Tommy G. Thompson
Governor

Gerald Whitburn
Secretary

State of Wisconsin
Department of Health and Social Services

DIVISION OF HEALTH

1 WEST WILSON STREET
P. O. BOX 309
MADISON WI 53701-0309

October 14, 1994

Mike Degen
DNR Southern District
3911 Fish Hatchery Rd
Fitchburg WI

Dear Mr. Degen:

Here is the final version of the public health assessment for the Refuse Hideaway Landfill Superfund Site in the Town of Middleton. Back in November 1993, we distributed a public comment draft of this assessment. Although we did make changes to the document, our conclusions are the same. A copy of the assessment will be mailed to the Middleton Public Library, 7425 Hubbard Avenue in Middleton today. I sent a copy of the assessment to Jane Lemcke, Cara Norland, and Terri Evanson. If you have questions about the assessment or its distribution, please call me at 267-6844 or Henry Nehls-Lowe at 266-3479.

Sincerely,

Mary Young

Mary Young
Public Health Educator
Section of Environmental Epidemiology
and Prevention

Public Health Assessment for

REFUSE HIDEAWAY
MIDDLETON, DANE COUNTY, WISCONSIN
CERCLIS NO. WID980610604
SEPTEMBER 7, 1994

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

Comment Period Ends:

PUBLIC HEALTH ASSESSMENT

REFUSE HIDEAWAY

MIDDLETON, DANE COUNTY, WISCONSIN

CERCLIS NO. WID980610604

Prepared By:

Wisconsin Department of Health and Social Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

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

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30 day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

Additional copies of this report are available from:
National Technical Information Service, Springfield, Virginia
(703) 487-4650

ATSDR Public Health Assessment

ATSDR developed this fact sheet to provide information about its Public Health Assessments—a term that can be confusing. A Public Health Assessment is <u>not</u> the same thing as a medical exam or a community health study. It can sometimes lead to those things, as well as to other public health activities. ATSDR hopes this fact sheet is helpful to you in understanding what a Public Health Assessment is. You may have questions the fact sheet doesn't answer or need more information about ATSDR and its activities. A contact person is listed at the end of the fact sheet.

What is ATSDR?

ATSDR is the **Agency for Toxic Substances and Disease Registry**, a federal public health agency. ATSDR is part of the Public Health Service in the U.S. Department of Health and Human Services. ATSDR is not a regulatory agency like the U.S. Environmental Protection Agency. Created by Superfund legislation in 1980, ATSDR's mission is to **prevent exposure and adverse human health effects and diminished quality of life associated with exposure to hazardous substances from waste sites, unplanned releases, and other sources of pollution present in the environment.** Through its programs—including surveillance, registries, health studies, environmental health education, and applied substance-specific research—and by working with other federal, state, and local government agencies, ATSDR acts to protect public health.

What is a Public Health Assessment?

An ATSDR Public Health Assessment reviews available information about hazardous substances at a site and evaluates whether exposure to them might cause any harm to people. ATSDR conducts a Public Health Assessment for every site on or proposed for the National Priorities List (the NPL, also known as the Superfund list).

Public Health Assessments consider—

- what the levels (or "concentrations") of hazardous substances are
- whether people might be exposed to contamination and how (through "exposure pathways" such as breathing air, drinking or contacting water, contacting or eating soil, or eating food)
- what harm the substances might cause to people (or the contaminants' "toxicity")
- whether working or living nearby might affect people's health
- other dangers to people, such as unsafe buildings, abandoned mine shafts, or other physical hazards

To make those determinations, ATSDR looks at three primary sources of information—

- ***environmental data***, such as information about the contaminants and how people could come in contact with them
- ***health data***, including available information on communitywide rates of illness, disease, and death compared with national and state rates
- ***community concerns***, such as reports from the public about how the site affects their health or quality of life

How Are Public Health Assessments Used?

ATSDR's Public Health Assessments identify health studies or other public health actions—such as community environmental health education—that might be needed. They advise federal, state, and local agencies on actions to prevent or reduce people's exposure to hazardous substances.

How Is the Community Involved in a Public Health Assessment?

The community plays a key role in a Public Health Assessment and any activity that may follow. Throughout the Public Health Assessment, ATSDR talks with people living or working near the site—action groups, local leaders, and health professionals, among other community members—about what they know about the site and their site-related health concerns. Community health concerns are addressed in every Public Health Assessment for every site.

Two-way communication between the public and ATSDR is vital to every Public Health Assessment. For that reason, ATSDR has many ways to give and receive information and involve the community in its activities, such as—

- **Public Availability Sessions** where community members can meet individually with ATSDR staff.
- **Public Meetings** so community members can express ideas in a larger forum.
- **Community Assistance Panels**, or CAPs, which work to inform ATSDR about community concerns and health information and, in turn, to inform the community about ATSDR activities and the status of the Public Health Assessment.
- Other **communication channels**, such as contact with local community groups, political leaders, and health professionals, as well as articles in local newspapers and stories on television and radio.
- Before the Public Health Assessment is finished, it is available in the community during the **Public Comment Period**. The Public Comment Period lets the community tell ATSDR how well the Public Health Assessment addresses their concerns. ATSDR responds to the public's comments in the final Public Health Assessment.

Fact sheets are available on Public Health Advisories, Health Consultations, Community Assistance Panels, and other ATSDR activities. If you want to know more about ATSDR, or if you have health concerns or information to share about ways people might have been or might now be exposed to hazardous substances, please contact the person listed below.

For more information, call or write:

Community Involvement Specialist
ATSDR-Division of Health Assessment and Consultation
1600 Clifton Road, NE (E32)
Atlanta, Georgia 30333
24-hour, toll-free message service
1-800-447-4784, then 329-1175

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SUMMARY

Refuse Hideaway Landfill is a former landfill located in the Town of Middleton, west of the City of Middleton, in Dane County, Wisconsin. When in operation, from 1974 to 1988, the Superfund site received a variety of municipal, commercial, and industrial wastes.

Groundwater around the site is contaminated with low levels of volatile organic compounds (VOCs), which probably originate from the site. VOC contamination was first detected in 1988 at three private wells located approximately 3,000 feet southwest of the site. These wells provided water for three homes and an agricultural business. A Point-of-Entry water filtration system was installed at two of these wells in 1990 and the system removes all measurable VOC contamination. The third well provided water for a home and private business. This home was vacated in late 1989 and is currently unoccupied. An employee at the business reported, in 1992, the well is no longer used.

Refuse Hideaway Landfill currently poses no apparent public health hazard to nearby residents who obtain their drinking water from private wells. Approximately eight nearby residents and three employees of the agriculture business were evidently exposed to low-levels of VOCs in their well water. It is estimated no individual was exposed to contaminated groundwater for more than four years. Despite these exposures, adverse health effects are not expected in people who were exposed for such a length of time.

No other nearby private wells are identified as contaminated by the site. Refuse Hideaway Landfill might pose a future public health hazard to nearby residents if no actions were taken to clean-up the site. Groundwater samples collected from monitoring wells immediately around the site reveal high levels of certain VOCs. If existing on-site control measures have a negligible effect, higher levels of groundwater contamination might migrate away from the site and reach currently uncontaminated wells.

Refuse Hideaway Landfill is an indeterminate public health hazard to workers at an adjacent sand and gravel business. In 1990 explosive levels of gas were detected twice in a building at the business and the corrective action was taken to eliminated this potential physical hazard. The gas in the building is suspected to have come from the site, yet it is possible the gas came from another source. Landfill gas at the site contains VOCs. If gas in the building came from the landfill then those who worked there may have breathed indoor air contaminated with VOCs. No indoor air samples were collected from the building and analyzed for VOCs. This represents a data gap. Estimates of worker exposure, based on several assumptions, indicate workers are not likely to have any adverse health effects.

BACKGROUND

A. Site Description and History

Description

Refuse Hideaway Landfill (the Superfund site) is located in the SW¼ of the NW¼ of Section 8, T7N, R8E, at 7812 Highway 14, in the Town of Middleton, Dane County, State of Wisconsin (Figure 1). Refuse Hideaway is approximately two miles west of the City of Middleton and is approximately four miles east of the Village of Cross Plains. This former landfill is 23 acres in size and is located on a 40-acre property parcel (Figure 2). The site is situated north of Black Earth Creek [14, P20] and is found in the upper Black Earth Creek watershed. Black Earth Creek is rated as a class I trout stream.

History

Refuse Hideaway, Inc., operated the landfill, which received approximately 1.2 million cubic yards of municipal, commercial and industrial waste from 1974 till 1988 [57]. In 1974, Refuse Hideaway Landfill was licensed by the DNR to receive commercial, municipal, and industrial wastes [53, p1-1]. The landfill owner reported receiving a variety of commercial and industrial waste, including: barrels of glue and paint; barrels of ink and ink washes; spray paint booth by-products and paint stripper sludge; spill residues containing methylene chloride and acetone; and other organic solvents [57]. A liner was not installed in the landfill to function as a barrier underneath the waste materials [14, p20].

In 1986, as the landfill neared its capacity, preparatory work was initiated to shut down operations at the site. The presence of leachate seeps in 1986 and operational problems at the site prompted the DNR to begin regulatory actions against the owner [33]. In 1988 the DNR found contamination of groundwater around the site (Table 2) and nearby private wells. A January 1988 report evaluating site conditions concluded the nearby groundwater contamination probably came from the site [14, p9]. A follow-up sampling program was immediately initiated.

The DNR issued an order in May 1988 requiring Refuse Hideaway, Inc., to stop receiving waste, to close and cap the landfill, to investigate the full extent of contamination, and recommend any necessary remedial measures [53, p1-1]. The 1988 Remedial Action Report, published by RMT, supported the earlier conclusion that nearby groundwater contamination probably came from the site. This report also concluded the extent of nearby groundwater contamination was much greater than previously suspected [53, p2-6]. The owner closed and capped the site according to Wisconsin Administrative Codes in late 1988. Then the owner conducted several investigations and actions, but did not enact all the clean-up actions requested by the DNR [33, p4]. A groundwater investigation was conducted in 1990 and 1991 by a DNR

contractor to find out the extent of off-site groundwater contamination around Refuse Hideaway (Tables 3 and 4) [46].

One private well near the site (PW-2) was sampled for VOCs once in 1986 and no contamination was found [19]. Eight other private wells were sampled in January 1988, and VOC contamination was found in a water sample collected from one home (PW-1) southwest of the site [15].

Private wells were again sampled near Refuse Hideaway in January and March 1988 and it was learned there were three private wells, located approximately one-half mile southwest of the site, that were contaminated, and the contamination was probably site-related. These private wells were contaminated with several VOCs (Table 6) and served eight people. One of these private wells (PW-3) also provided water for three employees of a small agricultural business. Several VOCs detected in the private wells were at levels above the Wisconsin Public Health Groundwater Quality Enforcement Standard [53, p1-1] [69]. The November 1988 Remedial Action Report concluded the site was the probable source of the private well contamination [53, p7-1]. In March 1988 low levels of two trihalomethanes were detected in a private water supply south of the site. This contamination is probably not site-related [22]. In November 1989, the DNR collected water samples from all private wells located within one-mile of the site. The results from this sampling did not reveal contamination in any other private wells.

A supply of bottled drinking water was provided to the three households and the business with contaminated water in early 1988, however residents and employees continued to use contaminated water for other domestic purposes [15]. In October 1988 representatives of the Wisconsin Division of Health (DOH) talked to these people about ways to reduce their dermal and inhalation exposure to contaminants. The household sharing the well with the business (PW-3) was vacated by the tenant in late 1989, and the owner did not rent out the home. One employee at the business reported in 1992 that well water is no longer used. In 1989 the DNR installed a carbon-activated filtration system in the other two homes to clean their drinking water [62, p1-3]. Testing of post filter samples showed the system did not adequately remove all contamination [26]. This system was replaced by the DNR in May 1990 with a larger Point-of-Entry (POE) water filtration system [29]. A regular monitoring program has shown the POE system effectively removes all detectable VOCs. In July 1992 the DNR transferred the POE system ownership, maintenance, and monitoring responsibilities to the homeowners. These POE treatment systems became permanent water systems with the transference of ownership [36]. Bottled water continues is still provided by DNR to the offices of the seed company.

In dealing with the landfill, the DNR determined in 1990 that surface water was eroding the cap. A DNR contractor installed several ditch checks on the cap in July 1990 to reduce erosion [30]. Despite these actions erosion of the cap continued. Additional erosion control efforts were completed by the DNR in Fall 1992.

The level of landfill gas production from the site was much higher than originally estimated when Refuse Hideaway was first designed and opened. Landfill gas could potentially migrate away from the site and possibly cause an explosive hazard in nearby buildings [27]. In December 1989 a partial landfill gas and leachate extraction system was installed at Refuse Hideaway landfill. On two different dates in 1990 an explosive level of landfill gas was detected in a building on the landfill property. Private homes have not been threatened by landfill gas. The situation was corrected by a minor renovation to the building (see page 18). A full gas and leachate extraction system became operational in August 1991 [34]. This system includes extraction wells, connective piping, a gas blower, a gas flaring device, leachate pumps, and a leachate storage tank [30]. The gas flaring device was designed to burn up to 650 cubic feet per minute of gas. In 1992 the device typically burned approximately 400 cubic feet per minute of gas [30]. At the time of a DOH site visit in 1992 over 30,000 gallons of leachate per month were removed from the site [34], and one year later the system was extracting between 10,000 and 15,000 gallons per month, which suggest the cap is effective in reducing leachate production. Landfill gas is no longer detected by gas probes around the site, which suggests the gas extraction system reduces gas levels.

Refuse Hideaway Landfill was proposed for nomination to the National Priorities List (NPL) in August 1991 [33]. The U.S. EPA officially placed Refuse Hideaway on the NPL on October 14, 1992. There has not been previous involvement by ATSDR in matters relating to Refuse Hideaway Landfill.

Geology

The site is located in the glaciated Black Earth Creek valley. The unconsolidated deposits in the valley are of glacial origin and consist of till, outwash, and glacial lake sediments [57]. Black Earth Creek once drained glacial meltwater [14, p20]. Gravel and sand make up most of the deep sediments found in the Black Earth Creek valley, with much thinner glacial deposits found on rocky ridges of exposed bedrock [57]. The thickness of these glacial deposits around the site vary widely. South of the site deposits are over 100 feet deep. Northwest of the site on the ridge deposits are less than 5 feet thick [33, p2].

Bedrock ridges sit high and are exposed north of the site. The bedrock is made up of sandstones overlaid by dolomite [57]. The depth to bedrock slopes steeply to the south of the site [33, p2]. A high degree of bedrock fracturing has been found at various locations around the site [53, p5-4]. The fractures apparently provide a quick route for contaminants to leave the site and enter the sandstone bedrock underlying the site. Groundwater and contaminants move relatively quickly through the bedrock and enter the sand and gravel deposits of the valley southwest of the landfill. However, none of the site-related hydrogeologic reports estimate the rate of groundwater movement through fractures in the bedrock.

Two of the contaminated private wells (PW-1 & PW-3) are 77 feet and 25 feet deep, respectively, and draw water from sand and gravel deposits. The third private well (PW-2) is 181 feet deep and draws water from the contaminated sandstone bedrock.

Groundwater close to the site generally moves to the southwest, toward the Black Earth Creek Valley. Once groundwater approaches Black Earth Creek it follows the regional flow pattern. However, groundwater at the site disperses in a radial pattern. It is thought the groundwater mounding causes this radial flow pattern [33, p3] [46, p7-1]. South of the site, the water table is between 5 to 15 feet below the surface of the ground [14, p25].

B. Site Visit

Two DOH representatives, Henry Nehls-Lowe and Mary Young, visited the site on July 1, 1992 [40] with Terry Evanson, the DNR Project Manager. From State Highway 14 the site appears as a grass covered and mounded hill, nestled up against a ridge running north of the site. Approaching the site from Highway 14 a small catchment basin was seen south of the sand and gravel business. This catchment receives runoff from the entire site. The Project Manager stated this basin is inadequate to handle the large volume of runoff that runs from the site during heavy rains. Testing of surface water collected from this basin, as described in the 1988 Remedial Action report, did show some contamination, but it is difficult to pinpoint the source. When the landfill was operational, leachate from the site may have entered this basin [53].

To reach the site from the east via the access road, one must pass through the operations of a private sand and gravel company, which rents the property from the landfill owner. This property is an operational base and for storing equipment. No quarrying activities occur on the landfill property.

Near the eastern edge of the Superfund site is a fenced area where landfill gas flaring occurs. Access to this compound is restricted by a locked gate. The flaring facility was installed in July 1991 and was operating during the site visit. Landfill gas is collected from extraction wells in the site connected by a system of pipes that converge at the flaring device. The flaring device burns landfill gas at approximately 1,500 degrees Fahrenheit. Flare stack emissions are monitored and meet Wisconsin emission guidelines.

Outside the flaring compound is the leachate pumping station. Similar to the landfill gas collection system, leachate pumped from wells at the site flows into underground pipes, which converge at the collection station. Leachate is regularly hauled away by tanker truck. Automatic alarm systems on the leachate collection system and the flaring device automatically alert the contractor by telephone when either system is overloaded or not operational.

Leachate and landfill gas extraction wells were observed on the site. Riprap is in drainage areas of the cap and locations where cap erosion has occurred or is threatened. At a few

locations waste material (including medical waste) was seen protruding or lying on the surface of the cap. The smell of landfill gas was noted at one location on the site. Surface soil around the site is mainly sand and gravel. Exposed limestone/sandstone outcroppings were seen around the site.

The site is not fenced, however the access road is gated and locked. There was no evidence of trespassing. Some individuals reportedly had a number of unauthorized entries onto the site when it was open and receiving waste. There were no obvious physical hazards seen at the site during the visit. Heavily wooded and steep terrain west and north of the site would discourage people from coming onto the site from those directions. The Project Manager said she has observed turkey and deer tracks on the landfill property.

Homes are at least one-quarter mile from the site. There are approximately 53 homes within one mile of the site. Farming occurs mostly south of the site in the Black Earth Creek valley. Corn was the predominant crop seen growing at the time of the visit. Farm animals were not observed at the farms located around the site. An inactive dairy farm is approximately 1,000 feet south of Highway 14 and approximately 4,000 feet southwest of the site.

The Project Manager pointed out the three private homes and business southwest of the site that have contaminated wells (there are no other private wells with site-related contamination). The two nearest homes with contaminated water are approximately 2,000 feet from the site and on the north side of Highway 14. The third contaminated private well is found at a house another 500 feet west of these homes. An employee at the business stated the water from the well is no longer used. This rental property is part of a seed farm that is south of Highway 14. The inactive dairy farm is 1,000 feet south of the seed farm. Black Earth Creek traverses the seed farm property. Monitoring well P-31 is located near the bank of Black Earth Creek. Well P-31 is 3,500 feet from the site and is the furthest detected point of groundwater contamination.

One mile west-southwest of the site is Deer Run Heights. This neighborhood has 25 homes and all obtain water from private wells. There are an estimated 80 people living here. None of these private wells have shown signs of groundwater contamination, but the neighborhood is in the apparent path of the contaminant plume coming from the site. The DNR tests a selection of these private wells for contamination on an annual basis. Half the wells are tested during one six-month cycle, and the remaining wells are tested during the second six-month cycle. People living in this neighborhood are middle to upper-middle class, and the homes have been built within the last 20-25 years.

C. Demographics, Land Use, and Natural Resource Use

The area surrounding Refuse Hideaway landfill is rural and predominantly agricultural. Corn and soybeans are grown in the Black Earth Creek valley to the east and south of the site. There are many small-scale dairy farms in the Black Earth Creek valley, with an inactive farm located about one mile southwest of the site. Approximately one-half mile

north-northwest of the site is a tree farm. A seed farm (PW-3) is on Highway 14 and 2,500 feet southwest of the site. On the landfill property and to the immediate east of the site is an office, storage and staging area for a sand and gravel company. No quarrying activities are performed on or next to the landfill property. A number of active quarries are located in the vicinity of the site. Local residents reported hearing blasting from some quarries [14, p20].

There are many private homes in the area of Refuse Hideaway Landfill. There are 25 homes in the Deer Run Heights neighborhood and residents report an estimated 80 people living there. Approximately 53 homes are within one mile of the site [57]. This converts to a population of 131, using 3.2 people per household [16, TABLE C-6]. The DNR estimates 14,600 people obtain drinking water from public and private wells within four miles of the site [57]. The Village of Cross Plains has two municipal wells providing water to its 2,362 residents and the wells have a depth of 253 and 295 feet. The Village of Cross Plains is located along the Black Earth Creek. The Town of Middleton is not served by a municipal water supply [18].

Refuse Hideaway Landfill is located in a rural portion of the Town of Middleton, with the western edge of the City of Middleton two miles to the east and the Village of Cross Plains four miles to the west. According to the 1990 Census there are 3,628 persons living in the Town of Middleton. There are 16,774 persons residing within the City of Middleton and the Village of Cross Plains has a population of 2,362. Over 97 percent of the population is white, with the median age between 32 and 33 years, and an average household income between $42,500 and $41,000 [12] [13] [16, TABLE C-1].

D. Health Outcome Data

"Health Outcome Data" refers to records of death and illness. When there is evidence people living near a site have been exposed to contaminants at levels that could lead to an increase in rates of death or disease, a review of health outcome data may be appropriate. A review also may be appropriate if there are reports of unusual clusters of disease near the site or due to specific community health concerns. As discussed in the Pathways Analysis section, despite a completed exposure pathway in the past, there is no evidence of significant public exposure to chemicals from the site that might plausibly result in deaths or illness. One case of skin cancer was reported for an individual who was exposed to contaminated groundwater. The Division of Health also received reports of several prostate cancer cases in the vicinity of the site. See Community Health Concerns Evaluation, on page 29, for further a discussion of these cancers.

COMMUNITY HEALTH CONCERNS

The DOH has solicited community concerns from the public on a number of occasions. This includes at two public meetings (1992 and 1993), correspondence and discussions with specific individuals, and during DNR community interviews [42]. During these contacts,

some citizens have asked health-related questions and expressed general concerns related to the Refuse Hideaway Landfill. The issues they asked includes the following:

- When we hear about how chemicals in groundwater might affect our health we are only told about the adverse health effects from an individual chemical. What are the health effects a person might have when they are exposed to combinations of chemicals detected in the private wells around Refuse Hideaway?

- How often should people living near the site test their wells, particularly private wells that are not in the plume and have not shown any contamination?

- What impact will the health assessment have on the remedial investigation and the clean-up process?

- An individual who lived in a home with contaminated water was recently diagnosed with skin cancer (basal cell carcinoma). Was this cancer caused from exposure to contaminated groundwater coming from the site?

- A number of nearby residents expressed concerns about illnesses in their families, though most acknowledged no obvious ways their family was exposed to contamination from the site.

- The Division of Health received reports of three cases of prostate cancer among males living within three miles of the site. One of these cancers occurred in an individual who lived in one of the households that was later found to have contaminated well water. Would someone exposed to contamination from the site have an increased risk of prostate cancer? Are there an elevated number of prostate cancers in the vicinity of the site?

- Some nearby residents expressed concern that contamination from the site affected the health of a child who lives nearby and was born with an immune system disorder.

- During the DNR interviews, a number of people living near the site stated they were worried about groundwater contamination from farm products (pesticides, fertilizers, etc.).

ENVIRONMENTAL CONTAMINATION AND OTHER HAZARDS

This section of the health assessment describes how "chemicals of concern" are distributed in soil, sediment, water, and biota in and near the site. "Chemicals of Concern" are those that occur above a level where the maximum plausible exposure to the contaminated material might affect human health. This assessment addresses only those contaminants that the authors judge to be present at levels of concern. For carcinogenic chemicals, a level of health concern refers to a concentration where a lifetime of exposure to the most

contaminated material might result in a upper-level estimated risk of more than one cancer for every one million people exposed. Levels of concern are listed as "health comparison values" in Tables 2 through 7. These values frequently differ from regulatory standards or health advisory levels. Subsequent sections of this health assessment discuss whether chemicals of concern do pose a significant threat to public health. A summary of media sampling appears in Table 1.

TABLE 1: Summary of Media Sampling
Refuse Hideaway Landfill
Middleton, Dane County, Wisconsin

Media	Date	Sampler	Location	Parameters
Leachate	1988	RMT[53]	a	VOC, Inorganics, Indicators
Surface Water	1988	RMT[53]	b	VOC, Indicators
	1989	DNR[33]	b	VOC, Inorganics
Groundwater	1987	DNR[14]	b	VOC, Inorganics, Indicators
	1988	RMT[53]	b	VOC, Indicators
	1989	DNR[33]	b	VOC
	1990 & 91	Hydro-Search[46]	b	VOC
Private Wells	1986	DNR[19,20]	c	VOC
	1988	RMT[53]	c	VOC
	1988	DNR[33,21]	c	VOC, Inorganics, Indicators
	1989	DNR[33,24,25]	c	VOC
	1989 & 90	Warzyn[64]	c	VOC
	1990	DNR[28,31]	c	VOC
	1991	DNR[32,35]	c	VOC, Inorganics
	1992	DNR[39,38]	c	VOC, Inorganics
	1993	Hellenbrand[44]	c	VOC

Sampling Locations: a-On-Site; b-Off-Site; c - Private Wells

Definitions: Indicators: A minimum of pH, Conductivity, Alkalinity, Hardness, Dissolved Solids, and certain inorganic compounds.
Inorganics: Inorganic chemicals including heavy metals (lead, chromium, cadmium, etc).
VOC: Volatile Organic Compounds

A. On-Site Contamination

Landfill Gas

On-site landfill gas samples were analyzed for constituent VOCs as part of planning and designing a gas extraction system to control migration of gas away from the landfill [67] [49]. The results of this testing are presented in Table 7.

Refuse/Waste

Refuse Hideaway Landfill received approximately 1.2 million cubic yards of municipal, commercial and industrial waste. The landfill owner reported receipt of hazardous

substances including barrels of printing "ink and ink washes from a local newspaper and printing companies, barrels of glue and paint, spray paint booth by-products, paint stripper sludge, and spill residues containing methylene chloride, acetone" and other solvents.

TABLE 2: On-Site Leachate Sampling Results
1987 & 1988
Refuse Hideaway Landfill
Dane County, Wisconsin

Compound	Well LH-1		Well LH-2	
	8/88 (µg/L)	9/88 (µg/L)	8/88 (µg/L)	12/87 (µg/L)
Benzene	5	56	25	11
1,2-Dichloroethylene	2	5	ND	2
Tetrachloroethylene (PCE)	ND	ND	ND	ND
Toluene	43	99	280	210
Trichloroethylene (TCE)	ND	ND	ND	5
Vinyl Chloride	8	45	ND	3

Source: RMT, Inc. Remedial Action Report for Refuse Hideaway Landfill, Middleton, Wisconsin. November, 1988, Tables 7-6 & 7-7.

ND - Not Detected in the sample.

Leachate

Samples were collected from two of the on-site leachate wells (LH-1 and LH-2) in 1987 and 1988, and analyzed for VOCs and inorganic compounds. The results of this testing appear in Table 2. These samples revealed the presence of a number of VOCs (Table 2) [53, TABLES 7-6 & 7-7]. Both leachate wells are less than 60 feet deep, and are screened in waste material situated above the water table [53, TABLE 4-5]. There are no groundwater monitoring wells within the waste boundaries.

Other media

On-site media sampling was restricted to refuse, landfill gas and leachate. On-site soils and ambient air were not sampled as they are not expected to currently contain contaminants because a clay cap was applied to the site in 1988 and a gas extraction system was installed in 1991. The cap and gas extraction system prevents landfill wastes gases from surfacing on the site.

TABLE 3: Off-Site Groundwater Monitoring Results†
Collected from Shallow Wells
Refuse Hideaway Landfill
Town of Middleton, Dane County, Wisconsin

Compound	June 1987			August 1987			Comparison Value (µg/L)
	Minimum Detected (µg/L)	Maximum Detected (µg/L)	Frequency of Detection	Minimum Detected (µg/L)	Maximum Detected (µg/L)	Frequency of Detection	
Benzene	10*	24*	4/8	0	5	2/6	1.2 [a]
1,2-Dichloroethylene	8	600*	6/8	19	620*	3/6	70 [b]
Tetrachloroethylene (PCE)	34*	530*	7/8	2*	340*	6/6	1 [a]
Trichloroethylene (TCE)	4*	180*	6/8	2	140*	5/6	3.2 [a]
Toluene	1	3	3/8	1	2	2/6	343 [d]
Vinyl Chloride	1*	130*	8/8	20*	200*	3/8	0.7 [c]

† On landfill property, but wells located outside of boundaries of waste/refuse.
* Exceeds Comparison Value.

a Oral Cancer Risk Evaluation Guideline for $1x10^{-6}$ excess cancer risk.
b U.S. EPA's Adult LTHA (Lifetime Health Advisory).
c ATSDR's Chronic Oral EMEG (Environmental Media Evaluation Guideline) for an adult.
d Wisconsin Public Health Groundwater Quality Enforcement Standard.

Source: Creative Resource Ventures, Ltd. Infield Conditions Report on Refuse Hideaway Land. Table 6-3. January 14, 1988.

B. Off-Site Contamination

Groundwater - Monitoring Wells

Groundwater around the site was first found to be contaminated in 1987. These results appear in Table 3. A report issued in January 1988 suggested nearby groundwater contained contamination that could be coming from the site [14]. The November 1988 Remedial Action Report also concluded Refuse Hideaway Landfill as the probable source of contamination found in the nearby private wells. This conclusion was made, in part, because the extent of groundwater contamination around the site was much greater than previously suspected. Samples were collected from 15 off-site groundwater monitoring well clusters and analyzed for VOCs and inorganic compounds. The results of this 1988 investigation for chemicals of potential health concern are shown in Table 3.

This report suggested an excessive build-up of leachate at the landfill was the primary mechanism for contaminant movement from the site and into groundwater. Monitoring wells with the highest VOC concentrations (P-8, P-9, and P-21) located on the landfill property along the south boundary of the Superfund site [46, p1-2]. For each well the water table was no more than ten feet below the surface [53, TABLE 7-2].

TABLE 4: Off-Site Groundwater Monitoring of Shallow Monitoring Wells
December 1990 and January 1991
Refuse Hideaway Landfill
Town of Middleton, Dane County, Wisconsin

Compound	On Landfill Property[a]			Off Landfill Property[a]			Comparison Value (µg/L)
	Minimum Detected (µg/L)	Maximum Detected (µg/L)	Frequency of Detection	Minimum Detected (µg/L)	Maximum Detected (µg/L)	Frequency of Detection	
1,2-Dichloroethylene	3	32	3/9	-	-	0/16	70 [c]
Tetrachloroethylene (PCE)	3*	16*	5/9	2*	114*	5/16	1 [b]
Trichloroethylene (TCE)	7*	28*	4/9	2	12*	3/16	3.2 [d]
Vinyl Chloride	6*	525*	5/9	-	10*	1/16	0.7 [d]

* Level detected exceeds Comparison Value.

a. Monitoring wells located either off or on the Landfill property, but not on the Superfund Site. No monitoring wells are located on the Superfund Site.
b. Oral Cancer Risk Evaluation Guideline for $1x10^{-6}$ excess cancer risk.
c. U.S. EPA's Adult LTHA (Lifetime Health Advisory).
d. ATSDR's Chronic Oral EMEG (Environmental Media Evaluation Guideline) for an adult.

Source: Hydro-Search, Inc. Groundwater Monitoring Study at the Refuse Hideaway Landfill, Middleton, Wisconsin. Table 5-16. Brookfield, Wisconsin: June 24, 1991.

A groundwater investigation was conducted in 1990 and 1991 to determine the extent of off-site groundwater contamination around Refuse Hideaway [46]. This investigation discovered no other private wells showing contamination from the site. During the investigation an additional 27 monitoring wells were installed, increasing the number of monitoring wells around the site to 54. VOC contamination was found in 29 of the 54 monitoring wells, and these results are shown in Table 5. The groundwater investigation reported contaminated groundwater has spread radially at least 1,500 feet around the site [46, p5-18].

This investigation also examined the stratification of groundwater contamination. During drilling of ten monitoring wells, groundwater samples were collected at regular intervals. These samples were analyzed for VOCs. In one well (P-40), VOC contamination was detected in samples collected from 50 to 250 feet. The VOCs detected in this well included tetrachloroethylene and trichloroethylene [46, p5-11].

TABLE 5: Groundwater Monitoring of Off-Site Deep Wells
December 1990 to January 1991
Refuse Hideaway Landfill
Town of Middleton, Dane County, Wisconsin

Compound	On Landfill Property[a]			Off Landfill Property[a]			Comparison Value (μg/L)
	Minimum Detected (μg/L)	Maximum Detected (μg/L)	Frequency of Detection	Minimum Detected (μg/L)	Maximum Detected (μg/L)	Frequency of Detection	
Benzene	1	7*	3/6	-	-	0/15	1.2 [b]
cis 1,2-Dichloroethylene	1	13	2/6	-	1	1/15	70 [c]
Tetrachloroethylene (PCE)	-	3*	1/6	6*	99*	5/15	1 [b]
Trichloroethylene (TCE)	0	10*	1/6	2	11*	4/15	3.2 [b]
Toluene	1	7	2/6	1	58	5/15	343 [e]
Vinyl Chloride	14*	32*	3/6	2*	50*	2/15	0.2 [d]

* Level detected exceeds Comparison Value.

a. Monitoring wells may be located on the Landfill property, but not on the Superfund Site.
b. Oral Cancer Risk Evaluation Guideline for $1x10^{-6}$ excess cancer risk.
c. U.S. EPA's Adult LTHA (Lifetime Health Advisory).
d. ATSDR's Chronic Oral EMEG (Environmental Media Evaluation Guideline).
e. Wisconsin's Public Health Groundwater Quality Enforcement Standard.

Source: Hydro Search, Inc. Groundwater Monitoring Study at the Refuse Hideaway Landfill, Middleton, Wisconsin. Table 5-16. Brookfield, Wisconsin: June 24, 1991.

The 1991 groundwater investigation provided a good characterization of the leading edge of the contaminant plume. The report described the edge of the plume as 3,800 feet southwest from the site. The leading edge of the plume is within the upper 250 feet of the aquifer [46, p7-2]. Figure 2 depicts the approximate boundary of the plume. The three contaminated private wells are found within the southeastern lobe of the plume, and the plume is traveling toward the Deer Run Heights neighborhood. The principle plume constituents described in the 1991 investigation include 1,2-dichloroethylene, tetrachloroethylene, and trichloroethylene [46, TABLE 5-16].

Groundwater - Private Wells

One nearby private well (PW-2) was first sampled for VOCs in July 1986 and no contamination was found. When seven nearby private wells were again sampled in January 1988, VOC contamination was detected in water collected from the PW-1. In February and March 1988 the DNR found three nearby private wells with VOC contamination. Table 6 summarizes the history of contaminant levels in the three private wells. DNR has regularly tested well water samples collected from selected private wells in the vicinity of the site. Private well samples were only tested for VOCs. Other than the three wells there have been no additional private wells near the site showing signs of contamination from the site.

In March 1988, two VOCs were discovered at very low levels in a private well located 1,000 directly south of the site. The two detected trihalomethanes, which were not at levels of health concern, were attributed by the DNR to the chlorine water treatment system installed at the house [22]. However, the owner reported the treatment system was not in operation when the two water samples were collected. The source of contamination is probably not site-related because trihalomethanes have not been detected in any groundwater monitoring wells on or around the site. Furthermore, monitoring wells in the vicinity of the house suggest the contaminant plume is currently to the north and does not threaten this private well. Therefore, the source of this contamination is not known. No other contamination has been found in this private well, which has been tested five other times [43].

The DNR performed inorganic analysis on samples collected from two contaminated private wells (PW-1 & PW-2) in June 1989 [33, TABLE 5]. The DNR also collected one unfiltered sample from one private well (PW-2) in December 1992 [55]. No inorganic chemicals have been detected in these wells at a level of potential health concern. No other private wells have been analyzed for inorganic chemicals. All private wells have not been analyzed for SVOCs, pesticides, or specific organic compounds with a high molecular weight. This represents a potential data gap. The sampling plan of the remedial investigation proposes to test selected private wells around the site for VOCs, SVOCs, inorganic chemicals, pesticides, and specific organic compounds of a high molecular weight (such as PCBs).

TABLE 6: Private Well Contamination
Selected Samples Collected from March 1988 to August 1993
Refuse Hideaway Landfill
Dane County, Wisconsin
All Concentrations in μg/L

Private Well Location and Chemical Detected	1/88	2/88	3/88	9/88	3/89	9/89	2/90	10/90[a]	4/91[a]	10/91[a]	6/92[a]	8/93[a]	Comparison Value (μg/L)
PW-1 (7734 Highway 14)													
cis-1,2-Dichloroethylene	28[d]	47[d]	32	33	36	26	27	-	15	16	18	NT	70[b]
Tetrachloroethylene (PCE)	24*	28*	26*	21*	24*	14*	18*	14*	8*	9*	8*	NT	1[c]
Trichloroethylene (TCE)	8*	8*	9*	9*	10*	8*	8*	5*	4*	5*	4*	NT	3.2[c]
Vinyl Chloride	4*	6*	-	-	-	-	-	-	-	-	-	NT	0.7[e]
PW-2 (7750 Highway 14)													
cis-1,2-Dichloroethylene	NT	21[d]	30	12	12	9	8	-	5	6	5	7	70[b]
Tetrachloroethylene (PCE)	NT	31*	27*	22*	19*	14*	17*	19*	10*	12*	12*	15*	1[c]
Trichloroethylene (TCE)	NT	4	8*	5*	4*	2	3	2	2	2	2	2	3.2[c]
Vinyl Chloride	NT	6*	2*	-	-	-	-	-	-	-	-	-	0.7[e]
PW-3 (7755 Highway 14)													
cis-1,2-Dichloroethylene	NT	NT	2	-	-	-	(Testing of well was discontinued)						70[b]
Tetrachloroethylene (PCE)	NT	NT	3*	-	-	1*							1[c]

* Exceeds or matches Comparison Value.
NT Well Not Tested

a. Point-Of-Entry filtration system in operation and samples drawn from unfiltered water.
b. U.S. EPA's Drinking Water Lifetime Health Advisory
c. Oral Cancer Risk Evaluation Guideline for $1x10^{-6}$ excess cancer risk.
d. The results reported are for the "trans" isomer of 1,2-dichloroethylene.
e. ATSDR's Chronic Oral EMEG (Environmental Media Evaluation Guideline) for an adult.

Surface Water

Surface water samples were collected in December 1987 from three off-site points from the drainage way flowing east along the southern edge of the landfill property. A surface water sample was also collected from the off-site catchment basin that receives runoff from the central portion of the site. It is important to note these water samples were collected from the drainage way and sediment basin when it was frozen over.

Contamination was only found in a water sample collected from the catchment basin. The basin was drained and dredged in the fall of 1992. This contamination included 1,2-dichloroethylene (11 μg/L) [53, p7-32]. These concentrations were likely higher than those expected during spring, summer, or fall because frozen conditions would probably restrict volatilization of contaminants. None of contaminants are at levels of potential health concern.

It is unclear whether the contamination found in this basin is from the site. The catchment basin receives runoff not only from the site, but also from the sand and gravel company's staging area, which is immediately east of the site. Maintenance and repairs of heavy equipment and machinery are done in a garage at the sand and gravel business and could contribute to, or be the sole source of, VOCs detected in these surface water samples.

Indoor Air of a Nearby Building

Gas was detected at explosive levels in a building used by the gravel business, which is on the landfill property and immediately east of the site (refer to page 18 for a discussion of this physical hazard). No gas samples were collected for analysis from the building, which represents a data gap. However, landfill gas samples from the site were analyzed for VOC constituents. The gas detected in this building may have contained similar types and levels of contaminants as found in the on-site landfill gas samples. The estimated levels of these contaminants are in Table 7. See page 27 for the possible health effects from these potential chemical exposures.

Other media

Off-site sampling has been restricted to groundwater and surface water from the run-off catchment basin. Samples have not been collected for soil, air, and biota.

C. Toxic Chemical Release Inventory

A Toxic Chemical Release Inventory (TRI) search was conducted by the Division of Health for the Village of Cross Plains and the City of Middleton zip codes (53528 and 53562 respectively). The TRI is searched to investigate any other sources of the same type of

environmental contamination as found on the Superfund site. Certain manufacturers are required to report to the U.S. EPA of releases to the environment of over 300 hazardous chemicals. This reported information is entered into the automated TRI system. There were no reports in the TRI of the release of hazardous substances also found at the site for the Village of Cross Plains and the City of Middleton zip codes.

D. Quality Assurance and Quality Control

The Wisconsin Division of Health assumes the DNR and contractors fully met standard sampling protocol, unless stated otherwise, including those cited as appendices in referenced reports. These quality assurance and quality control measures were to be followed during the field sampling and measurements, the chain of custody activities, laboratory analytical procedures, and data reporting. The ability of the Division of Health to make valid conclusions depends on the amount and quality of data provided.

TABLE 7: VOC Concentrations of Landfill Gas
On-Site Landfill Gas and
Estimated Indoor Air of Adjacent Building
Refuse Hideaway Landfill
Town of Middleton, Dane County, Wisconsin
All Values in Parts Per Billion

Compound	Highest Level Detected in On-Site Gas (ppb)	Estimated Level in Building (ppb)	Non-Cancer Comparison Values (ppb)
Benzene	2,000	11*	2[a]
1,2-Dichloroethylene	ND	n/a	n/a
Tetrachloroethylene (PCE)	26,000	142	600[s]
Toluene	26,000	142	300[s]
Trichloroethylene (TCE)	23,000	125	n/a
Vinyl Chloride	61,000	320*	2[i]

* Exceeds Non-Cancer Comparison Value.
ND- Not Detected.
a- ATSDR's acute (<30 days) Environmental Media Evaluation Guideline.
i- ATSDR's intermediate (31 - 365 days) Environmental Media Evaluation Guideline.
s- Threshold Limit Value - Short Term Exposure Limit maximum occupational exposure for 15 minutes.

Sources: Warzyn Engineering, Inc. Gas and Leachate Extraction System. Refuse Hideaway Landfill, Town of Middleton, Dane County, Wisconsin. Engineering Design 13928.48. Prepared for the Wisconsin DNR. Madison, Wisconsin: Warzyn, August 1990.

Mostardi-Platt Associates, Inc. Landfill Gas System Destruction Efficiency Tests. A Gaseous Study Performed for Warzyn Engineering, Inc. Refuse Hideaway landfill. Middleton, Wisconsin. Bensenville, Illinois: Mostardi-Platt: September 30, 1991.

E. Physical and Other Hazards

Landfill Gas

Landfill gas generated at Refuse Hideaway Landfill is a potential explosive hazard to persons living and/or working in buildings found near the site. In 1989, landfill gas was found in soil outside of the site perimeter [65, p2]. Monitoring throughout 1990 did not reveal landfill gas in nearby homes, though it was detected in a commercial building adjacent to the site [61, p4] [68].

Landfill gas has been detected at elevated levels in Refuse Hideaway Landfill and is reported to have a high potential for migrating away from the site in the ground [65, p4]. Methane, a primary constituent of landfill gas, is generated from the anaerobic decomposition of organic waste material found at the site. The fractured dolomite bedrock found under the site provides a permeable pathway for landfill gas to move away from the site [65, p6]. Landfill gas could then flow into nearby buildings and homes and accumulate in these structures up to an explosive level. A spark from a furnace, water heater, or other mechanical source could ignite the gas.

In 1990, gas was detected three times at high levels (once at 80% and twice at 100% of the Lower Explosive Limit) in a commercial building located east of the site, but on the landfill property. These explosive levels were found around the base of a toilet in an office of the sand and gravel business. It is possible the septic holding tank was the source of a portion or all of the gas detected in the building, as suggested by the owner/operator of the sand and gravel business [41]. This hazardous situation was corrected when cracks in the floor of the restroom were filled with grout, thus halting the infiltration of gas into the building [68]. Since this time explosive gas has not been detected in this building as a monitoring system continues to operate. When gas was detected in the building it was recommended the business proprietor adequately ventilate the building and place signs on the building warning of the explosive hazard. These temporary measures were recommended until the installation and operation of a gas extraction system, which was expected to reduce the levels of off-site landfill gas [65, p6 & Appendix B].

The gas detected in this building was not tested for constituent chemicals, which is a potential data gap as VOC contamination found in on-site landfill gas samples were at elevated levels. Only landfill gas samples from the site were analyzed for any hazardous constituents. If landfill gas were coming into this building, it could contain chemicals, such as benzene or vinyl chloride, which could pose a health hazard to people even if gas concentrations occurred below 100 percent of the Lower Explosive Level (refer to page 21 for a discussion of this potential pathway). Any future gas samples collected from nearby buildings should be analyzed for constituent chemicals.

A combination landfill gas and leachate extraction system was installed at the site on July 1991 to reduce landfill gas migration away from the site [27]. The extraction system has significantly reduced or eliminated off-site migration of landfill gas.

PATHWAYS ANALYSES

There are several ways people are exposed to contamination from a site. This section of the health assessment describes how people may become exposed to site-related contaminants.

A "Completed Exposure Pathway" are those pathways where there are clear indications people were exposed to contaminants from the site and when there is sufficient information to evaluate such an exposure. All five of the pathway elements must exist for there to be a "Completed Exposure Pathway" (a description of these five elements is found in Appendix D). This considers exposures likely occurred in the past and these exposures are currently occurring. A "Potential Completed Pathway" is when there is insufficient information to link a contaminant or chemical to a known level of exposure among an identified population. A "Potential Completed Pathway" refers to when an exposure may have occurred in the past, is probably occurring, or may occur in the future. An exposure pathway can be eliminated from consideration if at least one of the five elements is missing and will never be present.

A. Completed Human Exposure Pathways

Past: Groundwater - Private Wells

An estimated eight people living in three households southwest of the site apparently were exposed to contaminated groundwater. Additionally, three employees at the seed business probably were exposed to contaminated groundwater during their working hours. The exposure routes from the domestic use of contaminated groundwater includes ingestion, inhalation, and dermal absorption.

Once contamination of these private wells was found, actions were taken to reduce and eliminate human exposure to contaminants. A supply of bottled drinking water was provided to the three households and business in early 1988. However, contaminated water was still being used for other domestic purposes. In October 1988 representatives of the Wisconsin Division of Health (DOH) advised these people of methods to reduce their inhalation and dermal exposure to contaminants.

To halt all exposures to contaminated groundwater the DNR installed a carbon-activated filtration system in July 1989 at two of these homes (the third home was no longer occupied) [62, p1-3]. Initially all contamination was removed, but post-filter sampling later found this filtration system was beginning to fail [26]. This system was replaced by the DNR in May 1990 with a POE (Point-of-Entry) water filtration system [29].

Subsequent monitoring has shown the POE system effectively removes all detectable VOCs. VOCs are still being found in unfiltered water. The POE treatment systems have become permanent water systems for these homes [36]. The household sharing the well with the business (PW-3) was eventually vacated by the tenant in late 1989, and the owner did not rent out the home. One employee at the business (7755 Highway 14) stated the well is no longer used. The DNR continues to provide bottled water to the business.

This health assessment assumes people living in these households were exposed to contaminated groundwater for no more than four years. When private well contamination was first found in January 1988 these residents probably were not exposed to contaminated well water for more than two years. A water sample collected in July 1986 from one private well west of the site (PW-2) which did not reveal signs of contamination [19]. Despite a bottled water supply and efforts to reduce dermal and inhalation exposure, it was not until May 1990, four years later, the installed filtration system was shown to be removing all detectable contaminants from their water.

The assumption that people who lived in nearby households with contaminated groundwater, and were exposed for no more than four years, is based on a single August 1986 water sample collected from one well (PW-2) that showed no contamination. This water sample was collected by the DNR. While one water sample may not completely depict VOC contamination of an aquifer, there is no information which suggests this water sample was improperly collected and analyzed, nor is evidence available that shows contamination was present prior to the sampling date. Therefore, the authors interpret This sample as accurate in showing VOC contamination was not present in these private wells at levels above the method detection limits before August 1986.

As stated under Quality Assurance and Quality Control (page 17), the Division of Health expects all groundwater samples collected and tested fully met standard sampling protocols, unless otherwise stated. The ability to make valid conclusions depends on the quality of data provided.

B. Potential Human Exposure Pathways

Future: Groundwater - Private Wells

Contaminated groundwater coming from the site has not been detected in other nearby private wells. DNR is conducting an ongoing program to monitor the movement of the contaminant plume. Selected private wells in the Deer Run Heights neighborhood are sampled every six months. This monitoring program will alert the DNR to any changes in the location of groundwater contamination and provide advance warning of potential threats to nearby residents.

If the site was not cleaned-up and the contaminant plume continued moving away from the site, contaminated groundwater might reach Deer Run Heights neighborhood at sometime in the future. This represents a future potential pathway. Deer Run Heights neighborhood is approximately one mile west-southwest of the site and is in the apparent path of the contaminant plume, which is less than 1,300 feet from the nearest home. There are an estimated 80 people living in 25 homes in this neighborhood.

In March 1992 the DNR received a report from a contractor which used a mathematical model to analyze and predict future movement of the contaminant plume. This study was conducted, in part, to evaluate the possibility of the plume reaching residential areas in the vicinity of the site. Using conservative assumptions (low degradation, low dispersion, no source remediation and other variables) one scenario predicted a low level of tetrachloroethylene (1 μg/L) might be detected in those Deer Run Heights homes closest to the site in as little five years. However, the report states such information is not conclusive because of "inherent uncertainties in model input parameters" [47].

Past: On-Site Waste

When the landfill was operational, people who regularly went on the site and came in contact with waste material may have been exposed to hazardous substances. However it is difficult to estimate and evaluate such potential exposures because many details of are unavailable. No data were collected about ambient air quality, the constituents of surface leachate, nor the quality of surface water runoff.

It is not known if workers at Refuse Hideaway were exposed to any hazardous substances at levels that exceeded levels established by the U.S. Occupational Safety and Health Administration (OSHA). Consequently, it is difficult to estimate the types and levels of contaminants these individuals may have been exposed to. Workers may have inhaled or come in contact with hazardous materials as a normal part of receiving and handling waste.

There are reports of nearby residents who frequently went onto the site to inspect the landfill and retrieve samples of waste. When these residents came onto the site, they may have received an exposure similar to workers. In 1991, a 71 year-old resident, who regularly went on the site, died of adenocarcinoma of the pancreas. Contaminated groundwater from the site has not reached the private well at this person's home. The many unknowns make it difficult to attribute this cancer to potential exposures received during site visits. Furthermore, there may have been non-site related factors that predisposed this individual to cancer.

Past: Indoor Air of a Nearby Building

People who worked in a building adjacent to the landfill may have breathed air containing site-related VOCs, but no air sampling data are available. Consequently, this

represents a data gap. Estimates of indoor air contaminant concentrations can be made only by making several assumptions.

On three occasions in 1990 gas was detected at explosive or near explosive levels around the base of a toilet in this nearby building, which is used by a sand and gravel business (see page 18). Though this gas is suspected of originating from the landfill, part or all of the gas found around the toilet could have come from the septic holding tank, which is less than 6 feet away and connected to the toilet.

While the gas entering the building was tested for a potential to explode, samples were not collected and tested for chemical analysis. Gas samples collected from the landfill were analyzed and showed elevated levels of a number of VOCs. Gas found in the building may also have contained a similar mixture of VOCs as the gas found in the landfill. Gas entering the building may have contained as much as 15 percent methane by volume, while methane levels in gas from the landfill were measured at 55 percent by volume [49] [67]. Any landfill gas entering the building would quickly mix with the air, diluting the levels of VOCs and methane. Consequently, any VOCs present in the gas detected in the building the concentrations were probably lower than the levels measured in on-site landfill gas.

The lack of data on gas constituents make it difficult to draw conclusions about a potential worker exposure without relying on a number of assumptions. A potential exposure for workers, presented in Table 7, can be estimated by assuming: 1) all gas entering the building originated entirely from the landfill; 2) the gas had a VOC mixture similar to that measured in landfill gas; 3) VOC concentrations in the gas entering the building was 15/55ths of that measured in gas samples taken from the landfill; 4) once landfill gas entered the building the levels of VOCs and methane would be diluted by air in the building such that air containing an average of two percent landfill gas by volume; 6) workers were in the building for no more than eight hours per day; 7) and landfill gas was present in the building for a period no longer than 30 working days.

PUBLIC HEALTH IMPLICATIONS

A. Toxicological Evaluation

The chemicals in groundwater of potential health concern at Refuse Hideaway Landfill include cis-1,2-dichloroethylene, tetrachloroethylene, trichloroethylene, and vinyl chloride (Table 6). Chemicals of potential health concern in indoor air include benzene, tetrachloroethylene, toluene, trichloroethylene, and vinyl chloride.

Groundwater

cis-1,2-Dichloroethylene (DCE)

People apparently were exposed to groundwater contaminated with cis-1,2-dichloroethylene (DCE) at three homes and one private business near Refuse Hideaway Landfill. These people probably ingested DCE when drinking contaminated water, inhaled DCE vapors released from domestic use of contaminated water, and absorbed DCE through their skin while bathing in contaminated water. DCE continues to be present in unfiltered water samples collected from two of these homes (PW-1 & PW-2), but the installation of the POE filters removes the all measurable levels of contaminants from the water.

People living in the homes and working at the seed business probably were exposed to DCE for no more than four years. The highest detected levels of DCE were found in private wells during 1988 and 1989, and were 36 μg/L (PW-1), 30 μg/L (PW-2), and 2 μg/L (PW-3).

Past exposure to cis-1,2-dichloroethylene is not likely to affect the health of people who live in nearby homes with contaminated well water. The highest level of DCE found in a private well (36 μg/L) is not known to be detrimental to human or animal health [6] [59]. Refer to Appendix E for supporting information.

If Refuse Hideaway Landfill were not cleaned-up the higher levels of DCE-contaminated groundwater could move away from the site and possibly increase DCE contamination in found in the unfiltered water of private wells or reach other private wells that are not currently contaminated. One shallow monitoring well on the landfill property and adjacent to the site (P-8), had DCE levels over 600 μg/L (Table 3). It is unknown how a person's health would be affected if they were exposed long-term to 300 μg/L of DCE in drinking water (assuming there was a 50 percent dispersion and degradation of the 600 μg/L concentration). There is a little information about the possible health effects from a chronic exposure to such low levels of DCE.

Tetrachloroethylene (PCE)

People living in three households and working at the private business near the site evidently were exposed to groundwater contaminated with tetrachloroethylene (PCE). These people probably ingested PCE when drinking contaminated water, inhaled PCE vapors released from the domestic use of contaminated water, and absorbed PCE through their skin while bathing in contaminated water.

Tetrachloroethylene was detected in the three private wells at the highest levels during March 1988: 26 μg/L (PW-1), 24 μg/L (PW-2), and 3 μg/L (PW-3). PCE continues to be present in unfiltered water samples collected from two of these homes (PW-1 & PW-2), but POE filtration system, installed in May 1990, removes all measurable levels of PCE. People living in these households and working at the seed business were probably not exposed to contaminated well water for more than four years.

Past exposure to tetrachloroethylene in well water poses "no apparent increased cancer risk" to people who used water from contaminated wells. The highest level of PCE detected in a private well (26 μg/L) is not expected to cause any other adverse health effects.

EPA formerly categorized PCE as probable human carcinogen, but this classification is currently being re-evaluated. The Department of Health and Social Services indicates PCE may reasonably be anticipated to be a carcinogen because it causes cancer in laboratory animals. Assuming PCE is a carcinogen a person would have "no apparent increased risk" of cancer if they were exposed for four years to drinking water contaminated with PCE at a level of 26 μg/l. Some studies have suggested a potential relationship between exposure to PCE and some forms of cancer, but these human and laboratory animal studies are inconclusive [8, p60]. There is no conclusive evidence that shows PCE causes cancer in humans. Laboratory mice have shown increases in liver cancer when exposed to much higher levels of PCE than what was found at the site (386 mg/kg/day or the drinking water equivalent of 13,510 μg/L) [8, p28]. See Appendix E for supporting information.

If the site were not cleaned-up PCE-contaminated groundwater could reach residential wells farther away from the site. One shallow monitoring well on the landfill property and adjacent to the site (P-8), had a PCE concentration of 530 μg/L. Taking this hypothetical situation one step further and assuming PCE is a carcinogen (as previously classified by the U.S. EPA), a person exposed to one-half of this concentration of PCE (265 μg/L) for thirty years, they would have a moderate increased cancer risk. Refer to Appendix E for supporting information.

Certain individuals are suspected of being more susceptible to adverse health effects from a PCE exposure than most people. The reasons for a person's increased susceptibility may include genetic makeup, age or developmental stage, health and

nutritional status, and a history of previous chemical exposures. A PCE exposure might have a greater affect on an individual with a chronic liver or kidney function problems. Children or unborn babies may be particularly susceptible to the toxic effects of PCE [8, p56]. There are no known non-cancer health effects people would experience if they were exposed to 265 μg/L (half of this concentration assuming a 50 percent dispersion and degradation of the 530 μg/L concentration in P-8).

Trichloroethylene (TCE)

People living in two nearby households were probably exposed to drinking water contaminated with trichloroethylene (TCE). These people probably ingested TCE when drinking contaminated water, inhaled TCE vapors released from domestic use of contaminated water, and absorbed TCE through their skin while bathing in contaminated water.

The highest levels of trichloroethylene found in the private wells levels were 8 μg/L (PW-2) and 10 μg/L (PW-1), which was during 1988 & 1989. TCE continues to be present in unfiltered water samples collected at two of the homes, but a POE filter system installed in May 1990 removes all measurable levels of TCE. It is estimated people in these households probably were exposed to TCE for no more than four years.

Past exposure to TCE in private well water around the site poses "no apparent increased cancer risk" to people who used water from the contaminated wells. The highest level of TCE detected in a private well (10 μg/L) is not known to have any adverse, non-cancer health effects.

The EPA formerly categorized trichloroethylene as probable human carcinogen, but this classification is currently being re-evaluated. There is no definitive evidence that shows TCE causes cancer in humans, but some studies suggest higher concentrations of chemical may cause cancer in laboratory animals. An increase in liver cancer was found in laboratory mice when exposed to a high level of TCE (the drinking water equivalent of 35,000 mg/L), but the results are not conclusive [7, p27]. If it is assumed TCE is a carcinogen, as previously defined, a person would have no increased risk of cancer if they were exposed for four years to drinking water contaminated with TCE at a level of 10μg/L. Refer to Appendix E for supporting information.

Some people are more susceptible to adverse health effects from TCE exposure than most of the population. People who drink alcohol or are treated with disulfiram (Antabuse), may have problems with excreting TCE. The presence of alcohol and/or disulfiram limits the effectiveness of the liver and inhibits the removal of TCE and its by-products. The net effect could be a lengthening of TCE exposure by a delay of its removal from the body. Individuals who smoke may increase their risk of gene damage with an exposure to TCE [7, p58].

If the site was not cleaned-up higher levels of TCE-contaminated groundwater might migrate away from the site and possibly increase TCE contamination found in private wells or reach currently uncontaminated private wells. The highest level of TCE detected in groundwater was 180 μg/L (Table 2), which was sampled from a monitoring well located on the landfill property, but not on the site. Taking this hypothetical situation one step further and assuming TCE is a carcinogen, a person exposed to 90 μg/L of TCE for thirty years (assuming there was a 50 percent dispersion and degradation of the 180 μg/L concentration) would have a low increased risk of cancer. There are no other known adverse health effects people would experience if they were exposed to such a TCE concentration in their domestic water supply. Refer to Appendix E for supporting information.

Vinyl Chloride

People were evidently exposed to groundwater contaminated with vinyl chloride at two homes near Refuse Hideaway Landfill. These people may have ingested vinyl chloride when drinking contaminated water, inhaled vinyl chloride vapors released from domestic use of contaminated water, and absorbed vinyl chloride through their skin while bathing in contaminated water. Vinyl chloride was reported to be found in these two wells only in early 1988. The highest vinyl chloride concentration found in each private well was 6 μg/L (February 1988). Vinyl chloride was not detected again in any private well samples, although other VOCs continued to be found.

It is assumed vinyl chloride was not present in well water for more than two years. This two-year exposure to vinyl chloride in private well water poses "no apparent increased cancer risk" to people who used water from the contaminated wells. (Refer to Appendix E for supporting information). Also, exposure to such a level of vinyl chloride in drinking water for two years is not known to cause any adverse, non-cancer health effects.

Most of what is known about how vinyl chloride affects human health is from studies of people exposed in the workplace. Such occupational exposures to vinyl chloride are well above that seen in these private wells. Vinyl chloride is identified as a known human carcinogen because people who inhaled very high concentrations in the workplace and over a number of years were shown to have a significantly increased risk of developing liver cancer [10].

If the site were not cleaned-up groundwater contaminated with vinyl chloride could move away from the site and possibly reach residential wells farther away from the site. One shallow monitoring well on the landfill property and adjacent to the site (P-21), had a vinyl chloride concentration of 525 μg/L. A person exposed to one-half of this concentration of vinyl chloride (263 μg/L) for thirty years, they would have a "high increased cancer risk." Refer to Appendix E for supporting information.

Indoor Air

The indoor air of a building used by the nearby sand and gravel business may have contained volatile organic compounds. If VOCs were present, people who worked in the building may have breathed these contaminants. We do not know if this indoor air contained VOCs because indoor air was not tested for contaminants, which represents a data gap (see page 21). An estimate of worker exposure can be made only by relying on a number of assumptions. Consequently, it is difficult to evaluate the validity of these estimated levels. However, using these assumptions workers are not expected to experience adverse health effects because they were probably exposed to relatively low levels of contaminants for no more than 30 working days.

Benzene

Workers at the business adjacent to the landfill may have breathed the air inside of a building that contained benzene. The highest estimated benzene concentration in the air was calculated at 55 ppb (parts per billion)(Table 7). We assume workers were not exposed for a period longer than 30 days. Though this is above the protective comparison value of 2 ppb, no adverse health effects are expected from such an exposure [4].

Tetrachloroethylene (PCE)

People who worked at the sand and gravel business next to the landfill and breathed air inside of one building may have inhaled tetrachloroethylene. These workers probably were not exposed to PCE for longer than 30 days. The highest estimated level of PCE in indoor air was 760 ppb, which is above the comparison value of 600 ppb. However, no adverse health effects are expected from such an exposure to PCE for a 30-day period [7].

Toluene

Workers at the business operating possibly breathed indoor air for no more than 30 working days which contained toluene. The highest level of toluene in this air was calculated to be 709 ppb, which is above the comparison value of 300 ppb. Yet, there is no evidence the health of people or laboratory animals are adversely affected by such a level of toluene [9].

Trichloroethylene (TCE)

People who worked in a building at the sand and gravel business may have breathed air containing trichloroethylene (TCE). It is estimated the highest level of TCE in the indoor air of the building was 627 ppb, and TCE was present in this air for no more

than 30 working days. There are no expected human health effects from this exposure [7].

Vinyl Chloride

People who worked at the nearby building may have breathed indoor air that was contaminated with vinyl chloride. Vinyl chloride in air of the building was estimated to have reached a level as high as 1,600 ppb, or 1.6 ppm (parts per million), which is above the comparison value of 2 ppb. This value is based on a laboratory study of rats which had an intermediate inhalation exposure (for 6 hours per day over six months) to 10 ppm of vinyl chloride [10]. We do not expect the health of workers to be adversely affected from a vinyl chloride exposure at 1,600 ppb for thirty days.

B. Health Outcome Data Evaluation

A review of health outcome data is appropriate when there is evidence of people who have been exposed to contaminants at levels that might plausibly lead to an increase in rates of death or illness. "Health Outcome Data" refers to records of death and/or illness. A review of health outcome data might also be appropriate if there are reports of unusual clusters or higher-than-expected levels of specific diseases or illness near a site, or due to a specific community health concern.

A single individual who lived in a nearby house with contaminated groundwater (PW-2) was diagnosed in 1990 with basal cell carcinoma, a form of skin cancer. The Division of Health has not received additional reports of this cancer type among people living near Refuse Hideaway Landfill who may have been exposed to contaminants from the site. See page 30 for further discussion of this community health concern.

The Division of Health received reports of three cases of prostate cancer among males living within three miles of the site. One of these cancers occurred in an individual who lived in one of the households that was later found to have a contaminated well. Refer to page 31 for a discussion of this community health concern.

The estimated levels of exposure to contaminants from the landfill are not expected to affect people's health. Therefore, further analysis of health outcome data is not appropriate. This conclusion is based on existing data from the investigations on and around Refuse Hideaway Landfill and current information on diseases caused by contaminants detected at the site. Such a study may be desirable if additional data become available showing that people living around Refuse Hideaway Landfill were exposed to a much higher level of contaminants than has been shown.

C. Community Health Concerns Evaluation

- **When we hear about how chemicals in groundwater might affect our health we are only told about the adverse health effects from an individual chemical. What are the health effects a person might have when they are exposed to combinations of chemicals detected in the private wells around Refuse Hideaway?**

People who drink groundwater contaminated from a nearby hazardous waste site usually have simultaneous exposures to a number of chemicals. There is limited information available about how each of one these chemicals can affect human health. Even less is known about how pairs or combinations of these chemicals might produce a more powerful adverse health effect than is expected from simply adding the individual known health effects. An amplified health effect from two or more chemicals is called synergy. Synergism is when two or more substances cause an effect that is greater than what is expected from adding the effects of the individual substances.

Certain combinations of chemicals are known to have a synergistic effect on human health, but no such combinations of these substances have been found in groundwater or contaminated private wells near Refuse Hideaway. The contaminants detected in groundwater, at levels exceeding the Wisconsin Groundwater Enforcement Standard, include benzene, tetrachloroethylene (PCE), trichloroethylene (TCE), and vinyl chloride. Groundwater carrying these contaminants is moving to the southwest and away from the site. The contaminants 1,2-dichloroethylene, PCE, TCE, and vinyl chloride have been found in nearby private wells and are chemicals of concern.

Human and laboratory animal studies have suggested some contaminants found at the site may interact with each other or with other chemicals. Consumption of alcoholic beverages can reduce how quickly the body excretes TCE and vinyl chloride. The presence of other VOCs may suppress the removal of TCE from the body [10] [7].

Some people may be unusually susceptible to an exposure from trichloroethylene or tetrachloroethylene. Refer to the toxicological evaluation of PCE and TCE for a discussion of these unusual susceptibilities.

- **How often should people living near the site test their wells, particularly private wells that are not in the plume and have not shown any contamination?**

The DNR is conducting regular private well sampling of selected homes in the Deer Run Heights neighborhood, which is evidently in the path of the contaminant plume. The ongoing testing of groundwater collected from monitoring wells around the site should show if contamination is moving toward any other nearby homes.

- **What impact will the health assessment have on the remedial investigation and the clean-up process?**

A health assessment evaluates how a Superfund site may be affecting the health of people living near the site. In preparing the health assessment, the Division of Health can make recommendations that could affect the remedial investigation and/or the clean-up process. The Division of Health could recommend more information be collected if the remedial investigation is not adequate to evaluate how people are affected by the site. The Division of Health could also recommend an additional clean-up action be undertaken if those being considered for a Superfund site do not adequately protect public health.

- **An individual who lived in a home with contaminated water was recently diagnosed with skin cancer (basal cell carcinoma). Was this cancer caused from exposure to contaminated groundwater coming from the site?**

It is very difficult to show a single episode or cluster of cancer was caused by an exposure to a known cancer-causing substance. People who have a long-term or lifetime exposure to the specific chemicals found in two private wells may have an increased cancer risk. Because residents of the households with contaminated water were probably exposed to these chemicals for no more than four years, these residents are expected to have no apparent increased risk of contracting cancer.

There is no information suggesting any of the VOC contaminants found in groundwater may cause basal cell carcinoma. A literature search did not reveal any information about a potential relationship between basal cell carcinoma and any of the eight contaminants detected in groundwater known or suspected to cause cancers (benzene, 1,2-dichloroethane, 1,1-dichloroethylene, 1,2-dichloropropane, methylene chloride, tetrachloroethylene, trichloroethylene, and vinyl chloride). Please note only four of these contaminants were found in water samples collected from nearby private wells.

Non-melanoma skin cancers are the most common forms of cancers found in the fair-skinned population of the United States [50, p11]. State cancer registries, including the Wisconsin Cancer Reporting System, do not collect information from hospitals and health care providers about occurrences of non-melanoma skin cancers. Therefore, the incidence of basal cell carcinoma in Wisconsin must be calculated based on national studies and census information. An estimated 500,000 new cases of non-melanoma skin cancers occur in the U.S. each year, of which 80 percent are basal cell carcinoma. Extrapolating this, an estimated 6,400 cases of basal cell carcinoma occur annually in Wisconsin [50], with approximately 150 cases diagnosed in people 24 to 35 years old (the age group of the diagnosed individual). Most cases of skin cancer are thought to be sun-related. People who work with coal tar, pitch, creosote, or radium are also thought to have an increased risk of skin cancer [2].

There is strong evidence that people ingesting low levels of inorganic arsenic may have an increased risk of skin cancer [3, p50]. Arsenic is classified as a known human carcinogen by the U.S. EPA and the U.S. Public Health Service [58] [3, p65]. A very

low level of arsenic was found in one groundwater monitoring on the landfill property, but it was below the Wisconsin Groundwater Enforcement Standard of 50 μg/L [53, TABLE 7-9]. Arsenic was not detected in water samples collected in June 1989 from two private wells, including the well where the individual with this cancer lived [33, TABLE 5]. Results of water testing also in December 1992 and May 1993, from the private well at this home, did not show a detectable level of arsenic [55].

- **A number of nearby residents expressed concerns about illnesses in their families, though most acknowledged no obvious ways their family was exposed to contamination from the site .**

Extensive sampling has shown groundwater is the only significant pathway that transports contaminants away from the site. Among all of the private wells near Refuse Hideaway only three private wells are known to be contaminated. It is unlikely nearby residents came in contact with contaminants by other pathways, unless they came onto the site or worked at the sand and gravel business, where they may have inhaled landfill gas. There are no other pathways which are shown to transport contaminants away from the site.

- **The Division of Health received reports of three cases of prostate cancer among males living within three miles of the site. One of these cancers occurred in an individual who lived in one of the households that was later found to have contaminated well water. Would someone exposed to contamination from the site have an increased risk of prostate cancer? Is there an elevated number of prostate cancers in the vicinity of the site?**

Prostate cancer is receiving increased attention by the American public. Each year the number of prostate cancer cases steadily grows. Prostate cancer is the second most common cancer in men and an estimated one in eleven men will develop prostate cancer at sometime in their life [2].

A number of factors are suspected of increasing a person's risk of prostate cancer, but much about its causes remain unknown. The incidence of prostate cancer increases with age more rapidly than any other cancer. Other factors which increase the risk of prostate cancer include eating high amounts of fat, use of tobacco products, and practice of certain sexual activities. Men who live in industrialized countries have much higher rates of prostate cancer compared with men from nonindustrialized countries. Some studies found an association between occupational exposures to certain heavy metals (such as cadmium) and an increased risk of prostate cancer, but this remains controversial (39). These heavy metals have not been found at elevated levels in the environment on or around Refuse Hideaway Landfill. There have been no studies that suggest a relationship between increased prostate cancer risk and exposure to VOCs, such as those detected in contaminated groundwater from the site.

An individual with prostate cancer lived at a household (7734 Highway 14) that was later found in 1988 to have contaminated groundwater. This individual died of an unrelated cause in 1984. It is not likely this person was exposed to contaminated groundwater and there are no reports that he went onto the site.

Data from the Wisconsin Cancer Reporting System (CRS) were used to evaluate the incidence of reported prostate cancers among people in the vicinity of Refuse Hideaway Landfill. CRS data are readily available at the greatest resolution for ZIP code areas, and were obtained for Cross Plains (53528), Middleton (53562), and Verona (53593). Prostate cancer data from the CRS were sorted by ten-year age groups for the period 1980 to 1990. For each ZIP code and ten-year age group, the differences between the number of cancers observed and the number expected were tested for statistical significance ($p < 0.05$). The number of prostate cancers diagnosed from 1980 to 1990 for most ten-year age groups codes were not elevated, and in a some of cases were less than expected. There were four age groups with a slightly elevated number of prostate cancers, but none were significantly different than what was expected.

- **Some nearby residents expressed concern about contamination from the site affecting the health of a child, who lives nearby and was born with an immune system disorder.**

A nine-year old child with an immune system disorder, was born and currently lives in a home 1,000 feet south of the site. This house is the closest house to the landfill. Twice in March 1988, two VOCs were detected at this private well. The source of these contaminants is uncertain, but they were not found at levels of a potential health concern (see page 13). We know of no association between chemical exposure and the development of the immune illnesses diagnosed in this child [43].

- **During the DNR interviews, a number of people living in the vicinity of the site stated they were worried about groundwater contamination from farm products (pesticides, fertilizer, etc.).**

Contamination of groundwater by pesticides and fertilizers is a growing concern in Wisconsin. One study found aldicarb present in 25 percent of sampled wells and atrazine present in 20 percent around the state. Approximately 10 percent of wells in south-central Wisconsin had levels of atrazine above Wisconsin's preventive action limit groundwater standard of 0.35 μg/L. Generally, nitrates (a by-product of fertilizers) are the most common groundwater contaminant in Wisconsin [45].

Pesticides typically contaminate groundwater by two routes: point and nonpoint sources. Improper handling, storage, and disposal (including landfills) account for point sources. Nonpoint sources include seepage of chemicals into groundwater after application to fields. Preliminary results of groundwater testing around Refuse Hideaway suggests the site is probably not a significant point source of pesticides. In May 1993 five pesticides

were detected in three monitoring wells at very low levels that are not a health concern. Conversely, the nonpoint sources are probably the most significant pesticide contributors to groundwater in the Black Earth Creek valley.

People who are concerned about private well contamination from pesticides and nitrates may want to test having their well water. Relatively inexpensive test kits for nitrates and atrazine are available from the Wisconsin State Laboratory of Hygiene, (1-800-442-4618 or 608-262-1641). The University of Wisconsin - Extension has an informative publication titled "Home Water Safety", which is available from county extension offices [56]

CONCLUSIONS

1. Refuse Hideaway Landfill currently poses no apparent public health hazard to nearby residents who obtain their drinking water from private wells. People living in three houses or who worked at a nearby seed business were exposed for no more than four years to VOC contaminated groundwater provided by three private wells.

2. No other nearby private wells are known to have been reached by contaminated groundwater coming from the site. The DNR is monitoring the movement of the contaminant plume for any changes. This should provide adequate warning of potential threats to nearby private wells.

3. Refuse Hideaway Landfill might pose a future public health hazard to users of nearby private wells if no further action were taken to clean-up the site. Groundwater samples collected from some monitoring wells located on and around the site property reveal high levels of some VOCs. If the effect of existing on-site control measures were negligible and higher levels of groundwater contamination were to migrate away from the site and reach uncontaminated wells, nearby residents would have an increased risk of contacting cancer.

4. There are no toxicological data available on the effects of simultaneous exposures for 1,2-dichloroethylene, tetrachloroethylene, trichloroethylene, and vinyl chloride.

5. Refuse Hideaway Landfill is an indeterminate public health hazard to people who worked inside a building at an adjacent sand and gravel business. Those who worked inside a building at the business breathed air that could have been contaminated with VOCs. However there was no data available on possible indoor air contamination, which represents a data gap. Estimates of worker exposure can be created only by making a number of assumptions. If these assumptions are correct, then workers are not expected to have any adverse health effects from breathing indoor air at the calculated levels.

RECOMMENDATIONS

The Wisconsin Division of Health offers the following recommendations concerning Refuse Hideaway Landfill:

1. Private wells in use around the site should be regularly tested for contamination, as planned by the DNR.

2. All private wells and monitoring wells should be tested for inorganic contaminants, particularly arsenic, as planned by the DNR as part of the Remedial Investigation. Samples collected from private wells with POE filtration systems should be unfiltered water.

3. Monitoring of the contaminant plume and groundwater quality around the site should continue as planned by the DNR.

4. The two private homes with Point-Of-Entry water filtration system should monitor and maintain their systems as recommended by the DNR.

5. Landfill gas extraction from the site should continue to reduce the movement of landfill gas away from the site and toward any nearby buildings.

6. Restrict access of unauthorized personnel to the site. Currently there are no hazard signs around the perimeter of the site, but there are "no trespassing" signs along the entry road. Fencing is limited to the gas flaring device, the buried leachate tank, and extraction well heads. The access road to the site has a gate that can be locked.

A. Need For Follow-up Health Activities

The ATSDR Health Activities Review Panel and the Wisconsin Division of Health evaluated the data on this site to determine what needs exist for additional research and/or local education about health related concerns. Such activities could include further studies on cases of disease in the vicinity of the site or providing residents with additional information about the health effects of exposures to specific toxic chemicals coming from the site. People living in three households and workers at an agricultural business were probably exposed to low-levels of contaminants from the site, but no adverse health effects are expected from these exposures. However, both the community and local health professionals need continuing information about public health issues related to the site. It was also determined that additional toxicological information is needed to evaluate how mixtures of contaminants might affect the health of people drinking contaminated groundwater.

B. Public Health Action

The following actions either have been or will be performed to meet the needs expressed by the recommendations of this public health assessment. The Wisconsin Division of Health, in cooperation with ATSDR, will:

1. Continue to consult with the Wisconsin DNR and the U.S. EPA on public health issues that may arise as any action(s) happen at the site;

2. Provide continuing health education as new information becomes available concerning public health issues related to the site;

3. Continue to solicit the health concerns of citizens of the Town of Middleton directly or through the Wisconsin DNR, the Dane County Health Department, and through public meetings;

4. Continue to cooperate with the Wisconsin DNR and Dane County Health Department to address environmental health and public health issues that pertain to the site and the community;

5. Offer professional education opportunities about the site to practicing health care providers in the Town of Middleton and nearby areas.

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CERTIFICATION

The Refuse Hideaway Public Health Assessment was prepared by the Wisconsin Division of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health assessment was begun.

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

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APPENDIX A: Figures

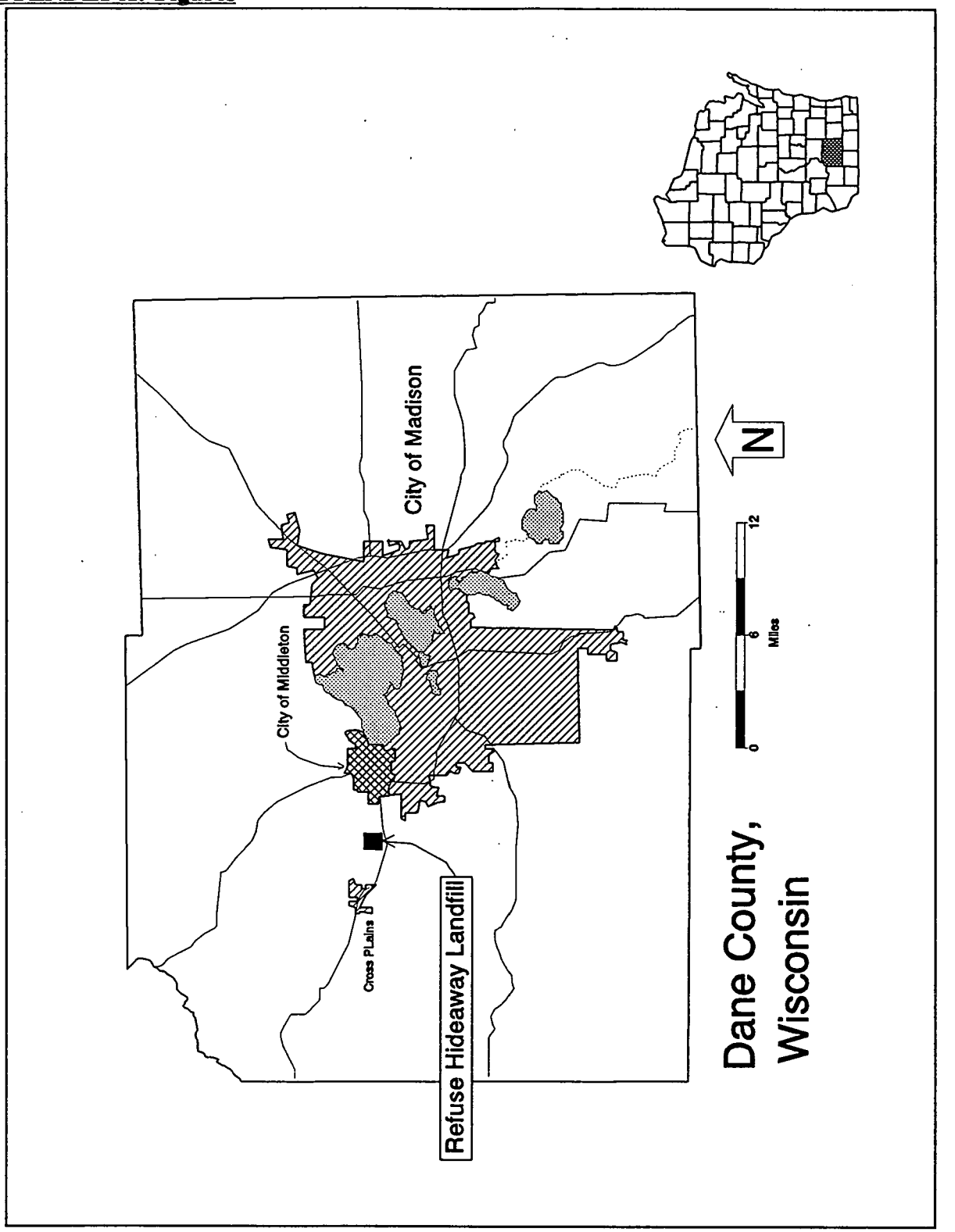

Figure 1: Refuse Hideaway Landfill, Dane County, Wisconsin.

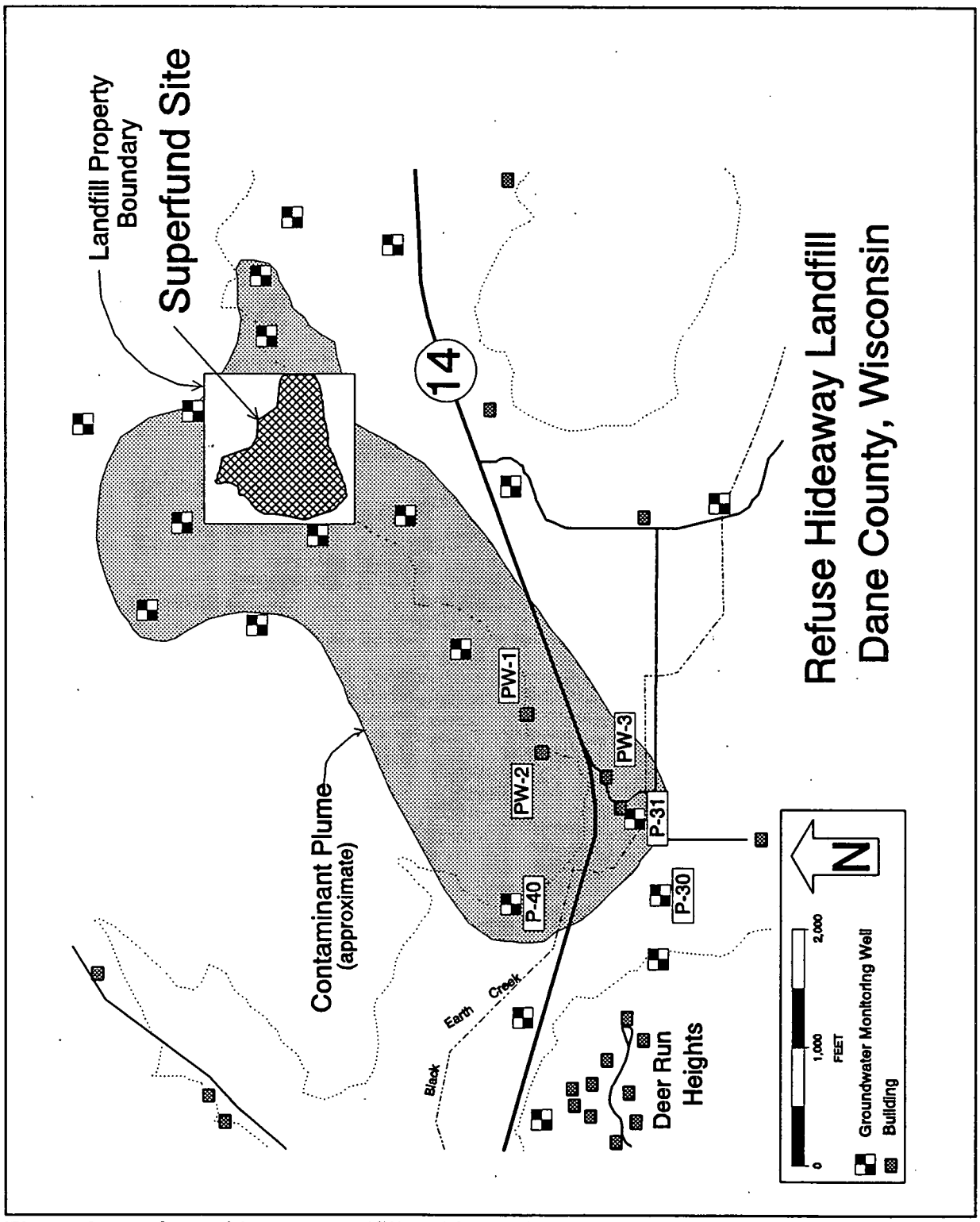

Figure 2: Refuse Hideaway Landfill and immediate vicinity. Off-site groundwater monitoring wells.

APPENDIX B: Cancer Risk Estimation

UPPER LEVEL ESTIMATES OF LIFETIME CANCER RISKS ASSOCIATED WITH POTENTIAL FUTURE CONSUMPTION OF CONTAMINANTS IN GROUND WATER

Chemical contaminants in on-site and off-site groundwater currently do not pose a cancer risk because people are not exposed to contaminated groundwater. The upper level estimates of lifetime cancer risks listed in the table below offer a perspective on the relative cancer risks the contaminants in on-site ground water would pose if that water were used for drinking water. In general, the chemicals with the highest estimated risk pose the greatest threat to downgradient wells. Obviously, the maximum concentrations found in on-site and adjacent off-site monitoring wells are at concentrations which are not likely to reach private wells due to natural attenuation and biodegradation of the contaminants between the site and private wells. The estimates below are only a **relative index** of the potential lifetime cancer risks that the chemicals pose. A more detailed discussion of the potential toxic effects of each chemical begins on page 23.

Chemical	Maximum Level Detected ($\mu g/L$)	USEPA[a] Carcinogen Group	Unit Cancer Risk $(\mu g/L)^{-1}$	Upper Level Estimated Lifetime Cancer Risk ($\times 10^{-6}$)
Tetrachloroethylene[b]	530	B2	1.5×10^{-6}	795
Trichloroethylene[b]	180	B2	3.1×10^{-7}	60
Vinyl Chloride	525	A	5.4×10^{-3}	28,500

a Source: [60]

b Carcinogen classification group is under review by the U.S. EPA.

EPA Carcinogen Group

The EPA uses one of five groups to classify the carcinogenic potential of a chemical, according to the weight of evidence from epidemiological studies and animal studies. The following list explains categories listed on the above table:

Group A - Human Carcinogen (sufficient evidence of carcinogenicity in humans);

Group B2 - Probable Human Carcinogen (sufficient evidence of carcinogenicity in animals and inadequate or no evidence of carcinogenicity in humans);

Group C - Probable Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or no evidence of carcinogenicity in humans).

NA - This is not an EPA category. This notation indicates that information is "not available" because the EPA has not evaluated this chemical.

Cancer Risk

The EPA estimates the level of cancer risk posed by exposure to relatively low doses of carcinogens. The EPA uses the available data and a theoretical "model" of how chemicals cause cancer to estimate the carcinogenic potency of a chemical. This potency is an "upper-bound estimate." In other words, the true risk is not likely to be higher and may be lower. The estimated lifetime cancer risk is the upper bound estimate of the increase in one's probability of contracting cancer as a result of ingesting the chemical in drinking water for a lifetime. The "unit cancer risk" is the EPA's estimate of one's increased risk from drinking 1 μg of the chemical per liter of drinking water for a lifetime. The higher the unit risk, the greater is the estimated carcinogenic potency of the chemical [60].

The "upper level estimated lifetime cancer risk" is the product of the maximum concentration of the chemical in ground water at the Refuse Hideaway Landfill site and the unit cancer risk. The estimated risk is rounded to one significant digit because of the great uncertainty involved in estimating the risk. At best the order of magnitude of the risk reflects the relative carcinogenic hazard that a chemical poses. The table does not include risks associated with breathing VOC's released from residential water or from dermally absorbing carcinogens in the water. As a general rule of thumb, combined inhalation and dermal exposures to VOC's would be roughly equivalent to twice that from drinking contaminated water [51].

APPENDIX C: Definitions

ATSDR: The Agency for Toxic Substance and Disease Registry, a federal agency.

Cancer Risk Evaluation Guide (CREG):
An estimate of the excess upper-bound lifetime probability (at or less than 1 in 1,000,000) of an individual developing cancer from an exposure to a concentration of a specific chemical or substance.

Cancer Slope Factor (CSF):
The upper limit on the lifetime probability (at or less than 1 in 1,000,000) that a cancer causing chemical will cause cancer at a dose of 1.0 mg/kg/day.

Carcinogen: A substance which has been proven to cause cancer in humans or animals.

CERCLA: The Comprehensive Environmental Response, Compensation, and Environmental Liability Act. Also known as "Superfund", this program is administered by the U.S. Environmental Protection Agency.

DCE: 1,2-Dichloroethylene.

DNR: Wisconsin Department of Natural Resources.

DOH: Division of Health, Wisconsin Department of Health & Social Services.

Drinking Water Lifetime Health Advisory (LTHA):
That portion of an individual's total exposure to a chemical that is attributed to drinking water, and is considered protective of noncarcinogenic health effects during a lifetime exposure, as established by the U.S. EPA.

Environmental Media Evaluation Guideline (EMEG): Expressed in either $\mu g/L$ or $\mu g/m^3$. Derived from ATSDR's Minimal Risk Level (expressed in mg/kg/day), which is an estimate of the daily human exposure to or dose of a chemical that is likely to be without an appreciable risk of deleterious, noncancerous effects over a specified duration of exposure. EMEGs are categorized by timeframes of exposure: acute ($\leq$ 14 days); intermediate (15 - 365 days); and chronic ($\geq$ 365 days).

Lower Explosive Limit (LEL):
The minimum concentration of a chemical or substance in air which will create an explosive reaction on contact with an ignition source.

Maximum Contaminant Level (MCL):
Drinking water health goals set by the U.S. EPA at which "no known or anticipated adverse effect on the health of persons occur and which allows an adequate margin of safety".

mg/L: Milligrams per Liter, or PPM (water).

mg/kg/day: Milligrams per Kilograms per Day.

National Priorities List (NPL):
U.S. EPA's list of top priority hazardous waste sites that are eligible for investigation and cleanup under Superfund.

Off-Site: Pertaining to locations OUTSIDE of the boundaries of the Superfund site (Figure 2). It is possible for a location to be off-site and still be on the Landfill Property.

On-Site: Pertaining to locations WITHIN the boundary of Superfund site (Figure 2).

PPB: Parts Per Billion - in water Micrograms per Liter ($\mu g/L$), or in air Micrograms per Cubic Meter ($\mu g/m^3$).

PPM: Parts Per Million - in water Milligrams per Liter (mg/L), or in air Milligrams per Cubic Meter (mg/m^3).

PCE: Tetrachloroethylene or Perchloroethylene

Reference Dose (RfD):
An estimate of a daily exposure level to a substance for the human population that is likely to be without an apparent risk of causing damaging health effects during a lifetime of exposure.

Remedial Investigation and Feasibility Study (RI/FS):
Two parts of the Superfund process. The Remedial Investigation includes the collection and evaluation of data to define site conditions, including the nature of hazardous substances found at a site and the extent that those hazardous substances were released from the site. These releases are evaluated to assess the effect on public health and the environment. The Feasibility Study defines a range of likely alternatives for cleaning up a site.

SVOC: Semi-Volatile Organic Compounds.

TCE: Trichloroethylene

TCL/TAL: Target Compound List / Target Analyte List.

U.S. EPA: United States Environmental Protection Agency

$\mu g/L$: Micrograms per Liter or Parts Per Billion (water).

$\mu g/m^3$: Micrograms per Cubic Meter or Parts Per Billion (air).

$\mu g/kg$: Micrograms per Kilogram.

mg/kg: Milligrams per Kilogram.

VOC: Volatile Organic Compounds.

APPENDIX D: Pathways Evaluation

Pathways are evaluated to determine whether nearby residents have been exposed to contaminants originating from the site. A pathway is a route along which contaminants can move away from a site and enter the bodies of people living nearby. There are five elements in a completed pathway:

1) Contaminant Source: The place where contaminants entering the environment are coming from.
2) Media: a media that the contamination is found in (soil, sediment, groundwater, air, surface water, fish, and game animals).
3) Exposure Point: the location at which human contact is made with the contamination. The Exposure Point is specific to each type of media (e.g. - groundwater, surface water, soil, etc.)
4) Exposure Route: the process by which the contaminated media gets inside of people (eating/drinking, skin/dermal contact, or inhaling).
5) Receptor Population: groups of people who are or may be exposed.

APPENDIX E: Supporting Calculations - Toxicological Evaluation

cis-1,2-Dichloroethylene

Past exposure not expected to affect resident's health (page 23): Assuming the combined exposure of all three routes (dermal, ingestion, and inhalation) is three times that expected from drinking water alone, this combines to create a total DCE exposure of 108 μg/L, and converts to 11 μg/kg/day or 0.011 mg/kg/day (10 kg child drinking 1 liter of water per day). The USEPA Lifetime Health Advisory (LTHA) and the MCL is 70 μg/L, which is based on 20 percent drinking water contribution of the DWEL of 400 μg/L. The intermediate Oral MRL is 300 μg/kg/day, which would convert to a 3,000 μg/L intermediate EMEG (for a 10 kg child).

Tetrachloroethylene

No apparent increased risk of cancer from highest PCE levels found in private wells (page 24): Assuming that tetrachloroethylene (PCE) is a carcinogen, as previously determined by the U.S. EPA, and the cancer screening value is used (Cancer Slope Factor [5.1E-02] is 0.69 μg/l), this 1:1,000,000 excess cancer risk level was exceeded by all the levels detected in private wells. Assuming the combined exposure of all three routes (dermal, ingestion, and inhalation) is three times that expected from drinking water alone, this combines to create a total PCE exposure equivalent to 78 μg/L, and converts to 2 μg/kg/day or 0.002 mg/kg/day (70 kg adult drinking 2 liters of water per day). Using the U.S. EPA's former cancer slope factor it is estimated that a person exposed to drinking water contaminated at 26 μg/l for four years would have no apparent increased risk of cancer ([0.002 x 5.1E-02 x 4/70] = [1.02E-04 x 4/70] = 5.8E-06). There are no other known health effects from ingesting the highest level of PCE found in private wells.

Moderate increased risk of cancer potentially resulting from PCE exposure caused by failure to clean-up the site (page 24): Assuming ingestion, inhalation and dermal exposure from drinking water contaminated with 265 μg/L would combine to create a total PCE exposure of 22.7 μg/kg/day or 0.0227 mg/kg/day (70 kg adult drinking 2 liters of water per day) and using U.S. EPA's former cancer slope factor, there would be a moderately increased cancer risk ([0.0227 x 5.1E-02 x 30/70] = 5.0E-04).

Trichloroethylene

No apparent increased risk of cancer at highest TCE levels found in private wells (page 25): Assuming trichloroethylene (TCE) is a carcinogen, as previously defined by the U.S. EPA, and a Cancer Slope Factor of 1.1E-02, this value was exceeded by all levels detected in one private well (PW-1), and in the levels detected in the other well before March 1989. Combined ingestion, inhalation and dermal exposures would then total an equivalent TCE exposure of 30 μg/L. This converts to 8.6 μg/kg/day or

0.0086 mg/kg/day (70 kg adult drinking 2 liters of water per day). Using the slope factor it is estimated a person drinking water contaminated at 10 μg/l for four years would have a no apparent increased risk of cancer ([0.0086 x 1.1E-02 x 4/70] = [9.5E-05 x 4/70] = 5.4E-06).

Low increased risk of cancer potentially resulting from TCE exposure caused by failure to clean-up the site (page 25): Assuming ingestion, inhalation and dermal exposure would combine to create a total TCE exposure of 540 μg/L, this converts to 15.4 μg/kg/day or 0.0154 mg/kg/day (70 kg adult drinking 2 liters of water per day). If TCE maintains a carcinogen classification from the U.S. EPA and the cancer slope factor is used, there would be a low increased cancer risk ([0.0154 x 1.1E-02 x 30/70] = 7.3E-05).

Vinyl Chloride

No apparent increased risk of cancer at highest Vinyl Chloride levels found in private wells (page 26): Vinyl chloride is a known human carcinogen and has a Cancer Slope Factor of 1.9E-00, which converts to 0.015 μg/L. This 1:1,000,000 risk level was exceeded when vinyl chloride was detected in two private wells (PW-1 & PW-2) early in 1988. The highest concentration detected in these well was 6 μg/L. A combined ingestion, inhalation and dermal exposure to vinyl chloride is equivalent to an oral exposure of 18 μg/L. This converts to 0.52 μg/kg/day or 0.00052 mg/kg/day (70 kg adult drinking 2 liters of water per day). Using the slope factor it is estimated a person drinking water contaminated at 6 μg/L for two years would have a no apparent increased risk of cancer ([0.00052 x 1.9E-00 x 2/70] = [9.9E-04 x 2/70] = 2.8E-05).

High increased risk of cancer potentially resulting from PCE exposure caused by failure to clean-up the site (page 26): Assuming ingestion, inhalation and dermal exposure to 263 μg/L would combine to create a total vinyl chloride exposure of 22.5 μg/kg/day or 0.0225 mg/kg/day (70 kg adult drinking 2 liters of water per day) and using U.S. EPA's cancer slope factor, there would be a high increased cancer risk ([0.0225 x 1.9E-00 x 30/70] = 1.8E-02).

APPENDIX F: Response to Public Comments

Comments on the Public Comment Draft of the Refuse Hideaway Landfill Public Health Assessment were solicited for the period from November 10 to December 10, 1993. Public comments were received from one source. These comments pointed out minor inconsistencies, addressed items about grammar, and indicated areas needing additional clarification. Where appropriate, this information was incorporated into the public health assessment, however these comments did not alter the conclusions and recommendations of the report.