Environmental Health Issues in Kansas—An Overview

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The Kansas Health Institute is an independent, nonprofit health policy and research organization based in Topeka, Kansas. Established in 1995 with a multi-year grant from the Kansas Health Foundation, the Kansas Health Institute conducts research and policy analysis on issues that affect the health of Kansans.

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EXECUTIVE SUMMARY

We know that the environment in which we live can affect our health and cause certain diseases, yet many challenges remain to fully understanding under what circumstances the presence of a toxic substance in the environment (usually referred to as a *hazard*) will cause disease. Producing scientific evidence that a certain hazard can cause specific diseases is more complex than linking diseases to other causes, such as microorganisms. Exposure to environmental hazards can cause diseases that appear decades after the exposure occurred, which makes proving the linkages more difficult. People are frequently exposed to a multitude of hazards, and it is difficult to sort out the individual health effects of each hazard or the synergistic effects of hazards. Many diseases may be precipitated by exposure to environmental hazards, but also by other individual behaviors or genetic factors. Finally, and most importantly, even for the linkages between environmental hazards and health outcomes that have been demonstrated, the monitoring systems available in the nation and in the state are insufficient to fully capture the effects of the environment on health outcomes.

This study provides a concise, non-technical description of some important environmental health issues in Kansas, with the goal to inform decision-making about how resources might be most effectively targeted to improve health.

Through a review of available published information and interviews with key experts in the field, the Kansas Health Institute (KHI) identified environmental health issues of special relevance to Kansas and indicators related to these issues that could be used for monitoring and planning purposes.

Indicators of the *presence* of environmental hazards:

- Levels of ozone and particulate matter in ambient air
- Tobacco smoke in homes with children
- Use of pesticides
- Contamination of ambient water with pesticides and mercury
- Contamination of drinking water with nitrates, arsenic and pesticides
- Contamination of fish with mercury

Indicators of *exposure* to environmental hazards:

- Blood lead levels in children

Indicators of *diseases* linked to environmental hazards:

- Carbon monoxide poisoning
- Morbidity and mortality due to extreme meteorologic and climatic conditions
- Unusual patterns of asthma, cardiovascular and respiratory disease
- Incidence and mortality from lung cancer in non-smokers, mesothelioma and soft tissue sarcoma
- Pesticide-related poisoning and illness
- Lead poisoning in children

It appears clear from the review conducted that there are opportunities for new initiatives in the state concerning environmental health. The challenge will be the lack of good information on the extent to which certain hazards represent a problem in the state, the magnitude of their effects on Kansans and knowledge of trends over time in these areas. While significant amounts of data are currently being collected (mostly by the Kansas Department of Health and Environment), the information is generally used to monitor and enforce federal and state environmental quality standards. A population-based approach to environmental health issues will require stronger environmental health epidemiologic capacity, in-depth analysis of the available information, additional information on the indicators of special interest not currently covered by existing programs and linkage of the information on environmental hazards with the distribution of related health outcomes in the state. With these systems in place, the state's environmental health needs could be better assessed and priorities for intervention identified. Interventions might include public information campaigns (for example, precautions to take when the air quality indexes fall below safety thresholds), community-level interventions (for example, encouraging the development and use of personal transportation alternatives in communities with outdoor air quality problems) or educational activities on best practices to manage health conditions exacerbated by exposure to environmental hazards, such as asthma.

INTRODUCTION AND METHODS

The purpose of this study is to provide a brief overview of the current state of knowledge regarding the interaction between our environment and health and to identify environmental health issues of potentially high relevance for Kansas. The report identifies some environmental health issues of high interest for Kansas and discusses gaps in knowledge and data availability that exist in the state. This report also describes the surveillance activities for environmental health issues that are currently conducted, what indicators have been defined nationwide to track environmental public health issues, and the extent to which those indicators are monitored in Kansas.

This study does not provide a comprehensive or technical description of all environmental health hazards in the state, but rather a general introduction to these topics for a non-technical audience. This study only deals with environmental hazards that could have negative health effects on the general population, or on selected high-risk groups, such as children or pregnant women. The effects of environmental exposure that occur in more limited or special situations, such as those related to occupational activities, were not addressed. In addition, the study is limited to the effects of toxins and chemicals on human health and does not cover issues of food or water contamination with microorganisms.

As a first step, KHI reviewed current concepts of linkage between environmental hazards and health conditions and conducted an Internet search for relevant data and background materials. Information from several sources was reviewed; particular attention was given to information provided by the Centers for Disease Control and Prevention (CDC), the Environmental Protection Agency (EPA) and the Kansas Department of Health and Environment (KDHE) on current programs and interventions addressing environmental health concerns, as well as regulatory environmental quality standards.

In addition to this review, KHI met with key individuals who are knowledgeable about environmental issues in Kansas and in the rest of the nation regarding significant environmental threats to the health of Kansans.

Based on the information collected during the review and from the experts, KHI made an attempt to identify environmental health issues of potentially high relevance for Kansas. Issues were ranked for their relevance to Kansas based on the following characteristics:

- How common and widespread is the hazard or condition being addressed?
- How severe is the threat? Does the hazard cause adverse health effects in large portions of the population? Are the health consequences of exposure to the hazard severely debilitating or life threatening?
- How easily preventable is the contamination or the exposure to the hazard?
- How high is public concern about the hazard or the health conditions linked to it?

Next, KHI reviewed the status of surveillance activities for environmental health issues in the country and in Kansas and identified the current state-of-the-art practices in the monitoring of environmental health problems. Two major sets of national indicators for environmental health were identified. The first group is a sub-set of the Healthy People 2010 objectives published in 2000 by the U.S. Department of Health and Human Services (DHHS), which is included in Appendix A. The second set of indicators, a joint effort between the CDC and the Council of State and Territorial Epidemiologists (CSTE), was published in December 2003 by the CDC and is included in Appendix B. These indicators are discussed in detail later in this document.

Finally, the report presents recommendations on possible priorities for environmental public health surveillance and intervention activities in the state.

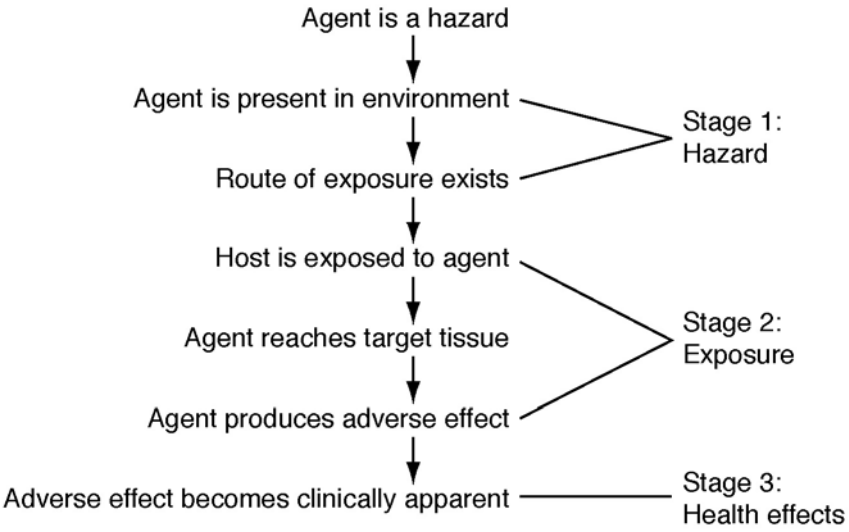
THE RELATIONSHIP BETWEEN ENVIRONMENT AND HEALTH

The environment in which we live plays an important role in human development and health. Having access to clean air to breathe, clean water to drink and foods that are free from contamination with hazardous materials have been identified for centuries as factors that are vital to good health. In the past few decades, there has been a growing interest in studying and monitoring the effects of the environment on the health of our populations. With many infectious diseases becoming less and less threatening, people are paying more attention to other threats around them, such as those represented by environmental hazards. As a result, many initiatives and projects have been implemented by both governmental and non-governmental organizations, and the body of our knowledge has grown rapidly.

Despite the long-lasting recognition of the effects of the environment on our health and important scientific achievements in recent years, understanding the complexities of exactly how environmental factors influence human health remains challenging. To examine the relationship between environmental factors and human health, it may be helpful to define a framework for the discussion. The process through which an environmental factor can produce harm includes three stages:

1) a harmful agent, often referred to as a *hazard*, is present in the environment in concentrations sufficient to produce a health effect;
2) individuals are *exposed* to the agent, and the agent penetrates their bodies and reaches target tissues; and
3) the exposure to the agent produces adverse *health effects* and disease.

Figure 1. **The Process by Which an Environmental Agent Produces an Adverse Health Effect**



Source: American Journal of Public Health

The study of the relationship between environmental factors and health is hindered by several challenges.

The extent of our knowledge about each of the three stages outlined above is highly variable. Existing scientific evidence of linkages between environmental exposures and adverse health outcomes is extensive for some types of hazards, but absent for many others. Historically, much of environmental health research has focused on environmental linkages to various forms of cancer, and scientists have only recently begun to study other health effects such as neurological problems, endocrine and reproductive disruption and immunological effects.

The ability to quantify an individual's true exposure to an environmental hazard in a valid and reliable manner is limited by the following factors:

- Many environmental hazards and pollutants are not confined to the geographic areas where they originate—water contaminants may move with the flow of a surface water system, and air pollutants may drift freely around the globe.

- People move freely from location to location and frequently transfer in and out of situations where they are exposed to different hazards, making it more difficult to study and quantify the health effects of individual hazards.
- The persistence of a hazard in the environment is highly variable; while some pollutants degrade or dissipate fairly quickly, others remain present for long periods of time.

In some cases, adverse health outcomes caused by exposure to environmental hazards may not become evident until many years following the exposure.

Individuals are likely to be exposed to multiple hazards simultaneously. To date, most studies of relationships between environmental exposures and health conditions have focused on exposure to a single factor, and have not taken into consideration the possible interactive effects of exposure to multiple environmental hazards, or the possible combined effects of environmental exposures with other factors such as genetic susceptibility.

For the demonstrated linkages between hazards and health outcomes, national and state monitoring systems are highly variable. In some instances, sufficient data are available to indicate the presence of an environmental hazard, but we have far less information about the degree to which any one individual or a group of individuals may be actually exposed to the hazard. In addition, while there are well established surveillance systems in place for some health conditions and diseases related to environmental exposures (e.g., lead intoxication), for other conditions, like asthma, no adequate population-based tracking mechanisms exist.

In many parts of the country, public health officials consider the monitoring of environmental hazards and related health conditions an important public health function. When the linkage between environment and disease is well demonstrated, these monitoring activities can assist in assessing the magnitude of the problem and the effectiveness of control programs. In other instances, the information collected can help to clarify some of the unanswered scientific questions.

SELECTED TOPICS OF HIGH RELEVANCE FOR KANSAS*

A. ENVIRONMENTAL HAZARDS

OZONE (LOW LEVEL AIR)

Background

Ozone is a gaseous compound composed of three atoms of oxygen. It is formed by a chemical reaction between oxides of nitrogen and volatile organic compounds in the presence of heat and sunlight. Ozone occurs naturally in the earth's upper atmosphere, and forms a protective layer that shields us from the sun's harmful ultraviolet rays.[1] However, the presence of ozone in the air we breathe causes health problems, particularly for people with underlying predisposing conditions.

Ozone is one of the *criteria air pollutants* for which National Ambient Air Quality Standards (NAAQS) have been established under the federal Clean Air Act, setting maximum allowable concentrations in outdoor air.[2] Communities in which any of the criteria pollutants, including ozone, exceed the NAAQS levels are designated as *non-attainment* areas and are required under the federal Clean Air Act to develop and implement a State Implementation Plan to reduce levels of ozone in ambient air.

Sources and mechanisms of contamination

The main sources of ozone or its precursors are exhaust from motor vehicles, industrial emissions, gasoline vapors and chemical solvents. Peak ozone levels are most likely to occur during hot, stagnant summertime weather conditions.

Health effects

Ozone irritates the airways and causes inflammation. Short-term exposure to even low levels of ozone has been linked to increased hospital admissions and emergency room visits for acute

[1] Stratospheric ozone is not discussed in this report.

[2] Other criteria pollutants included in the NAAQS are carbon monoxide, lead, nitrogen dioxide, particulate matter and sulfur dioxide.

*For selection criteria, please refer to page 2.

respiratory events, such as asthma attacks. Children are particularly susceptible to the effects of ozone. Repeated short-term exposure to ozone may damage children's developing lungs and may lead to reduced lung function later in life; long-term exposure to high ozone levels may be responsible for increased incidence of asthma in children.

Special interest for Kansas

The Kansas City metropolitan area has had intermittent difficulties meeting the NAAQS ozone standards since the 1970s. Since the area's initial corrective action plan was approved by the EPA in 1979, Kansas City has experienced periods of non-attainment of ozone standards in at least four years. In 1997, EPA further lowered the standards, and despite numerous corrective actions implemented in the Kansas City area to lower ozone levels, the region is struggling to reach attainment.

In Wichita/Sedgwick County, monitoring results from the years 1999 through 2001 show that the area has been very close to exceeding the NAAQS standards for ozone. Local officials have recognized the need to take a proactive stance and have been participating in EPA's Voluntary Ozone Reduction Consortium program. The county has implemented a number of actions to reduce emissions and educate citizens about how they can help to lower ozone levels. The effect of these interventions will become clearer as updated air quality monitoring results become available.

PARTICULATE MATTER IN OUTDOOR AIR

Background

Particulate matter refers to particles found in the air, including dust, dirt, soot, smoke and liquid droplets. Some particulates are large enough to be seen, such as soot or smoke, while others are so small that they can only be seen with a microscope. Small particles can remain suspended in the air for long periods of time and can be carried long distances by wind. Particulate matter is the major source of haze that reduces visibility in many parts of the U.S. When particulates become a health concern, they are classified into one of two groups. The term PM10 refers to larger particles with a diameter of 10 microns or less, such as dust and smoke. Smaller particles, with a diameter of 2.5 microns or less are referred to as PM2.5. The smaller

PM2.5 particles are of particular concern because of their ability to penetrate deep inside the lungs, their potential linkages to severe health effects, and the difficulty in reducing their concentration in ambient air.

Sources and mechanisms of contamination

Some particles are emitted directly into the air from sources such as vehicles and factories, but also from tilled fields, unpaved roads and the burning of wood and other materials. Others may be formed in the air when gases from burning fuels react with sunlight and water vapor; these gases can result from power plant emissions (particularly those burning coal), vehicles and industrial facilities. Unlike other sources of air pollution, particulate matter may represent a problem both in industrial and in rural areas because of the multiple potential sources involved.

Health effects

Many scientific studies have linked breathing of particulate matter to significant health problems, particularly respiratory and cardiovascular events such as heart attacks and strokes. Long-term exposures have been linked to deaths from heart and lung diseases. Exposure to particulate matter has also been linked to school and workplace absenteeism due to respiratory illnesses.

Special interest for Kansas

Some regions experience occasional severe episodes of blowing dust or dust storms. In 1996, high winds and extremely dry soil conditions in Morton and Sedgwick counties resulted in levels of particulate matter exceeding standards established by the EPA. Although no monitored locations in Kansas have exceeded the particulate standards since 1996, much of Western Kansas is not routinely monitored for criteria air pollutants such as particulate matter.

SECOND-HAND TOBACCO SMOKE

Background

Second-hand smoke is also called environmental tobacco smoke (ETS); exposure to second-hand smoke is called involuntary smoking, or passive smoking, and was first recognized as a health hazard in the 1980s.

Sources and mechanisms of contamination

Second-hand smoke is a mixture of the smoke given off by the burning end of a cigarette, pipe, or cigar and the smoke exhaled from the lungs of smokers.

Health effects

Exposure to second-hand smoke has been proven harmful to children's health in that it causes or contributes to a multitude of conditions including asthma, bronchitis, pneumonia, ear infections and Sudden Infant Death Syndrome (SIDS). Breathing second-hand smoke can cause lung cancer in non-smokers, and has been estimated by the EPA to cause about 3,000 lung cancer deaths among non-smokers each year in the United States. Second-hand smoke may affect the cardiovascular system, as some studies have linked exposure to second-hand smoke with the onset of chest pain.

Special interest for Kansas

As a result of increasing public awareness and concern over the adverse health effects of direct and second-hand exposure to tobacco smoke, laws and regulations restricting smoking in public places such as public offices, schools, restaurants and workplaces have been adopted in the last two decades. Widespread media campaigns have encouraged smokers to take their cigarette smoking outdoors to reduce second-hand smoke exposures to other household members. While these efforts have, without doubt, reduced second-hand smoke exposure, the problem is not completely solved. Although there is no evidence that the problem is worse in Kansas than in the rest of the country, any effective environmental health surveillance program must address indoor smoking as one of the most preventable causes of morbidity and mortality due to indoor air pollution.

In 2002, just over two-thirds of Kansas households surveyed reported that they did not allow smoking anywhere inside their home.[3] However, we do not have information about how frequently individuals smoke inside the remaining one-third of Kansas homes, or how many children and other household members may be exposed to second-hand smoke.

[3] Kansas Behavioral Risk Factor Surveillance System, 2002

CARBON MONOXIDE IN INDOOR AIR

Background

Carbon monoxide is a colorless, odorless gas that is formed when carbon in fuel is not completely burned. Carbon monoxide is highly toxic and exposure can be fatal. The highest risk of exposure in indoor environments typically occurs during the cold months of the year, when faulty furnaces or improperly vented supplemental heating devices may be in use. In recent years, carbon monoxide detectors have become available for installation in homes. Similar to smoke detectors, the devices trigger an alarm if carbon monoxide is detected at dangerous levels.

Sources and mechanisms of contamination

Carbon monoxide in indoor air may be produced by unvented kerosene and gas space heaters; leaking chimneys and furnaces; back-drafting from furnaces, gas water heaters, wood stoves and fireplaces; gas stoves; generators or other gasoline-powered equipment; automobile exhaust in attached garages; and tobacco smoke.

Health effects

Carbon monoxide can cause harmful health effects by impairing the ability of the blood to bind oxygen, thus reducing oxygen delivery to the body's organs and tissues. Infants and children are especially vulnerable because they have higher metabolic rates, and the gas accumulates in their small bodies faster than in adults. At low levels, carbon monoxide exposure may result in fatigue in healthy individuals, and chest pain in individuals with heart disease. At high concentrations, exposed individuals may experience impaired vision and coordination, headaches, dizziness, confusion and nausea. Exposed individuals may become unconscious within minutes, before they become aware that they are being exposed to a toxic substance. Exposures at high concentrations can be fatal.

Special interest for Kansas

While there is no evidence that carbon monoxide poisoning occurs at a higher rate in Kansas than in the rest of the country, this is a highly preventable hazard with the potential for fatal consequences.

Carbon monoxide poisonings are not routinely monitored in Kansas. An analysis published by KDHE, Division of Health in 1999 reported that there were 80 deaths in Kansas attributed to unintentional poisonings from carbon monoxide, utility gases and other gases between the years 1989 to 1997.

ARSENIC IN DRINKING WATER

Background

Arsenic is a metal-like substance that is found naturally in small amounts in rocks, soil, water, air, plants and animals. Drinking water containing high levels of arsenic may cause health problems. In October 2001, EPA lowered the maximum allowable level for arsenic in public drinking water to 10 parts per billion (ppb), from a previous level of 50 ppb; public water systems have until January of 2006 to meet the new standard.

Sources and mechanisms of contamination

Elevated levels of arsenic occur naturally in groundwater in some parts of Kansas. Arsenic in groundwater may also be present as a result of contamination by hazardous waste or industrial processes. About 90 percent of arsenic used by industry in the United States is used for wood preservative purposes; arsenic is also used in paints, medications, dyes, soaps, metals and semi-conductors.

Health effects

The health effects of arsenic exposure depends upon a variety of factors, including the type and amount of arsenic that has entered the body, and the length of time over which an individual has been exposed. Fetuses, young children, people with chronic illnesses and elderly individuals are at greatest risk of adverse effects due to arsenic exposure. Although acute exposures to high doses of inorganic arsenic can cause adverse effects, such exposures do not occur from drinking water that meets the previous EPA standard of 50 ppb. Studies link prolonged ingestion of low doses of arsenic to a number of health effects, including cancers of the skin, bladder, lung, kidney, nasal passages and prostate; and non-cancerous effects on the cardiovascular, pulmonary, immunological, neurological and endocrine (e.g., diabetes) and skeletal systems.

Special interest for Kansas

Arsenic levels in source water used to supply public water systems have raised public concerns in recent months. Implementation of additional water treatment processes to remove the arsenic, or the identification of alternative sources of water with arsenic levels below the new 10 ppb threshold, is expected to be costly. The new standard must be met by the year 2006. KDHE estimates the cost to be about $2 million per water supply system to implement additional treatment processes to remove arsenic. Approximately 20 small public water systems in Kansas currently draw water from sources where naturally occurring arsenic levels exceed the new standard of 10 ppb. These water systems supply drinking water to about 39,000 Kansas residents.

PESTICIDES

Background

A pesticide is a chemical that is used to control pests, such as insects, weeds, bacteria, funguses, rodents, fish or other troublesome organisms. There are more than 865 active ingredients registered as pesticides. Most pesticides are man-made chemical compounds synthesized from petroleum, although some occur naturally in the environment. While pesticides have beneficial effects when applied appropriately, some may also have harmful effects on the ecosystem and on humans through either direct or indirect contact. Pesticides have been subject to government regulation for decades. EPA and state governments (in Kansas, the Department of Agriculture) register or license pesticides for use in the United States. Government regulation includes activities such as issuing label directions that must be followed during application procedures, licensing of commercial pesticide applicators and setting limits for the amounts of pesticide residues allowed in water or in food commodities.

Sources and mechanisms of contamination

People can be exposed to pesticides through several routes, including breathing of pesticide vapors or aerosol drift from spray applications, absorption through the skin, or ingestion by drinking contaminated water or eating foods contaminated with pesticide residues.

Contamination of water with pesticides has been a concern for a long time. Even when applied correctly, pesticides may be washed from the application site by rain that falls on a

treated area before the pesticide has had sufficient time to fully bind or degrade. Pesticides can seep into the soil and contaminate groundwater aquifers. Pesticides are sometimes applied directly to water bodies to control insects, weeds or fish (these products are labeled to avoid use near drinking water systems). Some pesticides can move into the air from the application site to surface waters used in drinking water systems. Pesticides may also enter a water system through an accidental spill or when individuals illegally dispose of them by pouring them down a drain.

Health effects

Pesticide exposure may have various harmful effects on health. Adverse health effects are linked to the type of pesticide, the dose, route and duration of the exposure. Health effects confirmed or suspected to be linked to pesticide exposure include cancer, acute and chronic injury to the nervous system, lung damage, reproductive dysfunction, birth defects and dysfunction of the endocrine and immune systems.

Children are especially vulnerable to the health effects of pesticide exposure, because they are growing and developing. Children living on or near farms may be exposed to pesticides in the air. Pesticides are also used extensively in homes, schools, child care centers and public buildings. Pesticides used for lawn care are another major source of childhood exposure.

Special interest for Kansas

In an agricultural state like Kansas, application of pesticides and herbicides is common. EPA has estimated that in 1999, agricultural pesticide use accounted for nearly 77 percent of all pesticide applications nationally. Currently, no system exists at either the national or state level to track the total extent of pesticide use. Although some estimates have been developed based on information such as crop profiles, pesticide sales and farm surveys, most estimates capture only agricultural uses of pesticides, and the accuracy of these estimates varies widely.

NITRATES IN DRINKING WATER

Background

Nitrates are substances containing nitrogen and oxygen that occur naturally in the environment or can be generated through human activities. When dissolved in water, nitrates are tasteless, odorless, and colorless. Excessive levels of nitrates in drinking water have been linked to methemoglobinemia (so-called “blue-baby syndrome”) in formula-fed infants.

Sources and mechanisms of contamination

Nitrogen and nitrates are widely found in nature, and they may find a way into water systems from decaying plant and animal matter and urban runoff. Fertilization of soils with ammonium nitrate and runoff from livestock contamination (e.g., from pastures or confined animal feeding operations) are a significant source of nitrate contamination of surface and ground water systems. Nitrogen oxides released into the air from the combustion of fossil fuel can find their way into water through precipitation in the form of rain.

Health effects

Nitrates in drinking water may bind to hemoglobin in the blood to form methemoglobin. This altered hemoglobin does not carry oxygen effectively. Babies are particularly susceptible to the effects of nitrates, and excessive levels of ingestion in infants (usually fed with formula reconstituted with contaminated water) may cause severe disease and death. Studies have also linked nitrate exposure to bladder cancer.

Special interest for Kansas

As an agricultural state, Kansas is at risk for nitrate contamination of water supplies. Nitrates move freely through most soils. Once a water source is contaminated, the costs of protecting consumers from exposure can be significant. Nitrates cannot be removed by conventional water treatment processes; removal requires additional, relatively expensive treatment. Boiling water is not an effective remedy, as it only serves to concentrate the nitrates. During 2002, 770 public water systems in Kansas were required by KDHE and EPA to monitor for nitrates; 26 systems had post-treatment nitrate levels that exceeded the established maximum contaminant level for drinking water. Approximately 20,000 people were served by these systems.

While public water supply systems are monitored for the presence of nitrates, there are no requirements for monitoring private wells. Nitrate contamination of private wells used for drinking water is of particular concern because these wells typically are located in rural areas, where the potential for contamination from agricultural practices is more likely. A 1994 KDHE water quality study of a sample of 1,000 private wells in Kansas found that one in four of sampled wells may have had nitrate levels that exceeded safe limits for drinking water. Approximately 10 percent of Kansans obtain their drinking water from private wells.

Methemoglobinemia is not routinely monitored in Kansas; no information is available on the number of individuals who may suffer health effects resulting from nitrate exposures.

LEAD POISONING IN CHILDREN

Background

Lead is a highly toxic metal that historically has been used in products found in and around our homes, including paint and gasoline. Lead poisoning is a disease caused by exposure to and absorption of lead. Once absorbed, lead is persistent and accumulates in the body.

Sources and mechanisms of contamination

Of particular concern is children's exposure to lead given that lead-based paints were widely used in homes until 1978, when they were banned. In older homes, lead may be present in peeling paint chips, household dust or soil around the home. Some homes have old plumbing with lead pipes or lead solder, which can leach lead into the drinking-water supply. Remodeling and renovation of older homes, if not done properly, is likely to generate dust and residue containing lead.

Another important source of lead exposure is the release of lead from gasoline into the air; the use of unleaded gasoline in the past few decades has resulted in a dramatic decrease of levels of lead in the air. Other potential sources of lead exposure include some hobbies, such as pottery or stained glass that use materials containing lead. Industrial processes such as mining and smelting can also cause lead contamination of soils.

Health effects

Lead has been linked to a range of harmful health effects, involving primarily the central nervous system, ranging from behavioral problems and learning disabilities, to seizures and death. Children under six years old are at greatest risk, because they are more likely to be exposed by playing in contaminated areas and more likely to ingest dust or soil. Because their bodies are growing quickly, children are more susceptible to the adverse health effects from lead exposure. Most children have no acute symptoms of lead poisoning until blood levels are quite high, but they may suffer from more subtle changes (such as impaired neurological development) that are difficult to detect.

Special interest for Kansas

Kansas has over 480,000 occupied housing units that were constructed prior to 1960, where the highest concentration of lead-based paint is found; children residing in these houses may be at increased risk for lead exposure. In addition to concerns with residential exposures, the community of Galena, located in Southeast Kansas, has been designated a “Superfund site” due to soil contamination resulting from lead and zinc mining operations that continued from 1876 into the late 1960s. Cleanup and prevention efforts to reduce potential exposures to community residents have been underway since the early 1990s.

Surveillance and intervention activities aimed at reducing lead exposures and lead poisoning in children have been in place in Kansas for many years. Regulations require that elevated blood lead levels be reported to Kansas public health authorities. In 2002, 278 Kansas children aged 0-5 years were confirmed to have a blood lead level that met or exceeded the reportable level. Based on these results, KDHE estimated that 124 of every 100,000 Kansas children aged 0-5 could have elevated blood lead levels. While there is no evidence that the problem of lead poisoning in children is worse in Kansas than in the rest of the country, this is a highly preventable, serious condition that should receive special attention in any environmental public health surveillance program.

MERCURY

Background

Mercury is a naturally occurring metal that has several forms. At room temperature, elemental mercury is a shiny, silver-white, odorless liquid. If heated, it becomes a colorless, odorless gas. Mercury combines with other elements to form compounds with varying levels of toxicity. Because ingestion of mercury (usually through consumption of fish) can cause adverse health effects in pregnant women and their fetuses, standards have been established to limit the consumption of fish containing high levels of mercury.

Sources and mechanisms of contamination

Elemental mercury in best known for its use in devices such as thermometers, blood pressure gauges, barometers and switches. However, most of the mercury in our environment originates from natural processes or is generated from industrial smokestacks. In the U.S., coal-burning power plants are a significant source of mercury emissions. Other sources include mining, smelting and waste incineration.

Mercury released into the atmosphere from various industrial activities is deposited onto soil or in waterways. Bacteria in the water then convert it to methylmercury, which is easily absorbed into fish, and is not easily eliminated. As large fish feed on smaller fish, concentrations of mercury increase with the size of the fish, a process known as bioaccumulation. In turn, humans eating the fish then ingest the methylmercury.

Mercury can remain suspended in air for long periods of time. Mercury contamination observed in the U.S. may be the result of air contaminants that originate in other parts of the world and drift around the globe before being deposited on our soils and waterways.

Health effects

All forms of mercury are poisonous to humans. The severity of health effects resulting from mercury exposure vary, depending on the amount and timing of exposure, but the effects may be irreversible. Short-term exposures to high concentrations of mercury vapor may have harmful effects on the nervous, digestive and respiratory systems and the kidneys. Chronic exposures can

cause permanent damage to the brain or kidneys. Fetuses and young children are most sensitive to the effects of mercury exposure, even at low levels, because the developing nervous system and brain are highly sensitive to any form of mercury. Exposure of pregnant women to mercury may have serious effects on fetal development, causing brain damage, mental retardation, poor coordination, impaired speech and other difficulties.

Special interest for Kansas

Mercury contamination (particularly bioaccumulation in fish) is an emerging environmental health concern in Kansas, as it has been in many other states. More than 40 states and territories have issued fish advisories due to mercury levels. Kansas routinely monitors fish at 124 locations in the state for concentrations of mercury that exceed established safety guidelines; to date, results from the monitoring system have not required the issue of any fish advisory notices in Kansas due to excessive mercury levels.

B. ENVIRONMENTAL HAZARD PRODUCERS

COAL-FIRED POWER PLANTS

Background

Electricity generated by the process of burning coal generates an array of solid and gaseous residues, many of which escape directly into the environment.

Sources and mechanisms of contamination

Emissions from coal-fired power plants are a major industrial source of air pollutants including carbon dioxide, nitrogen dioxide and sulfur dioxide. In addition, other toxic by-products, such as mercury, are emitted into the air. Carbon dioxide emissions contribute to global warming. Nitrogen oxides contribute to the formation of ground-level ozone and smog, and can cause the formation of small particles that penetrate deeply into the lungs. Sulfur dioxide dissolves in water vapor to form acids, and interacts with other particles and gases in the air that can be harmful to people and the environment. Mercury emitted into the air precipitates and becomes deposited on soil and bodies of water, where it can be ingested by fish, taken up into the food chain and eventually ingested by humans.

Health effects

Breathing air pollutants, including ozone and particulates, can exacerbate chronic respiratory conditions such as asthma, and is associated with the onset of cardiovascular events and possibly strokes. Mercury is highly toxic to humans, especially children, and can cause harmful effects to the nervous, digestive and respiratory systems and kidney damage.

Special interest for Kansas

Power plants contribute to the emission of several environmental hazards of concern in Kansas (see sections on specific hazards for more information). In 2002, coal-burning power plants generated an estimated 75 percent of the electricity produced in Kansas, resulting in an estimated 124,000 tons of sulfur dioxide, 91,000 tons of nitrogen dioxide and 41,781,000 tons of carbon dioxide emitted into the atmosphere. Coal-fired power plants accounted for approximately 95 percent of the total emissions of sulfur dioxide, nitrogen dioxide and carbon dioxide from all electrical power producers in the state, and are the largest single industrial source of these air pollutants.

GRAIN STORAGE OPERATIONS

Background

Grain elevators, a common sight throughout Kansas, are facilities in which grains are received, stored and then distributed for direct use, process manufacturing or export. Operations other than storage, such as cleaning, drying and blending, are often performed at elevators. Grain elevator operations carry a well-known risk of fire and explosion. Additional environmental concerns are represented by the release of particulate matter into the air and the use of pesticides in grain fumigation processes.

Sources and mechanisms of contamination

Of major concern is the particulate matter that escapes into the atmosphere, primarily related to grain dust that is generated by the loading, unloading and grain cleaning processes. While grain elevators use a variety of methods to reduce the amount of dust generated and to capture or collect dust, some dust inevitably escapes into the environment. Pesticides used as fumigants for vermin control can also become environmental hazards if spilled or applied inappropriately.

Currently, only three fumigants are approved for use in grain storage—phosphine, chloropicrin and methyl bromide. Carbon tetrachloride, which was widely used for grain fumigation until banned in 1985, has been found as a contaminant in ground water near many grain elevators in Kansas.

Health effects

Particulate matter can be inhaled deeply into lung passages, where it can cause several adverse health outcomes, including aggravated asthma, chronic bronchitis, decreased lung function and cardiovascular events (see section on particulate matter in outdoor air). Exposure to high concentrations of carbon tetrachloride can cause liver, kidney and central nervous system damage.

Special interest for Kansas

Groundwater contamination has resulted from the pre-1985 use of carbon tetrachloride as a fumigant at grain elevator operations. In recent years, KDHE and EPA have sampled groundwater near 273 former grain storage facilities; carbon tetrachloride levels exceeding safe drinking water standards were found in 22 locations. The contamination has necessitated the identification of alternative sources for drinking water supplies in several areas in the state. The presence of numerous grain elevators throughout the state, combined with other factors like windy conditions, also raises concerns about air pollution from particulate matter.

CONCENTRATED ANIMAL FEEDING OPERATIONS (CAFOs)

Background

Concentrated animal feeding operations (CAFOs) are facilities that house and feed a large number of animals in a confined area for 45 days or more during any 12-month period. CAFOs are subject to federal and state regulation governing the management and disposal of waste products. In particular, federal regulations require CAFOs to carry a permit and to develop nutrient-management plans to prevent animal waste from contaminating surface water and ground water, and state regulations include additional requirements for some swine operations. CAFOs are often unpopular with residents living in surrounding areas because of nuisances such as unpleasant odors and flies.

Sources and mechanisms of contamination

Pollutants potentially associated with manure-related discharges into water at CAFOs include:

- antibiotics, which are frequently added to feeds to enhance weight gain, may contribute to the development of antibiotic-resistant organisms;
- disease-causing bacteria, viruses and parasites;
- nutrients, such as ammonia, nitrogen and phosphorous which can result in algal blooms and contaminate drinking water; and
- pesticides and hormones.

In addition, CAFOs release ammonia into the air, which in turn can contribute to the generation of particulate matter by reacting with other molecules and compounds present in the air.

Health effects

Potential pollutants may affect human health directly or indirectly (by encouraging the growth of potentially harmful plants and organisms). Chemical and infectious compounds from swine and poultry operation discharge have been shown to migrate into soil and water near CAFOs; the extent to which the migration of these compounds might affect human health is unclear.

Special interest for Kansas

Rural Kansas has become an attractive setting for large animal feeding operations. Beef feedlots have had a long-established, strong presence in Western Kansas, and several large hog confinement operations have been established in more recent years. The expansion of CAFOs, especially hog feeding operations, has been controversial, often generating high levels of public attention. Health concerns have been raised as a basis for recommending restrictions in the establishment of CAFOs plants. The effect of CAFOs on human health is still largely unknown, but given the widespread presence of these structures in Kansas, this issue should be closely monitored.

SURVEILLANCE FOR ENVIRONMENTAL HEALTH— ROLES AND RESPONSIBILITIES

Surveillance in public health is defined as continued monitoring of the distribution and trends of health conditions in a population. The analysis of surveillance information is critical to identifying emerging problems and targeting available resources.

Responsibility for monitoring environmental hazards and their potential health effects is shared among federal, state and local governments, and responsibilities and authority are distributed across multiple agencies. Environmental activities had been an integral part of public health services until the 1960s and 1970s, when major changes in environmental health policy, planning and organization took place at both the federal and state levels of government. The resulting split was motivated, at least in part, by an expanded view of environmental issues including natural resources and conservation of energy, combined with concerns that public health agencies had been slow to respond to environmental health issues. Symbolic of the division, EPA was formed in July of 1970. However, as noted by the Institute of Medicine in the 1988 report *The Future of Public Health,* the result of this separation of environmental issues from public health frequently has been fragmentation, lack of coordination, inadequate attention to the health dimensions of environmental problems and failure to implement and maintain surveillance systems that monitor environmental health issues in a comprehensive manner.

At the federal level, there are environmental programs in several agencies including the Department of Health and Human Services (DHHS). Within DHHS, CDC houses both the National Center for Environmental Health (NCEH) and the Agency for Toxic Substances and Disease Registry (ATSDR). Both of these entities focus their efforts primarily on the health effects of environmental exposures. ATSDR maintains registries of individuals exposed to certain environmental hazards, particularly for specially designated sites with high-level contamination that need intensive remediation activities ("Superfund sites").[4] CDC collects information on environmental health issues from states and publishes national statistics. CDC conducts biomonitoring of a nationally representative sample of individuals to measure the level

[4] Eleven locations in Kansas have been designated as "Superfund sites".

of selected chemical substances in blood and urine; the CDC also provides some limited funds for selected states that conduct biomonitoring surveillance programs (Kansas is not one of the recipients of these funds). Outside of DHHS, EPA is primarily responsible for the monitoring and enforcement of federal environmental quality laws and regulations. EPA frequently coordinates with states to define required monitoring activities, and states often have the responsibility to carry out the environmental monitoring and to enforce the federal standards.

Kansas is one of a few states where the state environmental protection and public health functions have remained in the same department. KDHE houses both the Division of Environment and the Division of Health. The Division of Environment is responsible primarily for: administering and enforcing regulations on environmental issues and standards, including regulating the handling and disposal of toxic substances; monitoring environmental contaminants and pollutants in air, soil and water; imposing sanctions against violators; and assuring clean-up and remediation of contaminated sites. The Division of Environment works in close coordination with EPA, and has responsibility for monitoring activities to assure compliance with federal environmental standards. The Division of Health focuses on monitoring health conditions in the population of the state, and has only limited direct involvement in assessment of environmental health issues (the most notable exception is in the monitoring of blood lead levels among children). Also within KDHE, the Division of Laboratories performs analysis and testing of air, ambient water[5] and drinking water samples.

Despite the fact that these functions are housed within the same state agency, the divisions operate for the most part independently of one another. Linkages between these environmental and health surveillance and monitoring activities are limited, and there is little analysis of relationships between the presence of environmental hazards, human exposures to such hazards, and health effects, at either the individual or community level.

[5] Ambient water is defined as water in the environment. Ambient water includes both surface waters (i.e., rivers, lakes, reservoirs, wetlands, etc.), and ground waters (i.e., below the surface). Ambient water can be used for human activities such as recreational purposes or irrigation and can be purified and used as a source for drinking water.

At the local level, the responsibility for environmental health functions varies greatly from one jurisdiction to the next. Local authorities, frequently health departments, have responsibility for monitoring and permitting sewage disposal systems and may take on other environmental health roles as their staffing capacities and expertise allow. Local environmental health activities are often coordinated closely with KDHE's Division of Environment, but the same separation observed at the federal and state level between health and environmental monitoring and surveillance exists at the local level. The need for coordination of programs and activities generated at the federal, state and local levels adds an extra layer of complexity.

As a result of the accumulation of evidence of potential health threats originating from environmental exposures and the resulting public concern, numerous environmental and environmental health advocacy groups have been formed in the past 20 years. Some advocacy groups have grown to be large national (or even international) networks. Advocacy groups can play an important role in environmental surveillance, by providing monitoring activities independent of those of government entities. The groups may function to draw public attention to issues, and frequently promote in-depth informational materials about topics of interest. Advocacy groups may also be involved in generating or analyzing scientific evidence that supports a link between certain environmental hazards and health conditions. It is important to note that the information generated by these groups may be focused on limited aspects of issues.

ENVIRONMENTAL HEALTH INDICATORS

All public health surveillance programs, including those addressing environmental health issues, are based on indicators that provide relevant information. Good surveillance indicators must be suitable for reliable, standardized and practical measurement methods. Two sets of surveillance indicators, described below, support environmental health surveillance activities.

HEALTHY PEOPLE 2010

Healthy People 2010 is a national initiative conducted by the Healthy People Consortium, an alliance of more than 350 national organizations and 250 state public health, mental health, substance abuse and environmental agencies. It is designed to serve as a roadmap for improving the health of all people in the U.S. during the first decade of the 21st century and is generally regarded as a comprehensive, nationwide health promotion and disease prevention agenda. Healthy People 2010 goals and indicators were published in 2000 in order to set health-related targets to be achieved by 2010.

As a part of that process, it also defines a set of measurable indicators that can be used to monitor the progress towards those targets. One of the areas, environmental health, includes the following components:

- Outdoor air quality
- Water quality
- Toxics and waste
- Healthy homes and healthy communities
- Infrastructure and surveillance
- Global environmental health

A complete list of the Healthy People 2010 environmental health goals and indicators can be found in Appendix A.

CDC/CSTE ENVIRONMENTAL PUBLIC HEALTH INDICATORS

The Council of State and Territorial Epidemiologists (CSTE) and CDC have identified specific areas of interest and indicators that can be used to assess health status as it relates to the environment. The indicators can be used to assess baseline status and trends, track program goals and objectives, and build core surveillance capacity in state and local agencies. These indicators are meant to support the implementation of the Healthy People 2010 objectives at the state level. A document describing the indicators developed was published in 2003. The indicators are organized into the Hazard-Exposure-Health Effects model described in the introduction section of this document.[6] Indicators are grouped into the following topics:

- Air, Ambient (Outdoor)
- Air, Indoor
- Disasters
- Lead
- Noise
- Pesticides
- Sentinel Events
- Sun and Ultraviolet Light
- Toxics and Waste
- Water, Ambient
- Water, Drinking

Indicators are also classified into core indicators (recommended for monitoring by all state health departments), optional indicators (recommended for monitoring only in some states, depending on individual needs, priorities and data availability), and developmental indicators (indicators that may have environmental public health relevance, but the measurements either have not yet been established or pose significant interpretation challenges). A complete list of the indicators proposed in the CDC/CSTE document is contained in Appendix B.

[6] The document also includes an additional set of indicators, called intervention indicators, defined as programs or official policies that minimize or prevent an environmental hazard, exposure or health effect.

INDICATORS OF SPECIAL INTEREST FOR KANSAS

Based on the environmental health topics identified during the review phase of this project as having high relevance for Kansas, the project team identified the following indicators as being of special interest for Kansas:

Indicators of the presence of environmental hazards

- Levels of ozone and particulate matter in ambient air
- Tobacco smoke in homes with children
- Use of pesticides
- Contamination of ambient water with pesticides and mercury
- Contamination of drinking water with nitrates, arsenic and pesticides
- Contamination of fish with mercury

Indicators of exposure to environmental hazards

- Blood lead levels in children

Indicators of health effects linked to environmental hazards

- Carbon monoxide poisoning
- Morbidity and mortality due to extreme meteorologic and climatic conditions
- Unusual patterns of asthma, cardiovascular and respiratory disease
- Incidence and mortality from lung cancer in non-smokers, mesothelioma and soft tissue sarcoma
- Pesticide-related poisoning and illness
- Lead poisoning in children

These high-interest indicators represent only a fraction of what a full environmental health monitoring program could include, and in some cases, information on additional indicators is already collected and available. The project team concluded that, based on the information reviewed, these indicators could form the core components of an environmental health surveillance system in Kansas. A more detailed description of these indicators, their measures and their relevance to Kansas is contained in Appendix C.

ENVIRONMENTAL HEALTH SURVEILLANCE ACTIVITIES IN KANSAS

Significant data related to environmental health are currently being collected in Kansas. The Division of Environment at KDHE collects information from ongoing air and water monitoring activities, primarily to assess compliance with the federal Clean Air Act, the Clean Water Act, the Safe Drinking Water Act, and other federal and state laws and regulations. The Division of Environment also maintains data on the status of all toxic contamination sites in the state that require remediation or ongoing monitoring.

Also at KDHE, the Division of Health collects a variety of information on disease and health-related conditions, and the Office of Vital Statistics receives and analyzes information on all births and deaths that occur within the state. The Kansas Cancer Registry, managed through a contract between KDHE and the University of Kansas Medical Center, collects data on all newly diagnosed cases of cancer in Kansas.

While a good deal of information is collected, there are still critical gaps in the available state data. For example, we know little about patterns of pesticide applications, such as the type of pesticide, amount applied and where it was applied. Information on ambient air quality is monitored closely in the most populated areas of the state, but not as well in rural areas where the presence of particulate matter in the air may also represent a hazard. On the health outcomes side, there is some limited information describing hospital discharges, but not on visits to emergency departments, which might frequently represent the result of an environmental exposure. Kansas does not have a fully functional birth defects surveillance system in place, which would be a critical source of information for more fully investigating and understanding the potential health effects of pesticides and other toxic substances on pregnant women and fetuses. Finally, little or no information is collected routinely for some health conditions of interest, such as asthma, carbon monoxide intoxication or unusual patterns of cardiovascular or respiratory events.

For the data that are being collected, the information rarely is analyzed in ways that provide an enhanced understanding of the effects of environmental factors on the health of Kansans. Each program tends to analyze only its own data, and linkages are not made between

environmental hazards, exposures and health outcomes data, either by linking the experience of specific individuals or by looking at aggregate trends and patterns in a geographic region. KDHE does not have an environmental health epidemiologist on staff. This may impede both interest and capacity for fully utilizing existing data to evaluate the impact of the environment on the health of Kansas residents.

Table 1 summarizes the status of environmental health surveillance activities in Kansas.

Table 1. **Environmental Health Surveillance in Kansas**

Topic	Responsible Agency	Data Collected
Hazards		
Air, Ambient*	EPA KDHE, Div. of Environment	Criteria air pollutants through statewide air monitoring network (data shared with EPA). Permits for all regulated sources of air emissions. Toxic emissions reported to EPA's Toxic Release Inventory database.
Air, Indoor*	N/A	***No surveillance activity*.**
Disasters*	N/A	***No surveillance activity.***
Lead	EPA KDHE, Div. of Environment	Monitoring and remediation of contaminated sites.
Noise	N/A	***No surveillance activity.***
Pesticides*	Kansas Dept. of Agriculture U.S. Dept. of Agriculture	***No comprehensive monitoring of pesticide use.*** KS Dept. of Agriculture approves pesticides for sale in state and licenses and monitors commercial pesticide applicators. USDA generates estimates of agricultural use for specific crop types, based on surveys.
Sun & UV Light	EPA, National Weather Service	Limited data collected.
Toxics & Waste	EPA KDHE, Div. of Environment	KDHE regulates hazardous waste generators and disposal. Toxic emissions reported to EPA's Toxic Release Inventory database.
Water, Ambient*	EPA KDHE, Div. of Environment	Extensive statewide monitoring and testing of surface waters for organic and inorganic chemicals and fecal coliforms.
Water, Drinking*	EPA KDHE, Div. of Environment Public Water Supply Systems	Public Water Supply systems required to test treated water for a list of potential biological and chemical contaminants. Results reported to Div. of Environment, and to EPA. Private wells not routinely tested and monitored by state agencies.

Table 1 (continued). **Environmental Health Surveillance in Kansas**

Topic	Responsible Agency	Data Collected
Fish tissue monitoring*	KDHE, Div. of Environment	Sampling of fish from water systems throughout the state. Fish tested for the presence of toxic substances such as pesticides and heavy metals (including mercury).
Exposures		
Lead*	KDHE, Div. of Health	Active screening program for high-risk children. All blood lead test results reported to KDHE.
Toxics, Pesticides	N/A	***No biomonitoring surveillance activity.***
Health Effects		
Deaths*	KDHE, Div. of Health	All deaths occurring in Kansas reported KDHE. Information includes cause of death.
Cancer*	Kansas Cancer Registry, University of Kansas Medical Center (under contract with KDHE, Div. of Health)	All cases of cancer are reported. Includes information on type and stage of cancer.
Asthma*	KDHE, Div. of Health	***Limited surveillance (Behavioral Risk Factor Surveillance System).***
Hospitalizations*	Kansas Hospital Association	Database of hospital discharges, with diagnosis codes to identify the nature of the illness. Database does not include personal identifiers, so linkage with other information is difficult.
Birth Defects	KDHE, Div. of Health	***Currently very limited registry.*** The 2003-04 Kansas Legislature authorized establishment of a birth defects registry, but no funding was provided.
Pesticides-related poisoning and illness*	Hospitals KS Poison Control Center	***No comprehensive surveillance activity.*** Some information is available at individual hospitals. Kansas Poison Control Center tracks calls related to pesticide exposures. No coordination with state and local agencies.

*Denotes topics and indicators of high interest for Kansas.

FINDINGS AND CONCLUSIONS

SURVEILLANCE OF POTENTIAL ENVIRONMENTAL HEALTH RISK FACTORS IS WEAK

This report identifies environmental health issues of special interest for Kansas that could be targeted for prevention and control activities. A problem common to all of the issues identified is the lack of a comprehensive, integrated public health surveillance system specifically targeted to environmental health. In Kansas, public health surveillance programs exist to monitor several types of health conditions, primarily infectious diseases, but surveillance activities for environmental health conditions are limited and fragmented. In some cases, the necessary information is not collected. In other cases, information is available, but it is not analyzed and disseminated in ways that could be useful for decision makers and program managers. Environmental health control programs and activities can be more effective if they are supported by an effective surveillance system. The CDC has provided limited funding to a few states to establish environmental health tracking programs. If the interest and capacity for implementing a stronger environmental health surveillance system were demonstrated, Kansas could become a recipient of these funds in the future.

ENVIRONMENTAL HEALTH SURVEILLANCE MUST TARGET ALL THREE STAGES OF THE HAZARD-EXPOSURE-OUTCOME CONTINUUM

For a full understanding of the connections between the environment and health conditions in the population, all three stages described in this report (hazard, exposure and health outcome) must be targeted by surveillance and control programs. The most important opportunities for improvement within each stage are summarized below.

Hazard surveillance

- *Pesticides.* Tracking of the amount and patterns of use of pesticides in the state is incomplete.
- *Meteorologic and climatic conditions.* Only fragmented information is available and is not routinely utilized for public health purposes.
- *Outdoor air particulate matter.* Monitoring is conducted primarily in urban areas, but the problem is also likely present in rural regions.

Exposure surveillance

Limited information is collected on actual exposures to environmental hazards, with the exception of blood lead levels in children. Biomonitoring is the direct measurement of environmental chemicals or their by-products in people, usually by testing of blood or urine specimens. The CDC has provided funding to some states to implement biomonitoring programs. KDHE Division of Laboratories has recently developed the laboratory infrastructure necessary to conduct some biomonitoring activities. The ability to analyze the information collected and use it for decision-making (through the development of some epidemiologic capacity) could put Kansas in a better position to compete for these funds.

Health outcome surveillance

Limited or no systematic collection and analysis of information is performed for the following environmental health conditions:

- Carbon monoxide poisoning
- Morbidity and mortality due to extreme meteorologic and climatic conditions
- Pesticide-related poisoning and illness
- Asthma
- Methemoglobinemia

INFORMATION FROM ENVIRONMENTAL HAZARDS IS NOT FULLY ANALYZED

Currently, most of the data on the presence of environmental hazards is used to monitor and assess compliance with federal or state environmental quality standards. While these are important activities that should be continued, the same information could be used to identify trends and monitor important health hazards throughout the state. This application likely would require additional capacity beyond what currently exists within KDHE, primarily in the fields of epidemiology and quantitative methods.

INFORMATION FROM ENVIRONMENTAL HAZARDS IS NOT LINKED TO HEALTH OUTCOMES

There is no systematic effort to identify relationships between the presence of environmental hazards and the occurrence of adverse health outcomes. As a result, the true health effect of

exposure to environmental hazards is difficult to quantify. These relationships can be identified in two ways:

1) By studying the distribution of environmental hazards in relation to population health outcomes. For example, air quality indicators in a defined geographical area can be studied in relation to hospital visits and admissions for asthma to determine if the two measures relate to each other. This type of study is often referred to as an ecological study. While useful in providing preliminary or general information on the relationships between hazards and diseases, ecological study results may be biased by factors unrelated to the hazard and health outcome of interest, and this type of study has a limited ability to evaluate the individual contribution of multiple hazards.
2) By studying individual exposures to environmental hazards. For example, individuals who develop certain types of cancer suspected to be linked to environmental hazards can be tested for their previous exposure to those hazards by measuring the levels of the hazardous material or by-products present in their blood or tissues. This type of study is more accurate than an ecological study, but also more complex and expensive to conduct, and requires the presence of a biomonitoring surveillance system, as described above.

ACTION ITEMS FOR CONSIDERATION

RAPID ANALYSIS OF CURRENTLY AVAILABLE DATA

To assure that prevention and control programs addressing environmental health issues are appropriately targeted to the needs in Kansas, improvements to current environmental health surveillance activities are essential. The full deployment of a functional environmental health surveillance program may take years, but very valuable information could be gained through a preliminary analysis of some of the currently available data on the presence of environmental hazards. Most of the information is stored within KDHE programs, and these analyses could be performed in a relatively short time, with the support of outside resources such as academic or research institutes. Some examples of investigations with currently available data could include:

- analysis of ambient water quality data for trends in contaminant levels over time and variation of contaminant levels by geographic locations;
- analysis of death certificate data for deaths attributed to environmentally related conditions, such as unintentional carbon monoxide poisoning or exposure to extreme temperatures;
- analysis of hospital admissions for health conditions related to environmental exposures, such as methemoglobinemia, unintentional carbon monoxide poisoning or pesticide exposures; and
- analysis of cancer incidence data for specific frequency and patterns of cases of certain types of cancers, such as mesothelioma, melanoma, and soft-tissue sarcomas, which are known to result from environmental exposures.

ESTABLISH AN ENVIRONMENTAL EPIDEMIOLOGIST POSITION AT KDHE

The establishment of a senior position for environmental health epidemiology activities within KDHE is an important goal that should be aggressively pursued, although securing the funding for such a position and recruiting an experienced professional may take some time. A trained, experienced epidemiologist could facilitate in a relatively brief period of time the acquisition of additional federal funds available to states from EPA and CDC. These funding awards are usually competitive, and states are required to submit applications that include some level of needs assessment and justification. The availability of seed money to establish the

presence of a trained environmental health epidemiologist at KDHE would increase the opportunity for Kansas to submit a successful application and secure a source of more stable funding for that position.

In the mid-1990s, a senior medical epidemiologist employed in KDHE's Bureau of Epidemiology and Disease Prevention acted as a liaison between the Division of Environment and the Division of Health to address health issues related to environmental exposures. Although this individual spent only a small portion of his time in this role, his presence had a positive effect on the ability of both divisions to identify areas for coordination of efforts. Since his departure from KDHE the position has remained vacant, but that experience is a testimony to the potential benefit of the addition of a skilled environmental epidemiologist. KDHE officials have recognized the importance of strengthening the agency's environmental epidemiology activities, but their efforts to secure adequate resources for that purpose have been so far unsuccessful.

ESTABLISH PRIORITIES FOR INTERVENTION TO ADDRESS ENVIRONMENTAL HEALTH ISSUES

As described in this report, multiple prevention and control programs are already operational addressing environmental health issues, usually as a result of the need to enforce federal and state environmental quality standards. By strengthening the environmental health epidemiology capacity, the state could provide the infrastructure necessary for the identification of priorities for intervention, based upon the same criteria that were used in this report for preliminary identification of issues of high relevance (that is, frequency of the hazard or condition, severity, potential for preventability and public concern).

A systematic approach such as this could add a population health dimension to the existing regulatory and enforcement environmental protection programs, lead to the establishment of additional intervention activities, and guide the allocation of available resources to competing programs.

IMPLEMENT INTERVENTION ACTIVITIES BASED ON IDENTIFIED NEEDS

The identification of priority areas could justify intervention projects, some of which would require legislative action, while others could be addressed through public information and education. Examples of environmental health issues that could be targets for public education campaigns include safety precautions to prevent injuries or disease from tornadoes, heat waves or very cold weather; actions to prevent intoxication from indoor carbon monoxide; proper application and use of pesticides; and precautions to be taken when the outdoor air quality indexes fall below safety thresholds. Some issues may be targeted through community-level interventions, such as encouraging the use of personal transportation alternatives in communities with outdoor air quality problems. Since exposure to environmental hazards may cause or exacerbate respiratory and cardiovascular diseases, interventions aimed at reducing the severity of symptoms associated with these conditions might also be helpful in reducing concerns about environmental health issues. For example, there is evidence that the impact of asthma can be reduced through patient and provider education on the optimal disease management strategies.

These activities are provided only as examples, and while some interventions could be initiated easily within a short period of time if resources were made available, realization of their full potential and assessment of their effectiveness can be accomplished only if they are accompanied by good epidemiologic information on the distribution of the hazards and the health conditions being targeted.

REFERENCES

Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry. (2000). *Shared Vision: Report of the CDC/ ATSDR Working Group on a Shared Vision for Environmental Public Health at CDC/ ATSDR*. Atlanta, GA. Available for download at: http://www.cdc.gov/nceh/sharedvision/

Centers for Disease Control and Prevention, National Center for Environmental Health, Division of Environmental Hazards and Health Effects. (2003). *Environmental Public Health Indicators*. Atlanta, GA. Available for download at: http://www.cdc.gov/nceh/indicators/default.htm

Centers for Disease Control and Prevention, National Center for Environmental Health, Division of Laboratory Sciences. (2003). *Second National Report on Human Exposure to Environmental Chemicals*. Atlanta, GA. Available for download at: http://www.cdc.gov/exposurereport/

Hanna, K., & Coussens, C. (2001). *Rebuilding the Unity of Health and the Environment*. Washington, DC: National Academy Press.

Institute of Medicine. (1988). *The Future of Public Health*. Washington, DC: National Academy Press.

Kaiser, J. (2002). National Tracking Plan Picks Up Speed. *Science* 296(5567): 452(2).

Kansas Department of Health and Environment. (2003). *Kansas 2001-2002 Air Quality Report*. Topeka, KS. Available for download at: http://www.kdhe.state.ks.us/bar/download/2001-2002_AQ_Report_6-11-03.pdf

Kansas Department of Health and Environment (2002). *Kansas Environment 2002*. Topeka, KS. Available for download at: http://www.kdhe.state.ks.us/environment/download/ksenv02.pdf

Kansas Department of Health and Environment. (2003). *State of Kansas Public Water Supply Annual Compliance Report for Calendar Year 2002*. Topeka, KS. Available for download at: http://www.kdhe.state.ks.us/pws/2003annualreport.pdf

Kansas Department of Health and Environment, Division of Environment, Bureau of Environmental Field Services (2004). *2004 Kansas Water Quality Assessment (305(b) Report)*. Topeka, KS. Available for download at: http://www.kdhe.state.ks.us/befs/305b_2002/ks305b2002f.pdf

Shepherd, M. D., West, G. C., Hargrove, W. L., Shoemaker, T. S., & St. Peter, R. F. (1999). *The Organization of Public Health and Environmental Functions in Kansas.* Topeka, Kansas: Kansas Health Institute. Pub. No. 99-103.

The Pew Environmental Health Commission, Johns Hopkins School of Hygiene and Public Health. (2000). *America's Environmental Health Gap: Why the Country Needs a Nationwide*

Health Tracking Network. Baltimore, MD. Available for download at: http://healthyamericans.org/reports/files/healthgap.pdf

Thacker, S. B., Stroup, D. F., et al. (1996). Surveillance in Environmental Public Health: Issues, Systems, and Sources. *American Journal of Public Health* 86(5): 633-8.

United States Department of Health and Human Services. (2000). *Healthy People 2010 (2nd Ed.) With Understanding and Improving Health and Objectives for Improving Health*. 2 vols. Washington, DC: U.S. Government Printing Office.

United States Environmental Protection Agency. (2003). *America's Children and the Environment: Measures of Contaminants, Body Burdens, and Illness*. Washington, DC. Available for download at: http://www.epa.gov/envirohealth/children/ace_2003.pdf

United States Environmental Protection Agency, Office of Research and Development and the Office of Environmental Information. (2003). *EPA's Draft Report on the Environment Technical Document*. Washington, DC. Available for download at: http://www.epa.gov/indicators/roe/

Appendix A. **U.S. Healthy People 2010 Environmental Health Objectives**

Objective	Indicator	U.S. 1997 Baseline	U.S. 2010 Target
8.1 Reduce the proportion of persons exposed to air that does not meet the U.S. EPA's health-based standards for harmful air pollutants	a. Ozone	43%	0%
	b. Particulates	12%	0%
	c. Carbon monoxide	19%	0%
	d. Nitrogen dioxide	5%	0%
	e. Sulfur dioxide	2%	0%
	f. Lead	<1%	0%
	g. Total # of people	119,803,000	N/A
8.2 Increase use of alternative modes of transportation to reduce motor vehicle emissions and improve the Nation's air quality	a. Trips made by bicycling	0.9%	1.8%
	b. Trips made by walking	5.4%	10.8%
	c. Trips made by transit	1.8%	3.6
	d. Persons who telecommute	Developmental	Developmental
8.3 Improve the nation's air quality by increasing the use of cleaner alternative fuels	Alternative fuel use as % of motor fuel consumption	2.7%	30%
8.4 Reduce air toxic emissions to decrease the risk of adverse health effects caused by airborne toxics	Tons of toxic emissions per year	8.1 million (1993)	2.0 million
8.5 Increase proportion of persons served by community water systems who receive a supply of drinking water that meets the regulations of the Safe Water Drinking Act (SWDA)	% of persons served by community water systems received drinking water that met SWDA (Public Law 93-523) regulations	85% (1995)	95%
8.6 Reduce waterborne disease outbreaks arising from water intended for drinking among persons served by community water systems	Number of outbreaks per year	6 (1987–96 avg.)	2

Appendix A (continued). **U.S. Healthy People 2010 Environmental Health Objectives**

Objective	Indicator	U.S. 1997 Baseline	U.S. 2010 Target
8.7 Reduce per capita domestic water withdrawals	Gallons of domestic water use per capita, per day	101 gallons (1995)	90.9 gallons
8.8 Increase the proportion of assessed rivers, lakes and estuaries that are safe for fishing and recreational purposes	Developmental	N/A	N/A
8.9 Reduce the number of beach closings that result from the presence of harmful bacteria	Developmental	N/A	N/A
8.10 Reduce the potential human exposure to persistent chemicals by decreasing fish contaminant levels	Developmental	N/A	N/A
8.11 Eliminate elevated blood lead levels in children	% of children age 1-6 years had blood lead levels exceeding 10 mcg/dl	4.4% (1991-94)	0%
8.12 Minimize the risks to human health and the environment posed by hazardous sites	Targeted reduction in number of sites on baseline lists		
	National Priority List	1,200 sites	98% of sites on lists
	Resource Conservation and Recovery Act	2,475 sites	98% of sites on lists
	Leaking underground storage facilities	370,000 sites	98% of sites on lists
	Brownfield properties	1,500 sites	98% of sites on lists
8.13 Reduce pesticide exposures that result in visits to a health care facility	Annual visits to health care facilities due to pesticide exposures	27,156 visits (1997)	13,500 visits

Appendix A (continued). **U.S. Healthy People 2010 Environmental Health Objectives**

Objective	Indicator	U.S. 1997 Baseline	U.S. 2010 Target
8.14 Reduce the amount of toxic pollutants released, disposed of, treated or used for energy recovery	Developmental	N/A	N/A
8.15 Increase recycling of municipal solid waste	% of total municipal solid waste generated that was recycled (includes composting)	27% (1996)	38%
8.16 Reduce indoor allergen levels	Millions of homes where:		
	Group I dust mite allergens > 2mcg per gram of dust in bed	36.3 million	29.0 million
	Group I dust mite allergens >10mcg per gram of dust in bed	18.6 million	14.9 million
	German cockroach allergens > 0.1 mcg per gram of dust in the bed	4.7 million	3.8 million
8.17 Increase the number of office buildings that are managed using good indoor air quality practices	Developmental	N/A	N/A
8.18 Increase the proportion of persons who live in homes tested for radon concentrations	% of population living in homes that have been tested for radon	17% (1998)	20%
8.19 Increase the number of new homes constructed to be radon resistant	Number of new homes constructed to be radon resistant	1.4 million homes as of (1997)	2.1 million additional new homes

Appendix A (continued). **U.S. Healthy People 2010 Environmental Health Objectives**

Objective	Indicator	U.S. 1997 Baseline	U.S. 2010 Target
8.20 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	Developmental	N/A	N/A
8.21 Ensure that state health departments establish training, plans, and protocols and conduct annual multi-institutional exercises to prepare for response to natural and technological disasters	Developmental	N/A	N/A
8.22 Increase the proportion of persons living in pre-1950s housing that has been tested for the presence of lead-based paint	Proportion of persons living in pre-1950s housing that has been tested for the presence of lead-based paint	16% (1998)	50%
8.23 Reduce the proportion of occupied housing units that are substandard	% of occupied housing units that had moderate or severe physical problems	6.2% (1995)	3%

Appendix A (continued). **U.S. Healthy People 2010 Environmental Health Objectives**

Objective	Indicator	U.S. 1997 Baseline	U.S. 2010 Target
8.24 Reduce exposure to pesticides as measured by urine concentrations of metabolites	Pesticide metabolite level at which 95% of population had concentrations below:		
	a. 1-napthol (carbaryl)	36.0 mcg/gm	25.2 mcg/gm
	b. Paranitrophenol (methyl parathion and parathions)	3.8 mcg/gm	2.7 mcg/gm
	c. 3,5,6-trichloro-2-pyridinol (chlorpyrifos)	8.3mcg/gm	5.8 mcg/gm
	d. Isopropoxyphenol (propoxur)	1.6 mcg/gm	1.1 mcg/gm
8.25 Reduce exposure of the population to pesticides, heavy metals and other toxic chemicals, as measured by blood and urine concentrations of their metabolites	Developmental exposure items:	N/A	N/A
	a. Arsenic	N/A	N/A
	b. Cadmium	N/A	N/A
	c. Lead	N/A	N/A
	d. Manganese	N/A	N/A
	e. Mercury	N/A	N/A
	f. 2,4-D	N/A	N/A
	g. o-phenylphenol	N/A	N/A
	h. Permethrins	N/A	N/A
	j. Polychlorinated biphenyls	N/A	N/A
	k. Dioxins	N/A	N/A
	l. Furans	N/A	N/A
	m. Chlordane	N/A	N/A
	n. Dieldrin	N/A	N/A
	o. DDT	N/A	N/A
	p. Lindane	N/A	N/A
8.26 Improve the quality, utility, awareness and use of existing information systems for environmental health	Developmental	N/A	N/A

Appendix A (continued). **U.S. Healthy People 2010 Environmental Health Objectives**

Objective	Indicator	U.S. 1997 Baseline	U.S. 2010 Target
8.27 Increase or maintain the number of territories, tribes, and states and the District of Columbia that monitor diseases or conditions that can be caused by exposure to environmental hazards	Number of jurisdictions monitoring:		
	a. Lead poisoning	51	51
	b. Pesticide poisoning	20	25
	c. Mercury poisoning	14	20
	d. Arsenic poisoning	10	15
	e. Cadmium poisoning	10	15
	f. Methemoglobinemia	9	15
	g. Acute chemical poisoning	8	15
	h. Carbon monoxide poisoning	7	51
	i. Asthma	6	25
	j. Hyperthermia	4	10
	k. Hypothermia	Developmental	N/A
	l. Skin cancer	Developmental	N/A
	m. Malignant melanoma	Developmental	N/A
	n. Other skin cancer	Developmental	N/A
	o. Birth defects	Developmental	N/A
8.28 Increase the number of local health departments or agencies that use data from surveillance of environmental risk factors as part of their vector control programs	Developmental	N/A	N/A
8.29 Reduce the global burden of disease due to poor water quality, sanitation, and personal and domestic hygiene	Number of deaths attributed to these factors	2,668,200 (1990)	2,135,000

Appendix A (continued). **U.S. Healthy People 2010 Environmental Health Objectives**

Objective	Indicator	U.S. 1997 Baseline	U.S. 2010 Target
8.30 Increase the proportion of the population in the U.S.–Mexico border region that have adequate drinking water and sanitation facilities	Percent of population receiving wastewater sewer service:		
	a. Ciudad Acuna	39%	49%
	b. Matamoros	47%	57%
	c. Mexicali	80%	90%
	d. Nogales, Sonora	81%	91%
	e. Piedras Negras	80%	90%
	f. Reynosa	57%	67%
	Wastewater receiving treatment:		
	g. Ciudad Acuna	0%	10%
	h. Matamoros	0%	10%
	i. Mexicali	72%	82%
	j. Nogales, Sonora	100%	199%
	k. Peidras Negras	0%	10%
	l. Reynosa	100%	100%

Appendix B. **CDC/CSTE Environmental Public Health Indicators**

Air, Ambient	
Indicator	**Suggested Measures**
Hazards	
*Criteria pollutants in ambient air	1. *Annual high levels of criteria pollutants: • carbon monoxide (CO) • lead (Pb) • nitrogen dioxide (NO2) • ozone (O3) • PM10 • sulfur dioxide (SO2) 2. *Tons of criteria pollutants released in ambient air
*Hazardous or toxic substances in ambient air	1. *Tons of one or more hazardous or toxic substances released in ambient air 2. Number of reports of noncompliance for emissions releases
*Motor vehicle emissions	1. *Vehicle miles driven per capita 2. Average fuel efficiency of registered motor vehicles
*Residence in non-attainment areas	*Percentage of human population residing in non-attainment areas (for criteria air pollutants)
Exposures	
None identified	
Health effects	
*Unusual patterns of asthma events	1. *Number of asthma-related deaths 2. *Incidence of asthma 3. *Rates of hospitalization and emergency department visits for acute asthma 4. Number of work days missed because of asthma 5. Number of school days missed because of asthma 6. Proportion of population filling prescriptions for asthma medication
*Unusual pattern of cardiovascular or respiratory events	1. *Incidence of cardiovascular and respiratory events 2. *Rates of hospitalization and emergency department visits for acute cardiovascular and respiratory events

Appendix B (continued). **CDC/CSTE Environmental Public Health Indicators**

Indicator	Suggested Measures
Interventions	
*Programs that address motor vehicle emissions	1. *Proportion of population residing in jurisdictions that have vehicle emissions mandates 2. Number of public education messages to encourage the use of personal transportation alternatives
*Alternative fuel use in registered motor vehicles	*Proportion of registered vehicles powered by alternative fuel
*Availability of mass transit	1. *Proportion of population for whom mass transit is available 2. Proportion of population who chose personal transportation alternatives (walking, bicycling)
Programs that address hazardous or toxic substances in ambient air	1. Number of jurisdictions that have air toxics monitoring programs 2. Number of operating permits for releases of hazardous air pollutants 3. Number of fines for hazardous releases violations
Air, Indoor	
Hazards	
*Tobacco smoke in homes with children	1. *Proportion of children residing in households with adult smokers 2. *Proportion of households with adult smokers 3. Proportion of children who smoke
Hazardous or toxic substances in indoor air	1. Proportion of houses with Group I dust mites in beds 2. Proportion of houses with >0.1unit/g German cockroach dust in beds 3. Proportion of schools with indoor air hazards
Exposures	
None Identified	
Health effects	
*CO poisoning (not fire-related)	1. *Number of deaths from CO poisoning 2. *Number of hospitalizations and emergency department visits attributed to CO exposure

Appendix B (continued). **CDC/CSTE Environmental Public Health Indicators**

Indicator	Suggested Measures
Unusual pattern of respiratory events	1. Number of emergency visits in which an air-borne agent is suspected 2. Number of deaths in which an air-borne agent is suspected
Interventions	
*Policies that address indoor air hazards in schools	1. *Proportion of schools with indoor air policies 2. *Proportion of schools with smoke-free and tobacco-free policies
*Laws pertaining to smoke-free indoor air	1. *Number of jurisdictions with laws on smoke-free indoor air 2. *Proportion of resident population in jurisdictions with laws pertaining to smoke-free indoor air
*Indoor air inspections	*Number of complaint-related indoor air inspections
Use of best practices for protecting indoor air	1. Number of local jurisdictions with ordinances requiring CO detectors in apartment buildings 2. Proportion of non-manufacturing work force that occupies office buildings for which indoor air quality management practices address human health 3. Proportion of resident population for which programs are available for testing radon in high-risk homes
Disasters	
Hazards	
*Residence in a flood plain	*Proportion of resident population with homes in a flood plain
Meteorologic or climatic conditions that increase susceptibility to hazards	1. Number of days in which temperatures exceed safe thresholds 2. Amount of excessive rainfall 3. Duration of drought conditions 4. Number of days of flooding 5. Number of floods in areas with high concentrations of pesticide through production, sales or use
Residence in a temporary or unsafe structure	1. Proportion of population residing in damaged or destroyed home 2. Proportion of population residing in temporary shelter

Appendix B (continued). **CDC/CSTE Environmental Public Health Indicators**

Indicator	Suggested Measures
Exposures	
None identified	
Health effects	
*Deaths attributed to extremes in ambient temperatures	1. *Number of heat-attributed deaths 2. Number of deaths from hypothermia
Morbidity and mortality attributed to natural forces	1. Number of illnesses or injuries from natural disasters, by type of disaster 2. Number of deaths from natural disasters, by type of disaster
Interventions	
*Emergency preparedness, response and mitigation training programs, plans and protocols	1. *Proportion of jurisdictions for which multi-institutional exercises to prepare for disaster are conducted annually 2. Proportion of jurisdictions for which protocols exist for public education messages to elicit preventive behaviors among resident population 3. Proportion of jurisdictions for which early warning systems are in place 4. Proportion of jurisdictions for which sheltering programs exist 5. Proportion of jurisdictions for which safe building codes are enforced
Lead	
Hazards	
Lead contamination in the environment	1. Proportion of housing stock built before 1950 2. Lead levels in sediment and in game or commercial fish
Residence near metal processing industries	Proportion of population residing near lead smelters
Exposure	
*Blood lead level in children	*Proportion of high-risk children with elevated blood lead level
Health effects	
*Lead poisoning in children	*Number of hospitalizations from lead poisoning in children

Appendix B (continued). **CDC/CSTE Environmental Public Health Indicators**

Indicator	Suggested Measures
Interventions	
Lead elimination programs	1. Number of jurisdictions with lead training certification programs 2. Proportion of population living in pre-1950 housing that has been tested for the presences of lead-based paint 3. Number of completed lead abatements
Noise	
Hazards	
Residence in noisy environments	1. Number of noise complaints 2. Level of noise monitored in a community
Exposures	
None identified	
Health effects	
*Noise-induced hearing loss (non-occupational)	1. *Proportion of noise-exposed adults with hearing loss 2. Proportion of children and adolescents with hearing loss
Interventions	
Hearing protection practices	1. Proportion of population using appropriate ear protection devices and equipment 2. Number of jurisdictions with noise ordinances and prohibitions on specific activities
Pesticides	
Hazards	
*Pesticide use and patterns of use	1. *Annual tons used 2. *Pounds applied 3. Patterns of use in agriculture, home and garden 4. Number of worker and community complaints about possible pesticide exposure
*Residual pesticide in foods	*Proportion of foods with residual pesticide levels that fail to meet safe consumption regulations and guidelines

Appendix B (continued). **CDC/CSTE Environmental Public Health Indicators**

Indicator	Suggested Measures
Exposure	
Biologic markers of pesticides or pesticide metabolites in human tissue	1. 95th percentile blood and urine concentration levels for biomarkers of exposure to carbaryl (1-napthol), methyl parathion and parathion (paranitrophenol), chlorpyrifos (3,5,6-tricholoro-2-pyridinol), propoxur (isopropoxyphenol), 2,4-D, o-phenylphenol, permethrins, diazinon, chlordane, dieldrin, DDT, lindane 2. 95th percentile urine concentration level for six biomarkers of exposure to 28 pesticides: dimethyl phosphate, dimethyl thiophosphate, dimethyl dithiophosphate, diethyl phosphate, diethyl thiophosphate, diethyl dithiophosphate
Health effects	
*Pesticide-related poisoning and illness	1. *Incidence of pesticide-related poisonings and illnesses in pesticide workers 2. *Number of non-occupational pesticide-related poisoning and illness 3. *Number of pesticide-related poisoning and illness in children
Interventions	
*Compliance with pesticide application standards	1. *Proportion of workers, handlers and trainers in compliance with employee training standards 2. Proportion of workers in compliance with recommendations for home and yard use
Public and professional education	1. Public awareness campaigns about pesticide hazards and safe application 2. Public and professional education about symptoms of low-level pesticide exposure
Alternatives to pesticide use	1. Number of jurisdictions in which “organic” foods are available 2. Consumption patterns of “organically grown” foods
Sentinel Events	
Hazard	
Unsafe or unhealthy environmental event or condition	1. *Chemical spill 2. Ambient ozone concentration that exceeds the safe level 3. Ambient temperature that exceeds safe threshold 4. Disaster (e.g., natural, sociopolitical)

Appendix B (continued). **CDC/CSTE Environmental Public Health Indicators**

Indicator	Suggested Measures
Exposure	
None identified	
Health effects	
*Illness or condition with suspected or confirmed environmental exposure	1. *Asthma-related death 2. *Case of methemoglobinemia 3. *Illness attributed to ambient or drinking water contaminants 4. *CO poisoning (not fire-related) 5. *Hospitalization from lead poisoning in a child 6. *Consultation or emergency department visit for possible poisoning in a child, including lead poisoning 7. *Pesticide-related poisoning or illness 8. *Temperature-attributed death 9. Food-borne illness
*Unusual pattern of illness or condition with suspected or confirmed environmental contribution	1. *Rates of acute asthma 2. *Rates of cardiovascular and respiratory events in persons with underlying disease on days when outdoor air standards are exceeded or when temperatures are at dangerous levels 3. Cancer incidence and mortality rates, specifically lung cancer in non-smokers, mesothelioma, soft tissue sarcoma and melanoma 4. Incidence rates for adverse reproductive outcomes, specifically very low birth weight and pre-term and very pre-term 5. Incidence rates of developmental disabilities, specifically mental retardation and autism spectrum disorder 6. Incidence rates of birth defects, especially cerebral palsy 7. Syndromes with unknown etiologies that require emergency medical care or cause death
Interventions	
Use of surveillance and warning system	1. Number of surveillance systems for sentinel events, syndromes and unusual patterns of disease that include environmental data 2. Number of vector-control programs that use environmental data

Appendix B (continued). **CDC/CSTE Environmental Public Health Indicators**

Indicator	Suggested Measures
Sun and Ultraviolet Light	
Hazard	
*Ultraviolet Light	*Number of days in which the UV light index exceed a safe threshold
Exposures	
None identified	
Health effects	
*Melanoma	1. *Incidence of melanoma 2. *Melanoma mortality
Injuries attributed to UV light	1. Number of corneal burns 2. Number of other eye injuries 3. Incidence of cataracts
Interventions	
Public education	1. Proportion of adults who follow protective measures to prevent melanoma and skin cancer 2. Proportion of adolescents who follow protective measures to prevent melanoma and skin cancer 3. Number and type of sun protection messages issued to the public 4. Number of purchases of sun-blocking products
Toxics and Waste	
Hazards	
*Chemical spills	*Number of chemical spills by type and location
*Toxic contaminants in foods	*Levels of toxic contaminants in foods
Hazardous waste sites	1. Proportion of leaking underground storage facilities that have not been remediated 2. Proportion of identified Brownfield properties that have not been remediated 3. Tons of toxic substances and materials sold to general public

Appendix B (continued). **CDC/CSTE Environmental Public Health Indicators**

Indicator	Suggested Measures
	4. Proportion of population in close proximity to leaking underground storage facilities, Brownfield properties and sites on the National Priority List and RCRA lists 5. Number of worker and community complaints about possible toxic exposures
Exposures	
Biologic markers of human exposure to heavy metals	Blood and urine concentration level (95th percentile) for lead, arsenic, cadmium, manganese, mercury
Biologic markers of human exposure to persistent chemicals	Serum concentration level (95th percentile) for polychlorinated biphenyls (PCB), dioxins, furans
Health effects	
*Possible child poisoning	1. *Consultations for child poisoning 2. *Emergency department visits for child poisoning
Morbidity and mortality associates with toxic substances	1. Number of non-occupational poisonings 2. Number of deaths from non-occupational poisoning 3. Number of injuries resulting from chemical spills
Interventions	
Use of surveillance and warning systems	1. Number of jurisdictions that have surveillance systems for detecting methemoglobinemia and acute poisoning from lead, arsenic, cadmium, mercury, pesticides and other chemicals 2. Number of fish consumption advisories
Waste and toxic substances reduction	1. Proportion of solid waste diverted from disposal 2. Identified sites with completed exposure pathways
Public Education	1. Pubic awareness campaigns about toxic and hazardous household products 2. Number of purchases of home safety and child-proofing devices (e.g., electrical outlet covers, cabinet locks, smoke detectors)
Water, Ambient	
Hazards	
*Monitored contaminants in ambient water	1. *Levels of contaminants monitored under the Clean Water Act and state regulations and guidelines by type of water body (e.g., surface, recreational, marine)

Appendix B (continued). **CDC/CSTE Environmental Public Health Indicators**

Indicator	Suggested Measures
	2. *Proportion of marine and freshwater recreational waters that fail to meet water quality regulations and guidelines 3. *Proportion of treated recreational waters that fail to meet state and local standards for free chlorine levels by type of recreational water (swimming pools, water parks, play fountains) 4. Number of health-related closure days for marine and freshwater recreational areas 5. Land-use patterns
*Point-source discharges into ambient water	1. *Volume of point-source discharges by type of contaminant (permitted sanitary waste disposal, sewage overflows, unintentional discharges and spills) (core) 2) 2. Levels of mercury, dioxin, PCB, other in recreational (fishing) water bodies
*Contaminants in shellfish and sport and commercial fish	1. *Levels of fecal coliform and mercury in shellfish beds 2. *Levels of mercury, dioxin and PCB in sport and commercial fish
Exposures	
None identified	
Health effects	
*Outbreaks attributed to fish and shellfish consumption	*Number of outbreaks by source (fish, shellfish) and etiologic agent (biologic, toxic, other)
*Outbreaks attributed to ambient water contaminants	*Number of outbreaks by source (freshwater, marine, treated recreational water)
Interventions	
*Activity restrictions	*Number and type of health-based activity restrictions
Compliance with regulations and guidelines	Number of fines for noncompliance with Clean Water Act regulations or local guidelines
Public education	Public Awareness campaigns about health hazards associated with on-lot wastewater treatment systems

Appendix B (continued). **CDC/CSTE Environmental Public Health Indicators**

Indicator	Suggested Measures
Water, Drinking	
Hazards	
*Monitored contaminants in drinking water	1. *Number and proportion of drinking water systems that fail to meet water quality regulations and guidelines (Safe Drinking Water Act MCLs, CCLs, state lists) by type of water supply 2. *Measurements of Safe Drinking Water Act MCLs, CCLs and contaminants monitored under state regulations and guidelines by type of water supply 3. Number of citations for noncompliance with local standards for free chlorine levels
Source water contamination	1. Number and type of point-source discharges into drinking water aquifers 2. Levels of naturally occurring toxicants 3. Levels and types of contamination of private water supplies
Exposures	
None identified	
Health Effects	
*Methemoglobinemia	*Cases of methemoglobinemia
*Outbreaks attributed to drinking water	*Number by type of water supply (including bottled water) and etiologic agent (biologic, toxic, other)
Interventions	
*Implementation of sanitary surveys	*Number and proportion of drinking water systems in which a sanitary survey has been conducted within past 5 years (by type of water supply)
*Compliance with operation and maintenance standards	1. *Fines for noncompliance with Safe Drinking Water Act regulations or local guidelines 2. *Citations for noncompliance with local water quality regulations or guidelines
*Boil water advisories	*Number of boil water advisories by type of water supply
Source water protection programs	1. Proportion of wellheads covered by protection programs

Appendix B (continued). **CDC/CSTE Environmental Public Health Indicators**

Indicator	Suggested Measures
	2. Proportion of surface water supplies covered by watershed protection programs
Public Education	Proportion of the population aware of availability and meaning of consumer confidence reports

*Designated as a core indicator, an indicator or measure that might be included in a state health department's basic environmental health surveillance program.

Appendix C. **Environmental Health Indicators of Special Interest to Kansas**

Indicator	Measurement	Relevance to Kansas
Hazard Indicators		
Criteria pollutants in ambient air		
Ozone	• Annual peaks of ozone • Percentage of population living in non-attainment areas for ozone	Air monitoring results are near non-attainment levels in the Kansas City metro and the Sedgwick county areas.
Particulate matter	• High annual levels of particulates • Percentage of population living in non-attainment areas	Some areas experience occasional severe episodes of blowing dust or dust storms. In 1996, high winds and extremely dry soil conditions resulted in exceeding the air quality standards in Morton and Sedgwick counties.
Tobacco smoke in homes with children	• Proportion of children residing in households with adult smokers • Proportion of households that report not allowing any smoking inside the home	The number of children living in homes where they are exposed to second-hand smoke is unknown.
Meteorologic/climactic conditions		
Number of days in which temperatures exceed safe thresholds	• Deaths attributed to extremes in ambient temperature conditions	Extreme heat conditions in Kansas can be a health concern for the elderly and individuals with predisposing conditions.
Pesticides		
Use and patterns of use	• Pounds of pesticides applied annually, by specific pesticide and sector of application (agriculture, building treatment, lawn care) • Compliance rates with pesticide application standards	Agricultural applications account for about three-quarters of all pesticide use. Pesticide exposure has been linked to many adverse health effects. The extensive agricultural practices in Kansas make pesticides an environmental health concern for the state.

Appendix C (continued). **Environmental Health Indicators of Special Interest to Kansas**

Indicator	Measurement	Relevance to Kansas
Monitored contaminants in ambient water		
Pesticides	• Concentrations of pesticides found in waters tested under the Clean Water Act, by type of pesticide, type of water body and location	Extensive agricultural use of pesticides makes this issue a concern. Agricultural application of pesticides and herbicides can easily contaminate ambient water sources through run-off or aerosol drift.
Mercury	• Concentrations of mercury found in waters tested under the Clean Water Act, by type of water body and location	Mercury is highly toxic to humans. Bio-accumulation of mercury in fish is a growing concern throughout the U.S.
Monitored contaminants in drinking water		
Nitrates	• Number and proportion of drinking water systems that fail to meet water quality regulations and guidelines for nitrates	Excessive nitrate levels are found in both ground water and surface water in many locations in Kansas. Nitrates are difficult to remove and require additional water treatment processes.
Arsenic	• Number and proportion of drinking water systems that fail to meet water quality regulations and guidelines for arsenic	In some parts of Kansas, naturally occurring arsenic levels in water sources used by public water supplies exceed new tightened allowable levels.
Pesticides	• Number and proportion of drinking water systems that fail to meet water quality regulations and guidelines for pesticides	Agricultural application of pesticides and herbicides can easily contaminate ambient water sources through run-off or aerosol drift. Drinking water supplies must be closely monitored to assure safe levels.

Appendix C (continued). **Environmental Health Indicators of Special Interest to Kansas**

Indicator	Measurement	Relevance to Kansas
Contaminants in shellfish and sport and commercial fish		
Mercury	• Number of fish advisories issued due to mercury levels	Although no fish advisories have yet been issued in Kansas, mercury is felt to be an emerging environmental health concern.
Exposure Indicators		
Blood lead levels in children	• Number of children with elevated blood lead levels	Kansas has nearly 500,000 occupied housing units constructed prior to 1960 that are likely to have lead-based paint. Old lead and zinc mining operations have resulted in lead contamination of soils in Southeast Kansas.
Health Effects Indicators		
Carbon monoxide poisoning (not fire-related)	• Number of deaths attributed to carbon monoxide poisoning • Number of visits to emergency departments for carbon monoxide poisoning • Percent of households that report having at least one working carbon monoxide detector in the home	Cold Kansas winters require that houses have supplementary heating systems. Incomplete burning of fuels from faulty furnaces, wood stoves or space heaters may result in toxic exposure.
Deaths attributed to extremes in ambient temperature	• Number of deaths attributed to temperature extremes	Kansas experiences both extreme heat in summer and extreme cold in winter.
Morbidity and mortality attributed to natural forces	• Number of deaths attributed to tornadoes	Tornadoes are the most frequent form of natural disaster in Kansas.
Lead poisoning in children	• Number of children with reported elevated blood lead levels	Kansas has nearly 500,000 occupied housing units constructed prior to 1960 that are likely to have lead-based paint. Old lead and zinc mining operations have resulted in lead contamination of soils in Southeast Kansas.

Appendix C (continued). **Environmental Health Indicators of Special Interest to Kansas**

Indicator	Measurement	Relevance to Kansas
Pesticide-related poisoning and illness	• Number of visits to emergency departments for pesticide-related exposure • Number of calls to the state poison control center for pesticide-related exposures	Extensive use of pesticides in an agricultural state makes this issue a concern in Kansas. Human exposure to pesticides has adverse effects on health.
Conditions with suspected or confirmed environmental contribution (a case or unusual pattern)		
Unusual patterns of asthma events	• Number of deaths attributed to asthma • Rates of acute asthma events	Unusual patterns of asthma events could result from poor air quality.
Incidence of cardiovascular and respiratory events in persons with underlying disease, on days when outdoor air standards are exceeded or when temperatures are at dangerous levels	• Number of deaths attributed to cardiovascular events or respiratory illnesses • Rates of hospitalization and emergency department visits for acute cardiovascular or respiratory events	Unusual patterns of cardiovascular and respiratory events could result from poor air quality or extreme temperature conditions.
Cancer incidence and mortality: ▪ Lung cancer in non-smokers ▪ Mesothelioma ▪ Soft tissue sarcoma	• Number of newly diagnosed cases of lung cancer in non-smokers, mesothelioma and soft tissue sarcoma • Number of deaths attributed to lung cancer in non-smokers, mesothelioma and soft tissue sarcoma	Lung cancer in non-smokers may be related to second-hand smoke or other environmental exposures. Mesothelioma results from asbestos exposure. Soft tissue sarcoma may be caused by exposure to pesticides or radiation.
Cases of methemoglobinemia ("blue baby syndrome") in infants	• Number of reported cases of methemoglobinemia	Excess nitrates in drinking water are a hazard in Kansas and are known to cause methemoglobinemia.