Health Consultation

INTERPLASTIC CORPORATION:
REVIEW OF EMISSION TESTING DATA

CITY OF MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA

EPA FACILITY ID: MND006151336

MAY 2, 2005

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.

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Prepared By:

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MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA

MINNESOTA FACILITY ID: MND006151336

April 15, 2005

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FOREWORD

This document summarizes human health concerns related to data acquired during permit-required stack testing of the Interplastic NE Minneapolis facility. It is based on a formal evaluation prepared by the Minnesota Department of Health (MDH). A number of steps are necessary for this evaluation:

- **Evaluating exposure:** MDH scientists begin by reviewing available information about emissions from the facility and potential receptors. The first task is to review emissions data and dispersion analyses. Usually, MDH does not conduct our own environmental sampling data. We rely on information provided by the Minnesota Pollution Control Agency (MPCA), U.S. Environmental Protection Agency (EPA), and other government agencies, private businesses, and the general public.

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

- **Developing recommendations:** In the evaluation report, MDH outlines its conclusions regarding any potential health threat posed by emissions, and offers recommendations for reducing or eliminating human exposure to chemicals of concern. The role of MDH in dealing with individual sites is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies—including EPA and MPCA. However, if an immediate health threat exists, MDH will issue a public health advisory warning 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 cleaning up the site, and community 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 Specialist
Site Assessment and Consultation Unit
Minnesota Department of Health
121 East Seventh Place/Suite 220
Box 64975
St. Paul, MN 55164-0975

OR call us at: (612) 215-0778 ***or*** 1-800-657-3908
(toll free call—press "4" on your touch tone phone)

Summary

The Interplastic facility in Northeast Minneapolis received a total facility air permit that required characterization of emissions in 2000. This requirement was part of the permit because of concerns by the nearby community, including neighboring businesses, the Minnesota Pollution Control Agency (MPCA), and the Minnesota Department of Health (MDH), about the potential for adverse health effects that may accompany exposure to emissions. Testing and modeling of emissions was completed in the fall of 2004.

Chemicals emitted from the facility include: acetone, dicyclopentadiene (DCPD), 1,4-dioxane, ethyl benzene, ethylene glycol, maleic anhydride, methanol, methyl ethyl ketone (MEK), methyl methacrylate, nitrogen oxides, particulates (PM_{10}), phthalic anhydride, styrene, and xylene. When emissions of these chemicals were modeled by the MPCA (ISCST-Prime) to determine potential concentrations offsite, potential exposures to MEK is of concern for short-duration exposures; DCPD is of concern for intermediate-duration exposures, and; DCPD is also of concern for long term exposure. Furthermore, emissions of DCPD are likely to result in exposure to concentrations well above the odor threshold near the facility. These odor threshold exceedances extend to the boundaries of the model used for calculating emission dispersion. Long-term emissions of nitrogen oxides, while not likely to exceed the National Ambient Air Quality Standards by themselves, may significantly contribute to poor air quality in Northeast Minneapolis.

Neighboring businesses and visitors to the area near the facility are likely to be the most exposed individuals. It is assumed that there are no people living within ¼ mile of the facility, and residents living further than ¼ mile from the facility are expected to have much less exposure.

Since about 1998, significant improvements in controlling emissions have been made by Interplastic. Additional improvements could be achieved by raising the thermal oxidizer and scrubber stacks. This would further decrease potential exposures, especially for individuals close to the facility. Efforts should also be made to better reduce or control emissions when the thermal oxidizer is shutdown.

Introduction

The Minnesota Department of Health (MDH) was asked by the City of Minneapolis (Minneapolis), residents of the community near the Interplastic Corporation (Interplastic) and the Minnesota Pollution Control Agency (MPCA) to assist in evaluating emissions from the facility and their potential health impacts in the surrounding community.

Interplastic is a producer of unsaturated polyester resins in northeast Minneapolis, Hennepin County, Minnesota. The Interplastic facility is located at 2015 N.E. Broadway on land that was used as a dump and later for manufacturing. Currently, the site itself has relatively little exposed soil. The majority of the site is covered by buildings, pavement, gravel haul roads, and railroad spurs. Interplastic has operated at this location since 1966.

The area surrounding the site is zoned for light industry and manufacturing. The nearest residential areas are approximately 0.3 miles to the west and south (Figure 1). The residential area consists of fairly large, older, 2-story homes and streets covered by a canopy of trees, with local schools, and playgrounds/parks. About 850 people live within ½ mile of Interplastic, and about 13,000 live within a mile of the facility (1990 census). About 0.2 miles north of the site, in an area called 'The Quarry', there is a large retail and grocery shopping area.

Historically, there have been numerous complaints from the surrounding community about odors emanating from the Interplastic facility. MDH reviewed a number of these complaints in 2001 (MDH, 2001). Health complaints included: breathing problems, allergic reactions, and eye, nose and throat irritation. Generally, the complaints were thought to be related to the shutdown of the large thermal oxidizer (TO) that burns chemical emissions from manufacturing processes at the facility. However, in 1998, additional potential pollution sources were identified. These include a hotbox used to bake and solidify waste resins and the storm sewers that may have transferred some wastes or waste water offsite. The hotbox was connected to the thermal oxidizer, and manufacturing area access to the storm sewers was also restricted in 1998 (MPCA, 1998).

Emissions during Interplastic TO breakdowns or shutdowns are still a concern. When the TO isn't operational, emissions are shunted through a scrubber system to reduce emissions. The scrubber is much less efficient than the TO in reducing emissions of concern. Typically, the TO breaks down or is turned off about 3 times a year. However, there were 4 TO breakdowns between December 11, 2003 and March 16, 2004.

MDH has previously reviewed documents, permits and data on Interplastic at the request of the MPCA and Minneapolis. Documents on Interplastic authored by MDH include: a 1994 health consultation in response to a request from a resident on general issues of health concern (MDH, 1994a); comments on a 1994 Environmental Assessment Worksheet (EAW) for the City of Minneapolis (MDH, 1994b); a 1998 health consultation in response to a request from the MPCA to evaluate monitoring data from a single air release from the facility (MDH, 1998); a 1999 health consultation that evaluated the proposed Interplastic total facility air permit at the request of the MPCA (MDH, 2000), and; a 2001 health consultation reviewing MDH comments on the Interplastic total facility air permit and discussed the importance of modeling facility emissions (MDH, 2001).

This health consultation discusses emission modeling data acquired as a result of stack-testing provisions in the 2000 Interplastic total facility air permit, and potential health impacts of emissions on individuals near the facility. MDH has also written a summary of this health consultation in an Information Sheet titled: Interplastic Corporation: April 2005 Update (available under Interplastic at: http://www.health.state.mn.us/divs/eh/hazardous/sites/sitesbyname.html).

Chemicals of concern

Chemicals found to be emitted from Interplastic during stack testing in late October and early November 2001 are listed in Table 1. Available toxicity criteria for specific chemicals are also shown in Table 1. These chemicals account for about 95% of the total emissions from Interplastic (MPCA, 2005).

MPCA modeled facility emissions dispersion, using the ISCST-Prime model (see below) and determined that the chemicals of biggest concern (i.e. chemicals with the largest hazard quotients (HQs)) are: dicyclopentadiene (DCPD), nitrogen dioxide, maelic anhydride, phthalic anhydride, methyl ethyl ketone (MEK), styrene, methyl methacrylate, 1,4-dioxane and acetone (MPCA, 2005). Of these chemicals, DCPD emissions are of most concern because of its' toxicity and low odor threshold (Table 1). The HQ was determined by dividing the modeled air concentrations by the respective health-based value. HQs greater than 1 may be of health concern.

Dicyclopentadiene (DCPD)

MDH has a sub-chronic Health Risk Value for DCPD of 3 $\mu g/m^3$ (MDH, 2002). This criterion is supported by studies that have shown liver dysfunction in female mice, and blood pressure, CNS, kidney, pulmonary, spleen, liver and thyroid effects in rats (EPA, 1987; Dodd et al., 1982).

There is also a DCPD chronic reference concentration (RfC: 0.21 $\mu g/m^3$) available from the EPA Health Effects Assessment Summary Tables (HEAST: EPA, 1997). The HEAST criterion is based on the same sub-chronic studies as the HRV. MDH chose to develop a sub-chronic criterion because, given the available studies, a sub-chronic averaging time was determined to be appropriate. On the other hand, EPA does not typically establish sub-chronic criterion, so the HEAST chronic criterion was established. Typically when converting from a sub-chronic to a chronic duration, an uncertainty factor of 3 to 10 is applied (e.g. subchronic criterion / 10 = chronic criterion). This factor accounts for dose-response uncertainties when effects from a shorter study (sub-chronic) are interpolated to a longer duration exposure (chronic).

There are no criteria available for evaluating short-term exposure to DCPD. However, there are a few acute and sub-acute studies which identify health hazards associated with short-term exposures to DCPD. Kinkead et al. (1971) reported eye and throat irritation in one of two volunteers after seven minutes of exposure to 5 mg/m^3; diarrhea in a dog following three 7-hour exposures to 100 mg/m^3; and loss of hind-quarter control in dogs after sub-acute exposure to 250 mg/m^3 dicyclopentadiene. These studies support identification of dicyclopentadiene as a potential acute exposure hazard, but are not sufficient to develop an acute exposure criterion. MDH believes that 10 times the sub-chronic HRV (30 $\mu g/m^3$) is a safe acute exposure concentration for dicyclopentadiene. But available data do not support development of an acute criterion for purposes other than initial screening; somewhat higher concentrations might also be safe.

Dicyclopentadiene has a sweet but pungent odor, and the odor threshold for people is about 15 $\mu g/m^3$ (US Coast Guard, 2005). Odor and health complaints from businesses adjoining Interplastic are consistent with reports in the scientific literature about DCPD (Stillman, 2000). Some authors suggest that human exposure to dicyclopentadiene are self-limiting because of its low odor threshold and its noxious odor.

Nitrogen dioxide

Nitrogen oxide (NO_x) releases (as nitrogen dioxide) from Interplastic are from the burning of natural gas or propane primarily in the thermal oxidizer. Propane use results in greater NO_x emissions than natural gas. In urban areas, ambient NO_x concentrations may already approach the regulatory ceilings. Therefore, the addition of large quantities of NO_x from this facility contribute to general air quality concerns in Northeast Minneapolis.

The National Ambient Air Quality Standard for annual NO_x concentrations is 100 µg/m^3 (EPA NAAQS, 2004). This standard is not health-based, but is a legal ceiling. EPA will not be deriving an inhalation RfC for nitrogen dioxide because a National Ambient Air Quality Standard (NAAQS) is available (EPA IRIS, 2004). The California EPA has an acute criterion for NO_2 of 470 µg/m^3 (CA OEHHA, 2003).

Maelic anhydride and phthalic anhydride

Maelic anhydride and phthalic anhydride are emitted from Interplastic in significant quantities. Both anhydrides are reactive and are irritating to the eyes, skin, nose and respiratory system. The chronic RELs of 0.7 µg/m^3 and 20 µg/m^3 are the appropriate health criteria for long-term exposures to maleic anhydride and phthalic anhydride, respectively. While both compounds will also cause irritation over shorter time periods, there are no acute health criteria available to quantify hazards.

Styrene, methyl ethyl ketone (MEK), methyl methacrylate and acetone

Styrene, methyl ethyl ketone (MEK), methyl methacrylate and acetone are organic solvents that have general neurological effects and are also irritants. Excessive occupational exposure to styrene has also been shown to cause color-blindness which may, or may not, be reversible (Gong et al., 2002). Methyl methacrylate exposures may cause some liver and kidney concern (EPA, 1998). In addition, very high exposures to MEK may cause some developmental concerns (EPA, 2003). These 4 solvents have higher fenceline concentrations at Interplastic than all chemicals except NO_x.

Chronic criteria are available for all 4 solvents; and acute criteria are available for styrene and MEK (see Table 1). While methyl methacrylate is likely more irritating than the other solvents, there is no criterion with which to quantitatively evaluate acute exposures to methyl methacrylate.

1,4-dioxane

1,4-Dioxane (dioxane) has been classified as a probable human carcinogen by the US EPA (EPA IRIS, 2004), the International Agency for Research on Cancer (IARC, 1999), and the California Office of Environmental Health Hazard Assessment (CA OEHHA, 2002). A slope factor of 2.7 E-2 / (mg/kg/d) corresponds to an inhalation unit risk of 7.7 E-6 / (µg/m^3). Therefore, an ambient air concentration of 1.3 µg/m^3 over a lifetime will result in an incremental cancer risk of 1 in 100,000 (Table 1). MDH considers a calculated cancer risk of no more than 1 additional cancer per 100,000 people exposed for a lifetime to be negligible. The Human odor threshold for dioxane is also listed in Table 1 (620,000 µg/m^3: US Coast Guard, 2005) .

Sensitization

Following an initial large exposure to chemicals called sensitizers, smaller exposures may elicit an immune response in some individuals. Ambient air concentrations that trigger such a response may be well below levels that would affect non-sensitized individuals and may be below public health criteria as well. Maleic anhydride and phthalic anhydride are considered to be sensitizers (CA OEHHA, 2001; 2000a). In addition, methyl methacrylate (EPA, 1998; MDH, 2002) and styrene (CA OEHHA, 1999) may also be sensitizers. There is no indication that any individuals in the vicinity of Interplastic have suffered from a hyper-sensitive, immune-enhanced, or sensitized response to chemicals emitted from the facility.

Table 1

Compound (odor threshold - from CHRIS)	**Acute** health-based values - μg/m^3 (standards)	**Toxic Endpoint**	**Sub-chronic** health-based values - μg/m^3	**Chronic** health-based values - μg/m^3 (standards)	**Toxic Endpoint**
acetone (100 ppm - 370 mg/m^3)	63,000 - MRL	Neurological		31,000 - MRL	Neurological
dicyclopentadiene (0.003 ppm - 0.015 mg/m^3)			3 - HRV	0.21 - RfC - HEAST	Renal system, liver
1,4-dioxane (170 ppm - 620 mg/m^3)	3,000 - HRV	Irritant - eye and nasal		1.3 - CA OEHHA	Cancer
ethylbenzene (140 ppm - 620 mg/m^3)	10,000 - HRV	Reproductive / developmental	4400 - MRL	1,000 - RfC - IRIS	Developmental
ethylene glycol (odorless)	1300 - MRL	Renal		400 - REL	Respiratory system; kidney; development
maleic anhydride (0.32 ppm - 1.3 mg/m^3)				0.7 - REL	Respiratory system
methanol (100 ppm - 130 mg/m^3)	25,000 - HRV	Nervous system		4,000 - REL	Development
methyl ethyl ketone (MEK) (10 ppm - 30 mg/m^3)	10,000 - HRV	Irritant - eye and respiratory system		5,000 - RfC - IRIS	Developmental
methyl methacrylate (0.05 ppm - 0.2 mg/m^3)				700 - HRV	Upper and lower respiratory system
nitrogen oxides	470 - NO_2 REL	Respiratory irritant		(100 - NO_2 NAAQS)	
particulates (PM_{10})	(150 - 24 hr NAAQS)			(50 - NAAQS)	
phthalic anhydride (0.32 ppm - 2 mg/m^3)				20 - REL	Eye and respiratory system
styrene (0.15 ppm - 0.65 mg/m^3)	21,000 - HRV	Irritant - eye and respiratory system		1,000 - HRV	Nervous system
xylene (0.05 ppm - 0.22 mg/m^3)	43,000 - HRV	Irritant - eye and respiratory system	3100 - MRL	100 - RfC - IRIS	Impaired motor coordination

CHRIS - Chemical Hazards Response Information System (US Coast Guard, 2005).

HRV - MDH Health Risk Values are air concentrations that MDH has determined to be safe exposure levels for the general public, including sensitive individuals (MDH, 2002).

MRL - Minimum Risk Levels developed by ATSDR as safe exposure levels for the general public. Averaging times: acute (1 - 14 day exposures), intermediate (listed in table as sub-chronic: 14 - 364 day exposures) and chronic (365 or more days exposures) (ATSDR, 2004)

NAAQS - National Ambient Air Quality Standards (NAAQS) criteria are concentrations of specific pollutants, not to be exceeded from 0 to 3 times (standard dependent) during a specified averaging period (EPA NAAQS, 2004). (24-hour PM_{10} NAAQS is not to be exceeded 98 % of the time.)

REL - Reference Exposure Levels developed by the California Office of Environmental Health Hazard Assessment (OEHHA) as safe exposure levels for the general public, including sensitive individuals (CA OEHHA, 2000b; 2003; 2002).

RfC - IRIS - Reference Concentrations developed and peer-reviewed by the EPA as safe, chronic exposure levels for the general public, including sensitive individuals (EPA IRIS, 2004).

RfC - HEAST - Reference Concentrations developed by the EPA as safe, chronic exposure levels for the general public, including sensitive individuals (EPA, 1997)

Testing and modeling data

Stack testing data

Stack testing of the Interplastic facility was performed from October 29 through November 1, 2001. Emissions testing was designed to address a “worst case” condition.

Because Interplastic production is a batch process, this required staggering the start times of different batches. The MPCA observed the testing and used the data acquired during testing to calculate facility emissions. These emissions were used as inputs into the dispersion model that calculated likely Hazard Indexes and ambient air concentrations of chemicals of concern near the facility.

Dispersion model and model validation

Emissions from various sources, including stack (point) and fugitive (facility-wide) sources disperse into the air. This dispersion was modeled by the MPCA using a refined dispersion model, ISC-PRIME. The EPA provides recommendations on models at http://www.epa.gov/scram001/tt22.htm . EPA recommends using the ISC3 model for assessing "pollutant concentrations from a wide variety of sources associated with an industrial complex. This model can account for the following: settling and dry deposition of particles; downwash; point, area, line, and volume sources; plume rise as a function of downwind distance; separation of point sources; and limited terrain adjustment. ISC3 operates in both long-term and short-term modes." (EPA, 2005) The ISC3-PRIME model offers further refinement of building wake effects as described by the EPA at http://www.epa.gov/scram001/tt26.htm .

Validation of models is complex. Dispersion models can be biased with respect to actual ambient air concentrations, or they can have inappropriate sensitivity to variables. Monitoring data is restricted to the specific monitor location and the specific time and duration while the sample is collected. In addition, while models can predict concentrations in air below analytical detection limits, monitoring data is restricted to data above detection limits. The EPA has promulgated the use of the ISC3 model and has validated the ISC3-PRIME model. Additional information on the validation of these models can be found in Paine and Lew, 1997 and Pratt et al., 2004.

Inputs to the ISC-PRIME model of Interplastic emissions included: 1987 - 1991 meteorological data from the Minneapolis - St. Paul International Airport (about 7 miles south of the facility); stack and emissions data from the 2001 testing; and physical characteristics of the site.

Hazard Quotient and Hazard Indexes

Chemical concentrations obtained by modeling are divided by appropriate health criteria to determine a hazard quotient (HQ) for each chemical at a specific location. HQ's for chemicals with similar toxic endpoints are added to determine a potential hazard index (HI) at the location. If the HI is greater than 1, and an individual is at the location for an appropriate period of time, there is some potential for the exposed individual to experience adverse health effects.

Potential exposure pathways

Emissions from facilities are of concern to MDH when the concentration of toxic chemicals and the duration of exposure may result in a total exposure to individuals that exceed safe exposures. Interplastic is located in an area that is predominantly light industry and manufacturing. It is unlikely that there are any individuals within ¼ mile of

Interplastic 24 hours a day, 7 days a week. The people with the highest potential exposure within ¼ mile of Interplastic are likely workers at neighboring businesses. These individuals will have a completed exposure pathway during the hours that they are at work, and they are not assumed to be exposed to the chemicals of concern at Interplastic when they are not working.

Two types of modeling are described in the sections below: equivalent risk emission rate modeling (ERER), and fenceline modeling. Technical differences between the 2 models are also discussed in sections below. ERER modeling is used in this document primarily to describe potential exposures to residents (i.e. individuals who may be in a single location 24 hours a day, seven days a week year-round). Whereas, the fenceline model is used in this document to describe potential exposures to individuals working near the Interplastic facility.

The manufacturing process at Interplastic is a batch process, with some chemical use being dictated by customers. Therefore, it is possible that some chemicals may be substituted in different batches. For instance, MEK is sometimes substituted for a portion of the styrene used in the process. For potential acute exposures, the dispersion/hazard model inputs have been adjusted by adding MEK to the model and omitting "styrene as MEK" for batches using MEK (Table 2).

Equivalent risk emission rate modeling

Dispersion modeling has typically been conducted on individual chemicals. The maximum hazard quotients are then added to determine a maximum exposure hazard index - regardless of the time or location of each chemical's maximum concentration. In reality, if the maximum chemical concentration for 2 chemicals occur at different times or locations, the same individual may not be exposed to the maximum concentration of both chemicals or suffer health impacts from both chemicals. Therefore, because this method may have over-estimated potential exposures in some instances, the method is considered conservative. More recently some modelers have calculated a hazard index for the sum of all chemicals (with calculated HQs) coming out of each emission point. These HIs, from different stacks or areas, are then modeled as if they were chemical concentrations. In this way, locations and times of the maximum HIs can be modeled. This modeling, equivalent risk emission rate modeling (ERER), is likely a better predictor of hazards associated with emissions (for chemicals that are quantitatively analyzed), but it is less conservative than traditional modeling. In addition, it does not allow easy computation of exposures to specific chemicals at different locations in an exhaust plume. As a result, estimating possible exposures to any single chemical is less certain.

MPCA used ERER modeling to determine potential exposures to Interplastic emissions for 1 year, 3 months and 1 hour intervals; as appropriate for chronic, sub-chronic and acute exposure scenarios, respectively. Four cases were considered:

- Normal operation (but no thermal oxidizer breakdowns) chronic endpoints
- Normal operations sub-chronic endpoints (normal operations in this ERER analysis includes 1 or 2 anticipated thermal oxidizer breakdowns)

- Normal operation acute endpoints
- Thermal oxidizer breakdown-acute endpoints

Dispersion analyses were performed assuming current physical and operational conditions and also following proposed facility changes: raising the thermal oxidizer stack 15 feet, and; raising the scrubber stack 10 feet. HIs calculated using ERER modeling are for a residential receptor: 24 hours per day, seven days a week at a single location on the map.

The results of the MPCA ERER analysis are shown in Figures 2 through 6:

- Figure 2 (from MPCA, 2004), shows the isopleth (aqua: an isopleth is a line where the maximum modeled hazard index, or chemical concentration, is equal) where the chronic hazard index (HI) is equal to 1. The HI=1 isopleth extends to the freeway on the north and 0.2 to 0.3 miles to the south. Ambient air concentrations of evaluated chemicals within this isopleth may exceed a HI of 1 when averaged over a year. If the thermal oxidizer stack is raised by 15 feet, the chronic HI=1 isopleth shrinks into two smaller areas, one to the north of the facility and one to the south (outlined by light green in Figure 2). Raising the stack does not only result in a smaller area with a HI greater than 1, it also results in a significant reduction in exposure for all individuals exposed to Interplastic emissions. Chemicals evaluated for chronic duration in Figure 2 were acetone, DCPD, ethylbenzene, ethylene glycol, maleic anhydride, MEK, methanol, methyl methacrylate, NO_x, phthalic anhydride, styrene, and xylene. Dicylcopentadiene (DCPD) is responsible for 96% of the chronic hazard index values; maleic anhydride, 2.3%, and; NO_x, 1.1%. Criteria used to calculate HQs are listed in Table 1.

- DCPD is the only chemical emission from Interplastic for which sub-chronic modeling was performed. Figure 3 (from MPCA, 2004) shows isopleths where the sub-chronic hazard quotient (HQ) for DCPD is equal to 1 under four different conditions:
    1. current stack heights and conditions (downward pointing scrubber stack), and 1 TO failure during a 3 month period;
    2. raised stack heights and scrubber stack directed upward, and 1 TO failure during a 3 month period;
    3. current stack heights and conditions, and 2 TO failures during a 3 month period, and;
    4. raised stack heights and scrubber stack directed upward, and 2 TO failure during a 3 month period.

  Ambient air concentrations inside these isopleths may be greater than the HQ, with the highest concentrations likely occurring directly adjacent to the site, at neighboring businesses.

  During 3 months of normal operation, including 2 breakdowns of the thermal oxidizer, the sub-chronic HQ=1 isopleth extends 0.2 to 0.3 miles from the facility. Therefore, the total area where concentrations could be greater than the MDH

HRV is about 180,400 square meters (m^2) (~ 45 acres). Raising the scrubber stack decreases the area 93% to about 3 acres.

- Figure 4 (modified MPCA, 2004) shows maximum hourly DCPD concentration isopleths for about 1.8 times the odor threshold for DCPD during normal operations (i.e. no TO breakdown). HI for other chemicals evaluated for acute exposure along this isopleth is about 0.1. Inside of this isopleth, DCPD concentrations and the HI may be greater than 1.8 times the odor threshold and 0.1, respectively. The isopleth extends out from the facility for 0.1 to 0.2 miles in most directions, extending to the freeway (I35W) on the north. When the thermal oxidizer stack is raised 15 feet, a smaller area extending mainly to the north of the facility lies within a similarly derived isopleth.

- Figures 5 and 6 (MPCA, 2004) show the areas of potential odor impact during times of thermal oxidizer shutdown. Figure 5 show isopleths of potential DCPD concentrations during a TO shutdown with the scrubber stack redirected upward and raised 10 feet. This figure shows that even with a raised scrubber stack, DCPD concentrations 2 times the odor threshold may reach over 1 mile from the facility during a TO shutdown. The 500 µg/m^3 isopleth (~ 33 times the odor threshold) extends about 0.2 miles from the facility. The 15 µg/m^3 isopleth (~ the odor threshold; not shown) was beyond the model domain, even with a raised scrubber stack - more than 1¾ miles away. In fact, under these conditions the odor threshold may be exceeded anywhere within the model's domain (16 square kilometers).

  Figure 6 compares isopleths for 2 conditions: when there is a TO shutdown, and; when there is a TO shutdown with a raised (10 feet) scrubber stack. Note that when there is a TO shutdown, DCPD concentrations in the 'Quarry' and nearby residences may exceed 200 µg/m^3 (13 times the odor threshold). If 10 feet elevation is added to the scrubber stack there is a significant reduction in potential exposures. This includes both a reduction in the area impacted by emissions and a reduction in the concentration of chemicals to which individuals may be exposed (maximum reduction 98%, near the facility; average reduction 40%) (MPCA, 2004).

Fenceline modeling

Fenceline modeling, in contrast to ERER modeling, calculates the maximum possible concentration at the fenceline for each chemical from different emission points. Fenceline concentrations at Interplastic are dominated by thermal oxidizer stack emissions and, when the TO is shutdown, by scrubber emissions.

Table 2 summarizes the MPCA-modeled fenceline concentrations for emissions from Interplastic. Hazard indexes have been calculated assuming receptors may be exposed at the fenceline. These exposures are likely limited to exposures at neighboring businesses. As a result, the HIs have been calculated for individuals that are only exposed at work. This may be less conservative than residential exposure modeling because workers are only assumed to be at work for 40 hours per week, and yet these individuals may be exposed at other times or places during the week. It is expected that individuals inhale 5/14 of their total volume of inhaled air at work. Therefore, to calculate hazard indices for workplace exposures (HI_{wk}), modeled concentrations are divided by health criterion and multiplied by 5/14. This workplace adjustment only applies to longterm (chronic and sub-chronic) exposure averaging, because an acute exposure is a one hour exposure.

Table 2 (A, B and C) shows HI_{wk}'s above 1 for potential workplace exposure scenarios at Interplastic's fenceline for: chronic, sub-chronic, and acute exposure durations. Cancer risk for 1,4-dioxane exposure is less than 1 additional incremental cancer in 1,000,000 individuals exposed over a lifetime.

Table 2A

Maximum Annual Average Chemical Concentration and Hazard Quotients at Fenceline					
No Thermal Oxidizer Shutdowns					
Emitted Chemical	**Annual Average Fenceline Concentration µg/m³**	**Chronic Human Health Criteria / NAAQS - µg/m³** (reference)		**Nearby Worker Hazard Quotients or (% of NAAQS)**	**Percent contribution to Hazard Index**
Acetone	58.2	31,000	(ATSDR-MRL)	0.0007	< 1%
DCPD	**1.31**	0.21	(HEAST-RfC)	**2.2**	88%
Ethylbenzene	0.540	1,000	(IRIS-RfC)	0.0002	< 1%
Ethylene Glycol	0.251	400	(CA-REL)	0.0002	< 1%
Maleic Anhydride	**0.493**	0.70	(CA-REL)	**0.25**	9.9%
MEK	5.95	5,000	(IRIS-RfC)	0.0004	< 1%
Methanol	0.341	4,000	(CA-REL)	0.00003	< 1%
Methyl Methacrylate	31.5	700	(MDH-HRV)	0.016	< 1%
NOx	**54.1**	100	(NAAQS)	**(54 %)**	
Nox-Propane backup	**83.6**	100	(NAAQS)	**(84 %)**	
Phthalic Anhydride	1.55	20	(CA-REL)	0.028	1.1%
Styrene	16.4	1,000	(MDH-HRV)	0.0059	< 1%
Xylene	0.434	100	(IRIS)	0.002	< 1%
			Hazard Index =	**2.5**	
	Fenceline Concentration (ug/m³)	Cancer Risk per ug/m³ (Unit Risk)		**Nearby Worker Cancer Risk**	
Dioxane	0.121	7.7E-06	(CA-UR)	3.3E-07	

Table 2B

Maximum 3-month Average Chemical Concentration and Hazard Quotients at Fenceline				
Emitted Chemical	**3-Month Average Fenceline Concentration µg/m^3**	**Sub-chronic Human Health Criteria** µg/m^3 (reference)	**Nearby Worker Hazard Quotients**	**Percent contribution to Hazard Index**
2 Thermal Oxidizer Shutdowns				
DCPD	23.1	3.0 (MDH-HRV)	**2.8**	100%
Scrubber stack raised 10 feet, TO stack raised 15 feet				
DCPD	3.70	3.0 (MDH-HRV)	**0.44**	100%
3 Thermal Oxidizer Shutdowns				
DCPD	34.3	3.0 (MDH-HRV)	**4.1**	100%
Scrubber stack raised 10 feet, TO stack raised 15 feet				
DCPD	5.07	3.0 (MDH-HRV)	**0.60**	100%

Table 2C

Maximum 1-hour Average Chemical Concentration and Hazard Quotients at Fenceline					
Emitted Chemical	**One Hour Average Concentration µg/m³**	**Acute Human Health Criteria** µg/m³ (reference)		**Hazard Quotients**	**Percent contribution to Hazard Index**
During Thermal Oxidizer Shutdown					
Acetone	**26,600**	**63,000**	**(ATSDR-MRL)**	**0.42**	**14%**
DCPD	**6,970**	**(~ 465X the odor threshold of 15 µg/m3)**			
Dioxane	152	3,000	(MDH-HRV)	0.051	1.7%
MEK	**16,400**	**10,000**	**(MDH-HRV)**	**1.6**	**56%**
Methanol	460	25,000	(MDH-HRV)	0.018	< 1%
Styrene	**16,800**	**21,000**	**(MDH-HRV)**	**0.80**	**27%**
Styrene as MEK	**7,770**	21,000	(MDH-HRV)	**0.37**	
Xylene	372	43,000	(MDH-HRV)	0.009	< 1%
	Hazard Index (process w,w/o MEK) =			**2.9, 1.7**	
No Thermal Oxidizer Shutdown					
Acetone	**26,600**	63,000	(ATSDR-MRL)	**0.42**	**15%**
DCPD	**126**	**(~ 8X the odor threshold of 15 µg/m3)**			
Dioxane	3.26	3,000	(MDH-HRV)	0.001	< 1%
Ethylbenzene	16.8	10,000	(MDH-HRV)	0.002	< 1%
MEK	**15,500**	10,000	(MDH-HRV)	**1.6**	**54%**
Methanol	167	25,000	(MDH-HRV)	0.007	< 1%
NO2	**314**	470	(CA-REL)	**0.67**	**23%**
Styrene	**4,810**	21,000	(MDH-HRV)	**0.23**	**7.9%**
Styrene as MEK	**2,510**	21,000	(MDH-HRV)	**0.12**	
Xylene	364	43,000	(MDH-HRV)	0.008	< 1%
	Hazard Index (process w,w/o MEK) =			**2.9, 1.5**	

Discussion

Neither the ERER nor the fenceline models were used to evaluate chemicals for which health criteria data are not available (with the exception of the acute DCPD odor threshold modeling) or to evaluate particulate emissions and potential exposures. As a result about 95% of the VOCs emitted are evaluated for chronic exposure; less than 1% are evaluated for sub-chronic exposure, and; about 45% are evaluated for acute exposures. This restriction on analysis is common when evaluating industrial emissions, and is often not a concern when the hazard indices for evaluated chemicals are low. In addition, the level of analysis for the sub-chronic duration is reasonable, because endpoints are likely similar to the chronic exposure endpoints, and DCPD represents almost 90% of the chronic HI. However, HI_{wk}s for all 3 durations already exceed 1, and; all of the identified chemicals released from this facility have been classified as hazardous. Therefore, while the contribution of uncharacterized chemicals is unlikely to affect chronic and sub-chronic analysis, the acute hazard likely underestimates the effect of additional irritants that are only considered in the chronic analysis (e.g. maleic anhydride, DCPD and methyl methacrylate).

Chronic exposure

The maximum chronic exposure will also take place during a yearly period when there are a number of TO shutdowns. On the average, reported TO shutdowns occur 3.2 times a year (see Table 3 for shutdown occurance). Accounting for TO shutdowns in the annual exposure evaluation (i.e. dispersion modeling) would more than double yearly potential exposures for chemicals routed through the TO. However, annual dispersion modeling with TO failures has not been conducted.

Table 3

Shutdown Occurance: 1/2000 - 8/2004				
TO Shutdown (date)	Shutdown length (hours)	Days since previous shutdown	Shutdowns in previous 90 days (#)	Shutdowns in previous year (#)
2/16/00	3			
2/28/00	4.2	12		
4/12/00	4.1	44	3	3
3/5/01	3	323	1	2
3/14/01	5.8	9	2	3
6/14/01	3	90	2	3
8/2/01	1.8	48	2	4
10/24/01	0.07	82	2	5
11/20/02	4.9	386	2	1
4/16/03	3.6	146	1	2
4/22/03	1.3	6	2	3
12/11/03	1.8	229	1	3
1/17/04	2	36	2	4
1/21/04	1.5	4	3	5
3/16/04	8	55	3	6
7/4/04	3.3	108	1	5

Annual HI modeling of emissions (ERER) with chronic health-based criteria was conducted by MPCA. DCPD exposure accounts for 96% of the chronic HI.

Table 2A shows the maximum fenceline concentrations and HI_{wk}s when modeled over a 1 year period; assuming there are no TO shutdowns. The chronic HI at the Interplastic fenceline is 7.1. Workers are the nearest receptors, within feet of the fenceline. Therefore, the appropriate HI_{wk} is 2.5 (7.1 x 5/14 = 2.5) for workers adjacent to the facility. If TO shutdowns are assumed, the HI (and HI_{wk}) would more than double.

Sub-chronic exposure

Maximum sub-chronic exposures will occur when there are multiple thermal oxidizer failures. For the period of December 11, 2003 to March 16, 2004 (95 days) there were 4 TO failures for a total of 13.3 hours (Table 3). An analysis of data since February 2000 demonstrates that; twenty-five percent of the time 3 events occur within 89 days; and half of the time 2 events occur within 55 days. Therefore, there is a reasonable expectation that there will be 3 or 4 TO failures over some 3 month periods. There is no evidence that event occurrence has decreased since February 2000.

Table 2B shows the maximum ambient air concentrations at the fenceline and HI_{wk}s when modeled over a 3 month period; assuming there are 2 and 3 TO shutdowns. When 2, 3 or 4 TO failures occur during a 3 month period, the fenceline HIs are 7.7, 11 and 15, respectively. For people who only work near Interplastic (Table 2B), the sub-chronic HI_{wk}s are 2.8, 4.1 and 5.4, respectively. These are considerably above the MDH level of concern (HI=1) for an individual's exposure to chemicals that have a potential to cause health effects upon exposure over a sub-chronic duration. (Note that DCPD emissions are considered as one of several chemicals in the chronic emissions analyses. It is the biggest contributor to the chronic HI). Raising the TO stack 15 feet and the scrubber stack 10 feet would be expected to decrease the fenceline HI (and HI_{wk}) by a factor of about 7.

Acute exposure
Four different HIs (HI and HI_{wk} are the same for acute modeling) were calculated for the acute duration: with the TO operating and with it not operating; and with a batch using styrene, and with a batch using both styrene and MEK. The acute HIs from Table 2C show that fenceline concentrations under all modeled conditions may exceed 1 (2.9, 2.9, 1.7 and 1.5). These HIs were calculated for about 45% of emissions from Interplastic; not including DCPD, maleic anhydride, methyl metacrylate and phthalic anhydride for which reasonable acute health criteria are unavailable.

DCPD odors may affect the quality of life of employees at neighboring businesses and visitors. The DCPD odor threshold may be exceeded offsite by a factor of 8.4 under normal operating conditions. During a TO breakdown, DCPD concentrations may be 465 times the odor threshold (Table 2C). Businesses near Interplastic have complained to MDH and the MPCA about odors and possible health impacts from exposure to Interplastic emissions. "... dry eyes, burning eyes, sore throat, a constant complaint of many of the employees on that level of the building, to the degree where some have actually gone home (Stillman, 2000)." Complaints of irritation, headaches and nausea are consistent with expected health impacts from acute exposure to DCPD.

MPCA ERER dispersion modeling (Figure 6) show that during TO breakdowns, DCPD concentrations 200 times the odor threshold, or greater, may be found in the area of The Quarry Shopping Center, and reach into residential communities quite distant from Interplastic. In addition, odor thresholds for additional chemicals, such as methyl methacrylate, styrene, maleic anhydride and phthalic anhydride, may also be exceeded.

Conclusions

The results of dispersion modeling of stack testing emissions data from Interplastic (ERER and fenceline modeling using the EPA recommended ISC-PRIME model) demonstrate that health criteria are likely to be exceeded in ambient air near the facility. Exposures to employees at neighboring businesses may exceed hazard indexes for chronic, sub-chronic and acute exposures. Furthermore, the acute hazard exceeded levels of concern even though only about 45% of the emissions were evaluated and other known irritants without acute criteria could not be quantitatively evaluated.

Dicyclopentadiene (DCPD) is the chemical of most concern due to its low odor threshold, noxious smell and its relatively low health criterion for sub-chronic and chronic exposure. It is likely that individuals could be exposed to dicyclopentadiene at concentrations above the MDH sub-chronic and the EPA HEAST chronic dicyclopentadiene criteria. Furthermore, employees and visitors at businesses adjacent to Interplastic are likely exposed DCPD for short periods (1 hour) at concentrations well over the odor threshold. These shortterm exceedances may occur both during normal operations at Interplastic and when there is a thermal oxidizer breakdown.

Complaints about impacts to the health of employees of these neighboring businesses (Stillman, 2000) are consistent with the potential effects of shortterm exposure to DCPD and solvents used at Interplastic. In addition, odor (i.e. shortterm exposure, primarily to DCPD, styrene, methyl methacrylate, maleic anhydride and phthalic anhydride) may be a quality of life issue, even for people living and working quite a distance from the facility.

If the stacks on the thermal oxidizer and the scrubber are raised 15 and 10 feet, respectively, the effects of building downdraft will be lessened and the concentrations in ambient air will be reduced significantly. However, even if the stacks are raised it is possible that during times when the thermal oxidizer is shutdown, there still may be some odor and health concerns.

Public Health Category

Interplastic emissions likely cause ambient air to exceed public health criteria over sub-chronic, acute and chronic time periods in the immediate vicinity of the facility. Furthermore, there are nearby receptors (employees at neighboring businesses) likely exposed to concentrations similar to those modeled and who have reported experiencing health impacts. Therefore, emissions from this facility represent a Public Health Hazard as defined by the Agency for Toxic Substances and Disease Registry.

Recommendations

MDH recommends that the stack on the thermal oxidizer and the scrubber stack at Interplastic be raised to lower potential exposures, primarily nearby exposures. Furthermore, MDH recommends that additional controls (for example, a backup thermal oxidizer) be considered to decrease or stop the occurrence of large release events.

Public Health Action Plan

MDH will publicize the recommendations contained in this Health Consultation in a Fact Sheet for distribution to the neighborhood community group, neighboring businesses and the City of Minneapolis. In addition, MDH will support the efforts of the MPCA, Minneapolis and the company to decrease potential exposures to acceptable levels.

This consultation was prepared by:

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Certification

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

Technical Project Officer, CAT, SPAB, DHAC

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

Team Lead, CAT, SPAB, DHAC, ATSDR

Figure 1
Interplastic Corporation
Northeast Minneapolis, MN

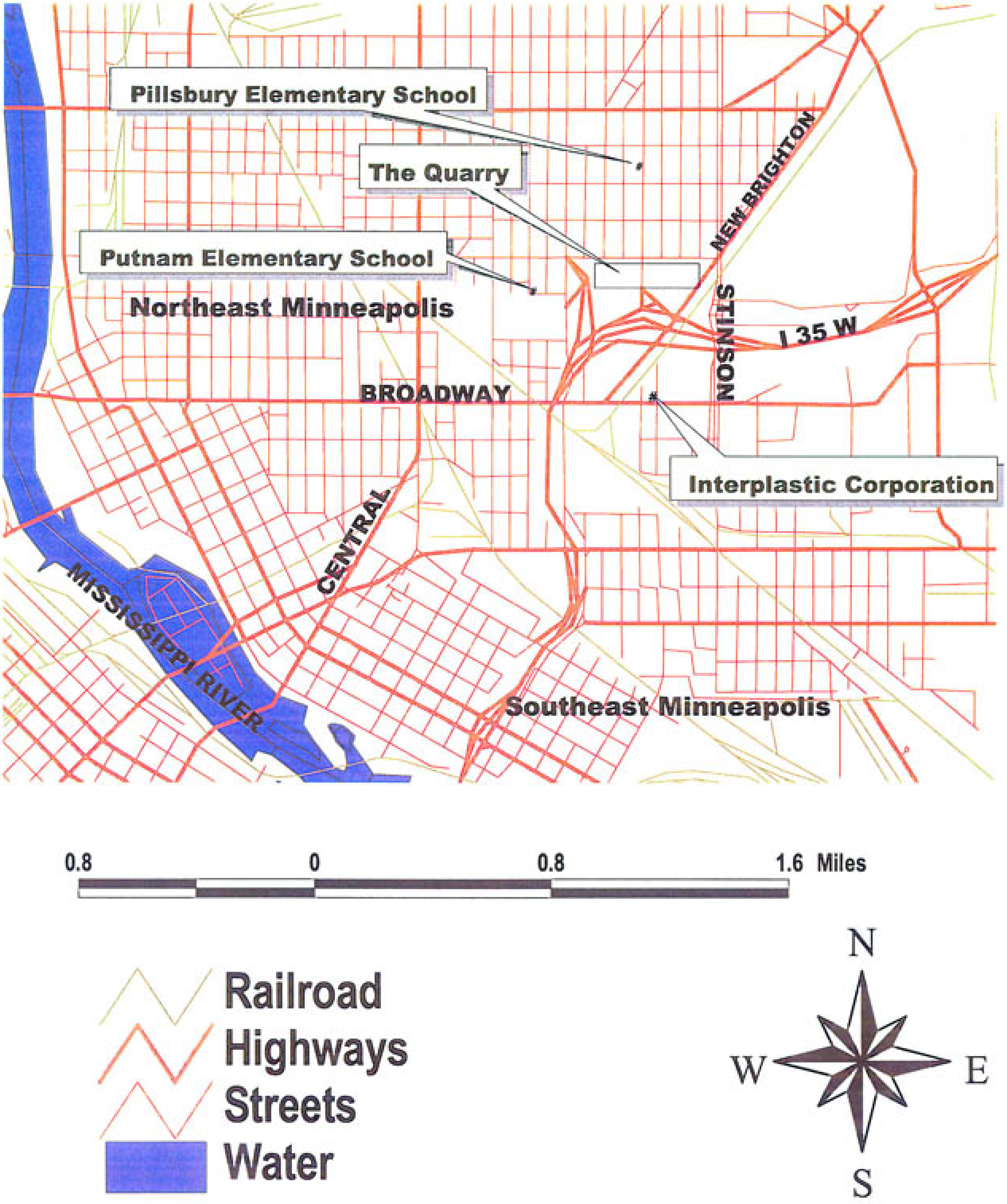
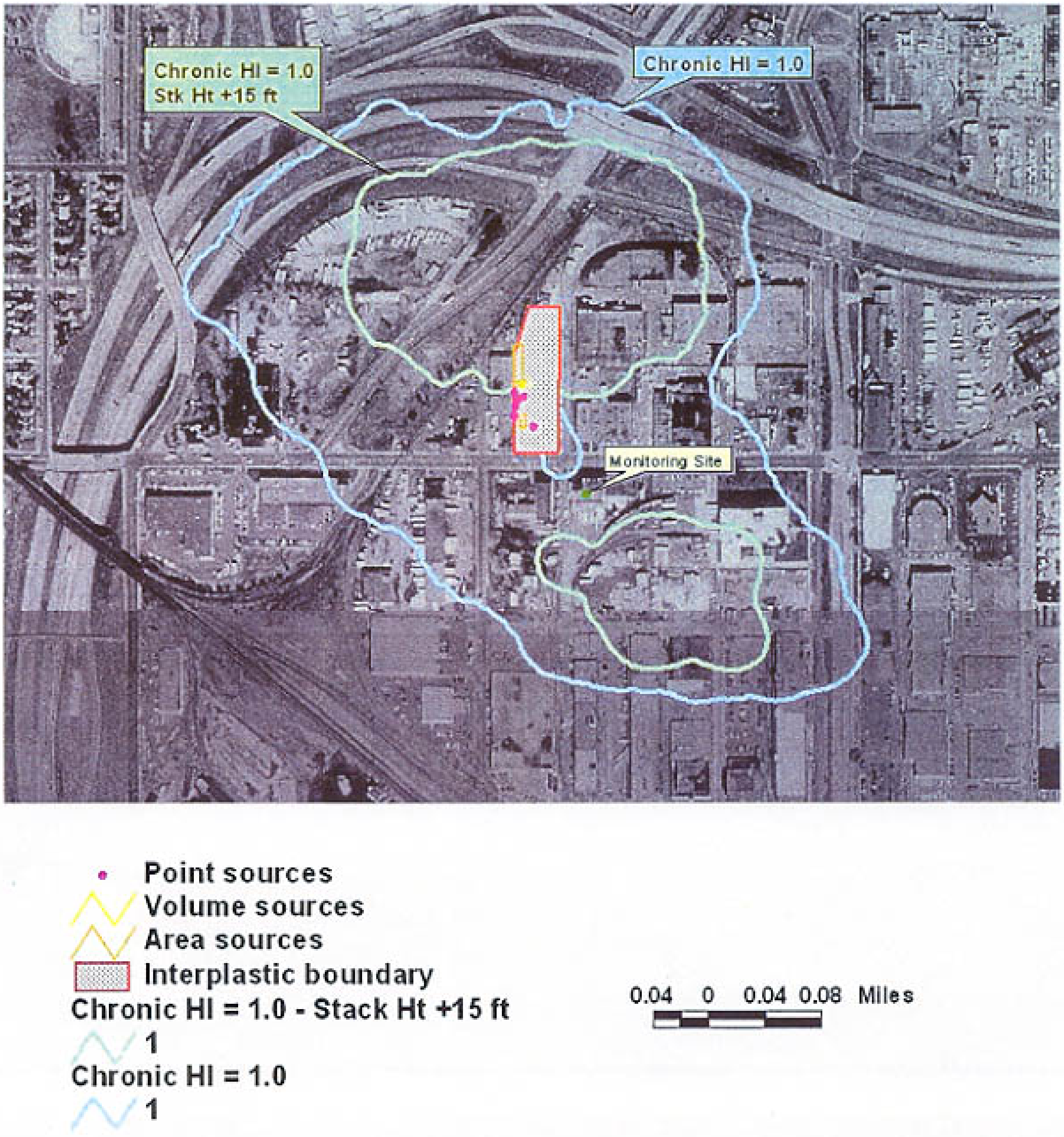


Figure 2

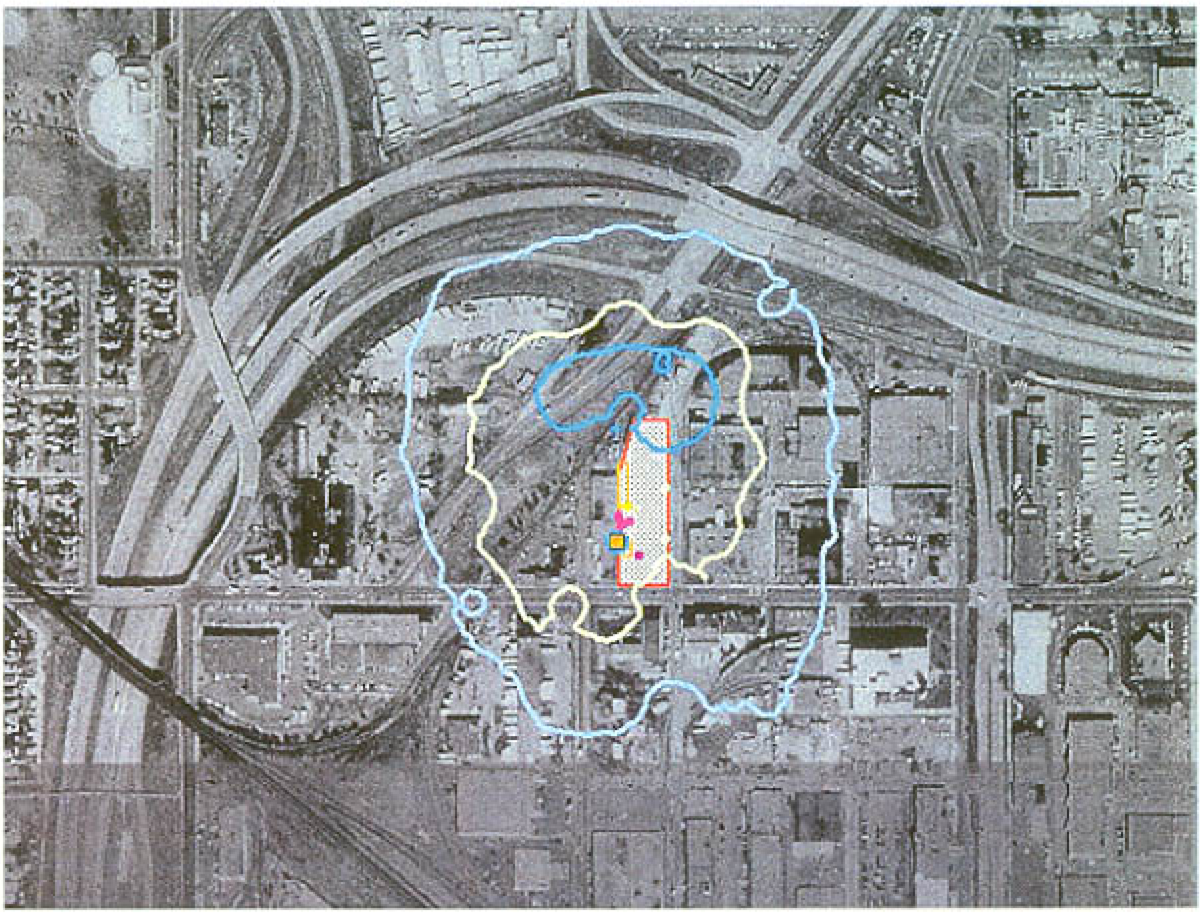
Interplastic Chronic Hazard Index



(MPCA, 2004)

Figure 3

Interplastic Subchronic Hazard Index



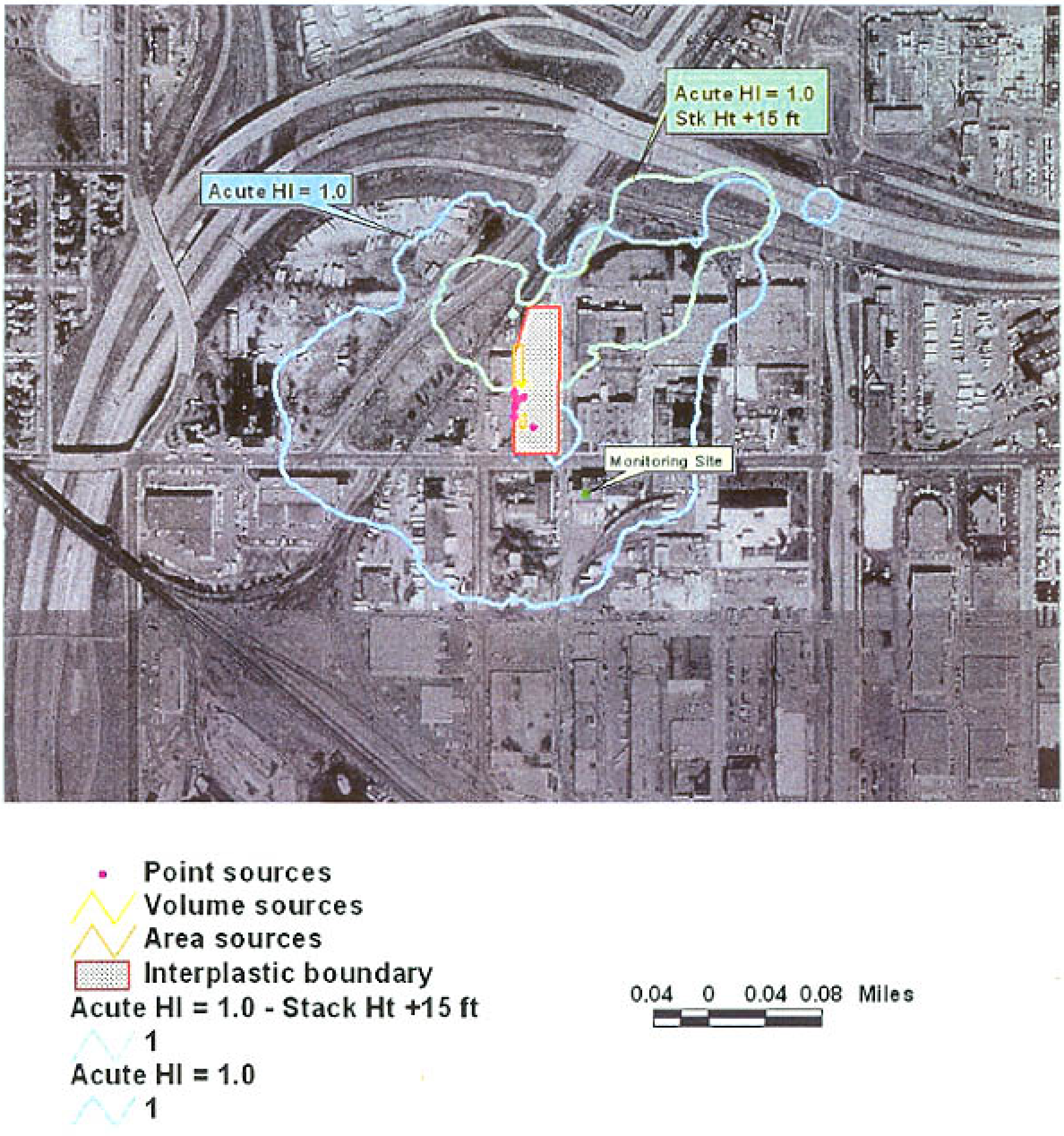
Subchronic HI=1, 1 TO malfunction in 3 mo-existing stks
1
Subchronic HI=1, 1TO malfunction in 3 mo-raised stks
1 - 1.039
Subchronic HI=1, 2 TO malfunctions in 3 mo-exiting stks
1
Subchronic HI=1, 2 TO malfunctions in 3 mo, raised stks
1
Point sources
Volume sources
Area sources
Interplastic boundary

0 0.07 0.14 Miles

(MPCA, 2004)

Figure 4

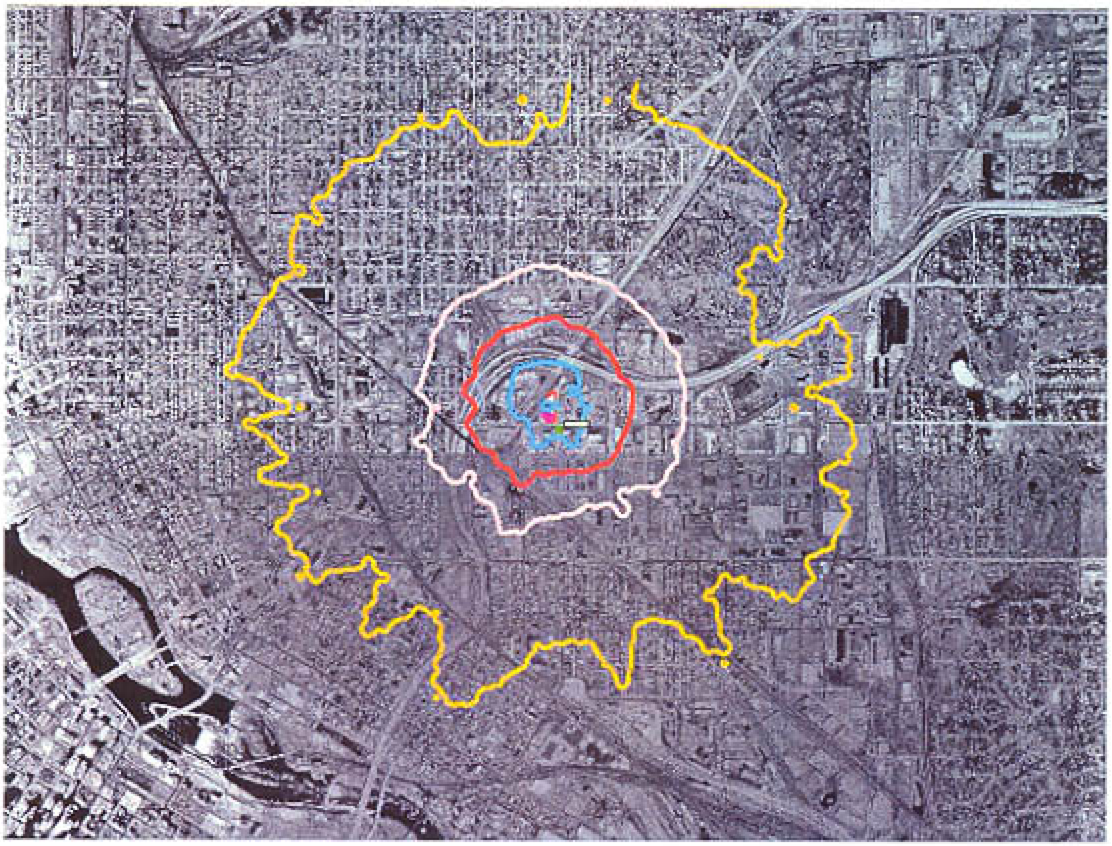
Interplastic Acute Hazard Index



(MPCA, 2004)

Figure 5

Interplastic Corporation maximum DCPD Concentration (ug/m3) during TO Malfunction Scrubber stack raised 10 ft



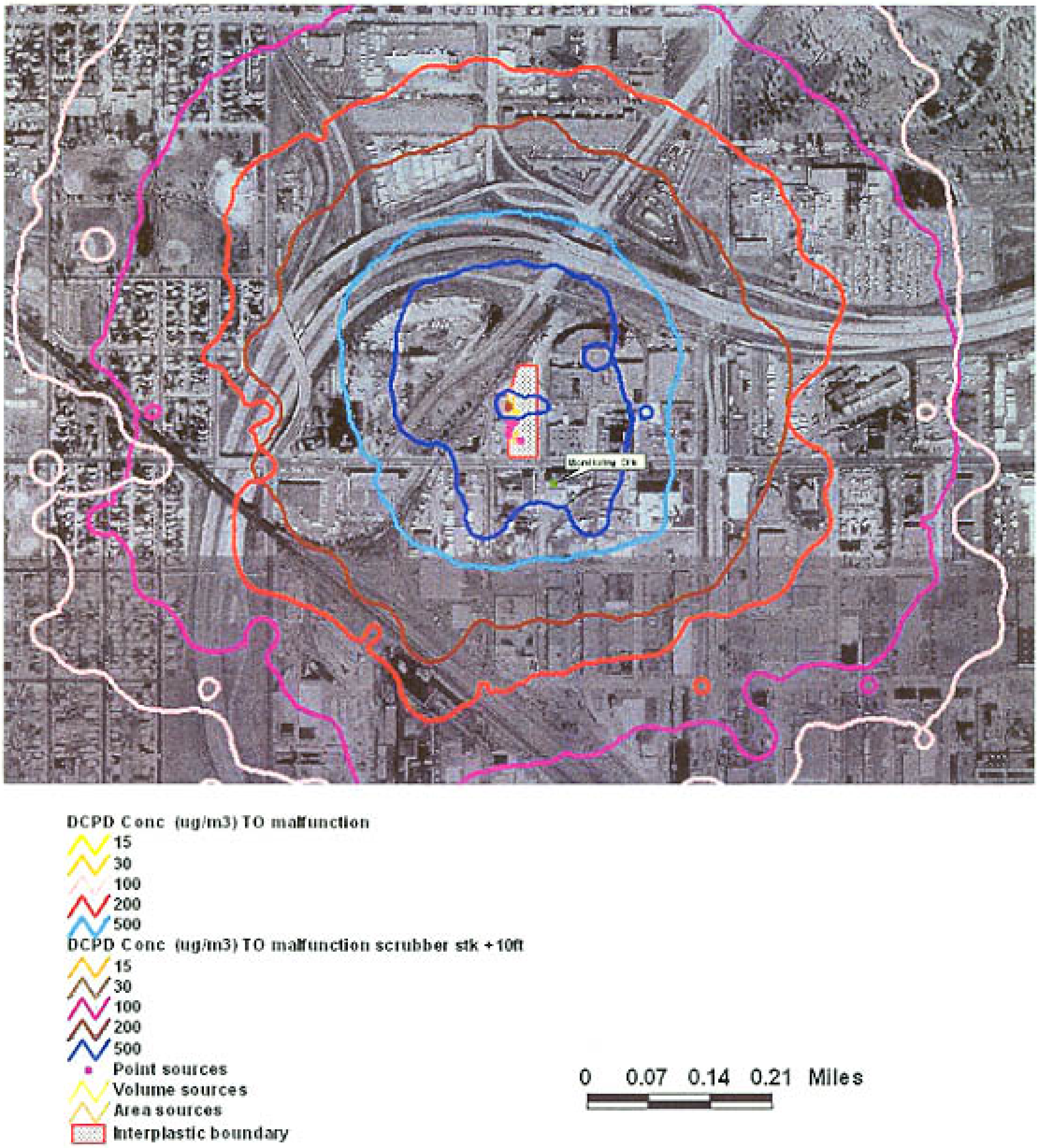
DCPD Conc (ug/m3) TO malfunction scrubber stk +10ft
- 15
- 30
- 100
- 200
- 500
- Point sources
- Volume sources
- Area sources
- Interplastic boundary

0 0.3 0.6 0.9 Miles

(MPCA, 2004)

Figure 6

Interplastic Corporation maximum DCPD Concentration (ug/m3) during TO Malfunction Scrubber stack raised 10 ft



(MPCA, 2004)