Environmental Health Tracking & Biomonitoring

Report to the Minnesota Legislature

Minnesota Department of Health

January 15, 2009

MINNESOTA MDH DEPARTMENT OF HEALTH

Commissioner's Office
625 Robert Street N
P.O. Box 64975
St. Paul, MN 55164-0882
651-201-5000
www.health.state.mn.us

Environmental Health Tracking & Biomonitoring

Report to the Minnesota Legislature

January 15, 2009

For more information, contact:
Environmental Health Tracking & Biomonitoring Program
Chronic Disease and Environmental Epidemiology Section
Health Promotion and Chronic Disease Division
Minnesota Department of Health
85 East Seventh Place, Suite 220
P.O. Box 64882
St. Paul, MN 55164-0882

Phone: 651-201-5000
Fax: 651-201-5898
TDD: 651-201-5797

As requested by Minnesota Statute 3.197: This report cost approximately $990.30 to prepare, including staff time, printing and mailing expenses.

EXECUTIVE SUMMARY

In 2007, the Minnesota Legislature passed a law creating the Environmental Health Tracking and Biomonitoring (EHTB) program at the Minnesota Department of Health (MDH). This legislation directed MDH to do the following:

- Establish an environmental health tracking program to collect, integrate, analyze and disseminate data on human exposures to chemicals in the environment and the diseases potentially caused or aggravated by those chemicals. In addition, the program was directed to develop a strategic plan and work plan describing future program development and compatibility with the Centers for Disease Control and Prevention's (CDC) National Environmental Public Health Tracking Program.

- Implement a pilot biomonitoring program, including four pilot projects to assess communities' exposure to arsenic, perfluorochemicals (PFCs), mercury, and a fourth chemical to be selected by MDH in consultation with an advisory panel. In addition, the program was directed to develop program guidelines that address the science and practice of biomonitoring and to make recommendations for conducting ongoing biomonitoring in Minnesota.

- Create an Environmental Health Tracking and Biomonitoring (EHTB) advisory panel.

Minnesota Statutes 144.995-144.998 require MDH to submit a biennial report to the chairs and ranking members of the committees with jurisdiction over environment and health on "the status of environmental health tracking activities and related research programs, with recommendations for a comprehensive environmental public health tracking program" and on "the status of the biomonitoring program and any recommendations for improvement." The statutes also require MDH to submit a report on the results of the biomonitoring pilot program.

This report summarizes the activities of the environmental health tracking program, the pilot biomonitoring program, and the EHTB advisory panel. MDH will release additional reports in 2009 that will include specific results from each of the pilot biomonitoring projects. In addition, a data report for the environmental health tracking program will be released in 2009.

Environmental health tracking program

Minnesota Statute 144.996 directs MDH to establish an environmental health tracking program. By making data on environmental hazards, exposures and health available in one place and by systematically monitoring those data, the environmental health tracking program will create new opportunities for learning about the risks of environmental exposures and for understanding the relationships between the environment and health.

Data collection and analysis for the newly established Minnesota Environmental Health Tracking System (MEHTS) are ongoing, with the program's first data report scheduled to be released in spring 2009. The preliminary focus of MEHTS has been to collect and analyze data that are consistent with the national Environmental Public Health Tracking Network, which includes 16 other states and New York City. The data content areas that are part of this initial focus include measures of air quality; water quality; childhood lead exposure; hospitalizations for respiratory disease and heart attacks; cancer; carbon monoxide poisoning; birth defects; and birth outcomes.

MEHTS staff are now working on the design of a state web-based portal for public access to MEHTS data. MDH plans to model the MEHTS portal on similar portals under development by the CDC-funded environmental health tracking programs in other states. Public education and outreach will be important components of this new system for disseminating information.

In addition, MEHTS is beginning to explore adding data in several new areas, including deaths due to chronic respiratory and heart diseases, health impacts of climate change, acute pesticide poisonings, and additional air quality measures. MDH is also exploring the feasibility of developing a surveillance system for autism spectrum disorders in Minnesota. Other new possibilities for environmental health tracking data will continue to be explored and developed in consultation with the EHTB advisory panel, stakeholders within Minnesota, and other states involved in environmental health tracking. In accordance with the EHTB statute, program staff will also work in collaboration with academic institutions to identify core priorities for research – including specific, targeted studies – on environmental health hazards, exposures and disease.

With separate funding from the U.S. EPA, investigators with MDH, the Minnesota Pollution Control Agency and Olmsted Medical Center are exploring new methods for measuring health impacts using linkages between air quality and health outcome data. This project is a demonstration of the type of research that could be facilitated in the future by the development of a comprehensive environmental health tracking system.

The MEHTS strategic plan, developed in 2008, will help guide the program toward fulfilling its mission of building knowledge about health and the environment and driving actions to protect the health of Minnesota communities. The goal areas outlined in the plan focus on data quality; data accessibility and usefulness; communication and data dissemination; stakeholder engagement; and infrastructure building.

As with any data system, the benefits of MEHTS will grow over time, as the system expands to include more data, the data are made more widely available, and data users are able to put the data into use in developing and evaluating public health actions. Already, MEHTS has begun to stimulate changes in the way public health programs use data.

Pilot biomonitoring program

Pilot projects

Minnesota Statute 144.997, subd. 1 directs MDH to develop a pilot biomonitoring program to include four projects. Implementation of all four biomonitoring pilot projects is underway, though each project is in a different stage.

Minneapolis Children's Arsenic Study: Recruitment, specimen collection and specimen analysis are completed. Sixty-five children participated in the study. Project results are expected to be released during early spring 2009.

East Metro Perfluorochemicals (PFCs) Biomonitoring Study: Recruitment and specimen collection are completed. One hundred ninety-six adults participated in the study. Laboratory analysis of specimens is ongoing. Overall project results are expected to be released during spring 2009.

Lake Superior Mercury Biomonitoring Study: Participant recruitment began in November. Because this study is part of a larger study funded by the U.S. EPA, recruitment is expected to continue into 2010 with project completion expected in September 2010. Interim reports will be prepared as data become available.

Riverside Prenatal Biomonitoring Study: The project is being conducted in partnership with investigators from the University of Minnesota Riverside Birth Study (RBS). Participant recruitment and specimen collection are expected to begin in winter 2009. The chemicals selected for analysis in this project are environmental phenols, including bisphenol A, and cotinine, which is a measure of exposure to secondhand smoke. Overall project results are expected to be released in fall 2009.

Though the four pilot projects are not yet completed, MDH has already learned valuable lessons about the complexities of implementing biomonitoring studies and has built infrastructure and capacity that could easily be capitalized on in future efforts. However, with a scheduled reduction in program funding beginning in SFY 2010, MDH will be unable to operate a biomonitoring program beyond the completion of the pilot program.

Biomonitoring program guidelines

Minnesota Statute 144.997, subd. 4 directs MDH to develop program guidelines to address the science and practice of biomonitoring. Program staff, in consultation with the EHTB advisory panel, have developed guidelines to inform decisions about the design and implementation of the four biomonitoring pilot projects. These guidelines define the primary purpose of the state's pilot biomonitoring program as providing information about the distributions and ranges of exposure to specific chemicals in the selected communities. The guidelines set standards for program development and implementation in the following areas: pilot project design, privacy of information, informed consent, laboratory quality assurance, laboratory approval program, storage of specimens, use of stored specimens for future research, communication of results, community acceptance and participation, follow-up counseling, selecting appropriate reference values for data interpretation, and inclusion of children in biomonitoring pilot projects.

In addition to guiding decisions about the four biomonitoring pilot projects, these guidelines, with ongoing review, provide a helpful framework for any future biomonitoring efforts carried out at MDH.

Recommendations for ongoing biomonitoring

Minnesota Statute 144.977, subd. 2 directs MDH to develop and implement a base biomonitoring program based on the findings and recommendations gleaned from the biomonitoring pilot program. Staff from MDH, the Minnesota Department of Agriculture, and the Minnesota Pollution Control Agency, in consultation with the EHTB advisory panel and the EHTB steering committee, are engaged in a strategic planning process to develop a purpose and vision for an ongoing state biomonitoring program. The purpose will describe why a state biomonitoring program exists; the vision will seek to describe what will be different because a state biomonitoring program exists.

Biomonitoring programs can take many forms, including an ongoing broad-based or targeted surveillance-type model and a community-based model responding to specific communities' concerns. Because there are many ways that a state biomonitoring program could be designed, the strategic planning process will also define and examine the benefits and limitations of various models that the state could potentially use in implementing a biomonitoring program in the future.

As part of the process for developing recommendations for an ongoing state biomonitoring program, the EHTB program is also developing priorities for chemicals to be included in future biomonitoring efforts.

A report summarizing recommendations for ongoing biomonitoring in Minnesota is expected to be released in 2009.

Environmental health tracking and biomonitoring advisory panel

Minnesota Statute 144.998 directs MDH to establish the environmental health tracking and biomonitoring advisory panel. The EHTB advisory panel advises program staff in the planning and implementation of the biomonitoring and environmental health tracking programs. As required by statute the panel is comprised of 13 scientists who represent a broad range of interests and expertise.

Since the inception of the EHTB program, the EHTB advisory panel has met six times and has made recommendations on a wide variety of issues, including biomonitoring pilot project designs (within the parameters established in statute); the development of biomonitoring program guidelines; a biomonitoring chemical selection process; the vision for an ongoing biomonitoring program in Minnesota; and strategic directions for the development of the Minnesota Environmental Health Tracking System.

In the future, the advisory panel will be involved in interpreting the results of the biomonitoring pilot projects; further articulating the direction for an ongoing biomonitoring program; developing additional priorities for environmental health tracking data analysis and research; and other aspects of the program.

The scope of the panel's duties, as defined in statute, is quite broad. The role of the advisory panel, as envisioned by the legislation, has been challenging to establish, given limited time and the significant number of tasks for the program and the advisory panel. Efforts will continue to make the best use of the panel members' expertise.

THE MINNESOTA ENVIRONMENTAL HEALTH TRACKING SYSTEM: INTRODUCTION

Background

We have witnessed a dramatic change in our nation's health burden over the last half century from infectious diseases such as pneumonia and tuberculosis, to chronic conditions – like asthma, heart disease, diabetes, neurological diseases, developmental disabilities, and cancer. The last half century has also spawned rapid advances in the development and production of tens of thousands of chemical compounds, many of which have made their way into our food, water, soil, air and homes.

And while the majority of Americans believe that exposure to environmental factors, such as pollution, causes increased rates of disease, in fact the evidence linking chemical exposures to disease is often lacking.

In Minnesota, as in other states, existing data on environmental hazards, exposures (measured either in the body or in the environment), and health have never been accessible in one place and systematically monitored. Data are collected across many programs, for various purposes, and are housed separately in what has been described as data "silos." This serves as an obstacle to studying and monitoring relationships among these elements.

Environmental health tracking was designed to bridge some of these data gaps, to make it easier for scientists and the public to examine and understand the relationships between environmental exposures and disease, and ultimately to take actions that will minimize environmental health threats and prevent disease.

Goals of environmental health tracking

In 2007, the Minnesota Legislature directed MDH to create an environmental health tracking program for Minnesota. Environmental Health Tracking is defined in the legislation as the "ongoing collection, integration, analysis, and dissemination of data on human exposures to hazardous chemicals in the environment and on diseases potentially caused or aggravated by those chemicals."

The newly developed Minnesota Environmental Health Tracking System (MEHTS) represents a systematic, expanded approach to gathering and integrating environmental and health data, such as birth defects and cancer surveillance data, air and drinking water quality monitoring data, and disease hospitalizations and death data.

MEHTS collects relevant information from disparate sources – focusing on the factors that have the greatest probability of impacting public health – analyzes it, and makes it available to those who can act to prevent or control disease. MEHTS data will be analyzed to recognize geographic and time trends, to identify exposure and health disparities and populations most affected, and to determine opportunities for public health action. MEHTS data will also help support research on environmental exposures and health outcomes.

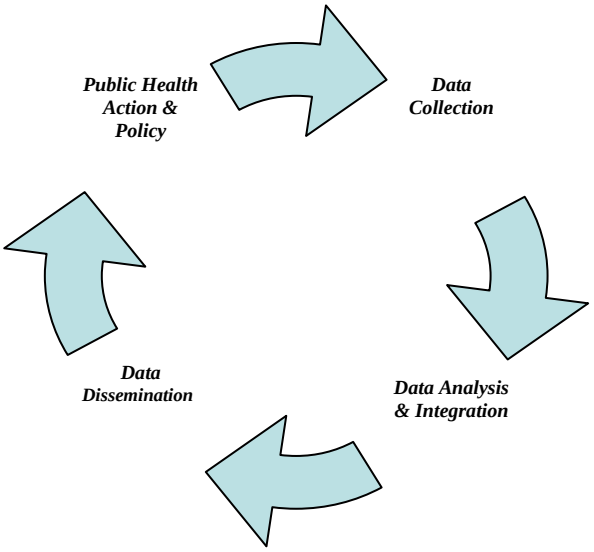
Over time, MEHTS will ultimately improve our capacity to better understand, respond to and prevent disease in Minnesota – thereby helping to guide public health action and investment in the state and leading to potential cost savings down the road.

How environmental health tracking works

The concept of conducting ongoing, systematic data collection to drive disease prevention policy and action is not new. Disease surveillance systems have been used by public health authorities to track infectious and chronic disease in the population for many years.

The typical cycle of a surveillance system includes four steps, as shown in Figure 1. These steps include collecting data, analyzing and integrating the data, disseminating the data, and using the data to inform public health action and policy.

Figure 1: Surveillance cycle



The goals of such surveillance systems are commonly defined as:

- Assessing or characterizing the scope of the problem
- Monitoring trends or changes over time
- Identifying groups at increased risk for targeting public health action or intervention
- Measuring the efficacy of those actions or interventions on public health

What is unique about the environmental health tracking program is that, for the first time, a population-based surveillance approach is being applied to a broad range of environmental data, together with disease data, as a means for driving environmental health policy, education, research and action.

Types of environmental health tracking data

Data that are part of MEHTS have been classified into three categories, which are unique to environmental health tracking programs: environmental hazard indicators, environmental exposure indicators and health outcome indicators:

- *Environmental hazard data* indicate the potential for people to be exposed to an environmental contaminant or hazardous condition. An example of environmental hazard data is the monitoring data that are routinely collected by public water suppliers and reported to MDH about contaminants found in drinking water.

- *Exposure data* indicate the presence of environmental contaminants in the body. An example of exposure data is the level of lead measured in children's blood by clinicians around the state, which is then mandatorily reported to MDH.

- *Health outcomes data* indicate the occurrence of diseases or health conditions that are known or suspected to be linked to exposure to environmental hazards. An example of health outcomes data is the number of hospital visits for asthma attacks, which is available through hospital billing records that are collected by the Minnesota Hospital Association.

More detailed information about the data that are currently part of MEHTS can be found in Figure 3.

Relationship between MEHTS and the national Environmental Public Health Tracking Program

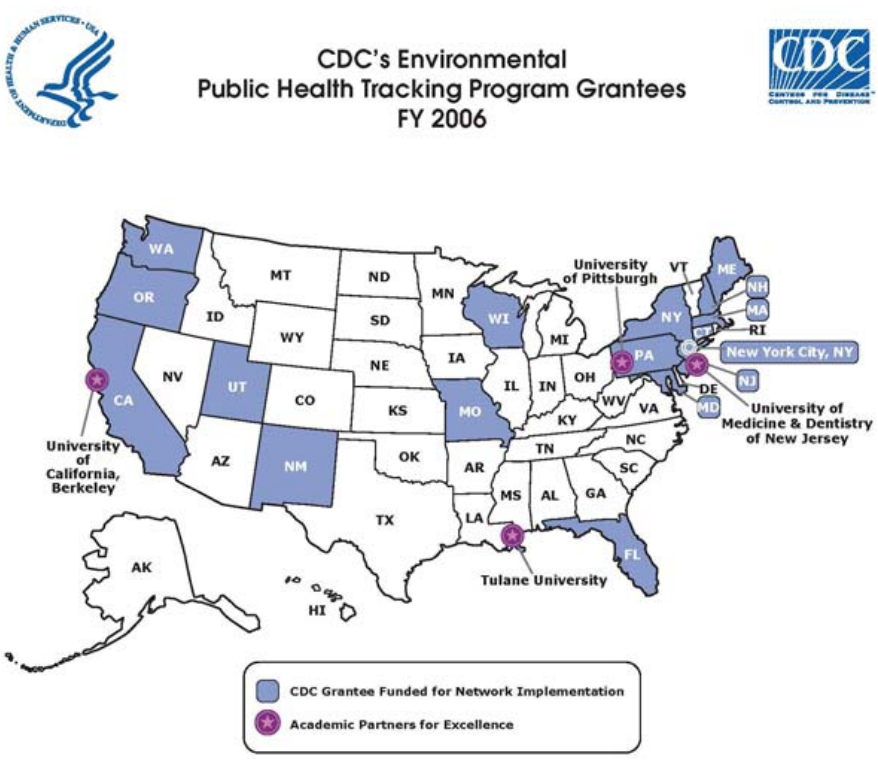
MEHTS is designed to be compatible with the national Environmental Public Health Tracking (EPHT) Program, which is housed at the Centers for Disease Control and Prevention (CDC). The national EPHT program began in 2002 and currently funds cooperative agreements with 16 states and New York City to build a web-based, electronic network for the collection, integration and dissemination of nationally consistent health and environmental data. (See Figure 2 for a map of EPHT grantees.) The EPHT Network is intended to provide standardized methods for comparing public

health and environmental data across multiple states and for building a comprehensive national environmental public health surveillance system.

Minnesota is unique in that funding for its environmental health tracking program comes from state sources rather than federal sources. As such, other non-CDC funded states look to Minnesota as a leader and innovator for working with our state legislature and stakeholders to develop a state-specific program. We are also the only environmental health tracking program in the country that includes, in the same legislation, a biomonitoring pilot program.

MEHTS program staff have been working closely with the national program and funded states in order to maintain consistency with national priorities wherever possible, to capitalize on resources available through the national program, and to influence the development of the national program.

Figure 2: National EPHT Grantees



Data collection, integration and analysis

The initial focus of MEHTS has been to collect and analyze data and measures within eight content areas that had been previously identified as a priority by the national EPHT program.

The eight initial content areas identified by the national program include the following:

Environmental hazards:
- Air quality
- Water quality

Exposures:
- Childhood lead exposure

Health outcomes:
- Hospitalizations
  - Respiratory disease
  - Myocardial infarctions (i.e., heart attacks)
- Cancers
- Carbon monoxide poisoning
- Birth defects
- Birth outcomes

These initial content areas were chosen by the national program because they reflect a demonstrated or suspected link between the environment and health. The specific data and measures within these content areas were chosen by the national program to standardize the available data across multiple states.

See Figure 3 and appendices A through C for more information on the specific data and measures that are part of the national EPHT program and MEHTS.

Figure 3: National EPHT and MEHTS data measures (indicators)

Air quality

National EPHT and MEHTS air quality measures currently include short-term exposure to ozone and short- and long-term exposure to particulate matter less than 2.5 microns in aerodynamic diameter, also called fine particulate matter or $PM_{2.5}$. High levels of ozone and $PM_{2.5}$ are the main known cause of poor air quality in much of the country. Both have been strongly linked with respiratory and cardiovascular health effects. Air quality data are limited to areas of the state where air quality monitors are located; currently this excludes most Minnesota counties. New methods are being developed in Minnesota and in other states to estimate exposures to air contaminants across the entire state for environmental health tracking purposes.

Water quality

The drinking water contaminants that are currently part of the national EPHT program and MEHTS include disinfection byproducts, arsenic and nitrates. These contaminants were selected by the national program because there is some evidence to support a link between exposure and health effects. The initial focus for these contaminants is community water systems (CWS), which provide water to people year round in their places of residence. Minnesota has 965 community water systems that serve approximately 80% of Minnesota residents.

Childhood lead exposure

Elevated blood lead levels (BLL) in young children have been associated with adverse health effects ranging from learning impairment and behavioral problems to death. The most common source of lead exposure for children today is lead paint in older housing and the contaminated dust and soil it generates. The national EPHT lead exposure measures include the percent of children born in a specific year tested for lead before the age of 36 months, the number and percent of pre-1950 housing units, and the number and percent of children under 5 living in poverty. These measures can be used to identify populations that are not being adequately tested, help parents determine if their community is at risk, and allow health care providers to identify children who should be tested for lead. In addition to the national EPHT lead exposure measures, MEHTS will also include data on the percentage of children poisoned (10 µg/dL or over) out of the number tested, the number of children with a test result triggering a housing inspection (15 µg/dL or over), and the number of children tested for the first time by year.

Hospitalizations (respiratory disease and myocardial infarctions)
Asthma hospitalizations have been associated with exposure to both particulate matter and ozone. Some research has also shown increases in heart attack hospitalization rates in relation to fine particles ($PM_{2.5}$), particularly in sensitive subpopulations such as the elderly and patients with pre-existing heart disease. National EPHT and MEHTS measures for hospitalizations include the number and rate of hospitalizations for asthma and acute myocardial infarction (heart attack). In addition to these measures, MEHTS will add hospitalizations for adult chronic lower respiratory diseases (which includes diagnoses of chronic bronchitis, emphysema, bronchiectasis and chronic obstructive pulmonary disease) in persons age 55 and over who are susceptible to air quality hazards.

Cancer
Cancer is a diverse group of diseases characterized by the uncontrolled growth and spread of abnormal cells. Risk factors for cancer include lifestyle choices (including cigarette smoking, alcohol consumption, diet, exercise, and exposure to certain medical drugs and hormones) environmental exposures (such as radiation, viruses, bacteria, and chemicals that may be present in the air, water, food, and the workplace) and genetics. However, the cause of many cancer types is not well established and the physical environment (air quality, chemical pollution, and water quality) remains a source of great public concern. The specific cancer types chosen for inclusion in the national EPHT program include breast cancer, cancer of the lung and bronchus, bladder cancer, cancers of the brain and other nervous system, cancers of the brain and central nervous system (in children), thyroid cancer, non-Hodgkin lymphoma, and leukemia. These cancers were chosen because of evidence that environmental factors, such as secondhand smoke, chemical exposures, and radiation, contribute to the risk of developing these diseases. In addition, MEHTS will add mesothelioma, a cancer that is known to be caused by exposure to asbestos.

Carbon Monoxide Poisoning
Carbon monoxide (CO) poisoning resulting in illness or death is a significant, but often overlooked, public health problem in the United States. Unintentional exposure to CO can occur in households (e.g., faulty furnaces and water heaters), in occupational settings (e.g., motor vehicle or small engine exhaust gas), or in recreational settings (e.g., boat exhaust). Natural disasters resulting in large-scale power outages have also been associated with CO poisoning. Many of these poisoning events are completely preventable through the proper installation, maintenance, and use of devices that burn fossil fuels, coupled with adequate ventilation practices and use of household CO detectors (now required by law in Minnesota. The national EPHT CO poisoning measures track annual numbers and rates of CO poisoning-related hospitalizations, emergency department visits, deaths, and calls to the Minnesota Poison Control Center. In addition, MEHTS will analyze data for monthly and seasonal variations in CO poisoning rates and will stratify poisoning events according to residence status inside and outside of the Twin Cities metropolitan area.

Birth defects
Birth defects are a leading cause of infant mortality and are responsible for considerable morbidity and disability with enormous economic and social costs. Approximately 60% of birth defects are of unknown cause. The ambient environment remains a source of great public concern, but few environmental exposures have been well-studied. Most birth defects will likely ultimately be explained by a complex interaction between genetic predispositions and environmental factors. The specific birth defects selected for inclusion in the national EPHT program include anencephaly, spina bifida, hypoplastic left heart syndrome, tetralogy of Fallot, transposition of great arteries, cleft lip, cleft palate, gastroschisis, upper limb deficiencies, lower limb deficiencies, hypospadias and trisomy 21 (Down Syndrome). These specific birth defects were selected because of possible environmental causes and because relatively consistent data are available across states. In Minnesota, information on the prevalence of birth defects is available only for Hennepin and Ramsey Counties.

Birth outcomes
There are critical windows of development during pregnancy when environmental exposures could damage growth and function of a fetus. Reductions in birth weight or increases in low birth weight have been associated with exposures during pregnancy. Preterm birth rates may also be associated with exposures during pregnancy. Preterm birth and decreases in birth weight can lead to infant death, disease, disability, and developmental problems. National EPHT and MEHTS measures for birth outcomes include the percent of preterm and low birth weight births, mortality rates, fertility rates, and sex ratio at birth.

By focusing first on data that are consistent with the national program, the MEHTS program was able to capitalize on the years of development work that had already been invested by EPHT grantees and others to refine the measures. In addition, MEHTS data will be able to be disseminated through the national network. This approach also positions Minnesota as a contributor to the national effort and as a competitive applicant for any future CDC funding to states.

Collecting, integrating and analyzing the data in these initial content areas involved numerous steps:

- MEHTS staff established relationships with the CDC EPHT program and actively participated in multi-state workgroups to develop methodology for national indicators.

- Working in partnership with various data stewards (i.e., the people and programs that collect and control the data that are used in the tracking system) across several programs and agencies, MEHTS staff identified the sources of the data in Minnesota and made a determination of whether all of the data needed to calculate the indicators that are part of the national set of data measures could be obtained.

- Data stewards were contacted and have contributed data and staff time to obtaining the MEHTS data measures. These data stewards included the following:
    - MPCA Air Quality Monitoring
    - MDH Drinking Water Protection Program
    - MDH Blood Lead Information System
    - MDH Birth Defects Information System
    - MDH Vital Statistics Program
    - MDH Injury and Violence Prevention
    - MDH Asthma Program
    - MDH Data Analysis Program
    - MDH Cancer Surveillance System

- MEHTS data analysts and epidemiologists, in collaboration with the data stewards, developed the necessary statistical code and methodology for analyzing the data. In some cases this required making improvements to methods that the national program developed.

- MEHTS staff have identified numerous limitations to the data available for environmental health tracking purposes, and are continually working with representatives from other states to modify the measures to improve data quality.

Identifying the limitations to the data and measures was an especially important part of the data collection and analysis process. While the data associated with each content area have unique limitations due to the variety of data sets in use, there are some challenges that are encountered across multiple areas.

For example, the geographic scope of the data is variable across data sets. Some data sets do not cover the entire state but may cover only certain counties, or certain segments of the population. Information on birth defects is currently available only for Ramsey and Hennepin Counties, for example. Air quality data are limited to areas of the state where air monitors are located, which excludes most counties. Water quality data are reported by community water system boundaries, which do not conform to other geographic units such as census tracts or counties. These kinds of variability will present a challenge to integrating certain data sets together.

In addition, MEHTS is limited to data that are already available. This means that some potentially important environmental exposures and diseases are excluded from the system because the information is not currently collected in a systematic manner. For example, private wells are not regulated by EPA and therefore do not have robust water quality data for approximately 20% of the Minnesota population. Air quality data are limited to information about outdoor air; even though indoor air quality can be a concern, systematic information is not currently available. Minnesota, along with most states, does not currently have a surveillance system for many health outcomes, including autism and other developmental disorders. (See below for a description of a feasibility assessment being conducted to develop an autism surveillance system.)

Another limitation is that for most health data, address and demographic information are incomplete. For example, hospitalization data contain zip code and county of residence, but more detailed street address information is not typically available. This limits the ability to link data on exposures – such as proximity to traffic corridors – to data on health. Information on race, ethnicity and socioeconomic status is also often not available or not reliable. Analyses based on these factors will be limited unless other supplemental sources of data are identified.

Data dissemination

In order for environmental health tracking information to be useful for driving action and policy, it must be disseminated in ways that make the information accessible and understandable by a wide audience of stakeholders. Potential audiences who will find MEHTS data useful include researchers, local and state public health and environment officials, policy makers, and non-governmental organizations.

As a first step toward data dissemination, MEHTS staff are currently working with data stewards, communications staff, the CDC and other states on determining the best methods for how data should be displayed and described. This includes making decisions about use of graphical displays and tables. Appropriate methodology for data displays being developed with CDC and state partners include methods for mapping and data smoothing. Data smoothing is a technique that helps to correct for large variability in disease rates in areas with smaller population sizes.

Establishing methods and rules for ensuring data privacy is also a necessary part of planning for data dissemination. Although all health outcome data used by the program for calculating indicators are de-identified (i.e., the data contain no names or address information) MEHTS staff also must ensure that data privacy is protected by implementing data suppression rules in cases where displays of small numbers in small geographic or demographic subsets of the data could possibly be used to identify an individual.

MEHTS data will be released in a variety of ways:

Environmental health tracking report

The next step toward data dissemination that is planned is publication of an environmental health tracking report, which will be released in the spring of 2009. This report will include a summary of all of the environmental health tracking data measures described in Figure 3 that are currently available. In accordance with the EHTB statute, the report will characterize statewide trends and geographic patterns of the data measures.

In recent years, new geographic information systems (GIS) technology and education has led to increased understanding of methods for mapping and associating geographic data, and there is much public interest in mapping health and environmental data together. But less attention has been paid to understanding the sources, complexity, quality and limitations of the data being examined. The MEHTS report will provide information about the limitations of the data and describe ways in which the data can be improved. The report will identify where new data sources and improved analytical methods are needed.

Environmental health tracking presentations

MEHTS staff are actively pursuing opportunities to speak to groups at conferences and other gatherings to share information about the program. Ongoing information sharing, outreach, education and risk communication are important components of the tracking program.

Web-based data access

Another important step towards improved data access and dissemination has been the development of web-based data access portals. The national EPHT program has been focusing attention on the development of a secure, web-based electronic network of integrated and nationally consistent health and environmental data. The national EPHT network, expected to be launched in February 2009, will include a public portal, providing access to aggregate environmental and health data, and a secure portal, providing password-protected access for researchers and public health officials. All CDC-

funded states are expected to submit state data to the national portal under their cooperative agreements.

Individual states that are funded by the CDC EPHT program are also in the process of developing their own online data portals, which will include the national data measures and additional data on their state-specific priorities. [See Figure 4 for examples of other states' portals. Also, see Appendix D for links to the websites of the national tracking program and state programs.]

Figure 4: State EPHT Web Portals

In Minnesota, as in other states, citizens and policy makers will need access to current, accurate information to serve as a basis for individual decisions as well as public policy to prevent disease and promote health. A public portal for web-based queries of MEHTS data is now in the early stages of design and planning. MDH Information Systems and Technology Management (IS&TM) experts are providing project management, systems architecture development, and other IT consultation to the EHTB program as needed.

To date, MEHTS and IS&TM staff have developed a software license agreement to adapt (with appropriate authorizations) an existing data portal developed by the Utah Department of Health, the Indicator-Based Information System for Public Health (IBIS) for use in Minnesota. This will allow MDH to download programs from the IBIS site and begin detailed evaluation of the resources and time required to adapt these programs to EHTB program needs. The Utah IBIS site can be accessed at: http://ibis.health.utah.gov/home.

Not only is this a well-established and powerful data portal, this system is being adapted for use in several other CDC-funded tracking programs (e.g., Missouri, New Jersey, and New Mexico). Evaluation of the IBIS system has shown that the development environment and software used for IBIS is compatible with systems used at MDH, thus minimizing the costs and development resources.

Minnesota is also considering the option to submit data to the national EPHT portal. Having Minnesota data available on the national portal will allow for cross-state comparisons, where appropriate. Also, some disease outcomes are so rare that having data available on a national level is the only way to facilitate learning about them.

Eventually MEHTS hopes to develop a secure data portal in addition to the public portal, which would grant data access to specific approved users. However, within the current funding allotment, this is not feasible. Financial constraints may limit the scope of the public portal as well. It may take up to two years of working with data stewards to complete the development of the portal and to load all of the current data content onto the public portal.

From data to public health action

Any data surveillance system is only useful in as much as it is used. The ultimate goal of data surveillance is to identify health priorities that can provide the basis for actions to improve public health. To achieve this goal, MEHTS staff have begun building relationships with individuals and programs that have a stake in the development and implementation of the environmental health tracking system. This includes data stewards (the people and programs that collect and control the data that are used in the tracking system) and data users (the people and programs that could potentially use the data to inform public health decisions).

Regular meetings of staff from three agencies, MDH, the Minnesota Pollution Control Agency (MPCA), and the Minnesota Department of Agriculture (MDA), are held to share information, plan and improve the collection of data for tracking purposes, and to discuss ways that the data are useful to our programs.

This process of interaction with stakeholders and data stewards has already yielded changes in some of the activities of programs that can make an impact on public health. See Figure 5 for specific examples.

Staff will continue to seek out opportunities to get feedback from stakeholders in terms of how they might use tracking data and what their priorities are for the development of the tracking system. We expect the number of state and local public health programs and activities that are impacted by environmental health tracking in Minnesota to continue to grow as the program develops.

Figure 5: Environmental health tracking data in action

Carbon monoxide poison prevention
MEHTS staff met with the Indoor Air Quality Unit and the Injury Prevention Unit at MDH to present the findings of the data collection and analysis for unintentional carbon monoxide (CO) poisonings in the state. A standard methodology for consistently monitoring CO deaths, hospitalizations, and exposure calls to Minnesota's Poison Control Center will now be used to inform these programs that work to educate and prevent such poisonings. The Indoor Air Quality Unit has requested more information about where, how and to whom these events most often occur. In addition, tracking of CO poisonings and CO detector usage will serve as a direct measure of the public health impact of new state legislation requiring CO detectors in all homes. More outreach to public safety officials is planned.

Developments in drinking water monitoring data and communications
MEHTS staff are working closely with staff in the Drinking Water Protection (DWP) Program at MDH to enhance drinking water quality information made available to the public. Content on the MEHTS web-based data portal is being developed to augment information that DWP currently provides on the MDH website and in annual reports. Improvements include new population-based measures of drinking water quality and community water system-level data. Further, the web portal is being designed to be user-friendly and provide maximum accessibility via graphical displays and interactive web queries.

Outreach and data sharing with the American Lung Association (ALA)
MEHTS staff and the Minnesota Chapter of ALA have recently teamed up to share surveillance data on the occurrence of chronic lower respiratory diseases in Minnesota. MEHTS program data are now part of the Minnesota ALA's Strategic Action Plan for COPD, one of the first programs in the nation to comprehensively address this disease. COPD is one of the leading causes of death in the United States. In 2009, Minnesota will be one of a small number of states to measure COPD prevalence statewide in the Minnesota Behavioral Risk Factor Surveillance System, utilizing support from MEHTS. MEHTS staff, together with ALA, plan to work with MPCA and MDH programs to provide information that will guide efforts to educate people about air quality alerts in Minnesota so that vulnerable adults, as well as children with asthma, are reached.

Changes in birth defects surveillance
Collaboration between MEHTS and the Birth Defects Information System has resulted in a change in how certain data elements are managed for cases. MEHTS staff plan to work with BDIS staff to support physician consultation services to classify a diagnosis accompanied by other birth defects as multiple congenital anomalies, which are considered sentinel events, or as syndromic.

Response to local public health inquiries
Through the coordinated action of two state agencies, MDH and MDA staff involved in the MEHTS program were able to respond to questions from a local public health agency about cancer and other health effects and public concerns related to pesticide spray or "drift" in an agricultural community. Data from the MDA about pesticide use in the affected area and specific pesticide toxicity and regulation were brought together with data from the Minnesota Cancer Surveillance System and current health studies of community exposure to pesticide drift. Follow-up with information for local health care providers and consideration of future tracking and biomonitoring for pesticide exposure was recommended.

Changes in air quality monitoring
MPCA has begun working with MEHTS staff at MDH to explore how existing air monitoring data can be integrated with health data to better understand the health effects of air pollution in Minnesota. As a result, PM10 monitoring was added at MPCA's Rochester monitoring site to assist an MDH EPA Start Grant that is exploring the connections between particle and ozone pollution and hospital admissions. In addition, MPCA is becoming more involved with national tracking teams at the CDC and EPA and is striving to ensure that, where possible, new monitoring siting decisions consider population exposure, comparability with other states, and the adequacy of the data to be integrated in modeling and health studies. These considerations will also be included as MPCA prepares its five-year monitoring network assessment.

Strategic planning

MEHTS staff have developed a strategic plan to guide program activities. The plan defines the mission of MEHTS and the specific goals and objectives to be attained in the next five years in order to achieve that mission. The plan also describes its potential stakeholders.

The mission of MEHTS, as described in the strategic plan, is to provide ongoing monitoring and analysis of information on hazards in the environment and the adverse health effects potentially related to those hazards. MEHTS will integrate this information on the environment and health and make it accessible to the general public, professionals and researchers in order to build knowledge about health and the environment and to drive actions to improve and protect the health of Minnesota communities.

The five goals described in the plan include the following:

- Develop a strong environmental health tracking system for Minnesota based on the collection and analysis of high-quality data
- Ensure environmental health tracking data are accessible and used
- Build awareness, knowledge and skills among potential data users related to environmental health tracking in order to inform actions to improve public health (e.g., policies, programs)
- Build relationships to enhance environmental health tracking in Minnesota
- Build and maintain a strong infrastructure within partnering state agencies to support the environmental health tracking program

THE MINNESOTA ENVIRONMENTAL HEALTH TRACKING SYSTEM: FUTURE DIRECTIONS AND RECOMMENDATIONS

MEHTS has the potential to be a powerful tool for affecting environmental health policy and action, but it will take time for the vision and goals set forth in the strategic plan and the requirements set forth in the statute to be fully realized.

While the early stages of data collection and working with data stewards have already led to promising new activities, it is clear that there is much more work to be done.

Ongoing work will focus on the following:

Evaluating the initial round of environmental health tracking data and measures

Once the initial data collection and analysis is completed, MEHTS staff will develop a process for evaluating each of the indicators that make up the tracking system. Some attributes of the tracking system that will be evaluated include the quality of the specific data, the stability of the measures and the representativeness of the data. The tracking system will also be evaluated to determine whether data users find the data useful and are actually using the tracking data to guide public health decisions and research.

Assessing gaps in the available data

MEHTS is limited to data that are already being collected through existing surveillance and monitoring systems. As the program has piloted the first round of tracking measures, some gaps in the available data have already become apparent. As new priorities are identified for possible inclusion in MEHTS, additional data gaps will be identified. As these gaps are noted, MEHTS will have a role in making recommendations about the development of new surveillance systems in Minnesota to measure health effects, environmental exposures and hazards.

Establishing new Minnesota-specific priorities for environmental health tracking indicator development and new data initiatives

As part of an overall strategic planning process, MEHTS staff will continue to identify and prioritize new content areas for developing environmental health tracking indicators in the future. This will be done in consultation with a variety of stakeholders. As new priorities are identified, MEHTS staff will continue to build relationships with data stewards to enhance future data collection efforts. Some of the priorities that MEHTS staff and partners have begun to explore are the following:

Mortality due to cardiovascular and respiratory diseases:

In addition to looking at hospitalizations for asthma and myocardial infarction (MI) (which are part of the national EPHT program), MEHTS is analyzing data on deaths due to MI, asthma and other chronic lower respiratory diseases (e.g., chronic obstructive pulmonary disease, bronchiectasis). Research has demonstrated associations between short-term exposures to particulate matter and deaths due to MI and chronic lower respiratory disease, especially in those 65 and older.

Tracking of autism spectrum disorders:

MEHTS is partially supporting the work of MDH staff in the Community and Family Health Division in assessing the feasibility of developing a surveillance program for autism spectrum disorders in Minnesota. In consultation with the CDC and other states, epidemiologists are reviewing the available data sources and working with data stewards to address issues of data access and limitations. The hypothesized links between environmental exposures and rates of autism spectrum disorders have been difficult to study partially due to the lack of a consistent methodology for measuring the occurrence of autism.

Climate change:
MEHTS is exploring ways to use existing data to track potential indicators of the impacts of climate change on public health in Minnesota. Some examples include hospitalizations and deaths attributed to extreme heat and cold events; air pollution episodes (temperature inversions); and mapping measures of population vulnerability to extreme weather-related events. This work is being done in collaboration with other states who are part of the State Environmental Health Indicator Collaborative of the Council of State and Territorial Epidemiologists.

Additional air quality indicators:
Additional measurements of air quality that are being explored include exposure to hazardous air pollutants (or air toxics) and measures of traffic exposure based on residential proximity to major roads. Traffic is known to be a strong contributor to local differences in air quality and can cause measurable impacts on health. Risk assessments of hazardous air pollutants suggest that population risk for cancer and non-cancer effects may be impacted by local exposure to certain air toxics (beyond the criteria pollutants that are currently regulated).

Pesticide poisoning and pesticide exposure:
Minnesota plans to join with New York City and other states to develop national and state indicator measures for pesticide exposures and health outcomes. Pesticide poisonings may be tracked through mortality, hospitalizations, and Poison Control Center call data. Exposures may be monitored through pesticide use and sales data, in collaboration with staff at MDA.

Disseminating MEHTS data to a variety of audiences and continue to educate stakeholders about the potential uses and limitations of the tracking system
A priority will continue to be placed on ensuring that MEHTS data are widely available to those who can use them. Given the multiple audiences who may benefit from MEHTS data, the program will explore a variety of formats for conveying the data.

Staff will continue developing a web-based, public-access data portal and will explore the development of a secure data portal as new funds become available. Outreach with public health scientists at local universities and colleges is planned to discuss data needs and identify ways that MEHTS could facilitate environmental public health research through. Communication avenues that will be explored include conference presentations and submissions to professional journals.

As a new surveillance system, potential users will need to learn how to appropriately use environmental health tracking data. MEHTS staff will assess data users' needs and offer opportunities for data users to build their capacity related to environmental health tracking. This may include information on how to interpret the data, potential applications of the data, how to use the online data portal, how to communicate about environmental health risks, and other topics.

Exploring data linkages
MDH and MPCA epidemiologists and research scientists, together with investigators at Olmsted Medical Center in Rochester, are currently working on developing methods for measuring the impacts of local and regional air pollution reduction strategies on cardiovascular and respiratory disease indicators. This work is being conducted with separate research funding from the U.S. EPA and is focused on the Twin Cities seven-county metropolitan area and Olmsted County. However, the methodology that is being utilized to study the statistical relationships or "links" between health and air quality data may be directly applicable to linkage projects that may be conducted in other areas and possibly be done on a statewide basis for MEHTS in the future. Other states, including New York, Michigan, and California, as well as several academic partners, including the University of Minnesota, are pursuing similar approaches.

This project serves as a model for new collaborations in environmental health research by joining the efforts of state, academic and medical scientists together in solving the challenges of working with the available health outcome and exposure data.

BIOMONITORING PILOT PROGRAM: INTRODUCTION

Biomonitoring is the direct measurement of chemicals (or the products that chemicals break down into) in people's bodies – in their blood, urine, or some other body fluid or tissue. Biomonitoring measurements can be a good way to determine exposure to a chemical, because biomonitoring indicates the amount of the chemical that actually gets into people, rather than the amount that could potentially get into people. Depending on how it is conducted, biomonitoring can be used to identify populations who are most at risk for exposure, to track changes in exposure over time, and to help target programs and interventions to reduce exposures.

In 2007, the Minnesota Legislature directed MDH to develop four biomonitoring pilot projects in communities likely to be exposed to environmental chemicals. Three of the chemicals were specified in the legislation (i.e., arsenic, mercury and PFCs); a fourth chemical was to be selected by MDH in consultation with the EHTB science advisory panel.

The four pilot projects, once completed, will provide information on the range of exposures to specific environmental chemicals in the selected communities. This knowledge will guide future efforts to develop, implement, or evaluate interventions to protect people's health.

In addition, the pilot projects will help MDH learn valuable lessons about the feasibility and usefulness of conducting biomonitoring in the future.

The four projects, when taken together, demonstrate a wide variety of biomonitoring project designs. (See Figure 6 for more information.) The populations selected include infants, children, pregnant women, and adults. The communities included in the pilots include urban, suburban and rural areas. The specimens that will be collected in the pilots include urine, blood, and newborn dried blood spots. Recruitment strategies range from random selection to convenience sampling. The variation in the project designs allows MDH to explore a wide range of approaches and to maximize its learning opportunities.

Figure 6. Comparison of four biomonitoring pilot projects

	Study population	Study community	Biospecimen/ Analyte	Likely source of exposure	Population sample	Recruitment goal
Minneapolis Children's Arsenic Study	Children, 3-10 years old	Urban; geographic community	Urine/ total and speciated arsenic	Ingestion of residential soil contamination, diet, and other exposure routes	Random selection	100
East Metro PFC Biomonitoring Study	Adults, 20 years and older	Suburban; communities based on drinking water source	Blood serum/ 7 PFCs including PFOA, PFOS, and PFBA	Ingestion of contaminated drinking water; diet, and other exposure routes	Random selection	200 (100 from each of 2 communities)
Lake Superior Mercury Biomonitoring Study	Newborns	Rural; geographic community	Newborn dried blood spot/ total mercury	Maternal dietary exposure (fish consumption)	Total population meeting inclusion criteria	1,150 in Minnesota; 600 in Wisconsin and Michigan
Riverside Prenatal Biomonitoring Study	Pregnant women	Urban; clinic-based community	Urine/ Environmental phenols including BPA, and cotinine	Diet and consumer product use (phenols); secondhand smoke (cotinine)	Total population meeting inclusion criteria; stratified by ethnicity	90 (30 from each of 3 ethnic communities)

While there are key differences among the four projects, there are several components that are common across all of the projects:

- In order to ensure the pilot projects are conducted in a way that is acceptable to and successful for the community, a priority has been placed on notifying study communities about the projects and offering opportunities for community stakeholders to provide input. Outreach and education efforts vary depending on the project and have involved numerous strategies, including sending project information home with school children in the project area, posting flyers at neighborhood parks and libraries, submitting articles to community newspapers, enlisting the assistance of neighborhood organizations, holding community meetings, and meeting with medical providers, public health officials, and advocacy groups.

- Each project is submitted for review by an Institutional Review Board to ensure that participants' rights are protected in accordance with the laws that protect human subjects in research.

- Participation in each of the pilot projects is completely voluntary. Written informed consent (including parental consent when applicable) is obtained for all participants.

- With the exception of the mercury project, which uses anonymous specimens, all participants have the opportunity to receive their own biomonitoring results, along with information to help them interpret their result. When possible, participants are provided with information about reducing their exposure to the chemicals being measured.

- With the exception of the mercury project which uses anonymous specimens, participants are also provided an opportunity to speak with a physician consultant about their results. When appropriate, participants with chemical levels in their bodies that are elevated above a level defined as "normal" will be advised to follow up with a medical provider for retesting or treatment.

- Education and information about the chemicals being tested along with guidelines and recommendations for medical follow-up are being provided to health care providers in each of the project communities.

- As pilot projects, these biomonitoring studies are limited in scope. The purpose of the pilot projects is to determine the ranges in the levels of selected chemicals in the study communities. The pilot projects also serve to build capacity at the state to conduct future biomonitoring projects and to inform recommendations for developing an ongoing state biomonitoring program. The pilot projects are not designed to determine the ways people are exposed to the chemicals or the health effects associated with exposure to the chemicals.

A detailed progress report on each of the four pilot projects is included below.

MINNEAPOLIS CHILDREN'S ARSENIC STUDY

The Minneapolis Children's Arsenic Study is measuring both individual and population-level exposure to arsenic in children living in specific neighborhoods in south Minneapolis, where elevated levels of arsenic were detected in the soil. In addition to the soil, people can also be exposed to arsenic through some foods (such as seafood), treated wood, pesticides, fertilizers, traditional and herbal medicines, and dietary supplements.

The study will help determine whether children living in the community as a whole have elevated levels of arsenic when compared to the level considered "normal" from a health viewpoint and compared to average levels found in a sample of the U.S. population.

Study community: The Minneapolis Children's Arsenic Study is being conducted in several neighborhoods in south Minneapolis, where elevated levels of arsenic were detected in the soil of several hundred residences. The specific neighborhoods include Corcoran, East Phillips, Longfellow, Midtown Phillips, Powderhorn Park, Seward, and Ventura Village. These are the same neighborhoods where the U.S. EPA conducted testing of the soil as part of an investigation of a former pesticide facility in south Minneapolis.

Study population: Participation in the study was limited to children, ages three through ten. Children were selected as the study population for this project because they are more likely to be exposed to arsenic in the soil, as they are more likely to be playing in the soil and to get soil in their mouths.

Biospecimen: Arsenic was measured in children's urine, which is considered the most reliable way to measure arsenic. However, because arsenic does not stay in the body for very long, an arsenic measurement in urine is just a snapshot of recent exposure to arsenic through the soil and other sources.

Recruitment and enrollment: A total of 65 children participated in the study. Though the original goal was to recruit 100 children from 100 different households where arsenic levels were over 20 parts per million (ppm), difficulties in recruitment led to several changes in the recruitment goals and eligibility criteria.

Using EPA soil sampling results, biomonitoring project staff first identified 883 households that were eligible to participate in the project. Each of these households was contacted to determine which of the households had children. Two mailings were sent to each household and up to three door-to-door visits by English-, Spanish-, and/or Somali-speaking study staff were made in an attempt to identify all eligible children. Study materials were translated into Spanish and Somali.

A 12% vacancy rate in the households originally identified reduced the number of eligible households, and fewer children resided in the eligible households than had been anticipated. When it became clear that the study would not be able to recruit 100 children from the original list of households, recruitment was expanded to all households in the study area (i.e., households with soil arsenic levels of 20 ppm or less), which added over 2600 potentially eligible homes. In addition, the study protocol was changed to allow more than one child per household to participate in the study. With these changes, the project was able to recruit 65 children, including 40 from the households with soil arsenic levels above 20 ppm. Participants received a $10 Cub Foods gift card to compensate them for their time.

Specimen collection and analysis: Specimen collection was completed between August 1 and October 1. Specimen collection was conducted at that time to ensure that children in the study were likely to have been in contact with the soil by playing outdoors. Participants' urine samples were collected at their own homes and picked up by project staff.

The measurement of arsenic levels in the urine samples was performed at the MDH Public Health Laboratory according to methodology developed by the CDC. The total level of arsenic in the urine was measured for all participants. In addition, when participants' arsenic levels were above 15 ug/L, the urine specimen was further analyzed to determine how much of the arsenic was organic (generally a safe form of arsenic) and how much was inorganic (a potentially harmful form of arsenic).

Communication of individual results: Parents of children participating in the study who requested to receive their children's results have received them, along with information to help interpret their result, identify possible ways their children are exposed to arsenic, and take steps to reduce the exposure. Parents of any children who had elevated levels of arsenic were provided with information about following up with a medical provider for retesting.

Community outreach: In order to ensure the project was conducted in a way that would be acceptable to and successful for the community, a priority was placed on notifying the community about the project and offering opportunities for community stakeholders to provide input.

For example, information about the project was sent home with school children in the project area; posted at neighborhood parks, libraries and other gathering places; and listed in community newspapers. Presentations about the project were made to a variety of community organizations, a display booth was staffed at several community events, and a formal community meeting was held to describe the project and to solicit input from residents. City public health and environmental staff, local elected officials, and neighborhood civic organizations were also consulted.

Further efforts will be made to engage community members once the overall project results are available later in the winter.

In addition to general community outreach, project staff contacted clinics in or near the project area with information about the project and made presentations to medical providers at three of the clinics. This helped ensure that medical providers in the area were aware of the project and could provide their patients with appropriate testing, follow-up care and counseling.

Data analysis and dissemination of results: Analysis of the grouped results is underway. This analysis will determine whether the community as a whole has elevated levels of arsenic. The analysis will also look for any correlation between levels of arsenic in the soil and levels found in the participants' bodies.

Overall project results are expected to be released in early spring 2009. A separate report describing the results of the Minneapolis Children's Arsenic Study will be released later in 2009.

EAST METRO PERFLUOROCHEMICALS (PFC) BIOMONITORING STUDY

The East Metro PFC Biomonitoring Study is measuring individual and population-level exposure to PFCs in adults living in specific communities in Washington County, where the drinking water was found to be contaminated with PFCs.

The study will help determine whether the community as a whole has elevated levels of PFCs when compared to the national average and range of exposures, when available.

Study communities: The East Metro Perfluorochemicals (PFCs) Biomonitoring Study is being carried out in two communities in Washington County, where the drinking water is contaminated with PFCs. The PFCs that have been detected in the water include perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorobutanoic acid (PFBA).

The two communities are defined not by geographic boundaries, but by their drinking water source. The first community is defined as households that are served by the Oakdale municipal water supply. This includes not only Oakdale residents, but a small number of households in surrounding communities as well. The second community is households with private wells contaminated with PFCs in Lake Elmo and Cottage Grove.

These communities were selected because testing has shown that the drinking water in these communities is contaminated not only with PFBA (which leaves the body relatively quickly due to its short half-life) but also with PFOA and PFOS (which have half-lives of three to six years and, as a result, stay in the body much longer).

Study population: This study was limited to adults, ages 20 and older. Adults are more likely to have been exposed to the contaminated drinking water over many years while living in the community. Adults were also selected as the study population for this project because participation involves having blood drawn from a vein in the arm. This is an invasive medical procedure with no health benefit, which posed ethical obstacles to including children in the pilot.

Biospecimen: PFCs are being measured in blood serum, which is considered the most reliable way to measure PFCs.

Recruitment and enrollment: For the Oakdale municipal water community, a total of ninety-eight participants completed the study. In the Lake Elmo and Cottage Grove private well community, ninety-eight participants also completed the study. The initial goal was to recruit 100 participants in each community.

To identify eligible households, Oakdale city water billing records and MDH well sampling results were used. In Oakdale, 500 households were randomly selected to receive an initial recruitment mailing to identify eligible adults living in the households; in the Lake Elmo/Cottage Grove community, all 168 eligible households were sent the initial mailing. To be eligible for the study, adults must have been living at their current residence before the PFCs were detected in the water.

From the lists of eligible adults generated by the initial recruitment mailing, 100 in each community were randomly selected and invited to participate in the biomonitoring study. When an invited individual declined to participate in the study, a new name was randomly selected from the list of eligible adults.

A study recruitment specialist made numerous phone calls to try to reach the initial recruitment goal.

Participants received a $20 gift card to Holiday to compensate them for their time and transportation cost.

Specimen collection and analysis: Specimen collection began in October 2008 and was completed in December 2008. Participants were directed to one of two HealthEast clinics under contract with MDH that were located in or near the study area to have their blood drawn.

The measurement of PFC levels in the blood samples is being performed at the MDH Public Health Laboratory according to methodology developed by the Centers for Disease Control and Prevention and by the MDH Public Health Laboratory. A total of seven PFCs will be measured; these are the same PFCs that were measured in the water in the east metro area:

- PFBA Perfluorobutanoic acid
- PFPeA Perfluoropentanoic acid
- PFHxA Perfluorohexanoic acid
- PFOA Perfluorooctanoic acid
- PFBS Perfluorobutane sulfonate
- PFHxS Perfluorohexane sulfonate
- PFOS Perfluorooctane sulfonate

Communication of individual results: All participants who request them will be mailed their own results. When possible, values will be compared to results obtained through the National Health and Nutrition Examination Survey (NHANES), which represents the average levels of exposure in the United States. Participants will be provided with information to help them interpret their results. Unfortunately, research on human health effects from environmental exposures to many PFCs is sparse, so it will not be possible to fully explain what the results mean.

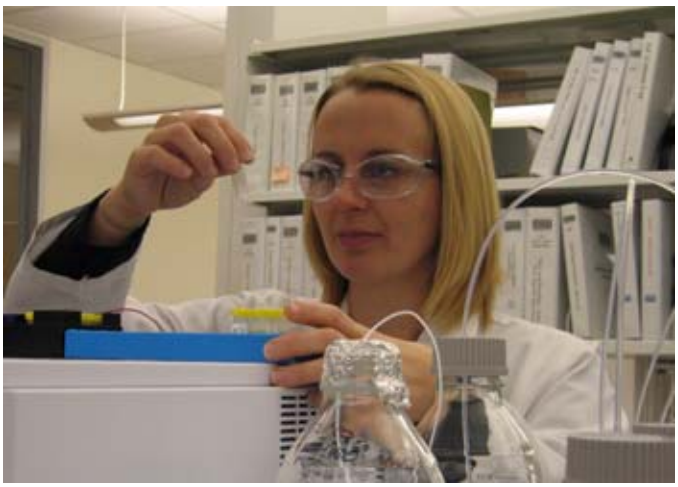
Community outreach: In order to inform community members and stakeholders about the project – and to obtain advice and input – project staff have taken several steps. Staff met with county public health and environmental staff and city administrators and local elected officials were also notified about the project. A series of formal community meetings was held and a display booth was staffed at additional meetings held in the community. Local officials assisted in getting the word out to residents through direct mailings, newsletters and websites. The local newspapers ran stories about the project and staff were interviewed for a show on a local cable station.

Further efforts will be made to engage community members once the overall project results are available in spring 2009.

In addition to general community outreach, efforts have been made to inform medical providers in the study area about the project. To date, project staff have conducted three presentations at medical clinics in or near the project area. This included an overview of the current research on the possible health effects of PFCs and suggestions for appropriate follow-up care for individuals who are concerned about their exposure to PFCs. Additional outreach to medical providers is planned when community results are released.

Data analysis and dissemination of results: Analysis of the grouped results will begin after all individual results are measured. This analysis will determine whether the two communities as a whole have elevated levels of PFCs when compared to national data.

Overall project results are expected to be released in the spring of 2009. A separate report describing the results of the East Metro PFC Biomonitoring Study will be released later in 2009.



LAKE SUPERIOR MERCURY BIOMONITORING STUDY

The Lake Superior Mercury Biomonitoring Study is funded primarily by the U.S. Environmental Protection Agency and is being conducted at MDH in collaboration with state newborn screening programs in Wisconsin and Michigan. The purpose of the study is to assess population-level exposure to mercury within the Lake Superior basin and to establish a reference range for mercury exposure in newborns. Information from the study will be used to assist local and state public health agencies to develop exposure prevention activities. The study also serves as a demonstration and assessment of the technical feasibility of a newly developed laboratory method for using dried newborn blood spots for biomonitoring.

Recognizing that financial and human resources for implementing pilot biomonitoring projects were limited, the EHTB program decided to provide support to the Lake Superior Mercury Biomonitoring Study in lieu of conducting a separate biomonitoring study for mercury, which would have been more costly.

Study community: The Lake Superior Mercury Biomonitoring Study is being carried out in northeastern Minnesota, within the Lake Superior Basin, specifically identified by ZIP code areas that that drain water into Lake Superior. While at this time there are no data to indicate whether people living in the Lake Superior basin are more likely to be exposed to mercury than people living in other parts of the state, all Minnesotans who consume fish are considered likely to be exposed to mercury.

Study population: The study is limited to newborns who are born to women living in the project area.

Biospecimen: In Minnesota, a few drops of blood are collected from the heel of newborns at 24-48 hours after birth. The blood is collected onto filter paper, dried, and submitted to the MDH Public Health Laboratory where it is analyzed for more than 50 heritable or congenital disorders.

For the Lake Superior Mercury Biomonitoring Study, mercury is being measured in the residual portion of the newborn dried blood spots. The mercury in the newborns' blood indicates the mothers' exposure to mercury while the baby was *in utero.*

Recruitment and enrollment: The study is attempting to recruit approximately 1,150 babies in Minnesota. Recruitment began in November 2008 and is expected to continue into 2010

Virtually all infants born in the Lake Superior basin during the study period for whom a blood spot is provided to the newborn screening program will be eligible to be included in the study. Blood spots will be excluded from the study if the infants died, were of very low birth weight, had abnormal newborn screening results, or their parents directed MDH to destroy the newborn blood specimen.

Mothers whose infants are eligible to participate in the study will be sent a letter and consent form within a few weeks of giving birth. The first letters were sent from MDH to prospective participants in November 2008. As of January 9, twenty-nine newborns have been enrolled in the study. Local public health departments in the study area plan to assist with recruitment.

Specimen collection and analysis: Because the study utilizes specimens collected for other reasons, specimen collection is not a part of the project.

Once consent is received from parents, the newborn dried blood specimens will be retrieved from storage and anonymized. This means that no identifying information will be linked to the blood spot or the result; only the ZIP code cluster, baby's birth month and year, and the baby's gender will be retained.

The measurement of mercury levels in the newborn blood spots is being performed at the MDH Public Health Laboratory according to methodology adapted from the CDC by MDH and Utah public health laboratory scientists.

Communication of individual results: Because the blood spots will be anonymized, participants will not receive their individual results. Potential participants are notified of this fact during the recruitment and informed consent process.

Community outreach: MDH staff have met with local, county and tribal health officials in the project area to inform them of the project and to solicit their input on developing a communication plan. Over the course of the study, MDH staff will communicate with medical providers about the study and will distribute informational materials on mercury exposure to community members, medical providers and local public health officials.

Data analysis and dissemination of results: Analysis of the grouped results will begin after all individual results are measured. Though study recruitment will continue into 2010, interim reports will be prepared as data become available. A separate report describing the results of the entire Lake Superior Mercury Biomonitoring Study will be released in fall 2010.

RIVERSIDE PRENATAL BIOMONITORING STUDY

The Riverside Prenatal Biomonitoring Study is being conducted as an ancillary study to a research project at the University of Minnesota. The Riverside Prenatal Biomonitoring Study will measure pregnant women's exposure to a class of chemicals called environmental phenols, which are found in certain plastics, cosmetics and toiletries, and to cotinine, which is an indicator of exposure to secondhand smoke. These chemicals were selected because of concerns that they may affect fetal development.

The study will determine the range and distribution of exposures to the selected chemicals in the study participants and will attempt to examine differences in exposure based on race/ethnicity. Where possible, the results will be compared to national data. The project also serves as a demonstration of the feasibility of collaborating with an external researcher as an ancillary study to conduct biomonitoring and will help the state learn alternate methods for recruiting participants using a clinic-based approach.

As with the mercury biomonitoring study, limitations on time as well as financial and human resources led the EHTB program to explore various ways to conduct biomonitoring without developing a free-standing study. Collaborating with another study already in progress was deemed the best and most viable option.

Study community and population: The study includes pregnant women who obtain prenatal care at one of several clinics and who plan to give birth at the University of Minnesota Medical Center, Fairview (Riverside Campus) in Minneapolis.

Biospecimen: The selected chemicals will be measured in urine, which was the most feasible specimen that could be obtained given the study design. All of the chemicals that were selected are appropriate to measure in urine.

Recruitment and enrollment: Participation is limited to women who are enrolled in the Riverside Birth Study (RBS), a research study being conducted at the University of Minnesota. Women who enroll in the RBS will be offered the opportunity to indicate whether they wish to be contacted about other studies in the future. If they say yes, they will be eligible for inclusion in the biomonitoring study and will receive information about the study in the mail.

The Riverside Prenatal Biomonitoring Study will attempt to recruit 90 women. Efforts will be made to include an equal number of Latina, African/African-American, and white women.

Participants will receive a $10 gift card to compensate them for their time.

Specimen collection and analysis: Specimen collection is expected to begin in early 2009. Participants will be asked to provide a urine specimen using a collection kit that will be sent to their homes.

The measurement of environmental phenols in the urine samples is being performed at the MDH Public Health Laboratory according to methodology developed by the CDC. The specific environmental phenols that will likely be measured include the following:

- Bisphenol A
- Triclosan
- Benzophenone
- Methyl paraben
- Ethyl paraben
- Propyl paraben
- Butyl paraben

The measurement of cotinine in the urine will be performed by a commercial lab paid by MDH.

Communication of individual results: Participants will be offered the opportunity to receive their individual results. Where possible, results will be compared to a national average from the National Health and Nutrition Examination Survey (NHANES). Because research on the human health effects from environmental exposures to environmental phenols is inconclusive, it will be

difficult to provide detailed information about what the results mean. Participants will also be provided with general information on avoiding environmental tobacco smoke and other environmental hazards during pregnancy and after the birth of their children.

Community outreach: EHTB staff will contact local and county health officials to inform them about the project and to solicit their input. Community groups and organizations with a stake in the project will also be consulted.

Data analysis and dissemination of results: Analysis of the grouped results will begin after all individual results are measured.

A report describing the results of the Riverside Prenatal Biomonitoring Study will be released later in 2009.

BIOMONITORING PILOT PROGRAM: CONCLUSIONS

Though not yet completed, the biomonitoring pilot projects have already provided MDH with many valuable lessons about carrying out state biomonitoring efforts. The state's capacity for conducting biomonitoring has been built in numerous areas.

In the MDH Public Health Laboratory, new equipment has been purchased to ensure that the most accurate measurements possible are obtained. Staff have received extensive training in analyzing human biomonitoring specimens, including in-person training with staff from the CDC's Environmental Health Laboratory and other state public health labs.

The process for developing and mastering laboratory methods for analyzing environmental chemicals in human biospecimens is time-consuming. Steps have included internal and external validation studies, proficiency testing, and federal certification. Because the MDH Public Health Lab had already invested several years studying several of the selected chemicals in water, soil and/or fish samples and, using separate funding, developing the capacity to measure environmental toxins in human specimens, the biomonitoring program was able to respond with relative speed. Having conducted the four pilot projects, the MDH public health lab is now positioned even more advantageously to tackle the challenges of biomonitoring and to address emerging environmental concerns in the future.

In the Health Promotion and Chronic Disease and Environmental Health Divisions at MDH, capacity has also been built in terms of biomonitoring project design and implementation:

- Designing and implementing high quality biomonitoring projects requires significant time and effort. In order to ensure that the projects are scientifically defensible, ethically sound, and acceptable to the community, numerous review and approval processes are necessary. In conducting the pilot biomonitoring projects, staff have learned about effectively navigating these processes.

- Recruitment and enrollment of study participants is one of the most labor intensive parts of implementing a biomonitoring program. The four pilot projects have allowed program staff to learn about effective recruitment methods in a variety of settings. Recruitment strategies included fliers, community meetings, mailings, phone calls, and door-to-door visits. Recruitment challenges differed depending on the specific communities (which included a diverse, multi-lingual urban area, a rural area and a suburban area) and how engaged and knowledgeable the community was about environmental issues.

- Because biomonitoring studies are relatively new and can be difficult to understand, it is important that community members be informed about the state's biomonitoring efforts. By carrying out the pilot projects, program staff have established numerous community connections in each of the project areas and learned a great deal about appropriate communication channels in different communities. These connections were vital for establishing a basic level of trust with the community and for ensuring that community members were informed about the projects. If a biomonitoring program were to continue, these community connections would be strengthened and expanded with time, allowing an ongoing biomonitoring program to be implemented more smoothly.

- Generally speaking, scientists' ability to measure chemicals in the body through biomonitoring has outpaced their ability to explain what those results mean for human health. This presents challenges for communicating with biomonitoring study participants about their results. The four pilot projects allowed program staff to explore different ways of communicating about environmental exposures when there are known health risks and when health effects are largely

unknown; when medical treatment is available and when it is not; when exposure routes are well documented and when they are less understood. Program staff also gained experience in developing educational materials for a wide variety of audiences.

- Biomonitoring poses a number of ethical challenges and the pilot projects have helped program staff and management to understand and confront some of these challenges. In development of project protocols, decisions were made to address some of these issues, including the participant's right to know their individual results versus the need to anonymize specimens in laboratory research, establishing separate informed consent for storage and future use of specimens in research, and determining when it is ethical and appropriate to include children. Where projects are community-based, the ethical challenge to "first do no harm" was also confronted in decisions regarding how to conduct the projects so that the communities' best interests and expectations were part of the decision process.

- Another looming challenge for public health practitioners is to identify and implement the appropriate public health responses that are needed as a result of new information learned from state biomonitoring activities. For many chemicals, there are no clinical reference values or "action levels" that identify when a given exposure is "high" or when further exposure investigation might be needed. When and how to intervene or respond to protect public health on the basis of biomonitoring results is still uncertain and an area where new public health policy development is needed.

Biomonitoring that is structured around selected communities has the potential to provide important information to community members about their exposures to specific chemicals. However, this model for biomonitoring also comes with some constraints and inefficiencies. For example, small community-level biomonitoring projects are generally not useful for follow-up health studies due to small numbers. Larger populations are needed for making links to health outcomes. In addition, opportunities for building knowledge and laboratory capacity are reduced when chemical analyses are limited to a specific chemical that the site or community is likely to have been exposed to. Due to the significant cost of enrolling project participants and collecting specimens, projects that measure multiple chemicals in a given population or community are more efficient than multiple community projects, each measuring one chemical. These benefits and limitations will be taken into account in developing recommendations for an ongoing biomonitoring program for Minnesota.

With four pilot projects well underway, Minnesota has built the knowledge, skills and relationships necessary for implementing further biomonitoring efforts in the future. However, with state funding to the EHTB program scheduled to be reduced by 50-percent beginning in fiscal year 2010, biomonitoring efforts will not continue beyond the four projects that are underway.

DEVELOPMENT OF BIOMONITORING PROGRAM GUIDELINES

Biomonitoring poses unique challenges when performed within a public health context. Public health agencies must give careful thought to how biomonitoring efforts are designed and must communicate and use biomonitoring data appropriately.

In order to guide decisions about the design and implementation of the four biomonitoring pilot projects, and in accordance with the EHTB statute, the EHTB program developed program guidelines that address the science and practice of biomonitoring.

These guidelines, which were developed in consultation with the EHTB science advisory panel and formally approved by the panel at its September 2008 meeting, define the purpose of the state's pilot biomonitoring program and include guidance in a number of areas related to pilot program development and implementation. The overarching guideline statements in each area are included below; a complete set of the biomonitoring program guidelines, which provides more detail about each of the guideline areas, is available upon request.

Pilot program purpose: Biomonitoring pilot projects should provide information to individuals and communities about the prevalence and range of exposure to chemicals in the selected community and compare those values to a reference range.

Pilot project design: For each pilot project, a protocol document will be developed for review by the EHTB Advisory Panel and the MDH Institutional Review Board to ensure the project is scientifically sound and conducted in a manner that meets all ethical and legal requirements as stipulated by the EHTB statute, the biomonitoring program guidelines, and the Minnesota Government Data Practices Act.

Privacy of information: MDH data storage systems, in compliance with the Minnesota Government Data Practices Act, provide adequate protection of data privacy; anonymization of samples and data collected by the EHTB pilot program, which limits the potential uses of the data and the communication of individual results, is not necessary to ensure data privacy.

Informed consent: Written informed consent will be obtained from each participant (or adult guardian of a participating minor) who provides a biospecimen as part of EHTB biomonitoring pilot projects. The consent document must meet informed consent requirements under federal rules and policy developed by the Department of Health and Human Services and be accepted by the Institutional Review Board (IRB) of MDH and any partnering institution.

Laboratory quality assurance: Laboratories approved to provide biomonitoring data for the EHTB Program must fulfill many criteria, including those listed herein. They must have a documented quality assurance plan and must adhere to any required quality control procedures specified in an approved method. They must ensure that the analytical data are scientifically valid and legally defensible. The data must be of known and acceptable precision and accuracy, and data must be protected in accordance with the Minnesota Government Data Practices Act.

Laboratory approval program: The EHTB program will utilize only those laboratories that have provided assurance that systems are in place to generate reliable data. Generally, assurance is provided by federal certification under the Clinical Laboratory Improvement Amendments (CLIA) for laboratory testing on humans.

Storage of specimens: Biospecimens collected through the EHTB biomonitoring pilot projects will be stored, at a minimum, for the duration of the project (approximately one year), with the written, informed consent of the participant. If continued storage of the specimens beyond the duration of the project for future research purposes is planned, then the consent document will offer participants the option to allow or refuse the storage and use of their specimen for future research. Specimens for which written consent for long-term storage and use has not

been obtained from the participant will be destroyed at the completion of the project.

Use of stored specimens for future research: Researchers (both internal to MDH and external) who request to use stored specimens for research beyond the pilot projects will be required to submit an Application for Sharing Biological Samples to an MDH oversight committee for review and approval.

Communication of results: All individual participants have a right to know their individual results.

Community acceptance and participation: Biomonitoring staff will take steps to learn about the communities in which the pilot projects take place and will solicit input from community members on specific aspects of the projects' design and materials. Project materials and procedures will be developed in ways that encourage voluntary participation.

Follow-up counseling: Basic follow-up health education and counseling services must be available for participants.

Selecting appropriate reference (comparison) values for data interpretation: Appropriate (clinical) guideline-based or population distribution-based reference values should be reviewed and used for the interpretation of individual and community pilot project results.

Inclusion of children in biomonitoring pilot projects: Children may be included in biomonitoring pilot projects as long as the ethical requirements for protection of research subjects set forth by federal rules and policy developed by the Department of Health and Human Services (45 CFR part 46) and accepted by the IRB of MDH and other partnering institutions have been met.

These guidelines helped inform decisions made about the four pilot projects by setting standards for biomonitoring projects in Minnesota that are scientifically sound, have community acceptance, and address all ethical and legal considerations for studies that involve human subjects. With ongoing revisions, these guidelines will also help inform the development and implementation of an ongoing statewide biomonitoring program, should funding for such a program become available.

These guidelines were informed by numerous sources, including the CDC's National Biomonitoring Program and recommendations developed by the National Research Council.

RECOMMENDATIONS FOR ONGOING BIOMONITORING IN MINNESOTA

While the pilot phase of the biomonitoring program is underway, the EHTB program has also been formulating recommendations about the development of an ongoing state biomonitoring program in Minnesota. These recommendations will help inform the directions of a future state biomonitoring program should funding be available.

A wide range of viewpoints have been sought to inform these recommendations. The planning process has drawn on the knowledge and expertise of state agency staff, EHTB advisory panel members, the general public, and other stakeholders, such as other state and federal biomonitoring programs.

Vision and purpose of biomonitoring

One component of the recommendations for a future state biomonitoring program is the development of a statement of vision and purpose for biomonitoring. Biomonitoring can be conducted for a variety of reasons and through a variety of formats. Through the visioning process, the program will seek to articulate what is the best use for biomonitoring in Minnesota and what difference a biomonitoring program could make in terms of the health of Minnesotans.

To elicit the varying viewpoints on these topics, the EHTB program conducted a series of interviews with the staff of other biomonitoring programs in the United States and with members of the EHTB workgroup, steering committee and advisory panel. Minnesota participants were asked to describe the role they felt a state biomonitoring program should play; the opportunities and challenges for a state biomonitoring program; and the potential beneficiaries and collaborators of a biomonitoring program. Participants from other government biomonitoring programs were asked to describe the vision and purpose of their respective programs; the advantages and disadvantages of their program's approach; and any lessons learned that Minnesota's program should be aware of. [A summary of these interviews is available at upon request.]

Through a series of discussions, state agency staff, in consultation with the EHTB advisory panel, have drafted a vision statement for the state biomonitoring program. The draft vision foresees the long-term impacts of a state biomonitoring program to be an increase in knowledge about environmental risks and disease; effective use of biomonitoring data by a variety of stakeholders; and, ultimately, safer environments and healthier people.

Program staff and advisory panel members are also considering the range of possible purposes of a state biomonitoring program. It is likely that the final recommendations for a state program will incorporate multiple purposes, including a focus on both population-level and community-specific monitoring and intervention. This would facilitate the linking of biomonitoring and environmental health tracking data while also addressing public health concerns in specific communities.

In establishing a strong biomonitoring program that fulfills the fundamental purposes of monitoring the distribution and trends in chemical exposures among specific communities and the broader population, additional gains can then be realized. For example, biomonitoring data could be used to support research to help better understand health outcomes, exposure pathways, and to develop laboratory methods.

The program's vision statement and purposes will be refined over the coming months as discussions continue about the most appropriate purposes and goals for biomonitoring in the state.

Biomonitoring strategies

In addition to articulating the vision and purpose of a state biomonitoring program, it is important to develop plans for the practical strategies that will help the program achieve its vision. This will include a consideration of the multiple models in which a state biomonitoring program could occur.

State agency staff and EHTB advisory panel members are also in the process of exploring these

models, learning about the relative merits and limitations of each in order to make recommendations for which models could provide the most benefit to Minnesota.

Priority chemicals for biomonitoring

A third component of the planning process is to develop recommendations for chemicals to be included in a future state biomonitoring program.

The first step of the chemical selection process was to develop a set of criteria to be used to score potential chemicals. In consultation with the EHTB advisory panel, the EHTB program settled on the following criteria:

- Degree of exposure in the state population or a sub-population of interest
- Seriousness of health effects resulting from exposure
- Interpretability of the result (e.g., availability of appropriate numbers for comparing the results; degree of information known about what different levels in the body mean)
- Actionability (e.g., ability for public health action to be taken to stop the exposure; there is a need to assess the effectiveness of prior public health actions to reduce exposure)
- Potential for information building (e.g., degree to which studying the chemical would add to the existing knowledge base about chemical exposures; degree of public concern)
- Ability to measure the chemical (e.g., adequacy of analytical methods to detect the chemical; availability of adequate biospecimen samples; degree to which the chemical stays in the body long enough to be measured)
- Feasibility (e.g., cost; capacity)

The next stage of the process was to identify a list of potential chemicals for consideration. During fall 2008, MDH solicited nominations for potential chemicals from the public and from the state agency staff.

Public input was sought via an online survey. The survey was posted for four weeks. Respondents also had the option of submitting input by U.S. mail or email. Response to the online survey was limited, with only 15 respondents.

Staff members working in state and regional agencies that potentially deal with environmental chemicals were contacted to provide input as well. The agencies contacted included the Minnesota Department of Agriculture, the Minnesota Department of Health, the Minnesota Department of Labor and Industry, the Minnesota Department of Transportation, the Minnesota Poison Control System, the Minnesota Pollution Control Agency, and the Metropolitan Council. In many cases, more than one division or program within an agency was sought out. Over 40 state agency staff were included in the process.

This chemical nominations process helped program staff gain an understanding of the priorities of various stakeholders.

[A summary of the chemical nominations process, including a list of chemicals that were nominated, is available upon request.]

It is anticipated that each of the chemicals that was nominated for inclusion will be scored according to the selection criteria provided above. In addition, the chemicals that are part of the national biomonitoring program (the National Health and Nutrition Examination Survey conducted by the CDC) will also be scored.

Once scored, the list of chemicals will be reviewed by the EHTB advisory panel, which will make recommendations to the commissioner of health about which chemicals are the highest priorities for inclusion in a state biomonitoring program.

Once the biomonitoring planning process is completed, a report will be released outlining the state's recommendations for an ongoing biomonitoring program. It is anticipated that this report will be released in 2009.

THE ENVIRONMENTAL HEALTH TRACKING AND BIOMONITORING SCIENCE ADVISORY PANEL

The Environmental Health Tracking and Biomonitoring science advisory panel advises program staff in the planning and implementation of the biomonitoring and environmental health tracking programs.

The panel is important in advising the program on the development and implementation of the EHTB program. Panel members represent many different constituencies and disciplines, which allows program staff to hear many viewpoints and to benefit from a wide range of expertise. Because the EHTB panel was established specifically as a science advisory panel, the group also plays a vital role in providing a scientific peer review on the program's work.

As required by statute, the panel is made up of scientists and citizens who have a background or training in designing, implementing, and interpreting health tracking and biomonitoring studies or in related fields of science. The panel members represent industry, medicine, public health, non-governmental organizations, academia, and state agencies.

As required by statute, panel members serve as volunteers.

The EHTB advisory panel meets four times per year. Occasionally, an additional meeting is scheduled to tackle a specific topic that cannot be adequately addressed during the limited time available for regular panel meetings. For example, in 2008, panel members were invited to attend meetings to inform the development of guidelines for the biomonitoring program and the vision and purpose of the biomonitoring program.

The role defined for the EHTB advisory panel in statute is quite broad. The panel is given responsibility for consulting with MDH on virtually all aspects of program development and implementation. The panel's purview extends to issues both large and small, including those related to the scientific integrity of program activities and overall priority setting as well as those relating to carrying out specific program functions, such as training and communications.

During 2007 and 2008, the advisory panel provided guidance on specific aspects of the biomonitoring pilot projects that were not already specified in statute. The advisory panel requested staff to engage in a strategic planning process to identify the long-term vision for an ongoing biomonitoring program and to develop a process for prioritizing chemicals for possible inclusion in a future program. The advisory panel provided input on a strategic plan for the Minnesota Environmental Health Tracking System and a set of guidelines for the biomonitoring pilot program.

Given the broad scope of the panel's role in statute and the voluntary nature of panel membership, MDH staff have struggled at times to involve the panel in the most meaningful ways and yet still keep the work of the program moving on schedule. Program staff will continue to search for ways to improve the function of the panel in the future.

APPENDIX A: NATIONAL EPHT MEASURES BY CONTENT AREA

The following list summarizes the specific measures recommended by the national EPHT program in each of the priority content areas.

Drinking Water

I. Level of Contaminant in Finished Drinking Water
   A. Disinfection byproducts (DBP)
      1. Number and % of community water systems (CWS) with any DBP MCL violation, by year
      2. Number and % of CWS with any DBP MCL violation, by quarter
      3. Number and % of CWS with each of 0,1,2,..8 DBP MCL violations, by year
   B. Arsenic
      1. Number and % of CWS with any arsenic MCL violation, by year
      2. Distribution of mean arsenic concentrations across CWS, by 3-year compliance (sampling) period (cut-points: <3, 5, 10, 15, >15 ppb)
   C. Nitrate
      1. Number and % of CWS with any nitrate MCL violation, by year
      2. Distribution of mean nitrate concentration across CWS, by year (cut points: <=1, 3, 5, 10, 20, >20 mg/L nitrate-nitrogen)
      3. Distribution of maximum nitrate concentration across CWS, by year (cut points: <=1, 3, 5, 10, 20, >20 mg/L nitrate-nitrogen)

II. Potential Population Exposure to Contaminants in finished drinking water
   A. Disinfection byproducts (DBPs)
      1. Number and % of people served by CWS with any DBP MCL violation, by year
      2. Number and % of people served by CWS with any DBP MCL violation, by quarter
      3. Number and % of people receiving water from CWS with each of 0, 1, 2, ,.., 8 DBP MCL violations per year
      4. Percent of 'person-months' for which no DBP violation occurred, by year
      5. Distribution of number of people by mean DBP concentration, by quarter
      6. Distribution of number of people by mean DBP concentration, by year
   B. Arsenic
      1. Number and % of people served by CWS with any arsenic MCL violation, by year
      2. Distribution of number of people by mean arsenic concentration, by 3-year compliance (sampling) period
   C. Nitrate
      1. Number and % of people served by CWS with any nitrate MCL violation, by year
      2. Distribution of number of people by mean nitrate concentration, by year (cut points: <=1, 3, 5, 10, 20, >20 mg/L nitrate-nitrogen)
      3. Distribution of number of people by maximum nitrate concentration, by year (cut points: <=1, 3, 5, 10, 20, >20 mg/L nitrate-nitrogen)

Air Quality

I. Short term exposure to ozone
   A. Number of days with maximum 8-hour average ozone concentrations over the National Ambient Air Quality Standards (NAAQS) (.075 ppm)
   B. Person-days with maximum 8-hour average ozone concentrations over the NAAQS (.075 ppm)

II. Short-term exposure to PM2.5
   A. Number of days with maximum 8-hour average PM2.5 concentrations over the NAAQS (35 ug/m3)
   B. Person-days with maximum 8-hour average PM2.5 concentrations over the NAAQS (35 ug/m3)

III. Long-term exposure to PM2.5
   A. Annual average (based on seasonal averages and daily measurements) for ambient PM2.5 concentrations
   B. Percent of the population living in areas that exceed the annual concentration NAAQS (15 ug/m3) *[Note: Due to the fact that all monitored counties in Minnesota met current NAAQS for annual PM 2.5 concentrations, this measure is not necessary and is not reported on.]*

Hospitalizations

I. Asthma
   A. Annual number of hospital admissions, all ages, by gender and for total
   B. Average, minimum and maximum daily number of hospital admissions, per month
   C. Daily number of hospital admissions, by gender and for total, by age group
   D. Annual age-specific rate of hospitalizations, by gender and for total
   E. Annual crude rate of hospitalizations, by gender and for total
   F. Annual age-adjusted rate of hospitalizations, by gender and for total

II. Myocardial Infarction
   A. Annual number of hospital admissions, all ages, by gender and for total
   B. Average, minimum and maximum daily number of hospital admissions, per month
   C. Daily number of hospital admissions, by gender and for total, by age group
   D. Annual age-specific rate of hospitalizations, by gender and for total
   E. Annual crude rate of hospitalizations, by gender and for total
   F. Annual age-adjusted rate of hospitalizations, by gender and for total

Carbon Monoxide (CO)

I. Annual number of hospitalizations from CO poisoning
II. Annual crude and age-adjusted CO poisoning hospitalization rate
III. Annual number of emergency department (ED) visits from CO poisoning
IV. Annual crude and age-adjusted rate of ED visits for CO poisoning
V. Annual number of deaths from CO poisoning
VI. Annual CO poisoning crude and age-adjusted death rate
VII. Annual number and rate of cases of CO exposure reported to the states' Poison Control Center

Birth Defects

I. Prevalence rates per 10,000 live births
   A. Anencepahaly
   B. Spina Bifida
   C. Hypoplastic Left Heart Syndrome
   D. Tetralogy of Fallot
   E. Transposition of Great Arteries
   F. Cleft Lip
   G. Celt Palate Alone
   H. Gastroschisis
   I. Upper Limb Deficiencies
   J. Lower Limb Deficiencies
   K. Hypospadias
   L. Trisomy 21 (Down Syndrome)

Birth Outcomes

I. Percent of births that are preterm/very preterm
II. Percent of births that are low/very low birth weight
III. Infant/neonatal/postneonatal/perinatal mortality rate per 1,000 live births
IV. Total fertility rate (average number of births to a hypothetical cohort of 1,000 women if they experienced the age-specific birth rates observed in a given year)
V. Sex ratio at birth

Cancer

I. Annual number of cases
   A. Breast Cancer in females by Age group (<50, ≥50)
   B. Lung and Bronchus Cancer
   C. Bladder Cancer (including in situ)
   D. Brain and other nervous systems Cancer
   E. Brain and Central Nervous System Cancer in children (<15 years and <20 years)
   F. Thyroid Cancer
   G. Non-Hodgkin's Lymphoma
   H. Leukemia
   I. Leukemia in children (<15 years and <20 years)
   J. Chronic Lymphocytic Leukemia
   K. Acute Myeloid Leukemia
   L. Acute Myeloid Leukemia in children (<15 years and <20 years)
   M. Acute Lymphocytic Leukemia in children (<15 years and <20 years)

II. Annual age-adjusted incidence
   A. Breast Cancer in females per 100,000 population by Age group (<50, ≥50 years old)
   B. Lung and Bronchus Cancer per 100,000 population
   C. Bladder Cancer (including in situ) per 100,000 population
   D. Brain and other nervous systems Cancer per 100,000 population
   E. Brain and Central Nervous System Cancer in children (<15 years and <20 years) per 1,000,000 population
   F. Thyroid Cancer per 100,000 population
   G. Non-Hodgkin's Lymphoma per 100,000 population
   H. Leukemia per 100,000 population

I. Leukemia in children (<15 years and <20 years) per 1,000,000 population
J. Chronic Lymphocytic Leukemia per 100,000 population
K. Acute Myeloid Leukemia per 100,000 population
L. Acute Myeloid Leukemia in children (<15 years and <20 years) per 1,000,000 population
M. Acute Lymphocytic Leukemia in children (<15 years and <20 years) per 1,000,000 population

Childhood Lead Poisonings

I. Number of children tested for lead poisoning prior to 36 months of age (by birth year cohort)
II. Percent of children tested for lead poisoning prior to 36 months of age (by birth year cohort)
III. Number of pre-1950 housing (as measured in 2000 census)
IV. Percent of pre-1950 housing (as measured in 2000 census)
V. Number of children under 5 living in poverty (as measured in 2000 census)
VI. Percent of children under 5 living in poverty (as measured in 2000 census)

APPENDIX B: DATA SOURCES AND YEAR

The following table summarized the data sources for the measures in each of the content areas and the years of data that are currently available through MEHTS.

Content area	Data source(s)	Year(s)
Drinking Water	Minnesota Drinking Water Information System (MNDWIS)	1999-2007
	U.S. Census Data	2000
Air Quality	EPA Air Quality System U.S. Census Data (2000)	Ozone: 1997-2007 PM2.5: 2001-2007
Hospitalizations	Hospital Discharge Data (inpatient)	2000-2006
	U.S. Census Data	2000-2006
Carbon Monoxide	Hospital Discharge Data (inpatient)	2002-2006
	Emergency Department Data	2002-2006
	Death Certificate Data	2002-2006
	MN Poison Control Center Data	2002-2006
Birth Defects	MN Birth Defects Information System (BDIS)	2006
	MN Vital Statistics	2006
Birth Outcomes	MN Vital Statistics	2001-2006
Cancer	MN Cancer Surveillance System (MCSS)	1988-2006
Childhood Lead Poisonings	Blood Lead Information System (BLIS)	2000-2007

APPENDIX C: LEVEL OF GEOGRAPHY

The following table describes geographic level currently available for each content area that is part of MEHTS.

Content area	**Geographic Level**		
	State	*County*	*Other*
Drinking Water	X		X (Community Water System)
Air Quality		X	X (Metropolitan Statistical Area)
Hospitalizations	X	X	
Carbon Monoxide	X	7-County Metro Only	
Birth Defects		Hennepin and Ramsey Only	
Birth Outcomes	X	X	
Cancer	X	X	
Childhood Lead Poisonings	X	X	X (ZIP code, census tract and block group)

APPENDIX D: LINKS TO MORE INFORMATION

The following links provide more information about the content areas that are part of MEHTS.

Drinking Water: http://www.health.state.mn.us/divs/eh/water/index.html

Air Quality: http://aqi.pca.state.mn.us/

Hospitalizations

- Asthma: http://www.health.state.mn.us/divs/hpcd/cdee/asthma/
- Myocardial Infarction: http://www.health.state.mn.us/divs/hpcd/chp/cvhdata/index.html

Carbon Monoxide (CO): http://www.health.state.mn.us/divs/eh/indoorair/co/index.html

Birth Defects: http://www.health.state.mn.us/divs/eh/birthdefects/index.html

Birth Outcomes: http://www.health.state.mn.us/divs/chs/top_2.htm

Cancer: http://www.health.state.mn.us/divs/hpcd/cdee/mcss/index.html

Childhood Lead Poisonings: http://www.health.state.mn.us/divs/eh/lead/index.html

The following links provide more information about the national Environmental Public Health Tracking Network and CDC-funded state tracking programs.

National EPHT program	http://www.cdc.gov/nceh/tracking/
California	http://www.ehib.org/cma/project.jsp?project_key=EHSS01
Connecticut	http://www.ct.gov/dph/cwp/view.asp?a=3140&q=386922&dphNav_GID=1826&dphPNavCtr=|#47432
Florida	http://www.doh.state.fl.us/environment/programs/Environmental_Public_Health_Tracking/index.html
Maine	http://www.maine.gov/dhhs/eohp/epht/
Maryland	http://eh.dhmh.md.gov/tracking.aspx
Massachusetts	http://www.mass.gov/?pageID=eohhs2terminal&L=5&L0=Home&L1=Consumer&L2=Community+Health+and+Safety&L3=Environmental+Health&L4=Environmental+Public+Health+Tracking&sid=Eeohhs2&b=terminalcontent&f=dph_environmental_c_tracking_in_ma&csid=Eeohhs2
Missouri	http://www.dhss.mo.gov/EPHT/index.html
New Hampshire	http://des.nh.gov/organization/divisions/air/pehb/ehs/ehp/ehtp/index.htm
New Jersey	http://www.state.nj.us/health/epht/index.shtml
New Mexico	http://www.health.state.nm.us/eheb/envtracking.html
New York	http://www.health.state.ny.us/statistics/environmental/public_health_tracking/
New York City	http://www.nyc.gov/html/doh/home.html
Oregon	http://oregon.gov/DHS/ph/epht/index.shtml
Pennsylvania	http://www.dsf.health.state.pa.us/health/cwp/browse.asp?a=171&bc=0&c=38923
Utah	http://health.utah.gov/epi/enviroepi/activities/EPHTP/NewEPHT/ephtpnew.htm
Washington State	http://www.doh.wa.gov/ehp/WTN/WTN_homepage.htm
Wisconsin	http://165.189.78.7/EPHTWebsite/default.aspx