



Public Health Assessment for

**FORMER CHLOR ALKALI FACILITY
BELOW SAW MILL DAM
BERLIN, NEW HAMPSHIRE
EPA FACILITY ID: NHN000103313
FEBRUARY 7, 2007**

**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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Prepared by:

New Hampshire Department of Environmental Services
Environmental Health Program
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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1. SUMMARY

The Former Chlor-Alkali Facility (Site) is a 4.6-acre plot located on the east side of the Androscoggin River in Berlin, New Hampshire. The site is owned by a Trustee for the Estate of Pulp and Paper of America, LLC which filed for bankruptcy in 2001. Structures previously located on the site employed various chemical processes to produce chlorine and sodium hydroxide used in paper manufacturing. Site operations were shut down and the majority of the buildings were subsequently demolished in the early 1960s. As a result of activities from the late 1800s until the early 1950s, various contaminants (including elemental mercury) were released to the environment. A series of environmental investigations and site removals has been conducted at the site starting in 1999. The most recent site remediation efforts involved the collection and removal of elemental mercury along the Androscoggin River's shoreline and bottom.

The site is located in an industrially-zoned area confined to the north, south, and east by property currently owned by North American Dismantling Corporation (formerly owned by Fraser NH LLC and operated by Fraser Papers, Inc.). The Androscoggin River defines the western boundary of the Site. The Fraser Paper perimeter fence as well as the Androscoggin River physically separate the residential neighborhood to the southeast, as well as residential and commercial property located to the northwest. Using available data, Environmental Health Program (EHP) has concluded that the site has three completed and potential exposure pathways for possible human exposure (offsite surface water, sediment, and fish). The proximity of drinking water wells, restricted access to the Site, and the previous remedial efforts, have eliminated all other on and off-site exposure pathways from consideration.

On the basis of available information, the New Hampshire Department of Environmental Services, EHP has made the following conclusions about the Site:

- Levels of contaminants in Androscoggin River surface water and sediment downstream from the site suggest that exposures to recreators (i.e., fisherman, boaters, and swimmers) pose *no apparent public health hazard*. These exposures are expected to be of limited duration and at contaminant levels lower than those that would be expected to produce adverse health effects.
- Consumption of fish caught in the Androscoggin River downstream from the site poses a *public health hazard*. This conclusion coincides with the existing EHP site-specific fish consumption advisory for the Androscoggin River. The advisory recommends that everyone (adults and children alike) should avoid consumption of all fish species from this area of the Androscoggin River.

EHP has made the following recommendations about the Site:

- The owner/operator should continue to limit public access to the site after Fraser Paper ceases operations at their Berlin pulp mill. Post signs at the site boundaries if necessary to prevent the public from entering and altering site controls (i.e., impermeable liner).
- EHP will conduct further evaluations of contaminant levels in the Androscoggin River as additional surface water, sediment and/or fish monitoring data become available. The contaminant levels should be evaluated for potential risks to people who swim, wade, or fish in the Androscoggin River downstream from the Site.
- The public should avoid consumption of all Androscoggin River fish species caught downstream of the Saw Mill Dam located in Berlin, NH. This recommendation concurs with the existing EHP fish consumption advisory for the Androscoggin River. EHP is currently working with regional stakeholders to develop a new outreach program to educate the public about the fish consumption advisory.
- DES and EPA should continue routine mercury remediation events along the Androscoggin River if elemental mercury deposits continue to migrate offsite.
- DES and EPA should continue to monitor on-site contaminant levels to assess whether they may be migrating off-site and warrant additional off-site sampling. EPA conducted additional sampling at the site in summer 2006. EHP will review the new environmental sampling data when it becomes available.
- DES and EPA should continue to monitor groundwater wells on-site to identify possible contaminants that may need to be added to sampling of Androscoggin surface water and sediment.
- DES and EPA should continue to monitor public water supplies for possible contamination.

2. PURPOSE AND HEALTH ISSUES

The former Chlor-Alkali Facility was proposed for the National Priorities List (NPL) on April 27, 2005. As mandated by Congress, the Agency for Toxic Substances and Disease Registry (ATSDR) performs Public Health Assessments (PHAs) on all hazardous waste sites proposed for the National Priorities List. The New Hampshire Department of Environmental Services, Environmental Health Program (EHP) has a cooperative agreement with ATSDR to evaluate the public health significance of waste sites in New Hampshire through PHAs and other health-related documents. The EHP completed this PHA under the cooperative agreement.

This document evaluates the potential public health implications of the former Chlor-Alkali Facility (Site). EHP has reviewed available environmental data and potential exposure scenarios to determine the probability of adverse human health effects. In

addition, this PHA recommends actions to prevent, reduce, or further identify possible site-related adverse health effects.

3. BACKGROUND

A. Site Description

The site is located in the northern portion of the former Burgess Mill property, east of the Androscoggin River, west of Hutchins Street, North of the Cleveland Bridge, and south of Bridge Street and Sawmill Dam in Berlin, Coos County, New Hampshire. According to property cards at the Town of Berlin Assessor's office, the site is located in an industrially-zoned area and is identified as Lot 54 on Berlin Tax Map Number 128. The approximately 4.6 acre property is currently owned by a Trustee for the Estate of Pulp and Paper of America, LLC. Pulp and Paper of America, LLC declared bankruptcy in 2001. The site is surrounded by Fraser Paper Inc. industrial property, owned by Fraser NH LLC, to the north, south, and east; and the Androscoggin River to the west. The site property is not currently accessible to the public. The only access to the property is through a staffed guard house located at the entrance to the fenced Fraser paper property, off Unity Street and east of the Androscoggin River. From the Fraser paper property guard house, a dirt access road enters the site from the southeast corner (1, 2).

B. Site Operational History

The current Fraser Paper property that surrounds the site has been associated with paper manufacturing since at least 1850. From the late 19th Century until the early 1950s, a chemical mill located on the site produced raw materials for use at the paper plant. The size of the chemical mill grew to approximately 200,000 square feet by 1920. The largest component of the chemical plant was the chlor-alkali facility, which used graphite-mercury cells to manufacture chlorine gas and sodium hydroxide (caustic) solution for use in creating wood pulp for paper manufacturing. The chlor-alkali facility included lime and liquor tanks, a hydrogen gasometer, as well as chlorine gas cell houses, a transformer house, an absorption building, evaporator building, a caustic plant, caustic shed, and chloroform still rooms (1).

There are three different types of chlor-alkali processes: the diaphragm cell process, the membrane cell process, and the mercury cell process; the only one that uses mercury. Mercury and lead were used (or were likely used) in the chlor-alkali process at the former facility prior to the end of operations in late 1962, and was disposed of throughout the Site. In the mercury cell process, elemental mercury flows along the bottom of an electrolytic cell and serves as the cathode. When an electric current passes through the cell brine, chlorine is produced at the anode and a sodium amalgam at the cathode. Scientists have estimated that for each ton of chlorine produced by the mercury cell process, half a pound of mercury was lost; this amount of mercury was lost to the products produced, the atmosphere, the river, and the site (3).

A portion of the original chemical mill buildings was removed between 1928 and 1950 (2). According to an interview with a former employee, the cell house operations were shut down in 1962, and the majority of the buildings were subsequently demolished in 1963. In 1999, a Limited Environmental Assessment (LEA) was conducted confirming that one cell house remained on the site – a brick building measuring approximately 76 feet by 96 feet (1). In 1999, this last remaining cell house at the site was demolished, the underlying contaminated soil was removed, an impermeable cap and slurry wall were constructed by DES contractors, drainage channels were dug, fencing was installed, and groundwater monitoring wells were installed for long-term monitoring. The chemical plant building demolition materials and clean sand were used as fill material during the capping project. Portions of the site with detected lead and mercury contamination were capped with a vented 40-mil high-density polyethylene (HDPE) cover, which was overlain by up to 3 feet (ft) of wood chips. Drainage channels along the east and south of the site were also dug to divert clean water away, and the Site's western side was fenced for safety purposes. In addition, a slurry wall was constructed along the east and southern boundaries of the landfill in an effort to reduce groundwater flow-through. Furthermore, all visible mercury and mercury-contaminated sediment from the Androscoggin River adjacent to, and approximately 450-feet downstream of the Site, was removed and the bedrock along a portion of the bank of the river was pressure-grouted to seal fractures and limit mercury migration. Lastly, deed restrictions on future use of the site were put in place. Despite these response actions intended to arrest contaminant migration from sources at the site, elemental mercury continues to seep out of bedrock fissures along the Androscoggin River and can be observed in river sediments (1, 2, 3).

In addition to the removal, grouting, and capping project described above, remedial actions have been undertaken to address elemental mercury that has been noted along the eastern bank of the Androscoggin River adjacent to the Site. Mercury has been discovered in pools above bedrock crevices in the river bottom, droplets and balls at the openings of bedrock fractures, and disseminated as fine droplets within sand and gravel deposits extended approximately 50-feet west into the river. Annual removals of elemental mercury have been conducted since 1999, with the first recovering the most mercury. Subsequent annual mercury removal efforts focused on fresh accumulations of mercury in the locations previously cleaned (1, 2).

Following is a summary of the elemental mercury remediation efforts to date:

- In 1999, Clean Harbors Environmental Services recovered mercury from the Androscoggin River's shoreline and bottom. It was estimated that approximately 50 to 100 pounds of mercury were collected.

- In 2000, United Industrial Services removed elemental mercury from the Androscoggin riverbank. The amount of mercury found and disposed of was approximately 1.5 pounds.
- Between November 11-15, 2002, Enpro Services and BG Environmental removed mercury from the riverbank of the Androscoggin River using pneumatic syringes, screwdrivers, and spoons. Approximately 32 ounces of mercury and four bags of mercury-contaminated scrap metal were collected.
- Between August 23-25, 2004, Global Remediation Services, subcontracted by Weston Solutions of Manchester, New Hampshire conducted a mercury removal along the Androscoggin riverbank adjacent to the Chlor-Alkali property; the amount of material removed was unknown (3).

C. Demographics

Demographic information characterizes the populations in the communities potentially affected by the site, the mobility of the population, and the current population trends. Identifying the presence of sensitive populations, such as young children (age 6 and under), the elderly (age 65 and older), and women of childbearing age (age 15 through 44), is particularly important because these sub-groups tend to be more sensitive to environmental exposures than the general population. Also, information on relevant issues such as poverty status, and household income can provide clues to factors such as access to health care and subsistence fishing. Demographic information is essential when analyzing health outcome data and behavior patterns in a community.

The site lies in the Town of Berlin, Coos County, New Hampshire. The closest residents live in private residences approximately 0.13-mile to the northwest, and in a housing subdivision approximately 0.2-mile to the southeast of the Site. According to the 2000 U.S. Census, approximately 7,127 people live within 1-mile radius of the Site. Other towns that follow the Androscoggin River include Gorham (population 2,895) to the south and Shelburne (population 379) to the southeast. The closest school or day-care facility (Kids Only Daycare) is located approximately 0.3 miles from any potential onsite source areas. Seven additional schools and day care facilities are also located in within the Berlin city limits (1). There are also no full-time workers associated with the site. More detailed demographic information is outlined in Appendix 1.

D. Land and Natural Resource Use

Natural resource uses in the area of the site can demonstrate if or how persons could be exposed to environmental contaminants. Activities such as water consumption, swimming, and fishing have the potential to result in exposure to site contaminants. Knowing the locations of sensitive populations (i.e., schools, hospitals, and nursing homes) is also important because elderly, sick, or very young persons are often at higher risk of adverse health effects. Reviewing land ownership, zoning patterns, and deed restrictions also helps us understand future use of land around the site and helps us evaluate the potential hazard to the community.

Berlin is a small city located in the White Mountains at the confluence of the Androscoggin and Dead Rivers. The surface of Berlin is broken and mountainous. There are many areas with ledges of rock outcropping and others with boulders of varying sizes scattered over the ground. Berlin is bounded on the north by Milan, east by Success, south by Gorham and Randolph, and west by Kilkenny. Many views of mountains, rivers, and forest scenery are afforded from various points (4).

The site is confined by property owned by North American Dismantling Corporation to the north, south, and east; and the Androscoggin River to the west. The surrounding property has been utilized for manufacturing purposes since the 1800s. Although there is residential property to the southeast, the Fraser property perimeter is fenced and can only be accessed through a staffed guard house located at the Fraser Paper property entrance east of the Androscoggin River (5). Residential and commercial property is also located northwest of the Site, but can only be accessed by crossing the river. Because access to the property is restricted and monitored, recreational activities and resultant exposure to site contaminants is not expected to occur.

Berlin Water Works supplies the Town of Berlin with drinking water from two sources: a primary surface water source located along the Upper Ammonoosuc River approximately 4 radial miles from the Site; and a backup groundwater well located 1.95 miles north-northeast of the Site. The nearest private well located east of the Androscoggin River is approximately 0.5 miles northeast of the Site, while the nearest private well to west is located approximately 0.4 miles northwest of the Site. The Gorham Water & Sewer Department supplies the Town of Gorham with public drinking water from two surface water sources (Icy Gulch Brook & Perkins Brook), and two back-up wells. All of these sources are located more than 4 radial miles from the site and none are located along the 15-mile downstream surface water pathway. According to Gorham Town Offices, there are 80 households within Gorham that utilize private wells. All residents within the Town of Shelburne are also served by private drinking water supplies. There are no known surface drinking water intakes along the 15-miles downstream surface water pathway for the Site. Based on the location and distance to the nearest public and private groundwater drinking water supply wells, no impacts to nearby drinking water sources from onsite sources are known or suspected (1).

The Androscoggin River is classified by the USGS as a “large stream to river” (greater than 1,000 to 10,000 cubic feet per second). It flows from north to south along the western boundary of the former chlor-alkali facility property (3). There are eight dams located on the Androscoggin River within the Target Distance Limit (TDL) designated from the most upstream portion of the site boundary extending 15-miles downstream to Shelburne, New Hampshire. The flow rate and height of the Androscoggin River fluctuate as a result of changes in seasonal precipitation and the operation of these dams (1).

The Androscoggin River is classified as a Class B surface water body by NH DES. Class B waters are defined as the second highest quality waters acceptable for fishing, swimming, and other recreational purposes, and after adequate treatment, for use as water supplies. According to the State of New Hampshire 2000 Section 305(b) Water Quality Report, the Androscoggin River is considered “impaired” due to water quality exceedances of copper, dioxins, pathogens, and zinc. In addition, the Androscoggin River Watershed Council posted a swimming advisory for the Androscoggin River beginning one mile north of the Berlin and Gorham town line. It is unknown when the swimming advisory took effect (1). Two city parks in the City of Berlin (Unity Park & Community Field - WW II Park) are located downstream of the site where residents may recreate in the Androscoggin River. Several other river access points are located off of Route 16 and Route 2, in Gorham and Shelburne (6, 7). A map of the recreational areas in Berlin is available in Appendix 2.

According to a local conservation officer, the Androscoggin River near Gorham is an “excellent trophy trout fishery.” As a result, recreational fishing activities in the area have apparently increased significantly according to reports from Trout Unlimited (a fisheries conservation group), and as indicated by the increased number of licensed fishing guides whose clients fish the river in the towns of Gorham and Shelburne. The New Hampshire Fish and Game Department has designated the stretch of the Androscoggin River from Sawmill Dam in Berlin, downstream through the towns of Gorham and Shelburne to the Maine border as open to fishing, but closed to harvest (taking of fish). This “no-kill” regulation was put in place primarily due to dioxin contamination in the river, and secondarily as an effort to conserve larger sport fish (3).

Although this specific fishery is classified as catch-and-release only, several factors exist that may allow fish from this stretch of the river to enter the food chain. These factors are as follows: 1) the “lower Androscoggin River” has recently been discovered as a trophy trout fishery, and an increased number of licensed fishing guides utilize this part of the river; 2) during spring spawning months, large trophy fish migrate upstream into tributaries which are not classified as catch-and-release; and 3) with Berlin’s high poverty rate (12.4% vs. 6.5% statewide), a higher than average proportion of its residents may use these fish as a supplemental food source (1).

4. DATA/DISCUSSION

A. Exposure Pathways

Human exposure to environmental contamination occurs only when a completed pathway exists. A *completed* pathway exists when the following five critical elements are present: 1) a source of contamination; 2) environmental fate and transport through a medium; 3) a point or area of exposure; 4) a route of human exposure; and 5) a receptor population. These five elements largely determine to what extent site-related exposures may have occurred, may be occurring, or may occur in the future. In a *potential* exposure pathway,

one or more of the critical elements may not be present, but information is insufficient to eliminate or exclude it. For example, an exposure could have occurred in the past, could be occurring currently, or could occur in the future. An exposure pathway is *eliminated* if one or more of the critical elements is missing. Eliminated exposure pathways may also be referred to as incomplete. Site-specific characteristics make current and future exposures extremely unlikely (8).

In the following sections, each of these onsite and offsite pathways of exposure is outlined in more detail. The completed, potential and eliminated exposure pathways are listed for the site in the following tables:

Onsite Pathways

Source	Environmental Transport And Media	Exposure Point	Exposure Route	Exposed Population	Time Frame	Status
Landfill Waste	Waste to Groundwater to Private/Municipal Drinking Water Wells	Tap Water	Ingestion Dermal Inhalation	Residents	Past	Eliminated
					Present	Eliminated
					Future	Eliminated
Landfill Waste	Waste to Contaminated Surface Soil	Onsite	Ingestion Dermal	Workers Onsite	Past	Potential
					Present	Eliminated
					Future	Eliminated
Landfill Waste	Waste to Contaminated Soil to Ambient Air	Ambient Air Onsite	Inhalation	Workers Onsite	Past	Potential
					Present	Eliminated
					Future	Eliminated

1. Drinking Water

Groundwater in the area originates as precipitation falling on the site and surrounding upland areas to the north and east. A portion of the precipitation runs off directly into the Androscoggin River. In the small portions of the site without the impermeable HDPE cover, precipitation infiltrates the ground, migrating vertically through the unsaturated zone until it reaches the overburden water table. The water then flows through overburden, perched upon the top of the bedrock surface until it reaches a fracture. Water may subsequently enter the complicated pattern of fractures and move vertically downward, or move upward from the bedrock fracture into the overburden (2).

To date, actions taken to address groundwater contamination at the site include: 1) installation of a slurry wall from the bedrock to the ground surface along the south and east sides; 2) pressure grouting of exposed productive bedrock fractures within the

Androscoggin River; 3) installation of the HDPE liner to restrict groundwater recharge; 4) installing piezometers throughout the site to monitor groundwater elevation; and 5) groundwater sampling efforts (1).

Based on recent analytical data, groundwater beneath the site has been impacted by a release of hazardous substances which is at least partially attributable to onsite sources. However, the direction of groundwater flow through the site is west and southwest toward the Androscoggin River. As acknowledged in the previous Land and Natural Resource Use Section, no impacts to nearby drinking water sources from the site are known or suspected based on the location and distance to the nearest public and private groundwater drinking water supply wells. There are also no known surface drinking water intakes along the 15-mile downstream surface water pathway for the Site. Furthermore, there are no additional CERCLIS-listed properties located within 1 radial mile of the site (1). Thus, local residents are not using this contaminated groundwater as a source of drinking water and are not being exposed to contaminants. It is also extremely unlikely that onsite contaminated groundwater would ever be allowed to be used as a drinking water supply. Consequently, this pathway has been eliminated and will not be considered further in this assessment.

2. Onsite Soil

The site contains no native soils but rather consists of fill, including gravel, brick, demolition debris, and ash on top of fractured bedrock (1). Although recent soil sample data confirm that some soil contamination remains onsite, access to the property is restricted, and there are no onsite workers or residents; thus exposure to contaminants in the soil is limited (1, 3, 5). Actions taken to address soil and groundwater contamination at the site include: 1) installation of the HDPE liner to prevent direct contact with the site surface; 2) the removal of mercury along the east bank of the Androscoggin River; and 3) the placement of a deed restriction on the site (1). Consequently, this pathway has been eliminated and will not be considered further in this assessment.

3. Onsite Air

Some of the contaminants currently remaining beneath the ground surface of the site have the potential to evaporate into the air spaces between soil grains (“soil gas”) and gradually work their way to the surface. Approximately 4.0 acres of the 4.6 acre site are covered with an impermeable HDPE liner. However, the six passive vents installed through the site liner create a potential conduit for releasing soil gas contaminants. When soil gas reaches the ground surface, the contaminants enter the ambient (outdoor) air. In general, however, concentrations of contaminants in ambient air are much lower than those in soil gas (1).

In October, 2002, the six gas vents on the site were field-screened with a Mercury Vapor Analyzer (MVA). No mercury was detected (detection limit 0.003 mg/m³). During a later site reconnaissance, no elevated readings of volatile organic compounds were detected by

a photoionization detector (PID), a combustible gas indicator & oxygen meter, or an MVA (1). Based on these data, human exposure to contaminants in ambient air is unlikely. Additional factors serve to eliminate the potential for human exposure from ambient air at this site: 1) absence of onsite workers or nearby residents; 2) restricted access to the Site; and 3) deed restrictions placed on the property concerning its use.

Offsite Pathways

Source	Environmental Transport And Media	Exposure Point	Exposure Route	Exposed Population	Time Frame	Status
Landfill Waste	Waste to Groundwater to Surface Water	Androscoggin River	Ingestion Dermal	Swimmers Waders	Past	Completed
					Present	Completed
					Future	Completed
Landfill Waste	Waste to Groundwater to Surface Water to Sediments	Androscoggin River	Ingestion Dermal	Swimmers Waders	Past	Completed
					Present	Completed
					Future	Completed
Landfill Waste	Waste to Groundwater to Surface Water to Fish	Androscoggin River	Ingestion	Fishers	Past	Completed
					Present	Completed
					Future	Completed

1. Surface Water & Sediments (Ingestion & Dermal)

The Androscoggin River is the surface water body physically connected to the site. The river flows from north to south along the western boundary of the site property. Hazardous substances can travel into the river through bedrock fractures (seeps) along several hundred feet of the Site’s river frontage, and from two steel conduits (pipes) that penetrate the concrete retaining wall (3). The physical and chemical properties of mercury facilitate several possible transport mechanisms through the fractured bedrock and into the river (2). Once in the river surface water, contaminants may flow downstream and be deposited in sediments. Impacts to the Androscoggin River surface water and river sediment partially attributable to site releases were documented through:

- a) Confirmed mercury contamination in water samples taken from a manmade conduit;
- b) Visual observations of elemental mercury deposits (liquid form, and other solid metal deposits) made along the bank of the Androscoggin River;

- c) Sediment sample data from downstream locations in the Androscoggin River indicating monomethyl mercury levels at least three times above the established background level; and
- d) No other sources of mercury or methyl mercury identified in the area by EPA database searches (3).

To date, actions taken to address the release of elemental mercury from the site to the surface water pathway include the removal of mercury along the banks of the Androscoggin River, adjacent to the Site, in 1999, 2000, 2002, 2004, and 2005 (1).

People who recreate (swim, wade) in the Androscoggin River downstream of the site could be exposed to contaminants in the water and sediment. Exposure could occur by ingesting small amounts of water or sediment, or by absorbing chemicals through bare skin. There are two municipal parks downstream of the site in the City of Berlin from which residents may access the Androscoggin River (Unity Park & Community Field - WW II Park) (6). Several other river access points along Route 16 and Route 2 in the Towns of Gorham and Shelburne are also available for recreational opportunities (7). Although a swimming advisory is posted for the Androscoggin River upstream of the Berlin/Gorham town line, some in the area (especially those from out of town) may not be aware of the restrictions. As a result, the surface water and sediment pathway is deemed complete.

2. Ingestion of Fish from the Androscoggin River

As discussed in previous sections, contamination from the site has migrated into the surface water and sediments of the Androscoggin River. Some of these contaminants accumulate in the tissues of fish in the river. Thus, individuals who eat fish from the river could be exposed to the contaminants. EHP and the New Hampshire Department of Fish and Game have acted to limit this type of human exposure through the fish consumption advisory and the catch-and-release policy. Because residents or visitors may ignore or be unaware of these warnings and restrictions, fish consumption has been designated as a potential pathway for exposure. Given Berlin's high poverty rate (12.4% vs. 6.5% statewide), a higher than average proportion of its residents may use these fish as a supplemental food source (1).

B. Environmental Contamination Data

An integral element of every public health assessment is a review of environmental contamination on and nearby the Site. In the preceding section, completed and potential pathways for possible human exposure are identified (offsite surface water, sediment, and fish). This section examines onsite contaminants that may have migrated offsite to pose a hazard for the surrounding population. Offsite environmental sampling results are summarized below for each completed or potential pathway.

1. Offsite Surface Water (Section C, Table 1)

- a. On April 30, 1999, five surface water samples were collected from the Androscoggin River (one upgradient sample, two samples east of the site, and two samples downgradient of the Site). The samples were analyzed for lead and mercury by unspecified methods. Lead and mercury were not detected at concentrations above their laboratory detection limits (1).
- b. On June 1, 1999, three surface water samples were collected (one upgradient, two downgradient of the Site). The samples were analyzed for arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver. No metals were detected above their laboratory detection limits (1).
- c. On March 27, 2000, two surface water samples were collected from the Androscoggin River at a drainage ditch outfall located along the southern portion of the site (lined portion). The samples were analyzed for VOCs by EPA Method 8260B. They were also analyzed for arsenic, barium, lead, and mercury. No VOCs or mercury were detected in the samples, however arsenic (8.0 ppb), barium (7.0 ppb), and lead (2.0 ppb) estimated were detected (1).
- d. On June 13, 2000, two surface water samples were collected from the Androscoggin River at similar locations to those taken on March 27, 2000. The samples were analyzed for VOCs by EPA Method 8260B, and for the metals arsenic, barium, lead and mercury. No metals were detected above laboratory detection limits. Five VOCs, however, were detected at the following concentrations:
 - Acetone 16 ppb;
 - Methyl ethyl ketone 12 ppb;
 - 2-Hexanone 9 ppb;
 - Methyl isobutyl ketone 9 ppb; and
 - 1,2,3-Trichloropentane 1 ppb (1).
- e. On July 16, 2003, one surface water sample was collected from a pool of water located adjacent to the bedrock outcrop of the Site. The sample was analyzed for total mercury and methyl mercury. Results detected the presence of total mercury (59 ppb), and methyl mercury (0.00214 ppb) (1).

2. Offsite Sediment (Section C, Table 2)

- a. On June 17, 1999, five sediment samples were taken from the Androscoggin River in the vicinity of the site (one beside the site & four downstream). Samples were analyzed for lead and mercury by EPA Method 160.3 (1). Lead concentrations ranged from less than the method detection limit of 24 mg/kg, to a high of 120 mg/kg, which is within the range reported for natural soils (2 – 200 mg/kg). Mercury concentrations ranged from 0.055 – 1.2 mg/kg which exceed the reported values for natural soils of 0.01 – 0.5 mg/kg (9).
- b. On December 4-6, 2001, twenty sediment samples were taken from ten locations along the Androscoggin River. Three locations were upstream of the Sawmill Dam (dam adjacent to the site – considered background); three locations were between the Sawmill Dam and the Riverside Dam (next dam downstream); and four locations were between the Riverside Dam and Smith Hydro Dam (further downstream). Sediment samples were analyzed for total mercury and methyl mercury. In addition, eight samples were analyzed for selective sequential extraction (SSE) mercury which provides information on the biogeochemically relevant fraction of mercury in sediment under different aqueous environments. Total mercury concentrations, excluding upgradient samples, ranged from 0.0394 – 1.21 mg/kg, while methyl mercury concentrations were between 0.000022 – 0.00377 mg/kg (1).

3. Offsite Fish (Section C, Table 3)

- a. Pulp & Paper Testing: On September 25-26, 2000, three composite fish fillet samples (trout with skin on, trout with skin off, and brown bullhead with the skin off) were analyzed for tetra-to-octa chlorinated-p-dioxins and chlorinated dibenzofurans by EPA Method 1613. The fish were caught in the Androscoggin River in Shelburne, NH. The Toxicity Equivalent Quotient (TEQ) ranges for the three composite fish fillet samples were based on U.S. EPA Toxicity Equivalent Factors (TEFs):
 - Trout with skin: 1.44 - 1.47 picograms per gram (pg/g);
 - Trout w/ skin off: 0.740 – 0.843 pg/g
 - Brown Bullhead with skin off: 3.44 – 3.47 pg/g (3).
- b. Pulp & Paper Testing: On April 18, 2001, twenty-one fish tissue samples were taken from fourteen fish (seven trout and seven brown bullhead) and analyzed for total mercury by EPA Method 7471A. The seven trout fillets were divided into two groups: skin on and skin off for subsequent analysis. Sources assume that the fish were caught in the Androscoggin River. Analytical results indicated that mercury concentrations ranged from 140 – 720 ppb (3).

- c. In June and July 2001, EHP conducted a voluntary fish collection event at the Androscoggin River. According to EPA START, the muscles of 63 individual fish were analyzed for total mercury. They included the following species: rainbow trout, small mouth bass, brook trout, northern pike, brown bullhead, yellow perch, horn pout, fall fish, and Atlantic salmon. The fish were collected in the Androscoggin River downstream between the site to the town of Shelburne. Analytical results indicated concentrations of total mercury ranging from 8 – 1,600 parts-per-billion (ppb) within the study area. Fish caught in the Berlin, NH section of the Androscoggin River had mercury concentrations ranging from 121 – 638 ppb (3).

According to the New Hampshire Public Health Laboratory's Food Chemistry Procedure, the following guidelines and procedures were employed during the analysis of Androscoggin River fish tissue samples:

1. Fish were at least 8 inches in length to warrant analysis;
2. Edible portions of each fish (mid-back fillet) were analyzed;
3. All reagents used in analysis were tested via a method/reagent blank to ensure they do not contribute contamination;
4. Sampling devices, sample containers and plastic items were determined to be free of mercury or any laboratory contamination;
5. Fish samples were microwave digested and analyzed using a cold-vapor Mercury Analyzer (Atomic Absorption) (10).

C. Environmental Data Evaluation & Contaminants of Concern

After exposure pathways are designated and environmental data are summarized, site-related contaminants are evaluated. The highest environmental concentration of each contaminant (Upper Confidence Limit or UCL) is initially compared to health-based, media-specific comparison values (CVs) to identify contaminants that do not have a realistic possibility of causing adverse health effects. CVs include ample safety factors that account for the most sensitive populations.

Typically, contaminants with maximum levels below CVs do not represent a public health concern and are eliminated from further discussion. For contaminants that occur naturally in the environment, or may be deposited by other anthropogenic (man-made) sources, background values may also be considered. Generally, no further evaluation is needed for contaminants which are below their respective CVs.

Contaminants with maximum levels that exceed CVs, or are of specific concern to the community, are designated as “contaminants of concern (COC)” and are subjected to further evaluation. Because CVs are based on conservative assumptions, the presence of contaminants above CVs does not necessarily mean that adverse health effects will result for exposed individuals.

1. Surface Water – Incidental Ingestion & Dermal Contact Pathway

EHP evaluated five separate surface water sampling data sets collected from the Androscoggin River on April 30, 1999; June 1, 1999; March 27, 2000; June 13, 2000; and July 16, 2003. The specific surface water contaminants evaluated by EHP were selected based on the availability of data. Also considered was the Site Investigation Report which stated that the hazardous substances associated with the site (chloroform, arsenic, lead, mercury, and monomethyl mercury) are available to migrate into surface water (2). EHP also took into account an observed, direct discharge into the Androscoggin River from a site outfall drain pipe where mercury was detected in a December 2001 sample (3). Soil contaminants could migrate to off-site surface water through fractured bedrock and outfall pipes.

EHP used the maximum concentration detected for each selected contaminant (identified during each surface water sampling event). Selected contaminants that were identified at the site in 2004, but were undetected during surface water laboratory analysis were also included at one-half of their analytical detection limit as a conservative measure (referred to as “estimated” in Table 1). These contaminant concentrations were compared to relevant ATSDR and EPA cancer and non-cancer drinking water CVs (**Table 1**).

The use of drinking water CVs is very conservative for intermittent exposure while swimming or wading. When cancer CVs were unavailable to evaluate Androscoggin River surface water data, EHP considered EPA Cancer classifications. As a result, eight surface water contaminants were chosen for further evaluation as contaminants of concern (**Table 1**, bold items).

Table 1. Summary of Androscoggin River Surface Water Concentrations and Respective Comparison Values (1, 11, 12, 13)

Contaminant	Maximum or Estimated Concentration (ppb)	Cancer Comparison Value (CV) (ppb)	Non-cancer Comparison Value (CV) (ppb)
Metals			
Lead	2.0	None (B2)	15.0 (1)
Mercury and Compounds (Total)	59.0	None	11.0 (5)
Methyl Mercury	0.00214	None (C)	1.0 (2) child
Arsenic	8.0	0.02 (3)	3.0 (4) child
Barium	7.0	None (D)	2000.0 (2) child
Cadmium	1.0 estimated	None (B1)	2.0 (4) child
Chromium	5.0 estimated	None (D)	100.0 (1)
Selenium	5.0 estimated	None (D)	50.0 (4) child
Silver	2.5 estimated	None (D)	50.0 (2) child
VOCs			
Benzene	1.0 estimated	0.6 (3)	5.0 (1)
Chloroform	1.0 estimated	None (LI)	80.0 (1)
Acetone	16.0	None (IN)	9000.0 (2) child
Methyl ethyl ketone	12.0	None (IN)	6000.0 (2)
Naphthalene	1.0 estimated	None (C)	200.0 (2) child
1,2,3	1.0	None (DI)	60.0 (2) child
Trichloropropane			
2-Hexanone	9.0	None	None
Methyl isobutyl ketone	9.0	None (IN)	2000.0 (5)

Comparison Value Sources

- (1) – EPA Maximum Contaminant Level (MCL)
- (2) – ATSDR Reference-dose Media Evaluation Guide (RMEG)
- (3) – ATSDR Cancer Risk Evaluation Guide (CREG)
- (4) – ATSDR Environmental Media Evaluation Guide (EMEG)
- (5) – EPA Region 9 – Preliminary Remediation Goal (PRG)
- (B1) – EPA Probable Human Carcinogen (limited human data)
- (B2) – EPA Probable Human Carcinogen (evidence in animals & inadequate/no human evidence)
- (C) – EPA Possible Human Carcinogen
- (D) – Not Classifiable as to Human Carcinogenicity by EPA
- (DI) – Data inadequate for an assessment of human carcinogenic potential
- (LI) – Likely to be Carcinogenic to Humans
- (IN) – Inadequate information to assess carcinogenic potential.

2. Sediment - Incidental Ingestion & Dermal Contact Pathway

EHP evaluated two sediment sampling data sets collected from the Androscoggin River, one on June 17, 1999, the other on December 4-6, 2001. The 2001 sediment samples were collected at depths between 0-to-1.5 feet, while the depth of the 1999 samples is unknown (1). EHP used the maximum values for total mercury, methyl mercury, and lead, along with a value that accounts for data variability (upper 95th confidence interval): ProUCL Version 3.0 Statistical Software’s recommended “Approximate Gamma & Students-t UCL” values for comparative purposes (**Table 2**). The ProUCL software was employed in order to provide a better representation of the variations in the sampling data (because there was no consistent trend in the vertical distribution of mercury in sediment) (14).

EHP used relevant EPA and State of California non-cancer CVs. These non-cancer CVs are based on a residential exposure scenario, and represent the most conservative values among the available, highly regarded sources (11, 12).

Table 2 shows that lead, total mercury and methyl mercury concentrations in Androscoggin River sediments do not exceed established CVs. Therefore, non-cancer adverse health effects are not expected to occur as a result of incidental ingestion or dermal contact with Androscoggin River sediment. Since Cancer CVs to evaluate the selected sampling values were unavailable, EHP also considered each respective EPA Cancer classification as conservative measures. As a result, two sediment contaminants were chosen for further evaluation as contaminants of concern (seen in bold below).

Table 2. Summary of Androscoggin River Sediment Concentrations and Respective Comparison Values (1, 11, 12)

Contaminant	Maximum Concentration (ppm)	95th UCL Concentration (ppm)	Non-Cancer CV (ppm)	Cancer CV (ppm)
Total Mercury	1.21	0.58	23.0 ₍₁₎	None
Methyl Mercury	0.00377	0.00198	5.0 ₍₂₎	None (c)
Lead	120	n/a	150.0 ₍₃₎	None (B ₂)

Comparison Value Sources

- (1) – EPA Region 9 Preliminary Remediation Goal (PRG)
- (2) – EPA RMEG
- (3) – CAL-Modified PRG
- (B₂) – EPA Probable Human Carcinogen (evidence in animals & inadequate/no human evidence)
- (c) – EPA Possible Human Carcinogen

3. Fish - Ingestion Pathway

The New Hampshire Fish and Game Department has designated the stretch of the Androscoggin River from Sawmill Dam downstream to the Maine border as open to catch and release fishing, but closed to harvest (taking of fish). This regulation was put in place due to high dioxin levels, and to preserve larger sport fish (3). Although this specific fishery is classified as catch-and-release only, fish may migrate upstream into tributaries without harvesting restrictions during spring spawning months (1).

It is likely that a substantial number of residents of the Berlin area use Androscoggin River fish as a food source (1). It is also plausible that recreational fishermen seeking trophy fish will harvest them for consumption. For this reason, Androscoggin River fish sampling data was evaluated.

EHP evaluated three data sets of fish samples collected from the Androscoggin River.

1. September 25-26, 2000 samples collected for dioxin/furan analysis on behalf of Pulp & Paper of America;
2. April 18, 2001 mercury samples collected for analysis on behalf of Pulp & Paper of America; and
3. June – July 2001 samples collected for analysis of mercury during the State of New Hampshire’s Voluntary Fish Collection Program (3).

EHP utilized the June and July 2001 mercury data results because of the large number of fish sampled, the variety of fish species collected, and because complete descriptions of sampling methods and quality assurance/quality control (QA/QC) measures were available. For purposes of evaluating dioxins and furans, EHP utilized the single available data set (with skin removed - to represent the most appropriate exposure scenario). Mercury concentrates in the muscle of the fish and is not associated with the skin.

Table 3 summarizes the average mercury concentration, as well as the dioxins/furan TEQ range for each species of Androscoggin River fish. The toxic equivalent (TEQ) is calculated by multiplying the amounts of each toxic dioxin/furan compound with their respective Toxic Equivalency Factor (TEF), and subsequently adding them together. The TEQ and TEFs are explained further in the Public Health Implications Section. Mercury concentration values and TEQs were compared to the risk-based consumption limits outlined in EPA’s Guidance “*Assessing Chemical Contaminant Data for Use in Fish Advisories*” (15) to yield a recommended safe, monthly fish consumption limit. These fish consumption limits are based on calculations assuming: an 8-ounce meal size, and incorporate the most conservative EPA RfDs and CSFs that are protective of the fetus for neurodevelopmental effects (12, 15).

Table 3. Summary of Mercury and Dioxin/Furan Concentrations in Androscoggin River Fish (3, 16).

Species	Average Hg Concentration (Jun – Jul '01) (ppb)	Recommended Meals/Month (Non-Cancer)	Dioxin/Furan TEQ Min & Max (ppt)	Recommended Meals/Month (10 ⁻⁶ cancer risk)
Rainbow Trout	86	8	0.740 - 0.843	Zero
Small Mouth Bass	385	2	No data	**Not Calculated
Northern Pike	241	3	No data	**Not Calculated
Brook Trout	105	8	No data	**Not Calculated
Fall Fish	201	4	No data	**Not Calculated
Atlantic Salmon	112	8	No data	**Not Calculated
Yellow Perch	437	2	No data	**Not Calculated
Horn Pout	135	4	No data	**Not Calculated
Brown Bullhead	546	1	3.44 - 3.47	Zero
All Species	*252	Not Calculated	No data	**Not Calculated

* Analytical data concentrations of all 63 fish averaged together.

** The recommended meals/month (10⁻⁶ cancer risk) was not calculated because TEQ data was not available.

NOTE: The lowest level of mercury that triggers a reduction in fish consumption (Recommended Meals/Month) is 29 ppb.

Table 3 illustrates that the available, minimum dioxin/furan levels measured in Androscoggin River Brown Bullhead, as well as Rainbow Trout (typically a stocked species), exceed the threshold whereby one excess cancer will occur per one-million persons similarly exposed. Although the mercury levels measured in Androscoggin River fish do not warrant such a strict consumption restriction (zero meals consumed per month - according to EPA guidelines), the dioxin/furan advice supersedes the less restrictive mercury recommendations. Because Rainbow Trout are normally grown in a hatchery environment and subsequently released, it can also be theorized that the dioxin/furan levels in all of the remaining native fish species (no data available) warrant an equal restriction. The dioxin/furan advice also coincides with the existing “NH DES Fish Consumption Advisory for Freshwater Fish” previously developed by EHP (17). Mercury and dioxins/furans in fish tissue are discussed further in the Public Health Implications Section.

D. Public Health Implications of Exposure

A review of environmental data and conditions at the site indicates that there are three completed pathways by which people could be, or could have been, exposed to chemicals from the Site: surface water, sediment, and fish. To assess the public health implications of these exposures, site-specific conditions were evaluated to determine realistic exposure scenarios for each completed pathway. These exposure scenarios make it possible to estimate exposure doses which can then be compared to scientific studies to help ascertain whether the extent of exposure indicates that adverse health effects could be associated with the types of exposures at this site. Our evaluation considers the susceptibility of children to the chemical exposures.

To understand how adverse health effects could be caused by a specific chemical, it is helpful to review factors related to how the body processes such a chemical. Those factors include the exposure concentration (how much), the duration of exposure (how long), the route of exposure (breathing, eating, drinking, and/or skin contact), and the multiplicity of exposure (combinations of contaminants). Once exposure occurs, a person's individual characteristics such as age, gender, diet, general health, lifestyle, and genetics, influence how the body absorbs, distributes, metabolizes, and excretes the chemical. Together these factors determine the potential health effects that can be caused by the chemical.

To help evaluate the potential for health effects, ATSDR has developed Minimal Risk Levels (MRLs) for contaminants commonly found at hazardous waste sites. ATSDR publishes MRLs in its series of chemical-specific Toxicological Profiles. The MRL is an estimate of daily human exposure to a contaminant below which non-cancer, adverse health effects are unlikely. MRLs are developed for oral and inhalation exposure routes, and for duration of exposure (acute: 14 days or fewer; intermediate: 15-364 days; chronic: 365 days or more). Acute MRLs are typically higher than chronic MRLs because of the shorter duration of exposure.

The EHP also uses EPA chemical specific Reference Doses (RfDs) to determine if non-cancer health effects are possible. RfDs, which are analogous to ATSDR's MRLs, are estimates of daily human exposure to a contaminant that is unlikely to result in adverse non-cancer health effects over a lifetime. For COCs that are considered to be “known”, “probable”, or “possible” human carcinogens, EHP also uses (when available) EPA chemical-specific cancer potency values to determine a theoretical estimate of excess lifetime cancer risk associated with exposure to the COC.

The following subsections discuss in detail the potential effects of each individual COC for each pathway of exposure (surface water, sediment, fish). Actual exposures to contaminants in the Androscoggin River surface water and sediment are limited to residents who occasionally access downstream portions of the river (i.e., swim and wade) during the warmer, summer months. Individuals who wear protective outerwear (e.g., rubber boots or waders) when fishing or engaging in other recreational activities are less

likely to be exposed via the dermal route. Non-intensive recreators who walk the river shoreline, or wade in the shallow water are very unlikely to be exposed to surface water via ingestion.

1. *Surface Water & Sediment*

Lead - *Surface Water & Sediment – Incidental Ingestion & Dermal Contact*

The maximum detected lead concentration recorded in the Androscoggin River *surface water* (2.0 ppb) did not exceed the non-cancer CV of 15.0 ppb. The maximum detected lead concentration recorded in Androscoggin River *sediments* (120 ppb) also did not exceed the non-cancer CV of 150.0 ppb. Because cancer comparison values and EPA cancer potency values were not available, EHP investigated the potential for carcinogenic health effects to occur via the ingestion and dermal exposure routes using the available literature. Modeling software was also utilized to predict increased blood lead levels in children.

According to NTP, lead and lead compounds are *reasonably anticipated to be human carcinogens* based on limited evidence from studies in humans and sufficient evidence from studies in experimental animals. However, the mechanisms by which lead causes cancer are not understood, and most studies of lead exposure and cancer reviewed had limitations (did not demonstrate relationships between the amount of exposure and the magnitude of cancer risk). Furthermore, the absorption of lead into the body is limited via dermal environmental exposures (18).

Lead (Pb) is regulated based on blood-lead concentration (PbB) since its toxicokinetics (the absorption, distribution, metabolism, and excretion of toxins in the body) are well understood. EPA and the Centers for Disease Control and Prevention (CDC) have determined that childhood blood-lead concentrations at or above 10 micrograms of lead per deciliter of blood ($\mu\text{g}/\text{dL}$) present risks to children's health. Accordingly, EPA's post-remediation goal is to limit the probability (to 5% or less) that a child's blood-lead concentration exceeds the 10 $\mu\text{g}/\text{dL}$ threshold (19).

EHP attempted to evaluate the Androscoggin River exposure scenario using the accepted Integrated Exposure Uptake Biokinetic Model for Lead in Children [IEUBK (Windows version 1.0 build 263)] model to predict blood-lead concentrations and the probability that a child trespasser's blood-lead concentration would exceed 10 $\mu\text{g}/\text{dL}$. Due to the transient nature of the exposure to Androscoggin River sediments and surface water, the IEUBK model was not directly applicable for an estimation of blood lead concentrations. As a conservative measure, EHP modified the exposure scenario by: 1) assuming a continual exposure; and 2) using the higher default IEUBK model concentrations of lead in soil (200 mg/kg) and drinking water (4 $\mu\text{g}/\text{L}$).

Using extremely conservative exposure assumptions, the resulting predicted blood lead level was below the USEPA level of concern (10 ug/dL). Based on this information, the low detection frequency of lead in surface water samples (1/9), and because actual exposures are limited and short-term, adverse health effects are not expected to occur as a result of exposure. Thus, lead in surface water and sediments near the site is considered to pose no apparent public health hazard.

Mercury & Compounds (Total) - Surface Water & Sediment – Incidental Ingestion & Dermal Contact

Mercury exists in several forms including: metallic or elemental mercury, inorganic mercury (combined with elements, such as chlorine, sulfur, or oxygen, to form compounds or ‘salts’), and organic mercury (i.e., methylmercury)(20, 21). Total mercury (all mercury forms added together) was detected in only one of the thirteen Androscoggin River surface water samples (59.0 ppb). This exceeded the non-cancer CV of 11.0 ppb (11). As a result, EHP evaluated an exposure scenario for a child who may be exposed to mercury in surface water through incidental ingestion and dermal contact while recreating in the Androscoggin River.

Most of the mercury found in the environment is in the form of metallic mercury and inorganic mercury compounds (20). The July 16, 2003, USGS sampling data substantiates this claim (methyl mercury represented only 0.1% of total mercury at an identical sampling site) (22). For comparative purposes, EHP utilized the most conservative inorganic mercury value (mercuric chloride) when evaluating the exposure scenario.

The potential for non-carcinogenic health effects to occur was evaluated through a direct comparison with the EPA Oral Reference Dose of 3.0×10^{-4} mg/kg-day for inorganic mercuric chloride (12). EHP determined that the combined average daily doses calculated for incidental ingestion and dermal contact surface water exposures did not exceed the established Reference Dose. As a conservative measure, EHP also factored in the average daily dose for mercury associated with dermal contact from the Androscoggin River *sediment*. The resultant, cumulative average daily dose also did not exceed the established Reference Dose. It is unlikely, therefore, that children recreating in the Androscoggin River would experience adverse non-cancer type health effects as a result of these exposures. This statement is further substantiated by noting the location of the only surface water sample containing measurable concentrations of mercury; immediately adjacent to the site and taken from a pool containing visible mercury droplets. Mercury contamination in surface *water and sediment* near the site is considered no apparent public health hazard according to ATSDR’s health hazard categories.

Methyl Mercury - Surface Water & Sediment – Incidental Ingestion & Dermal Contact

The maximum detected methyl mercury (organic mercury) concentration recorded in the Androscoggin River surface water (0.00214 ppb) did not exceed the non-cancer CV of 1.0 ppb (13). The maximum detected methyl mercury sediment concentration (0.00377 ppb) also did not exceed the non-cancer CV of 5.0 ppb (12). However, because cancer comparison values and an EPA cancer potency value were not available, EHP investigated the potential for carcinogenic health effects to occur via the ingestion and dermal exposure routes using the available literature.

EPA classifies methylmercury as a group C - possible human carcinogen based on inadequate data in humans, and increased incidence of kidney tumors in male mice. A review of the oral exposure animal studies revealed conflicting evidence between similar studies, and complications including: 1) the tumors were observed mainly at doses exceeding the Maximum Tolerated Dose; 2) mortality occurred in mice before the onset of cancer; and 3) tumors were observed at a single site, in a single species and single sex of mice. Based on the limited, inadequate, and/or inconclusive available data, a clear conclusion on the genotoxic potency of organic mercury could not be made. Thus, the EPA did not estimate carcinogenic risk (12, 23).

The carcinogenicity of methyl mercury is also discussed in the ATSDR Toxicological Profile for Mercury where associations were reported between the use of mercury-containing fungicides (i.e., mercury levels in hair) and leukemia in farmers. The use of mercury-containing seed dressings and the incidence of leukemia in cattle were also studied. However, limitations in the reporting methodology used to conduct this study were noted. Furthermore, the study did not adequately address exposure to other chemicals, or adjust for other leukemia risk factors (20).

Based on the aforementioned information, the actual exposure scenario (limited, short-term exposures that are unlikely to occur over a lifetime), and the single sample where the methyl mercury was detected (pool of water containing a visible mercury droplet immediately along the site boundary), adverse health effects are not expected to occur as a result of exposure. Therefore, methyl mercury contamination in surface water and sediment near the site is considered no apparent public health hazard according to ATSDR's health hazard categories.

Arsenic - Surface Water – Incidental Ingestion & Dermal Contact

Arsenic found in the environment combined with oxygen, chlorine, and sulfur is called inorganic arsenic while when combined with carbon and hydrogen is referred to as organic arsenic. Organic forms are usually less harmful than the inorganic forms. Oral doses of inorganic arsenic (ranging from about 300 to 30,000 ppb in food or water), may irritate the stomach and intestines, with symptoms such as stomach ache, nausea, vomiting, and diarrhea. Other effects from ingesting inorganic arsenic also include decreased production of red and white blood cells which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function

causing a "pins and needles" sensation in your hands and feet. Direct skin contact with inorganic arsenic compounds may cause irritation with some redness and swelling, but skin contact is unlikely to lead to any serious internal effects. For these reasons, EHP presumed the "total arsenic" detected in the Androscoggin River to be entirely inorganic arsenic for comparative purposes (24).

The maximum detected arsenic concentration recorded in the Androscoggin River surface water (8.0 ppb) exceeded the cancer CV of 0.02 ppb as well as the non-cancer CV of 3.0 ppb (13). As a result, EHP evaluated an exposure scenario for a child who may be exposed to arsenic in surface water through incidental ingestion and dermal contact while recreating in the Androscoggin River. Using upper-bound estimates of cancer potency by the oral route for inorganic arsenic, and assuming that the maximum arsenic concentration remained constant, this exposure represents an insignificant increased theoretical cancer risk (the potential for 5.5 excess cancers per ten-million exposed) for children who may recreate in the Androscoggin River. This theoretical excess cancer risk is not considered to be significant.

The potential for non-carcinogenic health effects to occur was evaluated through a direct comparison with the EPA Oral Reference Dose of 3.0×10^{-4} mg/kg-day (12). EHP determined that the cumulative average daily dose calculated for arsenic via the incidental ingestion and dermal contact routes of exposure did not exceed the established Reference Dose. It is unlikely, therefore, that children recreating in the Androscoggin River would experience adverse non-cancer type health effects as a result of these exposures. This statement is further substantiated by the location of the one and only surface water sample that contained detectable levels of arsenic (immediately adjacent to the Site). Therefore, arsenic contamination in surface water near the site is considered no apparent public health hazard according to ATSDR's health hazard categories.

Cadmium - Surface Water – Incidental Ingestion & Dermal Contact

Two surface water samples were analyzed for cadmium during the five Androscoggin River sampling events (collected on June 1, 1999). These two samples both revealed undetectable levels of cadmium. However, because cadmium was identified at the Site, the EHP utilized a concentration equal to one-half of the analytical detection limit (1.0 ppb) as a conservative estimate. Upon comparison, this cadmium concentration did not exceed the non-cancer CV of 2.0 ppb (13). Nonetheless, because a cancer comparison value and an EPA cancer potency value were not available, EHP investigated the potential for carcinogenic health effects to occur via the ingestion and dermal exposure routes using the available literature.

EPA has classified cadmium as a B1 - probable human carcinogen. This weight-of-evidence classification is based on all routes of exposure; although available data were inadequate for EPA to estimate the carcinogenic risk for the oral route (25). The ATSDR Toxicological Profile for Cadmium also did not identify studies regarding cancer in humans or animals after dermal exposure to cadmium. Furthermore, neither the human

nor the animal studies reviewed by ATSDR provided sufficient evidence to determine whether or not cadmium is a carcinogen by the oral route (26).

Based on the aforementioned information and the limited, short-term exposures that are unlikely to occur over a person's lifetime, adverse health effects are not expected to occur as a result of exposure. This statement is further substantiated by noting the location of one of the surface water samples (immediately down-gradient of the Site), the timeframe the samples were taken (prior to the completion of site remediation activities), as well as the actual data results (both revealed undetectable levels of cadmium). Therefore, surface water contamination near the site is considered no apparent public health hazard according to ATSDR's health hazard categories.

Benzene – Surface Water – Incidental Ingestion & Dermal Contact

Benzene is classified as a Category A - "known" human carcinogen. Based upon evidence presented in numerous occupational epidemiological studies, exposure to benzene is causally related to an increase in the risk of cancer, specifically leukemia. In addition, many experimental animal studies, both inhalation and oral, also support the evidence that exposure to benzene increases the risk of cancer in multiple organ systems (12).

Four surface water samples were analyzed for benzene during the five Androscoggin River sampling events. Benzene was not detected in these samples. However, because benzene was identified at the site and is a known carcinogen, EHP utilized a concentration equal to one-half of the analytical detection limit (1.0 ppb) as a conservative estimate. Upon comparison, this benzene concentration exceeded the cancer CV of 0.6 ppb (13). As a result, EHP evaluated an exposure scenario for a child who may be exposed to benzene in surface water through incidental ingestion and dermal contact while recreating in the Androscoggin River.

Using estimates of cancer potency by the oral route for benzene, and assuming that the estimated benzene concentration remained constant, this exposure represents a negligible increased theoretical cancer risk for children who may recreate in the Androscoggin River (the potential for 2.5 excess cancers per thousand-million people exposed). This theoretical excess cancer risk is not considered to be significant. Therefore, benzene contamination in surface water near the site is considered no apparent public health hazard according to ATSDR's health hazard categories.

Chloroform - Surface Water – Incidental Ingestion & Dermal Contact

Four surface water samples were analyzed for chloroform during the five Androscoggin River sampling events (collected on March 27, 2000 and June 13, 2000). Chloroform was not detected in these samples. However, because chloroform was identified at the Site, the EHP utilized a concentration equal to one-half of the analytical detection limit (1.0 ppb) as a conservative estimate. Upon comparison, this chloroform concentration did not exceed the non-cancer CV of 80.0 ppb (12). Because a cancer comparison value was not

available, EHP evaluated an exposure scenario for a child who may be exposed to chloroform in surface water through incidental ingestion and dermal contact while recreating in the Androscoggin River.

The EPA has determined that the oral RfD of 1.0×10^{-2} mg/kg-day can be considered protective against increased risk of cancer (25). As a result, EHP determined that the cumulative average daily dose calculated for chloroform via the incidental ingestion and dermal contact routes of exposure did not exceed the established Reference Dose. Using estimates of cancer potency, EHP furthermore determined that there is a negligible theoretical cancer risk for children who may recreate in the Androscoggin River. This theoretical excess cancer risk is considered to be insignificant. Therefore, chloroform contamination in surface water near the site is considered no apparent public health hazard according to ATSDR's health hazard categories.

2-Hexanone - Surface Water – Incidental Ingestion & Dermal Contact

Four surface water samples were analyzed for 2-Hexanone during the Androscoggin River sampling events. One of the four samples revealed an estimated 2-Hexanone concentration of 9.0 ppb, while the remaining samples had undetectable levels. A review of the available sources and literature revealed that cancer and non-cancer CVs, as well as EPA cancer potency values, were not available.

2-Hexanone, also known as methyl n-butyl ketone, MBK, or propyl acetone, is a clear, colorless liquid with a sharp odor. It dissolves very easily in water, and can evaporate easily into the air as a vapor. 2-Hexanone is formed as a waste product resulting from industrial activities such as making wood pulp, producing gas from coal, and in oil shale operations (27). 2-Hexanone may be broken down by microorganisms in water and soil, but doesn't usually attach to soils or sediment, or bioaccumulate in aquatic organisms (27, 28). If released to water, 2-hexanone should be expected to undergo rapid volatilization and biodegradation. The estimated half-life for volatilization from a typical river 1 m deep, flowing at 1 m/sec, and with a wind velocity of 3 m/sec is 1.2 days (28).

2-Hexanone has been identified among the natural volatile components of several foods including certain cheeses, nectarines, roasted filberts, chicken muscle, milk and cream (concentrations ranging from 7-18 ppb), and bread. According to Allen et al., the major target organ of 2-hexanone in humans is the nervous system. No studies were located regarding neurological effects in humans after oral exposure to 2-hexanone. However, sub-chronic (90-day) hen, guinea pig and rat studies documented adverse effects at relatively high dosages (100 mg/kg/day or higher); with apparent recovery soon afterward (29).

No studies were located regarding neurological effects in humans after dermal exposure to 2-hexanone. However, the application of *undiluted* 2-hexanone to the skin of rabbits for 24 hours resulted in Grade 1 (least severe) irritation, and Grade 3 (moderate) corneal necrosis (cell death) when applied to the eye. There is currently no information on the carcinogenic potential of 2-hexanone (29).

Based on the physical properties, the low incidence of detection, and the exposure scenario (limited, short-term exposures that are unlikely to occur over a person's lifetime), adverse health effects are not expected to occur as a result of exposure. Therefore, surface water contamination near the site is considered no apparent public health hazard according to ATSDR's health hazard categories.

2. Fish Data

Dioxin/Furan Compounds - Ingestion of Fish

Chlorinated Dibenzo-p-Dioxins - General Information

Chlorinated dibenzo-p-dioxins (CDDs) are a family of 75 different compounds with varying harmful effects. CDDs are divided into eight groups of chemicals based on the number of chlorine atoms in the compound. For example, tetra-chlorinated dioxin (TCDD) and octa-chlorinated dioxin (OCDD) contain four and eight chlorine atoms respectively. 2,3,7,8-TCDD (chlorine atoms on the 2,3,7 & 8 positions of the molecule) is one of the most toxic of the CDDs to mammals and has received the most attention. Thus, 2,3,7,8-TCDD serves as a prototype for the CDDs. CDDs with toxic properties similar to 2,3,7,8-TCDD are called "dioxin-like" compounds (30).

Aside from small amounts required for research purposes, CDDs are not purposely manufactured by industry. They are, however, unintentionally produced by industrial, municipal, and domestic incineration and combustion processes. CDDs are also naturally produced from the incomplete combustion of organic material by forest fires or volcanic activity. CDDs (mainly 2,3,7,8-TCDD) furthermore may be formed during the chlorine bleaching process used by pulp and paper mills. Human activities are believed to be the predominant environmental source (30).

CDDs are found at very low levels in the environment and are usually measured in parts per trillion (ppt). Most people are exposed to very small background levels of CDDs when they breathe air, or have skin contact with materials contaminated with CDDs. However, the vast majority of CDD and Chlorinated Dibenzofuran (CDF) exposure is associated with ingested food (primarily meat, dairy products, and fish). Elevated levels of CDDs have been documented in fish, shellfish, birds, and mammals in areas near chemical production facilities, hazardous waste sites, and at pulp and paper mills that use the chlorine bleaching process. People who eat food from these contaminated areas are at risk of increased exposure. However, the actual intake of CDDs from food harvested in an affected area depends on the amount and type of food consumed, and the level of contamination (30).

Several authors have studied the disposition and metabolism of CDDs in fish. A study by Kleeman on the disposition of 2,3,7,8-TCDD in Rainbow Trout and Yellow Perch indicated that fatty tissues (i.e., fat, carcass, & skin) typically contain the bulk of 2,3,7,8-TCDD (78–90%), with only a small percentage (2–5%) associated with the skeletal muscle (30). EHP evaluated sample data from fish tissue with the skin removed.

Once in your body, CDDs can be found in most tissues; with the highest amounts found in the liver and body fat. The body can store these CDDs for many years before eliminating them. Many studies have examined how CDDs can affect human health. Recent studies have measured 2,3,7,8-TCDD levels in the blood or fat tissue of exposed populations to estimate the extent of past exposures. The most obvious health effect encountered in persons exposed to relatively large amounts of 2,3,7,8-TCDD was a severe skin disease called chloracne (acne-like lesions generally on the face and upper body). Changes in blood and urine, indicating liver damage, as well as slight increases in the risk of diabetes and abnormal glucose have also been observed. The EPA has determined that 2,3,7,8-TCDD is a probable human carcinogen. For this reason, cancer was the primary health endpoint when EHP determined the fish consumption recommendations in Section C (30).

Chlorinated Dibenzofurans- General Information

Chlorinated dibenzofurans (CDFs) are a family of chemicals (135 individual compounds or congeners) that contain one to eight chlorine atoms attached to the carbon atoms of the parent chemical, dibenzofuran. CDFs, with chlorine atoms at the 2,3,7,8-positions, are especially harmful. Like CDDs, CDFs are not deliberately produced by industry (except for small amounts used for research and development). Rather, CDFs are produced as unwanted impurities of certain products and processes that utilize chlorinated compounds. Only a few of the 135 CDFs have been studied to assess their toxicity (31).

Small amounts of CDFs enter the environment from accidental fires or breakdowns of PCB-containing capacitors, transformers, and other electrical equipment. CDFs may also enter into the environment from burning coal, wood, or oil, and are produced as unwanted compounds during the manufacture of wood treatment chemicals, some metals, and paper products. The resultant waste water, sludge, or solids from these processes can release CDFs into waterways or soil in dumpsites. CDFs also enter into the environment from burning municipal and industrial waste in incinerators. Like CDDs, CDFs do not dissolve in water very easily, breakdown very slowly in the environment, and can remain in soil for years. Once in the environment, CDFs can accumulate in fish tissue; with concentrations tens of thousands times higher than the levels in surface water. Cattle that eat plants contaminated by air-deposited CDFs also produce milk and yield meat with greater CDF amounts. Birds and mammals living near CDF-contaminated water bodies, as well as humans that ingest the fish, are subsequently exposed. Eating large amounts of fatty fish from water containing CDFs may increase the amount of exposure. Exposure to CDFs from drinking water is less than that from food (31).

CDFs are often found in association with CDDs, which cause similar toxic effects. The health effects of CDFs were mostly derived from studies of accidental poisonings where people ate food cooked with polychlorinated biphenyl (PCB)-contaminated oil containing CDFs. Skin and eye irritations (i.e., acne), darkened skin color, and swollen eyelids with discharge, developed weeks or months after exposure. CDFs also caused vomiting and diarrhea, anemia (a blood disease), more frequent lung infections, numbness and other

effects on the nervous system, and mild changes in the liver. Many of the same health effects that occurred in the people accidentally exposed also occurred in experimental or laboratory animals that ate CDFs; animals fed CDFs had severe body weight loss, and their stomachs, livers, kidneys, and immune systems were seriously injured. Some fed high doses also died. CDFs also caused birth defects and testicular damage in animals. The Environmental Protection Agency has not classified the carcinogenicity of CDFs (30, 31).

TEF and TEQ

CDDs and CDFs occur in the environment together, are highly persistent compounds, and are resistant to microbial degradation. 2,3,7,8-TCDD is one of the most toxic and extensively studied of the CDDs, and serves as a prototype for the toxicologically relevant or “dioxin-like CDDs. Using information learned from animal studies, scientists express the toxicity of dioxin-like CDDs and CDFs as a fraction of the toxicity attributed to 2,3,7,8-TCDD. For example, the toxicity of dioxin-like CDDs and CDFs can be $\frac{1}{2}$, or $\frac{1}{10}$, or any fraction of that of 2,3,7,8-TCDD. Scientists call that fraction a Toxic Equivalent Factor (TEF). The toxic potency of a mixture of congeners (i.e., the TEQ) is the sum of the products of the TEFs for each congener and its concentration in the mixture. Thus, TEQs represent 2,3,7,8-TCDD toxic equivalents for mixtures of CDDs and/or CDFs (30).

Based on the analysis of TEQ data results, CDD and CDF contamination in Androscoggin River fish exceeds the recommended EPA threshold for consumption. This recommendation is based upon the probability that eating rainbow trout (a typical stocked species) will result in at least one excess cancer per one-million persons similarly exposed. In comparison, the minimum TEQ level for the native brown bullhead was roughly 29-times higher than the identical risk threshold recommending no consumption. This evaluation coincides with the existing EHP site-specific fish consumption advisory for the Androscoggin River recommending that everyone (adults and children alike) should avoid consumption of all fish species (17). Any ingestion of Androscoggin River fish from the Sawmill Dam downstream to the Town of Shelburne, NH is thus considered a public health hazard according to ATSDR’s health hazard categories.

Mercury - Ingestion of Fish

Mercury exists in several forms while in the environment including: metallic mercury (also known as elemental mercury), inorganic mercury, and organic mercury (i.e., methyl mercury). Approximately 80% of the total mercury released from human activities is elemental mercury released to the air, with the remaining 20% released to the soil and water from fertilizers, fungicides, municipal solid waste, and industrial discharges (32). If elemental mercury is ingested, it is absorbed relatively slowly and may pass through the digestive system without causing damage (33). However, methyl-mercury is easily absorbed through the gastrointestinal tract (about 95% absorbed). After you eat methyl mercury-contaminated foods, the methyl mercury easily enters your bloodstream, circulates rapidly to most tissues, and readily enters the brain. Methyl mercury present in the blood of a pregnant woman will also easily cross the threshold into the blood of the

developing child and then into the child's brain and other tissues. Some of the methyl mercury in a nursing woman's body will also pass into her breast milk. After exposure, methyl mercury leaves the body slowly over a period of several months (32).

The primary effect of methyl mercury exposure in humans is neurotoxicity. Because methyl mercury easily passes into the developing brain, it can cause adverse developmental effects in young children. Furthermore, since methyl mercury is passed from a mother's breast milk to a nursing infant, it can accumulate in an unborn baby's blood at concentrations higher than in the mother (32). Accordingly, EHP has issued a fish consumption advisory which outlines specific water bodies where fish have shown to be contaminated with methyl mercury. EHP's advisory also provides safe eating guidelines (limits on certain fish species and sizes), as well as fish preparation guidelines to limit exposure (17).

Eating methyl mercury-contaminated fish is one of the most common forms of mercury exposure for the general population. Once in the aquatic environment, organisms such as bacteria and fungi convert elemental mercury into methyl mercury which is, in turn, accumulated in fish species higher on the food chain (32). Thus, small environmental concentrations of methyl mercury can build up to potentially harmful concentrations in fish, fish-eating wildlife, and people (33). The accumulated methyl mercury constitutes over 99% of the total mercury detected in fish muscle tissue. Concentrations in carnivorous fish at the top of the food chain (e.g., Smallmouth Bass and Pike) can be 10,000–100,000 times as high as those found in surface waters (32). Older, larger fish also tend to have higher concentrations of methyl mercury within the same water body. But, unlike dioxin, mercury concentrates in the muscle of the fish and cannot be removed or cooked out of consumable game fish (33). A 2000 United States Geological Survey (USGS) study found that mercury bioaccumulation in fish was strongly (positively) correlated with methyl-mercury concentrations in water, but only moderately with methyl-mercury concentrations in sediment or the total mercury in water (34).

EHP evaluated the potential for non-carcinogenic health effects to occur from eating Androscoggin River fish. Table 3 outlines the recommended risk-based consumption guidelines for each fish species based on mercury tissue levels. Although this analysis suggests that certain amounts of fish may be safely consumed, these guidelines are superseded by the dioxin/furan restrictions identified above. Thus, any ingestion of Androscoggin River fish from the Sawmill Dam downstream to the Town of Shelburne, NH is considered a public health hazard according to ATSDR's health hazard categories.

5. COMMUNITY HEALTH CONCERNS

When performing any public health assessment, EHP gathers health concerns from people living in the vicinity of the site. The health concerns that people express help direct the focus of the evaluation. For the Former Chlor-Alkali Facility, EHP accomplished this task by summarizing community concerns from a public availability session. Draft versions of this document were also distributed to the public for their input. During this stage, however, no public comments were received. Below are EHP responses to concerns expressed immediately after the public availability session:

- I am concerned about what seems to be a large number of people in this area diagnosed with muscle pain and fatigue.

Reply: Muscle pain and fatigue are common, non-specific symptoms for which there can be many causes. People are encouraged to contact their medical care providers if these problems persist over time. With respect to chemical releases from the Chlor-Alkali Site; EHP thoroughly reviewed the environmental media monitoring data collected near the Site, and carefully examined whether short-term or long-term exposures to pollutants reached levels of concern. As a result of these evaluations, EHP has found no evidence that site-related contaminants are a likely cause of adverse health effects to people who live or recreate near the Site.

Evaluating the potential effects of environmental contaminants on humans is complicated and involves some uncertainty. For example, health effects that might result from exposure to complex mixtures of contaminants are often poorly understood. Moreover, other risk factors such as smoking, family history of disease, lifestyle, and past exposures may also contribute to, or cause, a reported health concern. Although these uncertainties exist, EHP's process when evaluating the health implications of contaminant exposures is generally conservative, thus taking into account the inherent unknowns associated with establishing links between exposure and adverse health effects.

- I know three young women with MS (Multiple Sclerosis) in this area; it seems like an unusually high number.

Multiple Sclerosis is a condition of the central nervous system. It is the most common disabling neurological disease among young adults (ages 20 to 40); women are much more likely to develop MS than men. This disease does respond to treatment. Many people who have been diagnosed with MS can successfully manage their symptoms with proper medical treatment and follow-up care.

With MS, the body's own immune system attacks myelin (a substance that the body produces which helps nerve fibers to conduct electrical impulses) that covers and protects nerve cells. During this process, the myelin is removed, leaving scar tissue or lesions. Sometimes, even the nerve fibers are damaged.

When myelin or nerve fibers are destroyed or damaged, the ability of nerves to conduct electrical impulses to and from the brain is disrupted. Scientists do not yet understand what causes the body's immune system to react this way. Research indicates that several factors including genetics, gender, and environmental triggers, including certain viruses, may be involved. There has also been concern that heavy metal poisoning may be a factor in developing MS. However, no scientific evidence currently exists connecting exposure to metals with the development of this disease. Research regarding the causes and treatment of MS continues.

- There seems to be some concern that children and young people have elevated cancer rates.

According to the NH State Cancer Registry, there were 525 newly diagnosed cancers among NH children age 0-14 from 1987 through 2001. Based on the size of Berlin's child population in 1990 and 2000, EHP estimated that four new childhood cancers would have been diagnosed among Berlin children over this 15 year period if their cancer rates were the same as the State as a whole. According to the NH State Cancer Registry, the actual number was less than 5. (The exact number cannot be specified in accordance with NH data confidentiality rules.)

In addition to reviewing NH Cancer Registry data, EHP examined the theoretical impact on the community of potential contaminants from the Chlor-Alkali Site. As indicated in a previous response, EHP carefully reviewed the environmental media monitoring data available for the Site. EHP has found no indication that site-related contaminants could be a likely cause of adverse health effects to people who live or recreate near the Site.

EHP recognizes the importance of community concerns regarding cancer. Although it has determined that releases from the site should not have an impact on cancer rates, EHP will continue to review updated Cancer Registry data for Berlin as it becomes available.

6. CONCLUSIONS

EHP evaluated surface water, sediment, and fish data collected from the Androscoggin River. On the basis of its evaluation of available environmental information, EHP concluded the following for each completed exposure pathway:

1. The surface water and sediment data suggest that exposures to persons recreating in the Androscoggin River downstream of the site poses *no apparent public health hazard*. These exposures to residents are expected to be seasonal and of limited duration. Contaminant levels are also lower than those that would be expected to produce adverse health effects.

2. The best available fish data suggest that consumption of fish caught in the Androscoggin River downstream from the site poses a *public health hazard*. This conclusion is based on EPA's fish consumption guidance, and coincides with the existing EHP site-specific fish consumption advisory for the Androscoggin River; recommending that everyone (adults and children alike) avoid consumption of all fish species.

7. RECOMMENDATIONS

1. The owner/operator should continue to limit public access to the site after Fraser Paper ceases operations at their Berlin pulp mill. Post signs at the site boundaries if necessary to prevent the public from entering and altering site controls (i.e., impermeable liner).
2. EHP will conduct further evaluations of contaminant levels in the Androscoggin River as additional surface water, sediment or fish monitoring data become available. Contaminant levels should be evaluated for potential risks to people who swim, wade, or fish in the Androscoggin River downstream from the Site.
3. The public should avoid consumption of all Androscoggin River fish species caught downstream of the Saw Mill Dam located in Berlin, NH. This recommendation concurs with the existing EHP fish consumption advisory for the Androscoggin River.
4. DES and EPA should continue routine mercury remediation events along the Androscoggin River if elemental mercury deposits continue to migrate offsite.
5. DES and EPA should continue to monitor on-site contaminant levels to assess whether they may be migrating off-site and warrant subsequent off-site sampling. Once the new EPA site sampling for summer 2006 is evaluated, previous off-site sampling strategies may require modification to reflect sites of probable human exposure and the inclusion of additional contaminants.
6. DES and EPA should collect and analyze additional fish tissue samples (multiple species) for dioxins and furans. Such revised data will provide a more up-to-date measurement of the current contamination levels presently in Androscoggin River fish.
7. DES and EPA should continue to monitor groundwater wells and public water supplies to see if there are impacts to municipal water supplies.

8. PUBLIC HEALTH ACTION PLAN

The Public Health Action Plan (PHAP) for this Public Health Assessment describes the actions taken or planned for the Site. The purpose of the PHAP is to ensure that this PHA not only identifies public health hazards, but provides a plan of action designed to mitigate and prevent adverse human health effects that could result from future exposure to contaminants. EHP is committed to following up on this plan and to assist in its implementation. As needed, EHP will revise this PHAP by identifying the actions completed and those in progress. The public health actions taken or to be implemented are as follows:

Actions Completed

1. Since 1999, a series of environmental investigations were conducted to characterize the nature and extent of contamination at the Site.
2. In 1999, the site was cleared, the underlying contaminated soil was removed, an impermeable cap and slurry wall were constructed, drainage channels were dug, fencing was installed, and groundwater monitoring wells were installed for long-term monitoring.
3. Annual removals of elemental mercury along the Androscoggin River have been conducted from 1999 to 2005.
4. In April 2005, EPA proposed the Former Chlor-Alkali site for the National Priorities List (Superfund).
5. In May 2006, EHP conducted a public availability session to gather community health concerns about the site.
6. In 2006, EHP attended an EPA-sponsored meeting with Berlin City Officials to discuss the Site.
7. In 2006, EHP distributed public health fact sheets to residents in and around Berlin, New Hampshire.
8. In 2006, EHP collected names of residents who were interested in obtaining a copy of this Public Health Assessment.

Actions Planned

1. EHP will continue to disseminate information regarding the health effects of consuming fish caught in the Androscoggin River.
2. EPA will conduct a Remedial Investigation/Feasibility Study (RI/FS) as part of the Superfund process.

3. EHP will evaluate any additional sampling data that becomes available for the site that may indicate a future hazard to the community.

EHP will reevaluate and expand the Public Health Action Plan when needed. New environmental data, or the results of implementing the above actions may warrant additional actions at this site.

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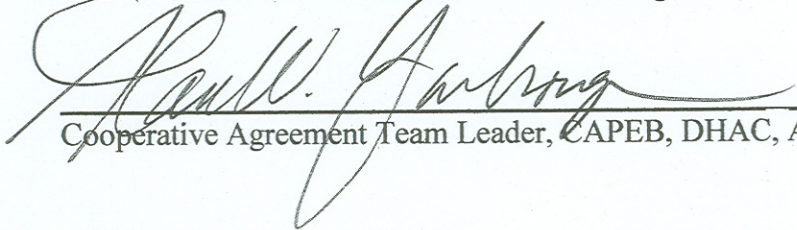
10. CERTIFICATION

This public health assessment on the evaluation of data for the Former Chlor-Alkali Facility was prepared by the New Hampshire Department of Environmental Services, Environmental Health Program, under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was prepared in accordance with methods and procedures approved at the time the consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.



Technical Project Officer, Cooperative Agreement Team, CAPEB, DHAC, ATSDR

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



Cooperative Agreement Team Leader, CAPEB, DHAC, ATSDR

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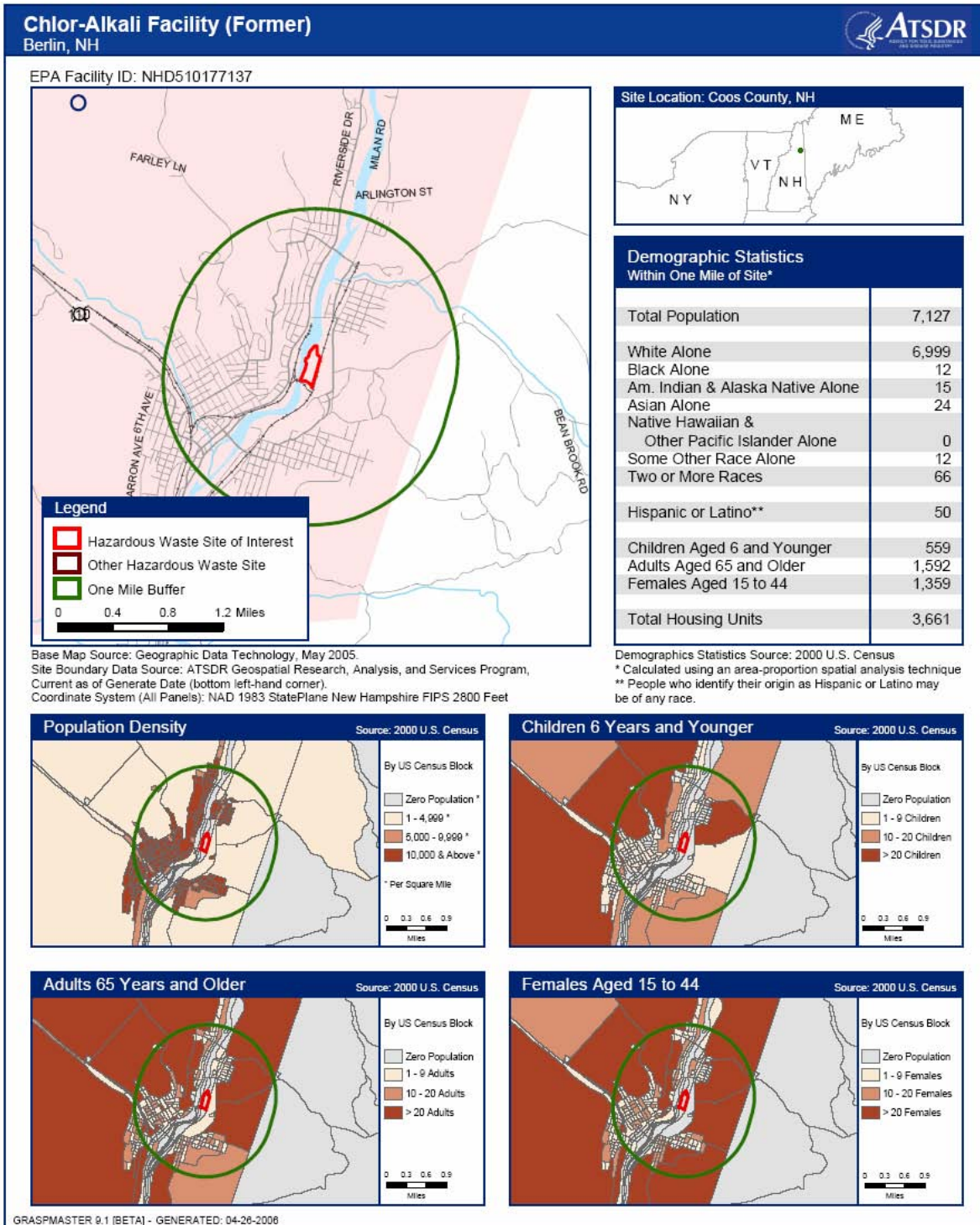
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12. APPENDICES

APPENDIX 1



APPENDIX 2

