Health Consultation

Public Comment Release

Cully Park Site

Portland, Oregon

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Prepared by:

Oregon Public Health Division
Environmental Health Assessment Program (EHAP)

Public Comment

This report is being released for a 30-day public comment period, and is distributed solely for the purpose of obtaining public comment under applicable information quality guidelines.

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Environmental Health Assessment Program
800 NE Oregon St., Suite 640
Portland, OR 97232

Foreword

The Environmental Health Assessment Program (EHAP), part of the Oregon Health Authority, partners with communities affected by hazardous waste in Oregon. EHAP works to assess and prevent human exposure to contamination at sites listed on the National Priorities List (also known as Superfund sites) and other hazardous waste sites that impact communities.

Individuals, organizations, or governmental agencies may request EHAP's assistance to assess and communicate the health risks of hazardous waste sites in Oregon. EHAP works with many partners, including the Environmental Protection Agency (EPA), Oregon Department of Environmental Quality (DEQ), ATSDR, local health departments, and most importantly, the affected communities to assess and prevent exposure to hazardous chemicals.

This report was supported by funds from a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Department of Health and Human Services. This has not been reviewed and cleared by ATSDR.

The Oregon Public Health Division's Environmental Health Assessment Program (EHAP) has prepared this Health Consultation (HC) regarding the Cully Park site in Portland, Oregon. This HC addresses the analysis of the surface soil and analysis of air.

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Summary

Introduction

At the Cully Park site, EHAP's purpose is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent people from coming into contact with harmful toxic substances.

The Cully Park site is a 25-acre closed landfill (the Killingsworth Fast Disposal landfill) located in Northeast Portland, in the Cully neighborhood, on NE Killingsworth Street, between NE 72nd and 77th avenues. The site served as a sand and gravel mine, prior to its use as a construction waste disposal landfill. The Killingsworth Fast Disposal landfill closed in 1990, was fully lined with a plastic-like liner, and covered with soil and grass. After several problems with methane buildup and underground fires, the Oregon Department of Environmental Quality (DEQ) repaired damage to the liner and installed a new methane collection system. The City of Portland, Parks and Recreation ultimately took over ownership with Metro (the regional governance body) taking responsibility for security and maintenance of the site.

In 2011, the Cully neighborhood-based non-profit organization Verde, received funds from Oregon Public Health Division to facilitate community involvement in a human health risk assessment for the site. Environmental conditions at the site were in question due to the unknown origin of the soil used to cover the landfill liner. Funding from the City of Portland and Oregon Department of Environmental Quality (DEQ) was used to collect samples from soil and air at the site in August, 2011 and April, 2012. In this Health Consultation, we state our conclusions about potential health risks at the site, based on the results of these sampling events.

Overview

EHAP reached *two* important conclusions in this Health Consultation.

Conclusion 1

*EHAP concludes that swallowing and touching soil found at the surface of the landfill cover at the Cully Park site is **not** expected to harm people's health. This includes adults (both park visitors and workers) and children on the site.*

Basis for Decision

In April 2012, soil samples were taken from the entire site, and evaluated by EHAP. The concentrations of all chemicals in the soil are too low to affect people who come into contact with the soil.

Next Steps	In the future, new soil may be brought onto the site for redevelopment purposes (*e.g.* grading, incorporating various park features, etc). EHAP supports DEQ's guidance for testing new soil as it is brought onto the site for redevelopment purposes (*e.g.* grading, incorporating various park features). EHAP will continue to be involved as the site is developed to mitigate and prevent exposures as redevelopment decisions are made.
Conclusion 2	*EHAP concludes that air pollutants related to the Cully park site are **not** expected to harm people's health.*
Basis for Decision	In April 2012, air concentrations of chemicals related to the landfill were monitored and found to be below levels of concern. Contaminants not produced by the landfill (specifically, benzene and naphthalene) were above their comparison values. These chemicals are related to regional air pollution rather than the landfill itself.
Next Steps	EHAP recommends that: • Portland Air Toxics Science (PATS) Advisory Committee continues its air toxics reduction strategy in the Portland metropolitan area. • DEQ continue reducing air toxics by encouraging people, businesses, and communities to produce less pollution. EHAP will: • Continue working with DEQ on ways to reduce air toxics pollution in the Portland area. • Encourage residents interested in obtaining daily regional air quality information to use EPA's "AIR NOW" website: http://www.airnow.gov.

Purpose and Health Issues

The Oregon Public Health Division's Environmental Health Assessment Program (EHAP) has prepared this Health Consultation (HC) regarding the Cully Park site, in Portland, Oregon, at the request of Verde, a Portland nonprofit group. This HC addresses the analysis of the surface soil, from one to six inches below the grass surface of the landfill, as well as analysis of air samples taken from standing level above the landfill cap. There are two general areas of public health concern addressed in this document:

1. The origin and content of the soil that was used to cover the plastic landfill liner is not known.

2. The effectiveness of the landfill gas collection system at containing gases produced by the landfill is not known.

Background

Site Description

In its current state, the Cully Park site is a 25-acre grassy field surrounded by commercial/industrial properties, residential areas, and streets. The property is bound by NE Columbia Boulevard to the north, NE Killingsworth Street to the south, and extends from approximately NE 72nd to NE 78th Avenues to the west and east, respectively (Figure 1).

The site is within a mixed-use area: To the west and south of the site, there are several residences. Several industrial and commercial businesses are also south and east of the site. The Union Pacific railroad line runs along the north side of the site. Across Columbia Boulevard is the Colwood National Golf Club and the Native American Youth and Family Center.

Currently, the site is the closed and covered Killingsworth Fast Disposal (KFD) landfill. The entire perimeter of the site is fenced off, and access is controlled through a locked gate on NE Killingsworth Street. Another access point at NE 72nd Avenue serves as a secured entrance to the Cully Park community garden. The entire site resembles a grassy plateau. Although much of the site appears flat, the ground is bumpy and unsmoothed in many areas. There is a steep slope along the northern boundary of the site. The entire landfill is capped with a 30 mil geomembrane liner, which is covered with soil that ranges from six inches to two feet in depth. Grass was planted soon after the top soil was brought onto the site. Thick vegetation is present on most areas of the site. There are six active groundwater monitoring wells, a leachate collection system, and a landfill gas management system (Geodesign, 2012). The site continues to produce methane, which is collected on-site and burned at a flare in a small secured facility at the entrance of the 75th Avenue and NE Killingsworth Street access point.

Site History

Cully Park is located on land that holds historic and cultural significance for many Cully residents, community based organizations and tribal communities. Before European arrival, the nearby Neerchokikoo Indian Village thrived in the Columbia Slough area. A rich trade economy flourished along the Columbia River, which attracted thousands of Native American Tribal members from across America. Some of the first maps of the village were drawn by Lewis and Clark in 1804-1805 and make reference to the Skil-lute Nation and "Sh-ha-las" people, a Chinook band. After Portland was settled, the area in and around the Cully Park site was primarily agricultural. Around the 1930s, a rock quarry began operating on the site. By the 1960s, wooded lands in the area were cleared, roads were expanded, and more houses were built.

In the early 1980s, Riedel Waste System (RWS) began operating the KFD landfill, which accepted construction and demolition waste under a DEQ permit. The landfill was permanently closed in 1990. Following the closure, RWS installed a landfill gas collection system. Shortly thereafter, RWS informed DEQ that it was financially unable to maintain post-closure maintenance and monitoring activities. RWS eventually abandoned the site and the company was eventually dissolved by the Secretary of State for failure to pay its annual license fees. By the mid-1990s, the landfill gas collection system had become unsafe and unreliable. High methane levels were reported throughout the landfill, and there was concern over the safety of nearby residences and businesses due to the possibility of fire and explosion. At least four underground fires occurred in the landfill, further damaging the existing gas collection system and the plastic liner that seals the surface of the landfill.

In 1995, DEQ began performing maintenance and monitoring to prevent further degradation of the property and to protect neighboring properties from threat of fire and landfill gas.

In early 1999, DEQ determined that high methane levels at the KFD landfill presented a substantial and imminent threat to human health. DEQ began taking actions at the property to reduce threats to human health posed by methane. These steps included: installation of new landfill gas removal wells, piping, air blowers and a methane flare tower; grading and drainage improvements; and extensive repair of the plastic liner that seals the surface of the landfill. These activities were completed in the fall of 2000, at a total cost of approximately $1,500,000. DEQ funded the activities primarily from Oregon's Solid Waste Orphan Site Program. DEQ did not accept ownership of the property.

In 2000, Multnomah County took possession of the KFD landfill through tax foreclosure. In 2002, DEQ and the City of Portland agreed to shift operation and maintenance of the closed landfill from DEQ to the city. Ownership of the property was transferred from Multnomah County to Portland Parks and Recreation. Since that time, the city of Portland and Metro (the elected regional government) have entered into an agreement where Metro manages the site for the city of Portland.

In 2010, sediment from Laurelhurst pond dredging was placed at the KFD landfill as additional top soil in areas that eroded and settled. The sediment was tested for contamination, including heavy metals, volatile and semi-volatile organic compounds (SVOCs), petroleum hydrocarbons, polychlorinated biphenyls (PCBs), total organic carbon, and pathogenic bacteria. Contaminated sediment was not placed at the site.

Site Plans

The Cully Park site is now entering a three-year development process to open the park by the fall of 2015. As with the health consultation process, community members remain deeply involved in all aspects of park development, including: conceptualization, design, construction and use. From July 1, 2012 through June 30, 2013 Verde will lead the design of a habitat restoration area, a temporary onsite plant nursery, a play area, a network of trails and a tribal plant gathering area. Through the opportunities created at Cully Park, this neighborhood can acknowledge the important contributions of the diverse communities who make the Cully Neighborhood their home. Park features will be constructed starting in the fall of 2012 and completed by the fall of 2013. Plans for the park construction include using local businesses and local labor, to benefit local, low income, and minority people.

It should be noted that Metro and DEQ will continue to monitor the KFD landfill once Cully Park is built over the landfill cap.

Site Visits

Since September 2011, EHAP visited the KFD landfill several times. These visits were made to inspect the current state of the site, tour the site with community group members, determine sampling plan specifics, and work with community members to involve neighboring residents in the risk assessment process.

Figure 1. Location of the Cully Park site

Discussion

Exposure Pathways

In order for a chemical contaminant to harm human health, there must be a way for people to come into contact with the chemical. An "exposure pathway" describes how a chemical moves from its source and comes into physical contact with people. An exposure pathway has five elements:

1) A contaminant source or release

2) A way for the chemical to move through the environment to a place where people could come into contact with it

3) A place where people could contact the contaminant

4) Route of exposure to a contaminant (breathing it, swallowing it, absorbing it through skin, etc.)

5) A population that comes in contact with the contaminant

An exposure pathway is called "completed" if all 5 of the elements are known to be in place and occurring. If it is unknown whether one or more of the elements is in place, then it is called a "potential" pathway. If it is known that one of these 5 elements is *not* in place, that pathway is "eliminated" (ATSDR, 2005a).

Completed Exposure Pathways

Currently, the only known completed exposure pathways are from trespassing on the KFD landfill. All official visitors are: accompanied under supervisory conditions, required to have proper footwear, and advised to avoid contact with the soil. However, there are holes in the perimeter fence. In the past, residents have witnessed people camping and squatting on the site. People climbing under fences and sitting/sleeping on the ground could come into contact with the soil, and breathe the air at the park. Table 1 describes the completed exposure pathways identified for this Health Consultation.

Table 1. Completed Exposure Pathways.

Pathway	Time	Source	Media and Transport	Point of Exposure	Route of Exposure	Exposed Population
Contact with surface soil on the park itself	Past and Present	Soil, that came from an unknown source, that was used to cover the plastic liner covering the landfill	Surface layer of soil	Areas of the park where people may swallow or touch the soil	Swallowing and touching soil to the skin	People who trespass on the site
Inhalation of airborne chemicals coming from inside the landfill	Past and Present	Gaseous chemicals that can come from inside the landfill	Transport of gaseous chemicals through ambient air	Ground-level air, approximately 1-2 meters above the soil surface	Inhalation	People who trespass on the site

Potential Exposure Pathways

Table 2 describes the potential exposure pathways identified for this Health Consultation. Once Cully Park is built, adults and children will be using the park regularly. Many users will be playing on and coming into contact with the ground (*e.g.*, sitting, rolling around, and playing sports). Although the site is heavily vegetated (the future park will also have a grass cover), it is possible to come into contact with soil, which can be accidentally swallowed and absorbed onto the skin. People will also inhale the air while at the park.

It is also likely that some of the existing soil will be covered. Currently there are some areas of the site that are bumpy, not smooth, and unsuitable for walking, playing, and sports. During park construction, areas of the site will be graded, several inches of new soil will be applied, and new vegetation will be planted over the surface. DEQ recommends testing soil for contamination prior to importing the material to the site.

Table 2. Potential Exposure Pathways.

Pathway	Time	Source	Media and Transport	Point of Exposure	Route of Exposure	Exposed Population
Contact with surface soil on the park itself	Future (there is currently no open access to the site)	Soil, that came from an unknown source, that was used to cover the plastic liner covering the landfill	Surface layer of soil	Areas of the park where people may accidentally swallow or touch the soil. (some areas of the park will be covered with new, clean soil)	Accidentally swallowing and touching soil to the skin.	People who use the park, both adults and children
Inhalation of airborne chemicals coming from inside the landfill	Future (there is currently no open access to the site)	Gaseous chemicals that can come from inside the landfill	Transport of gaseous chemicals through ambient air	Ground-level air, approximately 1-2 meters above the soil surface	Inhalation	People who use the park, both adults and children (currently, the site is not being used, but will be used as a park in the future)

Eliminated Exposure Pathways

Table 3 shows the eliminated exposure pathways identified for the Cully Park Site Health Consultation.

Most of the dust visible in a dust storm, or when a vehicle drives on a dirt road, consists of particles that are too large to go very deep into the lungs. These larger particles are trapped in mucus that lines the respiratory tract and are carried back up to the throat where they are swallowed. Therefore, in most cases, the dose of a contaminant from incidental swallowing of soil is much greater than the dose from inhaling it as dust.

It is also unlikely that significant amounts of dust will enter into the air because the soil at the Cully Park site is covered with a continuous layer of thick vegetation (and any soil that is added will be covered with vegetation or landscaping materials).

Table 3. Eliminated Exposure Pathways.

Pathway	Time	Source	Media and Transport	Point of Exposure	Route of Exposure	Exposed Population
Inhalation of contaminated soil from site	Past, present, future	Soil, that came from an unknown source, that was used to cover the plastic liner covering the landfill	Surface layer of soil	Areas of the park where people may inhale airborne soil particles.	Breathing in airborne dust (known not to occur in quantities that could harm health)	Area residents who use the park, both adults and children (currently, the site is not being used, but will be used as a park in the future)

Nature and Extent of Contamination

This section describes the types of data that EHAP considered in deciding whether or not people's health could be harmed by chemical contaminants from and around the Cully Park site. All environmental sampling data discussed were obtained using EPA-approved methods and technology by certified professionals and technicians. EHAP considers these data of adequate quality to support the conclusions of this report.

Soil Conditions at the Site

Prior to 2012, there was no environmental data available for soil on the site. The soil that covers the plastic landfill cover was put in place in the late 1990s, shortly after the landfill closed. EHAP (and partner agencies and firms) could not find a report or other evidence that details the source of this soil, and cannot determine if the soil was free of contamination at the time it was brought to the site. Although the site has been fenced off since 1990 and there have been few signs of illegal dumping, chemical releases could have taken place over the 22-year period of inactivity at the site. When underground fires occurred in the 1990s, the landfill's plastic liner was breached in several areas (DEQ, 2012c), exposing the soil covering to contents of the landfill and melted components of the plastic liner. The liner was repaired, but impact to the surrounding soil was not known. In addition, several industrial properties are in operation adjacent to the site. The Union Pacific Railroad (UPRR) maintains an active corridor on the north side of the site, and herbicides may have been applied to keep the tracks clear of vegetation. Portland Parks and Recreation and Metro have used herbicides on the site, to control the growth of invasive plants.

Soil Sampling

Soil samples were collected at the site on April 16-17, 2012. Incremental Sampling Methodology (ISM) was chosen to evaluate soil conditions on the site. ISM is a sampling technique that takes multiple samples from a designated area, known as a Decision Unit (DU), and combines them into a single sample for analysis. ISM reduces the chances of missing or underestimating chemicals that may be present in the soil. It also increases the likelihood of obtaining a result that is a good estimation of average concentrations. Park users are likely to use a large area of the park, rather than sit in a single spot, during their park experience. Chemical concentrations produced by ISM will likely reflect this type of exposure at the park.

The Cully Park site was divided into ten DUs (Figure 2). The DUs were drawn based on what is known about previous use of the land and activities on the site. 30 soil increments were collected from each DU, and were combined for analysis. Each DU was tested for several different chemicals, including:

- Polycyclic aromatic hydrocarbons (PAHs - chemicals found in coal, oil, tar, and are also formed by incomplete combustion of carbon-containing fuels);
- Polychlorinated biphenyls (or PCBs, which were formerly used in electrical coolant fluids and are persistent organic pollutants);
- Dioxin compounds (by-products of various industrial processes, burning trash, and forest fires, and are persistent organic pollutants) ;
- Hydrocarbon compounds (chemicals found in oil);
- Metals (including arsenic and heavy metals such as lead);
- Pesticides (24 different compounds, including DDT and 2,4,5-T); and
- Asbestos (a material formerly used in insulation and fireproofing).

Tables 4a and 4b show the complete list of chemicals for which the soil samples were tested, and compares the maximum concentration measured for each contaminant with a comparison value determined by federal and state agencies. When the maximum measured concentration of a given contaminant was higher than the comparison value (CV), that contaminant was identified as a "Contaminant of Potential Concern" (COPC). It is important to note that just because a COPC is identified, it does not necessarily mean that EHAP expects harmful health effects from exposure to that contaminant. Rather, it simply flags these contaminants for closer evaluation. For more information about the CVs used in Tables 4a and 4b, see Appendix A.

Although some chemicals were detected in the DUs, the overall levels were very low (Tables 4a and 4b). Since none of the maximum concentrations exceeded their respective comparison values, no COPCs were identified in soil samples taken from the ten DUs at the Cully Park site. Because no soil concentrations are above their comparison values, health effects from exposure are not expected.

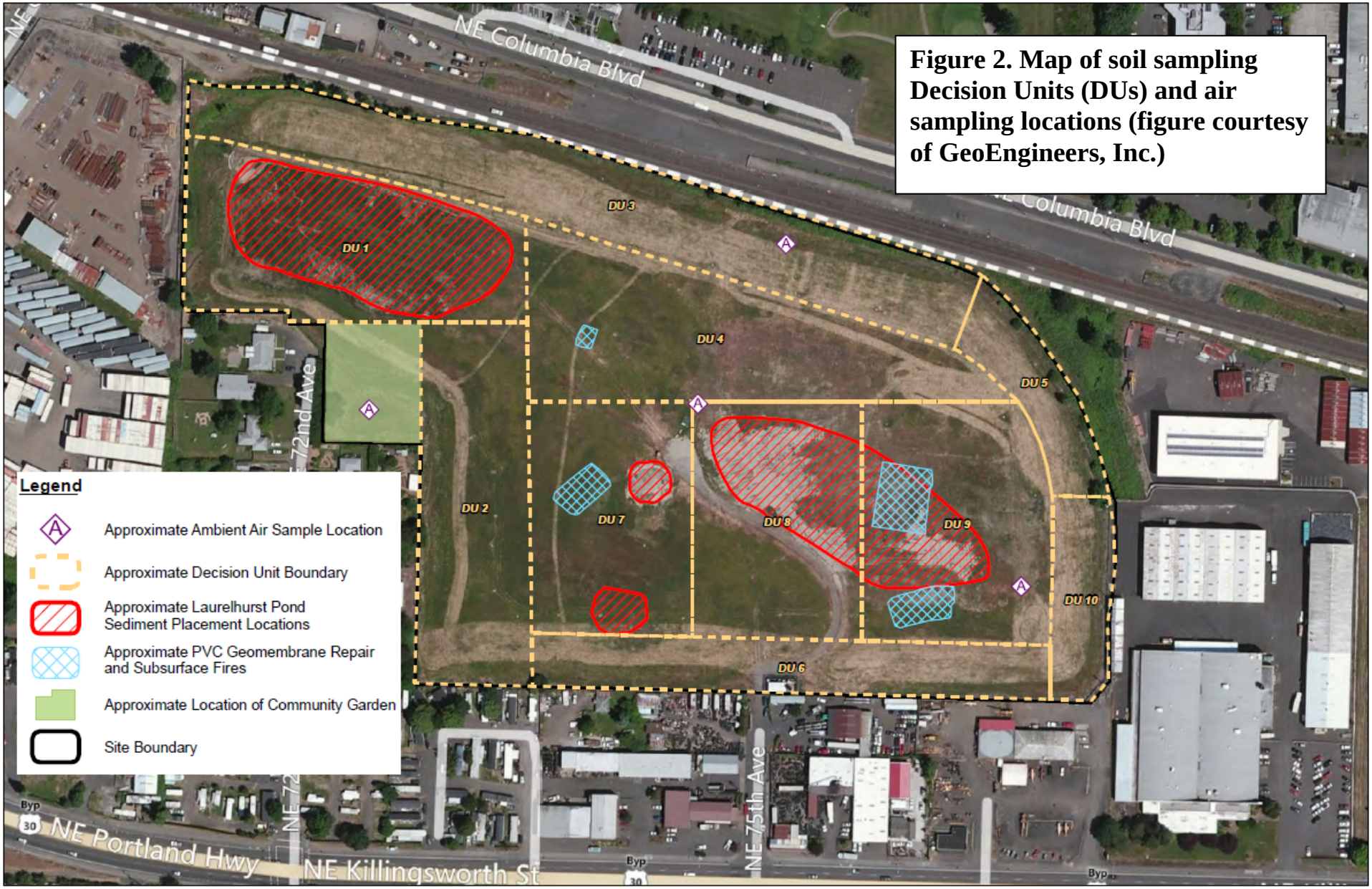

Figure 2. Map of soil sampling Decision Units (DUs) and air sampling locations (figure courtesy of GeoEngineers, Inc.)

Table 4a. Results of 2012 surface soil tests.

Chemical	Decision Units (DUs) with Detections	Site Wide Max. Conc. (ppm)	Comparison Value (CV) (ppm)	CV Source	Contaminant of Potential Concern (COPC)?
PCB-1016	0[1]	BDL[2]	NA[3]		NO
PCB-1221	0	BDL	NA		NO
PCB-1232	0	BDL	NA		NO
PCB-1242	0	BDL	NA		NO
PCB-1248	0	BDL	NA		NO
PCB-1254[4]	**1**	**0.0238**	**1**	**chr. EMEG**	**NO**
PCB-1260	0	BDL	NA		NO
Dioxin[5]	**10**	**<0.000001**	**0.00005**	**chr. EMEG**	**NO**
Asbestos	0	BDL	NA		NO
Diesel Range SG	**1**	**19**	**1,100**	**DEQ RBC**	**NO**
Motor Oil Range SG	**1**	**67**	**NA**	**NA**	**NO**
Arsenic	0	BDL	NA		NO
Barium	**10**	**145**	**10,000**	**chr. EMEG**	**NO**
Cadmium	0	BDL	NA		NO
Chromium (III)[6]	**10**	**17.8**	**75,000**	**RMEG**	**NO**
Lead	**10**	**15.5**	**400**	**EPA RSL**	**NO**
Mercury	**1**	**0.069**	**10**	**EPA RSL**	**NO**
Selenium	0	BDL	NA		NO
Silver	0	BDL	NA		NO
PAHs[7]	**10**	**0.082**	**0.096**	**CREG**	**NO**
Aldrin	0	BDL	NA		NO
alpha-BHC	0	BDL	NA		NO

1. A chemical was considered not present if all sample results were below the detection limit.
2. Below Detection Limit (BDL). The detection limit is the lowest amount of a chemical that can be accurately measured. Detection limits are usually much lower than the comparison value for a chemical.
3. If the level of a chemical was BDL on all DUs, it is considered not present, and a CV is not necessary.
4. Chemicals that were detected above the DL are in bold.
5. Dioxins are a class of similar compounds. EHAP assessed risk of dioxin exposure by using the Toxic Equivalency Factor (TEF) method, which assigns a value to each dioxin molecule, based its relative toxicity to 2,3,7,8-TCDD, the most toxic dioxin compound. These numbers are then summed, and expressed in mg/kg of 2,3,7,8-TCDD.
6. RMEG for trivalent chromium used because this is the form of chromium most likely at this site (ATSDR, 2008).
7. Polycyclic Aromatic Hydrocarbons (PAHs) are a class of several similar compounds. EHAP assessed risk of PAH exposure by using the Toxic Equivalency Factor (TEF) method, which assigns a value to each PAH molecule, based on its relative toxicity to benzo[a]pyrene, the most active PAH compound. These numbers are then summed, and expressed in mg/kg of benzo[a]pyrene.
8. All CVs are for child exposure.

Abbreviations: ppm = parts per million; BDL = Below Detection Limit; chr. = Value for chronic exposure (≥1 year); EMEG = Environmental Media Evaluation Guide (ATSDR); CREG = Cancer Risk Evaluation Guide (ATSDR); RBC = Risk-Based Concentration; RMEG = Reference Dose Media Evaluation Guide (ATSDR); RSL = Regional Screening Level (EPA)

Table 4b. Results of 2012 surface soil tests.

Chemical	Decision Units (DUs) with Detections	Site Wide Max. Conc. (ppm)	Comparison Value (CV) (ppm)	CV Source	Contaminant of Potential Concern (COPC)?
beta-BHC	0[1]	BDL[2]	NA[3]		NO
delta-BHC[4]	**7**	**0.006**	**0.11[5]**	**CREG**	**NO**
gamma-BHC	**1**	**0.003**	**15**	**RMEG**	**NO**
alpha-chlordane	0	BDL	NA		NO
4,4'-DDD	0	BDL	NA		NO
4,4'-DDE	**7**	**0.01**	**2.1**	**CREG**	**NO**
4,4'-DDT	**5**	**0.01**	**2.1**	**CREG**	**NO**
Dieldrin	**1**	**0.008**	**2.5**	**EMEG**	**NO**
Endosulfan I	0	BDL	NA		NO
Endosulfan II	0	BDL	NA		NO
Endosulfan sulfate	0	BDL	NA		NO
Endrin	0	BDL	NA		NO
Endrin aldehyde	0	BDL	NA		NO
Endrin ketone	0	BDL	NA		NO
Heptachlor	0	BDL	NA		NO
Heptachlor epoxide	0	BDL	NA		NO
Methoxychlor	0	BDL	NA		NO
Toxaphene	0	BDL	NA		NO
2,4-D	0	BDL	NA		NO
2,4,5-T	0	BDL	NA		NO
2,4,5-TP (Silvex)	0	BDL	NA		NO

1. A chemical was considered not present if all sample results were below the detection limit.
2. Below Detection Limit (BDL). The detection limit is the lowest amount of a chemical that can be accurately measured. Detection limits are usually much lower than the comparison value for a chemical.
3. If the level of a chemical was BDL on all DUs, it is considered not present, and a CV is not necessary.
4. Chemicals that were detected above the DL are in bold.
5. No CV available for delta-BHC. ATSDR CV for alpha-BHC is used as a surrogate.
6. All CVs are for child exposure.

Abbreviations: ppm = parts per million; BDL = Below Detection Limit; EMEG = Environmental Media Evaluation Guide (ATSDR); CREG = Cancer Risk Evaluation Guide (ATSDR); RMEG = Reference Dose Media Evaluation Guide (ATSDR)

Comparison values are not readily available for the "motor oil range" of petroleum hydrocarbons in Table 4a. Motor oil is a complex mixture of hydrocarbons, lubrication additives, metals, and various other organic and inorganic compounds. This mixture changes over time, since many of these molecules are degraded by sunlight, oxygen, and bacteria. This concentration listed in Table 4a represents a snapshot in time and cannot tell us which individual chemicals are currently present. Therefore, it is impossible to compare this number to a comparison value.

The concentration of motor oil detected at one of the DUs (DU6, along the south perimeter of the site) is relatively low (67 ppm) and is unlikely to affect human health. To put this concentration into perspective, EHAP compared this concentration to those measured at a Superfund site in Clark County, Washington (WA DOH, 1997). At this Washington site, hundreds of gallons of chemicals were dumped annually for nearly ten years. Concentrations of motor oil-like compounds at this Superfund site were as high as 6,570 ppm - this concentration was not high enough to result in non-cancer health effects for people playing on the site (WA DOH, 1997). At the Cully Park site, the maximum concentration was 67 ppm, nearly 100 times lower than the site in Washington. In addition, the concentration of 67 ppm is lower than petroleum hydrocarbons remediation guidelines (*i.e.*, the maximum concentration that can be present on a site that has been cleaned up) used in other states (TN DOH, 2005). Last, there were no other detections of petroleum hydrocarbons anywhere else on the site, meaning that it is highly unlikely there is any widespread presence of motor oil on the site.

Air Quality at the Site

Covered landfills can be sources of air contaminants, which can be inhaled by people walking or playing on top of them. These airborne contaminants also have the potential to affect areas nearby. Landfill gas occurs when accumulated materials break down, due to chemical reactions from microbes. Because landfills (even closed landfills) contain constantly-degrading materials, chemicals such as methane and hydrogen sulfide are constantly being produced. Since the core of a landfill contains compacted materials, its pressure is higher than the environment around it. As a result, the gases inside the landfill are also under higher pressure, and have the potential to leak off-site or into surrounding areas.

There have been several problems with the methane collection system at the KFD landfill since it closed. Several underground fires were reported, which caused the plastic landfill liner to melt and break open in some places. At the same time, the methane extraction system broke down (Portland Parts and Recreation, 2008). These structural failures resulted in the movement of methane in several areas of the site, which could have resulted in buildup of methane off-site (Geodesign, 2012). In 2000, the plastic membrane covering the landfill was repaired, and a new methane collection system was installed on the site (DEQ, 2012c).

Air Sampling

Both real-time air monitoring and ambient air monitoring was conducted during the sampling event at the Cully Park site. Real-time monitoring was conducted using hand-held hydrogen sulfide and methane meters. Field technicians walked the perimeter of the site and recorded the percent concentration of methane and hydrogen sulfide in several areas of the site, including around the methane extraction wells, the leachate and condensate sumps, and the methane flare.

Continuous air samples were also collected at the site on April 16-17, 2012. Eight-hour air samples were collected from four different areas of the KFD landfill/future Cully Park (Figure 2):

- In the center of the site, near the leachate sump
- At the southeast corner of the site
- At the north central portion of the site
- At the west side of the site

In addition, an offsite air sample was collected upwind of the site, and compared to air samples taken within the boundary of the site.

Real-time sampling detected no concentrations of methane or hydrogen sulfide anywhere on the KFD landfill.

Tables 5a and 5b show the complete list of chemicals for which the air samples were tested, and compares the maximum 8-hour air concentration measured at any time for each contaminant with a comparison value determined by federal and state agencies When the maximum measured air concentration was higher than the comparison value (CV), that contaminant was identified as a "Contaminant of Potential Concern" (COPC).

Several compounds were detected in the air samples taken from the four areas of the Cully Park site (Tables 5a and 5b). Of the compounds detected, benzene and naphthalene were detected above their respective CVs for chronic exposure (the maximum concentration of benzene was 1.1 $\mu g/m^3$ and its CV is 0.13 $\mu g/m^3$; the maximum concentration of naphthalene was 4.1 and its CV is 3.7 $\mu g/m^3$). Naphthalene and benzene were detected in all four sampling locations on the site, and were also detected in the air sample taken upwind, outside the boundary of the site. It should be noted that the measured concentrations of benzene do not exceed its comparison values for acute (short-term, less than 14 days) or intermediate (more than 14 days but less than one year) effects (29 $\mu g/m^3$ and 19 $\mu g/m^3$, respectively); ATSDR does not have acute or intermediate comparison values for naphthalene.

Table 5a. Results of 2012 air sampling tests.

Chemical	Air Samples with Detections	Site Wide Max. Conc. (µg/m^3)	Comparison Value (CV) (µg/m^3)	CV Source	Contaminant of Potential Concern (COPC)?
Sulfur Dioxide	0[1]	BDL[2]	NA[3]		NO
Methane	0	BDL	NA		NO
1,1,1-Trichloroethane	0	BDL	NA		NO
1,1,2,2-Tetrachloroethane	0	BDL	NA		NO
1,1,2-Trichloroethane	0	BDL	NA		NO
1,1,2-Trichlorotrifluoroethane	0	BDL	NA		NO
1,1-Dichloroethane	0	BDL	NA		NO
1,1-Dichloroethene	0	BDL	NA		NO
1,2,4-Trichlorobenzene	0	BDL	NA		NO
1,2,4-Trimethylbenzene	**5**	**2.2**	**7.3**	**EPA RSL**	**NO**
1,2-Dibromoethane	0	BDL	NA		NO
1,2-Dichlorobenzene	0	BDL	NA		NO
1,2-Dichloroethane	0	BDL	NA		NO
1,2-Dichloropropane	0	BDL	NA		NO
1,3,5-Trimethylbenzene	0	BDL	NA		NO
1,3-Butadiene	0	BDL	NA		NO
1,3-Dichlorobenzene	0	BDL	NA		NO
1,4-Dichlorobenzene	0	BDL	NA		NO
2-Butanone (MEK)	**5**	**3.3**	**5,000**	**EPA RfC**	**NO**
2-Hexanone	0	BDL	NA		NO
2-Propanol	0	BDL	NA		NO
4-Ethyltoluene	0	BDL	NA		NO
4-Methyl-2-pentanone (MIBK)	0	BDL	NA		NO
Acetone	**5**	**19.4**	**31,000**	**chr. EMEG**	**NO**
Benzene	**5**	**1.1**	**0.13**	**CREG**	**YES**
Bromodichloromethane	0	BDL	NA		NO
Bromoform	0	BDL	NA		NO
Bromomethane	0	BDL	NA		NO
Carbon disulfide	0	BDL	NA		NO
Carbon tetrachloride	0	BDL	NA		NO
Chlorobenzene	0	BDL	NA		NO
Chloroethane	0	BDL	NA		NO

1. A chemical was considered not present if all sample results were below the detection limit.
2. Below Detection Limit (BDL). The detection limit is the lowest amount of a chemical that can be accurately measured. Detection limits are usually much lower than the comparison value for a chemical.
3. If the level for a chemical was BDL on all DUs, a comparison value is not necessary.
4. Chemicals detected above the BDL are in bold, and those whose maximum concentrations exceed their comparison value are shaded.
5. All CVs are for child exposure.

Abbreviations: µg/m^3 = micrograms chemical per cubic meter of air; BDL = Below Detection Limit; RfC = Reference Concentration; chr. = Value for chronic exposure (≥1 year); EMEG = Environmental Media Evaluation Guide (ATSDR); RSL = Regional Screening Level (EPA)

Table 5b. Results of 2012 air sampling tests.

Chemical	Air Samples with Detections	Site Wide Max. Conc. (µg/m^3)	Comparison Value (CV) (µg/m^3)	CV Source	Contaminant of Potential Concern (COPC)?
Chloroform	0[1]	BDL[2]	NA[3]		NO
Chloromethane	0	BDL	NA		NO
cis-1,2-Dichloroethene	0	BDL	NA		NO
cis-1,3-Dichloropropene	0	BDL	NA		NO
Cyclohexane	**2**	**3.8**	**6,000**	**EPA RfC**	**NO**
Dibromochloromethane	0	BDL	NA		NO
Dichlorodifluoromethane	**4**	**3.0**	**100**	**EPA RSL**	**NO**
Dichlorotetrafluoroethane	0	BDL	NA		NO
Ethyl acetate	0	BDL	NA		NO
Ethylbenzene	0	BDL	NA		NO
Hexachloro-1,3-butadiene	0	BDL	NA		NO
m&p-Xylene	**3**	**2.6**	**220**	**chr. EMEG**	**NO**
Methyl Butyl Ketone	**3**	**1.4**	**3,000**	**EPA RfC**	**NO**
MTBE	0	BDL	NA		NO
Naphthalene	**5**	**4.1**	**3.7**	**chr. EMEG**	**YES**
n-Heptane	**3**	**3.5**	**4,000**	**Maine IAG[6]**	**NO**
n-Hexane	**5**	**10.3**	**2,100**	**chr. EMEG**	**NO**
o-Xylene	0	BDL	NA		NO
Propylene	0	BDL	NA		NO
Styrene	0	BDL	NA		NO
Tetrachloroethene	**1**	**2.2**	**3.8**	**CREG**	**NO**
Tetrahydrofuran	**3**	**6.5**	**2,000**	**EPA RfC**	**NO**
Toluene	**5**	**3.5**	**300**	**chr. EMEG**	**NO**
trans-1,2-Dichloroethene	0	BDL	NA		NO
trans-1,3-Dichloropropene	0	BDL	NA		NO
Trichloroethylene	0	BDL	NA		NO
Trichlorofluoromethane	**5**	**2.2**	**730**	**EPA RSL**	**NO**
Vinyl acetate	0	BDL	NA		NO
Vinyl chloride	0	BDL	NA		NO
Total Xylenes	**3**	**2.6**	**220**	**chr. EMEG**	NO

1. A chemical was considered not present if all sample results were below the detection limit.
2. Below Detection Limit (BDL). The detection limit is the lowest amount of a chemical that can be accurately measured. Detection limits are usually much lower than the comparison value for a chemical.
3. If the level for a chemical was BDL on all DUs, a comparison value is not necessary.
4. Chemicals detected above the BDL are in bold, and those whose maximum concentrations exceed their comparison value are shaded.
5. All CVs are for child exposure.
6. Maine has a 4,000 µg/m^3 interim ambient air guideline for heptane (Maine CDC, 2010).

Abbreviations: µg/m^3 = micrograms chemical per cubic meter of air; BDL = Below Detection Limit; RfC = Reference Concentration; chr. = Value for chronic exposure (≥1 year); EMEG = Environmental Media Evaluation Guide (ATSDR); CREG = Cancer Risk Evaluation Guide (ATSDR); RSL = Regional Screening Level (EPA); IAG = Interim Ambient Guideline (Maine)

Public Health Implications of Exposure

EHAP believes that adverse health effects from soil are unlikely, since none of the samples contained chemicals above their respective CVs. EHAP used CVs that take into account long-term exposure for children, *i.e.*, the most sensitive receptors.

EHAP also believes that acute effects (short-term effects from an exposure lasting 14 days or less) from coming into contact with soil are unlikely at the Cully Park site. Acute effects require exposure to higher chemical concentrations than those that cause chronic health effects (long-term effects from an exposure that last longer than a year), thus acute CVs are much higher. Since all chemical concentrations are below the CVs for chronic exposure, acute effects are highly unlikely.

It is also unlikely that people's health will be impacted by airborne chemicals coming from the landfill. The only COPCs identified from the April 2012 air sampling, naphthalene and benzene, are not related to the Cully park site. Rather, they are likely due to regional urban air pollution. Both of these compounds can be found in automobile exhaust, smoke from wood burning, and cigarette smoke (ATSDR, 2005b; ATSDR, 2007). Similar concentrations of naphthalene and benzene were detected in the upwind, off-site monitoring location (Table 6). This is supported by an air pollution modeling study by Portland Air Toxics Solutions (PATS), which concluded that regional air concentrations of naphthalene and benzene are currently above clean air health goals (OR DEQ, 2012a).

Table 6. Naphthalene and benzene levels on the Cully Park site compared to off-site concentrations.

Chemical	AA-1[1]	AA-2	AA-3	AA-4	AA-DUP[2]	AA-UG[3]
Naphthalene	4.1	ND	2.9	3.0	3.4	3.7
Benzene	1.1	0.79	0.79	0.91	0.90	0.79

1. Samples AA-1, AA-2, AA-3, AA-4, and AA-DUP were taken from within the Cully Park site (see Figure 2 for exact locations)
2. This is a duplicate sample of AA-4.
3. AA-UG is the "upgradient" sample that was taken upwind and off-site from Cully Park.
4. All concentrations are in $\mu g/m^3$.

It is possible for people to experience health effects due to elevated levels of benzene and naphthalene that are found in the Portland area. Long term exposure to naphthalene can result in respiratory irritation and lung disease (ATSDR, 2005b). The EPA states that naphthalene is a possible carcinogen (USEPA, 1998). Long-term exposure to benzene can affect the blood, damage bone marrow, reduce the number of red blood cells, and cause anemia. EPA also states that benzene is a known human carcinogen (USEPA, 2012). Long-term exposure to benzene can result in cancer of the blood-forming organs (also known as leukemia). As stated previously, none of these potential health risks would be unique to people on or near the Cully Park site.

These health concerns represent breathing the air throughout much of the Portland area. For more information on the health effects of breathing benzene and naphthalene, see Appendix C.

DEQ and the Portland Air Toxics Solutions (PATS) Advisory Committee have been working to develop a comprehensive air toxics plan with reduction goals for the Portland region (OR DEQ, 2012b). The PATS Advisory Committee has recognized the Oregon Health Authority (OHA) as a partner agency in researching air toxics, and OHA staff have served on the Advisory Committee itself. OHA is committed to working with the Advisory Committee and DEQ to assist in research and make recommendations that lead to reducing air toxics in the Portland area.

Uncertainty

In any public health assessment there are uncertainties. Some of the uncertainty is related to the health guideline values used to assess toxicity (i.e., MRLs and RfDs). These values have passed a rigorous multi-agency peer-review process; however, each individual is unique and individuals vary in their sensitivity to toxic chemicals. To some extent, these uncertainties have been addressed by applying uncertainty factors (*e.g.* dividing the doses where effects were observed by numbers ranging from 10 to 1,000). The intent of this practice is to be protective of health by building in a safety margin to these guideline values.

Children's Health

EHAP recognizes that infants and children may be more vulnerable to exposures than adults in communities faced with contamination of their air, water, soil, or food. This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and in contaminated areas.
- Children are shorter, resulting in a greater likelihood to breathe dust, soil, and heavy vapors close to the ground.
- Children are smaller, resulting in higher doses of chemical exposure per body weight.
- The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.
- Children are more likely to swallow or drink water during bathing or when playing in and around water.
- Children are more prone to mouthing objects and eating non-food items like toys and soil.

Because children depend on adults for risk identification and management decisions, EHAP is committed to evaluating their specific risks at the Cully Park site. It is important to note that all

of the health-based screening values EHAP used for soil and air were derived from health guidelines that incorporate the highest level of protectiveness for children and other sensitive individuals. In this Health Consultation, children were identified as the most vulnerable to potential contaminants in soil and pollutants in the air.

Conclusions

EHAP reached two important conclusions in this Health Consultation:

*EHAP concludes that swallowing and touching soil found at the surface of the landfill cover of the Cully Park site is **not** expected to harm people's health. This includes adults (both park visitors and workers) and children on the site.* In 2012, soil samples were taken from the entire site. The concentrations of all chemicals in the soil are too low to affect people who come into contact with the soil.

*EHAP has concluded that air pollutants related to the Cully park site are **not** expected to harm people's health.* In April 2012, air concentrations of chemicals related to the landfill were monitored and found to be below levels of concern. Contaminants not produced by the landfill (specifically, benzene and naphthalene) were above their comparison values. These chemicals are related to regional air pollution rather than the landfill itself.

Recommendations

Based on EHAP's analysis of the available information about the Cully Park site, EHAP has developed recommendations that, if followed, will improve public health.

EHAP recommends that:

- Portland Air Toxics Science (PATS) Advisory Committee should continue its air toxics reduction strategy in the Portland metropolitan area.
- DEQ should continue reducing air toxics by encouraging people, businesses, and communities to produce less pollution.

EHAP will:

- Continue working with DEQ on ways to reduce air toxics pollution in the Portland area.
- Encourage residents interested in obtaining daily regional air quality information to use EPA's "AIR NOW" website: http://www.airnow.gov.
- Support DEQ's recommendation for testing new soil as it is brought onto the site for redevelopment purposes (*e.g.* grading, incorporating various park features, etc).

- Continue to be involved as the site is developed to mitigate and prevent exposures as redevelopment decisions are made.

Public Health Action Plan

Public Health Actions that have been implemented to date:

- EHAP worked with DEQ, Portland Parks and Recreation, GeoEngineers, and the Cully Community to create soil and air sampling plans to determine if there could be any human health risks to future park users and workers.

- DEQ tested soil and air at the Cully Park site.

- Verde established a Community Involvement Committee (CIC), a conduit for the Cully neighborhood residents to participate in the risk assessment of the Cully Park site. The CIC has participated in several educational and learning/experience opportunities field events at the site.

- EHAP has worked closely with the CIC, providing education about concepts involved in assessing human health risks, soil sampling, and air sampling.

Public Health Actions that will be implemented in the future:

- EHAP will continue working with Verde to ensure public health protection and benefits at Cully Park.

- EHAP will be available to answer further questions and provide information to Cully residents about the soil and air test results taken at the Cully Park site.

- EHAP will distribute a Public Comment Draft of the HC to the Cully community and other members of the public. This will give the public an opportunity to provide feedback on EHAP's methodology and interpretation of results.

- EHAP will present the finalized version of this document to the local community.

Report Preparation

This Public Health Assessment/Health Consultation for the Cully Park Site was prepared by the Oregon Health Authority under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner.

Authors

Todd Hudson, MSPH
Toxicologist / Public Health Assessor
Environmental Health Assessment Program (EHAP)
Center for Health Protection (CHP)
Oregon Health Authority (OHA)

Jae P. Douglas, MSW, PhD
Principal Investigator
Section Manager, Research & Education Services
CHP/OHA

ATSDR Partners

Audra Henry,
ATSDR Div. of Community Health Investigations, Western Branch Technical Project Officer

References

ATSDR. Public Health Assessment Guidance Manual (Update). 2005a. Available from: http://www.atsdr.cdc.gov/hac/PHAManual/toc.html

ATSDR. Toxicological Profile for Benzene. 2007. Available from: http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=40&tid=14

ATSDR. Toxicological Profile for Chromium. 2008. Available from: http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=62&tid=17

ATSDR. Toxicological Profile for Naphthalene. 2005b. Available from: http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=240&tid=43

Geodesign, Inc. Phase I Environmental Site Assessment, Proposed Thomas Cully Park/Former KFD Landfill. 2012.

Portland Parks and Recreation. Thomas Cully Park Master Plan. 2008. Available from: http://www.portlandonline.com/parks/index.cfm?a=230324&c=51821

Maine Center for Disease Control and Prevention. Chronic Ambient Air Guidelines. 2010.

Oregon DEQ. Oregon Air Quality Data Summaries. 2012a. Available from: http://www.deq.state.or.us/aq/forms/2011AirQualityAnnualReport.pdf

Oregon DEQ. Portland Air Toxics Report. 2012b. Available from: http://www.deq.state.or.us/aq/planning/patsReport.htm

Oregon DEQ. Site Assessment Work Plan for the former Killingsworth Fast Disposal Landfill. 2012c.

Tennessee Department of Health (DOH). Health Consultation for Howard School aka Howard High School Landfill Site. 2005. Available from: http://www.atsdr.cdc.gov/hac/pha/howardschool/howardschoolhc032105.pdf

USEPA. Integrate Risk Assessment System Record for Naphthalene. 1998. Available from: http://www.epa.gov/iris/subst/0436.htm

USEPA. Technology Transfer Network Health Hazard Summary for Benzene. 2012. Available from: http://www.epa.gov/ttn/atw/hlthef/benzene.html

Washington Department of Health (DOH). Exposure Investigation at Walnut Grove, Clark County, Washington. 1997. Available from: http://www.doh.wa.gov/Portals/1/Documents/Pubs/334-249.pdf

Appendix A. Comparison Values and Contaminant Screening

This appendix defines the various comparison values (CVs) that were used in this Health Consultation and describes the hierarchy by which they were chosen. This process is also explained in Chapter 7 of ATSDR's Public Health Assessment Guidance Manual [ATSDR, 2005]. Appendix A also explains the contaminant screening process. EHAP uses the hierarchy shown in Figure A1 (Adapted from Figure 7-2 in ATSDR's Public Health Assessment Guidance Manual (ATSDR, 2005) to choose CVs for screening purposes. CVs used in this document are listed below.

Environmental Media Evaluation Guides (EMEGs)

EMEGs are an estimate of contaminant concentrations low enough that ATSDR would not expect people to have a negative, non-cancerous health effect. EMEGs are based on ATSDR Minimal Risk Levels (MRLs, described below) and conservative assumptions about the public's contact with contaminated media, such as how much, how often, and for how long someone may be in contact with the contaminated media. EMEGs also account for body weight.

Cancer Risk Evaluation Guide (CREG)

CREGs are media-specific comparison values that are used to identify concentrations of cancer-causing substances that are unlikely to result in an increase of cancer rates in an exposed population. ATSDR develops CREGs using EPA's cancer slope factor (CSF) or inhalation unit risk (IUR), a target risk level (10^{-6}), and default exposure assumptions. The target risk level of 10^{-6} represents a theoretical risk of 1 excess cancer cases in a population of 1 million. The default exposure assumptions account for ingestion rates and body weights. CREGs are only available for adult exposures—no CREGs specific to childhood exposures are available.

Regional Screening Levels (RSLs)

RSLs are contaminant concentrations in soil, water, or air, below which any negative health effects would be unlikely. RSLs are derived by EPA, using risk assessment guidance from the Superfund program. They are risk-based concentrations derived from standardized equations combining exposure information assumptions with EPA toxicity data. RSLs take into account both non-cancer and cancer risks. RSLs are available online at: (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

Reference Concentration (RfC)

Reference Concentrations are developed by the EPA. They are an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

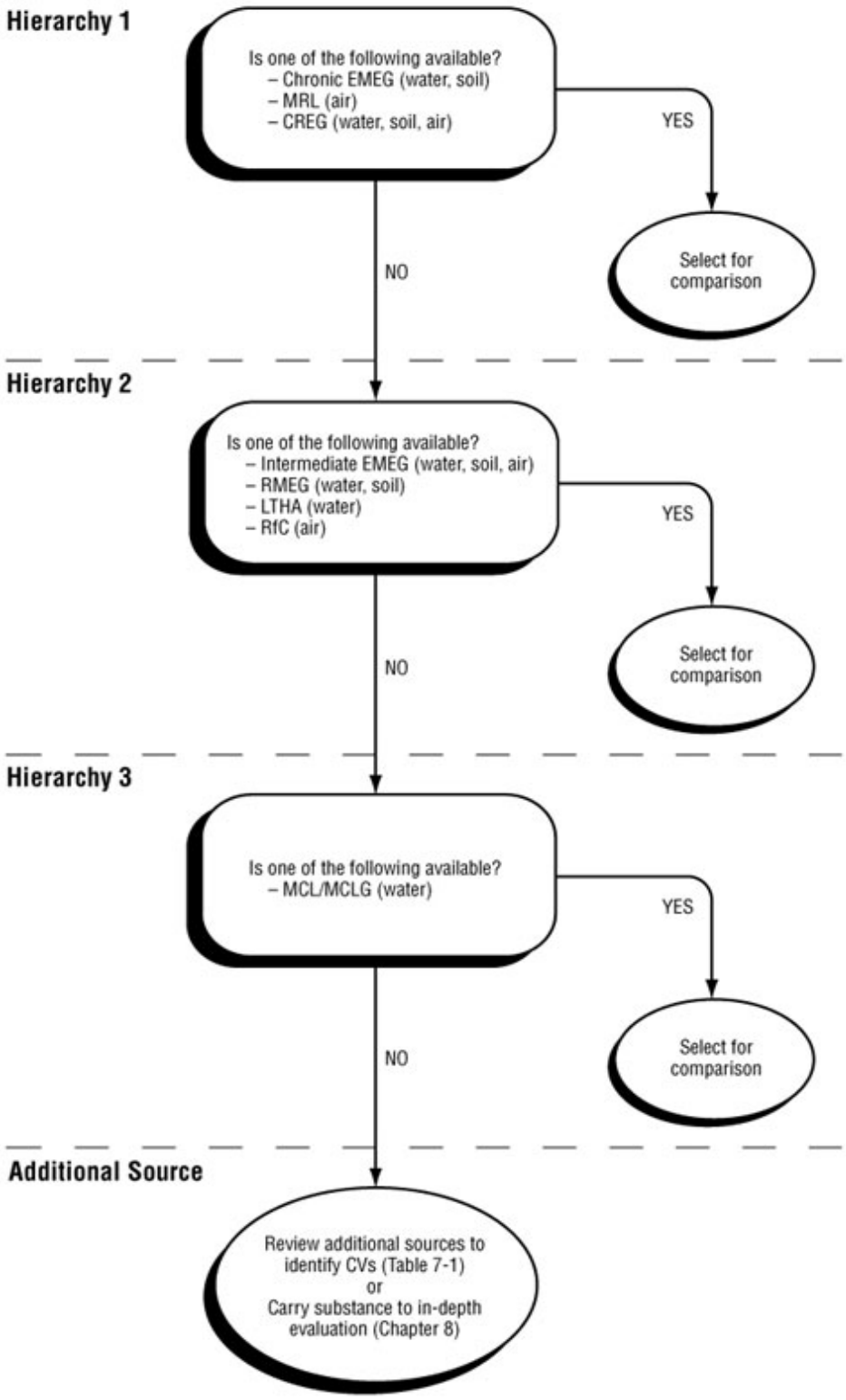

Figure A1. Environmental Guideline Hierarchy

Appendix B. Glossary

This glossary defines words used in this document. It is not a complete dictionary of environmental health terms. If you have questions about terms not listed here, call EHAP's toll-free telephone number, 1-877-290-6767.

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.
Adverse (or negative) Health Effects	A change in body function or cell structure that might lead to disease or health problems
ATSDR:	The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. 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.
Cancer:	A group of diseases which occur when cells in the body become abnormal and grow, or multiply out of control.
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.
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".
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.
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, or 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 Consultation: A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical.

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**).

kg Kilogram or 1000 grams. Usually used here as part of the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.

µg Microgram or 1 millionth of 1 gram. Usually used here as part of the concentration of contaminants in water (µg/Liter).

mg Milligram or 1 thousandth of 1 gram. Usually used here as in a concentration of contaminant in soil mg contaminant/kg soil or as in the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.

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.

Reference Dose (RfD):	An estimate, with safety factors (see **Safety Factor**) built in, of the daily, life-time exposure of human populations to a possible hazard that is not likely to cause harm to the person.
Relative Bioavailability:	The amount of a compound that can be absorbed from a particular medium (such as soil) compared to the amount absorbed from a reference material (such as water). Expressed in percentage form.
Route of Exposure:	The way a chemical can get into a person's body. There are three exposure routes: – breathing (also called inhalation), – eating or drinking (also called ingestion), and – getting something on the skin (also called dermal contact).
Safety Factor:	Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is not likely to cause harm to people.
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**.
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.
Tumor:	Abnormal growth of tissue or cells that have formed a lump or mass.

Uncertainty Factor: See **Safety Factor**.

Appendix C. ATSDR Fact Sheets on Benzene and Naphthalene

(see proceeding pages)

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

BENZENE

CAS # 71-43-2

Division of Toxicology and Environmental Medicine ToxFAQs™ August 2007

This fact sheet answers the most frequently asked health questions (FAQs) about benzene. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Benzene is a widely used chemical formed from both natural processes and human activities. Breathing benzene can cause drowsiness, dizziness, and unconsciousness; long-term benzene exposure causes effects on the bone marrow and can cause anemia and leukemia. Benzene has been found in at least 1,000 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is benzene?

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities.

Benzene is widely used in the United States; it ranks in the top 20 chemicals for production volume. Some industries use benzene to make other chemicals which are used to make plastics, resins, and nylon and other synthetic fibers. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include emissions from volcanoes and forest fires. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke.

What happens to benzene when it enters the environment?

- ❑ Industrial processes are the main source of benzene in the environment.
- ❑ Benzene can pass into the air from water and soil.
- ❑ It reacts with other chemicals in the air and breaks down within a few days.
- ❑ Benzene in the air can attach to rain or snow and be carried back down to the ground.
- ❑ It breaks down more slowly in water and soil, and can pass through the soil into underground water.
- ❑ Benzene does not build up in plants or animals.

How might I be exposed to benzene?

- ❑ Outdoor air contains low levels of benzene from tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions.
- ❑ Vapors (or gases) from products that contain benzene, such as glues, paints, furniture wax, and detergents, can also be a source of exposure.
- ❑ Air around hazardous waste sites or gas stations will contain higher levels of benzene.
- ❑ Working in industries that make or use benzene.

How can benzene affect my health?

Breathing very high levels of benzene can result in death, while high levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, and death.

The major effect of benzene from long-term exposure is on the blood. Benzene causes harmful effects on the bone

marrow and can cause a decrease in red blood cells leading to anemia. It can also cause excessive bleeding and can affect the immune system, increasing the chance for infection.

Some women who breathed high levels of benzene for many months had irregular menstrual periods and a decrease in the size of their ovaries, but we do not know for certain that benzene caused the effects. It is not known whether benzene will affect fertility in men.

How likely is benzene to cause cancer?

Long-term exposure to high levels of benzene in the air can cause leukemia, particularly acute myelogenous leukemia, often referred to as AML. This is a cancer of the blood-forming organs. The Department of Health and Human Services (DHHS) has determined that benzene is a known carcinogen. The International Agency for Research on Cancer (IARC) and the EPA have determined that benzene is carcinogenic to humans.

How can benzene affect children?

Children can be affected by benzene exposure in the same ways as adults. It is not known if children are more susceptible to benzene poisoning than adults.

Benzene can pass from the mother's blood to a fetus. Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals breathed benzene.

How can families reduce the risks of exposure to benzene?

Benzene exposure can be reduced by limiting contact with gasoline and cigarette smoke. Families are encouraged not to smoke in their house, in enclosed environments, or near their children.

Is there a medical test to determine whether I've been exposed to benzene?

Several tests can show if you have been exposed to benzene. There is a test for measuring benzene in the breath; this test must be done shortly after exposure. Benzene can also be measured in the blood; however, since benzene disappears rapidly from the blood, this test is only useful for recent exposures.

In the body, benzene is converted to products called metabolites. Certain metabolites can be measured in the urine. The metabolite S-phenylmercapturic acid in urine is a sensitive indicator of benzene exposure. However, this test must be done shortly after exposure and is not a reliable indicator of how much benzene you have been exposed to, since the metabolites may be present in urine from other sources.

Has the federal government made recommendations to protect human health?

The EPA has set the maximum permissible level of benzene in drinking water at 5 parts benzene per billion parts of water (5 ppb).

The Occupational Safety and Health Administration (OSHA) has set limits of 1 part benzene per million parts of workplace air (1 ppm) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Benzene (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

NAPHTHALENE
CAS # 91-20-3

1-METHYLNAPHTHALENE
CAS # 90-12-0

2-METHYLNAPHTHALENE
CAS # 91-57-6

Division of Toxicology ToxFAQs™ August 2005

This fact sheet answers the most frequently asked health questions (FAQs) about naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene happens mostly from breathing air contaminated from the burning of wood, tobacco, or fossil fuels, industrial discharges, or moth repellents. Exposure to large amounts of naphthalene may damage or destroy some of your red blood cells. Naphthalene has caused cancer in animals. Naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene have been found in at least 687, 36, and 412, respectively, of the 1,662 National Priority List sites identified by the Environmental Protection Agency (EPA).

What are naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene?

Naphthalene is a white solid that evaporates easily. Fuels such as petroleum and coal contain naphthalene. It is also called white tar, and tar camphor, and has been used in mothballs and moth flakes. Burning tobacco or wood produces naphthalene. It has a strong, but not unpleasant smell. The major commercial use of naphthalene is in the manufacture of polyvinyl chloride (PVC) plastics. Its major consumer use is in moth repellents and toilet deodorant blocks.

1-Methylnaphthalene and 2-methylnaphthalene are naphthalene-related compounds. 1-Methylnaphthalene is a clear liquid and 2-methylnaphthalene is a solid; both can be smelled in air and in water at very low concentrations.

1-Methylnaphthalene and 2-methylnaphthalene are used to make other chemicals such as dyes and resins. 2-Methylnaphthalene is also used to make vitamin K.

What happens to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene when they enter the environment?

- ❑ Naphthalene enters the environment from industrial and domestic sources, and from accidental spills.
- ❑ Naphthalene can dissolve in water to a limited degree and may be present in drinking water from wells close to hazardous waste sites and landfills.
- ❑ Naphthalene can become weakly attached to soil or pass through soil into underground water.
- ❑ In air, moisture and sunlight break it down within 1 day. In water, bacteria break it down or it evaporates into the air.
- ❑ Naphthalene does not accumulate in the flesh of animals or fish that you might eat.
- ❑ 1-Methylnaphthalene and 2-methylnaphthalene are expected to act like naphthalene in air, water, or soil because they have similar chemical and physical properties.

How might I be exposed to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene?

- ❑ Breathing low levels in outdoor air.
- ❑ Breathing air contaminated from industrial discharges or smoke from burning wood, tobacco, or fossil fuels.
- ❑ Using or making moth repellents, coal tar products, dyes or inks could expose you to these chemicals in the air.
- ❑ Drinking water from contaminated wells.
- ❑ Touching fabrics that are treated with moth repellents containing naphthalene.
- ❑ Exposure to naphthalene, 1-methylnaphthalene and 2-methylnaphthalene from eating foods or drinking beverages is unlikely.

How can naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene affect my health?

Exposure to large amounts of naphthalene may damage or destroy some of your red blood cells. This could cause you to have too few red blood cells until your body replaces the destroyed cells. This condition is called hemolytic anemia. Some symptoms of hemolytic anemia are fatigue, lack of appetite, restlessness, and pale skin. Exposure to large amounts of naphthalene may also cause nausea, vomiting, diarrhea, blood in the urine, and a yellow color to the skin. Animals sometimes develop cloudiness in their eyes after swallowing high amounts of naphthalene. It is not clear whether this also develops in people. Rats and mice that breathed naphthalene vapors daily for a lifetime developed irritation and inflammation of their nose and lungs. It is unclear if naphthalene

causes reproductive effects in animals; most evidence says it does not.

There are no studies of humans exposed to 1-methylnaphthalene or 2-methylnaphthalene.

Mice fed food containing 1-methylnaphthalene and 2-methylnaphthalene for most of their lives had part of their lungs filled with an abnormal material.

How likely are naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene to cause cancer?

There is no direct evidence in humans that naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene cause cancer. However, cancer from naphthalene exposure has been seen in animal studies. Some female mice that breathed naphthalene vapors daily for a lifetime developed lung tumors. Some male and female rats exposed to naphthalene in a similar manner also developed nose tumors.

Based on the results from animal studies, the Department of Health and Humans Services (DHHS) concluded that naphthalene is reasonably anticipated to be a human carcinogen. The International Agency for Research on Cancer (IARC) concluded that naphthalene is possibly carcinogenic to humans. The EPA determined that naphthalene is a possible human carcinogen (Group C) and that the data are inadequate to assess the human carcinogenic potential of 2-methylnaphthalene.

How can naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene affect children?

Hospitals have reported many cases of hemolytic anemia in children, including newborns and infants, who either ate naphthalene mothballs or deodorants cakes or who were in close contact with clothing or blankets stored in naphthalene mothballs. Naphthalene can move from a pregnant woman's blood to the unborn baby's blood. Naphthalene has been detected in some samples of breast milk from the general U.S. population, but not at levels that are expected to be of concern.

There is no information on whether naphthalene has affected development in humans. No developmental abnormalities were observed in the offspring from rats, mice, and rabbits fed naphthalene during pregnancy.

We do not have any information on possible health effects of 1-methylnaphthalene or 2-methylnaphthalene on children.

How can families reduce the risks of exposure to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene?

❑ Families can reduce the risks of exposure to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene by avoiding smoking tobacco, generating smoke during cooking, or using fireplaces or heating appliances in the their homes.

❑ If families use naphthalene-containing moth repellents, the material should be enclosed in containers that prevent vapors from escaping, and kept out of the reach from children.

❑ Blankets and clothing stored with naphthalene moth repellents should be aired outdoors to remove naphthalene odors and washed before they are used.

❑ Families should inform themselves of the contents of air deodorizers that are used in their homes and refrain from using deodorizers with naphthalene.

Is there a medical test to determine whether I've been exposed to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene?

Tests are available that measure levels of these chemicals and their breakdown products in samples of urine, feces, blood, maternal milk, or body fat. These tests are not routinely available in a doctor's office because they require special equipment, but samples can be sent to special testing laboratories. These tests cannot determine exactly how much naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene you were exposed to or predict whether harmful effects will occur. If the samples are collected within a day or two of exposure, then the tests can show if you were exposed to a large or small amount of naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene.

Has the federal government made recommendations to protect human health?

The EPA recommends that children not drink water with over 0.5 parts per million (0.5 ppm) naphthalene for more than 10 days or over 0.4 ppm for any longer than 7 years. Adults should not drink water with more than 1 ppm for more than 7 years. For water consumed over a lifetime (70 years), the EPA suggests that it contain no more than 0.1 ppm naphthalene.

The Occupational Safety and Health Administration (OSHA) set a limit of 10 ppm for the level of naphthalene in workplace air during an 8-hour workday, 40-hour workweek. The National Institute for Occupational Safety and Health (NIOSH) considers more than 500 ppm of naphthalene in air to be immediately dangerous to life or health. This is the exposure level of a chemical that is likely to impair a worker's ability to leave a contaminate area and therefore, results in permanent health problems or death.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Toxicological Profile for Naphthalene, 1-Methylnaphthalene, and 2-Methylnaphthalene (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.