ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

SOUTH MINNEAPOLIS NEIGHBORHOOD
SOIL CONTAMINATION NPL SITE

HENNEPIN COUNTY, MINNESOTA
EPA FACILITY ID: MNN000509136
JULY 29, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment 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.

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Prepared by:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation

Foreword

This document summarizes health concerns associated with the South Minneapolis Residential Soil Contamination site in Minnesota. It is based on a formal site evaluation prepared by the Minnesota Department of Health (MDH) in collaboration with the Agency for Toxic Substances and Disease Registry (ATSDR) and Minnesota Department of Agriculture (MDA). A number of steps are necessary to do such an evaluation:

- Evaluating exposure: MDH scientists begin a site evaluation by reviewing available information about environmental contamination at the site, or emitted from the site. The first task is to find out how much contamination is present, where it is found, and how people might be exposed to it. Usually, MDH does not collect its own environmental sampling data; instead MDH relies on information provided by the U.S. Environmental Protection Agency (EPA), Minnesota Department of Agriculture (MDA), and other government agencies, 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. The report focuses on public health i.e., the health impact on the community as a whole and is based on existing scientific information.

- Developing recommendations: In the evaluation report, MDH, MDA, and EPA outline their conclusions regarding any potential health threat posed by a site and offer recommendations for reducing or eliminating human exposure to contaminants. The role of MDH in dealing with individual sites is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies—including EPA, or local government. However, if an immediate health threat exists, MDH will issue a public health advisory warning 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 organizations responsible for cleaning up the site, and the community surrounding the site. Any conclusions about the site are shared with the groups and organizations that provided the information. Once an evaluation report has been prepared, MDH seeks feedback from the public. *If you have questions or comments about this report, you are encouraged to contact MDH.*

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Executive Summary

The South Minneapolis Neighborhood Soil Contamination Site (SMNSC) was recently added to the National List of Priorities (NPL; Superfund). The site encompasses the parent site (CMC Heartland Lite Yard Facility, Minneapolis, Minnesota). The CMC site in on the Minnesota Permanent List of Priorities (PLP; Minnesota Superfund). This PHA focuses on off-site soil data presented in the EPA document, Technical memo: *Surface Soil Sampling South Minneapolis Soil Contamination Site, Minneapolis, MN, (October 23, 2006).* This document is a collaborative effort between the Minnesota Department of Agriculture (MDA), Agency for Toxic Substances and Disease Registry (ATSDR) Region V, U.S Environmental Protection Agency Region V (EPA), and the Minnesota Department of Health (MDH). The South Minneapolis site encompasses a number of neighborhoods near the intersection of 28th Street and Hiawatha Avenue, where the CMC Heartland Lite Yard was located from about 1938 to 1968. A pesticide containing arsenic was produced there and believed to have been wind-blown into the Phillips, Seward, Longfellow, Corcoran, and Powderhorn neighborhoods during shipping of raw materials and production of final product.

The parent site, CMC Heartland Lite Yard Facility, has been remediated and developed into an office building. Approximately 62,000 cubic yards of soil were removed during the CMC Lite Yard remedial action, and another other 8,000 cubic yards of soil were remediated during onsite development. Smiley's Health Clinic has moved into the newly built office building. The clinic in conjunction with MDH developed protocols for identifying arsenic exposure and treatment for residents who believe they have been exposed to site related arsenic. A groundwater plume has migrated off-site, but no residential wells were identified during the door-to-door well receptor survey. A special well construction area designation at the CMC Heartland Lite Yard site prohibits wells from installed near the site, and the plume continues to be monitored.

The EPA developed an air dispersion model to define the potentially impacted area within a ¾ mile radius of the CMC site. This area is known as the South Minneapolis Neighborhood Soil Contamination Site (SMNSC). A total of 6511 soil samples were collected within the SMNSC site. In anticipation of the sampling event, ATSDR and MDH developed an arsenic soil action level (95 ppm) for addressing potential acute risks. EPA identified 197 properties above the 95 ppm action level and has remediated over half of them. The remaining properties above the action level will be remediated during the 2007 and 2008 construction seasons. Approximately 80% of the 3575 properties tested contained less than 20 ppm of arsenic.

The EPA proposed the SMNSC site for the inclusion into the Superfund program. The EPA has not finalized the SMNSC human health risk assessment addressing risks associated with soil arsenic concentrations below the 95 ppm action level. The Superfund remedial program is restricted from remediating properties below background contaminant levels and sites that have become contaminated through the legal use of pesticides and fertilizers. Statistical analysis of the soil arsenic data suggests that arsenic background concentrations for the SMNSC site range from 10-17 ppm. A total of 34 out of 50 states responded to an arsenic soil background survey requesting a background arsenic soil concentration. The arsenic background concentrations ranged from 0 to 350 ppm.

The SMNSC site was proposed for the National Priorities List (Superfund) and was listed in September 2007. Listing the site will provide funding for future remediation of arsenic levels below

the 95 ppm action level. The risk assessment being prepared by EPA will aid in the development of a site arsenic remedial goal.

At the SMNSC site, a complete exposure pathway exists for contaminants found in the top 3 inches of soil. Ingestion is the most important exposure pathway at the SMNSC site followed by inhalation. It is estimated that ingestion represents greater than 95% of the potential exposure. Inhalation represents approximately 5% of the potential exposure. Dermal exposure is not considered an important exposure pathway because arsenic adhered to soil does not readily pass through the skin.

ATSDR has developed Environmental Media Evaluation Guide (EMEG) values for arsenic in soil using common, health protective exposure assumptions. Arsenic soil concentrations less than an EMEG are unlikely to pose a health threat. However, arsenic soil concentrations above an 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 chronic soil arsenic EMEGs are 20 and 200 ppm for a child and adult, respectively.

The Minnesota Pollution Control Agency has developed an arsenic soil reference value (SRVs) for a residential exposure scenario. A child exposure scenario was utilized for evaluating noncarcinogenic risk, and an exposure scenario encompassing childhood and adult years was utilized for evaluating carcinogenic risk. An acute child exposure scenario was selected to derive the current MPCA Residential Arsenic SRV (5 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 Minnesota State Legislature (2007) appropriated funds for MDH to design and conduct a pilot arsenic biomonitoring study. The purpose of the pilot program is to measure arsenic in human tissues in a community with people identified as likely to be exposed. The study sample size will consist of 100 subjects whose urine and/or hair will be collected for analysis. A 13 member advisory board consisting of academia, state government, and community advocates will advise the commissioner on the design and conduct of the studies which will likely be done in the south Minneapolis neighborhood.

Properties over 95 ppm arsenic are a public health hazard. The Federal Superfund Removal Program is eliminating risks associated with potential exposure to soil arsenic concentrations above the 95 ppm action level. The Federal Superfund Remedial Program has been characterizing the soil arsenic extent and magnitude at the SMNSC site, and finalizing a human health risk assessment to help determine a final remedial goal to address chronic risks.

MDH continues to offer advice to EPA as it completes the risk assessment and determines remediation goals.

MDH will also continue to work with residents and parents of young children to reduce contact with contaminated soil. MDH continues to work with Smiley’s Clinic and with residents who have health concerns stemming from exposure to site contamination to ensure that these concerns are addressed.

I. Introduction

The South Minneapolis Neighborhood Soil Contamination (SMNSC) National Priorities List (NPL, Superfund) site encompasses the parent site (CMC Heartland Lite Yard Facility, Minneapolis, Minnesota); and the focus of this Public Health Assessment (PHA) is off-site residential soil impacts. The parent facility will be discussed briefly in the Background section. This document is a report of a collaborative effort between the Minnesota Department of Agriculture (MDA), Agency for Toxic Substances and Disease Registry (ATSDR) Region V, U.S Environmental Protection Agency Region V (EPA), and the Minnesota Department of Health (MDH). This document also discusses background arsenic levels and arsenic impacts found at other sites across the country, and methods to mitigate exposure to arsenic contaminated soil. The MDH reviewed EPA and MDA project files. The MDH project files include the following documents:

- CMC Heartland Lite Yard Site Health Consultation (May 1998); evaluates preliminary onsite remedial goals
- CMC Heartland Lite Yard Site Health Consultation (April 1999); evaluates proposed arsenic remedial goals based on in-vitro tests
- CMC Heartland Lite Yard Site Health Consultation (May 2001); reviews environmental data, recommends off-site soil and well receptor investigations
- 2005 MDH and ATSDR Arsenic Action Level recommendation for EPA removal actions
- CMC Heartland Lite Yard Site Off-Site Soils Health Consultation (August 2006); reviews arsenic toxicity, and provides information on how to avoid exposure

This PHA focuses on off-site soil data presented in the EPA document, Technical memo: *Surface Soil Sampling South Minneapolis Soil Contamination Site, Minneapolis, MN, (October 23, 2006).* These documents and numerous site visits form the basis for this PHA. Health effects associated with arsenic exposure and the outreach to health professionals and the community are also discussed.

II. Background

A. CMC Heartland Lite Yard Arsenic Source Description and History

The suspected source of the residential arsenic impacts is a 5-acre triangular shaped property (CMC Heartland Lite Yard) located on the corner of 28th Street (South) and Hiawatha Avenue (East) in south Minneapolis (see Figure 1). The CMC property was previously leased by Reade Manufacturing, and U.S. Borax Inc., which produced arsenic and/or lead arsenate-based pesticide. The raw materials were brought on site by open railcar and stock piled on the ground uncovered. Wind erosion of raw materials during storing, mixing, and rail transport are believed to have dispersed contaminants into the areas surrounding the CMC site. The property is located within an industrial corridor that included numerous railroad tracks, warehouses, and 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 the east Phillips neighborhood that includes some high-density housing and apartments.

B. CMC Site Remedial History

Approximately 62,000 cubic yards of soil were removed during the CMC Lite Yard remedial action, and another other 8,000 cubic yards of soil were remediated during onsite development. The Ryan Corporation has constructed a large building for smaller businesses on the site. The University of Minnesota Physicians has relocated Smiley's Clinic as well as University Hospital Systems in the newly constructed building onsite (2020 E 28th Street). The new building and parking areas cover most of the site property (See Figure 2). A detailed discussion of the onsite remedial activities is in the CMC Heartland Partners document, 2005 (11) [*Final Report-Response Action Documentation, Lite Yard Property and Hennepin County Railroad Authority Parcel, East 28th Street, Minneapolis, Minnesota*]. The groundwater beneath the site has been contaminated and has migrated off-site towards the southwest for approximately 3 city blocks. MDH and MDA staff visited every property located above or near the groundwater plume in search of any groundwater wells (well receptor survey), and none were found. Figure 3 displays the Special Well Construction Area that was implemented for the off-site groundwater plume. The Special Well Construction Area is outlined by East 26th Street on the north, 26th Avenue on the East, Lake Street on the south, and Bloomington Avenue South on the west (see Figure 3). The groundwater is being monitored with semi-annual sampling into the foreseeable future, and concentrations are expected to decline now that the arsenic source areas have been remediated.

C. South Minneapolis Residential Soil Investigations

EPA utilized an aerial dispersion model to determine a zone of potential impact to the southern Minneapolis neighborhoods surrounding the CMC property. The air model is a liberal estimate of how far powdered arsenic and contaminated soil could be blown off the CMC property. Based on model predictions, a ¾ mile radius was drawn around the CMC property and this area is called the South Minneapolis Neighborhood Soil Contamination Site (SMNSC) (www.epa.gov/region5/sites/cmcheartland/pdfs/final-sominn-fs-english-200508.pdf). EPA extended the ¾ mile radius to include whole blocks (see Figure 4). Each property within the expanded boundary was eligible for sampling. A total of 3,575 properties have been sampled for arsenic in surficial soils. Access was denied at 132 properties. EPA will make additional requests to gain access to properties adjoining properties above the action level of 95 mg/kg (parts per million (ppm)). If access is denied again, EPA can issue an order using the Minnesota Department of Agriculture authority under state statue to inspect, sample and analyze pesticide contamination (18D.201, Minnesota Statutes 2006). To date an access order has not been required.

D. SMNSC Composite Soil Sample Methodology

SMNSC surface soil samples were collected using a 5-on-a-dice composite pattern (see Figure 5). Actual sample locations were dependant upon the layout of the property taking into consideration the location of the house within the property, physical barriers, presence of (potentially) treated lumber, and other variables. Individual composite samples were collected from separate areas of the property with front and back yard samples collected wherever possible. In addition, side yard and gardens were sampled depending on the size of the property. For larger properties, such as parks or schools, the property was broken into sub-areas and composite samples were collected from each sub-area.

At each discrete composite point, the grass (if present) was lifted and a surface soil was collected from the 0 to 3-inch depth interval using a 2-oz sterile disposable plastic scoop. The soil was placed in a plastic bag where it was composited with the other discrete locations and homogenized by rotating the bag fifteen times. After homogenization, the composited sample was transferred to a 4-oz soil jar and labeled.

Composite sampling is best used to determine if contamination is present, and for estimating average exposure concentrations across an exposure area.

E. SMNSC Soil Sampling Results

A total of 3,575 properties were sampled, and the total number of soil samples collected during the investigation is 6,511. Approximately 88% of the properties (2,900) were below 20 ppm arsenic. All 13 childcare centers and 4 schools identified within the sample area had low arsenic concentrations (< 10 ppm) that were not a health concern. See Table 1 for a soil sample result summary.

Table 1. South Minneapolis Neighborhood Arsenic Soil Concentration Ranges

Concentration Range ppm	< 10	>10-20	>20-30	>30-60	>60-95	>95	Site Wide
Total samples	5177	417	232	349	141	195	6511
Total Properties	2598	302	127	231	120	197	3575

The 197 properties that exceed EPA's Arsenic Soil Action level (95 ppm) have had contaminated soil removal by EPA or are scheduled for soil removal. For removal action, 12-18 inches of soil are removed and replaced with clean topsoil. Approximately 100 yards have been addressed by the removal action through 2006. Weather permitting, 70-75 of the remaining properties will be addressed during the 2007 construction season.

Figure 4 illustrates all the sample point locations. The red dots on the figure signify exceedances of the action level. The distribution of red dots appears to be unsystematically scattered throughout the study area. Many of the red dots are surrounded by properties with low levels of arsenic. Typically, as contaminants disperse from a waste site via the wind, contaminant concentrations form a gradient from high to low the farther one moves from the source. This pattern does not appear to be present at the South Minneapolis Neighborhood Soil Contamination Site. The highest arsenic concentrations are not focused near the source area (CMC property), and some of the highest concentrations are located farthest from the source area. Furthermore, there is no clear plume emanating from the CMC property along the prevailing wind direction (northwest ↔ southeast). One possible explanation for the lack of this pattern is the shallow soil profile may have been altered within the past 40 years at individual properties. Any type of landscaping that resulted in digging the soil or adding new soil to the property would alter the soil arsenic levels. Mixing and tilling the soil could help dilute surface arsenic concentrations. Introducing new soil or using certain fertilizers and pesticides in the yard over the years can lead to elevated arsenic levels. Other potential sources of arsenic are the disposal of coal ash in the yard or the use of chromated copper arsenate (CCA) treated lumber.

III. Regulatory and Remedial Considerations

A. Remedial Program Restrictions

How a contaminant is manufactured or used can influence what environmental program is best suited to address its remediation. For example, in Minnesota, if arsenic is used to manufacture agricultural products such as the fertilizers, pesticides, or treated lumber then the Minnesota Department of Agriculture has oversight. If arsenic is used or manufactured in a non-agricultural process, such as mining, the Minnesota Pollution Control Agency has jurisdiction. This distinction does not apply to the USEPA. Currently, the USEPA in collaboration with MDA is addressing the SMNSC site contamination under the federal Superfund Program. Superfund has a Removal Program that addresses short-term (acute) risks, and a Remedial Program that addresses long-term (chronic) risks. The Removal Program has been cleaning-up the all the properties that are above the 95 ppm action level thereby addressing short-term risks associated with potential exposure to elevated arsenic levels at the SMNSC site (see section VII, subsection B for more action level discussion). Meanwhile the Remedial Program has been characterizing the arsenic soil concentrations, and drafting a risk assessment that describes the long-term risks associated with potential exposure to arsenic soil concentrations below 95 ppm. Before remedial activities could begin under the Superfund program, the site needed to be listed on the Superfund National List of Priorities (NPL). This was recently accomplished.

B. Remedial Goals

Typically, a remedial goal is based on a state standard or is derived in the risk assessment process. The risk assessment process can use standard default risk variables such as ingestion rates, exposure frequencies, and assume 100% absorption of contaminants even though these defaults may not be realistic. Sometimes risk assessments utilize site-specific considerations such as, but not limited to, bioavailability of arsenic in soil, reasonable resident tenures, and climate appropriate exposure frequencies resulting in a more realistic characterization of risk. Remedial goals can vary significantly even though the target risk level remains the same. Table 2 lists the cleanup goals prescribed in the Record of Decision (ROD) for 24 Superfund sites located in 15 U.S. states where arsenic was the main contaminant of concern. The cleanup goals ranged from 2 - 305 ppm.

Generally, under Superfund, cleanup levels are not set at concentrations below background levels (4). In cases where area-wide contamination may pose risks, but is beyond the authority provided under Superfund, EPA may be able to help identify other programs or regulatory authorities that are able to address the sources of area-wide contamination, particularly anthropogenic sources (4).
For example, the Superfund may not be able to act when the contaminant of concern is present as a result of use in a fertilizer, or a product distributed for retail use.

Table 2. Superfund Summaries of Arsenic Remedial Goals Based On A Residential Exposure Scenario

State	Site	Record of Decision	Remedial Goal (mg/kg)	Target Cancer Risk Level
South Dakota	Whitewood Creek	1990	100	1E-4
Utah	Sharon Steel	1990	70	1E-5
	Portland Cement	1992	70	1E-6*
New Mexico	Cal West Metals	1992	30	1E-5
Texas	Crystal Chemical Co.	1992	30	1E-5
	RSR Corp.	1997	20	1E-6*
Washington	Yakima Plating Co.	1991	20	1E-6*
	Commencement Bay	1993	230	1E-5
Montana	Anaconda Smelter	1994	250	1E-5
New Jersey	Myers Property	1990	20	1E-6*
	Sayreville Landfill	1990	20	1E-6*
	Ellis Property	1992	19	1E-6*
	Industrial Latex	1992	3.6	1E-6*
	Fried Industries	1994	27	1E-6*
Tennessee	Arlington Blending	1991	25	1E-6*
New Hampshire	Dover Muni Landfill	1991	50	1E-6*
Alabama	Interstate Lead Co.	1991	10	1E-6*
New York	Fecet Enterprises	1992	20	1E-6
	FMC Corp.	1993	40	1E-6
Oklahoma	Oklahoma Refining Co.	1992	305	1E-6*
Massachusetts	Salem Acres	1993	40	1E-6
Michigan	Lower Ecorse Creek	1996	13.6	1E-6*
California	Valley Wood Preserving	1991	2	1E-6
	Rhone-Poulenc/Zoecon	1997	70	1E-6*

*Authors of study assumed risk level = 1E-6, but this was not verified.
Adapted from Reference (8)

IV. Land Use and Demographics

The South Minneapolis Neighborhood Soil Contamination Site (SMNSC) includes portions of the following neighborhoods:

- Phillips
- Seward
- Longfellow
- Corcoran
- Powderhorn

These communities are a mixture of several sub-populations consisting of Latinos, Somali, Hmong, and Caucasians. The housing stock consists mostly of single-family homes and some multifamily rentals. The main north-south corridor dividing these communities is Hiawatha Boulevard (HWY 55).

The area has a long history of mixed land use consisting of residential communities, retail business, light industry, and rail transportation routes. The estimated population of the SMNSC is 10,000 – 13,000.

V. Discussion

A. 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 (10). The concentration of arsenic in U.S. soil varies widely, generally ranging from 1 to 40 parts of arsenic to a million parts of soil (ppm) with an average level of 5 ppm. However soils in the vicinity of arsenic-rich geological deposits, some mining and smelting sites, or agricultural areas where arsenic pesticides had been applied in the past may contain much higher levels of arsenic. Arsenic is an element that occurs naturally in the earth's crust, and is primarily associated with igneous and sedimentary rocks in the form of inorganic arsenic compounds (10). 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 (10). 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 in oxidation/reduction reactions. 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 µg/day (10). Typical U.S. dietary levels of arsenic in these foods range from 0.02 ppm in grains and cereals to 0.14 ppm in meat, fish, and poultry (10). These concentrations are due in part to soil uptake, or soil particle adhesion, and surficial deposition from atmospheric sources and pesticide application (10).

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/chemicals/fertilizers/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/news/publications/chemfert/heavymetals2002.pdf).

B. Background Arsenic Concentrations In The South Minneapolis Study Area

The EPA definition of *Background* refers to substances (arsenic) present in the environment in forms that have not been influenced by human activity (4). Numerous natural sources and human activities

influence background concentrations and accounting of these is important when establishing cleanup standards. Mining activities and the use of arsenic containing products such as CCA treated lumber, arsenic containing fertilizers and pesticides can elevate background arsenic levels in soil. It is not realistic to establish one single value for background contaminant concentration due to the wide variation in soil types and numerous variables that influence concentrations such as physical, chemical, and biological processes, as well as anthropogenic contributions. It is more practical to consider a concentration range when establishing background contaminant levels. Table 3 lists the arsenic concentration ranges for various soil types. Alluvial soils are typically found in the Twin Cities.

Table 3. Arsenic Concentration Ranges in Soils (5)

Soil Type	Concentration Range (ppm)	Mean (ppm)
Sandy soils and lithosols on sandstones	<0.1–30.0	5.1
Light loamy soils	0.4–31.0	7.3
Loess and soils on silt deposits	1.9–16.0	6.6
Clay and clay loamy soils	1.7–27.0	7.7
Alluvial soils	2.1–22.0	8.2
Soils over granites and gneisses	0.7–15.0	3.6
Soils over volcanic rocks	2.1–11.0	5.9
Soils over limestones and calcareous rocks	1.5–21.0	7.8
Soils on glacial till and drift	2.1–12.0	6.7
Light desert soils	1.2–18.0	6.4
Silty prairie soils	2.0–12.0	5.6
Chernozems and dark prairie soils	1.9–23.0	8.8
Organic light soils	<0.1–48.0	5.0
Forest soils	1.5–16.0	6.5
Various soils	<1.0–93.2	7.0

A 2004 geologic investigation conducted by the Minnesota Geological Survey (MGS) found that 98% of all samples collected across the state contained 20 ppm of arsenic or less (7). The highest soil concentration reported was 29.8 ppm. Figure 6 summarizes soil arsenic concentrations found across the state of Minnesota (including some samples collected just outside state boundaries). The MGS soil sampling methodology included the mixing of soil cores collected 1-2 meters below ground surface before the soil was sampled. The MGS investigation was not a surface soil study.

The Association of Environmental Health of Soils conducted a survey of state environmental agencies to determine what each state considered as their background arsenic soil concentration, and how it was established. A total of 34 out of 50 states responded to the survey. Table 4 summarizes each state's background arsenic soil concentrations, the method for establishing the arsenic background concentration, and how the state utilizes the background concentration in remedial decisions. The arsenic background concentrations ranged from 0 to 350 ppm. Note that most states will not clean up arsenic soil concentrations below background levels.

For the SMNSC site, EPA's contractor utilized 2 types of probability line plots to calculate arsenic background concentrations. The February 2006 draft document titled *South Minneapolis Arsenic Evaluations*, reported background arsenic levels ranging from 10 to 17 mg/kg (ppm) based on 1,610 soil samples (2). EPA is currently determining a site-specific arsenic background level using the full data set (6511 samples), and it will likely result in a similar finding.

Table 4. Background Concentrations Of Arsenic (6)

State	Arsenic Background Concentration Range	Method For Establishing Arsenic Background	State Considerations
Alaska	17.3 mg/kg	Geochemical Atlas of Alaska	Compare the mean concentration for each hazardous substance; compare the maximum hazardous substance concentration detected.
Alabama	0.1 - 10	USGS 1984	RCRA clean closure: to indicate disposal activities
Arizona	1.4 - 97 mg/kg	USGS sampling of surficial soils in Boerngen & Shacklette, 1981, USGS Open-file Report 81-197	Naturally occurring contaminant levels can be used as cleanup levels.
Arkansas	1.1 - 16.7 ppm	Regional numbers	Considered on a site specific basis after screening process.
California	5-40 (SF Bay Area) 5-20 (Southern Cal.) thousands (gold country)	Background levels of trace elements in Southern California soils Cal. EPA	Realistic standard in setting cleanup levels.
Colorado	4 - 40 ppm	Site-specific data collection	If risk-based clean-up levels fall below background, the background values are used as the clean-up standards.
Connecticut	Up to 10 ppm	DEP paper reporting arsenic levels in New England soils	Criterion for soil cleanup.
Delaware	0.4 mg/kg	From historical site investigations	Risk assessments, remediation standard requirements.
Florida	0 - 3 mg/kg	Empirically	To modify the SCTL (Soil Concentration Target Limit).
Hawaii	0.93 to 5 mg/kg	Background samples collected from non-contaminated areas or from subsurface of the study areas.	To establish action levels.
Illinois	0.35 - 24.0 ppm	Survey of data reported to State during site investigation.	Chemicals may be excluded as chemical of concern for a site by comparison to background and background conc. may be used as remedial goal.
Indiana	5 - 10 mg/kg	Approximation based on experience	No action required when near background levels.
Kansas	Non detect - <100 mg/kg	Various sites across the state	As a Tier 1 approach, use background if exceeds 1E-6 cancer risk or Hazard Index = 1.0
Kentucky	0.1 - 10 mg/kg	Based on analyzing samples from across the state which were labeled as "background"	To determine presence or absence of contamination.
Maine	1 - 28 mg/kg	Based on data available from 5 sites in Maine	If inorganic contaminants present at concentrations greater than soil criteria; background is considered the critical benchmark.
Maryland	No background Established	Not available	No state soil criteria.
Michigan	0.1 - 11.0 mg/kg	Background concentration established through a MI background soil survey	A background concentration is used as a default cleanup criterion when it is higher than the calculated criterion.

Table 4. Continued

State	Arsenic Background Concentration Range	Method For Establishing Arsenic Background	State Considerations
Mississippi	0 - 26 ppm (4 - 10 Avg.)	USGS paper 1270 (1984)	Background concentration can be considered as an alternative cleanup standard.
Missouri	Not available	Agriculture soil survey	Don't usually set cleanup goals lower than proven background concentrations.
Montana	Non detect – 100's ppm in geothermic areas.	Via soil testing (mostly XRF)	Take them into account, but use risk based human health numbers as action levels.
New Hampshire	0 - 12 mg/kg	Soil samples from playgrounds and background levels at sites that are then used for biosolid applications	The 95th percentile value of the data is used. Background is used as a cleanup standard when risk based numbers are lower.
New Mexico	.015 - 17.00 mg/kg	Sandia Labs	To establish cleanup of contaminated sites.
New Jersey	0.02 – 350 ppm	DEP background testing and review of sites under DEP oversight	Legislation states that remediation is not to be required below regional natural background levels.
New York	3 - 12 ppm	Site specific data is preferred but literature data is used	For inorganic materials, background is used as the starting point in determining the soil cleanup level.
North Dakota	<0.1 - 34 mg/kg	Use of documented studies by USGS in Region	Comparative background to established contamination
Ohio	Non detect - 30 ppm	Site data from several RCRA facilities	Setting up cleanup standards for metals only.
Oklahoma	0 - 32 mg/kg	USGS Soil survey and site specific background determinations for a variety of sites	Sometimes criteria for no further action – sometimes for screening.
Oregon	1 - 10 ppm	Limited survey of cleanup sites	Natural background is considered to be protective of human health & the environment. Cleanup to background concentration, if higher than risk-based concentration.
South Carolina	2 - 11 mg/kg	Average of sites sampled statewide	To determine clean-up levels in most cases.
Tennessee	0.1 - 120 ppm	TN Division of Superfund - from EPA or state site inspections	Used to evaluate whether concentrations at a site are within natural background. Not all Divisions consider background in making decision.
Texas	1 – 18 ppm	USGS	It can be used to screen contaminants from a risk assessment; it can be used as a cleanup level.
Virginia	Varies from site to site	By sampling	Not available
Washington	0.5 - 28.6 mg/kg	Background soil survey	Background concentration of 20 mg/kg is used as the cleanup standard if the human health value is below background. 1.67 mg/kg for human health
Wyoming	Not available	Not available	Site specific only - won't allow use of regional background

USGS = U.S. Geological Survey; DEP = Dept. of Environmental Protection

VI. Exposure

A. Complete Exposure Pathway

Area residents have to come into physical contact or *be exposed* to the arsenic contaminated soil at the SMNSC site in order for arsenic to cause adverse health effects. For the residents to come into contact with these chemicals, there must be a *completed exposure pathway*. A completed exposure pathway consists of *five factors* that must be present for exposure to the chemicals to occur. These include:

- A source of the toxic chemicals of concern (chemical releases and spills);
- Environmental transport allows the chemical to move from the site and bring it into contact with people (soil, air, groundwater, surface water, subsurface gas);
- A point of exposure is the place where people come into direct contact with the chemical;
- A route of exposure is how a person comes into contact with the chemical (drinking it, eating it, breathing it, touching it); and
- A population at risk includes people who may come into physical contact with site-related chemicals.

Exposure pathways can also be characterized by when the exposure occurred or might occur in the *past, present,* or *future.* Exposure to a chemical contaminant in and by itself *does not* necessarily result in adverse health effects. A chemical's ability to affect a person's health is also controlled by a number of factors including:

- How much of the chemical a person is exposed to (the *dose*).
- How long a person is exposed to the chemical (duration of exposure).
- How often a person is exposed to the chemical (acute versus chronic).
- The chemical's toxicity and how it impacts the body.

Other factors affecting a chemical's likelihood of causing adverse health effects upon contact include a person's:

- History of past exposure to chemicals;
- Sensitivity to certain substances;
- Current health status;
- Smoking, drinking alcohol, or taking certain medicines or drugs;
- Age and sex; and,
- Medical history.

B. Exposure Routes

The potential routes of exposure at the SMNSC site include:

- Ingestion of contaminated soil;
- Dermal (skin) exposure to contaminated soil, and
- Inhalation of airborne particulates

If the top 3 inches of soil are un-vegetated, then soil ingestion, soil dermal exposure, and inhalation of soil particulates are more probable. At the SMNSC site, a complete exposure pathway exists for contaminants found in the top 3 inches of soil. Ingestion is the most important exposure pathway at the SMNSC site followed by inhalation. It is estimated that ingestion represents greater than 95 % of the potential exposure (13, 3). Inhalation represents approximately 5% of the potential exposure (13, 3). Dermal exposure is not considered an important exposure pathway because arsenic adhered to soil does not readily pass through the skin.

C. Ingestion

The ingestion of contaminated soil is the primary means of exposure to non-volatile contaminants in soil, such as arsenic. Such ingestion is usually incidental, and occurs from hand-to-mouth contact while gardening or engaging in other work activities (in the case of adults) or outdoor play activities (in the case of children) (10). An extreme case of hand-to-mouth behavior (pica) occurs in small children who habitually ingest relatively large amounts of soil in one event (as much as 5000 mg/day). Pica may occur at this site due to the number of small children in the area and the numerous bare soil areas.

The amount of contaminant absorbed by the body from incidental soil ingestion and available to cause an adverse effect is dependent on a number of variables, including but not limited to (10):

- Soil ingestion rate;
- Oral bioavailability of soil contaminant, and
- Contaminant concentrations in accessible soil.

The SMNSC arsenic soil concentrations range from not detectable to >95 ppm. MDH considers all the residential sample locations that test positive for arsenic to be potential sources for current or future exposure.

Determining the soil contamination exposure dose via ingestion is challenging. The frequency and amount of soil ingestion are usually estimated using default exposure assumptions. The amount of contaminant absorbed is assumed to be 100% or is based on animal absorption studies. Most screening exposure scenarios utilize a residential setting, where exposure to soil could be assumed to occur on a regular basis. People who have frequent contact with soil, such as gardeners, tend to ingest more soil. Behaviors that involve frequent hand to mouth contact, such as smoking, can lead to higher soil ingestion rates. The EPA typically utilizes default ingestion rates of 100 mg/day and 200 mg/day in risk assessments for adults and children, respectively. The Minnesota Pollution Control Agency (MPCA) utilizes ingestion values of 100 and 50 mg/day in its derivation of the Soil Reference Values for children and adults respectively (3). Utilizing a child exposure scenario generally results in lower clean up levels.

It has been estimated that as much as 32% of indoor dust could originate from outdoor soil through foot tracking or other transport mechanisms (9). For young children indoor dust can be a significant source of exposure due to hand to mouth and object to mouth activity.

The EPA and MPCA risk calculations assume that 100% of ingested arsenic is bioavailable. This protective approach will likely result in an over estimation of risk because a considerable portion of the arsenic sequestered to soil particles is not be absorbed by the body.

D. Inhalation

The inhalation of arsenic contaminated particulate is plausible. However, it is a very minor exposure pathway based on exposure models used in standard risk assessments. During respiration, particles greater than 5-30µm are mostly captured by mucus lining the upper respiratory tract and are then swallowed. Therefore, inhalation exposure to arsenic contaminated dust/particulate is mostly an ingestion exposure. Only the smallest particles ($\leq$ 1 µm) will be inhaled into the deep lung.

E. Health Effects

EPA classifies the inorganic form of arsenic as a human carcinogen. Ingested arsenic is typically absorbed by the intestines and enters the bloodstream where it is distributed throughout the body. Inhaled arsenic is quickly absorbed by the lungs and enters the bloodstream. Arsenic is poorly absorbed through the skin, so skin contact with contaminated soil is not normally an important pathway for harmful exposure.

1) Non-cancer effects

Inorganic arsenic has been recognized as a human poison since ancient times, and large oral doses (above 60,000 ppb in food or water) can produce death. If you swallow lower levels of inorganic arsenic (ranging from about 300 to 30,000 ppb in food or water), you may experience irritation of your stomach and intestines, with symptoms such as stomach ache, nausea, vomiting, diarrhea and facial edema (10). Other effects include decreased production of red and white blood cells which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function causing a"pins and needles" sensation in hands and feet (10). One of the most documented effects of long-term oral exposure to inorganic arsenic is a pattern of skin changes. These include a darkening of the skin (hyperpigmentation) and the appearance of small "corns" or "warts" (hyperkeratosis) on the palms, soles, and torso (10). A small number of the corns may ultimately develop into skin cancer. Ingesting arsenic has also been reported to increase the risk of cancer in the liver, bladder, kidneys, prostate, and lungs (10).

2) Cancer effects

Arsenic has been shown to increase people's risk of developing several types of cancer including lung, bladder, skin, kidney and liver cancer. This document describes cancer risk that is attributable to site-related contaminants in qualitative terms like high, low, very low, slight and no significant increase in cancer risk. These terms can be better understood by considering the population size required for site-related exposures to result in a single cancer case. For example, a low increase in cancer risk indicates an increased risk of about one cancer case per ten thousand persons exposed over a lifetime. A very low risk is about one cancer case per several tens of thousands exposed over a lifetime and a slight risk would require an exposed population of several hundreds of thousands to result in a single case. MDH uses a calculated cancer of one cancer per one hundred thousand exposed over a lifetime to derive levels of contaminants that are safe exposure levels for the general public. The reader should note that these estimates are for excess cancers that might result in addition to those normally expected in an unexposed population.

3) EPA Human Health Risk Assessment for SMNSC site

EPA classifies arsenic as a Group A (known human) carcinogen by the oral and inhalation routes. In the human health risk assessment that EPA is finalizing for the SMNSC site, exposure doses were calculated for a child resident, child/adult resident, and a construction worker scenario using standard

EPA exposure assumptions. The theoretical increased cancer risk and hazard index is presented in Table 5 for various soil arsenic concentrations. A soil arsenic concentration of 29 ppm results in a hazard index of 1 for a reasonable maximum exposure (RME) child scenario. A soil arsenic concentration of 34 ppm has an excess lifetime excess cancer risk (ELCR) of 1 in 10,000 for RME.

Table 5. EPA Draft Soil Arsenic Risk Calculations (Reasonable Maximum Exposure)

Theoretical Excess Lifetime Cancer Risk (ELCR)	**ELCR = 1x10-4**	**ELCR = 1x10-5**	**ELCR = 1x10-6**	**Hazard Index = 1**
Receptor	**Soil Concentration (ppm)**			
Infant/Child Resident	--	--	--	29
Child/Adult Resident	34	3	0.3	--
Construction Worker	405	41	4	261

(reference 14) Notes: ELCRs were calculated for aggregate adult/child residents since ELCRs are averaged over a lifetime. A hazard index (HI) was calculated for an aggregate infant/child resident since the HI for this receptor is more conservative than the HI for an adult resident. Calculations are based on reasonable maximum exposures and exposure duration of 50 years (i.e., 44 years as an adult and 6 years as a child).

Based on a HI of 1, arsenic concentrations of 29 mg/kg or less in soil are protective of residents for non-cancer health effects and a lifetime incremental cancer risk of less than 1 in 10,000. EPA seeks to protect people within a risk range of 1 in 1,000,000 to 1 in 10,000 depending upon costs, feasibility of cleanup, and natural background contaminant concentrations. A soil concentration of 261 mg/kg or less is protective of construction workers for non-cancer health effects.

VII. Health Based Criteria for Arsenic in Soil

A. ATSDR Minimal Risk Levels and Environmental Media Evaluation Guides

Minimal Risk Levels (MRLs) for toxic substances are derived by ATSDR 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 set at levels below those 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. 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. 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. 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 MRLs are 3 and 21 micrograms per day for a 10 kg child and 70 kg adult respectively. These chronic MRLs are based on human exposure to contaminated drinking water in Taiwan resulting in black foot disease and dermal lesions (hyperkeratosis, and hyperpigmentation) (10).
Based on an accidental poisoning event with soy sauce contaminated with arsenic, 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 (10).

Using the MRL and standard soil exposure assumptions, ATSDR has developed Environmental Media Evaluation Guide (EMEG) values for arsenic in soil. 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 (5000 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 5.

B. Minnesota Pollution Control Agency Soil Reference Values (SRVs)

As with ATSDR comparison values for soil, the SRVs are based on standard health risk assessment methodologies, modeling, and risk management policy. 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 risk criterion 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 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. For a detailed discussion of the arsenic SRV derivation see the MDH Health Consultation titled *Off Site Soils: CMC Heartland Partners Lite Yard Site Minneapolis* (9).The acute child exposure scenario was selected to derive the current MPCA Residential Arsenic SRV (5 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 for arsenic (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 better suited to be an action level because it focuses removal activities on properties that pose the greatest risk. MDH and EPA added an extra level of safety, by selecting 95 mg/kg as the soil arsenic action level. Arsenic soil levels above the action level will be remediate by the EPA. Approximately half of the 197 properties above the action level have been remediated, and the remainder will be addressed in the 2007 and 2008 construction seasons. See Table 6 for a listing of arsenic soil criteria.

Table 6 Soil Arsenic Criteria

Minnesota Pollution Control Agency Arsenic Soil Reference Value (SRV) ppm			
Acute Residential		Chronic Residential	
Old	New	Old	New
110	5	10	5
Agency for Toxic Substances and Disease Registry Soil Environmental Media Evaluation Guide (EMEG) ppm			
Acute Child (pica)	Chronic Child	Chronic Adult	
10	20	200	
Minnesota Department of Health and United States Environmental Protection Agency Arsenic Soil Action Level (ppm)			
95			

VIII. Child Health Considerations

ATSDR recognizes that the unique vulnerabilities of infants and children make them of special concern to communities faced with contamination of their water, soil, air, or food. Children are at greater risk than adults from certain kinds of exposures to contaminants at hazardous waste sites. A child's behavior and lifestyle will influence exposure. Children can be additionally exposed to environmental arsenic because children play in the dirt, put things in their mouth, and they ingest

inappropriate items. Children often bring food into contaminated areas risking cross contamination when they eat items that have fallen to the ground or floor. In general, children ingest more soil than adults. Children often spend significant time outdoors with little or no clothing. Children exposures result in higher doses of chemical per body weight. Children have a larger skin surface in proportion to their body volume than adults. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

IX. Health Professional Education and Outreach

Due to the residential nature of activities at the site, there has been extensive outreach and health education for residents, including numerous public meetings and door-to-door visits for almost all residents within the sampling area. This widespread educational effort, together with local media coverage, attracted the interest of a local community clinic (Smiley's Clinic) focused on meeting the health needs of the nearby neighborhood residents. This interest was heightened when it was determined that the new facility for the Smiley's Clinic would be the office building that is part of the redevelopment of and located on the former CMC Heartland Partners Lite Yard Site.

When Smiley's Clinic made the decision to move to the former CMC Liteyard site, they knew that they would need to address the arsenic issue with the community. This eventually led to a series of meetings with the MDH staff, including Daniel Peña (health assessor), and Tannie Eshenuar (community health educator), and Dr. Mary Winnett (chronic disease epidemiologist), and key individuals at Smiley's Clinic. The initial vision for educational materials rapidly expanded from guidance for treating patients who present with concerns about arsenic exposure to a broader educational effort to promote pediatric environmental health. Educational strategies were targeted at two groups: clinicians and patients. See Appendix A for health education materials discussed in this section.

For clinicians, the clinic suggested that the guidance for managing reported arsenic exposure could be modeled on the existing procedures the clinic uses for lead exposure of children. In collaboration with the Great Lakes Pediatric Environmental Health Specialty Unit in Chicago, an arsenic testing algorithm for urinary arsenic and subsequent actions was developed. This was further refined with insight from MDH toxicologists and input from clinic staff. There is also an algorithm annotations sheet which explains the rationale, requirements for and limits of testing, and provides details and consultation resources for questions beyond the scope of the algorithm.

To guide the clinician through the visit process, an Arsenic Exposure Clinical Assessment form was developed. The form includes a place for the patient information sticker used by the clinic, questions about the patient's residence and whether or not the soil in the yard has been tested, a map to plot the location of the home, brief questions about symptoms and a place to list other school age children that may live in same residence.

An Arsenic Exposure Self-Assessment is to be completed by the patient or patient's guardian. It lists possible sources of arsenic and asks the patient to check off those that might be true for his/her situation. A companion sheet explains to the clinician why those particular sources are included on the list, how the activity or source might allow for exposure to arsenic and suggests follow up questions or counseling tips for the patient visit. The clinic saw this self-assessment as providing important information to the clinician without a longer interview process.

All patients receive basic educational materials on arsenic and the concept of urban contamination with many toxic substances. Other materials for patient education used in appropriate situations include:

- Information on arsenic, its sources, medical tests and health effects;
- Instructions on how to reduce contact with contaminated soil;
- A guide for obtaining soil testing;
- Information on chromated copper arsenate treated wood;
- Information on Ironite, a fertilizer known to be high in arsenic and information on arsenic in well water.

Some of the materials are available in Somali, Hmong and Spanish. These languages are spoken by large groups of residents in the area served by the clinic.

Key personnel from Smileys Clinic presented the site background and history, health information about arsenic and the entire package of materials at an educational lunch for clinic personnel. Both the MDH health assessor and health educator participated in this educational meeting. Of particular value was the insight the health assessor was able to provide to the clinic staff about site investigation, history and evaluating exposure pathways.

A major advantage of the clinic personnel taking the initiative and teaching their own staff is that they have become a recognized resource for environmental public health in their clinic and community. A recent e-mail from the outreach director indicated that they were in the process of taking the arsenic presentation and materials to other nearby community clinics that might see patients with concerns about arsenic exposure.

X. Proposed Arsenic Bio-monitoring Pilot Program

The Minnesota State Legislature (2007) appropriated funds for MDH to design and conduct a pilot arsenic exposure study. The purpose of the pilot program is to measure arsenic exposure in a community with people identified as likely to be exposed. Young children between the ages of 3 and 7 yrs of age living on arsenic contaminated properties within the SMNSC site are potential candidates for the exposure study. The study sample size will consist of 100 participants whose urine and/or hair will be collected for analysis. A 13 member advisory board consisting of academia, state government, and community advocates advise the commissioner on the design and conduct of the study.

XI. Methods to Reduce Exposure To Contaminants In Soil

Often urban soils contain elevated levels of several heavy metals such as lead, cadmium, mercury, and arsenic. Other probable contaminants include pesticides, paint residuals, and other products used to maintain a house and yard. The following suggestions have been made to residents to reduce exposure to soil contaminants:

Keep hands clean.

- Wash children’s hands and faces, especially before eating and bedtime. Keep 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 entering the house to prevent tracking contaminated soil inside. Store outdoor shoes at entryways. 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.
- 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 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 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.

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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, and animal waste.
- Find other places for children to play.

Prepare food carefully to reduce the amount of contaminants.

- Thoroughly wash and peel all homegrown 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.

XII. Conclusions

1. Arsenic soil contamination is scattered in an irregular pattern across the sample area, and there may be other sources besides the CMC site.

2. Individuals can limit/eliminate their exposures by practicing the methods presented in Section XI (Methods to Reduce Exposure To Contaminants In Soil).

3. 80% of properties tested were below the site-specific arsenic background level of 10-20 ppm. However, there remains some risk of exposure to other known urban soil contaminants including but not limited to lead, cadmium, and products used to maintain a house and yard. The contributions of other known arsenic sources such as treated lumber, aerial deposition, and agricultural product use has not been determined. The contributions of other potential arsenic sources are not clearly understood due to the ubiquitous presence of arsenic in the environment, the nature of homeowner soil alterations over the years, and the weathering of the arsenic compounds.

4. Properties over 95 ppm arsenic are a public health hazard. The federal Superfund Removal Program is eliminating the acute risks associated with potential exposure to soil arsenic concentrations above the 95 ppm action level. The federal Superfund Remedial Program has been characterizing the soil arsenic extent and magnitude, and developing a human health risk assessment to help determine a final remedial goal. A limitation of the Superfund program is it does not address contamination resulting from the legal use of pesticides or fertilizers. However, other programs may be able to address environmental contamination that does not meet Superfund requirements. Superfund remedial funds are available, as the SMNSC site has recently been listed on the NPL.

5. Superfund arsenic remedial goals can vary significantly from site to site even though the target risk remains the same. The risk assessment process often utilizes site-specific exposure scenarios, and other site-specific chemical factors instead of default parameters, leading to a wider range of cleanup goals that meet the same risk level. It is important to note that federal and state environmental programs typically do not remediate below background levels.

XIII. Recommendation

- EPA should complete the Human Health Risk Assessment, and develop a remediation strategy to address chronic risk associated with exposure to arsenic residuals below the action level.

XIV. Public Health Action Plan

MDH will continue to collaborate with MDA and Region 5 EPA, in addressing community concerns, mitigating exposures through community education, and helping facilitate remedial activities for properties above the arsenic 95 ppm action level. MDH is available for reviewing any site data results, risk documents, and remedial plans.

MDH will continue to work with residents and parents of young children to implement the methods presented in Section XI titled Methods to Reduce Exposure To Contaminants In Soil

MDH will work with residents who have health concerns stemming from exposure to site contamination should see their doctor and/or consult with a doctor at Smiley's Clinic. MDH will help design and conduct the Arsenic Bio-monitoring Pilot Program.

This document was made available for public comment. No comments were received.

This Public Health Assessment was prepared by:

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Environmental Surveillance and Assessment Unit
Minnesota Department of Health

XV. References

1. EPA Technical Memo: *Surface Soil Sampling South Minneapolis Soil Contamination Site, Minneapolis, MN,* prepared by CH2MHill, October 23, 2006.

2. EPA Technical Memo: *South Minneapolis Arsenic Evaluations (Draft).* Prepared by CH2MHILL, February 20, 2006.

3. Minnesota Pollution Control Agency, Draft Guidance: Risk-based Guidance for the Soil – Human Health Pathway, Volume 2, Technical Support Document. January 1999.

4. EPA (OSWER), Memo: "Role of Background in the CERCLA Cleanup Program" OSWER 9285.6-07P. May 1, 2002

5. EPA, Engineering Forum Issue: *Determination of Background Concentration of Inorganics in Soils and Sediments At Hazardous Waste Sites.,* R. P. Breckenridge and A. B. Crockett, EPA/540/S-96/500. (1995)

6. Association for the Environmental Health of Soils, Study of State Soil Arsenic Regulations. (http://www.aehs.com/surveys/arsenic.pdf), December 1998.

7. Minnesota Geological Survey, Soil Geochemical and Indicator Mineral Reconnaissance Survey of Till in Minnesota., February 2007

8. Davis, A., Sherwin, D., Ditmars, R., and Hoenke,. K. A. Analysis of Soil Arsenic Records of Decisions. Environmental Science and Technology, Vol. 35, No. 12 (2001)

9. Minnesota Department of Health. Off Site Soils: CMC Heartland Partners Lite Yard Site Minneapolis, Hennepin County, Minnesota. August 9, 2006.

10. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Arsenic, 2004.

11. CMC Heartland Partners. Final Report-Response Action Documentation, Lite Yard Property and Hennepin County Railroad Authority Parcel, East 28th Street, Minneapolis, Minnesota. Prepared by Peer Engineering, July 2005.

12. Shacklette, H.T., and J.G. Boerngen.. Element concentrations in soils and other surficial materials of the coterminous United States. USGS Paper 1270. Washington, DC: US Govern. Printing Office, 1984

13. Minnesota Pollution Control Agency, Soil Reference Values (SRVs): Arsenic SRV exposure calculation assumptions for unrestricted land use (residential), 2005.

14. EPA Technical Memo: Baseline Human Health Risk Assessment *South Minneapolis Arsenic Soil Contamination Site (Draft).* Prepared by CH2MHILL, August 27, 2007.

Figures

Figure 1
CMC Site

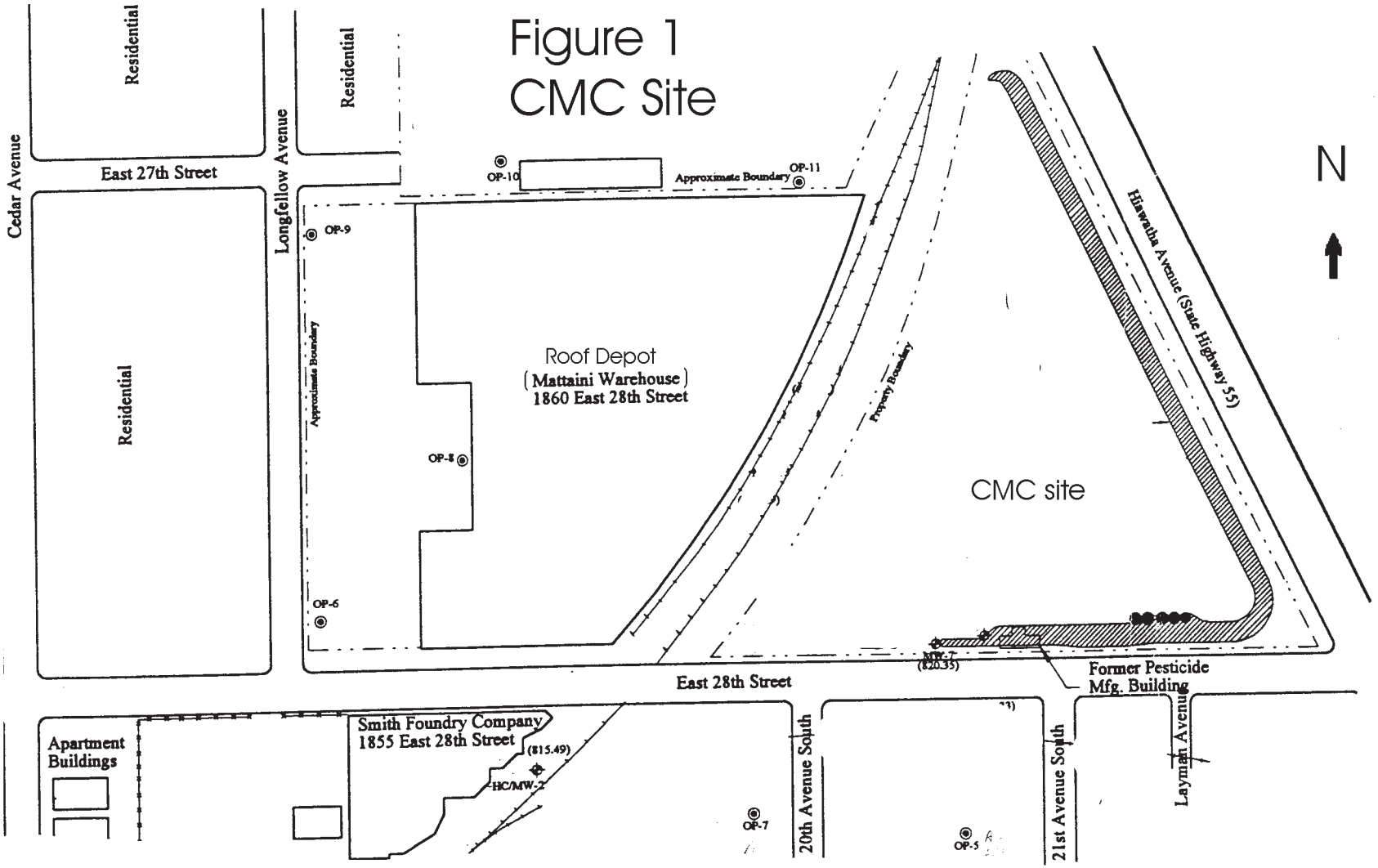


Figure 2
Building Layout

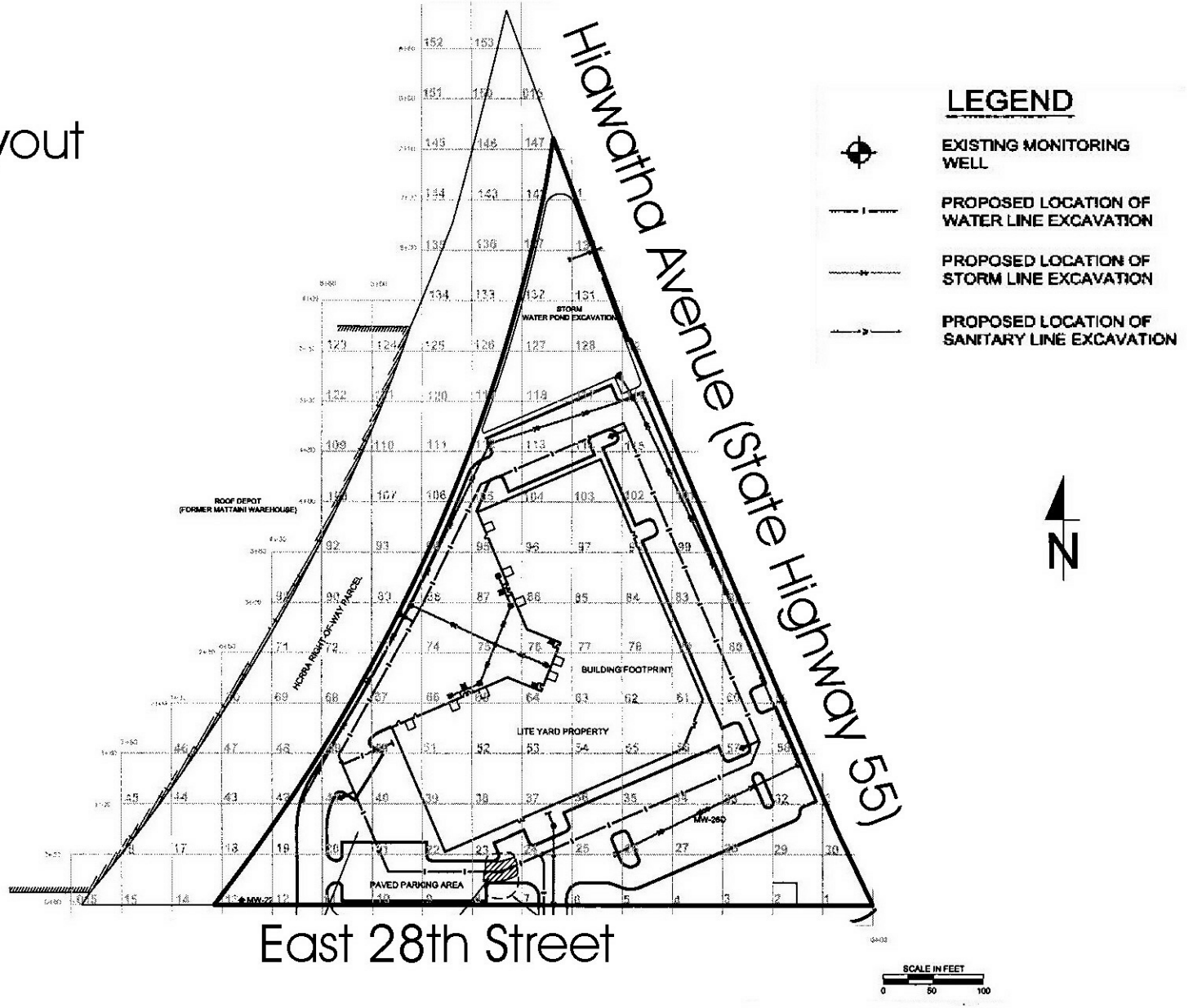
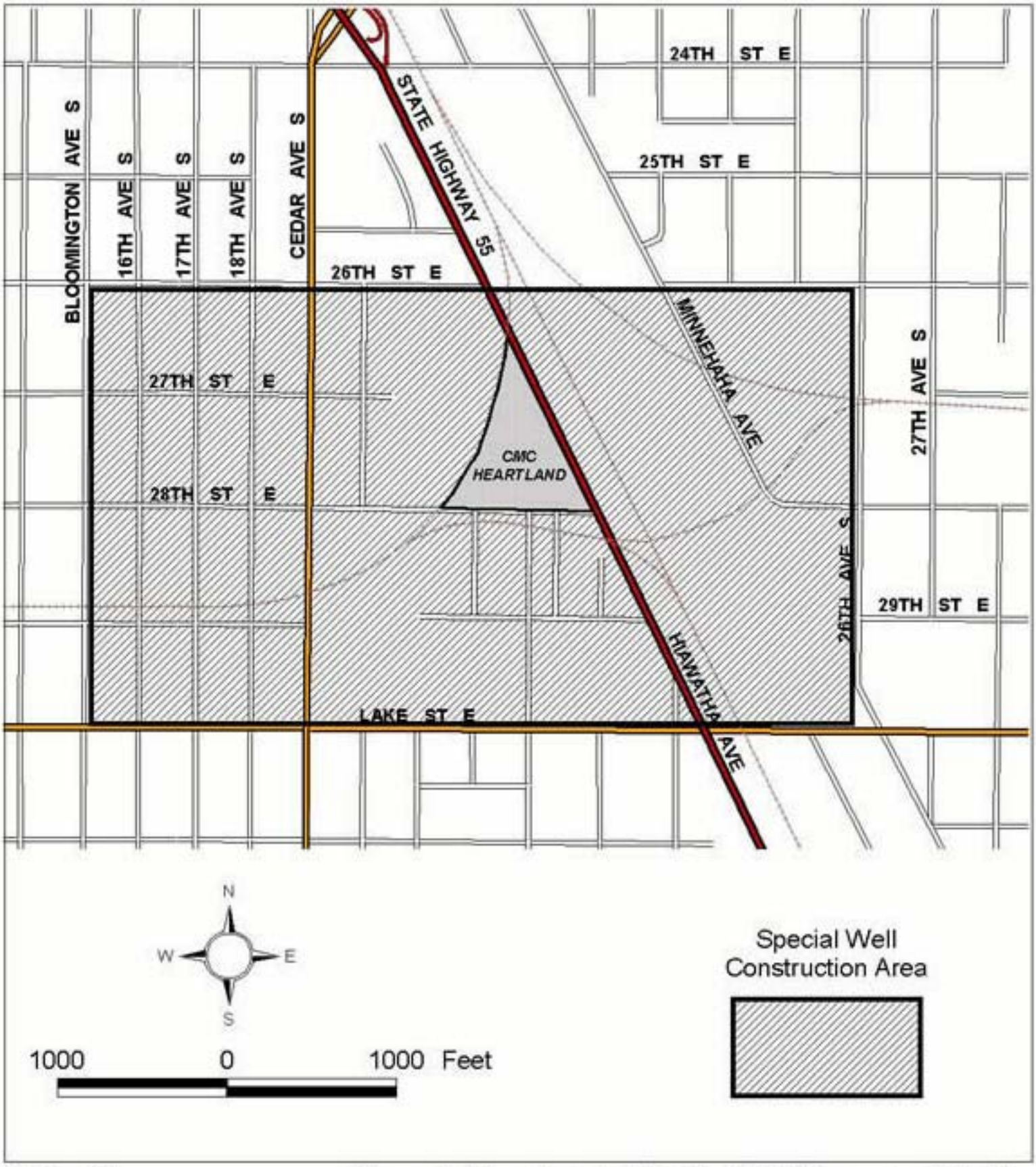


Figure 3 Special Well Construction Area
CMC Heartland Lite Yard Site



17 Mar 05

Minnesota Department of Health - Well Management Section

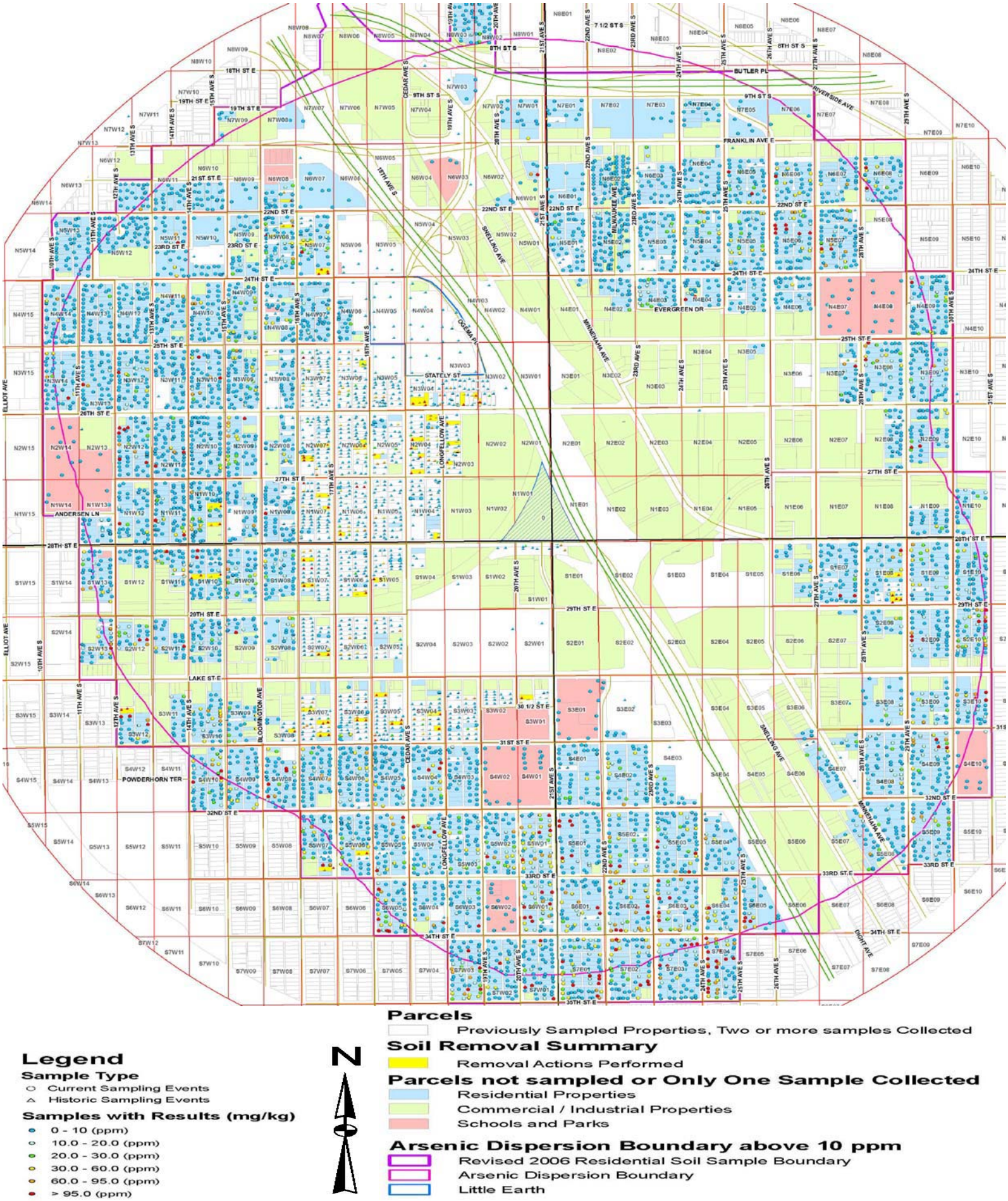


Figure 4 South Minneapolis Neighborhood Soil Sample Results

Figure 5
General Sampling Layout for Residential Properties

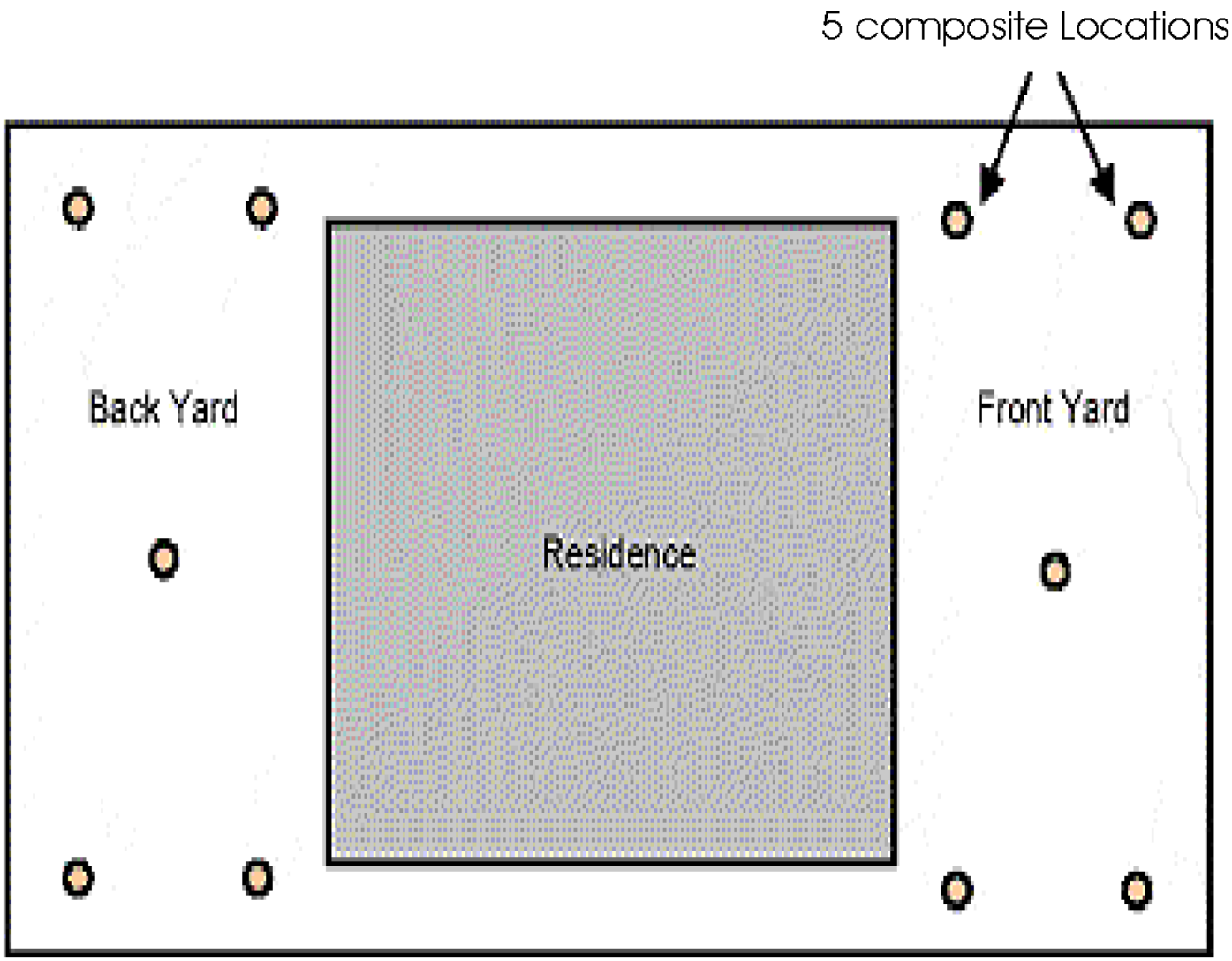
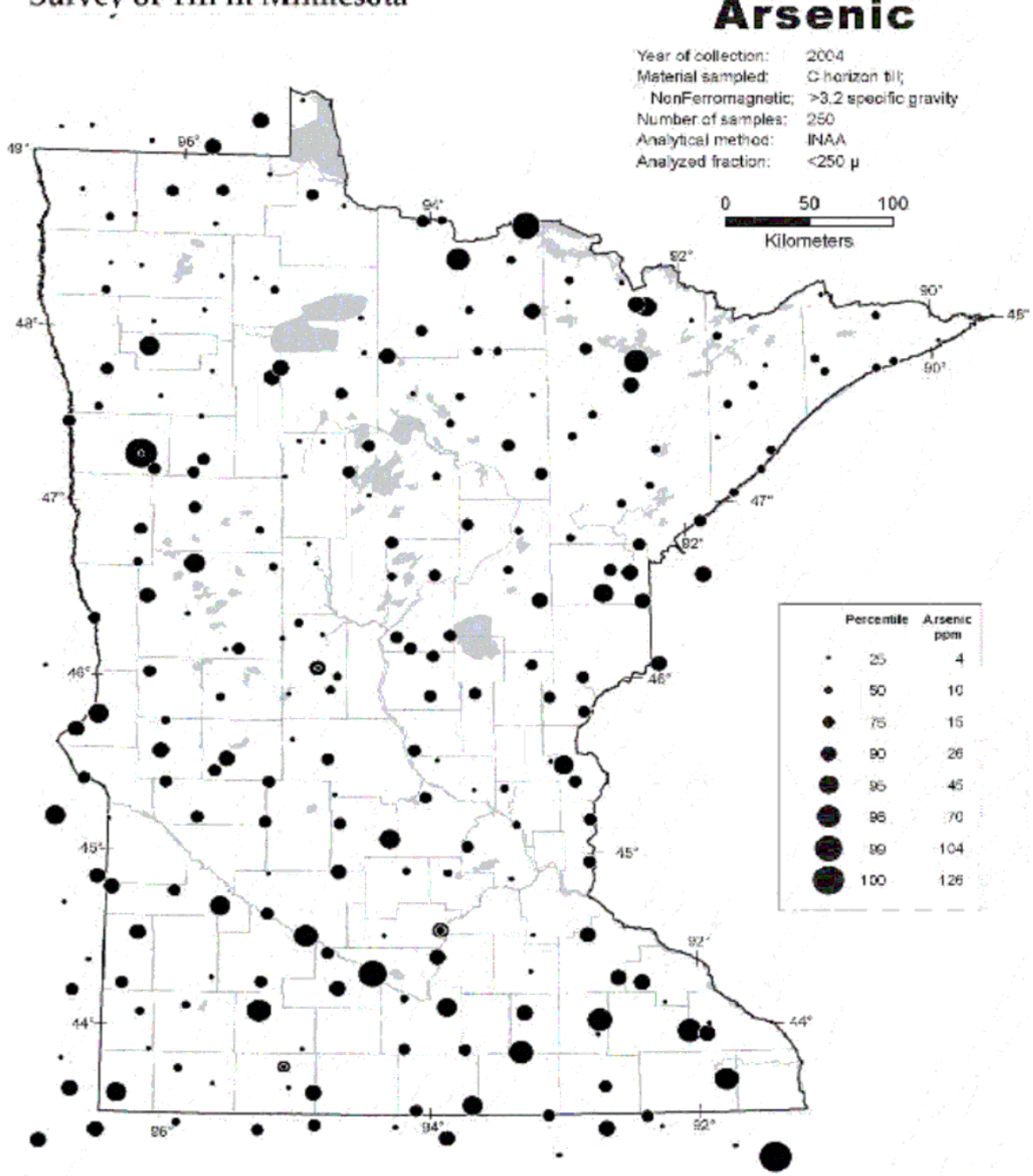


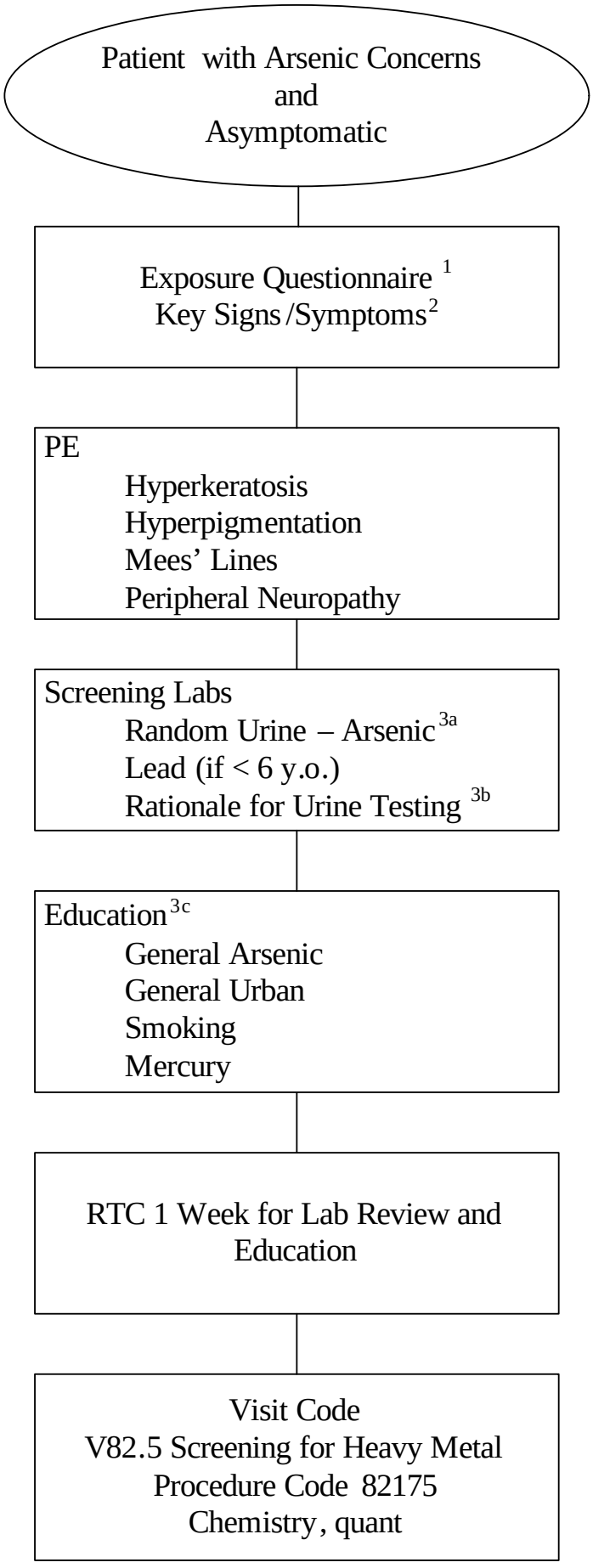
Figure 6

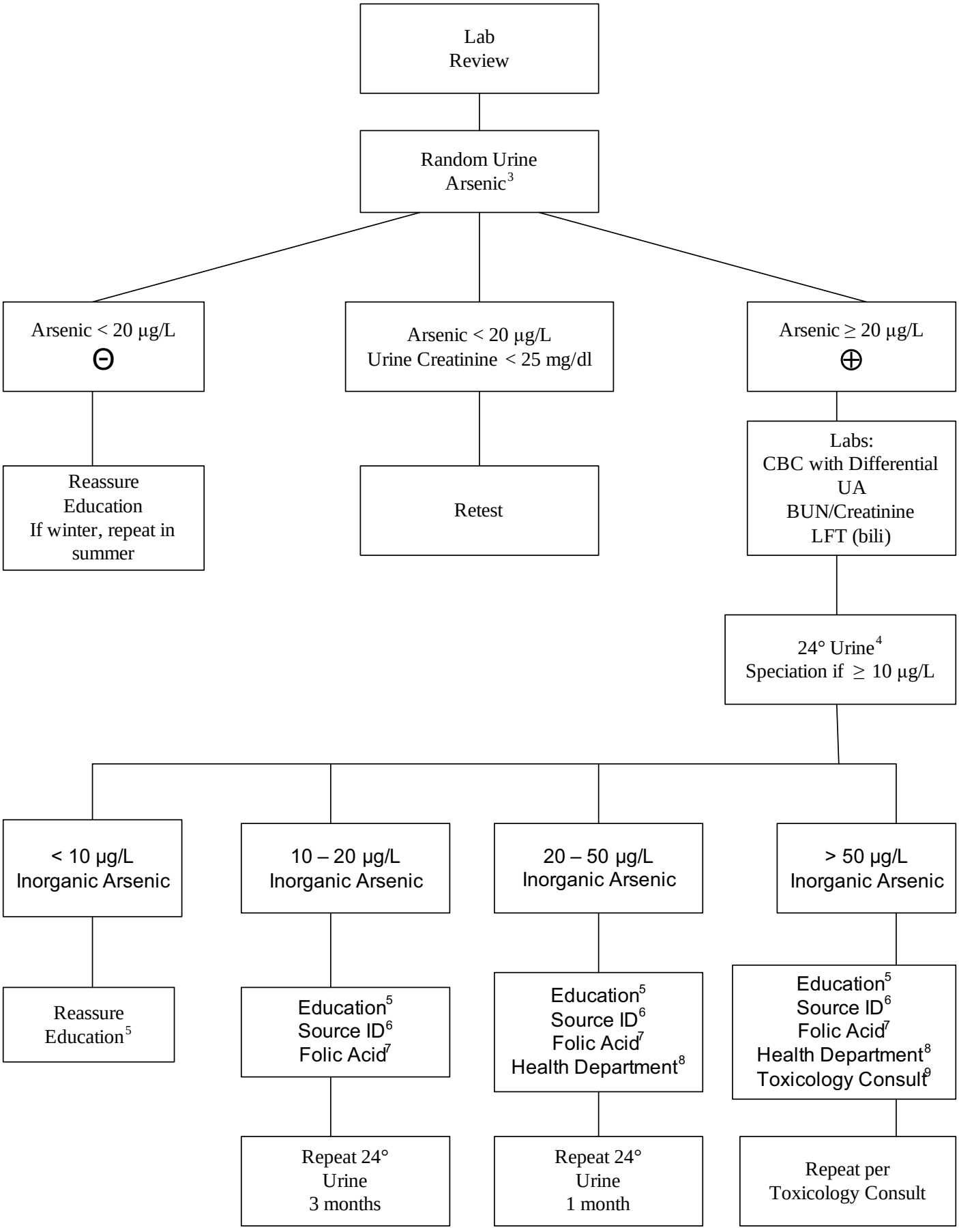
Soil Geochemical and Indicator Mineral Reconnaissance Survey of Till in Minnesota



UNIVERSITY OF MINNESOTA
Minnesota Geological Survey, Harvey Thorleifson, Director

Appendix A


Patient with Arsenic Concerns
and
Asymptomatic
Exposure Questionnaire [1]
Key Signs/Symptoms[2]
PE
Hyperkeratosis
Hyperpigmentation
Mees' Lines
Peripheral Neuropathy
Screening Labs
Random Urine – Arsenic[3a]
Lead (if < 6 y.o.)
Rationale for Urine Testing [3b]
Education[3c]
General Arsenic
General Urban
Smoking
Mercury
RTC 1 Week for Lab Review and
Education
Visit Code
V82.5 Screening for Heavy Metal
Procedure Code 82175
Chemistry, quant


Lab
Review
Random Urine
Arsenic[3]
Arsenic < 20 µg/L
⊖
Arsenic < 20 µg/L
Urine Creatinine < 25 mg/dl
Arsenic ≥ 20 µg/L
⊕
Reassure
Education
If winter, repeat in
summer
Retest
Labs:
CBC with Differential
UA
BUN/Creatinine
LFT (bili)
24° Urine[4]
Speciation if ≥ 10 µg/L
< 10 µg/L
Inorganic Arsenic
10 – 20 µg/L
Inorganic Arsenic
20 – 50 µg/L
Inorganic Arsenic
> 50 µg/L
Inorganic Arsenic
Reassure
Education[5]
Education[5]
Source ID[6]
Folic Acid[7]
Education[5]
Source ID[6]
Folic Acid[7]
Health Department[8]
Education[5]
Source ID[6]
Folic Acid[7]
Health Department[8]
Toxicology Consult[9]
Repeat 24°
Urine
3 months
Repeat 24°
Urine
1 month
Repeat per
Toxicology Consult

Algorithm Annotations

1. Exposure Questionnaire

The exposure questionnaire is a self-assessment of possible arsenic exposures including their residence/soil testing, home and garden, recreation, smoking, water, and occupation. Positive answers may require further inquiry. There are counseling tips for each area at the end of the Algorithm Annotations and on the MD section of the exposure questionnaire.

2. Key Signs/Symptoms

Acute – nausea, vomiting, diarrhea, hyperkeratosis on palms/soles, Mees' lines
Chronic – hyperpigmentation/darkening skin, peripheral neuropathy

3a. Random Urine for Arsenic

a) No fish/seafood for five days prior to test (these have organic arsenic in them)
b) Tests for both inorganic and organic arsenic
c) 5 ml minimum sample
- Concentration needs to be reasonable
- Urine creatinine > 25 mg/dl

d) Send on ice to FV Riverside lab within 2° of collection
e) Lab values
- Lab reference range: < 35 mcg/L
- Detection level: 5-6 mcg/L
- Smiley's cutoff: 10 mcg/L

3b. Rationale for urine testing

Urine arsenic tests are the preferred test for current or recent arsenic exposure.
Blood tests are very transient.
Hair/nail analysis is sometimes used for patients with symptoms and past exposures (months to years ago) without ongoing exposures. This is more appropriate for epidemiologic studies rather than individual patient assessment. There have been many concerns about the reliability of hair/nail analysis. Hair analysis can not distinguish between external sources (dirt on the hair) versus internal sources (in the body). Arsenic on the outside of the hair may show up as a positive test even though there is none in the body. Multiple studies have shown that washing the hair before testing does not remove all the arsenic. There may be other variables that also effect arsenic hair levels (age, color, thickness, curliness). There are also issues with finding a certified lab that does an adequate volume of tests. Lower volumes of hair testing can lead to variable results especially at lower levels (which we would expect in our population). There is also a lack of agreement about "normal" levels and what to do at these levels. Elevated hair/nail levels would usually be confirmed with a urine test.

3c. Education

Arsenic fact sheet (handout)
Urban contaminants fact sheet (handout)
How to test soil/water (handout)
Mercury (handout – TBD)
Verbal reinforcement
- Soil
  Shoes at door
  Vacuum / Wet mop
  Wash hands
  Gloves in garden
  Wash/peel vegetables grown in soil

3c. Education – (continued)

- CCA Treated Wood
  Remove/replace if possible, or seal every one to two years
  Wash hands!!
  Never burn
- Urban Contamination – General Precautions (see handout)
- Smoking

4. 24° Urine for Arsenic

a) No fish/seafood for five days prior to test.
b) Keep jug in refrigerator; transport to clinic in cooler with ice.
c) Send to FV Riverside lab. They send to ARUP in Utah (1-800-242-2787 x 2261 – supervisor, heavy metal lab).
d) If arsenic ≥10 mcg/L, need to speciate into organic and inorganic (bad one)
ARUP sends to another lab for speciation.

5. Education for Elevated Arsenic Level

Give educational packet with a source identification checklist and four handouts from MDH (soil, wood, ironite, water)
Also give urban contaminant fact sheet, soil testing sheet, and verbal reinforcements, as in 3c.

6. Source Identification

a) Soil Testing – (handout) also test for lead, cadmium
b) Well Water Testing – (if applicable)
c) Source Identification Questionnaire – (handout) occupational / soil / water
d) MDH handout packet

7. Folic Acid

a) Theoretical Benefit
- Arsenic interferes with methylation
- Folic acid needed for methylation

b) Dose
- Adult 400 mcg/day (0.4 mg/d)
- Children 150-400 mcg/d (one Flintstone vitamin)

8. Health Department

Will aid in source identification and evaluation
Carl Herbrandson
Email: Carl.Herbrandson@state.mn.us
Phone: 651-201-4906

9. Toxicology Consult

Children
Great Lakes Children's Environmental Health Group
Dan Hryhorczuk, MD - Director
Email: dhryhorc@uic.edu
Phone: 312-996-7887
Consults: 312-864-5520 – Ask for Ann Naughton

9. Toxicology Consult – (continued)

Adults (Occupational Medicine)

May consult with Dr. Hryhorczuk (see children)
Beth Baker, MD – HealthPartners OEM Residency Program
Sharda Katyl, MD – Regions Hospital
Richard Hirt, MD – Occupational Medicine Consultants (Edina)
Thomas Jetzer, MD – Occupational Medicine Consultants (Minneapolis)
Orrin Mann, MD – Multicare Associates (Roseville)

10. Tips for Counseling

Home and Garden

Regarding treated wood: Chromate Copper Arsenic (CCA) pressure treated wood can be any dimension with a slight green tint. Creosote (old railroad ties), on the other hand, is typically 6x6" and dark brown. Creosote does **not** contain arsenic.

Decks and playground equipment made of CCA pressure treated wood should be sealed with oil-based stain or polyurethane (not paint) every 1-2 years. If gardens are bordered by pressure treated wood, consider lining the beds with plastic to minimize leaching of arsenic into soil. Though vegetables have minimal uptake of arsenic, vegetables should be grown no closer than 15 inches from CCA treated wood. Never burn pressure treated wood since it releases arsenic in the smoke.

Patients should be advised to read ingredients on all pesticides, dips and fertilizers, and if they have old pesticides without labels or labels show arsenic content, contact the Minnesota Department of Agriculture at 651-201-6562 to find out about where to safely dispose of these. Even for newer, non-arsenic containing pesticides, there are still health risks associated with other ingredients and in-home application should be limited or be done by a certified applicator.

See MDH hand-outs (in education packet for elevated arsenic levels): 'How to reduce intake of contaminated soils,' 'Chromated Copper Arsenic' and 'Ironite' (afertilizer). For garden bed details see: http://www.extension.umn.edu/yardandgarden/YGLNews/YGLN-June0101.html#as.

Recreation

Patients should be advised to have family members wash hands after playing on wooden playground structures. Picnic tables should be covered with tablecloths, and no food preparations should be done directly on top of the wood.

Well water

Metropolitan water supplies have been tested and are safe. Well water, especially in agricultural areas, should be tested.

See MDH hand-out on Arsenic in Drinking water (in education packet for elevated arsenic levels)

Occupation

Patients who have potential exposures via occupation should consider contacting their supervisor about programs to test their urine for arsenic through their worksite. They could also consider seeing a physician who specializes in occupational medicine.

Arsenic Exposure Checklist

Please carefully read through the following list. Check all boxes that might fit you or your child being checked for arsenic exposure.

Home and Garden

- ☐ Do you have a wooden deck made from green pressure treated wood?
- ☐ Do you have a wooden play set for children?
- ☐ Do you ever burn scrap wood, outside or inside?
- ☐ If you have vegetable or food garden, does it have a border or edge made from green pressure treated wood?
- ☐ Do you use any pesticides (like ant killer) inside your house?
- ☐ Have you ever used fertilizers, pesticides or soil supplements (like Ironite) in your garden or on your lawn?
  If so, please list the kinds
  _____
  _____
- ☐ Are there fertilizers, pesticides or soil supplements stored anywhere in your home or yard?
- ☐ Are there any areas of bare soil in your yard (not covered by grass or plants)?
- ☐ Do you have a pet that spends time in your yard and indoors?
- ☐ Do you use animal shampoos for your pets?

Recreation

- ☐ Do you or your children play in playgrounds with wooden structures?
- ☐ Do you eat food on green pressure treated wood picnic tables?
- ☐ Do you make your own lead shot for hunting or lead weights for fishing?

Work

Please place a check in the box if you have ever done any of these things as part of your job. If the person is a child, check the box if any adult in the household has one of these jobs.

- ☐ poultry farming
- ☐ poultry wastes
- ☐ smelting copper or lead
- ☐ working with pressure treated wood
- ☐ making semiconductors
- ☐ making or applying pesticides
- ☐ making or applying fertilizers
- ☐ working on railroad cars, tracks or maintenance
- ☐ soldering or electronics
- ☐ making or applying animal “dip”

Drinking Water

- ☐ Has there been a recent change in the quality of your city water?
- ☐ Do you get drinking water from a well outside the metro area?

S**moking**

- ☐ Do you smoke cigarettes?
  If yes, how many per day?_____
- ☐ Are you exposed to cigarette smoke?

Foods and Medicines

- ☐ Do you eat shellfish (like crab, oysters or clams), tuna, fishsticks, fish from the oceans, or seaweed?
- ☐ Do you eat fruits and vegetables bought at a store without washing them?
- ☐ Do you eat rice often?
- ☐ Do you use any special medicines or teas? (e.g. homeopathic meds, traditional Hmong, Somali, and Mexican medications)
- ☐ Do you use any special skin creams?
- ☐ Do you take any dietary supplements? (e.g. chitin, seaweed)

Arsenic Exposure Clinical Assessment Form

Date _____

Patient Name _____

Date of Birth _____

Gender male female

Place Sticker Here
or
Fill in Name and DOB at Left

If the patient is a child - Name and relationship of person completing the survey:

_____

Residence and Soil testing

1. Where do you live (address)? _____
How long have you lived there? _____

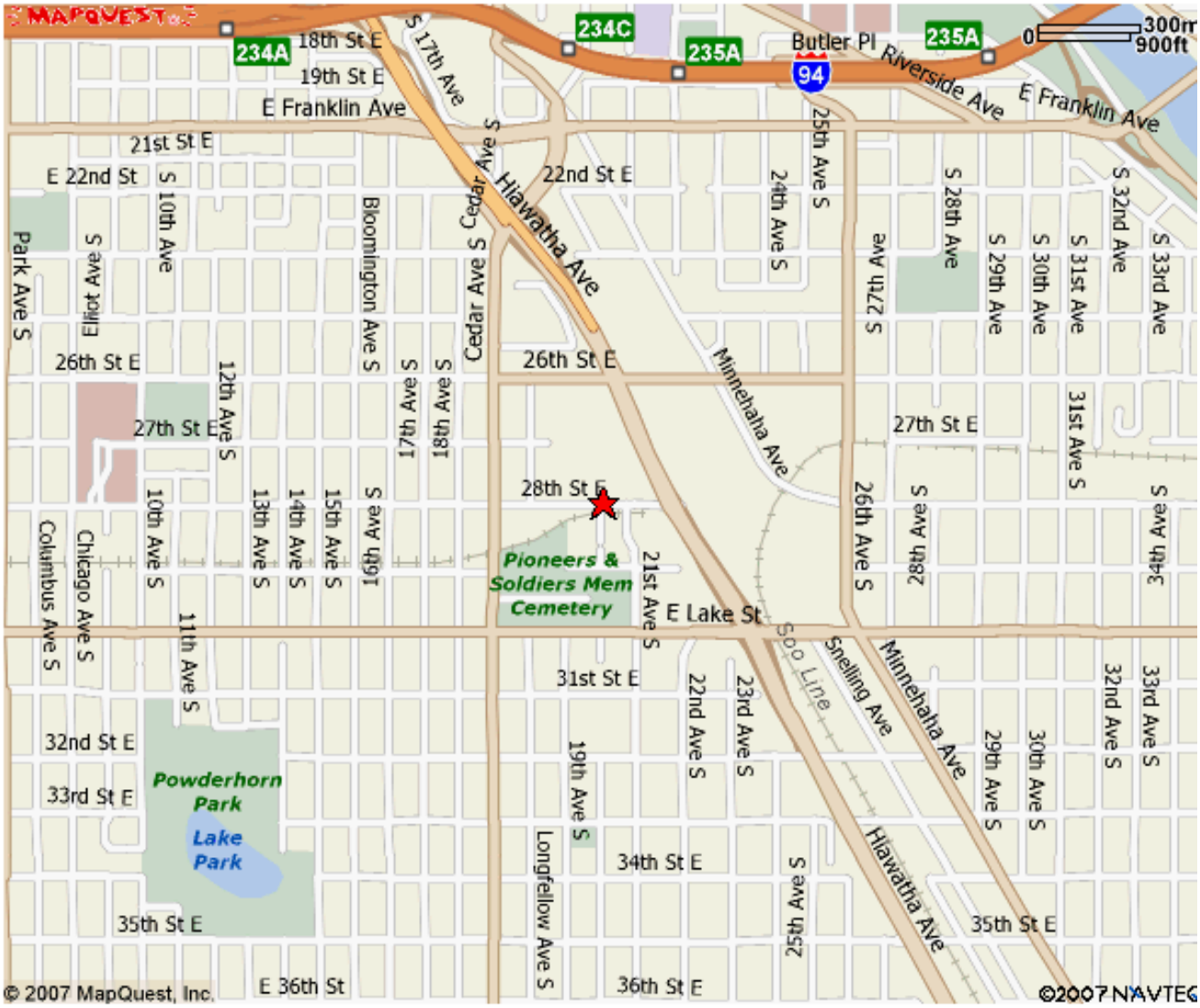
2. Have you or your family received any correspondence from the Dept of Health or EPA regarding arsenic contamination on your property?
☐ Yes ☐ No
If yes, what did that communication say? (Provide copy if available)

3. Has your property been tested for arsenic levels in the soil?
☐ Yes ☐ No
If yes, when? _____
What were the results? _____

4. Has your property been remediated (e.g. soil removed) for contamination?
☐ Yes ☐ No
If yes, when? _____

5. Has a neighbor had their property remediated (e.g. soil removed) for contamination?
☐ Yes ☐ No
If yes, when? _____

Mark your home on the map:



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- ☐ If you have vegetable or food garden, does it have a border or edge made from green pressure treated wood?
- ☐ Do you use any pesticides (like ant killer) inside your house?
- ☐ Have you ever used fertilizers, pesticides or soil supplements (like Ironite) in your garden or on your lawn?
  If so, please list the kinds
  _____
  _____
- ☐ Are there fertilizers, pesticides or soil supplements stored anywhere in your home or yard?
- ☐ Are there any areas of bare soil in your yard (not covered by grass or plants)?
- ☐ Do you have a pet that spends time in your yard and indoors?
- ☐ Do you use animal shampoos for your pets?

Recreation

- ☐ Do you or your children play in playgrounds with wooden structures?
- ☐ Do you eat food on green pressure treated wood picnic tables?
- ☐ Do you make your own lead shot for hunting or lead weights for fishing?

Work

Please place a check in the box if you have ever done any of these things as part of your job. If the person is a child, check the box if any adult in the household has one of these jobs.

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- ☐ poultry wastes
- ☐ smelting copper or lead
- ☐ working with pressure treated wood
- ☐ making semiconductors
- ☐ making or applying pesticides
- ☐ making or applying fertilizers
- ☐ working on railroad cars, tracks or maintenance
- ☐ soldering or electronics
- ☐ making or applying animal “dip”

Drinking Water

- ☐ Has there been a recent change in the quality of your city water?
- ☐ Do you get drinking water from a well outside the metro area?

Smoking

- ☐ Do you smoke cigarettes?
  If yes, how many per day?_____
- ☐ Are you exposed to cigarette smoke?

Foods and Medicines

- ☐ Do you eat shellfish (like crab, oysters or clams), tuna, fishsticks, fish from the oceans, or seaweed?
- ☐ Do you eat fruits and vegetables bought at a store without washing them?
- ☐ Do you eat rice often?
- ☐ Do you use any special medicines or teas? (e.g. homeopathic meds, traditional Hmong, Somali, and Mexican medications)
- ☐ Do you use any special skin creams?
- ☐ Do you take any dietary supplements? (e.g. chitin, seaweed)

Health Survey Questions (check if you/your child have any of the following symptoms)

	During past 12 months		**Currently**		
Symptom	**Yes**	**No**	**Yes**	**No**	**Comments**
Numbness/tingling of hands or feet					
Nausea/vomiting					
Chronic or unexplained diarrhea					
White lines across fingernails					
Thickened, scaly skin					

Children

If the patient is < 18years old, check if these apply to your child

_____Does the child have a history of pica (eating dirt or other non-food items)?

_____Does the child have a history of developmental delay?

Names / Date of Birth / School of children in the household

1._____ DOB_____ School _____

2._____ DOB_____ School _____

3._____ DOB_____ School _____

4._____ DOB_____ School _____

5._____ DOB_____ School _____

For MD office:

On physical exam:
Skin: Hyperkeratoses, hyperpigmentation (anywhere, but commonly seen on hands and feet)
Neuro: Check DTRs, sensorimotor testing of hands and feet
Nails: Mee's lines (white lines across fingernails)

Laboratory testing:
Begin with a random urine arsenic test.
If positive, get a 24 hour urine arsenic level and additional blood tests

Caution: *Urinary arsenic levels may be elevated in patients who have recently ingested fish/shellfish. Patients should abstain from fish/seafood for at least 3-5 days prior to testing.)*

Rationale for different arsenic tests
Urine arsenic tests are the preferred test for current or recent arsenic exposure.
Blood tests are very transient.
Hair/nail analysis is sometimes used for patients with symptoms and past exposures (months to years ago) without ongoing exposures. This is more appropriate for epidemiologic studies rather than individual patient assessment. There have been many concerns about the reliability of hair/nail analysis. Hair analysis can not distinguish between external sources (dirt on the hair) versus internal sources (in the body). Arsenic on the outside of the hair may show up as a positive test even though there is none in the body. Multiple studies have shown that washing the hair before testing does not remove all the arsenic. There may be other variables that also effect arsenic hair levels (age, color, thickness, curliness). There are also issues with finding a certified lab that does an adequate volume of tests. Lower volumes of hair testing can lead to variable results especially at lower levels (which we would expect in our population). There is also a lack of agreement about "normal" levels and what to do at these levels. Elevated hair/nail levels would usually be confirmed with a urine test.

Education
Handouts - Arsenic fact sheet, urban contamination, Soil testing (if needed)
Verbal reinforcement

1. Soil – shoes at the door, wash hands, vacuum / wet mop regularly, gloves in garden, wash/peel vegetables grown in yard
2. Pressure treated wood – remove if possible, wash hands after playing, never burn
3. Urban contamination – general precautions about a contaminated environment
4. Smoking – has arsenic and 4000 other harmful chemicals. Stop smoking and second-hand tobacco smoke exposure

Counseling Tips for Specific Issues

Home and Garden

Regarding treated wood: Chromate Copper Arsenic (CCA) pressure treated wood can be any dimension with a slight green tint. Creosote (old railroad ties), on the other hand, is typically 6x6" and dark brown. Creosote does **not** contain arsenic.

Decks and playground equipment made of CCA pressure treated wood should be sealed with oil-based stain or polyurethane (not paint) every 1-2 years. If gardens are bordered by pressure treated wood, consider lining the beds with plastic to minimize leaching of arsenic into soil. Though vegetables have minimal uptake of arsenic, vegetables should be grown no closer than 15 inches from CCA treated wood. Never burn pressure treated wood since it releases arsenic in the smoke.

Patients should be advised to read ingredients on all pesticides, dips and fertilizers, and if they have old pesticides without labels or labels show arsenic content, contact the Minnesota Department of Agriculture at 651-201-6562 to find out about where to safely dispose of these. Even for newer, non-arsenic containing pesticides, there are still health risks associated with other ingredients and in-home application should be limited or be done by a certified applicator.

See MDH hand-outs (in education packet for elevated arsenic levels): 'How to reduce intake of contaminated soils,' 'Chromated Copper Arsenic' and 'Ironite' (afertilizer). For garden bed details see: http://www.extension.umn.edu/yardandgarden/YGLNews/YGLN-June0101.html#as.

Recreation

Patients should be advised to have family members wash hands after playing on wooden playground structures. Picnic tables should be covered with tablecloths, and no food preparations should be done directly on top of the wood.

Well water

Metropolitan water supplies have been tested and are safe. Well water, especially in agricultural areas, should be tested.
See MDH hand-out on Arsenic in Drinking water (in education packet for elevated arsenic levels)

Occupation

Patients who have potential exposures via occupation should consider contacting their supervisor about programs to test their urine for arsenic through their worksite. They could also consider seeing a physician who specializes in occupational medicine.

Your doctor has given this information sheet to you because the level of inorganic arsenic in your or your child's urine is higher than normal. This list of sources of inorganic arsenic may help you identify where the arsenic is coming from and reduce your or your child's exposure.

- ☐ **HERBAL REMEDIES AND SUPPLEMENTS**: There are documented cases of people who had elevated arsenic levels from these sources. If you are using herbal teas, creams, remedies or supplements, consider stopping them and then having your urine retested in one week.

- ☐ **GREEN TREATED WOOD:** Copper Chromated Arsenic (CCA) was used to keep wood from rotting. In 2003 the use of CCA for treating wood used for residential structures (decks, fencing, picnic tables etc) was stopped, and other preservatives have replaced CCA. However, there may still be structures built before 2003, and CCA treated wood is permitted to be used for non-residential structures. Burning CCA treated wood is extremely dangerous because of the very high amounts of arsenic in the smoke and ash. Please see the attached information sheet for reducing your exposure to arsenic in CCA treated wood.

- ☐ **WORKING WITH POULTRY WASTE**: (as fertilizer, manure or fuel)

- ☐ **FERTILIZERS AND PESTICIDES:** In Minnesota there are now limits on the amount of arsenic that can be in fertilizers and pesticides. People may have old bags of these products at home. Check the ingredients of any old fertilizers or pesticides you may have for arsenic. If no ingredients are listed, you should dispose of the product. You cannot dispose of these products in the garbage; instead, you can take them to your local household hazardous waste site. Ironite is a soil supplement which has had high levels of arsenic. You can read more about Ironite in the attached information sheet.

- ☐ **SOIL:** Inorganic arsenic is naturally found at low levels in soil in most of Minnesota. Soil can become contaminated with additional arsenic through the use of fertilizers, pesticides or leaching from CCA treated wood. Soil can also have elevated levels of other hazardous metals such as lead. The most important thing you can do to you're your exposure to contaminants from soil is to reduce your accidental ingestion of soil, especially soil on your hands – please see the attached information sheet for how to do this. If you would like to have your soil tested for hazardous metals, ask your doctor for a list of soil testing services.

- ☐ **WATER:** City water supplies throughout the metropolitan area are carefully checked for inorganic arsenic. However, if you have another home in Minnesota that uses well-water or get drinking water from a non-city supply, it could be a possible source of inorganic arsenic. The attached information sheet provides resources for having water tested for arsenic.

Urban Contamination
General Precautions to Avoid Contaminants Found in Cities

Regardless of your arsenic results, there are other contaminants in your environment that can harm you and your family because you live in a city. All cities have been contaminated with harmful chemicals by industries over the years.

There are general precautions that we should all take to limit our exposure to these harmful chemicals around our homes. THIS IS ESPECIALLY IMPORTANT FOR CHILDREN AND PREGANT WOMEN.

Cigarette smoke alone contains over 4000 chemicals including arsenic. Other important indoor and outdoor contaminants in any city include:

- Arsenic
- Mercury
- Lead
- PCBs/dioxin
- Asbestos
- Water pollution
- Air pollution (including carbon monoxide, radon, molds, solvents)
- Pesticides

Since we may not know that these contaminants are in or around our homes, there are some general precautions that we should all take including:

- AVOID CIGARETTE SMOKE
- WASH HANDS AFTER PLAYING OR WORKING OUTDOORS
- TAKE SHOES OFF AND LEAVE THEM AT THE DOOR
- VACUUM AND WET MOP REGULARLY
- WASH ALL FRUITS AND VEGETABLES BEFORE EATING
- IF YOU EAT MORE THAN ONE SERVING OF FISH A MONTH, CHECK MERCURY RESOURCES (Minnesota Department of health website: http://www.health.state.mn.us/divs/eh/fish/index.html. Or call the Fish Advisory Program at 651-201-4911.)
- LET WATER RUN FROM YOUR FAUCETS FOR 1-2 MINUTES BEFORE USING TO CLEAR OUT PIPES
- MAINTAIN PAINT ON WALLS FROM PEELING (lead) AND INSULATION AROUND PIPES (asbestos)
- AVOID SPRAYING PESTICIDES IN THE HOME, GARDEN AND PETS (including flee and tick collars)

For more specific information on any of the common urban contaminants, please contact: The Greater Boston Physicians for Social Responsibility at www.igc.org/psr or The Minnesota Department of Health at http://www.health.state.mn.us/divs/eh/contactus.htm.

For more details on each contaminant see http://psr.igc.org/toolkit/ref_guide.pdf.

2/5/07

Arsenic Fact Sheet

2/5/07

What is arsenic?

Arsenic is a naturally occurring substance found in the earth's crust. Because of this, arsenic can be found in the air, groundwater, and in metal ores like lead or copper. Arsenic cannot be destroyed in the environment, but it can change forms: fish and shellfish accumulate arsenic, but mostly in a form that is not harmful to humans.

Industrial uses of arsenic have included the manufacture of pressure treated woods, pesticides, fertilizers, and 'dips' to protect animals from ticks and other pests. Builders working on construction of houses, playgrounds, decks and other residential structures have stopped using pressure treated wood containing arsenic, and have switched to safer forms of treated wood. However, arsenic containing wood can still be used for non-residential structures, and existing structures are not taken down.

How might I be exposed to arsenic?

- Ingesting small amounts present in food and water, or breathing air containing arsenic (e.g. cigarette smoke). While there is no clear evidence that arsenic benefits humans in any way, there is evidence that very minute amounts are not harmful.
- Breathing in sawdust from pressure treated wood, or smoke from pressure treated wood that is being burned.
- Applying pesticides or fertilizers that contain arsenic.
- Giving animals medications or treatments that contain arsenic.
- Working in jobs like lead or copper smelting, pesticide or fertilizer manufacture or application.

What are the health effects of arsenic?

At very high levels, arsenic causes death. Exposure to lower levels of arsenic over a short time period can cause nausea, vomiting, decreased production of red and white blood cells, abnormal heart rhythms and nerve damage resulting in a pin and needles sensation in the hands and feet.

Long term exposure to arsenic can cause darkening of the skin and the appearance of small corns or warts on the palms of hands, soles of feet and torso. Long term exposure to arsenic also increases the risk of developing cancer of the liver, bladder, kidneys, prostate, lungs and skin

How can I avoid exposure to arsenic?

- If your soil contains elevated levels of arsenic, make sure there is no bare soil in your yard. Take your shoes off before coming in the house so you are not tracking any soil into the house and vacuum /wet mop regularly. Always wash hands before eating or drinking. Use gloves when you garden. Though arsenic is not absorbed by plants, you should thoroughly wash and peel any vegetable grown in this soil
- Cigarettes contain arsenic. Avoid second-hand smoke and stop smoking cigarettes.
- If you have a deck or other home structures made of pressure treated wood, seal it every 1-2 years with oil-based stain or polyurethane (not paint).
- If your children play on a playground with pressure-treated wood structures, make sure they wash their hands after playing.
- Do not use pressure treated wood to create elevated vegetable beds for your garden.
- Never burn pressure-treated wood! If you want to burn scrap wood but are not sure whether it is pressure treated, do not burn it.
- Check any old pesticides and fertilizers you have to see if they contain arsenic. If you do not know whether they contain arsenic, do not use them, and contact the Minnesota Department of Agriculture to find out about where you can safely dispose of old pesticides and fertilizers at 651-201-6562.
- If you have well water, get it tested for arsenic. If you have high levels of arsenic in well water, you may buy treatment systems for your well water. Your local environmental health department can assist you with more information.

Are there medical tests to see whether I have been exposed to arsenic?
A urine arsenic test is the most reliable test for recent arsenic exposures. However, a urine test may also show a harmless form of arsenic if you are eating seafood. If a urine test shows a high level of arsenic, you may need to change your diet and be tested again.

Tests of hair and fingernails have sometimes been used to measure exposure to very high levels of arsenic in the past. There are concerns about the reliability of these tests (e.g. high levels on the hair but low level in the body), and how to interpret the results.

Has the federal government made recommendations to protect human health?
The Environmental Protection Agency (EPA) has set limits on the amount of arsenic that industrial sources can releases into the environment and has restricted or cancelled many of the uses of arsenic in pesticides. The EPA has set a limit of 0.01 parts per million for arsenic in drinking water.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit of 10 micrograms of arsenic per cubic meter of workplace air for 8 hour shifts and 40 hours per week. Workers exposure to arsenic can have their urine tested, and if the urine shows greater than 50 micrograms per deciliter of arsenic, the worker is taken off the job until urine levels are normal.

Collection and Analysis of Soil Samples for Arsenic:
Recommended Procedures for Homeowners-Renters-Residents

Minnesota Department of Agriculture, Incident Response Unit
June 2006

The Minnesota Department of Agriculture (MDA) recommends that you contact one of the laboratories listed at the end of this letter. The laboratories included in this list are local laboratories which are certified for arsenic analyses by the Minnesota Department of Health.

Please make sure that the laboratory uses a reporting limit of 3 milligrams per kilogram (mg/kg or parts per million) or less for arsenic for your sample(s). The recommended analytical method is SW-846 Method 6020 which utilizes Inductively Coupled Plasma and Mass Spectrometry. The cost for analysis of one soil sample for arsenic at this reporting limit is usually around $30. The laboratory should provide sample bottles for the soil.

For the MDA soil sampling study that was completed in September 2003 the soil samples were collected from a depth of 0-3 inches below ground. One soil sample was made up of five subsamples collected from a depth of 0-3 inches within a 5-foot diameter area. The five subsamples were then mixed together to form one sample. We recommend that you follow this procedure as well. Please make sure that you do not include vegetation, wood chips, gravel, sand or compost in your samples. In grassy areas you should collect your soil sample below the turf. In addition, avoid sampling near artificial sources of arsenic such as fences, picnic tables, decks or other structures made of wood treated with copper chromated arsenate (CCA) or green treated wood.

We recommend that you use a clean trowel for each sample and mix the subsamples in a clean, disposable foil roasting dish or some other clean, disposable container. The trowel should be cleaned with soap and water between each soil sample, in case you collect more than one sample.

The filled sample bottle(s) should be placed on ice in a cooler for transport to the laboratory.

We would be happy to help you interpret the analytical results once you receive them from the laboratory. If you have any questions please feel free to call Cathy Villas-Horns at (651) 201-6293 or Robert Anderson at (651) 201-6632.

Local laboratories certified by the Minnesota Department of Health for arsenic analyses:

Braun Intertec, Inc.
11001 Hampshire Avenue South
Minneapolis, MN 55438
(952) 993-2638

Legend Technical Services
775 Vandalia Street
St. Paul, MN 55114
(651) 642-1150

Interpoll Laboratories, Inc.
4500 Ball Road N.E.
Circle Pines, MN 55014
(763) 786-6020

Pace Analytical Services, Inc.
1700 Elm Street, Suite 200
Minneapolis, MN 55414
(612) 607-1700

Minnesota Department of Health

Environmental Health Information Sheet

Chromated Copper Arsenate (CCA)

This information is written in response to health concerns about the use of wood treated with chromated copper arsenate (CCA). Wood used in outdoor structures, such as decks and children's play equipment, is often pressure-treated with CCA. CCA protects the wood from deterioration and prevents structures from rotting, collapsing and causing injuries. The CCA in treated wood is a combination of the metals chromium, copper and arsenic, chemically bonded together. The most toxic part of the CCA pesticide is arsenic. Arsenic is a naturally occurring element and can be found in small amounts in soil, water and air.

Recommendations

➔ **NEVER BURN TREATED WOOD, WOOD SCRAPS OR SAWDUST.** Decide on a safe disposal method or location for wood, wood scraps and sawdust prior to purchasing treated wood. Contact the Minnesota Pollution Control Agency, city or county environmental officials for information. By law, treated wood cannot be disposed of in demolition landfills or unlined landfills in Minnesota. Improper disposal of CCA-treated wood or wood scraps may result in contaminated soil or groundwater.

➔ Seal existing CCA-treated structures (decks, playscapes) every 2 years with an oil-based sealant. This is in accordance with the wood manufacturers' recommendations for maintenance of CCA-treated wood. Proper sealants will decrease the amount of arsenic residue on the surface as well as keep the wood from cracking and splitting. Sealants should also minimize the amount of arsenic that can be leached into the soil beneath a structure.

➔ Encourage children to wash their hands following play on CCA-treated playscapes. Adults who work with treated wood should also wash their hands before handling food.

➔ Do not eat or prepare food on CCA-treated surfaces. If you use a CCA-treated picnic table, cover the table with a tablecloth.

➔ Follow safe handling guidelines if you use CCA-treated wood in building projects. Cut and sand CCA-treated wood outdoors; wear a dust mask; collect sawdust and scraps on a dropcloth; wash hands and clothing upon completing work.

➔ Limit use of under-deck areas where arsenic may have accumulated in the soil.

➔ Do not use treated wood on exposed indoor surfaces.

➔ Do not use CCA-treated wood for wood chips or mulch.

What are the Health Concerns?

Arsenic causes cancer in humans and has other toxic effects on the skin and internal organs. These effects may occur following long-term (chronic) exposures to small amounts of arsenic. Arsenic health effects can take years to develop. Short-term (acute) exposures to arsenic can also affect health.

Exposure to arsenic from treated wood occurs when the wood, scraps or sawdust is burned. Since arsenic is an element, it cannot be destroyed by fire. Burning CCA-treated wood releases arsenic, copper and chrome into the air in dangerous amounts and the leftover ash can have very high concentrations of arsenic. Arsenic in ash can be drawn into the groundwater by rainwater and contaminate drinking water wells. **CCA-treated wood should never be burned.**

Boards used in playgrounds may have a fine coating (or residue) of the pesticide left on the wood's surface. This can easily be picked up on hands or clothing of children. Given the skin-contact and frequent hand to mouth behaviors prevalent among young children, daily play activity could result in significant exposure. Older children who spend considerable time playing on CCA-treated structures or adults who frequently eat on CCA-treated tables that are not properly sealed, may also be at risk.

Recent studies have shown the CCA "leaches" (is released) from treated wood by rainwater. This can leave a residue on the wood surface and contaminate the soil beneath the wood structure.

This is of particular concern for children who play underneath CCA-treated wood structures and who may ingest soil. Leaching of CCA can be minimized by sealing structures every two years with an oil-based sealant.

People working with treated wood can also be exposed to significant amounts of arsenic. This can occur if dust is breathed, or if dust or residues on unwashed hands is ingested.

Arsenic is not readily absorbed by plants but soil or dust contaminated with arsenic can accumulate on leafy or root vegetables. If you are concerned, insert a plastic liner on the inside of treated wood to frame garden beds.

Are there alternatives to CCA-treated wood?

Yes. For new structures, consider redwood and cedar, which are naturally rot-resistant and can be used in above ground construction. Wood-plastic composites are another alternative. Metal play equipment and picnic tables are also available. Wood boards that are pressure treated with other pesticides may not contain arsenic but still should be carefully evaluated.

Who can I contact for more information?

Minnesota Department of Health, Division of Environmental Health: (651) 215-0700 or (800) 627-3529.

Minnesota Pollution Control Agency: (651) 296-6300 or (800) 657-3864; TDD (651) 282-5332.
Environmental Protection Agency, Office of Pesticide Programs: http://www.epa.gov/pesticides/

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

MDH.EH. April 2001

Facts about Ironite

The following information provides answers to frequently asked questions about Ironite, which is a home lawn and garden fertilizer found to contain high levels of toxic metals -- including arsenic and lead.

What is Ironite?
Ironite is a home lawn and garden fertilizer that contains high levels of arsenic and lead. These metals are known to be toxic to people, especially to young children who may exhibit frequent hand-to-mouth contact.

Ironite's manufacturer markets Ironite and Ironite Superferrite as iron and zinc micronutrient fertilizers. These products are derived from mining tailings from an former silver mine in Arizona. Ironite was recalled in Minnesota in 2003; however, it is still available in home and garden stores in other areas of the U.S.

What do tests of Ironite show?
Testing conducted by the Minnesota Department of Agriculture shows that Ironite contains between 3000 and 6000 parts per million (ppm) arsenic, and 3400 ppm lead. These concentrations are significantly higher (up to 1000 times) the levels in other Minnesota home and garden fertilizers.

In addition, tests show that the arsenic and lead concentrations in Ironite are highly variable from sample to sample. These differences are likely due to variability in the mineral composition of the source material (i.e., mine tailings).

Why be concerned about Ironite?
The Minnesota Department of Health (MDH) is concerned about Ironite because it poses a acute risk to children who may directly ingest the product. Children may also be at risk if they are indirectly exposed to Ironite applied on lawns, parks and other play areas.

Children are especially vulnerable to arsenic and lead because they exhibit frequent hand-to-mouth activity and other behaviors which increase the potential for exposure to these contaminants.

In addition, children are known to be more susceptible to the harmful effects of lead because they absorb lead more readily into their bodies than adults, and their nervous systems are developing. Arsenic is recognized as a highly toxic metal and known human carcinogen by the US Environmental Protection Agency. For more on the harmful effects of these metals, see Arsenic and Lead fact sheets.

MDH also is concerned because Ironite's label provides no information for parents and consumers regarding the high level of toxic metals it the product. Ironite's label also does not provide any precautionary warnings regarding potential health risks to children.

What about the bioavailability of metals in Ironite?
Ironite's manufacturer claims that the arsenic and lead in their product are not a health risk because these metals are in mineral forms that are not readily bioavailable to plants or people. However, MDH and the University of Minnesota soil scientists are concerned that metals in this product may become bioavailable over time.

MDH has concluded that the data supplied by Ironite's manufacturer are inadequate to evaluate the bioavailability of arsenic and lead in Ironite. Furthermore, it is unlikely that the nutritive or beneficial metals, such as iron and zinc, would become bioavailable while arsenic and lead would not (over time).

What is being done?
MDH and MDA have shared the results of fertilizer testing with other state agencies, the US Environmental Protection Agency (US EPA), the media, and the US Consumer Product Safety Commission. MDH also has urged the US EPA to remove the exemption for Ironite in their new proposed standards for metals in fertilizers (see letter). (PDF 13 KB/2 pages)

In 2003 the Minnesota Legislature passed an amendment requiring the recall of fertilizer products that exceed 500 parts per million arsenic. The MDA distributed a letter to fertilizer registrants and manufacturers requiring them to provide verification of the arsenic concentration for their products containing micronutrients, waste or ash (for information about the new law and MDA's requirements, see Arsenic Concentration Limits in Fertilizer.

MDA inventoried hardware and garden stores to identify any Ironite products; however, no Ironite products could be found.

What can I do?
Given that the issue of bioavailability is far from settled and that there is inadequate information to determine the safety of Ironite at this time, MDH recommends avoiding the use of Ironite and Ironite Superferrite, particularly in areas where children may be exposed.

Homeowners and others who are concerned about exposures to metals in Ironite may:

- Dispose Ironite by bringing it to you local household hazardous waste center. For information about household hazardous waste centers in your area, see the Minnesota Pollution Control Agency web site.
- Keep Ironite away from children; store Ironite in locked cabinets and areas out of the reach of children.

If you would like to find out more about metal concentrations in specific products, see Reports of Heavy Metal Analysis or contact Gregg Regimbal, Minnesota Department of Agriculture, 651-297-4871.