ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

VILLAGE OF LIBERTY WATER SUPPLY SYSTEM –
ELM STREET WELL
LIBERTY, SULLIVAN COUNTY, NEW YORK
EPA FACILITY ID: NYXCRA673000
MAY 6, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
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.

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PUBLIC HEALTH ASSESSMENT

VILLAGE OF LIBERTY WATER SUPPLY SYSTEM – ELM STREET WELL

LIBERTY, SULLIVAN COUNTY, NEW YORK

EPA FACILITY ID: NYXCRA673000

Prepared by:

New York State Department of Health
Center for Environmental Health
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry

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SUMMARY

In December 1992, contamination of water from the Village of Liberty's, Sullivan County, Elm Street well by a gasoline additive called methyl tertiary-butyl ether (MTBE) was discovered at levels that exceeded the New York State Department of Health (NYS DOH) drinking water standard in effect at that time.[1] Residents of the Village of Liberty and the Town of Liberty's Ferndale and Stevensville water districts were exposed to MTBE at levels above the applicable NYS DOH drinking water standard for an undetermined amount of time from possibly as early as 1979, when MTBE was first used as a gasoline additive, to January 1993. Residents of the village were exposed to levels above the applicable standard again for the month of November 1993.

Starting in December 1992, residents of the Town of Liberty's Ferndale and Stevensville water districts no longer were supplied drinking water from the Village of Liberty. From late January 1993 to August 1993, residents of the Village of Liberty were provided with drinking water from alternate water supplies (e.g., water from Revonah Lake, a water tanker and an external tap at the Town of Liberty's water system). From August 1993 to November 1993, the Elm Street well was used at a lower pumping rate without supplementation from an alternate source. Beginning on November 23, 1993, the Town of Liberty began providing water to the Village of Liberty to supplement water from the Elm Street well. The levels of MTBE in water from the well exceeded the applicable NYS DOH drinking water standard during June and July 1994; MTBE levels measured in the distribution system were below the applicable NYS DOH drinking water standard because the well water was mixed with the town's water in the distribution system.

The soil and groundwater cleanup efforts at the source of the contamination were successful, and as a result MTBE has not been detected in water from the Elm Street well since December 1998. The well is currently in use to supplement water from the Lily Pond water treatment plant, which was completed in 1998. The current use of the well poses no apparent public health hazard because the gasoline-related contaminants, including MTBE, have not been detected in the well water. Recent data showing intermittent low levels of tetrachloroethene (below the NYS DOH drinking water standard) in water from the Elm Street well indicate that the well continues to be vulnerable to contamination. The vulnerability is due to the shallow well depth, the permeable sand and gravel aquifer, and the location of the well near commercial/light industries. In 1998, the Village, with assistance from Cornell Cooperative Extension and Rural Water, developed an aquifer protection ordinance that places zoning restrictions on the area surrounding the well. As long as the well is used or maintained as a back-up water supply, monitoring of the well water should take place to ensure protection of public health.

This public health assessment provides greater detail about the MTBE contamination of the Elm Street well and an analysis of the health risks associated with exposure to this chemical in drinking water. Exposure to MTBE in drinking water could have occurred by ingestion, inhalation, or by

[1] On December 24, 2003, NYS DOH revised the drinking water standard for MTBE to a lower value than the standard that was in effect at the time that MTBE was detected in drinking water from the Elm Street well. The new drinking water standard is based on the same toxicological information used in this public health assessment.

dermal contact from household uses of water from the Village of Liberty water supply. The NYS DOH reviewed the analytical data on the levels of MTBE in the Village of Liberty's drinking water and the toxicological information on the health effects associated with exposure to this compound. NYS DOH estimated that the Village and the Town of Liberty's Ferndale and Stevensville water districts residents' past exposure to the average level of MTBE detected in water from the Elm Street well may be associated with a low risk for carcinogenic health effects. The risk for noncancer health effects is estimated to be minimal for both Village of Liberty and Town of Liberty residents. These estimates of cancer and noncancer health risks are based on information from animal studies; studies on the long-term health effects of MTBE exposure in humans are not available. Public health actions were needed to reduce exposure to MTBE in the water from the Elm Street well. Since January 1993, actions have been taken to address exposures to MTBE.

Residents in the Village of Liberty are concerned about a variety of long- and short-term health effects (e.g., cancer, neurological problems, respiratory illness, headaches, seizures, rashes) and health effects to unborn children that may have resulted from exposure to MTBE. Although some of these reported conditions are similar to known MTBE-related health effects in animals and humans, we are unable to determine if reported health effects are actually due to MTBE exposure or some other factor. Residents have also shown interest in the health effects associated with the breakdown products (in the environment or groundwater) of MTBE. Information in the literature suggests that MTBE is persistent in the groundwater under natural conditions and shows limited tendency for degradation. Residents have also expressed concern about MTBE metabolites (breakdown products in the body). Metabolites of MTBE identified in humans include 2-methyl-1,2-propanediol and 2-hydroxyisobutyrate and tertiary-butyl alcohol. We do not know if the health effects associated with MTBE exposure are due to MTBE or to its metabolites.

Residents of the Village of Liberty and the Town of Liberty's Ferndale and Stevensville water districts are encouraged to enroll and participate in the NYS Volatile Organic Compounds Exposure Registry. The exposure registry allows long-term follow-up on the health status of persons with documented exposures to volatile organic compounds, such as MTBE. NYS DOH began recruitment for the exposure registry in December 2002, and the active enrollment process continued through July 2003. Although this active recruitment period has ended, NYS DOH will still allow people to enroll at any time.

NYS DOH is continuing to work with the village on their water supplies and treatment facilities. On August 2, 2000, the village, with the assistance of the Sullivan County Planning Department, applied to NYS DOH for financial assistance to upgrade the village's water supply system. On May 24, 2001, the New York State Environmental Facilities Corporation sent a letter to the village to confirm that the village has been awarded a grant and is eligible for interest-free loans to make improvements to its water supply system under the NYS Safe Drinking Water Act, State Revolving Fund. On May 22, 2003, the village received short-term financing in the amount of $5.6 million dollars including the grant monies confirmed on May 24, 2001.

PURPOSE AND HEALTH ISSUES

The Village of Liberty's Elm Street well was contaminated with methyl tertiary-butyl ether (MTBE) from the transport of MTBE through soils from nearby underground gasoline storage tanks to the groundwater from which the well draws water. Residents of the Village of Liberty (Sullivan County, New York) expressed concerns about exposure to MTBE in public water from the Village's Elm Street well. The purpose of this public health assessment is to respond to the public's concerns regarding the MTBE contamination of the Elm Street well and to evaluate potential health risks associated with exposure to this chemical in drinking water from the Elm Street well.

BACKGROUND

This section provides information on the Elm Street well that was contaminated with gasoline-related compounds including MTBE. Figure 1 (see Appendix B) provides a map of the Village of Liberty area and the locations of the Elm Street well, Revonah Lake and Lily Pond. A detailed presentation of analytical data for the Elm Street well is found in the Discussion of Environmental Contamination section.

During the process of developing this public health assessment, the New York State Department of Health (NYS DOH) drinking water standard for MTBE was revised to a lower value based on the same toxicological information used in this public health assessment. The previous NYS DOH standard of 50 micrograms per liter (µg/L) was superceded on December 24, 2003 by the current standard of 10 µg/L (10 NYCRR, 2004). The standard in effect at the time of sampling (50 µg/L) determined if water from the Elm Street well was used. The toxicological information used to assess potential health effects associated with exposure to MTBE in drinking water from the Elm Street well is consistent with the information used to develop the current MTBE drinking water standard of 10 µg/L. The revision of the drinking water standard did not change our evaluation of potential health risks for MTBE in this public health assessment.

Methyl *tert*-Butyl Ether (MTBE) Facts:

MTBE is a volatile organic compound (VOC) that has a distinctive odor that most people find disagreeable (ATSDR, 1996). The first commercial use of MTBE occurred in 1979 when the US Environmental Protection Agency (US EPA) approved MTBE as a blending agent for octane enhancement in unleaded and premium gasoline (US EPA, 1980). Almost all of the MTBE produced in the United States is used as an additive in gasoline. However, MTBE is also used in small quantities as a laboratory reagent (ATSDR, 1996).

In 1992, the use of MTBE as an additive for gasoline increased in metropolitan areas as a result of US EPA's oxygenated fuels program (established as part of the 1990 Clean Air Act Amendment) to reduce pollutant levels in automotive exhaust. MTBE reduces the levels of carbon monoxide and pollutants that can result in the formation of ozone by promoting more complete burning of gasoline (US EPA, 1997). In June 1999, US EPA's Blue Ribbon Panel

concluded that MTBE posed risks to drinking water and the US EPA has taken steps to eliminate MTBE from gasoline. On September 7, 2000, US EPA announced that the Senate Environment and Public Works Committee is taking action to phase-out the use of MTBE from cleaner-burning gasoline.

Exposure to MTBE occurs from inhaling auto exhaust when driving or inhaling gasoline fumes while fueling cars. While inhalation is the major route of exposure to MTBE for the general population, oral and dermal exposures can also occur when MTBE contaminates drinking water supplies. Due to its small molecular size and solubility in water, MTBE moves more rapidly into groundwater than other constituents of gasoline (US EPA, 1997). MTBE's offensive odor and solubility in water make it an early indicator of gasoline-related groundwater contamination. Once in groundwater, remediation of MTBE contamination is complicated by MTBE's soluble properties, which causes this chemical to be difficult to treat with granular activated carbon, a widely-used remediation technique for VOCs (Bass and Sylvia, 1992).

Common household filtration, such as those installed on the consumer's tap or pitcher-type filters, may help remove low levels of VOCs. However, VOCs can break through a small carbon filter and care should be taken to replace these filters frequently as they can harbor bacteria. Conversely, whole-house filters such as those installed by the New York State Department of Environmental Conservation (NYS DEC) to remove VOCs from drinking water contain large amounts of activated carbon and a second filter to capture any contaminants that may break through the first filter. Additionally, these whole-house systems disinfect the water using ultraviolet light to kill bacteria that may grow on the carbon in the filters.

MTBE may be fairly persistent since it shows limited tendency for degradation by biological and chemical processes (ATSDR, 1996; Squillace et al., 1997). Tertiary-butyl alcohol, a suggested product of biodegradation (in the groundwater) and may also be present in the fuel itself (Landmeyer et al., 1998, Church et al., 1997), was not detected in a sample of Elm Street well water that was collected on October 18, 2000.

Site Description and History:

Elm Street Well:

The Elm Street well was installed and became the Village of Liberty's primary water source around 1960. In December 1992, an engineering firm was hired to operate the village's public water supply. Upon reviewing historical records on the Elm Street well, the firm found laboratory results indicating the presence of MTBE in August 20, 1990. Prior to this date, MTBE was not a routinely monitored analyte under the State Sanitary Code for drinking water supplies. A water sample collected from the Elm Street well on December 28, 1992 also exceeded the 50 μg/L maximum contaminant level for MTBE, but no other site-related contaminants were detected during these sampling events.

The Village of Liberty notified NYS DOH of the MTBE contamination on January 8, 1993 and the public was notified on January 22nd via radio, newspaper, and letter. On January 26, 1993 the

well was taken out of service and the distribution system was flushed to remove MTBE contamination on January 27, 1993. From this date until June 30, 1993, Revonah Lake, an unfiltered surface water source, was used to supply drinking water to the Village of Liberty. While MTBE was not detected in any water samples collected after switching to Revonah Lake water, new Federal and State mandates enacted on June 30, 1993 required filtration of all surface waters. The new regulation was implemented to reduce microbiological contaminants and naturally-occurring organic matter often found in surface waters. NYS DEC supplied a water tanker and installed an external tap connecting to the Town of Liberty water system as alternatives for residents not wanting to drink water from Revonah Lake since it violated the new filtration requirements.

Due to new regulations and a dwindling water supply, the village of Liberty discontinued use of Revonah Lake as a water supply on August 4, 1993. The village resumed pumping the Elm Street well at half capacity, but demand grew throughout the Autumn of 1993. An increase in demand may have pulled in water from contaminated ground supplies, resulting in a monthly average MTBE concentration exceeding the 50 μg/L limit standard in November, 1993. To reduce the demand on the Elm Street well, a pumping station was constructed that mixed the well water with Town of Liberty water. The Village of Liberty distribution system was supplied with the blended water from November 29, 1993 through July 30, 1997, during which time MTBE levels in the distribution system remained below the 50 μg/L drinking water standard. The well water (prior to blending) was continuously monitored for MTBE contamination and the levels of MTBE decreased to below the previous NYS DOH drinking water standard. Although MTBE levels were elevated in the summers of 1994 and 1995, the monthly average levels only exceeded the NYS DOH standard (50 μg/L) in June and July of 1994.

As of July 30, 1997, water was no longer purchased from the Town of Liberty because MTBE levels in the well fell and remained well below the NYS DOH standard (50 μg/L). The Elm Street well was operated as the Village of Liberty's sole water source until September 3, 1998. The MTBE levels remained low, even during heavy pumping, indicating that the clean-up (remedial) activities at the contaminating source were effective. A treatment plant at Lily Pond was constructed and became the village's primary water supply in September of 1998. The Elm Street well has since only been used to meet periods of high demand (seasonal) and to maintain pressure in the distribution system.

MTBE has not been detected in the well since December of 1998. However, other chemicals including naphthalene and xylene were detected infrequently below their respective public drinking water standards between December 1998 to October 2000. Trihalomethanes (THMs), a class of chlorine disinfection byproducts, have also occasionally been detected at low levels (below their public drinking water standards) in water from the Elm Street well. Tetrachloroethene was also detected in well water at levels below the drinking water standard between May and October 2000, but the source of this contamination is unknown. The presence of naphthalene, xylene, and tetrachloroethene, while remedial activities from the fuel-spill locations are on going, indicates that the Elm Street well may be vulnerable to VOC contamination from other sources. The physical location and characteristics of the Elm Street well may make it susceptible to pathogenic contamination. Because it is a shallow well in sand

and gravel, certain pathogens, such as *Cryptosporidium*, may not be adequately removed by the soil by natural filtration processes. Therefore, the well is being evaluated to determine whether it is a "groundwater under direct influence of surface water;" a condition that necessitates additional treatment, such as filtration, before water may be distributed to the public. This evaluation is expected to be conducted during the summer of 2005.

Although Lily Pond was the primary source of water from the 1920's until Elm Street well was dug and installed in 1960, it has some limitations. Lily Pond is shallow and has a high level of natural organic matter. Organic matter can react with chlorine during disinfection to form chemicals known as disinfection byproducts (DBPs) which include two chemicals classes, trihalomethanes (THMs) and haloacetic acids (HAAs), that are regulated by the US EPA and NYS DOH. The regulation requires the annual average of quarterly THM and HAA samples to be below 100 μg/L and 80 μg/L, respectively. Although annual averages for THMs and HAAs in the distribution system had not exceeded these standards, in 2000 the NYS DOH recommended some changes in plant operation to reduce DBP formation and ensure the treatment plant would comply with new drinking water standards. NYS DOH is continuing to work with the Village to optimize Lily Pond Treatment operations. On August 2, 2000, the Village, with the assistance of the Sullivan County Planning Department, applied to NYS DOH for financial assistance to upgrade the Village's water supply system. The Village of Liberty was notified in a confirmation letter dated May 24, 2001 from the New York State Environmental Facilities Corporation that the Village was eligible to receive a maximum grant of $2 million dollars, allowable under the NYS Safe Drinking Water Act, State Revolving Fund, to upgrade/repair water supply system. On May 22, 2003, the Village received short-term financing in the amount of $5.6 million dollars, which includes the grant monies confirmed on May 24, 2001.

Clean-up Activities:

NYS DOH staff notified NYS DEC of the MTBE contamination on January 8, 1993. In February 1993, NYS DEC, which is responsible for investigating petroleum spills in New York State, contacted establishments that may have been responsible for the MTBE contamination. Subsurface investigations conducted by NYS DEC indicated that more than one source of MTBE was affecting the well. NYS DEC identified three parties that are potentially responsible for the contamination. NYS DEC approached the potentially responsible parties and was involved in developing and implementing remedial measures. Source removal has been completed and remediation of contaminated groundwater is on-going. Currently, a network of recovery wells at the sources of the contamination pump and treat contaminated groundwater. Vapor extraction systems also are used to remediate contaminated soils. Remedial activities are expected to continue for four to five years. Quarterly reports on the remedial activities are available to the public at the Village Hall.

Site Visits:

NYS DOH staff has conducted routine visits and inspections of the village's water supply system. These activities continue to take place as NYS DOH works with the Village on their

water supplies and treatment facilities. In the past, NYS DOH staff has made site visits to the Elm Street well site. The following dates and activities identify the site visits related to the development of this public health assessment:

On July 23, 1998, NYS DOH staff met NYS DEC staff at the Elm Street well. NYS DEC staff supplied NYS DOH groundwater monitoring data and information on the spill remediation. NYS DEC staff checked the remedial systems and identified the locations of the potential responsible parties.

On September 30, 1998, NYS DOH staff met with staff from the Village of Liberty's water department. Village of Liberty staff checked NYS DEC remedial systems. Additionally, Village staff supplied NYS DOH with monitoring data for the drinking water supply, information on the history of the MTBE contamination and community concerns.

On October 11, 2000, NYS DOH staff met with staff from ATSDR, NYS DEC and the Village of Liberty Water Department at the location of the Elm Street well. Although NYS DOH continues to work with the Village on their water supply system, no site visits directly related the public health assessment have been made since 2000.

Demographics:

Village of Liberty:

NYS DOH estimated from the 1990 Census (US Bureau of the Census, 1991) that 4,131 people live within the village water districts boundaries. This population is 82.2% white and 12.5% black. The percent of persons of Hispanic origin is 9.4%. Based on the 1990 Census, 9.1% of the population is under six years of age, 19.1% is between six and 19 years of age, 52.6% is between 20 and 64 years of age, and 19.2% is 65 years or older (US Bureau of the Census, 1991). In 1990, there were 871 females of reproductive age (ages 15-44) in the area (US Bureau of the Census, 1991). The Village of Liberty and the Parksville Corridor are located within the Town of Liberty. In 1989, the median household income in the Town was approximately $25,918, with approximately 13.8% of the population living below the poverty level (US Bureau of the Census, 1992). There are 5 schools and 1 nursing home in the area. Table 1 (see Appendix A) compares the demographics for this area with statewide totals.

Demographics for the Town Water Districts:

From 1979 until late 1992, two Town of Liberty water districts, serving Stevensville and Ferndale, received water from the Village of Liberty by Town purchase. The following discussion provides the demographics for these water districts:

Demographics for the Stevensville Water District:

NYS DOH estimated from the 1990 Census that 259 people live within the Stevensville water district boundaries (US Bureau of the Census, 1991). This population is 89.6% white, 4.6% black and 2.3% Asian. The percent of persons of Hispanic origin is 10.4%. 12.4% of the population is under 6 years of age, 21.2% is 6-19 years of age, 56% is 20-64 years of age, and 10.4% is 65 years or older. In 1990, there were 59 females of reproductive age (ages 15-44) in the area. The median household income of the Town was approximately $25,918 in 1989, with approximately 13.8 % of the population living below the poverty level (US Bureau of the Census, 1992). There is one nursing home in the area. Table 1 (see Appendix A) compares the demographics for this area with statewide totals.

Demographics for the Ferndale Water District:

NYS DOH estimated from the 1990 Census that 217 people live within the Ferndale water district boundaries (US Bureau of the Census, 1991). This population is 79.7% white, 14.3% black and 3.2% Asian. The percent of persons of Hispanic origin is 11.1%. 8.8% of the population is under 6 years of age, 17.5% is 6-19 years of age, 60.8% is 20-64 years of age, and 12.9% is 65 years or older. In 1990, there were 54 females of reproductive age (ages 15-44) in the area. The median household income of the town was approximately $25,918 in 1989, with approximately 13.8 % of the population living below the poverty level (US Bureau of the Census, 1992). Table 1 (see Appendix A) compares the demographics for this area with statewide totals.

DISCUSSION

The following sections contain an evaluation of the environmental and toxicological data pertaining to MTBE contamination of the Elm Street well site (on-site groundwater). NYS DOH staff reviewed sampling data for the Elm Street well and groundwater monitoring wells close to the Elm Street well and used toxicological information specific to MTBE to evaluate carcinogenic and non-carcinogenic health risks.

Environmental Contamination:

Elm Street Public Well

On-Site Groundwater:

Prior to the Village's use of Lily Pond as the main source of drinking water, approximately 10 percent of Elm Street well water samples contained MTBE levels exceeding the NYS DOH drinking water standard (50 µg/L). Table 2 (see Appendix A) lists the concentrations of MTBE in the 25 samples of Elm Street well water that are greater than 50 µg/L. NYS DOH evaluated a total of 269 samples, collected from the Elm Street well sampling tap up to September 3, 1998, for this public health assessment.

In December of 1992, MTBE was first identified, at a concentration of 130 µg/L, by a consultant, in a water sample collected on August 20, 1990 from the Elm Street well. A sample collected on December 28, 1992 contained 150 µg/L of MTBE. These levels of MTBE exceed the NYS DOH drinking water standard (50 µg/L) at that time. An earlier well water sample, collected on March 6 1990, did not target MTBE as an analyte because routine monitoring of drinking water supplies for MTBE was not required by the State Sanitary Code.

From August 4, 1993 until November 23, 1993, when the village was connected to the Town of Liberty's water supply, MTBE levels generally remained below 10 µg/L (the current drinking water standard). In October 1993, the MTBE levels began to approach the 50 µg/L NYS DOH drinking water standard. In early November 1993, MTBE levels in water collected from the well exceeded the drinking water standard and other site-related contaminants (e.g., benzene and xylene) were also detected at levels below their respective NYS DOH drinking water standards. MTBE levels in well water fell back below the drinking water standard (50 µg/L) once the village combined Elm Street well water with water from the Town of Liberty.

However, in late June 1994, the MTBE levels (81 µg/L and 79 µg/L on June 23, 1994 and June 29, 1994, respectively) in well water again exceeded the NYS DOH drinking water standard. MTBE levels in the distribution system were unavailable to compare to the well samples, but levels in the distribution system were likely to be lower since distributed water was a blend of Elm Street well and Town of Liberty water. Frequent sampling of well water in July of 1994 indicated that MTBE levels (ranging from 34 µg/L to 68 µg/L) hovered around the 50 µg/L drinking water standard and those within the distribution system (ranging from 31 µg/L to 42 µg/L) were below the standard. During August 1994, MTBE levels were decreasing in the well water (use of the well had slightly decreased) and the NYS DOH drinking water standard was infrequently exceeded. MTBE levels in water samples from the distribution system never exceeded the drinking water standard in August 1994. From September 1994 to late August 1995, MTBE levels in water from the well did not exceed the 50 µg/L standard. In late August and early September of 1995 during increased use of the well, MTBE levels in well water slightly exceeded the NYS DOH drinking water standard, but MTBE levels in the distribution system did not. MTBE levels in the well water have not exceeded the former drinking water standard (50 µg/L) since mid-September, 1995. With one exception, MTBE levels in Elm St well water have been below the current drinking water standard of 10 µg/L since December of 1995.

The Elm Street well was the village's sole source of water again between July 30, 1997 and September 3, 1998. During this time, MTBE levels in the well water remained below the 50 µg/L drinking water standard. The average MTBE level was approximately 4 µg/L, and the highest observed level of MTBE in water from the well was 11 µg/L in a sample collected on March 3, 1998. Lily Pond became the main source of drinking water for the village on September 3, 1998. MTBE has not been detected in water from the Elm Street well since December 1998.

Tertiary-butyl alcohol, a possible breakdown product of MTBE in groundwater, was not detected in samples of water collected from the well or the distribution system on October 18, 2000. However, other VOCs have been detected in water from the Elm Street well. Concentrations of benzene were detected in Elm Street well water samples on several occasions (February 7, 1989, March 13, 1989, and frequently between August 4, 1993 and December 29, 1993) below its 5 µg/L NYS DOH drinking water standard. Xylene was detected in water from the Elm Street well on two occasions (August 4, 1993 and April 1, 1999) at levels below its NYS DOH drinking water standard (5 µg/L).

A sample collected on June 17, 1994 from a tap at a utility sink at the water workshop at Revona Hill (distribution sample) showed several VOCs at levels exceeding their respective drinking water standards, including tetrachloroethene, ethylbenzene, and xylenes. However, an inspection of this sample location by NYS DOH staff indicated that many products that may have contained these VOCs (including degreasers and lubricants) were used near the sink and could have contaminated the water sample.

Tetrachloroethene, which is a commonly used solvent, was detected in other samples of Elm Street well water at levels below the NYS DOH drinking water standard (5 µg/L). These samples were collected on July 24, 1996 (distribution sample), between May 24, 2000 and September 1, 2000, and on October 18, 2000. The source of tetrachloroethene in the well water is unknown. Naphthalene was detected in water samples collected from the Elm Street well on March 5, 1999, September 7, 1999 and March 31, 2000 at levels below its NYS DOH drinking water standard (50 µg/L). Although the specific source of naphthalene in water from the well is unknown, this chemical is typically associated with refined crude oil products. Disinfection byproducts, which are typically formed when chlorine reacts with naturally occurring organic matter in the water, have been detected at very low levels in water from the Elm Street well. Total trihalomethanes (TTHM) detected ranged from 0.5 to 1.6 µg/L, on January 19, 1993 (two distribution samples), January 27, 1993 (one distribution sample), January 8, 1999 (one well sample) and March 5, 1999 (one well sample).

<u>On-Site Groundwater - Monitoring Wells:</u>

Groundwater monitoring wells sampled as part of the spill investigation conducted by NYS DEC found gasoline-related compounds present in groundwater near the Elm Street well property. Benzene, toluene, ethylbenzene, xylenes and MTBE were found in monitoring well samples collected between December 15, 1993 and April 6, 1998. During this time period, contaminant levels dropped over time in some monitoring wells, but for other wells the levels remained constant or increased. The highest levels were found in monitoring wells near the establishments identified as potentially responsible for the spill. Monitoring well samples collected in April 1998 indicate that many of these compounds were still above the NYS DEC groundwater standards. As of April 2000, MTBE was not detected in nearly all of the monitoring wells near the Elm Street well. NYS DEC investigation and remediation of the spill are on-going.

Off-Site Groundwater:

The potential for MTBE to migrate away from the contaminated areas is currently reduced by the recovery systems that collect and treat contaminated groundwater. Also, the contaminated soils, which were the source of the problem, were excavated and removed. NYS DEC supervised the installation of three recovery systems at the locations of the three potentially responsible parties. Prior to the installation of the remediation systems, the possibility of MTBE traveling off-site was limited by the influence that the Elm Street well had on the natural flow of groundwater. Under natural conditions, flow of groundwater under the Elm Street well is generally south-east toward the Mongaup River. However, during pumping of the well, the local flow of groundwater is re-directed toward the Elm Street well and some groundwater recharge may be available from induced infiltration from the Mongaup River (Groundwater Associates, Inc., 1988). Recent data for monitoring wells near the potentially responsible parties show that the recovery systems are generally successful at reducing the levels of petroleum-related compounds.

Surface Water Runoff:

On July 28, 1997 NYS DEC collected three samples of surface water runoff from the Elm Street well site. The samples were analyzed for various VOCs including MTBE. No contaminants were found in the samples.

Exposure Pathways Analysis:

This section of the public health assessment identifies potential and completed exposure pathways associated with past, present, and future use of the Village of Liberty's Elm Street well. An exposure pathway is the process by which an individual may be exposed to contaminants originating from a site. Exposure to volatile contaminants in drinking water supplies, such as MTBE, can occur via ingestion, dermal contact and inhalation from water uses such as showering, bathing or other household uses. Although exposure varies depending on an individual's lifestyle, each of these exposure routes contributes to the overall daily uptake of contaminants and, thus, affects the potential for health effects.

Frequent sampling of water from the well and within the distribution system has taken place and monitoring should continue for MTBE, gasoline-related contaminants and other VOCs (e.g., tetrachloroethene) as long as the well is used. Based on the results of the 1990 Census, NYS DOH estimated that 4607 people were exposed to elevated levels of MTBE in water from the Elm Street well. These people include those who lived in the village and in areas that were served water from the Elm Street well including two town water districts, Ferndale and Stevensville (US Bureau of the Census, 1991). This population was exposed to MTBE from household use and ingestion of the water from the Elm Street well.

Past Completed Exposure Pathways:

MTBE Exposure Associated with Drinking Water from the Elm Street Public Well:

For an undetermined period of time, up to 20 years, residents from the village were exposed to MTBE in their drinking water. Residents in the Town of Liberty's Ferndale and Stevensville water districts may have been exposed to MTBE in their drinking water for an undetermined period of time up to 14 years. MTBE was first detected in a well water sample collected on August of 1990. Prior to 1990, we do not know how long or at what concentrations people were exposed to MTBE since monitoring of drinking water supplies for MTBE was not required by State Sanitary Code. Additionally, we do not know when the establishments that may be responsible for the MTBE contamination of the well began accepting MTBE-containing gasoline. However, because the use of MTBE as a gasoline additive was approved by the US EPA in 1979, we assumed for this public health assessment that village residents may have been exposed to elevated levels of MTBE in drinking water for a total period of approximately 20 years. Specifically, we assumed that residents of the village were exposed to the average concentration of MTBE (118 µg/L) for 14 years, from 1979 to January 1993 and for an additionally six years (1993 to 1998) to the highest monthly average concentration of MTBE (61.5 µg/L). We also evaluated residential exposure at the highest detected concentration of MTBE (150 µg/L) for the entire exposure duration (20 years). In September 1998, Lily Pond became the main source of water for the Village and as of December 1998 MTBE was no longer detected in water from the well. Also, we assumed that the residents in the Town of Liberty's Ferndale and Stevensville water districts were exposed to elevated levels of MTBE in drinking water for approximately 14 years, that is, from 1979 through the end of 1992 when the town no longer purchased water from the Village. These assumptions likely overestimate the duration of exposure to MTBE- contaminated drinking water. Additionally, MTBE levels in water from the Elm Street well have been below the previous drinking water standard (50 µg/L) since fall of 1995 and have been generally below the current drinking water standard (10 µg/L) since winter of 1995 and not detected since 1998.

Present and Future Potential Exposure Pathways:

The gasoline-contaminated soils that were the source of MTBE in the groundwater have been removed and the contaminated groundwater continues to be pumped and treated at the locations of the three potentially responsible parties. Therefore, the Elm Street well is not likely to become contaminated with MTBE from these sources in the future. Since December 1998, MTBE has not been detected in water from the well. However, recent analytical data for water from the Elm Street well sometimes show tetrachloroethene, and to a lesser extent xylene and naphthalene, contamination at levels below their respective drinking water standards. This contamination, the source of which is unknown, and other factors related to well-head protection indicate that the well remains vulnerable to environmental contamination.

The most recent analytical data for water from the Elm Street well show that MTBE and other gasoline-related compounds were not detected. Additionally, other volatile contaminants, specifically tetrachloroethene, were last detected in water from the Elm Street well on September 1, 2000 and October 18, 2000.

Public Health Implications:

General Issues:

To evaluate the health risks of exposure to a chemical, scientists use available information from studies on the health effects of the chemical in animals or humans. An estimate is then made of the likelihood that the chemical will cause adverse health effects in individuals at given levels and conditions of exposure. For most chemicals, there are relatively few (if any) studies on human health effects. More often, health risks are evaluated based on the results of studies in animals. Using animal studies to evaluate health risks has benefits. For example the amounts of chemical given to the animals (i.e., the exposure) are usually precisely known, the animals are generally exposed for long periods of time, and complete pathology reviews are included. However, using the results of animal studies introduces uncertainties into an evaluation of health risks because:

- the exposure levels used in the animal studies are usually much higher than the levels at which people are typically exposed to environmental contaminants, and

- the health effects observed in animals (such as rats and mice) at these high exposure levels must be applied (extrapolated) to human beings.

The human health effects of some environmental contaminants have been evaluated in epidemiology studies. Epidemiology evaluates health conditions or disease among human populations. Using epidemiology studies has benefits because the studies evaluate health effects in humans beings, which does not require the extrapolation of high exposure levels and health effects across species. However, using the results of epidemiology studies introduces uncertainties into an evaluation of health risks because:

- the levels and duration of exposure are usually not precisely known, and

- the influence of confounding factors (e.g., exposure to other chemicals), which may also contribute to the health effect being studied, are difficult to quantify.

When evaluating the health risks for exposure to a specific environmental chemical, the relative strengths and weaknesses of the studies on that chemical must be taken into account, as well as the relative amount of available information on each chemical. These general considerations are important for assessing the cancer and noncancer risks posed by exposure to MTBE in the Village of Liberty's drinking water. Chronic exposure to chemicals in drinking water is possible by ingestion, dermal contact and inhalation from water uses such as showering, bathing and cooking. Although exposure varies depending on an individual's lifestyle, each of these

exposure routes can contribute to the overall daily intake of contaminants and, thus, may increase the risk for chronic health effects. The effects are related to contaminant concentration, exposure pathway, exposure frequency and duration. For additional information on how NYS DOH determined and qualified health risks applicable to this public health assessment, see Appendix D.

Past Ingestion, Dermal and Inhalation Exposure to MTBE in the Village of Liberty Elm Street Well:

Residents in the Village of Liberty were exposed to MTBE in drinking water from the Elm Street well for an undetermined period of time, possibly up to 20 years (from 1979 through 1998). Residents in the Town of Liberty's Ferndale and Stevensville water districts were exposed to MTBE in drinking water for an undetermined period of time, possibly up to 14 years (from 1979 through 1992). We have no information on how long, or to what levels of MTBE, the residents may have been exposed prior to 1990, when the results of a single sample, collected in August 1990, were reviewed. The highest level of MTBE detected in water from the Elm Street well was 150 µg/L. From early-1993 to 1998, when regular monitoring of the well for MTBE was conducted, the monthly averages ranged from 1.3 to 61.5 µg/L. MTBE was last detected in water from the Elm Street well in December 1998. Both the highest level of MTBE detected and the highest monthly average from 1993 to 1998 exceed the previous NYS DOH drinking water standard of 50 µg/L as well as the MTBE health-based comparison value for cancer effects (Table 3).

Studies that evaluated whether MTBE caused cancer in humans have not been conducted. MTBE has induced several types of cancers in laboratory animals exposed to high levels for most or all of their entire life. MTBE caused liver tumors in male and female mice inhaling it 5 days/week for 18 months and kidney and testicular tumors in male rats inhaling it 5 days/week for 24 months (Bird et al., 1997). It also caused testicular tumors in male rats and lymphomas/leukemias in female rats that were given large doses of MTBE directly into their stomach 4 days a weeks for 24 months (Belpoggi et al., 1995; 1998). The MTBE exposure levels that cause cancer in laboratory animals are much greater than the estimated levels of exposure to MTBE in water from the Village of Liberty Elm Street well. Whether MTBE causes cancer in humans is unknown, but chemicals that cause cancer in laboratory animals may also increase the risk of cancer in humans who are exposed to lower levels over long periods of time.

Information on the noncancer health effects of MTBE in humans is limited. Some persons who breathed MTBE from gasoline exposure over a short period of time complained of headaches, nausea, dizziness, irritation of the eyes, nose and throat, and feelings of spaciness or confusion (ATSDR, 1996). Laboratory animals fed high levels of MTBE for short periods of time (up to 90 days) had effects on the nervous system, kidneys, liver and gastrointestinal tract (ATSDR, 1996; Robinson et al., 1990). There are no adequate studies on the noncarcinogenic effects of long-term oral exposures to MTBE. Most of the information on the toxicity of MTBE comes from studies of laboratory animals exposed via inhalation (ATSDR, 1996). These studies show that exposure to very high levels of MTBE vapors affected the central nervous system, blood components, liver, kidneys, adrenal glands and reproduction.

Studies that evaluate the reproductive and developmental toxicity of MTBE by the oral route of exposure in animals and humans have not been conducted. Inhalation studies of laboratory animals suggest that high levels of MTBE can adversely affect their ability to bear healthy offspring (Bevan et al., 1997a, 1997b; Conaway et al., 1985). The high MTBE exposure levels in some (but not all) of these studies also caused adverse health effects on the parent animals.

Risk Characterization:

Risks for Village and Town of Liberty Residents Exposed to MTBE in Public Drinking Water from the Elm Street Well:

There are no studies on the long-term health effects of MTBE in humans, and therefore an evaluation of the health risks based on human data cannot be made. MTBE is known to cause cancer in animals exposed to high levels for their lifetimes. The increased cancer risk for exposure to MTBE is estimated based on its cancer potency value derived from animal studies. Based on the results of animal studies, the chance for Village of Liberty residents to develop cancer is estimated to be low (i.e., the estimated increased cancer risk is between one-in-one million and one-in-ten thousand; see Table 5). This estimate assumes that the residents were exposed for 14 years to the average MTBE level (118 µg/L) detected in samples taken prior to January 27, 1993 (when the Elm Street Well was shut down), and to the highest monthly average (61.5 µg/L) for the six years thereafter (1993 through 1998). The chance for developing cancer among the Town of Liberty residents (Ferndale and Stevensville water districts), who received water from the Village of Liberty through 1992, is estimated to be low based on 14 years of potential exposure to the average MTBE level (118 µg/L). The estimated increased cancer risk would also be low if we assumed that the residents were exposed to the highest detected level of MTBE (150 µg/L) for all of the potential exposure duration (20 years). The risk for non-cancer effects (based on exposure to the highest measured level, 150 µg/L) is estimated to be minimal (see Table 6). The estimated dose for MTBE in water provided to the Village of Liberty residents is about 290,000 times lower than the lowest dose that caused cancer in animals, and about 12,000 times lower than the lowest dose that caused non-cancer effects in animals.

Health Outcome Data Evaluation:

NYS DOH has developed a registry of individuals in New York State who have been exposed to VOCs, such as the MTBE contamination in the Elm Street well. Appendix C provides a detailed description (in the form of a fact sheet) of the NYS VOC Exposure Registry. Residents of homes supplied with drinking water from the Village of Liberty's Elm Street well (including Ferndale and Stevensville water districts), who have been exposed to MTBE in their drinking water and/or indoor air, are encouraged to enroll in the NYS VOC Exposure Registry. The exposure registry allows long-term follow-up on the health status of persons with documented exposures to VOCs from the Elm Street well water as well as persons exposed to VOCs at other selected sites in New York State. An exposure registry, such as this one, is a resource for research that may help us learn whether exposures to VOCs are related to health effects. People who are enrolled in the registry will be kept informed of any findings resulting from analysis of the registry data. The invitation to enroll in the Registry was mailed to current residents (1581

households) of the Village of Liberty and the surrounding area in December 2002. The enrollment package included a letter introducing the VOC Exposure Registry, a fact sheet describing the Registry and the eligibility/interest questionaire. A follow-up letter was sent to households that did not respond to the initial package. Active enrollment continued through July 2003. Of the 1581 households initially contacted, 113 households returned completed VOC questionaires and are currently enrolled in the Registry (7.1% of total households). Although the active recruitment period has ended, current and former residents of the Village of Liberty and the Town of Liberty's Ferndale and Stevensville water districts remain eligible for enrollment in the Registry, if they lived at a residence served by the Elm Street well for a period of six months (or more) from 1979 through 1998.

ATSDR Child Health Considerations:

ATSDR Child Health Considerations emphasize the on-going examination of relevant child health issues in all of the Agency's activities, including evaluating child-focused concerns through its mandated public health assessment activities. ATSDR and NYS DOH consider children when we evaluate exposure pathways and potential health effects from environmental contaminants. We recognize that children are of special concern because of their greater potential for exposure from play and other behavior patterns. Children sometimes differ from adults in their susceptibility to hazardous chemicals, but whether there is a difference depends on the chemical. Children may be more or less susceptible than adults to health effects, and the relationship may change with developmental age.

The possibility that children or the developing fetus may have increased sensitivity to MTBE was taken into account when evaluating the potential health risks associated with the site. Exposure of laboratory animals to high levels of MTBE is known to adversely affect their ability to bear healthy offspring (Conaway et al., 1985; Bevan et al., 1997a, 1997b). The high exposure levels used in some (but not all) of these studies also caused adverse health effects on the parent animals, and are about 50,000 times higher than estimated exposures for MTBE in the Village of Liberty water system. As stated previously, measures were undertaken to minimize children's as well as others' exposure to MTBE beginning January 26, 1993 when the well was first taken out of service. Additional measures included providing water from alternate water supplies (e.g., water from Revonah Lake, a water tanker, Town of Liberty, and Lily Pond) and the remedial activities.

COMMUNITY HEALTH CONCERNS

The NYS DOH and ATSDR mailed this public health assessment to the public on July 17, 2000. The public comment period ran from July 17 to August 18, 2000. Based on a request from the community, NYS DOH and ATSDR extended the public comment period to October 18, 2000. NYS DOH and ATSDR held a public meeting on October 11, 2000 to discuss the findings of the public health assessment with concerned residents. The following section responds to specific

health concerns identified by the community during the public meetings, from written comments and during telephone conversations:

Concern 1: Residents want to know what possible long- and short-term health effects might be experienced due to exposure to MTBE.

Response 1: In studies, some persons who breathed MTBE from gasoline exposure (short-term exposure) complained of headaches, nausea, dizziness, irritation of the eyes, nose and throat, and feelings of spaciness or confusion. There are no adequate oral studies on the long-term exposure of MTBE. Studies with laboratory animals show that inhalation exposure to very high levels of MTBE affected the central nervous system, blood components, liver, kidneys, adrenal glands, and reproduction. The exposure levels that cause these effects are much greater than the estimated levels of exposure to MTBE in water from the Elm Street well in the Village of Liberty. NYS DOH assessed the noncancer health risks associated with exposure to the Village's MTBE-contaminated drinking water. The existing toxicity data suggest that the health risks would be minimal. Human cancer studies on MTBE are not available. MTBE has induced several types of cancers in laboratory animals exposed to high levels of MTBE for a long period of time. Inhalation of MTBE caused liver, kidney and testicular tumors in animals. MTBE caused testicular tumors and lymphomas/leukemias in animals that were given large doses directly into their stomachs. The MTBE exposure levels that cause cancer in laboratory animals are much greater than the estimated levels of exposure to MTBE in water from the Village's Elm Street well. Whether MTBE causes cancer in humans is unknown. However, based on the available information, NYS DOH estimates that the risk of contracting cancer is low for past exposure of MTBE-contaminated water from the Elm Street well. More information is found in the Public Health Implications Section of this document.

Concern 2: Residents want to know what byproducts are produced by MTBE (in the environment) and what possible health effects could be experienced from exposure to MTBE by products.

Response 2: As stated in the background section, MTBE may be fairly persistent in the subsurface and groundwater since it shows very limited tendency for degradation by biological and chemical processes. Although, tertiary-butyl alcohol (TBA) is a possible product of biodegradation, the chemical may also be present in the fuel (petroleum) itself. At high levels of exposure, TBA can cause irritation of the eyes, skin, nose, and throat. High levels of exposure may also affect the central nervous system and produce symptoms such as headaches, light-headedness, dizziness, drowsiness and narcosis. TBA was not detected in samples of water collected on October 18, 2000 from the well and from the distribution system. Analytical data for TBA is not currently available for the groundwater at the contaminated sites. We have no specific evidence that people were exposed to TBA from drinking Elm Street well water.

Concern 3: Residents want to know what metabolites (breakdown products in the body) are produced by MTBE.

Response 3: Information from studies in human volunteers have identified tertiary-butyl alcohol, 2-methyl-1,2-propanediol and 2-hydroxyisobutyrate as metabolites of MTBE. Tertiary-butyl alcohol, 2-methyl-1,2-propanediol and 2-hydroxyisobutyrate are also identified as metabolites in studies of laboratory animals. Evidence from animals studies also suggests that tertiary-butyl alcohol may undergo further metabolism to formaldehyde, acetone and methanol.

Concern 4: Residents want to know what effects the MTBE contamination may have on the development of unborn children due to the mother's exposure.

Response 4: Studies that evaluate the reproductive and developmental toxicity of MTBE by the oral route of exposure in animals and humans do not exist. Inhalation studies of laboratory animals suggest that high levels of MTBE can adversely affect their ability to bear healthy offspring. The high MTBE exposure levels in some (but not all) of these studies also caused adverse health effects on the parent animals, and are about 50,000 times higher than estimated exposures to MTBE in water from the Elm Street well. Although the risks of reproductive and developmental effects of exposure to MTBE in drinking water are not completely understood, the existing data suggest that they would be minimal for exposure to the highest level detected in the Elm Street well.

Concern 5: A resident expressed concern about MTBE exposure to an infant through ingestion of breastmilk.

Response 5: We did not find any studies that measured MTBE in breastmilk after low level exposure in drinking water. We found one study that measured the level of MTBE in the breastmilk of a patient who had MTBE directly applied to her gallbladder to dissolve gallstones. The peak concentration of MTBE in the woman's breastmilk four hours after treatment was about 25,000 µg/L and was undetectable 76 hours after treatment. Although this type of exposure is different from exposure to MTBE in drinking water, the level of MTBE in the breastmilk was similar to that found in blood, and is consistent with other types of evidence that suggest MTBE is readily distributed, rapidly excreted, and unlikely to accumulate in fat, including the fat in breastmilk.

Concern 6: Several residents have expressed concerns about the number of people in the area who have been diagnosed with cancer, particularly lymphoma and leukemia.

Response 6: Although, MTBE has been shown to cause cancer in laboratory animals exposed to high levels for their lifetimes (including lymphoma and leukemia), we do not know whether MTBE causes cancer in humans. NYS DOH evaluated the increased lifetime cancer risk due to exposure to MTBE at the highest detected level in the Elm Street well for a maximum possible exposure duration of up to 20 years and estimated it to be low. Cancer incidence will be evaluated in the NYS VOC Exposure Registry.

Concern 7: Residents have reported various conditions which they think may have been caused by exposure to MTBE, including: seizures, multiple sclerosis, arthritis, headaches (including migraines), gastrointestinal illness, rashes and skin lesions, respiratory illnesses (including asthma/respiratory airways), allergies, nose and throat problems, fatigue, neurological problems, attention deficit hyperactive disorder and psychological problems.

Response 7: Although, some of these reported conditions are similar to known health effects of MTBE (such as, nose and throat irritation, headaches, gastrointestinal illness and neurological problems), we do not know if they are due to MTBE exposure or something else. Based on the available information, the estimated levels of exposure to MTBE in water from the Elm Street well are at least 3000 times lower than the levels of exposure known to cause health effects in animals and people. One way of addressing possible health effects associated with MTBE exposure from the Village of Liberty's Elm Street well-water is to evaluate these concerns through the NYS VOC Exposure Registry.

Concern 8: Are your reports published in Spanish or any other language to get the MTBE report out to the community?

Response 8: In communities where there is a documented need to provide written information in a foreign language, efforts are taken to provide a translated written summary of reports such as a public health assessment. Based on previous public meetings and a review of demographic data for the Village of Liberty area, NYS DOH determined that there was no need to provide translated written material. If the need arises for translations to alternate languages, provisions can be made.

CONCLUSIONS

Residents of the Village of Liberty whose source of drinking water was the Elm Street well were exposed to MTBE for an undetermined amount of time, up to 20 years. Prior to 1993, we do not know when the MTBE contamination occurred and to what levels residents were exposed. Public health actions were needed to reduce exposure to MTBE associated with drinking water from the Village of Liberty's Elm Street well. Residents' past exposure to MTBE from consuming water from the Elm Street well may be associated with a low risk for carcinogenic health risks. NYS DOH also estimated the risk for non-cancer health effects based on exposure

to the highest detected MTBE level is estimated to be minimal for both Village of Liberty and Town of Liberty residents.

Exposure to MTBE in drinking water was reduced through the use of alternate drinking water sources, providing a water tanker and an external tap at the Town of Liberty water supply, decreasing the volume of water pumped from the well, combining water from alternate sources and the Elm Street well, and the remedial activities. Remediation of the sources of the MTBE contamination is effectively removing contamination and will continue over the next four to five years. Current use of the well poses no apparent public health hazard (see Appendix E, Category D) because the gasoline-related contaminants, including MTBE, have not been detected in the well water. Recently other VOCs have been detected in water from the Elm Street well at levels below their respective drinking water standards. Due to this and the well's location in a commercial/light industrial area, the well continues to be vulnerable to VOC contamination. As long as the well is used, monitoring of the well water should continue.

RECOMMENDATIONS

1. If the village plans to supplement Lily Pond with water from the Elm Street well or maintain it as a emergency or back-up source of water, then monitoring the water from the Elm Street well should continue, especially since the well may be vulnerable to VOC contamination. Continued monitoring of the Elm Street well will help to identify any VOC concentrations of concern. NYS DOH will also evaluate whether the well is vulnerable to biological contamination by determining whether it is "groundwater under direct influence of surface water."

2. Monitoring of groundwater near the Elm Street well site should continue until the sources of the MTBE contamination have been completely remediated.

3. The village should make use of the monetary opportunities available through the NYS Safe Drinking Water Act, State Revolving Fund to continue to make improvements to its water supply system.

4. Residents of the Village of Liberty and the Town of Liberty's Ferndale and Stevensville water districts, who were exposed to MTBE, are encouraged to participate in the NYS VOC Exposure Registry. Participants should be informed of any findings from the analysis of the NYS VOC Exposure Registry data.

PUBLIC HEALTH ACTIONS

The actions described in this section are designed so that this public health assessment identifies public health hazards and provides a plan of action to mitigate and prevent adverse health effects from exposure to hazardous substances in the environment.

Actions Completed During the Public Health Assessment Process:

1. NYS DOH and the Village of Liberty water department were involved with securing a reliable source of drinking water for the Village. This action began when MTBE contamination was reported to NYS DOH in January 1993.

2. NYS DOH held public meetings in January 1993 and October 2000. At these public meetings NYS DOH staff distributed fact sheets on the contamination.

3. NYS DEC is overseeing the remedial activities at the well site. Source removal is complete and remediation of contaminated groundwater is on-going.

4. NYS DOH reviewed the analytical data for MTBE contamination in the Elm Street well.

5. NYS DOH reviewed the available toxicological information associated with exposure to MTBE.

6. The village continues to monitor the Elm Street well for VOCs because it is used to supplement water from Lily Pond to meet water demands.

7. The village applied for monies through the NYS Safe Drinking Water Act, State Revolving Fund to make improvements to the water supply system. As a result, the NYS Environmental Facilities Corporation notified the Village that they were awarded a grant to upgrade/repair the water supply system in a letter dated May 24, 2001. On May 22, 2003, the Village received grant monies and financing in the amount of $5.6 million.

8. This Public Health Assessment was reviewed by members of the public as well as State and Federal agencies, such as ATSDR, US EPA, NYS DEC, and NYS DOH regional staff. Comments have been received and incorporated into this document.

Actions to Be Completed During the Public Health Assessment Process:

1. NYS DOH will continue community health education activities, as needed, regarding past exposure to MTBE in the Elm Street well.

2. Monitoring for VOCs in the Elm Street well (as deemed necessary based on the proposed future use of the well) will continue. Monitoring for VOCs in surrounding monitoring wells should take place until remedial goals have been met.

3. Also based on the proposed use of the well, the Elm Street well will be evaluated as to whether its source is “groundwater under the direct influence of surface water” to determine the need for additional treatment. This evaluation is expected to be conducted during the summer of 2005.

Remediation of the contaminated groundwater will continue until NYS DEC criteria for system shut-down have been met.

4. People exposed to VOCs, such as MTBE in drinking water, in the past are encouraged to enroll in the NYS VOC Exposure Registry.

5. NYS DOH and ATSDR will coordinate efforts with the appropriate Agencies to implement the recommendations contained in this public health assessment.

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CERTIFICATION

The Public Health Assessment for the Village of Liberty Water Supply System—Elm Street Well site was prepared by the New York State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health assessment was initiated.

Technical Project Officer, CAT, SPAB, DHAC

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

for Team Leader, CAT, SPAB, DHAC, ATSDR

Table 1. Comparison of Statewide, Village of Liberty and Parksville Corridor Demographics.

	N.Y. State	Village of Liberty	Parksville Corridor	Stevensville Water District	Ferndale Water District
Age Distribution					
<6	8%	9%	8%	12%	9%
6-19	18%	19%	15%	21%	18%
20-64	60%	53%	64%	56%	61%
>64	13%	19%	13%	10%	13%
Race Distribution					
White	74%	82 %	94%	90%	80%
Black	16%	13%	5%	5%	14%
Asian	4%	2%	< 1 %	2%	3%
Other	6%	4%	< 1 %	4%	3%
Ethnicity Distribution Percent Hispanic	12%	9%	3%	10%	11%
Median Income	$32,965		$25,918*		
Percent Below Poverty Level	13%		14%*		

*Median income and percent below poverty level are given for the Town of Liberty which encompasses all four of the districts.

Table 2. Concentrations of MTBE that Exceed the Previous NYS DOH Drinking Water Standard (50 micrograms per liter - µg/L) Found in the Water from the Village of Liberty Elm Street Well.

Date	Concentration (µg/L)	Date	Concentration (µg/L)
3/6/90 [1]	Not Analyzed	7/13/94 [5]	52
8/20/90 [1]	130	7/18/94 [5]	58
12/28/92 [2]	150	7/20/94 [5]	56
1/8/93 [2]	86	7/27/94 [5]	60
1/21/93 [2]	140	7/29/94 [5]	68
11/1/93	67	8/5/94 [5]	57
11/8/93	60	8/10/94 [5]	58
11/18/93	58	8/12/94 [5]	56
11/23/93 [3]	58	8/22/94 [5]	56
11/25/93	58	8/25/95 [5]	54
6/23/94 [4]	81	8/28/95 [5]	52
6/29/94 [4]	79	8/30/95 [5]	57
7/1/94 [5]	51	9/8/95 [5]	57
7/11/94 [5]	62	9/11/95 [5]	56

1. Routine monitoring for MTBE was not required by State Sanitary Code and therefore MTBE was not a usual target compound for laboratory analyses. However, an environmental laboratory identified MTBE in a sample collected on August 20, 1990 from the Elm Street well.

2 Confirmation testing of water from the Elm Street well. Analytical results for water samples collected between December 28, 1992 and January 21, 1993 were performed to verify the presence and levels of MTBE in the Elm Street well.

3. Connection to Town of Liberty water supply established. Elm Street well water combined with Town water.

4 Elm Street well water with Town of Liberty water beginning November 23, 1993. No analytical data available for MTBE levels in the distribution system for these sample events.

5 Analytical data for distribution system show that MTBE was below the previous drinking water standard for these sample events.

Table 3. Water Quality Standards/Guidelines and/or Public Health Assessment Comparison Values for MTBE in Village of Liberty's Elm Street Well.
[All values in micrograms per liter (µg/L)]

Contaminant	Water Quality Standards/Guidelines				Comparison Values*			
	New York State			US EPA				
	Ground Water	Surface Water	Drinking Water	Drinking Water	Cancer	Basis**	Noncancer	Basis**
methyl *tertiary*-butyl ether	**10[a]**	**10[a]**	**50[b]**	**--**	**10**	**NYS DOH**	**230**	**NYS DOH**

NOTES FOR TABLE 3.

[a] Guidance value

[b] During the process of developing this public health assessment, the New York State Department of Health (NYS DOH) drinking water standard for MTBE was revised to a lower value based on the same toxicological information used in this public health assessment. The previous standard (NYS DOH) standard of 50 micrograms per liter (µg/L) was superceded on December 24, 2003 by the current standard of 10 µg/L (10 NYCRR, 2004).

* Comparison values determined for a 70 kilogram adult who drinks 2 liters of water per day. A 20% relative source contribution is assumed for organic chemicals for noncancer comparison values.

** NYS DOH New York State Department of Health Ambient Water Quality Fact Sheet

Table 4. Cancer Risk Evaluation of Exposure to MTBE*
in Village of Liberty's Elm Street Well.

Health Endpoint	Water Concentration	Dates Exposed	Exposure Duration	Estimated Increased Cancer Risk	Cancer Risk Descriptor	Basis for Cancer Risk Estimates
Cancer	**118 µg/L**	**1979-1993**	**14 years**	**5 in 1,000,000**	**low**	**animal study**
	61.5 µg/L	**1993-1998**	**6 years**	**0.9 in 1,000,000**	**very low**	**animal study**

Table 5. Noncancer Risk Evaluation of Exposure to MTBE*
in Village of Liberty's Elm Street Well.

Health Endpoint	Maximum Water Concentration	Calculated Hazard Quotient[a]	Noncancer Risk Descriptor Based on Max. Water Concentration	Noncancer Margin of Exposure Versus LOEL[b]	Basis for Noncancer Risk Estimates
Noncancer	**150 µg/L**	**0.26**	**minimal**	**12,000**	**animal study**

* MTBE = methyl-*tertiary*-butyl ether

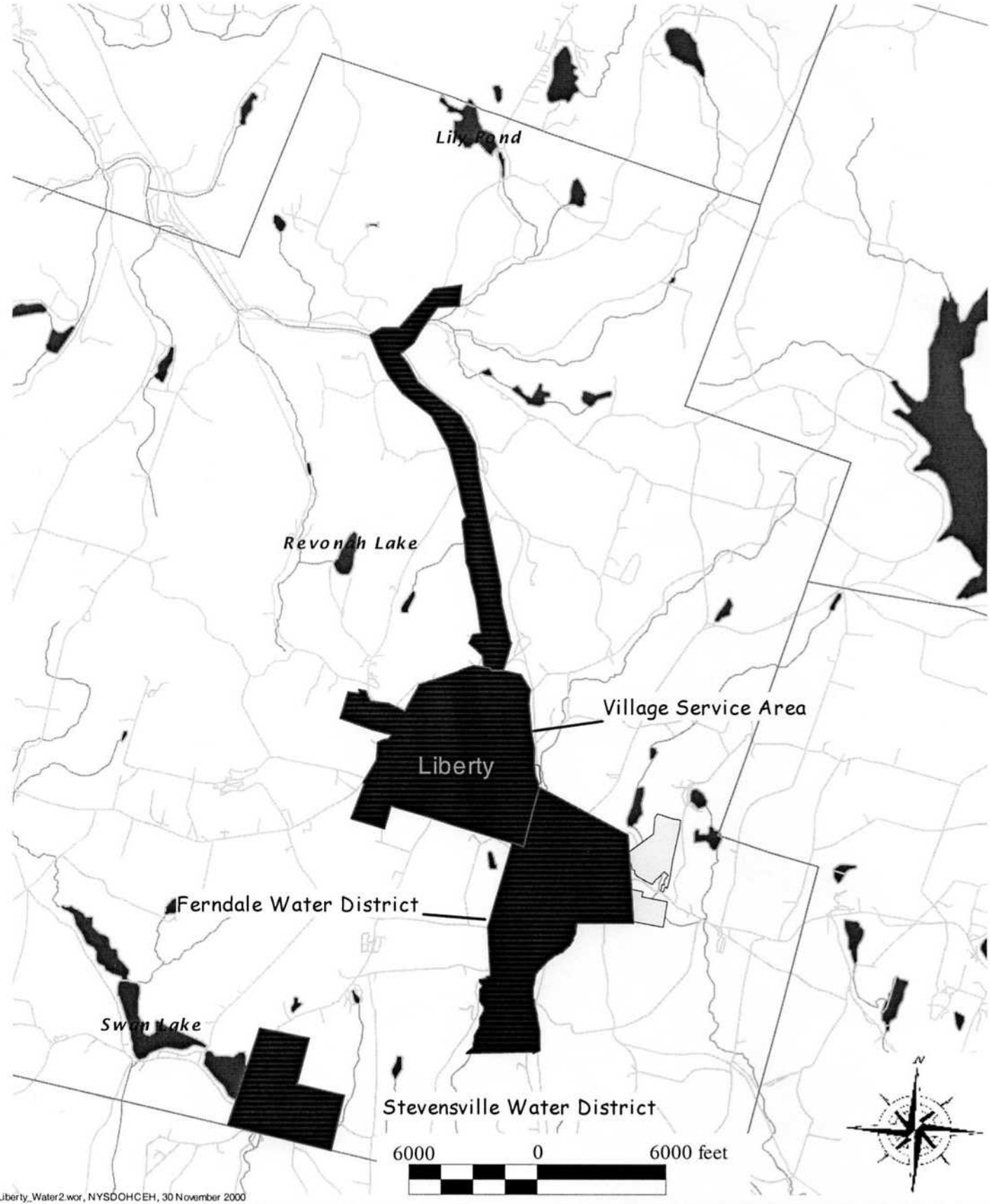
[a] The ratio of the estimated contaminant intake to the risk reference dose.

[b] LOEL = lowest observed effect level

APPENDIX B

FIGURE

Figure 1. Village of Liberty and Related Water Supply Areas



Liberty_Water2.wor, NYSDOHCEH, 30 November 2000

APPENDIX C

FACT SHEET

NEW YORK STATE
VOLATILE ORGANIC COMPOUNDS EXPOSURE REGISTRY

New York State Volatile Organic Compounds (VOC) Exposure Registry Health Status Assessment and Long-Term Follow-Up

BACKGROUND

Very little knowledge exists about health risks that may be associated with low-level community exposures to Volatile Organic Compounds (VOCs). Two reasons for this lack of knowledge are 1) there is usually no information proving exposure, and 2) there is generally no long-term follow-up of affected persons. To help address these problems, the New York State Department of Health (NYS DOH) has recently established the New York State VOC Exposure Registry. This Registry helps DOH staff study the relationship between someone being exposed to VOCs and potential health problems that might be associated with the exposure. Past and current health information is gathered using a questionnaire. Then, contact with that person is maintained, so that health status updates can be obtained periodically.

The Registry is currently evaluating exposures and health status of New York State residents at locations where drinking water or indoor air was contaminated with chemicals such as industrial solvents or petroleum products from landfills, industrial sites, spills, or other sources. Individuals and communities are considered for inclusion in the Registry if potential exposures from the contamination of private wells, public water supplies, or indoor air have been verified by sampling results.

HOW THE REGISTRY WORKS

Enrollment in the Registry is voluntary. Residents complete a questionnaire that asks about possible exposures, past and current health status of each household member, and other factors related to health such as smoking history. Questions about current and past cancer diagnoses, as well as respiratory, neurological, cardiovascular, gastrointestinal, musculo-skeletal, endocrine, and reproductive symptoms and diseases are included. The types of health problems reported by a community can be compared with state and national data to see if the community is experiencing unusually high rates of disease. Health information gathered from communities with similar types of potential exposures can be combined, thus improving the quality of research that can result.

The information collection process and initial review of health status information for a new site are projected to take from six to twelve months. A status report on the success of enrollment efforts and a summary of health information will be provided to the community. Those enrolled in the Registry will be kept informed of any research results. Information will be shared with VOC registrants and, if they wish, their health care providers if new information becomes available that points to potential health problems associated with these types of exposures. All information provided by Registry participants is strictly confidential, and no individual information is provided in reports. After household members have agreed to enroll in the Registry and have returned the completed questionnaire, NYS DOH will contact them

approximately every two to three years and ask for updated health information for each household member.

FOR MORE INFORMATION

If you have any questions or would like more information about the Registry, please call Megan Meldrum 1-800-458-1158, ext. 27950. If you wish to discuss your participation with an institutional representative who is not part of the study, please feel free to call Tony Watson, IRB Coordinator, 518-474-8539.

APPENDIX D

NYS DOH PROCEDURE FOR EVALUATING POTENTIAL HEALTH RISKS FOR CONTAMINANTS OF CONCERN

APPENDIX D

NYS DOH PROCEDURE FOR EVALUATING POTENTIAL HEALTH RISKS FOR CONTAMINANTS OF CONCERN

To evaluate the potential health risks from contaminants of concern associated with the Village of Liberty Water Supply System - Elm Street Well site, the New York State Department of Health assessed the risks for cancer and noncancer health effects.

Increased cancer risks were estimated by using site-specific information on exposure levels for the contaminant of concern and interpreting them using cancer potency estimates derived for that contaminant by the US EPA or, in some cases, by the NYS DOH. The following qualitative ranking of cancer risk estimates, developed by the NYS DOH, was then used to rank the risk from very low to very high. For example, if the qualitative descriptor was "low", then the excess lifetime cancer risk from that exposure is in the range of greater than one per million to less than one per ten thousand. Other qualitative descriptors are listed below:

Excess Lifetime Cancer Risk

Risk Ratio	Qualitative Descriptor
equal to or less than one per million	very low
greater than one per million to less than one per ten thousand	low
one per ten thousand to less than one per thousand	moderate
one per thousand to less than one per ten	high
equal to or greater than one per ten	very high

An estimated increased excess lifetime cancer risk is not a specific estimate of expected cancers. Rather, it is a plausible upper bound estimate of the probability that a person may develop cancer sometime in his or her lifetime following exposure to that contaminant.

There is insufficient knowledge of cancer mechanisms to decide if there exists a level of exposure to a cancer-causing agent below which there is no risk of getting cancer, namely, a threshold level. Therefore, every exposure, no matter how low, to a cancer-causing compound is assumed to be associated with some increased risk. As the dose of a carcinogen decreases, the chance of developing cancer decreases, but each exposure is accompanied by some increased risk.

There is general consensus among the scientific and regulatory communities on what level of estimated excess cancer risk is acceptable. An increased lifetime cancer risk of one in one million or less is generally not considered a significant public health concern.

For noncarcinogenic health risks, the contaminant intake was estimated using exposure assumptions for the site conditions. This dose was then compared to a risk reference dose (estimated daily intake of a chemical that is likely to be without an appreciable risk of health effects) developed by the US EPA, ATSDR and/or NYS DOH. The resulting ratio was then compared to the following qualitative scale of health risk:

Qualitative Descriptions for
Noncarcinogenic Health Risks

Ratio of Estimated Contaminant Intake to Risk Reference Dose	Qualitative Descriptor
equal to or less than the risk reference dose	minimal
greater than one to five times the risk reference dose	low
greater than five to ten times the risk reference dose	moderate
greater than ten times the risk reference dose	high

Noncarcinogenic effects unlike carcinogenic effects are believed to have a threshold, that is, a dose below which adverse effects will not occur. As a result, the current practice is to identify, usually from animal toxicology experiments, a no-observed-effect-level (NOEL). This is the experimental exposure level in animals at which no adverse toxic effect is observed. The NOEL is then divided by an uncertainty factor to yield the risk reference dose. The uncertainty factor is a number which reflects the degree of uncertainty that exists when experimental animal data are extrapolated to the general human population. The magnitude of the uncertainty factor takes into consideration various factors such as sensitive subpopulations (for example, children or the elderly), extrapolation from animals to humans, and the incompleteness of available data. Thus, the risk reference dose is not expected to cause health effects because it is selected to be much lower than dosages that do not cause adverse health effects in laboratory animals.

The measure used to describe the potential for noncancer health effects to occur in an individual is expressed as a ratio of estimated contaminant intake to the risk reference dose. A ratio equal to or less than one is generally not considered a significant public health concern. If exposure to the contaminant exceeds the risk reference dose, there may be concern for potential noncancer health effects because the margin of protection is less than that afforded by the reference dose. As a rule, the greater the ratio of the estimated contaminant intake to the risk reference dose, the greater the level of concern. This level of concern depends upon an evaluation of a number of factors such as the actual potential for exposure, background exposure, and the strength of the toxicologic data.

APPENDIX E

PUBLIC HEALTH HAZARD CATEGORIES

INTERIM PUBLIC HEALTH HAZARD CATEGORIES

CATEGORY / DEFINITION	DATA SUFFICIENCY	CRITERIA
A. Urgent Public Health Hazard This category is used for sites where short-term exposures (< 1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.	This determination represents a professional judgement based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicates that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards.
B. Public Health Hazard This category is used for sites that pose a public health hazard due to the existence of long-term exposures (> 1 yr) to hazardous substance or conditions that could result in adverse health effects.	This determination represents a professional judgement based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.
C. Indeterminate Public Health Hazard This category is used for sites in which "*critical*" data are *insufficient* with regard to extent of exposure and/or toxicologic properties at estimated exposure levels.	This determination represents a professional judgement that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.	The health assessor must determine, using professional judgement, the "criticality" of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.
D. No Apparent Public Health Hazard This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.	This determination represents a professional judgement based on critical data which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.	Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.
E. No Public Health Hazard This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.	Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future	

**Such as environmental and demographic data; health outcome data; exposure data; community health concerns information; toxicologic, medical, and epidemiologic data; monitoring and management plans.*

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Appendix F: ATSDR Glossary of Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

General Terms

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.
Acute
Occurring over a short time [compare with chronic].
Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].
Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].
Adverse health effect
A change in body function or cell structure that might lead to disease or health problems
Aerobic
Requiring oxygen [compare with anaerobic].
Ambient
Surrounding (for example, ambient air).
Anaerobic
Requiring the absence of oxygen [compare with aerobic].
Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.
Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.
Antagonistic effect
A biologic response to exposure to multiple substances that is less than would be expected if the

known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Background level

An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation

Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study

A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring

Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake

The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing

Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota

Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden

The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP [see Community Assistance Panel.]

Cancer

Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk

A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen

A substance that causes cancer.

Case study

A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study

A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.
Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.
CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]
Chronic
Occurring over a long time [compare with acute].
Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]
Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.
Community Assistance Panel (CAP)
A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.
Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
Completed exposure pathway [see exposure pathway].
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).
Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.
Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Delayed health effect
A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.
Dermal contact
Contact with (touching) the skin [see route of exposure].
Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.
Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.
Disease prevention
Measures used to prevent a disease or reduce its severity.
Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.
DOD
United States Department of Defense.
DOE
United States Department of Energy.
Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.
Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).
Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.
Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.
EPA
United States Environmental Protection Agency.
Epidemiologic surveillance [see Public health surveillance].

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.
Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].
Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.
Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.
Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.
Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.
Exposure registry
A system of ongoing followup of people who have had documented environmental exposures.
Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.
Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.
Grand rounds
Training sessions for physicians and other health care providers about health topics.
Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].
Half-life (t½)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number

of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard

A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)

The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste

Potentially harmful substances that have been released or discarded into the environment.

Health consultation

A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

Health education

Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation

The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health promotion

The process of enabling people to increase control over, and to improve, their health.

Health statistics review

The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard

The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence

The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion

The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation

The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure

Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].
In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].
Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.
Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.
Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.
Metabolite
Any product of metabolism.
mg/kg
Milligram per kilogram.
mg/cm2
Milligram per square centimeter (of a surface).
mg/m3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.
Migration
Moving from one location to another.
Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].
Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.
Mortality
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.
Mutagen
A substance that causes mutations (genetic damage).
Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.
National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.
No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.
No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.
No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.
NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]
Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.
Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.
Plume
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.
Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].
Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).
Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.
ppb
Parts per billion.
ppm
Parts per million.
Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].
Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.
Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.
Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.
Public health action
A list of steps to protect public health.
Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.
Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].
Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.
Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.
Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.
Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.
Public meeting
A public forum with community members for communication about a site.
Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.
RCRA [see Resource Conservation and Recovery Act (1976, 1984)]
Receptor population
People who could come into contact with hazardous substances [see exposure pathway].
Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.
Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].
Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.
Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.
RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.
RfD [see reference dose]
Risk
The probability that something will cause injury or harm.
Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.
Risk communication
The exchange of information to increase understanding of health risks.
Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
Safety factor [see uncertainty factor]
SARA [see Superfund Amendments and Reauthorization Act]
Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.
Sample size
The number of units chosen from a population or an environment.
Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.
Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.
Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.
Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.
Substance
A chemical.
Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.
Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)
Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.
Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].
Surveillance [see public health surveillance]
Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].
Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].
Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.
Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.
Toxicology
The study of the harmful effects of substances on humans or animals.
Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).
Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].
Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.
Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:

Environmental Protection Agency (http://www.epa.gov/OCEPAterms/)

National Center for Environmental Health (CDC)
(http://www.cdc.gov/nceh/dls/report/glossary.htm)

National Library of Medicine (NIH)
(http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

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