Health Consultation

LAFARGE CORPORATION
(a/k/a IDEAL BASIC INDUSTRIES-CEMENT PLANT)

SEATTLE, KING COUNTY, WASHINGTON

EPA FACILITY ID: WAD041580176

JUNE 23, 2004

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members.

This document has previously been released for a 30 day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The health consultation has now been reissued. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared by:

Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Foreword

This health consultation has been prepared by the Washington State Department of Health (DOH) has prepared in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. Methodologies and guidelines developed by ATSDR were used in the preparation of this document.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation, and should not necessarily be relied upon if site conditions or land use changes in the future.

For additional information or questions regarding DOH or the contents of this health consultation, please call the health advisor who prepared this document:

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Glossary

Acute	Occurring over a short time [compare with **chronic**].
Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Carcinogen	Any substance that causes cancer.
Chronic	Occurring over a long time (more than 1 year) [compare with **acute**].
Comparison value	Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
Contaminant	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Dose (for chemicals that are not radioactive)	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An “exposure dose” is how much of a substance is encountered in the environment. An “absorbed dose” is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
Environmental Protection Agency (EPA)	United States Environmental Protection Agency.

Epidemiology	The study of the occurrence and causes of health effects in human populations. An epidemiological study often compares two groups of people who are alike except for one factor, such as exposure to a chemical or the presence of a health effect. The investigators try to determine if any factor (i.e., age, sex, occupation, economic status) is associated with the health effect.
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].
Hazardous substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
Indeterminate public health hazard	The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].
Inorganic	Compounds composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.

No apparent public health hazard	A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.
Organic	Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.
Parts per billion (ppb)/Parts per million (ppm)	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
Plume	A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.
Route of exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
Volatile organic compound (VOC)	Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Purpose

The Washington State Department of Health (DOH) was asked by the Community Coalition for Environmental Justice (CCEJ) to evaluate the potential health impacts posed by eight businesses (sites) of concern in the South Park community. The petitioner, CCEJ, worked with the community to prepare this site list. One of these sites was Lafarge Corporation's Seattle plant. This health consultation uses existing data to evaluate the potential human health impacts resulting from exposure to emissions at the Lafarge site.

Site Background

Lafarge is located at 5400 West Marginal Way SW in Seattle, Washington. The 25-acre site is bordered by the Duwamish River to the north and east, West Marginal Way to the west, and commercial/industrial properties to the south. The site was initially used by the Ideal Corporation to distribute cement in 1964, with operations expanding to include cement production in 1967. Ideal Corporation changed its name to Holnam on March 7, 1990. Holnam became Lafarge on October 16, 1998.

The cement making process mixes limestone, sand, clay, iron, and waste products, such as petroleum contaminated soils, fly ash, sludge, and spent sandblasting grit, at high temperatures to form clinker that is then ground with 5% gypsum to form Portland cement.

Raw materials are shipped in by barge and off-loaded on Lafarge's east boundary with the Duwamish River. These materials are combined with water to form a slurry. This slurry is fed into the elevated end of a 500 ft long, 14 ft diameter kiln that heats the materials to about 2700 degrees Fahrenheit. The kiln rotates and the slight decline gradually moves the materials to the lower end of the kiln. At about 2450 F, a chemical reaction occurs and cement clinker is formed. At the outlet of the kiln, golf ball sized chunks of clinker are cooled before they are ground into a fine powder and mixed with gypsum powder to make Portland cement. Lafarge has the capacity to produce 490,000 tons of cement per year. The finished product is stored in silos on-site. Up to 70,000 tons of cement product can be stored on the property. Trucks and railcars are used to distribute the finished product off-site.

Coal and petroleum coke fuels are used to create high temperatures in the kiln. Lafarge also uses waste products for fuel, including waste oils and tank bottom oil.

Ideally, Lafarge's cement kiln operates 24 hours per day, 7 days per week. The kiln is usually shut down for maintenance a couple of weeks per year. Other shut downs may occur for unscheduled maintenance or when market conditions are not favorable for cement production.

Regulated by many state, federal and local agencies, Lafarge is required to comply with a number of laws and regulations, including the Federal Mine Safety and Health Act, Clean Air Act, Clean Water Act, and the Resource Conservation and Recovery Act.

Environmental Contamination

Wastewater

Lafarge is permitted to discharge stormwater and cooling water to outfalls in the Duwamish River. Lafarge has violated conditions of their discharge permit in the mid-1990s, but process upgrades have enabled the facility to recycle their stormwater and cooling water back into their cement production process. As a result, some of the outfalls have been plugged and permanently sealed.[1]

Petroleum contaminated soils used as raw materials are stored on-site, and can potentially be discharged to Duwamish in storm event. This is not likely since storm water at Lafarge is recycled into the process.

Soils, sediments, surface water, and groundwater

The entire Lafarge site is paved except for landscaped areas. In the early 1990s, three 1000-gallon underground storage tanks containing petroleum products were removed.[2] Contaminated soil was also removed.

Air Releases

Lafarge is permitted by the Puget Sound Clean Air Agency (Clean Air) under Title V of the Clean Air Act. By-products of the cement making process are emitted to the air from several sources at Lafarge. The main kiln exhaust stack is approximately 250 feet high and 13 feet wide. An electrostatic precipitator (ESP) is used to control particulate emissions from the cement kiln.[3] Several baghouses designed to minimize particulate emissions are attached to the clinker-cooler unloading and loading docks.

In general steam, carbon dioxide (CO_2), oxygen (O_2), and nitrogen (N_2) make up the bulk of the gasses that comes from the main cement kiln stack. Particulate, carbon monoxide (CO), sulfur oxides (SO_2) and nitrogen oxides (NO_x) make up the bulk of the remaining emissions. Lafarge is required to continuously monitor SO_2 and particulate emissions. Although Lafarge is not required to continuously monitor NO_x emissions, they do so for their own purposes.

Community Concerns

Clean Air has documented many violations of Lafarge's air emission permit. The majority of violations have been related to opacity and SO_2 exceedances. Between January 2000 and October 2002, the following violations occurred:[4]

- Opacity > 20% for 6 minutes or more (more than 50 incidences)
- Opacity >12% for 1 hour or more (more than 40 incidences)
- SO_2 > 1000 ppm 1 hour average (6 times)
- Fallout (once)

South End Odor

South Seattle residents began noticing an odor throughout their neighborhood in the spring of 2001. A variety of descriptions, such as “chlorine-like,” “acrid,” and “caustic” have been used to characterize the odor. Respiratory effects were also reported in conjunction with odor complaints. Clean Air received complaints not only from the South Park and Georgetown neighborhoods, but also from Highland Park, West Seattle, and Beacon Hill. Teachers and students at Highland Park Elementary School repeatedly reported odors. Clean Air investigated the source of the odors, looking at various industries and utilities that used or stored chlorine or chlorine-like compounds. This search was inconclusive.

Some complainants identified a visible plume coming from Lafarge’s stack and settling in their neighborhood at times when the odor was present. Other more indirect evidence suggested that Lafarge may be the source of odors: wind was usually blowing from Lafarge’s direction at times odors were reported; odors were reported on weekends and only a fraction of the industries operate 7 days/wk, and complaints nearly ceased at times when Lafarge’s kiln was shut down for maintenance.

Lafarge hired a consultant at the request of Clean Air to help identify potential sources of odor emissions from their process. This consultant was highly regarded by Clean Air as being an expert in cement kiln operations. After months of study, it was concluded that nothing had changed in Lafarge’s process that could have brought about a sudden increase in odors.[5] Furthermore, air dispersion modeling predicted levels of chlorine and Hydrogen Chloride (HCl) emitted from the stack were too low to cause chlorine-like odors downwind from the stack. The modeling showed, however, that nitric oxide (NO) levels could have exceeded odor thresholds at Highland Park and the FBI garage (a location north of Lafarge where odors were frequently reported). It was assumed that 95% of the NOx emissions were in the form of NO, and that NO is not converted to NO_2 at a rate that is relevant to the model.

Discussion

The primary offsite exposure source to chemicals generated at Lafarge is the main cement kiln stack. Clean Air requires air dispersion modeling to ensure that emissions from a proposed project will not adversely affect the health of people in the community. The specific model required by Clean Air is called TSCREEN.[6] This model attempts to determine the worst-case impacts of an air pollution source on the surrounding community.[7] Stack test data from the source, in conjunction with worst-case climatological assumptions, are used to make this determination. In general, if the results of the model indicate that levels of air contaminants are below acceptable source impact levels (ASILs), then the facility is granted a permit to operate through the notice of construction process.

An ASIL is a concentration of a toxic pollutant in air that is considered to be safe for humans to breathe over a lifetime of exposure without experiencing adverse health effects.[8] ASILs exist for both carcinogenic and non-carcinogenic pollutants. The Washington State Department of Ecology (Ecology) derives ASILs primarily from EPA’s reference concentration (RfC) and inhalation unit risk (IUR) values. If EPA has not established an RfC or IUR, then ASILs are derived from the American Conference of Government Industrial Hygienists (ACGIH) Threshold Limit Value (TLV). A TLV is an airborne concentration of a chemical, established by the ACGIH that represents conditions under which it is believed nearly all workers may be exposed day after day with no adverse effect. Since TLVs are occupational standards based on an eight-hour workday, they are divided by a factor of three to reflect a 24-hour exposure. This result is divided by a safety factor of 100 to account for sensitive populations and the fact that there is no recovery period in a residential exposure scenario.

In general, cement kilns do not emit high levels of organic pollutants because the residence times and combustion temperatures in the kiln are high enough to destroy most organic chemicals, but levels of combustion by-products are high. NOx, CO_2 and SO_2 are the main pollutants emitted from the Lafarge stack. A recent report by Lafarge revealed that the level of NOx emitted per ton of cement clinker produced at the Seattle plant was higher than other similar cement kilns across the country.[9]

The air dispersion modeling performed by Lafarge's consultant concluded that emissions from Lafarge would not impact South Park at levels that could cause an odor. However, the modeling did show that NOx emissions from Lafarge, specifically nitric oxide (NO), could exceed odor thresholds at Highland Park and the FBI garage for more than 100 hours per year.

With regard to South Park, Clean Air has noted that the conclusions obtained from Lafarge's air modeling effort are based on the assumption that the concentration of NO at the stack does not exceed 871 ppm. The reality is that NO concentrations sometimes exceed this level and have been periodically measured at levels in excess of 2000 ppm. Based on Clean Air's analysis, NO concentrations of 1010 ppm at Lafarge's stack could cause odors in South Park, and because Lafarge's emissions sometimes exceed this level, they are capable of causing odors there. Similarly, modeled odor impacts at Highland Park would likely be more frequent if the model accounted for periods where stack concentrations were higher than 871 ppm.[10] This lends some support that Lafarge may in fact be responsible for odors in South Park and Highland Park.

The presence of NO at or above odor thresholds does not necessarily indicate that a health hazard exists, but that Lafarge's emissions, under certain meteorological conditions, can impact its surroundings at noticeable levels. This health consultation will discuss NOx as the main Lafarge pollutant that impacts south Seattle.

Nitrogen Oxides (NOx)

The main emission sources of nitrogen oxides are combustion processes. Fossil fuel power stations, motor vehicles and furnaces emit nitrogen oxides, mostly in the form of NO. In most urban areas, the automobile is the single largest producer of NOx.[11] In general, the higher the temperature of the combustion source, the more NOx that is emitted. Ninety-five percent of Lafarge's NOx emissions are in the form of NO, the remaining 5% are NO_2.

Nitric oxide is readily oxidized to nitrogen dioxide in ambient air. Both NO and NO_2 are colorless at low concentrations, but appear reddish-brown at high concentrations in the air.[12]

Because of the concurrent exposure to some NO_2 in nitric oxide exposures, it is difficult to discriminate nitric oxide effects from those that might be attributable to nitrogen dioxide.[13]

Low levels of nitrogen oxides in the air can irritate eyes, nose, throat, and lungs, possibly causing a cough, shortness of breath, tiredness, and nausea. Exposure to low levels can also result in fluid build-up in the lungs 1 or 2 days after exposure. Breathing high levels of NOx can cause rapid burning, spasms, and swelling of tissues in the throat and upper respiratory tract, reduced oxygenation of body tissues, a build-up of fluid in your lungs, and death.[14]

NOx is a key component in the formation of ground level ozone and smog through photochemical degradation and reaction with volatile organic compounds (VOCs). It also reacts with moisture in the air to produce a weak acid (one source of acid rain).[11]

Nitric Oxide (NO)

NO has a sharp, sweet odor that can be smelled at concentrations as low as 0.29 ppm. Exposure at concentrations of 1.5 to 5 ppm may cause narrowing of the airways. Symptoms may include respiratory irritation and coughing. Higher concentrations (60-150 ppm) in occupational settings cause immediate irritation of the nose and throat, with coughing and burning in the throat and chest. These symptoms often clear upon breathing fresh air, and the exposed person may feel well for several hours. Several hours after exposure, a sensation of tightness and burning in the chest develops, followed by shortness of breath, sleeplessness, and restlessness.[11]

There is no national standard for NO in ambient air, but Ecology has established an ASIL for NO of 100 µg/m3 or 81.5 ppb averaged over a 24-hour period. This ASIL was derived from an occupational TLV of 25 ppm.[15]

Nitrogen Dioxide (NO_2*)*

NO_2 has been characterized as having a pungent, harsh, bleach-like odor. Perceptible odor has been reported as low as 0.058 ppm, but it should be noted that odor thresholds vary by study (Appendix A, Table A2). The current National Ambient Air Quality Standard (NAAQS) for NO_2 is an annual arithmetic mean (average) value not to exceed 0.053 ppm or 53 ppb. This means that for a violation to occur, NO_2 concentrations would have to be high enough that the average over the entire year would exceed 0.053 ppm. No U.S. cities are currently in violation of the NO_2 NAAQS.

Short-term exposure to NO_2 at existing ambient air levels in the U.S may cause coughing, wheezing, and shortness of breath in people with pre-existing respiratory illness (i.e., asthma, emphysema), and exacerbate respiratory illness in children. This is an indication that people with sensitive respiratory conditions living in an urban area that is in compliance of the NAAQS can be still be negatively impacted by NO_2. Long-term exposures to NO_2 may increase an individual's susceptibility to respiratory infection.

NO_2 levels in the U.S. have decreased by 14% between 1988 and 1997. In 1997, the average annual NO_2 level of 80 urban sites in the U.S. was about 23 ppb. The average annual NO_2 level in King County for that same year was 19.4 ppb.[16] These levels are consistent with the average levels of NO_2 detected at the Georgetown (22 ppb) and Beacon Hill (19 ppb) monitoring stations between February 2000 and August 2002. [17]

NOx Monitoring Stations in South Seattle

Clean Air and Ecology have a network of monitors across the region used for measuring air quality. Some monitoring stations measure multiple physical and chemical parameters, while others only monitor a select group of parameters. For the purpose of identifying potential impacts from Lafarge, monitors used for measuring NOx are of the most interest.

The two monitors closest to Lafarge and South Seattle that measure NOx are located in Georgetown and Beacon Hill (Figure B2). The Georgetown monitor is located in the Duwamish Valley about 1.25 miles southeast of Lafarge (120 degrees). Data from the Georgetown monitor are available from February 1, 2000, through August 15, 2002. The Beacon Hill monitor is located about 1.8 miles East-Northeast (55 degrees) of Lafarge at an elevation of about 100 ft above the Duwamish Valley. The Beacon Hill monitor is the only active NOx monitor in Seattle providing data since 1995. Table 1 shows a comparison of summary statistics from the Georgetown and Beacon Hill monitors between February 1, 2000, and August 15, 2002. NOx levels were higher at the Georgetown monitor indicating a greater impact from combustion sources in the Duwamish Valley as opposed to atop Beacon Hill.

Table 1. NO concentrations at the Georgetown and Beacon Hill air monitoring stations in Seattle, WA from February 1, 2000, through August 15, 2002 (24-hour average).

Chemical	**Location**	**Concentration (ppb)**				
		Mean	Max	Median	90^{th}	ASIL or NAAQS
NO	Georgetown	38	347	19	96	82
	Beacon	19	189	11	45	
NO_2	Georgetown	22	49	22	33	53
	Beacon	19	61	18	34	
NOx	Georgetown	59	382	42	128	NA
	Beacon	38	223	30	71	

Thirty months of available Georgetown monitor data were split into two data sets, data from before and after June 2001. This facilitates a comparison of NOx levels in the Duwamish Valley from times before and after the onset of odor complaints. This comparison is shown in Table 2. The NOx levels were generally higher prior to June 2001.

Table 2. NOx concentrations at the Georgetown air monitoring station in Seattle, WA from February 1, 2000, to May 31, 2001, vs. June 1, 2001, to August 15, 2002 (24-hour average).

Chemical	Time Period	Time Frame	Concentration (ppb)				
			Mean	Max	Median	90th	ASIL or NAAQS
NO	Before Odors	2/1/00 – 5/31/01	45	347	26	124	82
	During Odors	6/1/01 – 8/15/02	31	299	15	77	
NO_2	Before Odors	2/1/00 – 5/31/01	22	49	23	34	53
	During Odors	6/1/01 – 8/15/02	19	45	19	30	
NOx	Before Odors	2/1/00 – 5/31/01	68	382	49	152	NA
	During Odors	6/1/01 – 8/15/02	50	320	36	109	

The average hourly NO concentration at the Georgetown monitoring station was above the odor threshold (~290 ppb) 182 times between February 1, 2000, and August 15, 2002.[a] Table 3 shows that average hourly NO and NO_2 concentrations in Georgetown exceeded the odor threshold more frequently prior to June 2001 as opposed to after June 2001 when odor complaints were most frequently voiced.

[a] Data obtained from monitoring station records are reported as hourly averages meaning that there may be periods of time during an hour where the NO level may be higher or lower than the reported concentration.

Table 3. Number of average hourly NO and NO_2 levels measured at the Georgetown monitoring station in Seattle, WA that exceed odor thresholds before and after June 2001.

Chemical	Time Period	Time Frame	Number of Hourly Concentrations Exceeding Odor Threshold	Odor Threshold (ppb)
NO	Before Odors	2/1/00 – 5/31/01	143	290
	During Odors	6/1/01 – 8/15/02	39	
NO_2	Before Odors	2/1/00 – 5/31/01	35	58[a]
	During Odors	6/1/01 – 8/15/02	22	

[a] This odor threshold was rejected by the American Industrial Hygiene Association because the study was not adequately reviewed.

Clean Air maintained an odor complaint log that documents the time and date of the complaint, the complainant's address (place of business or home), and a description of the odor. These data were obtained from Clean Air in order to correlate the days where NO levels exceeded odor thresholds at the Georgetown monitor with complaint times and location. None of the odor complaints were logged on days when average hourly NO concentrations exceeded the odor threshold. Of the 22 instances that NO_2 levels were reported above 58 ppb (lowest reported odor threshold), only three complaints occurred on the same day that a complaint was logged. Furthermore, the time of the high measurement did not correspond to the time of the complaint.

The lack of a positive correlation between NOx levels and complaints indicate that

- odors may not be related to NOx
- air monitors are not situated at places most impacted by NOx. The majority of odor complaints come from South Park and Highland Park. Data from the air monitoring stations at Georgetown and Beacon Hill may not be representative of impacted areas in the Duwamish Valley considering differences in prevailing winds, climatology, and geography.
- average hourly concentrations of NOx reported at monitoring stations do not adequately characterize fleeting odor events. There are likely to be brief periods of time when levels of NOx are much higher than what is indicated from an average hourly concentration.

Wind Direction

Average hourly NO and NO_2 levels were plotted against wind direction (Figure 1). NO_2 levels are higher when the wind blows from 90 to 149 degrees (East to Southeast) and again from the 270-359 degree interval. The lowest NO_2 levels occur when the wind is blowing from the South and Southwest. The highest single hourly NO_2 concentration (27.2 ppb) was measured when winds were blowing from between 330-339 degrees (North-Northwest). Lafarge is located at 300 degrees from the Georgetown air monitor.

NO levels follow a similar trend except a steeper peak occurs in the 90-149 degree interval. A second smaller peak begins to rise at about 230 degrees and continues through 350 degrees (North). The lowest NO levels also occur when the wind blows from the south and southwest. These trends indicate that NOx emission sources might originate from the East, Southeast (Interstate 5) West and Northwest (Duwamish Valley).

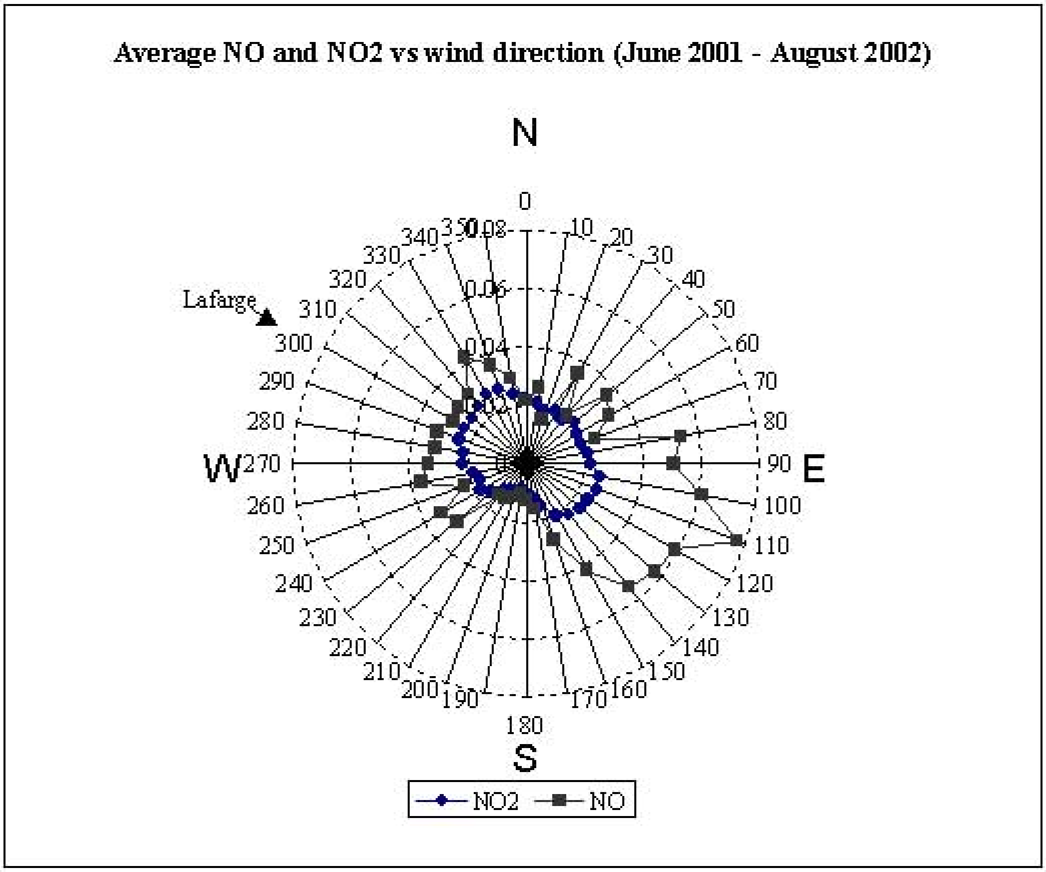


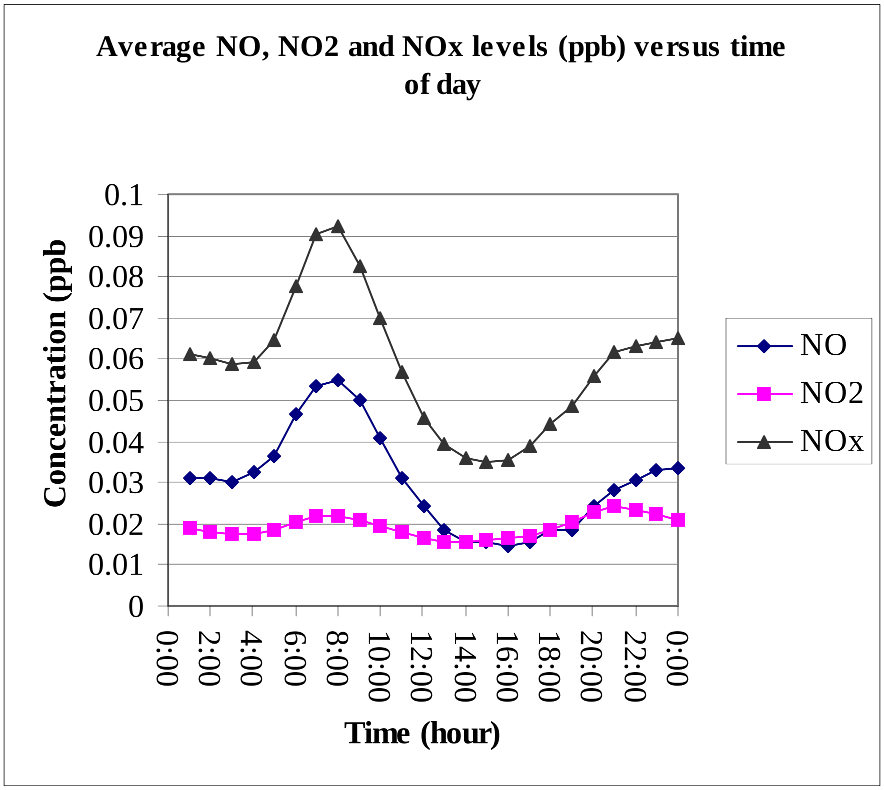
Figure 1. Average NO and NO_2 concentrations (ppm) measured at the Georgetown monitor in Seattle, WA between June 2001 and August 2002 versus wind direction.

Time of Day/Year

Average NO, NO_2 and NOx levels are highest from 6 – 9 AM (Figure 2). This is an indication that morning rush hour traffic has an impact on NOx levels at the Georgetown monitor, and is consistent with the fact that motor vehicles are the largest contributors to NOx emissions in the U.S.[18]

NOx concentrations in Georgetown are higher primarily between the months of October and April (fall and winter months). This is consistent with other locations in the U.S. and can be explained by the increase in heating fuel combustion during these months.

Figure 2. Average NO, NO_2, and NOx concentrations measured at the Georgetown monitoring station in Seattle, WA between June 2001 and August 2002 versus time of day



Child Health Considerations

ATSDR recognizes that infants and children may be more vulnerable to exposures than adults when faced with contamination of air, water, soil, or food.[19] This vulnerability is a result of the following factors:

- Children are more likely to play outdoors.
- Children are shorter and their breathing zone is closer to the ground, resulting in a greater likelihood to breathe dust, soil, and heavy vapors.
- Children are smaller and receive higher doses of chemical exposure per body weight.
- Children's developing body systems are more vulnerable to toxic exposures, especially during critical growth stages in which permanent damage may be incurred.

Children with existing respiratory illness such as asthma are more susceptible to pollutants emitted from Lafarge and other sources in the Duwamish Valley.

Multiple Emission Sources

Lafarge is located in an area of South Seattle that has a mixture of residential and industrial land use. Clean Air records show at least 210 businesses are registered as active sources of air pollution in the 98106, 98108, and 98134 zip codes (Duwamish Valley). These sources range from small businesses such as gas stations, dry cleaners, and body shops to larger industries such as cement kilns. In addition to these registered sources of air pollution, two major north-south highways run through this valley: U.S. 99 carries 89,100 cars and trucks per day over the 1st Avenue South Bridge, and Interstate 5 carries about 228,000 cars and trucks per day one mile east of this bridge.

A report published by Public Health Seattle & King County showed that South Park and Georgetown communities in south Seattle experienced higher hospitalization rates for respiratory diseases and lower life expectancies when compared to Seattle overall.[20] It has not been determined whether or not these trends are due to air pollution or other confounding factors such as a lack of access to primary health care, but it has been established that NO_2 at existing ambient air levels can impact people with pre-existing respiratory illness.

The Duwamish Valley has multiple sources of NOx emissions. NOx levels are higher at the Georgetown monitoring station than atop nearby Beacon Hill indicating that there are higher exposures to NOx in the valley than outside of it. Lafarge routinely emits a large amount of NOx, but based on wind direction and monitoring at Georgetown, vehicle traffic appears to be a larger contributor to NOx levels measured in Georgetown than industry in the Duwamish Valley. The geography of the valley, however, may have an effect on wind patterns and, if so, monitoring at Georgetown alone would be insufficient with regard to estimating exposures in South Park and Highland Park.

While it is important to assess emissions from individual sources, it is clear that, in areas where industrial and residential land uses are commingled, multiple sources of air pollutants exist and must be considered cumulatively.

Conclusions

1. An *indeterminate public health hazard* exists for exposure to air emissions at the Lafarge cement facility located in Seattle. Washington.

   - Lafarge emissions include high amounts of combustion gases (NOx, SO_2, CO_2)
   - Modeling revealed that there are short periods of time where NO emissions from Lafarge may be smelled at Highland Park.
     - Odors do not necessarily indicate adverse health effects
     - NO_2 at ambient levels, irrespective of the source, can cause adverse respiratory health effects to sensitive populations (asthmatics, people with emphysema).

2. The monitoring station in Georgetown showed that NO levels were occasionally above odor thresholds but it does not appear that these readings were attributable to Lafarge.
   - Exceedances of odor thresholds occurred mostly in the morning, and when the wind was originating in the direction opposite Lafarge's cement kiln.

3. No odor complaints were logged on the days that the Georgetown monitor measured hourly concentrations above odor threshold. This may be an indication that
   - odors may not be related to NOx
   - air monitors are not situated at places most impacted by NOx. The majority of odor complaints come from South Park and Highland Park. Data from the air monitoring stations at Georgetown and Beacon Hill may not be representative of impacted areas in the Duwamish Valley considering differences in prevailing winds, climatology, and geography.
   - average hourly concentrations of NOx reported at monitoring stations do not adequately characterize fleeting odor events. There are likely to be brief periods of time when levels of NOx are much higher than what is indicated from an average hourly concentration.

4. The Duwamish Valley contains multiple combustion sources and highways that can contribute to air pollution.
   - The Georgetown monitoring station in the valley has higher levels of NOx than the Beacon Hill station.
   - The 24-hour NO levels measured at the Georgetown monitoring station were above the ASIL more than 10% of the time.
     - The Beacon Hill monitoring station measured no days above the NO ASIL during this same time period.
   - The combination of many combustion sources, including automobiles and industry in the valley, contribute to NOx levels found in the Duwamish Valley.

5. No NOx air monitors are currently operating in the Duwamish Valley.
   - The Beacon Hill monitoring station is the only one currently operating in Seattle.
     - This monitor is not representative of NOx levels in the Duwamish Valley.
   - Monitors do not exist in locations where the most frequent odor complaints originate.

Recommendations

1. NOx Air monitors should be located at other areas potentially impacted by Lafarge's emissions such as Highland Park and South Park.

2. An assessment of multiple combustion sources in the Duwamish Valley is necessary to better characterize health impacts from industrial and vehicle emissions in south Seattle.

Public Health Action Plan

1. Clean Air has purchased open path air monitors to be installed at locations in South Park and Highland Park during the summer of 2004. Clean Air will monitor NOx and SO_2 levels in the neighborhoods to determine if these combustion gasses are impacting residents.

2. DOH will evaluate data generated by air monitors to determine the health impacts related to NOx and SO_2.

3. DOH will evaluate the feasibility of conducting an area-wide assessment of South Seattle.

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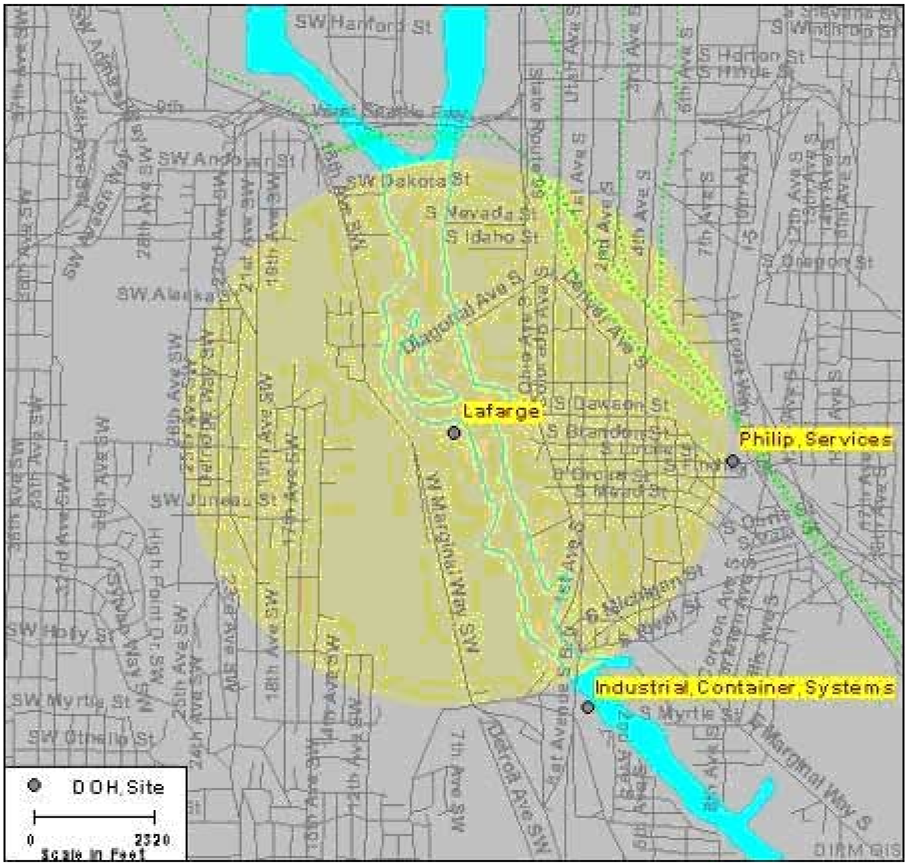
Appenix A

Table A1. Published Odor thresholds for NO and NO2

Chemical	Low (ppm)	High (ppm)	Source
Nitrogen Dioxide	0.1		[21]
	0.11		[22]
	0.058	0.14	[23]
	1.1	5.3	[24]
Nitric Oxide	0.290	0.978	[21]

Appendix B: Figures

Figure B1. Lafarge Site Location and area Demographic



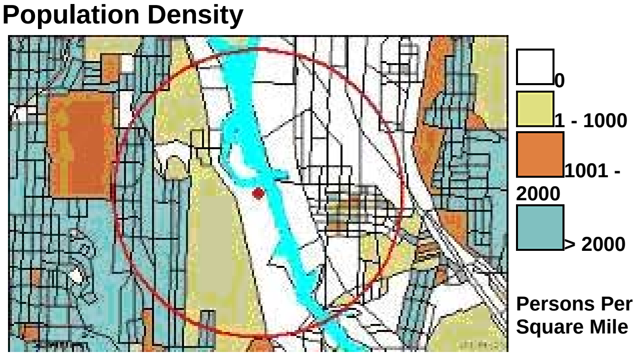
King County

Demographic Statistics Within One Mile of the Site*

Total Population	3841
White	1723
Black	447
American Indian, Eskimo, Aleut	61
Asian or Pacific Islander	1094
Other Race	220
Hispanic Origin	345
Children Aged 6 and Younger	389
Adults Aged 65 and Older	231
Females Aged 15 - 44	947
Total Aged over 18	2816
Total Aged under 18	1026
Total Housing Units	1384

* Calculated using the area proportion technique. Source: 2000 U.S. CENSUS

Population Density



Children 6 Years and Younger

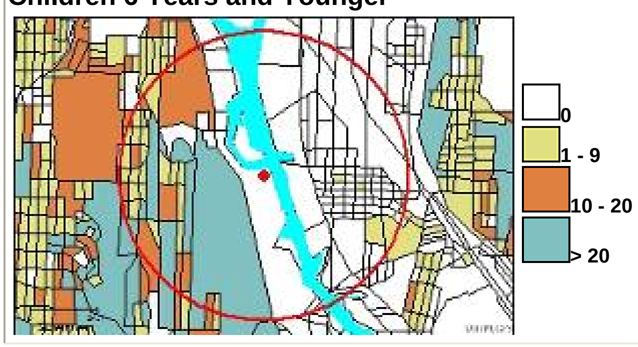
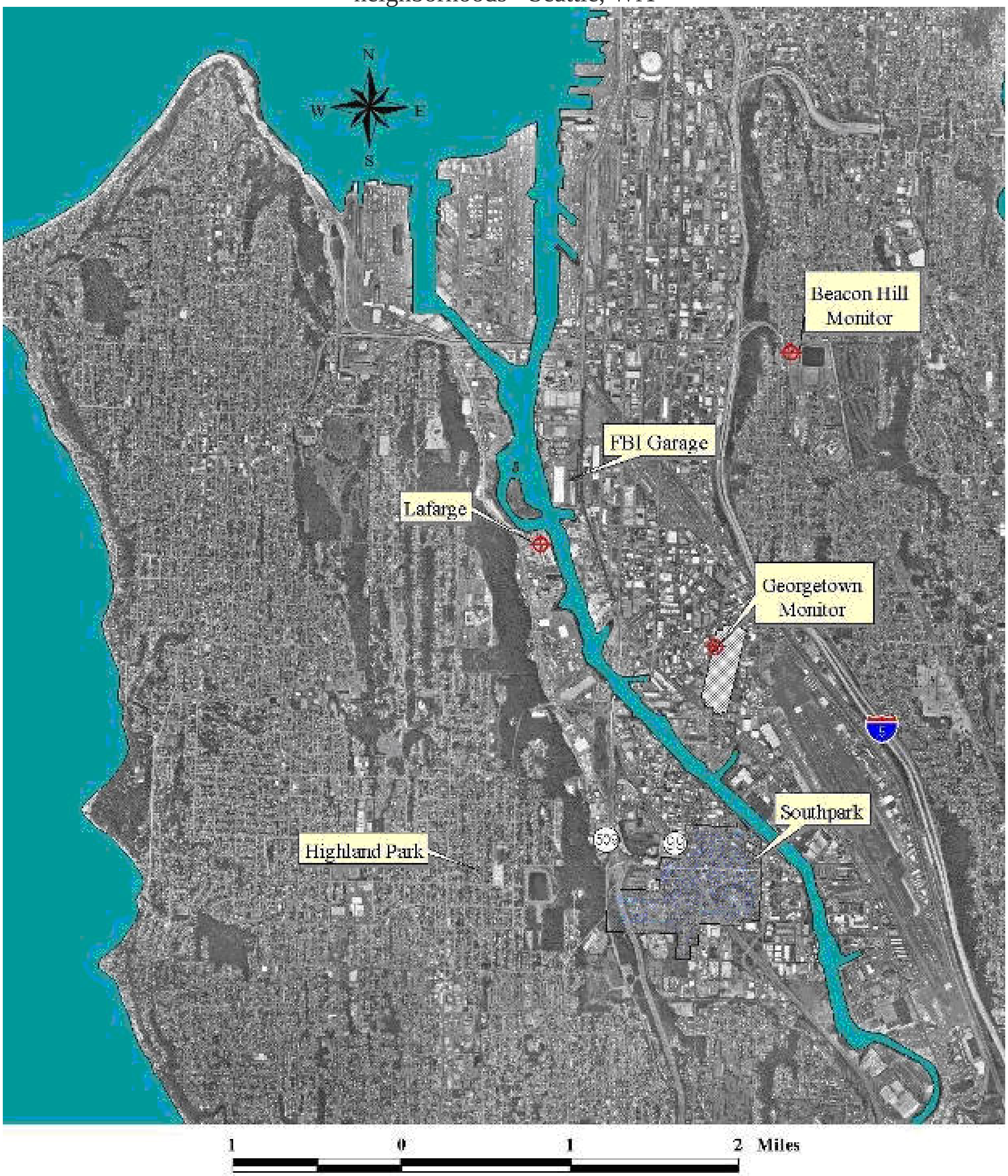


Figure B2. Location of air monitors relative to Lafarge and other potentially impacted neighborhoods - Seattle, WA



Certification

This Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

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

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