Health Consultation

OFF SITE SOILS: CMC HEARTLAND PARTNERS LITE YARD SITE

MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA

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

Health Consultation: A Note of Explanation

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

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

HEALTH CONSULTATION

OFF SITE SOILS: CMC HEARTLAND PARTNERS LITE YARD SITE

MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA

Prepared by:

The Minnesota Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry
U.S. Department of Health and Human Services

FOREWORD

This document summarizes public health concerns related to contamination from an industrial facility in Minnesota. It is based on a formal site evaluation prepared by the Minnesota Department of Health (MDH). For a formal site evaluation, a number of steps are necessary:

- *Evaluating exposure:* MDH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out the quantity of pollutants released from a facility, where they go from the site, and how people might be exposed to them. Usually, MDH does not collect its own environmental sampling data. Rather, MDH relies on information provided by the Minnesota Pollution Control Agency (MPCA), Minnesota Department of Agriculture (MDA), the US Environmental Protection Agency (EPA), and other government agencies, private businesses, and the general public.

- *Evaluating health effects:* If there is evidence that people are being exposed—or could be exposed—to hazardous substances, MDH scientists will take steps to determine whether that exposure could be harmful to human health. MDH's report focuses on public health— that is, the health impact on the community as a whole. The report is based on existing scientific information.

- *Developing recommendations:* In the Health Consultation (HC), MDH outlines its conclusions regarding any potential health threat posed by a site and offers recommendations for reducing or eliminating human exposure to pollutants. The role of MDH is primarily advisory. For that reason, the HC will typically recommend actions to be taken by other agencies—including EPA and MPCA. If, however, an immediate health threat exists, MDH will issue a public health advisory to warn people of the danger and will work to resolve the problem.

- *Soliciting community input*: The evaluation process is interactive. MDH starts by soliciting and evaluating information from various government agencies, the individuals or organizations responsible for the site, and community members living near the site. Any conclusions about the site are shared with the individuals, groups, and organizations that provided the information. Once an HC has been prepared, MDH seeks feedback from the public. *If you have questions or comments about this report, we encourage you to contact us.*

Please write to:	Community Relations Coordinator Site Assessment and Consultation Unit Minnesota Department of Health 625 North Robert Street PO Box 64975 St. Paul, MN 55164-0975
OR call us at:	(651) 201-4897 *or* 1-800-657-3908 (toll free call - press "4" on your touch tone phone)
On the web:	http://www.health.state.mn.us/divs/eh/hazardous/index.htmls

I. Introduction

This Health Consultation (HC) represents a collaborative effort between the Agency for Toxic Substances and Disease Registry (ATSDR), United States Environmental Protection Agency (EPA), Minnesota Department of Agriculture (MDA), and the Minnesota Department of Health (MDH). This HC will focus on the health impacts associated with off-site arsenic contaminated soils associated with the CMC Heartland Partners Lite Yard (CMC). Arsenic soil concentrations, and routes of exposure (ingestion, inhalation and dermal contact) are examined to determine the potential for exposure to residents living in the area surrounding the CMC site. The EPA, ATSDR, and MDA paper and electronic project files were reviewed. MDH site files include three Health Consultations that review proposed site-specific cleanup goals, arsenic bioavailability considerations, and soil contamination on and off-site (MDH 1998, 1999 and 2001). These documents and numerous site visits form the basis for this HC. Health effects associated with arsenic exposure and community health concerns are also discussed.

II. Background

A. Site Description and History

The CMC site is an approximate 5 acre triangular lot in south Minneapolis, situated between 28th Street (South), Hiawatha Avenue (East), railroad tracks and the Roof Depot Warehouse (West), and the city of Minneapolis Asphalt Plant immediately north of the Roof Depot Warehouse (see Figure 1). The site was previously leased by Reade Manufacturing, and U.S. Borax Inc., which produced arsenic and/or lead arsenate-based pesticide. The property was also used as a bulk petroleum storage facility. Two petroleum releases on site have been reported to the MPCA. These have been investigated and issued file closure statements (MPCA Site File ID#s LEAK 00009035, and 00001583).

The site is located within an industrial corridor which includes numerous railroad tracks and switching areas, warehouses, streets with high volumes of traffic, and retail businesses. Two large retail and grocery shopping areas are within one-half mile of the site, to the south and southeast. The residential properties closest to the site are approximately one and a half blocks west and northwest of the site on Longfellow Avenue (Figure 1). This residential area is along the edge of the Phillips neighborhood which includes some high density housing and apartments to the west-northwest, within one-fourth mile of the site.

Prior to site remediation, the site was rented and used by Bituminous Roadways for the stock piling of aggregate materials. Currently, the Ryan Companies US, Inc. is constructing an office/warehouse building on the site, the Hiawatha Business Center. The new building foot print covers most of the site property (Figure 2).

Arsenic at the CMC site is not found in one specific compound but is a mixture of weathered arsenic pesticide products. Initial speciation showed a large portion (of a single core sample) to be calcium arsenate, which was assumed to be an end product manufactured or packaged at the site, and iron oxide arsenate, which may have been a raw material, by-product of production, or a product of weathering. Arsenic was found in surficial soils throughout the site. However, deeper contaminated soils were found primarily in the hot spot (see Section C. On-site Remedial Activities).

B. Potential Sources of Arsenic

Arsenic is widely distributed in the environment, and all humans are exposed to low levels via air, water, food, and soil (1). Arsenic is an element that occurs naturally in the earth's crust at an average concentration of 2–5 mg/kg (parts per million; ppm), and is primarily associated with igneous and sedimentary rocks in the form of inorganic arsenic compounds (1). While arsenic is released to the environment from natural sources such as wind-blown dirt and volcanoes, releases from anthropogenic sources far exceed those from natural sources. The three major anthropogenic arsenic emissions sources are coal combustion facilities, metal mining, and pesticide spraying (1). Most anthropogenic releases of arsenic are to land or soil, primarily in the form of pesticides or solid wastes. Substantial amounts are also released to air and water.

Arsenic released to land is predominantly inorganic and relatively immobile because it binds to soil particles. It is often primarily associated with iron and manganese oxides in soil and may therefore be released when these oxides are reduced. Soluble forms of arsenic are known to leach into shallow groundwater in areas that are geologically rich in arsenic; runoff may also enter surface water. Arsenical pesticides are specially formulated to be water soluble making them a leaching hazard if improperly applied, stored, or disposed.

Arsenic compounds are also found in food resulting in typical "background" exposures levels ranging from 20 to 70 ug/day (1). Arsenic content in plant and animal tissues typically varies from 0.01 – 5 ppm (1). These concentrations are due in part to soil uptake, or soil particle adhesion, and surficial deposition from atmospheric sources and pesticide application (1).

In the past, some pesticide and fertilizer formulations may have contained heavy metals such as arsenic, cadmium, and lead. The residential use of these products decades ago could result in elevated metal concentrations in surface soils today. In 2003 the Minnesota legislature modified the Minnesota Fertilizer Law to limit the arsenic concentration to $\leq$ 500 mg/kg in any fertilizer used or sold in the state (www.mda.state.mn.us/fertilizer/arseniclimits.htm). Today, many of the currently available fertilizer formulations contain much lower levels of arsenic, cadmium, and lead. The MDA requires arsenic analysis prior to registration for all fertilizer products containing micronutrients, waste or ash. Some fertilizer test results are provided on MDA's website (www.mda.state.mn.us/fertilizer/heavymetals.htm).

Another potential source of arsenic is contaminated fill materials such as dirt and ash from unknown sources, mulch made from pressure treated wood products containing arsenic, and green-treated lumber.

C. On-site Remedial Activities

Between October 2004 and June 2005, approximately 13,000 cubic yards of soil were excavated from the Lite Yard site hot spot **(**Figure 3**)**. All of this soil was subjected to chemical stabilization using magnesium oxide, and ferric sulfate. In order to excavate the hot spot down to the water table (27 feet below grade) the side walls were terraced outward (layback soils) to prevent the walls from collapsing. The end result was an inverted cone shaped excavation. There were approximately 11,000 cubic yards of layback soils that were stockpiled, tested and disposed off-site. Approximately 900 cubic yards of this layback soil was treated prior to disposal. Another 18,200 cubic yards were excavated from the shallow soils surrounding the excavation and sent to an off-site disposal facility. Approximately 960 cubic yards of the shallow soil was treated prior to disposal.

In Summer 2005, the entire Lite Yard property was capped with clean soil (< 20 mg/kg arsenic) that included clean corridors for utility trenches. Additionally, the whole site is covered with a new building, pavement, and landscaping. Also included in the on-site remedy was a Hennepin County Regional Railroad Authority Parcel (60 ft wide) that runs along the entire west-side of the site. This parcel of land is destined to be a bike path and the entire area has been excavated and covered with 4 feet of clean fill.

Institutional controls include a special well construction area advisory that prohibits installation of new water supply wells in the contaminated groundwater formations near the site. The advisory also requires areas with impacted groundwater to be serviced with the public (City of Minneapolis) water supply.

D. Residential Off-Site Soil Impacts

In June 2001, MDH and MDA conducted a surficial soil sample study (49 properties) to investigate potential off-site arsenic impacts to residential yards west and northwest of the Site. Test results confirmed off-site presence of high levels of arsenic in residential soils in the 1-3 and 3-6 inch soil depth with arsenic concentrations ranging 4-210 ppm and 3-120 ppm respectively (Figure 4). The highest concentrations appeared to follow the prevailing wind direction axis (NW↔ SE) indicating possible impact of wind dispersion from the site.

In September 2003, MDA conducted a follow-up investigation (167 properties) in the residential area NW of the site (2). The following was found:

- 140 of the properties (84 %) had arsenic levels below background (<10ppm).
- 17 properties (10%) had arsenic levels between 10 and 100 ppm.
- 6 properties (4%) had arsenic concentrations ranging from 100 to 200 ppm.
- 4 properties (2%) had arsenic concentrations greater than 200ppm.

In January of 2004, MDA requested that the US Environmental Protection Agency review the data and address contamination issues in the Phillips neighborhood. Since 2004 EPA has been addressing immediate threats at the Site with its Emergency Response Program using residential property sampling programs and soil excavation on properties with arsenic above 95 parts per million. EPA is also considering proposing the site for inclusion on the National Priorites List (NPL), also known as Superfund. If placed on the NPL, the site would then be eligible for resources from the Superfund program. If listed, the EPA would design and conduct a Remedial Investigation (RI) to fully characterize the contamination problem. EPA would also conduct a Feasibility Study (FS) that reviews cleanup options. The RI/FS would include a risk assessment, and these documents would be used to determine the appropriate long-term cleanup standard for the arsenic impacted (< 95%) soils off-site.

EPA has implemented a phased approach to characterize the arsenic in the Phillips neighborhood. Any yard identified with arsenic soil concentrations of 95 ppm or higher is being addressed by EPA Emergency Response Program. Under the program, soils are excavated to a depth of 12 inches (18 inches in garden areas) and backfilled with clean soil. For detailed discussion of the action level derivation see Appendix A, and the Minnesota Pollution Control Agency Soil Reference Levels (SRVs) section below. EPA's first phase, performed in 2004, included sampling 192 residential lots to provide additional delineation of arsenic impacts to the northwest of the CMC property. MDA had previously sampled another 167 properties in the same area. EPA initiated phase two in 2005 EPA by sampling approximately 600 additional properties to provide 100 percent sampling of yards within 1500 feet of the CMC property. Sixty of those sampling locations were collected radially from the site to assess whether contamination from the site may have spread in directions other than the northwest quadrant (Figure 5).

In the first two phases of sampling, EPA identified 61 properties (7%) with arsenic concentrations greater than 95 ppm within the area of concern (figure 6). Contaminated soils at 57 of those properties were remediated by the end of 2005. The remainder will be addressed in the 2006. In total 817 properties have been sampled by MDA and EPA. The data can be summarized as follows:

- 679 properties (83%) had at least one sample with < 10 ppm arsenic
- 158 properties (19%) had at least one sample with 10 – 30 ppm arsenic
- 95 properties (12%) had at least one sample with 30 – 60 ppm arsenic
- 52 properties (6%) had at least one sample between 60 – 95 ppm arsenic
- 61 properties (7%) had greater than 95 ppm arsenic

EPA also tested a total of 13 childcare centers and 4 schools within the area of concern; no arsenic impacts were observed. Sampling results to date suggest that the contamination plume does not appear to follow a natural concentration gradient from the site (highest concentrations) to the residential yards (lower concentrations farther from the site). Furthermore, some yards have high arsenic concentrations (greater than 95 ppm) while their neighboring yards appear to have background levels (10 ppm or less). A possible explanation for unpredictable off-site contamination distribution is that deposition occurred many years ago. Over the years, it is possible that landscaping, and construction has altered the soil profile on many properties. Another explanation is the arsenic soil concentrations resulted from the use of arsenic treated lumber or arsenic containing pesticides and fertilizers. EPA is currently preparing a third phase of investigation that includes contaminant air distribution modeling and more residential sampling.

Air model simulations identified a ¾ mile radius as an area that may have been impacted by releases from the CMC property. In 2006 EPA will initiate sampling every residential property (3000 properties) within a ¾ mile radius from the site (see figures 5, and 6). The data from the sampling event will help further define the contaminant boundaries, fill existing data gaps, and provide data for the risk assessment calculations.

E. Exposure Pathway

To determine exposure, MDH evaluated the environmental and human components that lead to an exposure pathway. An exposure pathway describes how a person comes in contact with chemicals originating from a contamination source. An exposure pathway consists of the following five elements:

1. A source of contamination,
2. A medium (air, water, or soil) through which the contaminant is transported,
3. A point of exposure where people can contact the contaminant,
4. A route of exposure by which the contaminant enters (inhalation, ingestion, or dermal absorption) or contacts the body, and
5. A receptor population.

Completed exposure pathways exist when all five elements of a pathway link the contaminant source to a receptor population. A **potential exposure pathway** indicates that exposure to a contaminant could have occurred in the past, could be occurring currently, or could occur in the future. A potential exposure exists when information about one or more of the five elements of an exposure pathway is missing or uncertain. An **incomplete pathway** is missing one or more of the pathway elements and is probable the elements were never present and are not likely to be present at a later point in time.

Although ingestion and inhalation exposure to arsenic contaminated soils has not been confirmed, the potential for exposure does exist in residential yards that test positive for arsenic. Dermal contact with arsenic contaminated soil is less of a concern because arsenic is not readily absorbed through the skin.

III. **Health Based Criteria for Arsenic**

A. ATSDR Minimal Risk Levels and Environmental Media Evaluation Guides

Minimal Risk Levels (MRLs) for toxic substances are derived when reliable and sufficient data exist to identify the target organ(s) of effect and the most sensitive health effect(s) for a specific duration for a given route of exposure. An MRL is an estimate of the daily human exposure (dose) to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified route and duration of exposure. MRLs do not consider cancer effects. These substance-specific estimates, which are intended to serve as screening levels, are used by MDH health assessors to identify contaminants and potential health effects that may be of concern at hazardous waste sites. It is important to note that MRLs are not intended to define clean-up or action levels.

MRLs are derived for hazardous substances using the no-observed-adverse-effect level/uncertainty factor approach. They are below levels that might cause adverse health effects in the people most sensitive to such chemical-induced effects. MRLs are derived for acute (1–14 days), intermediate (15–364 days), and chronic (365 days and longer) durations and for the oral and inhalation routes of exposure. MRLs are generally based on the most sensitive chemical-induced end point considered to be of relevance to humans. In general, serious health effects (such as irreparable damage to the liver or kidneys, or birth defects) are not a basis for establishing MRLs. Exposure to a level above the MRL does not mean that adverse health effects will occur.

MRLs are intended only to serve as a screening tool to help public health professionals decide when more investigation may be needed. They may also be viewed as a mechanism to identify those sites that do not pose health issues. Although human data are preferred, MRLs often must be based on animal studies because relevant human studies are lacking. In the absence of evidence to the contrary, ATSDR assumes that humans are more sensitive to the effects of hazardous substance than animals and that certain persons may be particularly sensitive. The resulting MRL may be as much as a hundredfold below levels shown to be nontoxic in laboratory animals. ATSDR uses a conservative (i.e., protective) approach to address this uncertainty consistent with the public health principle of prevention. Thus, MRLs are meant to protect sensitive subpopulations, such as infants, the elderly, or people who are nutritionally or immunologically compromised.

ATSDR's chronic arsenic MRL is 3 and 21 micrograms per day for a 10 kg child and 70 kg adult respectively. The chronic MRL is based on human exposure to contaminated drinking water in Taiwan resulting in black foot disease and dermal lesions (hyperkeratosis, and hyperpigmentation) (3). The chronic arsenic MRL incorporates an uncertainty factor of 3 in its derivation.

Based on an accidental soy sauce poisoning event, the acute arsenic MRL is 50 and 350 micrograms per day for a 10 kg child and 70 kg adult respectively. For derivation of the acute oral MRL, facial edema and gastrointestinal symptoms (nausea, vomiting, diarrhea), which were characteristic of the initial poisoning and then subsided, were considered to be the critical effects (4). The acute arsenic MRL utilized a safety factor of 10 in its derivation.

Using the MRL and standard soil exposure assumptions, ATSDR has developed Environmental Media Evaluation Guide (EMEG) values for arsenic in soil. EMEGs are media-specific (soil, water, or air) contaminant concentrations that are used by health assessors to screen out environmental contaminants for further evaluation. Arsenic soil concentrations less than the EMEG are unlikely to pose a health threat. However, arsenic soil concentrations above the EMEG do not necessarily represent a health threat. EMEGs should not be used as predictors of adverse health effects, or for setting clean-up levels. The acute soil arsenic EMEG is 10 ppm for a child. It is important to note that the acute arsenic soil EMEG is protective of a pica child who has a propensity to ingest soil (200 mg/day). The chronic soil arsenic EMEG is 20 and 200 ppm for a child and adult, respectively. These values are displayed in the following Section in Table 1.

B. Minnesota Pollution Control Agency Soil Reference Levels (SRVs)
As with ATSDR comparison values for soil, the SRVs are based on standard health risk assessment methodologies, modeling, and risk management policy. In calculating SRVs, a set of acceptable risk levels has been established by the MPCA to ensure the same level of protection of human health regardless of the person affected (receptor) or intended property use or exposure scenario. The acceptable risk levels targeted by the SRV risk-based evaluation process are as follows:

- Noncarcinogenic effects - a noncancer risk not to exceed a hazard quotient (HQ) of 0.2 per contaminant for chronic exposure or 1 for subchronic and acute exposure and a cumulative hazard index (HI) of 1 for multiple contaminants with similar target endpoints. The HQ is determined by dividing the site contaminant exposure by the contaminant reference dose, which is an estimate of the daily exposure that is not likely to result in an appreciable risk of deleterious effects. The reference dose is thus similar to the MRL. The HI is determined by adding the HQs for each contaminant with similar endpoints.

- Carcinogenic effects - a total or cumulative site excess lifetime cancer risk (ELCR) not to exceed 1 in 100,000 (i.e., 1E-5) for chronic exposure. In other words, the acceptable risk level is a maximum of one additional case of cancer per 100,000 chronically exposed individuals in the general population. For subchronic exposure where higher exposures occur during a shorter exposure period (e.g., 1 year) the acceptable cumulative ELCR is limited to ten percent of the chronic ELCR (i.e., 1E-6).

Risk is evaluated separately for carcinogenic (cancer-causing) and noncarcinogenic effects.

The MPCA intends the SRVs to be protective without being unduly stringent (i.e., avoiding "cascading conservatism"). The exposure scenarios utilized represent reasonable maximum exposure (RME) activities for the planned use of the site. Recommended default exposure parameters have been developed for residential (also applicable to unrestricted commercial use) exposure scenarios. In calculating SRVs for a residential exposure scenario a child receptor was utilized for evaluating noncarcinogenic risk whereas an exposure scenario encompassing childhood and adult years was utilized for evaluating carcinogenic risk.

The residential arsenic SRV value was selected from 3 different exposure calculations.

- A residential chronic exposure scenario (child) was evaluated using a noncancer reference dose derived from an epidemiological study of humans exposed to arsenic in drinking water study (3,5). An uncertainty factor of 3 was used to arrive at the reference dose. The exposure evaluation included standard exposure parameters for ingestion, dermal, and inhalation pathways (body weight 15kg, ingestion rate 100 mg/day, exposure duration 6yrs, etcetera). Ingestion contributed 95% of the total hazard with dermal contributing 5%. The critical effects identified in the study were, skin, nervous system, and possible cardiovascular complications. The chronic soil criterion of 10 mg of arsenic/kg of soil incorporates a hazard quotient of 0.2.

- For (theoretical) carcinogenic effects, a chronic residential (child) exposure scenario was evaluated using an oral cancer potency factor (1.5E+0 per (mg/kg)/day) and standard exposure parameters. The oral cancer potency factor was derived from a contaminated well water exposure study (human). The exposure evaluation included ingestion, dermal, and inhalation pathways. However, the inhalation pathway was an insignificant contributor to the total cancer risk. Ingestion contributed 95% of the total risk with dermal contributing 5%. The total estimated cancer risk at the criterion (10 mg arsenic/kg soil) for carcinogenic effects of arsenic is equal to 1 case per 100,000 individuals.

- An acute child exposure scenario was evaluated using an acute reference dose derived from an accidental arsenic contaminated soy sauce poisoning event (6). Ingestion was the only pathway considered. Dermal effects (facial endema and hyperpigmentation) are the most sensitive human critical effect identified in the literature. An uncertainty factor of 10 was used to calculate the acute reference dose derivation. The acute exposure scenario for a child assumes that on any given day a child will ingest as much as 10 grams (10,000 mgs) or more of soil (7).

The acute child exposure scenario was selected to derive the current Residential SRV (5 mg/kg). It is lower than the criteria calculated to protect against non-cancer and cancer health effects from chronic ingestion of arsenic (10 mg/kg). The SRV is a screening number and indicates a level of a contaminant that warrants further consideration. Note that exposures to higher levels in soil do not mean that health effects will occur.

The old acute SRV of 110 mg/kg was also based on a child exposure scenario. However, the critical effect was potential death. The old acute SRV also included several safety factors that sufficiently protected against lethality resulting from exposure to arsenic contaminated soil containing 110 mg/kg. The old acute SRV is really better suited to be an action level as presented by ATSDR and MDH (Appendix A), because it focuses removal activities on properties that pose the greatest risk. EPA has added an extra level of safety, by selecting 95 mg/kg as its soil arsenic action level. See Table 1 for a listing of MPCA and ATSDR soil arsenic criteria.

Table 1 Soil Arsenic Criterion

<table>
<tr><td colspan="4">MPCA Arsenic Soil Reference Value (SRV) ppm</td></tr>
<tr><td colspan="2">Acute Residential</td><td colspan="2">Chronic Child</td></tr>
<tr><td>Old</td><td>New</td><td>Old</td><td>New</td></tr>
<tr><td>110</td><td>5</td><td>10</td><td>5</td></tr>
</table>

<table>
<tr><td colspan="3">ATSDR Soil Environmental Media Evaluation Guide (EMEG) ppm</td></tr>
<tr><td>Acute Child (pica)</td><td>Chronic Child</td><td>Chronic Adult</td></tr>
<tr><td>10</td><td>20</td><td>200</td></tr>
</table>

C. Remedial (Cleanup) Criteria

If the CMC site gets listed on the National Priorities (Superfund) list, a human health risk assessment will be conducted. The risk assessment will include a conceptual site model that identifies the exposure pathways. The exposure pathways will be quantified and a site-specific remedial goal will be established. The final remedial goal is determined using standard risk assessment methodologies while considering costs, feasibility, protectiveness, and permanence of remedy. The MDH, MDA, and EPA will collaborate in developing the final remedial goal. Superfund law requires public participation and there will be several opportunities for the public to comment during the process.

IV. Health Concerns

MDH, MDA, and EPA met with many residents in several meetings to discuss current site conditions and any other concerns that often focused on health. Health problems reported in these conversations and meetings include both cancer and non-cancer health concerns. Some people discussed their own health problems or history of illnesses, while others described the health problems of neighbors, relatives or friends. Residents want to know whether these health problems are caused by exposure to the site contaminants.

A. Non-Cancer Health Concerns

Most arsenic exposure to the general population is from the presence of small amount of arsenic in food and incidental ingestion of soil. The acute (1-14 days) effects most likely to be of human health concern from ingestion of arsenic are facial edema, gastrointestinal irritation (nausea, vomiting, diarrhea), peripheral neuropathy, vascular lesions, and anemia (1, 6).

The classic cutaneous lesions caused by inorganic arsenic are distinctive, characteristic, and appear to be the most sensitive effect due to sub-chronic exposure (15 days – 7 yrs) to inorganic arsenic. Their appearance usually follows a temporal progression, beginning with hyperpigmentation which can occur several weeks after exposure, then progressing to palmar-plantar hyperkeratosis. Although cutaneous manifestations have been most commonly reported following ingestion of drinking water containing arsenic, cohorts exposed to medicinals, contaminated grape beverages, and via inhalation have also shown an increased prevalence of skin lesions. The hyperpigmentation appears in a finely freckled, “raindrop” pattern that is particularly pronounced on the trunk and extremities (6). Chronic exposure (greater than 7 yrs) to low levels of arsenic is also associated with skin effects, and possibly cardiovascular and neurological effects (1).

Some of the non-cancer health concerns reported by residents living near this site are:

- Skin problems, rashes
- Allergies
- Respiratory problems
- Learning disabilities among children
- Neurological disorders (autism)
- Kidney, liver and bladder problems

It is not possible to determine if exposure to site chemicals has caused or contributed to any of these reported illnesses. These illnesses have many possible causes, and are known to occur in all communities. Community members are strongly encouraged to discuss their health concerns with their health care provider, so that appropriate health information, diagnosis and medical care can be provided. A physician who knows their patient’s complete medical history is in the best position to determine what may be causing or contributing to an illness.

Some residents suspect that these illnesses have occurred at elevated rates in their neighborhood and are therefore site related. However, MDH and ATSDR do not have surveillance data needed to identify unusual patterns or trends of these chronic, non-cancer effects in Minnesota communities. While the state maintains extensive surveillance systems for monitoring trends in infectious diseases, chronic diseases (except cancer) are not routinely tracked.

B. Cancer Concerns

Several residents have reported a perceived excess of cancers among people who lived in the neighborhoods near the site. Several different types of cancer, including brain cancer, breast cancer and leukemia have been reported.

MDH, EPA and the U.S. Public Health Service consider inorganic arsenic to be a known human carcinogen (Group A). There is clear evidence from studies in humans that exposure to inorganic arsenic at relatively high levels over long periods may increase the risk of cancer. In workers exposed by inhalation, the predominant carcinogenic effect is increased risk of lung cancer, although a few reports have noted increased incidence of tumors at other sites (8). Several studies have shown some excess risks for developing cancer among occupational groups exposed to arsenic in industrial settings. However, no specific type of cancer has been identified, and the risk to the general population remains uncertain (1). The data provided in Tseng et al., 1968 and Tseng, 1977 have shown increased incidence of skin cancer for individuals who consumed arsenic contaminated water and are the basis for the oral cancer slope factor listed in EPA's Integrated Risk Information System (IRIS) database. The studies were criticized for not determining the amount of water consumed by study subjects and temporal variability of arsenic concentrations in specific wells was not known (9).

In response to concerns of excess cancer in the neighborhood, MDH has conducted a review of cancer data for the CMC area zip codes (55404, 55406, and 55407) in the Minnesota Cancer Surveillance System. The results and discussion of this health outcomes data review are presented in the next section of this document.

MDH has written an informational booklet, entitled Cancer and the Environment (Appendix B) to answer some of the most commonly asked questions about cancer. This booklet describes what is known about the causes of cancer and provides resources for residents to get answers to questions about specific cancers.

Appendix C contains an information sheet on how to avoid exposure to contaminants in soil. Recommendations for reducing contact with contaminated soils include keeping hands clean, keeping dust out of the house, reducing outdoor activities that stir up dust, taking special care when gardening (i.e. by wearing gloves), providing a safe play area for children and taking precautions when preparing home grown vegetables. It is important to keep in mind that arsenic is only one of many possible hazards found in soil. It is well established that urban soils often contain lead and other metals in elevated levels. MDH recommends that residents prevent their children from ingesting soil even if a yard has tested low for arsenic, because other potential chemical and biological hazards are often found in soil.

C. Feasibility of a Health Study

Residents want to know whether MDH or other scientists are or will be conducting a health study of people who were exposed to chemicals from the site.

A scientific health study, or epidemiological investigation, is one of the possible actions that can be initiated at a hazardous waste site. An epidemiological study collects data about a particular health outcome in a specific population at risk and measures exposure or other risk factors that may be associated with the outcome. Such an investigation may be recommended by MDH if the scientific study could provide a public health benefit to the community (and does not harm the community), is scientifically feasible (has a reasonable probability of answering the scientific question), and the necessary resources are available.

A broad scientific study designed to measure a causal connection between past exposure to site contaminants and a range of health problems experienced by people living near the CMC site is not recommended. There are several reasons why epidemiological methods are generally not statistically powerful enough to be successful in most cases. For one, many health effects have multiple causes making it very difficult to identify a single causative agent. For example, short-term effects of arsenic ingestion are gastrointestinal distress, which mimic the flu, indigestion, or other common maladies. Long-term effects of chronic arsenic exposure can lead to expression of numerous cancer types decades after exposure discontinued and in some cases after residents have moved away. Another complication is the high background incidence rate for all cancers. Additionally, many cancers can also be attributed to other risk factors such as smoking. Limited historical measures of exposure and population data profoundly limit the scientific feasibility of such a study.

V. Health Outcome Data Review

In response to the concern that an excess of cancer has occurred or is occurring in communities near the CMC site, MDH has examined available data in the Minnesota Cancer Surveillance System (MCSS). The MCSS systematically collects demographic and diagnostic information on all Minnesota residents with newly diagnosed (incidents) cancers. Knowing the address at time of diagnosis makes it possible for health officials to examine cancer rates within defined geographic boundaries, but it is important to note that cancers in people who moved from the area and were diagnosed somewhere else are not included. The primary objectives of the Minnesota Cancer Surveillance System are to:

- Monitor the occurrence of cancer in Minnesota and describe the risks of developing cancer;
- Inform health professionals and educate citizens regarding specific cancer risks;
- Answer the public's questions and concerns about cancer;
- Promote cancer research; and
- Guide decisions about how to target cancer control resources.

From MCSS we know that approximately ½ of all Minnesotans will be diagnosed with a cancer at some time in their lives and about ¼ will die from cancer. Cancer is the second most common cause of death after heart disease.

To address the concerns of residents, all new cancers diagnosed from 1988-2002 in the zipcodes 55404, 55406, and 55407 were counted and are shown in the tables below as observed cases. These observed cancers are then compared to the number of cancers that would be expected in that population if cancer rates in the 55404, 55406, and 55407 areas were identical to the 7 county metro area cancer rates.

Population estimates are developed from the United States Census Bureau’s 1990 and 2000 censuses. Population statistics are necessary for estimating the size of the population at risk and for calculating disease and death rates. All cancer incidence rates presented below are age-adjusted to the 1970 US standard population. Expected cancer values in the 55404, 55406, and 55407 zipcode populations were calculated using Indirect Standardization Methods whereby the age-specific rates in the standard population (7 county metro area) are applied to the age distribution of the population of interest (in this case, zip codes 55404, 55406, and 55407). Age-adjustment minimizes the effect of differences in age distributions when comparing rates among different populations.

The tables below show the observed and expected counts for some of the most common types of cancer and the total of all cancers. The accuracy of the expected cancer incidence numbers is partly dependent on an accurate census count for these zip codes.

Table 1. Observed and Expected Incident Cancers in 55404, 1988-2002

Cancer Type	Males			Females	
	Observed	Expected		Observed	Expected
Esophagus	8	8		6	3
Stomach	18↑	10		10	9
Colo-Rectal	85↑	65		106	91
Larynx	21↑↑	7		4	2
Lung/Bronchus	156↑↑	78		105↑↑	70
Breast	3	1		180	202
Prostate	155↓	182		NA	NA
Bladder	39	40		24	20
Kidney	24	19		9	13
NH Lymphoma	40	30		30	31
Leukemia	21	21		32↑	19
All Cancers	752↑↑	613		723↑	669

Expected number based on Metro rates for same time period
↑↑ = $p < 0.01$, ↑ = $p < 0.05$ higher than expected
↓↓ = $p < 0.01$, ↓ = $p < 0.05$ lower than expected

From 1988-2002 in the 55404 zip code there were 752 and 723 newly diagnosed cancers for males and females respectively. Theses values are statistically elevated when compared to expected rates for the 7 county metro area. This excess appears to be largely due to an observed excess of stomach, colo-rectal, and lung cancers. In females, the MCSS data show an excess of lung cancer. Observed prostate cancer cases were statistically low.

Table 2. Observed and Expected Incident Cancers in 55406, 1988-2002

Cancer Type	Males			Females	
	Observed	Expected		Observed	Expected
Esophagus	21	14		8	5
Stomach	18	19		13	13
Colo-Rectal	127	117		141	135
Larynx	17	13		6	4
Lung/Bronchus	186↑↑	145		176↑↑	130
Breast	1	2		371	377
Prostate	334	343		NA	NA
Bladder	80	73		29	31
Kidney	34	33		28	23
NH Lymphoma	49	51		58	50
Leukemia	41	36		36	29
All Cancers	1143	1084		1276↑↑	1157

Expected number based on Metro rates for same time period
↑↑ = $p < 0.01$, ↑ = $p < 0.05$ higher than expected
↓↓ = $p < 0.01$, ↓ = $p < 0.05$ lower than expected

From 1988-2002 in the 55406 zip code there were 1143 and 1276 newly diagnosed cancers for males and females respectively. The 1276 cases of new cancers in women is statistically elevated when compared to expected rate (1157) for the 7 county metro area. Lung cancer in males and females is also statistically elevated (see table 2).

Table 3. Observed and Expected Incident Cancers in 55407, 1988-2002

Cancer Type	Males			Females	
	Observed	Expected		Observed	Expected
Esophagus	8	10		6	5
Stomach	18	14		10	11
Colo-Rectal	85	87		106	116
Larynx	21↑↑	10		4	3
Lung/Bronchus	158↑↑	105		105	106
Breast	3	2		180↓	320
Prostate	154↓	246		NA	NA
Bladder	39↓	54		24	27
Kidney	24	26		9↓	19
NH Lymphoma	40	41		30↓	43
Leukemia	21	30		32	26
All Cancers	752↓	827		723↓	998

Expected number based on Metro rates for same time period
↑↑ = $p < 0.01$, ↑ = $p < 0.05$ higher than expected
↓↓ = $p < 0.01$, ↓ = $p < 0.05$ lower than expected

From 1988-2002 there were statistically significant increase in larynx and lung cancers in the 55407 zip code area. There were no significant increases in any type of cancer in females for the same area code. It is important to note that prostate cancer, bladder and all cancers were statistically low for males, and females were statistically low for breast, kidney, NH lymphoma and all cancers.

MCSS data quality is high and provides an excellent surveillance tool for tracking cancer trends throughout the state. Recognizing these trends leads investigators to suggest or hypothesize the risk factors that may be contributing to these trends. For example, an excess in lung and larynx cancers suggests that there may be an excess in cigarette smoking compared to the state population. The observation of an excess of any particular cancer does not necessarily point to an environmental cause because many other genetic and behavioral factors contribute to cancer occurrence in a community. Conversely, the absence of a statistical excess of a particular cancer does not prove a lack of an environmental risk to health.

To better understand the relationship between exposure to hazardous substances and adverse health effects in human populations, scientists must apply more precise methods for measuring both exposure and disease. Observational epidemiology is a particular type of scientific investigation that relies on observation of human populations using carefully designed protocols and statistical methods to measure the wide range of variables that can affect human health. Unfortunately, these types of studies are very expensive and can take years to reach a conclusion. They also require a large number of people, exposed and unexposed. If the population under study is too small, exposure status cannot be reliably determined, or a suitable control group cannot be identified, the study result will be inconclusive.

Basic research efforts are needed to improve our scientific understanding of the environmental causes of disease. One such effort is the study of clinical biomarkers. Biomarkers are measurements of unique substances in the body (usually in blood or urine) that indicate exposure or that represent early sub-clinical signs of an effect in the body. Even with very low environmental exposures, it is sometimes possible to measure subtle biological changes that may increase individual susceptibility to disease.

Another useful approach is to focus the investigation on a particular subset of the population that is more vulnerable to the risk. For example, investigators may choose to study a group of people who share certain genetic factors or family history of disease. Children are believed to be more susceptible to a number of environmental contaminants and are increasingly the focus of environmental health research.

While such research studies may advance our understanding of how chemical exposures impact human health, they are not very satisfying to communities and individuals living in the vicinity of a hazardous waste site. They do not answer questions about cause and effect in individual cases of disease. Questions about individual health concerns are best answered by qualified physicians who will examine the complete medical and family history, perform the necessary diagnostic tests, and provide appropriate medical care.

If a physician observes an unusual disease case, or a group of similar unusual cases, he/she can publish these observations as a case report or case series. These types of reports often bring new ideas to investigators and can lead to more research.

VI. Conclusions

- EPA's residential sampling plan and the soil arsenic action level ($\geq$ 95 mg/kg) are protective of public health. The EPA Emergency Response Program continues to aggressively removed soil from properties where arsenic concentrations exceed the action level. EPA is considering proposing the site for National Priorities List (Superfund), and listing will require a risk assessment that will aid in developing a final soil cleanup criteria.

- Any properties containing arsenic above the EPA action level ($\geq$ 95 mg/kg) could pose a health hazard. Other properties containing arsenic concentrations below 95 mg/kg do not pose an immediate health threat.

- Less than 10% of the properties sampled to date have exceeded the removal action level.

- Residents have reported various health effects believed to be site related and express interest in a health study. A well-designed health study for the site is not practical and will not aid in determining a cause and effect relationship between exposure to site related arsenic and a health outcome.

- A review of the Minnesota Cancer Surveillance System data for area codes surrounding the site found excess of cancers, but these are likely the result of other risk factors (such as smoking) and cannot be linked to arsenic exposure. The same data set also found lower incidence of prostate and bladder cancers in males, and lower incidence of breast, kidney, and NH lymphoma in females.

VII. Recommendations

- If residents have contaminated soil, they should avoid contact with contaminated soil as advised in Appendix C (Reducing Your Contact with Contaminated Soils).

- All properties with soil arsenic concentrations above 95 ppm should be remediated.

VIII. Public Health Action Plan

- EPA established a theoretical ¾ mile zone of influence around the site, and will sample every property within the area (approximately 3000 additional properties by the end of 2006).

- MDH will collaborate with MDA and EPA in developing a final remedial criteria and health education materials for community distribution.

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CERTIFICATION

This CMC Health Consultation was prepared by the Minnesota Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

Alan Parham
Technical Project Officer, SPS, SSAB, DHAC
ATSDR

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

Alan Yarbrough
Chief, State Program Section, SSAB, DHAC, ATSDR

Figures

Figure 1
CMC Site

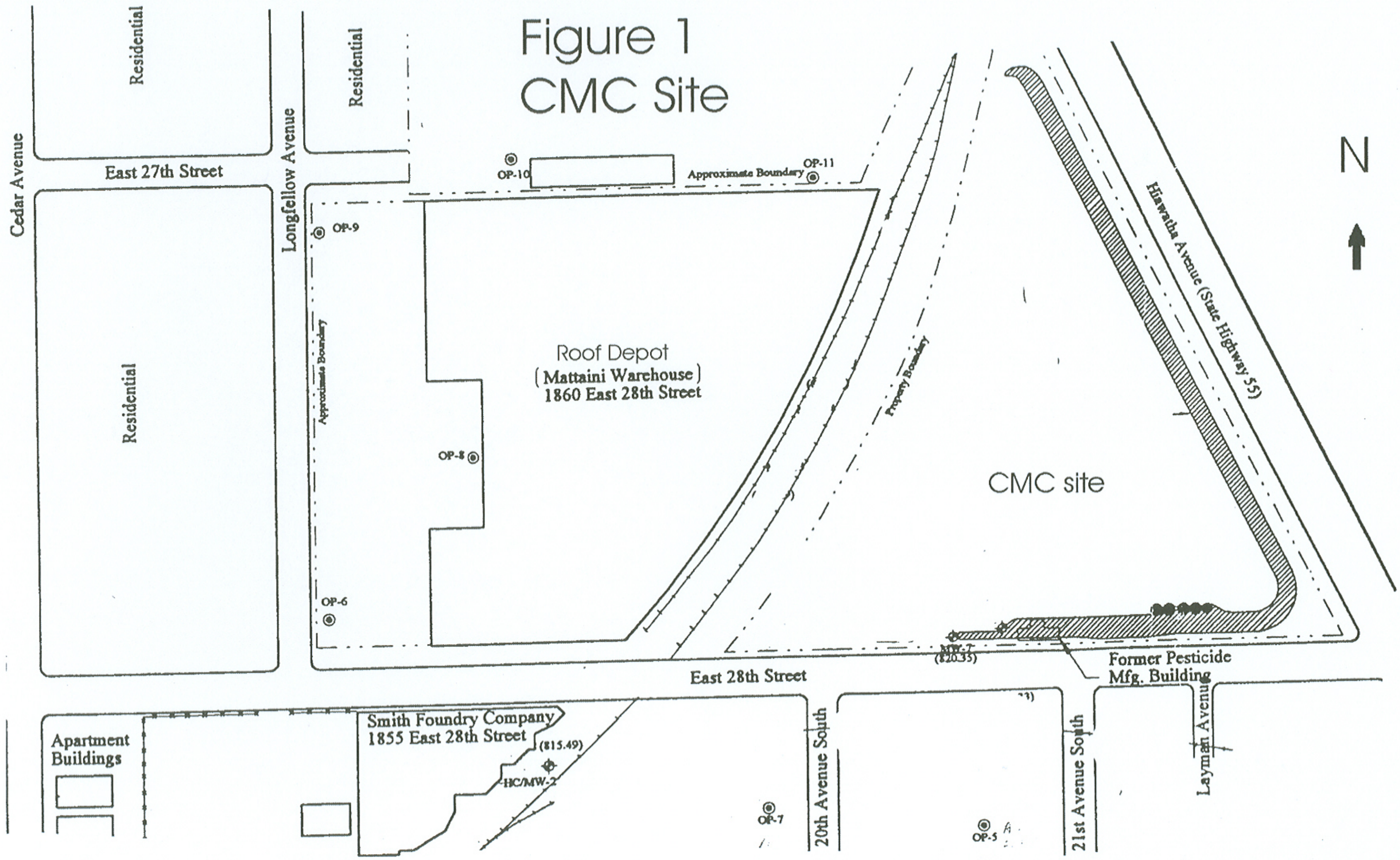


Figure 2
Building Layout

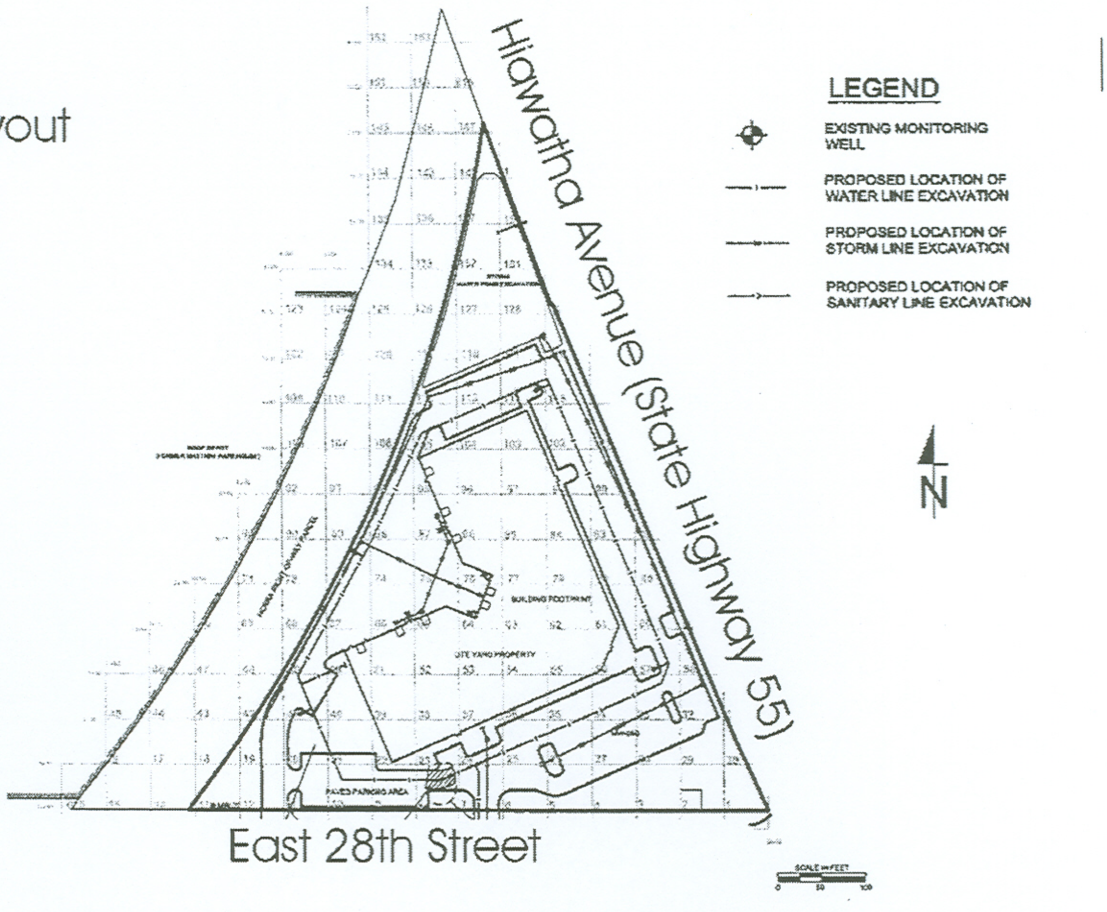


Figure 3
CMC Hot Spot Excavation

Soil Arsenic Concentrations (1-3in, 3-6in)

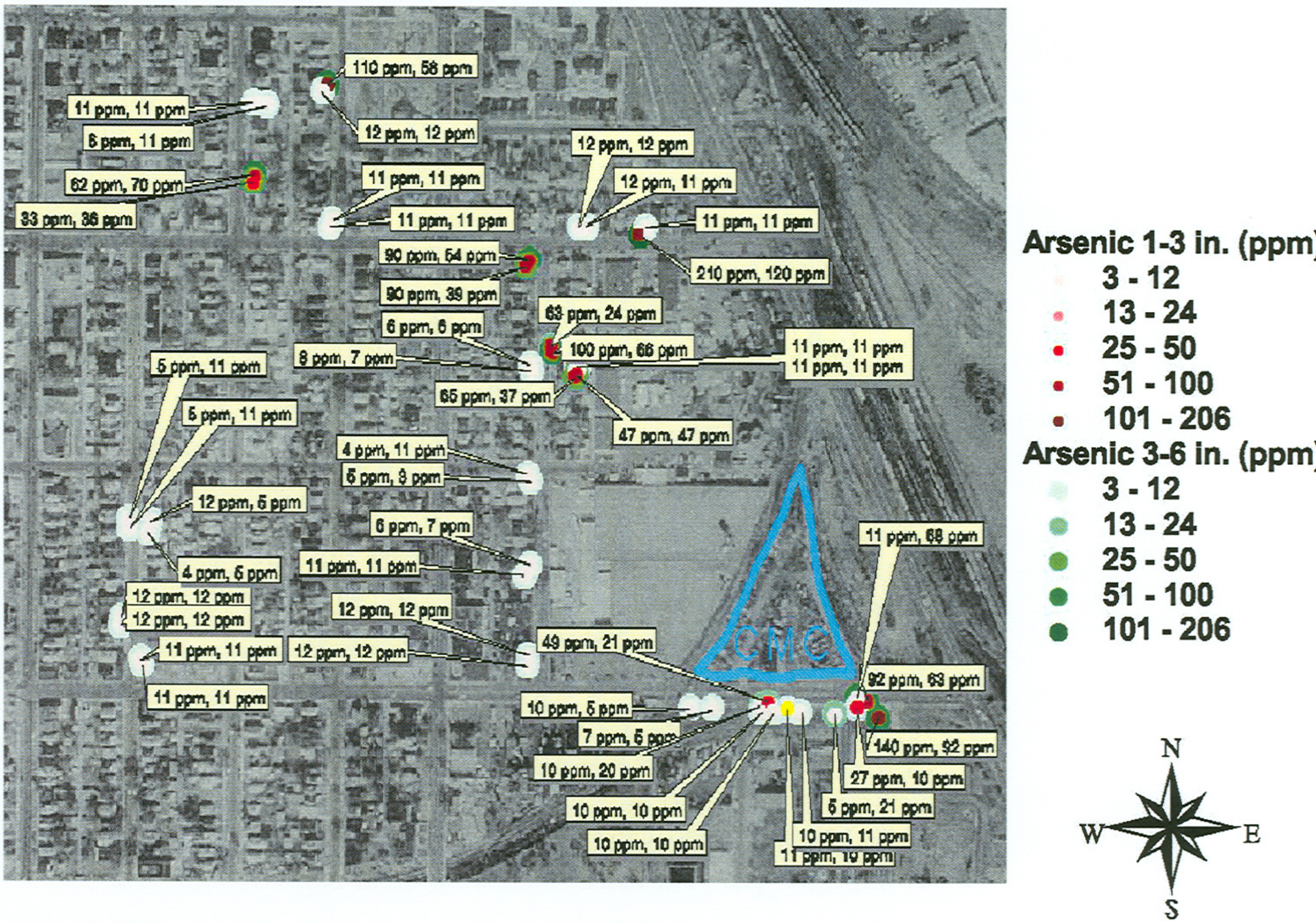


Figure 4

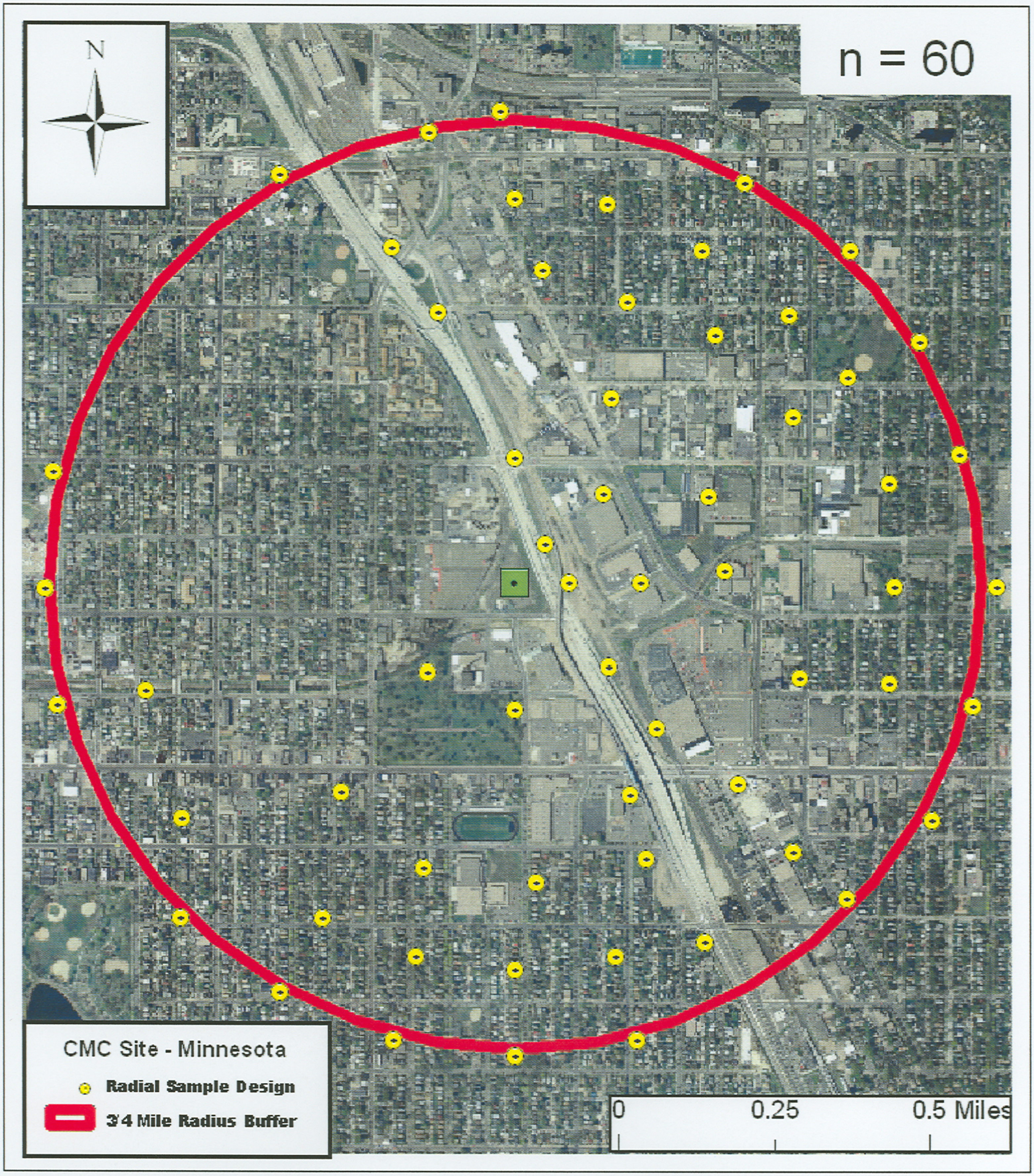
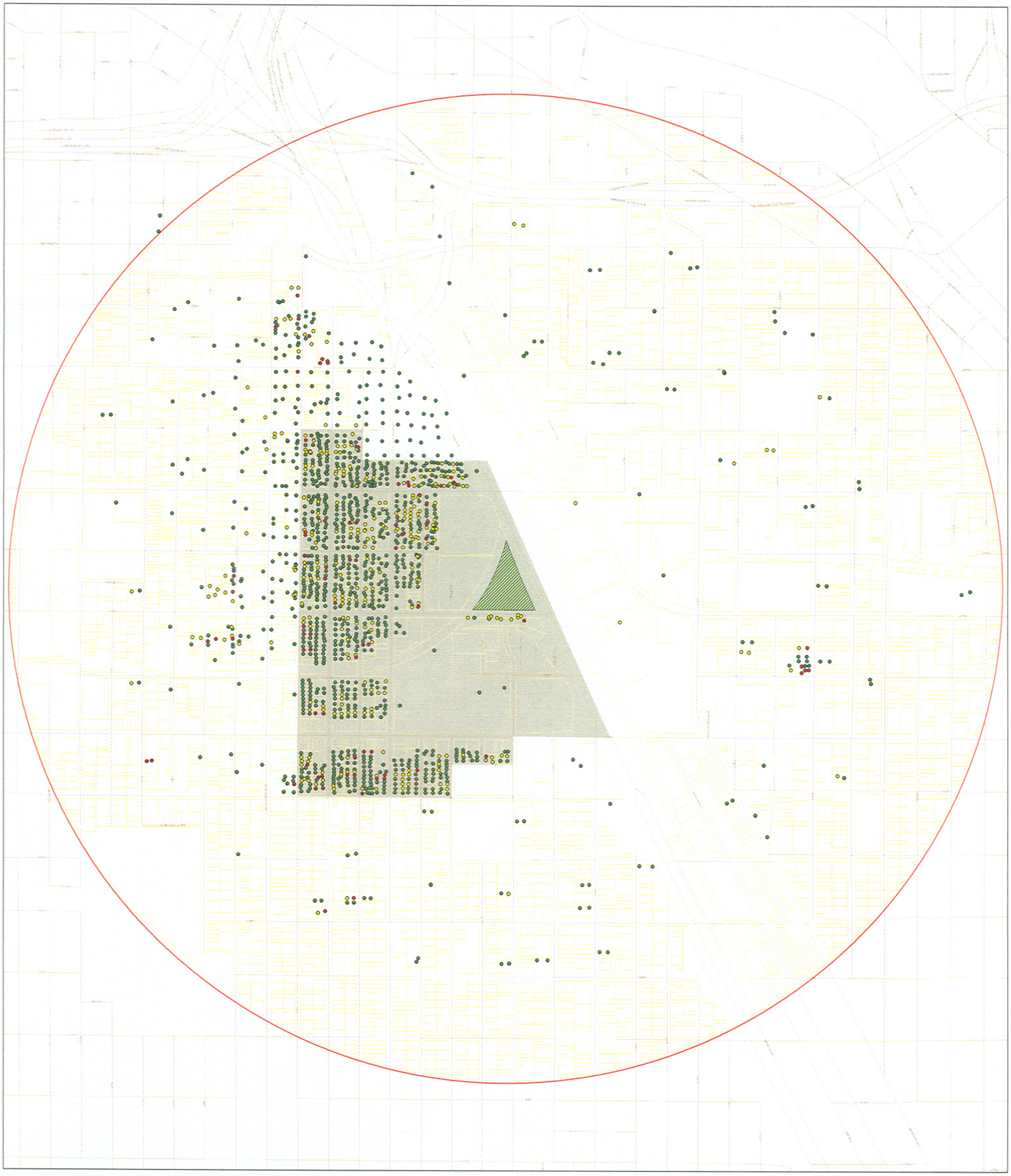


Figure 5. Radial sampling design surrounding the CMC facility. Samples are taken at an initial 328 ft (100 m) distance and 740 ft (225 m) intervals thereafter. A total of 6 radials were included in this design. Samples were determined at 45 degree bearing intervals for the first two radials (100 m , 325 m). Samples were determined at 22 degree bearing intervals for the following two radials (550 m, 775 m). Samples were determined at 15 degree intervals for the last two radials (1000 m, 1225 m). Samples occuring within 250 ft (76 m) of previously collected samples were deleted.
Additionally, samples located on industrial developments such as roadways and facilities were removed from this sampling design. In some instances, a sample located on such a development was relocated to a nearby (< 100 ft.) location where a sample may be easily obtained. Total number of samples equals 60.



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Contaminant Distribution for Parcels Sampled Through November 2005
South Minneapolis Soil Contamination Site
Minneapolis, Hennepin County, Minnesota

Samples Collected Through 11/15/2005

Arsenic in Soil (mg/kg)

- 0.00 - 9.99 (n=1,198)
- 10.00 - 94.99 (n=331)
- 95.00 - 1200.00 (n=83)
- August 2005 100% Residential Sampling Area
- One Mile Buffer of Site

0 500 1,000 1,500 Feet

Map created from data of varying accuracy and precision.

Figure 6

Appendix A

Arsenic Action Level

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

June 16, 2004

Ken Rhame
Superfund On-Scene Coordinator
U.S. EPA
77 West Jackson Blvd.
Chicago, IL 60604

Dear Mr. Rhame:

The CMC Heartland Lite Yard site at the corner of Hiawatha Avenue and East 28th Street has been identified as a suspected source of arsenic that has contaminated approximately 15% of the properties tested in the East Phillips neighborhood of Minneapolis, based on sampling conducted by the Minnesota Department of Agriculture (MDA) and EPA.

The Agency for Toxic Substances and Disease Registry (ATSDR) and the Minnesota Department of Health (MDH) consider the areas of highest arsenic contamination (over 600 mg/kg in composite samples) in surface soil to pose an urgent public health hazard. This conclusion is based on concerns that young children, who have been determined to experience infrequent episodes where they ingest significant amounts of soil (>10 grams) over a short period of time [Stanek, EJ and EJ Calabrese . Daily Estimates of Soil Ingestion in Children. Environ Hlth Perspec 103:276-285, 1995]. If this behavior occurred in an area where the highest arsenic levels were found, significant adverse health effects could occur. The ATSDR Minimal Risk Level (MRL) for acute exposure to arsenic is 0.005 mg/kg/day, based on acute gastrointestinal distress, edema and neurological damage observed at 0.05 mg/kg/day from a food-based arsenic source. Children who may ingest these elevated soil levels in the highest contaminated properties, even for a relatively short duration, could experience these health effects.

Other characteristics of the arsenic contamination contribute to the conclusion of an urgent public health hazard. The chemical form of the arsenic used for the pesticide formulation at the CMC Heartland site, sodium arsenate, is highly water soluble and is expected to have a high bioavailability, or capacity to absorb into the bloodstream. This issue is discussed in more detail in a 1999 MDH/ATSDR *Health Consultation* for the CMC Heartland site. In addition, since the sampling was performed as composite samples, individual locations in these residential yards could be significantly higher.

While a plan for a complete assessment and remediation of the arsenic contamination is being developed for this neighborhood, ATSDR and MDH recommend that *immediate* action be taken by the U.S. Environmental Protection Agency (EPA) to remove soil containing greater than 110 mg/kg (ppm)of arsenic. The basis for this specific recommendation is described in the *Risk*

Based Guidance for Soil – Human Health Pathway from the Minnesota Pollution Control Agency (MPCA) (attached). MPCA specifies a Soil Reference Value of 110 mg/kg of arsenic in soil as an acute criterion to guide investigation and response activities, based on evidence of significant health effects (e.g. gastrointestinal distress and neurological damage) that may result from acute exposure to arsenic at levels above the SRV. Since there are a number properties with composite arsenic levels between 100 and 110 ppm, EPA may decide to use a practical screening level of 100 mg/kg for the purposes of identifying properties for remediation.

Regarding a final soil clean-up goal for arsenic in residential soils, ATSDR and MDH concur that the proposed goal of 30 mg/kg is considered to be protective of public health for chronic, lifetime exposure.

If you have any questions you can contact either Rita Messing (651-215-0924) or Mark Johnson (312-886-0840).

Sincerely,

Mark D. Johnson

Rita B. Messing

Mark D. Johnson, PhD, DABT
Senior Environmental Health Scientist
ATSDR

Rita B. Messing, PhD
Supervisor
Site Assessment and Consultation Unit
Minnesota Dept. of Health

Attachment: MPCA Risk Based Guidance for Soil-Human Health Pathway; Section 3 Short Term Hazard Evaluation

Appendix B

Cancer and the Environment

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Cancer and the Environment

This publication is written for people who are concerned about cancers that they have experienced themselves or in members of their family or community. The information is presented for the purpose of answering common questions about cancer risks and the environment, including a list of steps people can take to prevent or minimize cancer risks.

The term "environment" includes air, water, and soil, but also substances and conditions in the workplace and at home. It includes diet; the use of tobacco, alcohol or drugs; exposure to chemicals; and exposure to sunlight and other forms of radiation.

We all learn about risks at an early age—how to recognize them and how to avoid them. Some risks are obvious and immediate: proximity to hot stoves, use of chain saws, driving on the highway. But other risks (especially those associated with cancer) like tobacco use, and chemical and radiation exposures, are delayed in their effects and are often hard to understand.

MINNESOTA MDH DEPARTMENT OF HEALTH
Environmental Health Division
Environmental Surveillance and Assessment
Site Assessment and Consultation Unit
P.O. Box 64975, St. Paul, MN 55164-0975

What is cancer?

Cancer is not a single disease; it is a group of more than 100 different diseases. Cancer is the uncontrolled growth and spread of abnormal cells in the body. Different types of cancer have differing rates of occurrence, causes, and chances for survival.

The development of cancer is a multi-step process, starting with genetic changes in cells, followed by cell division and growth over time. The time from genetic change to the development of cancer, known as the "latency period," is usually decades long, often 30 years or longer. This means that many cancers diagnosed today may be due to genetic changes that occurred in cells a long time ago.

Cancer can develop in individuals of all ages, but is most commonly found in people who are older than 60 years. Nearly one half of all Minnesotans will develop cancer at some point in their lives. Because people are living longer, the risk of developing cancer is increasing.

What causes cancer?

Since cancer is not a single disease, it does not have a single cause. There are a variety of causes (better known as "risk factors"). These factors act over many years to increase an individual's chance of developing cancer. They can include such things as age, race, gender, other genetic factors, chemical exposures, diet, radiation, exposure to tobacco, and reproductive history.

For many cancers, such as breast and colon cancer, genetics play a role. This means that a family history can be a risk factor for some types of cancers. It is not unusual for several cases to occur within a family.

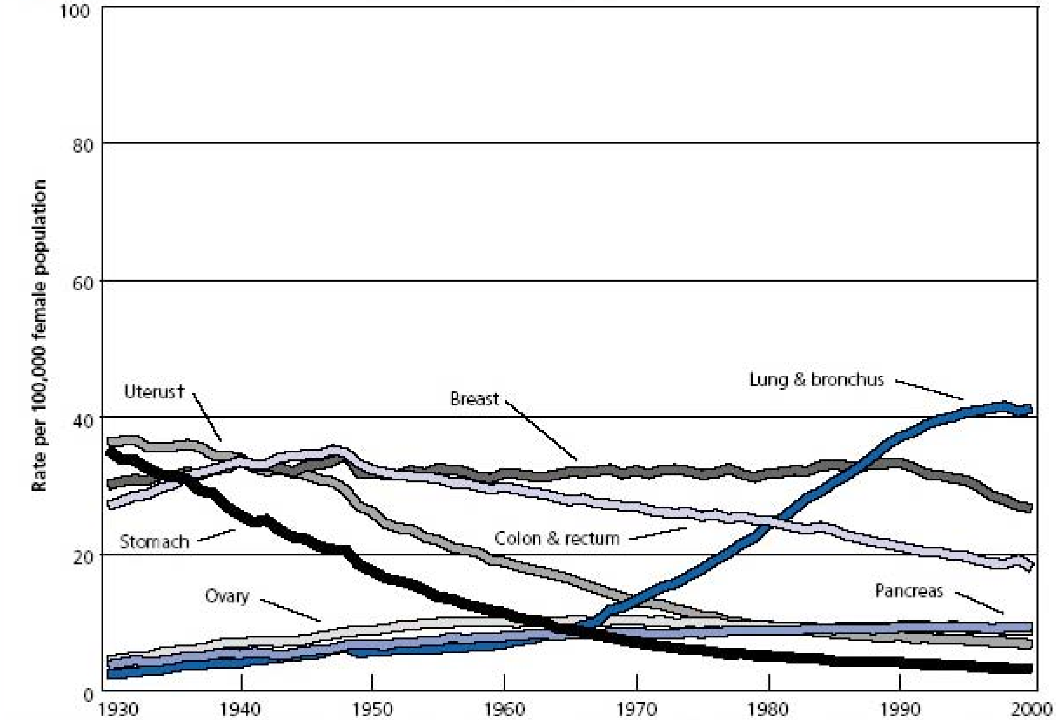
In addition, there are things we do in our daily lives that can increase our chance of developing cancer. These factors, sometimes called "lifestyle factors," include: cigarette smoking; heavy drinking; and eating foods that have excess calories, high fat, and low vegetable intake. Other lifestyle factors that increase risk have to do with reproductive patterns, sexual behavior, and sunlight exposure.

Cigarette smoking is a leading cause of cancer deaths in the U.S. today. In addition to being responsible for 80 to 90 percent of lung cancers, cigarette smoking is also associated with leukemia and cancers of the mouth, pharynx, larynx, stomach, esophagus, pancreas, kidney, bladder, cervix, and endometrium (lining of the uterus)**.**

Approximately 30 percent of all cancer deaths are related to smoking, and the risk of dying from lung cancer is 10 to 20 times higher for smokers compared to non-smokers. In fact, smoking is the most preventable cause of death in our society.

Are cancer rates increasing in the U.S.? In Minnesota?

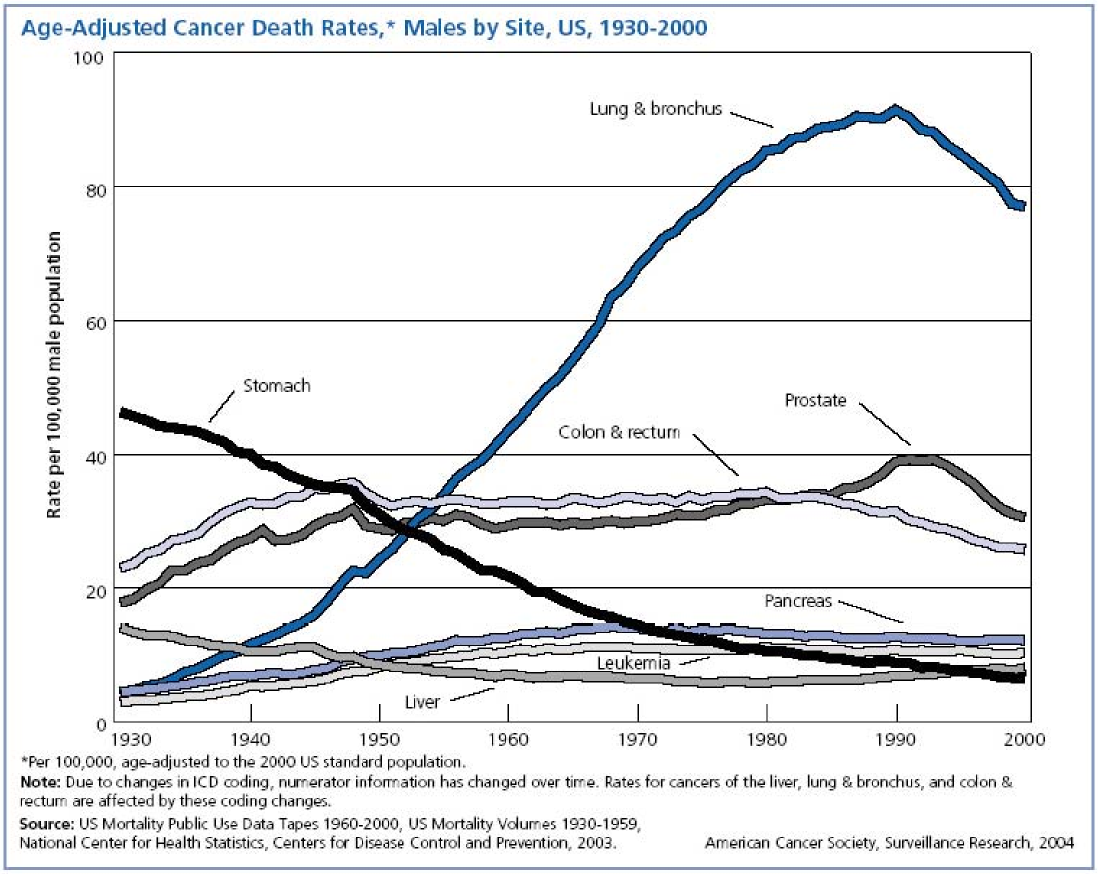
From the 1930s until 1991, there was a steady rise in the overall cancer death rate in the U.S. The major cause of this rise was the increase in lung cancer; this was strongly associated with increases in smoking. Death rates for many cancers—other than lung cancer—declined by 15 percent between 1950 and 1990. These decreases are due to improvements in the early detection and treatment of specific types of cancers, such as breast, colon, and cervical cancers. Between 1990 and 2000 the national cancer death rate fell 7.6 percent.



*Per 100,000, age-adjusted to the 2000 US standard population. †Uterus cancer death rates are for uterine cervix and uterine corpus combined.
Note: Due to changes in ICD coding, numerator information has changed over time. Rates for cancers of the liver, lung & bronchus, colon & rectum, and ovary are affected by these coding changes.
Source: US Mortality Public Use Data Tapes 1960-2000, US Mortality Volumes 1930-1959, National Center for Health Statistics, Centers for Disease Control and Prevention, 2003.
American Cancer Society, Surveillance Research, 2004

In Minnesota, the incidence of cancer (new cases) is monitored by the Minnesota Cancer Surveillance System. Created by the Minnesota Legislature in 1987, this statewide system collects information on all new cancers diagnosed in Minnesotans.

Minnesota's cancer rates are similar to the national rates for most types of cancer. However, our lung cancer rates are lower compared to the U.S. population. This may be due to the fact that smoking prevalence in Minnesota was lower years ago. Today our smoking rate is similar to the national average and the gap between the national lung cancer rate and Minnesota's rate is closing.
In men, cancer incidence has declined in Minnesota since 1988, largely due to decreases in colorectal, stomach and lung cancer. Prostate cancer incidence increased in the early 1990's when a new screening test found many cancers that would not have been found until later, or may never have become apparent, without screening.



In women, overall cancer incidence rates increased, largely due to increases in breast and lung cancer, which outweighed decreases in colorectal, stomach and cervical cancer. Despite these increases, breast cancer deaths decreased due to earlier diagnosis and improved treatment.

Odds of Cancer in Minnesota Males		
	Diagnosis	*Death*
Prostate	1 in 6	1 in 27
Lung	1 in 13	1 in 15
Colo-rectal	1 in 16	1 in 40
Bladder	1 in 26	1 in 125
Any Cancer	1 in 2	1 in 4

Odds of Cancer in Minnesota Females		
	Diagnosis	*Death*
Breast	1 in 7	1 in 29
Colo-rectal	1 in 17	1 in 40
Lung	1 in 20	1 in 23
Uterine	1 in 33	1 in 167
Any Cancer	9 in 20	1 in 5

In Minnesota, as in other parts of the country, racial differences have been observed. African American men have the highest cancer rates in Minnesota. Among American Indians, smoking-related cancers of the lung, larynx, and oral cavity, as well as prostate, colorectal and cervical cancers are unusually common.

What about cancer in children?

Many pediatric cancers occur early in life and parents want to know why. Nearly 1 in 450 children will be diagnosed with cancer before the age of 15. Although some childhood cancers are associated with specific genetic, prenatal, and environmental factors, in most cases the causes remain largely unknown.

It is believed that the organ systems of children are especially vulnerable to injury when undergoing periods of rapid growth and development. Factors that are *suspected* of playing a role in childhood cancers include genetics, infectious diseases, prenatal conditions, environmental pollutants, radiation, and use of medications. However, few studies have been able to show a consistent association between cancer and these factors.

The types of cancer most often seen in children are different from those seen in adults. The three most common types of cancer in children are: (1) leukemias; (2) tumors of the brain and nervous system; and (3) lymph node cancers. In contrast, the most common types of cancer in adults are: (1) lung cancer; (2) breast cancer; (3) colon or rectal cancer; and (4) prostate cancer.

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What about chemicals in the environment?

Lifestyle factors present some significant risks. However, exposures to certain chemicals in the environment, at home, and at work may also contribute to an individual's risk of developing cancer. Benzene, asbestos, vinyl chloride, and arsenic are examples of toxic substances that can increase the risk of cancer to those who are exposed. The International Agency for Research on Cancer (IARC) has classified these substances as "*known human carcinogens*."

Some chemicals have been shown to cause cancer in animals, but there is not enough evidence to show that these chemicals cause cancer in humans. These chemicals are classified by IARC as "*possible or probable* (*suspected) human carcinogens*."

Most of what we know about chemicals and cancer in humans comes from scientists' observations of workers. Historically, the most significant exposures to cancer-causing chemicals have occurred in workplaces where large amounts of toxic chemicals were used. That is why safe work practices, personal protection, ventilation, and other controls are so important in protecting workers and their families.

The amount of toxic chemicals found in food, air, and drinking water are typically much lower than in the work environment. Therefore, cancer risk from environmental exposures is thought to be very low compared to the risk in occupational settings. In fact, the cancer risk from environmental exposures is so low that it is difficult to measure in scientific studies.

Scientists have compiled a list of substances that are either known or suspected of causing human cancer in The 10th Report on Carcinogens published in 2003. The report also describes where these substances are found in our environment. For a condensed list of these substances, see Table 1 at the end of this publication. The complete report is available on the internet at:
http://ntp-server.niehs.nih.gov/NewHomeRoc/AboutRoC.html

How do I interpret information in the news about cancer and the environment?

There are several principles to keep in mind when you read an article or hear a news report about a new scientific study:

**A single study on the causes of cancer is seldom conclusive*. Scientists look for multiple studies with consistent results before drawing conclusions. Each new study that you hear or read about adds to the body of evidence that scientists use for understanding the causes of cancer.

**The dose determines the poison.* Scientific results are usually specific to a particular dose or route of exposure to a specific population being studied. Yet each individual's chance of getting cancer from an exposure will be different depending on:

- The amount of a contaminant to which a person is exposed
- The length of time a person is exposed
- The number of times a person is exposed
- How the person was exposed, such as by eating, breathing, or touching the substance

** Realize that uncertainties are always present in any study of environmental exposure and cancers.* Due to the long latency period of cancer development, it is often difficult to collect information regarding exposures years or decades after they occur. Individual genetic differences, age, gender, and health status interact with lifestyle habits, as well as environmental exposures -- causing some people to be more sensitive to developing cancer than others. Because it is difficult to account for all of these variables and how they interact, "uncertainties" exist in the study of cancer and environmental risk factors.

**"Safety factors" or "uncertainty factors" are used to set acceptable levels of exposure.* These factors take into account that certain individuals might be more sensitive to chemicals because of age (children and the elderly), genetic make-up, gender, diet, or health status. In addition, if mice or rats were used to test the chemical, the possibility is considered that people may be more sensitive to the cancer-causing effects of the substance than the rodents. To ensure that the acceptable level of exposure will protect the public, government agencies use safety factors that result in setting acceptable levels of exposure as much as 10,000 times lower than the level that causes cancer in mice and rats.

**Sometimes it is necessary to weigh risks vs. benefits.* Some drugs are prescribed even though they may increase the risk of cancers in later years. An example is the use of certain drugs to treat cancer that increase the risk of secondary cancers. In these situations, the immediate benefits of treating an often imminently life-threatening disease have been determined to outweigh the risks of developing cancer several years later. Before taking any medication that increases the risk of cancer in future years, discuss the risks versus the benefits with your physician.

What is being done to control cancer-causing chemicals?

Strict federal and state standards have been set to minimize our exposures to cancer-causing chemicals. On the federal level, the U.S. Environmental Protection Agency (EPA) is charged by the U.S. Congress to set environmental regulatory standards to protect human health and the health of the environment from substances released into air, water or soil.

In the State of Minnesota, the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Health (MDH) have state programs to meet or exceed the federal standards to protect human health and the health of the environment. Activities include monitoring of air, water, and soil, conducting scientific research, setting standards, proposing rules, and enforcement.

MDH, Division of Environmental Health protects people from environmental hazards in drinking water, the home, workplace, and community. Activities include monitoring health trends, assessing environmental exposures in communities, evaluating the scientific evidence and recommending safe exposure levels or other actions to protect public health. MDH has established standards for chemicals in air (called Health Risk Values) and water (called Health Risk Limits) specifying levels that are considered safe. MDH also provides education about hazardous substances for communities and health professionals.

Many hazardous substances, such as certain pesticides and metals, continue to be found in our environment from past use. Dioxin, for example, is widespread and persistent in the environment. Small amounts of dioxin can be found in our food and in our bodies. It will take many years for such persistent chemicals to break down or be removed from the environment.

Ironically, one of the most potent and well-known cancer-causing chemicals, tobacco, is still largely uncontrolled. There are over 40 known or suspected carcinogens present in tobacco smoke. Progress has been made, however, in controlling exposure to secondhand smoke in public buildings and on the job.

Some carcinogens in the environment occur naturally and are much more difficult to control. Arsenic in underground rock can get into drinking water wells. Radiation from the sun is also a strong cancer-causing agent. Sometimes our own actions offer the best control for exposure. When necessary, we can purify drinking water or use clothing and sunscreen to protect ourselves from the sun.

Many other agencies work to protect the public from harmful environmental exposures. For a listing of some of these agencies, see "Where can I get more information?" at the end of this booklet.

What if I see an unusual number of cancers among my neighbors or co-workers? Could it be something in our environment?

Cancer is a personal tragedy for those affected. But what may appear to be an "outbreak" of cancer does not, by itself, signal a special risk related to something in the environment. Unfortunately, cancer is common in our population, and differing types of cancer have differing causes.
It is not unusual to observe many cases of cancer in a single community or neighborhood, particularly if the community is aging. In fact, using information from our cancer surveillance system, we know that cancers *frequently* occur in clusters. Clusters often occur by chance and cancer cases are not evenly distributed throughout the population.

At MDH, patterns of disease are investigated by epidemiologists who study the frequency, distribution, risk factors, and control of diseases in populations. Epidemiologists look for an unusual pattern of a specific type of cancer, rather than several different types. They find out whether the specific type of cancer is a primary cancer or a cancer that is the result of metastasis (spread from another organ in the body).

Using statistical methods, epidemiologists can determine whether a reported excess of cancer in a population is really more than would normally be expected to occur. They must also take into account other characteristics of the population that can affect disease patterns, such as age, gender and heredity.

Most of our knowledge about the causes of cancer in people comes from studying large populations. Even our best scientific methods cannot tell us the cause of cancer in an individual, or in a small group of individuals.

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What steps can I take to minimize my cancer risks?

We can't eliminate all risks in our lives. But we can, to a certain extent, manage them by adopting healthy lifestyles. MDH endorses the following American Cancer Society recommendations to prevent or minimize cancer risks:

* Stop smoking and avoid all tobacco products
* Avoid excessive exposure to sunlight
* Eat more fruits and vegetables, along with a low-fat, high-fiber diet
* Limit consumption of smoked and nitrite-cured foods
* Limit alcohol intake
* Avoid obesity
* Exercise regularly
* Have routine physical exams since not all cancers have obvious symptoms
* Practice early detection—learn to practice self-exam and seek prompt medical attention for changes in your body which include:
    - A thickening or lump in any part of your body
    - An obvious change in a wart or mole
    - A sore that does not heal
    - A nagging cough or hoarseness
    - A change in bowel or bladder habits
    - Indigestion or difficulty swallowing
    - Unexplained changes in weight
    - Unusual bleeding or discharge

How Can I Protect Myself from Toxic Exposures in the Environment?

At Home:
We spend about 90% of our time indoors. The air inside your home may be more polluted than the air outside. If you use chemicals in the home, such as pesticides, paints, paint thinners, cleaning solvents,

or preservatives, the following steps may decrease exposure:

- Read labels and follow directions carefully
- Use these chemicals only in a well ventilated environment— outdoors when possible
- Throw away partially full containers of old or unneeded chemicals (following community guidelines for disposal of household hazardous waste)
- Make substitutions for less toxic substances whenever possible
- Have the basement of your home tested for radon. An estimated 1 out of 3 homes in Minnesota contain radon gas. For a list of local city or county agencies that distribute radon information and test kits, contact MDH at: 1-800-798-9050 or 651-215-0909. Or log on to the internet at: http://www.health.state.mn.us/divs/eh/indoorair/radon/index.html

If you have an older home (built before 1978)…

- Your home may contain flooring, roofing, insulation or other products with asbestos -- do not disturb or remove any asbestos containing material. For more information, contact MDH at: 651-215-0900. Or log on to the asbestos web site: http://www.health.state.mn.us/divs/eh/asbestos/index.html
- Old paint may contain lead or other toxic metal. Peeling paint should be safely removed or covered.

At Work:

- Be aware of any carcinogenic substances used in your workplace
- Participate in work hazard communication training programs
- Read labels and take precautions as directed
- Use recommended personal protective equipment

In Your Community:

- Stay informed. If you have concerns regarding pollutants in your community, contact the agencies responsible for safeguarding our environment and our health, such as MPCA and MDH, Division of Environmental Health.
- Members of tribal communities may contact their Natural Resource Management or Environmental Health departments.

Where can I get more information?

National Cancer Institute (NCI): http://www.cancer.gov
The largest cancer research organization in the country; supports research at universities, hospitals, foundations, and businesses throughout the U.S. and abroad.

- Cancer Prevention: http://www3.cancer.gov/prevention/
- NCI's SEER Program is the most authoritative source of information on cancer incidence and survival in the U.S.: http://www-seer.ims.nci.nih.gov
- NCI's Toll-Free Cancer Information Service for information about cancer and to request publications: 1-800-4-CANCER/1(800) 422-6237

National Institute of Environmental Health Sciences (NIEHS): http://niehs.nih.gov
Established to reduce human illness caused by unhealthy substances in the environment. Activities include biomedical research, prevention, and intervention programs along with training, education, and community outreach efforts.

- National Toxicology Program (NTP): Coordinates toxicology research and testing activities within the U.S. Department of Health and Human Services (DHHS). Publishes a biennial Report on Carcinogens: http://ntp-server.niehs.nih.gov/NewHomeRoc/AboutRoC.html

Centers for Disease Control and Prevention (CDC): http://www.cdc.gov/
CDC is an agency of the U.S. DHHS that is charged with promoting health and quality of life by controlling disease, injury, and disability:

- National Center for Environmental Health (NCEH) Health Line: 1(888) 232-6789 http://www.cdc.gov/nceh/ncehhome.htm
- For information about the *National Report on Human Exposure to Environmental Chemicals*, March 2002, call 1(866) 670-6052 or log on to: http://www.cdc.gov/nceh/dls/report

Agency for Toxic Substances and Disease Registry (ATSDR): http:// www.atsdr.cdc.gov
ATSDR is an agency of the U.S. DHHS that advises the EPA on hazardous waste issues. ATSDR has educational fact sheets about toxic chemicals.

- ATSDR Informational Center: 1(888) 422-8737

The International Agency for Research on Cancer (IARC): http://www.iarc.fr
IARC is part of the World Health Organization (WHO) and has a mission to coordinate and conduct research on the causes of human cancer.

Environmental Protection Agency (EPA): http://www.epa.gov
A government regulatory agency charged by the U.S. Congress to protect human health and safe-guard the natural environment:

- Indoor Air Quality: http://www.epa..gov/iaq
- Envirofacts Warehouse: http://www.epa.gov/enviro
- Environmental Atlas: http://www.epa.gov/ceisweb1/ceishome/atlas
- EPA National Pesticide Information Center: http://npic.orst.edu/
  Phone: 1(800) 858-7378
- EPA Superfund Hotline for hazardous waste: 1(800) 535-0202

Cornell University Program on Breast Cancer and Environmental Risk Factors (BCERF) in New York State: http://envirocancer.cornell.edu
A program developed by faculty and staff from Cornell University in Ithaca, New York, and the Joan and Sanford Weill Medical College of Cornell University in New York City. The website provides information about environmental risk factors and breast cancer.

The American Lung Association: http://www.lungusa.org
A voluntary health organization in the United States that has many programs and strategies to fight all forms of lung disease, which include funding professional research and promoting environmental health.

- Facts about lung cancer: http://www.lungusa.org/diseases/

Food & Drug Administration (FDA): http://www.fda.gov/
The FDA monitors products for safety and helps safe and effective products reach the market in a timely way.

- The National Center for Toxicological Research: http://www.fda.gov/nctr
- FDA Consumer Hotline: 1(800) 532-4440

Occupational Safety and Health Administration (OSHA): http://www.osha.gov
OSHA is an agency of the U.S. Department of Labor charged with preventing work-related injuries, illnesses, and deaths.

- OSHA information: 1(800) 321-6742

National Institute for Occupational Safety and Health (NIOSH): http://cdc.gov/niosh
An agency of the CDC that researches and makes recommendations to prevent work-related disease and injury.

- NIOSH information: 1(800) 356-4674

The Harvard School of Public Health: http://www.yourcancerrisk.harvard.edu/
An interactive website designed to help you identify and decrease your personal risk factors for several types of cancer.

This information was prepared in cooperation with the U.S. Agency for Toxic Substances and Disease Registry. To request this document in another format, call: (651) 215-0700 or toll-free 1–800-657-3908, press 4 and leave a message; TDD: (651) 215-0707 or 1-800-627-3529.

Table 1. Categories, Source, and Associated Sites of Known or Suspected Carcinogens

Substance	Source of Exposure	Cancer Site Associated with Exposure
Aflatoxins	Toxins from fungi in contaminated foods (peanuts and grains) or contaminated grain dust (agricultural workers exposed)	Liver
Alcoholic Beverages	Consumption of more than 2 alcoholic drinks per day	Mouth, throat, voice-box, and esophagus; possible link with breast and liver cancer.
Arsenic	Naturally occurs in soils and groundwater from the weathering of rock. Industrial uses: wood preservative, glass, and pesticides. Exposure can occur through food and drinking water, automobile emissions or emissions from industrial facilities, and smoking.	Skin, lung, bladder, kidney and liver
Asbestos	Air-born microscopic fibers released from products, mostly found in homes and buildings, also brake linings.	Lung, larynx and lining of the lung (mesothelioma)
Benzene	Used in chemical and drug industries, and as a gasoline additive. Found in gasoline vapors, auto exhaust, and cigarette smoke.	Leukemia
Benzidine and Benzidine-based Dyes	Exposure can occur near dye and pigment plants where wastes may be discharged.	Bladder
Diesel Exhaust Particles	Diesel automobiles, trucks and engines	Lung
Dioxin (TCDD)	By-product during paper and pulp bleaching, incineration of wastes, forest fires, and in some pesticides and wood preservatives. Most human exposure is dietary: meat, dairy, fish.	Cancers, no specific site
Formaldehyde	Used in construction products, textiles, disinfectants, coatings, moldings, furnishings; exhaust from cars, power plants, wood stoves, kerosene heaters and cigarettes.	Nasophyarygeal, brain
Ionizing Radiation	Medical X-rays, rays entering the earth's atmosphere, naturally radioactive substances	Leukemia, breast, thyroid, lung, stomach, and other organs at very high doses
Ultraviolet Radiation	Sun, sunlamps, or tanning beds	Skin-melanoma
Medical Drugs:		
Cyclophosphamide, Chlorambucil, Melphalan	Cancer therapy agents	Increased occurrence of secondary cancers Endometrium (lining of the uterus)
Estrogen	Treatment of menopause and gynecologic conditions	Endometrium (lining of the uterus)
Tamoxifen	Synthetic hormone	Cervix and vagina; in daughters exposed prenatally
Diethylstilbestrol (DES)	Synthetic estrogen	
Metals:		
Cadmium and cadmium compounds	Industrial processes, contamination can be released into air, surface water, ground water and topsoil.	Lung
Nickel and Nickel Compounds	Steel, dental fillings, copper, brass, glazes, and storage batteries. Found in air, water, soil, food, and consumer products.	Lung, nasal cavity, and larynx
Chromium VI Compounds	Used in corrosion protection, electroplating, textile and tanning, paper, pigments, roofing, and glass. Contaminant in soil, air, water, food.	Lung
Beryllium Compounds	Industrial uses: aerospace and defense, electrical components, aircraft brakes, fuel additive, ceramics, glass, fiber optics and plastics. Exposure occurs through burning of coal and fuel oil.	Lung
Lead Compounds	Lead acetate used in dyes, metal coatings, paints, varnish, pigments. Found in contaminated soils, water, dust, food and paint chips.	Lung, stomach

Obesity		Colon, esophagus, stomach, gall bladder, endometrium, kidney, and breast
Pesticides	Used for agricultural practices, restricted use. About 20 out of 600 are carcinogenic: e.g. lindane, ethylene oxide, DDT, chlorophenoxy herbicides, toxaphene, hexachorobenzene, lead acetate.	Lymph system, prostate, and stomach, increased cancers among highly exposed occupational groups
Polycyclic Aromatic Hydrocarbons (PAHS)	Produced from burning organic fuels such as wood and gasoline, and waste incinerators. Also in diesel exhaust, coke oven emissions, cigarette smoke, and charcoal-broiled food.	Lung, genital-urinary
Radon .	Naturally occurring radioactive gas seeps into lower levels of homes and buildings from soils.	Lung
Solvents	Industrial solvents: carbon tetrachloride, chloroform, methylene chloride, tetrachloroethylene and trichloroethylene; used in paint thinners, paint and grease removers, and dry cleaning solvents.	Lung, liver
Tobacco	Cigarettes, cigars, chewing tobacco, snuff and environmental tobacco smoke (ETS)	Lung, bladder, oral cavity, throat, voice box, esophagus, lip, pancreas, and nasal sinus
Vinyl Chloride	Major release is from plastics industry. Also found in groundwater near solvent waste sites.	Liver, brain, blood, and lung
Viruses and Bacteria: Helicobactor pylori Human papilloma-virus Hepatitis B and C viruses Epstein-Barr virus Human Immunodeficiency virus (HIV)	 Waste-tainted food or water, oral contact. Sexually transmitted virus Direct contact with blood and/or body fluids Contact with oral secretions Direct contact with blood and/or body fluids	 Stomach Cervix Liver Lymphoma Kaposi's Sarcoma, endothelial layer of blood, lymph system
Wood Dusts	Inhalation of small air-born particles from wood	Lung

Information in this chart is based on materials from the National Cancer Institute and National Institute for Environmental Health Sciences

Appendix C

Reducing Your Contact with Contaminated Soils

Environmental Health Information

How to reduce accidental intake of contaminated soils

May 2006

How can you be exposed to contaminants in soil?

While it is possible to breathe in contaminated dust, accidental ingestion of contaminated soil is a greater concern. Accidental ingestion of contaminated soil may occur when normal activities leave soil on our fingers and hands, increasing the chance that contaminants could be swallowed. Children who live and play in a contaminated area can have more exposure than adults. Preschool-age children are more likely to be exposed because of their frequent hand to mouth activity. Dust from contaminated soil can be tracked into the house on shoes and can end up on indoor surfaces and toys.

What can you do to prevent or reduce contact with contaminants?

Keep hands clean.

- Wash children's hands and faces, especially before eating and bedtime. Keep their fingernails short and clean. Clean toys or objects that children put in their mouths.
- Adults should wash their hands before feeding their children, smoking, eating or drinking.

Try to reduce soil dust in the house.

- Take off your shoes when you enter your home to prevent tracking contaminated soil inside. Store outdoor shoes at entryways. Remember that pets can carry in soil dust on their paws.
- Vacuum carpeting, rugs and upholstery. Regular vacuuming will keep dust from accumulating.
- Dust with a damp cloth.
- Scrub tile and linoleum floors and wash windowsills.
- Keep windows closed on windy days, at least on the windward side of the house. This will keep dust from blowing inside.
- Wash gardening gloves and clothes separately from family clothes.
- Change the furnace filter every 3 months.

Reduce outdoor activities that stir up dust.

- Seed or sod bare areas in your yard. Bushes and grass help keep soil in place and reduce the amount of dust in the air.
- Minimize mowing over areas of sparse lawn during periods of dry weather.
- Avoid dirt biking, mountain biking, ATV use or any other recreational activities that disturb the soil.
- Avoid digging or disturbing soil. If it cannot be avoided, keep the soil moist to reduce making dust.

Take special care when gardening or harvesting.

- Use gardening gloves (leather is better than cloth) when gardening to keep contaminated dust out from under fingernails and reduce the chance that soil on fingers and hands could be swallowed.
- Keep garden tools and gloves in one area of the garage or shed.
- Periodically rinse tools off.
- All plants used for traditional or cultural purposes should be rinsed off carefully, even if they will not be used as food.
- Use the same tips when harvesting wild vegetation (use gloves and rinse tools).

Give children a safe play area.

- Build a sandbox with a bottom and fill it with clean sand. Cover it when not in use to keep out contaminated dust.
- Find other places for children to play.

Prepare food carefully to reduce the amount of contaminants.

- Thoroughly wash and peel all home-grown vegetables before eating or cooking them. Or, if possible, grow vegetables in a raised garden bed filled with clean soil.
- Rinse the dust off of wild vegetation carefully before using.

For more information contact:
MDH/Site Assessment and Consultation: (651) 201-4897 or 1 (800) 657-3908, press "4" and leave a message.

To request this document in another format, call (651) 201-5000, TDD: (651) 201-5797 or, the Minnesota Relay Service at 1 (800) 627-3529.

This information sheet was prepared in cooperation with the federal Agency for Toxic Substances and Disease Registry.