KNOX COUNTY, TENNESSEE ENVIRONMENTAL HEALTH STATUS REPORT

OCTOBER, 2007

Surveillance, Evaluation and Research Group
Knox County Health Department
140 Dameron Avenue
Knoxville, TN 37917-6413

Knox County Health Department

Public Health
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This document is a product of the Knox County Health Department, Mark Jones, J.D., Director; Dr. Martha Buchanan, M.D., Public Health Officer. Mike Ragsdale, Knox County Mayor.

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For additional information, requests for copies of this report, as well as comments, errors, omissions, questions, or suggestions as to how future editions of this report might be improved please contact:

Albert Iannacone, Environmental Epidemiologist
Knox County Health Department
Surveillance, Evaluation and Research Group
140 Dameron Avenue
Knoxville, TN 37917-6413

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Cover Image: A view along the French Broad River Conservation Corridor in eastern Knox County. Despite being an urban county, there are many areas of great natural beauty remaining in Knox County for residents to enjoy and preserve. Cover Image Credit - Knox County Website: http://www.knoxcounty.org/frenchbroad/gallery_river.php

Executive Summary

This report provides an overview of the many facets of environmental health in Knox County. Environmental health is the science investigating how the natural and man-made world around us impacts human health. Over 100 pages of text and an additional 100 pages of appendices provide detailed documentation supporting the following conclusions, and numerous internet links are incorporated into the text for those interested in exploring a topic in greater detail. The following subjects were examined, with the major findings in each area as noted:

Drinking Water

- There are six major suppliers of drinking water to the citizens of Knox County. All six utilities derive their water from treated surface (river) water.
- Three of these suppliers, serving roughly two-thirds of County residents, have not had any violations of water quality or reporting requirements in the last ten years.
- Four of these suppliers, providing water to 82.6% of residents, have not had any violations of health requirements for water contaminants in the last 10 years. The other two suppliers each had one incident in the last decade (the most recent in 2006) where health-based requirements were not met. Knox County thus falls short of the "Healthy People 2010" (Centers for Disease Control and Prevention, CDC) objective of 95% of residents to receive water from water systems meeting federal safety standards.
- All six major suppliers provide fluoridated water to residents, exceeding the Healthy People 2010 goal of 75% of residents to receive fluoridated water.
- The percentage of County residents who drink well water is small; however, the geology of parts of Knox County makes long-distance transport of contaminants a threat for such households. Incidents of residential well contamination in recent years are a reminder that this threat is real and ongoing for some County residents. Locating all residences in Knox County on well water supply is an unmet environmental health challenge at this time.
- There have been no waterborne illness disease outbreaks in Knox County in the last decade, meeting Healthy People 2010 goals.

Food Safety

- Knox County has an established program in place to monitor restaurants and prevent conditions that would permit food-borne illness outbreaks, and to educate food handlers in safe procedures. Restaurants are inspected regularly; performance scores are reported by the local media and are available on the internet.
- There are a total of 1,750 facilities that serve food in Knox County (including 1,350 restaurants) which are inspected regularly by the Health Department.
- There are typically at least two outbreaks of foodborne Illnesses in Knox County each year that can be traced back to a specific cause. The CDC estimates the incidence of foodborne illnesses that cannot be traced to a source to be significantly higher.

Hazardous Wastes

- While there are no hazardous waste sites in Knox County on the Environmental Protection Agency's (EPA) "Superfund" site list, there are a small number of waste sites/industrial facilities under investigation in the County, as well as "Brownfield" sites (former industrial sites awaiting redevelopment).
- 1.25 million pounds of chemical wastes were processed on-site or off-site by Knox County industries in 2005 (facilities generating a sufficient volume of chemicals are required to report to EPA's Toxic Release Inventory).
- An increase has occurred in poisoning deaths for young to middle-aged adults since 2000; the cause of this increase appears related to drug abuse, not chemical exposures.
- In recent years there has been a decline in household hazardous waste submitted to the Knox County – Knoxville Household Hazardous Waste Center, paralleling the decline seen in residential recycling in recent years.
- The CDC's Agency for Toxic Substances and Disease Registry (ATSDR) has determined that while there may have been some historical releases of small amounts of radiation 50 or more years ago from Oak Ridge which may have reached rural areas of western Knox County, there is no current health threat from these releases and no measurable elevation in cancer rates.

Housing / Indoor Air Quality

- Knox County meets the Healthy People 2010 goals for the quality of our housing stock (indoor plumbing, rooms per person, etc.), and performs better than the statewide and national averages.
- While progress continues to be made in removing the threat of lead based paint from homes in the County, a renewed effort will be needed to reach the Healthy People 2010 goal of testing 50% of persons living in pre-1950 housing for elevated blood lead levels.
- Knox County is considered at high risk for elevated levels of radon in homes due to the geology of the county.
- Cases of asthma are increasing in the county. A number of household triggers can contribute to asthma attacks, and an increased public education effort regarding actions residents can take to remove asthma and allergy triggers from the home would be one action the Health Department can take.
- The passage of a state law in 2007 restricting workplace smoking is a positive step for improved respiratory health and indoor air quality.

Land Use / Community Design

- Compared to other communities, Knox County has underinvested in land set aside for parks. Recent efforts to change this situation should continue and be expanded.
- The tree coverage in Knox County is declining with development, and steps to address this loss must occur before development limits the options available to preserve green space. A portion of anticipated temperature increases and loss of soil moisture caused by climate change can be countered by increasing the tree coverage in the County.
- The "Smart Design" movement, advocating increased availability of parks, recreation centers, trails and greenways for exercise, can help combat obesity-related health effects in the community, as well as saving energy and preventing pollution through better urban planning. Designing "utilitarian walking" into our neighborhoods is one way to encourage daily walking for better health.

Occupational Health

- Data on workplace injuries are not compiled by the federal Occupation Health and Safety Administration (OSHA) at the county level, hampering analysis. However, analysis on the county scale may be too influenced by local business openings, closings, and layoffs for trends to become apparent.
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Outdoor Air

- Due to its climate and topography as well as human-caused emissions, Knoxville often experiences poor air quality. Knox and surrounding counties are in "nonattainment," having failed to meet Clean Air Act (CAA) requirements for ground-level ozone and particulate matter within required time limits.
- In order to avoid potential penalties associated with nonattainment, as well as to protect public health and the environment, a number of public-private partnerships are taking active steps to achieve better air quality for the area. There are also many steps individual citizens can take to help improve air quality and their health.
- Natural factors such as pollen and mold can trigger allergic reactions and aggravate asthma; the lush greenery of eastern Tennessee contributes to this problem, which can combine with man-made pollution to cause a two-pronged attack on respiratory health for area residents.
- Emissions from on- and off-road vehicles are larger contributors to air pollution and county-wide health than industry. Industrial emissions can, however, pose a localized nuisance and possible health threat.
- Increased temperatures resulting from climate change will make it more difficult to address the ground-level ozone problem. Since much of the temperature increase will be in the form of hotter summer nights, health effects such as increasing levels of heat stress for those without access to air conditioning are expected to increase.

Recreational Water Quality

- Due to PCB contamination, health warnings have been issued to limit consumption of fish from both Ft. Loudon Lake and Melton Hill Lake.
- A bacteriological health warning has been issued for the Sinking Creek embayment of Ft. Loudon Lake in western Knox County, due to wastewater from a sewage treatment plant. Additional bacteriological advisories exist for several other creeks in the county due to urban runoff.
- Despite the above, the Holston River and the French Broad River, above their confluence to form the Tennessee River, are recognized by the state as High Quality Waters where endangered species occur. Tuckahoe Creek is a designated State Scenic River. Both it and the portion of Hogskin Branch within the House Mountain State Natural Area are designated High Quality Waters.
- All of these High Quality Waters are in eastern Knox County, and protecting these resources will affect the nature of future land uses allowable in that area.
- Climate change may decrease the level of water in local rivers and streams, with both ecological and economic costs. Rising water temperatures will decrease dissolved oxygen levels in local bodies of water, damaging fish stocks and the industries (sport fishing, boat sales) dependent on them.

Solid Waste and Wastewater

- There are no Class I (residential trash) landfills in Knox County. Most county refuse is disposed at the Chestnut Ridge Landfill just outside county limits off I-75 in Anderson Co.
- While Knox County and Knoxville have programs in place to promote recycling, in the last two years the county has fallen below the Healthy People 2010 goal for recycling rate.
- The county contracts out management of its two green waste recycling (composting) facilities. The Solway facility incorporates biosolids from local wastewater utilities into their compost as well. Sewage biosolids not composted are applied to farm fields outside the county.
- Keep Knoxville Beautiful statistics indicate litter is a problem being managed well in most areas. A few neighborhoods could use improvement, however.
- There are four utilities providing wastewater treatment in Knox County, but there are several treatment facilities, as wastewater is commonly treated on a watershed basis.
- The largest area of the county is served for wastewater disposal by KUB, which is implementing a consent agreement to reduce overflows of untreated sewage. Minor overflows are correlated with amount of rainfall, but the infrequent, major overflows only occur when additional conditions are present beyond rainfall alone. KUB makes sewage overflow data available to the Knox County Health Department and on its website.
- The County licenses septic fields and addresses complaints of septic system problems.

Vector-Borne and Zoonotic Illnesses

- Mosquito-borne illnesses occurring in Knox County include West Nile Virus and LaCrosse Encephalitis. As a result, the County has a program in place to monitor mosquito levels and spray along County roads during mosquito season on a regular schedule, posted on the Health Department website.
- Tick-borne illnesses in East Tennessee include Rocky Mountain Spotted Fever, Lyme Disease, and Ehrlichiosis. Personal and pet preventive measures can reduce risks of these illnesses.
- Rabies is fortunately rare in people and their pets due to a vigorous vaccination program, but is documented to occur in various species of wildlife in the County.
- Rodents can be both a source of disease and a symptom of unhealthy conditions. There are no good statistics on the prevalence of rodents and rodent problems in Knoxville.
- Fire ants have recently reached Knox County, financially affecting plant nurseries and agriculture, as well as posing a health threat. A quarantine is in place for affected areas.
- Continued warming of the climate would likely increase the threat of vector-borne illnesses in Knox County, both in types of illnesses and number of cases.

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Acronyms

AQI	Air Quality Index
AQS	Air Quality System
ATSDR	Agency for Toxic Substances and Disease Registry (part of CDC)
BMP	best management practices
CDC	Center for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response Compensation, and Liability Act
CFC	chlorofluorocarbon ("Freon")
CFI	Conservation Fisheries, Inc.
CO	Carbon Monoxide
CPSC	Consumer Product Safety Commission
DEET	N,N-diethyl-m-toluamide, a chemical mosquito repellent
DOE	Department of Energy
EARS	Early Aberration Reporting System
EEE	Eastern Equine Encephalitis
EHSNet	Environmental Health Specialist Network
EMF	Electromagnetic Field
EMF RAPID	electric and magnetic fields research and public information dissemination (in NIEHS)
EPA	Environmental Protection Agency
EPHT	Environmental Public Health Tracking
ERS	Eligible Response Site (under CERCLA)
ETCFC	East Tennessee Clean Fuels Coalition
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FoodNet	Foodborne Diseases Active Surveillance Network
GIS	Geographic Information System
HAP	Hazardous Air Pollutant
HHW	Household Hazardous Waste
HVAC	heating, ventilation and air conditioning
IAQ	Indoor Air Quality
KAT	Knoxville Area Transit
KCAQM	Knox County Department of Air Quality Management
KCHD	Knox County Health Department
KUB	Knoxville Utilities Board
LAC	LaCrosse Encephalitis
LCWC	Lower Clinch Watershed Council
MCL	Maximum Contaminant Level
mpg	miles per gallon
mph	miles per hour
NAAQS	National Ambient Air Quality Standards
NAB	National Allergy Bureau (of the American Academy of Allergy, Asthma and Immunology)
NATA	National Air Toxics Assessment
NFRAP	No Further Remedial Action Planned
NH_3	Ammonia
NIEHS	National Institute of Environmental Health Studies
NO_2	Nitrogen Dioxide

NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NWS	National Weather Service
O_3	Ozone
OSHA	Occupationa Safety and Health Administration
PA	Preliminary Assessment (under CERCLA)
PCBs	Polychlorinated biphenyls
pCi/L	picoCuries per liter (a measurement of radioactivity per volume)
PM_{10}	Particulate Matter of diameter 10 microns or less
$PM_{2.5}$	Particulate Matter of diameter 2.5 microns or less
ppm	parts per million
RCAC	(Knoxville area) Regional Clean Air Coalition
RCRA	Resource Conservation Recovery Act
RF	Radiofrequency (energy)
SDWIS	Save Drinking Water Act Information System
SI	Site Assessment (under CERCLA)
SIDS	Sudden Infant Death Syndrome
SLE	St. Louis Encephalitis
SO_2	Sulfur Dioxide
SSO	sanitary sewer overflow
STARI	Southern tick-associated rash illness
TDEC	Tennessee Department of Environment and Conservation
TDOT	Tennessee Department of Transportation
TfS	Tools for Schools
TOSHA	Tennessee Occupational Safety and Health Administration
TPO	Knoxville Regional Transportation Planning Organization
TRI	Toxic Release Inventory (EPA)
TVA	Tennessee Valley Authority
U.S.	United States
UST	Underground Storage Tank
UT	University of Tennesee
UTCVM	University of Tennessee College of Veterinary Medicine
UV	ultraviolet (radiation)
VOC	Volatile Organic Compound(s)
WHO	World Health Organization (part of the United Nations)
WNV	West Nile Virus
WQF	Water Quality Forum
WWTP	wastewater treatment plant

Acknowledgements

I would like to thank the following people or organizations for their contributions to the production of this report:

The American Academy of Allergy, Asthma and Immunology, for use of images and information from their website; the anonymous staff at the Division of Health Statistics in the Tennessee State Department of Health, for promptly answering numerous requests for statistical data; Karen Bailey of Knox County Parks and Recreation, Carol Evans of the Legacy Parks Foundation, and Anne Wallace of the Metropolitan Planning Commission, for discussions related to the Knox County/Knoxville greenways system, relative land acreage of local parks versus other communities, and future plans for the park system; Roger Bardsley of the Guilford County (Greensboro, NC) Parks Department and Shain Dennison of Nashville/Davidson Parks for information on their greenways systems; Toni Bounds and other fellow environmental epidemiologists across the state for encouragement, useful suggestions, and constructive criticism; Kathy Brown for editorial review and technical comments in the production of this report; Sheila Dalton and Betsy Woods of the TWRA Boating Division for statistics on boating accidents in Knox County; Chris Halcomb of KGIS for the maps of service areas of local drinking water and sewer utilities; John Evans and Sarah Hart of Knox County Engineering and Public Works Department, and John Homa of the City of Knoxville, for information regarding waste disposal and recycling; Lieutenant Robert Hubbs of the Knoxville Police Department for discussions regarding social implications of graffiti; Larry Hutsell, Knox County Health Department, for funding this project; Janice Johnson, Epidemiology Nurse for the KCHD for data and discussions regarding foodborne outbreaks in Knox County; Martin Kohl of the Tennessee Division of Geology for the maps indicating radon sources and pathways (karst topography) in Knox County; Lynne Liddington of Knox County Air Quality Management for technical information and review of the Outdoor Air section of the report; Abelardo Moncayo, Tennessee State Medical Entomologist, for permission to reproduce slides and for statistical information on the incidence of various vector-borne illnesses in the county and state; Ronnie Nease and Susan Beam for data and discussions on restaurant inspections, food safety, and swimming pool inspections; Donna Parang, Knox County Health Department, for editorial review and helpful comments; Mark Prather for providing BRFSS data and other demographic information; Pat Rakes and J.R. Schute of Conservation Fisheries, inc. for discussions regarding effects of poor water quality on local endangered fish species, for a fascinating tour of their hatchery, and for review comments; Grant Rosenberg of the Knox County Office of Neighborhoods for discussions on the subject of the built environment and the health of the community, as well as many useful contacts; and Tom Salter of Keep Knoxville Beautiful for information on the incidence and effects of litter and graffiti on our community. Numerous unknown individuals contributed to the data collection and posting on the government websites and other information sources linked to in this report; their efforts made possible the compilation of resources provided herein. Errors or omissions are, of course, my own.

-- Albert Iannacone, October 8, 2007

1 - Introduction

Knox County is a growing, vibrant area in which to live and work. For example, the U.S. Census Bureau reports our population grew by 6% from 2000 to 2005. While fueling our economy, this growth can be a mixed blessing as the forces that contribute to making East Tennessee a desirable place to live can also threaten the natural infrastructure – our water, air, and the community of living creatures of which we are a part - on which we all depend for both our health and the quality of our lives. To avoid unpleasant, unintended consequences for ourselves – and even more so, for future generations of East Tennesseans, it is essential that we conduct our business and our daily lives with greater awareness of the impacts we are having on our environment, the problems we are creating, and the opportunities we can seize by addressing these challenges to create an even more desirable community.

This report provides an overview of the many facets of environmental health in Knox County. Environmental health is the science of the way the world around us impacts our health. Its wide scope ranges from the cleanliness of the water we drink and the air we breathe to the healthfulness of the food we eat; whether the design of our homes and communities promote healthy living, whether our workplaces are safe, and whether we dispose of our wastes in a wise or foolish manner. With such a wide scope, we cannot provide the level of detail we would like in this report. However, we have provided numerous references (including internet references) for those interested in understanding a specific issue or topic in greater depth.

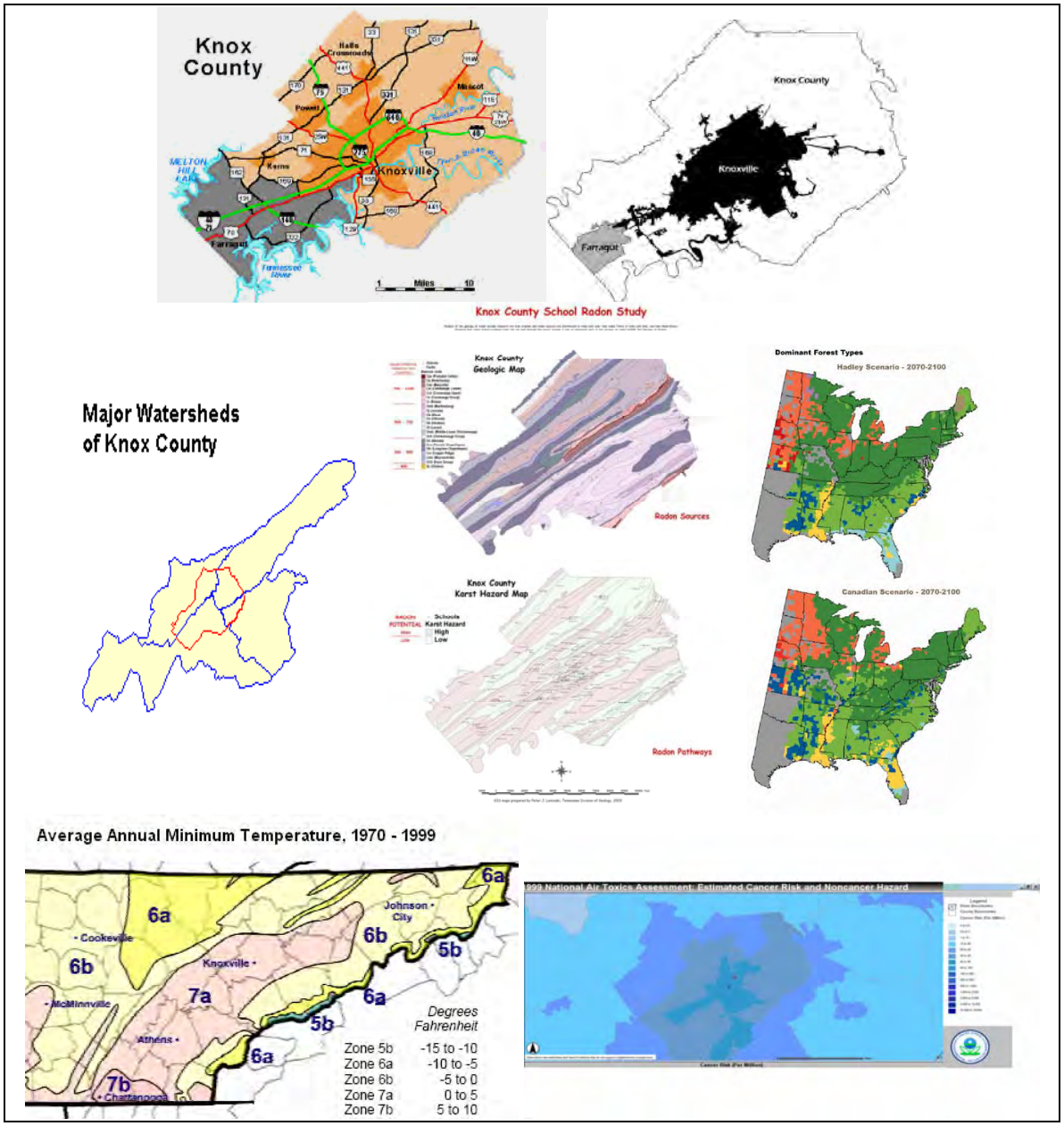
Environmental health issues impact us in many ways. Consider the following questions and issues, which are all aspects of environmental health affecting our daily lives, and which are typical of the kinds of environmental health questions citizens pose to the Health Department:

- Is my water safe to drink?
- Is the food I eat wholesome and uncontaminated?
- Is it safe for me to go running in the summer when it's smoggy?
- Is that factory contaminating our community? Will we get sick?
- Is it safe for my kids to play in the creek near my house?
- Is it safe to eat the fish my husband caught in Ft. Loudon Lake?
- My child has asthma and I think _____ is making it worse.
- I'm worried that the chemicals my spouse works with are making her sick.
- My apartment is moldy and my landlord refuses to do something about it.
- What happens to the trash after it's hauled away?
- Are the rats in that abandoned building something to worry about?
- Mommy, where does the poop go when we flush?
- My son came home from a scout hike with ticks on him. Will he get sick?
- How do I safely get rid of the old cans of paint in my garage?
- Does the county really need to spray for mosquitoes?

For each topic in this report, we will provide background information on the nature of the health threat posed, Knox County's current status in addressing the issue, indicators or benchmarks that can be used to monitor performance into the future, problems we face, and areas of progress and positive developments. This last aspect will allow us to inform the reader of some of the many groups in our community working to make Knox County a better and healthier place to live. Contact information is provided so the reader can reach these groups for additional information or to support their activities, as the human capital of informed, involved citizens working for the common good yields a long-lasting, positive return in a healthier, more sustainable community for us and future generations. It is also our intention that this document serve to facilitate a wider dialog within our communities on both the subjects covered herein, and other matters of concern to our citizens falling under the subject "environmental health."

The words *ecology* and *economics* both derive from the same Greek word, *oikos*, which refers to one's household or home. While on the surface it appears that addressing environmental problems may involve costs that could harm the economy, there are also health costs - often hidden (as with increased cancer rates), sometimes obvious (as with an outbreak of food poisoning) – that are associated with allowing environmental problems to go unaddressed. Our natural resources directly contribute to our economic well being through tourism to this region, and less directly through local businesses, such as watercraft manufacturing and the sale of sporting goods: if our rivers are too polluted to swim or fish, that will not encourage sales of boats, fishing rods, etc. And nature provides valuable services in recycling our wastes and generating oxygen we need to survive.

Figure 1. Differing Images of Our Knox County Environment



East Tennessee is an area of great natural beauty, generously endowed with the natural resources we need to live and prosper. But whether these resources bear fruit for all, now and into the future, vitally depend on the stewardship we exercise today. This report presents a snapshot of where we stand and the implications of those facts for the community at large to assess. Where we go from here and what use we make of this information is a decision the community will make. It is the daily individual and collective decisions of the community, especially as regards to the subjects that fall under the heading "environmental health," that determine whether we will preserve the beauty of this place or squander the resources we have; whether we will be a healthier community or not; and what will be the condition of our community when we turn it over to our posterity. While we at the Health Department leave the determination of solutions to problems identified in this report to the community, we will highlight issues of concern, as well as successful strategies that might be worthy of wider implementation. We welcome your feedback, and thank you for taking the time to learn more about the status of environmental health in Knox County.

Summary of Findings

Drinking Water

- There are six major suppliers of drinking water to the citizens of Knox County. All six utilities derive their water from treated surface (river) water.
- Three of these suppliers, serving roughly two-thirds of County residents, have not had any violations of water quality or reporting requirements in the last ten years.
- Four of these suppliers, providing water to 82.6% of residents, have not had any violations of health requirements for water contaminants in the last 10 years. The other two suppliers each had one incident in the last decade (the most recent in 2006) where health-based requirements were not met. Knox County thus falls short of the "Healthy People 2010" (Centers for Disease Control and Prevention, CDC) objective of 95% of residents to receive water from water systems meeting federal safety standards.
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- Rabies is fortunately rare in people and their pets due to a vigorous vaccination program, but is documented to occur in various species of wildlife in the County.
- Rodents can be both a source of disease and a symptom of unhealthy conditions. There are no good statistics on the prevalence of rodents and rodent problems in Knoxville.
- Fire ants have recently reached Knox County, financially affecting plant nurseries and agriculture, as well as posing a health threat. A quarantine is in place for affected areas.
- Continued warming of the climate would likely increase the threat of vector-borne illnesses in Knox County, both in types of illnesses and number of cases.

Technical Notes

This report is broken into several topics at the intersection of environmental factors and human health: Drinking Water, Food-Borne Illness, Hazardous Wastes, Housing / Indoor Air Quality, Land Use / Community Design, Occupational Health, Outdoor Air, Recreational Water Quality, Waste Disposal, and Vector-Borne and Zoonotic Illness. Specific sub-topics under these headings are discussed in more detail in individual sections, or in even greater detail in the appendices, where applicable.

This report relies almost exclusively on secondary data, that is, data collected by the Health Department and other organizations for purposes which may or may not be directly related to the intent of this study (see for example, the discussion of syndromic surveillance, below). The data may also be of varying quality, and are not equally current. Whenever appropriate, we will include warnings to the user on the usability or reliability of the data. References to data sources are provided, especially by including links to websites for those interested in additional information on a topic. This document is intended as an educational resource for the community and the inclusion of numerous web links is intended as an invitation for readers to investigate a subject of interest more fully for themselves.

Surveillance – Present Status and Future Efforts

Following the 9-11 attacks and the subsequent anthrax letter incidents, there was a national awareness of a need to improve public health infrastructure to monitor for early detection of potential bioterrorism incidents. This system as practiced in Knox County can also be used to monitor for non-terror related outbreaks as well, such as food-borne illnesses, water-borne outbreaks, and the annual rise in illness when the flu season strikes each winter. Should avian influenza ("bird flu") or some similar major disease outbreak occur in Knox County, an early warning system is in place to alert health authorities so appropriate actions can be taken to limit the spread of disease as soon as possible.

The system put in place at the Knox County Health Department uses software called Early Aberration Reporting System (EARS), developed by the CDC, to serve as an early warning

system for possible bioterrorism or natural events. EARS is based on aberration detection models developed by CDC to identify deviations in current data when compared to a historical mean. The Knox County Health Department (KCHD) currently receives daily data from four sources: the 911 emergency call center, the Knox County public school system, local hospital emergency departments, and a local outpatient physician's group. Specific syndromes (sets of symptoms) were selected from each of these data sources to analyze daily events for aberrations (unexpected jumps in the number of reported cases). When syndromes are flagged as aberrations, epidemiological staff members review the software output and conduct further analyses, including the use of Geographic Information System (GIS) to examine spatial clustering. If warranted, further investigation will be initiated. The EARS programs are easy to operate and adaptable to various data sources.

Future goals for the Knox County system include further automation of electronic file transfer to ease the burden on data providers and improve the timeliness and quality of data. A specific goal is to investigate and implement the use of EARS for environmental health; for example, tracking asthma attacks versus air quality, including pollen and mold counts.

Due to the success of the EARS system in Knox County, the Tennessee Department of Health has targeted CDC's EARS as a model for statewide dissemination as part of the state Bioterrorism Preparedness Plan, and Knox County's experience has been the subject of presentations at professional conferences around the country.

The KCHD plans to implement a similar monitoring system for environmental health, as envisioned by the CDC's Environmental Public Health Tracking (EPHT) program which is in a phased implementation process. Such a system will allow the Health Department to:

- Monitor and detect changes of selected environmental public health events,
- Facilitate environmental public health decision making and law enforcement,
- Educate the public regarding actions they can take to avoid or abate hazards,
- Evaluate effectiveness of environmental public health interventions, and
- Develop environmental public health hypotheses for research.

Drawing upon existing data collected by other agencies to the fullest extent possible, the EPHT program will monitor local data for instances of trends and correlations known or suspected by the medical and scientific community to exist. Where data gaps are identified, opportunities to collect data to better identify public health threats will be pursued, in collaboration with other organizations where appropriate. Working with other health departments under the CDC EPHT guidelines will allow collection of data in a manner to facilitate comparison between locations and monitor variables that are regional or national in reach.

It is expected that this report will contribute to the design and implementation of a robust and ongoing environmental public health tracking system for Knox County by being the initial step in identifying data resources and data gaps. However, the process of monitoring self-performance and improving the quality of our efforts is unending.

2 - Demographics

Knox County is a largely urban and suburban county (50.2% of the county population in 2000 lived in either Knoxville or Farragut), with, however, some rural areas under increasing development pressure from urban sprawl. Knoxville comprised 45.5% of the county population in 2000, and is estimated to still comprise roughly that percentage of the county population.

The population of Knox County is undergoing significant growth, as indicated in the following table.

Table 1. Knox County Population Growth 1990 - 2006

1990 Population	2000 Population	2005 Population (est.)	2006 Population (est.)
335,749	382,032	404,972	411,967
	• 13.8% increase from 1990	• 6.0% increase from 2000 • 1.2% increase per year (average)	• 7.8% increase from 2000 • 1.7% increase from 2005

Additional characteristics of the county's population are as follows.

Table 2. Knox County Age and Gender Composition, 2005 (est.)

Persons Under Age 5	6.0 %
Persons Under Age 18	21.4 %
Persons Age 65 and Older	12.6 %
Females	51.4 %

Table 3. Knox County Racial Composition, 2005 (est.)

White	88.2 %
Black	8.7 %
Native American	0.3 %
Asian	1.6 %
Hawaiian / Pacific Islander	0.0 %
Two or More Races	1.1 %
Hispanic or Latino	1.7 %

While a healthy and safe environment is important to all citizens, the above data are significant because not all groups in the population are equally at risk from environmental health factors. It is well recognized that children and the elderly suffer disproportionately from environmental health factors, due to higher susceptibility, higher exposure, or both. Young children, for example, are at highest risk from lead-based paint in the home, and from exposure to indoor second-hand tobacco smoke. Very young children, the immune-compromised, and the elderly are at greater risk from food-borne illnesses. Poor air quality also affects the oldest and youngest in our community most significantly. Environmental exposures to toxic materials may affect future children through exposure of either parent, although most especially the mother while pregnant.

Income disparities also have an effect on the public health through environmental causes, especially the built environment in which we live. The poor are the segment of our community relegated to substandard housing, most likely to be exposed to problems such as mold, lead-based paint, vermin, noise and excessive traffic, crime and lack of safe places for children to play, and extremes of temperature. As a result, socioeconomically disadvantaged groups have higher rates of cancer, asthma, birth defects, infant mortality, diabetes and cardiovascular disease. While these illnesses are not caused solely due to environmental exposures, all of them have environmental factors as contributing or exacerbating causes.

One in eight individuals in Knox County (12.7% of the population, US Census, 2003) **live below the poverty line.** While this is better than the comparable figure for Tennessee as a whole (13.5%), it remains a large fraction of our neighbors exposed to multiple factors that are documented to cause ill health in many ways, including increased risk of health problems from environmentally-related factors. This figure increases to 19% of children under age 18, and 37% of female-headed families (Census, 2005). The documented increase in income disparity in our nation not only has a social cost, it has a physical toll on the health of many of our citizens as well (http://select.nytimes.com/gst/abstract.html?res=F00917FC3B540C7A8EDDAA0894DF404482). EPA (http://www.epa.gov/compliance/resources/faqs/ej/index.html) defines environmental justice as follows :

> Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, culture, education, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair Treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal environmental programs. and policies. Meaningful Involvement means that: (1) potentially affected community residents have an appropriate opportunity to participate in decisions about a proposed activity that will affect their environment and/or health; (2) the public's contribution can influence the regulatory agency's decision; (3) the concerns of all participants involved will be considered in the decision-making process; and (4) the decision-makers seek out and facilitate the involvement of those potentially affected.

To the degree that we fail to practice environmental justice, certain segments of our community will be at additional risk of harm from environmental health hazards. As we examine environmental health issues in Knox County, this observation will be one of the connecting threads as we identify those at risk for several of the environmental health hazards discussed.

Additional information on Knox County demographics is available from the Metropolitan Planning Commission (MPC): http://www.knoxmpc.org/locldata/cenhome.htm

U.S. Census Bureau data, available at:
http://quickfacts.census.gov/qfd/states/47/47093.html (for Knox County),
http://quickfacts.census.gov/qfd/states/47/4740000.html (for Knoxville), and
http://censtats.census.gov/data/TN/1604725760.pdf (for Farragut, TN).

2005 Population and Housing Narrative Profile for Knox County, TN is at:
http://factfinder.census.gov/servlet/NPTable?_bm=y&-geo_id=05000US47093&-qr_name=ACS_2005_EST_G00_NP01&-ds_name=&-redoLog=false

Much of the information in this report is discussed by census tracts. As many readers may not be familiar with the locations of the census tracts in Knox County, the borders of the tracts are displayed in maps in Appendix A, or download at: http://cber.utk.edu/Census/tracts/tntrcmap.htm.

3 - Drinking Water

The CDC document "Healthy People 2010" sets national goals for a number of health criteria. In the section of its section on environmental health that deals with drinking water quality, the following objectives are identified; additional water-related objectives are identified and discussed in the Recreational Water section of this report.

- 95% of persons to be served by a public water supply meeting EPA criteria
- Reduce waterborne disease outbreaks nationally to two per year
- Reduce per capita domestic water use to 90.9 gallons / day
- 75% of residents receiving fluoride-treated drinking water for dental health

In the United States, ensuring clean drinking water has contributed greatly to a declining threat from many infectious diseases; however, there is still more that can be done. Work to improve water quality and to develop a better understanding of such threats as chronic, trace-level exposures to hazardous substances in drinking water also must continue. This section discusses the progress made in these areas in Knox County and the challenges that remain.

Drinking Water Sources

There are six major suppliers of drinking water to the citizens of Knox County. All derive their water from treated surface (river) water, as indicated in the following map and table. If you live near a borderline on the map, please contact the individual supplier directly to confirm which supplier provides water for your location):

Figure 2. Major Knox County Drinking Water Suppliers

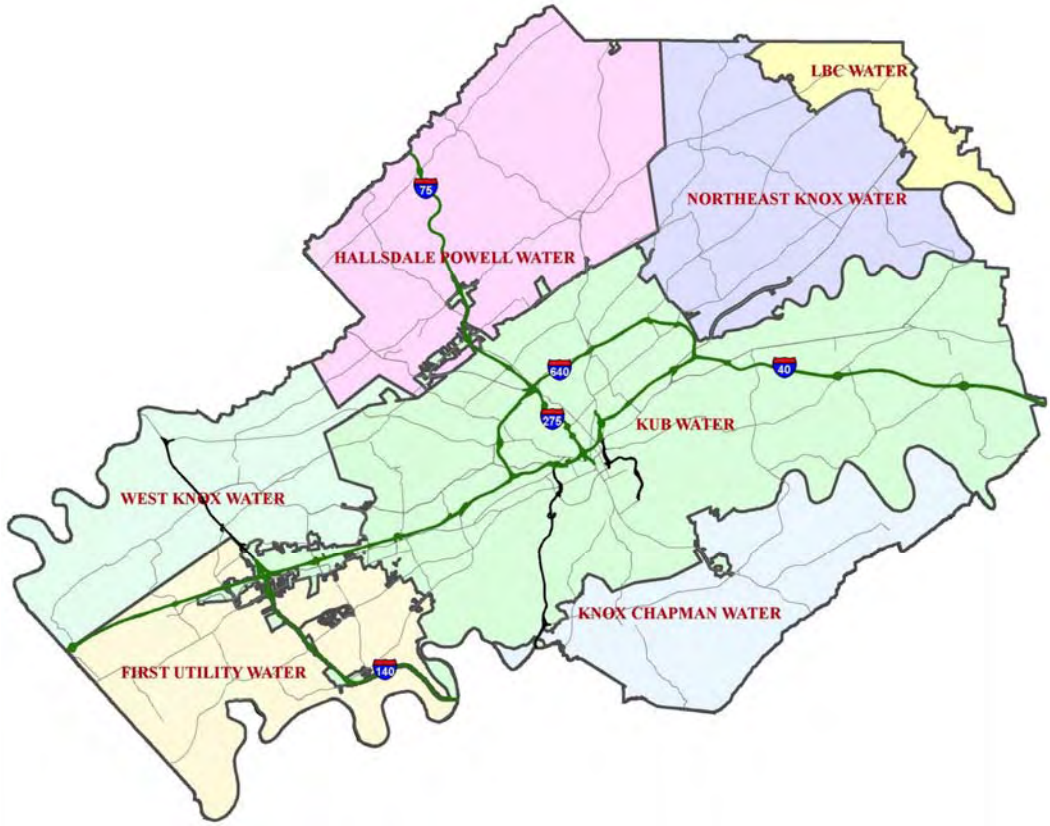


Table 4. Knox County Active Community Water Systems*

Water System Name	Population Served	Primary Water Source Type	Water System ID
Knoxville Utilities Board – KUB	219,815	Surface Water	TN0000366
First Utility District of Knox County	71,206	Surface Water	TN0000369
Hallsdale – Powell Utility District	59,876	Surface Water	TN0000280
West Knox Utility District	48,316	Surface Water	TN0000371
Knox-Chapman Utility District	28,099	Surface Water	TN0000367
Northeast Knox Utility District	17,550	Surface Water	TN0000515

*Water Systems that serve the same people year-round (e.g. in homes or businesses).

In addition to these suppliers, several apartment complexes provide water to their tenants under individual registrations from the state. Groundwater serves as a drinking water supply for some businesses providing drinking water as well. The following tables summarize these additional smaller drinking water suppliers, as registered with the state:

Table 5. Additional Active Knox County Water Systems*

Water System Name	Population Served	Primary Water Source Type	Water System ID
Reserve of Westland Apts.	720	Purchased surface water	TN0008112
Highland Terrace Apartments	660	Purchased surface water	TN0008262
The Grove at Deane Hill Apts.	636	Purchased surface water	TN0008113
Heritage Lake at Westland Apts.	613	Purchased surface water	TN0008221
Walker's Crossing Apts.	487	Purchased surface water	TN0008210
Statesview Apartments	358	Purchased surface water	TN0008261
The Canyon Apartments	265	Purchased surface water	TN0008257
Knox Landing Apartments	199	Purchased surface water	TN0008213
Cedar Hill Apartments	173	Purchased surface water	TN0008214

*Water Systems that serve the same people year-round (e.g. in homes or businesses).

Non-Transient Non-Community Water Systems: Water Systems that serve the same people, but not year-round (e.g. schools that have their own water system).

Water System Name	Population Served	Primary Water Source Type	Water System ID
CEMEX, Inc. Cement Plant	120	Groundwater	TN0004314

Transient Non-Community Water Systems: Water Systems that do not consistently serve the same people (e.g. rest stops, campgrounds, gas stations).

Water System Name	Population Served	Primary Water Source Type	Water System ID
Fort Loudoun Yacht Club	135	Groundwater	TN0004370

The percentage of residents drinking water from wells is believed to be within Healthy People 2010 goals, as the total population reported served by the six suppliers is greater than the population of Knox County as reported by the U.S. census. However, some water utilities provide water outside the county lines, so the number of individuals on well water is an estimated value. While the percentage of County residents drinking water from wells is small, the karst geology (typified by easily-dissolved limestone deposits, sinkholes, and caves) of parts of Knox County (see the map indicating karst areas of Knox County in the radon discussion under “Indoor Air”) makes long-distance transport of contaminants (and radon contamination of drinking water) a

threat to public health for those on well water supplies. The recent contamination of residential wells in the Burnett Creek area, resulting from chemically-contaminated fill dirt from a former industrial site deposited in a sinkhole, is a reminder that this threat is real and ongoing for some county residents.

One measure of the scale of well-water use in Knox County is the number of well water samples submitted for analysis to the KCHD in recent years, as illustrated in the following table. There is no requirement for wells to be tested on a regular basis, and well testing is a responsibility of the individual homeowner, so these numbers are useful only as a rough indicator of the scale of well use for drinking water:

Table 6. Well Water Samples Analyzed by the KCHD

Year	Area 1	Area 2	Area 3	Area 4	Total
2000	27	18	20	36	101
2001	30	21	12	56	119
2002	32	12	16	58	118
2003	27	8	10	36	81
2004	*	*	*	*	70
2005	11	9	88	31	139
2006	15	8	23	33	79
				Average	101

* = Date unavailable.

Area 1 comprises Northeast Knox County, Gibbs, Corryton, Mascot, and Maynardville Highway areas. Area 2 comprises North side of Hickory Creek, Hardin Valley Road, Middlebrook Pike, West side of Maynardville Hwy., Norris Freeway to Anderson County line, and Solway. Area 3 comprises West Knoxville and Farragut. Area 4 comprises East Knoxville, Strawberry Plains, South Knoxville, and Alcoa Hwy. areas.

Locating all residences in Knox County on well water supply is an unmet environmental health challenge at this time.

Drinking Water Quality

The federal clean water act and state laws and regulations implementing it in Tennessee require an extensive treatment and testing protocol for drinking water supplies. Not only the tests to be performed, but their frequency is specified, along with allowable levels of the parameters tested. Organic and inorganic chemicals, radiological and microbiological tests, and esthetic qualities such as color, cloudiness (turbidity) and odor are all analyzed under EPA protocols. There are also requirements for public notification if criteria are not met. Additional information on how public water supplies are treated and tested can be found at the layperson level here: http://www.epa.gov/safewater/dwh/index.html and at a more technical level here: http://www.nesc.wvu.edu/ndwc/ndwc_tb_available.htm.

Locally, the KCHD has an agreement with the Knoxville Utilities Board (KUB) drinking water laboratory that defines notification protocols and lines of communication in the event of a natural or man-made threat to the drinking water system. KCHD plans to establish similar protocols with other water suppliers in the county as well.

In Knox County, three of the six major suppliers, representing two-thirds of customers served, have had no violations of water quality or reporting requirements of any kind in the last ten years. Four of the six suppliers, providing water to 82.6% of residents, have not had any violations of health requirements for water contaminants in the last 10 years. The other two suppliers each had one incident in the last decade (the most recent in 2006) where health-based requirements were not met. Knox County thus falls short of the Healthy People 2010 (CDC) objective of 95%

of residents to receive water from water systems meeting federal safety standards. The incidents where health-based criteria (maximum contaminant levels, MCLs) were not met are:

Table 7. Violations of Health-Based Drinking Water Standards, Knox County, 1996-2006

Water System	Date	Nature of Violation
Hallsdale-Powell U.D.	2nd Q, 2006	Total Haloacetic Acids* exceeded Maximum Contaminant Level
Northeast Knox U.D.	4th Q, 1996	Methylene Chloride (Dichloromethane)* exceeded Maximum Contaminant Level
* See Appendix I, Glossary of Chemicals, for information on these compounds.		

In addition to chemical contamination, microbiological contamination of the water supply can pose a threat to public health. Fortunately, the processes employed at the drinking water treatment plants are generally very effective, and there have been no known outbreaks of waterborne disease in Knox County in the past decade, meeting the Healthy People 2010 goal in this area.

EPA's Safe Drinking Water Act Information System (SDWIS) site also reports violations of requirements for type and frequency of testing, or violations of water quality that, while not a threat to health, are an esthetic consideration for the users of the water, such as turbidity (cloudiness) of the water. The following violations were identified for Knox County water utilities in the 1996-2006 period:

Table 8. Violations of Monitoring or Esthetic Standards, Knox County, 1996-2006

Water System	Date	Nature of Violation
First Utility District	July, 2002	Failure to report data
	Feb., 2002	Turbidity exceeded standard
Hallsdale-Powell U.D.	July, 2002	Failure to report data
	Mar., 2002	Turbidity exceeded standard
	Feb., 2005 Jan. & Feb., 2002	Turbidity not reported
	Apr., 2002	Total Organic Carbon* not tested
	1996	Nitrate* not tested
Reserve of Westland Apts.	July, 2001	Failure to report data
Grove at Deane Hill Apts.	July, 2001	Failure to report data
Cedar Hill Apts.	June, 2003	Coliform bacteria not tested
* See Appendix I, Glossary of Chemicals, for information on these compounds.		

Fluoridation

Fluoride is a naturally-occurring element found in rocks and soil, and in fresh and salt water. Levels in the United States vary from 0.1 to 12 parts per million (ppm). It has been found that levels around 1 ppm have the beneficial effect of hardening teeth by incorporating the fluoride into the mineral structure of the tooth, and thus helping to reduce or prevent tooth decay. Even with the availability of fluoride-containing toothpastes, mouth rinses, and fluoride dental treatments, treatment of a community's water supply with fluoride contributes to an additional 20-40% decrease in tooth decay in children and 35% in adults. Over 60 years of research have shown fluoridation at the recommended level to be a safe and cost-effective way to promote oral health for all members of a community, especially those in the community who might (due to limited

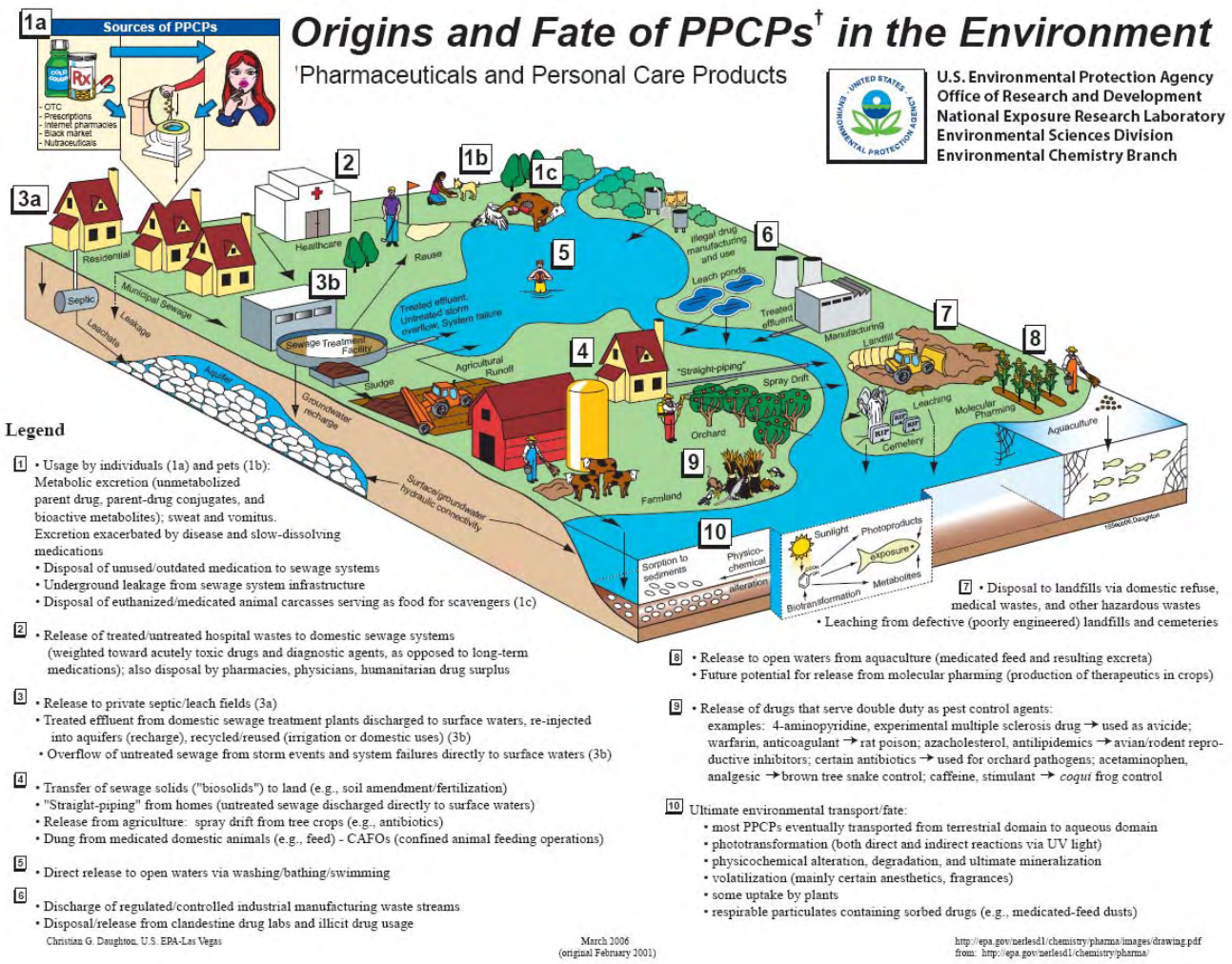
education or financial resources) be at greatest risk for oral health problems. In most cities, every dollar invested in fluoridation saves $38 in dental treatment costs, affecting the entire community through lower insurance rates and lower taxes for healthcare for the indigent.

All six major Knox County suppliers of drinking water provide fluoridated water to residents, exceeding the CDC's Healthy People 2010 goal of 75% of residents to receive fluoridated water. Information from the ADA is available at: http://www.ada.org/public/topics/fluoride/index.asp, from the US Public Health Service at http://www.health.gov/environment/ReviewofFluoride/ and from the CDC at: http://www.cdc.gov/fluoridation/.

New Challenges

As toxicological research has advanced and analytical instruments have become more sensitive, new challenges have come to light in providing safe drinking water to the public. An area that has been of concern for some years to the scientific community in North America and Europe is the presence in our waterways and drinking water supplies of minute amounts of pharmaceutical compounds and compounds mimicking the action of hormones.

Figure 3. Origin and Fate of PPCPs in the Environment



Analytical techniques in the last decade or more have matured to the point where these compounds can be regulated, but no laws in the US have been passed to date on this issue. A 2002 study determined the amounts of some of these compounds in our waterways is comparable to the levels of pesticides (http://toxics.usgs.gov/highlights/tracing_wastewater.html). In Milan, Italy and other European cities, authorities have monitored the levels of drug abuse in the community as a whole by testing samples at the sewage treatment plant for illegal drugs.

While the levels of most of these compounds are orders of magnitude below the concentration at which medical effects are seen, there is a question of whether the long-term exposure to lower amounts might have more subtle effects on the population, including behavioral effects (one of the compounds is Prozac). Fortunately, standard drinking water treatment seems to typically remove most of these compounds, although caffeine, acetaminophen, and nicotine were detected in drinking water in Atlanta in one study (http://www.wcp.net/column.cfm?T=T&ID=2199).

Research in this area is actively continuing to better understand the scope of contamination and the risks involved, as implementing additional treatment processes for drinking water would be a significant cost burden for communities. In the meantime, the federal government has recommended that waste pharmaceuticals *not be disposed by flushing them down the toilet.* The KCHD website has additional details on how to dispose of pharmaceuticals properly: http://www.knoxcounty.org/health/pharmaceutical_waste.php, and additional information on this subject can be found at: http://epa.gov/nerlesd1/chemistry/pharma/.

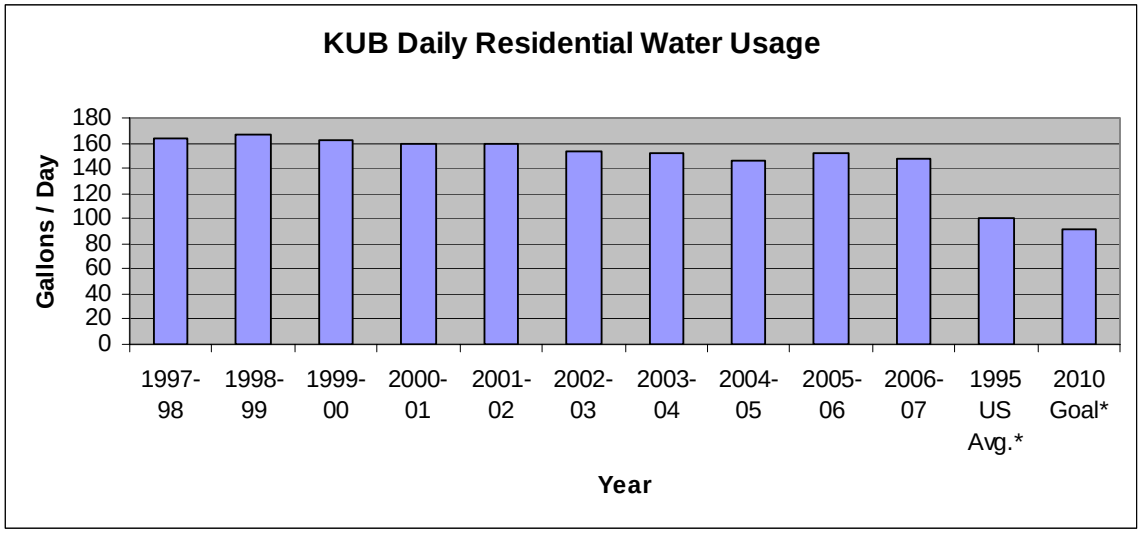
Future Supplies

Another Health People 2010 goal relates to the *drinking water supply*, which is threatened on several fronts:

> Increasing development costs, capital shortages, government fiscal restraint, diminishing sources of water supply, polluted water, and a growing concern for the environment have forced water managers and planners to begin to rethink traditional approaches to management and to experiment with new ones… As the population increases in the Eastern United States, the water quantity problems already facing the West will become apparent there as well. Estimates place the amount of water withdrawn for public supply during 1990 at about 5 percent more than during 1985. Public-supply domestic deliveries averaged 105 gallons per day for each person served, the same as during 1985. The per capita use remained about the same for the past decade as the result of active conservation programs that include the installation of additional meters and water-conserving plumbing fixtures. Information about water use is available from USGS at: http://water.usgs.gov/watuse/wudo.html.

In 1995, residential water usage had marginally improved to 101 gallons per person per day. The Healthy People 2010 goal is to reduce that figure 10% further, to 90.9 gallons per person per day, by 2010. Data for water usage are available from the annual reports of local utilities. For KUB, residential water usage in the past decade is shown in the graph below. While progress in reducing usage is continuing, the Healthy People 2010 goal is not likely to be achieved without additional steps. KUB is currently replacing old, leaking water mains, which should help toward achieving this goal, but greater public adoption of conservation habits is also needed.

Figure 4. Average Daily Residential Water Usage, KUB



NOTE: In the chart above, KUB data (from the Knoxville News-Sentinel, Sunday, May 13, 2007, page C-1) were converted to gallons and *divided by 365*, as the reported usage (in hundreds of cubic feet) was *annual*, while the Healthy People 2010 goal was a *daily* usage rate.

4 - Foodborne Illnesses

Foodborne diseases are an often underestimated environmental health threat, until a product recall - such as recently happened for peanut butter, spinach, lettuce, and ground beef – or an outbreak associated with a restaurant or caterer receives media attention. Foodborne Illnesses have been estimated to sicken approximately 76 million people nationally each year, accounting for 325,000 hospitalizations and 5,000 deaths. Resulting costs are tens of billions of dollars annually to the national economy.

A variety of viruses, bacteria and organisms can cause foodborne illnesses, as indicated in the table in Appendix B, but most cases have an "unknown" cause. This can be due to delayed reporting, inadequate investigation, failure to collect appropriate specimens for laboratory testing, illness due to viruses or other organisms that are difficult to identify, and as-yet-unidentified pathogens.

Restaurant Inspections

With over 1,350 restaurants in Knox County and over 1,750 establishments of all sorts serving food, inspection of restaurants and other food-serving facilities – from the hot dog stand at a sporting event to the salad bar in a supermarket or workplace cafeteria – is a major undertaking of the Environmental Health Division of the KCHD. Restaurant inspections evaluate the facilities, the practices of food handlers, sanitation, and legal requirements like posting permits and inspection results. The scoring system for inspections is somewhat complex, as an item that is an immediate health threat has a different result than failure to post a permit, so it is hard to define a "passing score." Approximately eight to ten non-critical violations (not leading to closure) are identified in a typical restaurant inspection. When a restaurant is closed for a health violation, the facility is reinspected to ensure effective corrective actions have been taken before the facility can reopen. Repeated problems can result in mandatory training sessions for food handlers, or even license revocation. The following table illustrates how often the indicated items are found in restaurant inspections by Knox County personnel:

Table 9. Examples of Violations Found During Restaurant Inspections

Violation	Percent of Inspections Where Problem Was Identified	
	During 2002	During 2006
Food Source	2.5	2.9
Food Temperature	13.9	9.3
Personnel with Infection	0.0	0.0
Good Hygienic Practices	7.0	2.9
Sanitization Problem	4.4	7.9
Water Source Problem	3.8	2.1
Sewage Problem	6.3	7.9
Cross-Connection	2.5	4.3
Hand Washing Facility	2.5	2.1
Insects, Rodents	13.9	11.4
Toxic Item Improperly Located	23.4	22.1
Permit Posted	1.9	2.9
Inspection Posted	2.5	1.4

Inspection results for any restaurant in Tennessee are available at this website:
http://tn.state.gegov.com/tennessee/

FoodNet

In order to provide an additional layer of defense in the food safety system, Tennessee began participating in 1999 in the Foodborne Diseases Active Surveillance Network (FoodNet). FoodNet is a multi-state collaboration with CDC, FDA, and the U.S. Department of Agriculture. FoodNet surveillance was initially conducted in several urban/suburban counties, including Knox County, and expanded statewide in 2003. Active surveillance is conducted to identify all cases of these illnesses in the monitored counties, to calculate incidence information and develop control methods. For information, see http://www2.state.tn.us/health/CEDS/EIP/programs.htm#FN, and at the national level see: http://www.cdc.gov/foodnet/.

Efforts to develop improved control strategies for foodborne illness is conducted in the EHS-Net (Environmental Health Specialist Network) program, a sister program to FoodNet. EHS-Net is a network of environmental health specialists and epidemiologists collaborating and exchanging ideas with laboratories, state food protection programs, the CDC, the Food and Drug Administration, and FoodNet.

The purpose of EHS-Net is to assist state health departments in their efforts to improve the practice of environmental health service programs. This will be accomplished by: Identifying environmental antecedents (underlying factors) to illness and disease outbreaks; translating findings into improved prevention efforts using a systems-based approach; offering training opportunities to current and future environmental health specialists; and strengthening the relations among epidemiology, laboratory, and environmental health programs. Information on EHS-Net in Tennessee is at: http://www2.state.tn.us/health/CEDS/EIP/programs.htm#EHS and nationally at: http://www.cdc.gov/nceh/ehs/EHSNet/highlights.htm.

Foodborne Illness in Knox County

The following table summarizes data for reported cases of foodborne illnesses in Knox County, but it is important to keep in mind that many cases are never identified by testing, and some identified cases are not reported to the Health Department. Most cases of foodborne illness are unable to be traced back to a specific food or location, which means that when foodborne illness cases are identified (such as recent cases of lettuce, spinach, peanut-butter, and chili where health problems were discussed widely in the media) the problem is potentially serious and might become widespread. Also, some foodborne illnesses can be due to other causes, like exposure to contaminated water (e.g. Giardia), or even certain pets (e.g., Salmonella), making identification of a cause for the reported illness that much more challenging.

Table 10. Cases of Common Foodborne Illnesses in Knox County and Tennessee, 2006

	Campylobacter	Salmonella	Giardia	E coli O157:H7
Knox County	38	72	18	2
TN Statewide	409	784	221	12

Typically, two foodborne illness outbreaks occur in Knoxville each year. In recent years local foodborne illness outbreaks have been associated with green onions at a nationally-known chain restaurant (65 cases of Hepatitis A, in 2003), an out-of-county small barbeque business catering a public event downtown (25 cases of norovirus, in 2006), catered luncheons for a local medical practice (32 cases of norovirus, 2006) and a senior citizens group (58 cases of norovirus, 2006) and an office Christmas party at a catering hall (50 cases of norovirus, in 2005). These instances illustrate the need for ongoing vigilance in the restaurant inspection program, and why doctors, hospitals, and laboratories are required by law to report certain diseases to the Health Department.

5 - Hazardous Waste

We are embedded in a modern society that offers us a range of products, options, and benefits beyond the imagination of our ancestors even a few generations ago. This industrial society has produced chemical processes to generate our electronic equipment, our medicines, our homes, our clothing, even our food. Unfortunately, since no process is 100% efficient and we have not yet mimicked nature's ability to use the waste from one thing as the food for something else, a wide variety of wastes are generated. Some of these are hazardous to health and safety of both humans and the environment. This section deals with the local impact of such issues.

Healthy People 2010 has several goals regarding health effects of exposure to hazardous wastes, but they are not all quantitative. These goals typically can only be achieved by the health department working with environmental investigation and enforcement agencies in a holistic manner on both the source of the problem and the effects on the surrounding community. The Healthy People 2010 goals relating to hazardous chemicals include:

- Eliminating elevated blood lead levels in children (due to the connection between leaded paint exposure and elevated blood lead levels, this topic is discussed in the section on Housing and Indoor Air in this report),
- Minimize risks to human health and the environment posed by hazardous waste sites,
- Reduce by 50% pesticide exposures that result in visits to a health care facility,
- Reduce the amount of toxic pollutants released, disposed of, treated, or used for energy recovery, and
- Increase recycling of municipal solid waste (target: 38%). (Recycling in Knox County is addressed in the section on Solid Waste and Wastewater in this report).

Hazardous Waste Sites

After the environmental disaster at Love Canal, New York, was identified in the 1980s, there was a public awareness that at sites across the nation chemical waste had been improperly disposed and environmental contamination had occurred, causing a threat to public health and safety. As a result, the Comprehensive Environmental Response Compensation, and Liability Act (CERCLA) was passed. Commonly known as "Superfund," this law established a trust fund (hence the name) for investigation and remediation of abandoned or uncontrolled waste sites, to be funded by a tax on the chemical industry (now expired) and legal actions by EPA against responsible parties who had contributed to the problem.

While there are no hazardous waste sites in Knox County identified as National Priority List (NPL) sites (aka "Superfund sites") in Knox County, there are a number of sites that have been investigated and cleaned (or are being investigated) under the program, as noted in the table on the following page.

Sites identified as "NFRAP" (No Further Remedial Action Planned) have been investigated and the risks have been found to be low enough that no further action is planned – the site is a "brownfield" (former industrial site) that can be redeveloped. Some sites are "state-led" and are being addressed by the Tennessee Department of Environment and Conservation (TDEC) instead of EPA. For some sites, the problem is known and there is no need for an extensive investigation before cleanup at the site (an example would the rail car accident and chemical spill near Farragut on Sept. 15, 2002, listed as "Norfolk Southern Derailment"); these are listed as "Removal Only Sites."

For some sites, the comment "An Eligible Response Site (ERS) Exclusion decision has been made at this site." is listed. This notation refers to eligibility of the site for brownfields cleanup funding. Per EPA guidance:

> Under CERCLA Section 101(41)(C), EPA may determine to exclude sites from the Brownfields eligible response universe if EPA "conducts or has conducted a preliminary assessment (PA) or site inspection (SI) and, after consultation with the State, determines or has determined that the site obtains a preliminary score sufficient for possible listing on the National Priorities List or otherwise qualifies for listing on the National Priorities List."

In other words, the site has enough evidence of contamination that it may yet be listed on the NPL, and so is not being included in the program for "ordinary" brownfield cleanup for redevelopment.

Table 11. (Non-Superfund) Hazardous Waste Sites in Knox County

EPA ID No.	Site Name	Status	Address	Status
TN0002320224	BERRY ROAD DUMP	No Further Remedial Action Planned (NFRAP)	Berry Road Knoxville, 37920	Not NPL
TN0001921477	CRUZE ROAD DUMP	Site Investigation Ongoing	Cruze Road Knoxville, 37920	Not NPL
TND034692632	DIXIE BARREL & DRUM COMPANY	Removal only site – no site assessment needed	2120 Jones St. Knoxville, 37920	Not NPL
TND003380037	KELLER FOUNDRY (AKA MIKE'S FOUNDRY)	NFRAP	112 Kentucky St. Knoxville, 37915-1208	Not NPL
TN0000590794	LUNDY LANE DRUM	NFRAP	1618 Lundy Lane Knoxville, 37902	Not NPL
TNN000407517	NORFOLK SOUTHERN DERAILMENT	Removal only site – no site assessment needed	Turkey Crossing Rd. Boyd, 37922	Not NPL
TND021565379	PLASTI-LINE	Site Reassessment Start Needed. An Eligible Response Site (ERS) Exclusion decision has been made at this site.	623 East Emory Rd. Powell, 37849	Not NPL
TND098071061	SMOKEY MOUNTAIN SMELTERS	Extended Site Investigation Ongoing. An ERS Exclusion decision has been made at this site.	1508 Maryville Pike Knoxville, 37920	Not NPL
TND003380441	TRW, INC	NFRAP	5008 N. National Dr. Knoxville, 37901	Not NPL
TN3640014699	TVA BULL RUN STEAM PLANT	NFRAP	Edgemoor Rd, 6 mi. SE of Oak Ridge, 37930	Not NPL
TND980848311	WITHERSPOON LANDFILL	State-led Cleanup. An ERS Exclusion decision has been made at this site.	Old Maryville Pike Knoxville, 37920	Not NPL
TND987768637	WITHERSPOON, DAVID, INC.	State-led Cleanup. An ERS Exclusion decision has been made at this site.	901 Old Maryville Pike, Knoxville, 37920	Not NPL
TND063194815	ZINTECH, INC.	Removal only site – no site assessment needed	707 Willow Ave. Knoxville, 37915	Not NPL

Reference:
http://cfpub.epa.gov/supercpad/cursites/srchrslt.cfm?start=1&CFID=813131&CFTOKEN=27126025&jsessionid=6630cf56b1831e365015TR60306630

The Knox County Health Department does not clean up hazardous waste sites. However, as such sites may pose a threat to public health, it is a part of our responsibility to serve as a representative of and advocate for the local public's health and safety during investigation and remediation of such sites or incidents by authorities at the state and/or national level. This role includes:

- Being aware of all such sites in the county, including activities planned or underway at them by state and/or federal agencies.

- Acting as a resource for local residents with concerns about hazardous waste sites, passing their concerns along to authorities at the state and/or federal level, providing them with information and resources as available, and addressing wider public concerns as expressed by the local news media.

- Reviewing and commenting on sampling and investigation plans, quality assurance plans, remedial action plans, or other site-related planning documents during the public comment period for these documents.

- Participating in the investigation and risk assessment process for such sites, through site visits (where appropriate), review of test results from samples collected by other agencies, and independent review and commentary on risk assessment reports.

- Informing local officials and appropriate authorities of risks to the community that are identified so that appropriate actions can be taken (e.g. evacuations in the event of a chemical release or informing and supporting the role of local emergency response personnel who deal on-site with hazardous materials incidents).

- Serving as a resource to the local medical community as they treat patients who may have been affected by a hazardous waste site or incident.

- Coordinating with the Red Cross and other agencies in the event of a disaster involving hazardous materials exposure.

- Working with counterparts at the state and federal level to collect patient exposure and medical data for environmental epidemiological analysis, in order to plan for appropriate response to possible future incidents, to foster deeper understanding of the effects of hazardous materials on human health and the environment, and to provide the information government officials need to develop laws or regulations to minimize future risks to the public.

Hazardous Materials in Business and Industry

Hazardous materials do not only exist at abandoned waste sites or chemical spill emergencies, they are used daily in businesses and industries across our community. Most of the time, they are used safely and in accordance with regulations to protect public and employee health and safety. A wide range of regulations affect operations at locations from dry cleaners to auto body repair shops, printers to metal plating shops, farmers treating crops and pesticide applicators to chemical plants. At the federal level, general chemical handling, use, storage, and disposal is regulated under the Resource Conservation Recovery Act (RCRA), with additional requirements for pesticide manufacturing, application, and training of applicators under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). When hazardous materials are emitted to the air or water, the requirements of the Clean Air Act and Clean Water Act come into play, as discussed in the sections of this report relating to air and water contamination. Finally, facilities storing or using hazardous materials are required to make the amounts and compounds present known to

the federal government and local emergency response personnel under the requirements of Community-Right-To-Know laws.

Details on all these requirements is beyond the scope of this report, but additional information can be found at the EPA website (http://www.epa.gov/), and for corresponding state requirements, at http://www.state.tn.us/environment/land.shtml.

Information on the largest users of hazardous chemicals by volume in Knox County, as compiled and released by EPA, can be found at the EPA's Toxic Release Inventory (TRI) website: http://www.epa.gov/tri/. For 2005 (the most recent year available), 1.25 million pounds of hazardous chemicals were disposed either on-site or off-site in Knox County. This information is presented in Appendix C.

Healthy People 2010 has as a goal to "Reduce the amount of toxic pollutants released, disposed of, treated, or used for energy recovery." While the KCHD does not enforce the various environmental laws noted above, we fulfill our public health responsibilities by increasing public awareness of the health effects of many chemicals, leading to increased reporting and enforcement where problems are present – and thus reduced health impacts. When involved in the risk assessment or permitting processes, public health can encourage adoption of "green chemistry" practices that avoid the use of toxic materials and the generation of hazardous wastes (see: http://www.epa.gov/greenchemistry/). Such practices benefit firms by reducing risks and potential liabilities, and allow marketing of products "as environmentally-friendly." Benefits to the public beyond health and environmental considerations include enhanced public safety by reducing the number of potential disaster opportunities and terror targets and in many cases cutting dependence on compounds derived from imported oil.

Underground Storage Tanks

Underground Storage Tanks (USTs) for chemical storage are of particular concern because if not properly constructed and maintained they can corrode and leak their contents into the environment unnoticed for an extended period of time. They can contaminate groundwater aquifers, and the contamination may reach surface waters through springs or seeps. The tank contents may also infiltrate the basements of nearby buildings, creating a health and safety threat. Detection may not occur until a problem is serious, and remediation is often expensive. For these reasons, USTs have been regulated since 1984 under the RCRA program, which is the major federal program regulating the handling, storage, and disposal of hazardous chemicals in industry.

For USTs containing petroleum products (e.g. gasoline), the federal program has been delegated to the Division of Underground Storage Tanks in TDEC. Their website (http://www.state.tn.us/environment/ust/) allows a download of information on all USTs in the state, provides contact information, and identifies opportunities for public comment on corrective action plans for leaking USTs. (As of this writing, there are no corrective action plans currently listed). A task force recommended additional funding sources for the program in 2004 (http://www.state.tn.us/environment/ust/pdf/UST_FinalReport.pdf), which was implemented in 2005 (http://tennessee.gov/sos/acts/104/pub/pc0283.pdf).

Nuclear Environmental Health Issues

The health and safety issues posed by exposure to nuclear materials – whether radioactive waste or material released as a result of an accidental or criminal incident - are different from those posed by chemical wastes. Residents of Knox County may have questions like these: "I've heard that TVA has nuclear power plants. Could these pose a threat to my health?" "What about

Department of Energy operations at Oak Ridge? Have they released anything that could harm me? What if something happened out there?" "What if a 'dirty bomb' was set off in Knoxville?" This section will discuss these concerns.

About 30% of Tennessee Valley Authority (TVA) power comes from its three nuclear plants, located at: Browns Ferry, near Athens, Alabama; Sequoyah, in Soddy-Daisy, Tennessee, and Watts Bar, near Spring City, Tennessee. The nearest plant to Knox County is Watts Bar, located below the Watts Bar dam.

Following the accident at the Three Mile Island nuclear power plant in central Pennsylvania in 1979, the Nuclear Regulatory Commission (NRC) reexamined emergency planning for public protection near nuclear power plants. Regulations required that before a plant could be licensed to operate, the NRC must have "reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency." The plans that resulted from this process consider two zones around each plant. Within ten miles of a plant, there are sirens to alert residents in the event of an emergency, and evacuations routes are posted along highways. Emergency shelters have been set up, and means of notifying the media put into place.

Within a 50 mile radius of a plant, an "ingestion pathway emergency planning zone" is in effect, meaning that – depending on the amount of radiation released – crops grown in that area might be affected, as well as milk from cattle grazing on pastures in that range. The portion of Knox County roughly west of Pellissippi Parkway lies within the 50-mile radius of the Watts Bar plant.

This does not mean the remainder of Knox County would in all cases be unaffected in the event of a catastrophe at Watts Bar, but under foreseeable circumstances, we are not in the immediate 10-mile zone where the highest risk of problems would be found. The exact nature of the risk posed to residents of Knox County would depend on the nature of the material released and the weather at the time, and therefore cannot be totally predicted. For comparison purposes, the scientific consensus is that at Three Mile Island, the average exposure to radiation within ten miles was eight millirems (equivalent to a chest x-ray) and no individual received more than 100 milirems (about one- third of the average background level of radiation received by US residents in a year). At most, one additional case of cancer resulted from this incident. The 1986 Chernobyl disaster in the USSR, while resulting in much higher releases of radiation extending over 100 miles, is not an accurate worst-case comparison to a US nuclear power plant, due to the vastly different designs of the plants and the safety features legally required to be incorporated into American designs. More information on TVA nuclear power plants can be found at the website: http://www.tva.gov/power/nuclear/index.htm, and information on NRC emergency plans can be found at: http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/emer-plan-prep.html.

The Oak Ridge Department of Energy (DOE) facility, of course, lies much closer to Knox County, and has been in operation since World War II. Workers and residents of Oak Ridge have been concerned about potential health effects from historical releases from the facility. The ATSDR is charged with conducting assessments of the environmental and human health effects of releases from Oak Ridge. These reports have been ongoing for several years, and are made available to the public for comment before being finalized.

The results from the assessments conducted so far are that there may have been some small releases of radiation 50 or more years ago that may have reached rural areas of western Knox County, but there is no current health threat from any such events due to the natural decay of radioactive isotopes over time to more stable forms. Given the small number of people living across the river from Oak Ridge at that time, and the low exposures they had (if any) – as well as limitations in the available data and records - there is no increase in the rates of cancer that CDC could attribute to releases that might have reached Knox County farms. The Clinch River has been impacted by DOE operations, but none of the Knox County drinking water supplies come

from the affected stretches of the river. Residents eating fish from the Clinch River should see the discussion of fish advisories in the recreational and surface water section of this report.

The ATSDR reports for Oak Ridge can be accessed at: http://www.atsdr.cdc.gov/HAC/oakridge/. Information on health and environmental effects of Oak Ridge operations can also be obtained from the DOE Information Center, 475 Oak Ridge Turnpike, Oak Ridge TN 37830, 865-241-4780.

In addition to releases from the Oak Ridge facility, there were contaminated scrap metal materials taken from Oak Ridge over the years that ended up at the "David Witherspoon sites" in the Vestal area of South Knoxville. A detailed history of the contamination and legal wrangling over these sites from a citizen-activist perspective can be found at this website, posted by John Nolt, a professor at the University of Tennessee: http://web.utk.edu/~nolt/envrepts/WSPOON.htm. A discussion of the completion of cleanup of these sites in 2006 by BechtelJacobs Company, LLC, the DOE environmental remediation contractor at Oak Ridge, can be found in the report at: http://www.bechteljacobs.com/pdf/CleanProg2006.pdf. Additional materials may have been disposed at other locations in Knox County, but to date such reports have not been confirmed.

The events of September 11, 2001, have brought home to residents of Knox County the possibility of an attack upon the Oak Ridge DOE facility resulting in a radiation release, or that a 'dirty bomb' might be set off in the county during a major public event. Emergency response personnel (including the Knox County Health Dept.) have response plans for local emergencies and conduct drills to test preparedness regularly. Additional information on these subjects can be found online at: the websites of the following organizations: Y-12 National Security Complex, http://www.y12.doe.gov/, TN Emergency Management Agency, http://www.tnema.org/Index.htm, or Knoxville-Knox County Emergency Management Agency, http://www.cityofknoxville.org/kema/.

Hazardous Materials in the Home

When we consider incidents with hazardous chemicals in the home, we typically refer to them as "poisonings," and the poison control center, as well as local medical facilities, can serve as a source for data on such events. **In Knox County, the poison control hotline number is 1-800-222-1222.** The following table presents the number of deaths from accidental poisoning and exposure to noxious substances for Knox County (all races, both sexes):

Table 12. Deaths of Accidental Poisoning, Knox County, 1990-2004

Year/Age	0-9	10-19	20-29	30-39	40-49	50-64	65+	Total
1990	0	0	2	1	1	2	4	10
1991	0	0	1	2	1	3	1	8
1992	1	0	2	3	1	1	1	9
1993	0	0	1	3	0	0	1	5
1994	0	1	0	2	2	1	2	8
1995	0	0	1	4	2	1	3	11
1996	0	0	1	4	6	3	2	16
1997	0	0	0	5	2	2	1	10
1998	0	0	1	6	3	2	3	15
1999	0	0	4	1	2	3	1	11
2000	0	0	4	6	8	3	3	24
2001	0	0	7	11	12	9	3	42
2002	1	1	6	14	13	7	1	43
2003	0	0	8	15	23	7	3	56
2004	0	1	10	14	22	18	2	67
Total	2	3	48	91	98	62	31	335

Reference: Tennessee Dept of Health website (http://hit.state.tn.us).

Pesticides are a particularly worrisome group of potential sources of poisonings, due to their effects on the central nervous system in many cases. Most at risk are children, home gardeners, and agricultural workers. Pets can also be exposed and suffer similar toxic effects from these compounds. Healthy People 2010 has set a goal to reduce by 50% pesticide exposures that result in visits to a health care facility (versus late 1990s levels).

However, the data in Table 12 do not appear to primarily reflect pesticide poisonings. The jump in 2000 and after, affecting college-aged to middle-aged adults (and possibly tracking somewhat older over time) could be due to increased abuse of a drug or drugs that is especially toxic. A request to the Division of Health Statistics at the state Department of Health confirmed that the elevated level of poisonings was drug related, but another possible explanation is wider adoption of post-mortem testing for poisonings, or a change in definitions or protocols over this time.

Table 13. Causes of Accidental Poisoning Death, Knox County, 2000-2005

ICD-10 Code	Accidental Poisoning by…	Age Group			
		20-29	30-39	40-49	50-64
X45	Alcohol	1	1	3	1
X41	Antiepileptic, Sedative Hypnotic, Antiparkisonism or Psychotropic Drugs	2	4	4	2
X42	Narcotics or Psychodysleptics (Hallucinogens)	30	54	69	26
X40	Nonopioid Analgesics, Antipyretics or Antirheumatics	0	0	1	4
X46	Organic Solvents and Halogenated Hydrocarbons	0	0	1	0
X47	Other Gases and Vapors	1	1	1	1
X49	Other Unspecified Chemicals and Noxious Substances	0	1	0	0
X44	Other Unspecified Drugs, Medicaments and Biological Substances	10	14	16	24
	Total	44	75	95	58

Source: Tennessee Department of Health, Division of Health Statistics.

Had the problem been related to agricultural workers in this age range, we would not have expected to see the jump in 2000 in Table 12 – especially since agricultural use of pesticides probably declined over the period reported, due to suburban sprawl into former farmland. As a result, it appears there are few enough pesticide-related fatalities in Knox County that reliable statistics cannot be generated at the county level on a year-to-year basis for tracking against the Healthy People 2010 goals.

Household Hazardous Waste

Knox County and the City of Knoxville opened Tennessee's first permanent Household Hazardous Waste (HHW) Collection Center in April, 1997. Located at 1033 Elm Street (off west Baxter Avenue), the facility is centrally located off Exit 1B of I-275. The facility operates Tuesday through Friday, 8:00 AM to 3:30 PM, and Saturday 8:00 AM – noon. It is closed Sunday and Monday. Up to 20 gallons or 100 pounds of residential waste is accepted per trip; businesses must contract privately for hazardous waste disposal. For additional information or to confirm hours of operation, call 865-215-6700, or visit their website:
http://www.cityofknoxville.org/solidwaste/hazwaste.asp

The HHW facility accepts:

- Adhesives
- Air Conditioning Refrigerants
- Automotive Oil and Fuel Additives
- Batteries
- Carburetor and Fuel Injection Cleaners
- Drain Openers
- Fluorescent Tubes
- Fungicides/Wood Preservatives
- Grease and Rust Solvents
- Herbicides
- Propane Cylinders
- Oven Cleaners
- Paint
- Paint Strippers and Removers
- Paint Thinner
- Pesticides
- Starter Fluids
- Wood and Metal Cleaners and Polish

Materials not accepted include:

- Materials generated by any type of business (Commercial Hazardous Waste)
- Explosives and Ammunition
- Medical Waste
- Non-propane Cylinders
- Pressurized Fire Extinguishers
- Radioactive Waste (including smoke detectors)
- Unidentifiable Materials

NOTE: Usable materials in good condition will be recycled; for example recycled paint from HHW has been used by Habitat for Humanity and for graffiti removal.

Table 14. Tons of Hazardous Waste Processed by the Knoxville-Knox County HHW Center

Year	Tons HHW
2004	172
2005	169
2006	167

As with recycling (discussed in the Section on Solid Waste and Wastewater), there has been a drop in community participation in submitting materials to the HHW center. Increased public education to encourage greater participation in both programs may be an appropriate response.

Mercury

Mercury is one of the more common hazardous materials to which one might be exposed in the home. It is potentially present in a number of common household items, such as thermometers, wall switches, thermostats, and certain antiques (see box, next page). Broken thermometers are also a potential source on injury from the broken glass, as well as a chemical hazard from the mercury in the thermometer.

Mercury is both an environmental and a health and safety problem. Mercury has many toxic effects in the body. If a thermometer or other device is broken and not properly cleaned up, tiny droplets of mercury can evaporate over time. When mercury vapor is inhaled, it enters the blood and can damage the brain, spinal cord, kidneys and liver. Children and fetuses are at special risk. Swallowing or touching mercury metal is not nearly as toxic; thus if a broken thermometer is cleaned up properly and promptly people will not be harmed. In the environment, mercury falls with rain and snow, contaminating lakes and streams and accumulating in the bodies of fish and wildlife. Natural processes can convert mercury into methylmercury, an even more dangerous form of the metal. See: www.usgs.gov/themes/factsheet/146-00/ and www.epa.gov/mercury/.

Mercury was used for many years in thermometers designed for household use because no alternatives were available. However, this is no longer the case today. In July 2001, the

American Academy of Pediatrics issued a policy statement about the health effects of mercury, and urged doctors and parents to stop using mercury thermometers and to dispose of them properly. **If a mercury-containing device breaks, individuals should NEVER use a vacuum cleaner to clean up the mercury.** The vacuum cleaner can make tiny droplets in the air, increasing the problem and contaminating the vacuum cleaner as well. The state of Tennessee has a fact sheet describing proper cleanup procedures for broken thermometers at: http://www2.state.tn.us/health/FactSheets/mercury.htm

Mercury containing devices can be turned in at the Knox County - Knoxville Household Hazardous Waste Center (1033 Elm Street). Mercury thermometers can be exchanged for digital thermometers for free at any of the several exchange events held during the year. Ongoing exchange locations include Farragut city hall, Rural-Metro fire stations, or the HHW site.

Measures to help prevent unintentional releases of elemental mercury from antiques

- Know the various types of antiques and items that might contain elemental mercury:
  - thermometers,
  - barometers,
  - pendulum clocks,
  - electrical switches,
  - blood-pressure gauges,
  - thermostats,
  - silvered mirrors, and
  - silvered vases.
- Do not purchase an antique known to contain mercury. If the seller is uncertain, have the seller verify the item is mercury-free.
- For mercury-containing antiques in the household, exercise care:
  - Inspect each item thoroughly for cracks or leaks in susceptible areas (e.g., seals, columns, and casings).
  - Replace or remove mercury-containing components, whenever possible. Do not attempt to drain or replace the mercury.
  - Because mercury is hazardous waste, contact the state or local health or environmental department for advice on cleaning up or disposing of mercury.
- When handling mercury-containing items, exercise care:
  - Move slowly.
  - Keep the item in a leak-proof container.
  - Support the item with padding.
  - Do not turn the item horizontal.
  - Keep barometers at a 45-degree angle when moving.
  - Because mercury is regulated by the U.S. Department of Transportation, know the applicable laws before shipping an item.
- Ensure that the antiques containing mercury are not within the reach of children and that children are educated about the dangers of mercury.

Reference: CDC, MMWR, 6/15/07: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5623a2.htm?s_cid=mm5623a2_e

6 - Housing and Indoor Air Quality

Appropriate housing and healthy indoor air quality are a key component of a healthy environment for all individuals, as most people spend more time indoors than outdoors. Some hazards associated with indoor environments include inadequate facilities, poor sanitation leading to exposure to a range of allergens, radon, second-hand tobacco smoke, and lead-based paint. These issues, which are addressed by a number of goals in CDC's report *Healthy People 2010*, are discussed in this section.

Quality of Housing Stock

Healthy People 2010 goal: Reduce the proportion of occupied housing units that are substandard to a target level of 3%. Baseline: 6.2 percent of occupied U.S. housing units had moderate or severe physical problems in 1995.

The US census uses the following measures as indicators of housing quality: having a complete kitchen, having complete plumbing facilities, and occurrence of overcrowding. Complete kitchen facilities are defined as a sink with piped water, a range, and a refrigerator. Complete plumbing facilities are defined as hot and cold piped running water, a flush toilet, and a bathtub or shower. A housing unit is considered crowded if it has more than one person to a room. The following table summarizes the quality of Knox County housing stock in terms of these variables. While small levels of problems remain, overall **Knox County meets the Healthy People 2010 goals and performs better than the statewide and national averages.** Within the county, housing units that are considered overcrowded are primarily located in the older neighborhoods ringing downtown Knoxville.

Table 15. Measures of Housing Stock Quality, 2000 Census (percent)

	Knox County			TN	US
	Owner-Occupied	Renter-Occupied	Total	Total	Total
Lack complete kitchen facilities	0.215	0.853	0.734*	1.14*	1.31*
Lack complete plumbing facilities	0.301	0.411	0.491*	1.05*	1.15*
Overcrowded unit, 1.01-1.50 Occupants / room	0.661	1.87	1.06	1.89	3.02
Overcrowded unit, 1.51-2.00 Occupants / room	0.108	0.872	0.361	0.638	1.73
Overcrowded unit, 2.01 or more occupants / room	0.019	0.165	0.067	0.206	0.998

* Includes occupied and unoccupied units
Source: Summary file 3, 2000 US Census. The 2005 US Census estimate for occupied housing units with over 1 occupant / room is 1.3% (+/-0.4%) for Knox County and 1.8% (+/-0.2%) for TN.

Property Maintenance Ordinances

Of course, a property can meet the criteria above and still be an unhealthy place to live if not properly maintained. For example, a leaking roof may result in mold infestation, or poor

maintenance might result in rodent infestation. Improper wiring or plumbing might create safety hazards as well as health threats. There are various government offices to address these issues: At the county level, Codes Administration and Inspection ensures that buildings are constructed, modified, or repaired in a proper manner for the health and safety of residents (http://www.knoxcounty.org/codes/index.php). The county Fire Prevention Bureau performs inspections to address fire hazards (http://www.knoxcounty.org/fire/code_enforcement/index.php) in areas of the county outside Knoxville and Farragut city limits, while within Knoxville such issues are addressed by the Fire Marshall and the city Fire Codes and Inspections staff (http://www.cityofknoxville.org/kfd/codes.asp). In Farragut they are addressed by the Fire Prevention Office (http://www.townoffarragut.org/fireprevention.pdf).

The county also has a dirty lot ordinance (http://www.knoxcounty.org/oon/pdfs/dlo.pdf) that addresses overgrown vegetation, trash, abandoned vehicles or buildings unfit for habitation on a property. The owner then has 30 days to correct the problem. To report such a property, call 215-HELP, or email neighborhoods@knoxcounty.org. In Knoxville, call Codes Enforcement at 311 to address issues of this type (http://www.ci.knoxville.tn.us/development/codes.asp); the noncompliant can end up in Municipal Court or before the Better Building Board (http://www.ci.knoxville.tn.us/boards/betterbuilding.asp). In Farragut, the Planning and Codes Enforcement Divisions are merged as the Community Development Department that can be contacted for enforcement information (http://www.townoffarragut.org/comm-dev-dept.htm).

Lead-Based Paint & Childhood Lead Poisoning

Lead is a highly toxic metal that was used for many years in products found in and around the home. Lead may cause a range of health effects, from behavioral problems and learning disabilities, to seizures and death. Children 6 years old and under are most at risk, because their bodies are growing quickly. Research suggests that the primary sources of lead exposure for most children are deteriorating lead-based paint, lead contaminated dust, and lead contaminated residential soil. A child's lead exposure can be measured by a blood test; the current blood lead level at which a child is considered to have an elevated blood lead level is 10µg/dL, although recent research suggests even this level may be too high.

The federal government banned lead-based paint from use in 1978. If a home is older than that, the paint in it should be tested for lead, especially if a child is found to have elevated blood lead levels. Additional information is available from EPA at http://www.epa.gov/lead/ and from CDC at http://www.cdc.gov/nceh/lead/about/program.htm.

The average age of homes in census tracts in Knox County is provided in Appendix D. There are correlations at the census-tract level (nationally and in Knox County) between age of homes, elevated blood lead levels, and number of lower-income residents.

Healthy People 2010 has two goals specifically related to this issue:

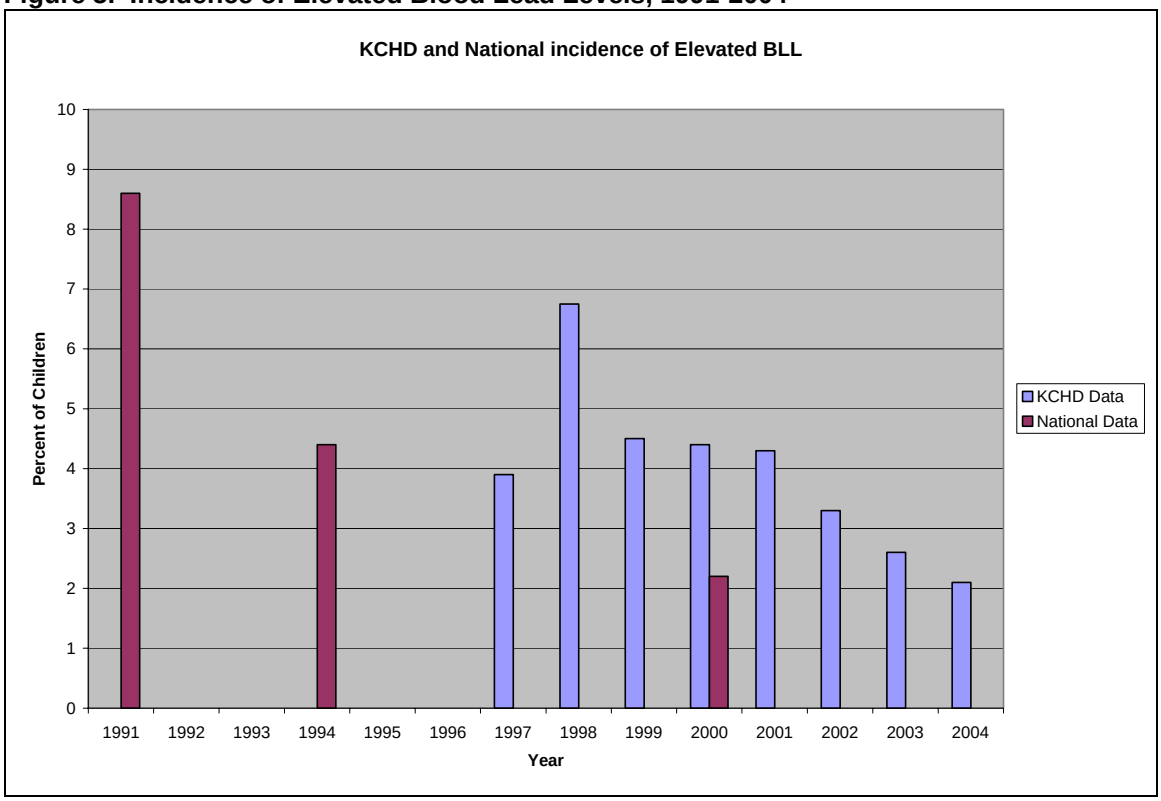
- Increase the proportion of persons living in pre-1950s housing that has been tested for the presence of lead-based paint. (Target: 50%; Baseline: 16 percent of persons living in homes built before 1950 in 1998 reported that their homes had been tested for the presence of lead-based paint.)

- Eliminate elevated blood lead levels in children. (Target: Zero percent. Baseline: 4.4 percent of children aged 1 to 6 years had blood lead levels exceeding 10 µg/dL during 1991–94.)

The Knox County Health Department has provided testing of children at-risk for lead poisoning for a number of years (such children typically are lower income and live in older housing, which is more likely to have lead-based paint present). The following charts present data collected

nationally and by the KCHD for the past several years, illustrating that while the problem is decreasing in Knox County, we have not yet achieved the Healthy People 2010 goal of eliminating elevated blood lead in children. A renewed effort will also be needed to reach the goal of testing 50% of persons living in pre-1950 housing for elevated blood lead levels.

Figure 5. Incidence of Elevated Blood Lead Levels, 1991-2004



Note: In the chart above, the national data are based on a sampling of all children, while the KCHD data are for children tested by the Health Department, which is a subset of the overall population primarily consisting of lower-income disadvantaged children.

Radon

Radon is a cancer-causing natural radioactive gas that cannot be seen, smelled or tasted. It is formed by the decay of radioactive uranium in the earth's crust and, being a gas, it then escapes to the atmosphere working its way up through the soil. If a building is located where the gas is present, it will infiltrate into the home and possibly pose a danger to the occupant's health. *Radon is the leading cause of lung cancer among non-smokers. Radon is the second leading cause of lung cancer in America and claims more than 20,000 lives annually.* Fortunately, it is a risk people can avoid by testing and fixing their homes (generally by installing better basement ventilation) if a radon level of 4 pCi/L or more is present.

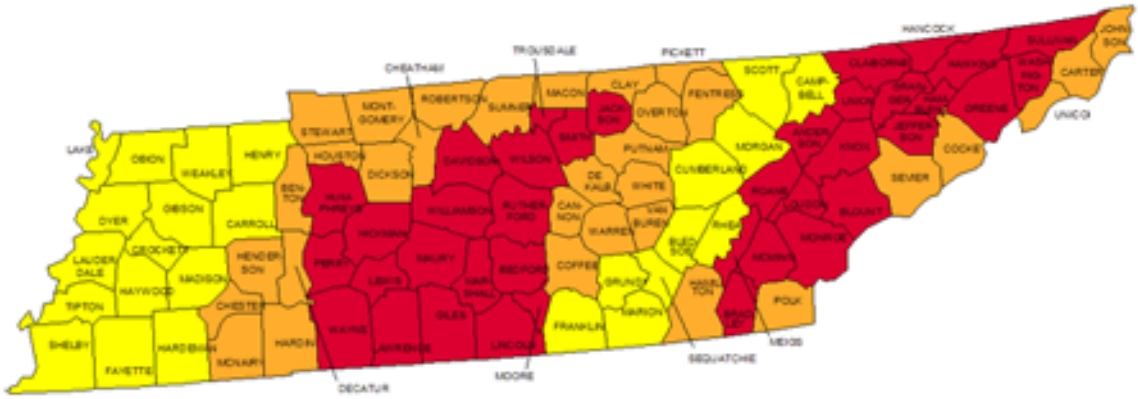
Healthy People 2010 has established two goals with respect to the presence of radon indoors:

- Increase the proportion of persons living in homes tested for radon contamination (Target: 20%; Baseline = 17% national rate in 1998)

- Increase the number of new homes constructed to be radon resistant (Target 50% improvement by 2010 over late 1990's rate)

Unfortunately, radon levels are especially a concern in Knox County. The Indoor Radon Abatement Act of 1988 directed EPA to list and identify areas of the U.S. with potentially elevated radon levels. EPA's Map of Radon Zones (http://www.epa.gov/radon/zonemap/tennessee.htm) assigns each of the 3,141 counties in the U.S. to one of three zones based on radon potential. As can be seen on the map below, Knox and several surrounding counties are at elevated risk for higher than recommended levels of indoor radon.

Figure 6. Radon Levels in Tennessee



	Zone 1 counties have a predicted average indoor radon screening level greater than 4 pCi/L (picocuries per liter) (red zones)	Highest Potential
	Zone 2 counties have a predicted average indoor radon screening level between 2 and 4 pCi/L (orange zones)	Moderate Potential
	Zone 3 counties have a predicted average indoor radon screening level less than 2 pCi/L (yellow zones)	Low Potential

However, the risk of elevated indoor radon is not uniformly distributed across the county. A more detailed analysis of areas where radon levels are potentially elevated was conducted by the TN Division of Geology to identify Knox County schools in areas where the local geology would suggest elevated radon is present.

In order for elevated radon to pose a threat, there must be appropriate bedrock that contains uranium to decay into radon, and then a pathway for the radon to reach the surface. In Knox County, the presence of karst geology provides such a pathway. Karst regions are typified by soluble limestone or dolomite, which is easily fractured or dissolved. Caves, sinkholes, and springs are common in karst areas.

While the map on the next page identifies schools only, it maps the geology of the entire county and residents can use it (based on their knowledge of where their home is located versus local schools and ridges) to see if they are in one of the zones of highest risk. However, even if the map suggests your home may not be in the zone of highest risk, a radon test is recommended to everyone, as the scale of this map cannot fully present the details of local geology at the street or neighborhood level.

Note: The level of detail in the original map cannot be reproduced at the scale of the image in this report. Individuals interested in obtaining by email a copy of the large-scale, detailed 3686 x 4991 jpeg image file – suitable for printing at poster size for classroom use - should contact the Knox County Environmental Epidemiologist (contact information can be found in the introduction to this report).

Figure 7. Knox County Radon Risk Map (from study for school risks)

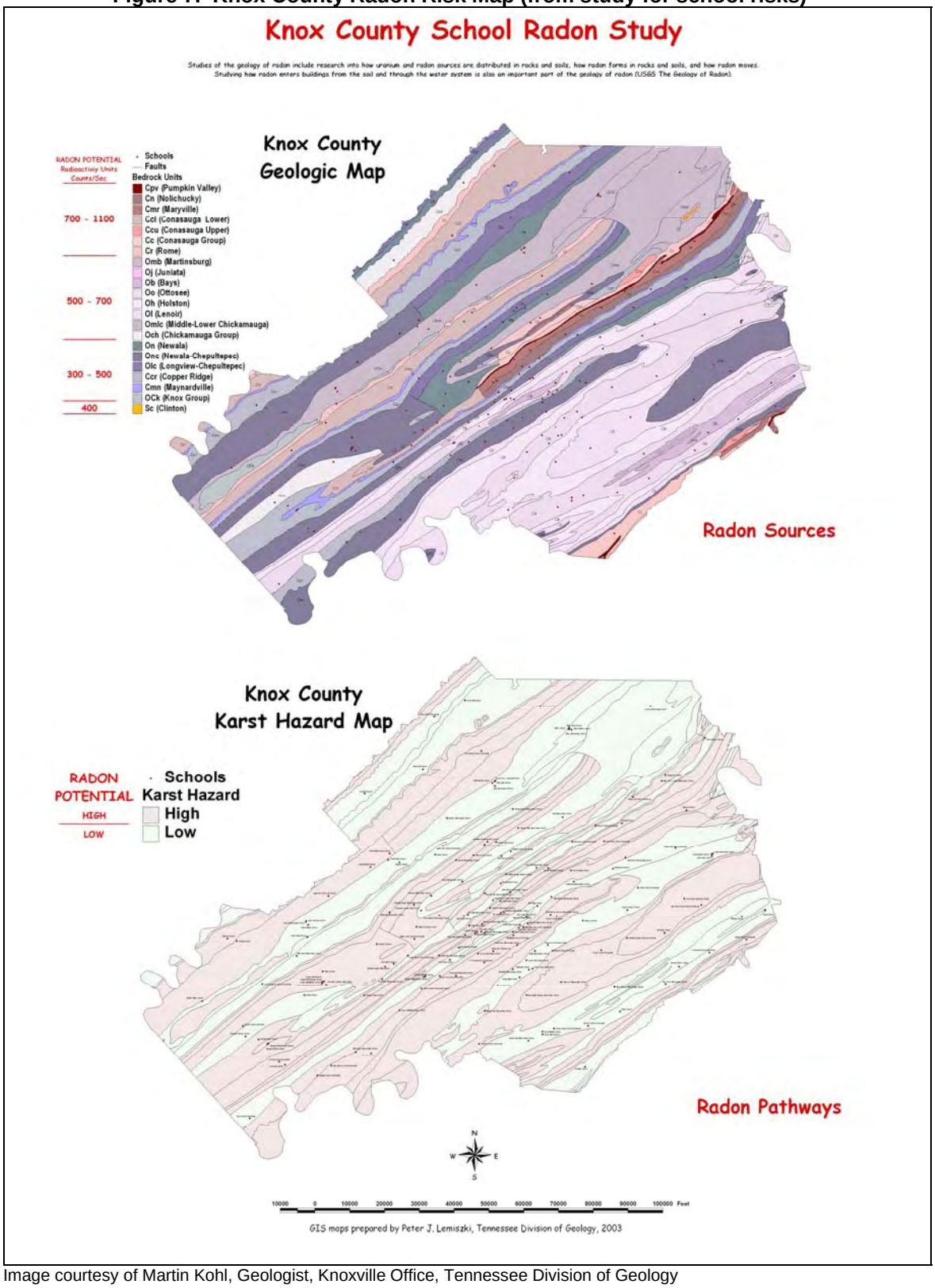


Image courtesy of Martin Kohl, Geologist, Knoxville Office, Tennessee Division of Geology

For additional information on radon, see the EPA's radon website: http://www.epa.gov/iaq/radon/

Allergens in the Home

Healthy People 2010 establishes goals for the reduction of indoor allergen levels, as indicated in the box below. While no studies are available measuring the occurrence of homes with allergen issues at the local level, this information is valuable in that it reinforces health education efforts regarding the need for families to take steps to control exposures to allergens in the home, especially if a family member has allergies or asthma.

Target and baseline:

Objective	Allergen	1998–99 Baseline	2010 Target
		Number of Homes (in millions)	
8-16a.	Group I dust mite allergens that exceed 2 micrograms per gram of dust in the bed	36.3	29.0
8-16b.	Group I dust mite allergens that exceed 10 micrograms per gram of dust in the bed	18.6	14.9
8-16c.	German cockroach allergens that exceed 0.1 microgram per gram of dust in the bed	4.7	3.8

Target setting method: 20 percent improvement.

Data source: National Survey of Lead and Allergens in Housing, NIEHS, and U.S. Department of Housing and Urban Development.

Asthma (http://www.cdc.gov/health/asthma.htm) is a lung disease that causes repeated episodes of wheezing, breathlessness, chest tightness, and nighttime or early morning coughing. Asthma can be controlled by following a medical management plan and by avoiding contact with environmental "triggers," such as cockroaches and their droppings, dust mites, pet dander, mold, tobacco smoke, and certain chemicals. Asthma is one of the most common long-term diseases of children.

In addition to asthma, millions of additional people suffer from allergies caused by every day exposures to materials such as dust mites, pet dander, and pollen. Agents encountered by workers can also cause allergic problems such as asthma, nasal and sinus allergies, hives, and even severe anaphylactic (allergic shock) reactions. Examples of these work-related agents include animal proteins, enzymes, flour, natural rubber latex, and certain reactive chemicals.

It can be vital that those who suffer from these problems avoid exposure to triggers. An allergist or immunologist can help determine the compounds that cause problems and recommend control measures to help avoid allergens. The "Outdoor Air" section of this report provides more information on where to find current information on outdoor allergen levels, but within the home the presence of allergens depends less on outdoor conditions than on proper maintenance of the home.

Families can take the following steps to control levels of allergens in the home (the information is adapted from EPA's Asthma information website: http://www.epa.gov/asthma/index.html). While allergy and asthma triggers may vary among people, the following provides suggestions that will help reduce problems for most people with these problems:

Control dust:

- Remove dust often with a damp cloth.
- Vacuum carpet and fabric-covered furniture to reduce dust build-up.
- Using vacuums with high efficiency filters or central vacuums may be helpful.
- People with asthma or allergies should leave the area being vacuumed.
- Hard flooring surfaces are preferred to carpeting.

Control dust mites:

- Cover mattresses and pillows with dust proof ("allergen-impermeable") zippered covers.
- Wash bedding (sheets, blankets and bedcovers) once per week in hot water.
- Choose washable stuffed toys, wash them often in hot water and dry them thoroughly.
- Keep stuffed toys off beds.
- Maintain low indoor humidity, ideally between 30-50% relative humidity. Humidity levels can be measured by hygrometers which are available at local hardware stores.

Control Cockroaches:

- Do not leave food or garbage out.
- Store food in airtight containers.
- Clean all food crumbs or spilled liquids right away.
- Wash dishes as soon as you are done using them.
- Keep counters, sinks, tables and floors clean and clear of clutter.
- Fix plumbing leaks and other moisture problems.
- Seal cracks or openings around or inside cabinets.
- Remove piles of boxes, newspapers and other hiding places for pests from your home.
- Make sure trash is stored in containers with lids that close securely; remove trash daily.
- Try using poison baits, boric acid or traps first before using pesticide sprays.
- If sprays are used:
    - Limit the spray to the infested area.
    - Do not spray where you prepare or store food, or where young children play, crawl or sleep.
    - Carefully follow instructions on the label.
    - Make sure there is plenty of fresh air when you spray and keep people with asthma out of the room while spraying.
    - After spraying, the room should be thoroughly aired out.

Recent research suggests airborne mouse allergens can contribute to asthma and allergies as well. The steps listed above for cockroaches will also help in controlling mice, as will use of a mousetrap.

Control Second-hand Smoke:

- Choose not to smoke in your home or car and don't allow others to do so.
- Choose not to smoke in the presence of people with asthma.
- Choose not to smoke in the presence of children, who are particularly susceptible to the harmful effects of secondhand smoke.
- Do not allow baby-sitters, caregivers or others who work in your home to smoke in your house or near your children.
- Take the Smoke-free Home Pledge (http://www.epa.gov/smokefre/pledge/) and encourage others to do so.
- Talk to your children's teachers and day care providers about keeping the places your children spend time smoke-free.

Control Mold:

- Wash mold off hard surfaces and dry completely. Absorbent materials, such as ceiling tiles and carpet, may have to be replaced if they are contaminated with mold.
- Fix leaky plumbing or other sources of water.
- Keep drip pans in your air conditioner, refrigerator and dehumidifier clean and dry.
- Use exhaust fans or open windows in kitchens and bathrooms when showering, cooking or using the dishwasher.
- Vent clothes dryers to the outside.

Control Pet Allergens:

- If pets are one of your asthma triggers, consider finding a new home for your pets.
- Keep pets out of the bedroom / sleeping area at all times and keep the door closed.
- Keep pets away from fabric-covered furniture, carpets and stuffed toys.
- Vacuum carpets, rugs and furniture two or more times per week.

Nitrogen Dioxide (NO_2) can be a byproduct of fuel-burning appliances, such as gas stoves, gas or oil furnaces, fireplaces, wood stoves and unvented kerosene or gas space heaters. NO_2 is an odorless gas that can irritate your eyes, nose and throat and cause shortness of breath. In people with asthma, exposure to low levels of NO_2 may cause increased bronchial reactivity and make young children more susceptible to respiratory infections. Long-term exposure to high levels of NO_2 can lead to chronic bronchitis.

Control Nitrogen Dioxide in the home:

- Properly ventilate a room where a fuel-burning appliance is used and use appliances that vent to the outside whenever possible.
- Do not idle the car inside your garage.
- Have the entire heating system -- including furnace, flues and chimneys -- professionally inspected and cleaned annually.
- Always open the flue on your fireplace before building a fire to ensure that smoke escapes through the chimney.
- Make sure the doors are tight fitting on your wood-burning stove and follow the manufacturer's directions for starting, stoking and putting out the fire.
- Follow the manufacturer's directions for proper fuel use on unvented kerosene or gas space heaters and keep the heater properly adjusted. Open a window slightly or use an exhaust fan in the room while using the heater.
- Install and use an exhaust fan over a gas stove and vent it outdoors.

While the Health Department does not have a mechanism for monitoring presence of allergens in individual homes, monitoring at the community level has shown **an increased incidence of asthma in our community in recent years** (see graphs in Appendix E). The data for Knox County indicates the problem affects both males and females, white and black (there were insufficient data to reliably plot trends for other racial or ethnic groups, and asthma is more of a problem for minorities), for almost all age groups, and holds for both cases of outpatient and inpatient treatment.

Indoor Air Quality: Schools

EPA reports (http://www.epa.gov/iaq/index.html) that twenty percent of the U.S. population, nearly 55 million people, spend their days in our elementary and secondary schools. In the mid-1990s,

studies showed that 1 in 5 of our nation's 110,000 schools reported unsatisfactory indoor air quality, and 1 in 4 schools reported ventilation - which impacts indoor air quality - as unsatisfactory. Students are at greater risk because of the hours spent in school facilities and because children are especially susceptible to pollutants.

As a result of such findings, Healthy People 2010 included as a goal to increase the proportion of the nation's primary and secondary schools that have official school policies ensuring the safety of students and staff from environmental hazards, such as chemicals in special classrooms, poor indoor air quality, asbestos, and exposure to pesticides.

Additionally, EPA has developed the *Indoor Air Quality (IAQ) Tools for Schools (TfS)* Program to reduce exposures to indoor environmental contaminants in schools through the voluntary adoption of sound indoor air quality management practices.

Locally, the Knox County School District, working with the KCHD, has implemented EPA's *Tools for Schools* in recent years, to help our schools maintain a healthy environment in school buildings by identifying, correcting, and preventing IAQ problems. Since poor indoor air quality can impact the comfort and health of students and staff, IAQ problems can affect concentration, attendance, and student performance. In addition, if schools fail to respond promptly to poor IAQ, students and staff are at an increased risk of short-term health problems, such as fatigue and nausea, as well as long-term problems like asthma.

Second-hand Tobacco Smoke

Second-hand smoke, also known as environmental tobacco smoke, is a complex mixture of gases and particles that includes smoke from the burning cigarette, cigar, or pipe tip and exhaled mainstream smoke. Secondhand smoke contains at least 250 chemicals known to be toxic, including more than 50 that can cause cancer. In 2006 the Surgeon General identified the following known harmful effects of second-hand smoke:

- Secondhand smoke exposure causes heart disease and lung cancer in nonsmoking adults.
- Nonsmokers who are exposed to secondhand smoke at home or work increase their heart disease risk by 25–30% and their lung cancer risk by 20–30%.
- Breathing secondhand smoke has immediate harmful effects on the cardiovascular system that can increase the risk of heart attack. People who already have heart disease are at especially high risk.
- Secondhand smoke exposure causes respiratory symptoms in children and slows their lung growth.
- Secondhand smoke causes sudden infant death syndrome (SIDS), acute respiratory infections, ear problems, and more frequent and severe asthma attacks in children.
- There is no risk-free level of secondhand smoke exposure. Even brief exposure can be dangerous.

Given the serious health threats caused by smoking, Healthy People 2010 has a number of goals relating to tobacco use. The following subset of those goals relate to environmental health aspects of smoking:

1. *Reduce the proportion of children who are regularly exposed to tobacco smoke at home:* 27 percent of children aged 6 years and under lived in a household where someone smoked inside the house at least 4 days per week in 1994. The goal is to reduce this percentage to 10%.
2. *Reduce the proportion of nonsmokers exposed to environmental tobacco smoke:* 65 percent of nonsmokers aged 4 years and older had a serum cotinine level

above 0.10 ng/mL in 1988–94 (cotinine is a chemical which can be measured in the blood after exposure to tobacco smoke). The goal is to reduce this to 45%.

3. *Increase smoke-free and tobacco-free environments in schools, including all school facilities, property, vehicles, and school events.* 37 percent of middle, junior high, and senior high schools were smoke-free and tobacco-free in 1994. The 2010 goal is 100%.
4. *Increase the proportion of worksites with formal smoking policies that prohibit smoking or limit it to separately ventilated areas.* Seventy-nine percent of worksites with 50 or more employees had formal smoking policies that prohibited or limited smoking to separately ventilated areas in 1998–99. The target goal is 100% by 2010.
5. *Establish laws on smoke-free indoor air that prohibit smoking or limit it to separately ventilated areas in public places and worksites.* 2010 Goal: Smoking banned in all private and public workplaces, restaurants, daycare centers, retail stores, and on public transportation.

Progress is being made on reducing exposure to second-hand smoke, although whether the Healthy People 2010 goals will be totally achieved remains to be seen.

Regarding the first goal above, health education on the harm to infants from secondhand smoke should continue; surveys such as the YRBS and BRFS can be used to monitor effectiveness of these messages.

For goal number two, the Knox County School District policy JCBB addresses tobacco use by students (http://www.kcs.k12tn.net/policy/policy/j/jcbb.htm):

> Students shall not possess nor use tobacco product in any form on school premises or on school buses during school hours. To "possess" shall mean to have tobacco products on the person or in the vehicle or other areas in control of the individual, including one's personal effects. To "use" shall mean any holding of a lighted cigarette, cigar, or pipe, any inhaling of the smoke of tobacco, or any chewing or dipping of any tobacco product. "School hours" shall include the period of time beginning with the first bus pickup (or arrival of car riders) in the morning and ending with the last bus drop in the afternoon.
>
> Instructional programs designed to inform students about the hazards of tobacco use and counseling programs designed to discourage students from the use of tobacco shall be included in the curriculum of each school.

For goals three through five, a bill banning smoking in most indoor workplaces, including restaurants, passed both houses of the state legislature in May 2007. Exemptions allow smoking in bars and other "age-restricted venues," a concession to lawmakers who would not support a more restrictive bill. Governor Bredesen has since signed the bill into law, and it takes effect in July. Private clubs and businesses with three or fewer employees are exempt from the ban as passed. See: http://www.knoxnews.com/kns/state/article/0,1406,KNS_348_5564827,00.html

Additional information on second-hand smoke can be found at these websites:

CDC website on secondhand smoke: http://www.cdc.gov/tobacco/secondhand_smoke/index.htm
EPA smoke-free homes website: http://www.epa.gov/smokefree/index.html
Americans for Nonsmokers Rights website: http://www.no-smoke.org/
Campaign for Tobacco-free Kids website: http://www.tobaccofreekids.org/
Campaign for a Healthy and Responsible Tennessee website: http://www.tnchart.org/

"Sick Building Syndrome"

Sick building syndrome is a combination of ailments associated with a person's place of work (usually an office setting). A 1984 World Health Organization (WHO) report on the syndrome suggested up to 30% of new and remodeled buildings worldwide may be linked to such symptoms. Cases of "sick buildings" are often attributed to flaws in the heating, ventilation and air conditioning (HVAC) system, and are often addressed by boosting the overall turn-over rate in fresh air exchange with the outside air. Other causes have been attributed to contaminants produced by out-gassing of some types of building materials, new carpets, etc., or improper exhaust ventilation of volatile chemicals used in the workplace (glues, inks, etc.).

Healthy People 2010 includes a goal of increasing the number of office buildings that are managed using good indoor air quality practices (no numerical target stated). Towards that end, the following websites on this topic may be of interest to the community:

EPA: http://www.epa.gov/iaq/pubs/sbs.html and http://www.epa.gov/iaq/pubs/ventilat.html

National Institute for Occupational Safety and Health: http://www.cdc.gov/niosh/topics/indoorenv/

American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org/ (search for "Sick Building Syndrome" at: http://www.ashrae.org/technology/page/336#standards)

Carbon Monoxide

Carbon monoxide (CO) is a poisonous, odorless, and invisible gas generated by incomplete combustion. Carbon monoxide poisonings most commonly occur as a result of burning materials in the home without proper ventilation, especially after a power failure or during cold weather. Improper maintenance or problems with gas-powered appliances (e.g. stove, hot water heater, furnace) can result in CO buildup in the home. It is recommended that every home have a CO detector, which looks and operates like a smoke detector, but is *not the same thing*. The CDC has issued the following dos and don'ts to prevent CO exposure:

- **Do** have your heating system, water heater and any other gas, oil, or coal burning appliances serviced by a qualified technician every year.
- **Do** install a battery-operated CO detector in your home and check or replace the battery when you change the time on your clocks each spring and fall. If the detector sounds leave your home immediately and call 911.
- **Do** seek prompt medical attention if you suspect CO poisoning and are feeling dizzy, light-headed, or nauseous.
- **Don't** use a generator, charcoal grill, camp stove, or other gasoline or charcoal-burning device inside your home, basement, or garage or near a window.
- **Don't** run a car or truck inside a garage attached to your house, even if you leave the door open.
- **Don't** burn anything in a stove or fireplace that isn't vented.
- **Don't** heat your house with a gas oven.

Even in the outdoors, CO can be a threat. The CDC has reported that campers have been killed by bringing a propane stove or a charcoal grill inside their tents for warmth. See: http://www.cdc.gov/mmwr/PDF/wk/mm4832.pdf.

In the workplace, the Tennessee Occupational Safety and Health Administration (TOSHA) has reported that operation of gas-powered forklifts in a confined environment can result in CO poisoning of workers: http://www.cdc.gov/mmwr/PDF/wk/mm4832.pdf

The federal Consumer Product Safety Commission (CPSC) estimates that, each year, carbon monoxide fumes from charcoal grills and hibachis used inside cause about 28 deaths and 300 hospital emergency-room-treated injuries, costing society about $143 million annually.

Across the US, about 300 people die annually from CO poisoning. The CDC website for additional information on CO is: http://www.cdc.gov/co/default.htm.

7 - Land Use and Community Design

Community design is increasingly viewed as a factor influencing the environmental quality and safety of cities, as well as the health of its citizens. Design factors may be partially responsible for the decline in physical activity and the increase in overweight and obesity among urban and suburban inhabitants, which in turn contributes to a range of negative health outcomes. Cardiovascular disease, diabetes, hypertension, obesity, and osteoporosis are linked to a sedentary lifestyle. At least one-third of all cancers are attributable to poor diet, physical inactivity, and being overweight. The design of our communities is related to these issues; the questions today are more ones of "How?", "To what degree?", and "What do we do with this knowledge?".

Research indicates that up to twice as many people may walk or bicycle in neighborhoods that have good public transportation than in neighborhoods that are designed for automobile use. In neighborhoods with more grid-like city blocks, people walk up to three times more than in neighborhoods with cul-de-sacs or other features that keep streets from connecting. Incorporation of greenways and other paths into the design of our communities can overcome some of these problems, but a holistic approach such as advocated by proponents of "Smart Growth" is designed to tackle the maximum number of these issues as possible and result in communities with more choices for residents and opportunities to live in areas where the chance to practice health-enhancing behaviors is designed into, not out of, the physical infrastructure of our neighborhoods.

Research has also shown that the design of our communities also involves the preservation (or not) of green space, trees, and vegetated land, which has repercussions for polluted runoff into streams, how hot the urban core becomes on a sunny day, and the availability of parks for residents to have an experience of nature (which in itself has demonstrated health benefits).

This section examines data and trends for Knox County in the light of the increasing body of such knowledge, to provide insight into difficult questions such as "Are the investment we are making in infrastructure the right ones?" and "How is our built environment affecting the health of residents?"

Transportation

As discussed in the section on Outdoor Air, motor vehicle transportation is the largest contributor to poor air quality in Knox County, and to the health effects which result. It also is a safety hazard:

The Knoxville Regional Transportation Planning Organization (TPO) discusses transportation safety issues in section 9 (http://www.knoxtrans.org/plans/lrtp2030/May06/11safety.pdf) of its 2005-2030 Long Range Transportation Plan, along with options to create a safer transportation system. The following statistics related to transportation safety in Knox County were reported:

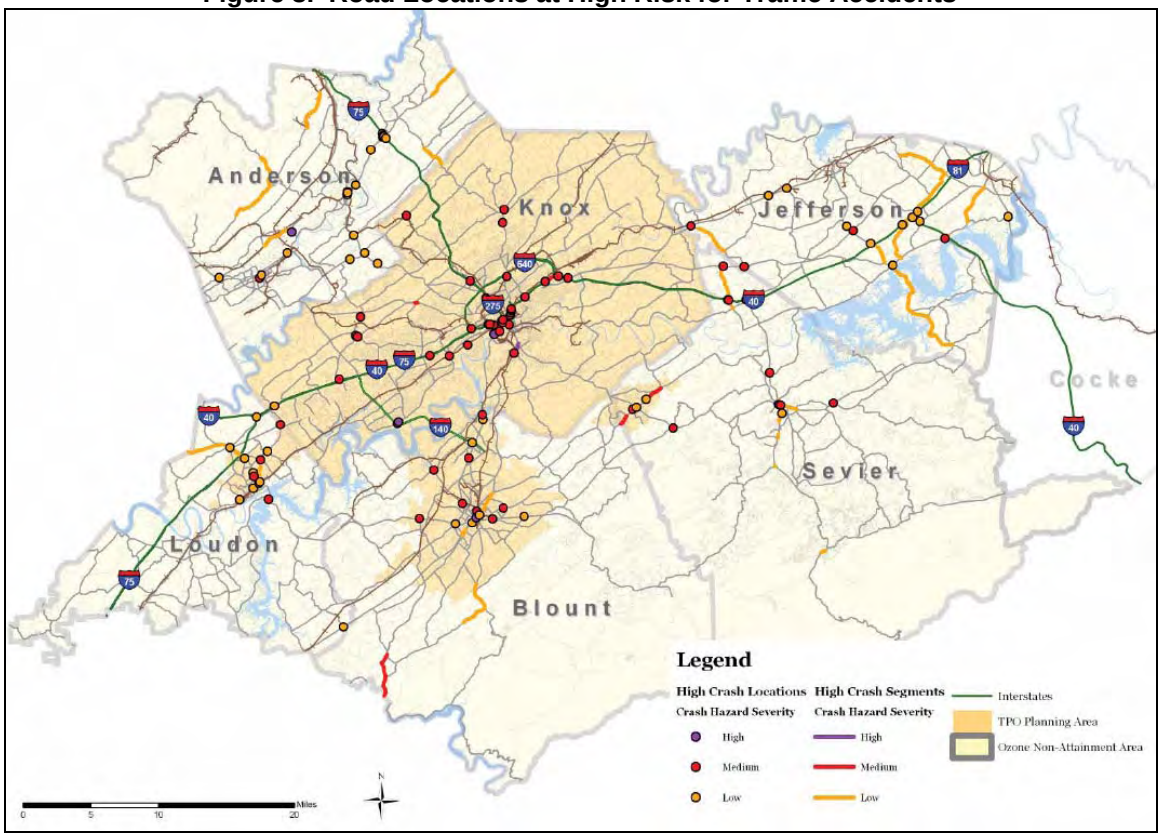
Table 16. Hospital Discharges Involving Motorized Vehicles and Pedestrians or Bicyclists

	Hospital Discharges Involving A Motorized Vehicle and a…	
Year	**Pedestrian**	**Bicyclist**
2000	54	20
2001	36	23
2002	48	24

- There were 17 pedestrian fatalities between 2001 and 2004.
- There were 28 incidents, with six injuries, in Knox County involving highway-rail incidents in the period from January 2000 to September 2004.

The following map illustrates the locations with the greatest traffic safety hazards in recent years, according to the Knoxville Regional TPO:

Figure 8. Road Locations at High Risk for Traffic Accidents



The TPO also has a map of Knox County on its website indicating the 2004-06 traffic counts at a large number of points across the county (http://www.knoxtrans.org/roadway/tc_maps/knox.pdf). Such information is useful for deciding on safe bicycle routes, choosing which intersections need to have stop signs upgraded to traffic lights, or where sidewalks are most critically needed for children walking to school within the zone where bus service is not available. (The scale of the poster-size map precludes its reproduction here, as the numbers would be too small to be legible.)

The TPO's Long-Range Transportation Plan also discusses strategies promoting mass transit use to reduce air pollution (http://www.knoxtrans.org/plans/lrtp2030/May06/12conformity.pdf). While light rail has been promoted by some as part of an overall mass transit strategy for the metropolitan area, the TPO does not believe the population density needed to support a light rail system exists in a wide enough area for the plan to be feasible. Instead, they recommend buses with dedicated traffic lanes or roads of their own, which would keep the bus system moving even in cases where traffic brings the highways to a standstill. Others (see, for example, http://www.knoxtransit.org/) are encouraging development of local light rail in connection with intercity rail and with bus transportation in a more visionary manner. Increasing gasoline prices and the return of residents to the urban core may make such systems increasingly feasible, if these trends continue into the future. In 2003, the state Department of Transportation (TDOT) issued a mostly positive report (http://ww2.tdot.state.tn.us/publictrans/RailPlan/tasks/task11.pdf) on the potential of rail for both freight and passenger service across the state and beyond. Development of such a system would ease highway congestion (reducing traffic accidents), and reduce health-threatening air quality issues.

Sprawling communities, increased traffic flow, increased accidents, increased air pollution, and increased health problems from poor air quality - these factors are increasingly recognized as interrelated. Another set of correlations exists between sprawling communities, lack of exercise, and obesity (with a range of health risks that result).

The Physical Activity – Obesity – Built Environment Connection

There is a widespread recognition that lack of exercise, in addition to our diet, has contributed to an American obesity problem, and the resulting illnesses, from heart disease to increased risks of diabetes and cancer. The statistics are sobering. At our local level:

- Measurement of height and weight from a 2005-06 sample of 7,032 Knox County students found 39.3% of children aged 4 to 15 were either "at risk for overweight" or "overweight." (Note: "overweight" is the highest weight category for children; CDC only uses the term "obese" when referring to adults.)

- The 2005 Knox County Youth Risk Behavior Study (426 respondents) found 31.9% of students aged 16-17 are either "at risk for overweight" or "overweight."

- The 2005-06 Knox County Behavior Risk Factor Study of 3576 adults found (based on self-reported weight and height) 60.7% of adults are overweight or obese.

- Between 2002 and 2005-06, the "overweight or obese" category for Knox County adults increased from 55.6% to 60.7%.

While some of the lack of exercise is by choice, a part is also due to the poor design of our communities. Physical activity can either be recreational or utilitarian. The latter would include walking to school, stores, church, children bicycling to playgrounds or friends' houses, walking to parks, libraries, bus stops, and so forth. As recently as 30 years ago, such behavior was the norm. Now, in many parts of Knox County – and much of America - such behavior would be considered inconvenient, unsafe, impossible, or "downright odd."

A British Medical journal article in 1995 asked the provocative question "Gluttony or Sloth?" and compared, for the period 1950-1990, the correlations between caloric and fat intake and obesity prevalence ("gluttony"), and that between cars per household and TV hours viewed per week and obesity prevalence ("sloth"). The correlation between "sloth" and obesity was far stronger than between "gluttony" and obesity. The take-home message: we need more exercise. Unfortunately, the physical structure of much of our community, with intermittent sidewalks, widely spaced houses on dead-end or cul-de-sac streets – far from shopping, community activities, parks, etc. – does little to facilitate exercise. Much of the remainder of this section will examine how we might address this issue.

Parks and Recreation Centers

Parks and recreation centers provide places where the public can exercise and come together as a community for concerts, picnics, and civic events – or just relax from the stress of daily life. A robust system of parks and recreation centers offers opportunities for exercise and recreational activities from indoor and outdoor sports leagues to quiet walks, bicycle rides to bird watching or fishing. Knoxville and Knox County, while having many fine parks, and despite an increase in park acreage from 2,800 acres (0.8% of land in the county) twenty years ago to 5,700 acres (1.7% of land area) today, needs to do more, as indicated by the following data (reference: MPC and the Trust for Public Land website - (table of acres of parkland as a percent of city area:

http://www.tpl.org/content_documents/ccpe_TotalAcresasaPercentofLandArea.pdf; acres of parks per 1000 residents: http://www.tpl.org/content_documents/ccpe_TotalAcresperResidents.pdf)

Table 17. Relative Parkland Acreages in Various Cities

Location* (City / County)	County** Population	County** Acreage	Parkland Acreage	Percent of Land Area	Acres per 1000 Residents
Knoxville / Knox County	411,967	336,640	5,881	1.75	14
Nashville / Davidson Co.	575,261	321,280	10,200	3.2	18
Memphis / Shelby Co.	909,035	483,200	18,854	3.9	21
Louisville / Jefferson Co. KY	693,604	255,360	14,000	5.5	20
Richmond, VA (city only)	192,494	40,000	1,500	3.8	7.8
Charlotte, NC	771,617	349,440	17,042	4.8	22
Kansas City, MO	444,387	203,520	17,188	11.8	39
Washington, DC	553,523	43,712	7,726	17.7	14
Philadelphia, PA	1,448,394	86,400	9,200	10.7	6.4
New York, NY	8,213,839	206,080	37,008	18.0	4.5

*Data for locations below the double line in the table are not from the MPC but from the Trust for Public Land or websites of the respective cities.
** Some cities (e.g. Kansas City, MO) span multiple counties.

Similar statistics are available for sports and recreational facilities at the Trust for Public Lands website (http://www.tpl.org/tier3_cd.cfm?content_item_id=20531&folder_id=3208). Knoxville is much better positioned in terms of recreational facilities, overall, than in terms of park acreage and preserved green space when compared to other cities. This information is useful in deciding where to invest limited public funds.

Table 18. Availability of Recreational Facilities in Various Cities

Location	Baseball Diamonds per 10,000 Residents	Dog Parks per 100,000 Residents	Golf Courses** per 100,000 Residents	Playgrounds per 10,000 Residents	Soccer Fields per 10,000 Residents
Knoxville*	3.3	0.5	3.2	2.3	1.0
Nashville	1.5	0.5	1.2	1.9	0.3
Memphis	1.7	0.1	1.0	1.5	0.5
Louisville, KY	1.4	0.0	1.3	1.5	0.6
Charlotte, NC	0.5	0.4	0.6	1.1	0.7
Kansas City, MO	3.5	0.2	1.4	2.0	0.6
Washington, DC	1.9	0.2	0.5	1.8	0.5
Philadelphia, PA	0.7	0.3	0.4	1.2	0.2
New York, NY	0.9	0.6	0.2	1.2	0.2

*Includes city and county, except soccer fields are for county only.
** Public courses

Given the above data, one might infer that there should not be an obesity problem in Knoxville compared to, say, New York City, as we are (on a per capita basis) relatively well endowed with a range of recreational facilities. The research into the actual *use* of these facilities, however,

suggests that they are most likely to be used frequently when they are within walking distance of residents' homes – bringing up again the issues of *utilitarian walking and urban design*. A map illustrating the few areas within walking distance of a park or recreation center can be found in Appendix F, courtesy of the MPC. An electronic file of the map (which can be enlarged for printing) can be obtained on request from the Knox County Environmental Epidemiologist.

In autumn 2006 a series of public meetings were held to discuss the need for improved public parks facilities in Knox County. The slide shows presented to the public, as well as public input into the process of planning for the future of Knoxville's / Knox County's parks and recreation system, are online at this website: http://archive.knoxmpc.org/plans/parks/06inventory/index.htm. The final report(s) coming from these meetings have not yet been issued by the MPC.

Greenways

A series of increasingly-interconnected greenways offer both an opportunity for exercise in a pleasant setting and an alternative transportation route via walking or bicycle. Details on the greenway system in Knox County, including maps, can be found at the following links:

- Knox County Greenways: http://www.knoxcounty.org/parks/greenwaytrails.php
- City of Knoxville Greenways: http://www.ci.knoxville.tn.us/greenways/default.asp
- Knoxville Track Club (summarizes future plans to connect greenways and covers the larger metro area as well): http://www.ktc.org/greenway.htm

While the greenways are useful for those interested in commuting by bicycle, they do not typically form a complete route to reach a desired destination. A resource for bicyclists to determine the safest route to their destination are the city and county bicycle maps published by the Knoxville Regional Transportation Planning Organization, available at this link (and by mail on request): http://www.knoxtrans.org/plans/bikeprog/resource.htm

There are currently 44 miles of greenways in Knox County: 31.3 miles within Knoxville city limits, 6.83 miles in Farragut, and 5.85 miles in the remaining areas of Knox County. Including unpaved trails, the total rises to over 60 miles. For comparison purposes, other regional counties have the following mileage of greenways available to residents:

- Mecklenberg Co., NC (Charlotte): 33 miles developed + 147 miles undeveloped trails
- Davidson Co., TN (Nashville): 36.5 in place, over 200 planned
- Hamilton Co., TN (Chattanooga): 50 miles (paved and unpaved)
- Asheville, NC: 6 miles completed, 23 in planning or construction
- Guilford Co, NC (Greensboro): 14 miles paved and 20 unpaved

In addition to offering opportunities for exercise and alternative commuting, greenways along streams or in wetlands areas improve environmental quality by protecting plant and animal habitat. Dedication of sensitive areas, such as flood plains, wetlands and forests, to low impact uses like greenways and parks can help clean our water and air.

The Value of Green Space to the Community

Maintaining green coverage in the county provides environmental services that would otherwise be costly to meet, such as absorption of rainwater that otherwise would cause flooding, reducing air pollution by absorbing some pollutants from the air, absorbing greenhouse gases and "fixing" the carbon in the form of wood, and helping reduce summer cooling costs by shading buildings and reducing the "heat island effect" (in which black surfaces like roads and roofs absorb heat, raising the temperature of urban areas compared to surrounding countryside). It has been

estimated that trees' evaporative cooling could be enough to significantly offset, at least locally, the warming from global climate change (http://environment.newscientist.com/article/dn11862-city-parks-could-cool-urban-areas-by-4c.html), much like perspiration from a person's skin results in cooling.

These benefits were evaluated locally in a 2002 assessment of tree cover in the county performed by the nonprofit group American Forests and the County, and reported in an Urban Ecosystem Analysis (https://www.americanforests.org/downloads/rea/AF_KnoxCounty.pdf). This report estimated that in 2002, local tree cover resulted in the following benefits to the public:

Table 19. Benefits of Tree Cover to the Community

	Tree Canopy (% cover)	Stormwater Managed (cu. ft.)	Value of Stormwater Management ($)	Air Pollution Removed Annually (lbs.)	Value of Air Pollution Removal ($)	Carbon Sequestered Annually (tons)	Total Carbon Stored (tons)
Knox County	52	744,011,728	1,488,023,456	16,575,016	41,249,267	58,399	7,501,293
Knoxville	40	140,088,728	280,177,456	2,391,395	5,951,324	8,425	1,082,264

The above values do not include the value of habitat provided to wildlife, the psychological value of natural features to people, or the value of the physical ailments avoided when children play or adults exercise outdoors in an inviting environment.

Additional findings of the Urban Ecosystem Analysis included:

- Between 1989 and 1999, heavy tree cover (areas with greater than 50% canopy) in Knox County declined by 2.2% (3,262 acres). Areas with under 20% tree canopy (urban and agricultural areas) increased by 9.8% (14,883 acres). The greatest loss of tree cover was in areas with moderate tree cover (20-49% canopy) – areas often representing a mixture of development and natural tree cover. These areas declined by nearly 42% (11,621 acres).

- Knox County is comprised of 174,327 acres of tree canopy (52%), 91,380 acres of open space (27%) 44,019 acres of impervious (paved) surfaces (13%), 15,847 acres of bare ground (5%) and 10,619 acres of water (3%).

- In the city of Knoxville, the dominant land cover features are trees (40%) Impervious surfaces comprise 27%, open space 21%, bare land 7%, and water 5%.

- The City of Knoxville as of 1999 met American Forest's minimum tree cover recommendations, but this status is potentially threatened by further development. American Forests' tree canopy goals are: 40% overall tree canopy, 50% tree canopy in suburban residential areas, 25% tree canopy in urban residential areas, and 15% tree canopy in central business districts.

A survey of 2,400 single-family households in Knox County, conducted by the University of Tennessee in 2005 (http://isse.utk.edu/publications/pdf/Knox_County_Tree_Survey.pdf), found:

> …Knox County homeowners have a positive attitude toward protecting and planting trees, and appreciate the natural environment's contribution to the quality of their lives. There is a high level of appreciation for trees in urban environments and business districts. Most of them have sought out houses that have mature trees because trees

have a personal meaning to them and/or they understand that trees will enhance their property values. Most homeowners value the ability to modify their environment to suit their needs and have removed trees from their property recently, mostly because the trees were dead or diseased. Also, a large number of them feel that the local utility company should do a better job trimming trees near power lines.

Tree canopy conservation is a more cost effective way to maintain the benefits of green infrastructure than tree replacement. Ten or more newly-planted trees are required to replace a mature tree's ecological value. However, where trees have been removed, replanting can be a valuable strategy in conjunction with tree conservation. Knoxville has had a City Tree Board (http://www.downtowntrees.com/treeboard.htm; http://www.ci.knoxville.tn.us/boards/citytree.asp) to make recommendations to local government since the passage of the 1992 Tree Ordinance (http://www.ci.knoxville.tn.us/engineering/ldmanual/LD-ORD14.pdf - the website provides the city ordinance as of 2005). In 2003, Knoxville City Council approved the Street Tree Master Plan (http://archive.knoxmpc.org/plans/treeplan/index.htm), which provides a detailed strategy and goals for maintaining and improving green infrastructure in the city. The MPC on May 10, 2007, adopted the Tree Conservation and Planting Plan:
(http://archive.knoxmpc.org/plans/knoxtree/treeplan_draft.pdf). If approved by Knoxville City Council and Knox County Commissioners, the plan would extend such efforts to the county as a whole, although the current version removes some enforcement provisions in the original draft of the proposed ordinance contained in the document.

Preservation of green space is of benefit to more than just humans. While it might be unexpected, even a predominantly urban / suburban county like Knox County – where the amount of developed land exceeds that of vacant and agricultural land combined - is home to a surprisingly large range of rare or endangered species. As compiled by the state Division of Natural Heritage (http://www.state.tn.us/environment/nh/), the following species are at varying degrees of risk (detailed at their website): 29 vascular plant species, 11 invertebrate animals (predominantly freshwater mussels, which require clean streams to survive), 21 vertebrate animals (7 fish, 2 amphibians, 2 reptiles, 5 birds, and 5 mammals), and 5 other species. It is up to us humans to preserve the habitats that they need to survive, a matter which benefits us directly in many ways as well.

A new not-for profit foundation has been formed with the support of Knox County and the City of Knoxville, called the Legacy Parks Foundation. Its purpose is "…to acquire, develop, maintain, improve, expand, erect, enhance, support, preserve, restore, fund, encourage, and sustain public parks and other recreational facilities operated and owned by the City of Knoxville or Knox County, for the benefit of the general public." Individuals or businesses with parcels of land who may be considering donations of land, conservation easements or greenway easements are encouraged to contact the Legacy Parks Foundation for assistance in these matters (http://www.legacyparksfoundation.org/who.php).

Designing the Community for Health

Given the range of issues discussed in this section, as well as elsewhere in this report, designing a community to promote the health of residents as much as possible would seem an impossible task, given the conflicts between segments of the community. And yet, given the increasingly clear needs to promote exercise, clear the air, etc. there is a definite need for something to be done. A movement to address these issues has arisen as a result, focusing on the basic design principles used in creating a new subdivision or business district, or restoring existing neighborhoods in a manner that promotes health. Various terms such as "the new urbanism" or "smart growth" are used to describe these efforts, but the common threads among these ideas are concepts such as:

- Mix land uses
- Take advantage of compact building design
- Create a range of housing opportunities and choices
- Create walkable neighborhoods
- Foster distinctive, attractive communities with a strong sense of place
- Preserve open space, farmland, natural beauty, and critical environmental areas
- Strengthen and direct development towards existing communities
- Provide a variety of transportation choices
- Make development decisions predictable, fair, and cost effective
- Encourage community and stakeholder collaboration in development decisions

Such concepts as they are implemented create a virtuous cycle of positive reinforcement: People choosing to live within walking distance of mass transit, and using it, cut air pollution. People living near greenspace and walkways get more exercise and improve their health. Downtown businesses are revitalized, as well as neighborhood shopping. There is an increased sense of neighborliness between residents as they meet on the sidewalks, rather than passing in their cars. This leads to an increased sense of emotional investment in their community, with benefits from reduced crime to better property upkeep, resulting in benefits from decreased litter and vermin problems to increased real estate values. Many of the environmental health indicators in this report will directly benefit from the implementation of this vision, as it is in part grounded in an understanding of the need to factor in sustainability in creating the community we will pass down to the next generation.

This process is now underway in Knox County, as we can see with the quickening pace of downtown redevelopment, plans to revitalize a number of urban corridors (see the MPC website to explore in more detail: http://www.knoxmpc.org/), plans to expand parks and greenways, etc.

Additional resources to learn more about this approach to urban revitalization and its benefits for the health of the community can be found at:

- CDC's "Designing and Building Healthy Places" http://www.cdc.gov/healthyplaces/default.htm
- EPA's Smart Growth website http://www.epa.gov/smartgrowth/index.htm
- Smart Growth America http://www.smartgrowthamerica.org/
- PBS report on the New Urbanism http://www.pbs.org/newshour/newurbanism/index.html

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Electromagnetic Field Exposures

A subject of periodic questions to the health department are concerns about the potential health effects of living near electrical transmission lines and broadcasting antennae; more recently similar wariness have been expressed about living near cell phone transmission towers (the concerns in these links are typical: http://www.wired.com/gadgets/wireless/news/2005/08/68600 and http://arts.envirolink.org/arts_and_activism/BlakeLevitt.html). The following discussion summarizes the current scientific consensus on the potential health effects of these aspects of our built environment.

As part of its charter to protect public health and in response to public concern over health effects of electromagnetic field (EMF) exposure, the WHO established the International EMF Project in 1996 to assess the scientific evidence of possible health effects of EMF in the frequency range from 0 to 300 GHz (see: http://www.who.int/peh-emf/project/EMF_Project/en/index.html). This range of frequencies includes those associated with power lines, TV and radio transmissions, wifi computer networks, home appliances, and mobile telephones and their towers. The project is scheduled to release its final report and recommendations in 2007. A number of fact sheets

addressing specific topics and exposures are already available on the WHO website: http://www.who.int/docstore/peh-emf/publications/facts_press/fact_english.htm.

In the United States, the National Institute of Environmental Health Studies (NIEHS) has a program called the EMF RAPID (electric and magnetic fields research and public information dissemination) program to provide the latest information from the scientific community to the public: http://www.niehs.nih.gov/emfrapid/home.htm.

The NIEHS presented a report to congress in June 1999 that there is weak evidence that EMF from power lines may be a possible cause of cancer, in particular leukemia, based on epidemiological studies but not confirmed in laboratory studies. No new regulations or actions were recommended or taken based on the NIEHS report.

The NIEHS did not recommend adopting EMF standards for electric appliances or burying electric power lines. Instead, it recommended providing public information about practical ways to reduce EMF exposure. The NIEHS also suggested that power companies and utilities "continue siting power lines to reduce exposures and . . . explore ways to reduce the creation of magnetic fields around transmission and distribution lines without creating new hazards." The NIEHS encouraged manufacturers to reduce magnetic fields at a minimal cost, but noted that the risks do not warrant expensive redesign of electrical appliances. NIEHS also encourages individuals who are concerned about EMF in their homes to check to see if their homes are properly wired and grounded, since incorrect wiring or other code violations are a common source of higher-than-usual magnetic fields.

These findings have been confirmed by scientific panels reporting to various governments, the National Academy of Sciences in the US, and the WHO. The connection between power lines and leukemia remains weak at best, with the evidence described using phrases like as “inconclusive,” “weak,” or “unproven.”

With cell phones, the sources of exposure include the base tower and the cell phone itself. The energy in radiation rapidly falls off with distance from the source, and the location of a cell phone next to one’s head has lead to concerns that it may be a cause of brain cancer. The Food and Drug Administration is currently (as of 3/2006) funding the National Academy of Sciences to investigate possible health effects of cell phone use: http://www.fda.gov/cellphones/. Regarding cell phones, the Food and Drug Administration says (http://www.fda.gov/cellphones/qa.html#8):

> The available scientific evidence does not show that any health problems are associated with using wireless phones. There is no proof, however, that wireless phones are absolutely safe. Wireless phones emit low levels of radiofrequency energy (RF) in the microwave range while being used. They also emit very low levels of RF when in the stand-by mode. Whereas high levels of RF can produce health effects (by heating tissue), exposure to low level RF that does not produce heating effects causes no known adverse health effects. Many studies of low level RF exposures have not found any biological effects. Some studies have suggested that some biological effects may occur, but such findings have not been confirmed by additional research. In some cases, other researchers have had difficulty in reproducing those studies, or in determining the reasons for inconsistent results.

On a visceral level, concern about health effects from man-made features in the environment like power lines and cell phone towers may also reflect general concerns about the effects humans are having on the environment. It also may reflect a perception of a decision-making process that allows such features to be placed with disregard for obtaining the informed consent of residents most immediately affected by such features. Interpreted this way, when such concerns surface (and this point is not limited to power lines or cell phone towers), it should be taken as a “canary in the coal mine” that citizens do not see themselves as having a voice in the processes affecting

the built environment in which their families live. In that regard, the concerns of a subdivision in Farragut about power lines and cell phone towers bear a similarity to environmental justice issues in poor, heavily-industrialized areas.

Our sense of the environment where we live is a deeply personal matter, the ultimate ramifications of which spread beyond a strict definition of environmental health to encompass broad swaths of the political issues of how we govern ourselves and the ethical issues of how we physically embody our values in our built communities and what we preserve for future generations.

8 - Occupational Health and Safety

Most adults spend roughly a third of their day at the workplace, and injuries, illnesses, and fatalities associated with one's occupation can be a major environmental health influence in a person's life. Since such statistics are collected by the Department of Labor rather than the CDC, we typically compartmentalize our thinking about such exposures as somehow not a concern of "public health." As a result, the available labor statistics on these topics less readily lend themselves to the traditional tools of epidemiology and public health. The following discussion is offered in the spirit decompartmentalizing our thought and expanding consideration of "environmental health" to include occupational health and safety, even if the reported data at the county level is meager.

In Tennessee, employers are required to report fatalities, catastrophes (three or more employees hospitalized from one incident), and mechanical power press accidents to TOSHA. Requirements apply to both private and public sector employers; public employers are required to report within eight hours the death of any employee from a work-related incident or the in-patient hospitalization of three or more employees as a result of a work-related incident. TOSHA also conducts workplace inspections and evaluates both health and safety compliance with applicable laws.

Health compliance officers trained in industrial hygiene evaluate workplaces for chemical, physical and biological hazards. They monitor and analyze occupational health conditions in the workplace to detect the extent of exposure versus limits listed in the TOSHA regulations (reference: http://www.tennessee.gov/labor-wfd/tabz1a.html) and the engineering and other methods (work practices and personal protective equipment) needed to control these hazards. Safety compliance officers conduct approximately 1,400 inspections statewide annually. Both the health and safety programs conduct training and outreach programs as well as enforce laws and regulations.

Workplace injuries, illnesses, and fatalities are not reported for Tennessee at the county level, as rates are often too low at that geographic scale for data to be statistically significant, especially for comparing year-to-year trends. Also, data at the local level are far more affected by plant openings and closings than data for the state as a whole. However, some limited information is available. While there are typically about 140 work-related fatalities in Tennessee annually, there are fortunately only about 5 or so in Knox County, limiting the inferences that can be made from such low numbers. For workplace-related illnesses and injuries, the comparable figures at the state level are typically about 8,000 illnesses and 100,000 injuries per year (2003-05 rates).

Those interested in further investigating this subject online might find the following resources useful:

- Statistical data on workplace injuries, illnesses, and fatalities at the state level are accessed through this OSHA website: http://www.bls.gov/iif/oshstate.htm#TN

- Information on safety incidents at a specific workplace is available using this search feature at the OSHA website: http://www.osha.gov/pls/imis/establishment.html

- The most recent (2003) annual report from TOSHA, the *Census of Fatal Occupational Injuries and The Occupational Injuries and Illnesses Survey,* is available online at: http://www.tennessee.gov/labor-wfd/census2003.pdf

- Additional statistical insights at the statewide level into workplace injuries, illnesses, and fatalities can be gleaned from information collected by the Worker's Compensation program. The annual reports of the Workers' Compensation Advisory Council provide a summary of this data: http://www.state.tn.us/labor-wfd/wcac/reports.htm

Heat Stress and Heat Stroke

Exposure to excess heat, especially for those whose work requires them to spend the hottest hours of the day outdoors, is a summertime environmental risk to public health in east Tennessee. When the body is unable to cool itself by sweating, several heat-induced illnesses such as heat stress or heat exhaustion and the more severe heat stroke can occur, and can result in death.

Factors leading to heat stress include: high temperature and humidity; direct sun or heat; limited air movement; physical exertion; poor physical condition; some medicines; and inadequate tolerance for hot workplaces. Anyone planning to spend time outdoors in the heat of summer should be familiar with the following symptoms:

Symptoms of Heat Exhaustion:

- Headaches, dizziness, lightheadedness or fainting.
- Weakness and moist skin.
- Mood changes such as irritability or confusion.
- Upset stomach or vomiting.

Symptoms of Heat Stroke:

- Dry, hot skin with no sweating.
- Mental confusion or losing consciousness.
- Seizures or convulsions.

When spending time in the heat and sun, monitor yourself and coworkers. The following additional steps can be helpful as well:

- Block out direct sun or other heat sources.
- Use cooling fans/air-conditioning; rest regularly.
- Drink lots of water; about 1 cup every 15 minutes.
- Wear lightweight, light colored, loose-fitting clothes.
- Avoid alcohol, caffeinated drinks, or heavy meals.

If someone appears to have the symptoms described above, Call 911 (or local emergency number) at once. While waiting for help to arrive, take the following actions:

- Move the person to a cool, shaded area.
- Loosen or remove any heavy clothing.
- Provide cool drinking water.
- Fan and mist the person with water.

Fortunately, given the medical resources of an urban area, heat-related deaths are rare in Knox County. There were four heat-related deaths in the years 1990-2004, one each in 1990, 1995, 1996, and 2004.

Those interested in additional information on this topic may want to visit the following websites:

- http://www.cdc.gov/niosh/topics/heatstress/
- http://www.bt.cdc.gov/disasters/extremeheat/heat_guide.asp

9 - Outdoor Air Quality

The CDC document "Healthy People 2010" sets national goals for a wide range of health criteria. In the section of its section on environmental health that deals with outdoor air quality, the following four objectives are identified; action on all of these objectives is underway in Knox County, as discussed in this section.

- Reduce harmful air pollutants
- Promote use of alternative modes of transportation
- Promote use of cleaner alternative fuels
- Reduce levels of airborne toxins

Outdoor air quality has a direct effect on heath at the widest level in our community. Poor air quality contributes to respiratory and cardiovascular disease, cancer, overall mortality, and perhaps even birth defects. The landmark Clean Air Act (CAA) of 1970 and subsequent amendments were passed to address these health threats. The EPA established regulations controlling two groups of air pollutants, called *criteria pollutants* and *air toxics*. Both are discussed below.

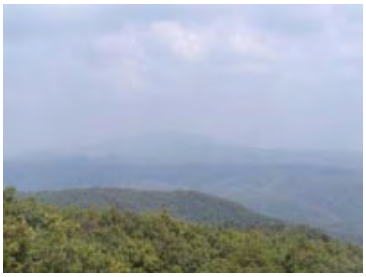
Criteria pollutants are six common air pollutants found across the nation. They are particle pollution (particulates or particulate matter), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. Of these, particulates and ozone are most commonly health threats.

Ground-level ozone and airborne particles are the two pollutants that pose the greatest threat to human health in this country. Ozone, also known as smog, can irritate the respiratory system, causing coughing, throat irritation or a burning sensation in airways. It can reduce lung function, cause a feeling of chest tightness, wheezing, or shortness of breath. Ozone can aggravate asthma and trigger asthma attacks. People at greater risk from ground-level ozone are people with lung diseases, such as asthma, and children and adults who are active outdoors.

Particulates are microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems. When exposed to these small particles, people with heart or lung diseases and older adults are more at risk of hospital and emergency room visits or, in some cases, even death from heart or lung disease. Even healthy people may experience temporary symptoms from exposure to elevated levels of particulates. Symptoms may include irritation of the eyes, nose and throat; coughing; phlegm; chest tightness; and shortness of breath. At greatest risk from particle pollution are people with heart or lung disease, older adults (possibly because they may have undiagnosed heart or lung disease), and children.

Particulates contribute to the "haziness" we see in the summer air. The effect of particulates on visibility at Look Rock in Great Smoky Mountains National Park can be checked on a real-time basis at the website http://www2.nature.nps.gov/air/webcams/parks/grsmcam/grsmcam.cfm:

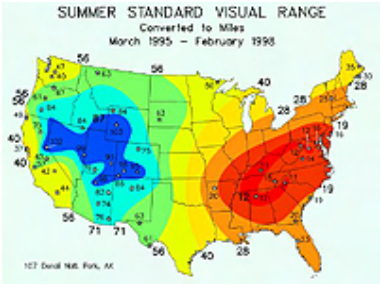
Figure 9. Good and Poor Air Quality Days, Seen From Look Rock



(Images from East Tennessee Regional Clean Air Coalition website: http://www.etnrcac.org/resource.htm)

Fortunately, levels of these pollutants are greatly reduced from what was common fifty years ago. EPA periodically reviews emission limits and, based on the latest information, tightens criteria. However, depending on local conditions, concentrations can still rise to an unhealthy level at times. Knox County lies in a valley between the Smoky Mountains to our east and the Cumberland Plateau to our west; this topography acts like a bowl in which air sometimes lies stagnant, accumulating pollutants. The presence of major highways through our community adds pollutants which can react with sunlight to form ground-level ozone and particulates, especially in the summer (the chemical reactions involved generate smog more quickly at warmer temperatures). Some of the air toxics (discussed below) can also react to form smog, and even compounds emitted by the trees can contribute to a background level of haze even in the total absence of human activity. For these reasons, the Southeast is prone to summer smog (see figure)

Figure 10. Summer Visibility



To inform the public on a daily basis of the health threat posed by air pollution, EPA and several partners have established an Air Quality Index (AQI) that is often included in local weather reports and which can be accessed from the AirNOW website: http://www.airnow.gov.

The Air Quality Index (AQI) and the Air Quality System (AQS)

Several times each day, ambient measurements of the concentrations of criteria pollutants such as ozone (O3), sulfur dioxide (SO2), carbon monoxide (CO), and particulate matter (PM2.5, PM10) are collected from a network of national, state, and local air monitoring stations. These data are used to create the Air Quality Index (AQI). The AQI is used to report daily air quality based on levels of the criteria pollutants. It has a scale of 0 to 500 and is categorized into the following six groups:

Table 20. Air Quality Index Values and Expected Health Effects

AQI Index Values	Levels of Health Concern	General Health Effects
0–50	Good	No health effects for the general population.
51–100	Moderate	Few or no health effects for the general population.
101–150	Unhealthy for Sensitive Groups	Some health effects may be experienced by sensitive people (e.g., children and adults who are active outdoors or have respiratory disease).
151–200	Unhealthy	Mild health effects among susceptible people, with irritation symptoms in the healthy population.
201–300	Very Unhealthy	Significant health effect symptoms and decreased exercise tolerance in persons with heart or lung disease; widespread symptoms in the healthy population.
301–500	Hazardous	Early onset of health effects for certain diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy persons. At AQI levels above 400, premature death of ill and elderly persons may occur. Healthy people experience adverse symptoms that affect normal activity.

The intervals on the AQI scale indicate the level of air pollution and are related to the potential health effects of the daily concentrations of each pollutant. An AQI of 100 generally corresponds to the maximum level allowed under the CAA; when an AQI level of a pollutant is over 100, the

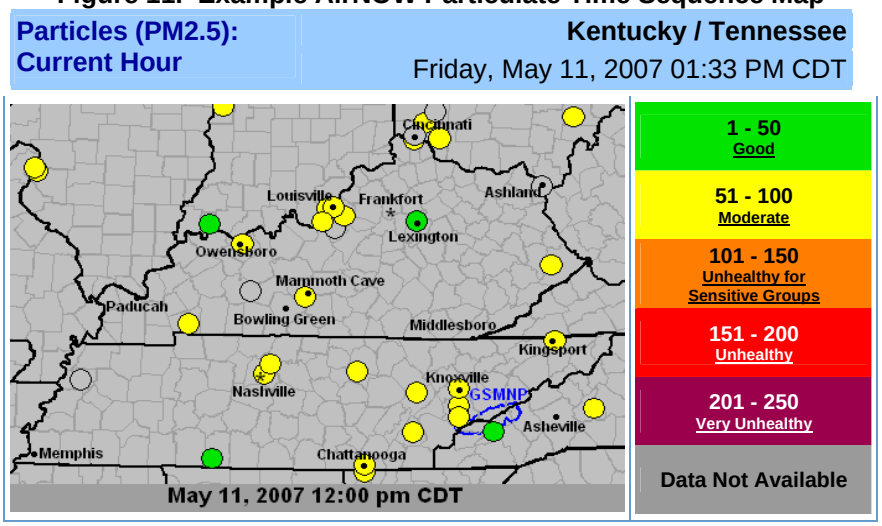
level of that pollutant is in the unhealthy range. The EPA determines the AQI value on a daily basis for each pollutant. The highest individual pollutant AQI score for each major metropolitan area is reported as the daily AQI score for that area and the pollutant with the highest AQI value is identified. For example, if the EPA reports an AQI level of 90 for O_3 for a given metropolitan area, this indicates that the O_3 level in that area is at the high end of the moderate range and that O_3 has the highest AQI reading of all pollutants on that day.

It is important to keep in mind that the AQI readings are *not* taken directly along interstate highways (see map of sampling stations, Appendix G), and thus the reported data for the county are *representative* readings, not *worst-case* data. Research by EPA indicates that most of the particulate matter from traffic on interstates are deposited in the first few hundred yards from the highway, and an 8-year study by the University of Southern California reported in the medical journal *The Lancet* in 2007 found that "Local exposure to traffic on a freeway has adverse effects on children's lung development, which are independent of regional air quality, and which could result in important deficits in attained lung function in later life." Before facilities like schools are sited along highways, a risk assessment taking local winds and topography into account should be performed. A growing body of medical literature is defining these risks more clearly and may well influence community design and zoning in the future. (Reference: http://media.sacbee.com/smedia/2007/01/26/17/lancet_gauderman_etal_traffic1.source.prod_affiliate.4.pdf)

The EPA's Air Quality System (AQS) database contains measurements of concentrations from AQI determinations at sites in all 50 states, plus the District of Columbia, Puerto Rico, and the Virgin Islands. These data can be viewed in maps demonstrating the increase and decrease in pollutions levels over a day, or historical data can be accessed to evaluate trends over time. The following websites provide additional information on this resource; a sample of the information available at the AirNOW website is provided on the following page:

- Additional information on the AQI is available at http://www.airnow.gov
- Additional information on the AQS is available at http://www.epa.gov/air/data/aqsdb.html
- The complete AQS data set can be accessed at http://www.epa.gov/air/data/index.html

Figure 11. Example AirNOW Particulate Time Sequence Map



To protect public health and the environment, National Ambient Air Quality Standards (NAAQS) have been established. Areas of the country where air pollution levels persistently exceed the NAAQS may be designated "nonattainment."

On December 12, 2003, County Mayors from Anderson, Blount, Cocke, Grainger, Hamblen, Jefferson, Knox, Loudon, Roane, Sevier and Union Counties signed into and created the Regional Clean Air Coalition (RCAC), agreeing to coordinate efforts to improve air quality throughout the region. The RCAC consists of committees formed by representatives from government, business and industry, educational institutions and the general public throughout the multi-county Knoxville region collectively focused on creating, promoting and implementing strategies to improve air quality. The RCAC advises and educates government, business and industry, educational institutions and the general public on air quality issues; promotes coordination and communication within the region and ensures that TDEC and other interested agencies remain involved in air quality actions throughout the region; assists and advises government in determining, implementing and administering voluntary and mandatory control measures to improve air quality; and advises state departments and legislators to draft and enact legislation that improves air quality. Their website is: http://www.etnrcac.org/. From the RCAC website:

On April 15, 2004 the EPA designated several areas throughout the country as non-attainment for air quality. These areas have ozone and PM 2.5 levels higher than allowed under EPA's NAAQS standard. The standard is designed to protect the public from exposure to unhealthy pollutants.

In the Knoxville region, the counties designated non-attainment for ground level ozone include Anderson, Blount, Jefferson, Knox, Loudon, Sevier and that portion of Cocke County within the Great Smoky Mountains National Park. These counties were categorized as basic non-attainment areas and will have to comply with more general non-attainment requirements in the CAA. Counties designated as non-attainment for PM 2.5 include Knox, Loudon, Anderson, Blount, and a portion of Roane. These counties must meet attainment for ground level ozone by June 2009 and for PM 2.5 by April 2010.

In Knox County, the Air Quality Management Department has the primary responsibility to achieve and maintain NAAQS, for all criteria pollutants designed to protect health and welfare, as set by local and federal law. This is accomplished through continuous monitoring of the ambient air to determine air quality levels; issuance of health alerts concerning air quality; permitting of industrial air contaminant sources; review of industrial source testing, computer modeling of air pollution dispersion; and air toxics evaluation and control. The department also performs compliance and complaint investigations, issues residential open burning permits and provides technical and educational services. Contact information for Air Quality Management is: Address - 140 Dameron Ave, Suite 242, Knoxville, TN 37917. Phone - 865-215-5900, fax: 865-215-5902, Air Info Line - 865-215-5925. Their website (which includes public notices and upcoming public hearings) is http://www.knoxcounty.org/airquality/.

Healthy People 2010 goals for reducing criteria air pollutants are:

- By 2010, 100% compliance with CAA requirements for carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead.
- By 2012, 100% compliance with CAA requirements for ground-level ozone.
- By 2018, 100% compliance with CAA requirements for particulate matter.

To date, the first objective has been achieved for Knox County. Efforts to address the second and third objectives are discussed later in this section.

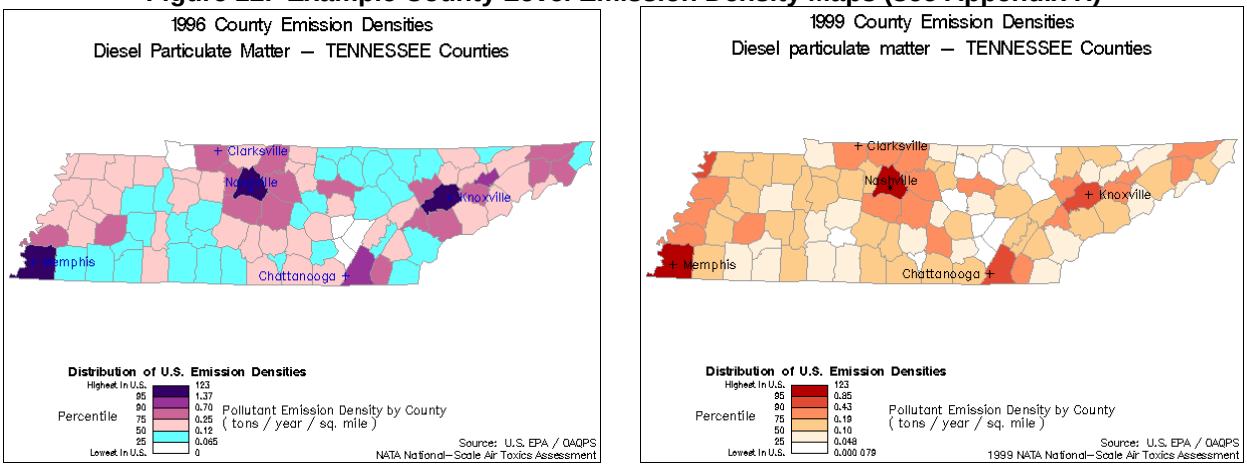
For the years 1996-2006, Knox County failed to meet CAA requirements for ozone in all years except 2004. For particulate matter (2.5 micron particle size) in the years 1999-2006 (no data are available prior to 1999), Knox County failed to meet criteria every year. While trends have been positive, improvements leveled off in 2005-2006, and with the hot, dry weather in summer 2007 air quality degraded compared to the previous two years. (Air quality for ozone was "unhealthy"

on August 15 and 16, 2007, for example.) See Appendix G for detailed data on Knox County performance against CAA requirements.

Air Toxics are 188 specific chemicals listed in the CAA as hazardous air pollutants (HAPs) which must be monitored and reported by industrial firms due to the potential threat they pose to human health and the environment. As part of EPA's National Air Toxics Assessment (NATA), in 1996 EPA evaluated 32 of these compounds and diesel particulate emissions by 1) compiling a national air emissions inventory, 2) estimating ambient concentrations of air toxics at the county-level, 3) estimating the average exposures of the populations of each county, and 4) using these results to calculate public health risks (from cancer and non-cancer effects). To date, EPA has also released an expanded inventory of 178 parameters (177 pollutants and diesel emissions) for the years 1999 and 2002. Details of the emissions inventories can be found at: http://www.epa.gov/ttn/atw/nata/

The maps in Appendix H illustrate the Pollutant Emission Density (tons / year / sq. mi.) for each county in the US, with the degree of shading corresponding to the percentile ranking of the county. The maps illustrate data for roughly half of the 178 parameters in the 1999 inventory (EPA did not post maps for all compounds on line, only those where at least one census track nationally had an elevated cancer risk from the compound in question), and the corresponding 1996 maps for comparison, where available. (Note that the quantitative scales for the two maps differ, so they can only be used to indicate relative levels of emissions in Knox County versus other counties). Discussion of the uses and health effects of each of the reported compounds in the charts is provided in Appendix I.

Figure 12. Example County Level Emission Density Maps (see Appendix H)



As indicated in the discussion above, EPA has combined county-level emission data (available from the EPA website) with population data (from the US census) and chemical-specific information on cancer and non-cancer health effects to generate maps that illustrate estimated risks from different chemicals at the census-tract level. (A census tract is a much finer level of detail than the county-level, and would correspond to part of a zip code area.) The following maps of overall cancer and non-cancer health risks for Knox County census tracts (based on the 1999 NATA data) resulted from this process. (Census tracts can be identified in Appendix A.) The note in the lower left of each figure is "Data shown are estimates and do not support neighborhood comparisons." The data are not strictly comparable over time, as there were slight sampling and analytical changes between the two inventories. ***Per EPA, the intent of these maps is not to quantitatively compare neighborhoods or regulate specific facilities, but rather to identify areas for further investigation and prioritize tasks based on which compounds are posing the greatest threat to the community.*** The Knox County Air Quality Management division (KCAQM) and the KCHD are currently implementing a program to conduct

more in-depth risk assessments using EPA data and software, but the details are beyond the scope of this report. The KCHD environmental epidemiologist may be contacted for additional information, if desired. Data limitations and supported uses are discussed in greater detail in Appendix H.

Cancer Risks from HAPs

The Clean Air Act has a health protective guideline that exposure to a pollutant should not cause more than a one-in-a-million risk of cancer. However, for several air toxic compounds, emissions exceed this risk in Knox County, primarily due to diesel emissions. In fact, the risk posed to all citizens of Knox County from diesel emissions is over 100 times the recommended limit (1 in 10,000 is 100 times 1 in 1,000,000). Diesel emissions contribute 80% of the added cancer risk in Knox County. The cancer risk from other HAP chemicals is one to two orders of magnitude less:

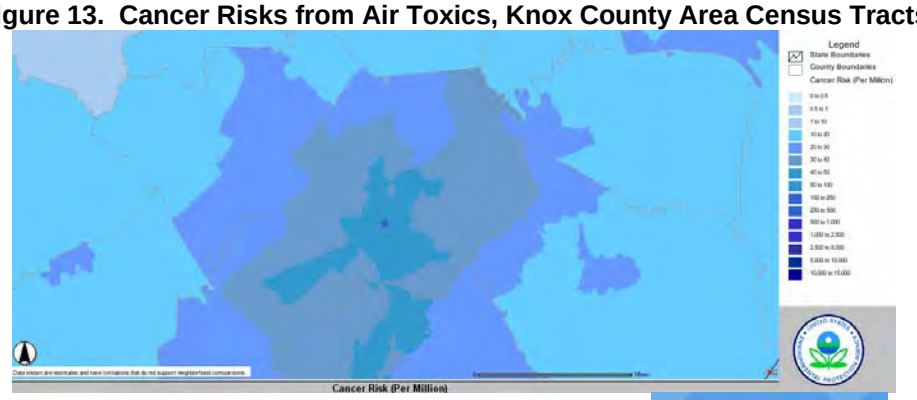
Table 21. Hazardous Air Pollutants of Greatest Concern in Knox County

Hazardous Air Pollutant (HAP)	HAP-Specific Cancer Risk (per million)	% Contribution to Added Cancer Risk	% of Population at Over 1 in 10,000 Risk
Diesel Emissions	560	80	100
Benzene	48	7	1
Carbon Tetrachloride	37	5	<1
1,3-Butadiene	20	3	<1
Chromium Compounds	9.5	1	<1
Polycyclic Organic Matter	9.5	1	<1
Formaldehyde	6.9	1	<1
Acetaldehyde	2.3	<1	<1
Tetrachloroethylene	1.6	<1	<1
1,2-Dichloroethane	1.3	<1	<1
1,3-Dichloropropene	1.2	<1	<1

Source: EPA Toxic Release Inventory

The following map indicates the relative distribution of cancer risks, by census tract. Risks are concentrated along major transportation arteries, and in older, industrialized areas where a higher proportion of residents are poor or minorities, which may contribute to health disparities:

Figure 13. Cancer Risks from Air Toxics, Knox County Area Census Tracts



Right: Enlarged portion of map above (central Knox County)

Non-Cancer Hazards from Air Toxics

For non-cancer health effects, a "hazard index" instead of a "risk factor" is calculated by comparing the concentration of a pollutant to its "reference concentration" (safe exposure level). If the hazard index is greater than one, non-cancer health effects may occur. These effects differ by chemical; a description of the health effects of chemicals in this report is given in Appendix I.

Table 22. HAPs with Non-Cancer Effects of Greatest Concern in Knox County

Hazardous Air Pollutant (HAP)	HAP-Specific Hazard Index	% Contribution to Total Hazard Index	% of Population with Hazard Index Over 1
Acrolein	1.9	65	97
Diesel Emissions	0.38	13	1
Formaldehyde	0.38	13	<1
Acetaldehyde	0.093	3	<1
Benzene	0.028	1	<1
Carbon Tetrachloride	0.023	1	<1
Nickel Compounds	0.013	<1	<1
Toluene	0.012	<1	<1
Beryllium Compounds	0.010	<1	<1

Source: EPA Toxic Release Inventory

The following maps indicate relative distribution of non-cancer risks, by census tract. Respiratory risks are concentrated along census tracts near major transportation arteries, as acrolein and formaldehyde (from burning gasoline) and diesel emissions are the major components of the hazard. Neurological risks are slightly elevated only in selected census tracts in the urban core. Information of this type provides a first-pass risk estimate to direct future risk assessments performed by KCAQM and the KCHD:

Figure 14. Non-Cancer Air Toxics Respiratory Risk (area-wide and central-county views)

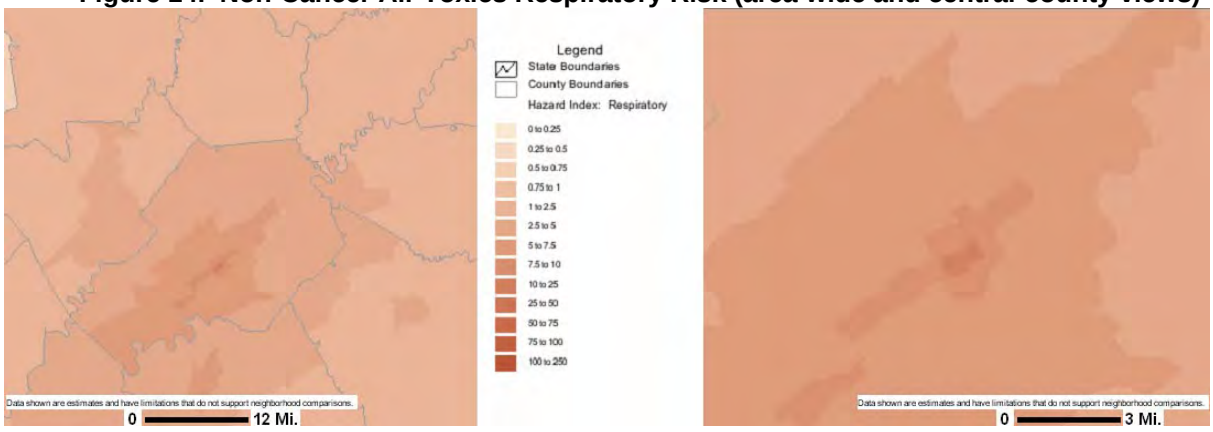
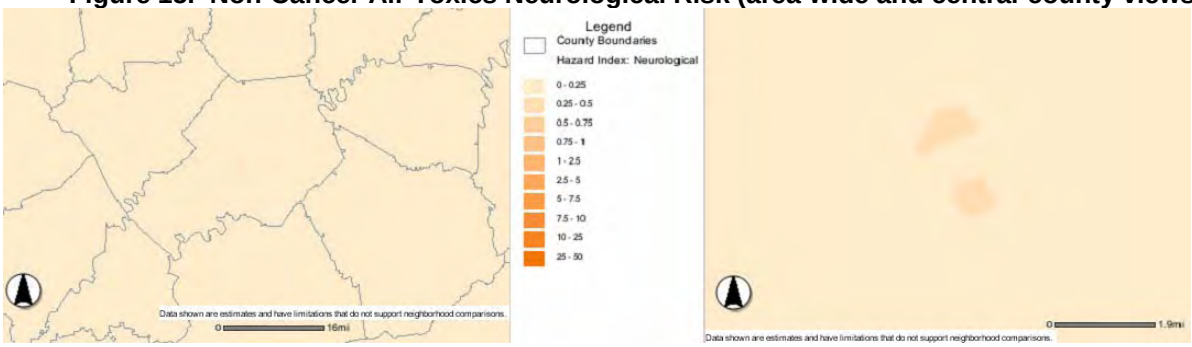


Figure 15. Non-Cancer Air Toxics Neurological Risk (area-wide and central-county views)



Healthy People 2010 goal for reducing hazardous air pollutants is:

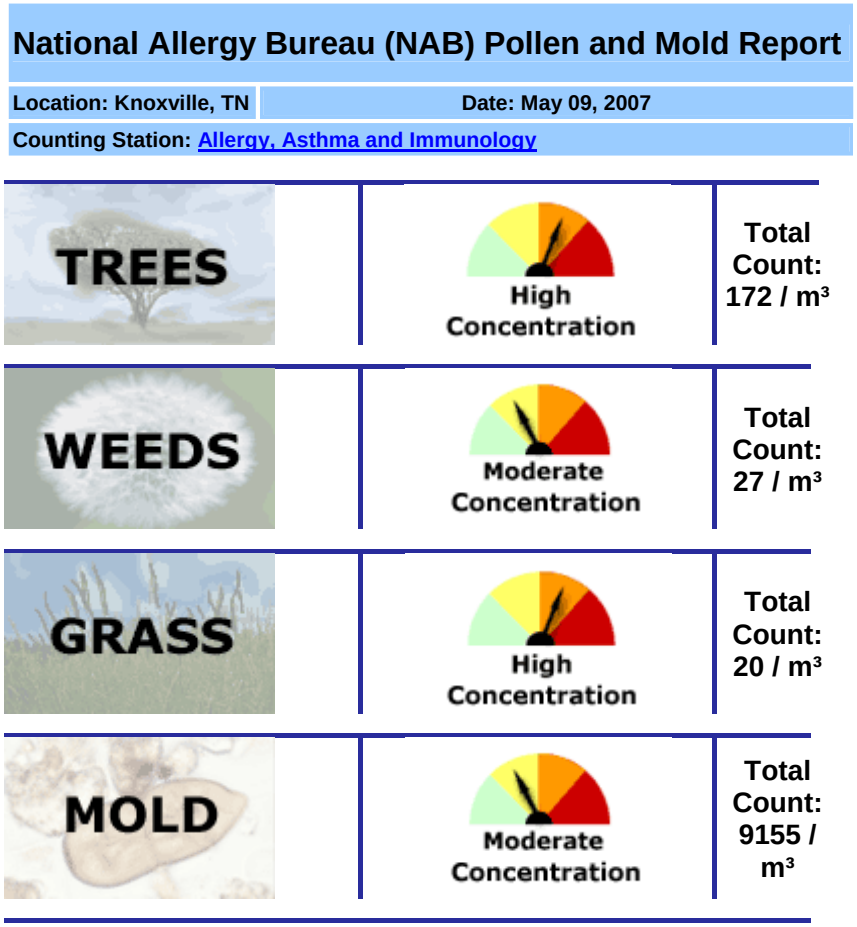
- By 2010, reduce emissions of hazardous air pollutants by 75%.

It is difficult to monitor progress on this objective for Knox County due to the time delay before EPA releases TRI data. Nationally, many firms are adopting "green chemistry" goals to reduce both air emissions and the hazard that would be created by a terrorist attack on a chemical facility. Lacking timely emissions data, Knox County is following EPA and CDC encouragement to use risk assessment as part of the monitoring process for firms releasing air toxics. The KCHD and KCAQM are initiating a program to quantitatively evaluate health risks posed by major emitters using EPA risk assessment software.

Health Effects of Allergens

Regulated air pollutants are not the only environmental contributors to health problems. Many in East Tennessee suffer from seasonal allergies. The pollen and mold that triggers allergies can aggravate the symptoms of asthma as well. Depending on the individual and the conditions where they live and work, natural irritants like pollen can be as or more important than poor air quality from ozone and/or particulates. An on-line resource for tracking pollen and mold levels is available from the American Academy of Allergy, Asthma and Immunology (**www.aaaai.org**):

Figure 16. On-Line Allergen Report for Knox County Area



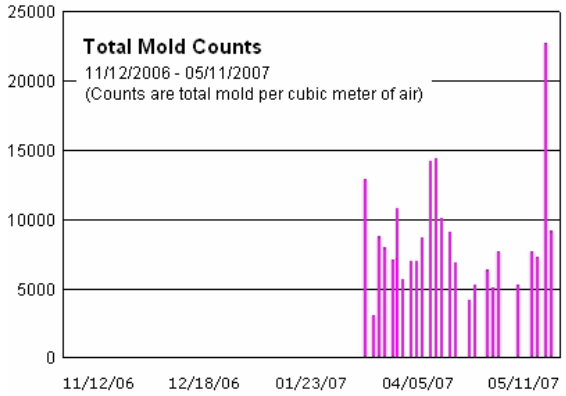
Information on the specific pollen types is provided for each category above, so individuals with a known sensitivity to a specific allergen (say, pine pollen) can monitor whether the particular allergen of concern to them is prevalent in the air. **[NOTE: Indoor mold is a separate consideration from outdoor mold levels. See the Indoor Air section for a discussion of this problem.]** For example, on the date above, for trees:

Figure 17. Detailed Allergen Breakdown

Trees	
Oak (*Quercus*)	88 / m³
Poplar, Cottonwood, Aspen (*Populus*)	36 / m³
Walnut, Butternut (*Juglans*)	14 / m³
Hickory, Pecan (*Carya*)	11 / m³
Mulberry (*Morus*)	9 / m³
Pine Family with air bladders (*Pinaceae*)	7 / m³
Maple, Box elder (*Acer*)	7 / m³
TOTAL	**172** m³

Graphs of data up to the past 180 days may be viewed (Note that in the winter, data may not be reported.):

Figure 18. Graph of Historical Allergen Data



The NAB suggests the following scale for interpretation of pollen and mold counts to determine the relative level of allergens present. Additional details on the development and interpretation of the ranges are given at the NAB website: http://www.aaaai.org/nab/index.cfm?p=reading_charts

Figure 19. NAB Scale of Allergen Level Severity

* MOLD		GRASS		TREE		WEED	
0	Absent	0	Absent	0	Absent	0	Absent
1 – 6499	Low	1 – 4	Low	1 - 14	Low	1 – 9	Low
6500 – 12999	Moderate	5 – 19	Moderate	15 - 89	Moderate	10 – 49	Moderate
13000 – 49999	High	20 - 199	High	90 - 1499	High	50 – 499	High
>50000	Very High	>200	Very High	>1500	Very High	>500	Very High

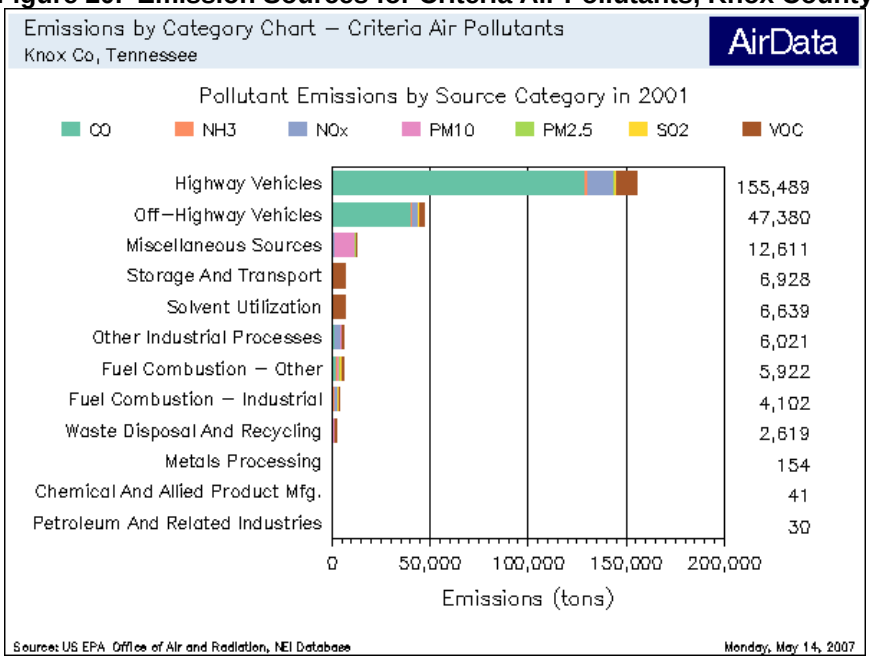
**These mold levels were determined based on outdoor exposure to natural occurring spores in the environment and should not be applied to indoor exposure which may represent an entirely different spectrum of spore types.*

The above pollen and mold count information and graphics are provided through the courtesy of the National Allergy Bureau and its participating station in Knoxville, TN.

Improving Air Quality

While industrial firms are among the most visible sources of air toxics (specific chemicals associated with health risks), there are other important sources of air pollutants. In particular, diesel emissions from vehicles and off-road equipment also contribute to health risks. And when the criteria pollutants that contribute to smog (and its respiratory and cardiovascular health effects) are considered, a different picture emerges (below).

Figure 20. Emission Sources for Criteria Air Pollutants, Knox County



(2001 data is the most recent available from EPA: http://www.epa.gov/air/data/emcatbar.html?co~47093~Knox%20Co%2C%20Tennessee)

Use of biodiesel, truck stop electrification, carpooling, riding the bus, properly maintaining vehicles, buying fuel-efficient vehicles and combining trips are all actions individuals and the community have taken to address the largest emission source in Knox County. There is a role for everyone to play in clearing the air: citizens, industry, private organizations, and the government.

Healthy People 2010 goals for improving air quality are:

- By 2010, increase use of cleaner alternative fuels from 2.7% (1997 level) to 30%.
- By 2010, increase trips made by bicycling from 0.9% (1995 baseline) to 1.8%.
- By 2010, increase trips made by walking from 5.4% (1995 baseline) to 10.8%.
- By 2010, increase trips made by transit from 1.8% (1995 baseline) to 3.6%.
- Encourage the use of telecommuting (no numerical goal).

These goals are discussed below, and (for bullets 2, 3, and 4) in the section on Land Use and Community Design.

Personal Steps to Improve Air Quality

In their personal lives, residents can take a number of steps in order to improve air quality and protect the public – and their personal – health. Both long and short term actions can help to improve regional air quality.

Long-Term: Since many of the air toxics emissions are actually precursors (things that react with and/or catalyze into the pollutants which have a negative environmental and health effects), lower quantities of these emissions yield lower concentrations of reaction- or catalyst-generated pollution. Proactive steps to *change behaviors that produce the emissions even on days of acceptable air quality* is, therefore, an investment toward improving air quality for the long-term future.

Short-Term: Individuals and corporations especially need to do their part on days when the quality of the air has degraded to the point that acute health effects in the community result. The cumulative effects and regional spread of pollutants may be reduced by taking the minimal (and ostensibly temporary) approach. Since even small reductions in emissions help in improving air quality, helping to stabilize the negative environmental and health effects during air alert day can contribute to better air quality in the short-term future.

Steps At Home

- When doing yard work, try to use hand-powered or electric lawn care equipment whenever possible. Use lawn rakes, non-motorized push mowers, hand edger's, and other hand tools. Delay the mowing of the lawn and trimming until cooler and cloudier days. If you must use gas-powered equipment, wait until after 6 p.m. or closer to dusk. Compost your yard wastes.

- Try to use simple environmentally sound substitutes for cleaning and for pest control (*e.g.* , vinegar, baking soda, and borax). Use all household products and insecticides according to the manufacturer's directions.

- When you barbecue with charcoal, start the charcoal with an electric or chimney-type fire starter instead of using lighter fluid.

- Insulate your home: It will reduce summer cooling costs and winter heating bills. Caulk and weather-strip your doors and windows.

- Use your ceiling fans rather than air-conditioning whenever possible. Try to set the thermostat for your home air conditioner at the lowest setting that is comfortable. When everyone is away or asleep, set the thermostat at a warmer temperature. Close off unused areas of your home to reduce cooling needs.

- Use natural light or lighting that saves energy and generates less heat (compact fluorescent or LED bulbs). Buy energy efficient appliances. Turn off appliances when they are not being used.

- Use paint brushes or rollers instead of spray-painting to reduce the evaporation of paint. Choose water-based paints, stains, and sealers instead of similar oil-based products. If you must use oil-based coatings, ask about the availability of low-solvent versions.

- Plant trees. They filter the air and shade your home to reduce cooling needs.

- Recycle. It takes less energy and pollution to recycle many articles than it does to make new ones from raw materials.

- Participate in your local utility's energy conservation programs such as green power, insulation

loans, and home inspections. "Green power" is electric power drawn from renewable resources that have a minimal impact on the environment

Steps At Work

- Take your lunch or walk to a nearby restaurant. This reduces the number of vehicles on the road during the daylight hours. Organize deliveries from popular restaurants to your department.

- Ask where the Air Quality Health Advisory notices are posted. Ask your workplace environmental issues coordinator what programs are available.

- Use teleconferencing instead of driving to meetings.

- Turn off delivery vehicles when loading or unloading for extended periods of time. Idling for long periods uses more fuel than stopping and starting your engine. Coordinate deliveries from your site to eliminate multiple vehicle trips using "trip linking" techniques.

Steps On The Road

- Share a ride or take public transportation to avoid single occupancy vehicles. Take a bus, carpool, and walk or ride your bike to your destination. For the bus route nearest you, see the Knoxville Area Transit (KAT) website: http://www.ci.knoxville.tn.us/kat/default.asp

- Park and walk into drive-through locations rather than idling. Avoid sudden stops and starts, and avoid idling for long periods of time. Idling can waste fuel and contribute to higher ground-level ozone.

- Consolidate trips by "trip linking" when you drive (*e.g.*, do errands on the way home from work). Plan your trips so that you combine short trips to reduce the total distance traveled. A cold engine consumes about 20 percent more fuel than a warm one.

- Maintain your vehicle by getting regular tune-ups. Engines that are well maintained are more fuel-efficient and emit less air pollutants. Get a tune-up once a year. Don't forget your personal watercraft and other recreational vehicles.

- Keep filters and fluids cleaned. Keep tires properly inflated. Low pressure reduces gas mileage and the life of the tire. Use high-efficiency motor oil. "EC-II" rated oil can provide a 2.7 percent gas mileage boost.

- Postpone the refueling your car until after 6:00 p.m. or closer to dusk. This reduces the emissions during the peak daylight hours when ground-level ozone formation is most likely. Don't top the tank after the pump has automatically shut itself off to avoid spills of gasoline and unnecessary volatile organic compound (VOC) emissions. Always tighten your gas cap securely.

- Try not to use the air conditioning in your car for local trips. Your car's air conditioner can reduce gas mileage up to 20 percent. An exception to this would be when traveling on interstates or other roads at 55 mph or faster. Under those conditions, the resistance created from open windows probably reduces gas mileage by about the same amount.

- Driving at 55 mph rather than 65 mph can increase your mileage by over 15 percent. When driving, use cruise control whenever practical. Stay within the speed limit.

- Are you buying a new car? Consider getting a high mpg model. Mileage for different model cars is available at: http://www.fueleconomy.gov/feg/FEG2000.htm

- Learn about alternatively-fueled vehicles and the work of the East Tennessee Clean Fuels Coalition (ETCFC): http://www.etnrcac.org/pdfs/etcfc.pdf.

Alternative Fuels

Significant progress in meeting the Healthy People 2010 goal for 30% use of alternative fuels has been made, although there is still far to go. In 2004, no locations existed for purchasing biodiesel or gasohol in East Tennessee. Today, there are a rapidly increasing number of locations for alternative fuels. The website of the ETCFC provides addresses, hours, and maps where alternative fuels can be purchased, both within and outside Knox County: http://eerc.ra.utk.edu/etcfc/refuel.html

For diesel vehicles, **B20** (20% biodiesel is currently available at two locations in Knox County, the Regal Fuels stations at 1206 Proctor Street (just off Middlebrook Pike) and 5428 Trebor Lane (three miles south of the intersection of John Sevier Highway (168) with Asheville Highway).

For those who drive gasoline-powered vehicles, **gasohol** (E10, 10% ethanol) is available in Knox County at six Weigels and 29 Pilot Oil locations (table at website above). Additionally, the Pilot station at the Bridgewater Road / Walker Springs Road exit of I-40/75 has recently begun offering **E85** (85% ethanol fuel). TDOT and TDEC are developing a plan to offer E85 fuel at multiple locations along interstate highways in Tennessee.

Propane can be used as an alternative vehicle fuel; ten Knox County locations where propane for vehicle use can be obtained is provided in a table at the ETCFC website. To date, no public locations offer **hydrogen** or **compressed natural gas** fuel, although locally some private firms are adopting these fuels.

The ETCFC website also discusses **hybrid electric vehicles**, as well as reporting the latest news on these topics with an East Tennessee focus.

(For more information on "Spare the Air": http://www.knoxcounty.org/airquality/sparetheair.php)

Solar Exposure and Skin Cancer

While not a health issue directly due to exposure to *the air itself*, an environmental health topic also connected to time spent outdoors is the connection between overexposure to the sun and an increased chance of developing skin cancer.

Some exposure to sunlight can be enjoyable and healthful, but too much can be dangerous. Ultraviolet radiation (UV), which comes naturally from the sun, is divided into three different categories based on wavelength. (Wavelength is the distance between two successive peaks of a wave.) UV wavelengths are measured in nanometers (nm) or one billionth of a meter. The shorter the wavelength the higher the energy.

- **UVA wavelengths** (315-400 nm) have the longest wavelengths, and are only slightly affected by ozone levels in the atmosphere. Most UVA radiation reaches Earth's surface and contributes to sunburn, skin aging, eye damage, and can suppress your immune system.

- **UVB wavelengths** (280-325 nm) are strongly affected by ozone levels. Decreases in the ozone layer in the upper atmosphere due to chlorofluorocarbon (CFC or "Freon") refrigerants (now banned, but still present in the atmosphere) mean that more UVB radiation can reach Earth's surface, causing sunburns, snow blindness, immune system suppression, and a variety of skin problems including skin cancer and premature aging.

- **UVC wavelengths** (180-280 nm) have the shortest wavelengths, and are very strongly affected by ozone levels. Virtually all UVC radiation is absorbed by the ozone layer, water vapor, oxygen and carbon dioxide before reaching Earth's surface.

As a result, the UV radiation reaching Earth's surface is largely composed of UVA with some UVB. Almost half the daytime total UV radiation is received between the hours of 10 a.m. an 4 p.m. *Even on a cloudy day, you can get sunburned because of UV radiation.*

One in five Americans develops skin cancer, and one person dies from this disease every hour. The incidence of melanoma, the most serious type of skin cancer, is increasing faster than most other forms of cancer. Since most of a person's lifetime sun exposure occurs before the age of 18, children are of special concern. The statistics for skin cancer in Knox County are not available, due to a gap in the cancer reporting system in Tennessee. As reported in the *Tennessee Comprehensive Cancer Control Plan 2005-2008*:

> The most notable limitation [on controlling melanoma] is identifying the full scope of the problem in Tennessee. Although melanoma is a reportable condition in Tennessee, an effective reporting mechanism is not in place. Dermatologists and primary care physicians in non-hospital settings diagnose and treat most primary cutaneous melanomas. These patients may never visit a hospital for their condition and are not counted in tumor registries. The end result is a lack of accurate data on melanoma and skin cancer in Tennessee.
>
> Reference: http://www2.state.tn.us/health/CCCP/TCCC_Plan.pdf (page 38)

There are simple protective measures that you can take to limit exposure to UV rays.

- **Limit Time in the Midday Sun:** Avoid overexposure to the sun during those hours when UV radiation is most intense (10-4), even in winter and especially at higher altitudes

- **Seek Shade:** Shade is a good source of protection, but keep in mind that shade structures (e.g., trees, umbrellas, canopies) do not offer complete sun protection.

- **Cover Up**: Wide brimmed hats offer good sun protection to areas particularly prone to overexposure to the sun (i.e., eyes, ears, faces, and necks). Wear tightly woven, loose-fitting, and full-length clothing.

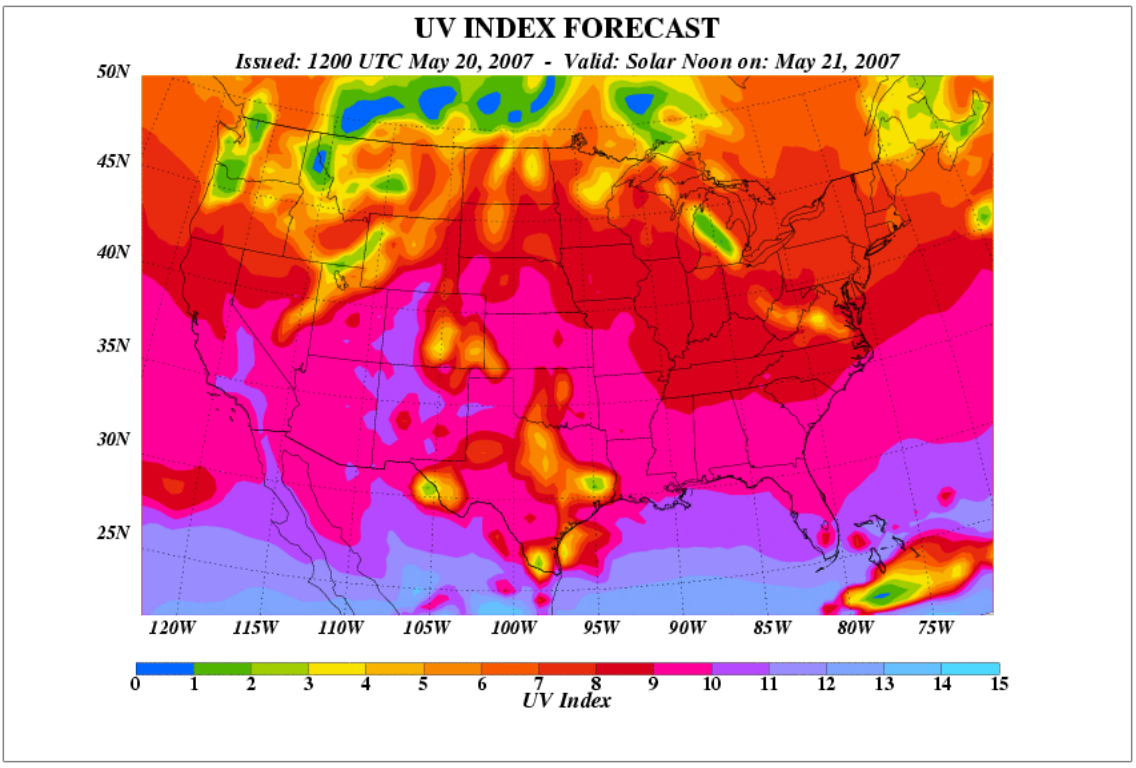
- **Watch the UV Index**: The UV Index provides important information to help people plan outdoor activities in ways that prevent overexposure to the sun.

- **Wear Sunglasses**: Sunglasses that provide 99-100% UVA and UVB protection greatly reduce sun exposure that can lead to cataracts and other eye damage.

- **Use Sunscreen**: Apply a broad spectrum sunscreen with a Sun Protection Factor (SPF) of 15 or higher liberally on exposed skin. Reapply every 2 hours, or after working, swimming, playing, or exercising outdoors.

The UV Index was developed by the National Weather Service (NWS) and EPA, and predicts the next day's ultraviolet radiation levels on a 1-11+ scale, helping people determine appropriate sun-protective behaviors. EPA issue a UV Alert when the level of solar UV radiation is predicted to be unusually high, and consequently the risk of overexposure is greater. The UV Index map for the entire nation is available online here: http://www.epa.gov/sunwise/uvindex.html and the local UV forecast is also included at the AirNOW website. It is often reported in local weather forecasts on TV and in the newspaper as well.

Figure 21. Example of EPA's UV Index Forecast Map



Additional information and resources are available at:

The EPA's SunWise Program is an environmental and health education program that aims to teach the public how to protect themselves from overexposure to the sun through the use of classroom-, school-, and community-based components: http://www.epa.gov/sunwise/index.html

The CDC's Skin Cancer webpage (http://www.cdc.gov/cancer/skin/) includes a link to a book, *Shade Planning for America's Schools* (http://www.cdc.gov/cancer/skin/pdf/shade_planning.pdf), that discusses the importance of providing areas protected from the sun in the outdoor play areas of every school: **"…providing shade on existing outdoor play areas could reduce the temperature in those areas by as much as 10° to 20°, increasing the period of time that students could engage in active outdoor play."**

Skin cancer is not only derived from childhood exposures, of course. Tanning – in the sun or in a tanning bed – poses additional risks for skin cancer, as discussed on this FDA website: http://www.fda.gov/cdrh/consumer/tanning.html

The National Cancer Institute's website has information on skin cancer detection and treatment, available at: http://www.cancer.gov/cancer_information/cancer_type/Skin/

10 - Recreational Water Quality

In this section, we look at the surface water resources of Knox County – the sources, supply and quality of surface water, as well as the threats to water quality and their impact on the environment and human health. The water quality of public swimming pools will also be discussed in connection with its impact on public health.

The Healthy People 2010 goals relating to recreational and surface water include:

- Increase the proportion of assessed rivers, lakes, and estuaries that are safe for fishing and recreational purposes.
- Reduce the potential human exposure to persistent chemicals by decreasing fish contaminant levels.
- Unintentional drowning rate of 0.9 per 100,000 people.

While there are not quantitative goals for all of these objectives, the status of Knox County regarding them will be discussed.

Watersheds

In assessing surface water quality, it is useful to evaluate streams on a watershed-by-watershed basis. A watershed is the land surrounding a stream or river from which runoff (from rainfall) drains into the river or stream. The divisions between watersheds typically occur along the tops of ridges. Knox County includes portions of four major watersheds, corresponding to the rivers in the area. These are then divided into smaller sub-watersheds for each stream. The map below illustrates major watersheds. A map of the smaller sub-watersheds in Knox County can be found at: http://www.waterqualityforum.org/watershedpop.htm

Figure 22. Major Knox County Watersheds Map

Water Quality Monitoring

The 2002 Federal Water Pollution Control Act requires a biennial report to congress of the water quality of each state. The 1999 Tennessee Water Quality Control Act also requires a report on water quality. In order to meet these requirements, the Division of Water Pollution Control in TDEC issues an assessment of the quality of surface waters, available on the internet: http://www.tennessee.gov/environment/wpc/publications/2006305b.pdf. Each stream is evaluated as to whether it can support its designated uses, and the sources of any problems. Advisories against swimming or consuming fish from a river or stream may be issued if a health threat is present due to pollution.

Typically, the most common causes of pollution in rivers and streams are sediment/silt from soil erosion, habitat alteration, pathogens (bacteria), and nutrients. The main sources of these pollutants are agriculture, changes to the landscape by earthmoving equipment during and after construction of roads, homes, and businesses that affect the way runoff in a watershed drains to streams and rivers (called "hydrologic modification"), soil erosion, and discharges from sewage treatment plants. The leading causes of pollution in reservoirs and lakes are organic chemicals, including pesticides and PCBs (polychlorinated biphenyls). Nutrients, sediment/silt, and low dissolved oxygen (which can result in fish kills) are additional causes. This pollution has real costs for the community, as noted by TDEC:

When the water is no longer safe for recreational activities, the community loses an important resource. Two of the most obvious costs of water pollution are the expenses of health care and loss of productivity while people are ill. The biggest health risks people encounter in polluted waters are from pathogens and contaminated fish. People who swim in waters polluted by pathogens can become sick. People (especially children and pregnant women) who eat contaminated fish are at a higher risk for cancer and other health problems than those who do not eat contaminated fish. Subsistence fishermen are faced with the loss of their primary protein source.

When people can no longer eat fish from rivers, streams, and lakes, there is a potential for economic loss in the community. Commercial fishermen lose income when it is no longer legal to sell the fish they catch. As the fishermen move out of the community to find another place to fish, local business can decline.

Another cost of water pollution is the expense associated with keeping waters navigable. Commercial navigation as a means to move goods and services around the country is one of the most economical methods of transportation. As channels fill with sediment from upland erosion, commercial navigation becomes less practical. Silt deposits also reduce the useful lifespan of lakes and reservoirs. They become filled with silt, which decreases the depth of the water until dredging is required or the lake or reservoir is completely filled.

Advisories

The following advisories affecting swimming and fishing in water bodies in or bordering Knox County are currently in place:

Table 23. Bacteriological Swimming Advisories, Knox County

Water Body	Portion	Comments
First Creek	Mile 0.2 to 1.5	Due to Knoxville urban runoff
Goose Creek	Entire Stream (4.0 miles)	Due to Knoxville urban runoff
Second Creek	Mile 0.0 to 4.0	Due to Knoxville urban runoff
Sinking Creek (Bay of Ft. Loudon Lake)	From head of embayment to cave (1.5 miles)	Due to Knoxville Sinking Creek Sewage Treatment Plant
Third Creek	Mile 0.0 to 1.4; mile 3.3	Due to Knoxville urban runoff
E. Fork Third Creek	Mile 0.0 to 0.8	Due to Knoxville urban runoff

Table 24. Fishing Advisories for Knox county

Water Body	Portion of Lake	Comments
Ft. Loudon Reservoir	Entirety (14,600 acres)	Commercial fishing for catfish prohibited. No catfish or largemouth bass over two pounds should be eaten. Do not eat largemouth bass from the Little River embayment.
Melton Hill Reservoir	Entirety (5,690 acres)	Catfish should not be eaten.

The cause of both fish advisories is PCBs in the river sediment, which is most readily taken up by bottom-dwelling fish like catfish. See: http://www.epa.gov/waterscience/fish/basic.htm

Progress in addressing the Healthy People 2010 goal of improving water quality will depend on improved stormwater management (discussed below) and wastewater treatment (discussed in the section on Waste Disposal). Improvements in these areas will help address the Healthy People 2010 goal of decreasing fish contaminant levels, but as PCBs are persistent chemicals once released to the environment, it may take many years of improved waste management before fish advisories on local rivers can be lifted.

High Quality Waters in Knox County

Not all news regarding stream and river quality in Knox County is bad; some higher quality (Tier 2 and Tier 3) waters remain. TDEC is responsible for identifying Tier 2 and Tier 3 high quality waters in the state. In Tier 2 waters, degradation cannot be authorized unless (1) there is no reasonable alternative to the proposed activity that would render it non-degrading and (2) the activity is in the economic or social interest of the public. In Tier 3 waters, also called "Outstanding National Resource Waters," no new discharges, expansions of existing discharges, or mixing zones will be permitted unless such activity will not result in measurable degradation of the water quality. In general, these are water bodies with good water quality, important ecological values, valuable recreational uses, and outstanding scenery. While there is a readily apparent cost in prohibited development near these waters, there are also economic benefits in terms of tourism, recreational activities, and decreased public health costs that accrue to the community when an ecosystem is preserved.

Table 25. High Quality Waters in Knox County (Tiers 2 and 3)

Watershed Name	Water Body	County	Description	Basis for Inclusion
Holston	Hogskin Branch	Knox	Portion in House Mountain State Nat. Area	House Mountain State Natural Area.
Holston	Holston River	Knox, Jefferson	From confluence with French Broad River to McBee Island.	Federal endangered Pink Mucket, federal threatened Snail Darter.
French Broad-Lower	Tuckahoe Creek	Sevier, Knox	In its entirety.	State Scenic River
French Broad-Lower	French Broad River	Sevier, Knox	From Holston River to Douglas Dam.	Federally endangered Pink Mucket, federal threatened Snail Darter, state endangered Lake Sturgeon and Blue Sucker.

From the website: "The Known High Quality (Tier 2 and Tier 3) Waters in Tennessee," at: http://www.tennessee.gov/environment/wpc/publications/hqwlist.mht. Questions about the antidegradation policy can be directed to Greg Denton, (615) 532-0699, or gregory.denton@state.tn.us

Water Quality and Loss of Species

As noted above, silt from soil erosion is an environmental problem in Knox County. Steams in developed areas have been channeled into unnatural configurations (and are eroding stream banks as a result), and in suburban areas are threatened by muddy runoff from construction sites. There are serious effects on the ecological communities in local streams as a result.

Each species of fish, shellfish, or other creature in a river or stream requires specific conditions to live and breed successfully. Some fish, for example, require rocks on the bottom of a stream, others gravel or sand of a certain size or type. Some find their mates by visual cues of color. When there is a continual flow of mud into a stream the fish may not be able to see potential

mates, or the substrate on the stream bed that they need to deposit their eggs may be covered over by silt, preventing breeding or making their young easy prey to predators. Shellfish have limited ability to move about, and silt can suffocate them. Silt is not the only problem facing life in local streams. Runoff from roadways and backyards, from oil to pesticides to infectious agents in pet droppings can affect the local ecology, in addition to resulting in swimming and fishing bans of the type noted above.

As each species is eliminated, the fabric of the ecosystem unravels one thread at a time. Small fish or amphibians that serve as prey for larger, commercial sport fish or for birds from herons to kingfishers die out. The control of mosquitoes that they provided for free now must be replaced by human interventions. Fishing also suffers, with additional impacts on the human community. Eventually the stream or river contains only a remnant of its former biodiversity. *Streams in the developed parts of Knox County contain, at best, ten species of fish. Before human development – and still, in the more remote or protected areas of East Tennessee – thirty species of fish in a stream of the same size would be typical*, according to scientists at Conservation Fisheries, Inc. (CFI), a local not-for-profit organization located in Knox County.

CFI works to preserve regional aquatic biodiversity and ecosystems by captive breeding of rare fish and subsequent release in suitable habitat once it is located or restored to conditions that would support the species in the wild. They also provide presentations to schools and the community on the subject. They have won national recognition and awards for their work. More information on CFI is available at their website: http://www.conservationfisheries.org/

Protecting urban water quality should not be just a concern to "tree huggers." The loss of biodiversity is an indicator of the transition of a stream from a place where it is healthy for children to play or students to learn into an open sewer – unhealthy, malodorous, and causing lower property values. The realization of this has led to a number of efforts in the County to protect or restore local watersheds and waterways (discussed below). Nature is resilient and with proper care it is quite possible for healthy (although probably not pristine) streams and human communities to coexist.

Stormwater Management

Because local streams ultimately carry a variety of pollutants into the Tennessee River (a navigable waterway protected by the Clean Water Act), the city of Knoxville is required to monitor streams as part of the overall stormwater discharge system under an NPDES permit (National Pollutant Discharge Elimination System), i.e. a "sewer discharge permit," from the state since 1996. The City of Knoxville currently has five wet-weather monitoring stations located in four stream watersheds (First, Loves, Second, Fourth). Each monitoring station collects a water sample every 15 minutes whenever the instruments detect heavier-than-normal flow (i.e. when rainfall is carried to the stream by storm sewers.) A weighted composite sample is created and then tested for a dozen parameters as specified in the municipal NPDES permit. The values are then reported to TDEC's Division of Water Pollution Control. Permit requirements and test results reported are available online at: http://www.ci.knoxville.tn.us/engineering/stormwater/reports/

The city of Knoxville has a Water Quality Hotline (865-215-4147) that can be called anonymously 24 hours a day to report illicit connections or illegal dumping in the creeks, streams, catch basins, storm sewer, or any area draining into the creeks or storm sewer system. However, urgent or emergency calls involving hazardous materials, human safety, or severe environmental damage should be reported by the public by calling 911. The fire department will involve other appropriate emergency response organizations (e.g. TDEC, EPA) as needed.

The city has developed a Best Management Practices (BMP) Manual, available online, (http://www.ci.knoxville.tn.us/engineering/bmp_manual/) to explain requirements for stormwater

pollution prevention and erosion control (as well as related issues such as preserving existing vegetation, required by the Tree Protection Ordinance), and also created a Land Development Manual (http://www.ci.knoxville.tn.us/engineering/ldmanual/) to assist developers with meeting design and construction requirements.

Outside city limits, Knox County operates under a different NPDES permit, but it also is required to monitor and manage stormwater. When the county's NPDES permit was issued, its stormwater ordinance at that time did not adequately address certain requirements, such as stream buffers, erosion prevention and sediment control, and water quality controls for site developments. Among other things, the permit requires the adoption of an ordinance that addresses these permit requirements. The county has (at the time of writing) passed a stormwater ordinance which the City of Knoxville maintains is not equivalent to the City's. A lawsuit between the City and County may result, as the City maintains it suffers flooding due to stormwater runoff originating in the County that is inadequately controlled by current County laws.

Watershed Conservation and Stream Restoration

A number of activities are underway by citizens groups or public-private-citizen partnerships to improve water quality and protect/restore watersheds, contributing to meeting the goals of swimmable and fishable waterways and reducing the levels of fish advisories. The Water Quality Forum (WQF) is a not-for-profit organization working since 1990 to protect, restore, and enhance the waterways of Tennessee and to support the goals of the Clean Water Act in the nine-county are surrounding Knox County. (http://www.waterqualityforum.org/). Agencies partnering in the WQF include local governments, TVA, UT's Water Resources Research Center, environmental engineering firms, and Ijams Nature Center (http://www.ijams.org/). Noteworthy specific efforts at watershed protection include:

- **River Rescue** is an annual shoreline cleanup of public sites along the Tennessee River from Forks-of-the-River to Fort Loudoun Dam in Knox and Blount Counties, a distance of fifty "river" miles (100 miles of shoreline) and a portion of the Clinch River at Melton Hill Dam in Anderson County. 2007 was the 18th year of the event, and almost 30 sites were cleaned up including Carl Cowan, Concord, Admiral Farragut, Sequoyah, I.C. King, Marine, Ned McWherter, Island Home and Lenoir City Parks; sites along First, Second, Third and Goose Creeks; Willow Point, Fox Road and Louisville Marinas; Wrights Ferry Landing, Peninsula Village, Sky Ranch Airport and Mariner's Point. While results are not final, reports so far indicate over 750 volunteers collected more than 1,400 bags (or 14 tons) and 25 tires. For more information see: http://www.waterqualityforum.org/asp/programs.asp?PGProgName=River%20Rescue

- The **Beaver Creek Task Force** is a Knox County Stormwater led partnership of agencies, utilities, institutions, and non-profits dedicated to restoring Beaver Creek to its intended uses, such as making the creek swimmable and fishable, and developing programs and procedures that will be used to restore other watersheds around Knox County and the surrounding region. This three year project will help accelerate restoration in the Beaver Creek Watershed by providing a cost effective way for developers and wastewater dischargers to comply with their regulatory requirements. The EPA will use this program as a model for other communities in Tennessee and around the Southeast. In 2006 the EPA awarded a $353,303 Cooperative Watershed Agreements Grant to Knox County Engineering and the Beaver Creek Task Force to develop and pilot test an Ecological Pollution Credit Trading Program in the Beaver Creek Watershed to improve water quality. For more information: http://www.waterqualityforum.org/asp/programs.asp?PGProgName=Beaver%20Creek

- The **Bullrun Creek Restoration Initiative** was recently formed after the State of Tennessee classified Bullrun Creek as impaired by pollution and not fully meeting its

designated uses. The Bullrun Creek watershed drains a 104 square mile area of land that includes parts of Anderson, Grainger, Knox and Union counties before discharging into Melton Hill Reservoir. The city of Maynardville and communities of Paulette, Heiskell and Claxton are located within the watershed. Both point and non-point pollution sources need to be addressed to restore water quality in the Bullrun Creek watershed. Cost share funds, technical assistance and economic incentives are available to assist land owners in the watershed who want to voluntarily implement non-point source pollution management practices. For more information see: http://www.waterqualityforum.org/asp/programs.asp?PGProgName=Bullrun%20Creek

- The **Stock Creek Task Force** is a consortium of agencies, universities and utilities that have come together to protect and improve Stock Creek. The Stock Creek Watershed, a part of the Little River Watershed, is located in the southern part of Knox County. With almost two-thirds in rolling pasture or covered in forest, the Stock Creek Watershed retains a largely rural character. The threats to Stock Creek are largely due to septic and agricultural runoff, and while listed as impaired due to bacterial levels, the creek is in good enough condition that restoration is very feasible if the sources of the pollution are addressed. The task force has been working together since 2001 to assess conditions, prioritize problems, educate residents and implement solutions. For more information: http://www.waterqualityforum.org/asp/programs.asp?PGProgName=Stock%20Creek

- The **Lower Clinch Watershed Council** (LCWC) is an umbrella organization formed in 2005 to represent the Lower Clinch Watershed as a whole. Previously, there have been successful efforts to improve water quality in the sub-watersheds over several counties of the Lower Clinch, including Beaver Creek, Bullrun Creek, Coal Creek, Hinds Creek, Poplar Creek and the Clinch River. The organization has successfully competed for a Cooperative Conservation Partnership Initiative Grant from the Natural Resources Conservation Service. This grant is being matched by LCWC members to implement a rapid watershed assessment, including updated satellite imagery and land cover interpretation, a resource inventory and a public input and prioritization component. The resulting assessment will be the basis for a watershed-wide management plan upon which the LCWC will base it's plan of work. Additional information is available at: http://www.waterqualityforum.org/details.asp?PRID=184

- The **French Broad River Conservation Corridor** has been established to conserve, protect, and enhance the natural beauty, rural heritage, wildlife habitat, and outdoor recreation on and around the French Broad River. A participatory, watershed-level planning process including all stakeholders identifies land that will provide benefit to the public if protected rather than developed, remaining available for common, multiple uses including: outdoor recreation, both active and passive; preservation of historic, archeological, and aesthetic resources; protection of sensitive ecosystems and habitat (see Tier 2 designation of the French Broad River, discussed above); enhancement of rural and agricultural resources; provision for public health and safety; buffer zones; and connection corridors to developed land throughout the open space system, and into the urban centers: http://www.knoxcounty.org/frenchbroad/index.php

- In September, 2006, restoration began of approximately 7,000 feet of **Third Creek** and 700 feet of a tributary along the Third Creek Greenway, beginning at Sutherland Avenue. This reach of Third Creek is on Tennessee's list of impaired waters due to historic channel straightening, excessive nutrient loading, and impacts to riparian buffers. The alterations to Third Creek have caused accelerated bank erosion and the degradation of in-stream habitat and water quality. The Tennessee Stream Mitigation Program funded the project as compensatory mitigation for impacts associated with transportation projects within the Fort Loudoun watershed. The total cost of the project is estimated at $1.1 million, with the City of Knoxville contributing $100,000 for earth moving and long-term management: http://www.ci.knoxville.tn.us/Press_Releases/Content/2006/0821.asp

Water Safety

Drowning statistics are reported by the Tennessee Department of Health. The Healthy People 2010 goal for accidental drowning is 0.9 incidents per 100,000. However, drowning is infrequent enough in Knox County that any statistical inferences or trends derived from the data at the county level are probably meaningless. It is more appropriate to evaluate trends against this goal at the state level, due to the infrequency of accidental drowning in any one county. The data for several recent years are as follows:

Table 26. Accidental Drownings / Submersion Deaths, Knox County, 2000-2005

Year	Number	Rate per 100,000
2000	3	0.8
2001	11	2.9
2002	6	1.5
2003	3	0.8
2004	9	2.3
2005	9	2.3
Total	41	1.8

Source: Tennessee Department of Health, Division of Health Statistics.

Boating Safety statistics are reported by the Tennessee Wildlife Resources Agency. Data for recent years are as follows; as with drowning, incidents are infrequent enough that any statistical inferences or trends derived from the data at the county level are probably meaningless. The data for recent years are as follows; the fatality and severe injury values are the number of individuals suffering the type of accident noted, while the property damage data reflect the number of incidents, not the number of boats (one accident may involve more than one boat).

Table 27. Yearly Boating Accidents, Knox County, 2000-2006

Accident Type	2000	2001	2002	2003	2004	2005	2006
Fatality	0	0	0	0	0	0	2
Severe Injury	1	2	0	0	2	2	0
Property Damage	3	2	2	5	2	2	2

Table 28. Boating Accidents, (3-Year Moving Average), Knox County, 2000-2006

Accident Type	2000	2001	2002	2003	2004	2005	2006
Fatality	--	--	0	0	0	0	0.6
Severe Injury	--	--	1.0	0.6	0.6	1.3	1.3
Property Damage	--	--	2.3	3.0	3.0	3.0	2.0

As with the drowning statistics, there is sufficient fluctuation in the data at the county level that examination of the data on a regional or statewide basis would be more appropriate before recommendations for more public education and enforcement of boating safety rules could be made.

An additional boating-related health threat is carbon monoxide poisoning or other respiratory distress from breathing boat exhaust, especially when lake conditions are crowded and there is no breeze. While reported in the medical literature as a hazard in heavily-used waterways, there are no statistics and little anecdotal evidence that this is a problem in Knox County at present.

Swimming Pool Inspections

The Environmental Health Division of the Knox County Health Department is responsible for monthly inspections of over 450 public swimming pools, hot tubs, and similar facilities in the county. Each facility receives a score up to 100, with numerous items inspected (see figure):

Figure 23. Pool Inspection Reporting Form

PHYSICAL FACILITIES

1.	Bathhouse: floors and walls clean	1
2.	Plumbing fixtures clean, operating properly	1
3.	Toilet tissue n holder, soap, single service towel, air dryer, mirrors nonbreakable	1
4.	Bathhouse facilities litter free, approved containers	1
5.	Adequate lighting, ventilation	2
6.	Pool facilities: walls, bottom, decking, walks, fixtures, equipment clean and in good repair	2

SAFETY

* 7.	Certified lifeguard(s), number, lifeguard chair, number	4
* 8.	Chemical storage, handling	4
* 9.	Personnel, patrons with communicable diseases restricted	4
*10.	Depth markers, diving boards, towers, fencing	4
*11.	Electrical	4
*12.	Gas chlorination	4
*13.	General safety: no broken bottles, cans, glass, sharp objects	4
*14.	Illumination, adequate	4
*15.	Lifeline adequate, constructed, approved material	4
*16.	Lifesaving equipment, adequate	4
*17.	Main drain, signs, starting blocks, steps, ladders	4
*18.	Telephone	4

WATER QUALITY

*19.	Bacteriological test results positive	4
20.	pH range, total alkalinity, cyanuric acid level	2
*21.	Absence of approved sanitizing residual	4
22.	Sanitizing residua : (ppm), approved chemical test kit	2
*23.	Approved sanitizing, disinfecting methods	4
*24.	Visual test, excessive turbidity	4
25.	Algae control	2
26.	No foreign material	2
27.	Water level maintained	2
*28.	Water temperature	4
29.	Non-breakable thermometer (Type D pools)	2

WATER, WASTE WATER

*30.	Cross connection(s)	4
*31.	Sewage disposal	4
*32.	Water supply, source, approved	4

ADMINISTRATION

**33.	Current permit posted	0
**34.	Most current inspection report posted	0

* = Identifies critical items
** = Identifies misdemeanor violations

Failure of a critical item during inspection, such as a bacteriological determination that the water is contaminated, or failure to detect chlorine disinfectant in the water, results in an immediate closure of the facility. Such closures typically are addressed immediately by pool operators, and within a short time the pool is reopened; the correction of the health hazard often being confirmed by county personnel on the same visit. Cooperation of this type between pool operators and county inspectors keep the threat of waterborne illnesses from public pools under control.

11 - Solid Waste and Wastewater

The CDC's Healthy People 2010 document establishes, as a goal associated with solid waste, an increase in the recycling of municipal solid waste from 27% (national baseline average in 1996) as measured by EPA (the number includes composting) to a target value of 38% by 2010. **While Knox County has met this goal as recently as 2004, a decline in the recycling rate for the last two years now has Knox County performing well under this benchmark.** This section will provide an overview of solid waste management and wastewater treatment in Knox County and discuss programs in place to encourage recycling to meet towards achieving this goal.

[Healthy People 2010 also discusses goals that could be considered related to wastewater treatment in its discussion of surface water quality. In this report, surface water quality goals are discussed in the section on Recreational Water Quality.]

Solid Waste

In Tennessee, solid waste is managed by the Solid Waste Management Program in TDEC. In 1971 the "Regulations Governing Solid Waste Processing and Disposal" provided for a permitting process for facilities that perform solid waste processing and disposal. There are four categories of landfills under these regulations:

- Class I landfills - municipal solid waste, household waste, shredded/waste tires, etc.
- Class II landfills - industrial waste
- Class III landfills - farming wastes, landscaping and land clearing wastes, etc.
- Class IV landfills - construction and demolition waste

Table 29. Landfills in Knox County (Operating and Closed)

Name	Class	Address	Status	Owner
UT Knoxville Landfill	I	2233 Volunteer Blvd. Knoxville TN 37917	Inactive	University of TN – Knoxville
Knoxville City Landfill	I		Inactive	City of Knoxville
Twin Oaks Landfill	I	2400 Chipman St. Knoxville TN 37917	Post-closure	BFI, Inc.
Modine Mfg. Landfill	II	5050 S. National Dr. Knoxville TN 37914	Inactive	Modine Manufacturing Co.
Neely Development	II	135 23rd Street Knoxville TN 37916	Inactive	Ed Neely
Cemex, Inc.	II	6212 Cement Plant Rd. Knoxville, TN 37924	Operating	Cemex, Inc. (cement plant)
Briggs Jim Walker	II	5040 National Dr. Knoxville TN 37914	Post-closure	Jim Walker Co.
Knoxville Demo LF.	III		Closed	City of Knoxville
Knoxville Demo LF.	III		Closed	City of Knoxville
Poplar View Landfill	III	4521 Rutledge Pike Knoxville TN 37914	Operating	Construction & Demolition Services, Inc.
Yarnell Demolition Landfill	III	1550 Lamon Quarry Rd. Knoxville 37932	Operating	Waste Corporation of America
Riverside C&D Landfill.	IV	3330 Delrose Dr. Knoxville TN 37914	Operating	Riverside C&D Landfill Inc.
Ridgeview Demolition Landfill	IV	4521 Rutledge Pike Knoxville TN 37931	Post-closure	Construction Demolition Landfill Services, Inc.

Note that there are no Class I landfills (municipal / household waste) operating in Knox County. Most Knox County trash is deposited in Chestnut Ridge Landfill, 240 Fleenor Mill Road, P.O. Box 139, Heiskell, TN 37754, located off I-75 at the Raccoon Valley Road exit just outside the Knox County limits. It consists of 412 acres and has over 35 years of estimated life. It is operated by Waste Management, Inc. http://www.wm.com/Templates/FAC4117/index.asp

Certain other wastes (such as medical/infectious waste, dead animals, sludges, pesticides wastes, asbestos, etc.) require special waste approval prior to disposal under Tennessee's Hazardous Waste Management Program. In addition to oversight of hazardous waste facilities, this program includes the State Remediation Program for sites that are not permitted but need to be cleaned up, and the Used Oil Management Program, which operates under regulations established to encourage recycling of used oils. (The hazardous waste program is discussed in the section of this report on Hazardous Waste.)

The following charts illustrate the amount of household trash (waste sent to Class I landfills) generated in Knox County in recent years, in tons and tons per resident (all data in bar charts courtesy of Sara Hart, Recycling Coordinator, Knox County Engineering and Public Works):

Figure 24. Tons of Knox County Residential Waste Sent to Landfills

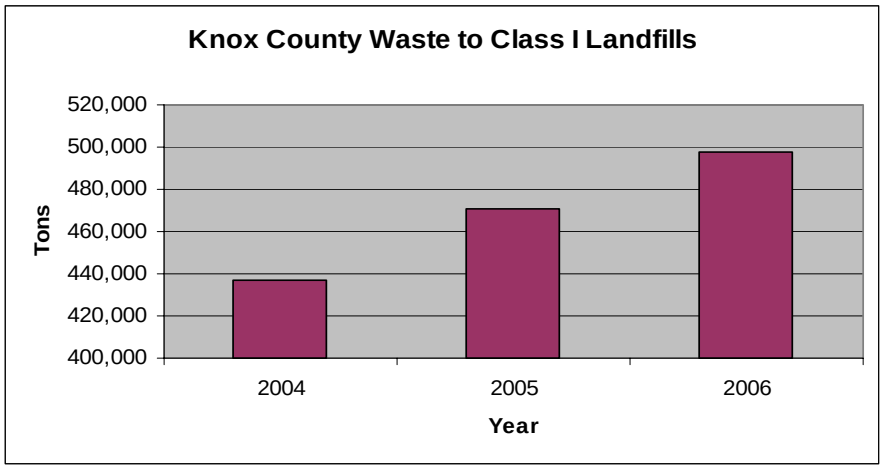
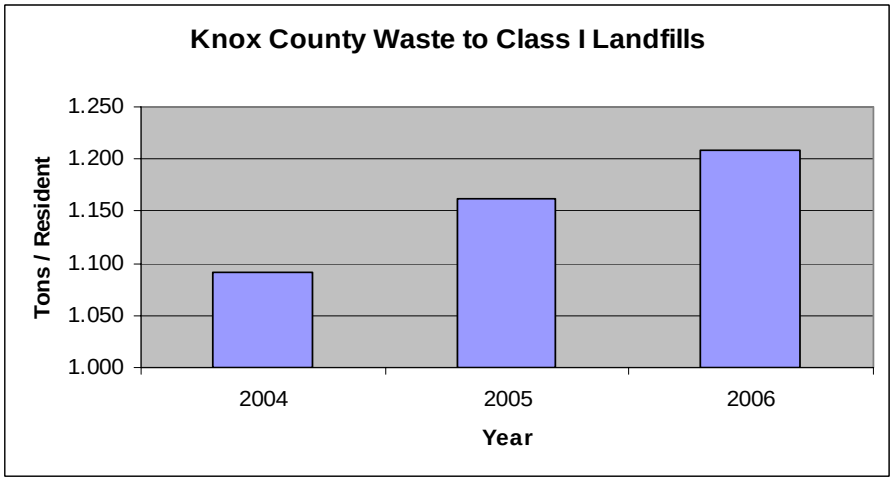


Figure 25. Per Person Residential Waste Sent to Landfills



Residential Waste Pick-up

In the City of Knoxville, residential wastes are picked up by the city, under the management of the Office of Solid Waste (865-215-2420), http://www.ci.knoxville.tn.us/solidwaste/. In areas of the county outside city limits, homeowners must contract with a private waste disposal firm for trash removal, which typically includes an option for curbside recycling. For those county residents who are renters or who cannot (or choose not to) participate in curbside recycling with their trash pickup, the city and county offers several recycling facilities where a range of materials can be brought for recycling.

The waste may be taken directly to a landfill, or it may be combined at a *transfer station* with waste from other locations before being taken to the landfill for disposal. Waste transfer stations in Knox County are located at Prosser Road off Magnolia Avenue (Waste Connections, Inc.) and on Elm Street off Baxter Avenue (City of Knoxville).

Recycling

In order to reduce the burden on landfills, as well as to save energy and promote environmental protection, the city and county provide opportunities for waste recycling to residents. Detailed information on the locations and hours of these centers and the kinds of wastes they can accept can be found at the city and county website links below. Additional information on recycling in Knox County can be found at the website of the Knoxville Recycling Coalition, http://www.discoveret.org/recycle/index.html. Information on special events such as computer recycling days, Christmas tree recycling events, etc. can be found at the Knoxville Recycling Coalition website, or those of the City (http://www.cityofknoxville.org/solidwaste/recycle.asp) and of Knox County Solid Waste (http://www.knoxcounty.org/solid_waste/index.php). An additional program to educate students about solid waste reduction is the Earth Flag competition (http://www.ijams.org/programs/program_detail.html?program_id=8), sponsored by Knox County and Ijams Nature Center. EPA information is available at: http://www.epa.gov/epaoswer/non-hw/muncpl/recycle.htm

Despite these efforts, the tons of waste recycled has dropped in recent years. When combined with the growing population of the County and the growing amount of total waste generated. **Knox County since 2004 has gone from exceeding the Healthy People 2010 goal for recycling (2004 recycling rate was 107% of the goal) to falling notably short of it (only 84% of the goal in 2006).** An examination by local government of the incentives and disincentives to recycling may be necessary to reverse local trends.

Figure 26. Percent of Knox County Waste Recycled

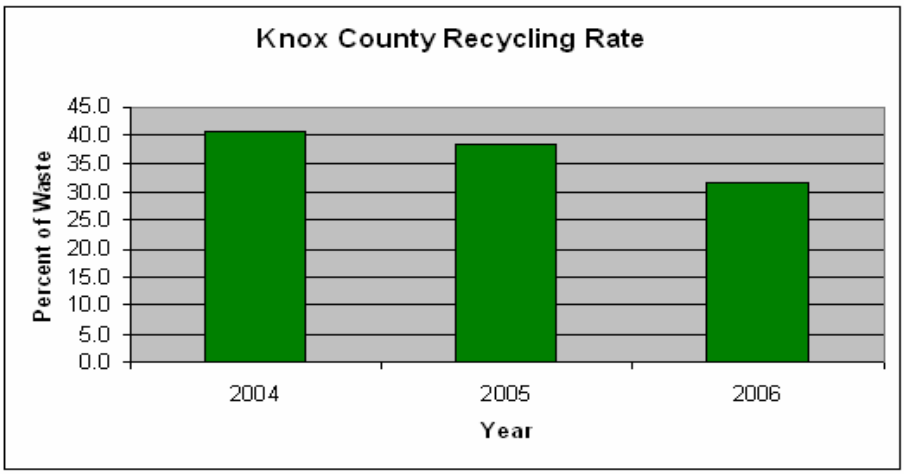
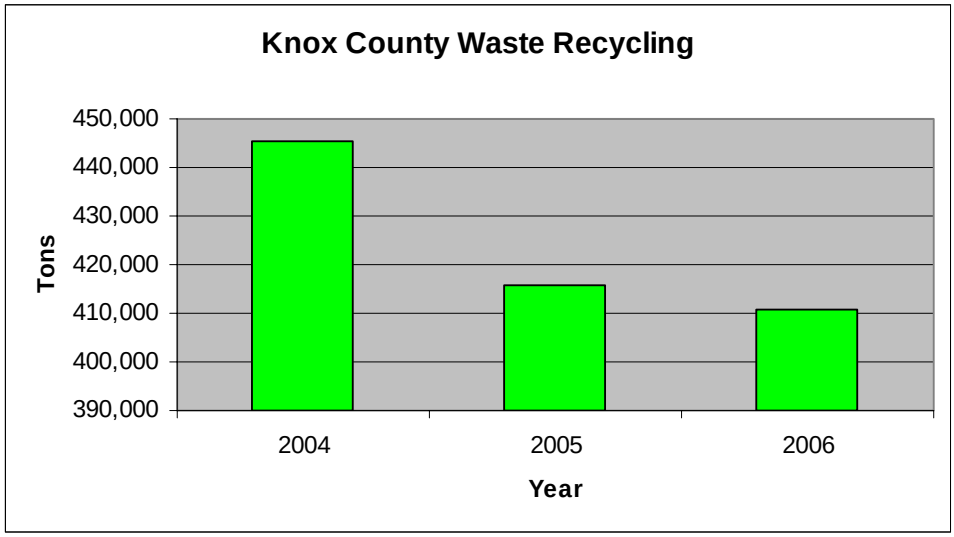


Figure 27. Tons of Knox County Waste Recycled



A significant part of the waste recycled in Knox County is yard waste or green waste, which is converted into compost. Green waste typically comprises 20-30% of the wastes generated in a community. Some residents do this at home, which is not captured in the statistics above, and may therefore contribute to the apparent decline in the recycling rate to an unknown degree. When yard waste is removed from site, it is taken to a *composing facility.* From the Knox County website (http://www.knoxcounty.org/solid_waste/greenwaste_recycling.php):

> Knox County has two municipal greenwaste recycling facilities. One is located in the Solway community at 8707 Joe Daniel Road, just off Oak Ridge Highway, two blocks east of Pellissippi Parkway. The other is located in the Forks of the River Industrial Park at 3106 Water Plant Road, just off National Drive. These facilities are operated under contract by Natural Resources Recovery of Tennessee, LLC, a local company specializing in organics recycling. Both facilities accept residential and commercial wood waste and yard waste.

There is also a residential yardwaste drop off site co-located with the Halls Solid Waste and Recycling Convenience Center located on Neal Road.

These facilities accept all types of yardwaste, including leaves, limbs, logs, branches, brush, grass clippings, shrubs, and even whole trees. They also accept clean, unpainted, unstained, or otherwise untreated lumber like pallets and crating lumber, framing wood, and plywood. These materials are processed and recycled into mulch, compost, and other soil amendment products. The fee schedule for material drop off includes residential flat rates and per-ton costs for larger volume disposal.

Hours of operation for the Solway facility are: Monday through Saturday, 8 AM-4:30 PM. Hours of operation for the Forks of the River facility are: Monday through Friday, 8 AM-4:30 PM; Saturday, 7 AM-3 PM.

For more information, or answers to specific questions, contact the Solway location at 865-927-7646, or the Forks of the River location at 865-546-0584.

In addition to the composting facilities, some organizations (such as Ijams Nature Center) accept Christmas trees for grinding into mulch (which differs from compost in that it has had less of an opportunity for decomposition). Locations are noted in the news at the end of the holiday season.

Until recently, compost generation at the Solway facility involved mixing plant waste with biosolids from local sewage treatment plants. This provided a means of locally recycling this material, which otherwise would be trucked out of Knox County for land application to farm soil (at higher cost to ratepayers in their sewer bills), or even possibly incinerated (contributing to air pollution and global warming) if the land application option was not available. However, this practice has been suspended due to odor complaints from residents near the facility.

Natural Resources Recovery sells the composted green waste as the “Nature’s Best” product line. The firm also manages the Knox County Tire Recycling program at the Forks of the River location. Commercial businesses and residents of Knox County can recycle their scrap tires for a small fee at this site.

Litter and Illegal Dumping

Despite the image of the litterbug as someone throwing a burger wrapper out the car window, only 20 percent of litter comes from careless motorists and pedestrians. Most comes from uncovered truckloads, unsecured business dumpsters, construction sites, loading docks and from bags and uncovered cans left at the street. In addition to being unsightly, litter (especially food wrappers and containers) can attract vermin and result in animals being injured or killed by traffic.

Litter is also an environmental health indicator for socioeconomic reasons. Litter drives down property values, and is a deterrent to new business and tourism, ultimately affecting employment and thus access to healthcare. There is strong evidence that uncollected trash and other types of physical disorder like graffiti and abandoned vehicles make people feel unsafe and attract crime. Littering reflects a lack of a sense of ownership or investment in the community and the presence of litter sends a negative message about the sense of community and the kinds of behaviors tolerated in the surrounding community.

Knox County Ordinance 96-4-101 makes it unlawful to throw trash onto the ground, allow trash to blow out of a moving vehicle, or leave trash in places not designated for regular trash pickup. It is everyone's responsibility to maintain control of their trash so that it does not become litter. The penalty for littering or illegal dumping is up to $1,000 plus court costs. Littering can be reported to

the county solid waste office at 215-JUNK (5865). A Litter Codes officer will cite the alleged offender to court based on your testimony. To make a case stick, you must be willing to be a witness in court. An alternative to court is a warning ticket sent by mail to the alleged offender. If you see littering, try to get a complete description including vehicle make, model and color, tag number, location and time of day. Call Knox County Solid Waste at 215-JUNK (5865). A Litter Codes officer will cite the alleged offender to court based on your testimony. To make a case stick, you must be willing to be a witness in court.

The same number, 215-JUNK (5685), can be used to request litter pickup. Knox County has a full-time litter crew that works with the State Office of Probation to pick up litter on County Roads. Knox County also oversees a Drunk Driver litter program that collects litter on State Highways and state-aid roads, roads that connect state highways.

Residents can also become actively involved in litter pickup (getting exercise while beautifying the community). If you are a member of a business, civic club, church or any other organization (including family), you can "Adopt-A-Road." Call 215-JUNK to submit a form and agree to pick up litter at least twice a year along a section of road of your choice in Knox County. The County provides bags, safety vests, gloves, litter pickers and warning signs. After your first collection day, the county picks up the bags along the road and places permanent signs at each end of your work area identifying your adoption. See: http://www.knoxcounty.org/solid_waste/litter.php.

Keep Knoxville Beautiful Litter Index

The group Keep Knoxville Beautiful (http://www.discoveret.org/keepknox/indexmain.htm) conducts an annual "windshield survey" of visible litter to develop a “Litter Index” for the community. Volunteers and staff drive through the survey area, and then give the area a score based on what they have observed. Keep America Beautiful provides a training video and printed material to provide an objective system for ratings. Volunteers use the following ratings (lower scores are better, meaning less litter was observed):

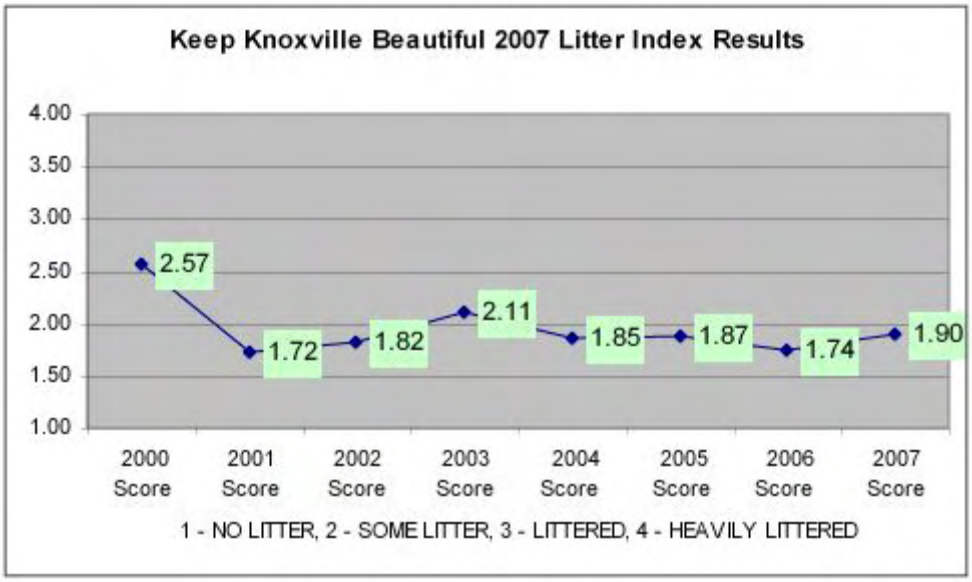
1 - NO LITTER - there is virtually no litter in the neighborhood. There may be one or two pieces visible, but it is something an individual could clean up very easily. The area has a clean, neat appearance and it is apparent that people care about this area.

2 - SLIGHTLY LITTERED - litter is something you notice, but your eye is not constantly drawn to it. One or two people could clean up all the litter in a short time. The area still has a generally neat appearance, but it does need some attention.

3 - LITTERED - litter is obvious and your eye is constantly drawn to the litter. The area is neglected and requires an organized cleanup. This is still something that neighborhood volunteers could do on their own with proper supplies and a little organization.

4 - EXTREMELY LITTERED - Illegal dumps, dirty lots, abandoned buildings, non-running junk vehicles area the predominant feature of the area. This area has been neglected for a long time and needs help from citizens and government. Heavy equipment will be required to clean this area.

Figure 28. Litter Data from Keep Knoxville Beautiful



Reference: Keep Knoxville Beautiful (http://www.discoveret.org/keepknox/littersurvey.htm)

While the overall trend since 2001 has been fairly steady, with the community as a whole scoring as "slightly littered," trends can be seen the neighborhood data that go into the overall score (http://www.discoveret.org/keepknox/2006%20KKB%20Litter%20Index%20Sub%20Area%20Scores.pdf). These results are provided in Appendix J. Data at the neighborhood level are "noisy," making trends perhaps statistically unreliable, and many areas only have data available since 2004, when the program was expanded county-wide.

Wastewater

Wastewater collection and disposal has been recognized as an essential part of healthy urban living since Roman times; the failure to provide such services contributed greatly to the unsanitary and disease-ridden conditions of the European Middle Ages. Today, wastewater treatment is a multi-step process involving the separation of liquid from solid waste, the disinfection and chemical treatment of the former before return to a waterway and the collection of the latter for recycling on farmland or into compost (the practices in Knox County), or incineration.

The Division of Water Pollution Control within TDEC is responsible for administration of the Tennessee Water Quality Control Act of 1977. This act provides that municipal, industrial and other dischargers of wastewater must obtain a permit from the state, issued under the federally delegated National Pollutant Discharge Elimination System (NPDES). These permits establish pollution control and monitoring requirements based on protection of designated uses of waterways, through implementation of water quality standards and other applicable state and federal rules. Industrial wastes that are discharged to municipal sewer systems are also subject to regulations at the state level (pretreatment regulations) and under local sewer permit regulations as well.

Wastewater treatment plants (WWTP) typically are located on a watershed-by-watershed basis to allow for collection by gravity as wastewater flows downhill, thus save the cost of pumping sewage from one area to another. As a result, there are several more wastewater treatment plants in the county than drinking water treatment plants, as indicated in the following table.

Table 30. Wastewater Treatment Plants, Knox County

Facility Management	Facility Address	Permit Issued Date	Permit Expires Date	Comments
First Utility Dist. Knox County	151 Concord Rd Knoxville, 37933	OCT-31-2002	FEB-28-2007	Turkey Creek WWTP
Hallsdale - Powell Utility District	3745 Cunningham Rd Knoxville, 37918	DEC-25-2005	DEC-25-2010	Beaver Creek, off Maynardville Hwy
Hallsdale - Powell Utility District	4301 W Beaver Creek Drive, Powell 37849	MAR-31-2003	MAR-31-2008	Beaver Creek, between Powell & Karns
Hallsdale - Powell Utility District	Diggs Gap Rd Knoxville, 37918	JUL-02-2003	MAY-31-2008	Raccoon Valley WWTP
KUB	1500 Lyons Bend Rd, Knoxville, 37919	APR-30-2004	APR-30-2007	Fourth Creek WWTP
KUB	2015 Neyland Dr. Knoxville, 37916	APR-30-2004	APR-30-2007	Kuwahee WWTP
KUB	5760 Sandis Ln. Knoxville, 37924	OCT-29-2004	OCT-29-2009	Loves Creek WWTP
KUB	1523 Saylors Ford Rd. Mascot, 37806	APR-30-2004	APR-30-2009	Eastbridge WWTP
West Knox Utility District	9916 Coward Mill Rd. Knoxville, 37931	FEB-27-2004	FEB-27-2008	Karns Beaver Creek WWTP

There are also a number of industrial facilities that have individual permits for their wastewater discharges; these are presented in Appendix K, which lists all NPDES permits for Knox County. The tables here and in Appendix K provide information on the NPDES Permit ID, Permit Date Issued and Permit Expiration Date, as before a permit is issued or renewed the public has the opportunity to provide comments to regulators. Commenting opportunities are posted at the TDEC website: http://www.state.tn.us/environment/wpc/ppo/.

Figure 29. Knox County Wastewater Utility Service Areas

Sanitary Sewer Overflows and the KUB Consent Agreement

In 1987, the Knoxville Utility Board (KUB) began managing the wastewater network for much of Knoxville and Knox County. The system it inherited was aging, and has ongoing problems with sanitary sewer overflows (SSO, i.e., when untreated sewage escapes from a manhole before reaching the treatment plant). Because of this and other problems in meeting Clean Water Act requirements, local, state, and federal regulatory agencies, as well as the Tennessee Clean Water Network, brought legal action against KUB, which was settled by consent agreement in 2004. Under the agreement, KUB is undertaking a major upgrade of its wastewater collection system. KUB agreed to make information about SSOs more available to the public. All SSOs are posted on the KUB website (http://www1.kub.org/AlphaPager.nsf/SSO_withvol2006?OpenForm). Additional information on SSOs is at http://www1.kub.org/newsite/sso_facts.shtml. The public documents associated with the KUB consent agreement are posted online and downloadable (http://www1.kub.org/newsite/epa_docrep.shtml); public comments are accepted on the reports.

The public should avoid contact with wastewater from an overflowing sewer, which can be a health hazard. Such overflows should be reported to KUB when spotted. Under a separate agreement, KUB reports SSOs to the Knox County Health Department. From the KUB website:

What should I do if I see an overflow? Avoid contact and call KUB at 524-2911. If you can't avoid contact, wash thoroughly with soap and water.

Are sewer overflows health hazards? Sewer overflows may expose you to bacteria. Overflows contain everything that goes down your drain, including water from washing machines, dishwashers, sinks, showers, and toilets. Although the toilet water is diluted by the other water, we urge you to avoid contact. If you can't avoid contact, wash thoroughly with soap and water.

According to the CDC, skin contact does not pose a serious health risk, but there is some risk of disease from swallowing bacteria. The CDC stresses that you should always wash your hands before preparing or eating food, after using the bathroom, and after handling articles that have been exposed to floodwater or sewage. [For more information, see www.bt.cdec.gov/disasters/floods/sanitation.asp.]

If you have an open cut and have skin contact with floodwater or sewage, the CDC says to keep the cut as clean as possible by washing well with soap to control infection. If a wound develops redness, swelling, or drainage, see a doctor.

The number of SSOs is related to the amount of rainfall, as the sewer system (which is currently a *combined system*, which mixes rainwater and wastewater before it reaches the treatment plant) can be overwhelmed in places by a heavy rain. As a result, the number of SSOs reflects precipitation levels as well as system maintenance (removing obstructions or grease blockages that can cause overflows, for example). Given that caveat, the following are summary data for KUB SSOs since the agreement went into effect at the end of 2004:

Figure 30. Number of KUB Sanitary Sewer Overflows, by Month

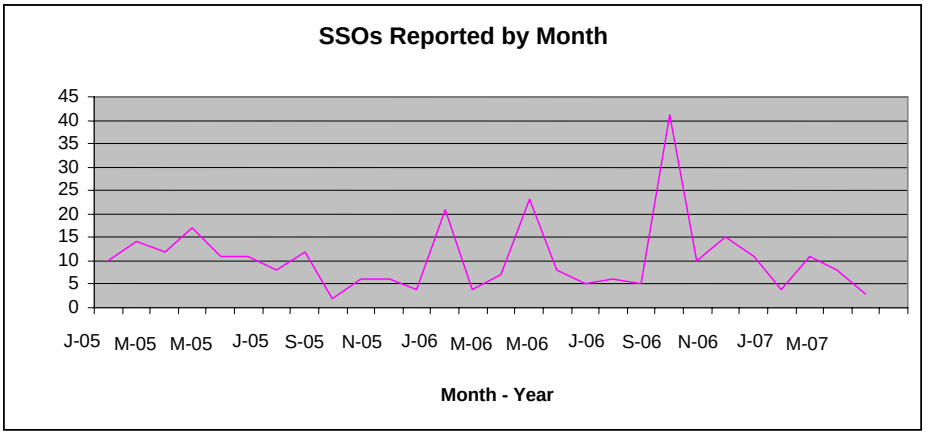
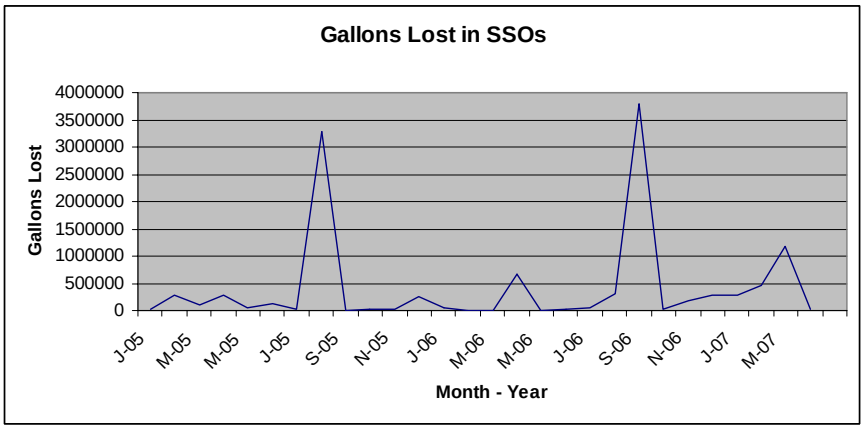


Figure 31. Gallons of Wastewater Lost in KUB Sanitary Sewer Overflows, by Month



Combining the SSO information above with rainfall data posted on the City of Knoxville website (http://www.ci.knoxville.tn.us/engineering/stormwater/rainfall/), we find that the **number** of SSOs in a month is proportional to the amount of rain, but the **volume** of water (gallons) lost from the system in SSOs is not proportional to the amount of rain. This would reflect a situation where rain typically triggers several small SSOs, but that other conditions (such as blockages from grease or debris) not related to the amount of rain trigger major SSO events. The two largest SSO events occurred in a month with an inch of rain (August, 2005), and a month with seven inches of rain (September, 2006). A heavy rainstorm is a necessary but not sufficient cause for a major SSO event – conditions in addition to a heavy rain must be present for a major SSO to occur. An understanding of such relationships is useful for KUB in performing system maintenance and repairs to keep SSOs to a minimum. The detailed data used to generate this analysis is provided in Appendix L.

Domestic Wastewater

As indicated in the county map of wastewater service providers, significant areas in the southern and northern parts of the county are not in any sewer district, and thus residents depend on septic systems for domestic wastewater disposal. Even in other parts of the county where sewer service is available, some suburban and rural residents may remain on septic tanks as well. The Environmental Health Division within the Knox County Health Department is responsible for issuing septic tank permits. Locating all residences in Knox County on septic tanks is an unmet environmental health challenge at this time.

Table 31. Septic Tank Permits Issues in Knox County, 2000 - 2006

Year	Area 1	Area 2	Area 3	Area 4	Total
2000	154	161	85	198	598
2001	142	115	102	202	561
2002	146	148	58	147	499
2003	162	71	93	168	494
2004	*	*	*	*	500
2005	145	117	78	160	500
2006	97	103	109	135	444
				Average	514

* = Date unavailable.

Area 1 comprises Northeast Knox County, Gibbs, Corryton, Mascot, and Maynardville Highway areas. Area 2 comprises North side of Hickory Creek, Hardin Valley Road, Middlebrook Pike, West side of Maynardville Hwy., Norris Freeway to Anderson County line, and Solway. Area 3 comprises West Knoxville and Farragut. Area 4 comprises East Knoxville, Strawberry Plains, South Knoxville, and Alcoa Hwy. areas.

12 - Vector-borne and Zoonotic Diseases

Vector-borne illnesses are diseases that reach people through other animals, such as mosquitoes, that are carriers ("vectors") of the disease-causing organism but are not affected by it themselves. Examples include mosquitoes that carry West Nile virus or ticks that carry Lyme disease. Zoonotic diseases are diseases that affect animals and can also affect people as well. Rabies and avian influenza ("bird flu") are examples of animal diseases that can also affect people. This section discusses these diseases as they are found or may occur in Knox County.

Vector-borne diseases that affect humans which may occur in Knox County include the following, grouped by the animal by which they are spread to humans. The symptoms and treatments of the listed illnesses are detailed in Appendix M.

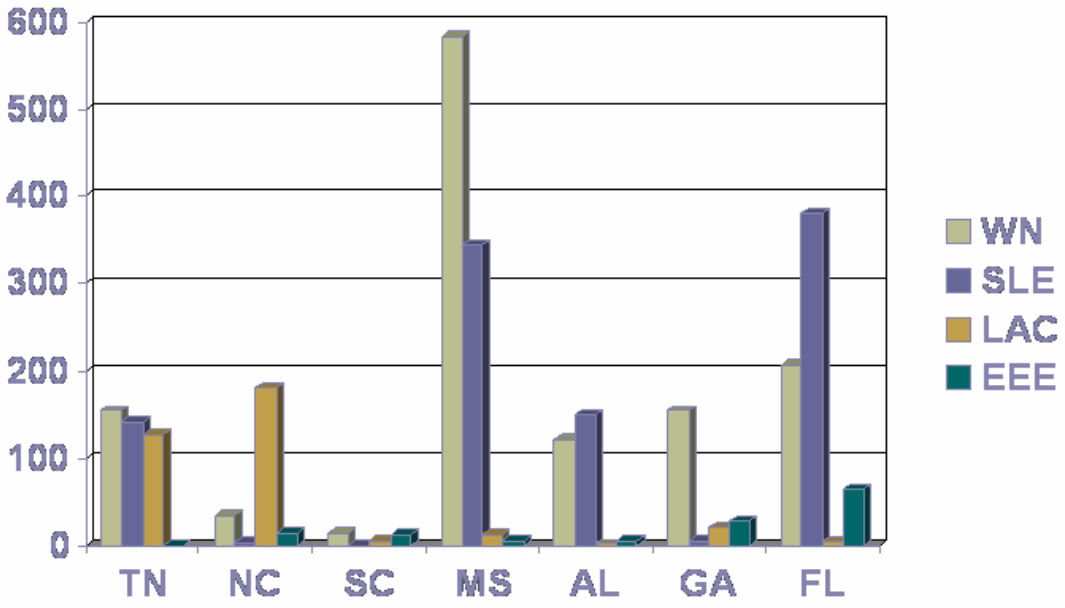
Table 32. Vector-borne Diseases which May Occur in Knox County

Vector	Disease(s)
Mosquitoes	West Nile Virus (WN), La Cross Encephalitis (LAC), Eastern Equine Encephalitis (EEE), St. Louis Encephalitis (SLE)
Ticks	Rocky Mountain Spotted Fever, Lyme Disease, Southern Tick-Associated Rash Illness (STARI), Ehrlichiosis
Fleas	Cat Scratch Disease (possible vector)

Mosquito-Spread Illnesses

The following chart indicates the occurrences of arthropod-borne viruses ("arboviruses," typically meaning mosquito-spread) in the states of the Southeast for the period 1964-2006. The differences from state to state reflect the differences in land use and in endemic species of mosquitoes and carriers, as well as differences in detection and reporting. However, it can be seen that three of the four illnesses (West Nile, St. Louis Encephalitis, and LaCrosse Encephalitis) are established health threats in Tennessee. (Chart courtesy of Dr. Abelardo C. Moncayo, Ph.D., State Medical Entomologist & Vector-Borne Disease Program Director Tennessee Department of Health Communicable and Environmental Disease Services)

Figure 32. Arbovirus Illnesses in the Southeastern US, 1964-2006



Mosquitoes actually feed on nectar for most of their life cycles; however, the female mosquito requires a blood meal to obtain the additional protein it needs for reproduction that it cannot get from its plant-based diet. The mosquito undergoes complete metamorphosis (egg, larva, pupa, adult), with the egg though pupa stages living in water. As a result, elimination of standing water is an important part of mosquito control efforts (discussed below).

Data for selected mosquito-spread diseases in Knox County are provided in the following tables. For EEE and SLE, no human cases have been in Knox County to date. While the case counts may appear low, it is important to remember that many cases do not result in doctor visits and/or are not reported to the state.

Table 33. Occurrence of LaCrosse Encephalitis (California serogroup)

	Knox County		Tennessee	
Year	**Cases**	**Rate / 100,000**	**Cases**	**Rate / 100,000**
1995	0	0.0	0	0.0
1996	0	0.0	1	0.0
1997	1	0.3	8	0.1
1998	5	1.4	9	0.2
1999	1	0.3	6	0.1
2000	7	1.8	19	0.3
2001	3	0.8	17	0.3
2002	4	1.0	15	0.3
2003	2	0.5	14	0.2
2004	3	0.8	13	0.2
2005	data not currently available			
2006	data not currently available			

Table 34. Occurrence of West Nile Disease (no official cases in Tennessee before 2002)

	Knox County		Tennessee	
Year	**Cases**	**Rate / 100,000**	**Cases**	**Rate / 100,000**
2002	0	0.0	10	0.2
2003	1	0.3	17	0.3
2004	0	0.0	14	0.2

Mosquito Control

Personal mosquito control can include wearing long-sleeved clothing in the evening hours when mosquitoes are most active; use of chemical repellents like DEET or natural compounds like catnip or eucalyptus oil, mosquito plant, etc.; use of citronella candles on patios; or even use of a fan – the moving air gusts are the mosquito equivalent of aircraft turbulence, which they attempt to avoid. Birds such as the purple martin may help reduce mosquito numbers, but bats, while they will eat mosquitoes, also eat a number of other insects so mosquitoes are usually only a small part of their diet. Dragonflies are a natural predator of mosquitoes in outdoor ponds. Aeration and fish can also help keep mosquito larvae from being a problem. The Knox County Health Department has a limited number of mosquito fish available to the public for natural mosquito control in outdoor ponds. Some people attract and are bitten more often by mosquitoes than other people, as some people produce more of the odors that attract mosquitoes. Cologne, perfumes, and scented body lotions can attract mosquitoes, and should be avoided if time will be spent outdoors. Dark-colored clothing is also more attractive to mosquitoes.

Citizens can help control mosquitoes on their property and in their neighborhoods by taking steps to reduce habitat where mosquitoes can breed. The Environmental Health Division recommends the following steps:

- Remove unnecessary water-holding containers, especially old tires, cans, buckets, drums, wheelbarrows, and bottles.
- Cover trash containers to keep out rain.
- Turn over plastic wading pools and wheelbarrows when not in use.
- Ensure that your home has tight-fitting screens over windows and doors to keep mosquitoes from entering apartments and homes. Be sure that all screens are in good repair.
- Clean roof gutters and remove standing water from flat roofs.
- Keep drains, culverts, and streams on your property clean of weeds and trash so that the water will drain properly.
- Ensure that stored boat covers are completely drained. Store small boats upside down.
- Drain the water in birdbaths, plant pots, and drip trays twice a week.
- Keep grass cut short and trim shrubs to eliminate hiding places for adult mosquitoes.
- Clean and chlorinate swimming pools, outdoor saunas and hot tubs. Be sure rainwater does not collect on pool, sauna or hot tub covers.
- Clean vegetation and debris from the edges of ponds.
- Fill in hollow tree stumps and rot holes that hold water with sand or concrete.
- Drill holes in the bottoms of recycling containers that are kept outdoors.
- Aerate ornamental pools or stock them with fish. Water gardens are fashionable but become major mosquito producers if they are allowed to stagnate.

At the community level, the Health Department has in place a mosquito control spraying program that operates between midnight and six AM during the months that mosquitoes are breeding (typically, May to October). The locations to be sprayed can be found online (http://www.knoxcounty.org/health/mosquitospray.php) or by calling 865-215-5200. Surveillance (mosquito trapping) is used to determine the species and number of mosquitoes in different locations throughout Knox County and is utilized to determine spraying thresholds. The county only uses a pesticide (Biomist 30+30, a mixture of 30% permethrin and 30% piperonyl butoxide in petroleum distillates) which has been approved by EPA for this application and is only applied by trained and licensed professionals using the minimum level of application needed for control.

The EPA and CDC have issued a joint statement on mosquito control in the United States that recognizes the health importance of public mosquito control programs and the need to use a variety of control techniques – including habitat reduction, monitoring, and biological and chemical controls - as part of an integrated pest management strategy, as described above: http://www.epa.gov/pesticides/health/mosquitoes/mosquitojoint.htm

West Nile virus affects a number of species of wildlife, in particular birds. Scientists believe that the heavy toll this disease has taken on native bird species since arriving from overseas will have a long-term effect on the composition and health of entire ecosystems. The public can submit freshly-dead crows, blue jays, and robins to the Health Department for testing. Once the presence of West Nile has been confirmed in an area, however, additional testing of birds is

unnecessary. If you find a dead bird you would like tested for West Nile virus, call 865-215-5200 for additional information.

Additional information on the Knox County Health Department mosquito control program is available at: http://www.knoxcounty.org/health/vector_mosquito_control.php.

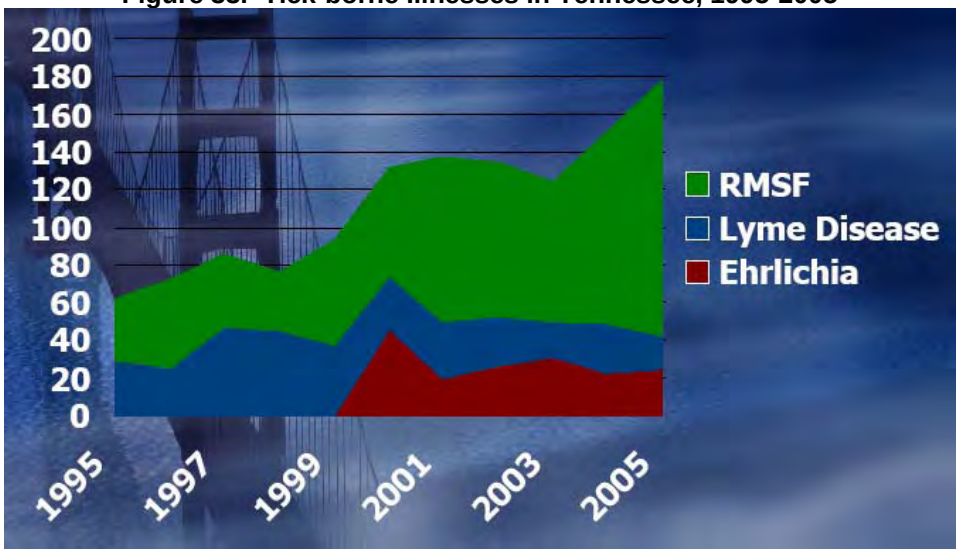
Tick-Spread Illnesses

Ticks are ectoparasites (external parasites) that feed on the blood of humans, mammals and birds, and occasionally reptiles and amphibians. Unlike mosquitoes, ticks undergo incomplete metamorphosis, which means that the young ticks that hatch from the egg look similar to the adult. Ticks typically are found in grass, brush, or trees, from which they can attach themselves to a passing host who brushes against them. It is a sometimes thought that ticks can jump onto passing hosts, but this is not true. After a blood meal, a tick will detach from the host and fall off, but this may take several days. While feeding, the tick can infect the host with a disease it carries. Ticks are important carriers of a number of diseases, including Lyme disease, as discussed below.

Generally, tick-borne diseases correspond to a specific tick-host combination, and are limited in their geographical extent compared to mosquito-borne diseases, as it is more difficult for ticks to spread from place to place. In part for this reason, while widespread spraying is a common means of mosquito control, tick control is more commonly achieved by application of repellents to people, and compounds that either repel ticks or affect their metabolism to pets. This method even extends to control of wild rodents that are a host for the ticks carrying Lyme disease. In New England bait boxes or treated nesting materials are used to apply tick control compounds to feeding rodents. A parasitic ichneumon wasp that lays its eggs in ticks has also been used for biological control, as have guinea fowl, which consume large amounts of ticks (two birds can clear two acres in a year). However, the birds are noisy so this method is only feasible in rural areas.

The following chart (also courtesy of Dr. Moncayo) shows that the three reportable tick-borne illnesses noted above are present in Tennessee. Reportable illnesses are illnesses where doctors are required to report occurrences to the state; STARI was not a reportable illness for the period in the chart below. It is believed that these data underestimate the occurrence of these diseases, as not all cases result in visits to a doctor, and of those, not all are properly identified and reported.

Figure 33. Tick-borne Illnesses in Tennessee, 1995-2005



Data for selected tick-borne diseases in Knox County are provided in the following tables. Again, while the case counts may appear low, many cases do not result in doctor visits and/or are not reported to the state.

Table 35. Occurrence of Rocky Mountain Spotted Fever

	Knox County		Tennessee	
Year	**Cases**	**Rate / 100,000**	**Cases**	**Rate / 100,000**
1995	0	0.0	32	0.6
1996	1	0.3	47	0.9
1997	1	0.3	38	0.7
1998	0	0.0	31	0.6
1999	3	0.8	55	1.0
2000	2	0.5	56	1.0
2001	8	2.1	87	1.5
2002	10	2.6	81	1.5
2003	4	1.0	74	1.3
2004	5	1.3	101	1.8
2005	3	0.8	139	2.5
2006	5	1.3	252	4.6

Table 36. Occurrence of Lyme Disease

	Knox County		Tennessee	
Year	**Cases**	**Rate / 100,000**	**Cases**	**Rate / 100,000**
1995	1	0.3	27	0.5
1996	1	0.3	25	0.5
1997	3	0.8	47	0.9
1998	2	0.5	45	0.8
1999	4	1.1	39	0.7
2000	1	0.3	28	0.5
2001	3	0.8	30	0.5
2002	2	0.5	27	0.4
2003	1	0.3	19	0.3
2004	1	0.3	26	0.4
2005	2	0.5	18	0.3
2006	3	0.8	26	0.4

Table 37. Occurrence of Ehrlichiosis

	Knox County		Tennessee	
Year	**Cases**	**Rate / 100,000**	**Cases**	**Rate / 100,000**
1995	0	0.0	0	0.0
1996	1	0.3	2	0.0
1997	0	0.0	5	0.1
1998	0	0.0	6	0.1
1999	1	0.3	19	0.3
2000	1	0.3	46	0.8
2001	0	0.0	20	0.3
2002	2	0.5	26	0.5
2003	0	0.0	31	0.5
2004	0	0.0	23	0.4
2005	1	0.3	24	0.5
2006	0	0.0	34	0.6

Data for 1995-2003 from http://www2.state.tn.us/health/CEDS/WebAim/interactive.htm
Data for 2004-06 from http://www2.state.tn.us/health/CEDS/WeeklyReports/WeeklyReports.asp

Rabies

Rabies is a preventable viral disease of mammals most often transmitted through the bite of a rabid animal. The vast majority of rabies cases reported each year occur in wild animals like raccoons, skunks, bats, and foxes. Domestic animals account for less than 10% of the reported rabies cases, with cats, cattle, and dogs most often reported rabid. Rabies virus infects the central nervous system, causing encephalopathy and ultimately death.

Over the last 100 years, rabies in the United States has changed dramatically. More than 90% of all animal cases reported annually now occur in wildlife; before 1960 the majority were in domestic animals. The principal rabies hosts today are wild carnivores and bats. The number of rabies-related human deaths in the United States has declined from more than 100 annually at the turn of the century to one or two per year in the1990's, as vaccination has proven nearly 100% successful. In the United States, human fatalities associated with rabies occur in people who fail to seek medical assistance, usually because they were unaware of their exposure. Information on testing for rabies and the incidence of rabies in Knox County for recent years is as follows:

Table 38. Animals Tested for Rabies, Knox County, 1998-2006

Year	Bats	Cats	Dogs	Foxes	Raccoons	Skunks
1998	9	104	147	34	42	6
1999	14	107	158	8	16	7
2000	data not available					
2001	data not available					
2002	20	76	79	7	25	4
2003	28	70	91	20	52	4
2004	22	72	103	19	132	9
2005	31	100	120	2	42	6
2006	35	73	89	1	26	2

Table 39. Positive Cases of Rabies, Knox County, 1999-2006

Year	Bats	Cats	Dogs	Foxes	Raccoons	Skunks
1999	1	0	0	0	0	0
2000	0	0	0	0	0	0
2001	1	0	0	0	0	0
2002	0	0	0	0	0	0
2003	3	0	0	0	0	0
2004	0	0	0	0	0	0
2005	4	0	0	1	0	0
2006	2	0	0	0	0	0

The first case of a raccoon with rabies in Tennessee was reported in 2003. Bats across east Tennessee can carry rabies, but they usually avoid people and pets, and so are less of a public health threat. Skunks also can carry rabies, but are typically slow, not aggressive, and easily avoided. The situations with raccoons, however, is different. Raccoons are common near human habitations, looking for food, and thus increasing the chances of encounters. Infected raccoons are very aggressive, thus resulting in more bites. Raccoons also can infect a greater variety of other species, such as foxes, groundhogs, and squirrels, so that there are additional threats to humans and pets. The federal government has expanded its program of air dropping and manually scattering raccoon baits containing rabies vaccine into east Tennessee to address this problem. The presence of raccoon rabies in Tennessee further emphasizes the need for pets to be vaccinated for rabies. Parents should teach children never to touch wild animals, and to tell if

they have been bitten or scratched by any wild or stray animal. Trash should be placed in well-sealed containers to avoid attracting raccoons or vermin (rats, mice, etc.). Pets should be fed indoors, as raccoons are capable of climbing onto decks to reach trash or pet food.

While baiting has not yet been required in Knox County, it has occurred in adjacent counties. If visiting those counties during baiting, instruct children to leave the baits alone (see photo at the state website, below), and keep pets leashed and under control so they do not eat the baits. If a pet finds bait, do not attempt to take it away or you may be bitten. If a child has contact with bait, wash the affected area. See the state website below for additional precautions.

Locally, pets are required by law to be vaccinated against rabies, and the Knox County Health Department, working with the local veterinary community, offers a series of low-cost ($10) vaccination clinics at area schools on two consecutive weekends each spring. Recent statistics for rabies vaccinations in Knox County are:

Table 40. Rabies Vaccinations, Knox County, 2001-2006

Year	Dogs Vaccinated	Cats Vaccinated	Total
2001	58,014	26,873	84,887
2002	61,125	32,561	93,686
2003	(data not available)		
2004	65,592	30,821	96,413
2005	68,711	29,705	98,416
2006	65,222	28,396	98,810

Stray dogs and cats are potentially carriers of a number of pest-borne and zoonotic diseases. Rabies is only the most fearsome of a number of potential diseases that stray animals might give to a curious child – aside from the potential for bites or other injuries. As a result, Knox County like most other American counties has an animal control program for the capture of stray dogs and cats, as well as other wild creatures that might pose a health threat to the community. Knox County operates the Young-Williams Animal Center (http://www.knoxpets.org/default.asp) as a location for captured strays to receive veterinary care while awaiting reunion with their owners, adoption, or euthanasia if they cannot be placed. Unfortunately, this fate awaits an increasing number of dogs and cats every year - over 12,000 in 2006. While the number of animals reclaimed by owners or released to rescue groups has increased, the number of adoptions has decreased, so the total of animals outgoing has remained fairly constant. With an increasing number of animals coming in to the shelter, this has led to an increase in euthanasia:

Table 41. Fate of Animals in Knox County Animal Shelters, 1998-2006

Shelter Statistics	1998	1999	2000	2001	2002	2003	2004	2005	2006
Incoming Animals	14822	13759	13423	11864	12331	13835	16033	16195	16914
Adopted	3647	3505	3567	1500	2326	2649	2953	2448	2194
Reclaimed by Owner	694	715	872	783	841	760	878	960	1078
Released to Rescue	751	552	584	1059	789	1080	888	1087	1200
Outgoing Animals	5092	4772	5023	3342	3956	4489	4719	4495	4472
Euthanized	9280	8496	8092	7718	8009	8966	10848	11546	12090

1998 - 2000: Statistics of the Humane Society of the Tennessee Valley
2001 - 2006: Statistics of the Young - Williams Animal Center

State information on rabies baiting is at: http://www2.state.tn.us/health/FactSheets/raccoon.htm
US wildlife rabies management program information is at: http://www.aphis.usda.gov/ws/rabies/
Additional rabies information from the CDC is available at: http://www.cdc.gov/ncidod/dvrd/rabies/

Community Pet Resources

The University of Tennessee College of Veterinary Medicine (UTCVM) has a number of educational resources to offer the community. A free program to educate schoolchildren regarding the risks of petting a stray dog is available (http://www.vet.utk.edu/dogbiteprevention/); additional community educational programs offered by UTCVM include their annual open house (http://www.vet.utk.edu/openhouse/), and, in conjunction with partners in the community, the HABIT, HALT, and HERO programs. HABIT stands for Human-Animal Bond in Tennessee, and sponsors programs which foster pet visitation to nursing homes, assisted-living residences, retirement centers, mental health centers, residences for children with special needs, rehabilitation facilities, hospital settings, and other facilities. Studies have shown medical benefits to such individuals from the opportunity to interact with animals. (http://www.vet.utk.edu/habit/about.html) HALT is Humans and Animals Learning Together, which provides a therapeutic intervention for at-risk adolescents through dog obedience training. (http://www.vet.utk.edu/halt/) HERO, Humane Education and Responsible Ownership, is a community educational program on pet ownership topics (http://www.vet.utk.edu/hero/).

Rodents

Rats and mice are the poster children of urban vermin. Whether infesting housing or restaurants, they can spread disease through their bites and droppings (see Appendix M), and cost the economy nationwide hundreds of millions of dollars annually. Worldwide, up to one-fifth of the food supply is eaten, spoiled, or destroyed by rats and mice. (On the other hand, in wealthy countries up to one-third of food may be disposed as garbage – also potentially becoming rodent food!)

In urban areas or restaurants, rodents face few predators, and can thus breed prolifically causing an infestation. Control of rodents in such situations then depends on use of poisons, traps, repellents, etc. It is believed cats were domesticated by the ancient Egyptians for the control of rodents.

Rats often chew electrical cables. Around 26% of all electrical cable breaks are caused by rats, and around 18% of all phone cable breaks. Around 25% of all fires of unknown origin are estimated to be caused by rats. Rats and mice often infest attics. Infestations can occur in even the cleanest homes and such an infestation is not necessarily a sign of poor housekeeping.

There are currently no reliable statistics on the prevalence of rodents and rodent problems in Knoxville; however, a corrective action for this is being implemented. New software on order for the Environmental Health Division of the KCHD will allow efficient tracking of rodent complaints in the future.

Local residents experiencing rodent problems should contact the Environmental Health Division of the KCHD at 865-215-5205.

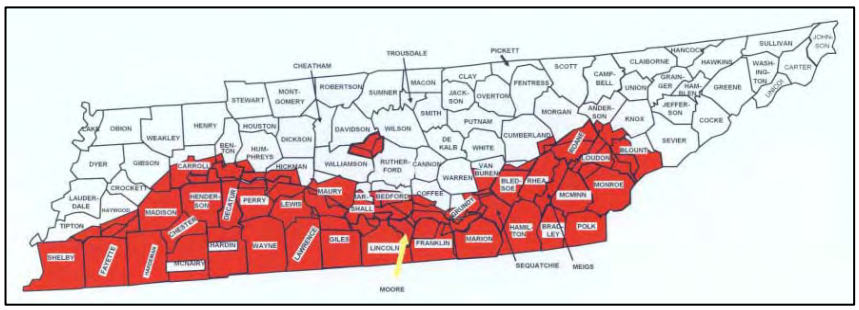
The Johns Hopkins University School of Public Health in Baltimore has done studies on rats in the urban environment and rat eradication, which can be at least taken as an indication of the potential scope of the problem in cities: http://www.citypaper.com/news/story.asp?id=12787. There are few epidemiological studies on rodent bites and infestations in urban areas, or the risk factors most closely associated with such infestations. One such recent study was reported for New York City in 1998: http://aje.oxfordjournals.org/cgi/reprint/148/1/78.

Additional information on rodents, their control, and the diseases they carry can be found at the following website, which is an entry point to extensive information: http://www.cdc.gov/rodents/.

Fire Ants

While not a vector-borne *disease* nor a zoonotic *illness,* a new arthropod-related environmental health threat has recently reached Knox County: fire ants. The fire ant has been slowly spreading north since accidentally being imported into Mobile, Alabama in 1918 on plants from South America. They were discovered in Knox County for the first time in the fall of 2002, and an agricultural quarantine was extended in 2006 to include the western part of Knox County (red area on map). They will continue to spread north (a May, 2007 newspaper report indicates fire ants are now present in Karns) until cold winter weather checks their advance. Unfortunately, with milder winters expected to continue due to global warming, their advance will not be checked until they have spread throughout Knox County and beyond.

Figure 34. Spread of Fire Ants into Tennessee, 2006



Map Reference: http://fireants.utk.edu/documents/TN2006Areas.pdf

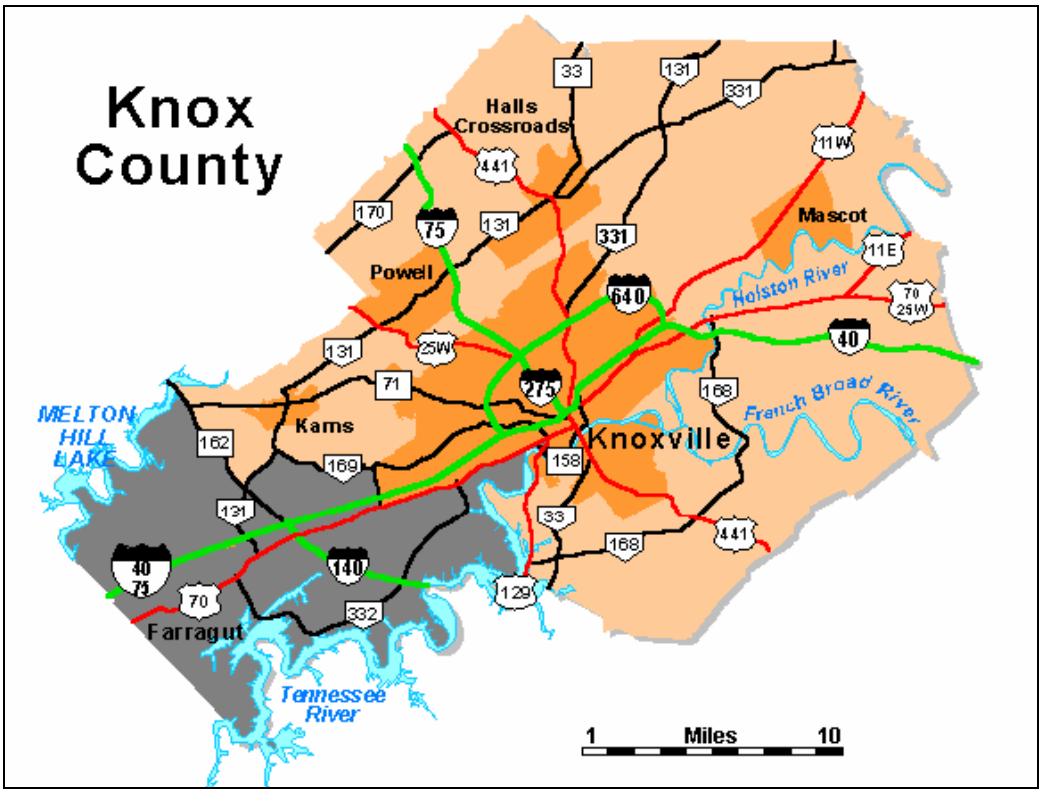
Fire ants are named for the fiery burning sensation caused by their bite. About 1% of those bitten have a severe allergic reaction and must have emergency medical attention for shock. The pain from an individual bite has been compared to a wasp sting. While tiny, fire ants form large colonies of loosely mounded dirt, and it is easy to step into an anthill accidentally and receive many bites. Pets, small farm animals, and young children have been killed or badly injured in this manner. In urban areas, they can enter homes, destroy gravestones, and damage electrically-based utilities (electric, phone, cable TV, central air conditioners) by attacking insulation of wires. They prefer to nest in disturbed areas, including urban areas and new subdivisions (where they can be carried in on fill dirt). Where other ants are present, they will attack the colonies. They can damage crops and other plants, and kill ground-nesting birds or other small animals.

Recommendations from the UT agricultural extension for control of fire ants in urban areas are available at: http://www.utextension.utk.edu/publications/spfiles/sp419.pdf. In addition to chemical insecticides, the phorid fly (a parasite of the fire ant) has been introduced in the Southeastern US and provides a natural check on the spread of this pest as well. Phorid flies are also present in Knox County and most other areas of Tennessee where fire ants occur (see: http://fireants.utk.edu/FireantPNGImages/phorid2005.png). There are two species of fire ants (red and black), and a hybrid of them. Hybrid and black types are found in Knox County.

The quarantined area of Knox County in the state regulations is illustrated in the map below; the legal description is: "That portion of the county lying south of a line beginning at the Anderson/Knox County line on Tennessee Highway 62 and then continuing east along Tennessee Highway 62 until reaching Tennessee Highway 131 and then continuing south along Tennessee Highway 131 until reaching Middlebrook Pike and then continuing southeast along Middlebrook Pike until reaching North Cedar Bluff Road and then continuing south along North Cedar Bluff Road until reaching U. S. Highway 70 and then continuing northeast along U. S. Highway 70 until reaching U. S. Highway 129 and then continuing south along U. S. Highway 129 until reaching the Blount/Knox County line." Within the quarantined area, insecticide treatment

and/or an inspection and permit is required before any of several materials (plants with roots and soil attached, grass sod, compost, humus, soil-moving equipment) are allowed through or into a non-quarantined area. The complete regulation is attached as Appendix N. Since the quarantine area bisects western Knox County, this will have a significant economic impact on plant nurseries and construction companies in the area. Links with additional information include: http://www.clemson.edu/sandhill/page.htm?pageId=2170; http://fireants.utk.edu/default.HTM; and http://www.metropulse.com/dir_zine/dir_2003/1310/t_cover2.html

Figure 35. Area of Fire Ant Agricultural Quarantine, 2006 (gray shading)



Other Invasive Species

There are a number of additional invasive species that do not directly impact human health but have a negative impact on the local ecology and the landscape, and an economic impact for residents, and thus in a broad sense negatively impact the community. While not discussed in detail here, references are provided for those interested in investigating the effects of these organisms on our local ecology. Invasive plants include such well-known species as kudzu, mimosa, tree of heaven, privet, vinca, dandelion, and English Ivy. Information on exotic plants in the state can be found at: http://www.tneppc.org/Invasive_Exotic_Plant_List/gtr_srs062.pdf

The impacts of invasive species are second only to habitat destruction as a cause of global biodiversity loss. The current environmental, economic, and health costs of the 50,000 invasive species in the United States alone could exceed $137,000,000,000 (137 billion dollars) per year, more than all other natural disasters combined, according to a January, 2000 article in the journal BioScience: http://people.hws.edu/bshelley/Teaching/PimentelEtal00CostExotics.pdf.

Control of kudzu is typical of the diligence needed to control invasive plants: The Tennessee Department of Agriculture notes that "Eliminating kudzu requires constant vigilance, since this vine grows as much as a foot per day, and birds spread its seeds… Persistence is the key. It may take up to 10 years to find and eradicate every sprout, and constant effort is required to combat invasion from neighboring property." Eradication methods can range from chemical treatment to grazing and placing opaque covers over tubers to prevent resprouting. For more details, see: http://www.state.tn.us/agriculture/forestry/health/vines.html

Non-native animal species include birds (pigeons, starlings, and English sparrows), fish (bluegill), mammals (nutria), shellfish (zebra mussel), insects (hemlock wooly adelgid, gypsy moth), and even fungi (Dutch elm disease, chestnut blight fungus). Overviews of the subject and portals to more extensive information can be found at these sites: http://invasivespecies.nbii.gov/, http://www.invasivespeciesinfo.gov/, http://tncweeds.ucdavis.edu/gallery.html, http://www.fws.gov/contaminants/Issues/InvasiveSpecies.cfm, and http://www.invasive.org/.

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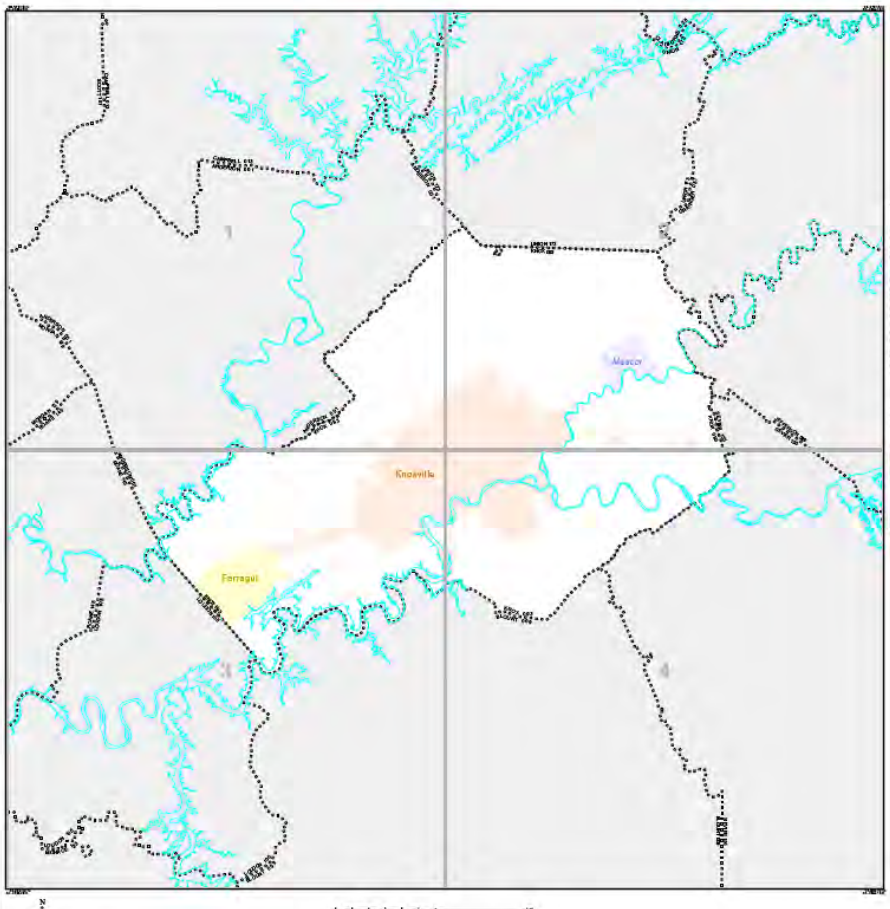
Appendices

Appendix A

Knox County Census Tract Maps

(The following images are presented for illustration only. For detailed examination of census tract boundaries, please see the pdf files of census tract 2000 boundaries downloaded from the U.S. Census website. The pdf files may be magnified without blurring to a greater degree than the images below, allowing a detailed examination of where tract boundaries occur.)

INDEX FOR CENSUS TRACT OUTLINE MAP (CENSUS 2000)



INDEX MAP LEGEND

FEATURE	FEATURE STYLE
INTERNATIONAL	
AIR (FEDERAL)	
TIGER Land/WIL	
STGA/ANVSA/TDSA	
TRIBAL SUBDIVISION	
AIR (State)	
SDA/SA	
ANRC	
STATE	
COUNTY	
MINOR CIVIL DIV.	
Consolidated City	
Incorporated Place*	
Census Designated Place*	

CENSUS TRACT OUTLINE MAP LEGEND (CENSUS 2000)

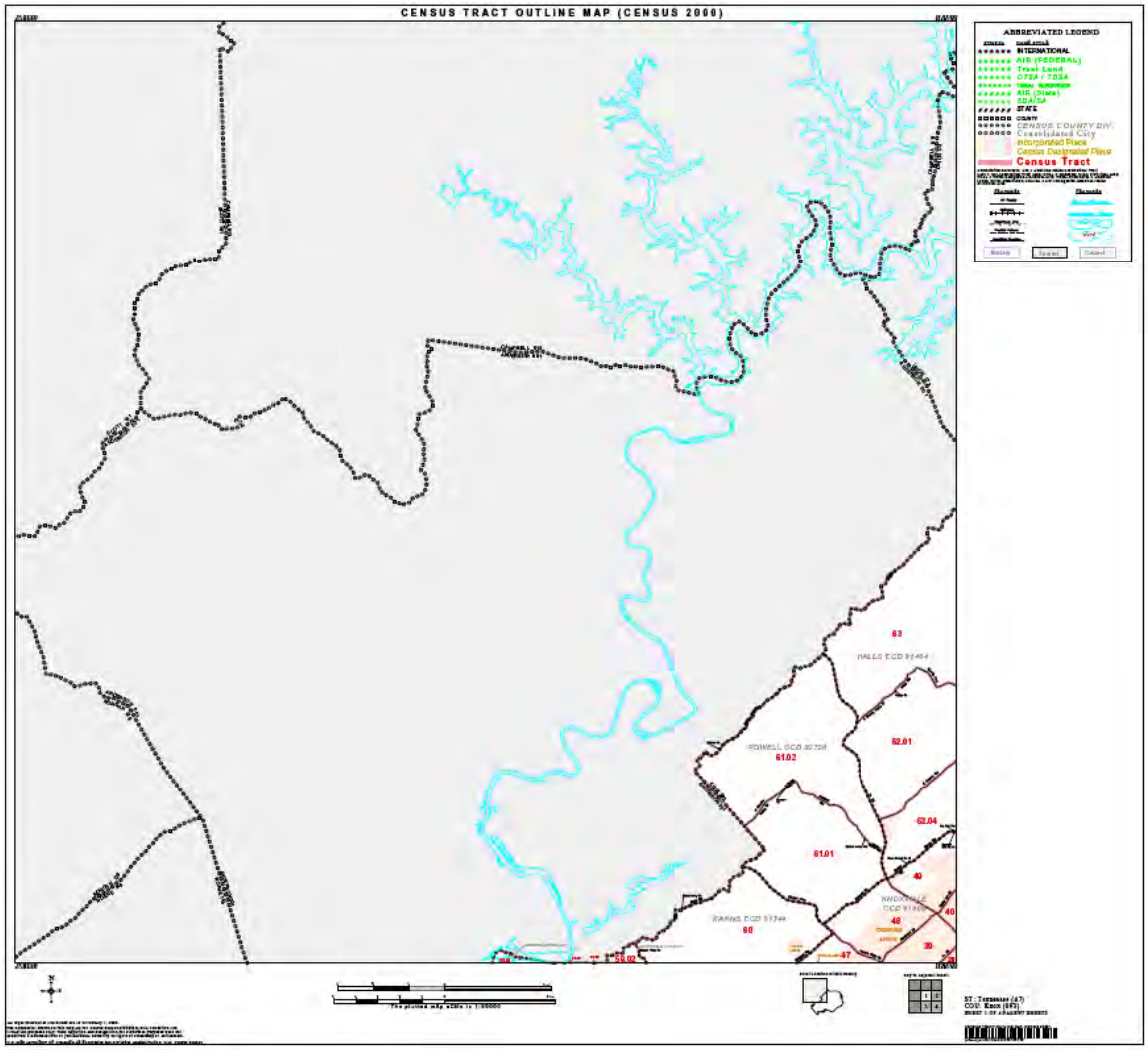
FEATURE DESCRIPTION	FEATURE	FEATURE STYLE
International		CANADA
American Indian Reservation (Federal)		L'ANSE RES (1960)
BIA-Recognized Trust Land, American Indian Land		T1960
Oklahoma Tribal Statistical Area, Oklahoma Tribal Statistical Area, BIA-Designated Statistical Area		KAW OTSA (6840)
American Indian Tribal Subdivision		MONTOGIAN
American Indian Reservation (State)		Tetlin Res (4128)
State-Designated American Indian Statistical Area		Lumbee (9875)
Alaska Native Regional Corporation		NAMA ANRC 52128
Place or Statistically Equivalent Entity		NEW YORK 36
County or Statistically Equivalent Entity		0000 025
Minor Civil Division (MCD)*		FIKE TWP 58742
Census County Division (CCD)		KULA CCD 91880
Consolidated City		Milford 47500
Incorporated Place*		Rome 53410
Census Designated Place (CDP)*		Zona 64187
Census Tract		5702.01

FEATURE	FEATURE STYLE	FEATURE	FEATURE STYLE
All Roads		Stream or River	
Railroad		Intermittent Stream or Intermittent River	
Coastline or Water Area		Large River or Lake	
Other Water or Intermittent Water		Glacier	
Selected Census Tract Boundary of Interest		Military Installation	
Block Area		Double Subject Area	

The plotted map scale is 1:12000

N

ST: Tennessee (47)
COU: Knox (093)


CENSUS TRACT OUTLINE MAP (CENSUS 2000)
ABBREVIATED LEGEND
INTERNATIONAL
AIR (FEDERAL)
Trust Land
STATE
COUNTY
Incorporated Place
Census Designated Place
Census Tract
63
HALLS CCD 91464
FIDWELL CCD 90728
61.02
62.01
62.04
61.01
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48
39
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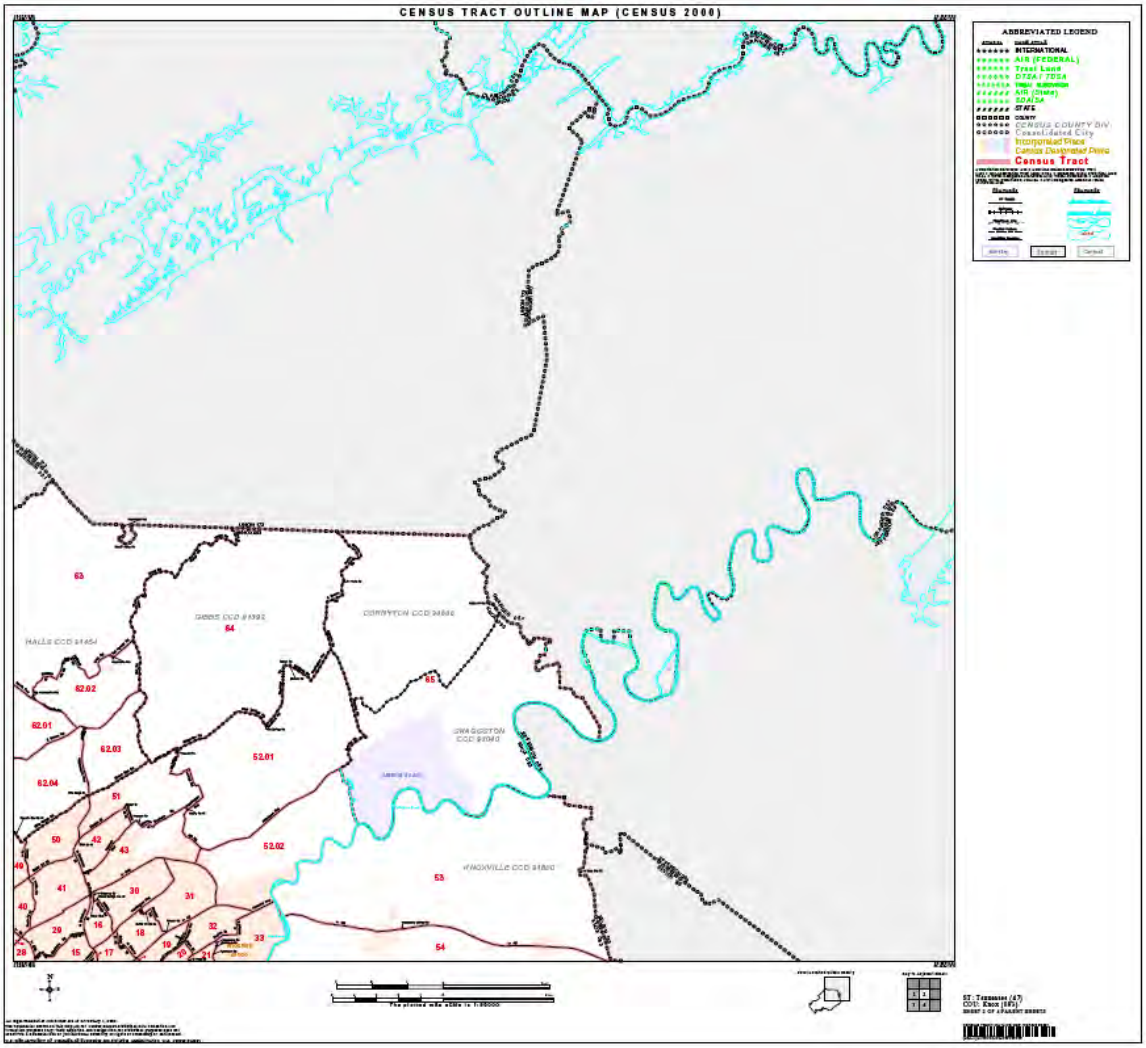
RARNS CCD 91744
60
58.02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Trust Land
DTSA / TDSA
AIR (State)
SDA/SA
STATE
COUNTY
CENSUS COUNTY DIV.
Consolidated City
Incorporated Place
Census Designated Place
Census Tract
HALLS CCD 94461
GIBBS CCD 94392
CORRYTON CCD 94464
LONGSTON CCD 94463
KNOXVILLE CCD 94460
63
64
62.02
62.01
62.03
62.04
52.01
51
50
42
43
49
41
40
39
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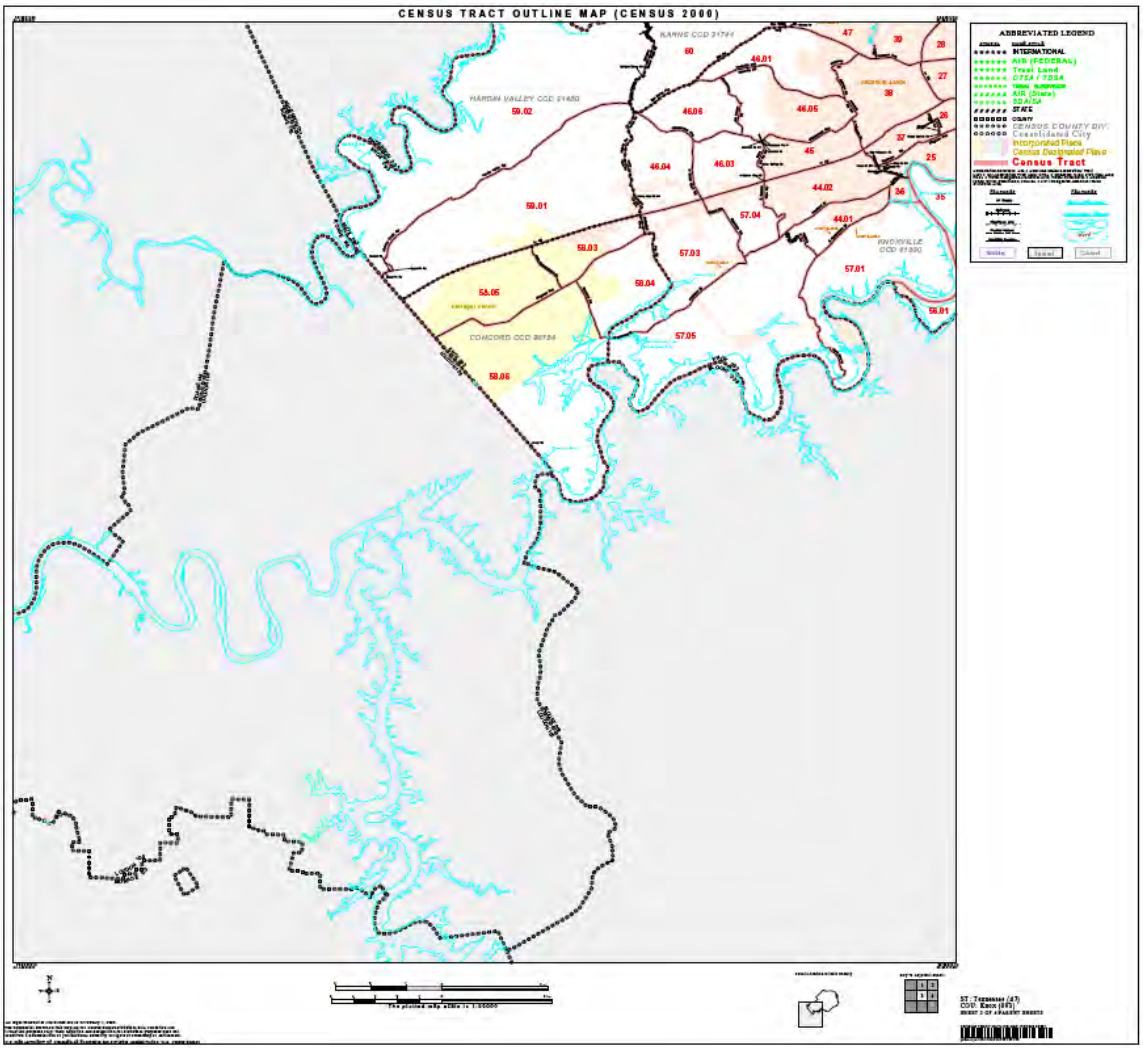
17
21
ST: Tennessee (47)
COU: Knox (093)


CENSUS TRACT OUTLINE MAP (CENSUS 2000)
ABBREVIATED LEGEND
INTERNATIONAL
AIR (FEDERAL)
Trust Land
STATE
COUNTY
Consolidated City
Incorporated Place
Census Designated Place
Census Tract
HARTMAN VALLEY CCD
RINGVILLE CCD
CONCORD CCD
60
59.02
59.01
58.05
58.06
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58.04
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57.01
56.01
46.01
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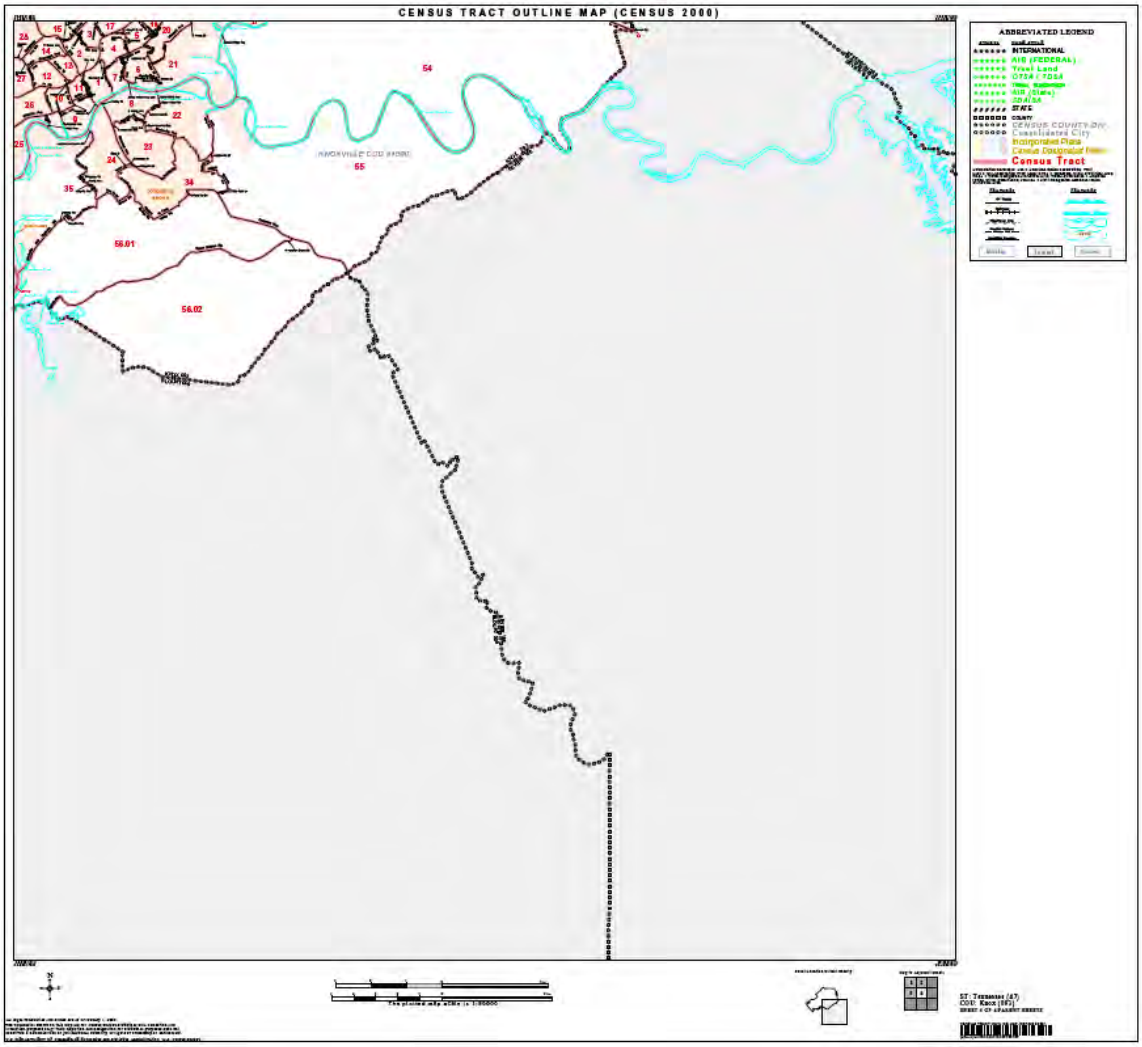

CENSUS TRACT OUTLINE MAP (CENSUS 2000)
ABBREVIATED LEGEND
INTERNATIONAL
AIR (FEDERAL)
Trust Land
STATE
COUNTY
Incorporated Place
Census Tract
54
55
56.01
56.02
KNOXVILLE COD (KNOX)
ST: Tennessee (47)
COU: Knox (093)

Appendix B
Most Common Causes of Foodborne Illness in the US

Disease Agent	Description
Noroviruses (Norwalk-like Viruses)	Noroviruses (genus *Norovirus*, family *Caliciviridae*) are a group of related single-stranded RNA viruses that cause acute gastroenteritis in humans. Norovirus was recently approved as the official genus name for the group of viruses provisionally described as "Norwalk-like viruses" (NLV). The incubation period for norovirus-associated gastroenteritis in humans is usually between 24 and 48 hours (median in outbreaks 33 to 36 hours), but cases can occur within 12 hours of exposure. Norovirus infection usually presents as acute-onset vomiting, watery non-bloody diarrhea with abdominal cramps, and nausea. Low-grade fever also occasionally occurs, and vomiting is more common in children. Dehydration is the most common complication, especially among the young and elderly, and may require medical attention. Symptoms usually last 24 to 60 hours. Recovery is usually complete and there is no evidence of any serious long-term sequelae. Studies with volunteers given stool filtrates have shown that asymptomatic infection may occur in as many as 30% of infections, although the role of asymptomatic infection in norovirus transmission is not well understood. Noroviruses are transmitted primarily through the fecal-oral route, either by consumption of fecally contaminated food or water or by direct person-to-person spread. Environmental contamination may also act as a source of infection. Good evidence exists for transmission due to aerosolization of vomitus that presumably results in droplets contaminating surfaces or entering the oral mucosa and being swallowed. No evidence suggests that infection occurs through the respiratory system. Noroviruses are highly contagious and as few as 10 viral particles may be sufficient to infect an individual. During outbreaks, several modes of transmission have been documented; for example, initial foodborne transmission in a restaurant, followed by secondary person-to-person transmission to household contacts. For additional information see: http://www.cdc.gov/ncidod/dvrd/revb/gastro/norovirus.htm
Campylobacter	Most people who become ill with campylobacteriosis get diarrhea, cramping, abdominal pain, and fever within 2 to 5 days after exposure to the organism. The diarrhea may be bloody and can be accompanied by nausea and vomiting. The illness typically lasts 1 week. Some persons who are infected with *Campylobacter* don't have any symptoms at all. In persons with compromised immune systems, *Campylobacter* occasionally spreads to the bloodstream and causes a serious life-threatening infection. For additional information see: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/Campylobacter_g.htm
Salmonella	Most persons infected with Salmonella develop diarrhea, fever, and abdominal cramps 12 to 72 hours after infection. The illness usually lasts 4 to 7 days, and most persons recover without treatment. However, in some persons the diarrhea may be so severe that the patient needs to be hospitalized. In these patients, the Salmonella infection may spread from the intestines to the blood stream, and then to other body sites and can cause death unless the person is treated promptly with antibiotics. The elderly, infants, and those with impaired immune systems are more likely to have a severe illness. For additional information see: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/salmonellosis_g.htm

(continued next page)

Disease Agent	Description
Clostridium perfringens	C. perfringens is a ubiquitous, anaerobic, gram-positive, spore-forming bacillus and a frequent contaminant of meat and poultry. C. perfringens food poisoning is characterized by onset of abdominal cramps and diarrhea 8-16 hours after eating contaminated meat or poultry. By sporulating, this organism can survive high temperatures during initial cooking; the spores germinate during cooling of the food, and vegetative forms of the organism multiply if the food is subsequently held at temperatures of 60 F-125 F (16 C-52 C). If served without adequate reheating, live vegetative forms of C. perfringens may be ingested. The bacteria then elaborate the enterotoxin that causes the characteristic symptoms of diarrhea and abdominal cramping.
Giardia intestinalis (Giardia lamblia)	Giardiasis (GEE-are-DYE-uh-sis) is a diarrheal illness caused by a one-celled, microscopic parasite, *Giardia intestinalis* (also known as *Giardia lamblia*). Once an animal or person has been infected with *Giardia intestinalis*, the parasite lives in the intestine and is passed in the stool. Because the parasite is protected by an outer shell, it can survive outside the body and in the environment for long periods of time. During the past 2 decades, *Giardia* infection has become recognized as one of the most common causes of waterborne disease (found in both drinking and recreational water) in humans in the United States . *Giardia* are found worldwide and within every region of the United States. *Giardia* is found in soil, food, water, or surfaces that have been contaminated with the feces from infected humans or animals. You **can** become infected after accidentally swallowing the parasite; you **cannot** become infected through contact with blood. *Giardia* can be spread by: • Accidentally putting something into your mouth or swallowing something that has come into contact with feces of a person or animal infected with *Giardia*. • Swallowing recreational water contaminated with *Giardia* in swimming pools, hot tubs, jacuzzis, fountains, lakes, rivers, springs, ponds, or streams that can be contaminated with sewage or feces from humans or animals. • Eating uncooked food contaminated with *Giardia*. • Accidentally swallowing *Giardia* picked up from surfaces (such as bathroom fixtures, changing tables, diaper pails, or toys) contaminated with feces from an infected person. For additional information see: http://www.cdc.gov/ncidod/dpd/parasites/giardiasis/factsht_giardia.htm
Staphylococcus aureus	*Staphylococcus aureus* is a common bacterium found on the skin and in the noses of up to 25% of healthy people and animals. *Staphylococcus aureus* is important because it has the ability to make seven different toxins that are frequently responsible for food poisoning. Staphylococcal food poisoning is a gastrointestinal illness. It is caused by eating foods contaminated with toxins produced by *Staphylococcus aureus* . The most common way for food to be contaminated with *Staphylococcus* is through contact with food workers who carry the bacteria or through contaminated milk and cheeses. *Staphylococcus* is salt tolerant and can grow in salty foods like ham. As the germ multiplies in food, it produces toxins that can cause illness. Staphylococcal toxins are resistant to heat and cannot be destroyed by cooking. Foods at highest risk of contamination with *Staphylococcus aureus* and subsequent toxin production are those that are made by hand and require no cooking. Some examples of foods that have caused staphylococcal food poisoning are sliced meat, puddings, some pastries and sandwiches. Staphylococcal toxins are fast acting, sometimes causing illness in as little as 30 minutes. Symptoms usually develop within one to six hours after eating contaminated food. Patients typically experience several of the following: nausea, vomiting, stomach cramps, and diarrhea. The illness is usually mild and most patients recover after one to three days. In a small minority of patients the illness may be more severe. For more information see: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/staphylococcus_food_g.htm

Disease Agent	Description
Toxoplasma gondii	A single-celled parasite called *Toxoplasma gondii* causes toxoplasmosis. While the parasite is found throughout the world, more than 60 million people in the United States may be infected with the Toxoplasma parasite. Of those who are infected, very few have symptoms because a healthy person's immune system usually keeps the parasite from causing illness. However, pregnant women and individuals who have compromised immune systems should be cautious; for them, a *Toxoplasma* infection could cause serious health problems. A *Toxoplasma* infection occurs by: • Accidentally swallowing cat feces from a *Toxoplasma*-infected cat that is shedding the organism in its feces. This might happen if you were to accidentally touch your hands to your mouth after gardening, cleaning a cat's litter box, or touching anything that has come into contact with cat feces. Eating contaminated raw or partly cooked meat, especially pork, lamb, or venison; by touching your hands to your mouth after handling undercooked meat. • Contaminating food with knives, utensils, cutting boards and other foods that have had contact with raw meat. • Drinking water contaminated with *Toxoplasma*. • Receiving an infected organ transplant or blood transfusion, though this is rare. For assitional information see: http://www.cdc.gov/ncidod/dpd/parasites/toxoplasmosis/factsht_toxoplasmosis.htm
Yersinia enterocolitica	Yersiniosis is an infectious disease caused by a bacterium of the genus *Yersinia*. In the United States, most human illness is caused by one species, *Y. enterocolitica*. Infection with *Y. enterocolitica* can cause a variety of symptoms depending on the age of the person infected. Infection with *Y. enterocolitica* occurs most often in young children. Common symptoms in children are fever, abdominal pain, and diarrhea, which is often bloody. Symptoms typically develop 4 to 7 days after exposure and may last 1 to 3 weeks or longer. In older children and adults, right-sided abdominal pain and fever may be the predominant symptoms, and may be confused with appendicitis. In a small proportion of cases, complications such as skin rash, joint pains, or spread of bacteria to the bloodstream can occur. Infection is most often acquired by eating contaminated food, especially raw or undercooked pork products. The preparation of raw pork intestines (chitterlings) may be particularly risky. Infants can be infected if their caretakers handle raw chitterlings and then do not adequately clean their hands before handling the infant or the infant's toys, bottles, or pacifiers. Drinking contaminated unpasteurized milk or untreated water can also transmit the infection. Occasionally *Y. enterocolitica* infection occurs after contact with infected animals. On rare occasions, it can be transmitted as a result of the bacterium passing from the stools or soiled fingers of one person to the mouth of another person. This may happen when basic hygiene and hand washing habits are inadequate. Rarely, the organism is transmitted through contaminated blood during a transfusion. For additional information see: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/Yersinia_g.htm
Shigella	Most who are infected with *Shigella* develop diarrhea, fever, and stomach cramps starting a day or two after they are exposed to the bacterium. The diarrhea is often bloody. Shigellosis usually resolves in 5 to 7 days. In some persons, especially young children and the elderly, the diarrhea can be so severe that the patient needs to be hospitalized. A severe infection with high fever may also be associated with seizures in children less than 2 years old. Some persons who are infected may have no symptoms at all, but may still pass the *Shigella* bacteria to others. For additional information see: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/shigellosis_g.htm

Disease Agent	Description
Clostridium botulinum	Botulism is a rare but serious paralytic illness caused by a nerve toxin that is produced by the bacterium *Clostridium botulinum*. There are three main kinds of botulism. Foodborne botulism is caused by eating foods that contain the botulism toxin. Wound botulism is caused by toxin produced from a wound infected with *Clostridium botulinum*. Infant botulism is caused by consuming the spores of the botulinum bacteria, which then grow in the intestines and release toxin. All forms of botulism can be fatal and are considered medical emergencies. Foodborne botulism can be especially dangerous because many people can be poisoned by eating a contaminated food. For more, see: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/botulism_g.htm
Escherichia coli O157:H7	*Escherichia coli* O157:H7 is a leading cause of foodborne illness. Based on a 1999 estimate, 73,000 cases of infection and 61 deaths occur in the United States each year. Infection with E. coli often leads to bloody diarrhea, and occasionally to kidney failure. People can become infected with *E.coli* O157:H7 in a variety of ways. Though most illness has been associated with eating undercooked, contaminated ground beef, people have also become ill from eating contaminated bean sprouts or fresh leafy vegetables such as lettuce and spinach. Person-to-person contact in families and child care centers is also a known mode of transmission. In addition, infection can occur after drinking raw milk and after swimming in or drinking sewage-contaminated water. Consumers can prevent *E. coli* O157:H7 infection by thoroughly cooking ground beef, avoiding unpasteurized milk, and by washing hands carefully before preparing or eating food. Fruits and vegetables should be washed well, but washing may not remove all contamination. Public service announcements on television, radio, or in the newspapers will advise you which foods to avoid in the event of an outbreak. Because the organism lives in the intestines of healthy cattle, preventive measures on cattle farms, during meat processing, and during the growth, harvest and processing of produce are being investigated. For additional information see: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/Escherichiacoli_g.htm
Listeria monocytogenes	Listeriosis, a serious infection caused by eating food contaminated with the bacterium *Listeria monocytogenes*, has recently been recognized as an important public health problem in the United States. The disease affects primarily pregnant women, newborns, and adults with weakened immune systems. Although healthy persons may consume contaminated foods without becoming ill, those at increased risk for infection can probably get listeriosis after eating food contaminated with even a few bacteria. Persons at risk can prevent *Listeria* infection by avoiding certain high-risk foods and by handling food properly. A person with listeriosis has fever, muscle aches, and sometimes gastrintestinal symptoms such as nausea or diarrhea. If infection spreads to the nervous system, symptoms such as headache, stiff neck, confusion, loss of balance, or convulsions can occur. Infected pregnant women may experience only a mild, flu-like illness; however, infections during pregnancy can lead to miscarraige or stillbirth, premature delivery, or infection of the newborn. *Listeria monocytogenes* is found in soil and water. Vegetables can be contaminated from the soil or manure used as fertilizer. Animals can carry the bacterium without appearing ill and can contaminate foods of animal origin such as meats and dairy products. The bacterium has been found in a variety of raw foods, such as uncooked meats and vegetables, as well as in processed foods that become contaminated after processing, such as soft cheeses and cold cuts at the deli counter. Unpasteurized (raw) milk or foods made from unpasteurized milk may contain the bacterium. *Listeria* is killed by pasteurization and cooking; however, in certain ready-to-eat foods such as hot dogs and deli meats, contamination may occur after cooking but before packaging. For more information see: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/listeriosis_g.htm

Disease Agent	Description
Vibrio parahaemolyticus	*Vibrio parahaemolyticus* is a bacterium in the same family as those that cause cholera. It lives in brackish saltwater and causes gastrointestinal illness in humans. *V. parahaemolyticus* naturally inhabits coastal waters in the United States and Canada and is present in higher concentrations during summer; it is a halophilic, or salt-requiring organism. When ingested, *V. parahaemolyticus* causes watery diarrhea often with abdominal cramping, nausea, vomiting fever and chills. Usually these symptoms occur within 24 hours of ingestion. Illness is usually self-limited and lasts 3 days. Severe disease is rare and occurs more commonly in persons with weakened immune systems. *V. parahaemolyticus* can also cause an infection of the skin when an open wound is exposed to warm seawater. For additional information see: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/Vibrioparahaemolyticus_g.htm
Cryptosporidium	Cryptosporidiosis is a diarrheal disease caused by microscopic parasites of the genus *Cryptosporidium*. Once an animal or person is infected, the parasite lives in the intestine and passes in the stool. The parasite is protected by an outer shell that allows it to survive outside the body for long periods of time and makes it very resistant to chlorine- based disinfectants. Both the disease and the parasite are commonly known as "crypto." *Cryptosporidium* is found in soil, food, water, or surfaces that have been contaminated with infected human or animal feces. If a person swallows the parasite they become infected. You **cannot** become infected through contact with blood. The parasite can be spread by • Accidentally putting something into your mouth or swallowing something that has come into contact with feces of a person or animal infected with *Cryptosporidium*. • Swallowing recreational water contaminated with *Cryptosporidium* (Recreational water includes water in swimming pools, hot tubs, jacuzzis, fountains, lakes, rivers, springs, ponds, or streams that can be contaminated with sewage or feces from humans or animals.) **Note:** *Cryptosporidium* can survive for days in swimming pools with adequate chlorine levels. • Eating uncooked food contaminated with *Cryptosporidium*. Thoroughly wash with clean, safe water all vegetables and fruits you plan to eat raw. See below for information on making water safe. • Accidentally swallowing *Cryptosporidium* picked up from surfaces (such as bathroom fixtures, changing tables, diaper pails, or toys) contaminated with feces from an infected person. For additional information see: http://www.cdc.gov/ncidod/dpd/parasites/cryptosporidiosis/factsht_cryptosporidiosis.htm
Cyclospora cayetanensis	*Cyclospora cayetanensis* is a unicellular parasite previously known as cyanobacterium-like or coccidia-like body (CLB). The first known human cases of illness caused by *Cyclospora* infection (i.e., cyclosporiasis) were reported in the medical literature in 1979. Cases have been reported with increased frequency since the mid 1980s, in part because of the availability of better techniques for detecting the parasite in stool specimens. The incubation period between acquisition of infection and onset of symptoms averages 1 week. *Cyclospora* infects the small intestine and typically causes watery diarrhea, with frequent, sometimes explosive, stools. Other symptoms can include loss of appetite, substantial loss of weight, bloating, increased flatus, stomach cramps, nausea, vomiting, muscle aches, low-grade fever, and persistent fatigue. If untreated, illness may last for a few days to a month or longer, and may follow a remitting-relapsing course. Some infected persons are asymptomatic. More information is at: http://www.cdc.gov/ncidod/dpd/parasites/cyclospora/healthcare_cyclospora.htm

Appendix C

EPA 2005 Toxic Release Inventory
Chemical Compounds Disposed (on-site or off-site) in Knox County (pounds)

Compound	On-Site	Notes*	Off-Site	Notes*	Total
1,1-Dichloro-1-fluoroethane	60,072	2,3	0		60,072
Acrylamide	98	2,3	470	7	568
Acrylic Acid	2,196	2,3	8,904	7	11,100
Acrylonitrile	794	2,3	0		794
Ammonia	11,597	2,3,4	0		11,597
Benzo(g,h,i)perylene	0		0		0
Butyl Acrylate	667	2,3	0		667
Certain Glycol Ethers	8	2,3	1,178	7	1,186
Chlorine	2.43	2	0		2.43
Chromium	0		1,801	8	1,801
Chromium Compounds	123	2,3,4	0		123
Copper	0		0		0
Copper Compounds	221	2,3,4	0		221
Dichloromethane	1,499	3	0		1,499
Diisocyanates	--	--	--	--	0
Dimethylphthalate	--	--	--	--	0
Dioxin & Dioxin-like Compounds	0.65 grams	3	0		0.65 grams
Ethyl Acrylate	4,552	2,3	0		4,552
Ethylbenzene	5,323	2,3	0		5,323
Ethylene Glycol	369	2,3	4,853	8	5,222
Hydrogen Fluoride	29,222	3	0		29,222
Lead	85	1,2,3	7.62	6	92.5
Lead Compounds	1,401	2,3,4	23.08	5,8,9	1,424
Maleic Anhydride	1,048	2,3	0		1,048
Manganese Compounds	1,082	2,3,4	0		1,082.4
Mercury	0.14	2,3	0		0.14
Mercury Compounds	218	2,3	0		218.2
Methanol	863	2,3	0		863
Methyl Isobutyl Ketone	--	--	--	--	0
Methyl Methacrylate	126,683	2,3	1,209	7	127,892
n-Hexane	2,378	2,3	0		2,378
N-Methylolacrylamide	160	2	2,930	7	3,090
Nickel	20	2	169	9	189
Nickel Compounds	48.3	2,3,4	0		48.3
Nitrate Compounds	128,000	4	0		128,000
Nitric Acid	250	2	0		250
Polycyclic Aromatic Compounds	0		0		0
Propylene Oxide	12	2	0		12
Styrene	701,861	2,3	0		701,861
tert-Butyl Alcohol	1,293	2,3	812	7	2,105
Toluene	3,062	2,3	0		3,062
Trichloroethylene	104,180	2,3	0		104,180
Vinyl Acetate	3,712	2,3	0		3,712
Xylenes (mixed isomers)	18,707	2,3	0		18,707
Zinc Compounds	17,766	2,3,4	0		17,766
TOTAL	**1,229,574**		**22,356.7**		**1,251,930**

*Notes: -- = No data available
1 = On-site landfill disposal
2 = On-site fugitive air
3 = On-site point-source air
4 = On-site surface water discharge
5 = Off-site land treatment disposal
6 = Off-site disposal via waste broker
7 = Off-site disposal – unknown
8 = Off-site landfill disposal
9 = Transfer to POTW (sewer)

Per EPA: Users of TRI information should be aware that TRI data reflect releases and other waste management activities of chemicals, not whether (or to what degree) the public has been exposed to those chemicals. Release estimates alone are not sufficient to determine exposure or to calculate potential adverse effects on human health and the environment. TRI data, in conjunction with other information, can be used as a starting point in evaluating exposures that may result from releases and other waste management activities which involve toxic chemicals. The determination of potential risk depends upon many factors, including the toxicity of the chemical, the fate of the chemical, and the amount and duration of human or other exposure to the chemical after it is released.

EPA 2005 Toxic Release Inventory
Chemical Disposal by Industry in Knox County (pounds)

Industry	On-Site	Off-Site	Total
Food	2	0	2
Chemicals	52,315	15,522	67,837
Plastics	750	4	754
Stone / Clay / Glass	29,307	0	29,307
Primary Metals	11,704	0	11,704
Fabricated Metals	171,233	1,970	173,203
Electrical Equipment	0	4,861	4,861
Transportation Equip.	961,070	0	961,070
Chemical Wholesalers	3,192	0	3,192
TOTAL	**1,229,574**	**22,357**	**1,251,930**

EPA 2005 Toxic Release Inventory
Chemical Disposal by Company in Knox County (pounds)
(table begins on following page)

Facility or Chemical	On-Site Other Landfills	Sub Total On-Site Disposal to Class I UI RCRA Landfills and other Landfills	On-site Fugitive Air	On-site Point Source Air	On-site Surface Water Dis-charges	Sub Total Other On-Site Disposal or Other Releases	Total On-site Disposal or Other Releases	Off-Site Disposal-Other Landfills	Sub Total Off-Site Disposal to UI RCRA Landfills and other Landfills	Transfers to POTWs Metal and Metal Com-pounds	Off-Site Disposal-Land Treat-ment	Off-Site Disposal-Waste Broker	Off-Site Disposal-Unknown	Sub Total Other Off-Site Disposal or Other Releases	Total Off-site Disposal or Other Releases	Total On- and Off-site Disposal or Other Releases
American Safety Razor Co. 2820 Media Dr., Knoxville 37914	0	0	44980	119718	.	164698	164698	1801	1801	0	0	0	0	0	1801	166499
1,1-Dichloro-1-fluoroethane	0	0	6007	54065	.	60072	60072	0	0	.	0	0	0	0	0	60072
Ammonia	0	0	419	27	.	446	446	0	0	.	0	0	0	0	0	446
Chromium	0	0	0	0	.	0	0	1801	1801	0	0	0	0	0	1801	1801
Trichloroethylene	0	0	38554	65626	.	104180	104180	0	0	.	0	0	0	0	0	104180
Aqua-Chem, Inc. 3001 E. John Sevier Hwy., Knoxville 37914	0	0	6515	0	.	6515	6515	0	0	0	0	0	0	0	0	6515
Chromium Compounds	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0
Copper Compounds	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0
Ethylbenzene	0	0	975	0	.	975	975	0	0	.	0	0	0	0	0	975
Nickel Compounds	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0
Propylene Oxide	0	0	12	0	.	12	12	0	0	.	0	0	0	0	0	12
Toluene	0	0	73	0	.	73	73	0	0	.	0	0	0	0	0	73
Xylene (Mixed Isomers)	0	0	5299	0	.	5299	5299	0	0	.	0	0	0	0	0	5299
Zinc Compounds	0	0	156	0	.	156	156	0	0	0	0	0	0	0	0	156
Ashland Distribution Co. 5263 National Dr., Knoxville 37914	0	0	1256	1936	0	3192	3192	0	0	.	0	0	0	0	0	3192
Ethylene Glycol	0	0	368	1	0	369	369	0	0	.	0	0	0	0	0	369
Methanol	0	0	225	638	0	863	863	0	0	.	0	0	0	0	0	863
Methyl Isobutyl Ketone	.	0	.	.	.	0	.	.	0	.	.	.	.	0	.	0
n-Hexane	0	0	440	1000	0	1440	1440	0	0	.	0	0	0	0	0	1440
Styrene	.	0	.	.	.	0	.	.	0	.	.	.	.	0	.	0
Toluene	0	0	223	297	0	520	520	0	0	.	0	0	0	0	0	520

Xylene (Mixed Isomers)	.	0	.	.	.	0	.	.	0	.	.	.	.	0	.	0
Bullet Boats, Inc. 8819 Valgro Rd., Knoxville 37920	0	0	0	10394	.	10394	10394	0	0	.	0	0	0	0	0	10394
n-Hexane	0	0	0	938	.	938	938	0	0	.	0	0	0	0	0	938
Styrene	0	0	0	9092	.	9092	9092	0	0	.	0	0	0	0	0	9092
Toluene	0	0	0	364	.	364	364	0	0	.	0	0	0	0	0	364
Cemex Inc Knoxville Cement Plant 6212 Cement Plant Rd., Knoxville 37924	22.82	22.82	5.86	56.32	.	62.18	85	0	0	0	0	0	0	0	0	85
Chromium	.	0	.	.	.	0	.	.	0	.	.	.	.	0	.	0
Lead	22.82	22.82	5.84	56.2	.	62.04	84.86	0	0	0	0	0	0	0	0	84.86
Mercury	0	0	0.02	0.12	.	0.14	0.14	0	0	0	0	0	0	0	0	0.14
Chevron Phillips Chemical Co Performance Pipe Div. 10420 Lexington Dr., Knoxville 37932	0	0	0	0	.	0	0	0.67	0.67	0	0	0	0	0	0.67	0.67
Lead Compounds	0	0	0	0	.	0	0	0.67	0.67	0	0	0	0	0	0.67	0.67
Exedy America Corp. 2121 Holston Bend Dr., Mascot 37806	0	0	250	1498.96	.	1748.96	1748.96	0	0	0	0	0	0	0	0	1748.96
Ammonia	0	0	250	0	.	250	250	0	0	.	0	0	0	0	0	250
Copper	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0
Dichloromethane	0	0	0	1498.96	.	1498.96	1498.96	0	0	.	0	0	0	0	0	1498.96
General Shale Brick Inc. Plant #7 1740 Riverside Dr., Knoxville 37915	0	0	0	29222	.	29222	29222	0	0	.	0	0	0	0	0	29222
Hydrogen Fluoride	0	0	0	29222	.	29222	29222	0	0	.	0	0	0	0	0	29222
Gerdau Ameristeel U.S. Knoxville Inc. 1919 Tennessee Ave., Knoxville 37950	0	0	9453.18	1681.001	569.93	11704.111	11704.111	0	0	0	0	0	0	0	0	11704.111
Chromium Compounds	0	0	84	37	2.24	123.24	123.24	0	0	0	0	0	0	0	0	123.24
Copper Compounds	0	0	121	93	7.08	221.08	221.08	0	0	0	0	0	0	0	0	221.08
Dioxin & Dioxin-like Compds.	0	0	0	0.001433	.	0.0014333	0.0014333	0	0	.	0	0	0	0	0	0.0014333

Lead Compounds	0	0	908	485	7.96	1400.96	1400.96	0	0	0	0	0	0	0	0	1400.96
Manganese Compounds	0	0	872	146	64.37	1082.37	1082.37	0	0	0	0	0	0	0	0	1082.37
Mercury Compounds	0	0	0.18	218	.	218.18	218.18	0	0	0	0	0	0	0	0	218.18
Nickel Compounds	0	0	10	37	1.28	48.28	48.28	0	0	0	0	0	0	0	0	48.28
Zinc Compounds	0	0	7458	665	487	8610	8610	0	0	0	0	0	0	0	0	8610
Greenway Chemical Co., 4320 Greenway Dr., Knoxville 37918	0	0	0	0	.	0	0	0	0	.	0	0	0	0	0	0
Ethylene Glycol	0	0	0	0	.	0	0	0	0	.	0	0	0	0	0	0
Methanol	0	0	0	0	.	0	0	0	0	.	0	0	0	0	0	0
n-Hexane	0	0	0	0	.	0	0	0	0	.	0	0	0	0	0	0
Nitric Acid	0	0	0	0	.	0	0	0	0	.	0	0	0	0	0	0
Industrial Powder Coatings 1737 Louisville Dr., Knoxville 37921	0	0	20	0	.	20	20	0	0	169	0	0	0	169	169	189
Nickel	0	0	20	0	.	20	20	0	0	169	0	0	0	169	169	189
Luxottica Optical Manufacturing North America Knoxville 4716 Middle Creek Lane, Knoxville 37921	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0
Lead	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0
Marathon Petroleum Co LLC Knoxville TN Terminal 1808 Jones St., Knoxville 37920	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0
Benzo(g,h,i)perylene	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0
Polycyclic Aromatic Compds.	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0
Panasonic Electronic Devices Corp of America 5105 S. National Dr., Knoxville 37914	0	0	0	0	.	0	0	4853	4853	0	0	7.62	0	7.62	4860.62	4860.62
Ethylene Glycol	0	0	0	0	.	0	0	4853	4853	.	0	0	0	0	4853	4853
Lead	0	0	0	0	.	0	0	0	0	0	0	7.62	0	7.62	7.62	7.62

Rocore Industries Inc Knoxville 5050 S. National Dr., Knoxville 37914	0	0	250	0	137000	137250	137250	0	0	.	0	0	0	0	0	137250
Nitrate Compounds	0	0	0	0	128000	128000	128000	0	0	.	0	0	0	0	0	128000
Nitric Acid	0	0	250	0	0	250	250	0	0	.	0	0	0	0	0	250
Zinc Compounds	0	0	0	0	9000	9000	9000	0	0	.	0	0	0	0	.	9000
Rohm & Haas Co - Knoxville Plant 730 Dale Ave., Knoxville 37921	0	0	34443	17867.12	5	52315.12	52315.12	0	0	18.71	0	0	15503	15521.71	15521.71	67836.83
Acrylamide	0	0	96	2	.	98	98	0	0	.	0	0	470	470	470	568
Acrylic Acid	0	0	1777	419	.	2196	2196	0	0	.	0	0	8904	8904	8904	11100
Acrylonitrile	0	0	655	139	.	794	794	0	0	.	0	0	0	0	0	794
Ammonia	0	0	10103	793	5	10901	10901	0	0	.	0	0	0	0	0	10901
Butyl Acrylate	0	0	524	143	.	667	667	0	0	.	0	0	0	0	0	667
Certain Glycol Ethers	0	0	4	4	.	8	8	0	0	.	0	0	1178	1178	1178	1186
Ethyl Acrylate	0	0	3745	807	.	4552	4552	0	0	.	0	0	0	0	0	4552
Ethylbenzene	0	0	1476	2872	.	4348	4348	0	0	.	0	0	0	0	0	4348
Lead Compds.	0	0	0	0.12	.	0.12	0.12	0	0	18.71	0	0	0	18.71	18.71	18.83
Maleic Anhydride	0	0	913	135	.	1048	1048	0	0	.	0	0	0	0	0	1048
Methyl Methacrylate	0	0	3409	663	.	4072	4072	0	0	.	0	0	1209	1209	1209	5281
N-Methylolacrylamide	0	0	160	0	.	160	160	0	0	.	0	0	2930	2930	2930	3090
Styrene	0	0	2666	287	.	2953	2953	0	0	.	0	0	0	0	0	2953
tert-Butyl Alcohol	0	0	6	1287	.	1293	1293	0	0	.	0	0	812	812	812	2105
Toluene	0	0	1112	993	.	2105	2105	0	0	.	0	0	0	0	0	2105
Vinyl Acetate	0	0	2781	931	.	3712	3712	0	0	.	0	0	0	0	0	3712
Xylene (Mixed Isomers)	0	0	5016	8392	.	13408	13408	0	0	.	0	0	0	0	0	13408
Safety-Kleen Sysytems (308001) 6617 Pleasant Ridge Rd., Knoxville 37921	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0
Lead	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0
Polycyclic Aromatic Compds.	0	0	0	0	.	0	0	0	0	.	0	0	0	0	0	0

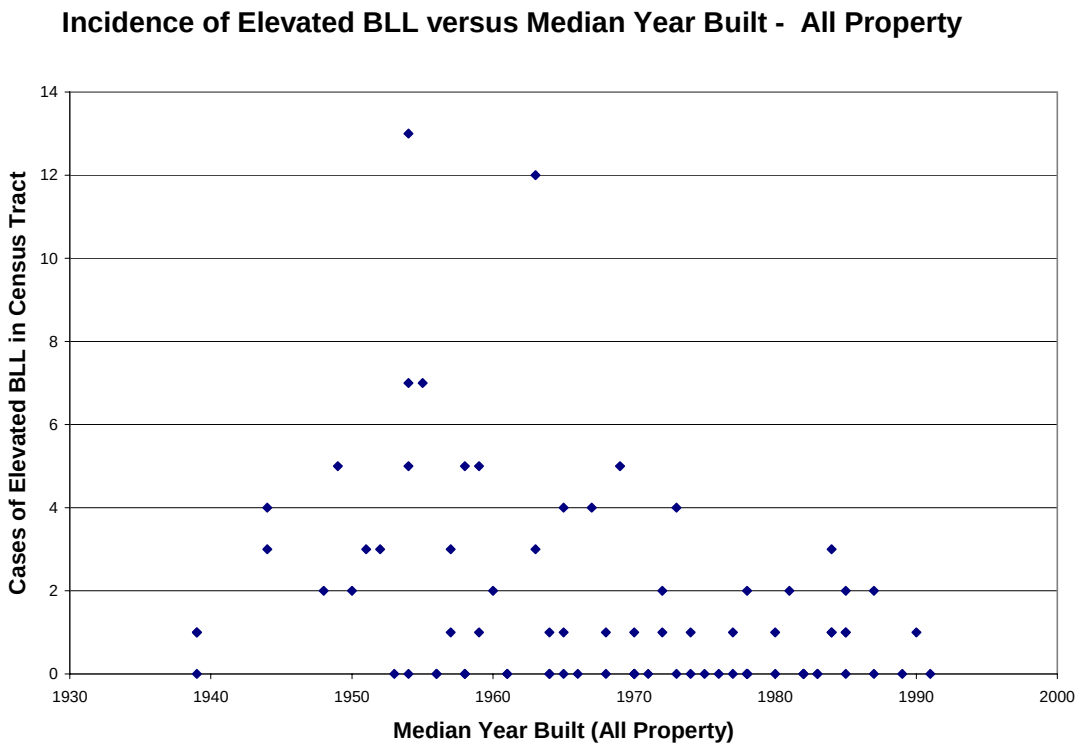
Sea Ray Boata Inc Knoxville Facility 2601 Sea Ray Blvd., Knoxville 37914	0	0	0	416203	.	416203	416203	0	0	.	0	0	0	0	0	416203
Diisocyanates	.	0	.	.	.	0	.	.	0	.	.	.	.	0	.	0
Dimethyl Phthalate	.	0	.	.	.	0	.	.	0	.	.	.	.	0	.	0
Methyl Methacrylate	0	0	0	66128	.	66128	66128	0	0	.	0	0	0	0	0	66128
Styrene	0	0	0	350075	.	350075	350075	0	0	.	0	0	0	0	0	350075
Sea Ray Boats Inc Riverview Facility 5502 Island River Dr., Knoxville 37914	0	0	0	395474	.	395474	395474	0	0	.	0	0	0	0	0	395474
Diisocyanates	.	0	.	.	.	0	.	.	0	.	.	.	.	0	.	0
Dimethyl Phthalate	.	0	.	.	.	0	.	.	0	.	.	.	.	0	.	0
Methyl Methacrylate	0	0	0	56483	.	56483	56483	0	0	.	0	0	0	0	0	56483
Styrene	0	0	0	338991	.	338991	338991	0	0	.	0	0	0	0	0	338991
Smokey Mountain Tops Inc. 7216 Ball Camp Pike, Knoxville 37931	0	0	750	0	.	750	750	0	0	.	0	0	0	0	0	750
Styrene	0	0	750	0	.	750	750	0	0	.	0	0	0	0	0	750
U.S. TVA Volunteer 500KV Substation 6720 Boruff Rd., Corryton 37721	.	0	.	.	.	0	.	.	0	.	.	.	.	0	.	0
Copper	.	0	.	.	.	0	.	.	0	.	.	.	.	0	.	0
Vinylex Corp. 2636 Byington-Solway Rd., Knoxville 37931	0	0	0	0	.	0	0	0	0	0	3.7	0	0	3.7	3.7	3.7
Lead Compounds	0	0	0	0	.	0	0	0	0	0	3.7	0	0	3.7	3.7	3.7
White Lilly Foods Co. 218 E. Depot St., Knoxville 37917	0	0	2.433	0	0	2.433	2.433	0	0	.	0	0	0	0	0	2.433
Chlorine	0	0	2.433	0	0	2.433	2.433	0	0	.	0	0	0	0	0	2.433
TOTAL	22.82	22.82	97925.47	994050.4	137574.93	1229550.8	1229573.6	6654.67	6654.67	187.71	3.7	7.62	15503	15702.03	22356.7	1251930.3

Appendix D Knox County Child Elevated Blood Lead Level Data

Cases of Elevated Blood Lead Levels (BLL) versus Average Age of Homes in Knox County Census Tracts, Number of Households, and 1999 Median Income (sorted by Number of Cases of Elevated BLL)

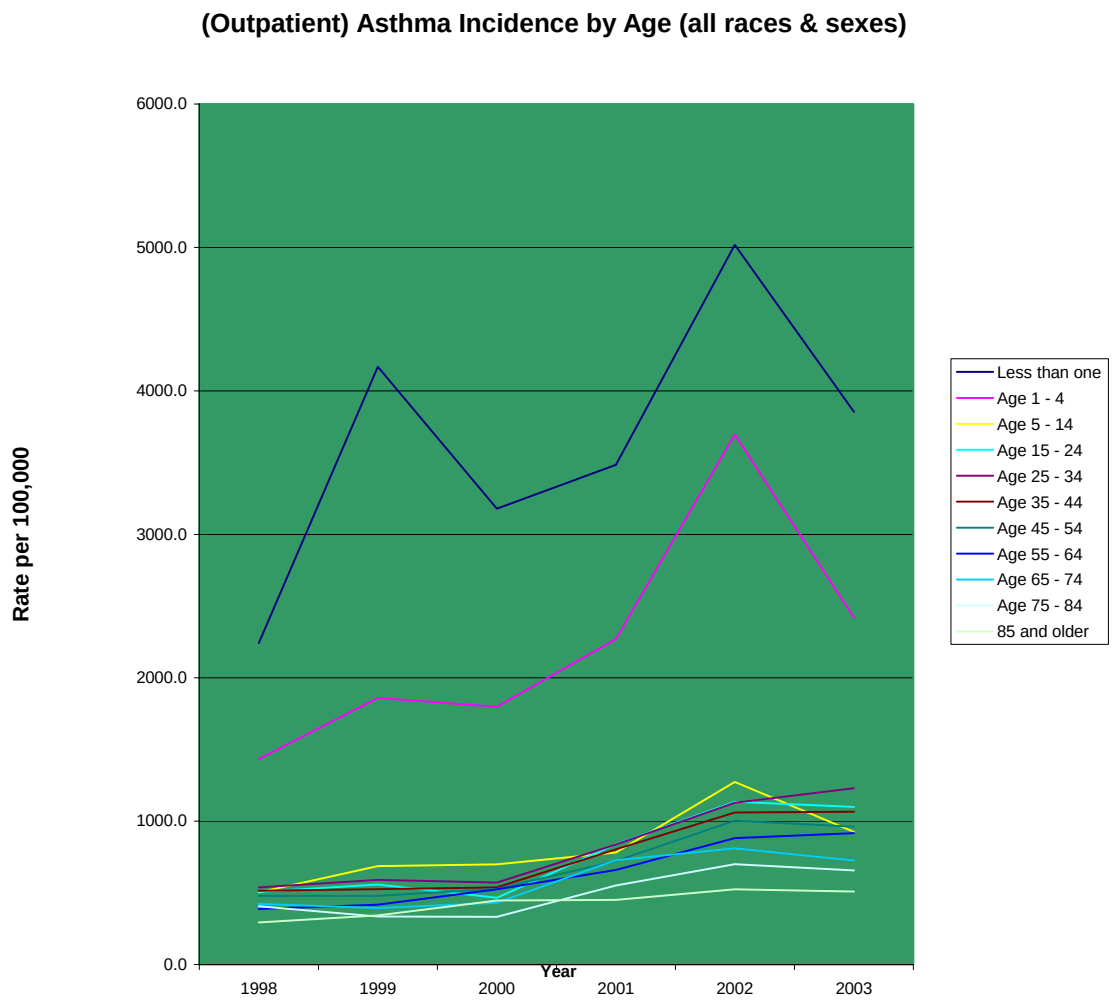
Census Tract, Knox County, Tennessee	Occupied housing units: Median year structure built; Total	Households: Total	Households: Median household income in 1999 ($)	Cases Blood Lead Above 10 ug/dL, 1998-2004
14	1954	1,275	11,305	13
1	1963	728	10,426	12
27	1954	1,168	23,500	7
24	1955	1,526	20,775	7
21	1959	1,000	23,986	6
5	1949	1,251	15,427	5
22	1954	1,754	28,291	5
29	1958	1,441	21,338	5
39	1969	3,077	29,520	5
15	1944	1,519	23,006	4
28	1963	1,730	20,969	4
6	1965	1,254	10,690	4
54	1967	2,581	33,856	4
7	1973	876	7,319	4
13	1944	564	16,528	3
12	1948	296	14,191	3
19	1951	766	20,395	3
17	1952	1,362	22,875	3
20	1957	1,441	18,714	3
32	1957	1,407	27,008	3
59.01	1984	3,051	53,535	3
16	1950	1,507	23,627	2
23	1960	1,640	24,856	2
55	1972	2,288	31,748	2
46.02	1978	4,442	37,595	2
46.01	1981	2,631	46,358	2
62.04	1985	2,954	39,417	2
58.06	1987	2,928	80,443	2
2	1939	523	18,536	1
3	1939	1,023	16,646	1
30	1959	2,050	26,899	1
37	1964	2,213	19,034	1
26	1965	1,012	19,167	1
52.02	1968	1,136	40,000	1
40	1970	1,882	26,276	1
43	1972	887	28,201	1
52.01	1974	1,604	41,266	1
8	1977	1,536	16,122	1

Census Tract, Knox County, Tennessee	Occupied housing units: Median year structure built; Total	Households: Total	Households: Median household income in 1999	Cases Blood Lead Above 10 ug/dL, 1998-2004
63	1980	2,325	39,012	1
62.01	1982	2,603	59,744	1
58.04	1984	2,729	63,685	1
64	1984	3,288	41,905	1
46.05	1985	4,577	36,789	1
59.02	1985	2,591	47,816	1
57.05	1990	5,848	75,468	1
4	1939	371	15,237	0
42	1953	1,572	34,612	0
18	1954	997	30,721	0
25	1956	1,901	54,716	0
33	1956	880	54,000	0
34	1958	1,819	32,179	0
41	1958	1,799	37,558	0
31	1961	1,215	39,788	0
50	1961	1,781	32,442	0
10	1964	799	10,817	0
11	1964	1,653	11,977	0
35	1965	1,742	40,250	0
9	1966	381	8,902	0
47	1968	1,578	38,844	0
48	1970	1,988	37,353	0
56.01	1970	2,302	45,428	0
65	1970	2,400	31,500	0
53	1971	2,730	37,583	0
51	1973	1,615	48,356	0
44.02	1974	4,014	36,824	0
45	1975	2,667	42,181	0
56.02	1976	1,468	43,589	0
38	1977	3,222	32,845	0
44.01	1978	1,996	58,904	0
49	1978	1,939	40,198	0
57.01	1978	1,711	79,484	0
61.01	1978	3,574	45,567	0
62.03	1978	1,906	38,777	0
58.03	1980	958	53,400	0
57.03	1982	2,018	61,094	0
62.02	1982	1,409	46,941	0
57.04	1983	2,332	49,045	0
60	1983	3,923	48,545	0
46.04	1985	2,405	61,250	0
58.05	1987	2,702	92,204	0
46.06	1989	1,937	55,026	0
61.02	1991	1,770	37,278	0


Incidence of Elevated BLL versus Median Year Built - All Property
Cases of Elevated BLL in Census Tract
0
2
4
6
8
10
12
14
1930
1940
1950
1960
1970
1980
1990
2000
Median Year Built (All Property)

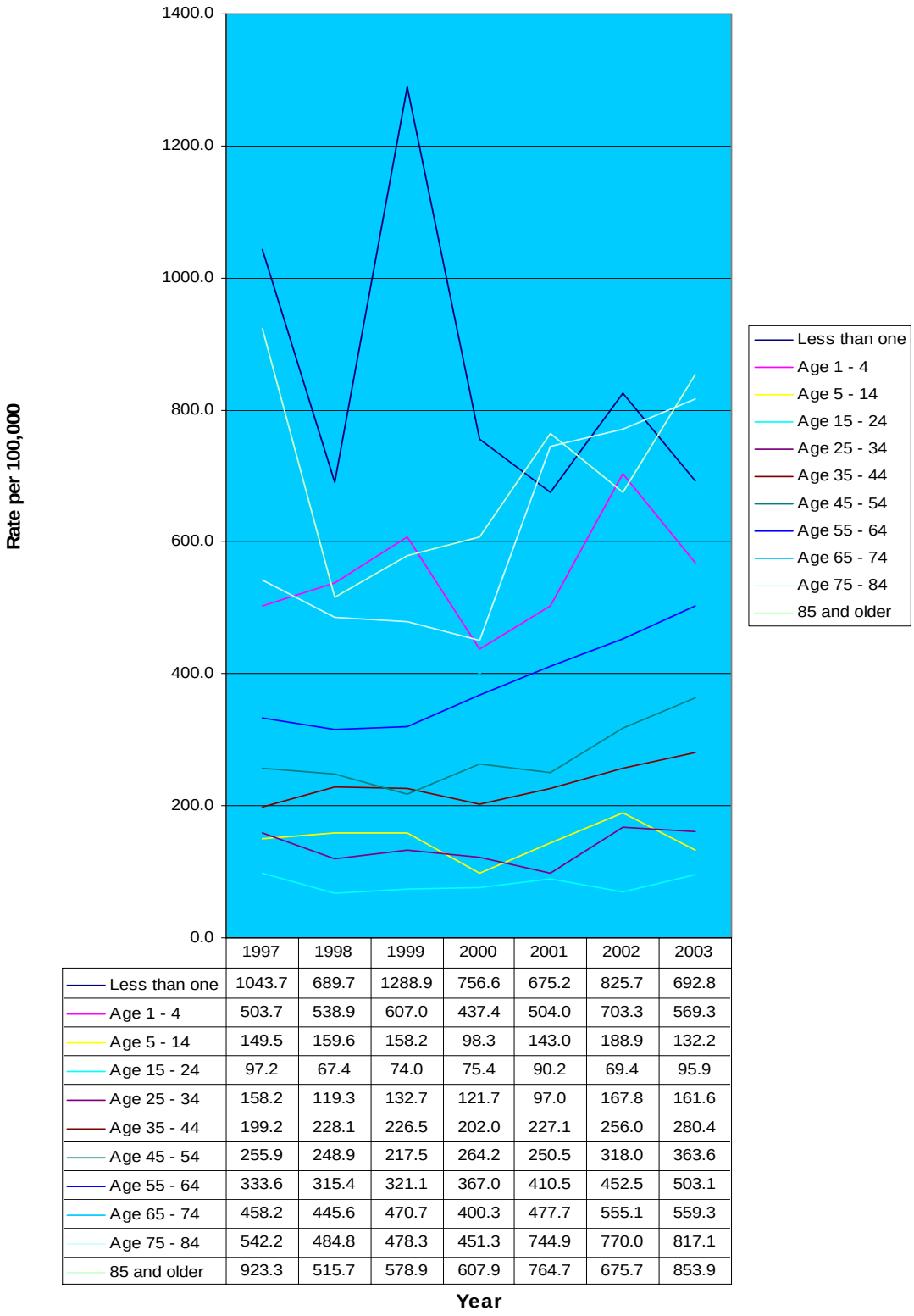
Appendix E

Asthma Incidence Data for Knox County, 1998 – 2003



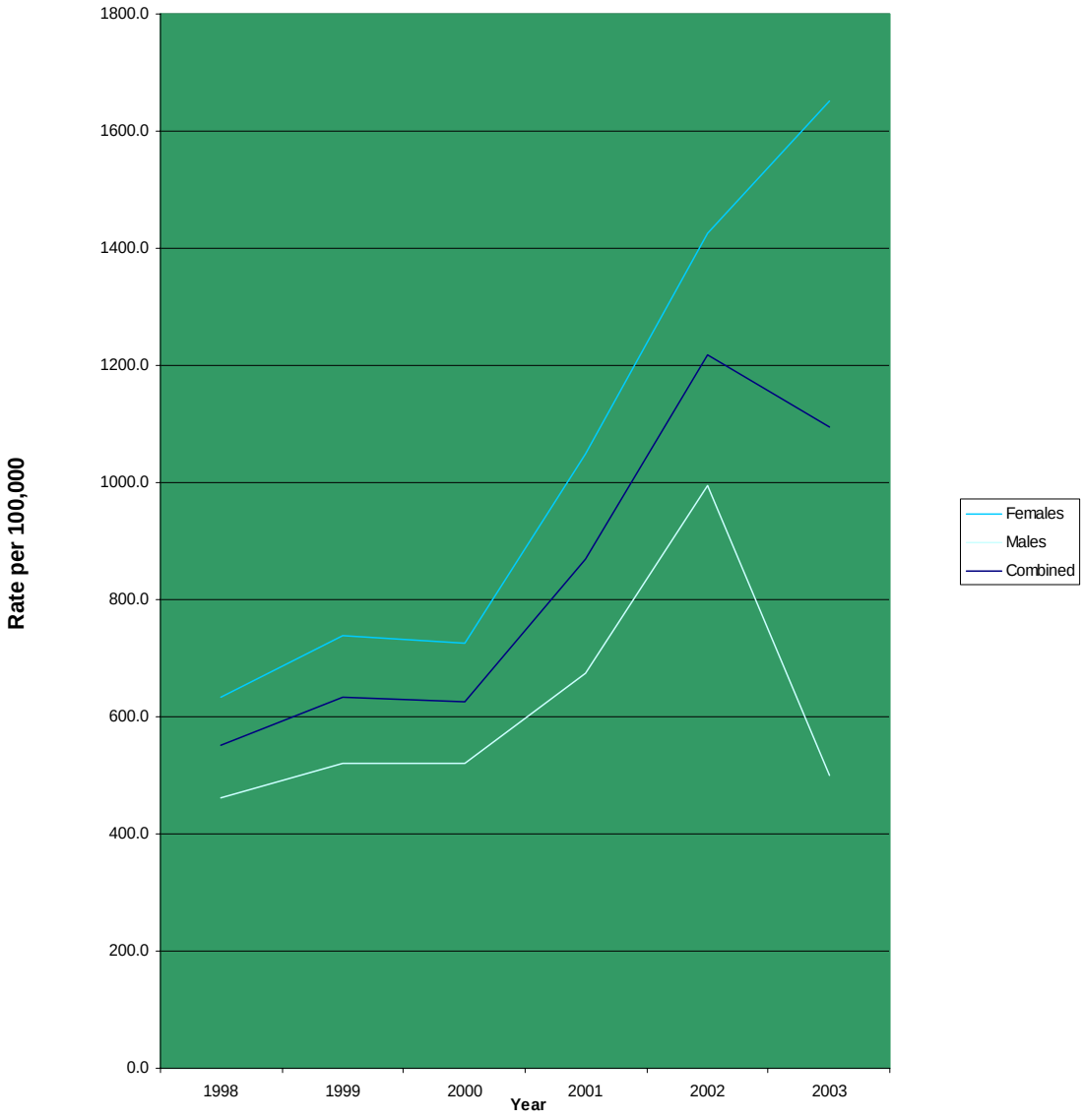
	1998	1999	2000	2001	2002	2003
Less than one	2241.4	4167.6	3177.7	3485.1	5019.6	3853.6
Age 1 - 4	1433.3	1858.7	1797.8	2270.7	3696.5	2419.7
Age 5 - 14	504.3	687.5	698.3	781.2	1273.0	925.7
Age 15 - 24	507.8	557.7	465.9	839.3	1135.4	1099.8
Age 25 - 34	538.4	590.0	572.1	838.1	1128.3	1229.5
Age 35 - 44	513.6	526.8	538.6	804.1	1061.0	1065.8
Age 45 - 54	478.2	478.9	528.5	722.3	1002.5	960.2
Age 55 - 64	387.5	418.4	524.3	659.1	880.9	916.3
Age 65 - 74	422.6	393.5	431.1	728.0	809.5	725.1
Age 75 - 84	406.0	334.8	332.6	551.3	700.6	657.1
85 and older	294.7	343.7	447.0	451.9	523.6	509.0

(Inpatient) Asthma Incidence by Age (all races and sexes)

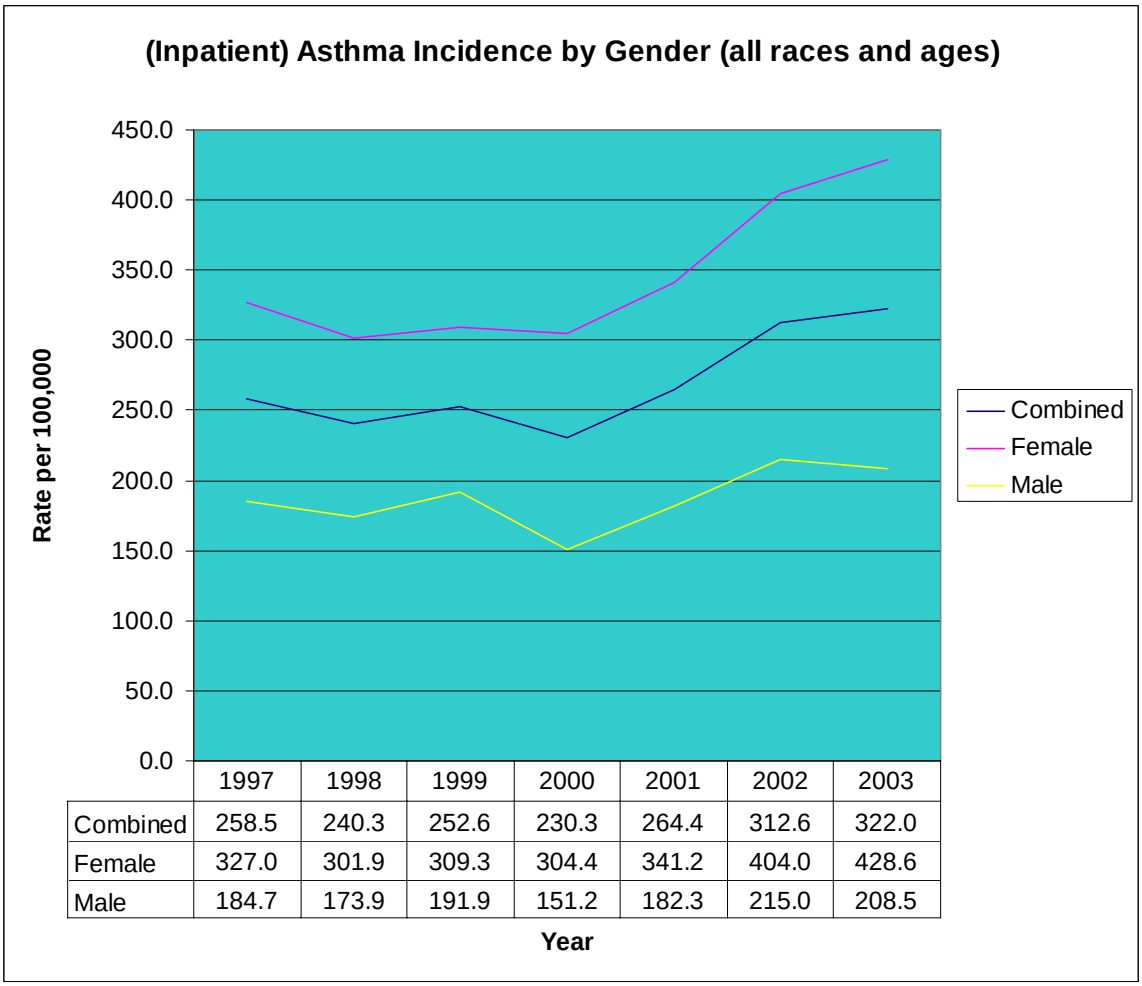


	1997	1998	1999	2000	2001	2002	2003
Less than one	1043.7	689.7	1288.9	756.6	675.2	825.7	692.8
Age 1 - 4	503.7	538.9	607.0	437.4	504.0	703.3	569.3
Age 5 - 14	149.5	159.6	158.2	98.3	143.0	188.9	132.2
Age 15 - 24	97.2	67.4	74.0	75.4	90.2	69.4	95.9
Age 25 - 34	158.2	119.3	132.7	121.7	97.0	167.8	161.6
Age 35 - 44	199.2	228.1	226.5	202.0	227.1	256.0	280.4
Age 45 - 54	255.9	248.9	217.5	264.2	250.5	318.0	363.6
Age 55 - 64	333.6	315.4	321.1	367.0	410.5	452.5	503.1
Age 65 - 74	458.2	445.6	470.7	400.3	477.7	555.1	559.3
Age 75 - 84	542.2	484.8	478.3	451.3	744.9	770.0	817.1
85 and older	923.3	515.7	578.9	607.9	764.7	675.7	853.9

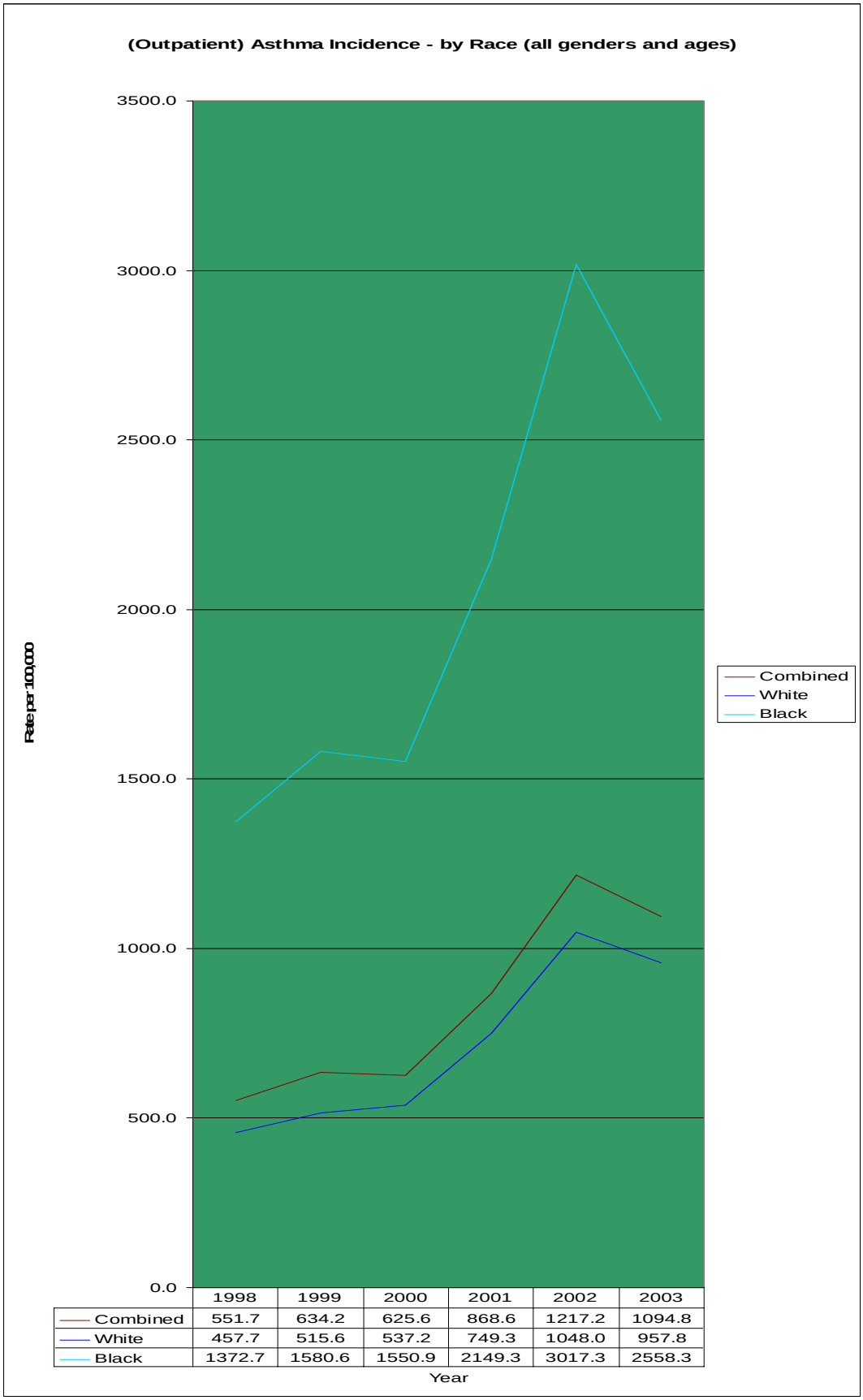
(Outpatient) Overall Asthma Incidence by Gender (all ages, all races)



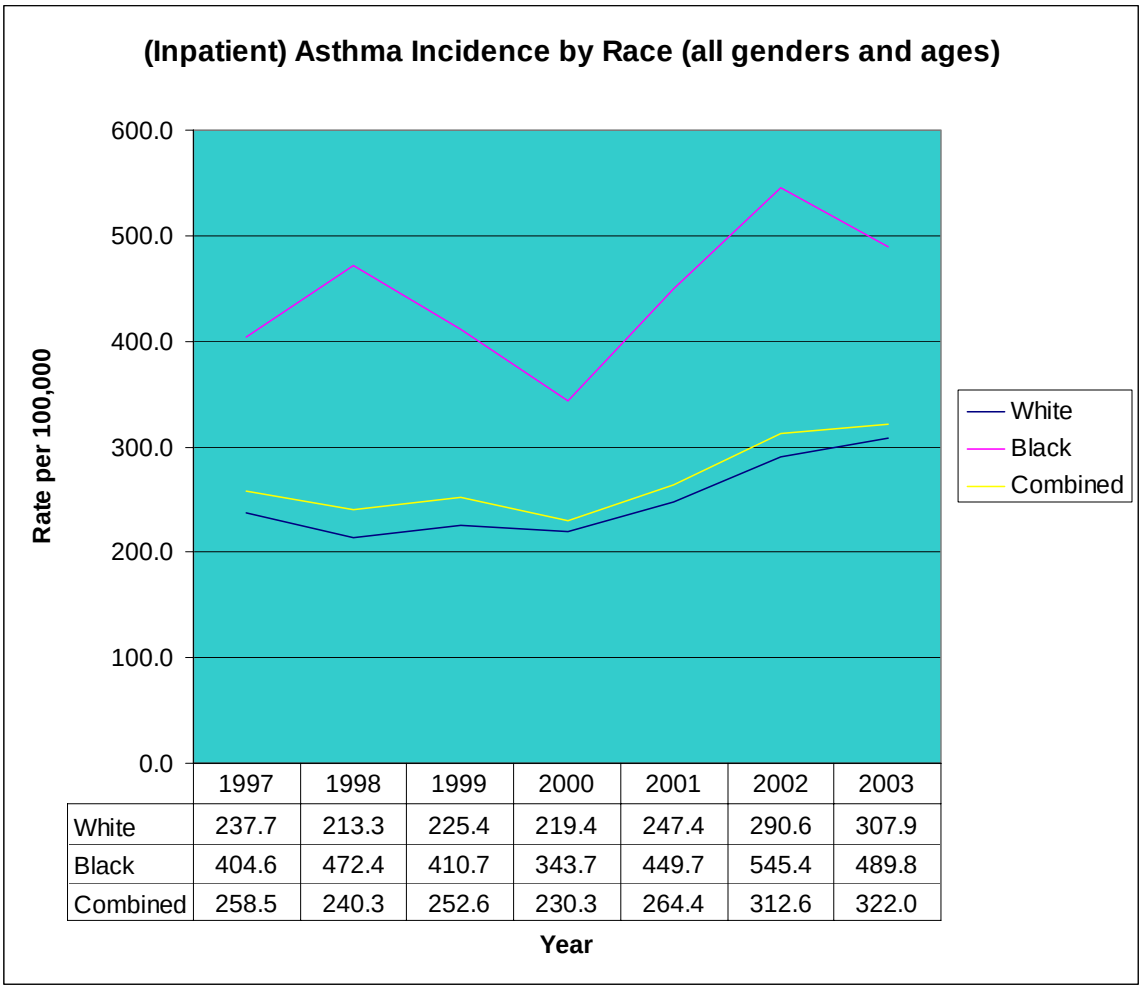
	1998	1999	2000	2001	2002	2003
Females	634.5	739.1	724.7	1049.4	1424.6	1652.1
Males	462.6	521.8	519.6	675.3	995.9	501.0
Combined	551.7	634.2	625.6	868.6	1217.2	1094.8



	1997	1998	1999	2000	2001	2002	2003
Combined	258.5	240.3	252.6	230.3	264.4	312.6	322.0
Female	327.0	301.9	309.3	304.4	341.2	404.0	428.6
Male	184.7	173.9	191.9	151.2	182.3	215.0	208.5

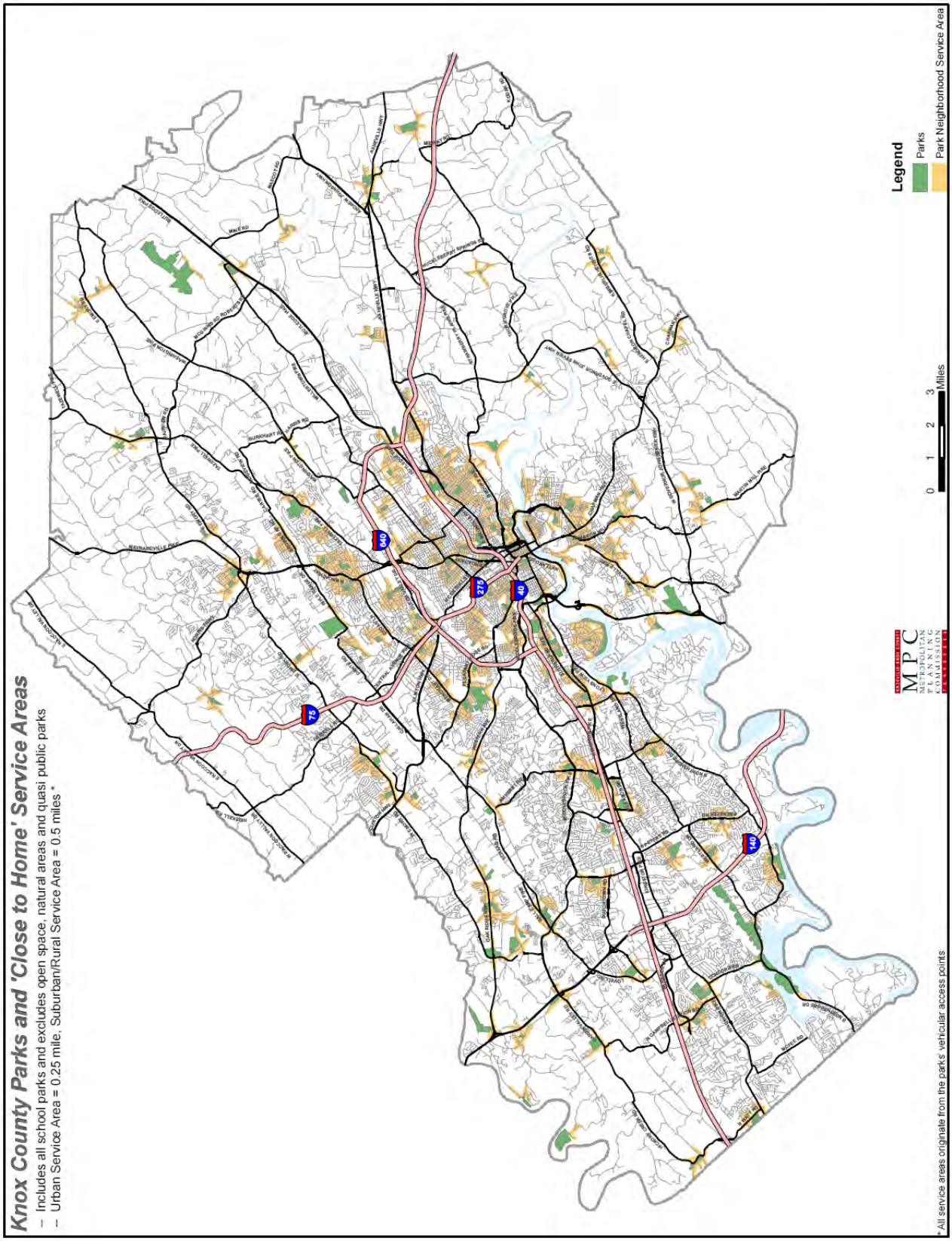


	1998	1999	2000	2001	2002	2003
Combined	551.7	634.2	625.6	868.6	1217.2	1094.8
White	457.7	515.6	537.2	749.3	1048.0	957.8
Black	1372.7	1580.6	1550.9	2149.3	3017.3	2558.3



	1997	1998	1999	2000	2001	2002	2003
White	237.7	213.3	225.4	219.4	247.4	290.6	307.9
Black	404.6	472.4	410.7	343.7	449.7	545.4	489.8
Combined	258.5	240.3	252.6	230.3	264.4	312.6	322.0

Appendix F
Map of Areas Within Walking Distance of Parks or Recreation Centers



Appendix G
Knox County Air Quality Management Monitoring and Knox County Air Emission Sources

The following table (from the USEPA website) summarizes Knox County Air Quality Management measurements of criteria air pollutants over the past several years, with outliers noted:

County Air Quality Report - Criteria Air Pollutants 1996 - 2006

EPA Air Quality Standards:
Carbon Monoxide: 35 ppm (1-hour average), 9 ppm (8-hour average)
Nitrogen Dioxide: 0.053 ppm (annual mean) *
Ozone: 0.12 ppm (1-hour average), 0.08 ppm (8-hour average)
Sulfur Dioxide: 0.14 ppm (24-hour average), 0.030 ppm (annual mean) *
Particulate (diameter < 2.5 micrometers): 65 µg/m3 (24-hour average), 15.0 µg/m3 (annual mean)
Particulate (diameter < 10 micrometers): 150 µg/m3 (24-hour average), 50 µg/m3 (annual mean)
Lead: 1.5 µg/m3 (quarterly mean)
ppm=parts per million µg/m3 = micrograms per cubic meter

* Knox County is not required to monitor these pollutants on an ongoing basis, as the data below demonstrated that levels of these pollutants are not a problem in this area.

2nd Max and 4th Max refer to the second-highest and 4th highest reading for the year indicated. Outlier readings (supporting a determination of nonattainment) are shaded and in bold below.

	CO (ppm)		NO2 (ppm)	O3 (ppm)		SO2 (ppm)		PM2.5 (µg/m3)		PM10 (µg/m3)		Pb (µg/m3)
Year	2nd Max 1-hr	2nd Max 8-hr	Annual Mean	2nd Max 1-hr	4th Max 8-hr	2nd Max 24-hr	Annual Mean	98th Percentile	Annual Mean	2nd Max 24-hr	Annual Mean	Quarterly Mean
1996	5.0	3.3		0.114	**0.098**					66	36	
1997	9.6	4.8		0.120	**0.096**					67	33	
1998	6.7	3.9		**0.138**	**0.114**					64	32	
1999	6.4	3.8		**0.129**	**0.099**			43	**23.9**	61	30	
2000	4.4	3.1	0.013	**0.131**	**0.100**	0.012	0.002	56	**21.0**	73	38	
2001	4.9	3.0	0.012	0.104	**0.090**	0.007	0.004	45	**18.2**	61	28	
2002	3.8	2.0		0.118	**0.098**			41	**16.9**	58	28	
2003				0.110	**0.090**			36	**16.0**	63	24	0.01
2004				0.092	0.078			32	**15.1**	63	24	0.02
2005				0.103	**0.086**			36	**16.4**	76	26	0.01
2006				0.107	**0.086**			41	**16.4**	53	26	

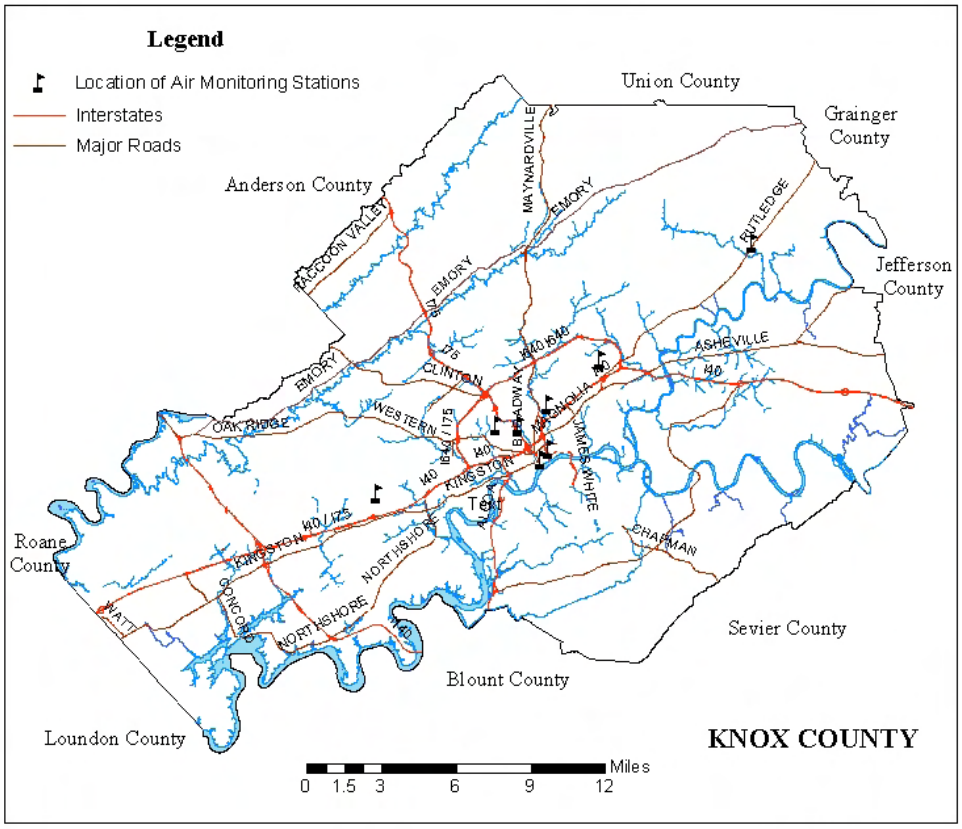
EPA Disclaimer: AirData reports are produced from a monthly extract of EPA's air pollution database, AQS. Data for this report were extracted on May 1, 2007. They represent the best information available to EPA from state agencies on that date. However, some values may be absent due to incomplete reporting, and some values subsequently may be changed due to quality assurance activities. The AQS database is updated daily by state and local organizations who own and submit the data. Please contact the pertinent state agency to report errors.

Readers are cautioned not to infer a qualitative ranking order of geographic areas based on AirData reports. Air pollution levels measured in the vicinity of a particular monitoring site may not be representative of the prevailing air quality of a county or urban area. Pollutants emitted from a particular source may have little impact on the immediate geographic area, and the amount of pollutants emitted does not indicate whether the source is complying with applicable regulations.

Website reference:
http://iaspub.epa.gov/airsdata/adaqs.summary?geotype=co&geocode=47093&geoinfo=%3Fco%7E47093%7EKnox+Co%2C+Tennessee&year=2006+2005+2004+2003+2002+2001+2000+1999+1998+1997+1996&fld=county&exc=1&rpp=25#disclaimer#disclaimer

MONITORING NETWORK

Air Sampling Stations



STATION #	LOCATION	PARAMETERS MONITORED
13	Air Monitoring Laboratory - 1407 Davanna Street	PM 10
17	Rule High School - 1919 Vermont Avenue	PM 10, PM 2.5, Lead
20	Springhill Primary School - 4711 Mildred Drive	Ozone, PM 2.5
21	East Knox Elementary School - 9315 Rutledge Pike	Ozone
22	Green Elementary School - 800 Town View Drive	PM 10
25	United States Post Office - 501 Main Street	CO
27	Burnside and Tennessee Avenue	Lead
28	Bearden Middle School - 1000 Francis Road	PM 2.5

Note: Station #25 (Main Street Post Office) is not in current use.

Hazardous Air Pollutants ("Air Toxics")

The following table lists facilities emitting over 1 ton of hazardous air pollutants annually, and the primary chemicals released, based on 1999 EPA facility emission reports, the most current toxic release inventory (TRI) data available to the public. Listing here does not reflect whether a facility meets or does not meet applicable regulations and permits. It also may not reflect potential exposures in the immediate vicinity of a plant, as smokestacks and prevailing winds may result in dispersal of emissions over a wide area at a distance from the source. Modeling which accounts for these factors is necessary to accurately evaluate health risks from facility emissions. However, the table can provide an estimate of the scale of air emissions and the chemicals involved. The reader is also cautioned that the table does not include facilities in counties adjacent to Knox County, whose emissions may contribute to the total VOC level in Knox County.

Knox County Facilities Emitting Over 1 Ton of Hazardous Air Pollutants Annually (EPA, 1999)

	Facility Name	Emissions (pounds/year)	% of Total Emissions	Major Compounds (pounds / year)	
1	Sea Ray Boats, Inc.*	229,511	29.48	Styrene	220,360
				Methyl Methacrylate	8,600
				Methyl Ethyl Ketone	388
				Ethylene Glycol	77.5
				Toluene	77.5
				4,4'-Methylenediphenyl Diisocyanate (MDI)	9.0
2	Sea Ray Boats, Inc.*	221,026	28.39	Styrene	208,017
				Methyl Methacrylate	13,000
				4,4'-Methylenediphenyl Diisocyanate (MDI)	9.0
3	Wienerberger Group (General Shale)	141,093	18.12	Hydrochloric Acid (gas)	57,304
				Hydrogen Fluoride	83,788
4	Rohm & Haas Co.	47,176	6.06	Xylenes (Mixed Isomers)	10,450
				Vinyl Acetate	7,737
				Ethyl Acrylate	7,577
				Methyl Methacrylate	6,105
				Styrene	4,144
				Ethylbenzene	3,395
				Acrylic Acid	2,710
				Toluene	1,797
				Acrylonitrile	1,301
				Maleic Anhydride	1,083
				Formaldehyde	591
				Acrylamide	231
				Glycol Ethers	54
				Ethylene Glycol	1.0
5	American Safety Razor	23,982	3.08	Trichloroethylene	23,982
6	Breed Technologies, Inc.	22,748	2.92	Glycol Ethers	17,696
				Methyl Ethyl Ketone	5,052
7	Silver Furniture Co. **	22,199	2.85	Toluene	22,199

* Sea Ray Boats has two production facilities in Knox County approximately one mile from each other, near the confluence of the French Broad and Holston Rivers.
** Silver Furniture Company has since gone out of business (EPA data is from 1999).

(table continued next page)

Knox County Facilities Emitting Over 1 Ton of Hazardous Air Pollutants Annually (EPA, 1999)

	Facility Name	Emissions (pounds/year)	% of Total Emissions	Major Compounds (pounds / year)	
8	Patterson Waste Landfill	22,038	2.83	Toluene	14,599
				Xylenes (Mixed Isomers)	1,234
				Methylene Chloride (Dichloromethane)	1,167
				Benzene (Incl. Gasoline)	833
				Tetrachloroethylene (Perchloroethylene)	594
				Hexane	544
				Methyl Ethyl Ketone	491
				Ethylbenzene	470
				Vinyl Chloride	441
				Trichloroethylene	356
				Acrylonitrile	323
				1,1-Dichloroethane (Ethylidene Dichloride)	223
				Methyl Isobutyl Ketone	180
				1,1,2,2-Tetrachloroethane	179
				Chloroethane (Ethyl Chloride)	77.5
				1,1,1-Trichloroethane (Methyl Chloroform)	61.5
				Chloromethane (Methyl Chloride)	58.7
				Carbon Disulfide	42.4
				1,2-Dichloroethane (Ethylene Dichloride)	39.0
				1,4-Dichlorobenzene	29.6
				Carbonyl Sulfide	28.3
				Chlorobenzene	27.0
				Propylene Dichloride (1,2-Dichloropropane)	19.5
				Vinylidene Chloride (1,1-Dichloroethylene)	18.6
				Chloroform	3.44
9	Gerdau-Ameristeel	13,620	1.75	Lead Compounds	7,706
				Manganese Compounds	5,593
				Chromium Compounds	278
				Nickel Compounds	43.0
10	Matsushita Electronic Components Corp.	11,952	1.54	Toluene	11,952
11	Daiken Drivetrain Components	8,871	1.14	Methylene Chloride (Dichloromethane)	8,871

(table continued next page)

Knox County Facilities Emitting Over 1 Ton of Hazardous Air Pollutants Annually (EPA, 1999)

	Facility Name	Emissions (pounds/year)	% of Total Emissions†	Major Compounds (pounds / year)	
12	Grainger Knox County Landfill	4,815	0.62	Toluene	3,190
				Xylenes (Mixed Isomers)	270
				Methylene Chloride (Dichloromethane)	255
				Benzene (Incl. Gasoline)	182
				Tetrachloroethylene (Perchloroethylene)	130
				Hexane	119
				Methyl Ethyl Ketone	107
				Ethylbenzene	103
				Vinyl Chloride	96.3
				Trichloroethylene	77.7
				Acrylonitrile	70.5
				Ethylidene Dichloride (1,1-Dichloroethane)	48.8
				Methyl Isobutyl Ketone	39.3
				1,1,2,2-Tetrachloroethane	39.1
				Ethyl Chloride (Chloroethane)	16.9
				Methyl Chloroform (1,1,1-Trichloroethane)	13.4
				Methyl Chloride (Chloromethane)	12.8
				Carbon Disulfide	9.26
				Ethylene Dichloride (1,2-Dichloroethane)	8.51
				1,4-Dichlorobenzene	6.48
				Carbonyl Sulfide	6.18
				Chlorobenzene	5.90
				Propylene Dichloride (1,2-Dichloropropane)	4.27
				Vinylidene Chloride (1,1-Dichloroethylene)	4.07
13	Exxon Terminal	4,735	0.61	Hexane	1,916
				Methyl Tert-Butyl Ether	1,357
				Toluene	543
				Xylenes (Mixed Isomers)	527
				Benzene (from Gasoline)	248
				Ethylbenzene	144
14	Ashland Distribution	2,469	0.31	Hexane	1,200
				Toluene	760
				Methanol	500
				Styrene	9.0

† Remaining firms in Knox County contributed 0.11% or less each.

Table reference:
http://iaspub.epa.gov/airsdata/adnti.ranking?geotype=co&geocode=47093&geoinfo=%3Fco%7E47093%7EKnox+Co%2C+Tennessee&pol=Hall&year=&emis=a&fld=percent&rpp=25

Appendix H
Compound-Specific Air Toxics Emissions for Knox County

The maps in this section illustrate the Pollutant Emission Density (tons / year / sq. mi.) for each county in TN, with the degree of shading corresponding to the percentile ranking of the county. The maps illustrate data for roughly half of the 178 parameters in the 1999 inventory (EPA did not post maps for all compounds on line), and the corresponding 1996 maps for comparison, where available. Specific information on each of the reported compounds follows the charts in the appendix. Additional information, including the data used to generate the maps, are available online at this EPA website: http://www.epa.gov/ttn/chief/net/index.html.

The following precautions apply to the data presented in the following maps:

- The data presented are for 1996 and 1999. This is the most recent air toxics data EPA has released. As new information becomes available, it will be incorporated into future versions of this report. The reported data should be viewed as a snapshot at those times. As industries may begin or cease operations over time, the data today are different than shown in the maps, but the maps still are useful to obtain a qualitative estimate of the relative degree to which specific chemicals are contributing to the air pollution in a given county.

- Because all counties are not the same size, the results from one county to another are not quantitatively comparable: If two factories put out the same amount of pollution in Counties A and B but County B was twice as big as County A, based on the units the EPA has chosen for the maps, County A would have twice the emission density as County B, and would appear to have a bigger problem. For this reason, the relative shadings between counties should be taken as qualitative estimates of the degree of emissions between the two counties. This is acceptable in most cases, as the differences in emissions between counties may be orders of magnitude, but this source of error is not likely to be even one order of magnitude (factor of ten) when comparing counties in the same state.

- Emissions travel between counties. For example, rural counties adjacent to major cities might have low emissions within those counties and thus have light shading, but the reality is that residents of that county might be breathing at least some of the emissions from the nearby city as the wind carries it into their county. Consider, for example, the first set of maps on the next page. Emissions of acetaldehyde in Loudon County potentially enter western Knox County, so in considering exposures for residents of Farragut (for example) such emissions would have to be taken into account.

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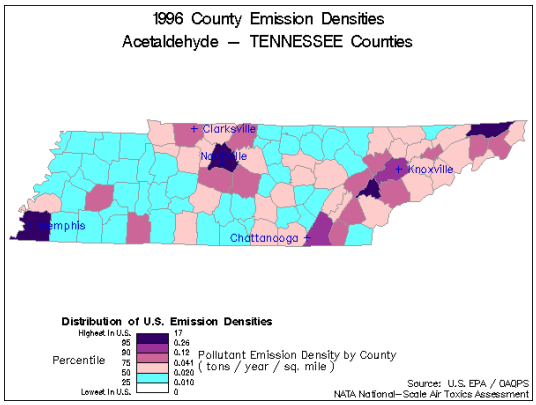

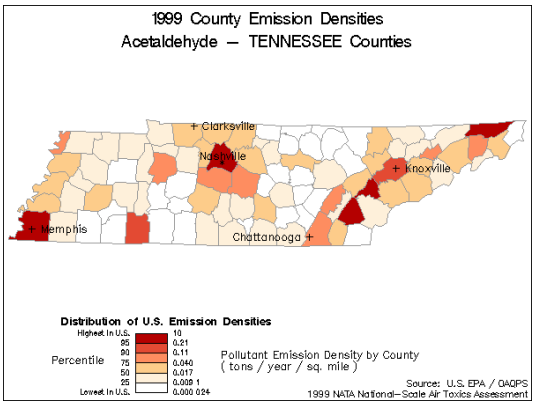

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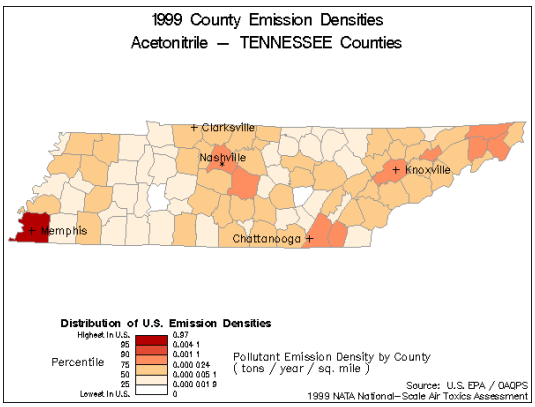

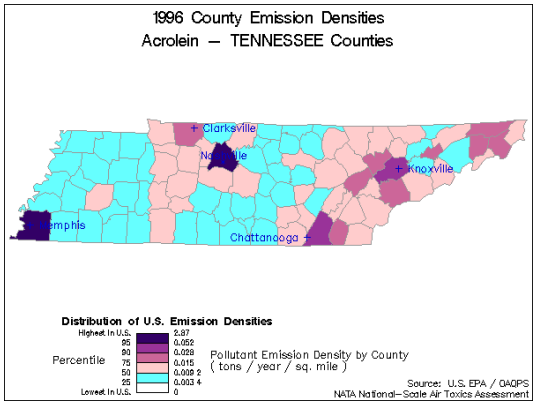

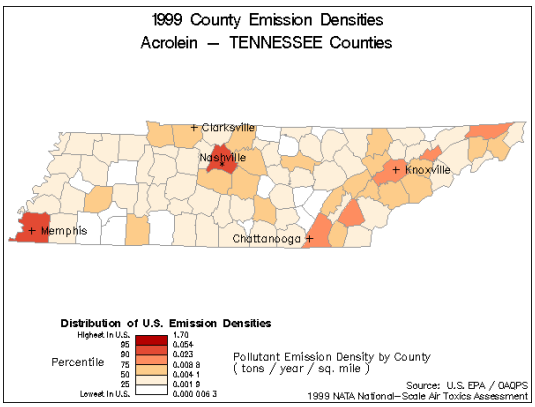

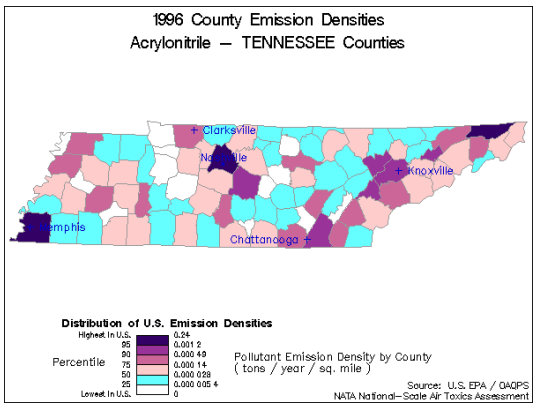

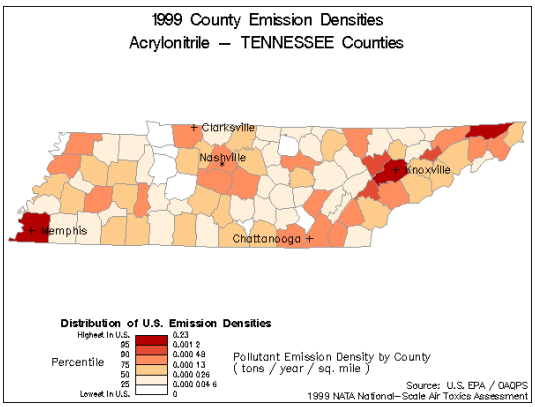

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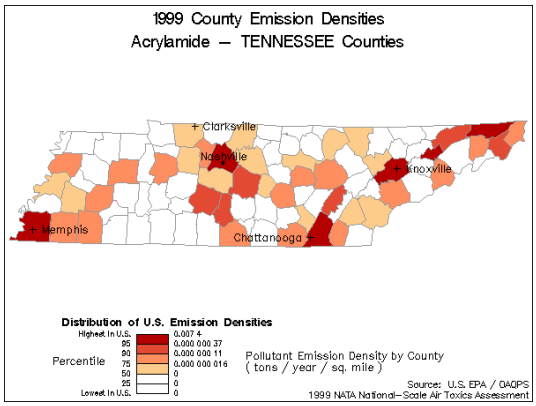

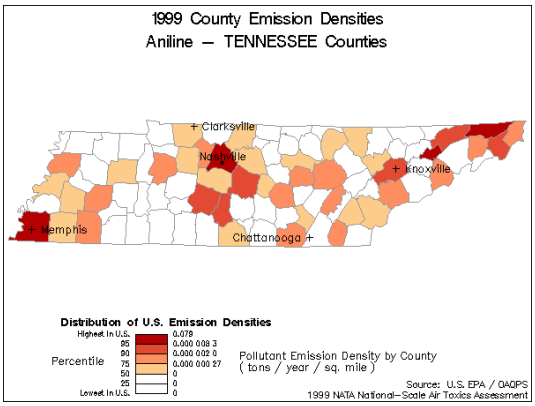

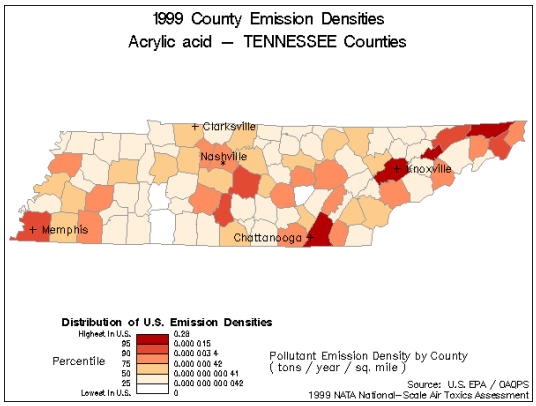

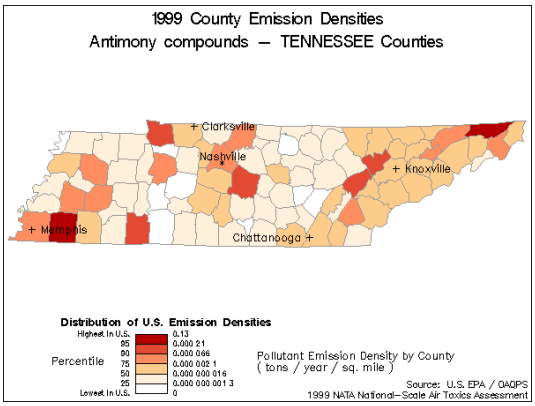

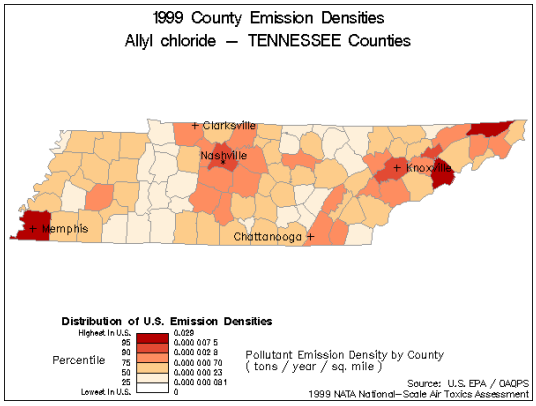

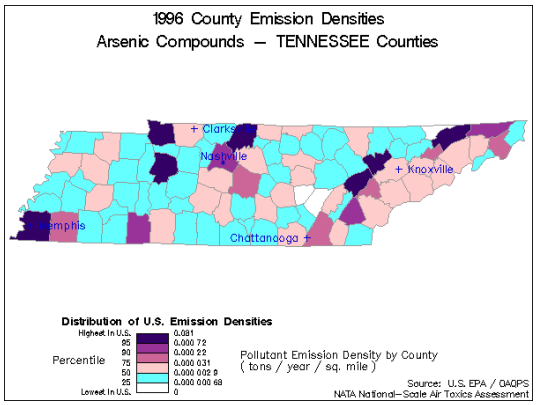

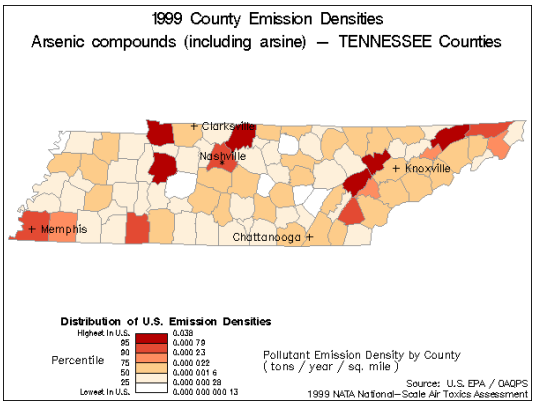

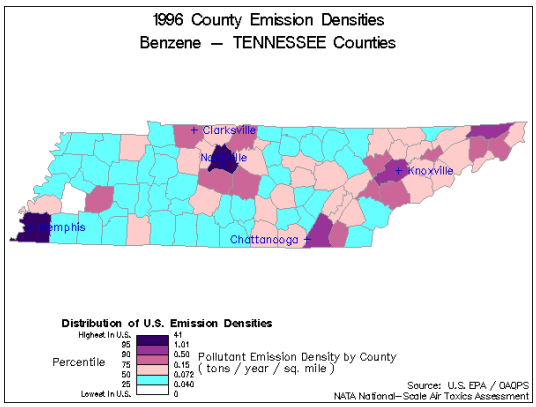

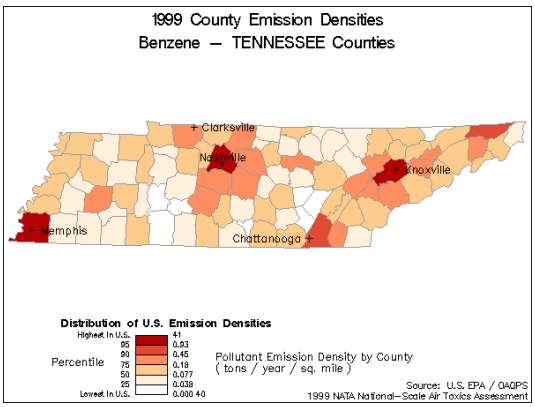

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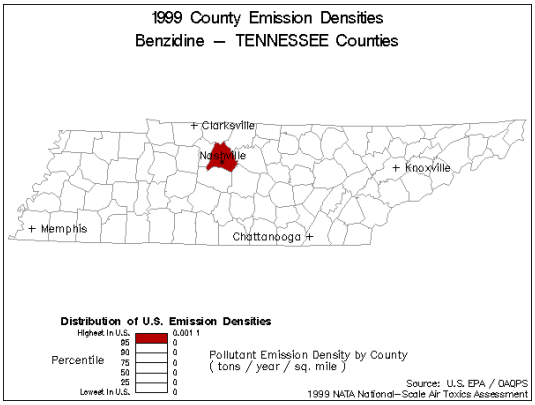

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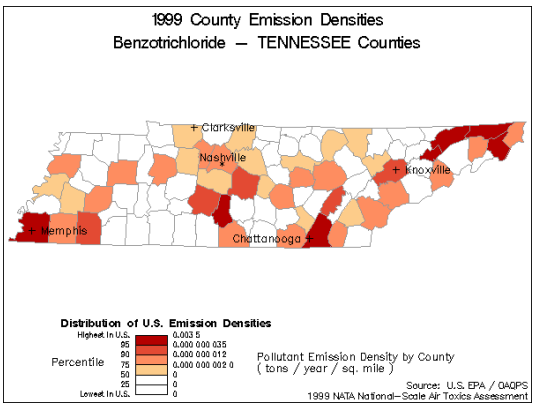

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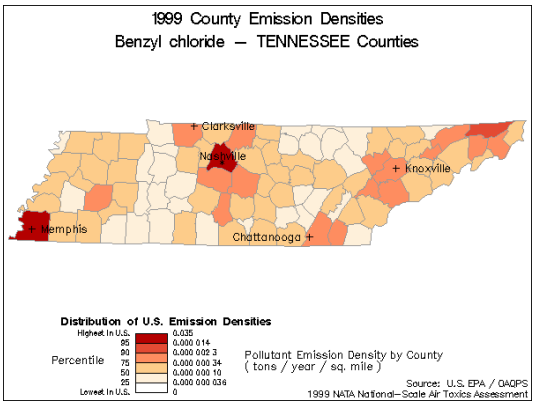

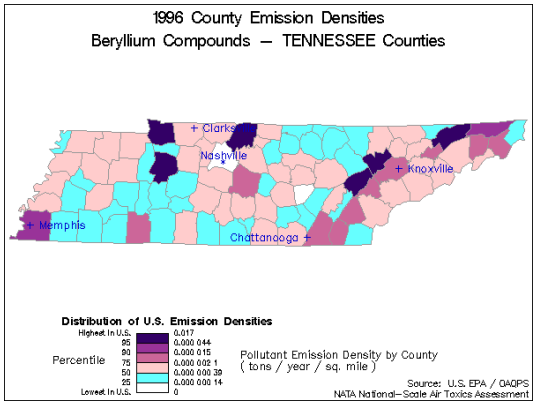

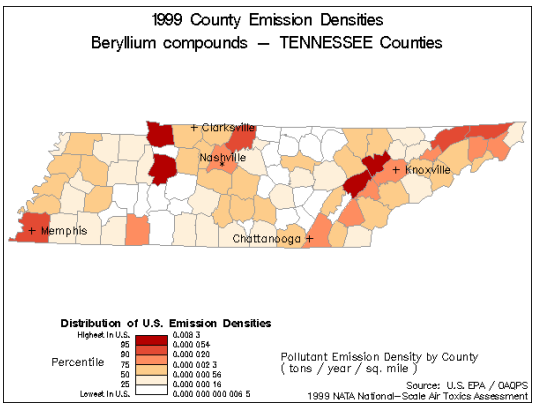

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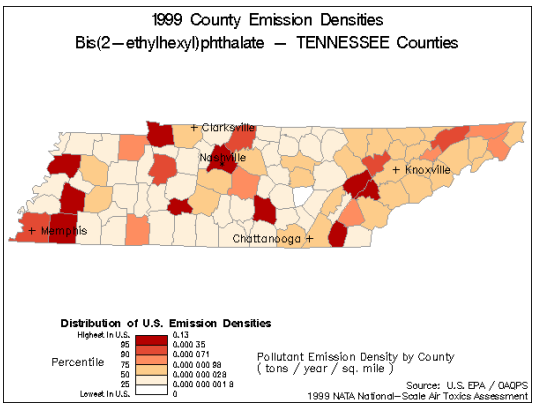

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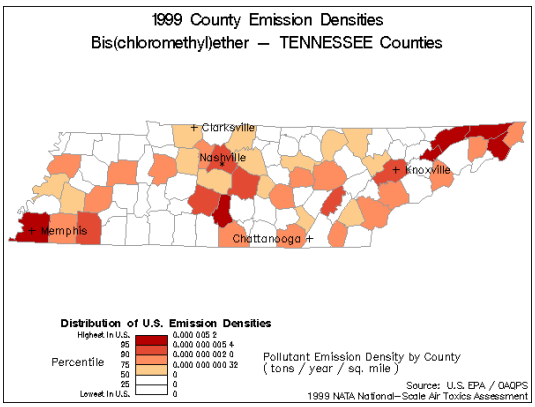

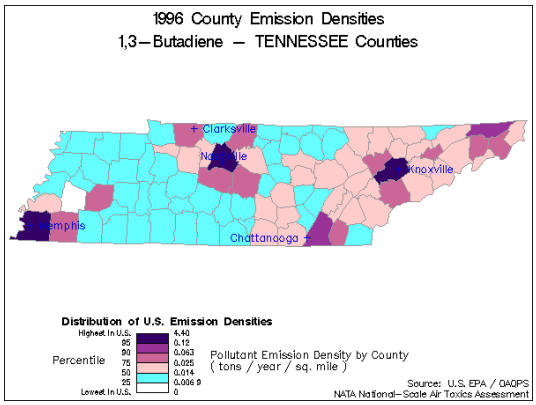

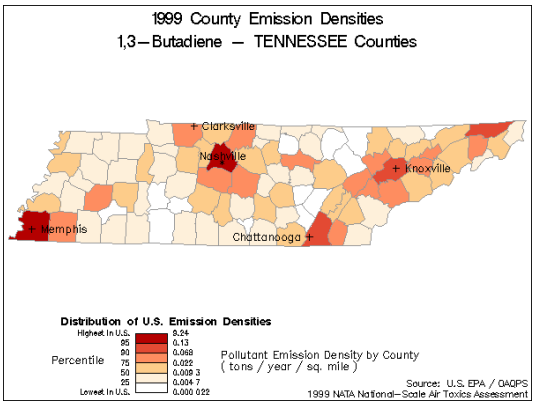

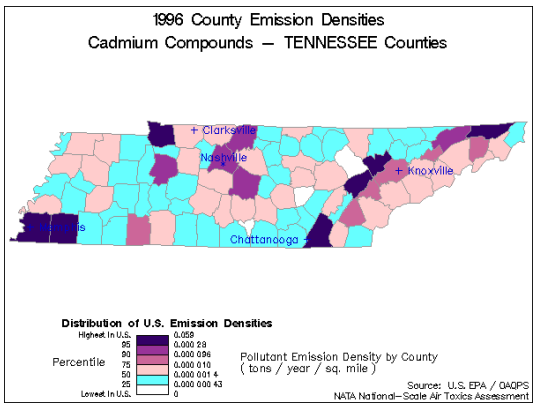

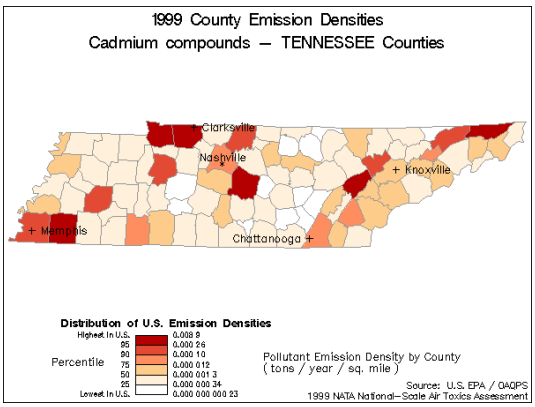

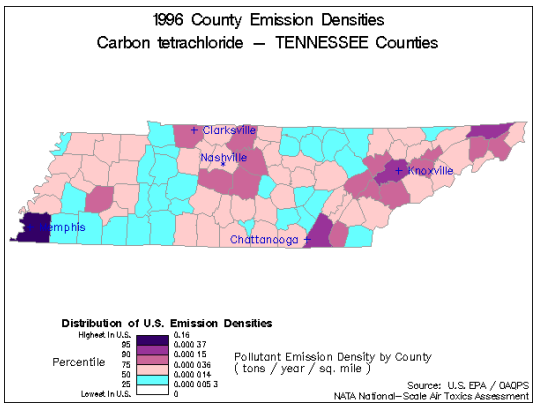

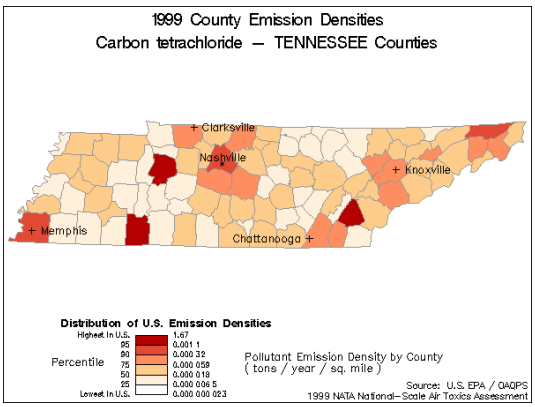

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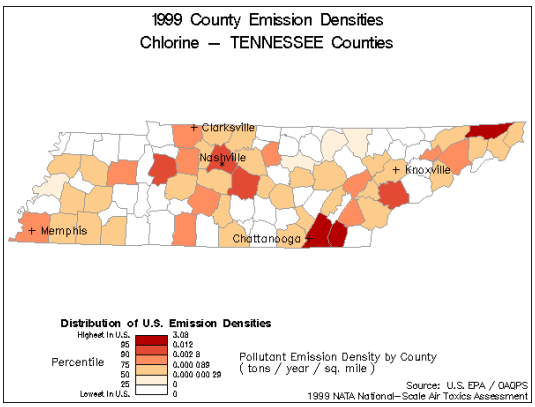

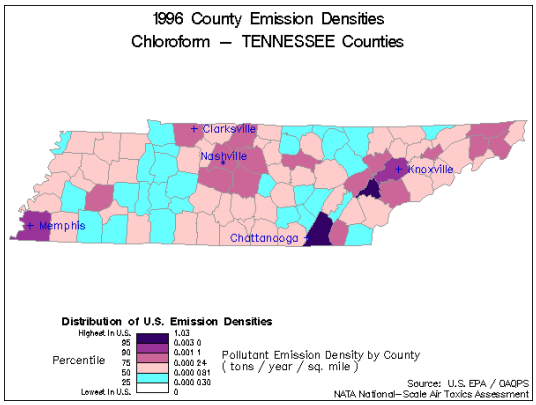

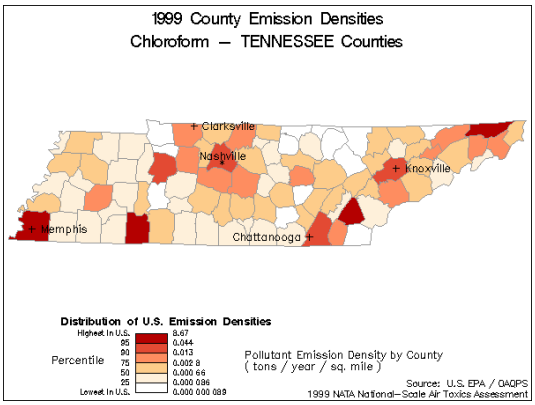

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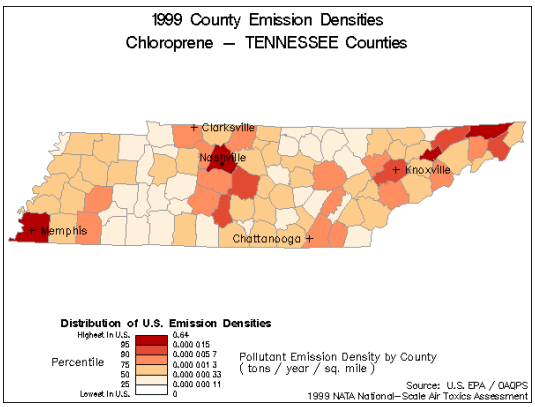

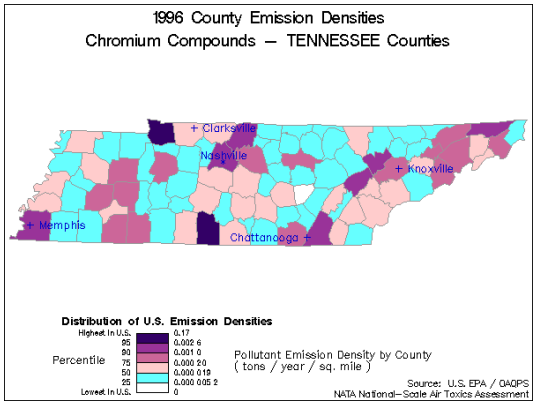

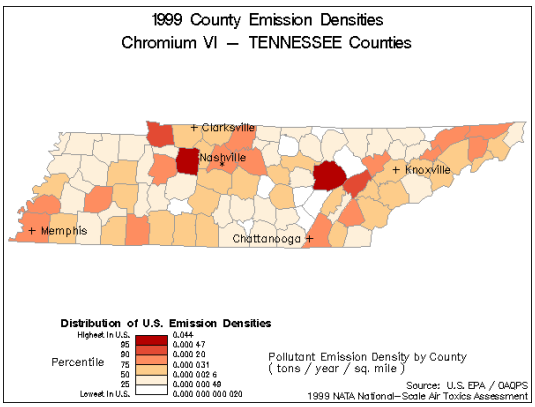

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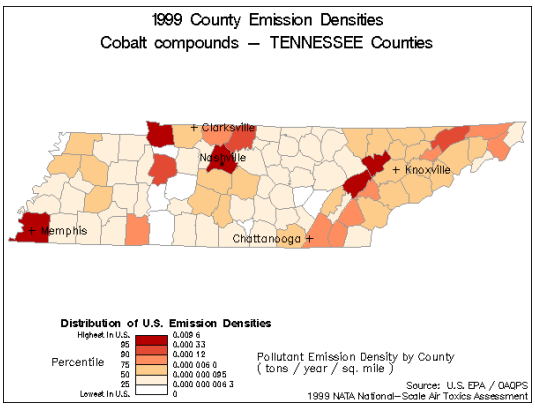

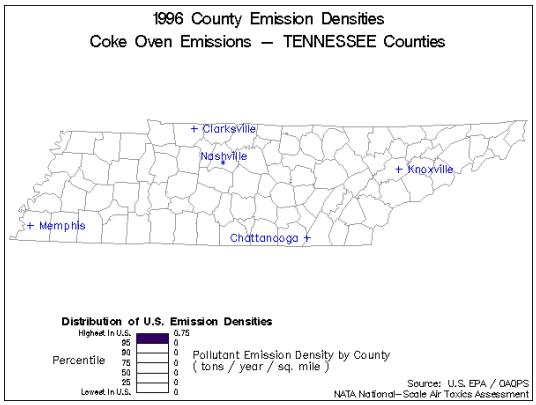

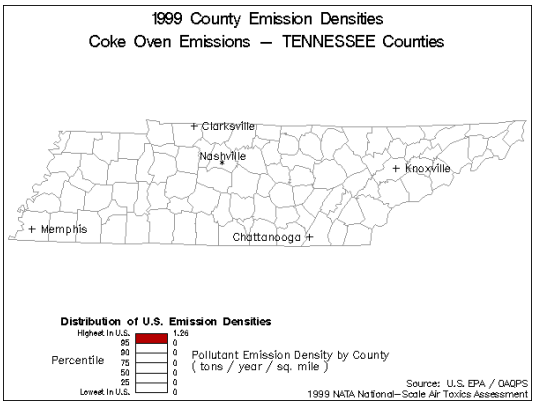

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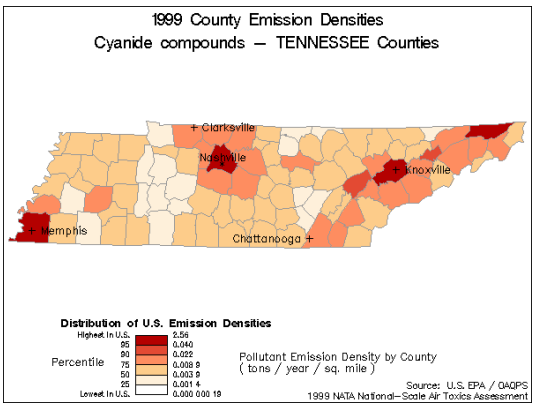

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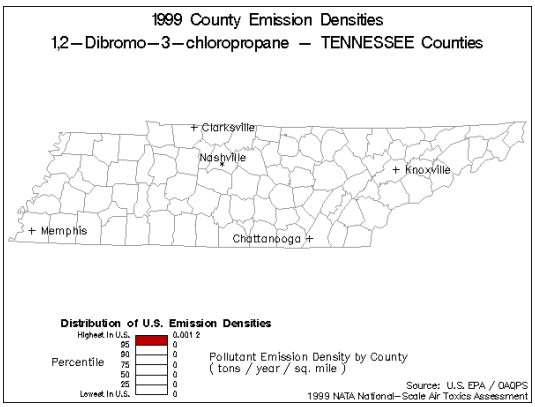

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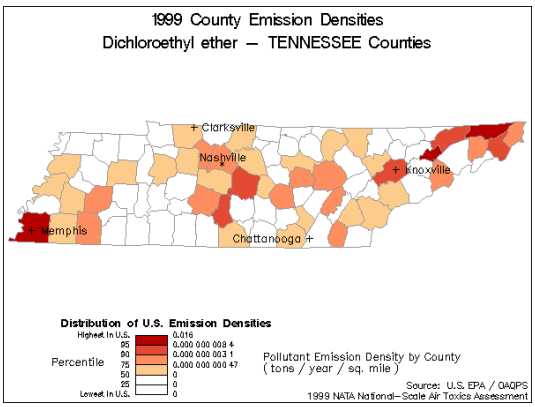

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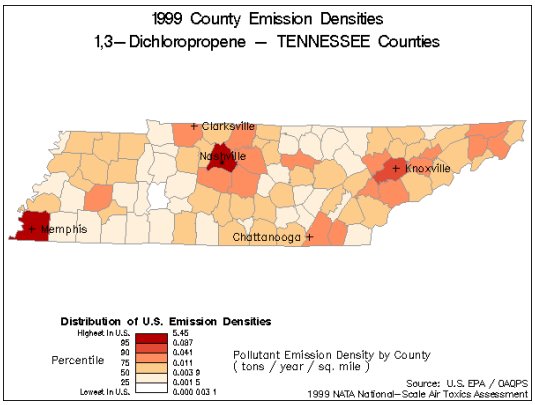

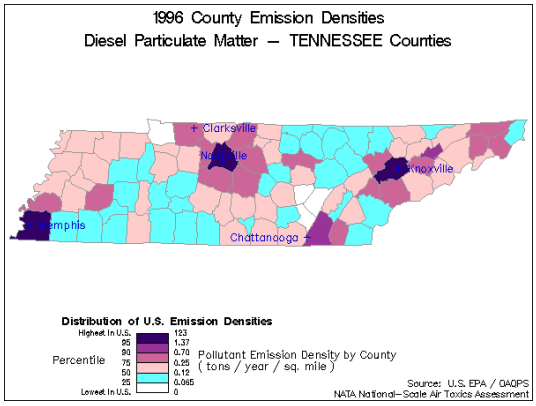

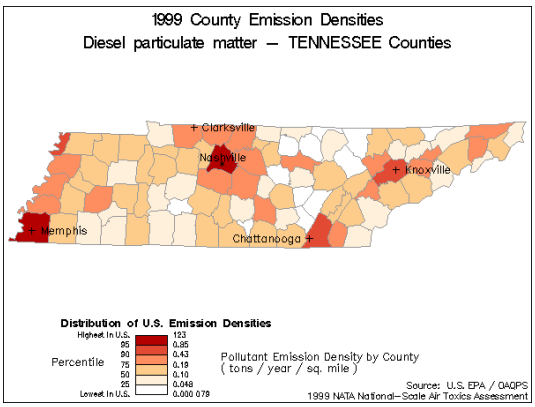

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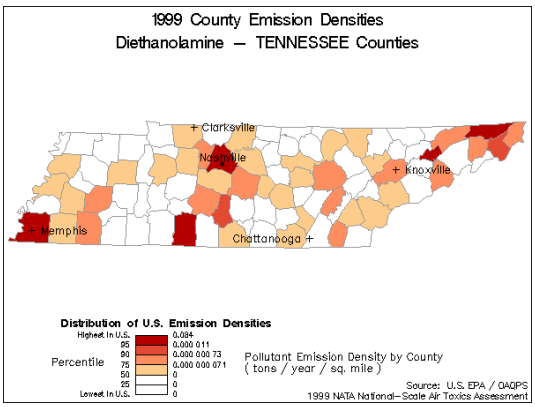

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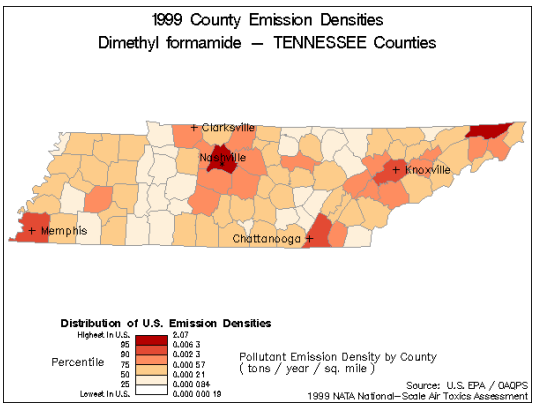

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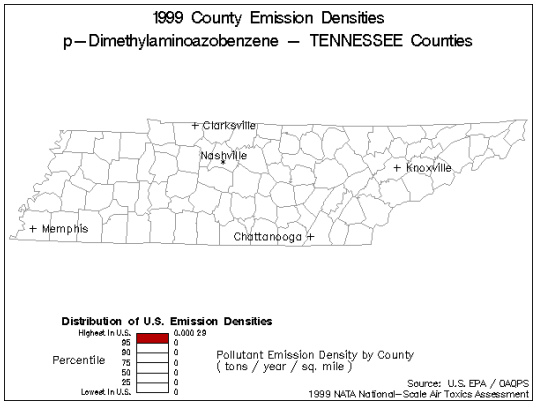
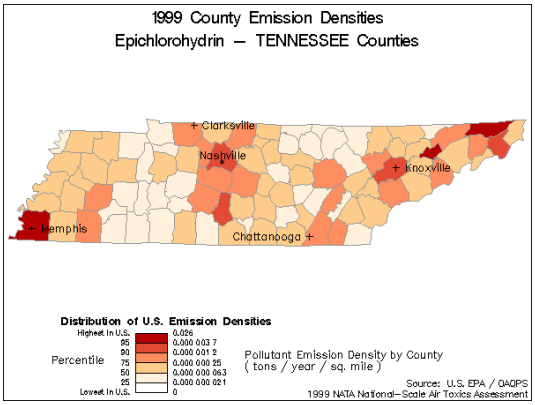
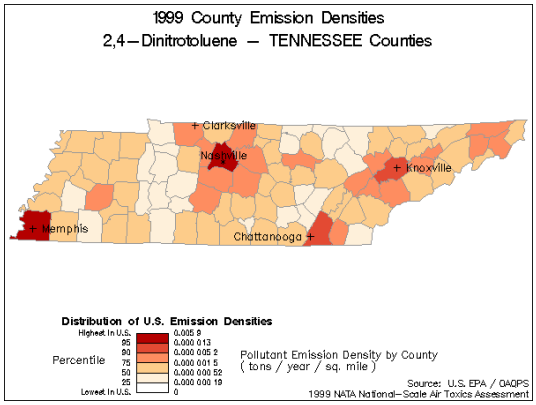
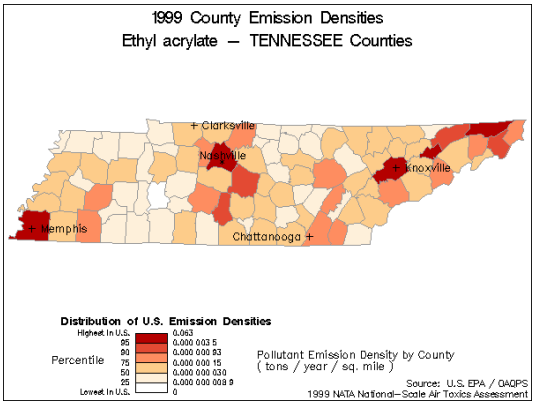
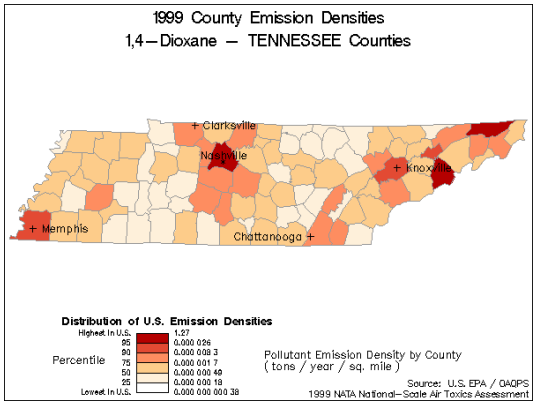
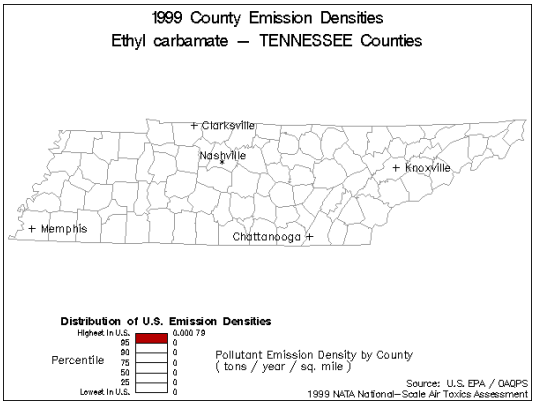


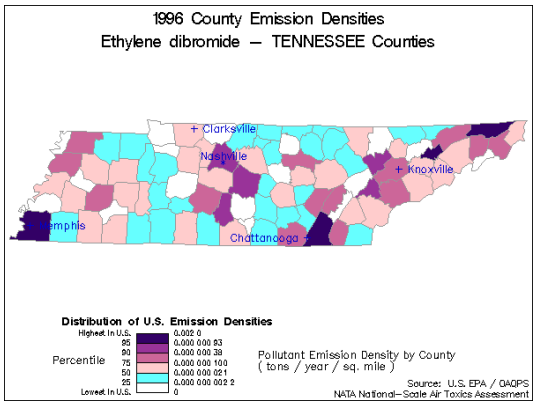


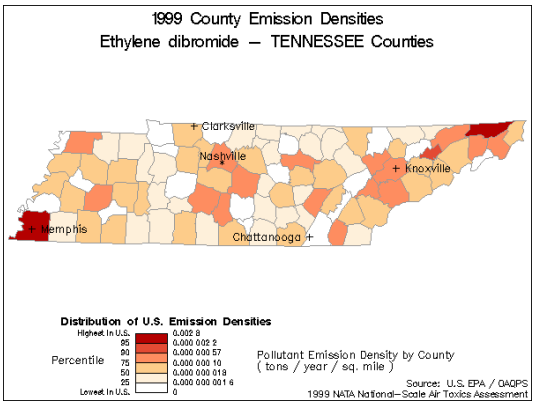


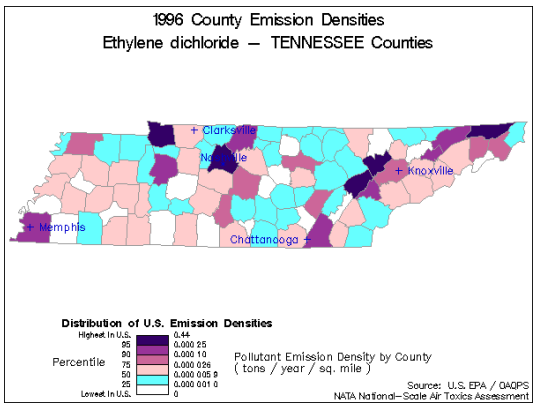


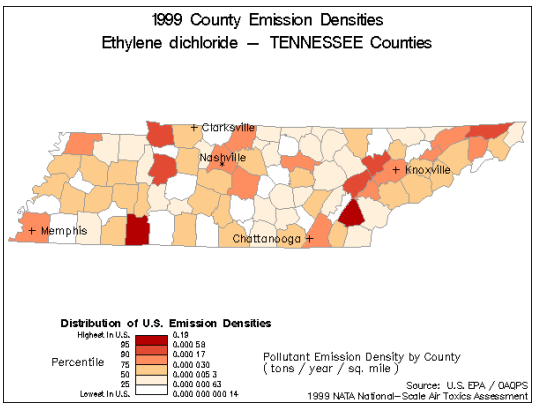


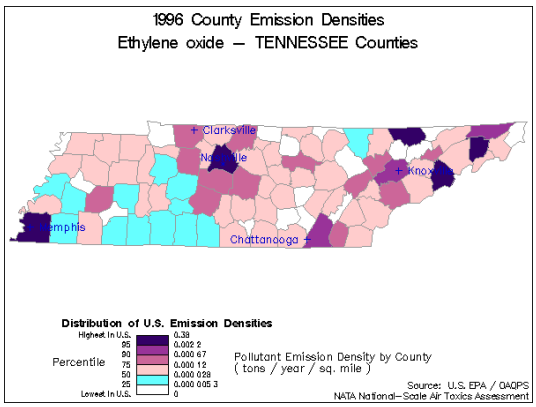


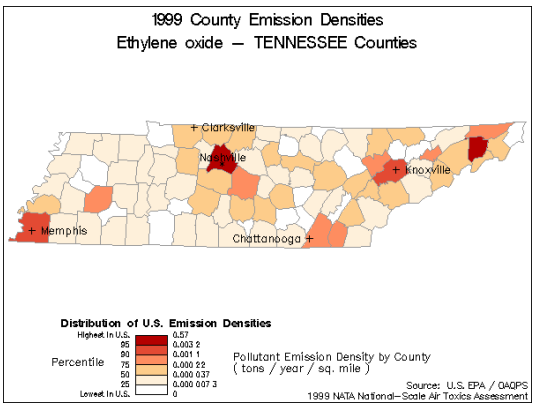

1996 County Emission Densities
Ethylene dibromide – TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S.
95
90
75
50
25
Lowest In U.S.
Percentile
0.002 0
0.000 000 93
0.000 000 39
0.000 000 100
0.000 000 021
0.000 000 002 2
0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
NATA National–Scale Air Toxics Assessment

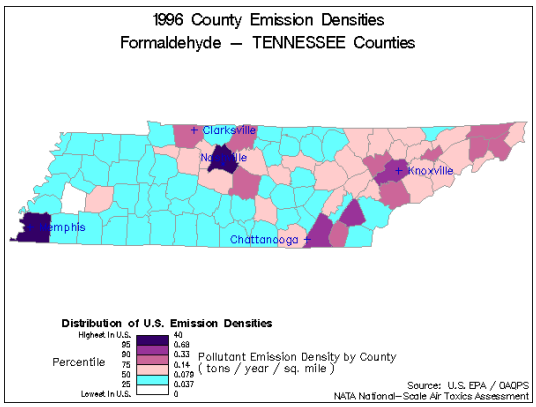

1999 County Emission Densities
Ethylene dibromide – TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S.
95
90
75
50
25
Lowest In U.S.
Percentile
0.002 8
0.000 002 2
0.000 000 57
0.000 000 10
0.000 000 019
0.000 000 001 6
0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
1999 NATA National–Scale Air Toxics Assessment

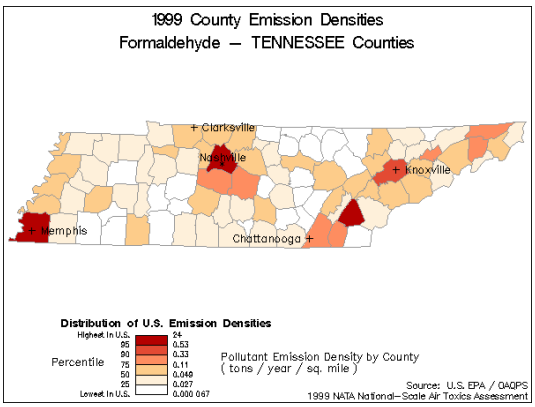

1996 County Emission Densities
Ethylene dichloride – TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S.
95
90
75
50
25
Lowest In U.S.
Percentile
0.44
0.000 25
0.000 10
0.000 026
0.000 005 9
0.000 001 0
0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
NATA National–Scale Air Toxics Assessment


1999 County Emission Densities
Ethylene dichloride – TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S.
95
90
75
50
25
Lowest In U.S.
Percentile
0.19
0.000 58
0.000 17
0.000 030
0.000 005 3
0.000 000 63
0.000 000 000 14
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
1999 NATA National–Scale Air Toxics Assessment


1996 County Emission Densities
Ethylene oxide – TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S.
95
90
75
50
25
Lowest In U.S.
Percentile
0.33
0.002 2
0.000 67
0.000 12
0.000 028
0.000 005 3
0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
NATA National–Scale Air Toxics Assessment


1999 County Emission Densities
Ethylene oxide – TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S.
95
90
75
50
25
Lowest In U.S.
Percentile
0.57
0.003 2
0.001 1
0.000 22
0.000 037
0.000 007 3
0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
1999 NATA National–Scale Air Toxics Assessment


1996 County Emission Densities
Formaldehyde – TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S.
95
90
75
50
25
Lowest In U.S.
Percentile
40
0.68
0.33
0.14
0.079
0.037
0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
NATA National–Scale Air Toxics Assessment


1999 County Emission Densities
Formaldehyde – TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S.
95
90
75
50
25
Lowest In U.S.
Percentile
24
0.53
0.33
0.11
0.049
0.027
0.000 067
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
1999 NATA National–Scale Air Toxics Assessment

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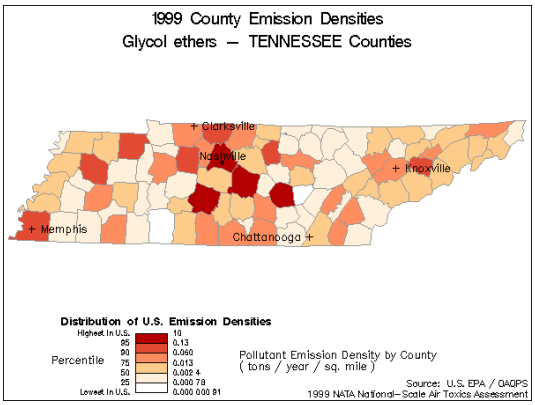

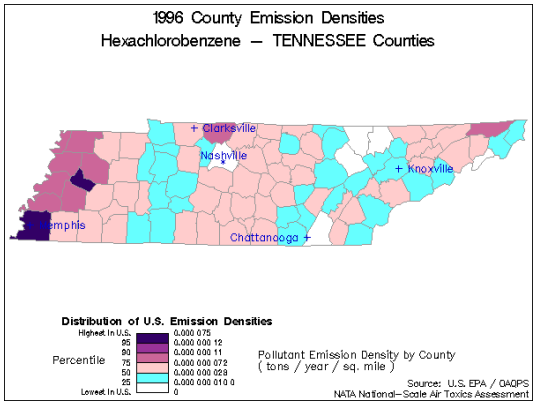

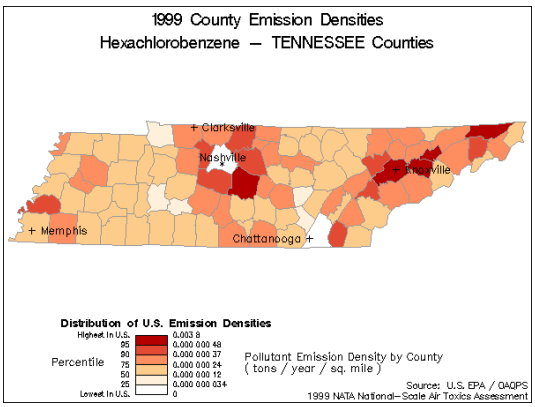

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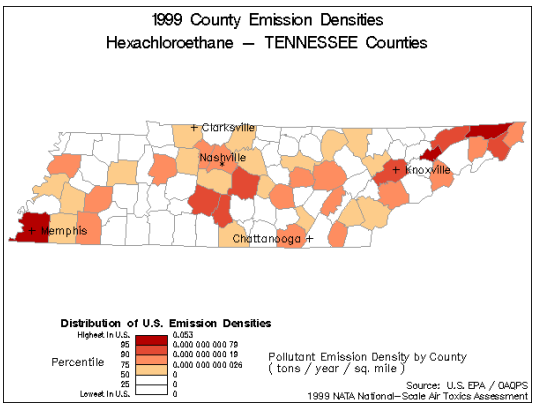

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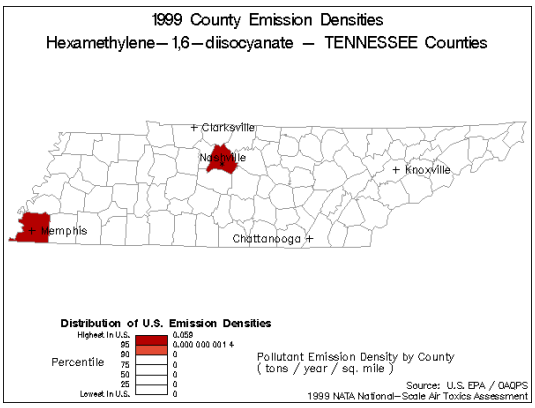

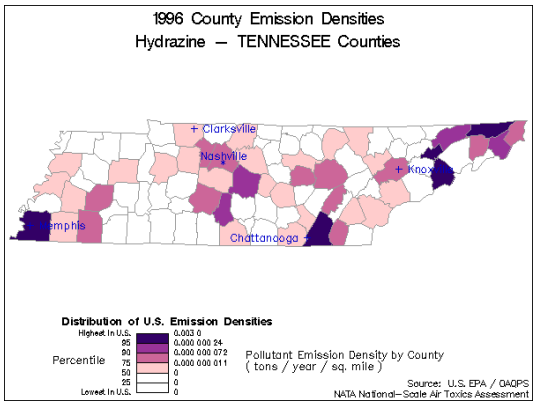

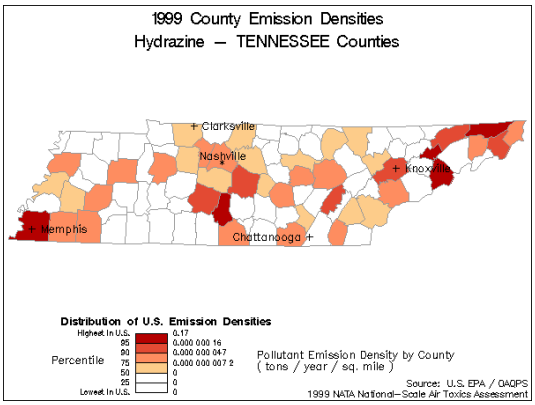

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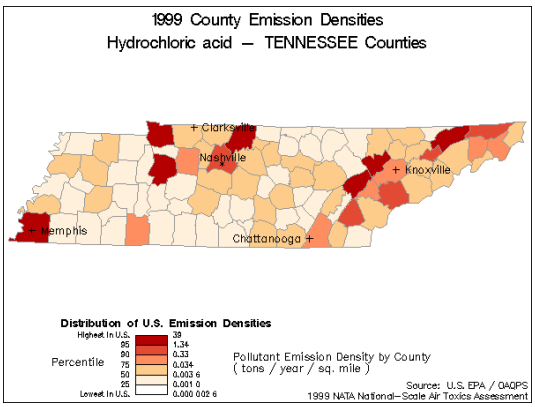

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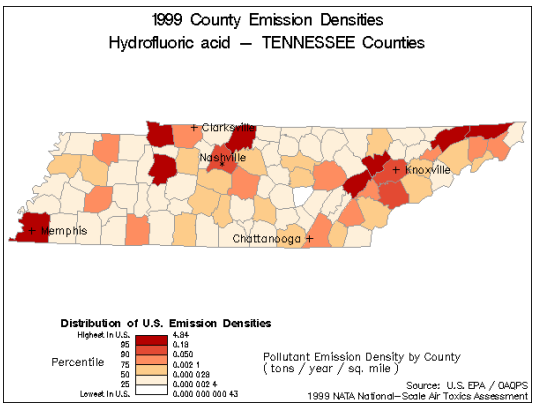

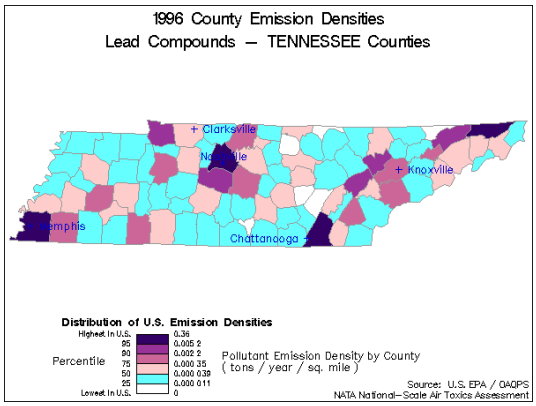

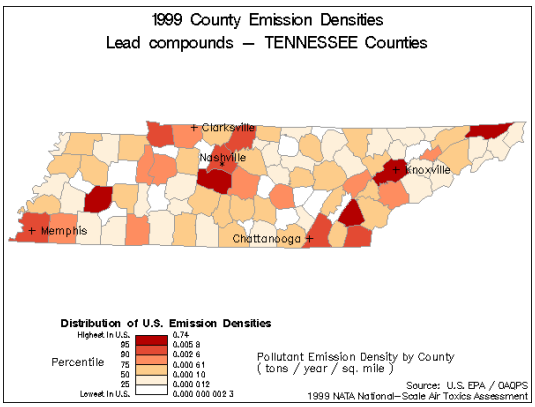

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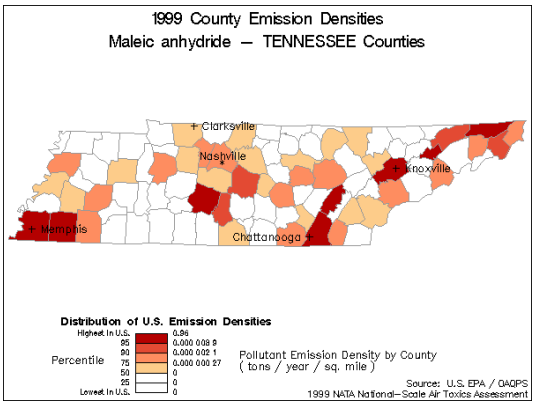

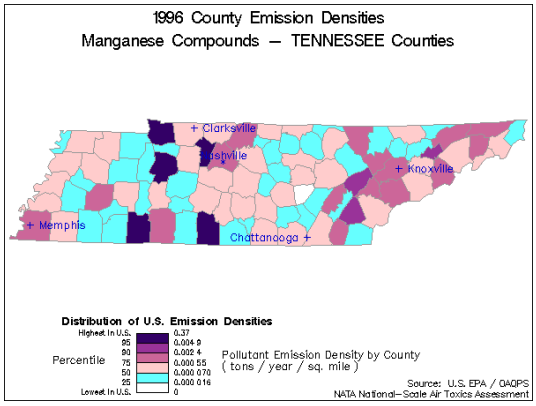

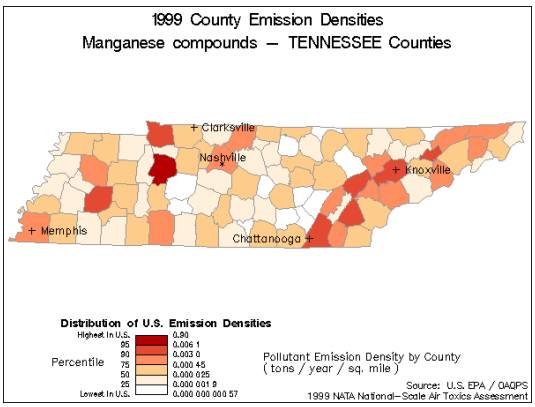

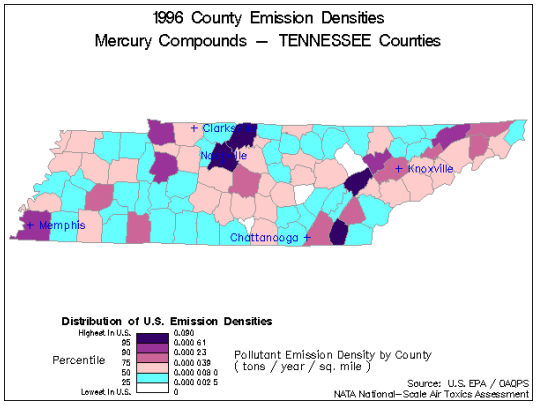

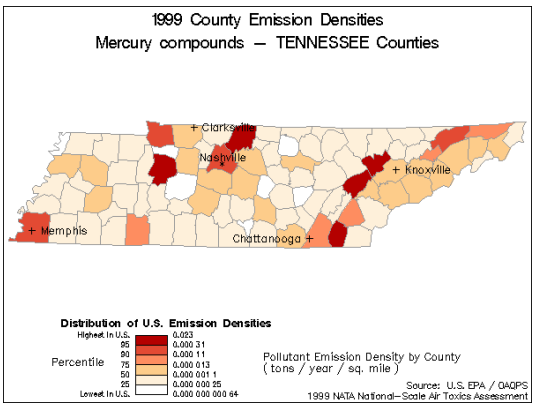

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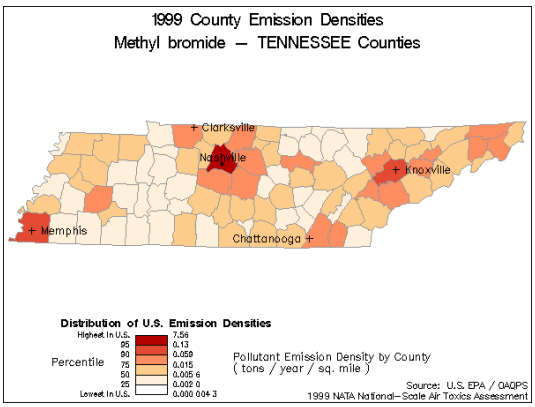
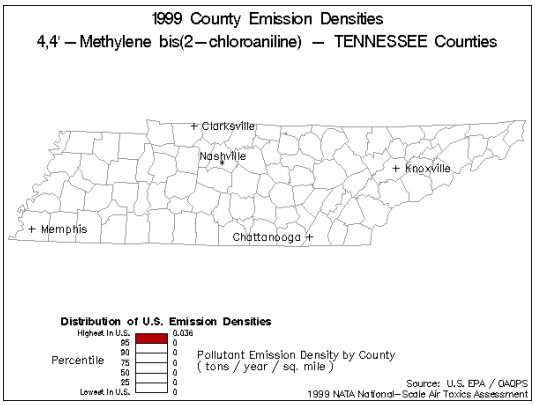
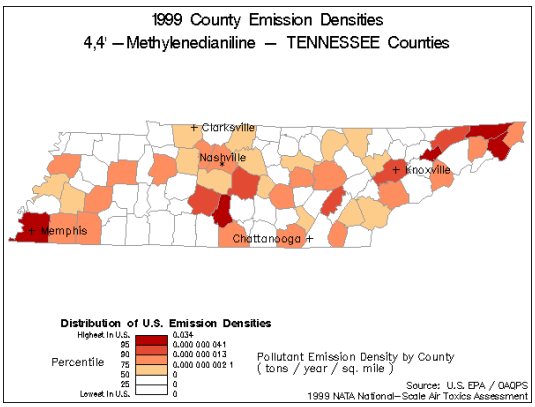
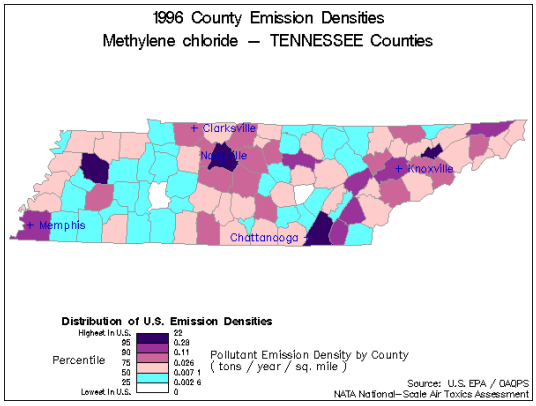


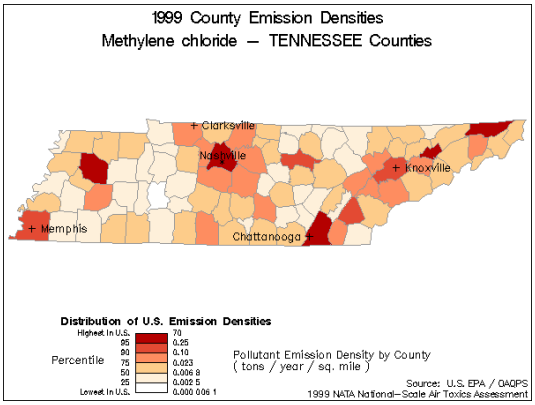
(1996 Information Not Available)



(1996 Information Not Available)







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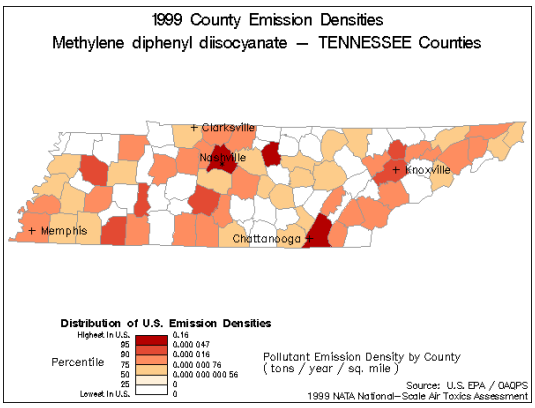

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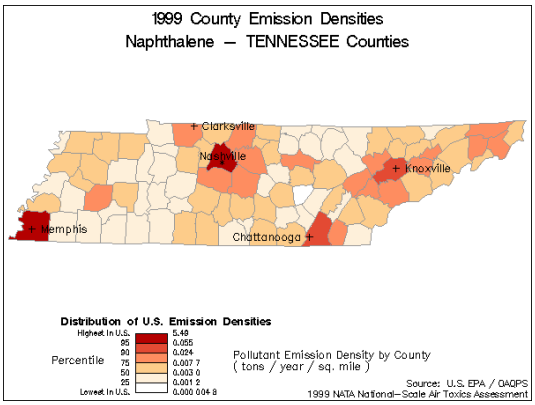
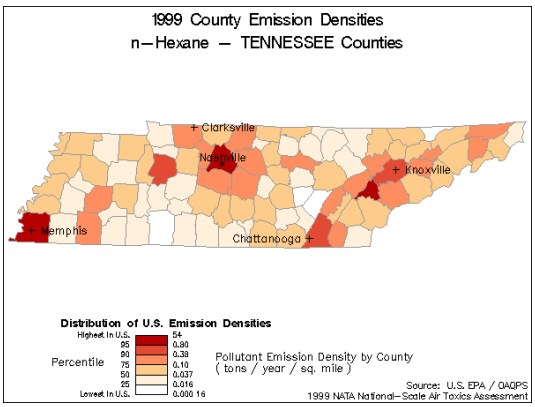
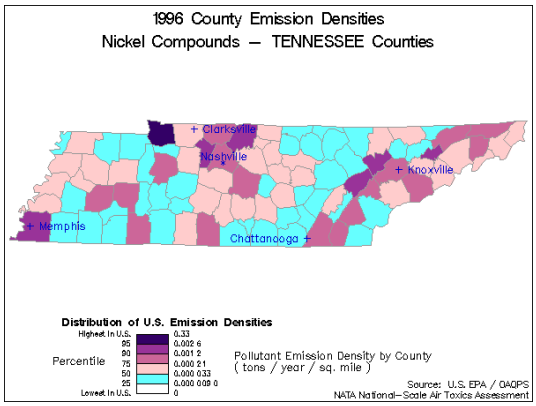
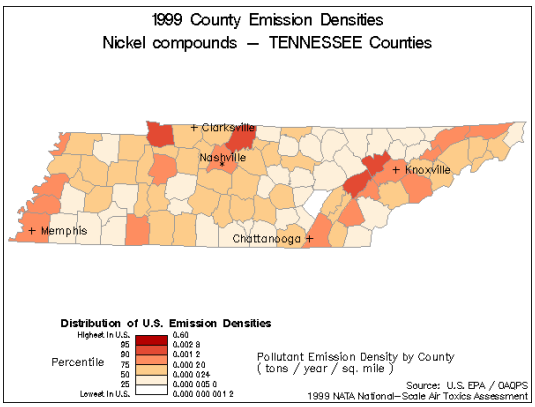


(1996 Information Not Available)







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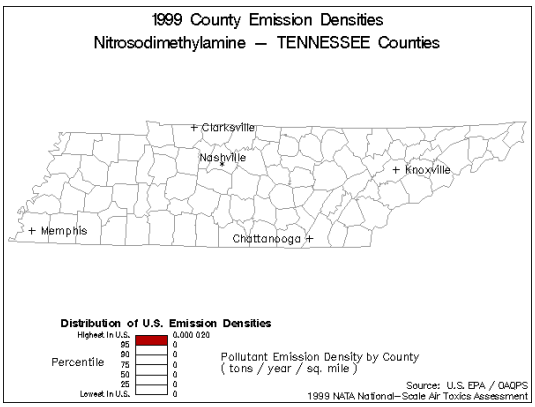

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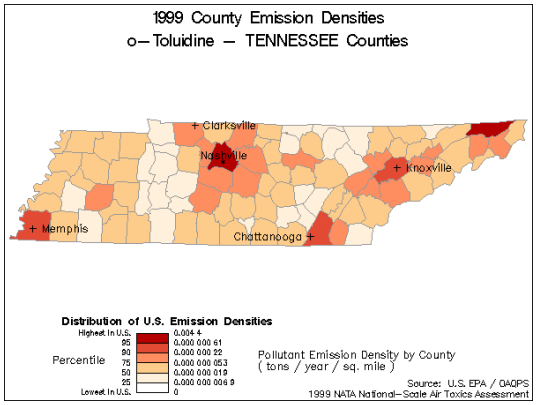
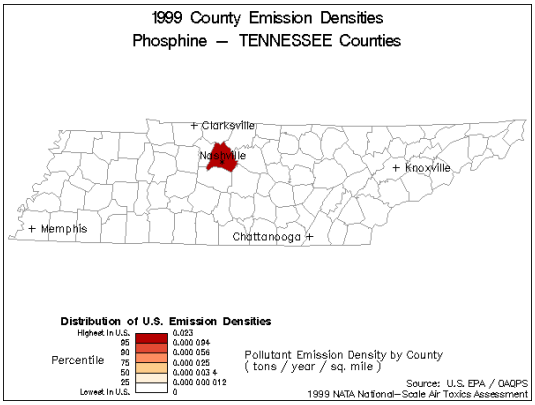
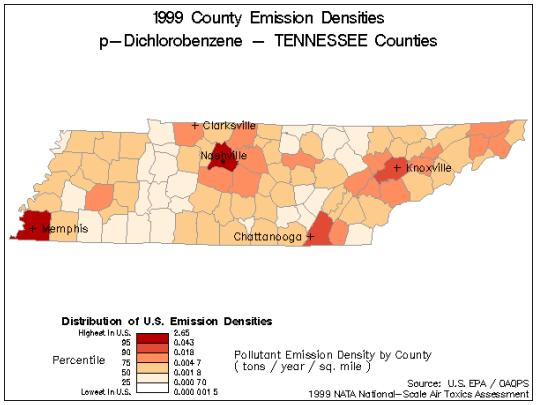
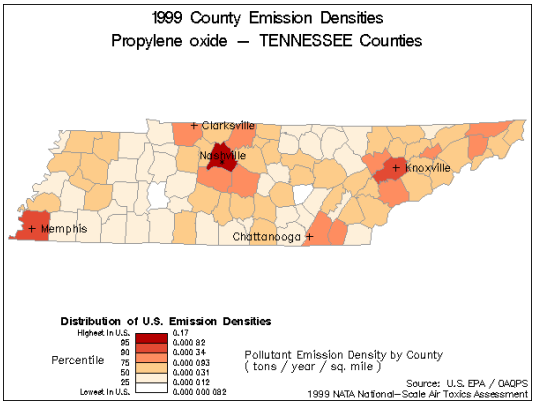
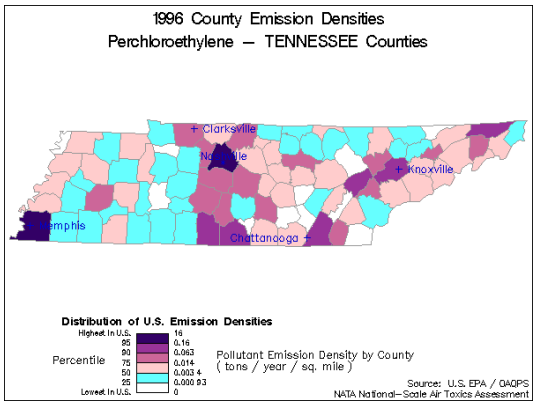
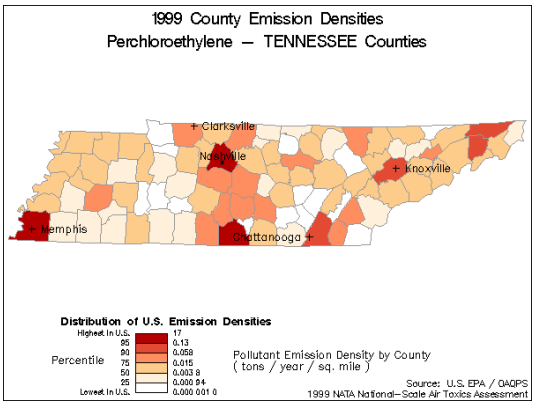


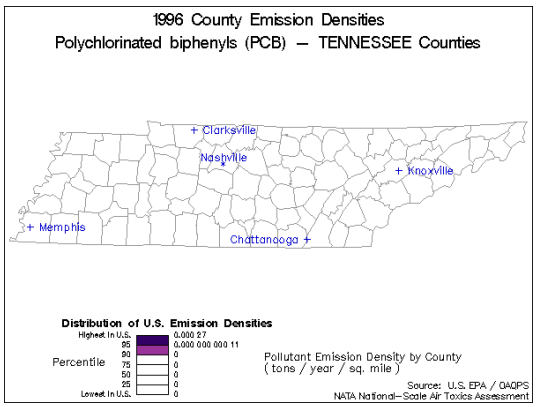


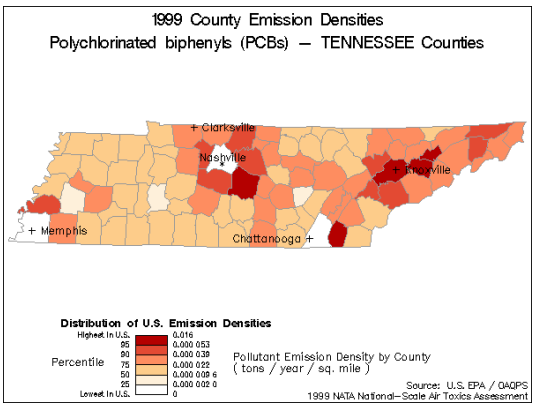


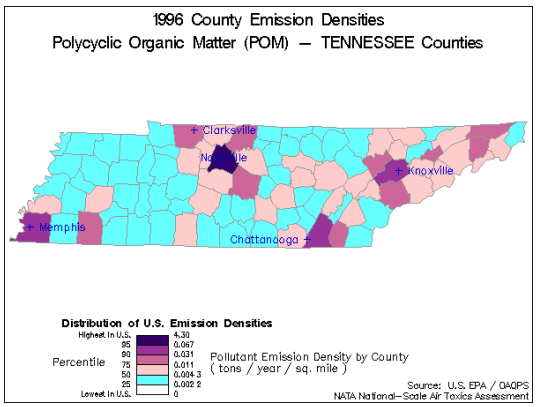


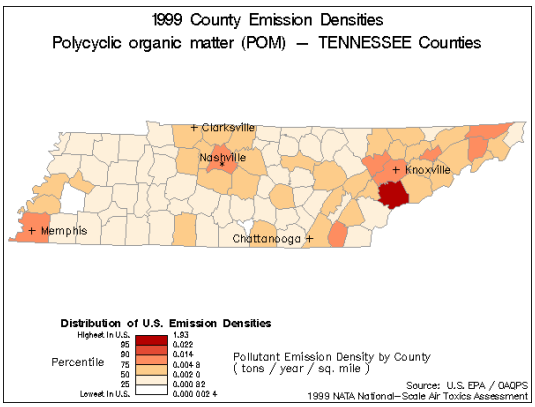

1996 County Emission Densities
Perchloroethylene — TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S. 16
95 0.16
90 0.063
Percentile 75 0.014
50 0.003 4
25 0.000 93
Lowest In U.S. 0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
NATA National–Scale Air Toxics Assessment

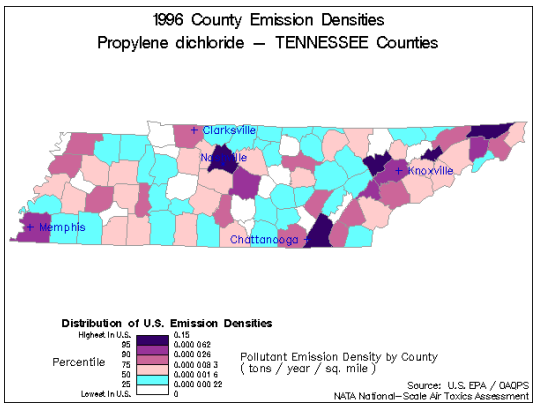

1999 County Emission Densities
Perchloroethylene — TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S. 17
95 0.13
90 0.058
Percentile 75 0.015
50 0.003 8
25 0.000 94
Lowest In U.S. 0.000 001 0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
1999 NATA National–Scale Air Toxics Assessment

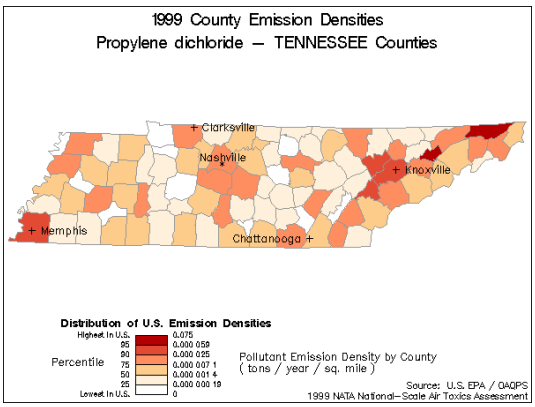

1996 County Emission Densities
Polychlorinated biphenyls (PCB) — TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S. 0.000 27
95 0.000 000 000 11
90 0
Percentile 75 0
50 0
25 0
Lowest In U.S. 0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
NATA National–Scale Air Toxics Assessment

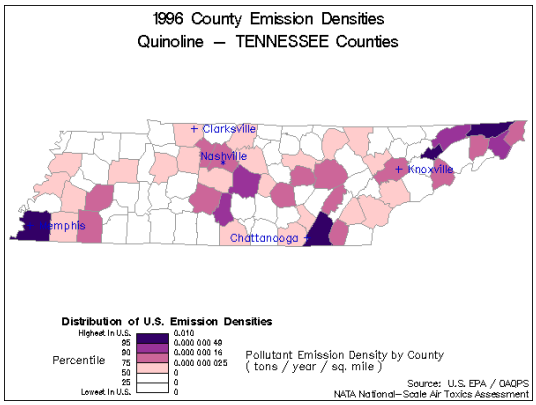

1999 County Emission Densities
Polychlorinated biphenyls (PCBs) — TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S. 0.016
95 0.000 053
90 0.000 039
Percentile 75 0.000 022
50 0.000 008 6
25 0.000 002 0
Lowest In U.S. 0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
1999 NATA National–Scale Air Toxics Assessment

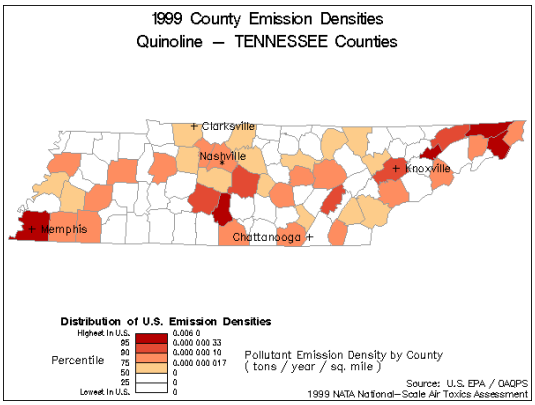

1996 County Emission Densities
Polycyclic Organic Matter (POM) — TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S. 4.30
95 0.067
90 0.031
Percentile 75 0.011
50 0.004 3
25 0.002 2
Lowest In U.S. 0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
NATA National–Scale Air Toxics Assessment

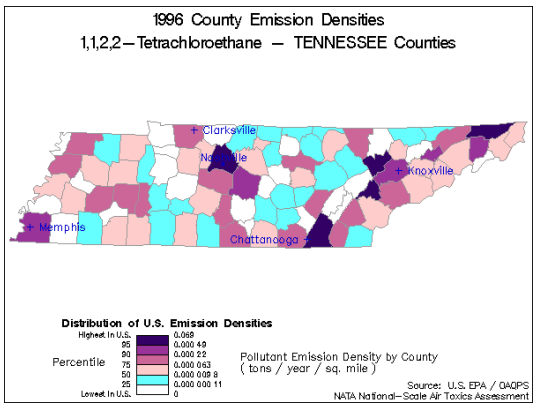

1999 County Emission Densities
Polycyclic organic matter (POM) — TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S. 1.83
95 0.022
90 0.014
Percentile 75 0.004 8
50 0.002 0
25 0.000 82
Lowest In U.S. 0.000 002 4
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
1999 NATA National–Scale Air Toxics Assessment

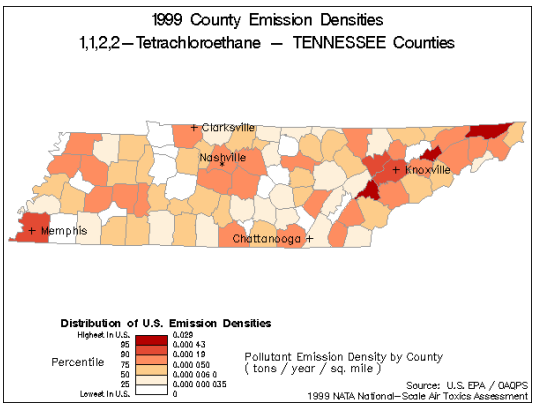

1996 County Emission Densities
Propylene dichloride — TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S. 0.15
95 0.000 062
90 0.000 026
Percentile 75 0.000 008 3
50 0.000 001 6
25 0.000 000 22
Lowest In U.S. 0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
NATA National–Scale Air Toxics Assessment


1999 County Emission Densities
Propylene dichloride — TENNESSEE Counties
Clarksville
Nashville
Knoxville
Memphis
Chattanooga
Distribution of U.S. Emission Densities
Highest In U.S. 0.075
95 0.000 059
90 0.000 025
Percentile 75 0.000 007 1
50 0.000 001 4
25 0.000 000 19
Lowest In U.S. 0
Pollutant Emission Density by County
(tons / year / sq. mile)
Source: U.S. EPA / OAQPS
1999 NATA National–Scale Air Toxics Assessment









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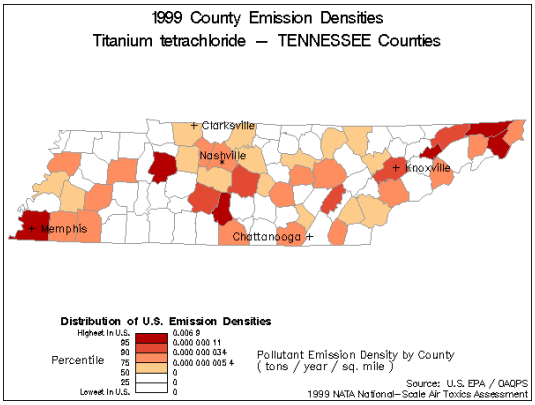

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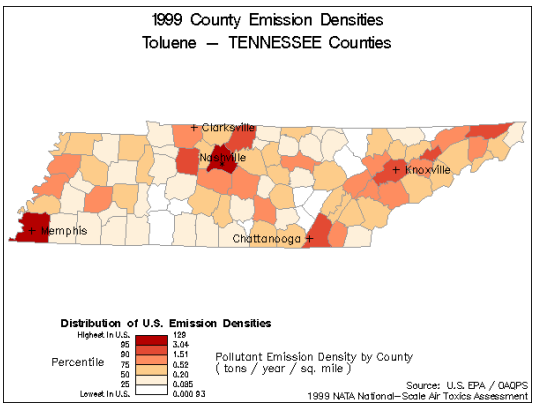

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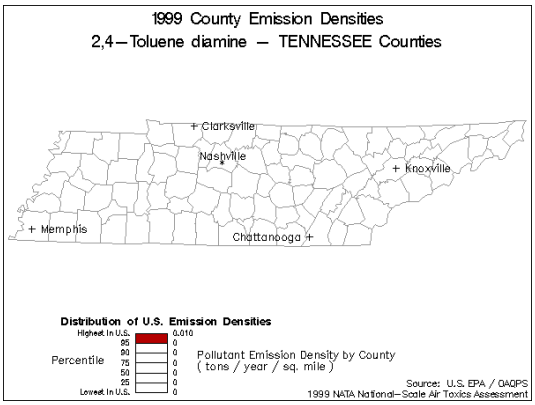

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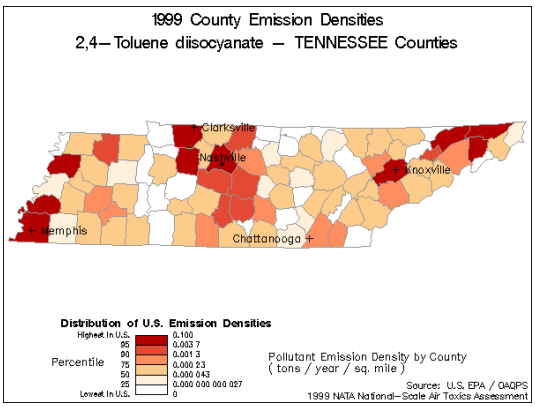

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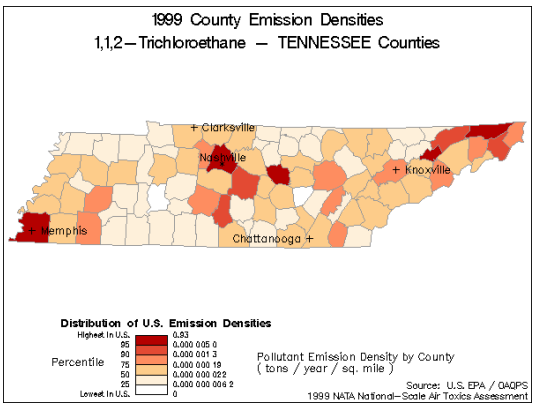

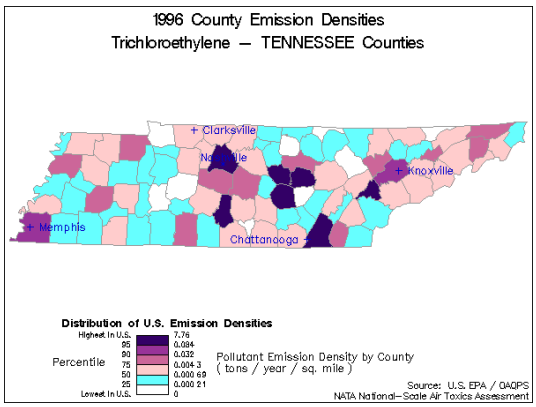

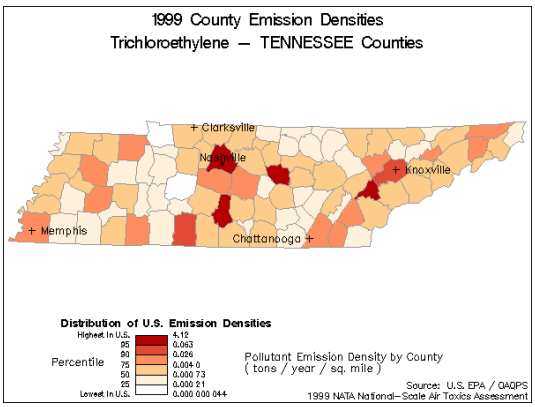

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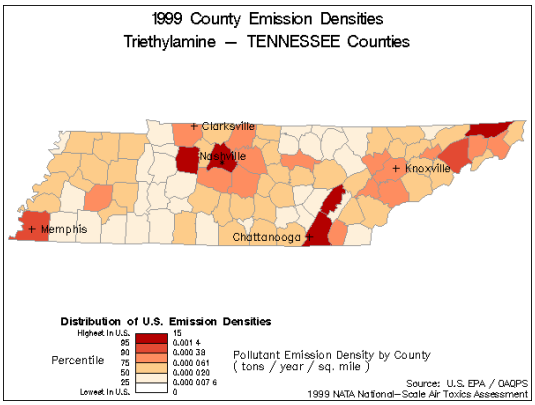

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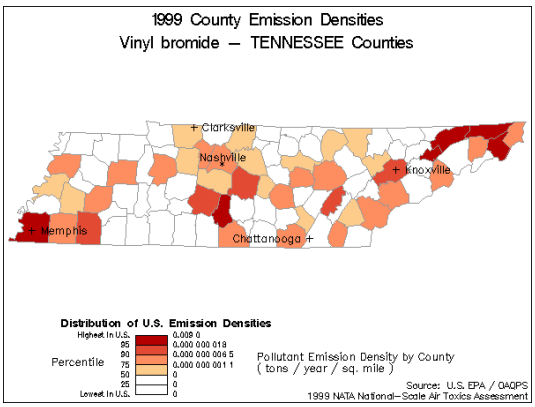

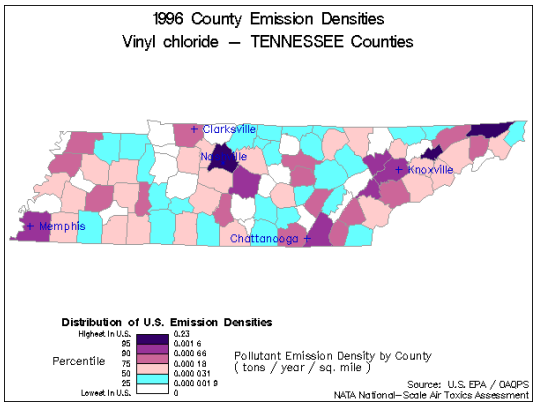

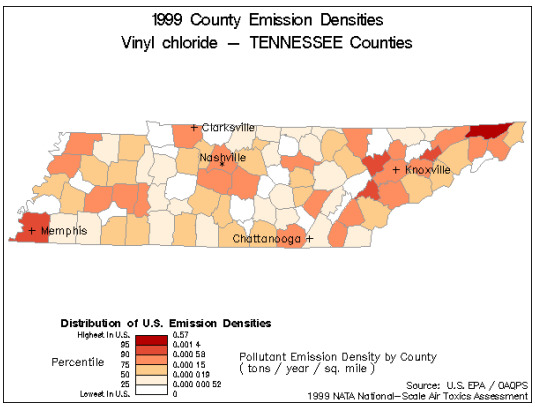

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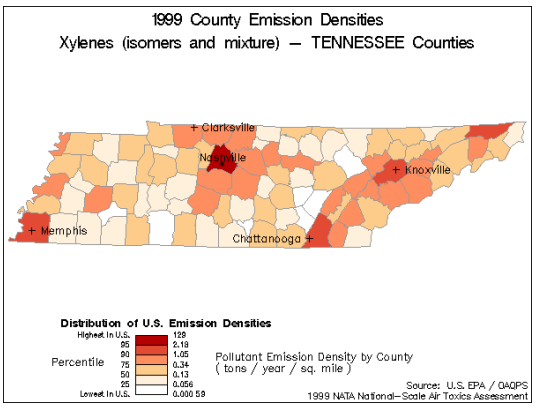


Appendix I
Glossary of Chemicals

The following are brief descriptions of the properties, uses, and hazards associated with the chemicals identified in the text and appendices of this report. Due to space limitations, the information is extremely abbreviated, and interested parties are recommended to consult the following websites for additional details:

- *EPA's Integrated Risk Information System (IRIS) Database:* http://www.epa.gov/iris/index.html and *Health Effects Notebook for Hazardous Air Pollutants: http://www.epa.gov/ttn/atw/hlthef/hapindex.html*

IRIS is a database of human health effects that may result from exposure to various substances found in the environment. IRIS was initially developed for EPA staff in response to a growing demand for consistent information on chemical substances for use in risk assessments, decision-making and regulatory activities. The information in IRIS is intended for those without extensive training in toxicology, but with some knowledge of health sciences. Substance files are typically about 15K to 40K in size, within a range from less than 10K up to about 120K. IRIS is more useful for those with some familiarity to toxicology testing than the average layperson. However, the Health Effects Notebook provides brief, layperson-friendly information on air toxics - *the following descriptions for specific chemicals are summarized from material at this website.*

- *CDC Agency for Toxic Substances and Disease Registry's Toxicological Profiles Database:* http://www.atsdr.cdc.gov/toxpro2.html

By Congressional mandate, ATSDR produces "toxicological profiles" for hazardous substances found at National Priorities List ("Superfund") sites. These hazardous substances are ranked based on frequency of occurrence at NPL sites, toxicity, and potential for human exposure. Toxicological profiles are developed from a priority list of 275 substances. ATSDR also prepares toxicological profiles for the Department of Defense (DOD) and the Department of Energy (DOE) on substances related to federal sites.

So far, 289 toxicological profiles have been published or are under development as "finals" or "drafts for public comment"; 268 profiles were published as finals; 124 profiles have been updated. Currently, 8 profiles are being revised based on public comments received. These profiles cover more than 250 substances. However, not all compounds in IRIS are yet in this registry. The profiles are long, but layperson-friendly.

- *National Institute for Health's (NIH) PubChem Project:* http://pubchem.ncbi.nlm.nih.gov/

PubChem provides information on the biological activities of small molecules, and extensive links to other websites with additional information. PubChem contains information on more than 17 million substances and 500 bioassays. Clear illustrations of the chemical structures are provided, but the site is somewhat less user-friendly overall that the previous two sites.

- *NIH's Toxicology Data Network: http://toxnet.nlm.nih.gov/index.html*

The Toxicology Data Network (TOXNET) provides links to several useful databases on toxicology, hazardous chemicals, environmental health, and toxic releases, including the *Hazardous Substances Database* (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB) which provides comprehensive, peer-reviewed toxicology data is provided for about 5,000 chemicals in an easier to read summary than at PubChem.

Acetaldehyde is mainly used as an intermediate in the synthesis of other chemicals, including in the production of perfumes, polyester resins, and basic dyes. Acetaldehyde is also used as a fruit and fish preservative, as a flavoring agent, and as a denaturant for alcohol, in fuel compositions, for hardening gelatin, and as a solvent in the rubber, tanning, and paper industries. At levels typically found in the environment, acetaldehyde contributes to the formation of photochemical smog. It is ubiquitous in the environment and may be formed in the body from the breakdown of ethanol. Acute (short-term) exposure to acetaldehyde results in effects including irritation of the eyes, skin, and respiratory tract. Symptoms of chronic (long-term) intoxication of acetaldehyde resemble those of alcoholism. Acetaldehyde is considered a probable human carcinogen (Group B2) based on inadequate human cancer studies and animal studies that have shown nasal tumors in rats and laryngeal tumors in hamsters.

Acetonitrile has many uses, including as a solvent, for spinning fibers, and in lithium batteries. It is primarily found in air from automobile exhaust and manufacturing facilities, and is generated in tobacco smoke. Acute (short-term) inhalation exposure results in irritation of mucous membranes. Chronic (long-term) exposure results in central nervous system effects, such as headaches, numbness, and tremors. No data are available on its carcinogenic effects in humans; EPA has classified it as a Group D, not classifiable as to human carcinogenicity. At levels typically found in the environment, acetonitirle contributes to the formation of photochemical smog.

Acrolein is primarily used as an intermediate in the manufacture of acrylic acid. It can be formed from the breakdown of certain pollutants in outdoor air or from burning tobacco or gasoline. It is extremely toxic to humans from inhalation and dermal exposure, and was used to that effect as a poison gas in WWI. Acute (short-term) inhalation exposure may result in upper respiratory tract irritation and congestion at a concentration of 0.2 ppm, which is also the threshold at which its odor can de detected. Exposure to 10 ppm can be fatal. No information is available on its reproductive, developmental, or carcinogenic effects in humans. The animal cancer data are limited, with one study reporting an increased incidence of adrenocortical tumors in rats exposed to acrolein in the drinking water. EPA considers acrolein data are inadequate for an assessment of human carcinogenic potential. Small amounts of acrolein can be found in fried foods and roasted coffee.

Acrylamide is used as a reactive monomer and intermediate in the production of organic chemicals and in the synthesis of polyacrylamides. Acrylamide is also used as a flocculent for sewage and waste treatment, soil conditioning agents, ore processing, paper and textile industries, and in the manufacture of dyes, adhesives, and permanent press fabrics. The largest use for acrylamide is as an intermediate in the production of organic chemicals and in the synthesis of polyacrylamides. Exposure occurs primarily in the workplace. Acute (short-term) and chronic (long-term) oral exposures to acrylamide have resulted in damage to the nervous system in humans and animals. Human data are inadequate on acrylamide and cancer risk. In rats orally exposed to acrylamide, significantly increased incidences of tumors at multiple sites have been observed. EPA has classified acrylamide as a Group B2, probable human carcinogen.

Acrylic acid is used in the manufacture of plastics, in latex applications, in floor polish, in polymer solutions for coatings applications, emulsion polymers, paint formulations, leather finishings, and paper coatings. Acrylic acid is also used as a chemical intermediate. Exposure occurs primarily in the workplace. It is a strong irritant to the skin, eyes, and mucous membranes in humans. No information is available on the reproductive, developmental, or carcinogenic effects of acrylic acid in humans. Animal cancer studies have reported both positive and negative results. EPA has not classified acrylic acid for carcinogenicity.

Acrylonitrile exposure is primarily occupational: it is used in the manufacture of acrylic acid and modacrylic fibers. Acute (short-term) exposure of workers to acrylonitrile has been observed to cause mucous membrane irritation, headaches, dizziness, and nausea. No information is available on the reproductive or developmental effects of acrylonitrile in humans. Based on limited evidence in humans and evidence in rats, EPA has classified acrylonitrile as a probable human carcinogen (Group B1).

Allyl chloride exposure primarily occurs for workers in manufacturing plants. The acute (short-term) effects of allyl chloride from inhalation exposure in humans consists of irritation of the eyes and respiratory passages. Chronic (long-term) exposure to allyl chloride in humans causes injury to the liver and kidneys and the onset of pulmonary edema (fluid in the lungs). There are no human cancer data available for allyl chloride. Limited animal studies indicate that exposure to allyl chloride by gavage (placing the chemical experimentally in the stomachs of mice) caused an increase in the incidence of forestomach tumors. EPA has classified allyl chloride as a Group C, a possible human carcinogen.

Aniline is predominantly used as a chemical intermediate for the dye, agricultural, polymer, and rubber industries. It is also used as a solvent, and has been used as an antiknock compound for gasoline. Exposure to aniline may occur from breathing contaminated outdoor air, smoking tobacco, or working or being near industries where it is produced or used. The acute (short-term) and chronic (long-term) effects of aniline in humans consist mainly of effects on the lung, such as upper respiratory tract irritation and congestion. Chronic exposure may also result in effects on the blood. Human cancer data are insufficient to conclude that aniline is a cause of bladder tumors while animal studies indicate that aniline causes tumors of the spleen. EPA has classified aniline as a Group B2, probable human carcinogen.

Antimony compounds are ubiquitous in the environment. Soil typically contains about 1 ppm antimony, and food about 1 ppb. Antimony is alloyed with other metals such as lead to increase its hardness and strength; its primary use is in antimonial lead, which is used in grid metal for lead acid storage batteries. Other uses of antimony alloys are for solder, sheet and pipe, bearing metals, castings, and type metal. Antimony oxides (primarily antimony trioxide) are used as fire retardants for plastics, textiles, rubber, adhesives, pigments, and paper. Acute (short-term) exposure to antimony by inhalation in humans results in effects on the skin and eyes. Respiratory effects, such as inflammation of the lungs, chronic bronchitis, and chronic emphysema, are the primary effects noted from chronic (long-term) exposure to antimony in humans via inhalation. Human studies are inconclusive regarding antimony exposure and cancer, while animal studies have reported lung tumors in rats exposed to antimony trioxide via inhalation. EPA has not classified antimony for carcinogenicity.

Arsenic compounds are naturally occurring throughout the environment; for most people, food is the major source of exposure. Acute (short-term) high-level inhalation exposure to arsenic dust or fumes has resulted in gastrointestinal effects (nausea, diarrhea, abdominal pain); central and peripheral nervous system disorders have occurred in workers acutely exposed to inorganic arsenic. Chronic (long-term) inhalation exposure to inorganic arsenic in humans is associated with irritation of the skin and mucous membranes. Chronic oral exposure has resulted in gastrointestinal effects, anemia, peripheral neuropathy, skin lesions, hyperpigmentation, and liver or kidney damage in humans. Inorganic arsenic exposure in humans, by the inhalation route, has been shown to be strongly associated with lung cancer, while ingestion of inorganic arsenic in humans has been linked to a form of skin cancer and also to bladder, liver, and lung cancer. EPA has classified inorganic arsenic as a Group A, human carcinogen.

Arsine is a gas consisting of arsenic and hydrogen. Most arsenic poisoning incidents in industry have involved the production of arsine. It is extremely toxic to humans, with headaches, vomiting, and abdominal pains occurring within a few hours of exposure. EPA has not classified arsine for carcinogenicity.

Benzene is found in the air from emissions from burning coal and oil, gasoline service stations, and motor vehicle exhaust. Benzene is used as a constituent in motor fuels; as a solvent for fats, waxes, resins, oils, inks, paints, plastics, and rubber; in the extraction of oils from seeds and nuts; and in photogravure printing. It is also used as a chemical intermediate. Benzene is also used in the manufacture of detergents, explosives, pharmaceuticals, and dyestuffs. Acute (short-term) inhalation exposure of humans to benzene may cause drowsiness, dizziness, headaches, as well as eye, skin, and respiratory tract irritation, and, at high levels, unconsciousness. Chronic (long-term) inhalation exposure has caused various disorders in the blood, including reduced numbers of red blood cells and aplastic anemia, in occupational settings. Reproductive effects have been reported for women exposed by inhalation to high levels, and adverse effects on the developing fetus have been observed in animal tests. Increased incidence of leukemia (cancer of the tissues that form white blood cells) have been observed in humans occupationally exposed to benzene. EPA has classified benzene as a Group A, human carcinogen.

Benzidine is no longer produced in the United States, although benzidine-based dyes may be imported into this country. Benzidine has been detected in soil and water near industrial sources, especially those that have disposed of benzidine solid wastes improperly. No information is available on the acute (short-term) effects of benzidine in humans by inhalation exposure but benzidine is considered to be very acutely toxic to humans by ingestion. Chronic (long-term) exposure to benzidine in humans may result in injury to the bladder. Epidemiological studies have shown occupational exposure to benzidine to result in an increased risk of bladder cancer. Animal studies have reported various tumor types at multiple sites from benzidine exposure via oral, inhalation, and injection exposure. EPA has classified benzidine as a Group A, known human carcinogen.

Benzotrichloride is used extensively in the dye industry and as an intermediate in the chemical industry. Acute (short-term) exposure to the vapors of benzotrichloride are highly irritating to the skin and mucous membranes. In mice and rats chronically (long-term) exposed by inhalation, proliferative lesions of the respiratory tract have been observed. Human data on the carcinogenic effects of benzotrichloride are inadequate. Increased incidences of tumors at multiple sites have been observed in female mice treated orally, dermally, and by inhalation. EPA has classified benzotrichloride as a Group B2, probable human carcinogen.

Benzyl chloride is used as a chemical intermediate in the manufacture of certain dyes and pharmaceutical products and as a photographic developer. The acute (short-term) effects of benzyl chloride from inhalation exposure in humans consist of severe irritation of the upper respiratory tract, skin, eyes, and mucous membranes, and lung damage along with pulmonary edema (fluid in lungs). Exposure to high concentrations also causes effects on the central nervous system (CNS). Animal data indicate that long-term exposure to benzyl chloride by gavage (placing it experimentally in the stomachs of mice) increased the incidence of benign and malignant tumors at multiple sites and resulted in a significant increase in thyroid tumors in female rats. EPA has classified benzyl chloride as a Group B2, probable human carcinogen.

Beryllium compounds and alloys have applications in electrical components, tools, structural components for aircraft, missiles, and satellites, and other metal-fabricating uses, including at the Oak Ridge nuclear facilities. Beryllium is also used in consumer products, such as televisions, calculators, and personal computers. Inhalation exposure to beryllium primarily occurs in the workplaces where it is mined, processed, or converted into alloys and chemicals, or from the burning of coal or fuel oil and in tobacco smoke. Acute (short-term) inhalation exposure to high levels of beryllium has been observed to cause inflammation of the lungs or acute pneumonitis (reddening and swelling of the lungs) in humans; after exposure ends, these symptoms may be reversible. Chronic (long-term) inhalation exposure of humans to beryllium has been reported to cause chronic beryllium disease (berylliosis), in which granulomatous lesions (noncancerous) develop in the lung. Human epidemiology studies are limited, but suggest a causal relationship between beryllium exposure and an increased risk of lung cancer. Inhalation exposure to

beryllium has been demonstrated to cause lung cancer in rats and monkeys. EPA has classified beryllium as a Group B1, probable human carcinogen.

1,3-Butadiene is released into the air by motor vehicle exhaust, manufacturing and processing facilities, forest fires or other combustion, and cigarette smoke. 1,3-Butadiene is used in the production of rubber and plastics, and in copolymers including acrylics. Although it breaks down quickly in the atmosphere, it is usually found in ambient air at low levels in urban and suburban areas. Acute (short-term) exposure to 1,3-butadiene by inhalation in humans results in irritation of the eyes, nasal passages, throat, and lungs. Epidemiological studies have reported a possible association between 1,3-butadiene exposure and cardiovascular diseases. Epidemiological studies of workers in rubber plants have shown an association between 1,3-butadiene exposure and increased incidence of leukemia. Animal studies have reported tumors at various sites from 1,3-butadiene exposure. EPA has classified 1,3-butadiene as a Group B2, probable human carcinogen.

Cadmium compounds primarily reach the environment through the burning of fossil fuels such as coal or oil, and incineration of municipal waste materials. Cadmium may also be emitted into the air from zinc, lead, or copper smelters. It is used to manufacture pigments and batteries and in the metal-plating and plastics industries. For nonsmokers, food is generally the largest source of cadmium exposure. Cadmium levels in some foods can be increased by the application of phosphate fertilizers or sewage sludge to farm fields. Smoking is another important source of cadmium exposure. Smokers have about twice as much cadmium in their bodies as do nonsmokers. The acute (short-term) effects of cadmium in humans through inhalation exposure consist mainly of effects on the lung, such as pulmonary irritation. Chronic (long-term) inhalation or oral exposure to cadmium leads to a build-up of cadmium in the kidneys that can cause kidney disease. Cadmium has been shown to be a developmental toxicant in animals, resulting in fetal malformations and other effects, but no conclusive evidence exists in humans. An association between cadmium exposure and an increased risk of lung cancer has been reported from human studies, but these studies are inconclusive due to confounding factors. Animal studies have demonstrated an increase in lung cancer from long-term inhalation exposure to cadmium. EPA has classified cadmium as a Group B1, probable human carcinogen.

Carbon disulfide exposure occurs mainly in the workplace. It is used predominantly in the manufacture of rayon, cellophane, and carbon tetrachloride; it is also used to produce rubber chemicals and pesticides. Acute (short-term) inhalation exposure of humans to carbon disulfide has caused changes in breathing and chest pains. Nausea, vomiting, dizziness, fatigue, headache, mood changes, lethargy, blurred vision, delirium, and convulsions have also been reported in humans acutely exposed by inhalation. Neurologic effects, including behavioral and neurophysiological changes, have been observed in chronic (long-term) human and animal inhalation studies. Reproductive effects, such as decreased sperm count and menstrual disturbances, have been observed in humans exposed to carbon disulfide by inhalation. Animal studies support these findings. EPA has not classified carbon disulfide for human carcinogenicity.

Carbon tetrachloride may be found in both ambient outdoor and indoor air. Carbon tetrachloride was produced in large quantities to make refrigerants and propellants for aerosol cans, as a solvent for oils, fats, lacquers, varnishes, rubber waxes, and resins, and as a grain fumigant and a dry cleaning agent. Consumer and fumigant uses have been discontinued and only industrial uses remain.. The primary effects of carbon tetrachloride in humans are on the liver, kidneys, and central nervous system (CNS). Human symptoms of acute (short-term) inhalation and oral exposures to carbon tetrachloride include headache, weakness, lethargy, nausea, and vomiting. Acute exposures to higher levels and chronic (long-term) inhalation or oral exposure to carbon tetrachloride produces liver and kidney damage in humans. Human data on the carcinogenic effects of carbon tetrachloride are limited. Studies in animals have shown that

ingestion of carbon tetrachloride increases the risk of liver cancer. EPA has classified carbon tetrachloride as a Group B2, probable human carcinogen.

Carbonyl sulfide is used as an intermediate in the synthesis of organic sulfur compounds and alkyl carbonates. Carbonyl sulfide may be released to the atmosphere naturally from volcanoes, marshes, soils, and deciduous and coniferous trees. It may also be released to the ambient environment as fugitive emissions from commercial processes and combustion emissions. Anthropogenic emissions have been estimated to be less than one-third of natural emissions. The general population may be exposed to low levels of carbonyl sulfide by the inhalation of ambient air. Limited information is available on the health effects of carbonyl sulfide. Acute (short-term) inhalation of high concentrations of carbonyl sulfide may cause narcotic effects in humans. Carbonyl sulfide may also irritate the eyes and skin in humans. No information is available on the chronic (long-term), reproductive, developmental, or carcinogenic effects of carbonyl sulfide in humans. EPA has not classified carbonyl sulfide with respect to potential carcinogenicity.

Chlorine is a commonly used household cleaner and disinfectant. It is widely used as an oxidizing agent in water treatment and chemical processes. It is also used in the bleaching process of wood pulp in pulp mills. Chlorine is a potent irritant to the eyes, the upper respiratory tract, and lungs at 30 ppm, and was used as a poison gas in WWI. It can be detected at concentrations as low as 15 ppb in air. Chronic (long-term) exposure to chlorine gas in workers has resulted in respiratory effects, including eye and throat irritation and airflow obstruction. No information is available on the carcinogenic effects of chlorine in humans from inhalation exposure. A National Toxicology Program (NTP) study showed no evidence of carcinogenic activity in male rats or male and female mice, and equivocal evidence in female rats, from ingestion of chlorinated water. EPA has not classified chlorine for potential carcinogenicity.

Chlorobenzene is used primarily as a solvent for pesticide formulations, diisocyanate manufacture, and degreasing automobile parts and for the production of nitrochlorobenzene. Limited information is available on the acute (short-term) effects of chlorobenzene. Acute inhalation exposure of animals to chlorobenzene produced narcosis, restlessness, tremors, and muscle spasms. Chronic (long-term) exposure of humans to chlorobenzene affects the central nervous system (CNS). Signs of neurotoxicity in humans include numbness, cyanosis, hyperesthesia (increased sensation), and muscle spasms. No information is available on the carcinogenic effects of chlorobenzene in humans. EPA has classified chlorobenzene as a Group D, not classifiable as to human carcinogenicity.

Chloroethane (Ethyl chloride) exposure may occur from the use of consumer products containing it. It is used in the production of ethyl cellulose, use as a solvent, refrigerant, and topical anesthetic, in the manufacture of dyes, chemicals, and pharmaceuticals, and as a medication to alleviate pain associated with insect burns and stings. The acute (short-term) effects of ethyl chloride from inhalation exposure in humans consists of temporary feelings of drunkenness, and higher levels cause lack of muscle coordination and unconsciousness. The chronic (long-term) health effects resulting from exposure to air containing low levels of ethyl chloride in humans is not known. Some animal studies indicate effects on the lungs, liver, kidneys, and heart due to exposure to ethyl chloride via inhalation. No studies were located regarding carcinogenic effects following ethyl chloride inhalation exposure in humans. A study by the National Toxicology Program (NTP) indicated that inhaled ethyl chloride is carcinogenic in female mice and may be carcinogenic in rats. EPA has not classified ethyl chloride for carcinogenicity.

Chloroform may be released to the air as a result of its formation in the chlorination of drinking water, wastewater and swimming pools. Other sources include pulp and paper mills, hazardous waste sites, and sanitary landfills. The vast majority of the chloroform produced in the United States is used to make the refrigerant HCFC-22. Chloroform was used in the past as an extraction solvent for fats, oils, greases, and other products; as a dry cleaning spot remover; in fire extinguishers; as a fumigant; and as an anesthetic. However, chloroform is no longer used in

these products. The major effect from acute (short-term) inhalation exposure to chloroform is central nervous system depression. Chronic (long-term) exposure to chloroform by inhalation in humans has resulted in effects on the liver**,** including hepatitis and jaundice, and central nervous system effects, such as depression and irritability. Chloroform has been shown to be carcinogenic in animals after oral exposure, resulting in an increase in kidney and liver tumors. EPA has classified chloroform as a Group B2, probable human carcinogen.

Chloromethane (Methyl chloride) occurs naturally at low levels in the environment. Higher levels may occur at chemical plants where it is made or used. It is used mainly in the production of silicones where it is used to make methylate silicon. It is also used in the production of agricultural chemicals, methyl cellulose, quaternary amines, and butyl rubber and for miscellaneous uses including tetramethyl lead. Chloromethane is formed in the oceans by natural processes (e.g., marine phytoplankton) and from biomass burning in grasslands and forested areas (e.g., forest fires); it has been detected at low levels in air all over the world. It is also present in some lakes and streams and has been found in drinking water at very low levels. Other sources of exposure to methyl chloride include cigarette smoke, polystyrene insulation, and aerosol propellants; home burning of wood, coal, or certain plastics; and chlorinated swimming pools. Occupations that present a higher risk of exposure include building contracting, metal industries, transportation, car dealers, and service-station attendants.

Acute (short-term) exposure to high concentrations of chloromethane in humans has caused severe neurological effects. It has also caused effects on the heart rate, blood pressure, liver, and kidneys in humans. Chronic (long-term) animal studies have shown liver, kidney, spleen, and central nervous system (CNS) effects. Inhalation studies have demonstrated that methyl chloride causes reproductive effects in male rats, with effects such as testicular lesions and decreased sperm production. Human cancer data are limited. EPA has classified chloromethane as a Group D carcinogen (not classifiable as to human carcinogenicity).

bis(Chloromethyl) ether is a clear liquid with a strong unpleasant odor. It does not occur naturally. It dissolves easily in water, but degrades rapidly and readily evaporates into air. It does n ot build up in the food chain because it decomposes so readily in the environment. In the past, it was used to make several types of polymers, resins, and textiles, but its use is now highly restricted. Only small quantities of bis(chloromethyl) ether are produced in the United States. The small quantities that are produced are only used in enclosed systems to make other chemicals. However, small quantities of bis(chloromethyl) ether may be formed as an impurity during the production of another chemical, chloromethyl methyl ether.

Bis(chloromethyl) ether causes irritation to the skin, eyes, throat, and lungs. In some cases, damage to the lungs can be severe enough to cause death. Breathing low concentrations will cause coughing and nose and throat irritation. Animal studies show effects similar to those observed in people. These effects include irritation to the skin, nose, and lungs and lung damage (swelling and bleeding). Application of the liquid to the skin of mice and rabbits has produced hair loss, bleeding, swelling, and destruction of tissue. We do not know if bis(chloromethyl) ether causes reproductive effects or birth defects in people or animals. There is evidence that bis(chloromethyl) ether causes lung cancer and other tumors in people and animals. The Department of Health and Human Services (DHHS) has determined that bis(chloromethyl) ether is a known human carcinogen.

Chloroprene exposure is primarily occupational. Chloroprene is polymerized to form polychloroprene (neoprene), a synthetic rubber used for wire and cable covers, gaskets, automotive parts, adhesives, caulks, flame-resistant cushioning and other applications requiring chemical, oil and weather resistance or high gum strength. Symptoms reported from acute (short-term) human exposure to high concentrations of chloroprene include giddiness, headache, irritability, dizziness, insomnia, fatigue, respiratory irritation, cardiac palpitations, chest pains, nausea, gastrointestinal disorders, dermatitis, temporary hair loss, conjunctivitis, and corneal

necrosis. Symptoms of chronic (long-term) exposure in workers were fatigue, chest pains, giddiness, irritability, dermatitis, and hair loss. Chronic occupational exposure to chloroprene vapor may contribute to liver function abnormalities, disorders of the cardiovascular system, and depression of the immune system. A National Toxicology Program (NTP) study concluded that chloroprene showed clear evidence of carcinogenic activity in both rats and mice. EPA has classified chloroprene as a Group D, not classifiable as to human carcinogenicity. The International Agency for Research on Cancer (IARC) has classified chloroprene as a Group 2B, possibly carcinogenic to humans.

Chromium compounds occur in the environment primarily in two valence states, trivalent chromium (Cr III) and hexavalent chromium (Cr VI). Exposure may occur from natural or industrial sources of chromium. Chromium III is much less toxic than chromium (VI). Chromium (III) is an essential element in humans. The body can detoxify some amount of chromium (VI) to chromium (III). The metal chromium is used mainly for making steel and other alloys. Chromium compounds, in either the chromium (III) or chromium (VI) forms, are used for chrome plating, the manufacture of dyes and pigments, leather and wood preservation, and treatment of cooling tower water. Smaller amounts are used in drilling muds, textiles, and toner for copying machines. The respiratory tract is the major target organ for chromium (VI) toxicity, for acute (short-term) and chronic (long-term) inhalation exposures. The respiratory tract is also the major target organ for chromium (III) toxicity, similar to chromium (VI). Shortness of breath, coughing, and wheezing were reported from a case of acute exposure to chromium (VI), while perforations and ulcerations of the septum, bronchitis, decreased pulmonary function, pneumonia, and other respiratory effects have been noted from chronic exposure. Human studies have clearly established that inhaled chromium (VI) is a human carcinogen, resulting in an increased risk of lung cancer. Animal studies have shown chromium (VI) to cause lung tumors via inhalation exposure.

Cobalt compounds are naturally found throughout the environment. Cobalt is used to make superalloys (alloys that maintain their strength at high temperatures approaching their melting points) and in pigment manufacture Acute (short-term) exposure to high levels of cobalt by inhalation in humans and animals results in respiratory effects, such as a significant decrease in ventilatory function, congestion, edema, and hemorrhage of the lung. Respiratory effects are also the major effects noted from chronic (long-term) exposure to cobalt by inhalation, with respiratory irritation, wheezing, asthma, pneumonia, and fibrosis noted. Cardiac effects, congestion of the liver, kidneys, and conjunctiva, and immunological effects have also been noted in chronically-exposed humans. Cobalt is an essential element in humans, as a constituent of vitamin B_{12}. Human studies are inconclusive regarding inhalation exposure to cobalt and cancer, and the one available oral study did not report a correlation between cobalt in the drinking water and cancer deaths. EPA has not classified cobalt for carcinogenicity.

Coke oven emissions exposure may occur for workers in the aluminum, steel, graphite, electrical, and construction industries. At coke oven batteries, coal is processed to produce coke (pure carbon) which is a component in manufacturing iron and steel. Chemicals recovered from coke oven emissions are used as a raw material for plastics, solvents, dyes, drugs, waterproofing, paints, pipe coating, roads, roofing, insulation, and as pesticides and sealants. Chronic (long-term) exposure to coke oven emissions in humans results in conjunctivitis, severe dermatitis, and lesions of the respiratory system and digestive system. Cancer is the major concern from exposure to coke oven emissions. Epidemiologic studies of coke oven workers have reported an increase in cancer of the lung, trachea, bronchus, kidney, prostate, and other sites. Animal studies have reported tumors of the lung and skin from inhalation exposure to coal tar. EPA has classified coke oven emissions as a Group A, known human carcinogen.

Cyanide compounds are used in a number of industries (e.g. electroplating and metal treatment) and are found at low levels in air from car exhaust. Cyanide is extremely toxic to humans. Chronic (long-term) inhalation exposure of humans to cyanide results primarily in effects on the central nervous system (CNS). Other effects in humans include cardiovascular and

respiratory effects, an enlarged thyroid gland, and irritation to the eyes and skin. No data are available on the carcinogenic effects of cyanide in humans via inhalation. Animal studies have suggested that oral exposure to cassava (a cyanide-containing vegetable) may be associated with malformations in the fetus and low fetal body weights. EPA has classified cyanide as a Group D, not classifiable as to human carcinogenicity.

1,2-Dibromo-3-chloropropane (DBCP) was used in the past as a soil fumigant and nematocide on crops; it is no longer used except as an intermediate in chemical synthesis. Acute (short-term) exposure to DBCP in humans results in moderate depression of the central nervous system (CNS) and pulmonary congestion from inhalation, and gastrointestinal distress and pulmonary edema from oral exposure. Chronic (long-term) exposure to DBCP in humans causes male reproductive effects, such as decreased sperm counts. Testicular effects and decreased sperm counts were observed in animals chronically exposed to DBCP by inhalation. Available human data on DBCP and cancer are inadequate. High incidences of tumors of the nasal tract, tongue, adrenal cortex, and lungs of rodents were reported in a National Toxicology Program (NTP) inhalation study. EPA has classified DBCP as a Group B2, probable human carcinogen.

1,4-Dichlorobenzene is used mainly as a fumigant for the control of moths, molds, and mildews, and as a space deodorant for toilets and refuse containers. The primary exposure to 1,4-dichlorobenzene is from breathing contaminated indoor air. 1,4-Dichlorobenzene is also used as an intermediate in the production of other chemicals, in the control of tree-boring insects, and in the control of mold in tobacco seeds. Acute (short-term) exposure to 1,4-dichlorobenzene, via inhalation in humans, results in irritation of the skin, throat, and eyes. Chronic (long-term) 1,4-dichlorobenzene inhalation exposure in humans results in effects on the liver, skin, and central nervous system (CNS). No information is available on the reproductive, developmental, or carcinogenic effects of 1,4-dichlorobenzene in humans. A National Toxicology Program (NTP) study reported that 1,4-dichlorobenzene caused kidney tumors in male rats and liver tumors in both sexes of mice by gavage (experimentally placing the chemical in their stomachs). EPA has classified 1,4-dichlorobenzene as a Group C, possible human carcinogen.

1,1-Dichloroethane (Ethylidene dichloride) is primarily used as an intermediate in chemical synthesis. Acute (short-term) inhalation exposure to high levels of ethylidene dichloride in humans results in central nervous system (CNS) depression and a cardiostimulating effect resulting in cardiac arrhythmias. Studies in animals have reported effects on the kidney. No information is available on the chronic (long-term), reproductive, developmental, or carcinogenic effects of ethylidene dichloride in humans. An oral animal study reported a significantly positive dose-related trend in hemangiosarcomas, mammary tumors, liver tumors, and endometrial stromal polyps. EPA has classified ethylidene dichloride as a Group C, possible human carcinogen.

1,2-Dichloroethane (Ethylene dichloride) can occur from breathing ambient or workplace air. It is primarily used in the production of vinyl chloride as well as other chemicals. It is also used in solvents in closed systems for various extraction and cleaning purposes in organic synthesis. It was added to leaded gasoline as a lead scavenger. It was formerly used in ore flotation, as a grain fumigant, as a metal degreaser, and in textile and PVC cleaning. Inhalation of concentrated ethylene dichloride vapor can induce effects on the human nervous system, liver, and kidneys, as well as respiratory distress, cardiac arrhythmia, nausea, and vomiting. Chronic (long-term) inhalation exposure to ethylene dichloride produced effects on the liver and kidneys in animals. No information is available on the reproductive or developmental effects of ethylene dichloride in humans. Decreased fertility and increased embryo mortality have been observed in inhalation studies of rats. Epidemiological studies are not conclusive regarding the carcinogenic effects of ethylene dichloride, due to concomitant exposure to other chemicals. Following treatment by gavage (experimentally placing the chemical in the stomach), several tumor types were induced in rats and mice. EPA has classified ethylene dichloride as a Group B2, probable human carcinogen.

1,1-Dichloroethene (Vinylidene chloride) is used as an intermediate in chemical synthesis and to produce polyvinylidene chloride copolymers. The major application of these chloride copolymers is in the production of flexible films for food packaging (SARAN® and VELON® wraps). These copolymers are also used extensively in many types of packing materials, as flame retardant coatings for fiber and carpet backing and in piping, coating for steel pipes, and adhesive applications. The primary acute (short-term) effects in humans from vinylidene chloride exposure are on the central nervous system (CNS), including CNS depression and symptoms of inebriation, convulsions, spasms, and unconsciousness at high concentrations. Low-level, chronic (long-term) inhalation exposure of vinylidene chloride in humans may effect the liver. Animal studies indicate that chronic exposure to vinylidene chloride can affect the liver, kidneys, CNS and lungs. Human data are considered inadequate in providing evidence of cancer from exposure to vinylidene chloride. Vinylidene chloride has been classified as a Group C, possible human carcinogen.

Dichloroethyl ether is mainly used as a chemical intermediate in industry for pesticide manufacture. In the past, dichloroethyl ether was used as a solvent for fats, waxes, greases, and esters. It has also been used as a constituent of paints and varnishes, as a cleaning fluid for textiles, and in the purification of oils and gasoline. Limited health effects information is available on this chemical. The major effect from acute (short-term) inhalation exposure to dichloroethyl ether in humans is extreme irritation of the respiratory tract and skin. Dichloroethyl ether has been shown to be carcinogenic in animal studies; an increased incidence of liver tumors in mice has been reported. EPA has classified dichloroethyl ether as a Group B2, probable human carcinogen.

1,2-Dichloropropane (Propylene dichloride) is used as a chemical intermediate in the production of chlorinated organic chemicals, as an industrial solvent, in ion exchange manufacture, in toluene diisocyanate production, in photographic film manufacture, for paper coating, and for petroleum catalyst regeneration. Acute (short-term) inhalation exposure to high levels of propylene dichloride by humans results in effects on the lungs, gastrointestinal system, blood, liver, kidneys, central nervous system, and eyes. Limited information is available on the chronic (long-term), reproductive, developmental, and carcinogenic effects of propylene dichloride in humans. Animal studies have reported effects on the respiratory system and blood from chronic inhalation exposure. Animal studies have reported developmental effects from propylene dichloride exposure by gavage (experimentally placing the chemical in the stomach). Animal studies have reported an increased incidence of mammary gland tumors in female rats and liver tumors in male and female mice given propylene dichloride by gavage. EPA has provisionally classified propylene dichloride as a Group B2, probable human carcinogen.

1,3-Dichloropropene is used as a component in formulations for agricultural soil fumigants. Acute (short-term) inhalation exposure of humans following a spill caused mucous membrane irritation, chest pain, and breathing difficulties. Effects on the lung have been observed in rats acutely exposed to 1,3-dichloropropene by inhalation. Chronic (long-term) dermal exposure may result in skin sensitization in humans. Damage to the nasal mucosa and urinary bladder are the primary health effects of rodents chronically exposed to 1,3-dichloropropene by inhalation. Information on the carcinogenic effects of 1,3-dichloropropene in humans is limited; two cases of histiocytic lymphomas and one case of leukemia have been reported in humans accidentally exposed by inhalation to concentrated vapors during cleanup of a tank truck spill. An increased incidence of bronchioalveolar adenomas has been reported in male mice exposed by inhalation but not in rats or female mice. EPA has classified 1,3-dichloropropene as a Group B2, probable human carcinogen.

Diesel Particulate Matter is among the substances that EPA has concluded in the national-scale air toxics assessment that pose the greatest relative risk to human health. Diesel exhaust is not a single chemical but a mixture of compounds. Several human epidemiology studies link increased lung cancer associated with diesel exhaust. Furthermore, exposures in several of these epidemiology studies are in the same range as ambient exposures throughout the United States.

In addition to the potential for lung cancer risk, there is a significant potential for diesel exhaust to pose noncancer health effects as well, based on the contribution of diesel particulate matter to ambient levels of fine particles. Exposure to fine particles has been linked to significant public health impacts, including respiratory and cardiovascular effects, as well as premature mortality. These effects are considered in setting and implementing EPA's National Ambient Air Quality Standards for PM-2.5. In addition, the national-scale assessment results show population exposures above the level EPA has designated for noncancer respiratory hazard (called a "reference concentration" which is based on specific noncancer effects found in several animal studies, which showed adverse changes in lungs such as inflammation and lesions)

Diethanolamine is used in a number of consumer products, such as shampoos, cosmetics, and pharmaceuticals. It is also used as an intermediate in the rubber chemicals industry, as a humectant and softening agent, and as an emulsifier and dispersing agent in various agricultural chemicals. Limited information is available on the health effects of diethanolamine. Acute (short-term) inhalation exposure to diethanolamine in humans may result in irritation of the nose and throat, and dermal exposure may irritate the skin. No information is available on the chronic (long-term), reproductive, developmental, or carcinogenic effects of diethanolamine in humans. Animal studies have reported effects on the liver, kidney, blood, and central nervous system (CNS) from chronic oral exposure to diethanolamine. The National Toxicology Program (NTP) reported an increased incidence of liver and kidney tumors in mice from dermal exposure to diethanolamine. EPA has not classified diethanolamine for carcinogenicity.

4-Dimethylaminoazobenzene (p-Dimethylaminoazobenzene) was used as a dye for coloring polishes, wax products, and soap, but is no longer made or used in the U.S. Acute (short-term) dermal exposure to 4-dimethylaminoazobenzene may result in contact dermatitis in humans. No information is available on the chronic (long-term), reproductive, developmental, or carcinogenic effects of 4-dimethylaminoazobenzene in humans. Animal studies have reported birth defects in the offspring of mice exposed to 4-dimethylaminoazobenzene and tumors of the lung, liver, and bladder from oral exposure to 4-dimethylaminoazobenzene. EPA has not classified 4-dimethylaminoazobenzene for carcinogenicity. The International Agency for Research on Cancer (IARC) has classified 4-dimethylaminoazobenzene as a Group 2B, possibly carcinogenic to humans.

Dimethylformamide is used as an industrial solvent and in the production of fibers, films, and surface coatings; exposure is most likely to occur in the workplace. Acute (short-term) exposure to dimethylformamide has been observed to damage the liver in animals and in humans. Symptoms of acute exposure in humans include abdominal pain, nausea, vomiting, jaundice, alcohol intolerance, and rashes. Chronic (long-term) occupational exposure to dimethylformamide by inhalation has resulted in effects on the liver and digestive disturbances in workers. Human studies suggested a possible association between dimethylformamide exposure and testicular cancer, but further studies failed to confirm this relationship. EPA has not classified dimethylformamide with respect to its carcinogenicity.

2,4-Dintirotoluene is used as an intermediate in the manufacture of polyurethanes. It is also used for the production of explosives, for which it is a gelatinizing and waterproofing agent. Other applications include uses as an intermediate in dye processes and in smokeless gunpowder. No information is available on the acute (short-term) effects of 2,4-dinitrotoluene in humans. Chronic (long-term) inhalation exposure to 2,4-dinitrotoluene affects the central nervous system (CNS) and blood in humans. A significant reduction in sperm count and normal sperm morphology was observed in one study of chronically exposed workers, while other studies have not reported this effect. No significant increase in cancer mortality was observed in a study of workers occupationally exposed to 2,4-dinitrotoluene by inhalation. Kidney, liver, and mammary gland tumors were observed in animals orally exposed to 2,4-dinitrotoluene. EPA has not classified 2,4-dinitrotoluene for potential carcinogenicity.

1,4-Dioxane is used as an industrial solvent, so exposure is most likely to occur in the workplace, although it has been detected in contaminated surface water and groundwater. Acute (short-term) inhalation exposure to high levels of 1,4-dioxane has caused vertigo, drowsiness, headache, anorexia and irritation of the eyes, nose, throat, and lungs in humans. It may also irritate the skin. Damage to the liver and kidneys has been observed in rats chronically (long-term) exposed in their drinking water. In three epidemiologic studies on workers exposed to 1,4-dioxane, the observed number of cancer cases did not differ from the expected cancer deaths. Tumors have been observed in orally exposed animals. EPA has classified 1,4-dioxane as a Group B2, probable human carcinogen.

"Dioxin" (2,3,7,8-Tetrachlorodibenzo-p-dioxin, or 2,3,7,8-TCDD) is formed as an unintentional by-product of incomplete combustion. It may be released to the environment during the combustion of fossil fuels and wood, and during the incineration of municipal and industrial wastes. Very low levels of 2,3,7,8-TCDD are found throughout the environment, including air, food, and soil. Most of the exposure of the general population to 2,3,7,8-TCDD is from food, mainly meat, dairy products, and fish. Historically, it was formed as a byproduct during the manufacture of certain herbicides (including "Agent Orange" during the Vietnam War). When the chemical waste from one manufacturer was improperly mixed with oil used for spraying gravel roadways for dust suppression the contamination of several sites in Missouri resulted, including the entire town of Times Beach, which had to be abandoned. The chemical causes chloracne in humans, a severe acne-like condition. It is known to be a developmental toxicant in animals, causing skeletal deformities, kidney defects, and weakened immune responses in the offspring of animals exposed to 2,3,7,8-TCDD during pregnancy. Human studies have shown an association between 2,3,7,8-TCDD and soft-tissue sarcomas, lymphomas, and stomach carcinomas. EPA has classified 2,3,7,8- TCDD as a probable human carcinogen (Group B2).

Epichlorohydrin is mainly used in the production of epoxy resins used in coatings, adhesives, and plastics. It is also used in the manufacture of synthetic glycerine, textiles, paper, inks and dyes, solvents, surfactants, and pharmaceuticals, and as an inert ingredient in pesticides. Acute (short-term) inhalation exposure to epichlorohydrin in the workplace has caused irritation to the eyes, respiratory tract, and skin of workers. At high levels of exposure, nausea, vomiting, cough, labored breathing, inflammation of the lung, pulmonary edema, and renal lesions may be observed in humans. Chronic (long-term) occupational exposure of humans to epichlorohydrin in air is associated with high levels of respiratory tract illness and hematological effects. Damage to the nasal passages, respiratory tract and kidneys have been observed in rodents exposed to epichlorohydrin by inhalation for acute or chronic duration. An increased incidence of tumors of the nasal cavity has been observed in rats exposed by inhalation. EPA has classified epichlorohydrin as a Group B2, probable human carcinogen.

Ethyl acrylate exposure is primarily occupational – it is used in the manufacture of water-based latex paints and adhesives, textile and paper coatings, leather finish resins, and in the production of acrylic fibers. Acute (short-term) exposure of workers to ethyl acrylate vapors has been reported to cause drowsiness, lethargy, headache, nausea, convulsions, and respiratory and gastrointestinal irritation. Noncancerous lesions and inflammation of the nasal mucosa and depressed body weight gain have been observed in rats and mice exposed by inhalation for a chronic (long-term) duration. Human studies on occupational exposure to ethyl acrylate/methyl methacrylate have suggested a relationship between exposure to the chemical(s) and colorectal cancer, but the evidence is conflicting and inconclusive. In a study by the National Toxicology Program (NTP), increased incidences of squamous cell papillomas and carcinomas of the forestomach were observed in rats and mice exposed via gavage (experimentally placing the chemical in the stomach). However, the NTP recently determined that these data were not relevant to human carcinogenicity and removed ethyl acrylate from its list of carcinogens. EPA has classified ethyl acrylate as a Group B2, probable human carcinogen, but has not developed a potency estimate to quantify risk by inhalation.

Ethylbenzene is mainly used in the manufacture of styrene. It is also used as a solvent, as a constituent of asphalt and naphtha, and is a component of fuels. It has also been used as an anti-neoplastic agent. Acute (short-term) exposure to ethylbenzene in humans results in respiratory effects, such as throat irritation and chest constriction, irritation of the eyes, and neurological effects such as dizziness. Chronic (long-term) exposure to ethylbenzene by inhalation in humans has shown conflicting results regarding its effects on the blood. Animal studies have reported effects on the blood, liver, and kidneys from chronic inhalation exposure to ethylbenzene. Limited information is available on the carcinogenic effects of ethylbenzene in humans. In a study by the National Toxicology Program (NTP), exposure to ethylbenzene by inhalation resulted in an increased incidence of kidney and testicular tumors in rats, and lung and liver tumors in mice. EPA has classified ethylbenzene as a Group D, not classifiable as to human carcinogenicity.

Ethyl carbamate (Urethane) is used as an intermediate in the synthesis of chemicals and pharmaceuticals, and is a cosolvent for pesticides and fumigants. Acute (short-term) exposure of humans to high levels of ethyl carbamate may result in injury to the kidneys and liver and induce vomiting, coma, or hemorrhages. No information is available on the chronic (long-term), reproductive, or developmental effects of ethyl carbamate in humans. An increased incidence of lung tumors has been observed in rodents exposed to ethyl carbamate by oral or inhalation exposure. The International Agency for Research on Cancer (IARC) has classifed ethyl carbamate as a Group 2B, possibly carcinogenic to humans.

Ethylene dibromide exposure primarily occurs from its past use as an additive to leaded gasoline and as a fumigant to protect against insects, pests, and nematodes in citrus, vegetable, and grain crops, and as a fumigant for turf, particularly on golf courses. In 1984, EPA banned its use as a soil and grain fumigant. However, it is currently used in the treatment of felled logs for bark beetles and termites, and control of wax moths in beehives. It is also used as a manufacturing intermediate for dyes, resins, waxes, and gums. Ethylene dibromide is extremely toxic to humans. The chronic (long-term) effects of exposure to ethylene dibromide have not been well documented in humans. Animal studies indicate that chronic exposure to ethylene dibromide may result in toxic effects to the liver, kidney, and the testis, irrespective of the route of exposure. Limited data on men occupationally exposed to ethylene dibromide indicate that long-term exposure to ethylene dibromide can impair reproduction by damaging sperm cells in the testicles. Several animal studies indicate that long-term exposure to ethylene dibromideincreases the incidences of a variety of tumors in rats and mice in both sexes by all routes of exposure. EPA has classified ethylene dibromide as a Group B2, probable human carcinogen.

Ethylene dichloride exposure at low levels can occur from breathing ambient or workplace air. Ethylene dichloride is primarily used in the production of vinyl chloride as well as other chemicals. It is used in solvents in closed systems for various extraction and cleaning purposes in organic synthesis. It was added to leaded gasoline as a lead scavenger. Inhalation of concentrated ethylene dichloride vapor can induce effects on the human nervous system, liver, and kidneys, as well as respiratory distress, cardiac arrhythmia, nausea, and vomiting. Chronic (long-term) inhalation exposure to ethylene dichloride produced effects on the liver and kidneys in animals. No information is available on the reproductive or developmental effects of ethylene dichloride in humans. Decreased fertility and increased embryo mortality have been observed in inhalation studies of rats. Epidemiological studies are not conclusive regarding the carcinogenic effects of ethylene dichloride, due to concomitant exposure to other chemicals. Following treatment by gavage (experimentally placing the chemical in the stomach), several tumor types were induced in rats and mice. EPA has classified ethylene dichloride as a Group B2, probable human carcinogen.

Ethylene glycol has many uses, including as antifreeze in cooling and heating systems, in hydraulic brake fluids, in the formulations of printers' inks, stamp pad inks, and inks for ballpoint pens, as a softening agent for cellophane, in the synthesis of safety explosives, plasticizers, synthetic fibers (Terylene, Dacron), and synthetic waxes, and as a solvent. It is used to de-ice

aircraft and runways. Acute (short-term) exposure of humans to ethylene glycol by ingesting large quantities causes three stages of health effects: central nervous system (CNS) depression, followed by cardiopulmonary effects, and later renal damage. The only effects noted in one study of individuals exposed to low levels of ethylene glycol by inhalation for about a month were throat and upper respiratory tract irritation. Rats and mice chronically (long-term) exposed to ethylene glycol in their diet exhibited signs of kidney toxicity and liver effects. Several studies of rodents exposed orally or by inhalation showed ethylene glycol to be fetotoxic. An epidemiologic study on renal cancer mortality did not find an increased risk for workers exposed to ethylene glycol. EPA has not classified ethylene glycol for carcinogenicity.

Ethylene oxide is primarily used as a chemical intermediate in the manufacture of textiles, detergents, polyurethane foam, antifreeze, solvents, medicinals, adhesives, and other products. Relatively small amounts of ethylene oxide are used as a fumigant, a sterilant for food (spices) and cosmetics, and in hospital sterilization of surgical equipment and plastic devices that cannot be sterilized by steam. The acute (short-term) effects of ethylene oxide in humans consist mainly of central nervous system (CNS) depression and irritation of the eyes and mucous membranes. Chronic (long-term) exposure to ethylene oxide in humans can cause irritation of the eyes, skin, and mucous membranes, and problems in the functioning of the brain and nerves. Some human cancer data show an increase in the incidence of leukemia, stomach cancer, cancer of the pancreas, and Hodgkin's disease in workers exposed to ethylene oxide. However these data are considered to be limited and inconclusive due to uncertainties in the studies. EPA has classified ethylene oxide as a Group B1, probable human carcinogen.

bis(2-Ethylhexyl)phthalate (BEHP or DEHP) is used in the production of polyvinyl chloride (PVC) and vinyl chloride resins, where it is added to plastics to make them flexible. It exhibits low toxicity from acute (short-term) and chronic (long-term) exposures. Acute exposure to large oral doses of DEHP can cause gastrointestinal distress in humans. No information is available on the chronic, reproductive, developmental, or carcinogenic effects of DEHP in humans. Animal studies have reported increased lung weights and increased liver weights from chronic inhalation exposure to DEHP. Oral exposure has resulted in developmental and reproductive effects in rats and mice. A study by the National Toxicology Program (NTP) showed that DEHP administered orally increased the incidence of liver tumors in rats and mice. EPA has classified DEHP as a Group B2, probable human carcinogen.

Formaldehyde is used mainly to produce resins used in particleboard products and as an intermediate in the synthesis of other chemicals. Formaldehyde (as urea formaldehyde foam) was extensively used as an insulating material until 1982 when it was banned by the U.S. Consumer Product Safety Commission. It also has minor uses in agriculture, as an analytical reagent, in concrete and plaster additives, cosmetics, disinfectants, fumigants, photography, and wood preservation. Exposure to formaldehyde may occur by breathing contaminated indoor air, tobacco smoke, or ambient urban air. Major outdoor sources appear to be power plants, manufacturing facilities, incinerators, and automobile exhaust. Acute (short-term) and chronic (long-term) inhalation exposure to formaldehyde in humans can result in respiratory symptoms, and eye, nose, and throat irritation. Limited human studies have reported an association between formaldehyde exposure and lung and nasopharyngeal cancer. Animal inhalation studies have reported an increased incidence of nasal squamous cell cancer. EPA considers formaldehyde a probable human carcinogen (Group B1).

Glycol ethers (2-methoxyethanol, 2-ethoxyethanol, and 2-butoxyethanol) have many uses; these include use as solvents and as an ingredient in cleaning compounds, liquid soaps, and cosmetics. Acute (short-term) exposure to high levels of the glycol ethers in humans results in narcosis, pulmonary edema, and severe liver and kidney damage. Chronic (long-term) exposure to the glycol ethers in humans may result in neurological and blood effects, including fatigue, nausea, tremor, and anemia. No information is available on the reproductive, developmental, or carcinogenic effects of the glycol ethers in humans. Animal studies have reported reproductive

and developmental effects from inhalation and oral exposure to the glycol ethers. EPA has not classified the glycol ethers for carcinogenicity.

Haloacetic Acids are a group of five compounds (monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid) formed under certain conditions during the chlorination of drinking water to kill disease-causing organisms. Exposure to these compounds over many years can result in an increased risk of cancer. As a result, the presence of these compounds in drinking water is monitored and regulated. When allowed levels of these compounds are exceeded, a water utility must issue a notice of violation to the public.

Hexachlorobenzene is formed as a byproduct during the manufacture of other chemicals. It was widely used as a pesticide until 1965, but has no current commercial uses. Chronic (long-term) oral exposure to hexachlorobenzene in humans results in a liver disease with associated skin lesions. Epidemiologic studies of persons orally exposed to hexachlorobenzene have not shown an increased cancer incidence. However, based on animal studies that have reported cancer of the liver, thyroid, and kidney from oral exposure to hexachlorobenzene, EPA has classified hexachlorobenzene as a probable human carcinogen (Group B2). Very little inhalation data are available.

Hexachloroethane is used by the military for smoke-producing devices (about half the usage in the US) , in fireworks, in metal and alloy production, and as an ingredient in insecticides. Hexachloroethane acts primarily as a central nervous system (CNS) depressant in humans acutely exposed to it. It is moderately irritating to the skin, mucous membranes, and liver in humans. Neurological, liver, and kidney effects have been observed in animals exposed to hexachloroethane. No information is available on the chronic (long-term), reproductive, developmental, or carcinogenic effects of hexachloroethane in humans. Hepatocellular carcinomas (liver tumors) were observed in mice following oral exposure to hexachloroethane. EPA has classified hexachloroethane as a Group C, possible human carcinogen.

Hexamethylene diisocyanate is used as a polymerizing agent in polyurethane paints and coatings. It is also used in the preparation of dental materials, contact lenses, and medical adsorbents. Acute (short-term) exposure to high concentrations of hexamethylene diisocyanate in humans can cause pulmonary edema, coughing, and shortness of breath. Hexamethylene diisocyanate is also extremely irritating to the eyes, nose, and throat. Human studies have suggested that chronic (long-term) exposure to hexamethylene diisocyanate may cause chronic lung problems. Animal studies have reported respiratory effects from chronic inhalation exposure and skin irritation and sensitization from dermal exposure to hexamethylene diisocyanate. No information is available on the reproductive, developmental, or carcinogenic effects of hexamethylene diisocyanate in humans. EPA has not classified hexamethylene diisocyanate for carcinogenicity.

Hexane is used to extract edible oils from seeds and vegetables, as a special-use solvent, and as a cleaning agent. The most probable route of human exposure to hexane is by inhalation. Individuals are most likely to be exposed to hexane in the workplace. Monitoring data indicate that hexane is a widely occurring atmospheric pollutant. Acute (short-term) inhalation exposure of humans to high levels of hexane causes mild central nervous system (CNS) effects, including dizziness, giddiness, slight nausea, and headache. Chronic (long-term) exposure to hexane in air is associated with polyneuropathy in humans, with numbness in the extremities, muscular weakness, blurred vision, headache, and fatigue observed. Neurotoxic effects have also been exhibited in rats. No information is available on the carcinogenic effects of hexane in humans or animals. EPA has classified hexane as a Group D, not classifiable as to human carcinogenicity.

Hydrazine exposure principally occurs in the workplace or to small amounts in tobacco smoke. It is used in agricultural chemicals (pesticides), chemical blowing agents, pharmaceutical intermediates, photography chemicals, boiler water treatment for corrosion protection, textile dyes, and as fuel for rockets and spacecraft. Hydrazine is the toxic chemical formed by

accidentally combining household bleach and ammonia cleaning products. Symptoms of acute (short-term) exposure to high levels of hydrazine may include irritation of the eyes, nose, and throat, dizziness, headache, nausea, pulmonary edema, seizures, and coma in humans. Acute exposure can also damage the liver, kidneys, and central nervous system in humans. The liquid is corrosive and may produce dermatitis from skin contact in humans and animals. Effects to the lungs, liver, spleen, and thyroid have been reported in animals chronically (long-term) exposed to hydrazine via inhalation. Increased incidences of lung, nasal cavity, and liver tumors have been observed in rodents exposed to hydrazine. EPA has classified hydrazine as a Group B2, probable human carcinogen.

Hydrochloric acid (Hydrogen chloride) is used in the production of chlorides, for refining ore in the production of tin and tantalum, for pickling and cleaning of metal products, in electroplating, in removing scale from boilers, for the neutralization of basic systems, as a laboratory reagent, as a catalyst and solvent in organic syntheses, in the manufacture of fertilizers and dyes, for hydrolyzing starch and proteins in the preparation of various food products, and in the photographic, textile, and rubber industries. Workplace exposure may be dermal or by inhalation. Hydrochloric acid is corrosive to the eyes, skin, and mucous membranes. Acute (short-term) inhalation exposure may cause eye, nose, and respiratory tract irritation and inflammation and pulmonary edema in humans. Acute oral exposure may cause corrosion of the mucous membranes, esophagus, and stomach and dermal contact may produce severe burns, ulceration, and scarring in humans. Chronic (long-term) occupational exposure to hydrochloric acid has been reported to cause gastritis, chronic bronchitis, dermatitis, and photosensitization in workers. Prolonged exposure to low concentrations may also cause dental discoloration and erosion. EPA has not classified hydrochloric acid for carcinogenicity.

Hydrogen fluoride (Hydrofluoric acid) is predominantly used in the production of aluminum and chlorofluorocarbons (CFCs). It is also used for glass etching, in the electronics industry, for separating uranium isotopes (including at Oak Ridge in the past), as a catalyst in the petroleum industry, and in stainless steel pickling. Acute (short-term) inhalation exposure to gaseous hydrogen fluoride can cause severe respiratory damage in humans, including severe irritation and pulmonary edema. Severe ocular irritation and dermal burns may occur following eye or skin exposure in humans. On dermal contact the chemical penetrates deeply, causing extremely painful burns. Chronic (long-term) exposure of humans to fluoride at low levels (around 1 ppm) in drinking water has a beneficial effect of dental cavity prevention and may also be useful for the treatment of osteoporosis. Exposure to higher levels of fluoride through drinking water may cause dental fluorosis or mottling, while very high exposures through drinking water or air can result in skeletal fluorosis in humans. The only developmental effect observed from fluoride exposure in humans is dental fluorosis which can occur in a child's teeth when a mother receives high levels of fluoride during pregnancy. EPA has not classified hydrogen fluoride for carcinogenicity.

Lead compounds are used in the manufacture of batteries, metal products, paints, and ceramic glazes. Tetraethyl lead was used in gasoline to increase the octane rating until lead additives were phased out and eventually banned from use in gasoline in the U.S. by the EPA by 1996. Exposure to lead can occur from breathing contaminated workplace air or house dust or eating lead-based paint chips or contaminated dirt. As has been known since ancient times, lead is a very toxic element, causing a variety of effects at low dose levels. Brain damage, kidney damage, and gastrointestinal distress are seen from acute (short-term) exposure to high levels of lead in humans. Chronic (long-term) exposure to lead in humans results in effects on the blood, central nervous system (CNS), blood pressure, kidneys, and Vitamin D metabolism. Children are particularly sensitive to the chronic effects of lead, with slowed cognitive development, reduced growth and other effects reported. Reproductive effects, such as decreased sperm count in men and spontaneous abortions in women, have been associated with high lead exposure. The developing fetus is at particular risk from maternal lead exposure, with low birth weight and slowed postnatal neurobehavioral development noted. Human studies are inconclusive regarding lead exposure and cancer.

Maleic anhydride is used primarily in the formation of unsaturated polyester resins for use in boats, autos, trucks, buildings, piping, and electrical goods. Lube oil adhesives synthesized from maleic anhydride are used to prolong oil-change intervals and improve engine efficiency. It is also used to make copolymers, pesticides, and other organic compounds. Exposure to maleic anhydride may occur from accidental releases to the environment or in workplaces where it is produced or used. Acute (short-term) inhalation exposure of humans to maleic anhydride has been observed to cause irritation of the respiratory tract and eye irritation. Chronic (long-term) exposure to maleic anhydride has been observed to cause chronic bronchitis, asthma-like attacks, and upper respiratory tract and eye irritation in workers. In some people, allergies have developed so that lower concentrations can no longer be tolerated. Kidney effects were observed in rats chronically exposed to maleic anhydride via gavage (experimentally placing the chemical in the stomach). EPA has not classified maleic anhydride for carcinogenicity.

Manganese compounds are naturally ubiquitous in the environment. Metallic manganese is used primarily in steel production to improve hardness, stiffness, and strength. Manganese dioxide is used in the production of dry-cell batteries, matches, fireworks, and the production of other manganese compounds. Manganese chloride is used as a catalyst in the chlorination of organic compounds, in animal feed, and in dry-cell batteries, while manganese sulfate is used as a fertilizer, livestock nutritional supplement, in glazes and varnishes, and in ceramics. Potassium permanganate is used for water purification purposes in water and waste-treatment plants. Manganese is essential for normal physiologic functioning in humans and animals, and exposure to low levels of manganese in the diet is considered to be nutritionally essential in humans. Chronic (long-term) exposure to high levels of manganese by inhalation in humans may result in central nervous system (CNS) effects. Visual reaction time, hand steadiness, and eye-hand coordination were affected in chronically-exposed workers. A syndrome named manganism may result from chronic exposure to higher levels; manganism is characterized by feelings of weakness and lethargy, tremors, a mask-like face, and psychological disturbances. Respiratory effects have also been noted in workers chronically exposed by inhalation. Impotence and loss of libido have been noted in male workers afflicted with manganism.

Mercury compounds exist in three forms: elemental mercury, inorganic mercury compounds (primarily mercuric chloride), and organic mercury compounds (primarily methyl mercury). All forms of mercury are quite toxic, and each form exhibits different health effects.

Acute (short-term) exposure to high levels of elemental mercury in humans results in central nervous system (CNS) effects such as tremors, mood changes, and slowed sensory and motor nerve function. Chronic (long-term) exposure to elemental mercury in humans also affects the CNS, with effects such as erethism (increased excitability), irritability, excessive shyness, and tremors. Human studies are inconclusive regarding elemental mercury and cancer.

Acute exposure to inorganic mercury by the oral route may result in effects such as nausea, vomiting, and severe abdominal pain. The major effect from chronic exposure to inorganic mercury is kidney damage. Animal studies have reported effects such as alterations in testicular tissue, increased resorption rates, and abnormalities of development. Mercuric chloride (an inorganic mercury compound) exposure has been shown to result in forestomach, thyroid, and renal tumors in experimental animals.

Acute exposure of humans to very high levels of methyl mercury results in CNS effects such as blindness, deafness, and impaired level of consciousness. Chronic exposure to methyl mercury in humans also affects the CNS with symptoms such as paresthesia (a sensation of pricking on the skin), blurred vision, malaise, speech difficulties, and constriction of the visual field. Methyl mercury exposure, via the oral route, has led to significant developmental effects. Infants born to women who ingested high levels of methyl mercury exhibited mental retardation, ataxia, constriction of the visual field, blindness, and cerebral palsy.

Methanol (Wood alcohol) is released to the environment during industrial uses and naturally from volcanic gases, vegetation, and microbes. Methanol is primarily used as an industrial solvent for inks, resins, adhesives, and dyes. It is also used as a solvent in the manufacture of cholesterol, streptomycin, vitamins, hormones, and other pharmaceuticals. It is used as an antifreeze for automotive radiators, an ingredient of gasoline (as an antifreezing agent and octane booster), and as fuel for picnic stoves. It has been proposed as an alternative automobile fuel. Methanol is an ingredient in paint and varnish removers. Exposure may occur from ambient air and during the use of solvents. Acute (short-term) or chronic (long-term) exposure of humans to methanol by inhalation or ingestion may result in blurred vision, headache, dizziness, and nausea. No information is available on the reproductive, developmental, or carcinogenic effects of methanol in humans. Birth defects have been observed in the offspring of rats and mice exposed to methanol by inhalation. EPA has not classified methanol with respect to carcinogenicity.

Methyl bromide (Bromomethane) is used as a fumigant and pesticide. Exposure may occur during fumigation activities. Methyl bromide is also used as a chemical intermediate as a methylating agent, as a refrigerant, as a herbicide, as a fire extinguishing agent, and as a solvent in aniline dye manufacture; for degreasing wool; for extracting oils from nuts, seeds, and flowers; and in ionization chambers. Trace amounts have been found in drinking water, and the compound is formed naturally by algae or kelp in the ocean. Methyl bromide is highly toxic. Studies in humans indicate that the lung may be severely injured by the acute (short-term) inhalation of methyl bromide. Acute and chronic (long-term) inhalation of methyl bromide can lead to neurological effects in humans. Neurological effects have also been reported in animals. Degenerative and proliferative lesions in the nasal cavity developed in rats chronically exposed to methyl bromide by inhalation. Chronic inhalation exposure of male animals has resulted in effects on the testes at high concentrations. EPA has classified methyl bromide as a Group D, not classifiable as to human carcinogenicity.

Methyl *tert*-butyl ether is used as a gasoline additive. Exposure may occur by breathing air contaminated with auto exhaust or gasoline fumes while refueling autos. Respiratory irritation, dizziness, and disorientation have been reported by some motorists and occupationally exposed workers. Acute (short-term) exposure of humans to methyl *tert*-butyl ether also has occurred during its use as a medical treatment to dissolve cholesterol gallstones. Chronic (long-term) inhalation exposure to methyl *tert*-butyl ether has resulted in central nervous system (CNS) effects, respiratory irritation, liver and kidney effects, and decreased body weight gain in animals. Developmental effects have been reported in rats and mice exposed via inhalation. EPA has not classified methyl *tert*-butyl ether with respect to potential carcinogenicity.

Methyl ethyl ketone (2-Butanone) is used as a solvent. It is also used in the synthetic rubber industry, in the production of paraffin wax, and in household products such as lacquer and varnishes, paint remover, and glues. It has been found in indoor and outdoor air and drinking water. Acute (short-term) inhalation exposure to methyl ethyl ketone in humans results in irritation to the eyes, nose, and throat. Limited information is available on the chronic (long-term) effects of methyl ethyl ketone in humans. Chronic inhalation studies in animals have reported slight neurological, liver, kidney, and respiratory effects. No information is available on the developmental, reproductive, or carcinogenic effects of methyl ethyl ketone in humans. Developmental effects, including decreased fetal weight and fetal malformations, have been reported in mice and rats exposed to methyl ethyl ketone via inhalation and ingestion. EPA has classified methyl ethyl ketone as a Group D, not classifiable as to human carcinogenicity.

Methyl isobutyl ketone (Hexone) is used as a solvent for gums, resins, paints, varnishes, lacquers, and nitrocellulose, as an alcohol denaturant, in the extraction of rare metals, and as a synthetic flavoring adjuvant. Acute (short-term) exposure to methyl isobutyl ketone may irritate the eyes and mucous membranes, and cause weakness, headache, nausea, lightheadedness, vomiting, dizziness, incoordination, narcosis in humans. Chronic (long-term) occupational exposure to methyl isobutyl ketone has been observed to cause nausea, headache, burning in

the eyes, weakness, insomnia, intestinal pain, and slight enlargement of the liver in humans. Lethargy and kidney and liver effects have been observed in rats and mice chronically exposed by gavage (experimentally placing the chemical in the stomach), ingestion, and inhalation. EPA has classified methyl isobutyl ketone as a Group D, not classifiable as to human carcinogenicity.

Methyl methacrylate is used in the manufacture of resins and plastics. The principal uses of methyl methacrylate are: cast sheet and other grades (advertising signs and displays, lighting fixtures, glazing and skylights, building panels and sidings, and plumbing and bathroom fixtures), molding/extrusion powder, and coatings (latex paints, lacquer, and enamel resins). It is used in the impregnation of concrete to make it water-repellent, and also has uses in the fields of medicine and dentistry to make prosthetic devices and as a ceramic filler or cement. Methyl methacrylate is irritating to the skin, eyes, and mucous membranes in humans. An allergic response to dermal exposure may develop. Respiratory effects have been reported in humans following acute (short-term) and chronic (long-term) inhalation exposures. Respiratory symptoms observed following acute exposures include chest tightness, dyspnea, coughing, wheezing, and reduced peak flow. Neurological symptoms have also been reported in humans following acute exposure to methyl methacrylate. Fetal abnormalities have been reported in animals exposed to methyl methacrylate by injection and inhalation. EPA considers methyl methacrylate not likely to be carcinogenic to humans.

Methylene chloride is predominantly used as a solvent in paint strippers and removers; as a process solvent in the manufacture of drugs, pharmaceuticals, and film coatings; as a metal cleaning and finishing solvent in electronics manufacturing; and as an agent in urethane foam blowing. It is used as a propellant in aerosols for products such as paints, automotive products, and insect sprays. It is approved for use as a post-harvest fumigant for grains and strawberries and as a degreening agent for citrus fruit. It is used as an extraction solvent for spice oleoresins, hops, and for the removal of caffeine from coffee. However, due to concern over residual solvent, most decaffeinators no longer use methylene chloride. The principal route of human exposure to methylene chloride is inhalation of ambient air. Occupational and consumer exposure to methylene chloride in indoor air may be much higher, especially from spray painting or other aerosol uses. People who work in these places can breathe in the chemical or it may come in contact with the skin. Methylene chloride has been detected in both surface water and groundwater samples taken at hazardous waste sites and in drinking water at very low concentrations.

The acute (short-term) effects of methylene chloride inhalation in humans consist mainly of nervous system effects including decreased visual, auditory, and motor functions, but these effects are reversible once exposure ceases. The effects of chronic (long-term) exposure to methylene chloride suggest that the central nervous system (CNS) is a potential target in humans and animals. Human data are inconclusive regarding methylene chloride and cancer. Animal studies have shown increases in liver and lung cancer and benign mammary gland tumors following the inhalation of methylene chloride. EPA has classified methylene chloride as a Group B2, probable human carcinogen.

4,4'-Methylenebis(2-chloroaniline), which is also called MBOCA, is used as a curing agent for liquid polyurethane elastomers. These elastomers have been used to produce shoe soles; rolls for postage stamp machines; cutting bars in plywood manufacturing; rolls and belt drives in cameras, computers, and reproducing equipment; and pulleys for escalators and elevators. In the only available acute (short-term) study of MBOCA in humans, an accidental exposure to MBOCA resulted in gastrointestinal distress, transitory kidney damage, and burning face and eyes in one worker. No information is available on the chronic (long-term), reproductive, or developmental effects of MBOCA in humans. Animal studies have reported effects on the lung, liver, and kidney from chronic oral exposure to MBOCA. Animal studies have reported that MBOCA produces tumors of the liver, lung, urinary bladder, and mammary glands from oral exposure. EPA has classified MBOCA as a Group B2, probable human carcinogen.

4,4'-Methylenediphenyl diisocyanate (MDI) is used to produce polyurethane foams. Occupational exposure to MDI occurs predominantly through inhalation and dermal contact. Acute (short-term) inhalation of high concentrations of MDI may cause sensitization and asthma in humans. Acute dermal contact with MDI has induced dermatitis and eczema in workers. MDI has been observed to irritate the skin and eyes of rabbits. Chronic (long-term) inhalation exposure to MDI has been shown to cause asthma, dyspnea, and other respiratory impairments in workers. Respiratory effects have also been observed in animals. No adequate information is available on the reproductive, developmental, or carcinogenic effects of MDI in humans. EPA has classified MDI as a Group D, not classifiable as to human carcinogenicity.

Naphthalene is used in the production of phthalic anhydride; it is also used in mothballs. Other uses of naphthalene include carbamate insecticides, surface active agents and resins, as a dye intermediate, as a synthetic tanning agent, as a moth repellent, and in miscellaneous organic chemicals. Acute (short-term) exposure of humans to naphthalene by inhalation, ingestion, and dermal contact is associated with hemolytic anemia, damage to the liver, and neurological damage. Cataracts have also been reported in workers acutely exposed to naphthalene by inhalation and ingestion. Chronic (long-term) exposure of workers and rodents to naphthalene has been reported to cause cataracts and damage to the retina. Hemolytic anemia has been reported in infants born to mothers who "sniffed" and ingested naphthalene (as mothballs) during pregnancy. Available data are inadequate to establish a causal relationship between exposure to naphthalene and cancer in humans. EPA has classified naphthalene as a Group C, possible human carcinogen.

Nickel compounds occur naturally in the environment at low levels. Nickel is used for nickel alloys, electroplating, batteries, coins, industrial plumbing, spark plugs, machinery parts, stainless-steel, nickel-chrome resistance wires, and catalysts. Nickel carbonyl has severely limited use in nickel refining. Nickel is an essential element in some animal species, and it has been suggested it may be essential for human nutrition. Food is the major source of nickel exposure, with an average intake for adults estimated to be approximately 100 to 300 micrograms per day (µg/d). Individuals also may be exposed to nickel in occupations involved in its production, processing, and use, or through contact with everyday items such as nickel-containing jewelry and stainless steel cooking and eating utensils, and by smoking tobacco. Nickel is found in ambient air at very low levels as a result of releases from oil and coal combustion, nickel metal refining, sewage sludge incineration, manufacturing facilities, and other sources. Nickel dermatitis, consisting of itching of the fingers, hands, and forearms, is the most common effect in humans from chronic (long-term) skin contact with nickel. Respiratory effects have also been reported in humans from inhalation exposure to nickel. Human and animal studies have reported an increased risk of lung and nasal cancers from exposure to nickel refinery dusts and nickel subsulfide. Animal studies of soluble nickel compounds (i.e., nickel carbonyl) have reported lung tumors. EPA has classified nickel refinery dust and nickel subsulfide as Group A, human carcinogens, and nickel carbonyl as a Group B2, probable human carcinogen.

Nitrate is a naturally-occurring ion that is commonly applied to crops as a fertilizer, and thus can end up in surface or groundwater supplies used as a drinking water source. When consumed by humans over the long term, excess nitrate can damage the spleen and kidneys. The more important health threat, however, is to infants, due to the conversion of nitrate to nitrite by the body, which can interfere with the oxygen-carrying capacity of the child's blood. This can be an acute condition in which health deteriorates rapidly over a period of days. Symptoms include shortness of breath and blueness of the skin (thus the common name, "blue baby syndrome"). As a result, nitrate levels in drinking water are monitored and regulated; if an exceedance of allowable levels occurs, the water utility must notify the public.

***N*-nitrosodimethylamine** exposure may occur in occupational settings, through the ingestion of food that contains it (e.g., cured meat products and smoked fish), and from breathing cigarette

smoke. It has been used as an antioxidant, as an additive for lubricants, as a softener of copolymers, and in rocket fuel production. Acute (short-term) exposure to *N*-nitrosodimethylamine may damage the liver in humans, with symptoms that include nausea, vomiting, headaches, and malaise. Chronic (long-term) exposure of humans to *N*-nitrosodimethylamine may cause liver damage and low platelet counts. Severe liver damage has been observed in animals. Limited human data are available on the carcinogenic effects of *N*-nitrosodimethylamine. Animal studies have suggested that chronic ingestion and inhalation of *N*-nitrosodimethylamine may cause an increase in liver tumors and other types of tumors. EPA has classified *N*-nitrosodimethylamine as a Group B2, probable human carcinogen.

Phosphine is used as an insecticide for the fumigation of grains, animal feed, and leaf-stored tobacco. It is also used as an intermediate in the synthesis of flame retardants for cotton fabrics, as a doping agent for n-type semiconductors, a polymerization initiator, and a condensation catalyst. Acute (short-term) inhalation exposure to phosphine may cause headaches, dizziness, fatigue, drowsiness, burning substernal pain, nausea, vomiting, cough, labored breathing, chest tightness, pulmonary irritation, pulmonary edema, and tremors in humans. Convulsions may ensue after an apparent recovery. Chronic (long-term) occupational exposure of workers to phosphine may cause inflammation of the nasal cavity and throat, weakness, dizziness, nausea, gastrointestinal, cardiorespiratory, and central nervous system symptomology, jaundice, liver effects, and increased bone density. EPA has classified phosphine as a Group D, not classifiable as to human carcinogenicity.

Propylene oxide is used in the production of polyethers (the primary component of polyurethane foams) and propylene glycol. It is also used in the fumigation of foodstuffs and plastic medical instruments and in the manufacture of dipropylene glycol and glycol ethers, as herbicides, as solvents, and in the preparation of lubricants, surfactants, and oil demulsifiers. Acute (short-term) exposure of humans and animals to propylene oxide has caused eye and respiratory tract irritation. Dermal contact, even with dilute solutions, has caused skin irritation and necrosis in humans. Propylene oxide is also a mild central nervous system (CNS) depressant in humans. Inflammatory lesions of the nasal cavity, trachea, and lungs and neurological effects have been observed in animals chronically (long-term) exposed to propylene oxide by inhalation. Propylene oxide has been observed to cause tumors at or near the site of administration in rodents, causing forestomach tumors following ingestion via gavage (experimentally placing the chemical in the stomach) and nasal tumors after inhalation exposure. EPA has classified propylene oxide as a Group B2, probable human carcinogen.

Polychlorinated biphenyls (PCBs) are a group of chemicals that contain 209 individual compounds (known as congeners) with varying harmful effects. Information on specific congener toxicity is very limited. Most toxicity testing has been done on specific commercial mixtures (known as Aroclors); however, PCB mixtures found in the environment will differ in composition from the commercial mixtures because of partitioning, biotransformation, and bioaccumulation (processes also collectively called “weathering’). The U.S. Environmental Protection Agency (EPA) treats all PCBs as being potentially hazardous based on results from some formulations. However, this can have large uncertainty for any given mixture situation.

PCBs are no longer produced or used in the United States today; the major source of exposure to PCBs today is the redistribution of PCBs already present in soil and water. Before 1974, PCBs were used in capacitors, transformers, plasticizers, surface coatings, inks, adhesives, pesticide extenders, and carbonless duplicating paper. After 1974, use of PCBs was restricted to the production of capacitors and transformers, and after 1979 PCBs were no longer used in the production of capacitors and transformers. Chronic (long-term) exposure to some PCB formulations by inhalation in humans results in respiratory tract symptoms, gastrointestinal effects, mild liver effects, and effects on the skin and eyes such as chloracne, skin rashes, and eye irritation. Epidemiological studies indicate an association between dietary PCB exposures and developmental effects. Human studies provide inconclusive, yet suggestive, evidence of an association between PCBs exposure and cancer. Animal studies have reported an increase in

liver tumors in rats and mice exposed orally to all tested PCB formulations. EPA has classified PCBs as a Group B2, probable human carcinogen.

Polycyclic organic matter (POM) defines a broad class of compounds that includes the **polycyclic aromatic hydrocarbons (PAHs)**, of which benzo[a]pyrene is a member. POM compounds are formed primarily from combustion and are present in the atmosphere in particulate form. Sources of air emissions are diverse and include cigarette smoke, vehicle exhaust, home heating, laying tar, and grilling meat. Occupational exposure to PAHs may occur in coal tar production plants, coking plants, coal-gasification sites, smokehouses, municipal trash incinerators, and other facilities. Cancer is the major concern from exposure to POM. Epidemiologic studies have reported an increase in lung cancer in humans exposed to coke oven emissions, roofing tar emissions, and cigarette smoke; all of these mixtures contain POM compounds. Animal studies have reported respiratory tract tumors from inhalation exposure to benzo[a]pyrene and forestomach tumors, leukemia, and lung tumors from oral exposure to benzo[a]pyrene. EPA has classified seven PAHs (benzo[a]pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as Group B2, probable human carcinogens. Benzo[a]pyrene, one of the more commonly monitored PAHs, has been detected in urban air at levels approximately twice as high as those in rural areas (e.g., 0.6 nanograms per cubic meter (ng/m^3) versus 0.3 ng/m^3). Seasonal variations have also been observed from monitoring in the Northeast U.S. during the early 1980s, with mean benzo[a]pyrene concentrations during the winter more than an order of magnitude greater than during the summer.

Propylene dichloride (1,2-Dichloropropane) is used as a chemical intermediate in the production of chlorinated organic chemicals, as an industrial solvent, in ion exchange manufacture, in toluene diisocyanate production, in photographic film manufacture, for paper coating, and for petroleum catalyst regeneration. It was used in the past as a soil fumigant for a variety of crops. This use has been discontinued, and pesticide formulations containing propylene dichloride are no longer available in the United States. In addition to workplace exposure, it is sometimes found in drinking water or ambient air. Acute (short-term) inhalation exposure to high levels of propylene dichloride by humans results in effects on the lungs, gastrointestinal system, blood, liver, kidneys, central nervous system, and eyes. Limited information is available on the chronic (long-term), reproductive, developmental, and carcinogenic effects of propylene dichloride in humans. Animal studies have reported effects on the respiratory system and blood from chronic inhalation exposure. Animal studies have reported developmental effects from propylene dichloride exposure by gavage (experimentally placing the chemical in the stomach). Animal studies have reported an increased incidence of mammary gland tumors in female rats and liver tumors in male and female mice given propylene dichloride by gavage. EPA has provisionally classified propylene dichloride as a Group B2, probable human carcinogen.

Quinoline is used mainly as an intermediate in the manufacture of other products. It is also used as a catalyst, a corrosion inhibitor, in metallurgical processes, in the manufacture of dyes, as a preservative for anatomical specimens, in polymers and agricultural chemicals, and as a solvent for resins and terpenes. It is also used as an antimalarial medicine. Potential exposure to quinoline may occur from the inhalation of cigarette smoke. Quinoline breaks down quickly in the atmosphere and water. Acute (short-term) inhalation exposure to quinoline vapors irritates the eyes, nose, and throat and may cause headaches, dizziness, and nausea in humans. Information on the chronic (long-term), reproductive, developmental, or carcinogenic effects of quinoline in humans is not available. Liver damage has been observed in rats chronically exposed to quinoline by ingestion. An increased incidence of liver vascular tumors has been observed in rats and mice orally exposed to quinoline. EPA has provisionally classified quinoline as a Group C, possible human carcinogen

Radionuclides (including Radon, Radium and Uranium) Uranium, radium, and radon are naturally occurring radionuclides found in the environment. Uranium is used in nuclear power plants and nuclear weapons. Very small amounts are used in photography for toning, in the leather and wood industries for stains and dyes, and in the silk and wood industries. Radium is used as a radiation source for treating neoplastic diseases, as a radon source, in radiography of metals, and as a neutron source for research. Radon is used for treating malignant tumors and for experimental studies, however, the most likely source of exposure is in indoor air, where radon has seeped into a building from the underlying soil and rock. Background levels in ambient air are approximately 0.1 to 0.4 pCi/L. Higher levels of radon are frequently present in indoor locations, such as homes, schools, or office buildings. Indoor radon levels measured in one study showed a mean level of 1.6 pCi/L. Studies have shown that 1-3% of single-family homes may exceed 8 pCi/L. Man-made radionuclides (not occurring in nature) exist, including plutonium (found in atomic weapons) and americium (found in smoke detectors). The small amount of americium in a smoke detector is not hazardous as long as the source containing the americium is not broken open.

No information is available on the acute (short-term) noncancer effects of the radionuclides in humans. Animal studies have reported inflammatory reactions in the nasal passages and kidney damage from acute inhalation exposure to uranium. Chronic (long-term) inhalation exposure to uranium and radon in humans has been linked to respiratory effects, such as chronic lung disease, while radium exposure has resulted in acute leukopenia, anemia, necrosis of the jaw, and other effects. *Cancer is the major effect of concern from the radionuclides.* Radium, via oral exposure, is known to cause bone, head, and nasal passage tumors in humans, and radon, via inhalation exposure, causes lung cancer in humans. Uranium may cause lung cancer and tumors of the lymphatic and hematopoietic tissues. EPA has not classified uranium, radon or radium for carcinogenicity.

Styrene is primarily used in the production of polystyrene plastics and resins, and as an intermediate in the synthesis of materials used for ion exchange resins and to produce copolymers. Acute (short-term) exposure to styrene in humans results in mucous membrane and eye irritation, and gastrointestinal effects. Chronic (long-term) exposure to styrene in humans results in effects on the central nervous system (CNS), such as headache, fatigue, weakness, and depression, CSN dysfunction, hearing loss, and peripheral neuropathy. Human studies are inconclusive on the reproductive and developmental effects of styrene; several studies did not report an increase in developmental effects in women who worked in the plastics industry, while an increased frequency of spontaneous abortions and decreased frequency of births were reported in another study. Several epidemiologic studies suggest there may be an association between styrene exposure and an increased risk of leukemia and lymphoma. However, the evidence is inconclusive due to confounding factors. EPA's Office of Research and Development has updated previous assessments on the carcinogenic potential of styrene and concluded that styrene is appropriately classified in Group C, "possible human carcinogen." However, EPA has not yet given a formal carcinogen classification to styrene.

1,1,2,2-Tetrachloroethane is no longer used much in the United States, current air emissions predominantly result from its use as a chemical intermediate during the manufacture of other chemicals. Low levels have been detected in air. The main effects of 1,1,2,2-tetrachloroethane are liver and neurological effects. Acute (short-term) inhalation exposure to very high levels of 1,1,2,2-tetrachloroethane has resulted in effects on the liver and respiratory, central nervous, and gastrointestinal systems in humans. Chronic (long-term) inhalation exposure to 1,1,2,2-tetrachloroethane in humans results in jaundice and an enlarged liver, headaches, tremors, dizziness, numbness, and drowsiness. Animal studies have shown a significantly increased incidence of liver tumors in mice orally exposed to 1,1,2,2-tetrachloroethane. EPA has classified 1,1,2,2-tetrachloroethane as a Group C possible human carcinogen.

Tetrachloroethylene is widely used for dry-cleaning fabrics and metal degreasing operations. The main effects of tetrachloroethylene in humans are neurological, liver, and kidney effects

following acute (short-term) and chronic (long-term) inhalation exposure. Adverse reproductive effects, such as spontaneous abortions, have been reported from occupational exposure to tetrachloroethylene; however, no definite conclusions can be made because of the limitations of the studies. Results from epidemiological studies of dry-cleaners occupationally exposed to tetrachloroethylene suggest increased risks for several types of cancer. Animal studies have reported an increased incidence of liver cancer in mice, via inhalation and gavage (experimentally placing the chemical in the stomach), and kidney and mononuclear cell leukemia in rats. In the mid-1980s, EPA considered the epidemiological and animal evidence on tetrachloroethylene as intermediate between a probable and possible human carcinogen (Group B/C). EPA is currently reassessing its potential carcinogenicity.

Titanium tetrachloride exposure from the environment is unlikely because it breaks down rapidly in water. Titanium tetrachloride is used as an intermediate in the production of titanium metal, titanium dioxide, and titanium pigments, in the manufacture of iridescent glass and artificial pearls, as a polymerization catalyst, and to produce smoke screens. Occupational exposure to titanium tetrachloride may occur via inhalation or dermal contact during its manufacture and use. Titanium tetrachloride is highly irritating to the skin, eyes, and mucous membranes in humans. Acute (short-term) exposure may result in surface skin burns and marked congestion and constriction of various sections of the upper respiratory tract in humans. Acute exposure may also damage the eyes. Diseases of the lung (pleural diseases) have been associated with chronic (long-term) occupational exposure of titanium tetrachloride in titanium metal production workers. Chronic inhalation exposure may result in upper respiratory tract irritation, chronic bronchitis, cough, bronchoconstriction, wheezing, chemical pneumonitis, or pulmonary edema in humans. EPA has not classified titanium tetrachloride with respect to carcinogenicity.

Toluene is added to gasoline, used to produce benzene, and used as a solvent. Exposed to toluene may occur from breathing ambient or indoor air. The highest concentrations of toluene usually occur in indoor air from the use of common household products (paints, paint thinners, adhesives, synthetic fragrances and nail polish) and cigarette smoke. The deliberate inhalation of paint or glue may result in high levels of exposure to toluene, as well as to other chemicals, in solvent abusers. Automobile emissions are the principal source of toluene to the ambient air. Toluene may also be released to the ambient air during the production, use, and disposal of industrial and consumer products that contain toluene. Levels of toluene measured in rural, urban, and indoor air averaged 1.3, 10.8, and 31.5 micrograms per cubic meter ($\mu g/m^3$), respectively.

The central nervous system (CNS) is the primary target organ for toluene toxicity in both humans and animals for acute (short-term) and chronic (long-term) exposures. CNS dysfunction and narcosis have been frequently observed in humans acutely exposed to toluene by inhalation; symptoms include fatigue, sleepiness, headaches, and nausea. CNS depression has been reported to occur in chronic abusers exposed to high levels of toluene. Chronic inhalation exposure of humans to toluene also causes irritation of the upper respiratory tract and eyes, sore throat, dizziness, and headache. Human studies have reported developmental effects, such as CNS dysfunction, attention deficits, and minor craniofacial and limb anomalies, in the children of pregnant women exposed to toluene or mixed solvents by inhalation. Reproductive effects, including an association between exposure to toluene and an increased incidence of spontaneous abortions, have also been noted. However, these studies are not conclusive due to many confounding variables. EPA has classified toluene as a Group D, not classifiable as to human carcinogenicity.

Toluene-2,4-diamine (2,4-Toluenediamine) exposure is primarily occupational. It is used primarily in the production of toluene diisocyanate, which is used in the production of polyurethane. It is used as an intermediate in the synthesis of dyes and heterocyclic compounds. It is also used to prepare direct oxidation black, a dye for hair and furs, and to prepare dyes for leather. Toluene-2,4-diamine was found to leach from boil-in-bags and pouches into water at low concentrations. Acute (short-term) exposure to high levels of toluene-2,4-diamine in humans has

caused severe skin and eye irritation sometimes leading to permanent blindness. Other effects include respiratory problems, stomach gas, rise in blood pressure, dizziness, convulsions, fainting, and coma. No information is available regarding the chronic (long-term) or carcinogenic effects of toluene-2,4-diamine in humans. Chronic animal studies have reported liver injury. In animal studies, toluene-2,4-diamine was carcinogenic following dietary administration, producing a significant increase in the incidence of a large variety of tumor types, including liver, mammary gland, subcutaneous fibromas, lung lymphomas, and leukemia. EPA has classified toluene-2,4-diamine as a Group B2, probable human carcinogen.

2,4-Toluene diisocyanate is primarily used as a chemical intermediate in the production of polyurenthane products. The general public may be exposed to 2,4-toluene diisocyanate through emissions from urethane foam production facilities. 2,4-Toluene diisocyanate is extremely toxic from acute (short-term) and chronic (long-term) exposures. Acute exposure to high levels of 2,4-toluene diisocyanate in humans, via inhalation, results in severe irritation of the skin and eyes and affects the respiratory, gastrointestinal, and central nervous systems (CNS). Chronic inhalation exposure to 2,4-toluene diisocyanate in humans has resulted in significant decreases in lung function in workers, an asthma-like reaction characterized by wheezing, dyspnea, and bronchial constriction. Animal studies have reported significantly increased incidences of tumors of the pancreas, liver, and mammary glands from exposure to 2,4-toluene diisocyanate via gavage (experimentally placing the chemical in the stomach). The International Agency for Research on Cancer (IARC) has classified 2,4-toluene diisocyanate as a Group 2B, possible human carcinogen.

***o*-Toluidine** is primarily used in the manufacture of dyes, and also in manufacturing rubber, and some pharmaceuticals and pesticides. *o*-Toluidine is highly toxic to humans when absorbed through the skin, inhaled as vapor, or swallowed. Acute (short-term) exposure of humans to *o*-toluidine affects the blood (i.e., methemoglobinemia), with clinical signs of central nervous system depression. The chronic (long-term) effects in workers exposed to *o*-toluidine include anemia, anorexia, weight loss, skin lesions, central nervous system depression, cyanosis, and methemoglobinemia. Animal studies indicate that chronic exposure to *o*-toluidine causes effects on the spleen, liver, urinary bladder, and blood. Occupational exposure to dyestuffs (including *o*-toluidine) is associated with an increased risk of bladder cancer. 2-Methylaniline hydrochloride (the hydrochloride salt of *o*-toluidine) was carcinogenic in rats and mice. *o*-Toluidine has been classified by EPA as a Group B2, probable human carcinogen.

Total Organic Carbon (TOC) is a measure of the sum of all organic (carbon-containing) compounds present in a sample. In drinking water treatment, TOC is regulated because such compounds can be broken down during chlorination (disinfection) of the water to form potentially hazardous compounds, such as chloroform or haloacetic acids. If allowable levels of TOC are exceeded, a water utility must notify customers of the event.

1,1,1-Trichloroethane (Methyl chloroform) is used as a solvent and degreasing agent in industry. It is an ingredient in consumer products such as household cleaners, glues, and aerosol sprays. It is also used as a chemical intermediate in the production of vinylidene chloride. It was formerly used as a food and grain fumigant. Effects reported in humans due to acute (short-term) inhalation exposure to methyl chloroform include hypotension, mild hepatic effects, and central nervous system (CNS) depression. Cardiac arrhythmia and respiratory arrest may result from the depression of the CNS. Symptoms of acute inhalation exposure include dizziness, nausea, vomiting, diarrhea, loss of consciousness, and decreased blood pressure in humans. After chronic (long-term) inhalation exposure to methyl chloroform, some liver damage was observed in mice and ventricular arrhythmias in humans. EPA has classified methyl chloroform as a Group D, not classifiable as to human carcinogenicity.

1,1,2-Trichloroethane is used as a chemical intermediate and a solvent. No information is available on the acute (short-term), chronic (long-term), developmental, reproductive, or carcinogenic effects of 1,1,2-trichloroethane in humans. The only effect that has been noted in

humans is stinging and burning sensations of the skin upon dermal exposure to the chemical. Acute animal studies have reported effects on the liver, kidney, and central nervous system (CNS) from inhalation and oral exposure to 1,1,2-trichloroethane, while chronic animal studies have reported effects on the liver and immune system from oral exposure. An animal study reported liver tumors and adrenal tumors in mice, but no tumors in rats, exposed to 1,1,2-trichloroethane by gavage (experimentally placing the chemical in the stomach). EPA has classified 1,1,2-trichloroethane as a Group C, possible human carcinogen.

Trichloroethylene (TCE) in the United States is most commonly released into the atmosphere from industrial degreasing operations. It is used as an extraction solvent for greases, oils, fats, waxes, and tars, a chemical intermediate in the production of other chemicals, and as a refrigerant. Trichloroethylene is used in consumer products such as typewriter correction fluids, paint removers/strippers, adhesives, spot removers, and rug-cleaning fluids; in the past it was used as a general anesthetic. Exposure can occur from breathing or drinking water contaminated with TCE. Acute (short-term) and chronic (long-term) inhalation exposure to trichloroethylene can affect the human central nervous system (CNS), with symptoms such as dizziness, headaches, confusion, euphoria, facial numbness, and weakness. Liver, kidney, immunological, endocrine, and developmental effects have also been reported in humans. A recent analysis of available epidemiological studies reports trichloroethylene exposure to be associated with several types of cancers in humans, especially kidney, liver, cervix, and lymphatic system. Animal studies have reported increases in lung, liver, kidney, and testicular tumors and lymphoma. The EPA is currently reassessing the cancer classification of trichloroethylene.

Triethanolamine (TEA) is used as a pH balancer in cosmetic preparations in a variety of different products, including skin lotion, eye gels, moisturizers, shampoos, shaving foams etc. The concentrated chemical is a skin and eye irritant; skin exposure can cause dermatitis. Chronic exposure can lead to liver and kidney damage.

Vinyl acetate is primarily used as a monomer in the production of polyvinyl acetate and polyvinyl alcohol. It is also used as a raw material in the production of other chemicals, in adhesives, water-based paints, nonwoven textile fibers, textile sizings and finishes, paper coatings, inks, films, and lacquers. Acute (short-term) inhalation exposure of workers to vinyl acetate has resulted in eye irritation and upper respiratory tract irritation. Chronic (long-term) occupational exposure did not result in any severe adverse effects in workers; some instances of upper respiratory tract irritation, cough, and/or hoarseness were reported. Nasal epithelial lesions and irritation and inflammation of the respiratory tract were observed in mice and rats chronically exposed by inhalation. No information is available on the reproductive, developmental, or carcinogenic effects of vinyl acetate in humans. An increased incidence of nasal cavity tumors has been observed in rats exposed by inhalation. In one drinking water study, an increased incidence of tumors was reported in rats. EPA has not classified vinyl acetate for carcinogenicity.

Vinyl bromide is primarily used in the manufacture of flame retardant synthetic fibers. Its copolymer with vinyl chloride is also used for preparing films, for laminating fibers, and as rubber substitutes. Workers may be occupationally exposed to vinyl bromide via inhalation during its manufacture or use. Acute (short-term) and chronic (long-term) studies indicate that the liver is the primary target organ following inhalation exposure to vinyl bromide in humans and animals. In high concentrations, vinyl bromide may produce dizziness, disorientation, and sleepiness in humans. Acute exposure of rats to very high concentrations via inhalation has showed liver and kidney damage and neurological effects. Chronic inhalation exposure primarily damages the liver, causing foci in the liver of rats. Vinyl bromide has been shown to be a potent carcinogen in rats exposed by inhalation, producing liver angiosarcomas. EPA has classified vinyl bromide as a Group B2, probable human carcinogen.

Vinyl chloride is primarily used to make polyvinyl chloride (PVC) plastic and vinyl products. Air inside new cars may contain vinyl chloride at higher levels than detected in ambient air because vinyl chloride may outgas into the air from the new plastic parts. Drinking water may contain vinyl

chloride released from contact with polyvinyl pipes. Vinyl chloride is a microbial degradation product of trichloroethylene in groundwater, and thus can be found in groundwater affected by trichloroethylene contamination. Acute (short-term) exposure to high levels of vinyl chloride in air has resulted in central nervous system effects (CNS), such as dizziness, drowsiness, and headaches in humans. Chronic (long-term) exposure to vinyl chloride through inhalation and oral exposure in humans has resulted in liver damage. Cancer is a major concern from exposure to vinyl chloride via inhalation, as vinyl chloride exposure has been shown to increase the risk of a rare form of liver cancer in humans. EPA has classified vinyl chloride as a Group A, human carcinogen.

Xylenes (mixed isomers) usually contains about 40-65% *m*-xylene and up to 20% each of *o*-xylene and *p*-xylene (three different chemical structures) and ethylbenzene. Xylenes are released into the atmosphere as fugitive emissions from industrial sources, from auto exhaust, and through volatilization from their use as solvents. Xylenes have also been detected at low levels in indoor air; they have been widely used in home use products such as synthetic fragrances and paints. One study reported concentrations of *m*- and *p*-xylene ranging from 0.010 to 0.047 mg/m^3. Acute (short-term) inhalation exposure to mixed xylenes in humans results in irritation of the eyes, nose, and throat, gastrointestinal effects, eye irritation, and neurological effects. Chronic (long-term) inhalation exposure of humans to mixed xylenes results primarily in central nervous system (CNS) effects, such as headache, dizziness, fatigue, tremors, and incoordination; respiratory, cardiovascular, and kidney effects have also been reported. EPA has classified mixed xylenes as a Group D, not classifiable as to human carcinogenicity.

Appendix J

Keep Knoxville Beautiful Litter Index
Comprehensive Results
2000 through 2007

Keep Knoxville Beautiful, Litter Index, Comprehensive Results - 2000 though 2007

	2000 Score (Baseline)	2001 Score	2002 Score	2003 Score	2004 Score (New Areas Added)	2005 Score	2006 Score	2007 Score	Change Since 2006	% Change Since 2006 (one year change)	% Change since baseline year
Total Community Score	2.57	1.72	1.82	2.11	1.85	1.87	1.74	**1.90**	**-0.16**	**-9%**	**26%**
Downtown, Fort Sanders and parts of South Knoxville											
Fort Sanders	3.00	1.30	1.80	2.40	2.40	3.40	1.95	**1.96**	**-0.01**	**-1%**	**35%**
Scottish Pike	2.70	1.30	1.30	2.00	1.90	2.40	1.20	**1.70**	**-0.50**	**-42%**	**37%**
Downtown	1.10	1.00	1.00	1.00	1.30	1.30	1.05	**1.20**	**-0.15**	**-14%**	**-9%**
Old Sevier	1.50	1.00	1.80	1.90	1.80	2.70	1.45	**2.20**	**-0.75**	**-52%**	**-47%**
Morningside	2.80	1.00	1.50	1.90	2.10	2.60	1.43	**2.00**	**-0.58**	**-40%**	**29%**
South Knoxville											
Woodlawn	1.60	1.00	1.20	1.30	1.20	1.60	1.23	**1.48**	**-0.25**	**-20%**	**8%**
Maryville Pike	3.80	2.00	2.50	2.30	2.10	1.70	2.23	**2.40**	**-0.17**	**-8%**	**37%**
Cherokee Trail	3.70	2.00	2.50	2.50	2.30	1.70	2.70	**2.50**	**0.20**	**7%**	**32%**
Sims Road	3.30	1.00	2.50	2.40	2.30	2.50	3.13	**1.50**	**1.63**	**52%**	**55%**
Lester Road	3.40	1.00	2.00	1.60	1.25	2.10	1.3	**1.60**	**-0.30**	**-23%**	**53%**
South Knoxville											
Magazine	Area added in 2004				1.00	1.00	1.99	**1.20**	**0.79**	**40%**	**-20%**
Cruze					1.70	1.80	1.88	**1.58**	**0.30**	**16%**	**7%**
Kaywood					1.50	1.60	1.55	**1.70**	**-0.15**	**-10%**	**-13%**
Bunett Creek					1.20	1.90	1.73	**2.48**	**-0.76**	**-44%**	**-107%**
Gilbert Lane					1.10	1.80	1.70	**1.50**	**0.20**	**12%**	**-36%**
East Knoxville											
Prosser Road	2.80	1.50	2.00	1.60	2.00	2.50	1.70	**2.25**	**-0.55**	**-32%**	**20%**
Burlington	3.60	1.50	1.10	2.30	2.20	1.80	2.00	**2.00**	**0.00**	**0%**	**44%**
Howell Nursery	2.90	2.00	1.40	2.80	1.90	2.20	2.00	**2.10**	**-0.10**	**-5%**	**28%**
Parkview	3.00	2.50	1.50	3.00	2.20	2.40	2.00	**2.30**	**-0.30**	**-15%**	**23%**
Graves/Brooks Road	3.50	3.00	3.00	3.80	2.90	3.60	2.90	**3.86**	**-0.96**	**-33%**	**-10%**
NorthEast Knoxville											
Whittle Springs Road	Area added in 2004				2.20	3.00	2.17	**2.30**	**-0.13**	**-6%**	**-5%**
Buffat Mills Drive					1.80	1.50	1.33	**1.36**	**-0.03**	**-2%**	**24%**
Ault Road					1.70	1.30	1.47	**1.48**	**-0.01**	**-1%**	**13%**
Alice Bell Road					1.90	1.50	1.47	**1.22**	**0.25**	**17%**	**36%**
Fairmont Blvd					1.90	1.80	1.40	**1.43**	**-0.03**	**-2%**	**25%**
North Knoxville											
Central/Wray	2.00	1.30	1.60	1.80	2.50	2.10	1.70	**1.90**	**-0.20**	**-12%**	**5%**
Gill/Caswell	1.30	1.00	1.00	1.00	1.25	1.10	1.30	**1.20**	**0.10**	**8%**	**8%**
Magnolia/5th	3.10	1.50	2.10	2.50	3.10	2.60	2.50	**2.30**	**0.20**	**8%**	**26%**
Oklahoma/Scott	1.60	1.30	1.90	1.40	1.25	1.60	1.50	**1.30**	**0.20**	**13%**	**19%**
Woodbine/Jefferson	2.10	2.30	2.20	2.70	2.25	2.90	2.00	**2.25**	**-0.25**	**-13%**	**-7%**
North Knoxville											
Lonsdale	2.80	2.30	1.60	2.80	1.80	2.60	2.60	**2.38**	**0.22**	**8%**	**15%**
Johnston Street	3.00	2.30	1.90	2.10	2.00	2.40	1.90	**1.88**	**0.02**	**1%**	**37%**
Atlantic/Hiwassee	1.40	1.80	2.40	2.00	1.70	1.30	1.70	**1.86**	**-0.16**	**-9%**	**-33%**
Freemason/Broadway	1.10	1.30	1.40	2.00	1.50	1.60	1.50	**2.00**	**-0.50**	**-33%**	**-82%**
Christenberry Heights	1.00	1.80	1.00	2.50	1.50	1.80	1.50	**1.64**	**-0.14**	**-9%**	**-64%**

	2000 Score (Baseline)	2001 Score	2002 Score	2003 Score	2004 Score	2005 Score	2006 Score	2007 Score	Change Since 2006	% Change Since 2006 (one year change)	% Change since baseline year
North Knoxville											
Bruhin Road	Area added in 2004				2.20	1.10	2.00	**2.35**	**-0.35**	**-18%**	**-7%**
Sterchi Road					2.00	1.20	1.70	**1.39**	**0.31**	**18%**	**31%**
Cedar Lane					2.20	1.20	1.70	**1.40**	**0.30**	**18%**	**36%**
Garden Drive					1.70	1.20	1.25	**1.33**	**-0.08**	**-6%**	**22%**
Tazewell Pike					2.70	1.70	1.63	**2.30**	**-0.68**	**-42%**	**15%**
NorthWest Knoxville											
Ball Camp Pike	Area added in 2004				1.40	1.20	1.58	**1.44**	**0.14**	**9%**	**-3%**
Schubert Road					1.40	1.40	2.05	**1.93**	**0.12**	**6%**	**-38%**
Merchant Drive					1.50	1.50	1.83	**1.65**	**0.18**	**10%**	**-10%**
Clinton Hwy					1.50	1.20	1.45	**1.70**	**-0.25**	**-17%**	**-13%**
Sullivan Road					1.60	1.30	1.80	**1.62**	**0.18**	**10%**	**-1%**
West Knoxville											
Marble City	2.20	1.50	1.80	2.00	1.70	1.90	2.20	**1.96**	**0.24**	**11%**	**11%**
College Hills	2.50	1.80	3.80	3.10	2.00	2.00	2.00	**2.02**	**-0.02**	**-1%**	**19%**
Hope VI	4.00	2.80	1.40	1.40	1.50	1.70	1.60	**1.84**	**-0.24**	**-15%**	**54%**
Mechanicsville	3.00	2.80	1.80	1.40	2.40	2.30	1.80	**2.34**	**-0.54**	**-30%**	**22%**
Beaumont	3.20	2.80	1.60	1.80	2.10	2.80	2.00	**2.40**	**-0.40**	**-20%**	**25%**
West Knoxville											
Gallaher Broome	Area added in 2004				1.70	1.90	1.47	**1.40**	**0.07**	**5%**	**18%**
Piney Grove Church					1.80	2.20	1.80	**2.30**	**-0.50**	**-28%**	**-28%**
Frances/Dick Lonas					2.10	2.00	1.67	**2.27**	**-0.60**	**-36%**	**-8%**
Lonas/Weisgarber					1.90	2.40	1.60	**2.37**	**-0.77**	**-48%**	**-25%**
Woods Smith/McKamey					2.70	2.60	1.74	**2.58**	**-0.84**	**-48%**	**4%**
West Knoxville											
Sutherland/Scenic	Area added in 2004				1.60	1.05	1.17	**1.83**	**-0.66**	**-57%**	**-14%**
Northsore/Deane Hill					1.60	1.49	1.23	**2.00**	**-0.77**	**-62%**	**-25%**
Morrell/Gleason					1.70	1.13	1.13	**1.73**	**-0.60**	**-53%**	**-2%**
Nubbin Ridge/Wallace Rd.					1.95	1.02	1.50	**2.23**	**-0.73**	**-49%**	**-14%**
Lyons Bend/Duncan Rd.					1.61	1.04	1.37	**1.63**	**-0.26**	**-19%**	**-1%**

The Litter Index was developed by Keep America Beautiful for use by its certified affiliates to measure the amount of visible litter in a community each year. Volunteers are trained to assign a score to an area based on the amount of litter they see and the effort they believe would be required to clean up the litter. Keep Knoxville Beautiful does not specifically target any areas in the community for litter cleanups. All cleanups are initiated by neighborhood organizations, civic clubs, youth groups, etc. Whether or not an area undergoes a cleanup prior to the Litter Index being conducted is a coincidence and is a result of citizen action, not a specific KKB effort. Therefore, we believe that this system provides a good, objective measure of changes in the amount of litter in a community over time. The sub-areas listed above typically represent several streets. Keep Knoxville Beautiful does not release the scores for specific streets or individual properties. Areas that are clean receive a score of 1, areas slightly littered receive a 2, areas that are littered receive a 3 and areas that are heavily littered receive a 4.

Appendix K

Detailed information on the volume and chemical composition of wastewater discharged by each of the facilities listed below can be obtained from the EPA by searching on the name or address at the following website: http://www.state.tn.us/environment/wpc/ppo/

Water Discharge Permits Issued in Knox County

(as of March 21, 2007)

NPDES Permit No.	Facility Name	Facility Address	Permit Issued Date	Permit Expires Date	Type of Facility
TN0027804	AMERISTEEL KNOXVILLE MILL DIVISION	1919 TENNESSEE AVENUE KNOXVILLE, TN 37950-1236	MAR-31-2003	MAR-30-2008	STEEL WORKS, BLAST FURNACES (INCLUDING COKE OVENS), AND ROLLING MILLS
TN0078361	AQUA-CHEM, INC.	3001 E. JOHN SEVIER HWY. KNOXVILLE, TN 37914-1824	DEC-25-2005	DEC-25-2010	
TN0001759	ASARCO, INC. TENNESSEE MINES DIVISION	2160 IMMEL MINE ROAD MASCOT, TN 37806	OCT-31-2001	OCT-30-2006	LEAD AND ZINC ORES
TN0029769	BP KNOXVILLE TERMINAL	1908 3RD CREEK ROAD KNOXVILLE, TN 37921	NOV-27-2002	NOV-26-2007	PETROLEUM BULK STATIONS AND TERMINALS
TNG830049	BP OIL COMPANY	505 LOVELL RD KNOXVILLE, TN 37932	JUL-05-2001	JAN-19-2002	GASOLINE SERVICE STATIONS
TNG830051	BP OIL COMPANY	KNOX COUNTY, TN	DEC-25-2005	DEC-25-2010	GASOLINE SERVICE STATIONS
TNG830078	BP OIL COMPANY	FARRAGUT-CONCORD RD, TN	DEC-25-2005	DEC-25-2010	CANDY, NUT, AND CONFECTIONERY STORES
TNG830060	BP PRODUCTS NORTH AMERICA INCORPORATED	4816 BROADWAY KNOXVILLE, TN 37902	MAR-01-2003	FEB-28-2008	GASOLINE SERVICE STATIONS
TN0066168	CARYVILLE STONE, LLC	P. O. BOX 1111 KNOXVILLE, TN 37901-1111	JUN-14-2006	DEC-14-2009	CRUSHED AND BROKEN LIMESTONE
TN0003352	CEMEX INC KNOXVILLE CEMENT PLANT	6212 CEMENT PLANT ROAD KNOXVILLE, TN 37924	JUL-30-2004	AUG-30-2009	CEMENT, HYDRAULIC
TN0022411	CITGO PETROLEUM CORP	2409 KNOTT RD KNOXVILLE, TN 37921	MAY-31-2002	APR-30-2007	PETROLEUM BULK STATIONS AND TERMINALS
TNG670135	COLONIAL PIPELINE	KNOX COUNTY, TN	DEC-18-2000	NOV-30-2001	

NPDES Permit No.	Facility Name	Facility Address	Permit Issued Date	Permit Expires Date	Type of Facility
TN0058483	CUMMINS TERMINAL	5100 MIDDLEBROOK PIKE KNOXVILLE, TN 37921	NOV-27-2002	NOV-26-2007	SPECIAL WAREHOUSING AND STORAGE, NOT ELSEWHERE CLASSIFIED
TN0060402	CUMMINS TERMINALS INCORPORATED	4715 MIDDLEBROOK PIKE KNOXVILLE, TN 37921	JUN-28-2002	APR-28-2007	PETROLEUM BULK STATIONS AND TERMINALS
TN0074705	DALEN PRODUCTS, INC.	11110 GILBERT DR. KNOXVILLE, TN 37932	FEB-28-2007	FEB-27-2012	WATER SUPPLY
TN0076236	DURACAP ASPHALT MATERIALS, LLC	ASPHALT PLANT HEISKELL, TN 377545135	NOV-27-2002	NOV-26-2007	ASPHALT PAVING MIXTURES AND BLOCKS
TNG110029	EAST READY MIX PLANT	1104 SPRINGHILL ROAD KNOXVILLE, TN 37914	DEC-17-2002	NOV-14-2007	READY-MIXED CONCRETE
TNG670207	EAST TENNESSEE NATURAL GAS COMPANY	1575 DOWNTOWN WEST BLVD KNOXVILLE, TN 37919	DEC-25-2005	DEC-25-2010	
TN0063657	EAST TN INDUSTRIES, INC.	ASBURY PROJECT - AREA #1 KNOXVILLE, TN 37914	JUN-18-2003	JUN-17-2008	CRUSHED AND BROKEN LIMESTONE
TNG670036	EL PASO ENERGY CORPORATION	318 ERIN DR KNOXVILLE, TN 37919	DEC-25-2005	DEC-25-2010	
TNR056118	EUROPEAN IMPORT AUTO PARTS	3412 CLINTON HWY POWELL, TN 37849	DEC-25-2005	DEC-25-2010	
TN0002216	EXXONMOBIL CORP KNOXVILLE TERMINAL	5009 MIDDLEBROOK PIKE KNOXVILLE, TN 37921	MAR-01-2002	FEB-28-2007	PETROLEUM BULK STATIONS AND TERMINALS
TN0023353	FIRST U.D. KNOX CO.-TURKEY CR	151 CONCORD ROAD KNOXVILLE, TN 37933-0580	OCT-31-2002	FEB-28-2007	SEWERAGE SYSTEMS
TN0060577	FIRST UTIL DISTRICT WTP	1239 JENKINS LANE KNOXVILLE, TN 37922	SEP-29-2004	SEP-27-2009	WATER SUPPLY

NPDES Permit No.	Facility Name	Facility Address	Permit Issued Date	Permit Expires Date	Type of Facility
TN0064548	FLYING J. TRUCK FUELING STATION	800 WATT ROAD KNOXVILLE, TN 37923	FEB-28-2005	JUN-29-2009	GASOLINE SERVICE STATIONS
TNG830056	FORMER STAR ENTERPRISE BULK	KNOXVILLE, TN	DEC-25-2005	DEC-25-2010	
TN0074501	FOWLER SPRINGS WTP	P.O. BOX 5199 KNOXVILLE, TN 37918	SEP-29-2004	SEP-27-2009	WATER SUPPLY
TN0075957	FREIGHTLINER OF KNOXVILLE, INC	1413 EVERETT RD KNOXVILLE, TN 37932	JUL-02-2003	JUN-30-2007	MOTOR VEHICLE DEALERS (NEW AND USED)
TNG670094	G.B. "BOOTS" SMITH CORP.	KNOXVILLE, TN	DEC-25-2005	DEC-25-2010	
TN0028223	GAP CREEK SCHOOL	1920 KIMBERLIN HIEGHTS RD KNOXVILLE, TN 37917	JUL-31-2002	JUL-31-2007	SEWERAGE SYSTEMS
TN0054453	GENERAL SHALE PRODUCTS, LLC	MINE #7 - MILLERTOWN A KNOXVILLE, TN 37924	OCT-19-2004	OCT-18-2009	CLAY, CERAMIC, AND REFRACTORY MINERALS, NOT ELSEWHERE CLASSIFIED
TN0078905	HALLSDALE POWELL UTILITY DIST	3745 CUNNINGHAM RD KNOXVILLE, TN 37918	DEC-25-2005	DEC-25-2010	SEWERAGE SYSTEMS
TN0024287	HALLSDALE POWELL UTILITY DISTRICT	4301 WEST BEAVER CREEK DRIVE POWELL, TN 37849	MAR-31-2003	MAR-31-2008	SEWERAGE SYSTEMS
TN0073288	HALLSDALE POWELL UTILITY DIST MELTON HILL WTP	285 MOORE LANE POWELL, TN 37849	OCT-06-2004	SEP-27-2009	WATER SUPPLY
TN0078352	HALLSDALE-POWELL NORRIS WTP	P.O. BOX 71449 KNOXVILLE, TN 37928	SEP-29-2004	SEP-27-2009	WATER SUPPLY
TN0059323	HALLSDALE-POWELL-RACCOON V STP	DIGGS GAP ROAD KNOXVILLE, TN 37918	JUL-02-2003	MAY-31-2008	SEWERAGE SYSTEMS
TNG110289	HARRISON READY MIX	1730 TRANSPORT LN KNOXVILLE, TN 37924	JUN-10-2004	NOV-14-2007	READY-MIXED CONCRETE
TN0004511	KNOX CHAPMAN UTILITY	1905 EAST JOHN SEVIER HIGHWAY KNOXVILLE, TN 37920	SEP-29-2004	SEP-27-2009	WATER SUPPLY

NPDES Permit No.	Facility Name	Facility Address	Permit Issued Date	Permit Expires Date	Type of Facility
TNG110288	KNOXVILLE CONCRETE, INC.	4900 BUFFAT MILL ROAD KNOXVILLE, TN 37914	MAY-14-2004	NOV-14-2007	READY-MIXED CONCRETE
TN0068055	KNOXVILLE MS4	KNOXVILLE, TN	OCT-09-2003	OCT-08-2008	EXECUTIVE OFFICES
TN0060429	KNOXVILLE TERMINAL	5101 MIDDLEBROOK PIKE KNOXVILLE, TN 37921	DEC-15-2003	NOV-30-2007	PETROLEUM BULK STATIONS AND TERMINALS
TN0023574	KNOXVILLE-FOURTH CREEK SEWAGE TREATMENT PLANT	1500 LYONS BEND ROAD KNOXVILLE, TN 37919	APR-30-2004	APR-30-2007	SEWERAGE SYSTEMS
TN0023582	KNOXVILLE-KUWAHEE STP	2015 NEYLAND DRIVE KNOXVILLE, TN 37916	APR-30-2004	APR-30-2007	SEWERAGE SYSTEMS
TN0021822	KNOXVILLE-LOVES CREEK STP	5760 SANDIS LANE KNOXVILLE, TN 37924	OCT-29-2004	OCT-29-2009	SEWERAGE SYSTEMS
TN0061743	KUB EASTBRIDGE SEWAGE TREATMENT PLANT	1523 SAYLORS FORD ROAD MASCOT, TN 37806	APR-30-2004	APR-30-2009	SEWERAGE SYSTEMS
TNG670261	MAGELLAN KNOXVILLE I TERMINAL	4801 MIDDLEBROOK KNOXVILLE, TN 37921	DEC-25-2005	DEC-25-2010	PIPELINES, NOT ELSEWHERE CLASSIFIED
TNG670245	MAGELLAN TERMINALS HOLDINGS LP	5101 MIDDLEBROOK KNOXVILLE, TN 37921	DEC-25-2005	DEC-25-2010	PIPELINES, NOT ELSEWHERE CLASSIFIED
TNG670281	MARATHON ASHLAND PETROLEUM LLC	2601 KNOTT RD KNOX COUNTY, TN 37921			PIPELINES, NOT ELSEWHERE CLASSIFIED
TN0001368	MODINE MANUFACTURING COMPANY	5050 SOUTH NATIONAL DRIVE KNOXVILLE, TN 37914	JAN-31-2001	FEB-28-2005	FABRICATED PLATE WORK (BOILER SHOPS)
TNR054475	MORRIS COUPLING COMPANY	5112 NATIONAL DR KNOXVILLE, TN 37914	DEC-25-2005	DEC-25-2010	
TN0005185	NORTHEAST KNOX UTILITY DIST	7210 WASHING-TON PIKE CORRYTON, TN 37721	SEP-29-2004	SEP-27-2009	WATER SUPPLY

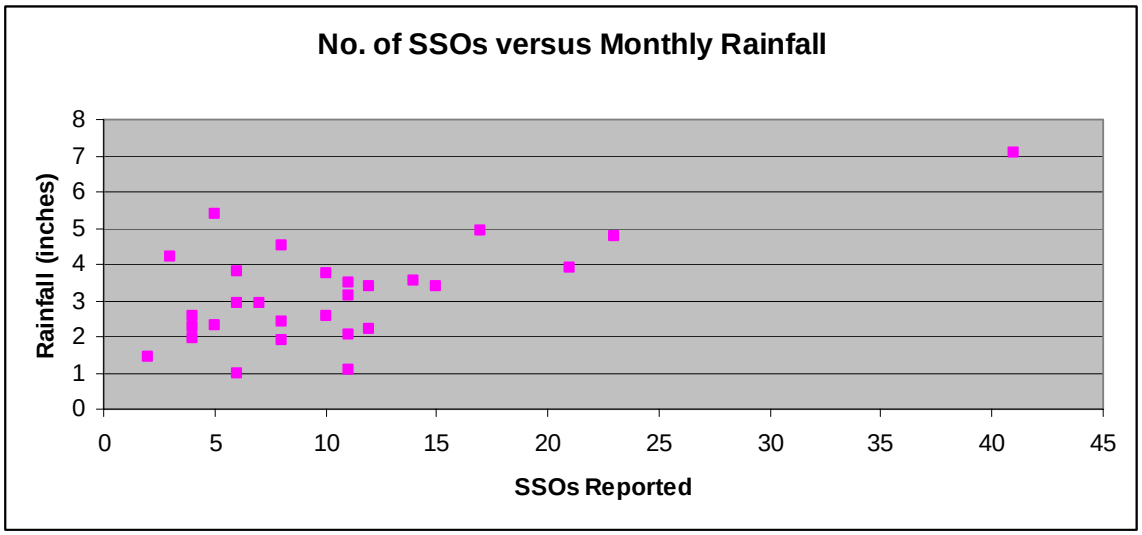
NPDES Permit No.	Facility Name	Facility Address	Permit Issued Date	Permit Expires Date	Type of Facility
TNG830071	PB PRODUCTS NO AMERICA 24396	I-40 AND GALLANTIN RD KNOXVILLE, TN 37917	DEC-25-2005	DEC-25-2010	GASOLINE SERVICE STATIONS
TN0061581	PEPSI COLA KNOXVILLE APC 71	2708 FEDERAL RD. KNOXVILLE, TN 37914	SEP-30-2005	SEP-30-2010	BOTTLED AND CANNED SOFT DRINKS AND CARBONATED WATERS
TN0067024	PETRO STOPPING CTR.	I-40@ WATT RD KNOXVILLE, TN 37933	AUG-31-2003	AUG-30-2008	GASOLINE SERVICE STATIONS
TN0064556	PILOT OIL HURRICANE MILLS	5508 LONAS RD KNOXVILLE, TN 37909	AUG-31-2005	JUN-28-2007	GASOLINE SERVICE STATIONS
TN0064351	PILOT OIL STORE #219	7200 STRAWBERRY PLAINS PIKE KNOXVILLE, TN 37909	OCT-29-2004	JUL-29-2009	GASOLINE SERVICE STATIONS
TNR053170	PIP'S IRON WORKS	900 EBENEZER RD KNOXVILLE, TN 37923	DEC-25-2005	DEC-25-2010	
TNR054194	PROCESSED FOODS CORP.	3600 PLEASANT RIDGE RD. KNOXVILLE, TN 37921	DEC-25-2005	DEC-25-2010	
TNR053231	REILY FOODS CO.	3434 MYNATT AVE. KNOXVILLE, TN 37950	DEC-25-2005	DEC-25-2010	
TN0072796	RENFRO CONSTRUCTION CO., INC.	DIGGS GAP ROAD ASPHALT PLANT HEISKELL, TN 377545135	SEP-18-2002	DEC-25-2010	ASPHALT PAVING MIXTURES AND BLOCKS
TNG110244	RINKER MATERIALS SOUTH CENTRAL	10509 LEXINGTON DRIVE KNOXVILLE, TN 37932	DEC-20-2002	NOV-14-2007	READY-MIXED CONCRETE
TN0063355	RINKER MATERIALS SOUTH CENTRAL	9509 DIGGS GAP ROAD HEISKELL, TN 377545135	JUL-26-2006	JUL-25-2011	CRUSHED AND BROKEN LIMESTONE
TNG110246	RINKER MATERIALS SOUTH CENTRAL	2200 NEYLAND DRIVE KNOXVILLE, TN 37920	DEC-20-2002	NOV-14-2007	READY-MIXED CONCRETE
TN0031089	RINKER MATERIALS SOUTH CENTRAL	9600 MASCOT ROAD MASCOT, TN 37806-1518	JUN-19-2003	JUN-18-2008	CRUSHED AND BROKEN LIMESTONE

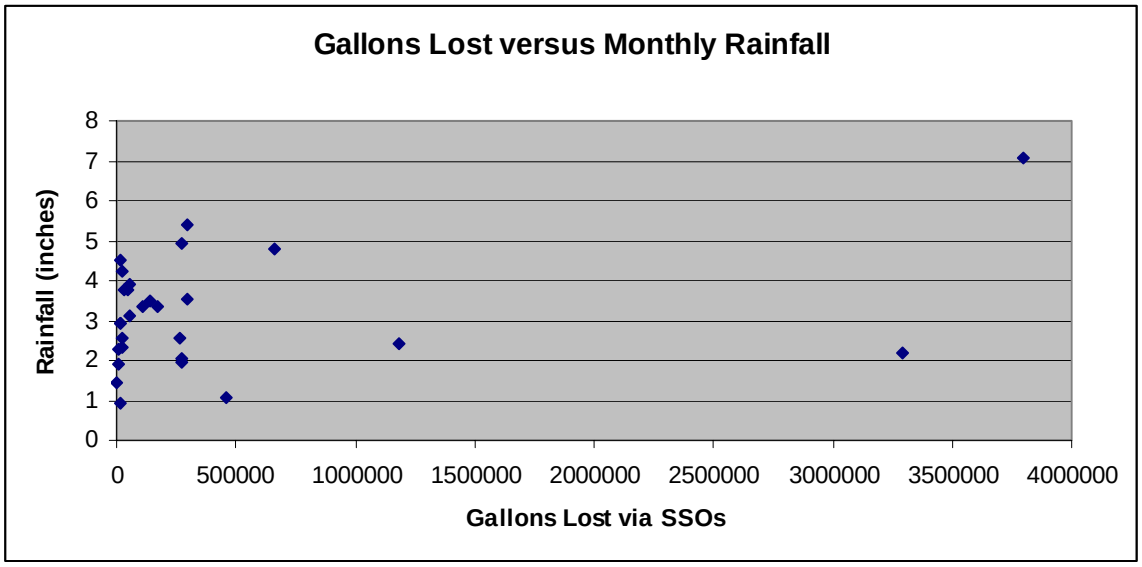
NPDES Permit No.	Facility Name	Facility Address	Permit Issued Date	Permit Expires Date	Type of Facility
TN0004987	RINKER MATERIALS SOUTH CENTRAL	2303 EAST GOVERNOR JOHN SEVIER HWY KNOXVILLE, TN 379146642	AUG-04-2004	AUG-03-2009	CRUSHED AND BROKEN LIMESTONE
TN0079341	RINKER MATERIALS SOUTH CENTRAL	PO BOX 2389 KNOXVILLE, TN 37901	JAN-07-2005	JAN-06-2010	CRUSHED AND BROKEN LIMESTONE
TN0028177	RITTA SCHOOL	6228 WASHINGTON PIKE KNOXVILLE, TN 37917	JUL-31-2002	JUL-31-2007	SEWERAGE SYSTEMS
TN0002682	ROHM & HAAS CO - KNOXVI LLE PLANT	730 DALE AVENUE KNOXVILLE, TN 37921	JUN-30-2004	JUN-29-2007	PLASTICS MATERIALS, SYNTHETIC RESINS, AND NONVULCANIZABLE ELASTOMERS
TNG110154	ROSS PRESTRESSED CONCRETE, INC	2701 INDEPENDENCE LANE KNOXVILLE, TN 37914	DEC-20-2002	NOV-14-2007	READY-MIXED CONCRETE
TNR055031	SEQUATCHIE CONCRETE SERVICE	2100 SUTHERLAND AVENUE KNOXVILLE, TN 37939	DEC-25-2005	DEC-25-2010	
TNG110157	SOUTHEAST PRECAST CORP.	POST OFFICE BOX 297 KNOXVILLE, TN 37901	DEC-19-1997	NOV-24-2001	READY-MIXED CONCRETE
TN0002089	SOUTHERN RAILWAY-JOHN SEVIER	7208 OLD RUTHLEDGE PIKE KNOXVILLE, TN 37914	OCT-31-2002	FEB-28-2007	RAILROADS, LINE-HAUL OPERATING
TN0072745	TENNESSEE MARBLE COMPANY	GRAY KNOX QUARRY KNOXVILLE, TN 37914	JUN-11-2006	JUN-10-2011	DIMENSION STONE
TNR053450	TOMS FOODS KNOXVILLE PLANT	2648 BYINGTON - SOLWAY ROAD KNOXVILLE, TN 37921	DEC-25-2005	DEC-25-2010	
TN0065137	TRAVELCENTERS OF AMERICA-KNOX	I-40 & I-75 @ 615 WATT RD. KNOXVILLE, TN 37922	APR-30-2004	APR-29-2008	GASOLINE SERVICE STATIONS

NPDES Permit No.	Facility Name	Facility Address	Permit Issued Date	Permit Expires Date	Type of Facility
TN0056073	TRUCK STOPS OF AMERICA CONCORD	608 LOVELL RD KNOXVILLE, TN 37932	NOV-01-2002	OCT-30-2007	GASOLINE SERVICE STATIONS
TN0027413	TVA KNOXVILLE OFFICE TOWERS	912 SOUTH GAY STREET KNOXVILLE, TN 37902	DEC-30-2004	DEC-29-2009	ELECTRIC SERVICES
TN0055433	VOLUNTEER ASPHALT COMPANY	3111 MCCLURE LANE KNOXVILLE, TN 37920	JUN-01-1997	OCT-30-2008	PETROLEUM REFINING
TN0003018	VULCAN CONSTR. MATERIALS, LP	P. O. BOX 7 KNOXVILLE, TN 37901-0007	MAR-17-2005	JAN-26-2010	CRUSHED AND BROKEN LIMESTONE
TN0026484	VULCAN CONSTRUCTION MATERIALS - DIXIE LEE QUARRY	1716 EVERETT ROAD KNOXVILLE, TN 37932-3403	APR-23-2003	APR-22-2008	CRUSHED AND BROKEN LIMESTONE
TN0077593	W. KNOX UD.-WILLIAMS BEND WTP	3203 WILLIAMS BEND RD KNOXVILLE, TN 37932	SEP-29-2004	SEP-27-2009	WATER SUPPLY
TN0060020	WEST KNOX UD-KARNS BEAV CR STP	9916 COWARD MILL RD KNOXVILLE, TN 37931	FEB-27-2004	FEB-27-2008	SEWERAGE SYSTEMS
TNG110027	WEST READY MIX PLANT	730 LOVELL RD. KNOXVILLE, TN 37914	DEC-17-2002	NOV-14-2007	READY-MIXED CONCRETE
TNR056332	WHITE LILY FOODS COMPANY	218 DEPOT AVE. KNOXVILLE, TN 37917	DEC-25-2005	DEC-25-2010	
TN0071048	YATES CONSTRUCTION INCORPORATED	617 SIMMONS ROAD KNOXVILLE, TN 37932	OCT-10-2005	JUN-25-2010	CHEMICAL AND FERTILIZER MINERAL MINING, NOT ELSEWHERE CLASSIFIED

Appendix L Sanitary Sewer Overflows

The following is a more detailed presentation of the data underpinning the discussion of SSOs and rainfall in the body of the report. The data tables on which the following graphs are based follow the scatter plots. Rainfall data is an average for the area, taken from several locations around Knoxville, as described at http://www.ci.knoxville.tn.us/engineering/stormwater/rainfall/. The SSO data is from KUB: http://www1.kub.org/AlphaPager.nsf/SSO_withvol2006?OpenForm.





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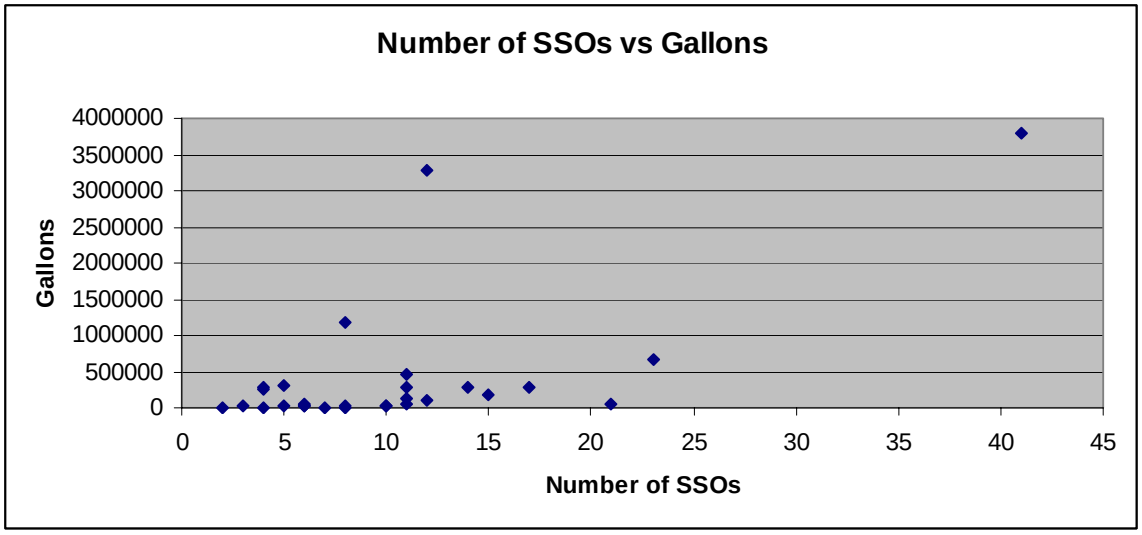

Summary Data for SSOs and Precipitation

Month	Number of SSOs	Gallons Lost	Rainfall (inches)
January 2005	10	23,069	2.57
February 2005	14	293,735	3.52
March 2005	12	108,327	3.37
April 2005	17	271,735	4.93
May 2005	11	56,610	3.13
June 2005	11	139,264	3.47
July 2005	8	18,026	4.51
August 2005	12	3,288,017	2.19
September 2005	2	220	1.44
October 2005	6	13,467	0.95
November 2005	6	12,999	2.92
December 2005	4	263,660	2.55
January 2006	21	51,868	3.92
February 2006	4	8,221	2.27
March 2006	7	11,967	2.94
April 2006	23	660,232	4.79
May 2006	8	4,206	1.89
June 2006	5	23,779	2.33
July 2006	6	42,828	3.77
August 2006	5	296,227	5.41
September 2006	41	3,794,504	7.09
October 2006	10	31,912	3.76
November 2006	15	173,743	3.37
December 2006	11	270,506	2.04
January 2007	4	1,021	1.97
February 2007	11	462,007	1.06
March 2007	8	1,185,216	2.43
April 2007	3	21,133	4.23
May 2007	3	715	(not available)

(Continued next page)

Detailed Data for SSOs and Precipitation

Date	Time	Location	Volume (gallons)	Completed Date
1/5/2005	6:19:00 PM	7609 Chatham Cir	400	1/5/2005
1/9/2005	6:14:00 PM	5713 Sourwood Ln	5400	1/9/2005
1/10/2005	5:06:00 PM	2724 Western Ave	375	1/10/2005
1/12/2005	2:51:00 PM	491 Dutch Valley Rd	480	1/12/2005
1/15/2005	12:45:00 PM	8748 Strawberry Plains Pk	270	1/15/2005
1/21/2005	5:24:00 PM	5548 Washington Pike	3740	1/21/2005
1/21/2005	3:43:00 PM	5000 Western Av	11220	1/22/2005
1/24/2005	3:21:00 PM	1711 Maple View Way	374	1/24/2005
1/31/2005	1:23:00 PM	1428 Carrie Belle Dr	810	1/31/2005
			23069	
2/10/2005	9:15 AM	5001 Maloneyville Rd	1410	2/10/2005
2/15/2005	8:00 AM	2015 Neyland Dr	5500	2/15/2005
2/18/2005	1:48 PM	4430 Washington Ct	270	2/18/2005
2/19/2005	1:00 PM	1012 Beck Pl	14620	2/19/2005
2/21/2005	1:00 PM	147 S. Cruze St.	2160	2/21/2005
2/22/2005	9:00 AM	2015 Neyland Dr	200	2/22/2005
2/21/2005	10:39 AM	438 Maryville Pike	5040	2/23/2005
2/21/2005	11:15 AM	600 N. Gallaher View Rd	260000	2/23/2005
2/21/2005	4:15 PM	1229 Louisiana Ave	750	2/23/2005
2/22/2005	3:45 PM	6522 Northshore Dr	3000	2/23/2005
2/22/2005	10:05 PM	4139 Ivy Ave	55	2/23/2005
2/23/2005	8:00 PM	5539 Stoneleigh Rd	5	2/23/2005
2/23/2005	7:30 PM	125 Tillery Rd	720	2/24/2005
2/26/2005	2:42 PM	5803 Millertown Pike	5	2/26/2005
			293735	
3/8/2005	6:48:00 PM	5525 Lonas Dr	23	3/8/2005
3/9/2005	12:59:00 PM	7590 Asheville Hw	5610	3/9/2005
3/10/2005	12:14:00 PM	5241 Bent River Blvd	20	3/10/2005
3/10/2005	7:28:00 PM	3921 Acorn Dr.	21600	3/10/2005
3/16/2005	10:20:00 PM	5209 Foxwood Rd	1405	3/16/2005
3/19/2005	10:15:00 PM	1700 Sundrop Dr	28750	3/19/2005
3/22/2005	12:09:00 PM	2015 Neyland Dr WW Plant	200	3/22/2005
3/28/2005	7:45:00 AM	4701 Minglewood Rd	125	3/28/2005
3/28/2005	2:56:00 AM	1500 Lyons Bend Rd.	50410	3/28/2005
3/28/2005	12:41:00 PM	438 Maryville Pk	32	3/28/2005
3/29/2005	9:45:00 AM	2505 Delrose Dr	32	3/29/2005
3/29/2005	12:15:00 PM	2004 Dutch Valley Rd	120	3/29/2005
			108327	
4/2/2005	1:15:00 AM	2015 Neyland Dr	9000	4/2/2005
4/2/2005	8:46:00 AM	438 Maryville Pike	225	4/2/2005
4/2/2005	10:50:00 AM	2505 Delrose Dr	375	4/2/2005
4/2/2005	2:35:00 PM	4408 Cheyenne Dr.	720	4/2/2005
4/2/2005	4:32:00 PM	2621 Parkview Ave	1200	4/2/2005
4/2/2005	1:35:00 PM	600 N . Gallaher View Rd	7200	4/3/2005
4/4/2005	8:42:00 AM	813 Barclay Dr	360	4/4/2005
4/4/2005	5:21:00 PM	3741 Eakers St	1200	4/4/2005

Date	Time	Location	Volume (gallons)	Completed Date
4/5/2005	11:47:00 AM	612 Edwards Dr.	60	4/5/2005
4/12/2005	9:30:00 AM	3920 Oakland Dr	480	4/13/2005
4/13/2005	12:45:00 PM	600 N. Gallaher View Rd	247680	4/15/2005
4/17/2005	7:19:00 PM	751 Murray Dr	4	4/17/2005
4/19/2005	2:00:00 PM	4713 Old Broadway	250	4/19/2005
4/20/2005	9:00:00 AM	3993 Midland Ave	20	4/21/2005
4/25/2005	3:25:00 PM	205 Bentley St	561	4/25/2005
4/29/2005	5:11:00 PM	1015 Phillip Fulmer Way	2160	4/29/2005
4/29/2005	4:20:00 PM	6218 Pleasant Ridge Rd	240	4/30/2005
			271735	
5/20/2005	5:40:00 AM	436 Maryville Pk	550	5/20/2005
5/20/2005	7:20:00 AM	2505 Delrose Dr	31860	5/20/2005
5/20/2005	9:08:00 AM	925 Maryville Pk	4150	5/20/2005
5/20/2005	1:57:00 PM	1305 Rickard Dr	1080	5/20/2005
5/20/2005	4:00:00 AM	2015 Neyland Dr	500	5/20/2005
5/21/2005	4:30:00 PM	801 Marlboro Rd	240	5/21/2005
5/20/2005	11:04:00 AM	600 N Gallaher View Rd		5/23/2005
5/24/2005	8:00:00 AM	3741 Eakers Rd	60	5/24/2005
5/25/2005	12:07:00 PM	305 W.Churchwell Av	18000	5/25/2005
5/26/2005	8:22:00 PM	5272 Bent River Blvd	50	5/26/2005
5/31/2005	2:08:00 PM	717 Ingersoll Ave	120	5/31/2005
			56610	
6/6/2005	5:12:00 PM	5548 Washington Pk	360	6/6/2005
6/6/2005	5:40:00 PM	6377 Love Song Ln	18	6/6/2005
6/7/2005	12:15:00 PM	2505 Delrose Dr	90	6/7/2005
6/7/2005	12:55:00 PM	1422 Hoitt Av	3850	6/7/2005
6/7/2005	7:08:00 PM	4817 Beverly Rd	480	6/7/2005
6/6/2005	8:48:00 PM	751 Murray Drive	1	6/7/2005
6/9/2005	10:14:00 PM	5205 Bent River Blvd	5	6/10/2005
6/10/2005	11:30:00 PM	7620 Bud Hawkins Rd	2880	6/10/2005
6/16/2005	9:10:00 PM	2645 Chukar Rd	1440	6/16/2005
6/27/2005	9:40:00 AM	4216 Valencia Rd	540	6/27/2005
6/30/2005	4:30:00 PM	900 Volunteer Landing Ln	129600	7/6/2005
			139264	
7/2/2005	5:58:00 PM	4304 Roberts Rd	2	7/2/2005
7/7/2005	9:38:00 AM	2505 Delrose Dr.	1080	7/8/2005
7/7/2005	10:00:00 AM	2612 Western Ave	2040	7/8/2005
7/7/2005	10:03:00 AM	816 Baxter Ave.	840	7/8/2005
7/7/2005	10:56:00 AM	438 Maryville Pk	12240	7/8/2005
7/19/2005	6:15:00 PM	1400 Marconi Dr	187	7/20/2005
7/19/2005	7:15:00 PM	600 N.Gallaher View	1037	7/20/2005
7/27/2005	5:55:00 PM	1620 N. Central Ave	600	7/27/2005
			18026	
8/1/2005	6:58:00 PM	4218 McCalla Ave	5	8/1/2005
8/4/2005	12:30:00 PM	7307 Rising Rd.	1000	8/5/2005
		Easton Meadows lift station		
8/13/2005	4:45:00 PM	2647 Woodrow Dr	834310	8/13/2005

Date	Time	Location	Volume (gallons)	Completed Date
8/13/2005	7:51:00 PM	1335 New York Av	6732	8/13/2005
8/17/2005	1:34:00 PM	308 Knox Rd	See Woodrow	8/17/2005
8/19/2005	11:30:00 AM	1219 Greens Crossing Ln	1238	8/19/2005
8/22/2005	7:30:00 AM	5548 Washington Pk	187	8/22/2005
8/21/2005	9:12:00 PM	1900 Maplewood Dr.	320	8/23/2005
8/23/2005	9:20:00 AM	2015 Neyland Drive	0	8/23/2005
8/23/2005	10:10:00 AM	2304 Woods Creek Rd	5	8/23/2005
8/29/2005	12:34:00 PM	8312 Corteland Dr	2397500	8/31/2005
8/29/2005	5:39:00 PM	8206 Glenrothes Blvd	46720	8/31/2005
			3288017	
9/13/2005	6:50:00 AM	5511 Holston Dr	100	9/13/2005
9/30/2005	7:20:00 PM	4405 Del Mabry Dr	120	10/1/2005
			220	
10/6/2005	9:23:00 AM	628 Cedar Ln	2	10/7/2005
10/11/2005	10:15:00 AM	2015 Neyland Dr	1526	10/12/2005
10/10/2005	12:09:00 PM	1920 Piney Grove Church Rd	3015	10/14/2005
10/23/2005	5:48:00 PM	1540 Jourolman Ave	2793	10/24/2005
10/26/2005	4:02:00 PM	5225 Bent River Blvd	30	10/26/2005
10/31/2005	8:38:00 AM	5001 Maloneyville Rd	6101	11/1/2005
			13467	
11/8/2005	3:15:00 PM	4800 Maloneyville Rd	598	11/8/2005
11/9/2005	10:00:00 PM	1312 Memory Ln	748	11/10/2005
11/11/2005	3:06:00 PM	1720 Cumberland Ave	36	11/14/2005
11/23/2005	8:50:00 PM	5604 Broadway N	204	11/23/2005
11/27/2005	4:28:00 PM	4905 Shannon Ln	11209	11/28/2005
11/28/2005	8:06:00 AM	4807 Coster Rd	204	11/28/2005
			12999	
12/5/2005	11:03:00 AM	526 W Baxter Ave	1350	12/7/2005
12/16/2005	11:30:00 AM	1204 Woodcrest Dr	1496	12/16/2005
12/25/2005	4:00:00 AM	4800 River Place Dr	256500	12/25/2005
12/26/2005	5:55:00 PM	4904 Shannon Ln	4314	12/27/2005
			263660	
2005 TOTAL			**4489129**	

(Continued next page)

Date	Time	Location	Volume (gallons)	Completed Date
1/2/2006	7:40:00 PM	5315 Bent River Blvd	10	1/3/2006
1/2/2006	4:15:00 PM	2111 Cove View Way	10	1/3/2006
1/4/2006	10:00:00 AM	928 Colonial Ave	1156	1/4/2006
1/7/2006	2:30:00 PM	520 Cherokee Blvd	449	1/7/2006
1/10/2006	3:15:00 PM	2631 Emoriland Blvd	92	1/10/2006
1/16/2006	1:20:00 PM	1100 Beaverton Rd	23	1/16/2006
1/17/2006	10:30:00 AM	5001 Maloneyville Rd	408	1/17/2006
1/17/2006	4:29:00 PM	4713 Old Broadway	270	1/17/2006
1/17/2006	5:17:00 PM	2505 Delrose Dr	1080	1/17/2006
1/17/2006	7:45:00 PM	436 Maryville Pk	3600	1/17/2006
1/17/2006	7:21:00 PM	4132 Martin Mill Pike	450	1/17/2006
1/18/2006	2:10:00 PM	2910 Rennoc Rd	61	1/18/2006
1/18/2006	2:45:00 PM	1815 Wayland Rd	270	1/18/2006
1/18/2006	3:39:00 PM	2601 Dayton St	56	1/18/2006
1/23/2006	7:40:00 PM	2828 Lowe Rd	15334	1/23/2006
1/26/2006	4:03:00 PM	5811 Woodburn Dr	216	1/26/2006
1/26/2006	8:17:00 PM	4404 Royalview Rd	45	1/27/2006
1/26/2006	9:02:00 PM	4713 Old Broadway	28050	1/27/2006
1/30/2006	11:28:00 AM	4701 Chapman Hwy	64	1/30/2006
1/31/2006	2:00:00 PM	6304 Roberts Rd	224	1/31/2006
			51868	
2/2/2006	11:45 AM	5544 Washington Pike	325	2/2/2006
2/6/2006	9:51 AM	1421 Broadway	2880	2/6/2006
2/28/2006	3:00 PM	810 West Fourth Av	1150	2/28/2006
2/28/2006	2:00 PM	3300 Division Street	3866	3/1/2006
			8221	
3/6/2006	1:15:00 PM	6441 Deane Hill Dr	254	3/7/2006
3/6/2006	8:45:00 AM	6504 Kingston Pike	32	3/7/2006
3/9/2006	1:07:00 PM	5548 Washington Pike	265	3/9/2006
3/12/2006	8:35:00 PM	2907 Ginnbrooke Ln	180	3/12/2006
3/20/2006	4:42:00 PM	1817 Rocky View Way	10800	3/21/2006
3/21/2006	1:28:00 PM	6917 Seaver Dr	256	3/21/2006
3/25/2006	4:49:00 PM	3323 Division St	180	3/26/2006
			11967	
4/4/2006	10:11:00 AM	5105 Ball Rd	442,400	4/6/2006
4/7/2006	2:30:00 PM	3310 Lexann Ln	48	4/7/2006
4/8/2006	9:25:00 AM	1422 Hoitt Ave	240	4/8/2006
4/8/2006	12:25:00 PM	436 Maryville Pk	360	4/8/2006
4/8/2006	9:03:00 AM	2900 Rennoc Rd	7155	4/9/2006
4/8/2006	1:12:00 PM	3001 Shelbourne Rd	38	4/9/2006
4/8/2006	3:45:00 AM	4713 Old Broadway	20196	4/10/2006
4/8/2006	11:25:00 AM	5000 Western Ave	409	4/10/2006
4/8/2006	3:10:00 PM	600 N Gallaher View Rd	38148	4/10/2006
4/12/2006	5:15:00 PM	635 Dameron Ave	144	4/12/2006
4/17/2006	10:14:00 AM	1707 Loraine St	1227	4/17/2006
4/19/2006	11:37:00 PM	4800 Maloneyville Rd	479	4/19/2006
4/20/2006	7:48:00 AM	2017 Amherst Ave	1	4/20/2006

Date	Time	Location	Volume (gallons)	Completed Date
4/21/2006	3:15:00 PM	4411 Cypress Ln	225	4/21/2006
4/22/2006	1:40:00 AM	410 Maryville Pike	24405	4/22/2006
4/22/2006	1:46:00 AM	436 Maryville Pike	2157	4/22/2006
4/22/2006	10:40:00 AM	1422 Hoitt Ave	1438	4/22/2006
4/22/2006	1:12:00 AM	4713 Old Broadway	89670	4/23/2006
4/22/2006	8:12:00 AM	3001 Shelbourne Rd	14945	4/23/2006
4/24/2006	12:54:00 PM	2900 Rennoc Rd	322	4/24/2006
4/24/2006	1:15:00 PM	600 N. Gallaher View	14890	4/24/2006
4/24/2006	1:30:00 PM	5000 Western Ave	660	4/24/2006
4/25/2006	10:07:00 AM	816 W Baxter Ave	675	4/25/2006
			660,232	
5/5/2006	2:08:00 PM	2201 Cumberland Ave.	289	5/5/2006
5/8/2006	1:03:00 PM	533 View Park Dr	135	5/8/2006
5/11/2006	5:37:00 PM	4605 Central Ave Pike	36	5/11/2006
5/18/2006	3:58:00 PM	1015 Phillip Fulmer Way	125	5/18/2006
5/20/2006	2:20:00 PM	4757 Sevierville Pk	180	5/21/2006
5/22/2006	10:39:00 AM	4322 Anderson Rd	2517	5/23/2006
5/26/2006	8:00:00 AM	1015 Phillip Fulmer Way	64	5/26/2006
5/31/2006	3:00:00 PM	5235 McNutt Rd	860	5/31/2006
			4206	
6/7/2006	12:30:00 PM	8530 Crosswind Landing Ln	150	6/7/2006
6/8/2006	2:03:00 PM	8432 Washington Pike	180	6/8/2006
6/15/2006	8:47:00 AM	5031 Sevierville Pike	409	6/15/2006
6/26/2006	12:00:00 PM	7612 Bud Hawkins Rd	600	6/27/2006
6/27/2006	4:56:00 PM	2429 Selma Ave	22440	6/28/2006
			23779	
7/1/2006	11:45:00 PM	719 W. Fourth Ave.	22933	7/2/2006
7/6/2006	3:15:00 AM	6410 Papermill Rd	3240	7/6/2006
7/12/2006	5:27:00 PM	7001 Middlebrook Pike	180	7/12/2006
7/12/2006	10:15:00 PM	5029 Tenwood Dr	60	7/12/2006
7/24/2006	1:30:00 PM	8216 Bennington Dr	95	7/24/2006
7/27/2006	8:55:00 AM	4003 Elderwood Rd	16320	7/27/2006
			42828	
8/4/2006	5:46:00 AM	2600 Woodson Dr	500	8/4/2006
8/4/2006	7:56:00 PM	3439 Magnolia Ave	3000	8/4/2006
8/4/2006	4:00:00 PM	2724 Western Av	16	8/7/2006
8/11/2006	10:20:00 AM	201 Tulane Rd	292752	8/11/2006
8/30/2006	12:50:00 PM	2335 Piney Grove Church Rd	9	8/30/2006
			296277	
9/9/2006	7:02:00 PM	4066 Valencia Rd	5460	9/10/2006
9/10/2006	12:47:00 PM	800 Graves St	360	9/10/2006
9/20/2006	7:13:00 PM	4421 Royalview Rd	750	9/21/2006
9/23/2006	1:11:00 PM	3001 Shelbourne Rd	1440	9/24/2006
9/23/2006	7:49:00 PM	3700 Whittle Springs Rd	8640	9/24/2006
9/23/2006	12:39:00 PM	1235 Watercress Dr	1440	9/24/2006
9/23/2006	7:45:00 PM	4606 Upchurch Rd	360	9/24/2006

Date	Time	Location	Volume (gallons)	Completed Date
9/24/2006	2:05:00 AM	2059 Saxton St	180	9/24/2006
9/23/2006	12:33:00 PM	2724 Western Ave	1080	9/24/2006
9/23/2006	9:57:00 PM	6540 Creekhead Dr	3240	9/24/2006
9/23/2006	11:56:00 PM	4817 Beverly Rd	2272	9/24/2006
9/24/2006	2:42:00 PM	5513 Fenway Ln	16200	9/24/2006
9/23/2006	10:55:00 AM	1422 Hoitt Ave	183444	9/25/2006
9/23/2006	1:18:00 PM	410 Maryville Pike	71904	9/25/2006
9/23/2006	1:04:00 PM	3400 W Blount Ave	43200	9/25/2006
9/23/2006	12:46:00 PM	2544 Fair Dr	2880	9/25/2006
9/23/2006	4:19:00 PM	1210 Moody Ave	8640	9/25/2006
9/23/2006	12:48:00 PM	820 Goldfinch St	8640	9/25/2006
9/23/2006	2:44:00 PM	2837 E Woodrow Dr	5040	9/25/2006
9/23/2006	12:07:00 PM	413 Higgins Ave	3240	9/25/2006
9/23/2006	12:53:00 PM	3741 Eakers Rd	10560	9/25/2006
9/23/2006	1:07:00 PM	7112 Shadyland Dr	4320	9/25/2006
9/23/2006	7:57:00 PM	961 E Ford Valley Rd	9000	9/25/2006
9/23/2006	8:24:00 PM	6833 Barkwood Dr	9000	9/25/2006
9/23/2006	8:53:00 PM	6422 Papermill Rd	1560	9/25/2006
9/24/2006	9:00:00 AM	2907 Ginnbrooke Dr	2250	9/25/2006
9/24/2006	2:30:00 PM	4105 Central Ave	3240	9/25/2006
9/24/2006	4:51:00 PM	2008 Riverside Dr	24480	9/25/2006
9/24/2006	5:10:00 PM	4713 Old Broadway	197712	9/25/2006
9/24/2006	6:56:00 PM	600 North Gallaher View RD	60000	9/25/2006
9/25/2006	11:59:00 AM	308 Knox Rd	720	9/25/2006
9/25/2006	2:45:00 PM	420 feet East of 2015 Neyland Dr	2300000	9/25/2006
9/25/2006	2:45:00 PM	1500 Lyons View Dr	489000	9/25/2006
9/25/2006	2:45:00 PM	2015 Neyland Dr	50	9/25/2006
9/25/2006	5:52:00 PM	5610 Jacksboro Pike	360	9/25/2006
9/25/2006	9:40:00 AM	203 S. Chilhowee Dr	2160	9/26/2006
9/25/2006	2:30:00 PM	6410 S. Northshore Dr	304380	9/26/2006
9/26/2006	9:30:00 AM	1517 N. Fourth Ave	240	9/26/2006
9/26/2006	12:55:00 PM	2377 Neyland Dr	2032	9/26/2006
9/28/2006	10:44:00 AM	302 Seventh Ave	3725	9/28/2006
9/28/2006	11:30:00 AM	5000 Western Ave	1305	10/29/2006
			3794504	
10/3/2006	5:41:00 PM	4312 Woodlawn Pike	898	10/3/2006
10/3/2006	10:30:00 PM	5912 Westmere Dr	375	10/3/2006
10/5/2006	11:09:00 AM	3238 Haggard Rd	540	10/5/2006
10/9/2006	7:03:00 PM	3170 Haggard Rd	17257	10/10/2006
10/17/2006	6:30:00 PM	131 Ingersoll Ave	3366	10/17/2006
10/26/2006	10:42:00 AM	923 Biddle St	62	10/26/2006
10/26/2006	11:33:00 AM	713 South Central Ave	64	10/26/2006
10/27/2006	7:15:00 PM	1500 Hoitt Ave	3350	10/28/2006
10/27/2006	10:26:00 PM	2706 Mynders Ave	5,100	10/28/2006
10/27/2006	10:36:00 PM	2724 Western Ave	900	10/28/2006
			31912	
11/1/2006	6:30:00 PM	1422 Hoitt Ave	106470	11/2/2006
11/1/2006	6:25:00 PM	1210 E Moody Ave	720	11/2/2006

Date	Time	Location	Volume (gallons)	Completed Date
11/1/2006	10:00:00 PM	2724 Western Ave	62	11/2/2006
11/1/2006	11:45:00 PM	304 Seventh Ave	558	11/2/2006
11/7/2006	6:25:00 PM	1422 Hoitt Ave	5610	11/8/2006
11/9/2006	3:46:00 AM	6107 Chapman Hwy	4500	11/10/2006
11/9/2006	6:15:00 PM	8025 Hayden Drive	1246	11/10/2006
11/15/2006	8:34:00 PM	2724 Western Ave	1078	11/16/2006
11/15/2006	8:30:00 PM	1422 Hoitt Ave	40320	11/16/2006
11/17/2006	4:00:00 PM	1517 N Fourth Ave	62	11/17/2006
11/20/2006	1:15:00 PM	8040 Kingston Pike	72	11/20/2006
11/20/2006	7:30:00 PM	4218 McCalla Ave	24	11/20/2006
11/27/2006	12:06:00 PM	3250 Mynatt Ave	11220	11/28/2006
11/28/2006	11:45:00 AM	1317 Rudder Oaks Way	1676	11/28/2006
11/28/2006	2:00:00 PM	735 Bagwell Rd	125	11/28/2006
			173743	
12/2/2006	10:00:00 AM	1608 Helmbolt Rd	360	12/2/2006
12/2/2006	4:30:00 PM	8040 Kingston Pk	2040	12/2/2006
12/2/2006	4:21:00 PM	1731 Pinebrook Dr	1620	12/2/2006
12/5/2006	10:05:00 AM	1901 Murray Rd	1250	12/5/2006
12/5/2006	12:37:00 PM	2501 Miss Ellie Dr	8640	12/5/2006
12/14/2006	1:45:00 PM	923 Biddle St	153	12/14/2006
12/18/2006	1:12:00 PM	8632 Old Rutledge Pike	75	12/18/2006
12/19/2006	10:40:00 AM	6304 Roberts Rd	47520	12/19/2006
12/19/2006	2:30:00 PM	4804 Gwinfield Dr	36608	12/19/2006
12/27/2006	12:30:00 PM	1021 Yellowstone Rd	12240	12/27/2006
12/31/2006	10:12:00 PM	2004 Neyland Dr	160000	12/31/2006
			270506	
2006 TOTAL			**5,370,043**	

(Continued next page)

Date	Time	Location	Volume (gallons)	Completed Date
1/3/2007	5:44:00 PM	3021 Rennoc Rd	31	1/3/2007
1/8/2007	1:30:00 AM	302 Seventh Av	720	1/8/2007
1/25/2007	1:00:00 PM	2868 London Cir	240	1/25/2007
1/27/2007	3:40:00 PM	4419 Coster Rd	30	1/27/2007
			1021	
2/1/2007	3:30 PM	300 Kingston Ct	180	2/1/2007
2/6/2007	2:15 PM	4421 Royalview Rd	112	2/6/2007
2/13/2007	2:14 PM	409 N. Broadway	120	2/13/2007
2/15/2007	2:43 PM	1611 Laurel Ave	480	2/15/2007
2/16/2007	5:22 PM	100 S. Hall of Fame Drive	400	2/16/2007
2/15/2007	10:36 AM	3022 Boright Ave.	452520	2/17/2007
2/17/2007	3:37 PM	2600 Holbrook Dr	3600	2/19/2007
2/18/2007	11:45 AM	1110 Woodcrest Dr	240	2/22/2007
2/22/2007	11:15 AM	6213 Ellesmere Dr	4100	2/24/2007
2/26/2007	3:07 PM	6304 Rutledge Pk	15	2/26/2007
2/28/2007	11:44 AM	3325 Dewine Dr	240	2/28/2007
			462007	
3/3/2007	4:00:00 PM	2004 Neyland Dr	1170000	3/3/2007
3/3/2007	5:09:00 PM	2015 Neyland Drive	10600	3/3/2007
3/3/2007	6:15:00 PM	2620 Scottish Pike	15	3/5/2007
3/5/2007	8:42:00 AM	1532 Wilder Pl	108	3/5/2007
3/22/2007	3:55:00 PM	4744 S Middlebrook Pike	1500	3/22/2007
3/22/2007	10:30:00 PM	2437 Keith Av	375	3/23/2007
3/27/2007	1:27:00 PM	2860 Jefferson Ave	30	3/27/2007
3/29/2007	1:14:00 PM	3804 W. Blount Av	2588	3/30/2007
			1185216	
4/17/2007	10:30:00 AM	9315 Rutledge Pk	180	4/17/2007
4/18/2007	1:17:00 PM	2314 N Broadway	20950	4/18/2007
4/24/2007	7:40:00 AM	5516 Brown Atkin Dr	3	5/24/2007
			21133	
5/22/2007	10:00:00 AM	8413 Washington Pike	5	5/22/2007
5/25/2007	10:30:00 PM	1749 Riverside Dr	710	5/26/2007
5/31/2007	2:00:00 PM	700 North Broadway	Unknown	6/1/2007
			715	

Appendix M Vector-Borne and Zoonotic Diseases

Note: The following tables do not include illnesses which are not known to occur in Eastern Tennessee, but which residents may contract while traveling.

Vector-borne Diseases Which May Occur In Knox County

Vector	Illness	Description
Several species of mosquitoes	West Nile Virus (WNV)	WNV is a seasonal epidemic in North America that flares up in the summer and continues into the fall. It is spread by the bite of an infected mosquito. Mosquitoes become infected when they feed on infected birds. Infected mosquitoes then spread WNV to humans and other animals when they bite. 80% of people infected have no symptoms, and about 20% have symptoms (developing in 3 to 15 days of being bitten) such as fever, headache, and body aches, nausea, vomiting, and sometimes swollen lymph glands or a skin rash on the chest, stomach and back. Symptoms can last for as short as a few days, though even healthy people have become sick for several weeks. In about 1 case in 150, severse symptoms develop. These can include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness and paralysis. These symptoms may last several weeks, and neurological effects may be permanent. See: http://www.cdc.gov/ncidod/dvbid/westnile/index.htm Birds are the natural WNV host; found recently-dead crows, blue jays, and robins may be submitted to the Health Dept. for testing if undecayed. See: http://www.knoxcounty.org/health/factsheet.php
Eastern Tree Hole Mosquito and Asian Tiger Mosquito	LaCrosse Encephalitis (LAC)	LAC virus occurs in the eastern US; in nature, the virus cycles between mosquitoes and hosts that include squirrels, chipmunks, and foxes. Humans are a dead-end host (virus cannot replicate enough to infect another mosquito). Risk factors include age under 16, residence near woodlands, an outdoor occupation or activity, and containers around the residence (mosquito breeding sites). Many infected persons have no apparent illness. In those persons who do develop illness, symptoms range from mild flu-like illness to seizures, coma and death (<1% of cases). The disease is believed to be widely underreported. No vaccine; treatment is supportive care (treatment of symptoms). See: http://www.cdc.gov/ncidod/dvbid/arbor/lacfact.htm

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Vector-borne Diseases Which May Occur In Knox County

Vector	Illness	Description
Several species of mosquitoes	Eastern Equine Encephalitis (EEE)	EEE virus occurs in the eastern US, where it causes disease in humans, horses, and birds. The main transmission cycle is between birds and mosquitoes. Many infected persons have no apparent illness. In those persons who do develop illness, symptoms range from mild flu-like illness to brain inflammation, coma and death. The mortality rate for those becoming seriously ill from EEE is about 1/3, making it one of the most deadly mosquito-borne diseases in the United States. There is no specific treatment for EEE; optimal medical care includes hospitalization and supportive care. Approximately half of people who survive EEE will have neurologic damage. People who work or participate in recreational activities outdoors near hardwood, freshwater swamps are at risk. Those over 50 or under 15 have greater risk for developing severe EEE when infected. See: http://www.cdc.gov/ncidod/dvbid/arbor/eeefact.htm
Culex species of mosquitoes	St. Louis Encephalitis (SLE)	SLE virus occurs across the US, especially in the Midwest and South-Central states, where it causes disease in humans, but no illness in infected birds. The main transmission cycle is between birds and mosquitoes. Mild infections occur without apparent symptoms other than fever with headache. More severe cases are marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, occasional convulsions (especially in infants) and paralysis. Symptoms appear 5 to 15 days after being bitten. Mortality rate is 3% (up to 30% in the aged). Outbreaks occur mainly in late summer and early fall, but can occur all year in warmer areas. There is no treatment for SLE other than supportive care. All are at risk in affected areas. See: http://www.cdc.gov/ncidod/dvbid/arbor/sle_ga.htm
American Dog Tick and Lone-Star Tick	Rocky Mountain Spotted Fever (RMSF)	RMSF is the most commonly reported tick-borne illness in Tennessee. The name is a misnomer, as the disease occurs from southern Canada to northern South America. It is caused by *Rickettsia rickettsii*, a species of bacteria that is spread to humans by ixodid (hard) ticks. Initial symptoms include sudden onset of fever, headache, and muscle pain, followed by development of a characteristic rash. The disease can be difficult to diagnose in the early stages, and without prompt and appropriate treatment it can be fatal (3-5% of cases). It is treated with antibiotics. It is prevented by avoiding exposure to ticks, by dressing appropriately and wearing repellent outdoors, removing ticks promptly, and treating pets for ticks. See: http://www.cdc.gov/ncidod/dvrd/rmsf/

Vector-borne Diseases Which May Occur In Knox County

Vector	Illness	Description
Blacklegged or Deer Tick	Lyme Disease	Red, expanding "bulls-eye" rash appears around site of bite within 3-30 days and may grow to 12" across. Rash is warm but not usually painful. Victim may have fatigue, chills, fever, headache, muscle and joint aches, and swollen lymph nodes. In some cases, these may be the only symptoms of infection. Untreated, the infection may spread to other parts of the body within a few days to weeks, producing symptoms that can include loss of muscle tone on one or both sides of the face (called facial or "Bell's palsy), severe headaches and neck stiffness due to meningitis, shooting pains that may interfere with sleep, heart palpitations and dizziness due to changes in heartbeat, and pain that moves from joint to joint. Many of these symptoms will resolve, even without treatment. After several months, approximately 60% of patients with untreated infection will begin to have intermittent bouts of arthritis, with severe joint pain and swelling. Large joints are most often effected, particularly the knees. In addition, up to 5% of untreated patients may develop chronic neurological complaints months to years after infection. These include shooting pains, numbness or tingling in the hands or feet, and problems with concentration and short term memory. Most cases of Lyme disease can be cured with antibiotics, especially if treatment is begun early. It is prevented by avoiding exposure to ticks, by dressing appropriately and wearing repellent outdoors, removing ticks promptly, and treating pets for ticks. Caused by a bacterium, *Borrelia burgdorferi.* See: http://www.cdc.gov/ncidod/dvbid/lyme/index.htm
Lone-Star Tick	Southern Tick-Associated Rash Illness (STARI)	Red, expanding "bulls-eye" rash appears around site of bite within 7 days and may grow to 3" or more. The rash may be accompanied by fatigue, fever, headache, muscle and joint pains, but not arthritic, neurological, or chronic symptoms (like Lyme Disease). Treated with antibiotics. Caused by a bacterium, *Borrelia lonestari.* It is prevented by avoiding exposure to ticks, by dressing appropriately and wearing repellent outdoors, removing ticks promptly, and treating pets for ticks. See: http://www.cdc.gov/ncidod/dvbid/stari/index.htm

Vector-borne Diseases Which May Occur In Knox County

Vector	Illness	Description
Black-legged (Deer) Tick and Lone-Star Tick, possibly other ticks	Ehrlichiosis	Initial symptoms generally include fever, headache, malaise, and muscle aches. It is unknown how many cases are so mild they go unreported. Other signs and symptoms may include nausea, vomiting, diarrhea, cough, joint pains, confusion, and occasionally rash. Treated with antibiotics. If untreated, 50% of cases require hospitalization, and kidney failure, encephalitis, adult respiratory distress syndrome, seizures, or coma can result. 2-3% of such patients may die. Ehrlichiosis is caused by *Ehrlichia chaffeensis*, *E. ewingii,* and a bacterium extremely similar or identical to *E. phagocytophila*. Other affected species include dogs and deer; similar illnesses affect cattle, sheep, goats, and horses. In the US, it is most common in the Southeast and South-Central states. It is prevented by avoiding tick exposure - dressing appropriately, wearing repellent outdoors, removing ticks promptly, and treating pets for ticks. See: http://www.cdc.gov/ncidod/dvrd/ehrlichia/Index.htm
Fleas	Cat Scratch Disease (“Cat Scratch Fever”)	Researchers now believe it may be possible for humans to contact this disease (discussed below as a zoonotic illness) from infected fleas, as well as directly from a cat bite or scratch.
Mites	Rickettsial Pox	A disease similar to chicken pox, spread to people by mites that are usually found on mice. It is caused by *Rickettsia akari* and is treated with antibiotics: http://www.nlm.nih.gov/medlineplus/ency/article/001351.htm

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Zoonotic Diseases Which May Occur In Knox County

Animal	Illness	Description
Bat, Cat, Dog, Fox, Skunk, Raccoon, possibly other animals	Rabies	Rabies is a deadly disease caused by a viral infection of the brain and spinal cord in animals and people. It is transmitted through the saliva of a rabid animal, usually by a bite. If people or pets are bitten by a wild or unfamiliar animal, the wound should be allowed to bleed, and washed with soap and water. Medical or veterinary care should be sought immediately. Vaccines can be given after exposure, but once symptoms develop, the disease is virtually always fatal. The formerly painful series of abdominal vaccine injections have been replaced with injections into the arm, which are much less painful. Rabies vaccines are available for dogs, cats, horses, ferrets, and some farm animals. Pet owners are required by Tennessee and Knox County law to vaccinate dogs and cats against rabies infection. Knox County Health Department, in cooperation with area veterinarians, operates community pet vaccination clinics at local schools each spring, or pets can be vaccinated by a veterinarian anytime. If the animal which bit the victim can be safely isolated (for example, closing a bat in a bedroom or a stray dog in the garage), Knox County Animal Control (865-215-6658) or Knoxville City Animal Control (865-215-7457) should be contacted so the animal can be tested to see if it is rabid.
Reptiles, Birds, Rodent Saliva or Droppings	Salmonellosis	*Salmonella* bacteria are commonly associated with food poisoning from contaminated or undercooked foods, but can also be transmitted by pets, which pass the organism in their feces. *Salmonella* are part of a reptile's normal digestive bacteria and cannot be removed by treatment, thus good hygiene is a must: no eating, drinking or smoking around pet reptiles; washing well with hot soapy water after contact with the pets or their cages. Reptiles are not appropriate pets for small children and should not be in the same house as an infant, CDC advises. Sale or ownership of pet turtles under 4" in size has been illegal since 1975 due to an outbreak of salmonellosis. However, there has been a resurgence in the popularity of turtles as pets, and the CDC estimates 74,000 cases of turtle-associated illness occur annually in America. Gastrointestinal symptoms develop 6 to 72 hours after exposure (usually 12 to 36 hours) and generally last 2-7 days. The illness can be serious for infants, children, the elderly, or those with compromised immune systems.

(continued next page)

Zoonotic Diseases Which May Occur In Knox County

Animal	Illness	Description
Dog, Cat, other animals	Worms (roundworms and hookworms)	Roundworms and hookworms can infect dogs, cats, and some other animals. FDA estimates over 90% of puppies are born infected with worms. Worms can also infect people if they ingest the organisms or, in the case of hookworms (which can penetrate the skin) if they walk barefoot on infected soil. Worms live in the intestines of animals and are expelled in the feces. If left untreated in pets, homes and yards can become contaminated from worm eggs that are passed and hatch in the soil. Hookworm larvae crawl beneath the skin, causing painful inflammation. They can travel to the small intestine, where they attach and suck blood. Between 5 to 20% of children have been infected with dog roundworms at some point. They often cause no symptoms, but can migrate to internal organs or the retina, causing damage. Pets should be examined annually for worms; both cures and preventive treatments are available.
Cat	Toxoplasmosis	Cats carry *Toxoplasma gondii,* the parasite causing toxoplasmosis, but it can also be ingested in raw or undercooked meat, or through exposure to cat feces or soil containing the organism. Most cats have no symptoms, and CDC estimates over 60 million Americans probably carry the toxoplasma parasite. Few become ill; those who do may have flu-like symptoms such as swollen glands and muscle aches. It is important for pregnant women to avoid contracting the disease as it can cause miscarriage, premature births and birth defects. They should avoid changing cat litter, or change it daily wearing disposable gloves, as the organism requires 24 hours to become infective. Wash hands well with soap afterwards. Coven children's sand boxes. Toxoplasmosis can be treated with antibiotics.
Birds	Psittacosis ("Parrot Fever")	*Chlamydophila psittaci* is the bacteria that causes psittacosis, a common bird disease also called parrot fever because of its frequent occurrence in parrot-type birds--especially cockatiels and parakeets. Some birds may get sick from it, while others show no signs of illness. Bacteria from infected birds are found in their droppings and nasal discharges. People can become infected by inhaling the dried droppings and secretions. Those exposed to birds with psittacosis should see a doctor if they develop flu-like symptoms such as fever, chills, headaches, muscle aches, or dry cough. Untreated psittacosis can develop into pneumonia and other health problems. The disease is treated with antibacterial drugs in both birds and humans.

Zoonotic Diseases Which May Occur In Knox County

Animal	Illness	Description
Usually Cat; also Dog, Ferret, Rabbit, Guinea Pig, Horse and other animals	"Ringworm"	Ringworm is a fungal infection of the skin that humans can contract from the soil, or from touching the skin or fur of an infected animal. In people, a ring-shaped, reddish, itchy rash that can be dry and scaly or wet and crusty develops. Pets may lose fur and have a bare, itchy patch, or may have almost no symptoms. Treatable in pets and humans with topical and oral medication.
Deer, Cow, Sheep, Rat, Raccoon, Opossum, Vole, Skunk, Mice, Infected Dogs	Leptospirosis	Leptospirosis is caused by spirochete bacteria of the genus *Leptospira.* It is transmitted by the urine of an infected animal, and is infectious as long as it is moist. Humans are infected through contact with water, food, or soil containing urine from infected animals, by swallowing contaminated food or water or through skin contact (including water sports in contaminated bodies of water). The disease is not known to be spread from person to person. Infected people may have no symptoms, but typically have an initial phase with flu-like symptoms (fever, chills, body aches, intense headache). The victim is briefly asymptomatic before the second phase - characterized by meningitis, liver damage (causing jaundice), and renal failure – begins. The typical incubation period in humans is 4-14 days. Approximately 5-50% of severe leptospirosis cases are fatal; however, such cases only constitute about 10% of all registered incidents. It is treated with antibiotics and supportive treatment as needed.
Cat	Cat Scratch Disease ("Cat Scratch Fever")	CDC estimates over 20,000 Americans get CSD each year. Most cat bites or scratches don't develop into CSD, but those that do may cause fever, fatigue, headache and swollen lymph glands. About 40 percent of cats carry the infectious bacteria at some time in their lives, according to the CDC. Many do not show signs of illness, but some develop fever, lethargy, swollen lymph glands, inflamed eyes and gums, and neurological disease, requiring treatment by a veterinarian. Cats should be treated with a flea control as fleas may transmit CSD to people.
Pet or Wild Rodents	Lymphocytic Choriomeningitis (LCM)	LCM is caused by a virus. Exposure occurs by inhaling airborne particles of rodent urine, feces, or saliva, or by ingesting food contaminated with the virus. LCM causes flu-like symptoms (fever, headache, and muscle aches), progressing to muscle weakness and paralysis. There are no drugs to treat LCM; hospitalization may be required.
Pet or Wild Rodents	"Rat Bite Fever" (RBF)	RBF is caused by bacteria transmitted through a rodent bite or scratch, or by ingesting food or water contaminated with rodent droppings. Initially causes flu-like symptoms, which can develop into severe complications. It is treated with antibiotics.

Zoonotic Diseases Which May Occur In Knox County

Animal	Illness	Description
Dog, Cat, Rodent, Pig, Cow, Fish, Other Animals	Tapeworm (Various Species)	Tapeworms are parasitic flat, segmented worms that can be spread to humans by undercooked meat or fish, or fecal contamination of food or food preparation areas. Where humans are the primary host, the worms are limited to the digestive tract. Once inside the digestive tract, the larva grows into an adult tapeworm, which can live for years and grow very large. Where humans are a secondary or intermediate host, the worms may be found in tissues in other parts of the body. Symptoms and treatment vary by species (see website below).
Fish or other aquarium pets, Birds	Mycobacterial Infection, Avian Tuberculosis	*Mycobacteria* are a common infectious germ family associated with fish and aquarium water. Infection can occur through cuts or scrapes on hands or feet, or by young children (or pets) ingesting aquarium water. Infections can be serious for those with compromised immune systems. Avian Tuberculosis is caused by *M. avium;* it is highly resistant to antibiotics and surgical removal of infected lymph nodes is often necessary.
Bird or Bat Droppings	Histoplasmosis	*Histoplasmosis* is a fungus that grows in soil enriched with bird or bat manure, or the droppings themselves in construction sites, caves, or church steeples. While the organism does no harm to birds, it can cause illness in humans, dogs, cats, cattle, sheep, horses, and wild mammals. Most human cases are asymptomatic. The incubation period is 7-14 days. There are three symptomatic forms of illness. In the acute pulmonary form, a flu-like illness lasting several weeks with chills, chest pain fever, and malaise occurs. In those over 40, the chronic form occurs, resembling tuberculosis. The victim has a productive cough, weight loss, and shortness of breath. In the very young or elderly, the disseminated form occurs, which can be fatal without treatment. The spleen and liver are affected, and mucosal ulceration occurs. The disease is treated with Amphotericin B.
Bird Nests or Droppings	Cryptococcosis	*Cryptococcus neoformans* is another fungus if bird droppings or soil. Humans, horses, dogs, cats, and other mammals are affected. It can infect by inhalation or ingestion. In humans, it manifests as meningitis or meningoencephalitis, often preceded by pulmonary infection with cough, blood-tinged sputum, fever, and malaise. It is often a chronic illness.

Reference: http://www.fda.gov/fdac/features/2004/104_pets.html
Local rabies information: http://www.knoxpets.org/
Turtles and salmonella: http://www.fda.gov/cvm/turtleregs.htm
Leptospirosis: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/leptospirosis_g.htm;
http://www.nih.gov/news/pr/nov96/niaid-14.htm
Tapeworms: http://www.emedicine.com/emerg/topic567.htm

Appendix N

Imported Fire Ant Quarantine Regulations
State of Tennessee

IMPORTED FIRE ANT QUARANTINE CHAPTER 0080-6-19

0080-6-19-.04 REGULATED ARTICLES. The following pests and articles shall be regulated by this quarantine.

(1) The black imported fire ant, Solenopsis richleri Forel, and the red imported fire ant, Solenopsis invicta Buren, in any living stage of development.

(2) Soil, compost, decomposed manure, humus, murk and peat, separately or with other things;

(3) Plants with roots with soil attached;

(4) Grass sod;

(5) Hay and straw;

(6) Used mechanized soil-moving equipment; and

(7) Any other products, articles, or means of conveyance of any character whatsoever, when it is determined by the Director that they present a hazard of spread of imported fire ants and the person in possession thereof has been notified.

Authority: *T.C.A. §§43-6-106, 43-6-106(9) and 43-6-108.* ***Administrative History:*** *Original rule filed October 6, 1989; effective January 29, 1990.*

0080-6-19-.05 CERTIFICATES AND PERMITS REQUIRED. Unless exempted, a certificate or a permit must accompany the movement of regulated articles from any regulated areas into or through any point outside thereof. Regulated articles originating outside a regulated area may be moved without a certificate or permit if

(1) The point of origin is clearly indicated on the shipping document accompanying the regulated articles provided; and

(2) The regulated articles moving through the infested area are protected to the satisfaction of the Director.

Authority: *T.C.A. §§43-6-104, 43-6-106(9) and 43-6-108.* ***Administrative History:*** *Original rule filed October 6, 1989; effective January 29, 1990.*

0080-6-19-.06 ATTACHMENT OF CERTIFICATES AND/OR PERMITS.

Every single article and/or every container of regulated articles is required to have a certificate or permit securely attached to the outside thereof, when being moved or offered for movement. Where regulated articles are adequately described on the certificate or permit attached to the way-bill, the attachment of a certificate or permit to each container of the articles or to the article itself will not be required.

Authority: *T.C.A. §§43-6-104, 43-6-106(9) and 43-6-108.* ***Administrative History:*** *Original rule filed October 6, 1989; effective January 29, 1990.*

0080-6-19-.07 CONDITIONS GOVERNING ISSUANCE OF CERTIFICATES AND PERMITS.

(1) CERTIFICATES: Certificates may be issued by the inspector for the movement of the regulated articles designated in this quarantine under any of the following conditions:

(a) When in the judgement of the inspector, they have not been exposed to infestation.

(b) When they have been examined by the inspector and found to be free of infestation

(c) When they have been treated to destroy infestations under the supervision of the inspector and in accordance with methods selected by him from procedures authorized by the Director of the Division of Plant Industries and known to be effective under conditions in which applied.

(d) When grown, produced, manufactured or handled in such manner that in the judgment of the inspector, no infestation would be transmitted thereby.

Authority: *T.C.A. §§43-6-104, 43-6-106(9) and 43-6-108.* ***Administrative History:*** *Original rule filed October 6, 1989; effective January 29, 1990.*

0080-6-19-.08 PROTECTING CERTIFIED ARTICLES.

Prior to certification, regulated articles must be loaded, handled and shipped only under such protections and safeguards against infestation as are required by the inspector.

Authority: *T.C.A. §§43-6-104, 43-6-106(9) and 43-6-108.* ***Administrative History:*** *Original rule filed October 6, 1989; effective January 29, 1990.*

0080-6-19-.09 MOVEMENT OF REGULATED ARTICLES WITHIN THE REGULATED AREAS.

Regulated articles within regulated areas may be freely moved unless:

(1) The articles originate on infested properties;

(2) The Commissioner has determined that a hazard of spread exists, and

(3) The property owner has been so notified. A property owner so notified may move the specified regulated articles within the regulated areas only under conditions approved by the Director.

Authority: *T.C.A. §§43-6-104, 43-6-106(9) and 43-6-108.* ***Administrative History:*** *Original rule filed October 6, 1989; effective January 29, 1990.*

0080-6-19-.10 EXEMPT ARTICLES. The following articles are exempt from all regulated area certification and permit requirements if they meet applicable conditions prescribed, and have not been exposed to infestation after cleaning or other handling

(1) Potting soil, if commercially prepared, packaged and shipped in original containers.

(2) Hay and straw, if used for packing or bedding.

(3) Used mechanized soil-moving equipment, if cleaned of all loose, non-compacted soil.

(4) Transplants, if substantially free of soil and house plants grown in the home and not for sale.

(5) Soil samples for processing, testing, or analysis, may be moved from the regulated area only to laboratories operated under compliance agreement, or only in emergencies under authorization from the Director.

(6) Compact, decomposed manure, humus and peat, if dehydrated, ground, pulverized or compressed.

(7) Logs and pulpwood, provided the loading site has been properly treated as recommended.