Participation Rates	15
Description of the Surveillance Population	15
Health Outcomes - First Year	17
Reproductive Outcomes - First Year	19

Vital Records Review - First Year	21
Health Outcomes - Second Year	21
Reproductive Outcomes - Second Year	23
Vital Records Review - Second Year	23
DISCUSSION	25
CONCLUSIONS	29
RECOMMENDATIONS	29
AUTHORS AND ACKNOWLEDGEMENTS	31
REFERENCES	33
TABLES	37
FIGURES	107
APPENDICES	117

LIST OF TABLES

Table 1.—Completion status-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	39
Table 2.—Completion status-Year 2, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	41
Table 3.—Demographic characteristics of Koppers and comparison area residents-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	43
Table 4.—Education level of Koppers and comparison area residents-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	45
Table 5.—Demographic characteristics by year, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	47
Table 6.—Smoking history by area of residence-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	49
Table 7.—Smoking history by year, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	51
Table 8.—Alcohol history by area of residence-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	53
Table 9.—Alcohol history by year, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	55
Table 10.—Residential and employment histories by area of residence-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	57
Table 11.—Dietary and residential characteristics, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	59

Table 12.—Subjective questions about health and environment by area of residence-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	61
Table 13.—Subjective questions about health and environment by year, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	63
Table 14.—Significant disease outcomes by community-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	65
Table 15.—Reported skin rashes by area of residence and by age group-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	67
Table 16.—Reported skin rashes by exposure opportunities Koppers area residents-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	69
Table 17.—Reported bronchitis by exposure opportunities Koppers area residents-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	71
Table 18.—Reported skin rashes by exposure opportunities Koppers area children 10 years of age and younger-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	73
Table 19.—Reported chronic bronchitis by exposure opportunities Koppers area children (10 years of age or younger)-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	75
Table 20.—Characteristics of 91 Koppers area and 93 comparison neighborhood women, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	77
Table 21.—Reproductive outcomes among women living in Koppers area and comparison neighborhoods, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	79
Table 22.—Reproductive outcomes among women 20 through 39 years of age who lived in Koppers area and comparison neighborhoods, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	81

Table 23.—Reproductive outcomes among women 40 through 59 years of age who lived in Koppers area and comparison neighborhoods, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	83
Table 24.—A comparison of reports of problems becoming pregnant among Koppers area and comparison neighborhood women, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	85
Table 25.—Relationship between concerns about chemicals in neighborhood and reported problems becoming pregnant among Koppers and comparison area women, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	87
Table 26.—Average number of pregnancies by neighborhood and reported difficulties becoming pregnant, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	89
Table 27.—Standardized incidence ratios for selected health conditions among Koppers site residents, Texarkana, Texas, 1991-1992, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	91
Table 28.—Reported skin rashes by exposure opportunities, Koppers area residents, Texarkana, Texas, 1991-1992, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	93
Table 29.—Reported skin rashes by exposure opportunities, Koppers area children 10 years of age and older, Texarkana, Texas, 1991-1992, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	95
Table 30.—Risk for skin rashes by exposures adjusting for risk perception, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	97
Table 31.—Risk of skin rashes by soil exposure stratified by perception of soil problems, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	99
Table 32.—Characteristics of reported rashes with onset March 1991 through March 1992, Koppers residents, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas	101

Table 33.—Characteristics of reported rashes with onset prior to March 1991 Koppers residents, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas 103

Table 34.—Morbidity/mortality ratios for reproductive outcomes among Koppers residents after moving into the Koppers area, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas 105

LIST OF FIGURES

Figures 1.—Percent of residential lot showing bare earth by area of residence	109
Figure 2.—How often, if ever, have you noticed a chemical odor in your neighborhood?	111
Figure 3.—When, if ever, have you noticed any problems with your water?	113
Figure 4.—When, if ever, have you noticed a problem with your soil?	115

LIST OF APPENDICES

Appendix A—Maps	A-1
Appendix B—Informed Consent Form	B-1
Appendix C—Community Newsletter	C-1

ABSTRACT

The Koppers Company, Inc., in Texarkana, Texas, is the site of an abandoned creosote wood treatment facility. Soil and groundwater throughout the entire site have been contaminated by polycyclic aromatic hydrocarbons (PAHs) and other chemicals. In 1984, the U.S. Environmental Protection Agency placed the site on the National Priorities List. In 1989, the Agency for Toxic Substances and Disease Registry released a health assessment which recommended that a health study be conducted among residents living on or near the site. In 1990, the Texas Department of Health began a surveillance project at this site. The objectives of this surveillance were (1) to determine whether residents living on or near the hazardous waste site (target population) had a higher prevalence of adverse health conditions than a similar community not situated near the site and the general population; (2) to assess whether adverse health outcomes were associated with exposure to potentially contaminated environmental media; and (3) to monitor the health of the target population by a follow-up interview and review of state vital statistics.

Results of the first year of the site-specific surveillance project showed that residents living on or near the hazardous waste site reported a higher prevalence of skin rashes (27.9%) than comparison neighborhood residents (4.9%) (relative risk [RR] = 5.72, 95% confidence interval [CI] = 3.01, 10.87). Even with adjustments for the belief that health problems were related to chemicals in or near their homes, Koppers residents were still 2.9 times more likely to report skin rashes than comparison neighborhood residents (95% CI = 1.27, 6.63). Koppers women who reported having problems becoming pregnant had an average of 1.3 pregnancies compared with an average of 3.4 pregnancies among comparison neighborhood women reporting this problem ($p < 0.04$).

During the second year, health outcomes of the Koppers area residents were compared with the 1990 National Health Interview Survey rates. Thirty-four Koppers area residents reported skin rashes, whereas four reports of these skin problems would have been expected based on the national rates (standardized incidence ratio = 8.5, 95% CI = 5.9, 11.9). Among Koppers area residents, increased risk for rashes was associated with digging in their yards (RR = 2.21, 95% CI = 1.19, 4.70); having contact with soil in the neighborhood area (RR = 2.25, 95% CI = 1.12, 4.90); and wading or having contact with Wagner Creek (RR = 2.12, 95% CI = 1.16, 3.90). During the second year, more detailed information on recent and past rashes indicated that most rashes (94%) were associated with itching or burning and were reported by residents who also reported having contact with soil in the area.

The Koppers area residents did not appear to have higher rates of either adverse pregnancy outcomes or cancer than comparison residents. From the results of this surveillance, residents in the Koppers area should wear protective clothing when having contact with soil in the on-site areas, as well as thoroughly wash any skin area coming in contact with potentially contaminated soil.

**SITE-SPECIFIC SURVEILLANCE PROJECT AT
THE KOPPERS COMPANY, INC.
TEXARKANA, TEXAS**

INTRODUCTION

The Koppers Company, Inc., a National Priorities List (NPL) site, is located within the city limits of Texarkana, Texas. From 1910 to 1961, the Koppers Company operated as a creosote wood treatment facility. In 1964, the Carver Terrace subdivision was built over the northern portion of the site. The southern portion of the site was owned by Kennedy Sand and Gravel Company, which operated from the late 1970s until September 1984. Since 1980, environmental sampling has shown soil and groundwater contamination over the entire site with polycyclic aromatic hydrocarbons (PAHs), phenolic compounds, chlorinated dibenzodioxins, and chlorinated dibenzofurans. In 1981, the U.S. Environmental Protection Agency (EPA) began its initial investigation of the site, which was placed on the NPL in 1984.

Because of the contaminants present in on-site residential surface soils and the potential past and present human exposure, a site surveillance project was implemented. Its purpose was to determine whether residents of the Carver Terrace subdivision and the adjacent community were experiencing a significantly higher incidence of health-related problems possibly related to site contaminants than a similar nonexposed community and the general population.

The Texas Department of Health (TDH) applied for and received a competitive grant from the Agency for Toxic Substances and Disease Registry (ATSDR) to perform the recommended surveillance. Staff members from the TDH and ATSDR conducted a household health survey at the Koppers site community from March 11 through March 16, 1991. The survey for the comparison community was conducted from April 22 through April 27, 1991. TDH staff members conducted a follow-up health survey at the Koppers site during the week of March 30 through April 4, 1992.

Objectives

The objectives of this surveillance were (1) to determine whether the communities living on or near the abandoned wood treatment site (the target population) had different prevalences of specific diseases or health problems (lung cancer, skin cancer, skin rashes, and adverse reproductive outcomes) than a comparison community not situated near the site; (2) to assess whether adverse health outcomes were associated with exposure to potentially contaminated environmental media; and (3) to monitor the health of the target population by a follow-up interview and review of state vital statistics.

BACKGROUND

History

From 1910 to 1961, the Koppers Company site operated as a creosote wood treatment facility, which included the preservation, drying, and storage of railroad cross and switch ties. In 1964, Carver Terrace, Inc., purchased 33.5 acres of land at the site and developed a residential area on the northern half of the site. The southern half of the site, with the exception of a half-acre tract belonging to the Mount Zion Missionary Baptist Church, was sold to the Kennedy Sand and Gravel Company. The Kennedy Sand and Gravel Company operated from the late 1970s until September 1984.

Because of soil and groundwater contamination, the EPA placed this site on the NPL in 1984. In 1985 and 1986, as a protective measure, the EPA placed a soil/sod protective barrier on several residential lots in the Carver Terrace subdivision. The criteria used to select the locations for emergency remedial activity were (1) soil concentrations of benzo[a]pyrene in excess of 325 milligrams/kilogram (mg/kg); (2) visibly oil-stained areas; or (3) if the majority of the yards in a block were remediated, the remaining yards were also resodded, even if they did not meet the other criteria. Not all of the subdivision lots had been sampled before the 1985 emergency action (placement of sod barriers).

EPA subsequently selected the clean-up methods for the Koppers site. The contaminated soils will be treated by mechanical soil washing, and the affected groundwater will be treated by a pump and treat system using carbon absorption. At the time of this report, EPA was still negotiating remediation with the potentially responsible parties for the site.

On April 10, 1989, ATSDR released the health assessment document for the Koppers Company site (1). According to this health assessment, EPA's protective remediation activity was only a temporary measure and did not adequately protect the public from long-term exposures to contaminated soils. Because of the residents' concerns, the health assessment was reviewed by members of Congress and the proposed plan was amended to include a buyout of homes located on the site. As of August 1992, several of the residents had moved from Carver Terrace. The remaining residents of this subdivision will also permanently relocate off site.

Site Description

The 62-acre site is located in northeastern Texas within the city limits of Texarkana, Bowie County (Appendix A). It is one mile from the Texas-Arkansas state line. The site is bordered by the Texas and Pacific Railroad to the north, Wagner Creek to the southwest, an unnamed tributary to the northwest, Jameson Street to the south, and a drainage ditch and gravel pits to the southeast. Within the site are a residential area, the former sand and gravel company, and a church. The residential area is known as the Carver Terrace subdivision and includes 79 houses. Access to the former sand and gravel company is currently restricted by a fence.

Site Characterization

Soil, groundwater, surface water, sediment, and subsoil samples were collected to characterize the site. The information provided in this section is summarized from the executive summary of the final remedial investigation report (2).

Soil

Three soil boring programs were conducted before the remedial investigation to characterize the extent of contamination in surface and subsurface soil. Supplemental samplings were conducted by EPA in October 1984 and December 1985; these samples focused on surface soils in the Carver Terrace subdivision. The base/neutral compounds most frequently detected in the soil were pyrene, fluoroanthene, phenanthrene, and anthracene, with concentrations of these compounds ranging from undetectable levels to 10^6 parts per billion (ppb).

Groundwater

The groundwater had been affected by contamination from the southern portion of the Koppers site. The base/neutral compounds most frequently detected were naphthalene, acenaphthene, fluorene, pyrene, and phenanthrene, with levels ranging from undetectable to 10^5 ppb. Metals detected in groundwater did not exceed the primary and secondary drinking water standards. Residents obtained their domestic water from the municipal water system, which was not affected by the site.

Surface Water and Sediments

Surface water samples were collected from Wagner Creek, the aforementioned unnamed tributary, an on-site drainage ditch, and gravel pits. The sampling was conducted in four rounds. The first sampling was conducted under normal conditions, the second sampling was conducted after a storm, and the third and fourth rounds of samplings were conducted in the gravel pits.

Analyses revealed that surface water had not been affected by on-site contamination. Surface water samples showed no detectable levels of acid or base/neutral compounds. Metals were detected in surface water samples, but all levels (with the exception of iron) were below the primary and secondary drinking water standards.

Analyses of sediment samples from Wagner Creek adjacent to the site showed detectable levels of base/neutral compounds in concentrations as high as 10^5 ppb. From downstream sediment samples in Wagner Creek, one base/neutral compound with a concentration of 10^3 ppb was detected. At the junction of Wagner Creek and the drainage ditch, seven base/neutral compounds were detected with levels ranging from 10^2 to 10^3 ppb. Analysis of sediments in the site drainage ditch also indicated that the site had affected sediment quality in the ditch. Detectable levels of predominantly base/neutral organic compounds ranged from 10^3 to 10^5 ppb.

Air

Air sampling was conducted for a 3-day period in November 1985. Data revealed that ambient air quality had not been affected.

Municipal Water System

Sampling of the municipal water system for the Carver Terrace subdivision was conducted in August 1985. Samples were analyzed for priority pollutant acid and base/neutral organic compounds and metals, and revealed no contamination from the Koppers site.

Human Exposure

Polycyclic aromatic hydrocarbons (PAHs) occur in a variety of environmental products, such as soot, coal, tar, tobacco smoke, air pollutants, petroleum, cutting oils, and creosote (3,4). PAHs are also present in smoke produced from burning wood for home heating, cereals, grains, flours, bread, vegetables, fruits, meat, processed or pickled foods, and beverages. Cooking meat or other food at high temperatures increases the amount of PAHs in food. Exposures to these compounds have been associated with increased incidences of skin and lung cancers (4). Studies of workers have indicated increased mortality from lung cancer after exposure to coke-oven and roofing tar emissions (5,6).

Studies in laboratory animals have indicated that benz[a]anthracene, benzo[b]fluoranthene, benzo[a]pyrene, chrysene, and dibenz[a,h]anthracene can induce skin tumors (7-10). Results from animal studies have also indicated that benz[a]anthracene, benzo[a]pyrene, dibenz[a,h]anthracene, and possibly other PAHs are potentially carcinogenic after oral exposure (11). Tumors found in these animal studies have included lung adenomas, papillomas, and carcinomas; squamous cell carcinomas of the forestomach (of questionable relevance to human cancer); mammary tumors; and hepatomas. Because these types of PAHs were found in surface and subsurface soils at the Koppers Company NPL site, on which Carver Terrace subdivision has been located for approximately 25 years, the surveillance of lung, skin, and other cancers was indicated.

Forbes et al. (12) found that hairless mice had enhanced dermal inflammation from ultraviolet radiation exposure after application of anthracene compared with mice exposed only to ultraviolet radiation. Therefore, anthracene might potentiate skin damage caused by sunlight and might be considered a photosensitizer. Since anthracene was found in the surface and subsurface soils at the Koppers NPL site, the presence of rashes and other skin problems was included in the surveillance of residents.

Although adverse effects of PAHs on human fetal development have not been documented, results of several animal studies (13,14) have indicated resorptions, dead fetuses, and reduced mean pup weight during postnatal development from prenatal exposure to benzo[a]pyrene. Benzo[a]pyrene administered in the diet of female rats also reduced the

incidence of pregnancy (14). Therefore, the surveillance of adverse reproductive outcomes was included as part of this project.

Both animal and occupational epidemiologic studies involve exposures to PAHs at far higher levels than were expected at the Koppers NPL site. However, very little is known about whether low-dose PAH exposures potentially encountered at or near hazardous waste sites such as Koppers are associated with adverse health outcomes (such as cancer, skin rashes, or adverse reproductive outcomes) in human populations. The primary health-related concerns expressed by the citizens included perceived excess numbers of rashes, cancers, and miscarriages.

METHODS

Study Design

Site-specific surveillance using a disease and symptom prevalence instrument was developed to determine whether residents were experiencing health problems that might be related to living at the site. The decision to use this design was based on the following criteria: (1) the target population resided on or near the Koppers NPL site, and, according to the ATSDR health assessment, residents were potentially exposed to site contaminants through ingestion and/or dermal absorption of contaminated soils; (2) the community reported excess numbers of cancers, miscarriages, and rashes; and (3) the residents appeared willing to participate in a longitudinal surveillance activity.

Target Community

Selection of the target area in Texarkana was determined by its proximity to the site. The target area included 79 single-family homes on the site, as well as approximately 50 homes immediately adjacent to the site, bounded by Lake Drive on the east, Lee Street on the south, the on-site subdivision to the north, and an open area in the west (Appendix A contains a map of the site).

Comparison Community

Members of the Texarkana-Bowie County Family Health Center suggested several communities that they believed had the potential to serve as comparison areas. Three TDH study team members toured the suggested communities to determine whether any one would be suitable as a comparison area. After touring the various areas, the TDH study team selected a neighborhood about 1.5 miles southwest of the site that was not affected by contamination from the site. The comparison community had similar housing characteristics, socioeconomic indicators, and racial structure as the target community. Members of the comparison community were interviewed during the first year of surveillance. During the second year of surveillance, prevalence rates of health conditions among the target community were compared with those from the 1990 National Health Interview Survey (15).

Sample Selection

All homes in the target community were included in the survey. The comparison neighborhood homes were sampled to maintain the same proportion of brick homes (61%) and wood frame homes (39%) found in the target community; 126 comparison homes were sampled.

In both the target and comparison communities, interviews were requested from every household member in each residence. Children from the ages of 11 through 17 years and adults

were requested to answer for themselves. Children under 11 years of age were also allowed to answer for themselves, but an adult household member was present to confirm or provide responses if necessary.

Study Instrument

The initial and follow-up instruments were disease and symptom surveillance questionnaires developed by ATSDR. The questionnaires covered individual demographic, lifestyle, residential, occupational, and health characteristics. Lifestyle (for example, smoking) and occupation (for example, jobs that could be associated with PAH exposure) were important confounding factors in this study, which examines the potential effect of residence on the prevalence of adverse health conditions.

Supplemental exposure and subjective questionnaires were also included in the surveillance. The exposure questionnaire contained questions similar to those used in the Crystal Chemical Arsenic Exposure Study (Houston, Texas) (16). The subjective questionnaire was used to elicit any environmental concerns and assess the impact of those concerns on reported health problems.

Information related to adverse health conditions was based on resident reports. For certain health problems, study participants were requested to sign a medical release form to allow access to their medical records for confirmation of reported conditions. Any such medical records were reviewed by a TDH physician.

A detailed skin questionnaire was developed for use the second year to better characterize the types of rashes reported by residents. Any resident with a history of a skin rash was asked specific questions on the characteristics and locations of rashes, and the events associated with or aggravating the rashes.

Interviewing

Before each data collection phase and to ensure the comparability of collected data, all interviewers were given training in administering all questionnaires, interviewing techniques, and the interview process. Initially, the 1990 city directory was used to obtain residential information for households within the target and comparison communities. With this information, letters were sent to residents' (one week before the survey) describing the purpose of the surveillance and the role of the participants. To facilitate interviewing, increase study participation, and answer questions about the project, investigators met with members of the Koppers community one month before the survey. During the second year, residents were notified by mail and follow-up telephone calls to schedule appointments for household interviews. During both years, the interviewers were not blinded to the status of the homes during interviews. Achieving blinding in this situation would have been very difficult because of the presence of fences and signs that indicated contamination at the Koppers site.

Household Contact

Residents were contacted at their homes. After the surveillance was explained and signed consent forms were obtained for each participant, household interviews were conducted; these generally lasted 30 to 60 minutes per person. If a participant reported an adverse health condition (that is, cancer, adverse reproductive outcome, or skin rash) during the interview, a medical release form was requested for each medical provider/institution responsible for the treatment of the condition.

Interviewers returned to a home as many times as necessary in order to interview all residents. For any hard-to-reach resident, a written notice with a telephone number and an alternate site for interview was left to document the attempted visit and to encourage rescheduling the interview at the resident's convenience. At least six attempts were made to reach each household at various times of the day and during the week before a household was listed as nonparticipating. In participating households, individual residents who were hard to reach were contacted by telephone whenever possible. When telephone contact could not be established, another household member served as a proxy to complete the questionnaires. No household was assumed to be nonparticipating until the survey periods were over (June 1991 and June 1992).

Environmental Samples

Because of previous sampling by contractors for EPA, environmental samples were not collected within the target community. Six soil samples were collected within the comparison neighborhood to check for any PAH contamination. The samples were analyzed at the TDH environmental chemistry laboratory by atomic absorption spectroscopy. All results were negative for PAHs.

Biological Monitoring

No biological specimens were collected from either population. Recent literature reviews of specific PAHs indicate that the most common tests for determining exposure to the various compounds include examination of tissues, blood, and urine for specific metabolites (7-11). Currently, it is not possible to determine from these tests how much of a specific PAH a person has been exposed to or to predict what health effects might occur at certain levels. Furthermore, there is no reliable method for measuring the low-level exposures that are or were likely encountered at the Koppers area.

Privacy and Notification

Informed Consent

All subjects were asked to give their written informed consent before participating in the surveillance. Parents and legal guardians were asked to give consent for minor children. A copy of the consent form is attached in Appendix B.

Data Protection and Privacy

In accordance with the Privacy Act of 1974 (5 U.S.C. Section 552a (e)) and the Texas Health and Safety Code (Chapter 161, Sections 161.02 and 161.022, which keeps the identity and condition of persons studied confidential), all completed interview forms and other identifying information were kept secure, out of sight of unauthorized persons, and in locked rooms. Each participant was assigned a unique number for identification purposes. Names and addresses were stored separately from nonidentifying information. The results of this surveillance are presented in the form of aggregate statistics to avoid disclosing the identities of specific subjects.

Community Notification

Results of the first year's health survey were reported in a newsletter (Appendix C) that was distributed to residents in the target community. The final surveillance report was approved by ATSDR in September 1993. Project staff members sent a newsletter to each participating household summarizing the results; placed a copy of the final report in the local public library for review and comment; and conducted a public availability session in the fall of 1993 in Texarkana to answer any questions about the project results.

Data Analyses

All interview data were entered into a computer database created by using Epi Info (17) software. Each year, a 20% sample of records was reentered to check the accuracy of data entry and detect data entry problems. Each variable was examined for out-of-range values. For analysis of first-year survey data, Student's t-tests were used to compare the means of continuous variables between groups. Crude prevalence rates between groups were examined using the chi-square test of independence and Fisher's exact test (18). Relative risks (prevalence in Koppers community divided by prevalence in comparison community) and 95% confidence intervals were calculated for disease outcomes using Greenland's and Robin's 95% confidence intervals for a relative risk (19). The 95% confidence interval indicates the range in which the relative risk would be expected to fall 95% of the time; a narrow confidence interval indicates that the precision of the relative risk (point estimate) is good. If the 95% confidence interval includes 1.00, no statistical excess of disease is indicated. The relative risk was selected as the measure of association because the two groups were sampled on the basis of whether they lived at the hazardous waste site or not, and investigators had an estimate of the population at risk in each

neighborhood. Relative risks for all disease outcomes were restricted by the date of diagnosis: diseases diagnosed before residents moved into their respective neighborhoods were eliminated from the analyses. Statistically significant relative risks for various disease outcomes were adjusted for age, sex, smoking status, and potential occupational exposure to PAHs. Data from children less than 11 years of age were also analyzed separately. The effect of differential recall was also assessed for disease outcomes with statistically significant relative risks. Outcomes were stratified by the belief that health outcomes were related to chemicals in or near their homes. Both strata-specific and adjusted relative risks (for health beliefs) were reported.

For analysis of second-year survey data, descriptive statistics were used to summarize the demographics, lifestyle characteristics, and health conditions of the Koppers community. The follow-up questionnaire collected information on conditions that were diagnosed during the preceding year. Rates from the 1990 National Health Interview Survey (15) were used to calculate standardized morbidity ratios for certain health conditions. Standardized incidence ratios (SIRs) were calculated in the following manner. Age- and race-specific rates of health conditions from the National Health Interview Survey were applied to the appropriate age groups in the Koppers area population to generate expected numbers of cases for each age category. These race- and age-specific expected numbers were summed for each condition. The ratios of observed cases to expected cases were then calculated to obtain the SIRs. SIRs were tested for significant deviation from 1.00 by using Fisher's exact test and exact confidence intervals for the Poisson variate (18). As with relative risks, if the 95% confidence interval for the SIR includes 1.00, no statistical excess of disease is indicated.

For survey data from each year, significantly elevated adverse health outcomes among Koppers area residents were also examined in relation to soil exposure and other exposures to potentially contaminated media. Relative risks for these outcomes were calculated by dividing the prevalence in potentially exposed residents by the prevalence in residents who reported not having been exposed to these environmental media.

RESULTS

Participation Rates

During the first year, a total of 118 households from the Koppers area and 126 households from the comparison community were eligible to participate in the health survey. Residences with one or more occupants at the time of this surveillance were eligible to participate. Table 1 shows the household and individual participation rates by community. Of the 118 eligible households in the Koppers area, 85 (72%) had one or more household members participate in the health survey. The comparison area had a similar participation rate; household members from 92 (73%) of the 126 eligible homes agreed to participate. Although household participation rates were equal, individual participation from Koppers area residents was much higher than that of comparison residents. Eighty-one percent of the eligible participants from the Koppers area agreed to participate compared with 67% in the comparison area.

Table 2 shows household and individual participation rates for the second-year survey; only Koppers residents who participated in the first year were eligible. Of the eligible Koppers area residents, 89% of the households and 88% of the residents participated during the second year of the site surveillance project.

Description of the Surveillance Population

During the first year, a total of 429 individuals from the Koppers and the comparison areas participated in the surveillance project. African Americans made up 100% (214) of the participants in the Koppers area and 98.6% (212) of the participants in the comparison area. The white participants from the comparison area were excluded from data analyses.

Children less than 11 years of age made up 14% of the population. There were 36 children under the age of 11 years from the Koppers area, and 23 children in this age group from the comparison area. Ages for five participants were unknown.

Table 3 summarizes the demographic characteristics of participants by area of residence. The two communities did not differ with respect to race, sex, age, or income. Koppers area residents reported a significantly higher proportion of high school graduates than did comparison area residents ($p = 0.05$). Table 4 shows education level by area of residence. Participants in the second-year survey were very similar to first-year participants in sex, age, race, and income distribution (Table 5).

Very little difference was noted in tobacco use by community. Table 6 shows smoking history by community. Among adults 18 years of age and older, approximately 45.2% of the Koppers residents reported smoking at least 100 cigarettes during their lifetime compared with 41.7% of comparison residents, and 23% of both groups were smokers at the time of this surveillance. However, a higher proportion of Koppers area residents reported exposure to smoke in the workplace than did comparison area residents ($p = 0.05$). Residents from the

comparison area were more likely to use snuff than Koppers area residents ($p = 0.02$). During the second-year survey, a slightly lower proportion of Koppers area residents reported smoking at least 100 cigarettes in their lifetime compared with what was reported the first year. Fewer also reported being exposed to smoking at work (Table 7).

Alcohol use did not vary significantly by community. Table 8 summarizes alcohol use by community. Among Koppers residents, reports of alcohol use were similar for both survey years (Table 9).

Table 10 shows residential and employment histories by community. Residents from the Koppers area had lived in their homes an average of 14.8 years compared with 12.9 years for residents in the comparison area ($p = 0.12$). The Koppers area had an average of 3.7 permanent residents per household compared with 3.8 permanent residents in the comparison community ($p = 0.62$). Employment history and occupational exposure to PAHs did not differ significantly by community. During the second-year survey, 16 Koppers residents reported that they had changed jobs in the past year. Seven of these job changes involved potential occupational exposure to PAHs; four of these were among residents whose previous positions were potentially associated with PAH exposure.

Residents were questioned about environmental characteristics of their household and exposure to dietary sources of PAHs. They were asked how they heated their homes. Nearly all reported having either electric or gas heat, with the exception of one Koppers area household that reported using a coal stove. Table 11 presents dietary and residential characteristics by neighborhood. Approximately 47% of Koppers area residents reported a complete sod cover on their yards compared with 82.6% of the comparison community ($p < 0.001$). Figure 1 illustrates the amount of each residential lot showing bare earth by community: only 22% of the Koppers residents lived on lots with full ground cover in their yards compared with 44% of the residents from the comparison neighborhood ($p < 0.001$). Residents from the Koppers community were also five times more likely to live next to an area without ground cover ($p < 0.001$).

Responses to subjective questions about health and environment are shown in Table 12 and Figures 2 through 4. A greater percentage of Koppers residents reported that their overall health was fair to poor than did residents of the comparison group ($p = 0.02$). Approximately 30% of the Koppers residents attributed their health problems to chemicals in or near their homes compared with 4% of comparison residents ($p < 0.001$). Koppers residents were five times more likely than comparison residents to report a concern about chemical and environmental chemical hazards in their neighborhood ($p < 0.001$); problems with chemical odors in their homes and yards (Figure 2) ($p < 0.001$); problems with their water (Figure 3) ($p < 0.001$); and problems with their soil ($p < 0.001$).

Table 13 compares responses of Koppers area residents concerning their health and risk perceptions for 1991 and 1992. Although responses were similar for both years, a higher

proportion of residents during the second year did not think their health problems were related to chemicals in or near their homes.

Health Outcomes - First Year

Table 14 presents the prevalence of disease outcomes in which differences were statistically significant for the two communities. After restricting conditions to those diagnosed only after residents moved into their respective neighborhoods, Koppers residents reported a statistically significantly higher prevalence of skin rashes (relative risk (RR) = 5.72), chronic bronchitis (RR = 2.65), urinary disease (RR = 2.73), and liver disease (RR = 11.11). Residents with missing information were excluded from the analyses. Descriptions of disease outcomes were reviewed to determine the heterogeneity of reported diagnoses. For example, liver disease was not further analyzed because of the variety of conditions reported, ranging from jaundice at birth (n = 5) to infectious hepatitis (n = 4); these conditions have specific causes not likely to be related to site contaminants. Urinary disease was not analyzed because of the large number of reports of urinary tract infections (n = 19) and prostate problems (n = 5) that were not indicative of chronic urinary tract disease. Further analyses of disease outcomes were limited to skin rashes and chronic bronchitis.

After adjustments for age, Koppers residents still had a higher prevalence of skin rashes (RR = 5.85, 95% confidence interval (CI) = 3.01, 11.36). Table 15 shows the prevalence of skin rashes by age group for the two communities. Both Koppers males and females reported a higher prevalence of skin rashes.

Koppers area residents (18 years of age and older) with potential occupational exposure to PAHs reported a higher prevalence of skin rashes compared with the comparison residents who also had potential occupational exposure to these compounds (RR = 3.63, 95% CI = 1.08, 12.21). Among those without any occupational exposure to PAHs, Koppers area residents also reported a significantly higher prevalence of skin rashes than comparison residents (RR = 6.80, 95% CI = 2.47, 18.68). Adjusting for potential occupational exposure to PAHs, Koppers residents were five times more likely to report skin rashes than comparison residents (RR = 5.38, 95% CI = 2.49, 11.63).

Because contact with the soil might increase risk for skin rashes independently from any soil contamination, the activities (current) of digging in the soil and gardening were adjusted for and compared between the Koppers and comparison communities. Among those who reported digging in their yards, 24.2% in the Koppers area reported rashes compared with 7.8% of the comparison group. Among those who denied current digging in their yards, 29.5% of the Koppers group reported rashes compared with 3.4% of the comparison group. Adjusting for this activity, the Koppers area group was 5.18 times more likely to report skin rashes (95% CI = 2.74, 9.79). Adjusting for current gardening, the Koppers area group was 5.36 times more likely to report skin rashes than the comparison group (95% CI = 2.75, 10.46).

Among Koppers area residents, there was no statistically significant difference in the reports of skin rashes by sex or age group. Residents from the Koppers area were stratified by exposure opportunities to determine which variables were associated with developing skin rashes. Table 16 shows the reports of skin rashes by exposure opportunities. Residents of the Koppers area who reported contact with water from Wagner Creek were twice as likely to develop skin rashes (95% CI = 1.23, 3.10).

Koppers residents 11 years of age or older reported a higher prevalence of chronic bronchitis than comparison residents in the same age group (RR = 2.73, 95% CI = 1.17, 6.38). The association between living in the Koppers area and a higher prevalence of chronic bronchitis was not confounded by sex, age, smoking status, or occupational exposure to PAHs.

Koppers area residents were also stratified by exposure opportunity to determine which variables were associated with the prevalence of chronic bronchitis (Table 17). Prevalence of chronic bronchitis did not vary significantly by any identified exposure opportunities.

To assess the impact of environmental concerns on reported health problems, outcomes were stratified by residents' belief that their health problems were related to chemicals in or near their homes. Among Koppers and comparison residents who believed that health problems were related to chemicals in or near their homes, 47% of Koppers residents reported skin rashes compared with 12.5% of the comparison residents (RR = 3.74, 95% CI = 0.59, 23.86). When this belief was not present in either Koppers or comparison individuals, 12.3% of the Koppers residents reported skin rashes compared with 4.7% of comparison residents (RR = 2.61, 95% CI = 1.07, 6.36). After adjustments for this belief, Koppers residents were still 2.9 times more likely to report skin rashes than comparison residents (95% CI = 1.27, 6.63).

Information available in the final remedial investigation report showed that 30 Koppers residences had surface soil samples analyzed for anthracene in 1985; 25 of these households participated in the Koppers site-specific surveillance project. The five nonparticipating households had anthracene levels ranging from nondetectable to 3,700 ppb, and the participating households had anthracene levels ranging from nondetectable to 180,000 ppb. On the basis of the 50th percentile of their distribution, the 25 Koppers households were divided into 2 groups of anthracene levels: those with $\leq 1,000$ ppb of anthracene ($n = 36$) and those with $> 1,000$ ppb ($n = 36$). When participants from the comparison group that had their soil also tested for PAHs ($n = 16$) were used as the reference group (prevalence of reported rashes was 6.3%), Koppers residents with anthracene levels $\leq 1,000$ ppb were 3.52 times more likely to report rashes (rash prevalence = 22.2%), and Koppers residents with anthracene levels $> 1,000$ ppb were 5.73 times more likely to report rashes (rash prevalence = 36.1%). The test for linear trend was statistically significant ($p = 0.02$).

Because the number of comparison residents who had soil testing was too small to assess the impact of environmental concerns on reported rashes, the entire comparison group was used to assess the effect of these concerns on reported rashes in the Koppers area group with anthracene levels $> 1,000$ ppb. The prevalence of reported rashes was similar among these two

comparison groups (6.3% rash prevalence in the group with soil testing and 4.8% prevalence for the entire comparison group). With adjustment for the belief that their health problems were related to chemicals in or near their homes, Koppers residents with measured anthracene levels >1,000 ppb were 5.11 times more likely to report skin rashes than the comparison group (95% CI = 1.59, 16.48). Adjusting for concerns of environmental hazards in the neighborhood, Koppers residents with anthracene levels >1,000 ppb were 8.86 times more likely to report rashes (95% CI = 2.18, 36.06).

When reports of chronic bronchitis were adjusted for the health belief, no statistically significant difference was noted in reports of chronic bronchitis by area of residence (RR = 1.60, 95% CI = 0.75, 3.41). Among Koppers and comparison residents who thought health problems were related to chemicals in or near their homes, 12.7% of Koppers residents reported chronic bronchitis compared with 25% of comparison residents (RR = 0.51, 95% CI = 0.13, 1.99). Among those without this belief, 10% of the Koppers residents reported chronic bronchitis and 4% of the comparison residents reported this problem (RR = 2.47, 95% CI = 0.93, 6.58).

Skin rashes and chronic bronchitis were also examined separately for children less than 11 years of age. Koppers children had a higher prevalence (32.4%) of reported skin rashes than comparison children (0.0%) ($p = 0.002$). Koppers area children were stratified by exposure opportunities to determine which variables were associated with skin rashes (Table 18). Children who took a favorite blanket or stuffed toy outside to play were 2.5 times more likely to have a reported skin rash.

Although the prevalence of chronic bronchitis was slightly higher among Koppers area children (17.1%) than among comparison neighborhood children (8.7%), this difference was not statistically significant (RR = 1.97, $p = 0.37$). Koppers area children were stratified by exposure opportunities to determine whether certain behaviors or exposures were associated with reports of chronic bronchitis (Table 19). Children who had dogs or cats coming in or going out of their homes had a higher prevalence of chronic bronchitis (RR = 5.60, CI = 1.55, 20.33).

Reproductive Outcomes - First Year

A total of 184 women 16 years of age and older were interviewed; 91 were from the Koppers site area and 93 from the comparison neighborhood. Table 20 shows the characteristics of these women by neighborhood. The two groups of women were similar with respect to age distribution, length of residence, smoking and drinking histories, and health characteristics that might have an effect on pregnancy outcomes. The average age of the Koppers area women was 45.9 years compared with 47.6 years for the comparison neighborhood women ($p = 0.51$). The average length of residence at their current address was 17.3 years for Koppers area women and 15.6 years for the comparison neighborhood women ($p = 0.66$).

The interviewed women in the Koppers area had a total of 270 pregnancies and 226 live births, whereas the comparison neighborhood women reported 332 pregnancies and 275 live

births. Koppers women 16 years of age and older had an average of 3.0 pregnancies and 2.5 live births per resident compared with 3.6 pregnancies and 3.0 live births per resident in the other neighborhood; these differences were not statistically significant. Table 21 presents the reported adverse reproductive outcomes in both groups. Although the prevalences of premature and low birth weight births were slightly higher among Koppers area women, the prevalence of the aggregate number of reported adverse reproductive outcomes (premature births, low birth weight births, spontaneous abortions, still births, and birth defects) was not statistically significantly different in the two neighborhood areas. Because information was not obtained on the dates of normal live births, prevalence rates for outcomes could not be calculated for the period after the women moved into their respective neighborhoods. Pregnancy outcomes were analyzed by respondents' age groups (Tables 22 and 23) to partially address this limitation. No statistically significant differences were found in the prevalence of premature births, low birth weight births, spontaneous abortions, still births, or birth defects among Koppers area and comparison neighborhood residents 20 through 39 years of age or 40 through 59 years of age. Although the differences were not statistically significant, Koppers area residents aged 20 through 39 years had a higher prevalence of spontaneous abortions (21.6%) compared with comparison neighborhood residents (12.3%). Although the differences were not statistically significant, Koppers women in the 40 through 59 years of age category had a higher prevalence of premature births, low birth weight births, and spontaneous abortions than the comparison neighborhood women.

Women in each neighborhood were also asked whether they were unable to become pregnant for at least one year. Sixteen (19.0%) of the Koppers area women reported problems becoming pregnant compared with five (5.7%) comparison neighborhood women ($p = 0.008$) (Table 24). These differences in prevalence rates were present for women in both the 16 through 39 years of age group and the 40 through 59 years of age group. The prevalence rates for reported problems becoming pregnant varied among the Koppers area women by whether they were concerned about chemical or environmental hazards in their neighborhood (Table 25). The prevalence rate for this problem was 22.1% among Koppers area women who expressed this concern compared with 7.7% among Koppers area women who did not identify this concern. Using the Koppers women as the standard population, prevalence rates for reported problems becoming pregnant were adjusted for chemical concerns. The adjusted prevalence rate for this reported problem was 19.4% for Koppers women and 12.5% for the comparison group women (prevalence ratio = 1.6, 95% CI = 0.8, 3.2). With adjustment for chemical concerns, the difference in prevalence rates was not statistically significant at the 0.05 level of statistical significance.

The average number of pregnancies did not differ by the belief that health problems were caused by chemicals in or near the home, but the difference was statistically significant for those residents who reported having difficulty becoming pregnant for at least one year. Among residents (both groups combined) who reported difficulty becoming pregnant, women had an average of 1.8 pregnancies compared with 3.6 pregnancies among women who denied having this problem.

Table 26 shows the average number of pregnancies by neighborhood and reported difficulties becoming pregnant. Among women reporting difficulties becoming pregnant, Koppers women had significantly fewer pregnancies than comparison women. Difficulty becoming pregnant was also examined by soil exposure. Among Koppers women who reported digging in their yards, 30.3% reported difficulty becoming pregnant compared with 10.9% who did not report digging in their yards (RR = 2.78, 95% CI = 1.11, 6.94).

Vital Records Review - First Year

From the TDH Bureau of Vital Statistics, death certificates citing cancer as a primary, secondary, or underlying cause of death and fetal death certificates were identified, pulled, and reviewed for all residents within the target and comparison communities from 1981 through 1990. During this 10-year period, 11 deaths related to various types of cancer were identified in the Koppers area, and 10 cancer deaths were identified for the comparison area. Among Koppers area residents, cancer types included prostate (2), esophagus, lung, colon (2), bladder, stomach, acute myeloblastic leukemia, and two unspecified primary sites. Comparison neighborhood cancers were prostate, lung (2), colon, chronic myelogenous leukemia, liver, cervix, pancreas (2), and adenocarcinoma of an unspecified site. One fetal death from each community was identified.

Health Outcomes - Second Year

During the second year, only Koppers area residents who had participated in the first year of surveillance were interviewed. Table 27 shows the number of residents reporting specific health conditions. The expected number of each condition is based on rates from the 1990 National Health Interview Survey and is adjusted for the age and racial distribution of Koppers area residents. Anemia, urinary tract diseases, high blood pressure, diabetes, chronic bronchitis, hay fever, and arthritis had elevated SIRs, but the 95% confidence intervals included 1.00, indicating no statistically significant difference at the 0.05 level of significance.

The number of reported skin rashes was significantly higher than expected (SIR = 8.5, 95% CI = 5.9, 11.9) in the second year of surveillance. A total of 34 rashes met the case definition—a rash that occurred from March 1991 through March 1992, excluding known parasitic, bacterial, fungal, and viral lesions. Ten of these rashes were medically verified: six by medical records and four by direct observation of the TDH physician interviewer during the week of household interviews. Twenty-one residents reported rashes during the second year only, and 13 residents reported rashes in both the first and second years.

Table 28 shows the prevalence of skin rashes by exposure opportunities among Koppers area residents. Increased risk for rashes was associated with residents digging in their yards (RR = 2.21, 95% CI = 1.19, 4.10); having contact with soil in the neighborhood area (RR = 2.35, 95% CI = 1.12, 4.90); and wading or having contact with Wagner Creek (RR = 2.12, 95% CI = 1.16, 3.90). A total of seven children reported having rashes from March 1991 through March 1992 (Table 29). Children who reported having their faces washed

after playing in the dirt (RR = 1.71) or taking blankets or stuffed toys outside (RR = 2.17) had an increased risk for rashes, but the 95% confidence intervals included 1.00.

The risk for skin rashes by reported exposures was also adjusted for risk perception. Table 30 shows the unadjusted and adjusted relative risks for rash by soil exposure and exposure to Wagner Creek. The perception of environmental hazards in the neighborhood had minimal effect on the relative risk estimates. Adjusting for the residents' perception that health problems were related to chemicals in or near their homes, however, reduced all risk estimates.

Table 31 presents the risk of skin rashes by soil exposure stratified by the perception of soil problems. People reporting both problems with their soil at least a few days per month and digging in the soil had the highest prevalence of rashes (40.7%). On the other hand, people who reported contact with soil in the area, but few or no problems with their soil, were three times more likely to report skin rashes than those who denied having soil contact (95% CI = 1.11, 9.20).

Residents were also questioned in detail about their rashes. Table 32 summarizes the reported characteristics of rashes with onsets from March 1991 through March 1992. The majority of rashes were on the extremities, and half were described as papular. Nearly all of the rashes (97.1%) were associated with itching or burning. Only four rashes (11.8%) were reported to be exacerbated by sun exposure.

Because over 75% (26) of the rashes were reported by residents who also reported contact with soil in the area, rashes of residents reporting soil contact were also analyzed separately for their characteristics. For residents who reported soil contact and a rash, over half (53.8%) of the rashes were papular. Nearly all (96.2%) of the rashes were associated with itching or burning. About half of the residents with these rashes reported wearing long sleeves (44.4%) and long trousers (55.6%) when having contact with the soil, but only 3 (16.7%) of the 18 residents reported wearing gloves.

Residents were also questioned in detail about rashes with an onset before March 1991. Table 33 shows some of the characteristics of these rashes. The most common affected area was the arm (37.5%). Approximately 43.8% of the rashes were reported as papular rashes, with another 29.2% as macular rashes. As with rashes with an onset after February 1991, most were associated with residents reporting soil contact. Thirteen (27.1%) of the rashes were reportedly exacerbated by sun exposure.

Among other adverse health outcomes, one resident who had lived in Carver Terrace for approximately 20 years reported being diagnosed with renal cell carcinoma in 1991. This report was confirmed by medical records.

Reproductive Outcomes - Second Year

For the period March 1991 through March 1992, four pregnancies were reported. Two women were still pregnant during the second-year health survey. One pregnancy resulted in a normal, full-term live birth. Another pregnancy ended in a spontaneous abortion during the first trimester. Two women reported difficulty becoming pregnant during the period March 1991 through March 1992.

Because dates of normal live births were not obtained during the first-year survey, these dates were obtained during the second-year survey. Table 34 compares the numbers of adverse pregnancy outcomes reported among Koppers women after they moved into the Koppers area with what would be expected based on published rates for African Americans. Differences in the number of reported birth outcomes between the first and second survey occurred because of missing data from women who did not participate in the second year of data collection. Rates for low birth weight births, still births, and spontaneous abortions were comparable with published rates. All 95% confidence intervals for the standardized incidence ratios/standard mortality ratios (SIRs/SMRs) included 1.00, indicating no statistical differences between reported and expected numbers of adverse outcomes.

Vital Records Review - Second Year

For the second year, 1991 death certificates were reviewed for all residents in the Koppers area and the comparison community. Four deaths were identified among Koppers area residents and five deaths among comparison community residents. Two deaths in the Koppers community were attributed to heart disease, one to renal failure, and another to cancer of the prostate. Two deaths in the comparison community were attributed to heart disease, one to a cerebrovascular accident, one to gastric carcinoma, and one to lung cancer. No fetal deaths were identified from either community.

During the second year, cancer mortality data for Koppers residents from 1981 through 1991 were also compared with the cancer mortality experience of Texas Department of Public Health Region (TDH PHR) 7, of which the Koppers area is a part. Compared with the cancer mortality experience of African Americans in TDH PHR 7, 12.96 cancer deaths were expected based on the age and sex distribution of the Koppers area community, whereas 12 such deaths were reported on death certificates (SMR = 0.9, 95% CI = 0.5, 1.6). Specific cancer sites were also reviewed for those sites with two or more cases. For prostate cancer, there were 3.0 deaths, whereas 1.5 would have been expected based on the mortality experience of that region of Texas (SMR = 2.0, 95% CI = 0.4, 5.7). Two death certificates indicated colon cancer as the cause of death, whereas 1.23 deaths would have been expected (SMR = 1.6, 95% CI = 0.2, 5.9).

DISCUSSION

During 2 years of surveillance at the Koppers Company NPL site, residents living in the area had a higher prevalence of reported rashes than that reported for a comparison neighborhood (the first year) and significantly more rashes than expected based on rates from the 1990 National Health Interview Survey (the second year). In the Koppers area, residents who reported contact with water from Wagner Creek or who reported contact with soil in the area, or both, were more likely to report skin rashes. Correlation of soil levels of site contaminants with skin rashes was somewhat limited, since recent surface soil sampling (1984-1985) results were available for review for only 25 of the participating households. Among residents with soil sample results for anthracene, those with anthracene levels > 1,000 ppb had the highest prevalence of reported skin rashes. Therefore, skin rashes appeared to be associated with potential exposure to site contaminants.

During the first year, only 6 of the 58 skin rashes reported as diagnosed by a physician were validated by medical records. During the second year, 34 people reported skin rashes that fit the case definition. Of those that met the case definition, six were verified by medical records and four were verified by the physician investigator during the week of the survey. Even if only 10 verified rashes are included, the observed number of reported and verified rashes is 2.5 times more than the expected number (95% CI = 1.20, 4.6) based on the 1990 National Health Interview Survey (rates that are based on self-reports).

Workers exposed to substances that contain PAHs have been found to experience chronic dermatitis and hyperkeratosis (11). Several surface soil samples taken from Carver Terrace yards were found to contain anthracene and other PAHs. In animal studies, application of anthracene to the backs of hairless mice followed by ultraviolet radiation exposure resulted in enhanced dermal inflammation compared with mice exposed exclusively to ultraviolet radiation (11,12). Burnham and Rahmen (20) found that application of anthracene to the skin of mice, followed by ultraviolet radiation, led to significant depletion of both epidermal Langerhans cells and Thy-1-positive dendritic cells. The investigators hypothesized that these effects might increase susceptibility to skin infections and possibly cancer. Had rashes associated with skin infections been included in this analysis, the SIR for skin rashes would have been even more elevated.

Only a small proportion (21%) of rashes were reported to be worse after sun exposure. During the second-year survey, people who reported digging in their yards or having contact with soil in the area were twice as likely to report skin rashes. These activities would also be associated with being outdoors and probable sun exposure. It is possible that the combination of soil and sunlight exposure could have precipitated the rashes, rather than that exposure to sunlight caused an existing rash to worsen. In future studies, the rash questionnaire should be constructed to better characterize the temporal sequence of rashes in relation to soil and sunlight exposure.

Over 90% of these rashes were associated with itching or burning, and approximately 79% of the rashes were associated with residents reporting soil exposure. No other specific patterns of the rashes were noted. Slightly less than half were described as papular; another 26% were described as macular. Of interest is that only 3 of 18 people reporting rashes and soil exposure during 1991 and 1992 reported wearing gloves when working in the soil. The risk for skin rashes with and without gloves could not be assessed since people without rashes who reported soil exposure were not asked about protective clothing. Future studies should examine the relation of skin rashes to the use of protective clothing among all residents who have contact with potentially contaminated environmental media.

From results of the first-year survey and vital record reviews, Koppers area residents did not appear to have more cancers than comparison neighborhood residents. No residents in either area reported skin cancers. There was one lung cancer case and one death from lung cancer in Koppers compared with three deaths from lung cancer in the comparison neighborhood. However, one death from bladder cancer was identified among the Koppers area residents, and another resident was diagnosed with renal cell carcinoma. Epidemiological studies (21,22) have found that occupational and environmental exposures to PAHs are associated with an increased risk for bladder cancer and renal cell carcinoma. Because of the small numbers of cases of these types of cancers identified in Koppers area residents, no further analyses were conducted.

Koppers residents reported a higher prevalence of chronic bronchitis than comparison neighborhood residents during the first-year survey. During the second year, 11 Koppers area residents reported this problem, whereas 7 would have been expected based on the National Health Interview Survey rates. Adverse noncancer respiratory effects from PAH exposure have not been reported in humans (11).

During the first year, the proportions of reported adverse reproductive outcomes (premature births, low birth weight births, spontaneous abortions, stillbirths, and birth defects) were similar among women in the Koppers area and the comparison neighborhood. A limitation of the first-year survey was that the dates of normal births were not obtained; this information was obtained during the second-year survey. The reproductive data were reanalyzed and included only pregnancies and live births that occurred after women moved into the Koppers area. The spontaneous abortion rate associated with living in the Koppers area (13.6%) was comparable with the estimated risk of 15% provided by several studies of spontaneous abortion (23). Furthermore, the low birth weight rate of 14.3% after mothers moved into the Koppers area was comparable with the Texas low birth weight rate for Texas African-American births in 1990 (13.0%). The number of stillbirths also was within the range of what would have been expected based on the 1990 Texas fetal death ratio (1.2 stillbirths per 1,000 live births) for African-American births.

Very little information is available about the reproductive effects in humans following exposure to PAHs. In animal studies, ingestion of benzo[a]pyrene has been found to produce a high incidence of sterility in progeny of mice and reduce the incidence of pregnancy in female rats (13,14). A higher proportion of Koppers area women reported problems becoming pregnant

for at least one year than comparison neighborhood women. When the prevalence rate for this reported problem was adjusted for concerns about chemical or environmental hazards, the difference of prevalences was reduced, indicating some potential reporting bias. However, Koppers women who reported having problems becoming pregnant had significantly fewer pregnancies than comparison women reporting this problem.

Concern that environmental problems might be affecting health might have led to differential reporting between the Koppers and the comparison groups. Since the Koppers area has been the focus of considerable attention from the media, and citizen and environmental action groups, residents from this area might be more likely to recall certain health conditions. Several studies (24-27) have reported the phenomenon of recall or reporting bias around hazardous waste sites. Participants who believe their health problems are related to chemical or environmental hazards in their neighborhoods might have a better recollection of these health problems than participants who do not have the same concerns. About 30% of Koppers area residents reported that they thought their health problems were related to chemical or environmental hazards in their neighborhood compared with 4% of the residents in the comparison neighborhood. Since such a belief itself might produce more reports of health problems, it is difficult to determine whether the concern of living on or near a hazardous waste site influenced the reporting of disease. However, even with adjustments for these concerns and beliefs, Koppers area residents were more likely to report skin problems. Furthermore, Koppers women who reported having problems becoming pregnant had significantly fewer pregnancies than comparison women who reported this problem. Concern about chemicals around the home was not related to the average number of pregnancies. Adjusting for the belief that health problems were related to chemicals in or near the home also reduced risk estimates for rashes associated with soil exposure and contact with Wagner Creek among Koppers residents. Nonetheless, reported rashes were more strongly associated with soil contact, with adjustment for perception of environmental hazards in the neighborhood.

Another limitation in this surveillance project was the lack of exposure indicators and estimated dosages. Because only 25 of the participating households had recent (1984 and 1985) surface soil samples available for review, only limited correlation of site contaminants (specifically anthracene) could be made with health outcomes. Soil contact and contact with other potentially contaminated media provided a crude estimate of exposure, however.

CONCLUSIONS

The findings of this surveillance project indicated that living in the Koppers area was associated with a higher prevalence of reported rashes among Koppers residents than among residents of a similar neighborhood in Texarkana not located near this site. People who reported soil contact in this area and those with measured levels of anthracene > 1,000 ppb were also more likely to report rashes. The prevalence of reported difficulties becoming pregnant was also higher for Koppers area women than for comparison neighborhood women. This prevalence difference was somewhat confounded by risk perceptions. Nevertheless, among women reporting this problem, Koppers women had fewer pregnancies than comparison women; this difference was statistically significant. Potential soil exposure also appeared to be associated with difficulty becoming pregnant among Koppers women. Two serious limitations in this surveillance project, however, were the lack of environmental data for each household to assess exposure and the reliance on self-reported health conditions for which the investigators were not always able to obtain medical confirmation. Therefore, the positive associations should be interpreted carefully, and negative results do not necessarily imply no effect.

Koppers area residents did not appear to have higher rates of either adverse pregnancy outcomes or cancer than comparison residents. They did have many more concerns about their soil, water, and chemical odors in their neighborhood than did residents of the comparison neighborhood.

RECOMMENDATIONS

1. When working in their yards, residents living on the Kopper Company, Inc., site, especially women of childbearing age, should wear gloves and protective clothing (long sleeves and trousers).
2. Thorough washing after contact with the on-site soil is advisable for both adults and children.
3. For residents (especially children) who might come in contact with on-site soil, certain behaviors, such as their taking food or toys outside to on-site areas, sucking thumbs or fingers, and not washing their hands or faces before they eat, should be avoided or minimized because they might result in exposure to contaminated soil.
4. Residents are encouraged to avoid contact with sediment in Wagner Creek until the site is remediated.

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TABLES

Table 1.—Completion status-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Household Completion Status	Koppers	Comparison	Total
Participating households	85	92	177
Household refusals/Not available	33	34	67
Vacant/Invalid address	17	7	24
Total households identified	135	133	268
Total eligible households	118	126	244
Household participation rate (%)	72	73	73

Individual Completion Status	Koppers	Comparison	Total
Individuals identified in participating households	265	315	580
Participating individuals	214	212	426
Individual participation rate (%)	81	67	73

Table 2.—Completion status-Year 2, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Household Completion Status	N
Participating households	76
Household refusals/Not available	9
Total eligible households	85
Household participation rate (%)	89%

Individual Completion Status	N
Individuals identified in participating households	214
Participating individuals	188
Individuals lost to followup	2
Individuals refused	7
Individuals not available	13
Individuals deceased	4
Individual participation rate (%)	88%

Table 3.—Demographic characteristics of Koppers and comparison area residents-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers		Comparison		p value
	N	(%)	N	(%)	
Sex					
Male	97	(45.3)	91	(42.9)	0.62
Female	117	(54.4)	121	(57.3)	
Of Hispanic Origin					
Yes	6	(2.9)	3	(1.4)	0.31
No	203	(97.1)	206	(98.6)	
Age (Years)					
<11	36	(17.0)	23	(11.0)	0.17
11 - 19	29	(13.7)	39	(18.7)	
20 - 39	52	(24.5)	41	(19.6)	
40 - 59	48	(22.6)	57	(27.3)	
60+	47	(22.2)	49	(23.4)	
Mean (Years)	35.5	(±22.8)*	39.0	(±24.1)*	0.12

* One standard deviation

Table 4.—Education level of Koppers and comparison area residents-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers		Comparison		p value
	N	(%)	N	(%)	
Education Completed (>17 Years of Age)					
Grade 1 - 6	5	(3.3)	12	(8.1)	0.05*
Grade 7 - 8	7	(4.6)	13	(8.8)	
Grade 9 - 11	116	(10.5)	20	(13.5)	
Grade 12	69	(45.1)	41	(27.7)	
1 - 2 years college	34	(22.2)	35	(23.6)	
3 - 4 years college	18	(11.8)	16	(10.8)	
Graduate school	4	(2.6)	11	(7.4)	

*Significantly different by community at the 5% level of statistical significance.

Table 5.—Demographic characteristics by year, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers-Yr 1	Koppers-Yr 2
	N (%)	N (%)
Sex		
Male	97 (45.3)	82 (43.6)
Female	117 (54.4)	106 (56.4)
Age (Years)		
< 11	36 (17.0)	34 (18.1)
11 - 19	29 (13.7)	21 (11.2)
20 - 39	52 (24.5)	49 (26.0)
40 - 59	48 (22.6)	40 (21.3)
60+	47 (22.2)	44 (23.4)
Mean (Years)	35.5	36.0
Income by Household		
< \$20,000	37 (43.5)	29 (38.2)
≥ \$20,000	26 (30.6)	24 (31.6)
Refused	7 (8.2)	7 (9.2)
Don't know	15 (17.7)	16 (21.0)

Table 6.—Smoking history by area of residence-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers		Comparison		p value
	N	(%)	N	(%)	
Smoked at Least 100 Cigarettes/Lifetime? (18 Years and Older)					
Yes	70	(45.2)	65	(41.7)	0.67
No	83	(53.6)	90	(57.7)	
Exposed to Smoke at Home					
Yes	82	(38.9)	70	(33.8)	0.22
Exposed to Smoke at Work					
Yes	63	(37.1)	47	(27.2)	0.05*
No	107	(62.9)	126	(72.8)	
Ever Used Cigars?	15	(8.8)	19	(10.7)	0.54
Ever Used Pipe?	14	(8.2)	16	(9.0)	0.73
Ever Used Chewing Tobacco?	10	(5.8)	17	(9.6)	0.19
Ever Used Snuff?	2	(1.2)	10	(5.6)	0.02*
Among Smokers,					
Smoke Cigarettes Now?					
Yes	36	(49.3)	36	(55.4)	0.50
Most Cigarettes Smoked/Day	17.5	(±15.5)†	17.8	(±16.6)†	0.91
Average Number Cigarettes Smoked/Day	13.9	(± 9.1)†	12.1	(±10.6)†	0.53

*Significantly different by community at the 5% level of statistical significance.

†One standard deviation

Table 7.—Smoking history by year, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers-Yr 1	Koppers-Yr 2
	N (%)	N (%)
Smoked at Least 100 Cigarettes/Lifetime? (18 Years and Older)		
Yes	70 (45.2)	58 (42.6)
No	83 (53.6)	78 (57.4)
Exposed to Smoke at Home?		
Yes	82 (38.9)	78 (41.5)
Exposed to Smoke at Work?		
Yes	63 (37.1)	48 (25.5)
Ever Used Cigars?	15 (8.8)	16 (8.5)
Ever Used Pipes?	14 (8.2)	11 (5.9)
Ever Used Chewing Tobacco?	10 (5.8)	8 (4.3)
Ever Used Snuff?	2 (1.2)	2 (1.1)
Current Smokers (18 Years and Older)	36 (23.2)	32 (23.5)

Table 8.—Alcohol history by area of residence-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers		Comparison		p value
	N	(%)	N	(%)	
Ever Drink Alcohol?					
Yes	99	(47.1)	89	(42.4)	0.33
Among Drinkers, Currently Drink Alcohol?					
Yes	53	(53.5)	42	(47.2)	0.43
Average Drinks/Week	4.7	(±9.6)*	3.3	(±3.8)*	0.30

*One standard deviation

Table 9.—Alcohol history by year, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers-Yr 1		Koppers-Yr 2	
	N	(%)	N	(%)
Ever Drink Alcohol?				
Yes	99	(47.1)	80	(42.6)
Currently Drink Alcohol?				
Yes	53	(24.8)	49	(26.1)

Table 10.—Residential and employment histories by area of residence-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers N (%)	Comparison N (%)	p value
Number of Permanent Residents in Home			
Mean	3.7 (± 1.8)*	3.8 (± 2.3)*	0.62
Length of Residence			
Mean (Years)	14.8 (± 12.2)*	12.9 (± 12.2)*	0.12
< 5 Years	56 (27.9)	69 (34.0)	0.29
5 - 9 Years	25 (12.4)	28 (13.8)	
10 - 14 Years	12 (6.0)	20 (9.9)	
15 - 19 Years	36 (17.9)	31 (15.3)	
20+ Years	72 (35.8)	55 (27.1)	
Ever Been Employed?			
Yes	152 (71.2)	149 (70.6)	0.81
No	60 (28.8)	62 (29.4)	
Among Employed, Currently Employed?			
Yes	89 (74.8)	77 (68.1)	0.26
Occupational Exposure to PAHs (18 Years and Older)			
Yes	62 (41.3)	58 (39.5)	0.74
No	88 (58.7)	89 (60.5)	

*One standard deviation

Table 11.—Dietary and residential characteristics, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers N (%)	Comparison N (%)	p value
Barbecue or Charbroil Foods?			
Yes	137 (69.2)	136 (69.4)	0.99
No	61 (30.8)	60 (30.6)	
How Often Barbeque or Charbroil Foods Eaten?			
Less than once a week	124 (62.3)	147 (76.6)	<0.001*
Once or twice a week	69 (34.7)	34 (17.7)	
More than three times a week	6 (3.0)	11 (5.7)	
Complete Sod Cover in Yard?			
Yes	84 (47.2)	157 (82.6)	<0.001*
No	94 (52.8)	33 (17.4)	
Live Next to an Area Without Ground Cover?			
Yes	78 (45.6)	17 (9.0)	<0.001*
No	93 (54.4)	170 (91.0)	
Water Source for Lawn/Gardens			
Municipal	173 (94.5)	148 (80.9)	<0.001*
Private well	0 (0.0)	3 (1.6)	
Other	10 (5.5)	32 (17.6)	

*Significantly different by community at the 5% level of statistical significance.

Table 12.—Subjective questions about health and environment by area of residence—Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers		Comparison		p value
	N	(%)	N	(%)	
How Would You Rate Your Overall Health?					
Excellent - Good	124	(59.0)	142	(70.0)	0.02*
Fair - Poor	86	(41.0)	61	(30.0)	
Worried About Chemical/Environmental Hazard in Neighborhood?					
Yes	149	(69.6)	28	(13.3)	<0.001*
No	36	(16.8)	154	(72.6)	
Not sure	29	(13.6)	30	(14.2)	
Health Problems Related to:					
Chemicals at Work					
Yes	12	(5.6)	11	(5.2)	0.30
No	176	(82.2)	164	(77.4)	
Not sure	26	(12.1)	37	(17.5)	
Chemical or Environmental Hazards In or Near Home					
Yes	64	(29.9)	8	(3.8)	<0.001*
No	81	(37.9)	177	(83.5)	
Not sure	69	(32.2)	27	(12.7)	

*Significantly different by community at the 5% level of statistical significance.

Table 13.—Subjective questions about health and environment by year, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers-Yr 1	Koppers-Yr 2
	N (%)*	N (%)*
How Would You Rate Your Overall Health?		
Excellent - Good	124 (59.0)	97 (51.6)
Fair - Poor	86 (41.0)	91 (48.4)
Worried About Any Environmental Chemical Hazards in Your Neighborhood?		
Yes	149 (69.6)	116 (67.8)
Think Health Problems Related to Chemicals at Work?		
Yes	12 (5.6)	2 (1.1)
No	176 (82.2)	172 (97.7)
Not sure	26 (12.1)	2 (1.1)
Think Health Problems Related to Chemicals In or Near Home?		
Yes	64 (29.9)	49 (27.7)
No	81 (37.9)	95 (53.7)
Not sure	69 (32.2)	33 (18.6)

*Missing values for some responses.

Table 14.—Significant disease outcomes by community*-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Disease Outcome	Koppers		Comparison		Relative Risk	95% Confidence Interval
	N	(%)	N	(%)		
Skin Rashes						
Yes	58	(27.9)	10	(4.9)	5.72	3.01, 10.87
No	150	(72.1)	195	(95.1)		
Chronic Bronchitis						
Yes	24	(11.5)	9	(4.3)	2.65	1.26, 5.57
No	185	(88.5)	199	(95.7)		
Urinary Disease						
Yes	27	(12.9)	10	(4.7)	2.73	1.35, 5.49
No	182	(87.1)	201	(95.3)		
Liver Disease						
Yes	11	(5.3)	1	(0.5)	11.11	1.45, 85.25
No	198	(94.7)	210	(99.5)		

*Only diagnoses made after moving into respective neighborhoods included. Unknown responses excluded. Outcomes significantly different by community at the 5% level of statistical significance.

Table 15.—Reported skin rashes by area of residence and by age group-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Age Group (Years)	Koppers		Comparison		Relative Risk	95% Confidence Interval
	N	(%)	N	(%)		
< 11	11	(32.4)	0	(0.0)	∞ *	---
11 - 19	12	(41.4)	4	(11.1)	3.7*	1.3, 10.3
20 - 39	12	(24.5)	1	(2.5)	9.8*	1.3, 72.2
40 - 59	13	(27.7)	3	(5.5)	5.1*	1.5, 16.7
60+	8	(17.0)	2	(4.2)	4.1	0.9, 18.2

*Significantly different by community at the 5% level of statistical significance.

∞ Infinity

Table 16.—Reported skin rashes by exposure opportunities Koppers area residents—Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Exposure Opportunities	Rash Prevalence % (# Residents Reporting Rash)	Relative Risk	95% Confidence Interval
Home Gardening			
Yes	18.2 (6)	0.63	0.29, 1.35
No	28.8 (49)		
Dig in the Yard			
Yes	24.2 (22)	0.82	0.52, 1.30
No	29.5 (33)		
Eat Homegrown Vegetables from Carver Terrace			
Yes	15.0 (6)	0.51	0.23, 1.10
No	29.6 (48)		
Mow Lawn			
Yes	25.2 (28)	0.89	0.56, 1.41
No	28.4 (25)		
Walked in Gravel Pits			
Yes	22.6 (14)	0.81	0.47, 1.38
No	27.9 (38)		
Ever Waded in or had Contact With Water from Wagner Creek			
Yes	40.4 (21)	1.95*	1.23, 3.10
No	20.7 (29)		
Ever Caught or Eaten Fish from Wagner Creek			
Yes	21.4 (3)	0.81	0.29, 2.28
No	26.4 (47)		

*Significantly elevated at the 5% level.

Table 17.—Reported bronchitis by exposure opportunities Koppers area residents-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Exposure Opportunity	Chronic Bronchitis Prevalence % (# Residents Reporting Bronchitis)	Relative Risk	95% Confidence Interval
Home Gardening			
Yes	6.1 (2)	0.59	0.14, 2.48
No	10.2 (14)		
Dig in the Yard			
Yes	10.1 (8)	1.15	0.45, 2.93
No	8.8 (8)		
Eat Home Grown Vegetables from Carver Terrace			
Yes	5.4 (2)	0.51	0.12, 2.14
No	10.6 (14)		
Mow Lawn			
Yes	8.8 (10)	0.64	0.29, 1.42
No	13.8 (12)		
Complete Sod Cover			
Yes	13.3 (11)	1.76	0.72, 4.33
No	7.5 (7)		
Walked in Gravel Pits			
Yes	11.5 (7)	1.22	0.51, 2.90
No	9.4 (13)		
Waded in or had Contact With Water from Wagner Creek			
Yes	15.4 (8)	1.67	0.73, 3.79
No	9.2 (13)		
Caught or Eaten Fish from Wagner Creek			
Yes	14.3 (2)	.42	0.37, 5.57
No	10.1 (18)		

Table 18.—Reported skin rashes by exposure opportunities Koppers area children 10 years of age and younger-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Exposure Opportunity	Rash Prevalence % (# Children With Rash)	Relative Risk	95% Confidence Interval
Food or Bottle Outside?			
Yes	50.0 (10)	6.00	0.87, 41.22
No	8.3 (1)		
Hands Washed Before Eating?			
Yes	37.9 (11)	∞	---
No	0.0 (0)		
Face Washed Before Eating?			
Yes	50.0 (11)	∞	---
No	0.0 (0)		
Hands Washed Before Bed?			
Yes	44.0 (11)	∞	---
No	0.0 (0)		
Face Washed Before Bed?			
Yes	45.8 (11)	∞	---
No	0.0 (0)		
Hands Washed After Playing in Dirt?			
Yes	41.7 (10)	2.50	0.39, 15.91
No	16.7 (1)		
Face Washed After Playing in Dirt?			
Yes	50.0 (10)	5.00	0.74, 33.76
No	10.0 (1)		
Used Pacifier Within Last Week?			
Yes	25.0 (1)	0.68	0.12, 3.95
No	37.0 (10)		
Suck Thumb or Fingers?			
Yes	42.9 (3)	1.34	0.48, 3.75
No	32.0 (8)		
Chew Nails?			
Yes	33.3 (3)	0.92	0.31, 2.69
No	36.4 (8)		
Swallow Things Other Than Food?			
A Lot	0.0 (0)	X ² =2.13	p = 0.34
Once in a While	60.0 (3)		
Almost Never	30.8 (8)		
Dog/Cat in or out of House?			
Yes	60.0 (3)	2.02	0.81, 5.09
No	29.6 (8)		
Takes Blanket or Toy Outside?			
Yes	66.7 (6)	2.56*	1.10, 6.48
No	26.1 (6)		

*Significantly elevated at the 5% level.

∞ Infinity

Table 19.—Reported chronic bronchitis by exposure opportunities Koppers area children (10 years of age or younger)-Year 1, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Exposure Opportunity	Chronic Bronchitis Prevalence % (# Children With Bronchitis)	Relative Risk	Confidence Interval
Food or Bottle Outside?			
Yes	25.0 (5)	3.25	0.43, 24.75
No	7.7 (1)		
Hands Washed Before Eating?			
Yes	20.0 (6)	∞	---
No	0.0 (0)		
Face Washed Before Eating?			
Yes	20.8 (5)	2.50	0.36, 20.74
No	8.3 (1)		
Hands Washed Before Bed?			
Yes	23.1 (6)	∞	---
No	0.0 (0)		
Face Washed Before Bed?			
Yes	24.0 (6)	∞	---
No	0.0 (0)		
Hands Washed After Playing in Dirt?			
Yes	16.0 (4)	0.96	0.13, 7.11
No	16.7 (1)		
Face Washed After Playing in Dirt?			
Yes	19.0 (4)	1.90	0.24, 14.91
No	10.0 (1)		
Pacifier Within Last Week?			
Yes	50.0 (2)	3.50	0.92, 13.31
No	14.3 (4)		
Suck Thumb or Fingers?			
Yes	28.6 (2)	1.86	0.42, 8.14
No	15.4 (4)		
Chew Nails?			
Yes	11.1 (1)	0.51	0.07, 3.79
No	21.7 (5)		
Swallow Things Other Than Food?			
A Lot	0.0 (0)	X ² =0.24	p = 0.88
Once in a While	20.0 (1)		
Almost Never	18.5 (5)		
Dog or Cat in or out House?			
Yes	60.0 (3)	5.60*	1.55, 20.33
No	10.7 (3)		
Takes Blanket or Toy Outside?			
Yes	0.0 (0)	0.0	0.0, 2.71
No	23.8 (5)		

*Significantly elevated at the 5% level.

∞ Infinity

Table 20.—Characteristics of 91 Koppers area and 93 comparison neighborhood women*, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Koppers Area		Comparison Area		p value
	N	(%)†	N	(%)†	
Age (Years)					
16 - 29	20	(22.0)	17	(18.3)	0.73
30 - 44	23	(25.3)	23	(24.7)	
45 - 59	23	(25.3)	29	(31.2)	
60 - 74	20	(22.0)	16	(17.2)	
75+	5	(5.5)	8	(8.6)	
Length of Residence (Years)					
< 10	24	(27.3)	32	(34.8)	0.26
10 - 19	28	(31.8)	29	(31.5)	
20 - 29	29	(33.0)	19	(20.7)	
30 - 39	3	(3.4)	9	(9.8)	
40+	4	(4.6)	4	(3.3)	
Smoking History					
Smoked at least 100 cigarettes in lifetime	30	(33.3)	28	(30.1)	0.64
Current smoker	12	(13.2)	16	(17.2)	0.45
Exposed to cigarette smoke at work	38	(42.7)	29	(31.9)	0.13
Exposed to cigarette smoke at home	34	(37.8)	27	(29.0)	0.21
Other					
Ever drink alcohol	43	(47.8)	40	(43.0)	0.52
Ever diagnosed with diabetes	12	(13.2)	8	(8.7)	0.33

*Women 16 years of age and older.

†Some questions had missing values.

Table 21.—Reproductive outcomes among women* living in Koppers area and comparison neighborhoods, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Outcome	Koppers Residents		Comparison Group		p value
	N	(%)	N	(%)	
Premature births	13	(5.8)	8	(2.9)	0.11
Low birth weight (<5 1/2 lbs)	15	(6.6)	11	(4.0)	0.19
Spontaneous abortions	36	(13.3)	43	(13.0)	0.89
Stillbirths	4	(1.8)	9	(3.3)	0.29
Birth defects	3	(1.3)	9	(3.3)	0.16
Total live births	226		275		
Total pregnancies	270		332		

*Women aged 16 years and older, 91 Koppers area and 93 comparison neighborhood women.

Table 22.—Reproductive outcomes among women 20 through 39 years of age who lived in Koppers area and comparison neighborhoods, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Outcome	Koppers Residents		Comparison Group		p value
	N	(%)*	N	(%)†	
Premature births	3	(7.9)	4	(8.5)	0.99
Low birth weight (<5 1/2 lbs)	2	(5.3)	4	(8.5)	0.69
Spontaneous abortions	11	(21.6)	7	(12.3)	0.20
Stillbirths	1	(2.6)	2	(4.3)	0.99
Birth defects	0	(0.0)	1	(2.1)	0.99

*Total live births (38) among Koppers women and total pregnancies (51).

†Total live births (47) among comparison neighborhood women and total pregnancies (57).

Table 23.—Reproductive outcomes among women 40 through 59 years of age who lived in Koppers area and comparison neighborhoods, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Outcome	Koppers Residents		Comparison Group		p value
	N	(%)*	N	(%)†	
Premature births	6	(6.1)	3	(2.2)	0.17
Low birth weight (<5 1/2 lbs)	7	(7.1)	4	(2.9)	0.21
Spontaneous abortions	17	14.2)	16	(10.0)	0.29
Stillbirths	1	(1.0)	3	(2.2)	0.64
Birth defects	0	(0.0)	5	(3.6)	0.08

*Total live births (99) among Koppers women and total pregnancies (120).

†Total live births (139) among comparison neighborhood women and total pregnancies (160).

Table 24.—A comparison of reports of problems becoming pregnant* among Koppers area and comparison neighborhood women, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Age Group	Reported Problems Becoming Pregnant		p value
	Koppers Area	Comparison Area	
	N (%)	N (%)	
16 Years and Older	16 (19.0)	5 (5.7)	0.008†
16 through 39 years	6 (23.1)	2 (6.5)	0.12
40 through 59 years	7 (20.0)	2 (5.7)	0.15

*Women reporting that they were unable to become pregnant for at least one year.

†Significantly different by community at the 5% level of statistical significance.

Table 25.—Relationship between concerns about chemicals in neighborhood and reported problems becoming pregnant among Koppers and comparison area women, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Concern About Environmental/ Chemical Hazards in Neighborhood	Reported Problems Becoming Pregnant		p value
	Koppers	Comparison	
	N (%)	N (%)	
Yes	15 (22.1)	1 (6.3)	0.29
No	1 (7.7)	4 (6.3)	0.99

Table 26.—Average number of pregnancies by neighborhood and reported difficulties becoming pregnant, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Reported Problems* Becoming Pregnant	Average Number of Pregnancies		p value
	Koppers Women	Comparison Women	
Yes	1.3	3.4	0.04†
No	3.5	3.6	0.77

*For at least one year.

†Significantly different by community at the 5% level of statistical significance.

Table 27.—Standardized incidence ratios for selected health conditions among Koppers site residents, Texarkana, Texas, 1991-1992, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Condition	Observed Number	Expected Number*	Standardized Incidence Ratio	95% Confidence Interval
Anemia	10	5.9	1.7	0.8, 3.1
Epilepsy/Seizures	2	1.6	1.3	0.2, 4.5
Stroke	3	3.1	1.0	0.2, 2.8
High blood pressure	45	34.2	1.3	1.0, 1.8
Heart disease	7	16.8	0.4	0.2, 0.9
Disorders of thyroid	3	2.7	1.1	0.2, 3.2
Kidney disease	2	1.9	1.1	0.1, 3.8
Other urinary tract diseases	5	1.9	2.6	0.9, 6.1
Diabetes	15	9.7	1.5	0.9, 2.6
Chronic bronchitis	11	7.0	1.6	0.8, 2.8
Hay fever or other respiratory allergy	18	11.3	1.6	0.9, 2.5
Asthma	8	7.6	1.1	0.5, 2.1
Arthritis	38	27.7	1.4	1.0, 1.9
Skin rash	34	4.0	8.5†	5.9, 11.9
Ulcer	3	4.1	0.7	0.2, 2.1

*Adjusted for the age distribution of Kopper's residents. Expected numbers are based on rates from the 1990 National Health Interview Survey.

†Significantly higher at the 5% level than expected.

Table 28.—Reported skin rashes by exposure opportunities, Koppers area residents, Texarkana, Texas, 1991-1992, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Exposure Opportunities	Rash Prevalence % (# Residents Reporting Rash)	Relative Risk	95% Confidence Interval
Home Gardening			
Yes	17.4 (4)	0.94	0.37, 2.44
No	18.4 (30)		
Dig in Yard			
Yes	27.4 (20)	2.21*	1.19, 4.10
No	12.4 (14)		
Ate Homegrown Vegetables From Carver Terrace			
Yes	11.8 (2)	0.62	0.16, 2.37
No	18.9 (32)		
Had Contact With Soil in Area			
Yes	24.1 (26)	2.35*	1.12, 4.90
No	10.3 (8)		
Walked in Gravel Pit Area			
Yes	16.7 (1)	0.91	0.15, 5.59
No	18.3 (33)		
Mow the Lawn			
Yes	20.0 (19)	1.20	0.65, 2.21
No	16.7 (15)		
Waded/Contact With Wagner Creek			
Yes	31.6 (12)	2.12*	1.16, 3.90
No	14.9 (22)		
Dogs/Cats In/Out House			
Yes	24.4 (10)	1.47	0.77, 2.83
No	16.6 (24)		

* Significantly elevated at the 5% level.

Table 29.—Reported skin rashes by exposure opportunities, Koppers area children 10 years of age and older, Texarkana, Texas, 1991-1992, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Exposure Opportunities	Rash Prevalence % (# Children With Rashes)	Relative Risk	95% Confidence Interval
Takes Food or Bottle Outside to Play			
Yes	26.7 (4)	1.16	0.32 - 4.24
No	23.1 (3)		
Hands Washed Before Eating			
Yes	100.0 (7)	∞	---
No	0.0 (0)		
Face Washed Before Eating			
Yes	21.1 (4)	0.63	0.18 - 2.25
No	33.3 (3)		
Hands Washed Before Bed			
Yes	29.2 (7)	∞	---
No	0.0 (0)		
Face Washed Before Bed			
Yes	31.8 (7)	∞	---
No	0.0 (0)		
Hands Washed After Playing in Dirt			
Yes	26.1 (6)	1.04	0.17 - 6.51
No	25.0 (1)		
Face Washed After Playing in Dirt			
Yes	28.6 (6)	1.71	0.25 - 11.61
No	16.7 (1)		
Sucks Thumbs or Fingers			
Yes	20.0 (2)	0.72	0.17 - 3.06
No	27.8 (5)		
Takes Blanket or Stuffed Toy Outside			
Yes	33.3 (5)	2.17	0.50 - 9.35
No	15.4 (2)		

∞ Infinity

Table 30.—Risk for skin rashes by exposures adjusting for risk perception, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Exposure Factor	Relative Risk for Skin Rashes and 95% Confidence Interval		
	Unadjusted	Adjusted for Perception of Environmental Hazards in Neighborhood	Adjusted for Perception of Health Problems Related to Chemicals at Home
Had soil contact in area	2.35* (1.12, 4.90)	2.55* (1.23, 5.28)	1.73 (0.89, 3.35)
Dug in yard	2.21* (1.19, 4.10)	2.59* (1.40, 4.79)	1.62 (0.90, 2.94)
Waded/Contact with Wagner Creek	2.12* (1.16, 3.90)	1.87 (1.00, 3.50)	1.21 (0.65, 2.25)

*Significantly elevated at the 5% level of statistical significance.

Table 31.—Risk of skin rashes by soil exposure stratified by perception of soil problems, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Frequency That Problems Noted With Soil and Soil Exposure	Rash Prevalence N (%)	Relative Risk	95% Confidence Interval
Noticed Problems With Soil at Least a Few Days per Month			
Dug in Yard			
Yes	11 (40.7)	3.19*	1.33, 7.66
No	6 (12.8)		
Contact With Soil in Area			
Yes	13 (27.7)	1.89	0.68, 5.16
No	4 (14.8)		
Noticed Problems With Soil Less Than Once a Month or Not at All			
Dug in Yard			
Yes	8 (20.5)	1.49	0.61, 3.63
No	8 (13.8)		
Contact With Soil in Area			
Yes	12 (25.5)	3.19*	1.11, 9.20
No	4 (8.0)		

*Significantly elevated at the 5% level of statistical significance.

Table 32.—Characteristics of reported rashes* with onset March 1991 through March 1992, Koppers residents, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Number of Rashes	Percent
Location		
Arm	10	29.4
Neck	10	29.4
Thigh	9	26.5
Back	9	26.5
Lower leg	7	20.6
Dorsal area of foot	7	20.6
Type		
Papular	17	50.0
Macular	7	20.6
Color at First Appearance		
Red	16	47.1
Dark	8	23.5
Itching or Burning	33	97.1
Rash Lasting More Than 2 Months	13	38.2
Rash Worse After Sun Exposure	4	11.8
Resident Reporting Soil Contact	26	76.4

*Number of rashes, 34.

Table 33.—Characteristics of reported rashes* with onset prior to March 1991 Koppers residents, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Characteristic	Number of Rashes	Percent
Location (Most Common)		
Arm	18	37.5
Cheek	17	35.4
Neck	16	33.3
Forehead	15	31.3
Chin	15	31.3
Chest	15	31.3
Type		
Papular	21	43.8
Macular	14	29.2
Color at First Appearance		
Red	18	37.5
Dark	13	27.1
Other Characteristics		
Itching or Burning	44	91.7
Rash Lasting More Than 2 Months	34	70.8
Rash Worse After Sun Exposure	13	27.1
Resident Reporting Soil Contact	39	81.3

*Number of rashes, 48.

Table 34.—Morbidity/mortality ratios for reproductive outcomes among Koppers residents* after moving into the Koppers area, Site-Specific Surveillance Project at the Koppers Company, Inc., National Priorities List Site, Texarkana, Texas.

Outcome	Observed Number (%)	Expected Number†	SIR/SMR§	95% Confidence Interval
Low birth weight ($\leq 5\ 1/2$ lbs)	8 (14.3)	7.3	1.1	0.5, 2.2
Spontaneous abortion	9 (13.6)	9.9	0.9	0.4, 1.7
Stillbirths	1 (1.8)	0.7	1.4	0.0, 8.8

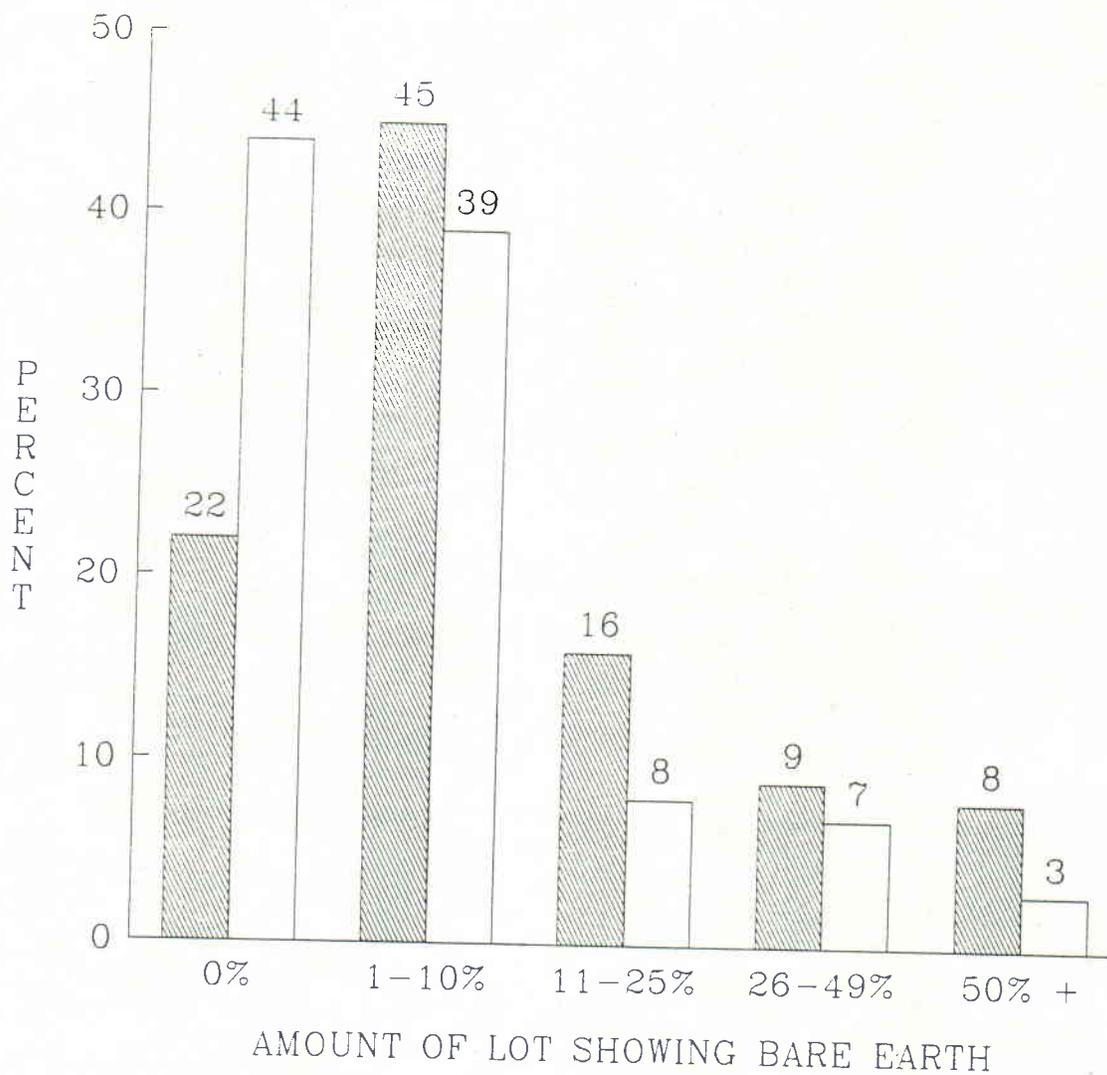
*Women age 16 years and older

†Expected numbers are based on published rates for African-American women and births. These women reported a total of 56 live births and 66 pregnancies after moving into the Koppers area.

§Standardized Incidence Ratio/Standardized Mortality Ratio (SIR/SMR)

FIGURES

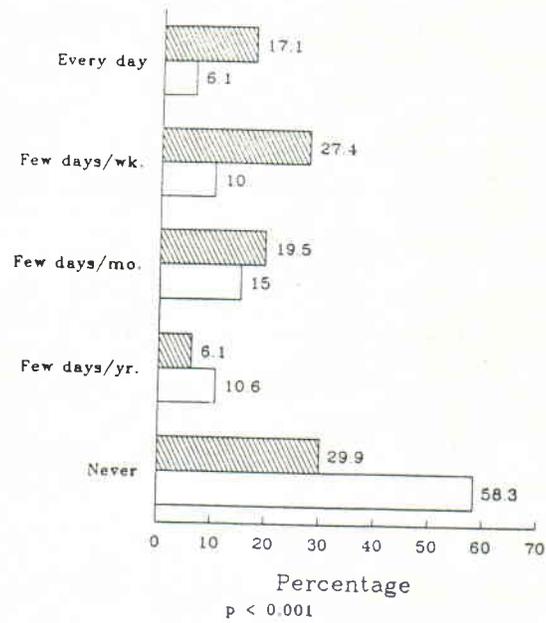
Figure 1.-Percent of residential lot showing bare earth by area of residence.



■ Koppers □ Comparison

$p < 0.001$

Figure 2.-How often, if ever, have you noticed a chemical odor in your neighborhood?



If yes, how concerned are you about the chemical odor?

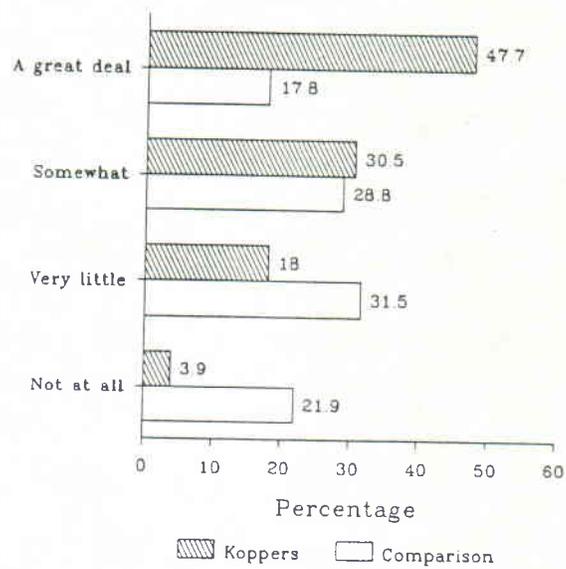
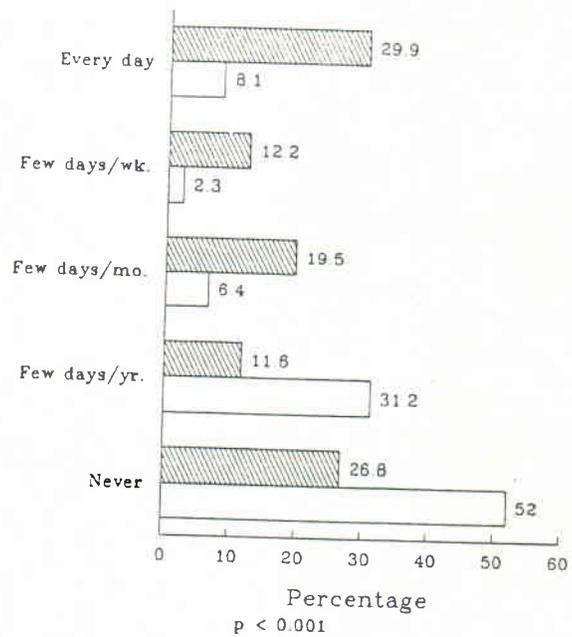


Figure 3.-When, if ever, have you noticed any problems with your water?



If yes, how much does the water problem bother you?

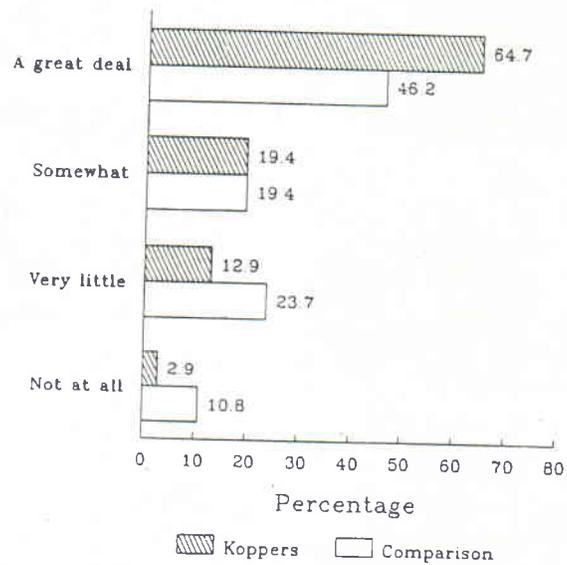
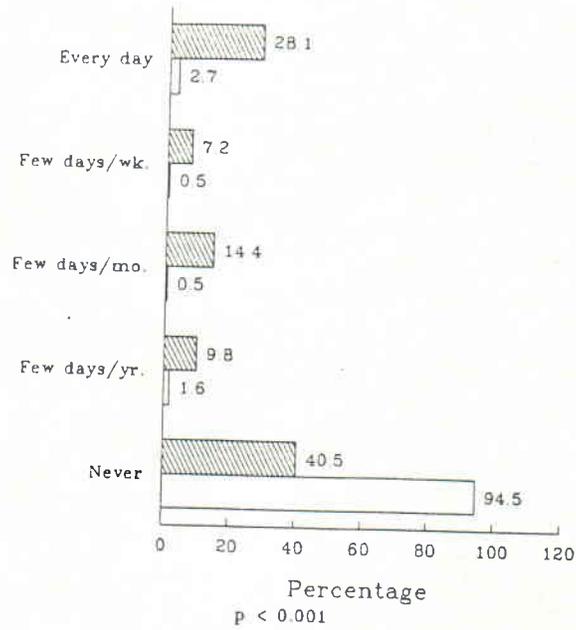
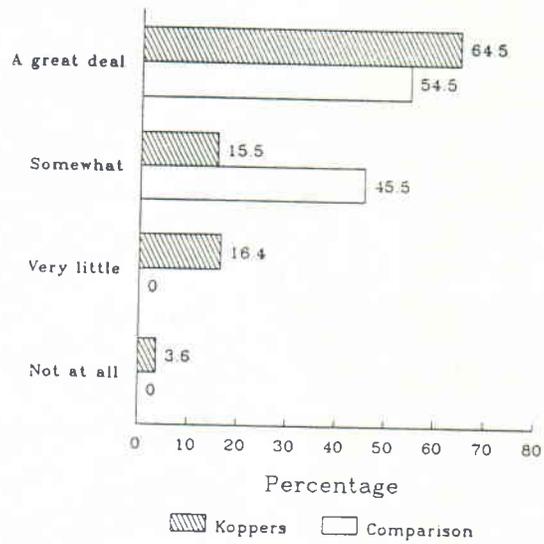


Figure 4.-When, if ever, have you noticed a problem with your soil?



84

If yes, how much does the soil problem bother you?

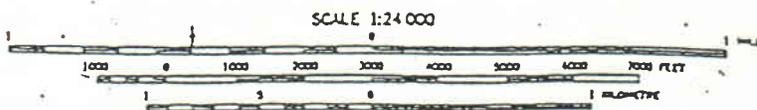
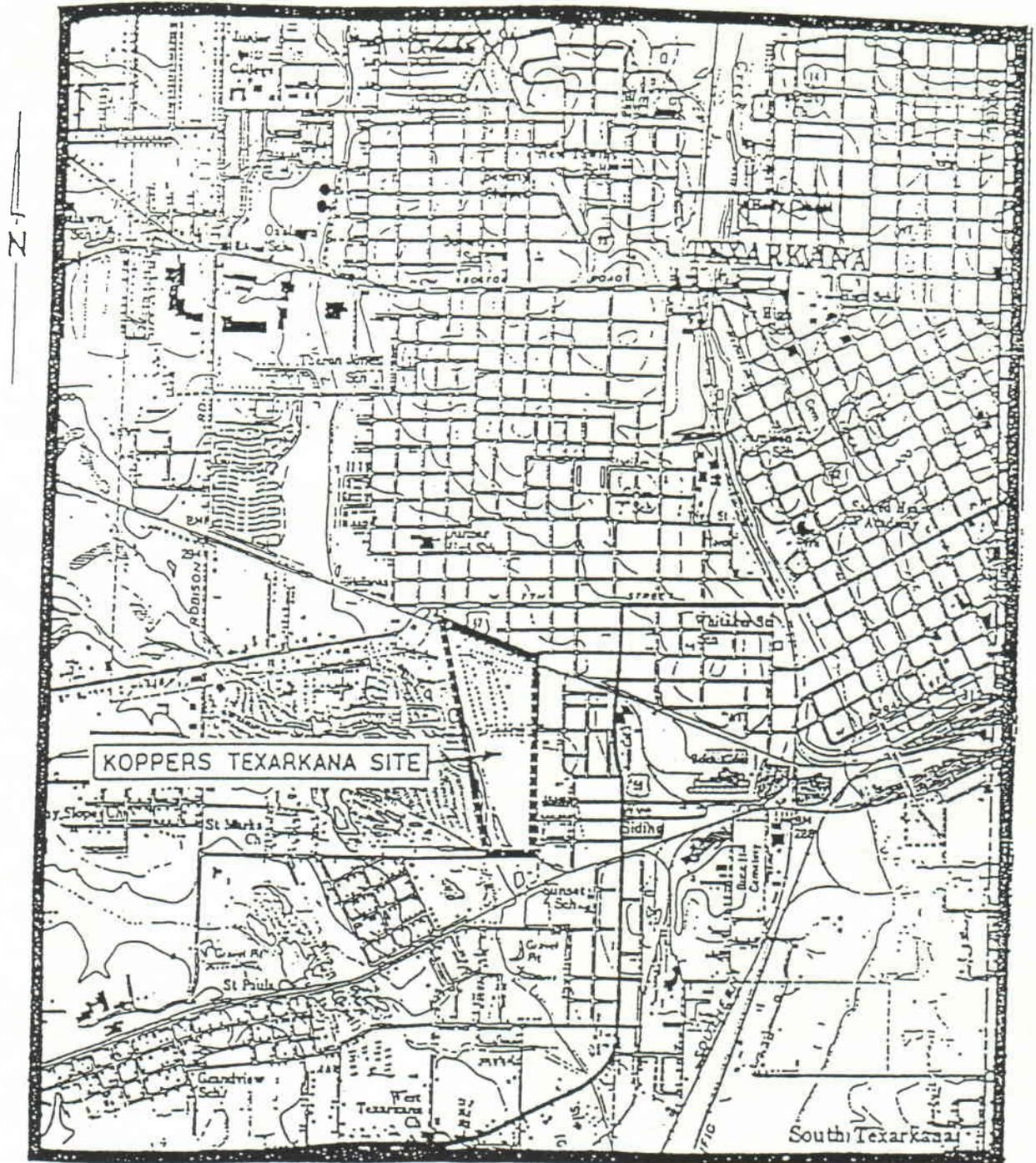


115

APPENDICES

Appendix A—Maps

MAP 1 KOPPERS COMPANY SITE LOCATION MAP

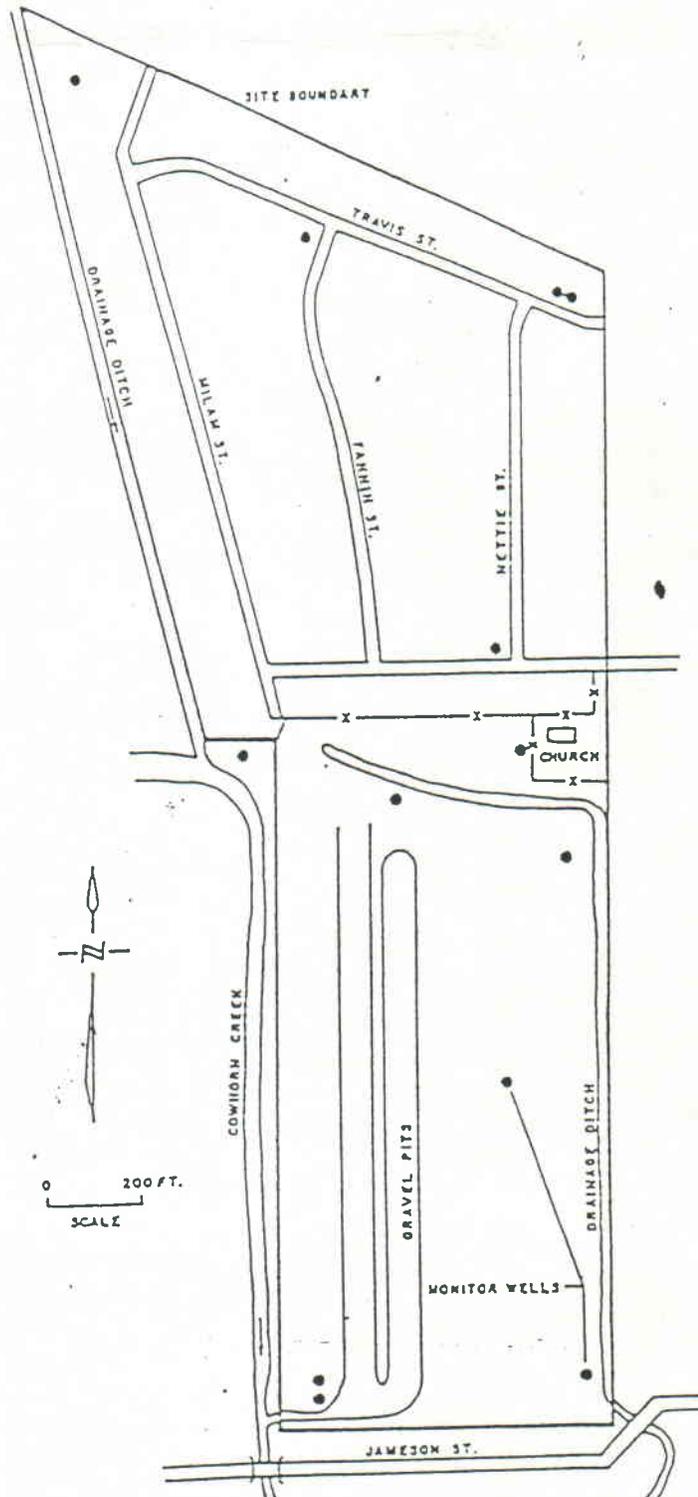


CONTOUR INTERVAL 10 FEET
NATIONAL GEOGEOGRAPHIC VERTICAL DATUM OF 1929



SOURCE: 7.5 MINUTE QUADRANGLE MAP OF TEXARKANA FROM THE
FINAL REMEDIAL INVESTIGATION REPORT, KOPPERS A-3
VOL I. PREPARED BY KEYSTONE ENVIRONMENTAL RESOURCES, 4/83.

MAP 2 KOPPERS COMPANY SITE DETAIL MAP



SOURCE: TEXAS SUPERFUND NOTEBOOK, A BRIEFING ON
NATIONAL PRIORITIES LIST SITES IN TEXAS. PREPARED
BY THE TEXAS WATER COMMISSION, 5/89, 3RD EDITION.

Appendix B—Informed Consent Form

KOPPERS HEALTH STUDY

PARTICIPANT CONSENT

FOR INTERVIEW

The Texas Department of Health (TDH), with assistance from the Agency for Toxic Substances and Disease Registry, is conducting a long-term follow-up of individuals living around hazardous waste sites. My participation will provide me with a yearly update and will provide information toward identifying whether adverse health effects are associated with exposure to hazardous waste.

This long-term follow-up occurs yearly and includes a questionnaire about medical and work history [and possible medical tests].

My part in the long-term follow-up will be the following:

1. Answering questions about demographic characteristics, my residential history, work history, health problems, and lifestyle (smoking, drinking, diet).
2. Allow the results of my medical examination to be transferred to TDH.
3. May be requested to sign a medical records release form so that TDH can review my hospital or physician records.

Participation: I understand that my participation will take about one to two hours each year. There is no physical examination provided as part of the long-term surveillance. There is no provision for compensation or medical treatment in the event of injury as a result of my participation. I understand that I can stop my participation at any time. If I choose not to participate or to stop at any time, there will be no penalty. Any benefits which I now receive or to which I am entitled will not be affected by this decision.

Results: As a result of my participation, I will receive reports which are summaries of the total group of individuals living around the Koppers Company, Inc., National Priorities List site on a periodic basis. Reports are generated yearly and I will receive the information through a newsletter and an annual community meeting.

Confidentiality: I understand that the TDH will take every reasonable precaution to keep my records confidential. Any information shared with the Agency for Toxic Substances and Disease Registry will be kept in accordance with the Federal Privacy Act of 1974, and a Texas statute which governs studies such as this and instructs the Texas Department of Health on how

to keep confidential records. Any reports of this survey will not identify specific individuals, and will only give group information. Texas Department of Health will not inform anyone of my participation in this survey, or release any identifying information to anyone without my written consent. Any reports of this survey will not identify specific individuals, and will only give group information.

Participant consent: I have read the description of this long-term follow-up. All of my questions have been satisfactorily answered. I voluntarily request that I (my child/ward, named above) be included in this survey.

Signatures

Section I:

Patient's Name _____
Patient's Signature _____
Person Authorized to Consent (if not patient) _____
Relationship _____

Signature _____ Date: _____

Section II: I certify that the person who has the power to consent cannot be contacted and has not previously objected to the service being requested.

Patient's Name _____
Name of person giving consent _____
Signature _____
Relationship to patient _____ Date: _____
Address _____
Phone Number _____

Section III:
Counselor Signature _____ Date: _____

If you have any questions, please contact:

Texas Department of Health
Janet L. Pichette, Telephone 512/458-7269

Appendix C—Community Newsletter

KOPPERS SITE SURVEILLANCE UPDATE

TEXAS DEPARTMENT OF HEALTH
Epidemiology Division
1100 West 49th Street
Austin, Texas 78756-3199

INTRODUCTION

On April 10, 1989, the Agency for Toxic Substances and Disease Registry (ATSDR) released the Health Assessment for the Koppers Company Superfund site. This report concluded that long term exposures to PAH contaminated surface soils and ground water could pose a significant health risk for residents living on site. The report also noted that the Koppers Site would be considered for the health study.

Based on these recommendations and findings, the Texas Department of Health (TDH) explored the possibility of conducting such a study at the Koppers Site. In May of 1990, TDH staff met with citizens to document health concerns and determine residents willingness to participate in a health study. The TDH prepared a proposal to conduct the study which was submitted to ATSDR. The proposal was approved in October 1990 and project staff were hired in January 1991.

In January 1991, TDH staff were present at an EPA hearing to discuss the health study and answer residents' health concerns. Staff were also present at a February meeting of the Carver Terrace Citizen's Action Group to discuss the health study, timetable of events, and what participation entailed.

METHODS

Target Community

Selection of the target community was determined by its proximity to the Koppers Company Site. The target community included 79 homes (Carver Terrace) on the Koppers Company Site as well as approximately 50 homes adjacent to the site bounded by Lake Drive on the east, Lee Street on the south, Carver Terrace Subdivision to the North and an open area to the west.

Comparison Community

After touring various areas in Texarkana, the TDH staff selected a neighborhood about 1.5 miles southwest from the Koppers Company Site. The distance of 1.5 miles from Koppers Site appeared to be adequate for the comparison community. The comparison community had similar housing characteristics, socioeconomic indicators, and racial structure. Special consideration was taken to maintain the same proportion of brick homes (61%) and wood frame homes (39%) for the comparison community.

Interviews

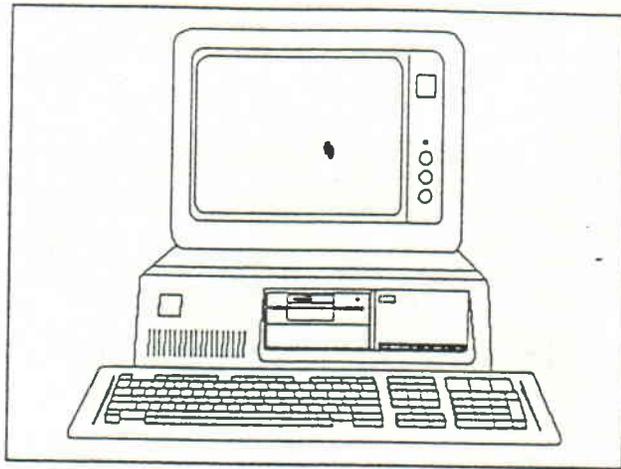
Interviews were obtained using a questionnaire developed by ATSDR. The standardized questionnaire covered individual demographic, lifestyle, residential, occupational, and health characteristics. Additionally, exposure questions and environmental concerns of participants were assessed. This questionnaire was used in both communities.

Each community was notified one week prior to data collection. Letters were sent to residents in each community describing the study, why it was being conducted, and the role of each participant.

Residents were contacted in person by a door to door interviewer. During the interview, if a person specified having a health problem (i.e., cancer or reproductive outcome), a medical release form was obtained to verify the diagnosis through obtaining medical records.

PRELIMINARY RESULTS

Analyses of data revealed little difference between communities with respect to demographic characteristics (Figures 1 - 5), smoking history (Table 1), alcohol history (Table 2), or residential and employment history (Table 3). Residents from the Koppers site community were more likely to graduate from high school ($p = 0.05$) than the comparison community, and they also reported more exposure to cigarette smoke at work ($p = 0.05$) than the comparison community. The comparison community had a larger proportion of snuff users ($p = 0.02$) than the Koppers site community.



Of disease outcomes, preliminary results (Figure 6) show that the Koppers site community suffered significantly more skin rashes ($p = 0.0000003$) than the comparison community. Because of this highly significant finding, the Texas Department of Health has requested medical records from individuals reporting skin rashes. By obtaining medical records, medical staff at TDH can determine whether there is a pattern in the occurrence of skin rashes. TDH will also continue to analyze data to look at disease outcomes by soil exposure and various exposure opportunities. Other disease outcomes which differed significantly from the comparison community included allergies ($p = 0.02$) and bronchitis ($p = 0.003$). Medical records were not requested for allergies since many were self-reported and not diagnosed by a physician. Medical releases may be requested from individuals reporting bronchitis; however, an extensive review of the literature will be conducted first.

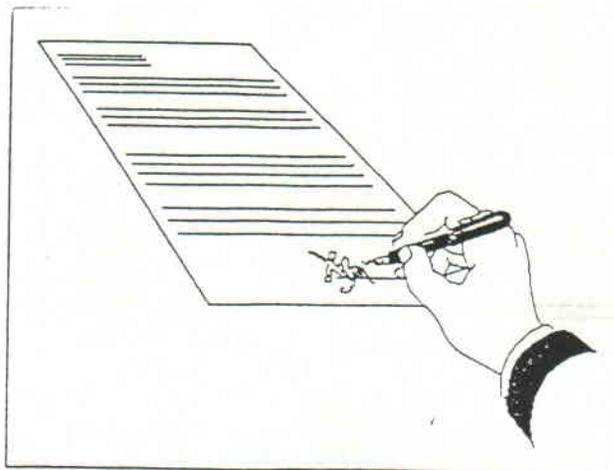
The final first year report will be completed by January 1992.

MEDICAL RELEASE FORMS

If you currently suffer from a skin rash for which you have seen a doctor, please fill out the attached medical release form and return it in the enclosed postage paid envelope.

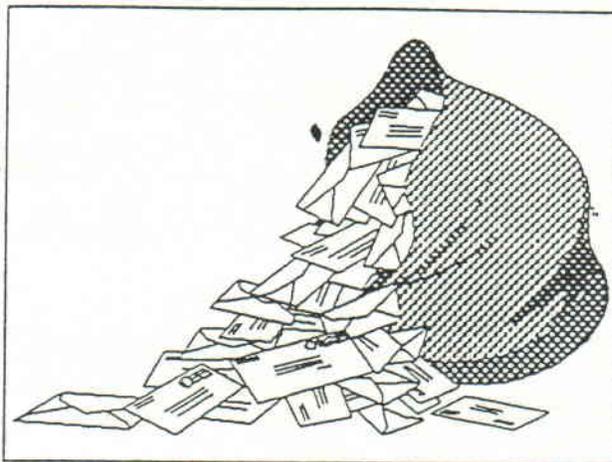
The following information will need to be complete:

- * Your Name and Address - listed under Name of Client
- * Your doctor's name and address
- * Your signature - at the bottom of the release form



CHANGE OF ADDRESS

We will be conducting a follow-up survey during the Spring of 1992. Since it is very important that we keep track of all residents who participated in the initial health survey, we are requesting a change of address form for any residents who move out of the Koppers area. This can be filled out and sent back to us in the postage paid envelope we have provided with this newsletter. Also, if you reported skin problems during the survey and haven't sent back a medical release, we would appreciate this release very much.



THANKS

The project staff at the Texas Department of Health would like to thank your residents for the warm reception we received during our March data collection trip. If you should have any questions, please feel free to contact us in Austin at 512/458-7269.

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FIGURE 1

SEX DISTRIBUTION OF CARVER TERRACE AND CONTROL NEIGHBORHOOD RESIDENTS

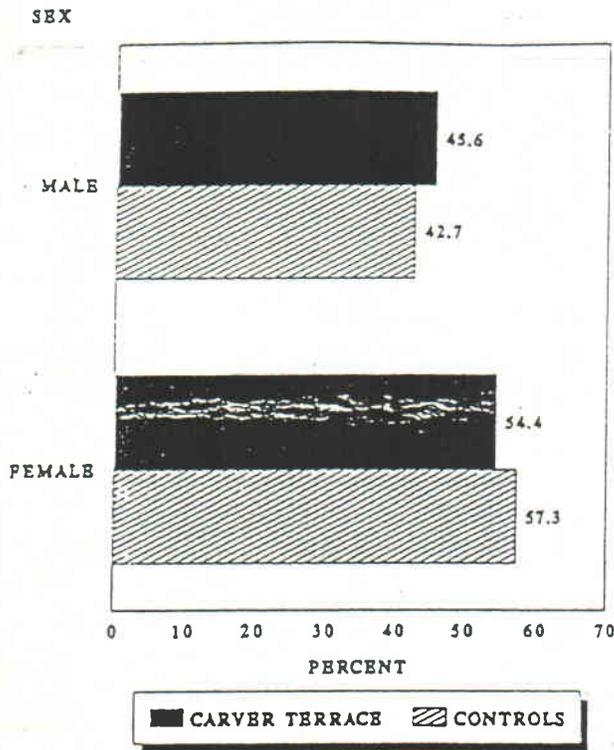
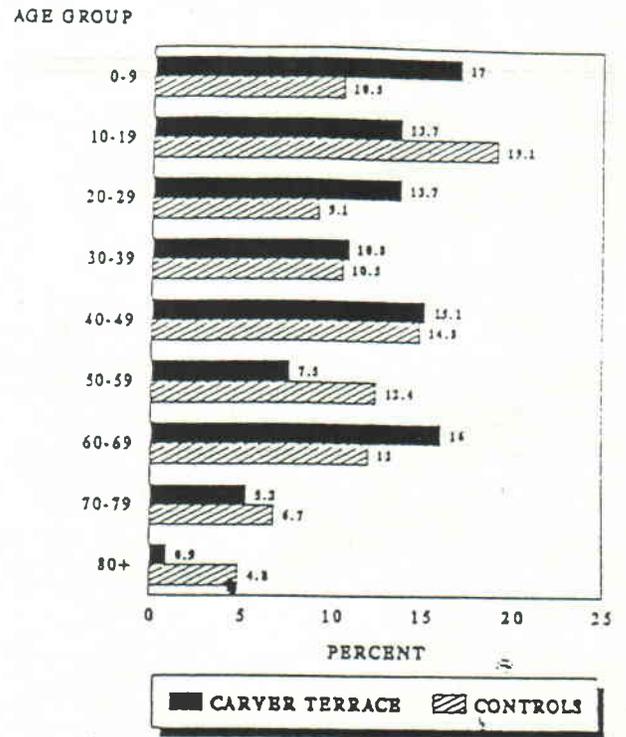


FIGURE 2

AGE DISTRIBUTION OF CARVER TERRACE AND CONTROL NEIGHBORHOOD RESIDENTS



MEAN AGE = 35.5 YEARS (CARVER TERRACE)
 MEAN AGE = 39.0 YEARS (CONTROLS)

FIGURE 3

EDUCATION (>17 YEARS) OF CARVER TERRACE AND CONTROL NEIGHBORHOOD RESIDENTS

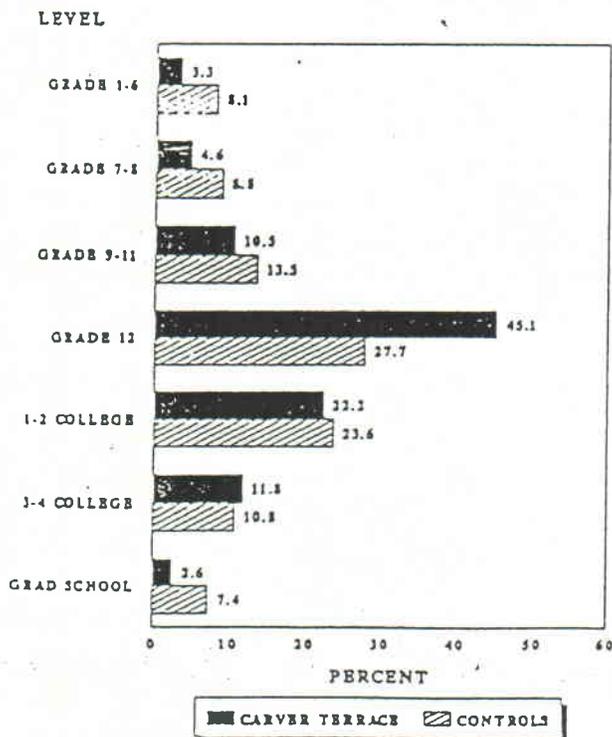


FIGURE 4

INCOME DISTRIBUTION OF CARVER TERRACE AND CONTROL NEIGHBORHOOD RESIDENTS

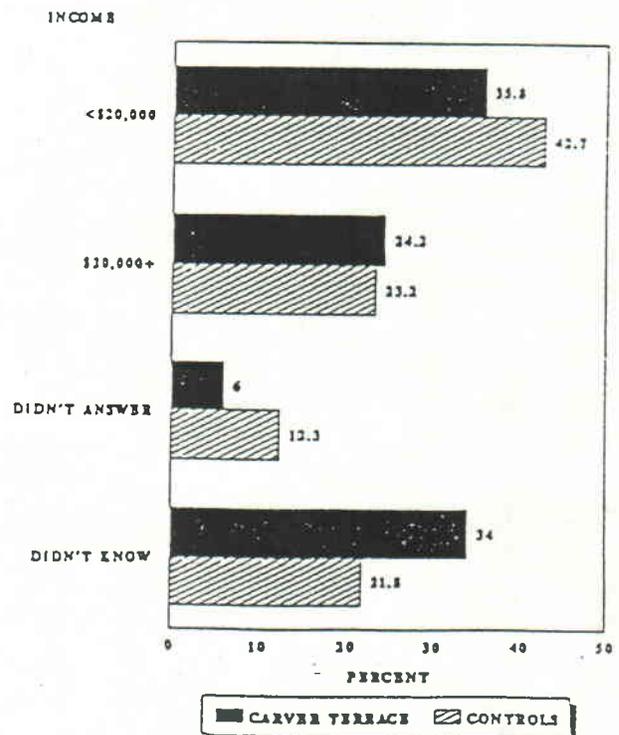


TABLE 1
SMOKING HISTORY

CHARACTERISTIC	CARVER TERRACE	CONTROLS	P-VALUE
SMOKED AT LEAST 100 CIGARETTES IN LIFETIME			
YES	70 (32.6)	65 (30.8)	0.65
NO	142 (66.0)	145 (68.7)	
UNKNOWN	3 (1.4)	1 (0.5)	
EXPOSED TO SMOKE AT WORK			
YES	65 (30.2)	47 (22.3)	0.05
NO	143 (66.5)	160 (75.8)	
UNKNOWN	7 (3.3)	4 (1.9)	
SMOKE CIGARETTES NOW			
YES	36 (49.3%)	36 (55.4%)	0.50 ³
EXPOSED TO CIGARETTES AT HOME			
YES	82 (38.9%)	70 (33.8%)	0.22
AVERAGE CIGARETTES SMOKED PER DAY			
	4.0 (± 1.5)	4.7 (± 2.1)	0.63
USES CIGARS	15 (7.1%)	19 (9.0%)	0.47
USES PIPE	14 (6.6%)	16 (7.6%)	0.71
CHEWING TOBACCO	10 (4.7%)	17 (8.1%)	0.16
SNUFF	2 (0.9%)	10 (4.7%)	0.02
AVERAGE CIGARETTES PER DAY			
	13.9 (± 9.1)	12.1 (± 10.6)	0.53
MOST CIGARETTES SMOKED PER DAY			
	17.5 (± 15.5)	17.8 (± 16.6)	0.91

TABLE 2
ALCOHOL HISTORY

CHARACTERISTIC	CARVER TERRACE	CONTROLS	P-VALUE
EVER DRINK ALCOHOL			
YES	99 (47.1)	89 (42.4)	0.33
TOTAL	210	210	
CURRENTLY DRINK ALCOHOL			
YES	53 (53.0)	42 (47.2)	0.43
TOTAL	100	89	
AVERAGE DRINKS PER WEEK	3.8 (± 5.4)	3.3 (± 3.8)	0.61

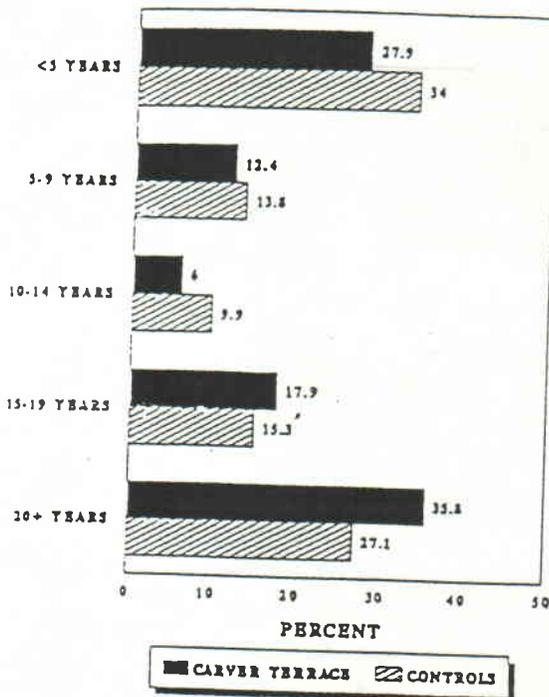
TABLE 3
RESIDENTIAL AND EMPLOYMENT HISTORY

CHARACTERISTIC	CARVER TERRACE	CONTROLS	P-VALUE
NUMBER OF RESIDENCES			
MEAN	3.8 (± 3.2)	4.0 (± 2.6)	0.61
NUMBER OF PERMANENT RESIDENTS IN HOME			
MEAN	3.7 (± 1.8)	3.8 (± 2.3)	0.62
EVER BEEN EMPLOYED			
YES	152 (71.2)	149 (70.6)	0.81
NO	60	62	
CURRENTLY EMPLOYED			
YES	89 (74.8)	77 (68.1)	0.26
NO	30	36	

FIGURE 5

RESIDENTIAL DEMOGRAPHICS OF CARVER TERRACE AND CONTROL NEIGHBORHOODS

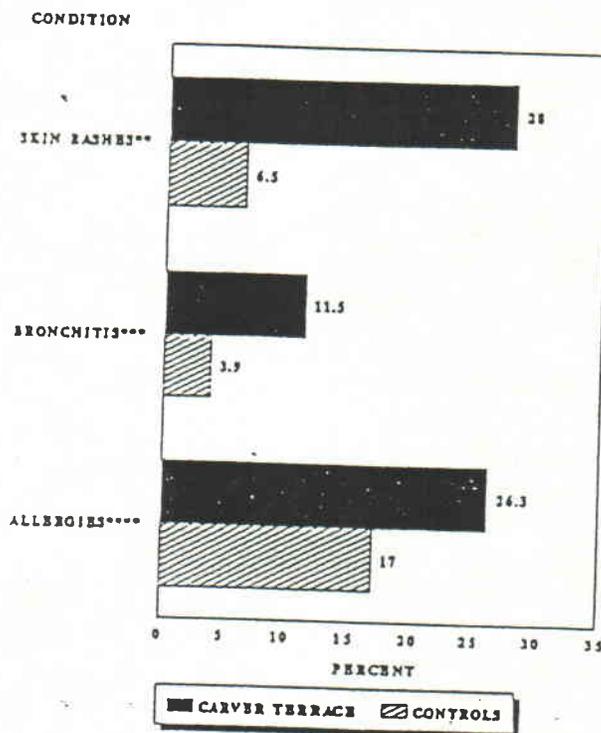
AT RESIDENCE



MEAN LENGTH OF RESIDENCE (IN YEARS)
 CARVER TERRACE = 14.8
 CONTROLS = 12.9

FIGURE 6

SIGNIFICANT DISEASE OUTCOMES*
 KOPPERS SITE SURVEILLANCE PROJECT, 1991



* PRELIMINARY RESULTS *** P = 0.004
 ** P = 0.0000003 **** P = 0.02

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