Health Consultation

CEDAR SERVICE SITE

CITY OF MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA

EPA FACILITY ID: MND982074544

MAY 22, 2006

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

Health Consultation: A Note of Explanation

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

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

You May Contact ATSDR TOLL FREE at
1-888-42ATSDR
or
Visit our Home Page at: http://www.atsdr.cdc.gov

HEALTH CONSULTATION

CEDAR SERVICE SITE

CITY OF MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA

EPA FACILITY ID: MND982074544

Prepared by:

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

FOREWORD

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

- *Evaluating exposure:* MDH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is found on the site, and how people might be exposed to it. Usually, MDH does not collect its own environmental sampling data. Rather, MDH relies on information provided by the Minnesota Pollution Control Agency (MPCA), the Minnesota Department of Agriculture (MDA), the US Environmental Protection Agency (EPA), private businesses, and the general public.

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

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

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

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

Summary

The Cedar Service site is contaminated with wood treatment products from a former wood treatment operation, primarily pentachlorophenol (PCP), polynuclear aromatic hydrocarbons (PAHs), and dioxins/furans. Residual contaminated soil remains at the site at depth, and is also present at the surface in some areas, although exposure is likely minimal. Groundwater is heavily contaminated with PCP on and off the site. Some groundwater is used for industrial or commercial purposes, and users of the groundwater may be exposed to PCP. The public health hazard from exposure to contaminated soil and groundwater is indeterminate at this time.

I. Site Background and History

The Cedar Service site is located at the southeast corner of the intersection of St. Anthony Boulevard and University Avenue in Northeast Minneapolis. The site occupies approximately 22 acres of relatively flat land within the much larger Shoreham Yard railroad facility that is currently owned and operated by the Soo Line Railroad Company (Soo Line), a business unit of the larger Canadian Pacific Railway (CP Rail). The eastern part of the site is currently used for storage of intermodal shipping containers, and has been covered with gravel. The remainder of the site is vacant land. The area around the site is primarily used for commercial/industrial purposes, although a golf course and park are located northeast of the site. The nearest residences are located approximately 1/3 mile to the west, across University Avenue. The Mississippi River is located approximately 2/3 mile to the west. The location of the site is shown in Figure 1.

Cedar Service, Inc. (previously known as Scott Pole and Treating Co.) operated at the site from 1926 to 1972 (Barr 1996). The company was involved in wood treating operations at the site using creosote (until the mid-1960s); later pentachlorophenol (PCP) mixed with fuel oil was used. The company used a variety of steel-lined concrete tanks and vats for their operations in a main process area on the western part of the site, and also stored untreated poles at the site. Treated wood was typically shipped out to customers by rail, and not stored on site. The layout of the site while it was in operation is shown in Figure 2.

Around 1961, it was reported that approximately 30,000 gallons of PCP wood treatment fluid were spilled when a truck accident caused a pipe rupture at the PCP pump house located at the southern end of the wood treatment area (Barr 1996). The spilled PCP reportedly flowed south toward a low area. Details regarding the spill and the response to it are not available.

Cedar Service, Inc. ceased operation at the site in 1972, and the structures associated with the operation were demolished in 1973. Cedar Service, Inc. reportedly buried between 8,000 and 10,000 gallons of wood treatment sludge on the property (Starns 2005). The former main process area remains vacant.

The Minnesota Pollution Control Agency (MPCA) conducted an initial site investigation in 1989 that consisted of five soil borings in the main process area (Barr 1996). PCP was detected in soil

samples from each of the soil borings, and petroleum-related contaminants were also found in some of the soil samples. Subsequent investigations have shown that PCP is present in shallow and deep groundwater at high concentrations at the site, and the area of PCP contamination in groundwater extends some distance off the site to the south. A number of wells that serve mainly industrial processes at businesses located south of the site have been impacted by PCP contamination.

In February 2004, Minnesota Department of Agriculture (MDA) staff requested that MDH staff assist MDA staff in evaluating the potential public health concerns associated with the site. In the preparation of this report, MDH consulted with local residents, a community group (the Shoreham Area Advisory Committee, or SAAC), as well as staff from the MDA, Minnesota Pollution Control Agency (MPCA), the City of Minneapolis, and Soo Line.

Geology/Hydrogeology

Surficial soils at the site are mixed sand and fill material, generally four to six feet thick (Golder Associates 2005a, 2006a). The sand and fill materials are underlain by 60 to 200 feet of complex unconsolidated sediments and alluvial deposits, primarily poorly graded sand with variable amounts of silt, gravel, clay and mixtures of the three (Barr 1996, Golder Associates 2005b). Clay till layers have been encountered on the western boundary of the site at depths of 30 to 45 feet below ground. The uppermost bedrock formations beneath the site are the St. Peter Sandstone (consisting of an upper sandstone unit above a lower mudstone unit) and Prairie du Chien Dolomite (limestone). A bedrock valley trending northeast to southwest exists in the area of the site. In this valley, the St. Peter Sandstone has been eroded away so that the Prairie du Chien Dolomite is the uppermost bedrock.

The uppermost groundwater at the site is present at depths between 36 and 42 feet (Barr 1996). Groundwater flow in the unconsolidated soils above the bedrock has been described as occurring in flow zones based on their different hydraulic properties (AMEC 2005a; IT 2001). However, it is more generally more accepted practice to consider groundwater flow in terms of the unconsolidated sediments and bedrock units.

Groundwater flow has been characterized by measuring ground water levels in the numerous monitoring wells installed at and near the site. Based on measurements collected in 2004 and 2005 (AMEC 2005a, Golder Associates 2006a), groundwater flow in the unconsolidated sediments beneath the site appears to be to the south, and divides to flow around a groundwater 'mound' at the southwest corner of the site. Groundwater flow in the bedrock units (the St. Peter and the upper Prairie du Chien) is generally to the south.

Groundwater level measurements collected in nested wells (several wells in the same location completed at different depths) also indicate a strong downward vertical gradient at the site, so that groundwater also flows from shallow unconsolidated sediments toward the deeper bedrock units. Groundwater flow at and near the site can be characterized as complex, in part due to the complex geology and in part due to the presence of a buried bedrock valley.

Soil Investigations and Response Actions at the Site

The first large-scale investigation at the site was conducted in 1995 by Barr Engineering Company on behalf of Soo Line (Barr 1996). It involved test trenches to investigate shallow soil contamination, and soil borings to investigate deeper soil contamination. Thirty-five soil samples were analyzed at the Barr office using an immunoassay method for PCP, selected petroleum-related volatile organic compounds (VOCs), and total polynuclear aromatic hydrocarbons (PAHs). These compounds were selected to be representative of past chemical use at the site. Creosote was the original wood treatment chemical used; PAHs were a main constituent of creosote. Later, PCP dissolved in light fuel oil was used, and therefore analysis for PCP and petroleum related VOCs is representative.

While the immunoassay analytical method is now accepted by EPA, it may not have been considered valid by EPA at that time. Immunoassay methods, which rely on an antigen-antibody response to PCP and a number of other chlorophenols, may be not be as accurate for PCP due to cross reactivity with the other chemicals. The same is true for immunoassays for other chemicals such as PAHs. Six of the 35 soil samples were also analyzed at a separate fixed laboratory using standard laboratory analysis methods. The soil boring/test trench locations are shown in Figure 3, and the data are presented in Table 1. A comparison of the two sets of data was performed to develop a rough correlation factor between the data from the two analytical methods. The correlation factor was then used to estimate an "equivalent laboratory concentration" for the samples that were analyzed by immunoassay only. That value is also shown in Table 1. It appears that the correlation was uneven at best.

Soil contamination was found in two distinct areas: the former process area, and a small fill area (the north disposal area) located just north of the former process area. Shallow soils (less than 10 feet deep) were found to be contaminated with PCP at concentrations as high as 1,300 milligrams per kilogram (mg/kg) based on immunoassay analysis, and total PAH concentrations were as high as 1,000 mg/kg. Soil samples from the deeper soil borings (10 to 34 feet below ground) showed lower concentrations of PCP and total PAHs, with maximum values of 22 mg/kg and 75 mg/kg respectively based on immunoassay analysis. Soil samples collected from below the water table (at depths greater than 34 feet) also showed contamination, with PCP levels as high as 250 mg/kg and total PAH concentrations as high as 630 mg/kg based on immunoassay analysis. Concentrations of petroleum-related VOCs were lower based on immunoassay analysis.

The above values generally exceed soil evaluation criteria developed by the MPCA known as Soil Reference Values (SRV) and Soil Leaching Values (SLVs). The SRVs represent the concentration of a contaminant in soil at or below which normal dermal contact, inhalation, and/or ingestion are unlikely to result in an adverse human health effect, while the SLVs represent the concentration of a contaminant in soil above which leaching could contaminate the groundwater to levels above established standards. The current SRV for PCP is 6 mg/kg based on a residential land use, and 120 mg/kg based on a commercial/industrial land use (MPCA 2005). The current SRV for total PAHs (expressed as benzo(a)pyrene equivalents; see below) is 2 mg/kg based on a residential land use, and 3 mg/kg based on a commercial/industrial land use.

The SRV for benzene, the most toxic petroleum-related VOC measured, is 6 mg/kg based on a residential land use, and 10 mg/kg based on a commercial/industrial land use. The current generic SLVs for PCP, benzene and total PAHs are 0.034 mg/kg (both benzene and PCP) and 10.2 mg/kg, respectively. The results of the Barr investigation showed that a significant area of soil contamination, extending to below the water table was present at the site in at least two locations, and that groundwater at the site had been severely impacted by site contaminants (see below).

In 1997, Soo Line proposed a Corrective Action Plan (CAP) to address the soil contamination at the site (Barr 1997). Prior to implementing the CAP, surface soil samples were collected from two locations at the site and five soil borings were advanced to collect sub-surface soil samples to further characterize soil contamination. Samples collected from the soil borings were screened (visually and using field instruments) for the presence of PCP and oil contamination, and the two surface soil samples and two sub-surface soil samples thought to be most contaminated were analyzed in a laboratory for dioxins and furans, which are known contaminants of PCP (see below). One subsurface sample was collected from soil boring SB-1 at a depth of 10.6 to 12 feet. This samples was designated sample SB-1-6, and had a strong odor and heavy oil sheen. The other subsurface sample (designated SB-5-C) was a composite of multiple samples from soil borings SB-3, SB-4, and SB-5 that appeared the most heavily contaminated, and no to weak odor, and only a trace of oil sheen. The surface soil sample and soil borings locations are shown in Figure 4.

Dioxins and furans were detected by fixed laboratory analysis in all four of the soil samples. The results of the dioxin/furan analyses are presented in Table 2a. Surface soil sample SS-1 (collected in the former process area) had the highest TCDD-TEQ estimate, 18.29 micrograms per kilogram of soil (ug/kg). The other surface soil sample (SS-2) was collected in the former pole storage area. Results are reported for individual dioxin and furan congeners, as well as in 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalents as determined using the most recent World Health Organization dioxin toxicity equivalency (TEQ) factors from1998. This scheme normalizes the toxicity of individual dioxin and furan congeners to TCDD, which is considered the most toxic dioxin/furan, to produce a total estimate of the risk of the dioxin/furan mixture.

The concentration of dioxins and furans, as expressed in TCDD-TEQ, exceeded the current MPCA SRVs for dioxin of 0.020 ug/kg for residential land use, and 0.035 ug/kg for industrial land uses (MPCA 2005). ATSDR has also developed a “Decision Framework For Dioxin Contaminated Sites” to assist health professionals in evaluating various actions based on TCDD-TEQ concentrations in environmental media (ATSDR 1997). The ATSDR framework uses a variety of evaluation criteria for dioxins in soil, ranging from a screening concentration of 0.050 ug/kg to an “action level’ of 1 ug/kg in soil. MDH has recommended use of the 0.050 ug/kg screening concentration as a recommended cleanup level at other dioxin-contaminated wood treatment sites (MDH 2002; MDH 2003). EPA also has an initial action level for dioxins in soil of 1 ug/kg for residential sites, and 5 to 20 ug/kg for commercial/industrial sites (EPA 1998).

Because of the high levels of PCP present in soils on the site the selected remedy for the CAP was excavation of the shallow (less than 12 feet in depth) contaminated soil for off-site disposal as a hazardous waste. The selected cleanup goal was 150 mg/kg of PCP, based on the potential for direct human contact (note that SRVs were not available at that time). Areas identified as exceeding this value are shown in Figure 4. This value was developed by MPCA staff at the request of MDA staff, and is close to the current MPCA SRV of 120 mg/kg for industrial land use. It was recognized that this cleanup goal was not protective of groundwater, as significant amounts of contaminated soil would remain at the site at depths below 12 feet.

In 1997, approximately 12,200 tons of contaminated soil were excavated and removed from the site for transport (by rail) to an out-of-state land disposal facility. The excavations, which ranged in depth from one to 12 feet, were generally expanded outside the originally identified areas shown in Figure 4 based on the results of confirmatory testing. The confirmatory testing did show some areas of PCP contaminated soil (up to 400 mg/kg) remained at depths of 12 feet but the majority of the contaminated soil identified in previous investigations (and described by the data in Tables 1 and 2a) was removed from the site (IT 2001). The outlines of the final excavated areas are shown in red in Figure 5. The excavations were backfilled with 2,800 tons of amended soil (containing low concentrations of PCP mixed with soil amendments and microbial nutrients to speed degradation) that was then covered with 9,400 tons of clean fill (Golder Associates 2005a). It was thought that the removal of the PCP contaminated soil and the use of soil amendments would also act to reduce PCP concentrations in groundwater over time.

A recent review of historic air photographs and anecdotal information suggests that several other areas of the site may have been used for waste disposal (Golder Associates 2005a). These areas were the subject of further soil investigation in 2005. The investigation included the collection of soil samples from 11 initial and 31 additional “step-out” soil borings in the former process area, the north disposal area, and other areas of the site to determine the nature and extent of residual PCP contamination in these areas (Golder Associates 2006c). All soil samples were analyzed in the field for PCP via an EPA-approved immunoassay analysis (EPA SW-846 Method #4010); all positive samples for PCP or, in the absence of PCP contamination, the shallowest sample from each boring location were also analyzed in a fixed laboratory for PCP and other semi-volatile compounds such as PAHs. Six samples plus one duplicate sample were also analyzed in a laboratory for dioxins and furans. The soil boring locations and PCP results are shown in Figure 5; the dioxin data are presented in Table 2b. Note that the 2005 soil investigation was focused on characterizing any remaining potential contaminated areas based on historical evidence, and is not an attempt to characterize the entire site. The eastern side of the site has been covered with gravel and is heavily used for intermodal container operations, which makes access difficult and limits potential for exposure (see Figure 5).

The 2005 soil investigation showed that several areas of PCP contaminated soil remain at the site, both at the surface and at depth. PCP was detected in 30 of the 42 soil borings done at the site. The highest levels of PCP were found near the former process area, and PCP in four surface soil samples exceeded the MPCA commercial/industrial SRV. Overall, there was good correlation between the field analysis for PCP and the fixed laboratory analysis. Total PAHs

(expressed as benzo(a)pyrene equivalents) exceeded the MPCA commercial/industrial SRV of 3 mg/kg in 14 soil samples, including six surface soil samples. Three locations where PAHs exceeded the SRV were not locations where PCP exceeded the SRV. Dioxin and furan results were generally similar to the 1997 results, ranging from 0.0072 ug/kg to 9.15 ug/kg (as expressed in TCDD-TEQ). The dioxin/furan data appears to correlate well with PCP levels at the same location, indicating that the PCP is the likely source of the dioxin/furans. In addition, the congener profile of the dioxins and furans generally matches the profile associated with the occurrence of dioxins/furans as impurities in PCP (EPA 2000).

Groundwater Investigation on and off the Site

Since site investigation activities began, numerous monitoring wells have been installed on and off the site to evaluate groundwater conditions. These include monitoring wells installed at the Cedar Service site, on the adjacent Dworsky Barrel site, and elsewhere on the Soo Line Shoreham Yards property. Five monitoring wells were originally installed by Barr in 1995 to evaluate groundwater quality (Barr 1996). PCP was detected at a concentration of 8,400 micrograms per liter (μg/L) in MW-101, which was installed in the former process area. PCP was found at very low levels in two other monitoring wells. Total PAHs were reported at a concentration of 6,200 μg/L in MW-101, and were below detection limits in the other four wells. Low levels of several petroleum-related VOCs were also found in MW-101, but not in any of the other monitoring wells. The locations of all monitoring wells at and near the site can be found in Figure 6.

The MDH Health Risk Limit (HRL) for PCP in water is 3 μg/L based on theoretical cancer risk; no HRL exists for total PAHs. The HRLs represent levels of contamination in drinking water supplies that MDH considers acceptable for daily human consumption over a lifetime, and are promulgated rules. The MDH Health-Based Value (HBV, essentially a site-specific guideline that has not been promulgated as rule) for total PAHs is 0.05 μg/L based on the cancer potency of benzo(a)pyrene as described on the EPA Integrated Risk Information System (IRIS) website (accessible at http://www.epa.gov/iris/). The HBV assumes that the PAHs are all benzo(a)pyrene. HRLs or HBVs for carcinogens are based on a calculated cancer risk of no more than one case per 100,000 exposed people for a lifetime.

In 1997, a water sample collected from monitoring well MW-126, located just south of the former process area, was analyzed for dioxins and furans. The results of the analysis are presented in Table 3. The concentration of dioxins and furans, expressed as TCDD-TEQ, was 6.83 picograms per liter (pg/L). The PCP concentration in the sample was 3,900 μg/L. Details such as whether the sample was filtered are not known. This could have affected the dioxin/furan concentration as these compounds would be expected to bind to micro particulates in the water. There is no state HRL for dioxins and furans. The EPA has established a Maximum Contaminant Limit (MCL) for public water supplies for 2,3,7,8-TCDD of 30 pg/L. The EPA Office of Water has recommended health advisory values for 2,3,7,8-TCDD of 40 pg/L based on non-cancer effects and 2 pg/L based on cancer effects (EPA 2004a). EPA also recommended a health advisory value of 1,000 pg/L that is designed to be protective based on a one-day exposure.

According to the most recent annual groundwater monitoring report, as of 2005, the monitoring well network used to evaluate groundwater consisted of 69 monitoring wells both on-site and off-site at the adjacent McFarland-Dworsky barrel site and other areas (Golder Associates 2006a). The wells are completed at various depths in the unconsolidated overburden and various bedrock units.

The most recent groundwater monitoring event occurred in November 2005, when samples were collected from 46 monitoring wells (Golder Associates 2006a). The groundwater samples were analyzed for the presence of PCP, ten PCP-related breakdown products, and a number of inorganic parameters. The groundwater data are presented in Table 4.

PCP was detected in most of the wells sampled; the highest concentration, 20,000 μg/L, was found in MW-126. PCP breakdown products were also detected in some wells, at much lower concentrations. Only one of the PCP breakdown products was detected at a concentration in excess of its respective HRL, although HRLs exist for only two of the ten compounds (2,4,6-trichlorophenol and 2,4-dichlorophenol). Toxicological information on which to base HRLs or Health-Based Values (HBVs, essentially unpromulgated HRLs) is currently unavailable for most of the other PCP breakdown products, with the exception of 2,4,5-trichlorophenol and 2,3,4,6-tetrachlorophenol. MDH is in the process of developing HBVs for those two compounds. The areas that have historically shown the highest concentrations of PCP in groundwater are in the area of monitoring wells MW-101 and MW-121 in the former process area, and the MW99-129/139/149 well nest located south and west of the former process area.

The PCP results have been roughly stratified and plotted by the depth of well completion, and are presented in Figures 8 and 9. In the unconsolidated sediment wells, the highest level of PCP observed (20,000 μg/L) was in MW-126, south of the former process area. The map shows concentrations of PCP in excess of 100 μg/L extending south of the Cedar Service site boundary; the full extent of the contamination is not shown.

High levels of PCP contamination also occur in the lower (mudstone unit) St. Peter aquifer, and the contamination is extensive. The highest level of PCP in the St. Peter (11,000 μg/L) was observed in MW03-59-MS, south of the former process area. High concentrations of PCP (in excess of 1,000 μg/L) have been found in monitoring wells located over 1,000 feet south of the Soo Line Shoreham Yard property, at depths of approximately 160 feet below grade. The full extent of the groundwater contamination in the lower St. Peter has not been defined, but extends at least 3,000 feet south of the site.

Lower levels of PCP have been detected in the underlying Prairie du Chien formation. The maximum level of PCP detected in the Prairie du Chien was 1,100 μg/L in MW03-59-OPD. The extent of PCP contamination in the Prairie du Chien is still being defined. In 2004, PCP was detected at a concentration of 35 μg/L in a monitoring well (MW03-55-OPD) not normally considered part of the Cedar Service Site monitoring network. The monitoring well was sampled for PCP as a part of a broader investigation of groundwater quality in the Prairie du Chien

aquifer south of the Soo Line Shoreham Yard Facility (AMEC 2005b). This investigation showed that the Prairie du Chien monitoring wells south of the Cedar Service site also typically contain low levels of volatile organic compounds (VOCs) such as trichloroethene (TCE), and petroleum products. Levels of TCE and petroleum products in some monitoring wells exceed their respective HRLs or HBVs. This contamination may originate from former railroad maintenance and chemical-related business operations located on the east side of the Soo Line Shoreham Yard facility, or from other sources.

In late 2005, two additional well nests were installed south of the site to characterize PCP contamination in the deeper aquifers. The well nests are located roughly at the intersection of 17th Avenue NE and 2nd Street NE (MW05-67-MS, OPD) and at the intersection of 13th Avenue NE and Monroe Street NE (MW05-68-MS, OPD). The wells were sampled in February 2006. Preliminary results for PCP are 1.2 μg/L in MW05-67-OPD and 47 μg/L in MW05-68-OPD. MW05-68-OPD is approximately 1.5 miles southeast of the former Cedar Service site.

Groundwater investigations continue to focus on determining the full geographic extent of the groundwater contamination rather than focusing on trends in the contamination over time. While in general PCP concentrations in groundwater both on and off the site have not varied significantly since the soil removal actions in 1997, levels have decreased in some of the wells and increased in others. An increase in the concentration of PCP daughter products in some wells may indicate that the PCP is degrading naturally, or as a result of the introduction of soil amendments in the backfill used in the soil removal in 1997 that were designed to speed biological degradation of PCP.

Beginning in 1998, samples have been collected for analysis for PCP from several commercial wells located south of the site by MDA, or by Soo Line at the direction of MDA. The wells, locations, and the PCP result are listed in Table 5, and locations are shown in Figure 7. High levels of PCP (well in excess of the HRL) have consistently been detected in samples from wells located at three businesses south of the site: Jax Café (a restaurant), Hard Chrome (a metal plating company), and Universal Plating (also a metal plating company). PCP was detected at a low level (only slightly in excess of the HRL) in one sample from a former General Mills building southeast of the site, and a 'suspect' detect was reported at a private well located south of the site. This well has subsequently been abandoned. The highest levels have been detected at Universal Plating, which had a maximum PCP detection of 422 μg/L in April 2004. The Jax Café and Universal Plating wells are completed in the Prairie du Chien aquifer (and possibly the lower portion of the St. Peter), while the former General Mills well is completed in both the Prairie du Chien and underlying Jordan aquifers. The well at the Hard Chrome facility is open to both the St. Peter and Prairie du Chien aquifers.

The well at Jax Café is used seasonally to provide water for an outdoor artificial trout stream (see description below). Since 2003, water samples from Jax Café have typically been collected by MDA staff at the well, at the front end of the stream, and at the base of the stream just prior to discharge. The samples are analyzed for PCP and various breakdown products of PCP. Historical data from these three monitoring points are presented in Table 6. The well at Jax Café

is reportedly not used for any other purpose than the trout stream. Trout from the stream are not used for food.
On March 10, 2005, the MDA issued a Request For Response Action (RFRA) for the site to CP Rail. The RFRA, which is an enforceable order, establishes the actions MDA believes are needed to investigate and remediate the remaining contaminated soil at the site, and groundwater contamination both on and off-site. It also establishes a schedule for conducting these activities, and describes potential penalties for failure to meet the schedule established in the RFRA. CP Rail has continued to conduct the activities laid out in the RFRA on a voluntary basis.

Site Visit

On April 23, 2004, September 15, 2005, and April 14, 2006 MDH staff accompanied MDA on visits to the Cedar Service Site in Northeast Minneapolis. The purpose of the visits was to become familiar with the site and the area around it, and to assist MDA in the collection of water samples from wells located south of the site for analysis for PCP and related chlorophenols by the MDA lab.

The site visits typically began at Jax Café, located at 1928 University Ave NE. MDH and MDA staff talked briefly with the staff, and then proceeded to the outdoor garden where an artificial stream containing live trout is located. The trout stream is fed by a dedicated well (Unique Well #200256), which is only turned on for the season (roughly April to October) according to the maintenance supervisor. PCP has been detected in the well for a number of years (see Tables 4 and 5). Samples were collected from the end of the stream (just prior to its discharge to the sanitary sewer), from the base of the waterfall where the water enters the stream, and from the wellhead itself. Prior to reaching the top of the waterfall from the well, the water passes through a 6-foot tall treatment tower made of buckets and 'wiffle-ball' type media. This simple device has been shown to reduce the PCP concentrations by about half, based on the results of sampling, by 'stripping' the PCP out of the water and into the air. The trout, which come from the Star Prairie, Wisconsin trout farm, have been doing well according to the maintenance supervisor.

Prior to leaving the site, it was confirmed with the head chef that the trout from the stream are not being served to the public.

During the 2004 site visit, staff next proceeded to Gluek Riverside Park, located at 2104 Marshall Street NE. MDH and MDA staff were met by a maintenance staff person from the Minneapolis Parks and Recreation Board, who had made the well (Unique Well #439817) ready for sampling by attaching the pump handle. The well was pumped for several minutes to flush it, and a water sample was collected for PCP analysis. The handle was then removed from the well. Gluek Riverside Park is closed pending removal of asbestos contamination that originated from the nearby Western Mineral Products vermiculite plant (EPA 2005). The well had been closed due to the presence of vinyl chloride at concentrations above the MCL from an unknown source (MDH 2005a). The MCL is the applicable standard as the well is considered a public water supply.

Next, MDH and MDA staff visited the Hard Chrome facility at 2631 2nd Street NE. The facility

is a large plating shop. The well on the site is used for process rinse water and cooling only, and is not used for potable purposes, according to the manager. Dermal contact with the process water is likely infrequent, as the plating baths are typically caustic and/or contain high concentrations of metals in solution. Employees appeared to avoid contact, and wore protective equipment (i.e., heavy rubber gloves, boots, and aprons). The process water is treated by the facility's wastewater treatment system prior to discharge to the sanitary sewer.

MDH and MDA staff also visited Universal Plating at 1900 Monroe St NE. This operation is smaller than, but similar to Hard Chrome. Water from the well (Unique Well #175857) is used for process water and for cooling during the summer months. There also appears to be little opportunity for dermal contact with the water at this facility, and the well is not used for potable water supply. The well water is ultimately run through the facility's wastewater treatment system prior to discharge to the sanitary sewer.

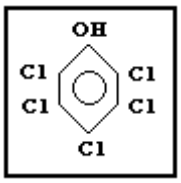
The Cedar Services site itself consists of a grassy area at the northwest corner of the Soo Line Shoreham Yard facility. The soil at the site is sandy, with tall grass over most of the original site area. Small pieces of wood (possibly old railroad ties) are visible in several areas. There is little else of note at the site except a number of monitoring wells that are visible. While the site is accessible, there is little at the site to attract visitors or trespassers (with the possible exception of the rail operations themselves), and no physical hazards (other than frequent truck and rail traffic) were apparent. A large sign at the entrance road to the facility states that it is CP Rail property and that trespassing is not allowed.

Public Comment Period

A draft version of this document was made available for public comment from December 8, 2005 until April 25, 2006. Four comments were received. A summary of the comments, and how they were addressed is attached as Appendix 1.

II. Discussion

Pentachlorophenol (PCP) is a white, crystalline solid that has been one of the most widely used chemicals for the preservation of wood products such as utility poles, fence posts, railroad ties, and other common industrial wood products. Beginning in 1936, it was widely used as an insecticide, fungicide, herbicide, molluscicide, and algicide in a wide variety of products and applications (ATSDR 1994, EPA 2004b). Because of its widespread use, PCP is common in the environment, and is found across the United States in surface waters, sediments, rainwater, groundwater, soils, food, and living organisms, including humans. Historically it has been estimated that volatilization from the surface of PCP-treated wood products results in the release of as much as 760,000 pounds of PCP to the air per year in the U.S. (ATSDR 1994). The chemical structure of PCP, which consists of five chlorine atoms and a hydroxyl group attached to a benzene ring, is shown below.



Chemical Structure of PCP

In the environment, PCP may adsorb to soils depending on the pH of the soil and its organic matter content. The amount of PCP adsorbed at a given pH increases with increasing organic content of the soil (ATSDR 1994). PCP is more mobile in soil under neutral or alkaline conditions, and adsorption is minimal at pH values above 6.8. PCP is broken down by microorganisms in the soil, and biodegradation is thought to be the major pathway of PCP degradation in the environment. PCP can also be degraded by sunlight, however (EPA 2004b). In groundwater systems, PCP has been shown to be capable of being degraded by indigenous soil microbes. In a laboratory study using contaminated groundwater from a former wood treatment site, Schmidt et al (1999) demonstrated a reduction of PCP in the groundwater from a maximum of 405 μg/L to <2 μg/L with the addition of oxygen, and regardless of the concentration of typical microbial nutrients.

PCP is considered a semi-volatile compound, and has a low vapor pressure. As such, volatilization from contaminated water and soil would not be expected to be a significant source of exposure under normal conditions (ATSDR 1994). PCP does volatilize from treated wood surfaces, however. PCP may also have the ability to bioaccumulate, or build up, in the tissues of animals (such as fish) exposed to it (EPA 2004b). It has not been shown to become further concentrated in animal tissues as it moves up the food chain, however.

In humans, PCP is readily absorbed through inhalation and ingestion (ATSDR 1994, Proudfoot 2003, Radon et al 2004) but is less easily absorbed through the skin. In aqueous solution, it has been estimated that only 10% - 20% of PCP can be absorbed through the skin (ATSDR 1994). However, in the presence of oils or other solvents, the absorption of PCP through the skin can be greatly increased (Baynes et al 2002). Once absorbed, most PCP binds to plasma proteins and is slowly metabolized by the liver (ATSDR 1994). The primary route of PCP elimination is through the urine.

In humans, short-term exposure to PCP in the workplace is associated with adverse effects to the kidneys, blood, lungs, nervous system, immune system, and gastrointestinal tract (ATSDR 1994). It can also cause a potentially serious increase in body temperature as the body attempts to metabolize it (Proudfoot 2003). Dermal contact can irritate the skin, eyes, and mouth. These types of adverse effects are usually only seen as a result of workplace exposures, which can be severe. Long-term exposure to low levels of PCP can cause damage to the liver, kidneys, blood, and nervous system. PCP is considered a probable human carcinogen by the U.S. EPA (ATSDR 1994). Some of the adverse effects associated with exposure to PCP may be caused by impurities present in commercially produced PCP. Typically, commercial grade PCP was approximately 86% pure (Proudfoot 2003). Impurities included other polychlorinated phenols, polychlorinated dibenzo-p-dioxins, and polychlorinated dibenzofurans. In PCP treated wood

products, one study showed that the concentrations of dioxins were closely related to the concentration of PCP (Fries et al 2002). In 1986, however, EPA executed an agreement with the wood preservative industry severely restricting the amount of impurities allowed in commercial PCP (EPA 2004b).

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (collectively referred to as dioxins) are the PCP impurities of most concern. The polychlorinated dibenzo-p-dioxins include 75 individual compounds, and the polychlorinated dibenzofurans include 135 individual compounds. These compounds are technically referred to as congeners. During PCP production, a variety of different congeners were typically formed, with dioxins and furans containing six, seven, and eight chlorine atoms making up by far the highest proportion of the congeners produced and dioxins being present in much greater proportion than furans (EPA 2000; Fries et al 2002). The proportion of dioxin congener groups found in soil samples at the site closely follows the typical congener profile for PCP (EPA 2000). However, it is unknown whether PCP and dioxin occurrence at the site are correlated.

One dioxin congener (2,3,7,8 TCDD) is thought to be the most toxic and has been studied extensively. Not all dioxins and furans are as toxic as TCDD, but all are thought to cause adverse effects through the same mechanisms. Penta- and hexachloro-dioxins with chlorine atoms in the 2, 3, 7 and 8 positions appear to have similar toxicities, while other dioxins that do not have chlorine atoms in those positions are relatively less toxic (ASTDR 1998).

Polynuclear aromatic hydrocarbons (PAHs) are produced by the incomplete combustion of organic materials such as coal, oil, wood, tobacco, and even food products (ATSDR 1995). They are also found in such products as asphalt, coal tar, creosote, and roofing tar. As a result, they are very common in the environment from such processes as volcanic eruptions, forest fires, home wood burning, and vehicle exhaust. Over 100 PAHs have been identified, and they are usually found in the environment as mixtures. PAHs generally fall into two groups based on their potential health effects: those that are carcinogenic (cancer causing, known as cPAHs), and those that are not (non-carcinogenic PAHs, or nPAHs). The PAHs found on the site are likely present as a result of the use of creosote in wood treatment. Creosote itself is usually derived from coal tar, and is described as a thick, oily liquid that is amber or black in color, and contains hundreds or even thousands of different chemicals including PAHs and phenols (ATSDR 1996). It has been in use as a wood preservative and waterproofing agent for over 100 years.

PAHs tend to bind to soil particles, especially organic matter, and therefore tend to remain in soils and sediments. Because of their affinity for organic matter, PAHs can accumulate in aquatic and terrestrial organisms, but unlike PCP, can become concentrated as they move up the foodchain (ATSDR 1995). This effect is somewhat balanced by the ability of many organisms, such as fish, to metabolize PAHs. In soil, PAHs can be broken down by microorganisms. The rate and extent of biodegradation can be influenced by environmental factors, the composition of the soil, the type of microbes present, the presence of other toxic compounds, and the properties and concentrations of the mixture of PAHs present (ATSDR 1995).

Individual cPAHs are classified as probable or possible human carcinogens by the International Agency for Research on Cancer (IARC) (ATSDR 1995). Exposure to high levels of PAHs in general has also been associated in animals with reproductive difficulties and adverse effects on the skin and immune system. Adverse effects on the liver and gastro-intestinal tract have also been noted. While PAHs have not been the main focus of investigation at the site, they are likely present in soil in the same places that PCP is detected.

Exposure to Contaminated Soil at the Site

The soil excavation conducted by Soo Line in 1997 resulted in the removal of approximately 12,200 tons of PCP contaminated soil, including the most contaminated areas described above and in Tables 1 and 2. The contaminated soils were excavated to a depth of 12 feet, with a cleanup goal of 150 mg/kg of PCP. While this cleanup action removed a large amount of contaminated soil, it remains at the site at depths below 12 feet in the excavation area. Contaminated soil remains at the surface elsewhere on the site where people could come into contact with it, including at least eight sample locations where the concentration of site related contaminants exceeded the MPCA commercial/industrial SRVs. Surface soils on the eastern part of the site (now used for intermodal container operations) have been covered with gravel fill.

Given the current status of most of the site as vacant land, separated from populated areas by a main highway and Soo Line property, it is unlikely that people are being exposed to contaminated soil on a regular basis. Employees at the shipping container operation on the eastern side of the site are unlikely to be regularly exposed to contaminants in surface soil because of the extensive gravel cover placed in that area. However, employees or other people (railfans, graffiti artists, or homeless people) may occasionally visit or trespass on the site. The MPCA has developed an SRV of 6 mg/kg for PCP based on incidental ingestion exposure of a large amount of soil by a child (MPCA 2005). While this in unlikely to occur in such a setting, it indicates that exposure over even short periods to contaminated soil in certain areas of the site could pose a health risk in certain circumstances. The contaminated soil at depth at the site is a continuing source of groundwater contamination, and the soil could be brought to the surface if the site is ever redeveloped for another use.

Exposure to Contaminated Groundwater

Groundwater contamination from the prior use of the site as a wood treatment operation is extensive, both in terms of the concentration of PCP in the groundwater and in terms of the size of the area and number of aquifers that have been impacted. PCP has been found at concentrations as high as 20,000 μg/L in the former process area on the site. High concentrations of PCP (in excess of 1,000 μg/L) have been found in monitoring wells located over 1,000 feet south of the Soo Line Shoreham Yard property, and the contamination extends at least 3,000 feet south of the site. Lower levels of PCP have been detected in the underlying Prairie du Chien formation, a regional aquifer, with a maximum level of PCP found in the Prairie du Chien of 1,100 μg/L. These concentrations are far in excess of the MDH HRL of 3 μg/L. Groundwater resources in the area have been significantly degraded by the extensive PCP contamination resulting from the Cedar Service site and other sources of PCP contamination. Repeated well searches in the area of the Soo Line Shoreham Yard facility have not identified

any private wells that are still in use for drinking water purposes (AMEC 2004; Golder Associates 2006b). A possible shallow residential well located south of the site was sampled prior to its abandonment in 2000; it showed only a trace of PCP. While the presence of private wells in the area impacted by the PCP contamination in groundwater cannot be conclusively ruled out, it is unlikely. Homes in the area are all connected to the City of Minneapolis public water supply.

Dermal and inhalation exposure to PCP may be occurring at several businesses that have wells contaminated by PCP. PCP is considered to be semi-volatile; data collected from the well and trout stream at Jax Café show that PCP is being removed from the water as it travels from the well to the point it enters the sanitary sewer (see Table 6). Therefore, there may be some exposure to PCP volatilizing from the treatment tower and trout stream. The area is outdoors, so the PCP would be quickly dispersed. Some of the PCP loss from the stream may also occur from absorption by the trout or binding to sediments. In the past, trout from the stream were reportedly served to customers, and some exposure to PCP that was absorbed by the trout would have occurred. In a 1998 memorandum to MDA staff, MDH staff calculated that the health risk from eating the trout was minimal (MDH 1998).

Workers at the two plating shops using PCP contaminated water may be exposed through infrequent accidental skin contact or inhalation. The water used in the various plating baths is often agitated, which would increase the volatilization of PCP. The amount of exposure would depend on many factors. While the water use is mainly indoors, there is a considerable amount of ventilation in the facilities to reduce the humidity and maintain a comfortable and safe working environment. However, there is also nothing to prevent another business from constructing a commercial well in one of the contaminated aquifers and using the water in other ways that would lead to more frequent, or more intense exposure to PCP.

The water pumped by the various businesses with impacted wells is ultimately discharged to the regional sanitary sewer system. PCP discharged to the sanitary sewer system should be broken down during wastewater treatment, and the concentration of PCP is within guidelines established by the Metropolitan Council, who operates the regional sanitary sewer system (ATSDR 1994; Cathy Villas-Horns, Minnesota Department of Agriculture, personal communication, 2006).

Dioxins have been detected in groundwater in one sample collected just south of the former process area. Migration of dioxin from contaminated soils to groundwater via colloidal transport can occur (EPA 2004b). The presence of other compounds, such as petroleum oils that were typically used as carriers for PCP, may also influence the movement of dioxins through soil. Dioxins have been detected in groundwater at other wood treatment sites, including a PCP-using pole treating operation located in the state of Idaho (EPA 2002). Dioxins have also been detected in groundwater at a former wood treatment site in northern Minnesota, the St. Regis site in Cass Lake (MDH 2005b).

Because of their much different physical properties (mainly their greater affinity for binding to organic matter), dioxins would not be expected to migrate as PCP does in groundwater systems. While their maximum travel distance has not been fully described in the literature, their behavior

in groundwater systems would likely be similar to that of PAHs. PAHs were detected in the most contaminated well in the former process area on the site (MW-101), but were not detected in other nearby monitoring wells. This indicates that their ability to migrate in groundwater is restricted. The low dioxin concentration (6.83 pg/L) but relatively high PCP concentration (3,900 μg/L) detected in the one sample from MW-126 analyzed to date for dioxins also supports the conclusion that PCP migrates much more easily than dioxins in groundwater. Therefore, dioxins may be a potential concern only if the most contaminated groundwater on site is disturbed or used in some way.

Child Health Considerations

ATSDR and MDH recognize 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 hazardous substances. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are smaller than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children also weigh less, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

At this time children are unlikely to be exposed to contaminants at or from the site. There is little to attract children to the site, and children should avoid the site in any event due to the frequent truck and rail traffic. Opportunities for exposure to contaminated groundwater are presently limited to several industrial facilities and a restaurant. Children could be exposed if they play in the artificial stream at Jax Café, but such exposure would be of short duration and unlikely to be of health concern.

III. Conclusions

The Cedar Service site remains heavily contaminated with wood treatment products, primarily pentachlorophenol (PCP) and polynuclear aromatic hydrocarbons (PAHs). Dioxin contamination at the site appears to correlate with the occurrence of PCP. Residual contaminated soil remains at the site at depth, and site-related contaminants exceed appropriate screening values at the surface in several areas. Groundwater is heavily contaminated with PCP on and off the site. Exposure to contaminated soils is likely minimal, but could occur. Some exposure to PCP from the use of contaminated groundwater in several commercial wells near the site is likely occurring, but is difficult to quantify. The Cedar Service site therefore represents an indeterminate public health hazard.

IV. Recommendations

1. People should follow posted signs and avoid trespassing on the Cedar Service site.
2. Site investigation activities, including groundwater monitoring should continue until the extent of contamination has been fully defined.
3. Remedial actions should be implemented to address areas of contaminated soil at the site that exceed MPCA commercial/industrial SRVs for site-related contaminants.
4. Any resident of the communities near the Soo Line Shoreham Yard facility who has an operating private well should contact MDH, MDA, or MPCA staff so that a water sample from the well can be collected and analyzed for the presence of contaminants from the Soo Line Shoreham facility.
5. MDA should ensure that any operating commercial or industrial wells located within one mile south of the site that have not been previously sampled be sampled for site-related contaminants.
6. Employees of businesses with wells impacted by PCP should avoid prolonged skin contact with the contaminated well water.

V. Public Health Action Plan

MDH's Public Health Action Plan for the Cedar Service site consists of continued consultation with MDA staff on environmental sampling and analysis, communication of the results to neighborhood residents near the site, and participation in any planned public outreach activities. MDH is also in the process of establishing a Special Well Construction Area to prevent future exposure to contaminants in groundwater from the site.

VI. References

AMEC 2004. Groundwater Receptor Survey Report, Shoreham Facility. AMEC Earth & Environmental, Inc. Minneapolis, MN, January 23, 2004.

AMEC 2005a. 2004 Groundwater Monitoring and Additional Site Investigation Report – Cedar Service Site. AMEC Earth & Environmental, Inc. Minneapolis, MN, March 28, 2005.

AMEC 2005b. 2002-2004 Shallow Prairie Du Chien Aquifer Investigation Report – East Side Shoreham Facility and Cedar Service Site. AMEC Earth & Environmental, Inc. Minneapolis, MN, February 2005.

ATSDR 1994. Toxicological Profile for Pentachlorophenol. Agency for Toxic Substances and Disease Registry, Atlanta, GA. May 1994.

ATSDR 1995. Toxicological Profile for Polycyclic Aromatic Hydrocarbons. Agency for Toxic Substances and Disease Registry, August 1995.

ATSDR 1996. Toxicological Profile for Creosote. Agency for Toxic Substances and Disease Registry, August 1996.

ATSDR 1997. Dioxin and Dioxin-like Compounds in Soil, Part I: ATSDR Interim Policy Guideline. Agency for Toxic Substances and Disease Registry. At: http://www.atsdr.cdc.gov/dioxindt.html. August 21, 1997.

ATSDR 1998. Toxicological Profile for Chlorinated Dibenzo-p-Dioxins. Agency for Toxic Substances and Disease Registry, Atlanta, GA. December 1998.

Barr 1996. Remedial Investigation Report – Cedar Service Wood Treating Site. Barr Engineering Company, Minneapolis, Minnesota, February 1996.

Barr 1997. Corrective Action Plan – Zone 1, Cedar Service Site. Barr Engineering Company, Minneapolis, Minnesota, July 1997.

Baynes, R.E., Brooks, J.D., Mumtaz, M., and Riviere, J.E. 2002. Effect of chemical interactions in pentachlorophenol mixtures on skin and membrane transport. Toxicological Sciences 69: 295-305.

EPA 1998. Approach for Addressing Dioxin in Soil and CERCLA and RCRA Sites. Memorandum from Timothy Fields, Jr. U.S. Environmental Protection Agency, April 13, 1998. OSWER Directive 9200.4-26

EPA 2000. Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) and Related Compounds, SAB Review Draft. U.S. Environmental Protection Agency, September 2000. Document No. EPA/600/P-00/001Bg.

EPA 2002. Environmental Fact Sheet – Poles, Inc. Site, Oldtown, Idaho. U.S. Environmental Protection Agency Region 10, Seattle, WA. September 2002. Accessed online at http://yosemite.epa.gov/R10/CLEANUP.NSF.

EPA 2004a. 2004 Edition of the Drinking Water Standards and Health Advisories. U.S. Environmental Protection Agency, Office of Water, Washington, D.C. Winter 2004.

EPA 2004b. Pentachlorophenol: Risk Assessment and Science Support Branch's Preliminary Risk Assessments and Science Chapters in Support of the Reregistration Eligibility Decision. U.S. Environmental Protection Agency, Office of Prevention, Pesticides, and Toxic Substances, Washington, D.C. EPA Docket OPP-2004-0402. Accessed online at http://docket.epa.gov/edkpub/do/EDKStaffCollectionDetailView?objectId=0b0007d4804d65f5

EPA 2005. Pollution Report #41 for the Western Mineral Products – Gluek Park site. U.S. Environmental Protection Agency, Region V, Chicago, IL. August 20, 2005.

Fries, G.F., Feil, V.J., Zaylskie, R.G., Bialek, K.M., and Rice, C.P. 2002. Treated wood in livestock facilities: relationships among residues of pentachlorophenol, dioxins, and furans in wood and beef. Environmental Pollution 116: 301-307.

Golder Associates 2005a. Remedial Investigation Workplan for On-Site Contaminated Soil, Cedar Service Inc. Site. Golder Associates Inc., Cherry Hill, New Jersey. May 2005.

Golder Associates 2005b. Remedial Investigation Report for the East Side Shoreham Facility. Golder Associates Inc., Cherry Hill, New Jersey. February 2005.

Golder Associates 2006a. 2005 Annual Groundwater Monitoring Report, Cedar Service, Inc. Site. Golder Associates Inc., Cherry Hill, New Jersey. March 2006.

Golder Associates 2006b. Extended Groundwater Receptor Survey, Shoreham Yard. Golder Associates Inc., Cherry Hill, New Jersey. January 30, 2006.

Golder Associates 2006c. Remedial Investigation Report, On-Site Contaminated Soil, Cedar Service Inc. Site. Golder Associates Inc., Cherry Hill, New Jersey. April 2006.

IT 2001. Request for Site Closure, Shoreham Facility – Cedar Service Site. IT Corporation, New Brighton, Minnesota, August 1, 2001.

MDH 1998. Memorandum from Patricia McCann, MDH, to Michele Puchalski, MDA regarding Jax Café. Minnesota Department of Health, St. Paul, Minnesota. November 13, 1998.

MDH 2002. Public Health Assessment, Joslyn Manufacturing and Supply Company Site, West Area, Brooklyn Center, Minnesota. Minnesota Department of Health, St, Paul, Minnesota. August 29, 2002.

MDH 2003. Health Consultation for the St. Regis Paper Company Site, Cass Lake, Minnesota. Minnesota Department of Health, St, Paul, Minnesota. August 28, 2003.

MDH 2005a. Health Consultation for the Van Waters & Rogers Site, Minneapolis Minnesota. Minnesota Department of Health, St, Paul, Minnesota. April 4, 2005.

MDH 2005b. Public Health Assessment Groundwater, Surface Water, and Sediments at the St. Regis Superfund Site, Cass Lake, Minnesota. Minnesota Department of Health, St, Paul, Minnesota (in press).

MPCA 2005. Soil Reference Value Updates. Memorandum from Laura Solem, Ph.D., dated September 7, 2005. Available on the MPCA web site at http://www.pca.state.mn.us/publications/srv-update-0905.pdf.

Proudfoot, A.T. 2003. Pentachlorophenol poisoning. Toxicological Review 22: 3-11.

Radon, K., Wegner, R., Heinrich-Ramm, R., Baur, X., Poschadel, B., and Szadkowski, D. 2004. Chlorophenol exposure in harbor workers exposed to river silt aerosols. American Journal Industrial Medicine 45: 440-445.

Schmidt, L.M., Delfino, J.J., Preston, J.F. III, and St. Laurent, G. 1999. Biodegradation of low aqueous concentration pentachlorophenol (PCP) contaminated groundwater. Chemosphere 38: 2897-2912.

Starns 2005. Letter from Byron E. Starns, Leonard, Street and Deinard to Commissioner Gene Hugoson, Minnesota Department of Agriculture, August 3, 2005.

Preparer of Report:

James Kelly, M.S.
Health Assessor
Site Assessment and Consultation Unit
Minnesota Department of Health
tel: (651) 215-0913
james.kelly@health.state.mn.us

CERTIFICATION

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

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

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

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

Appendix 1
Response to Public Comments

A draft of the Cedar Service site Health Consultation was made available for public comment from December 8, 2005 until April __, 2006. Four comment letters/e-mails were received. The original comments are available for review from MDH. The comments were addressed as described below. In addition, the document was modified to include soil and groundwater data that was not available at the time the original Health Consultation was prepared.

1. An e-mail was received from an official at Trimodal, who operates a container business on the eastern side of the Cedar Service site. The comment expressed concern for employees at the company who may be exposed to site contaminants. The comment was addressed in a response to the e-mail better describing the location of contaminated soil at the site and the fact that employees at the facility are unlikely to be directly exposed; further description was also added to the text of the document.

2. An e-mail was received from the Bottineau Neighborhood Association expressing concern regarding the fact that the Cedar Service site is just one of a number of sites that could impact Northeast Minneapolis, and that the document did not directly account for the possibility of exposures from multiple sources. It also expressed hope that cleanup of the site is completed promptly, at the cost of the responsible party. Because exposures to contaminants from the site are difficult to quantify, and other exposures are also not quantified, it is not possible at this time to evaluate the potential health effects of multiple exposures.

3. A formal comment letter was received from Golder Associates Inc., on behalf of Soo Line Railroad Company (dba Canadian Pacific Railway, CP Rail). The letter contained a number of comments, which can be grouped as follows:

    a. Several comments were related to the complex geology and groundwater flow at the site, and the fact that 2004 groundwater data was used in the report. Also, several clarifications were requested regarding the extent of PCP and VOC contamination in groundwater, and other possible sources of PCP. The document has been modified to reflect these changes, and the most recent (2005) groundwater data has been included (see Table 4, Figures 8 and 9).
    b. Several comments described soil investigation data (especially dioxin data) that was not available when the report was drafted. The data has been included in the final report, and the appropriate sections modified to reflect the new data.

4. An e-mail comment letter was received from a resident and community member with a long-standing involvement in environmental issues at the Soo Line Shoreham Shops. The comments fell into the following general categories:
    a. Several comments related to communication regarding public health issues, the need for a public meeting on the site, public education, and working with the City of

Minneapolis. MDH will continue to communicate the results of this Health Consultation, and will work with MDA and the City to ensure that citizens receive the appropriate information.

b. Public access to the Cedar Service site. The resident pointed out that access to the site is unrestricted, and that it may be a popular area for railfans, graffiti artists, or the homeless. The document has been modified to reflect the potential exists for exposure to these groups.
c. The resident expressed concern regarding the potential for inhalation exposure by people working or visiting the three businesses who use water from wells contaminated with PCP. The document acknowledges that such exposures may occur, but are difficult to estimate and are likely to be minor.
d. A comment was made regarding blood testing for contaminants of concern in people who may have been exposed to contaminants from the site. Due to the lack of certainty regarding exposure to contaminants from the site, and the fact that blood testing cannot identify the source of exposure, it is not warranted at this time.
e. Another comment expressed concern regarding the multiple number of sites and contaminant sources in Northeast Minneapolis, and that the document did not discuss or evaluate exposures from multiple sources. Again, because exposures to contaminants from the site are difficult to quantify, and other exposures are also not quantified, it is not possible at this time to evaluate the potential health effects of multiple exposures.
f. Concern was expressed about the lack of HRLs or HBVs for some of the contaminants found in groundwater at the site, and in off-site wells. MDH is in the process of developing HBVs for all compounds found in groundwater and wells at the site for which toxicological information is available.
g. A comment was made regarding the perceived uncertainty regarding the breakdown of PCP discharged to the sanitary sewer during wastewater treatment. The document has been modified to remove the uncertainty. PCP, at the concentrations found in the impacted off-site wells, will be fully degraded during wastewater treatment. The concentration of PCP in the wells is well below discharge limits established by the Metropolitan Council.
h. The final comments expressed concern over the possible impact of PCP discharges to the Mississippi River. Evaluating the possible ecological impact on the river is beyond the scope of this document. Discharge of PCP contaminated groundwater at the concentrations likely to be found at the river would be of minimal public health concern due to natural degradation of PCP in the river, dilution, and other natural processes.

Table 1

1995 Soil Investigation Data

(in mg/kg)

Sample Location	Depth	BTEX[1]		Pentachlorophenol (PCP)			PAHs		
		IA[2]	Lab[3]	IA	Lab	Lab Eq.[4]	IA	Lab	Lab Eq.
TT 101	6	**65**		89		31	**>500**		**>68**
TT 102	1	<0.5		38		13	**55**		**11**
TT 102	1	**120**		**500**		**170**	**>500**		**>68**
TT 103	3	1.2		47		16	**80**		**16**
TT 103	1.5	**140**		**1250**		**430**	**1000**		**140**
TT 105	3.5	**64**		60		21	**840**		**110**
TT 106	3	1.7		5.6		<1.5	**930**		**130**
TT 108	4.5	**25**		**690**		**240**	**220**		**30**
TT 109	3	<1.0		19		3.1	**61**		**12**
TT 110	7	0.7		0.65		<1.5	**4.1**		0.82
TT 112	4	0.6		<0.15		<1.5	1.5		0.3
TT 113	2.5	**91**		**>510**		**>180**	**810**		**110**
TT 113	2.5	**180**		**>1300**		**>450**	**440**		**60**
TT 114	4.5	**97**	0.4	**600**	**130**	**210**	**370**	0.41	**51**
SB 101	34	<0.5		<0.05		<1.5	0.56		<0.3
SB 102	40	<0.5		<0.05		<1.5	**4.4**		0.88
SB 104	14	4.4	<0.05	22	8.4	7.6	**75**	<0.29	**<15**
SB 104	76	**14**	<0.05	11	1.8	1.8	**15**	3.2	**3**
SB 104	81	3		15		2.5	2		0.4
SB 105	8	1.3		1.5		<1.5	2		0.4
SB 105	14	0.7		3.6		<1.5	1.2		<0.3
SB 105	36	**100**	<0.05	**250**	**170**	86	**630**	**81**	**86**
SB 107	6	**12**		45		16	**64**		**13**
SB 107	10	<0.5		0.13		<1.5	<1		<0.3
SB 107	16	<0.5/0.5		0.13/0.58		<1.5	0.7/1.2		0.14
SB 109	40	0.5		<0.05		<1.5	0.86		0.17
SB 110	36	<0.5		25		4.1	**10**		2
SB 112	4	**89**		**930**		**150**	**750**		**102**
SB 113	34	**27**	<0.05	46	16	16	**334**	<3.2	**<46**
SB 114	38	<0.5	0.06	0.18	<1.7	<1.5	2.3	<0.33	<0.46
SB 115	44	<0.5		0.23		<1.5	2		0.4
SB 116	19	<0.5		<0.05		<1.5	0.13		<0.3
SB 116	28	<0.5		0.18		<1.5	1.7		0.34
SB 116	36	<0.5		<0.05		<1.5	0.5		<0.3
SB 116	42	**160**		2.4		<1.5	**620**		**85**
MPCA SRV (comm./industrial)		10[5]			120			3	

Bold exceeds current MPCA industrial Soil Reference Value (SRV, 9/05)

[1] sum of benzene, toluene, ethylbenzene, xylenes

[2] Immunoassay result

[3] Fixed laboratory result

[4] Estimated laboratory equivalent value

[5] SRV for benzene

Source: Barr 1996

Table 2a

1997 Dioxin/Furan Soil Data

Dioxin/Furan	1998 WHO TEF	SS-1 (ug/kg)	TCDD-TEQ (ug/kg)	SS-2 (ug/kg)	TCDD-TEQ (ug/kg)	SB-1-6 (ug/kg)	TCDD-TEQ (ug/kg)	SB-5-C (ug/kg)	TCDD-TEQ (ug/kg)
2,3,7,8-TCDD	1	0.007*	0.007	0.0072	0.0072	0.0011*	0.0011	0.0041*	0.0041
1,2,3,7,8-PeCDD	1	0.18	0.18	0.69	0.69	0.0038	0.0038	0.041	0.041
1,2,3,4,7,8-HxCDD	0.1	1.8	0.18	0.24	0.024	0.028	0.0028	0.23	0.023
1,2,3,6,7,8-HxCDD	0.1	18	1.8	1.2	0.12	2.1	0.21	8.9	0.89
1,2,3,7,8,9-HxCDD	0.1	2.1	0.21	0.37	0.037	0.095	0.0095	0.64	0.064
1,2,3,4,6,7,8-HpCDD	0.01	430	4.3	31	0.31	61	0.61	210	2.1
OCDD	0.0001	4600	0.46	340	0.034	710	0.071	1900	0.19
2,3,7,8-TCDF	0.1	0.81	0.081	0.0099	0.00099	0.064	0.0064	0.33	0.033
1,2,3,7,8-PeCDF	0.05	4.5	0.225	0.063	0.00315	0.31	0.0155	1.6	0.08
2,3,4,7,8-PeCDF	0.5	9.6	4.8	0.19	0.095	0.56	0.28	3.7	1.85
1,2,3,4,7,8-HxCDF	0.1	28	2.8	0.8	0.08	1.8	0.18	9.2	0.92
1,2,3,6,7,8-HxCDF	0.1	4.9	0.49	0.25	0.025	0.45	0.045	2.2	0.22
2,3,4,6,7,8-HxCDF	0.1	2.6	0.26	0.36	0.036	0.62	0.062	3	0.3
1,2,3,7,8,9-HxCDF	0.1	11	1.1	0.27	0.027	0.8	0.08	4.5	0.45
1,2,3,4,6,7,8-HpCDF	0.01	120	1.2	7.6	0.076	16	0.16	65	0.65
1,2,3,4,7,8,9-HpCDF	0.01	15	0.15	0.67	0.0067	1.6	0.016	5.7	0.057
OCDF	0.0001	420	0.042	38	0.0038	56	0.0056	410	0.041
Total TCDD-TEQs			**18.29**		**1.58**		**1.76**		**7.91**
MPCA - Residential SRV			0.02						
MPCA - Industrial SRV			0.035						
ATSDR Screening Level			0.05						
EPA Action Level			1.0						

*Non-Detect, reported as 1/2 of Detection Limit

Source: Barr 1997

Table 2b

2005 Dioxin/Furan Soil Data

Dioxin/Furan	1998 WHO TEF	SB05-37 0-2' (ug/kg)	TCDD-TEQ (ug/kg)	SB05-37 8-10' (ug/kg)	TCDD-TEQ (ug/kg)	SB05-37 12-14' (ug/kg)	TCDD-TEQ (ug/kg)	SB05-46 0-2' (ug/kg)	TCDD-TEQ (ug/kg)	SB05-50 0-2' (ug/kg)	TCDD-TEQ (ug/kg)	SB05-50 0-2' (ug/kg)	DUP TCDD-TEQ (ug/kg)	SB05-52 10-12' (ug/kg)	TCDD-TEQ (ug/kg)
2,3,7,8-TCDD	1	0.0245*	0.0245	0.001	0.001	0.0002*	0.0002	0.00051	0.00051	0.0185*	0.0185	0.009*	0.009	0.00021*	0.00021
1,2,3,7,8-PeCDD	1	0.125*	0.125	0.017	0.017	0.0005*	0.0005	0.0063	0.0063	0.09*	0.09	0.045*	0.045	0.0038	0.0038
1,2,3,4,7,8-HxCDD	0.1	0.81	0.081	0.18	0.018	0.0005*	0.00005	0.023	0.0023	0.63	0.063	0.66	0.066	0.19	0.019
1,2,3,6,7,8-HxCDD	0.1	9.9	0.99	1.7	0.17	0.0086	0.00086	0.14	0.014	5.7	0.57	6.2	0.62	1.2	0.12
1,2,3,7,8,9-HxCDD	0.1	2.2	0.22	0.26	0.026	0.0015	0.00015	0.04	0.004	0.44	0.044	0.47	0.047	0.096	0.0096
1,2,3,4,6,7,8-HpCDD	0.01	250	2.5	63	0.63	0.21	0.0021	3.3	0.033	150	1.5	150	1.5	48	0.48
OCDD	0.0001	2300	0.23	760	0.076	2.9	0.00029	38	0.0038	1600	0.16	1500	0.15	650	0.065
2,3,7,8-TCDF	0.1	0.079	0.0079	0.0035	0.00035	0.00017*	0.000017	0.00066	0.000066	0.57	0.057	0.63	0.063	0.039	0.0039
1,2,3,7,8-PeCDF	0.05	0.48	0.024	ND	ND	0.0005*	0.000025	0.0034	0.00017	3.2	0.16	3.1	0.155	0.24	0.012
2,3,4,7,8-PeCDF	0.5	3.1	1.55	0.19	0.095	0.0014	0.0007	0.012	0.006	6.6	3.3	7.2	3.6	0.45	0.225
1,2,3,4,7,8-HxCDF	0.1	15	1.5	1.4	0.14	0.008	0.0008	0.045	0.0045	13	1.3	16	1.6	1.8	0.18
1,2,3,6,7,8-HxCDF	0.1	2.1	0.21	0.23	0.023	0.0019	0.00019	0.018	0.0018	3.4	0.34	3.7	0.37	0.34	0.034
2,3,4,6,7,8-HxCDF	0.1	2.9	0.29	0.49	0.049	0.0085	0.00085	0.025	0.0025	4.2	0.42	4.3	0.43	0.46	0.046
1,2,3,7,8,9-HxCDF	0.1	2.7	0.27	0.55	0.055	0.0033	0.00033	0.0093	0.00093	6.3	0.63	7.2	0.72	0.67	0.067
1,2,3,4,6,7,8-HpCDF	0.01	88	0.88	19	0.19	0.078	0.00078	1.5	0.015	54	0.54	54	0.54	15	0.15
1,2,3,4,7,8,9-HpCDF	0.01	13	0.13	2.5	0.025	0.011	0.00011	0.01	0.0001	6	0.06	5.6	0.056	1.8	0.018
OCDF	0.0001	210	0.021	81	0.0081	0.28	0.000028	5.2	0.00052	89	0.0089	83	0.0083	62	0.0062
Total TCDD-TEQs			**9.05**		**1.52**		**0.01**		**0.10**		**9.26**		**9.98**		**1.44**
MPCA - Residential SRV			0.02												
MPCA - Industrial SRV			0.035												
ATSDR Screening Level			0.05												
EPA Action Level			1.0												

*Non-Detect, reported as 1/2 of Reporting Limit

Source: Golder Associates 2006c

Table 3

1997 Dioxin/Furan Groundwater Sample Data

Dioxin/Furan	1998 WHO TEF	MW-126* (pg/L)	TCDD-TEQ (pg/L)
2,3,7,8-TCDD	1	ND	
1,2,3,7,8-PeCDD	1	ND	
1,2,3,4,7,8-HxCDD	0.1	2.4	0.24
1,2,3,6,7,8-HxCDD	0.1	7.6	0.76
1,2,3,7,8,9-HxCDD	0.1	3.3	0.33
1,2,3,4,6,7,8-HpCDD	0.01	210	2.1
OCDD	0.0001	2200	0.22
2,3,7,8-TCDF	0.1	ND	
1,2,3,7,8-PeCDF	0.05	2.2	0.11
2,3,4,7,8-PeCDF	0.5	2.1	1.05
1,2,3,4,7,8-HxCDF	0.1	7.1	0.71
1,2,3,6,7,8-HxCDF	0.1	2.8	0.28
2,3,4,6,7,8-HxCDF	0.1	3	0.3
1,2,3,7,8,9-HxCDF	0.1	ND	
1,2,3,4,6,7,8-HpCDF	0.01	65	0.65
1,2,3,4,7,8,9-HpCDF	0.01	5.5	0.055
OCDF	0.0001	200	0.02
Pentachlorophenol		3,900	

* Sample Date 7/16/1997

Total TCDD-TEQs (pg/L)	**6.83**
EPA Maximum Contaminant Level (MCL)	30
EPA Drinking Water Exposure Limit (DWEL)	40
EPA Cancer Risk Health Advisory Value	2

Table 4

November 2005 Groundwater Data

(detections only, in ug/L)

Compound	MDH HRL	MW02-82-MS 11/14/2005	MW03-54-OPD 11/11/2005	MW03-59-I 11/14/2005	MW03-59-MS 11/14/2005	MW03-59-OPD 11/14/2005	MW03-63-OPD 11/3/2005	MW03-64-OPD 11/11/2005	MW04-38-MS 11/4/2005
Pentachlorophenol (PCP)	3	**930**	**26**	**5**	**11,000**	**1,100**	**6**	**74**	1
2,3,4,5-tetrachlorophenol		58	2	18	590	100		5	
2,3,4,6-tetrachlorophenol				4		12			
2,3,5-trichlorophenol									
2,3,6-trichlorophenol									
2,4,5-trichlorophenol									
2,4,6-trichlorophenol	30								
2,4-dichlorophenol	20								
3,4-dichlorophenol									
3,5-dichlorophenol									
3-chlorophenol									

Compound	MDH HRL	MW04-38-OPD 11/14/2005	MW04-39-MS 11/14/2005	MW04-40-MS 11/11/2005	MW04-41-MS 11/4/2005	MW04-41-OPD 11/7/2005	MW04-42-MS 11/11/2005	MW04-79-MS 11/10/2005
Pentachlorophenol (PCP)	3			**3,800**	**1,000**	3	**1,700**	**7,100**
2,3,4,5-tetrachlorophenol				320			84	490
2,3,4,6-tetrachlorophenol		4		14	68		46	
2,3,5-trichlorophenol				6				
2,3,6-trichlorophenol								
2,4,5-trichlorophenol							4	
2,4,6-trichlorophenol	30							
2,4-dichlorophenol	20		5					
3,4-dichlorophenol								
3,5-dichlorophenol								
3-chlorophenol								

Compound	MDH HRL	MW04-79-OPD 11/10/2005	MW04-151-MS 10/31/2005	MW04-153-MS 11/2/2005	MW-101 11/8/2005	MW-108 11/8/2005	MW-5 11/8/2005	MW-121 11/8/2005	MW-126 11/9/2005
Pentachlorophenol (PCP)	3	**9**			**1,200**	**6**	**5**	**19,000**	**20,000**
2,3,4,5-tetrachlorophenol					410			1,800	1,000
2,3,4,6-tetrachlorophenol					1,800			1,500	180
2,3,5-trichlorophenol					290			360	74
2,3,6-trichlorophenol					130				
2,4,5-trichlorophenol									
2,4,6-trichlorophenol	30								
2,4-dichlorophenol	20		**96**	4					
3,4-dichlorophenol									
3,5-dichlorophenol					57			42	26
3-chlorophenol									

Compound	MDH HRL	MW-128 11/10/2005	MW99-129 11/11/2005	MW99-133 11/11/2005	MW99-139 11/11/2005	MW99-146 11/9/2005	MW99-149 11/11/2005	MW99-541 11/11/2005
Pentachlorophenol (PCP)	3	**520**	**5,600**	**9**	**5,100**	**6**	**2,300**	**360**
2,3,4,5-tetrachlorophenol		100	230		220		140	26
2,3,4,6-tetrachlorophenol		13						
2,3,5-trichlorophenol			10	1				
2,3,6-trichlorophenol								
2,4,5-trichlorophenol								
2,4,6-trichlorophenol	30	3						
2,4-dichlorophenol	20							
3,4-dichlorophenol								
3,5-dichlorophenol								
3-chlorophenol								

MDH HRL = MDH Health Risk Limit

Source: Golder Associates 2006

Note: The following wells were sampled, but no PCP or daughter products were detected above the lab reporting limit:

Well Number	Date
MW01-01-BR	11/14/2005
MW02-82-T	11/7/2005
MW03-53-OPD	11/1/2005
MW03-59-T	11/7/2005
MW03-88-OPD	11/3/2005
MW04-151-MS	10/31/2005
MW04-151-OPD	11/1/2005
MW04-152-MS	11/2/2005

Well Number	Date
MW04-152-OPD	11/2/2005
MW04-152-T	11/2/2005
MW04-153-OPD	11/2/2005
MW04-34-MS	11/1/2005
MW04-42-OPD	11/11/2005
MW-106	11/8/2005
MW-136	11/14/2005
MW99-521	11/11/2005

Table 5

Off-site Wells Pentachlorophenol Data, in ug/L

	CP Rail-Jax Café	Jax Café-Jax Café	MDA-Jax Café	CP Rail-Hard Chrome	MDA-Hard Chrome	Gluek Park	Universal Plating	Sander & Co. (Gen. Mills)	Marshall Concrete	NSP	Sharon Ellis Res.
Unique No.	**200256**			**Not available**		**439817**	**175857**	**200264**	**200252**	**200258**	**255292**
Address	1928 University Ave NE			2631 2nd St NE		2104 Marshall St NE	1900 Monroe St NE	1620 Central Ave NE	2610 Marshall St NE	31st Ave NE & river	1813 2nd Ave NE
Date Sampled											
5/13/1998			53			ND					
5/26/1998			56								
5/26/1998	40		53.4								
6/5/1998				25							
6/29/1998			32.6								
8/27/1998					29.3						
10/9/1998	49										
7/2/1999			12.2		17.7	<0.2	203	<0.2	<0.2	<0.2	
3/30/2000		44									
6/6/2000											Suspect
9/18/2002		<1.2									
12/30/2002					114						
4/9/2003			161								
5/20/2003			195		102		293	3.92			
8/7/2003			110								
4/23/2004			152		98.7	<0.5	422				
9/28/2004			141		68.3		278				
4/13/2005			193		99.8		260				
9/15/2005			158		126		349				

ND = not detected above reporting limit

MDH HRL = 3 ug/L

Analysis by MDA lab unless noted otherwise

Source: MDA

Table 6

Jax Café Analytical Data

All results in ug/l

Sample Date:	**4/9/2003**		**5/20/2003**			**8/7/2003**			**4/23/2004**			**9/28/2004**			**4/13/2005**			**9/15/2005**			**MDH**
Sample Point:	**A**	**B**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**HRL**
Compound																					
Pentachlorophenol (PCP)	**161**	**141**	**195**	**161**	**88.3**	**110**	**75.5**	**76.5**	**152**	**118**	**89.8**	**141**	**154**	**55.8**	**193**	**144**	**82.2**	**158**	**118**	**37.7**	3
2,3,4,5-Tetrachlorophenol	6.30	5.80	2.55	2.19	1.65	2.07	1.93	1.08	5.60	4.80	1.27	2.66	2.16	<1.5	1.90	1.64	1.36	2.5	2.54	1.04	--
2,3,4,6-Tetrachlorophenol	26.2	23.1	17.9	14.4	9.33	9.07	8.10	6.17	26.4	22.0	6.83	10.5	8.69	4.54	13.4	11.8	9.18	7.19	8.4	3.52	--
2,3,5-Trichlorophenol	0.54	<0.50	PP	PP	PP	PP	PP	PP	PP	PP	PP	<1.5	<1.5	<1.5	PP	0.70	0.54	PP	PP	PP	--
2,3,6-Trichlorophenol	PP	PP	PP	PP	PP	PP	PP	PP	PP	PP	PP	<1.5	<1.5	<1.5	PP	PP	PP	PP	PP	PP	--
2,4-Dichlorophenol	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<1.5	<1.5	<1.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	20
2,4,5-Trichlorophenol	PP	PP	PP	PP	PP	PP	PP	PP	PP	PP	PP	<1.5	<1.5	<1.5	0.51	PP	PP	PP	PP	PP	--
2,4,6-Trichlorophenol	PP	<0.50	PP	<0.50	<0.50	PP	PP	PP	PP	PP	PP	<1.5	<1.5	<1.5	PP	PP	PP	PP	PP	PP	30
3-Chlorophenol	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<1.5	<1.5	<1.5	<0.5	<0.5	<0.5	PP	<0.5	<0.5	--
3,4-Dichlorophenol	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<1.5	<1.5	<1.5	<0.5	<0.5	<0.5	PP	<0.5	<0.5	--
3,5-Dichlorophenol	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<1.5	<1.5	<1.5	<0.5	<0.5	<0.5	PP	<0.5	<0.5	--

Key: **A** = Well **B** = Pond below waterfall at start of stream **C** = End of stream by water wheel

Bold indicates exceedance of MDH - Health Risk Limit (-- indicates no HRL available) Source: MDA

PP = compound detected in sample at concentration below its lab reporting limit

All samples collected and analyzed by MN Dept of Agriculture