Public Health Assessment

Bison Corporation
(Vapor Intrusion in Residential Homes along Kimball Road)

Canton, Stark County, Ohio

Prepared by:

The Health Assessment Section
of the Ohio Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

TABLE OF CONTENTS

SUMMARY

The Bison Corporation is a now defunct facility that specialized in the manufacture of grinding and buffing wheels for use in the metal plating industry. The company also stored degreasing solvents on-site in bulk for distribution to metal working and plating industries. The facility property consists of 6.05 acres of land situated between Allen Avenue S.E. and Kimball Road S.E. in Canton, Ohio. Groundwater contamination was initially discovered on the Bison Corporation Property during a Phase II Property Assessment conducted in August 2000. The groundwater investigation indicated the presence of several chlorinated solvents including trichloroethylene (TCE) and tetrachloroethylene (PCE). An additional groundwater investigation was conducted in 2001 that included sampling of the groundwater both on and off of the facility property. Analytical results revealed that elevated concentrations of volatile organic compounds (VOCs) were detected in 16 of 21 samples collected. The highest level of groundwater contamination was detected on-site and revealed total VOC concentrations of 125,500 ug/l. This well is located on the property boundary near an area of former drum storage. Contamination was also discovered at off-site monitoring locations at total VOC concentrations of over 61,500 ug/l. During this investigation it was discovered that groundwater in the area was relatively shallow and began at approximately eight feet to ten feet below ground surface.

As a result of the off-site groundwater contamination and the fact that groundwater in the area was only eight feet below ground surface, Bison Corporation became concerned that groundwater contamination may be impacting the nearby residential homes. Concern was expressed that VOCs in the groundwater may be volatilizing into the indoor air of homes near the facility. Bison Corporation hired a consultant to conduct a theoretical model (Johnson & Ettinger Model) to determine the likelihood that chemicals from the groundwater could be volatilizing into neighboring homes. The results of the model indicated that is was likely that contamination in the groundwater could be migrating into the indoor air of residential homes.

Upon receipt of the results of the model, the Canton City Health Department contacted the Health Assessment Section of the Ohio Department of Health to ask for assistance in reviewing the model results and making recommendations with regard to further public health actions at the site. The Health Assessment Section, Canton City Health Department, and the Ohio Environmental Protection Agency (Ohio EPA) were all in agreement that it was necessary for Bison Corporation to sample the indoor air of residential homes in the vicinity of Bison Corporation to determine if there has been impact from groundwater contamination.

Indoor air samples were collected from thirteen residential properties in November 2002 and analyzed for volatile organic compounds. Chemicals that were detected in the groundwater on the Bison Property were detected in the indoor air of all thirteen residences. The primary chemicals of concern were determined to be TCE and PCE due to the high concentrations detected and the fact that they are potential cancer causing chemicals. It was determined that levels of contaminants were high enough in eight homes and one apartment building with four units to require immediate action. Ohio EPA and the Bison Corporation were able to agree on interim actions that would involve installing remediation systems, similar to radon removal systems, in the impacted homes to reduce the levels of VOCs in the indoor air.

Confirmation sampling was done at the homes with remediation systems in May 2003 to determine if the systems were effective in reducing the contamination in the home. Analytical results indicated that the systems were effective in dramatically reducing the concentration of VOCs in the indoor air. Low levels of TCE and PCE were still detectable in some of the homes; however, the levels were extremely low and were just slightly above the detection level. There are also no reliable toxicological or epidemiological studies that indicate that adverse health effects can occur at these low levels.

The Health Assessment Section (HAS) concluded that prior to the remediation systems being installed in the impacted homes, the indoor air posed a "public health hazard" to the residents in the homes. Based on analytical data collected after the systems were installed, the levels of contaminants in the indoor air currently pose "no apparent public health hazard."

Several homes with low levels of TCE and PCE in the indoor air were not offered remediation systems. The levels of TCE and PCE in the indoor air of these homes was extremely low and there is no scientific evidence that exposure to these low levels can cause adverse health effects. HAS recommended that all homes previously sampled that have had indoor air detections of chemicals associated with the Bison Corporation continue to be sampled to ensure that the remediation systems continue to be effective and the low levels of contaminants in the homes not offered systems do not increase. Should the levels of contaminants increase significantly in any of these homes, HAS recommends that remediation systems be offered to these impacted homes as well. HAS also recommended that Ohio EPA continue to pursue an agreement with the Bison Corporation to remove the source of contamination at their facility and also to fully characterize the extent of the contamination in the area. HAS will continue to review all available environmental data collected at the site and will be available to assist the community and the Canton City Health Department in answering any health questions related to exposure to hazardous chemicals.

PURPOSE AND HEALTH ISSUES

The Health Assessment Section (HAS) of the Ohio Department of Health was contacted by the Health Commissioner of the Canton City Health Department on October 10, 2002 with regard to a potential public health hazard posed by a groundwater contamination plume associated with the Bison Corporation facility in Canton, Ohio. The Canton City Health Department became concerned after receiving a report from HzW Environmental Consultants, a consultant working for the Bison Corporation, which indicated that groundwater contamination had migrated off-site into a residential community and could possibly pose an elevated risk to nearby residents. The report stated that the potential existed for contaminants in the groundwater to volatilize and enter the indoor air of homes above the contamination plume. The health department asked HAS to review the consultant's report and provide comments as to the possibility of the groundwater contamination posing a threat to the nearby community. This report documents our review of the Indoor Air Risk Assessment Report completed by HzW and review of additional data collected and actions taken since the initial contact by the Canton City Health Department.

BACKGROUND

Site Location and History

The Bison Corporation property consists of 6.05 acres of land situated between Allen Avenue S.E. and Kimball Road S.E. in Canton, Ohio (Figure 1&2). The eastern 4.7 acres is developed, while the western 1.35 acres consists of an open lot covered with grass and weeds. The eastern portion of the property was used for the manufacture of grinding and buffing wheels for use in the metal plating industry. Degreasing solvents were stored in bulk in several large capacity aboveground storage tanks for distribution to metal working and plating operations. These tanks have recently been removed. The facility also managed degreasing solvents in 55-gallon drums. Most of the management of raw solvent occurred in the southwestern corner of the developed portion of the property. The entire Bison Corporation property is fenced (HzW, January 2002).

Site Topography and Geology

The Bison Corporation Facility is situated near the top of a low north-south trending hill (elevation 1021 feet MSL) that slopes down to the west and south towards the valley of Nimishillen Creek, a south-flowing tributary whose waters eventually flow into the Tuscarawas River southwest of the Canton area. Homes in the adjacent residential area along the east side of Kimball Road are sited on a slightly raised stream terrace on the west flank of the hill. Homes along the west side of Kimball Road are somewhat lower in elevation on the level flood plain of Nimishillen Creek (elevation 1005 feet MSL). Surface water in the vicinity of the Bison Corporation facility either flows west and southwest towards Nimishillen Creek or south towards Sherrick run. A storm sewer line transports run-off collected from the area along Kimball Road south to a discharge point on Sherrick Run.

The Bison Corporation facility is located on the east flank of a north-south trending sand and gravel-filled buried bedrock valley that roughly parallels the trend of the current valley of

Nimishillen Creek (Schaefer, 1946). The thickness of glacial cover and the depth to the top of the bedrock surface increases as you go from the Bison property towards the creek to the west. Depth to bedrock in the area ranges from a minimum of 14 feet at MW-4 at the northeast corner of the Bison property near Allen Road (HzW Environmental, January 2002) to depth greater than 100 feet below the ground surface west of Kimball Road near the present day course of Nimishillen Creek (Schaefer, 1946; Brockman and Vorbau, 1996). Soils in the vicinity of the Bison Corporation facility are classified as Chili Series silty loams which are described as well-drained, rather permeable sandy soils (Christman et. al., 1971). Well borings on and adjacent to the Bison Corporation property indicate these soils overlie at least 20 feet of fine to medium-grained sand that coarsens with depth to include coarser sand and gravel. These glacial sands and gravels are highly permeable and water-saturated with the local water table being 8 to 20 feet below the ground surface, becoming shallower moving from the Bison plant towards the Nimishillen Valley to the west (HzW Environmental, January 2002). Elevations of the water levels within monitoring wells indicate that groundwater flow follows the surface topography, flowing from the Bison plant to the west and southwest towards Nimishillen Creek. However, all area residents obtain their drinking water from the city of Canton's municipal water system (Canton City Health Department, pers. comm.).

Nature and Extent of Contamination

Groundwater contamination at the Bison Corporation Facility was initially discovered during an August 2000 Limited Phase II Property Assessment conducted by Sharp & Associates. The Phase II Property Assessment was conducted because Bison Corporation was interested in selling their property. The initial investigation involved the installation of four groundwater monitoring wells on the Bison Corporation property.

Groundwater results from the Phase II Property Assessment indicated the presence of several industrial solvents and their representative breakdown products in the groundwater below the property. The chemicals detected included trichloroethylene (TCE), tetrachloroethylene (PCE), 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethylene (1,1-DCE), cis-1,2-dichloroethylene (cis-1,2-DCE), 1,1,1-trichloroethane (1,1,1-TCA), and vinyl chloride. Based on these detections, Sharp & Associates concluded that the "...analytical results indicate that somewhere on the Bison Corporation site a historic release of volatile organic compounds (VOCs) occurred" (Sharp & Associates, August 2000). The chemicals of greatest concern at the site are TCE and PCE because they are present in the highest concentrations and also have been classified as potential human carcinogens.

To further evaluate the groundwater contamination on the Bison Corporation Property, HzW conducted additional investigation between May and August 2001. During this investigation, HzW collected seventeen (17) groundwater samples from both permanent and temporary groundwater sampling locations (Figure 3). Analytical results for the additional sampling indicated that elevated concentrations of VOCs were detected in 16 of the 21 samples collected (HzW, January 2002). One or more chemical in each of these samples exceeded the maximum contaminant level (MCL) established for drinking water in public water supplies. Total VOC concentrations in one location (WP-12) exceeded 125,500 micrograms per liter (ug/l), with TCE

being the largest contributor to the contamination at 70,700 ug/l (Table 1). It was also discovered that groundwater contamination was relatively shallow (8 to 10 feet below ground surface) and had migrated off-site to the southwest across Kimball Road S.E. and that the plume was flowing directly under several residential homes along Kimball Road S.E.

Table 1
Groundwater Sampling Results for Bison Corporation
(all results listed in micrograms per liter) (ug/l)

Well #	TCA	Cis-1,2-DCE	PCE	TCE	Vinyl Chloride	1,1-DCE	1,1-DCA
MW-1	2,830	321	2,140	23,000	ND	ND	ND
MW-2	67	119	82	128	ND	ND	ND
MW-3	ND	ND	ND	ND	ND	ND	ND
MW-4	ND	ND	ND	ND	ND	ND	ND
MW-5	1,780	ND	538	2,080	ND	206	ND
MW-6	ND	ND	ND	ND	ND	ND	ND
MW-7	ND	ND	ND	6	ND	ND	ND
MW-8	ND	ND	ND	ND	ND	ND	ND
MW-9	199	ND	486	434	ND	ND	ND
WP-1	331	1,570	478	883	43	ND	ND
WP-2	2,810	3,020	12,000	11,800	ND	ND	194
WP-3	5,330	603	10,500	4,080	ND	ND	121
WP-4	37,700	30,406	2,910	14,500	137	853	4,670
WP-5	80	112	663	928	ND	ND	ND
WP-6	ND	ND	ND	ND	ND	ND	ND
WP-7	196	245	278	104	ND	ND	34
WP-8	1,530	1,690	2,740	1,760	28	27	430

Well #	TCA	Cis-1,2-DCE	PCE	TCE	Vinyl Chloride	1,1-DCE	1,1-DCA
WP-9	3,930	2,320	3,870	4,130	ND	ND	2,230
WP-10	5,320	1,500	4,760	2,960	ND	405	4,680
WP-11	3,880	773	1,680	8,460	ND	104	266
WP-12	36,000	ND	18,800	70,700	ND	ND	ND

Demographics

Population of Concern

The area in the vicinity of the property consists of mixed industrial/commercial/residential land use. North of the property is a commercial self-storage facility and the right-of-way for Interstate 77. East of the property (across Allen Avenue S.E.) are commercial/industrial operations and private residences. West of the property (across Kimball Road S.E.) is a tavern and residential properties. South of the property is an executive office park, consisting of multi-tenant commercial or light industrial buildings. Southwest of the property are residences that front the west side of Kimball Road S.E.(HzW, January 2002). There are approximately 25-30 homes in the immediate vicinity of the Bison Corporation Property. Homes in the area of the facility consist mainly of slab-on-grade homes constructed in the 1950's, however, there are a few homes constructed in the early 1900s that contain basements. The population is predominantly white and in the middle to low income range (2000 U.S. Census Data).

DISCUSSION

Vapor Intrusion Issue

Vapor intrusion is the migration of volatile chemicals from subsurface groundwater and/or soils into overlying buildings. Volatile chemicals in buried wastes and/or contaminated groundwater can emit vapors that may migrate through permeable soils and into indoor air spaces of overlying buildings in ways similar to that of naturally-occurring radon gas seeping into homes (USEPA Draft Guidance, 2002). Because of the extremely high concentrations of VOCs in a groundwater plume that is eight to ten feet below ground surface and runs directly beneath residential housing, Bison Corporation tasked HzW Environmental Consultants to complete an indoor air risk assessment of several residential properties along Kimball Road S.E. in the immediate vicinity of the Bison Corporation Property (HzW, March 2002). The risk assessment was completed in March 2002. To complete the indoor air risk assessment, HzW entered the data from the expanded groundwater investigation (HzW, January 2002) into the Johnson & Ettinger Model for Subsurface Intrusion Into Buildings (Revised) Advanced Mode for Groundwater Contamination (Johnson and Ettinger Model). The Johnson & Ettinger Model is made available by the United

States Environmental Protection Agency (USEPA) to be used by federal and state agencies to quantify the risks posed to residents from volatile organic compounds vaporizing and entering the indoor air from soil or groundwater beneath the buildings (Johnson, et. al., 1991)

The Johnson & Ettinger Model used by HzW is a one-dimensional model that assumes that vapors of the volatilized chemical of concern move from soil or groundwater toward the soil surface until they reach a capture zone of an overlying building. Negative air pressure within the building then moves the vapors through cracks in the foundation, slab, or basement walls and into the living space of the building. The model also assumes that the groundwater source of contamination is a never ending source that remains at a constant concentration. When site specific information was not available, generic default values presented in the Johnson & Ettinger model were used. Generic default values are thought to represent average site conditions and do not necessarily reflect the true site conditions at this particular location.

Because groundwater flow is expected to be in the direction of Kimball Road, the indoor air risk assessment modeled groundwater to indoor air concentrations for fifteen properties along Kimball Road in the vicinity of Bison Corporation. Volatile organic compound concentrations were taken from the groundwater monitoring location nearest each parcel to estimate potential indoor air risks posed by vapor intrusion. Using site specific geologic information along with default values provided in the Johnson & Ettinger model, HzW was able to calculate the theoretical lifetime cancer risk posed to residents living in the homes on the properties modeled. The potential lifetime cancer risk is expressed as the risk of developing cancer for one individual in a specific population exposed to a given concentration of chemical. Generally, an acceptable risk is one additional case of cancer in a population of 100,000 people. This means if 100,000 people were exposed to the same level of contamination, we would expect to see one l case of cancer because of that contamination. HzW was also able to determine whether the potential existed for non-cancer health effects to occur as a result of exposure to vapors in the homes. The non-cancer potential is estimated by looking at a ratio called the hazard index. The hazard index is calculated by dividing the estimated indoor air vapor concentration by a scientifically derived safe level of exposure called a reference concentration. If the result of the calculation is greater than 1 ($x > 1$) then the exposure needs to be looked at more closely to determine if people would be expected to experience adverse health effects.

Results of the Johnson & Ettinger model indicated that the potential existed for vapors to migrate from the contaminated groundwater into overlying homes at levels exceeding acceptable theoretical cancer risk standards and exceeding the hazard index standard (HzW, March 2002). These results suggested that contaminated groundwater at the site posed a potential public health threat to residents along Kimball Road.

Table 2
Summary of Theoretical Risk and Hazard Index from Johnson & Ettinger Model

Parcel #	Chemical	Cancer Risk	Cumulative Risk	Hazard Index	Cumulative Hazard Index[4]
3247 & 3249	PCE	3.0 E-05[1]		**0.49**	
	TCE	4.2E-05[2]			
	Vinyl Chloride	5.0E-06		**0.013**	
	1,1 DCE	5.3E-05	1.3E-04		
	1,1,1 - TCA	NA	**NA**	**0.052**	
	1,1 DCA	NA	**NA**	**0.001**	**0.567**
	Cis- 1,2 DCE	NA	**NA**	**0.15**	**0.15** [3]
39135, 3242, & 3244	PCE	**3.3 E-05**		**0.5**	
	TCE	**2.6 E-06**	**1.6 E-04**	**NA**	
	Vinyl Chloride	**NA**	**NA**	**NA**	
	1,1 DCE	**NA**	**NA**	**NA**	
	1,1,1 - TCA	**NA**	**NA**	**0.012**	
	1,1 DCA	**NA**	**NA**	**0.0014**	**0.071**
	Cis- 1,2 DCE	**NA**	**NA**	**0.1**	**0.1**
3246 & 3248	PCE	**3.3 E-05**		**0.058**	
	TCE	**4.2 E-05**		**NA**	
	Vinyl Chloride	**1.6 E-05**		**ND**	
	1,1 DCE	**6.4 E-05**	**1.6 E-04**	**NA**	
	1,1,1 - TCA	**NA**	**NA**	**0.012**	
	1,1 DCA	**NA**	**NA**	**0.017**	**0.686**
	Cis- 1,2 DCE	**NA**	**NA**	**0.68**	**.068**

Parcel #	Chemical	Cancer Risk	Cumulative Risk	Hazard Index	Cumulative Hazard Index
3250 & 3252	PCE	**1.4 E-05**		**0.23**	
	TCE	**2.2 E-05**		**NA**	
	Vinyl Chloride	**6.1 E-06**		**0.016**	
	1,1 DCE	**1.6 E-04**	**2.0 E-04**	**NA**	
	1,1,1 - TCA	**NA**	**NA**	**0.024**	
	1,1 DCA	**NA**	**NA**	**0.034**	**0.304**
	Cis- 1,2 DCE	**NA**	**NA**	**0.19**	**0.19**
36651 & 3258	PCE	**3.0 E-06**		**0.049**	
	TCE	**3.0 E-05**		**NA**	
	Vinyl Chloride	**3.4 E-06**		**0.0089**	
	1,1 DCE	**3.7 E-05**	**7.3 E-05**	**NA**	
	1,1,1 - TCA	**NA**	**NA**	**0.032**	
	1,1 DCA	**NA**	**NA**	**0.0015**	**0.091**
	Cis- 1,2 DCE	**NA**	**NA**	**0.044**	**0.044**
3251, 3253, 3255, 3257	PCE	**1.5 E-04**		***2.4***	
	TCE	**1.1 E-03**		**NA**	
	Vinyl Chloride	**3.7 E-04**		**0.97**	
	1,1 DCE	**3.9 E-03**	**5.5 E-03**	**NA**	
	1,1,1 - TCA	**NA**	**NA**	***1.3***	
	1,1 DCA	**NA**	**NA**	**0.061**	**4.73**
	Cis- 1,2 DCE	**NA**	**NA**	**0.63**	**0.063**

1. Theoretical cancer risk is presented as the amount of risk in a given population. For example, 3.6 E-04 is the same as 3.6 out of 10,000. This means that if 10,000 people were exposed to the same concentration of contamination that approximately 4 people would develop cancer as a result of that exposure.
2. The toxicity values used to calculate risk from exposure to TCE by HxW in using the Johnson and Ettinger indoor air model were the U.S. EPA National Center for Environmental Assessment (NCEA) provisional values used prior to the publication of the U.S. EPA preliminary draft document titled "TCE Health Risk Assessment:Synthesis and Characterization.". This document has not yet been finalized. The TCE toxicity values used in future risk calculations presented in this PHA are more conservative because they use the U.S. EPA Preliminary draft values that have not yet been finalized.
3. The primary organ of impact is different for Cis- 1,2 DCE than the other VOCs detected. Therefore, it is not included in the Hazard Index calculation.
4. Hazard Index is a measure of the potential for non-cancer health effects. If the Hazard index is above one (1) the exposure needs to be looked at more closely to determine if non-cancer health effects are occurring.

After reviewing the results of the indoor air risk assessment, the Canton City Health Department contacted HAS for assistance in determining what public health actions needed to be taken at the site. HAS, along with the Canton City Health Department, the Ohio EPA Division of Remedial Response and also the Division of Air Pollution Control met on several occasions to discuss possible options and to determine if a public health threat existed.

Usually when there is groundwater contamination, the main pathway of concern is drinking water ingestion. However, in this case, all of the residences in the vicinity of the Bison Corp. use municipal drinking water as their water supply and therefore, their drinking water supply would not be impacted by this groundwater plume. Instead, inhalation of solvent vapors that may migrate into the homes from the shallow groundwater is considered to be the main contaminant pathway of concern at this site.

Residents in the homes along Kimball Road must come into physical contact with the solvent vapors in order for the chemicals to have the ability to cause adverse health effects. In order for residents to come into contact with the solvent vapors there must be a *completed exposure pathway*. A completed exposure pathway consists of five main parts that must be present for chemical exposure to occur. These include: 1) a source of the toxic chemicals of concern; 2) environmental transport, which is a way for the chemical to move from its source to bring it into contact with the residents (soil, air, groundwater, surface water); 3) a point of exposure, which is a place where the residents come into physical contact with the chemical (on-site, off-site); 4) a route of exposure, which is how the residents come into physical contact with the chemical (drinking, eating, touching); and, 5) people who could be exposed, which are people living near the facility who are likely to come into physical contact with site-related chemicals.

Physical contact with a chemical contaminant, in and by itself, does not necessarily result in adverse health effects. A chemical's ability to affect a resident's health is also controlled by a number of other factors including:

- How much of the chemical a person is exposed to (the dose).
- How long a person is exposed to the chemical (the duration).
- How often a person is exposed to the chemical (the frequency).

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

- past chemical exposure
- smoking, drinking alcohol, or taking certain medications
- current health status, sensitivity to certain substances
- age
- family medical history

Subsequent indoor air sampling of residences along Kimball Road indicated that a completed exposure pathway is present in these homes through the indoor air route.

Indoor Air Sampling

The preferred method for investigating potential vapor intrusion issues is to collect soil gas samples to determine if chemicals in the groundwater are volatilizing into the soil and potentially into the indoor air (USEPA Draft Guidance, 2002). However, due to the extremely high level of contamination in the groundwater and the fact that contamination has been shown to be present under several homes, it was decided that the best way to characterize whether the indoor air of adjacent residences has been impacted by vapor intrusion was to collect indoor air samples directly from the homes. This action was taken because the Canton City Health Department, HAS, and the Ohio EPA were concerned that residents were currently being exposed to VOCs at levels that may pose a health threat.

Indoor air samples were collected by the Canton City Health Department and Ohio EPA on November 12-14, 2002 from eleven (11) residential properties which totaled thirteen (13) individual residences along Kimball Road S.E. and analyzed for a full spectrum of volatile organic compounds. Samples were collected in Summa canisters which are small metallic sampling devices about the size of a basketball. Sampling was not limited to only chemicals detected on the Bison Corporation Property. One of the structures was a four-plex apartment of which three of the units were sampled. Sampling canisters were placed in the lowest area of the home and left for 24 hours to ensure that the maximum amount of potential contamination would be detected. Prior to sampling, residents were asked to conduct an inventory of their homes to attempt to remove any household products that may contain VOCs that could affect the sampling results. An inspection of the home was conducted to verify the removal of confounding household chemicals prior to placing the testing canisters.

Analytical results indicated that chemicals identical to those found on the Bison Property were found in the indoor air of all thirteen buildings sampled (Figure 4). Ten of the residences sampled had detections of VOCs that were significantly above the pre-established theoretical cancer risk level of 1 in 100,000 ($1x10^{-5}$). The indoor air risk levels were calculated using provisional cancer slope factors recently developed by U.S. EPA in a draft document titled “TCE Health Risk Assessment: Synthesis and Characterization.” This is a draft document and the slope factors used in this report should be considered draft and have not yet been finalized as official U.S. EPA Guidance. The new slope factors are considerably more conservative than the previous versions. If the previous versions were used, the theoretical cancer risks would have been approximately 100 times less than those presented in this report. A consensus has not yet been reached as to which version of the slope factor is best. For the purposes of this report the newer provisional values that were used in the Draft Vapor Intrusion Guidance Manual were used to calculate theoretical cancer risks. Two residences had considerably lower concentrations that were not immediately able to be matched with the Bison Corporation. It is possible that the lower concentrations are indicative of some other indoor air source or possibly due to regional background levels of gases in the environment. The other structure with detections of site related VOCs was a garage and represented a potential for only short-term exposure and therefore, there was no immediate concern regarding exposure. The indoor air results are presented in Table 3.

Table 3
Indoor Air Sampling Results for Kimball Road Residents
November 2002
micrograms per cubic meter (ug/m3)

Site #	TCE	PCE	1,1,1-TCA	1,1-DCE	cis1,2-DCE	1,1-DCA
1	251.75	377.85	85.13	1.03	29.48	3.44
Cancer Risk[1]	2.8E-02[2]	1.10E-03				
Hazard Index[3]	6.2		0.03	0.005	0.84	0.007
2	30.77	50.65	13.24	ND	2.67	2.59
Cancer Risk	3.5E-03	1.5E-04				
Hazard Index	0.76		0.006	ND	0.07	0.005
3	15.63	72.95	32.95	0.51	0.43	0.49
Cancer Risk	1.7E-03	2.10E-04				
Hazard Index	0.39		0.01	0.003	0.001	0.001
4	8.70	20.95	98.15	3.21	0.43	0.57
Cancer Risk	9.9E-04	6.30E-05				
Hazard Index	0.21		0.04	0.02	0.001	0.001
5	39.47	74.78	170.64	7.17	5.68	1.86
Cancer Risk	4.5E-03	2.3E-06				
Hazard Index	0.98		0.08	0.04	0.16	0.004
6	791.81	353.41	727.85	21.27	10.00	2.92
Cancer Risk	9.0E-02	1.1E-03				
Hazard Index	19.7		0.33	0.11	0.28	0.005
7	171.25	78.99	484.72	5.90	14.58	53.50
Cancer Risk	1.9E-02	2.3E-04				
Hazard Index	4.28		0.22	0.03	0.42	0.11

Site #	TCE	PCE	1,1,1-TCA	1,1-DCE	cis 1,2-DCE	1,1-DCA
8	228.33	123.26	494.26	4.91	16.78	56.46
Cancer Risk	2.6E-02	3.7E-04				
Hazard Index	5.7		0.22	0.02	0.47	0.11
9	225.38	107.73	134.94	1.94	7.41	19.60
Cancer Risk	2.8E-02	3.2E-04				
Hazard Index	5.6		0.06	0.009	0.21	0.04
10	264.20	85.09	99.35	2.26	1.65	0.61
Cancer Risk	3.0E-02	2.5E-04				
Hazard Index	6.6		0.05	0.01	0.04	0.001
11	1.72	2.37	5.34	ND	ND	ND
Cancer Risk	1.9E-04	7.1E-06				
Hazard Index	0.043		0.002			
12	3.65	3.05	3.82	ND	ND	ND
Cancer Risk	4.1E-04	9.1E-06				
Hazard Index	0.09		0.001			
13	3.22	5.09	6.00	ND	ND	ND
Cancer Risk	3.6E-04	1.50E-05				
Hazard Index	0.08		0.002			

1. Theoretical cancer risk is presented as the amount of risk in a given population. For example, 3.6 E-04 is the same as 3.6 out of 10,000. This means that if 10,000 people were exposed to the same concentration of contamination that approximately 4 people would develop cancer as a result of that exposure.
2. Draft toxicity values were used in calculating the cancer (0.4 mg/kg/day) and non-cancer (40.0 ug/m3) health risk for TCE. These values replace previous values used by HzW in the Johnson-Ettinger Model.
3. Hazard Index is a measure of the potential for non-cancer health effects. If the Hazard index is above one (1) the exposure needs to be looked at more closely to determine if non-cancer health effects are occurring.

Evaluation of Indoor Air Sampling Results

HAS, in conjunction with Ohio EPA and the Canton City Health Department, reviewed the analytical results of the November 2002 indoor air sampling event. It was obvious from the initial review of the data that vapor intrusion had occurred in the residences along Kimball Road. Site related chemicals were detected as vapors in all residences at levels that exceeded the predetermined theoretical cancer risk level of 1 in 100,000 for TCE and PCE. A review of the calculated hazard indices indicated that indoor air concentrations currently are not likely to pose non-cancer health effects for the majority of the chemicals detected. However by using newly established draft toxicity data for TCE, the potential for non-cancer health effects did exist for

TCE exposure in seven of the homes sampled. Concern for the possibility of non-cancer health effects exists when the hazard index for the individual chemical exceeds one (1.0). The potential adverse health effects that could possibly be seen are effects on the central nervous system, liver, and endocrine system. The risk of non-cancer health effects could not be determined for PCE because there are no reliable toxicological data available to use as comparison. The potential for PCE to cause adverse health effects is addressed in the theoretical cancer risk calculations in the above table. HAS staff, along with Ohio EPA, and the Canton City Health Department visited the community in December 2002 to hand deliver the results to residents and answer any questions that they may have. HAS staff also attended a community meeting on January 14, 2003 to inform the general community of the results of the indoor air sampling and the proposed plan of action to be followed at the site.

TCE and PCE are considered the primary chemicals of concern because they are present in the highest concentrations and they are also considered to be probable human carcinogens. As mentioned previously, TCE and/or PCE levels exceeded the 1 in 100,000 theoretical cancer risk goal in all thirteen structures sampled. One of the structures was a garage and was eliminated from further consideration. Three other homes had low detections, near the detection limits, of site-related chemicals that could be from an alternate source such as a household chemical or ambient urban air. The contamination in these three homes will need to be confirmed or refuted by conducting additional sampling to establish background levels of TCE and PCE in the area of the Bison Corporation. The remaining nine homes had indoor air concentrations of TCE and PCE that left little doubt as to their source.

Toxicology of the Contaminants of Concern

The primary contaminants of concern in the indoor air of the residents along Kimball Road are TCE and PCE. Both compounds were most recently considered by U.S. EPA to be class B2 carcinogens, which are probable human cancer-causing agents (ATSDR, 1997 A&B). However, the cancer classification for both chemicals has been withdrawn and is currently under review by U.S. EPA. A draft toxicity assessment was recently completed for TCE. Data from this draft assessment was used when developing risk associated with TCE exposure. The Johnson and Ettinger Model completed for Bison by HzW utilized previously released TCE toxicity values. If the new values were used, the predicted risk would have been higher than stated in the model. Both TCE and PCE are VOCs that readily will vaporize upon exposure to the air. However, they have a tendency to leach into groundwater as the result of the infiltration of rainwater through contaminated soils. Both chemicals are normally liquids with specific gravities that are denser than water and tend to sink through an aquifer with time and increasing distance from the original source.

Under anaerobic conditions (oxygen-poor conditions that typically increase with depth below the ground surface), TCE and PCE eventually biodegrade to cis-1,2-dichloroethylene (DCE) and vinyl chloride (VC) (Vogel and McCarty 1985). Currently, cis-1,2 DCE is classified as a class D carcinogen, which is defined as “not classifiable as a human carcinogen” because of inadequate or no evidence of carcinogenicity in humans or animals. Vinyl chloride (VC), normally a gas, is classified by U.S. EPA as a class A carcinogen, a known human cancer-causing agent. It should be pointed out that no VC has been detected in the indoor air of the homes along Kimball Road.

A study of residents living on the east side of Woburn, Massachusetts associated excessive cases of leukemia in children with exposures by their mothers to elevated levels of TCE (187-267 ppb) in the public drinking water supply over the course of 5 to 10 years (Lagako et al. 1984). The impacted well had low levels (<50 ppb) of PCE, 1,2-dichloroethylene, and chloroform as well as TCE. A similar study of residents exposed to trichloroethylene and other chemicals through their drinking water in a New Jersey township indicated an increase in the standard mortality ratio for leukemia in females (Fagliano et al. 1990). In contrast, medical tracking of nearly 5,000 residents at 15 sites in five states that were exposed to TCE through their drinking water supply failed to indicate the development of excess cancer cases in these populations over the course of a 12-year study period (ATSDR 1999). Tracked residents were exposed to varying levels of TCE in drinking water (3-24,000 ppb) for varying periods of time (7-33 years). Adverse health problems showing a statistically significant association with TCE exposure included such non-cancer effects as speech and hearing impairments, anemia, increased incidence of strokes, increased incidence of diabetes, and increased incidence of liver disease, kidney disease, and urinary tract disorders (ATSDR, 1999). The above studies involve exposures to VOCs through drinking water and not inhalation. The data from these studies may not provide the best comparison for the population on Kimball Road but do show some of the possible health effects from exposure to TCE and PCE.

The primary exposure route of concern for this health consultation is inhalation of indoor air. Occupational studies indicate that workers breathing high concentrations of TCE (levels above 70 ppm) on a daily basis experience depression, headaches, dizziness, sleepiness, fatigue, and nausea. Chronic exposure to these levels of TCE in indoor air by workers occasionally resulted in changes in lung function that disappeared within a short time once the worker was removed from the TCE-saturated environment (NIOSH, 1976). Occupational studies of workers in dry-cleaning facilities have indicated that breathing high concentrations of PCE at levels above 50 ppm on a daily basis led to the development of symptoms similar to those described for TCE (NIOSH 1976, 1978 B). The major difference between the two solvents is the retention of PCE in the body for longer periods of time and its ability to accumulate in fatty tissues in the body (NIOSH, 1976). Several studies of workers at dry-cleaning businesses have suggested associations between the development of elevated incidences of urinary tract, kidney, and cervical cancers and chronic exposures to high levels of PCE and other dry-cleaning solvents in the air at their places of work (Katz and Jowett, 1981). These studies were confounded, however, by the presence of carbon tetrachloride, trichloroethylene, and several additional petroleum solvents, in addition to PCE in the indoor air environments. The levels of contaminants detected in the homes along Kimball road are significantly below levels that have resulted in adverse health effects in occupational studies, however due to the presence of elderly residents and children the levels detected still pose a concern.

Health Outcome Data and Community Concerns

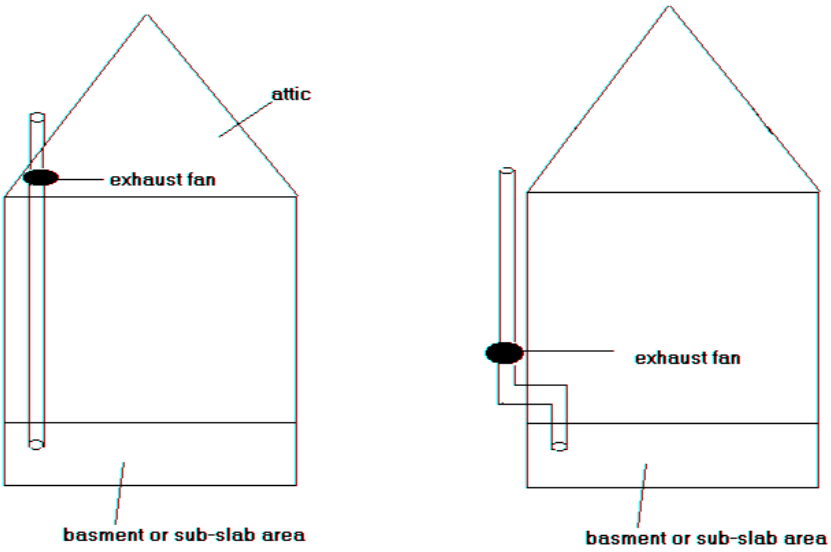
As part of the health evaluation, HAS asked the Community Health Assessment Section of the Ohio Department of Health to look at cancer incidence data along Kimball Road. According to data contained in the Ohio Cancer Incidence Surveillance System database there were only two cases of cancer diagnosed among residents of Kimball Road S.E. from 1996-2002, the years that

the data in the database is most complete. The cancers diagnosed were a lung and bronchus cancer among a 75 year old white male and a melanoma among a 46 year old white male. These cancers would not be suspected to be caused by exposures to the chemicals of concern associated with the Bison Corporation site.

HAS staff attended public meetings hosted by the Canton City Health Department and the Ohio EPA on November 6, 2002 and January 14, 2003 in addition to conducting door to door visits with residents of Kimball Road on December 18, 2002. During these meetings, HAS staff listened to and assisted the Canton City Health Department with answering health questions from residents. Most questions from residents focused on the source of the contamination and how it occurred. Questions also centered on the nature of the contamination and what the company was going to do to clean up the contamination. Other questions focused on how long these chemicals stayed in the environment, if they could be taken up by vegetables in the garden, and the effectiveness of the proposed remediation system to be installed in the affected homes to remove the contaminated air. The health concerns consisted of one elderly resident reported having respiratory problems while another elderly resident reportedly had emphysema and was using supplied oxygen. The remaining residents had general concerns about being exposed to VOCs in the indoor air, but did not have state that they had specific health problems that might be related to the exposure. At these public meetings, HAS also distributed chemical fact sheets for TCE and PCE, the main chemicals of concern at the site (Attachment A).

Interim Actions Taken

Because of the unusually high concentrations of TCE and PCE in the indoor air of eight impacted residences and an apartment building along Kimball Road, HAS, Ohio EPA, and the Canton City Health Department decided that the most protective approach was to pursue immediate remedial action. Ohio EPA began initial negotiations with Bison Corporation to develop orders to install what are known as sub-slab depressurization systems to lower the concentrations of TCE and PCE in the indoor air. The sub-slab depressurization systems operate on the same principle as radon remediation systems installed to lower radon concentrations in homes. The systems involve installing a pipe under either the basement floor or the slab floor of the homes. A small exhaust fan is then attached to the pipe which, in turn, produces a negative pressure environment and draws the vapors from beneath the slab and vents them to the outside air. Examples of system schematics are given below.



System installation began on February 21, 2003 and the final scheduled installation was completed on April 22, 2003. Systems were installed in the seven single-family homes that showed the highest levels of contamination. Two systems were installed under the four-plex apartment and were designed to remediate the indoor air of all four apartments. A final system was installed in a home that had not been previously sampled (Site # 15). This home was chosen because it was known to be located directly over the groundwater contamination plume and also was directly adjacent to two homes that had elevated levels of contaminants in the indoor air. An initial test to determine radon levels before and after system installation indicated that radon levels were significantly lower after system installation. This is a good indication that the system will be effective in removing the VOCs from the indoor air. Confirmation sampling was conducted in early May to determine if the systems were effective in removing the VOCs from the indoor air. Confirmation sampling was not conducted at Site #6 due to the short time between system installation and follow-up sampling. All other homes with systems were sampled and the analytical results indicated that the systems were successful in reducing the concentrations of VOCs in the indoor air. TCE and PCE were still detectable at low levels in several homes, however, the systems may still need more time to reduce the levels to below detection limits. In addition to re-sampling the homes with remediation systems, indoor air samples were also collected from nine additional residential properties and one commercial property. Chemicals similar to those detected on the Bison property were detected in three of the additional buildings sampled. One sample was collected in the basement of a commercial structure that had no residential occupants. The levels of TCE detected were above the 1 in 100,000 theoretical cancer risk level, however because there is no residential occupant, the threat for lifetime exposure does not exist at this time, HAS does not feel that the levels of contaminants present pose a health threat to workers and patrons of the business. A second home (Site #17) that had very low detections was located south of the Bison Corporation. Previous sampling in this area has revealed very low levels

of site related chemicals in the indoor air of nearby homes. While the levels of TCE in these homes do exceed the predetermined theoretical cancer risk value of 1 in 100,000, it is unlikely that the concentrations are high enough to cause adverse health effects due to the conservative nature of the risk calculations. There have not been any credible toxicological studies that show that exposure to TCE at these low levels could result in adverse health effects. However, HAS still has concerns that site related chemicals are being detected in the indoor air of homes and recommends that these homes continue to be monitored to ensure that the concentrations of contaminants do not increase. It is recommended that this monitoring continue until remediation on the Bison Property takes place and we begin to see a decrease in site related chemicals in the vicinity of the impacted homes. The third additional home sampled that showed detections of site related chemicals was located in an area that was thought to be well outside of the contaminant plume associated with Bison (Figure 5). The levels of TCE in the indoor air of the home were in excess of the predetermined 1 in 100,000 theoretical cancer risk level and are similar to levels in homes that have had remediation systems installed. Further evaluation of the groundwater conditions in the vicinity of the home needs to be conducted to determine if contaminants in the home are associated with Bison. HAS also recommends that the home be re-sampled to determine if the detections were just an anomaly or are indicative of usual conditions. If similar concentrations of contaminants are detected in subsequent sampling events, HAS recommends that the homeowners be advised to pursue the option of having a system installed similar to those installed in the homes near the Bison facility.

Table 4
Results of Confirmation and Additional Background Sampling
micrograms per cubic meter (ug/m^3)

Site #	Nov 2002 (Pre-system Installation)		May 2003 (Post-system Installation)	
	TCE	PCE	TCE	PCE
1	251.75	46.88	1.5	1.28
2	30.77	50.65	1.5	1.56
3	15.63	72.95	ND	ND
4	8.70	20.95	2.89	3.05
5	39.47	74.78	ND	ND
6	791.81	353.51	NS	NS
7	171.25	78.99	0.91	ND
8	228.33	123.26	ND	ND

Site #	**Nov 2002 (Pre-system Installation)**		**May 2003 (Post-system Installation)**	
	TCE	**PCE**	**TCE**	**PCE**
9	225.38	107.73	NS	NS
10	264.28	85.09	ND	ND
11	1.72	2.37	NS	NS
12	3.65	3.05	NS	NS
13	3.22	5.09	1.07	1.76
14	NS	NS	101.3	48.48
15	NS	NS	ND	ND
16	NS	NS	ND	ND
17	NS	NS	1.87	3.93
18	NS	NS	ND	ND
19	NS	NS	ND	ND
20	NS	NS	ND	ND
21	NS	NS	ND	ND
22	NS	NS	ND	ND
23	NS	NS	ND	ND
24	NS	NS	NS	4.2

NS = Not Sampled
ND =Not Detected

CHILDREN'S HEALTH CONSIDERATIONS

ATSDR and HAS recognize the unique vulnerabilities of children exposed to environmental contamination and hazards. As part of this health assessment, HAS considered the greater sensitivity of the children in the Kimball Road area when drawing conclusions and making recommendations regarding health effects from exposure to chemicals related to the Bison Corporation.

CONCLUSIONS

1. Levels of VOCs in the indoor air of ten residences posed a “public health hazard” prior to the remediation systems being installed due to the increased theoretical cancer risk posed by long-term exposure to TCE and PCE vapors, and the possibility in seven residences of developing adverse non-cancer health effects from exposure to TCE vapors. Initial confirmation monitoring in the affected homes indicated that the remediation systems have been effective in reducing the concentration of VOC vapors in the homes. Based on the results of the confirmation, the indoor air of the homes with remediation systems currently poses “no apparent public health hazard” to the residents in the homes. Levels of TCE still exist in five homes that exceed the 1 in 100,000 theoretical cancer risk level. However, the concentration of TCE in these homes is barely above the detection limit and there are no known toxicological or epidemiological studies that have shown adverse health effects at these levels.

2. The level of VOCs in the three homes that were not initially offered remediation systems in addition to the additional buildings sampled in May 2003 currently pose “no apparent public health threat” to residents living in the homes. While some of the buildings currently have TCE vapors that exceed the 1 in 100,000 theoretical cancer risk level, the levels detected are very low and there is no current scientific data that indicates that adverse health effects would occur at these levels. People who are hypersensitive to chemical exposure may be at greater risk but it is unlikely that most people would experience any adverse health effects at these levels. Further monitoring is needed at homes with detectable levels of site related chemicals to ensure that vapor concentrations of VOCs do not increase in these homes.

RECOMMENDATIONS

1. The Ohio Environmental Protection Agency should continue to pursue orders with Bison Corporation to conduct a thorough clean-up of the soil and groundwater on the Bison property and in the surrounding residential area.

2. Bison Corporation should continue to sample all homes whose indoor air has been impacted by site related groundwater contamination. Indoor air should be sampled in homes with remediation systems to ensure that they are working properly. Indoor air monitoring should also continue in homes that do not have remediation systems but do have low levels of site related contaminants in the indoor air to ensure that vapor concentrations in the homes do not increase. HAS recommends that the indoor sampling be conducted at a minimum of two times a year with special emphasis being made to conduct sampling in the winter months when the home is likely to be closed up and the potential for vapor intrusion would be the greatest. If the concentrations of site-related chemicals in the indoor air of these homes without systems begin to increase, HAS recommends that these homes be offered remediation systems.

3. The Canton City Health Department and the Ohio Department of Health should continue to be available to residents to provide education and assistance in answering health questions related to exposure to hazardous chemicals.

4. The Ohio Department of Health should continue to be available to review any additional data generated at the site to determine if residents are being exposed to chemicals at levels of health concern.

PUBLIC HEALTH ACTION PLAN

Actions Completed

1. The Canton City Health Department and Ohio EPA conducted a community meeting in November 2002 to announce the discovery of contaminated groundwater beneath the Bison Corporation and the surrounding neighborhood. Plans to conduct indoor air monitoring at potentially impacted homes were also announced. HAS attended the meeting and distributed educational information and answered questions related to health concerns.

2. HAS along with the Ohio EPA and the Canton City Health Department visited the community in December 2002 to deliver indoor air monitoring results to residents. A HAS staff person was available to answer questions regarding possible health effects resulting from exposure to the VOCs detected in the indoor air.

3. The Canton City Health Department and Ohio EPA conducted a public meeting on January 14, 2003 to present the results of the indoor air monitoring project to the community and outline plans for remediation. HAS attended the meeting and answered health related questions.

Actions Planned

1. The Canton City Health Department and the Ohio EPA will conduct additional public meetings to keep the public up to date on any new data that is generated at the site and also to inform the public of any upcoming work to be completed. HAS will attend any new meetings and be available to assist the City of Canton in answering any health concerns expressed by residents.

2. HAS will review any new environmental data collected in relation to the on-going investigation at the Bison Corporation property.

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