
Health Consultation (Corrected Version)

Former Lakeview Mill Uranium Processing Site

Lakeview, OREGON

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Prepared by the
Environmental Health Assessment Program
Office of Environmental Public Health
Public Health Division
Oregon Health Authority



Foreword

The Environmental Health Assessment Program (EHAP) within the Oregon Public Health Division (OPHD) has prepared this Health Consultation with funds from a cooperative agreement with the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services. This document has not been reviewed and cleared by ATSDR. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and disease related exposures to toxic substances. This Health Consultation was prepared in accordance with ATSDR methodology and guidelines.

ATSDR and its cooperative agreement partners review the available information about hazardous substances at a site, evaluate whether exposure to them might cause any harm to people, and provide the findings and recommendations to reduce harmful exposures in documents called Public Health Assessments (PHAs) and Health Consultations (HCs). ATSDR conducts a Public Health Assessment for every site on or proposed for the National Priorities List (the NPL, also known as the Superfund list). Health Consultations are similar to Public Health Assessments, but they usually are shorter, address one specific question, and address only one contaminant or one exposure pathway. Another difference is that Public Health Assessments are made available for public comment, while Health Consultations usually are not. Public Health Assessments and Health Consultations are not the same thing as a medical exam or a community health study.

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Summary

Introduction The Environmental Health Assessment Program's (EHAP's) top priority is to ensure that people who work at or live near the Lakeview Mill Site have the best information possible to safeguard their health.

The Lakeview Mill is located approximately 1 mile outside the city of Lakeview in Lake County, Oregon. The Mill formerly received and processed ore from nearby uranium mines in order to produce uranium oxide for the U.S. Atomic Energy Commission. The U.S. Department of Energy (DOE) cleaned up the site's surface contamination to meet the U.S. Environmental Protection Agency's (EPA) standards, and implemented a program to prevent people from using contaminated groundwater at or near the site.

In September 2010, a private citizen contacted the Oregon Office of Environmental Public Health (OEPH) with concerns about the construction of a biomass energy facility adjacent to the Lakeview Mill site. Specifically, the requestor wanted to know the following:

1. Does residual contamination in the soil at or near Lakeview pose a risk to construction workers or future indoor workers?
2. Are there health risks from contact with contaminated groundwater at the site?
3. Does OEPH have the authority to enter and conduct radiological testing on the Lakeview site or adjacent properties?

Conclusions EHAP reached two conclusions in this Public Health Consultation:

Conclusion 1 Touching, breathing or swallowing radium-226 (Ra-226), thorium-230 (Th-230) and arsenic in soil or dust for a year or longer at or near the Lakeview mill site is not expected to harm people's health. These contaminants have been cleaned up to levels below health concern for people who work on the site.

Past activities at the Lakeview Mill site resulted in the soil being contaminated with Ra-226, Th-230 and arsenic. The DOE has cleaned up the surface contamination at this site, and these contaminants are now below levels known to be harmful to human health. The levels at adjacent properties are expected to be even lower than post-cleanup levels at the Lakeview mill site. Therefore, construction workers at the biomass plant being built next to the Lakeview mill site are not expected to have increased health risks.

Basis for Conclusion

The post-cleanup levels of these contaminants are below levels known to be harmful to human health. However, because these chemicals are carcinogens, EHAP recommends that workers minimize their contact with soil or dust at the site. Workers could come in to contact soil or dust during construction activities on the biomass facility, or when dust is stirred up by wind, vehicles, or other causes. EHAP recommends that construction workers take some basic protective measures, such as: 1) minimizing dust generation by using wet methods or other controls; 2) using appropriate personal protective equipment (PPE); 3) and minimizing the spread of soil or dust from the site to homes or other indoor areas.

Conclusion 2

EHAP concludes that touching, breathing or swallowing small amounts of uranium, arsenic, boron, manganese and sulfate in groundwater for a year or longer at or near the Lakeview mill site is not expected to harm people's health.

Basis for Conclusion

There are a number of institutional controls to prevent people from using groundwater at the site for drinking or cooking. Further, these chemicals are at levels that will not be harmful to people who occasionally come into contact with the groundwater during construction or excavation activities.

Next Steps

- EHAP did not find any health-based reasons to recommend additional environmental testing of soil or groundwater at or near the Lakeview Mill site.
- EHAP will communicate the findings of this report to the petitioner, the Oregon Radiation Protection Services program, and other agencies involved at the site.
- EHAP will contact the biomass facility developer to discuss our findings and our recommendations to minimize workers' contact with soil or dust at the site.
- EHAP is available to discuss the findings of this report with residents, workers or agencies with concerns about the Lakeview Mill site.

**For More
Information**

If you have concerns about the findings of this report, you should contact the Environmental Health Assessment Program at 971-673-0977 or ehap.info@state.or.us. You can also call ATSDR at 1-800-CDC-INFO and ask for information on the Lakeview Mill Site in Oregon.

Note: This health consultation was updated in September 2011 to correct an inaccuracy about the location of the proposed biomass energy facility. After releasing an initial version of this report, EHAP was notified that the biomass plant was being built on property adjacent to (not on) the Lakeview Mill site. EHAP has corrected this report to reflect the correct location of the plant. This new information did not change our overall findings and conclusions in the earlier version of this report.

Purpose and Health Issues

In September 2010, a private citizen contacted the Oregon Public Health Division - Office of Environmental Public Health (OEPH) with concerns about the construction of a biomass energy facility on land adjacent to a former uranium processing site. The requestor had concerns about workers being exposed to residual radioactive materials in soil and groundwater from the former processing site. Specifically, the requestor wanted to know the following:

1. Are there potential health risks to workers from contact with residual contamination in the soil from the former processing site?
2. Are there potential health risks from contact with contaminated groundwater in the area?
3. Does OEPH have the authority to enter and conduct radiological testing on the Lakeview site or adjacent properties?

The Oregon Public Health Division has the authority to enter and conduct radiological testing on private properties when there is evidence of “clear and present danger to the health, safety or security of the state or its citizens.” In all other cases, public health authorities must obtain permission from property owners in order to conduct testing, or obtain a warrant if permission is not granted. This authority is specified in Oregon Revised Statute (ORS) 453.685. The Radiation Protection Services (RPS) program within OEPH is charged with executing this authority when appropriate.

In this health consultation, EHAP evaluated the available environmental data to determine if there are health-based reasons to conduct further environmental testing at the Lakeview site.

Note: This health consultation was updated in September 2011 to correct an inaccuracy about the location of the proposed biomass energy facility. After releasing an initial version of this report, EHAP was notified that the biomass plant was being built on property adjacent to (not on) the Lakeview Mill site. EHAP has corrected this report to reflect the correct location of the plant. This new information did not change our overall findings and conclusions in the earlier version of this report.

Background

The Lakeview Mill Former Uranium Processing Site (Lakeview Mill) is located approximately 1 mile outside of the city of Lakeview in Lake County, Oregon (Figure 1). The city of Lakeview is the county seat of Lake County, and had a population of approximately 2,685 people in 2010 (1). The Lakeview Mill site is located in a general industrial land use zone. The land to the north and east of the site is zoned for general industrial use, and the land to the south and west of the site is zoned for residential use. The site of the proposed biomass cogeneration plant is located adjacent to the former uranium processing site (Figure 2).

Figure 1. Location of Lakeview Mill Site in Oregon.



Source: U.S. Energy Information Administration, Lakeview Mill Site.
http://eia.doe.gov/cneaf/nuclear/page/umtra/lakeview_title1.html. Accessed 3/31/2011.

The Lakeview Mill was formerly used to receive and process ore from nearby uranium mines in order to produce uranium oxide for the U.S. Atomic Energy Commission. The Lakeview Mill is one of 24 sites in the U.S. that was remediated under the 1978 Uranium Mill Tailing Radiation Control Act (UMTRCA). UMTRCA's purpose is "to protect the public and safety and the environment from radiological and non-radiological hazards associated with radioactive materials" at abandoned uranium mill tailing sites and nearby properties (2). For each site, UMTRCA required the following:

- The Department of Energy (DOE) must remediate the site so that it meets the environmental standards specified by the Environmental Protection Agency (EPA) at the time of clean-up.
- DOE must obtain agreement from the Nuclear Regulatory Commission (NRC) on the remedial action plan at each site.
- The NRC has the authority "to issue a license for long-term custody, maintenance, and monitoring of the [uranium tailing] disposal sites to ensure continued protection of the public health and safety and environment".

Figure 2. Location of Lakeview Mill site, Lakeview Oregon.



The uranium mill at the Lakeview site operated for only 3 years, and closed in 1961. DOE began cleanup activities at the site in 1986, and the site was considered remediated in 1989. During remediation of the mill site, over 925,000 cubic yards of material were relocated to the final disposal area at the Collins Ranch, which is located approximately five miles northwest of the Lakeview site. On September 1993, the NRC certified that the surface contamination at the site had been cleaned up to meet EPA standards. RPS independently conducted confirmatory testing, and found that the site had been remediated to meet Oregon's public health regulatory standards. In the mid-1990s, DOE implemented a separate program to address groundwater contamination at the site. This program implemented regular and ongoing groundwater monitoring at the site, and includes institutional controls to prevent people from using any of the contaminated

groundwater for drinking or cooking. The institutional controls used at the Lakeview Mill site are detailed on page 15.

Discussion

EHAP contacted several government agencies for information on the contamination and clean-up at the Lakeview Mill site. RPS provided two boxes of archived records and reports on the site, and the Eastern Region Office of the Department of Environmental Quality (DEQ) obtained and shared DOE's clean-up reports for the site (3). We also reviewed ordinances specific to this site in the Lakeview and Lake County Zoning Ordinances.

1. Are there potential health risks to workers at the biomass plant from contact with residual contamination in the soil/dust at the Lakeview mill site?

We reviewed data from NRC's "Final Completion Review Report for the Remedial Action at the Lakeview, Oregon Uranium Mill Tailings Site (1993)" to address this question. This report describes conditions on the former mill site, which had the heaviest contamination from uranium processing activities. In the absence of recent data on surface conditions at the biomass plant site, which is located adjacent to the former mill site, we used post-cleanup data for the Lakeview Mill site to assess potential risks from surface contamination. This is a conservative assumption about the actual levels of contamination at the biomass plant site. The actual contaminant levels are expected to be lower, and are probably similar to background levels found in the area. Therefore, our risk estimates represent a worst-case scenario for workers at the biomass plant.

Contaminants of Concern and Comparison Values

The major contaminants of concern identified by DOE for clean-up were radium-226 (Ra-226) and arsenic. Thorium-230 (Th-230) was also a contaminant of concern because it decays into radium-226 and radon-222 (Rn-222) over time; therefore, it was included in DOE's clean-up activities. Ra-226, Rn-222 and arsenic are known carcinogens. People can come into contact with these contaminants in soil by accidentally swallowing or inhaling small amounts of dirt or dust, and through skin contact with contaminated soil.

We compared post-cleanup levels of arsenic to environmental and health-based comparison values (CVs). CVs are chemical-specific guidelines that the Agency for Toxic Substances and Disease Registry (ATSDR) and EPA have developed, based on the best available information about a chemical's toxicity and risks to human health. ATSDR and EPA use CVs to prioritize cleanup actions and other decisions to prevent harmful exposures at contamination sites. However, these guidelines do not predict whether people will get sick from exposure to a chemical in the environment.

For radioactive contamination, the EPA uses CVs that are concentration-based values for soil only. ATSDR approaches radiological contamination differently, using a site-specific

dose assessment. Because this site contains the precursors to radon (Ra-226 and Th-230), ATSDR included radon in its dose assessment.

The CVs that EPA used at this site were developed specifically for the cleanup of radionuclides and other contaminants at UMTRCA sites (4). These CVs represent the radionuclide concentrations, above background levels, that would not pose more than a 1 in 10,000 increased cancer risk after taking into account the radiologic dose received. Both ATSDR and EPA consider this a low and acceptable level of risk.

The specific CVs used at the Lakeview site are described in more detail below.

Ra-226: Exposure to Ra-226 can result in increased risks for bone, liver and breast cancer, and can cause non-cancer effects such as anemia and cataracts. Ra-226 decays into Rn-222 over time, and exposure to Rn-222 can result in increased risks for lung cancer. EPA has two standards to minimize health risks from radium. For surface soils (top 15 cm of soil), the standard is 5 pCi/gm (picocuries per gram) above background levels; for subsurface soils (soil deeper than 15 cm), the standard is 15 pCi/gm above background levels. EPA's standards for radium also ensure that Rn-222 emissions will not exceed 20 pCi per second per square meter. These standards have remained unchanged since the time cleanup began at Lakeview in 1986, and are the same as those used today by RPS to protect public health and safety.

Th-230: Th-230 decays into Ra-226, which in turn decays into Rn-222; therefore, this radionuclide could pose potential health risks in the future. There were some subsurface areas of the Lakeview site where Th-230 was the main radionuclide found in the soil. For these areas, DOE measured Th-230 levels using a method called the Field Analysis Systems for Th-230 in soil (F.A.S.T), and used these levels to project future Ra-226 concentrations after 1000 years of decay. DOE then removed Th-230 to levels such that even after 1000 years, the resulting Ra-226 levels would not exceed the 15 pCi/gm standard for subsurface soil. DOE allowed for a certain amount of error in these projections ($\pm 30\%$ at the 95% confidence level).

Arsenic: Arsenic is a known carcinogen, and also can pose serious non-cancer risks to health. For cancer risks, ATSDR considers soil concentrations that pose no more than a 1 in 10,000 additional cancer risk to be adequately protective of health. For non-cancer risks, we calculated the hazard index by dividing the estimated dose by ATSDR's MRL (Minimal Risk Level) for arsenic (0.0003 mg/kg-day). The MRL is an estimate of the amount of a chemical a person can be exposed to every day without having increased health risks. If the hazard index was greater than 1, we calculated the margin of safety by dividing the dose by the LOAEL (Lowest Observed Adverse Effect Level) for arsenic (0.014 mg/kg-day). The LOAEL is the lowest dose of a chemical in a study, or group of studies, that has been shown to cause harmful health effects in people or animals. If the margin of safety was greater than 10, we considered the exposure dose to be below levels that could pose health risks.

EPA used two cleanup standards for arsenic at the Lakeview site. In the top 2 ft of soil, the target cleanup level was <200 ppm (parts per million); in soil deeper than 2 ft, the cleanup level was <400 ppm.

Review of Sampling Data

After DOE completed their cleanup of the Lakeview site, they tested over 6000 soil samples for Ra-226 and Th-230, and over 1200 samples for arsenic. Table 1 provides a summary of how these post-cleanup levels compared to EPA’s clean-up levels. The background level of Ra-226 in areas near the site was 1 pCi/gm; we were not able to find data on background levels of arsenic in the area.

Table 1. Comparison of EPA clean-up standards to post-cleanup soil contaminant levels at the former Lakeview Uranium Processing Site, Lakeview Oregon.

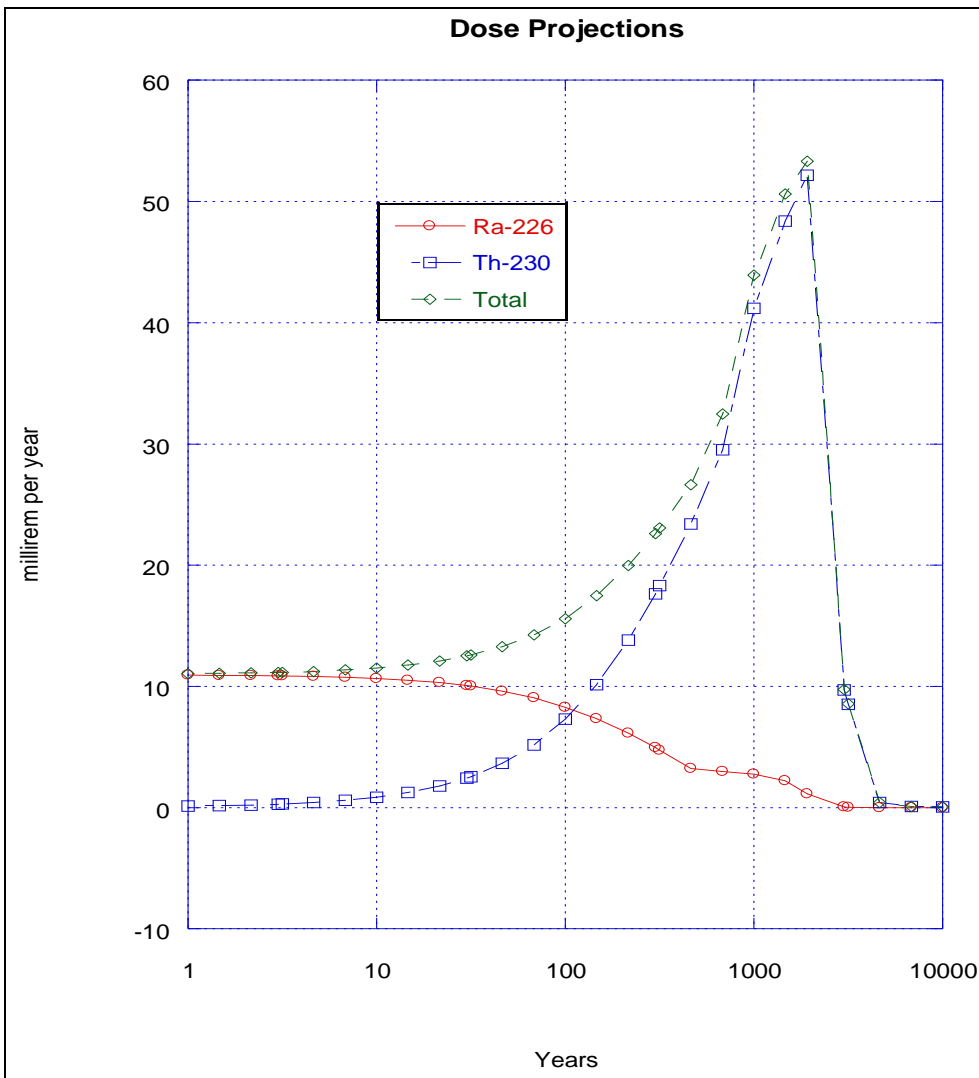
Contaminant	EPA Clean-Up Levels	Final Site Conditions		
		N	Measured concentrations at Lakeview	Notes
Radium 226 (Ra-226)	Surface soil: 6 pCi/gm (5 pCi/gm above background level of 1 pCi/gm) Subsurface soil: 16 pCi/gm (15 pCi/gm above background level of 1pCi/gm)	6630	Maximum surface: 4.5 pCi/gm Maximum subsurface: 15.3 pCi/gm Average of all samples: 1.76 pCi/gm.	DOE concluded that all of the surface and subsurface samples met EPA clean-up standards.
Thorium 230 (Th-230)	Projected Ra-226 concentration after 1000 yrs decay: 16 pCi/gm ± 30% at the 95% confidence level	6206	Maximum projected Ra-226: 17.3 pCi/gm	One sample (17.3pCi/g) exceeded 16 pCi/gm, but was within the acceptable range for clean-up.
Arsenic	In top 2 ft. of soil: <200 ppm In soil > 2ft: < 400 ppm	1242	Top 2 ft of soil: Range = 0.5-199 ppm Soil > 2 ft: Range = 203-394 ppm	DOE concluded that all of the surface and subsurface samples met EPA clean-up standards.
N = Number of samples pCi/gm = picocuries per gram ppm = parts per million (same as mg/kg) DOE: US Department of Energy; EPA: US Environmental Protection Agency				

The current and projected Ra-226 concentrations in soil at Lakeview are not necessarily below EPA’s standards for surface and sub-surface soils. As mentioned previously, these standards were established to ensure Rn-222 emissions would not exceed 20 pCi per second per square meter. To confirm this, we obtained assistance from ATSDR health physicists to estimate the radiologic dose that might result from the contamination. ATSDR used the USDOE computer code RESRAD (Residual Radioactivity) to estimate

the dose out to 10,000 years (Figure 3). This analysis indicated that the highest estimated radiologic dose would be 53 millirem per year (0.53 milliSievert, mSv). This value is less than the ATSDR Minimal Risk Level of 100 millirem per year (1 mSv).

From these data, we concluded that Ra-226 and Th-230 in soil at the former Lakeview mill site have been cleaned up to levels that will not pose risks to human health. Since the levels of these contaminants at adjacent properties are probably even lower than those at the mill site, we do not expect that construction workers at the biomass co-generation plant will have increased health risks from contact with soil.

Figure 3. Radiological dose projection for the Lakeview site (provided by ATSDR).



For arsenic exposures, we assumed that a construction worker would work on the biomass cogeneration plant site for 250 days per year for two years, would swallow 100 mg of soil a day, and also would absorb a small amount through uncovered skin. In a worst-case scenario, a worker would be exposed to 400 ppm arsenic (the maximum allowed by EPA at the Lakeview mill site). At this level of exposure, a construction

worker would have an eight in 100,000 (low) increased cancer risk (see Appendix A for calculation). The estimated dose for non-cancer risks is 0.0005 mg/kg/day. This dose slightly exceeds the MRL (minimal risk level) for arsenic, and is 28 times lower than the LOAEL (lowest observed adverse effect level).

These worst-case estimates are based on very conservative assumptions about exposure. In reality, workers will probably have less contact with the more highly contaminated sub-surface soil (most likely during excavation or soil removal activities), and construction activities at the site will probably last less than two years. A more likely scenario assumes that a worker would be exposed to an average of 200 ppm arsenic (the maximum allowed in surface soil) for 250 days over a one year period. In this scenario, a construction worker would have a 2 in 100,000 cancer risk. The estimated dose for non-cancer risks is equal to the MRL of 0.0003 mg/kg/day, and is 55 times lower than the LOAEL.

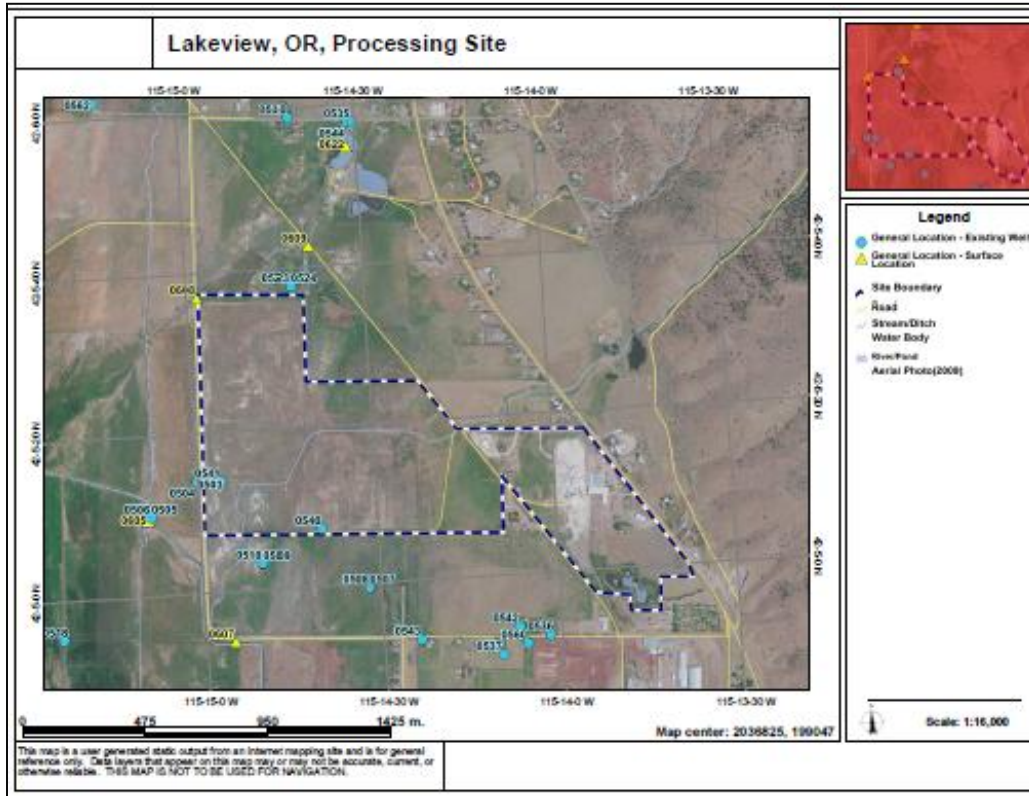
We used a similar approach to assess the risks to future indoor workers at the proposed biomass plant, and found a low level of increased health risks (See Appendix A, Tables 2 and 3). Based on these findings, we do not expect arsenic in soil to pose health risks to workers on or near the Lakeview mill site.

In summary, EHAP concludes that Ra-226, Th-230 and arsenic in the soil at the will not pose health risks to construction or indoor workers who work on or adjacent to the Lakeview Mill former uranium processing site.. However, construction workers are encouraged to use basic protective measures while they work on the site. These measures include controlling dust emissions on the site, using personal protective equipment, regularly cleaning clothes and equipment, and avoiding taking clothes and equipment into homes or indoor offices (see Recommendations section below).

2. Are there potential health risks from contact with contaminated groundwater at/near the site?

To answer this question, we evaluated groundwater monitoring data collected by DOE at the Lakeview Processing Site since 1982. These data are available online through DOE's Geospatial Environmental Mapping System (9). We evaluated data collected since 2000 from all 31 wells sampled at or near the Lakeview site. Figure 4 shows a map of these sampling locations. Note that some of these sampling locations are located near the site of the proposed biomass cogeneration plant.

Figure 4. Map of groundwater sampling locations at Lakeview Site.



The groundwater at the Lakeview processing site contains elevated concentrations of arsenic, boron, chloride, manganese, sodium, and sulfate. There are many potential sources of these chemicals:

- Arsenic and boron: These chemicals are naturally occurring, and originate in geothermal springs located to the northeast of the site. This spring water flows under the processing site, and contributes to the elevated levels of arsenic and boron in water near the site. DOE concluded that these chemicals are not the result of contamination from the site.
- Chloride, manganese, sodium and sulfate: The soils in Lakeview are naturally high in salt. At least some of the high levels of chloride, manganese, sodium and sulfate in groundwater are believed to be related to uranium and lumber processing at the site. Water from ponds used during processing may have leached salts from the soil, and then entered the groundwater.

The groundwater at the site is very shallow. Measurements taken at four monitoring wells from 2006-2010 found an average groundwater depth of 4.2 feet below ground surface (range: 0.62 – 6.56 ft).

Pathways for exposure

There are two main pathways of concern for exposure to contaminated groundwater at the Lakeview site, described in more detail below.

Pathway 1: Exposure through existing or new groundwater wells on the property.

People could be exposed to contaminated groundwater through contact with water from existing or new groundwater wells on the property. This contact could occur through contact with water from domestic wells (used for drinking, cooking, bathing, and other home uses), or contact with irrigation wells (used for farming, gardening, and other outdoor uses). However, several factors at the site reduce the likelihood of exposure through groundwater wells, including:

- All existing wells were abandoned as part of the remedial actions at the site (5).
- The Lakeview Planning department noted that “the applicant does not propose the use of a groundwater well for potable water” in their review of the application for a conditional use permit for the biomass plant (6).
- An institutional control boundary was established on the western side of the mill site, which encompasses the processing site and the groundwater contamination plume. The following institutional controls are in place within this boundary:
 - The city and county land use ordinances require that landowners within the boundary hook up to the municipal water supply. If the landowners decide to drill a well, it must meet special requirements for depth and construction as specified by Oregon Administrative Rule 690-200-0028, and enforced by the Oregon Water Resources Department (7).
- In an email correspondence, the Lake County Watermaster confirmed that only monitoring wells have been drilled within the institutional control boundary at Lakeview since the early 1990s.

The City of Lakeview's municipal water system serves approximately 2,800 people and uses groundwater as its source. This system is required to meet federal drinking water standards, which are enforced by the Oregon Drinking Water Program within the Office of Environmental Public Health. The most recent water quality data from July 2008 showed that the Lakeview system met federal drinking water standards for regulated contaminants (including arsenic and radionuclides) (8).

Given these conditions, it is unlikely that people will come into contact with contaminated water from groundwater wells at the Lakeview Mill site. Therefore, we eliminated this as a potential exposure pathway at this site.

Pathway 2: Contact with shallow groundwater during construction and excavation activities.

The second possible exposure pathway is contact with shallow groundwater during construction and excavation activities. Workers could potentially come into contact with shallow groundwater while digging into the ground to build the foundation of buildings

and other structures, or during other construction activities at the site. These workers could be exposed through the following routes:

- Dermal: Skin contact with contaminants in groundwater through the skin
- Ingestion: Accidentally swallowing small amounts of water

It is difficult to estimate how much contact workers would have with contaminated groundwater at a construction site. The amount of exposure will be influenced by exposure frequency (days per year), exposure duration (number of years on construction site), whether they use protective equipment (such as gloves, face masks, or waterproof clothing) to minimize skin contact, and many other factors.

Review of sampling data

Currently, the Lakeview monitoring plan requires that the groundwater be tested every other year on even years. The most recent sampling event was in May 2010. The major constituents tested were uranium, manganese and sulfate. There are historical data available for arsenic and boron, but these were not included in the most recent sampling events, presumably because these chemicals are naturally occurring in the water at Lakeview and are not related to site contamination.

In a follow-up letter received on 12/16/2010, the petitioner expressed concern that groundwater contamination at Lakeview has migrated off-site, and questioned whether data from on-site monitoring wells represent the highest contamination levels at or near the site. He requested that we include data from wells 507 and 542 in our assessment, since these wells are located close to the site of the proposed biomass plant. EHAP has confirmed that data from wells 507 and 542 were included in our evaluation. However, it should be noted that these wells did not have the highest contamination levels measured at the site over the past decade.

Table 2 shows a summary of groundwater sampling data for arsenic, boron, uranium, manganese and sulfate from the processing site. The data in the shaded columns show the maximum and average measurements for each chemical over the past 10 years, and the number of samples collected during this time. The data in the un-shaded columns show the most recent measurements for each chemical.

Table 2. Summary of groundwater sampling data at the Lakeview Processing Site, 2001-2010.

Chemical	Data from all samples collected between 2001-2010			Data from most recent sampling event			
	Maximum (mg/L)	Average (mg/L)	N	Year	Maximum (mg/L)	Average (mg/L)	N
Arsenic	0.098	0.020	48	2006	0.097	0.040	6
Boron*	42.1	4.95	32	2002	42.1	4.95	32
Uranium	0.057	0.002	49	2010	0.003	0.002	3
Manganese	32.3	4.23	65	2010	8.2	4.00	6
Sulfate	2680	680.2	64	2010	2400	1054	6

N = number of samples
mg/L = milligrams per liter
*There was only one sampling event in the past 10 years that included testing for boron (2002).

Comparison Values

The EPA has developed a number of standards to prevent exposure to contaminants in drinking water. These standards are intended to minimize the health risks from daily use of water for drinking, cooking and other uses. These standards assume that people consume 2 liters of water per day (L/day).

It is unlikely that workers at the biomass plant would accidentally swallow, inhale or absorb 2 liters of the site's groundwater per day. However, in the absence of appropriate CVs for this exposure scenario, we used drinking water standards as an initial screen to evaluate the potential health risks to construction workers at the Lakeview site. Table 3 shows a comparison of the maximum chemical levels at Lakeview to the available standards for these chemicals in water.

Arsenic: The drinking water standard for inorganic arsenic is 0.010 mg/L, which is equivalent to 10 parts per billion (ppb). Arsenic molecules are relatively large in size, and are not easily absorbed by the skin. ATSDR has determined that water with arsenic levels up to 0.500 mg/L is safe for uses other than drinking, washing food, or cooking (10). The highest level of arsenic measured at Lakeview over the past 10 years was 0.098 mg/L. This is well below the guideline of 0.500 mg/L. Therefore, we do not anticipate that workers will experience health risks from occasional contact arsenic in groundwater, assuming that they do not use the water for drinking, washing food or cooking.

Boron: The EPA does not have an enforceable drinking water standard for boron, but has developed a Long Term Health Advisory (LTHA) of 5 mg/L for adults. The highest level measured at the Lakeview site was 42.1 mg/L. This level is above the LTHA. However, it is important to note that the LTHA is a drinking water standard. In order exceed the

LTHA, a worker would have to drink approximately 1 cup (0.24 L) of the site’s groundwater per day. It is unlikely that a worker would absorb, ingest or inhale this amount of water during construction or excavation activities.

Uranium: The drinking water standard for uranium is 0.030 mg/L. The highest level of uranium measured at Lakeview was 0.057 mg/L (measured in 2002, which was almost twice the drinking water standard. However, the maximum levels measured in subsequent years have all been below the standard. During the most recent sampling event, the maximum uranium level was 0.003 mg/L, which was 10 times lower than the drinking water standard. Therefore, we do not anticipate that workers will experience health risks from coming into occasional contact with uranium in groundwater during construction activities at the mill site.

Table 3. Comparison of chemical levels at Lakeview Processing Site to water standards.

Contaminant	10-year Max (mg/L)	Most recent Max (mg/L)	Comparison Value (CV)	CV Rationale
Arsenic	0.098	0.020	0.010 mg/L (Drinking Water - MCL) 0.500 mg/L (All other uses)*	Toxic effects to multiple body systems; increased risk for cancer
Boron	42.1	42.1	5 mg/L (Drinking Water – adult LTHA)	Toxic effects to gastrointestinal system, liver, kidney and brain
Uranium	0.057	0.003	0.030 mg/L (Drinking Water - MCL)	Toxic effects to kidney; increased risk for cancer
Manganese	32.3	8.2	0.05 mg/L (Drinking Water – Secondary MCL) 0.3 mg/L (EPA Health Reference Level)	Manganese has a secondary standard, which is not health-based. The standard is for black/brown staining and metallic taste associated with high manganese levels.
Sulfate	2680 mg/L	2400 mg/L	250 mg/L* (Drinking Water- Secondary MCL)	Sulfate has a secondary standard, which is not health-based. The standard is for the salty taste associated with high sulfate levels.
mg/L = milligrams/L EPA: Environmental Protection Agency MCL: Maximum Contaminant Limit LTHA: Long Term Health Advisory				

Manganese: Manganese is an essential nutrient that is present in our water, air and food. Manganese deficiency can affect bone formation, wound healing and has been linked to disorders of the nervous system. Overexposure to manganese can result in nervous system disorders such as ataxia (lack of coordination), dementia, and manganism syndrome, which has symptoms that closely resemble Parkinson's disease. Manganese poisoning usually occurs from inhalation exposures. Other exposure routes (e.g., swallowing or absorption through the skin) are rarely associated with harmful health effects (11).

The EPA's secondary standard for manganese is 0.05 mg/L; this standard is for manganese's effects on the aesthetic qualities of water, such as smell, color and taste. The EPA also has a Health Reference Level of 0.3 mg/L in water, which is intended to protect against over-exposure to manganese in drinking water, while also taking into account manganese intake from food, air, and other sources. The maximum levels of manganese at Lakeview exceed both the secondary MCL and the Health Reference Value. However, it is important to note that these standards are for drinking water. In order to exceed the Health Reference Level for manganese, a worker would have to accidentally swallow 0.31 cups (5 tablespoons) of water at the Lakeview site per day. . With adequate personal protection, it is unlikely that a worker would absorb, ingest or inhale this amount of water during construction or excavation activities.

Sulfate: The EPA's secondary drinking standard for sulfate in water is 250 mg/L; this standard is for sulfate's effects on the aesthetic qualities of water such as smell, color and taste. The maximum level of sulfate at Lakeview exceeds the secondary standard. However, given that this standard is not health-based, and that groundwater at Lakeview is not being used for drinking water, it is unlikely that workers who occasionally come into contact with water during construction activities will experience any health risks.

Based on these findings, EHAP does not believe that construction workers working near the Lakeview site who come into contact with contaminated groundwater will experience any increased risks to their health. However, given the uncertainty about the levels of exposure and the lack of appropriate comparison values for this scenario, we recommend that workers use appropriate protective measures while working on the site. These measures include using appropriate PPE (such as waterproof gloves, boots and other coverings), regularly cleaning work clothes/equipment, and avoiding taking unclean clothes, shoes or equipment into homes/indoor offices.

Conclusions

EHAP reached two conclusions in this health consultation:

EHAP concludes that touching, breathing or swallowing radium-226 (Ra-226), thorium-230 (Th-230) and arsenic in soil or dust for a year or longer at or near the Lakeview mill site is not expected to harm people's health. These contaminants have been cleaned up to levels below health concern for people who work on the site. The levels at adjacent properties are expected to be even lower than post-cleanup levels at the Lakeview mill

site. Therefore, construction workers at the biomass plant being built next to the Lakeview mill site are not expected to have increased health risks.

EHAP concludes that touching, breathing or swallowing small amounts of uranium, arsenic, boron, manganese and sulfate in groundwater for a year or longer at or near the Lakeview mill site is not expected to harm people's health. There are a number of institutional controls to prevent people from using groundwater at the site for drinking or cooking. Further, these chemicals are at levels that will not be harmful to people who occasionally come into contact with the groundwater during construction or excavation activities.

Recommendations

EHAP did not find a health-based reason to recommend additional radiological or environmental testing at the Lakeview Site, or on properties adjacent to this site. However, because the contaminants at this site are carcinogens, we recommend that construction workers take steps to reduce their contact with soil or groundwater at the site. An industrial hygienist in OEPH provided the following recommendations to reduce contact with dust on the site (Personal communication with D. Cain, 12/9/2010):

1. Dust generation should be minimized during construction activity at the site. Wet methods are an effective way of controlling dust.
2. We recommend that workers use precautionary measures to to minimize contacting or spreading dust at the site. These measures include:
 - a. Washing hands before eating, drinking, or smoking, before breaks, and after shifts.
 - b. Use of dedicated work clothes and shoes, removed at the end of shift.
 - c. No eating, drinking, and smoking on the work site (to minimize ingestion of soil/dust on the hands), and the designation of a protected area for those activities.
3. We recommend workers use standard PPE for construction (boots, gloves, hard hats, vests, ear plugs, etc). Respirators are not needed if measures are taken to control dust at the site.

Public Health Action Plan

The Public Health Action Plan includes a description of actions that have been or will be taken by EHAP at the Lakeview Site. EHAP is committed to implementing these actions in order to reduce or prevent exposures to hazardous substances in the environment.

Public Health Actions that will be implemented in the future:

- EHAP will communicate the findings of this report to the petitioner, the Oregon Radiation Protection Services program, and other agencies involved at the site.
- EHAP will contact the biomass facility developer to discuss our findings and our recommendations to minimize workers' contact with soil or dust at the site.
- EHAP is available to discuss the findings of this report with residents, workers or agencies with concerns about the Lakeview Mill site.

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Appendix A. Equations and assumptions used in this report.

Cancer risk is calculated using the estimated exposure dose and a chemical-specific cancer slope factor (CSF). The equation for calculating cancer risk is:

$$\text{Cancer Risk} = [\text{Dose}_{\text{Total}}] \times [\text{CSF}]$$

The total exposure dose is an estimate of how much contact people have with contaminated soil at Lakeview. To get $\text{Dose}_{\text{Total}}$, we added the estimated doses from ingestion (swallowing soil) and dermal exposures (absorbing in chemicals from soil on the skin).

$$\text{Dose}_{\text{ingestion}} = \frac{C \times \text{IR} \times \text{EF} \times \text{ED} \times \text{CF}}{\text{BW} \times \text{AT}}$$

$$\text{Dose}_{\text{dermal}} = \frac{C \times \text{AF} \times \text{ABS}_d \times \text{SA} \times \text{EV} \times \text{EF} \times \text{ED} \times \text{CF}}{\text{BW} \times \text{AT}}$$

$$\text{Dose}_{\text{Total}} = \text{Dose}_{\text{Ingestion}} + \text{Dose}_{\text{dermal}}$$

Table A.1 shows the exposure factors we used to calculate the ingestion and dermal doses. Note that the averaging time (AT) is different for assessing cancer and non-cancer risks.

The following example shows how we calculated the cancer risk to construction workers who are exposed to 400 ppm (or mg/kg) arsenic per day for two years:

$$1. \text{Dose}_{\text{ingestion}} = \frac{400 \frac{\text{mg}}{\text{kg}} \times 100 \frac{\text{mg}}{\text{day}} \times 250 \frac{\text{days}}{\text{yr}} \times 2 \text{ yr} \times 10^{-6} \frac{\text{kg}}{\text{mg}}}{70 \text{ kg} \times 25550 \text{ days}} = 0.000011 \text{ mg/kg-day}$$

$$2. \text{Dose}_{\text{dermal}} = \frac{400 \frac{\text{mg}}{\text{kg}} \times 0.3 \frac{\text{mg}}{\text{cm}^2\text{-event}} \times 0.03 \times 3300 \text{ cm}^2 \times 1 \frac{\text{event}}{\text{day}} \times 250 \frac{\text{days}}{\text{yr}} \times 2 \text{ yr} \times 10^{-6} \frac{\text{kg}}{\text{mg}}}{70 \text{ kg} \times 25550 \text{ days}}$$

$$= 0.0000033 \text{ mg/kg-day}$$

$$3. \text{Dose}_{\text{Total}} = 0.000011 + 0.0000033 = 0.0000143 \text{ mg/kg-day}$$

$$4. \text{Cancer Risk} = 0.0000143 \frac{\text{mg}}{\text{kg-day}} \times \frac{5.7}{\text{mg}} = 0.000082 \text{ (or 8 in 100,000)}$$

Tables A.2 and A.3 show the dose and risk estimates for all scenarios evaluated in this report.

Table A.1. Exposure factors used to calculate cancer and non-cancer doses.

Parameter	Value		Units	Notes
	Construction Worker	Indoor Worker		
C (Chemical concentration)	chemical specific		mg/kg = ppm	From DOE's reports on the Lakeview Processing Site
IR (Ingestion Rate)	100	50	mg/day	EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (EPA 2002)
EF (Exposure Frequency (EF))	250	250	days/year	EPA 2002
ED (Exposure Duration) – High-end exposures	2	25	years	Professional judgment/EPA 2002
ED (Exposure Duration) – Average exposures	1	6	years	Professional judgment/EPA 2002
CF (Conversion Factor)	10 ⁻⁶		kg/mg	-
BW (Body Weight)	70	70	kg	EPA Exposure Factors Handbook
AF (Adherence factor)	0.3		mg/cm ² - event	EPA 2002
ABS _d (Dermal Absorption Fraction)	0.03		-	EPA 2002
SA (Surface Area)	3300		cm ²	Surface area of exposed skin (EPA 2002)
EV	1		events/day	EPA 2002
AT _{nonc} (Averaging Time – Noncancer)	365xED	365xED	Days	ATSDR Public Health Assessment Guidance Manual (2005)
AT _c (Averaging Time – Cancer)	25550		Days	ATSDR Public Health Assessment Guidance Manual (2005)
CSF (Cancer Slope Factor) for arsenic	5.7		(mg/kg-day) ⁻¹	The current CSF for arsenic (1.5 per mg/kg –day) is based on risks for developing skin cancer. There have been recommendations to base the CSF on risks for lung and bladder cancers, which are more serious endpoints than skin cancer. In this report, EHAP used the CSF for lung and bladder cancers combined (5.7 per mg/kg-day) ^{1, 2} .

Table A.2. Cancer risk estimates for construction and indoor workers at Lakeview

¹ Environmental Protection Agency, *Issue Paper: Inorganic Arsenic Cancer Slope Factor*, Environmental Protection Agency, Editor. 2005.

² Washington State Department of Health, *Evaluation of Soil Contamination, Apple Valley Elementary School*. 2006: Olympia, WA.

Scenario	Assumptions	Total Dose (mg/kg-day)	Cancer Risk
Construction Workers: High-end exposure	Exposed to 400 ppm arsenic; ingest 100 mg/day; 250 days/year; 2 years	0.000014	8 in 100,000
Construction Workers: Average exposure	Exposed to 200 ppm arsenic; ingest 100 mg/day; 250 days/year; 1 year	0.0000036	2 in 100,000
Indoor Workers: High-end exposure	Exposed to 200 ppm arsenic; ingest 50 mg/day; 250 days/year; 25 years	0.00006	3 in 10,000
Indoor Workers: Average exposure	Exposed to 200 ppm arsenic; ingest 50 mg/day; 250 days/year; 6 years	0.000013	7 in 100,000

Table A.3. Non-cancer risk estimates for construction and indoor workers at Lakeview.

Scenario	Assumptions	Total Dose (mg/kg-day)	Hazard Index*	Margin of Safety[^]
Construction Workers: High-end exposure	Exposed to 400 ppm arsenic; ingest 100 mg/day; 250 days/year; 2 years	0.0005	1.7	27
Construction Workers: Average exposure	Exposed to 200 ppm arsenic; ingest 100 mg/day; 250 days/year; 1 year	0.0003	1.0	55
Indoor Workers: High-end exposure	Exposed to 200 ppm arsenic; ingest 50 mg/day; 250 days/year; 25 years	0.00015	0.5	90
Indoor Workers: Average exposure	Exposed to 200 ppm arsenic; ingest 50 mg/day; 250 days/year; 6 years	0.00015	0.5	90

*Hazard Index = MRL/Total Dose. The MRL for arsenic is 0.0003 mg/kg-day.
[^]Margin of Safety = LOAEL/Total Dose. The LOAEL for arsenic is 0.014 mg/kg-day.

Appendix B. ATSDR Glossary of Environmental Health Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR serves the public by using the best science to take responsive public health actions and provides trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

- Absorption:** How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.
- ATSDR:** The Agency for Toxic Substances and Disease Registry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
- Background Level:** An average or expected amount of a chemical in a specific environment, or amounts of chemicals that occur naturally in a specific environment.
- Bioavailability:** See **Relative Bioavailability**.
- Cancer:** A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control
- Carcinogen:** Any substance shown to cause tumors or cancer in experimental studies.
- CERCLA:** See **Comprehensive Environmental Response, Compensation, and Liability Act**.
- Chronic Exposure:** A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.
- Completed Exposure Pathway:** See **Exposure Pathway**.
- Comparison Value (CVs):** Concentrations of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):	CERCLA was put into place in 1980. It is also known as Superfund . This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. This act created ATSDR and gave it the responsibility to look into health issues related to hazardous waste sites.
Concern:	A belief or worry that chemicals in the environment might cause harm to people.
Concentration:	How much or the amount of a substance present in a certain amount of soil, water, air, or food.
Contaminant:	See Environmental Contaminant .
Dermal Contact:	A chemical getting onto your skin. (see Route of Exposure).
Dose:	The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as “amount of substance(s) per body weight per day”.
Dose / Response:	The relationship between the amount of exposure (dose) and the change in body function or health that result.
Duration:	The amount of time (days, months, years) that a person is exposed to a chemical.
Environmental Contaminant:	A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the Background Level , or what would be expected.
Environmental Media:	Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. Environmental Media is the second part of an Exposure Pathway .
U.S. Environmental Protection Agency (EPA):	The federal agency that develops and enforces environmental laws to protect the environment and the public’s health.
Epidemiology:	The study of the different factors that determine how often, in how many people, and in which people will disease occur.
Exposure:	Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see Route of Exposure .)
Exposure Assessment:	The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway: A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.

ATSDR defines an exposure pathway as having 5 parts:

1. Source of Contamination,
2. Environmental Media and Transport Mechanism,
3. Point of Exposure,
4. Route of Exposure, and
5. Receptor Population.

When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

Frequency: How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.

Hazardous Waste: Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effect: ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

Ingestion: Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Inhalation: Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).

LOAEL: **Lowest Observed Adverse Effect Level.** The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

MRL: **Minimal Risk Level.** An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

NPL: The **National Priorities List.** (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.

NOAEL: **No Observed Adverse Effect Level.** The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

PHA:	Public Health Assessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.
Point of Exposure:	The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Some examples include: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.
Population:	A group of people living in a certain area; or the number of people in a certain area.
Public Health Assessment(s):	See PHA .
Route of Exposure:	The way a chemical can get into a person's body. There are three exposure routes: <ul style="list-style-type: none"> – breathing (also called inhalation), – eating or drinking (also called ingestion), and – getting something on the skin (also called dermal contact).
Source (of Contamination):	The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an Exposure Pathway .
Special Populations:	People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.
Statistics:	A branch of the math process of collecting, looking at, and summarizing data or information.
Superfund Site:	See NPL .
Toxic:	Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.
Toxicology:	The study of the harmful effects of chemicals on humans or animals.