Health Consultation

Former Chamberlain Manufacturing Site

550 Esther Street

Waterloo, Black Hawk County, Iowa

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Purpose

The United States Environmental Protection Agency (EPA) has requested the Iowa Department of Public Health (IDPH) to evaluate the health impacts associated with exposure to contaminants of concern that have been found at the Former Chamberlain Manufacturing Site. The EPA has been involved in the investigation and remediation of the Former Chamberlain Manufacturing Site since 2005. As part of these investigative activities, on-site soil sampling and both on- and off-site groundwater sampling has been completed. In addition, sub-slab soil gas, indoor air, and ambient air sampling at properties located near the Former Chamberlain Manufacturing Site has been completed. This health consultation addresses potential health risks to the public from exposure to the soil, groundwater and potential vapors within homes or buildings at or near the Former Chamberlain Manufacturing Site. The information in this health consultation was current at the time of writing. Data that emerges later could alter this document's conclusions and recommendations.

Background

Site History

Manufacturing operations started at the site in the early 1900's. This facility has manufactured metal washing machine wringers, projectile metal parts, aluminum awnings, and refrigerator shelves. According to information included in the Resource Conservation and Recovery Act (RCRA) Facility Assessment prepared by PRC Environmental Management, Inc. and submitted to the EPA in February 1996, the facility was operational from 1919 until the facility closed in 1993 or 1994 (1). The Former Chamberlain Manufacturing site is located to the east of E. 4th Street from East Louise Street at the northern end of the property extending to the Iowa Northern Rail Line at the southern edge of the property. The address of the property is 550 Esther Street, Waterloo, Iowa. It is bounded by single-family residences to the west and surrounded by Gates Park Golf Course on the remaining portions of the property (Figure 1).

Site Characterization and Evaluation

Since the time the Former Chamberlain Manufacturing Site has been closed it has undergone several site characterizations and evaluations of contamination within the groundwater and soils on site left by previous manufacturing activities. A Phase II Environmental Site Assessment was completed in 2005. This assessment included a radiological survey, a geophysical investigation, and the collection of soil, groundwater, surface water, and sediment samples. The radiological survey did not reveal any radiological contamination on site. The geophysical investigation revealed the potential presence of buried drums or tanks on site. The other sampling revealed the presence of environmental contamination in soil, groundwater, surface water, and sediment above IDNR statewide standards and surface water criteria (2).

A Supplemental Phase II Environmental Site Assessment was completed in September 2005. In this assessment groundwater monitoring wells were installed on surrounding site property and

sediment soil samples were obtained within Virden Creek (a creek located to the east and south of the site property). Results from the sediment soil samples were below IDNR statewide standards and results from the groundwater monitoring were above the IDNR statewide standards for protected groundwater (3).

An assessment of environmental contamination within the soil and groundwater at the site of the Former Chamberlain Manufacturing Property was completed in 2006 and 2007 (4). The purpose of this assessment was to determine the degree and extent of environmental contamination within the areas of concern where previous activities had been conducted on the site property. The results of this assessment are as follows:

- Arsenic, barium, chromium, selenium, 1,1,1 trichloroethane, 1,2,4 trimethylbenzene, acetone, and cis-1,2 dichloroethene were detected above the EPA preliminary site remediation goals in the top 2.5 feet of site soils.

- Cadmium, tetrachloroethene, and trichloroethylene were detected above the EPA preliminary site remedial goals in soils 2 to 4 feet below ground surface.

- Groundwater samples were also obtained from both on-site and off-site monitoring wells and Geoprobe® groundwater samples. The levels of 1,1,1 trichloroethane, 1,1 dichloroethane, 1,1 dichloroethene, cis-1,2 dichloroethene, tetrachloroethene, trans-1,2 dichloroethene, vinyl chloride were above EPA preliminary site remedial goals within on-site groundwater samples.

- The levels of chloroform, cis-1,2 dichloroethene, tetrachloroethene, trichloroethylene, and 1,1,2 trichloroethane were above EPA preliminary site remedial goals within off-site groundwater samples.

Subsequent groundwater monitoring events were conducted in 2008. Samples were obtained from off-site Geoprobe® monitoring locations in April 2008 and in on-site and off-site groundwater monitoring wells in June 2008 (5). The following are the results of these monitoring events in 2008:

- The levels of cis-1,2 dichloroethene, tetrachloroethylene, trichloroethylene were above EPA preliminary site remedial goals within on-site groundwater samples.

- The level of trichloroethylene was above EPA preliminary site remedial goals within off-site groundwater samples.

An additional monitoring event was conducted in November 2008. Samples were obtained from on-site and off-site groundwater monitoring wells (6). The following are the results of this monitoring event.

- The levels of cis-1,2 dichloroethene, 1,2 dichloropropane, benzene, tetrachloroethylene, trichloroethylene were above EPA preliminary site remedial goals within on-site groundwater samples.

- The level of trichloroethylene was above EPA preliminary site remedial goals within off-site groundwater samples.

An additional monitoring event was conducted in June 2009. Samples were obtained from on-site and off-site groundwater monitoring wells (7). The following are the results of this monitoring event:

- The levels of cis-1,2 dichloroethene, 1,2 dichloropropane, 1,1,2 trichloroethane, tetrachloroethylene, trichloroethylene were above EPA preliminary site remedial goals within on-site groundwater samples.

- No chemicals were detected above EPA preliminary site remedial goals within off-site groundwater samples.

Since groundwater contamination above EPA preliminary site remedial goals for volatile organic chemicals exists within areas outside of the site boundary, it was felt there was a need to investigate the potential for vapor intrusion of these chemicals into residential properties located near the site. Vapor intrusion is the phenomena of volatile chemicals present within groundwater and soil to migrate upward through soil and cracks in the foundation of homes into the homes and presents a potential for inhalation exposure to people living in these homes. In an effort to determine this potential risk, samples of sub-slab (below the foundation) air were obtained through small sampling ports that were installed in the basement floors of the homes. In addition to the sub-slab samples, indoor air within homes that were randomly selected and ambient (outside) air near homes that were randomly selected was sampled and analyzed.

Sub-slab air, indoor air, and ambient air samples were collected and analyzed for several volatile organic compounds. These air samples were compared to screening values established by the EPA. The following is a summary of the results of the air samples:

- The concentration of tetratchloroethylene exceeded EPA screening values in sub-slab air samples in twelve residences.

- The concentration of trichloroethylene exceeded EPA screening values in sub-slab air samples in nine residences.

- The concentration of tetrachloroethylene exceeded EPA screening values in indoor air samples in three residences.

- The concentration of trichloroethylene EPA exceeded screening values in indoor air samples in one residence.

- Volatile organic chemicals were not detected above EPA screening values in all ambient air samples.

Discussion

Exposure to Site Contaminants

The previously completed site characterizations and evaluations showed the presence of environmental contamination within on-site and off-site groundwater, within on-site soil, and within indoor air in homes near the Former Chamberlain Manufacturing Site. In order for human health impacts to be seen in people living and working in the area near the Former Chamberlain Manufacturing Site it is necessary for people to be exposed to the contaminants found at and near the site. At or near the Former Chamberlain Manufacturing Site exposure to site contaminants could occur through direct exposure to groundwater, to soil, and to indoor air. It is unlikely that significant exposure to groundwater will occur since no drinking water wells are installed in the area and all homes and nearby businesses are provided water from the City of Waterloo Water Works (8). Exposure to environmental contamination within the soil can occur from direct exposure of soil through the skin and through incidental ingestion of soil from activities that may be conducted on the site. Exposure to site contaminants can also occur from inhalation exposure to volatile chemicals that can find their way into homes through vapor intrusion through the foundations of homes and businesses in the area. Exposure to site soils and exposure to indoor air will be the only exposure scenarios that will be discussed in this health consultation, since these exposures are the only exposures that have any potential of impacting human health

Exposure to Site Soils

Exposure to site soils can occur at the present time and in the future by individuals that may come in direct contact with the soil. At the present time there is limited use of the site since environmental investigation activities have not been completed. This health consultation will be focusing on future uses of the site and the risk and health significance of exposure to site contaminants keeping these futures uses of the site in mind. It is the understanding of the Iowa Department of Public Health that several uses of the site have been discussed by the community. These proposed uses include a recreational area, use for commercial or light industrial businesses, or use as a residential area. Each of these proposed uses have a different potential risk from exposure to site contaminants. For each of these proposed uses this health consultation will assume that no additional site remediation will be completed in order to evaluate the risk posed by the site as it exists now. As a conservative approach to risk, this consultation will also assume that individuals will be exposed to the highest levels contamination found is site soils. This consultation will also assume that exposure to site soils can possibly occur from incidental ingestion of soil and dust. Absorption of contaminants through the skin from soil is much smaller than absorption of contaminants by ingestion and will not be included in the analysis.

The following table includes the highest levels of contaminants found in site soils above the preliminary site remedial goals within the top 2.5 feet of site soils. The levels of the chemicals of

concern within the top 2.5 feet of the site are being considered since the top portion of the site soils is the layer that people would most likely be exposed to when accessing the site.

Table 1 – Highest Concentration of Chemicals of Concern in Shallow Soil

Chemical of Concern	Concentration (mg/kg)
Arsenic	5.8
Barium	2420
Selenium	33
Acetone	67.4
1,1,1 Trichloroethane	0.0473
1,2,4 Trimethylbenzene	0.0084
Cis-1,2 Dichloroethene	0.00676

Recreational Use

If the site will be used as a recreational area, then people can be potentially exposed to site soils during recreational activities at the site. In this exposure scenario, the individuals that have the greatest potential of being exposed to the largest amount of soil are children that may be using the site as a play area periodically throughout the year. The amount of soil that may be incidentally ingested by a child playing at the site can be estimated. The EPA has completed research on many exposure scenarios and has included this information in the Exposure Factors Handbook: 2011 Edition (9). Within this handbook is a section on incidental ingestion of soil. According to this handbook, the upper percentile estimation of incidental soil and dust ingestion for children is 200 milligrams soil per day. According to the handbook, it is estimated that children may be involved in recreation about 4 hours per day. If it is assumed that all of this recreation is completed at the site for 9 months out of the year, then a generous estimate of the percentage of time spent at the site throughout the year would be:

$$\frac{4 \text{ hours}}{24 \text{ hours}} \times \frac{9 \text{ months}}{12 \text{ months}} \times 100 = 12.5\%$$

Using this percentage the estimated incidental ingestion of site soils for a child would be 25 milligrams of soil per day averaged over a year of exposure. If we assume that a child weights 15 kilograms, then the dose of exposure for each of the chemicals of concern can be calculated by the following equation:

$$\frac{\text{X mg chemical of concern}}{\text{kg soil}} \times \frac{\text{25 mg soil}}{\text{day}} \times \frac{\text{kg soil}}{10^6 \text{ mg soil}} \times \frac{1}{\text{15 kg body weight}}$$

The following table is the estimated maximum dose of exposure of each chemical of concern for a child using the site as a recreational area utilizing the exposure assumptions discussed above.

Table 1 – Dose of Exposure for Chemicals of Concern in Shallow Soil – Recreational Use

Chemical of Concern	Dose (mg/kg/day)
Arsenic	0.0000097
Barium	0.00403
Selenium	0.000055
Acetone	0.000112
1,1,1 Trichloroethane	0.000000078
1,2,4 Trimethylbenzene	0.000000014
Cis-1,2 Dichloroethene	0.000000011

Commercial or Light Industrial Use

If the site will be used for commercial or industrial properties, then people who work at the site can be potentially exposed to site soils. In this exposure scenario, the individuals that that have the greatest potential of being exposed to the largest amount of soil are adults who would be working at the site. The amount of soil that may be incidentally ingested by an adult working at the site can be estimated. According to the EPA Exposures Factor Handbook: 2011 Edition, the average level of incidental soil and dust ingestion for adults is 50 milligrams soil per day. If we assume that an adult would be at the site 40 hours per week for 50 weeks per year, then a generous estimate of the percentage of time spent at the site throughout the year would be:

$$\frac{8 \text{ hours}}{24 \text{ hours}} \times \frac{5 \text{ days}}{7 \text{ days}} \times \frac{50 \text{ weeks}}{52 \text{ weeks}} \times 100 = 22.9\%$$

Using this percentage the estimated incidental ingestion of site soils for an adults would be 11.5 milligrams of soil per day averaged over a year of exposure. If we assume that an adult weighs 70 kilograms, then the dose of exposure for each of the chemicals of concern can be calculated by the following equation:

$$\frac{\text{X mg chemical of concern}}{\text{kg soil}} \times \frac{\text{11.5 mg soil}}{\text{day}} \times \frac{\text{kg soil}}{10^6 \text{ mg soil}} \times \frac{1}{\text{70 kg body weight}}$$

The following table is the estimate maximum dose of exposure of each chemical of concern for an adult working at the site utilizing the exposure assumptions discussed above.

Table 1 – Dose of Exposure for Chemicals of Concern in Shallow Soil – Commercial Use

Chemical of Concern	Dose (mg/kg/day)
Arsenic	0.00000095
Barium	0.000398
Selenium	0.0000054
Acetone	0.0000111
1,1,1 Trichloroethane	0.0000000078
1,2,4 Trimethylbenzene	0.0000000014
Cis-1,2 Dichloroethene	0.0000000011

Residential Use

If the site will be used as a residential area, then people can be potentially exposed to site soils while they are present at their homes. In this exposure scenario, the individuals that have the greatest potential of being exposed to the largest amount of soil are children that are living at the residential location. The amount of soil that may be incidentally ingested by a child living in a residence located on the site can be estimated. As stated before according to the Exposure Factors Handbook: 2011 Edition, the upper percentile estimation of incidental soil and dust ingestion for children is 200 milligrams soil per day. As a generous estimate we will assume that all the child's exposure to soil and dust will come from the site. The dose of exposure for each of the chemicals of concern can be calculated by the following equation:

$$\frac{\text{X mg chemical of concern}}{\text{kg soil}} \times \frac{\text{200 mg soil}}{\text{day}} \times \frac{\text{kg soil}}{10^6 \text{ mg soil}} \times \frac{1}{\text{15 kg body weight}}$$

The following table is the estimated maximum dose of exposure of each chemical of concern for a child living in a residence at the site as a recreational area utilizing the exposure assumptions discussed above.

Table 1 – Dose of Exposure for Chemicals of Concern in Shallow Soil – Residential Use

Chemical of Concern	Dose (mg/kg/day)
Arsenic	0.000077
Barium	0.0323
Selenium	0.00044
Acetone	0.000899
1,1,1 Trichloroethane	0.00000063
1,2,4 Trimethylbenzene	0.00000011
Cis-1,2 Dichloroethene	0.00000009

Toxicological Evaluation of Exposure to Site Soils

In order to determine the health significance of the dose of exposure to site soils a review of toxicological studies of each chemical of concern is needed. Information on toxicological studies can be obtained by a review of the Toxicological Profile for each chemical of concern.

Arsenic

The Toxicological Profile for Arsenic includes information on the health impacts of oral exposure to arsenic or ingestion of arsenic (10). Ingestion of large amounts of arsenic can cause irritation of the stomach, fatigue, abnormal heart rhythm, blood vessel damage resulting in bruising, and impaired nerve function. Perhaps the single-most characteristic effect of long-term oral exposure to inorganic arsenic in the environment is a pattern of skin changes. These include darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso, often associated with changes in the blood vessels of the skin. A few corns may ultimately develop into skin cancer. Arsenic is classified as a known human carcinogen. Ingestion of arsenic has also been reported to increase risk of liver, bladder, kidney, prostate, and lung cancer.

The lowest dose of long-term or chronic oral exposure to arsenic found in the Toxicological Profile for Arsenic to cause non-cancerous health impacts in humans is 0.0012 mg/kg/day. At this level an increased risk of premalignant skin lesions was observed. The lowest dose linked to

cancer impacts (lung cancer) in humans was 0.0011 mg/kg/day. The estimated dose of exposure for recreational, commercial or light industrial, and residential use of the site is all below either of these two health impact levels.

Barium

The Toxicological Profile for Barium includes information on the health impacts of oral exposure to barium or ingestion of barium (11). Oral exposure to elevated barium for longer periods of time may cause adverse cardiovascular system effects. There is not enough information to classify barium as carcinogenic.

The lowest dose of long-term or chronic oral exposure to barium found in the Toxicological Profile for Barium to cause adverse health impacts is 0.8 mg/kg/day. This lowest adverse health impact level occurred in a study with rats. The estimated dose of exposure for recreational, commercial or light industrial, and residential use of the site are all below this health impact level.

Selenium

The Toxicological Profile for Selenium includes information on the health impacts of oral exposure to selenium (12). Selenium has both beneficial and harmful effects. Low doses of selenium are needed to maintain good health. Chronic oral exposure to high concentrations of selenium compounds can produce a disease called selenosis. The major signs of selenosis are hair loss, nail brittleness, and neurological abnormalities (such as numbness and other odd sensations in the extremities). Studies of laboratory animals and people show that most selenium compounds probably do not cause cancer.

The dose of long-term or chronic oral exposure to selenium found in the Toxicological Profile for Selenium found to not cause adverse human health impacts is 0.0098 mg/kg/day. The estimated dose of exposure for recreational, commercial or light industrial, and residential use of the site are all below this health impact level.

Acetone

The Toxicological Profile for Acetone includes information on the health impacts of oral exposure to acetone (13). Health effects from long-term exposures to higher amounts of acetone are known mostly from animal studies; and include kidney, liver, and nerve damage, increased birth defects, and lowered ability to reproduce. There is not enough information to classify acetone as carcinogenic.

The lowest dose of intermediate or sub-chronic oral exposure to acetone found in the Toxicological Profile for Acetone to cause adverse health impacts is 500 mg/kg/day. The estimated dose of exposure for recreational, commercial or light industrial, and residential use of the site property are all below this health impact dose.

1,1,1 Trichloroethane

The Toxicological Profile for 1,1,1 Trichloroethane includes information on the health impacts of oral exposure to 1,1,1 trichloroethane (14). With this toxicological profile there is no information on studies in humans that determine whether oral exposure to 1,1,1-trichloroethane could harm health. Placing large amounts of 1,1,1-trichloroethane in the stomachs of animals has caused effects on the nervous system, mild liver damage, unconsciousness, and even death. There is not enough information to classify 1,1,1 trichloroethane as carcinogenic.

The lowest dose of chronic oral exposure to 1,1,1 trichloroethane found in the Toxicological Profile for 1,1,1 Trichloroethane to cause adverse health impacts is 500 mg/kg/day. This lowest adverse health impact level occurred in a study with rats. The estimated dose of exposure for recreational, commercial or light industrial, and residential use of the site property are all below this health impact dose.

1,2,4 Trimethylbenzene

There is very limited toxicological information available for 1,2,4 trimethylbenzene. A toxicological profile is not available for this chemical and this chemical is not included in the EPA Integrated Risk Information System (IRIS) database. Because of this limited information it will be difficult to provide a health assessment of exposure to 1,2,4 trimethylbenzene, and consideration of oral exposure to this chemical will not be included in this health consultation.

Cis-1,2 Dichloroethene

The Toxicological Profile for 1,2 Dichloroethene includes information on the health impacts of oral exposure to cis-1,2 dichloroethene (15). This toxicological profile indicates that certain doses of cis-1,2 dichloroethene caused effects on the blood, such as decreased numbers of red blood cells, and also effects on the liver.

This lowest dose of intermediate or sub-chronic oral exposure to cis-1,2 dichloroethene found in the Toxicological Profile for Cis-1,2 Dichloroethene to cause adverse health impacts is 97 mg/kg/day. This lowest adverse health impact level occurred in a study with rats. Additional toxicological information is included in the IRIS database. In this database information for cis-1,2 dichloroethene is available (16). The IRIS database uses a benchmark dose of exposure of 5.1 mg/kg/day that represents the lowest dose where health impacts are considered to be statistically significant. The estimated dose of exposure for recreational, commercial or light industrial, and residential use of the site property are all below these health impact doses.

Exposure to Site Soils – Health Significance of Potential Future Site Uses

In the paragraphs above, the estimated dose of exposure for chemicals of concern for three potential future site uses (recreational, commercial or light industrial, and residential) were determined. These estimated doses of exposure for were then compared to the lowest doses where adverse health impacts were observed in human and animal studies. For all chemicals of

concern the estimated exposure dose for all potential future site uses were below the lowest dose where adverse health impacts were observed in human and animal studies. An evaluation of the information regarding on-site soil contamination presented in this health consultation would seem to indicate that using the property for all three potential site uses would have minimal adverse health impact to people. The determination of minimal health impact is based upon exposure to the levels of chemicals of concern in the top 2.5 feet of the site without any site remedial activities.

Exposure to Indoor Air

Volatile contaminants of concern within the groundwater and soil have the potential of moving from being dissolved within the groundwater and adsorbed onto the soil and diffusing into the air within underground soil and then migrating up through home and building foundations into the inside air within homes and businesses near the site. Because of this potential, the EPA has overseen the collection and analyzing of sub-slab and indoor air samples from homes located to the west and southwest of the site.

The following is a summary of the results of these sampling events:

- The maximum concentration of tetrachloroethylene in sub-slab air samples was 140 $\mu g/m^3$ (17, 18).
- The maximum concentration of tetrachloroethylene in indoor air samples was 2.5 $\mu g/m^3$ (17, 18).
- The maximum concentration of trichloroethylene in sub-slab air samples was 6,000 $\mu g/m^3$ (17, 18).
- The maximum concentration of trichloroethylene in indoor air samples was 2.1 $\mu g/m^3$ (17, 18).

Toxicological Evaluation of Exposure to Indoor Air

In order to determine the health significance of exposure to air that contains chemicals of concern a review of toxicological studies of each chemical of concern with levels above EPA screening values is needed. Information on toxicological studies can be obtained by a review of the Toxicologial Profile for each chemical of concern. Direct exposure to sub-slab air does not occur within homes or businesses, therefore an estimation of the percent reduction from the concentration of chemicals found in sub-slab air to the concentration in indoor air needs to be made. The EPA has found that a 10-fold reduction (multiplying the sub-slab air concentration by 0.10) is a conservative estimation of the percent reduction from the concentration of chemicals found in sub-slab air to the concentration in indoor air (19). In the past, EPA and other environmental agencies have also utilized the Johnson-Ettinger Model for Subsurface Vapor Intrusion into Buildings (20). Using default inputs of this model produces about a 0.3 percent reduction from the concentration of chemicals found in sub-slab air to the concentration in indoor

air for trichloroethylene. This health consultation will use both a 10 percent and a 0.3 percent reduction in the estimation of the percent reduction from the concentration of chemicals found in sub-slab air to the concentration in indoor air. Both of these estimates are considered to be a generous estimate of the concentration of chemicals of concern within indoor air coming from soil gas below the slab of a home or building. As a point of reference, the percent reduction utilized in the Underground Storage Tank Program of the Iowa Department of Natural Resources is about 0.007 percent (21).

Tetrachloroethylene

The Toxicological Profile for Tetrachloroethylene includes information on the health impacts of inhalation exposure to tetrachloroethylene (22). Breathing small amounts of tetrachloroethylene may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. The lowest concentration of tetrachloroethylene in air found in human studies to not cause non-cancerous health impacts is about 1,400 $\mu g/m^3$.

Tetrachloroethylene is reasonably anticipated to be a human carcinogen based upon an association of exposure to tetrachloroethylene and incidences of liver cancer and leukemia incidences in animal studies. Environmental agencies attempt to estimate the risk of getting cancer from exposure to chemicals by looking at incidences of cancer in animal studies. The EPA has attempted to make this estimation for tetrachloroethylene (23). It is estimated that exposure to a concentration of 4 $\mu g/m^3$ tetrachloroethylene in air over an entire lifetime is associated with a one-in-a-million risk of getting cancer. The EPA and other environmental agencies usually considers a one-in-ten-thousand risk of getting cancer from environmental exposures to be an acceptable level of risk. Using the cancer risk determination utilized by the EPA an estimated one-in-ten-thousand risk of cancer can be determined. It is estimated that exposure to an air concentration of 400 $\mu g/m^3$ tetrachloroethylene over an entire lifetime equates to a one-in-ten-thousand risk of getting cancer.

The maximum concentration of tetrachloroethylene in sub-slab air samples was 140 $\mu g/m^3$. Applying the 10 percent reduction from sub-slab air gives an estimate of 14 $\mu g/m^3$ tetrachloroethylene within indoor air. Applying the estimated 0.3 percent reduction from sub-slab air gives an estimate of 0.42 $\mu g/m^3$ tetrachloroethylene within indoor air. Both estimated levels of tetrachloroethylene within indoor air resulting from sub-slab air and the highest level of tetrachloroethylene found in indoor air (2.5 $\mu g/m^3$) are all lower than the level where no adverse non-cancerous impacts are seen and lower than the level of tetrachloroethylene estimated to contribute to a one-in-ten thousand risk of getting cancer.

Trichloroethylene

The Toxicological Profile for Trichloroethylene includes information on the health impacts of inhalation exposure to trichloroethylene (24). Breathing small amounts of trichloroethylene may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. The lowest concentration of trichloroethylene in air found to not cause non-cancerous health impacts in animal studies is 100,000 $\mu g/m^3$.

Trichloroethylene is reasonably anticipated to be a human carcinogen based upon limited evidence and an association of exposure to trichloroethylene and excess incidences of liver cancer, kidney cancer, and non-Hodgkin's lymphoma. The EPA estimates that breathing a concentration of 0.2 µg/m^3 trichloroethylene over an entire lifetime is associated with a one-in-a-million risk of getting cancer (25). Using this number we can estimate that exposure to an air concentration of 20 µg/m^3 trichloroethylene over an entire lifetime equates to a one-in-ten-thousand risk of getting cancer.

The maximum concentration of trichloroethylene in sub-slab air samples was 6,000 µg/m^3. Applying the estimated 10 percent reduction from sub-slab air gives and estimated of 600 µg/m^3 trichloroethylene within indoor air. Applying the estimated 0.3 percent reduction from sub-slag air gives an estimate of 18 µg/m^3 trichloroethylene within indoor air. The lowest estimated level of trichloroethylene within indoor air resulting from sub-slab air (18 µg/m^3) and the highest level of trichloroethylene found in indoor air (2.1 µg/m^3) are both lower than the level where no adverse non-cancerous impacts have been seen in animal studies and lower than the level of trichloroethylene estimated to contribute to a one-in-ten thousand risk of getting cancer. But, when the estimated 10 percent reduction from sub-slag air is used a greater than one-in-ten-thousand risk of getting cancer is determined to exist.

Exposure to Indoor Air – Health Significance of Current and Potential Future Site Uses

In the paragraphs above, the estimated and actual concentrations of chemicals of concern in indoor air within homes located near the site were evaluated. The potential exposure to volatile chemicals within homes and business located near the site is due to the potential for vapor intrusion of these chemicals into the homes and businesses. In all cases the estimated and actual level of exposure to chemicals of concern within indoor air are below levels where non-cancerous health impacts are anticipated to be seen.

In the case of cancerous impacts, the estimated cancer risk from exposure to volatile chemicals within indoor air in homes or building near or on the site is below the one-in-ten-thousand risk of getting cancer in most homes where sampling was conducted. But, when the assumption of a 10 percent reduction from sub-slab air to indoor air is utilized, a cancer risk greater than an estimated one-in-ten-thousand risk of getting cancer was determined to exist for one sub-slab sample result. This 10 percent reduction assumption estimates the indoor air concentration of trichloroethylene to be 600 µg/m^3 in a home with a sub-slab air sample of 6,000 µg/m^3 trichloroethylene. This estimated level of trichloroethylene within indoor air has not been verified and is far greater than the highest level of trichloroethylene found within indoor air in homes that were sampled. This would seem to indicate that this 10 percent reduction assumption is too generous of an assumption.

Community Health Concerns

It is IDPHs understanding the community is concern about the current public health impacts of the Former Chamberlain Manufacturing Site and the potential public health impacts as this site is developed. The IDPH understands that the City of Waterloo is considering several potential uses

for the site property – recreational use, commercial or light industrial use, or residential use. The information presented within this health consulting can be used to evaluate these public health concerns. When evaluating these public health concerns it is necessary to evaluate the possibility of exposure to chemicals of concern for each of these potential site uses. This health consultation concludes that the only potential risk of exposure to site chemicals of concern comes from direct exposure to site soils and from exposure to vapor intrusion into homes and businesses. Protection of the public health can be achieved by either reducing the levels of chemicals of concern or by eliminating exposure to these contaminants of concern.

Conclusions

The following conclusions can be made from an evaluation of the current and potential exposure to site contaminants:

- There are no current or potential public health risks from any site contaminants or concern that are present within on-site or off-site groundwater since this groundwater is not currently utilized or is not planned to be utilized as a source of potable water.

- It is anticipated that there will not be any adverse public health impacts from exposure to surface soil when considering future recreational, commercial or light industrial, and residential uses of the Former Chamberlain Manufacturing Site.

- There is most likely no adverse public health impacts from exposure to volatile chemicals within indoor air of residential or commercial properties that currently exist or will be constructed on or near the Former Chamberlain Manufacturing Site. Using the assumption of a 10 percent reduction from sub-slab air to indoor air utilized by EPA seems to indicate a cancer concern in one of the homes from exposure to trichloroethylene, but this 10 percent reduction assumption may be too conservative and may not present the true risk of exposure to trichloroethylene in this home.

Recommendations

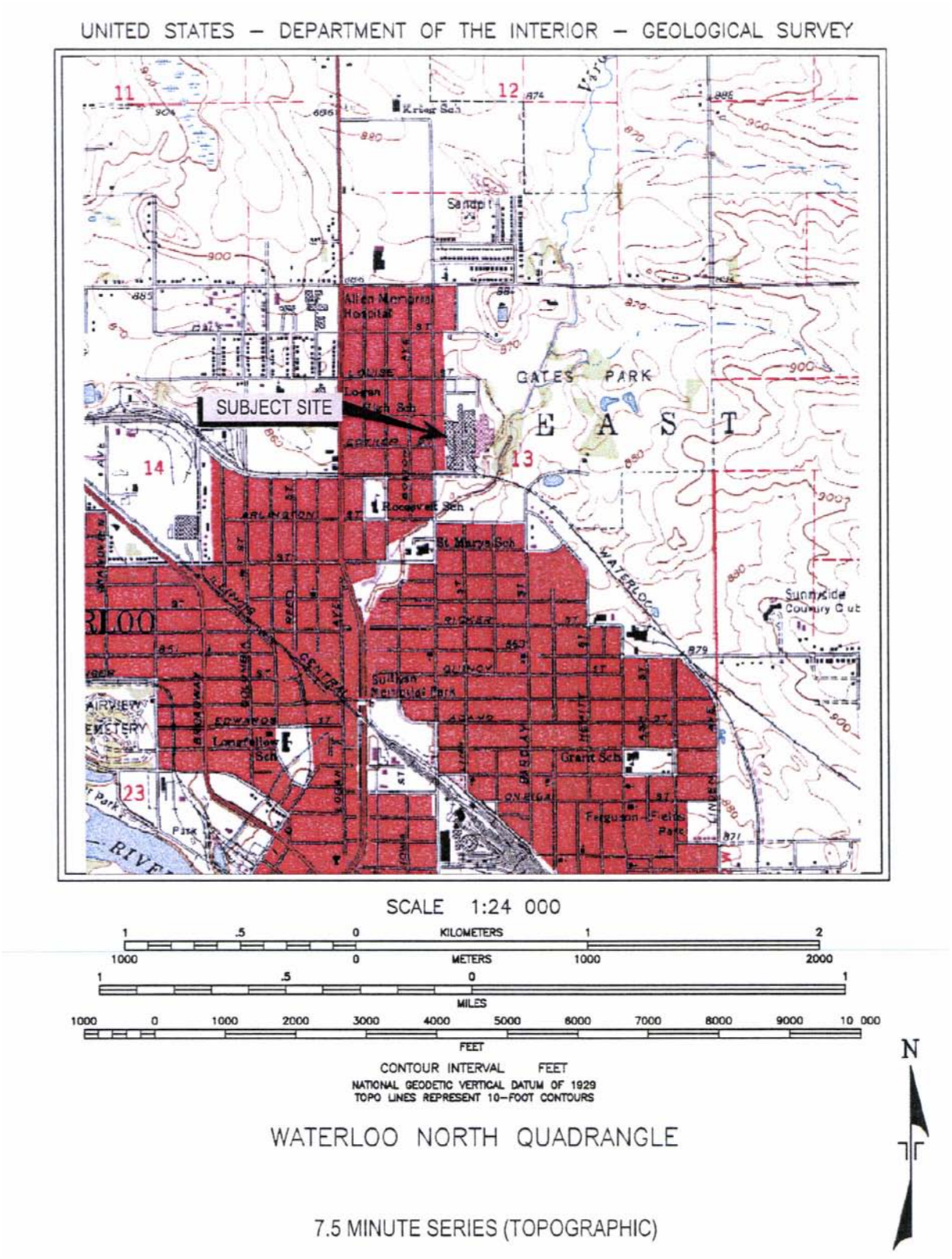
Public health risks from exposure to volatile chemicals from vapor intrusion into buildings at or near the Former Chamberlain Manufacturing Site are unlikely, but additional data are required before a more definitive determination can be made. Additional data would include measurement of the concentration of chemicals of concern within indoor air of additional homes. If vapor intrusion is determined to pose an unacceptable exposure threat based on additional data, risks can be eliminated by installing vapor intrusion mitigation systems. These systems can be active systems similar to radon mitigation systems, or passive venting systems in new building construction. Vapor intrusion mitigation systems could also be installed as a precautionary measure, in lieu of conducting further assessment of indoor air within homes located near the site.

The development of the Former Chamberlain Manufacturing Site in a manner that would be protective of public health can be accomplished by either eliminating exposure to chemicals of

concern or by reducing the levels of chemicals of concern below levels that can impact human health. The following are activities that should be considered by the City of Waterloo in their determination of use of the Former Chamberlain Manufacturing Site.

- For recreation use, the following activities could be completed to allow use of the site without adversely impacting public health:
    - As a precautionary measure, buildings or shelters constructed on the site could be equipped with vapor mitigation systems to prevent the potential for vapor intrusion of volatile chemicals
- For residential use, the following activities could be completed to allow use of the site without adversely impacting public health:
    - As a precautionary measure, homes built on the site could be equipped with vapor mitigation systems to prevent the potential for vapor intrusion of volatile chemicals.
- For commercial or light industrial use, the following activities could be completed to allow use of the site without adversely impacting public health:
    - As a precautionary measure, buildings built on the site could be equipped with vapor mitigation systems to prevent the potential for vapor intrusion of volatile chemicals.

Figure 1 – Location of Former Chamberlain Manufacturing Site



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