Health Consultation

KINGSTON NIKE SITE #92

KINGSTON, KITSAP COUNTY, WASHINGTON

EPA FACILITY ID: WAN001002492

FEBRUARY 17, 2005

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 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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HEALTH CONSULTATION

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EPA FACILITY ID: WAN001002492

Prepared by:

Washington State Department of Health
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Forward

The Washington State Department of Health (DOH) has prepared this health consultation 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. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

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

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.
Aquifer	An underground formation composed of materials such as sand, soil, or gravel that can store and/or supply groundwater to wells and springs.
Cancer Risk Evaluation Guide (CREG)	The concentration of a chemical in air, soil or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a *comparison value* used to select contaminants of potential health concern and is based on the *cancer slope factor* (CSF).
Cancer Slope Factor	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
Carcinogen	Any substance that causes cancer.
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.
Dermal Contact	Contact with (touching) the skin (see route of exposure).
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 Media Evaluation Guide (EMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a *comparison value* used to select contaminants of potential health concern and is based on ATSDR's *minimal risk level* (MRL).

Environmental Protection Agency (EPA)	United States Environmental Protection Agency.
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**].
Groundwater	Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].
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.
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].
Ingestion rate	The amount of an environmental medium that could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
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.
Lowest Observed Adverse Effect Level (LOAEL)	The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.
Maximum Contaminant Level (MCL)	A drinking water regulation established by the federal Safe Drinking Water Act. It is the maximum permissible concentration of a contaminant in water that is delivered to the free flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
Minimal Risk Level (MRL)	An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see **reference dose**].

Model Toxics Control Act (MTCA)	The hazardous waste cleanup law for Washington State.
No apparent public health hazard	A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.
No Observed Adverse Effect Level (NOAEL)	The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.
Oral Reference Dose (RfD)	An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.
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.
Reference Dose Media Evaluation Guide (RMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The RMEG is a *comparison value* used to select contaminants of potential health concern and is based on EPA's oral reference dose (RfD).
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].
Surface Water	Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].
Volatile organic compound (VOC)	Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Summary and Statement of Issues

In December 2003, the Agency for Toxic Substances and Disease Registry (ATSDR) received a petition from a community member requesting a public health assessment of the Nike Site # 92 in Kingston, Kitsap County, Washington. The community member was concerned about a potential cancer cluster among residents near the site, and potential future health consequences for children who will attend a proposed school on the site. The Washington State Department of Health (DOH) has prepared this health consultation as a result of the petition. DOH prepares health consultations under a cooperative agreement with ATSDR.

The purpose of this health consultation report is to determine the extent of exposure to environmental contaminants at the site, whether any such exposure is expected to be of health concern and provide recommendations, as needed, for additional public health actions. DOH reviewed community concerns and environmental sampling data provided by the Environmental Protection Agency (EPA), US Army Corps of Engineers (ACE) and Kane Environmental, Inc (KEI). This health consultation evaluates potential pathways of human exposure to hazardous substances in groundwater, surface water, and soil.

Background

The former Nike Missile Launch Site #92 is located approximately 1 mile west of the town of Kingston, in Kitsap County, Washington State, and comprises approximately 50 acres (See figure 1). The Nike Missile site was functional from 1954–1975. It was originally designed to launch Ajax missiles, but was later redesigned for launching the second generation of Nike missiles, called Hercules missiles, which had the capability of carrying nuclear warheads. The site contained two missile magazines, support buildings, and barracks. At present the Spectrum Community School and the North Kitsap County School District Bus Maintenance Facility occupy the site. The Bus Maintenance Facility is partially located over the sealed underground missile magazines (now filled in). The rest of the site is undeveloped.

The Spectrum Community School (a small alternative high school) is located on-site in a building formerly used as a barrack since the early 1980's. The school serves about 150 students from all areas of the school district. Only a small percentage of the students are from the Kingston area [1]. Students typically attend the school for a period of 1–3 years. According to the principal, neither parents nor students have expressed any health concerns since the school was placed on the city's water system about 10 years ago.

The North Kitsap School District (NKSD) is considering building a new high school on the former Nike missile site. A group of citizens is concerned that toxic liquid fuels (nitric acid and hydrochloric acid) and other contaminants, such as ammonium perchlorate and polychlorinated biphenyls (PCBs), might exist at the site, posing a risk to human health.

Previous site assessment activities have characterized the site's level of contamination and its risk to humans and the environment. This health consultation uses the information from previous reports made available to DOH, and explores in detail the July 2004 site assessment report from EPA to determine conclusions and recommendations.

The Department of Defense's (DOD), Defense Environmental Restoration Program (DERP), carried out an inventory assessment to determine the potential for toxic or hazardous contamination in ground water, surface water and soil at all former Nike Ajax and Nike Hercules Missile Sites located throughout the United States. [2]

In mid-1987, Law Environmental Inc. (Law) conducted an environmental assessment (carried out for the ACE under DERP) of soil and ground water quality at NIKE site #92. No contaminants were found at levels that would pose a risk to human health or to the environment. [3]

In 1991, Tetra Tech Inc. (carried out for the ACE under DERP) sampled abandoned on-site underground storage tanks (UST) for petroleum products and electrical transformers to determine whether the transformer oil contained polychlorinated biphenyls (PCBs). Products identified in the UST were diesel fuel and water. PCBs were not detected in the transformer oil above the analytical detection limit of 1 milligram per liter (mg/l). [3] [4]

In 1992, after removal of the UST, White Shield, Inc. (WSI) carried out a site closure assessment. Under the direction of the U.S. Army Corps of Engineers (ACE), WSI tested soil samples for petroleum contamination. The results indicated that two of the 10 examined sites contained petroleum contamination exceeding cleanup levels for unrestricted land use [Model Toxics Control Act (MTCA) Method A and B Soil Cleanup Levels]. WSI recommended additional soil removal at these sites to reduce petroleum concentrations to acceptable levels [5]. Cleanup work at the site was completed in 1995 under the Defense Environmental Restoration Program–Formerly Used Defense Sites (DERP/FUDS). In its closure report ACE recommended no further action at this site [6].

In 1997, the Washington State Department of Ecology (Ecology) visited the site and reviewed soil and ground water quality data [6, 7]. Ecology determined that no further action was necessary because the site was properly remediated and did not pose a risk to human health or to the environment [8].

In 2003, Kane Environmental, Inc, prepared an environmental impact statement (EIS) of the Nike site for the North Kitsap School District (NKSD). Soil and groundwater samples were collected and tested for inorganic chemicals, volatile organic compounds (VOCs), and semi-volatile organic compounds (SVOCs). Results indicated the presence of methylene chloride in soil samples and groundwater samples. Three SVOCs — known as carcinogenic polycyclic aromatic hydrocarbons (cPAHs) — were detected in a single, near-surface soil sample (under the bus barn). Concentrations of arsenic, barium, chromium III, and lead in unfiltered groundwater samples exceeded applicable MTCA Method A or B groundwater cleanup levels [9, 10]. These levels were in all likelihood a result of the suspended soil particles contained in the unfiltered samples.

In October 2003, EPA initiated the process for a site inspection in response to a citizen petition. EPA's work was conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. In April and May 2004, EPA contractors collected and analyzed soil and groundwater samples. In July 2004, EPA finished its Preliminary Assessment/Site Inspection Report (PA/SI) for the Kingston Nike site. EPA concluded that chemicals in soil were at levels below residential Preliminary Remediation Goals (PRGs), and all chemicals in drinking water wells, except manganese, were below drinking water PRGs [11].

In July 2004, community members raised the issue of potential radiation contamination from past storage of nuclear warheads. In August 2004, DOH and EPA carried out a radiation field survey for alpha/beta and gamma radiation, and municipal and private drinking water sampling for isotopic plutonium and uranium. The analysis found no detectable levels of the isotopes of interest.

Objective

The following discussion evaluates environmental sampling data from the previous site investigations discussed above and provides responses to community concerns expressed to EPA, ATSDR, and DOH.

Discussion

Contaminants of Concern

Environmental sampling data were screened using ATSDR, EPA, and Ecology health-based criteria, or comparison values. Comparison values (CVs) are calculated concentrations of a substance in air, water, food, or soil that are unlikely to cause adverse health effects in exposed individuals. In the health consultation process, substances found in amounts greater than their CVs are selected for further evaluation. The derivation of a comparison value is based on high-end exposure assumptions resulting in values that should be protective of public health in all exposure situations. That is, if the concentrations in the exposure medium are less than the comparison values, the exposures are not of health concern, and no further analysis of the pathway is required. While concentrations below the comparison value are not expected to lead to any observable health effect, it should not be inferred that a concentration greater than the comparison value would necessarily lead to adverse effects. Depending on site-specific environmental exposure factors (e.g., duration of exposure) and human activities that result in exposure (i.e., time spent in the area of contamination), exposure to levels above the comparison value might or might not lead to a health effect.

Comparison values used in this document include ATSDR's environmental media evaluation guide (EMEG), ATSDR’s reference dose media evaluation guide (RMEG), ATSDR's cancer risk evaluation guide (CREG), and EPA Region 9 Preliminary Remediation Goals (PRGs).

Comparisons can also be made with legal standards such as the cleanup levels specified in the Washington State hazardous waste cleanup law, known as the Model Toxics Control Act (MTCA). Legal standards might be strictly health-based or could incorporate non-health considerations such as the cost or practicality of attainment (e.g., in cases where a chemical is naturally present in a medium at levels above a health-based value).

Tables 1 and 2 show chemicals measured in on-site soil relative to their comparison values. Using the methodology described above, arsenic and antimony are contaminants of concern (COC) in soil at Nike site #92.

Several other trace organic compounds were found in soil (Appendix C). These compounds have no health comparison values. Some of these compounds are found naturally in plants and some are breakdown products of plants, animals and insects. These compounds will not be further evaluated — a vast amount of uncertainty is associated with attempting to quantify health hazards and risks for chemicals with little toxicological information (the Uncertainty section below further describes this issue). Tables 3 and 4 show chemicals measured in groundwater on or near the site, of which only manganese is considered to be a contaminant of concern.

Although carcinogenic polycyclic aromatic hydrocarbons (cPAHs) were reported at values above comparison values, they were not considered as a contaminant of concern because they were not actually detected. The laboratory detection limits used for the drinking water and groundwater analyses were not low enough to distinguish the level of PAH contamination reported in water. In addition, no comparable source of cPAHs were found in soil, as would be expected if cPAHs were detected in groundwater. PAHs are non-polar, hydrophobic compounds with very low solubility in water (See appendix D for extra discussion on page 44).

Several inorganic and organic compounds were found in the perched groundwater (Appendix C - Table C2 and C3). Chemicals identified in this sample were not considered as contaminants of concern because suspended soil particles and other solids were present in this sample. These suspended solids can cause high metal concentration when analyzed, making the results inappropriate for use in human health assessment. Furthermore, the perched groundwater is not used as a source of drinking water.

Uncertainty

Assessment of risk from environmental exposures is often an uncertain process.

The health assessment process is uncertain because information is often unavailable on site-related issues such as chemical toxicity, human variability and susceptibility, human behavior patterns, and chemical concentrations in the environment.

But the majority of this uncertainty arises from our limited knowledge of chemical toxicity. For most chemicals, little or no evidence exists documenting harm in humans from environmental exposures. As a result, toxicological experiments are performed on animals. These animals are exposed to chemicals at much higher levels than are found in the environment. The critical doses in animal studies are often extrapolated to represent "real world" exposures for use in human health risk assessments. To be protective of human health, uncertainty factors are used to lower that dose in consideration of the variable sensitivities of animals and humans, and the variability within humans. These uncertainty factors can account for a difference of two to three orders of magnitude in the calculation of risk. Furthermore, for hundreds of chemicals little toxicological information is available for either animals or humans. These chemicals could in fact be toxic at some level, but because of uncertainty, risks to humans cannot be quantified. The amount of contaminated media (e.g., soil, water, air) that people eat, drink, inhale, or absorb through their skin is another source of uncertainty. Although recent work has improved our understanding of these exposure factors, they are remain sources of uncertainty.

Finally, the amount and type of chemicals in the contaminated media is another source of uncertainty. Environmental samples are very costly, so it is not practical or efficient to analyze samples for every existing chemical. Instead, sampling usually focuses on contaminants that are thought to be present according to historic land use or knowledge of specific chemical releases.

Table 1. Maximum Concentrations of Inorganic Compounds Detected in Soil and Their Respective Comparison Values at The Kingston Nike # 92 Site in Kingston, Kitsap County, Washington.

Inorganic Compounds	*Maximum Concentration (ppm)*	*Comparison Value (ppm)*	*EPA Cancer Class*	*Comparison Value Reference*	*Contaminant of Concern*	*Puget Sound Background range (ppm)*
Aluminum	18800	76000		Region 9	No	7390 – 84900
Antimony	33.7	20	D	RMEG	Yes	
Arsenic	18.1	0.5 20	A	CREG EMEG	Yes (cancer) No (non-cancer)	1.45 – 17.17
Barium	207	4000	D	RMEG	No	
Cadmium	6.4	10	B1	EMEG	No	0.1 – 5
Calcium	12000				No	
Chromium	62	200*	A	RMEG	No	12 – 235
Cobalt	12.6	500		IM EMEG	No	
Copper	73.1	2000	D	IM EMEG	No	4 – 234.5
Iron	31600	23000		Region 9	No (within background)	5920 – 112500
Lead	147	250	B2	MTCA	No	2.1 – 207.5
Magnesium	10000				No	
Manganese	1060	3000	D	RMEG	No	90 – 2750
Mercury	0.51	1	D	MTCA	No	0.012 – 0.094
Nickel	45.9	1000		RMEG	No	9 – 244.5
Potassium	682				No	
Vanadium	80.9	200		EMEG	No	
Zinc	1130	20,000	D	IM EMEG	No	12 – 132.5

CREG - ATSDR's Cancer Risk Evaluation Guide (child)
RMEG - ATSDR's Reference Dose Media Evaluation Guide (child)
EMEG - ATSDR's Environmental Media Evaluation Guide (child)
IM EMEG - ATSDR's Intermediate Environmental Media Evaluation Guide (child)
A - EPA: Human carcinogen
B1 - EPA: Probable human carcinogen (limited human, sufficient animal studies)
B2 - EPA: Probable human carcinogen (inadequate human, sufficient animal studies)
C - EPA: Possible human carcinogen (no human, limited animal studies)
D - EPA: Not classifiable as to health carcinogenicity
Region 9 – EPA: Preliminary Remediation Goals
* - Assume Hexavalent Chromium

Table 2. Maximum Concentrations of Organic Compounds Detected in Soil and Their Respective Comparison Values at The Kingston Nike # 92 Site in Kingston, Kitsap County, Washington.

Organic Compounds	*Maximum Concentration (ppm)*	*Comparison Value (ppm)*	*EPA Cancer Class*	*Comparison Value Reference*	*Contaminant of Concern*
2-Butanone (MEK)	0.05	3000		RMEG	No
2-Propanone (Acetone)	1.3 K	50000		RMEG	No
Acenaphthene	0.13	3000		RMEG	No
Anthracene	0.2	20000	D	RMEG	No
Benzo(a)anthracene	0.15	0.62	B2	Region 9	No
Bis (2-ethylhexyl)-phthalate	2.0	50	B2	CREG	No
Carbon disulfide	0.0036	5000		RMEG	No
Chrysene	0.19	62	B2	Region 9	No
Dibenzofuran	0.13	290	D	Region 9	No
2,4-Dinitrophenol	4.6 UJK	120		Region 9	No
Ethylbenzene	0.016	5000	D	RMEG	No
Fluoranthene	0.93	2000	D	RMEG	No
Fluorene	0.27	2000	D	RMEG	No
Indeno (1,2,3-cd)- pyrene	0.1	0.62	B2	Region 9	No
Methylene Chloride	0.28	90	B2	CREG	No
4-Methylphenol (p-cresol)	0.35 J	310	C	Region 9	No
Perchlorate	0.0069 J	7.8		Region 9	No
Phenanthrene	1.2	2000*	D		No
Pyrene	0.74	2000	D	RMEG	No
Toluene	0.914	1000	D	IM EMEG	No
Trichloroethene	0.043	200	C	RMEG	No
Freon 11	0.0021 UJK	20000	D	RMEG	No

CREG - ATSDR's Cancer Risk Evaluation Guide (child)

RMEG - ATSDR's Reference Dose Media Evaluation Guide (child)

EMEG - ATSDR's Environmental Media Evaluation Guide (child)

IM EMEG - ATSDR's Intermediate Environmental Media Evaluation Guide (child)

J - data qualifier: The analyte was positively identified. The associated numerical result is an estimate

UJK- data qualifier: The analyte was not detected at or above the reported estimated result. The associated numerical value is an estimate of the quantitation limit of the analyte in this sample. Unknown Bias

K - data qualifier: Unknown Bias

B2 - EPA: Probable human carcinogen (inadequate human, sufficient animal studies)

C - EPA: Possible human carcinogen (no human, limited animal studies)

D - EPA: Not classifiable as to health carcinogenicity

Region 9 – EPA: Preliminary Remediation Goals

*Fluoranthene RMEG value was used as a surrogate for Phenanthrene

Table 3. Maximum Concentrations of Inorganic Compounds Detected in Drinking Water Wells Near the Kingston Nike # 92 Site in Kingston, Kitsap County, Washington.

Inorganic Compounds	*Maximum Concentration (ppb)*	*Comparison Value (ppb)*	*EPA Cancer Class*	*Comparison Value Reference*	*Contaminant of Concern*
Antimony	0.39 J	4	D	RMEG	No
Barium	21.4 J	700	D	RMEG	No
Calcium	30600				No
Chromium	1.8 J	30*	A	RMEG	No
Copper	20.6 J	300	D	IM EMEG	No
Iron	3240	11000		Region 9	No
Lead	4.8 J	5		MTCA	No
Magnesium	20700				No
Manganese	**924**	500	D	RMEG	**Yes**
Nickel	8.4 J	100		LTHA	No
Potassium	8550 JK				No
Sodium	46800				No
Vanadium	4.7 J	30	------	IM EMEG	No
Zinc	550	3000	D	EMEG	No

LTHA - EPA's Lifetime Health Advisory for drinking water

RMEG - ATSDR's Reference Dose Media Evaluation Guide (child)

EMEG - ATSDR's Environmental Media Evaluation Guide (child)

IM EMEG - ATSDR's Intermediate Environmental Media Evaluation Guide (child)

J - data qualifier: The analyte was positively identified. The associated numerical result is an estimate

JK - data qualifier: The analyte was positively identified. The associated numerical result is an estimate. Unknown Bias

D - EPA: Not classifiable as to health carcinogenicity

Region 9 – EPA: Preliminary Remediation Goals

MTCA – Washington State Department of Ecology: Model Toxics Control Act

- \- Assume Hexavalent Chromium

Table 4. Maximum Concentrations of Organic Compounds Detected in Drinking Water Wells Near the Kingston Nike # 92 Site in Kingston, Kitsap County, Washington.

Organic Compounds	*Maximum Concentration (ppb)*	*Comparison Value (ppb)*	*EPA Cancer Class*	*Comparison Value Reference*	*Contaminant of Concern*
2-Propanone	6.0 UJK	20000		IM EMEG	No
Methylene Chloride	0.63 UJK	5	B2	CREG	No
Trichloromethene (Chloroform)	1.6	100		EMEG	No
Benzo(b)fluoranthene	5.2 UJK		B2		No (cPAH)
Benzo(k)fluoranthene	5.2 UJK		B2		No (cPAH)
Benzo(a)pyrene	5.2 UJK	0.005	B2	CREG	No (cPAH)
Indeno (1,2,3-cd)- pyrene	5.2 UJK		B2		No (cPAH)
Dibenzo(a,h)anthracene	5.2 UJK		B2		No (cPAH)
Benzo(g,h,I)perylene	5.2 UJK	400*	D		No
Hexachlorocyclopentadiene	5.1 UJK	60	E	RMEG	No
1,1'-Biphenyl	5.1 UJK	500	D	RMEG	No
Dimethylphthalate	5.1 UJK	16000	D	MTCA B	No
Diethylphthalate	5.1 UJK	8000	D	RMEG	No
Butylbenzylphthalate	5.1 UJK	3200		MTCA B	No
Bis(2-ethylhexyl)phthalate	5.1 UJK	6.25		MTCA B	No
Di-n-octylphthalate	5.1 UJK	4000		IM EMEG	No
2,2'-oxybis (1-chloropropane)	5.2 UJK	400	D	RMEG	No
4-Nitroaniline	21.0 UJK				No
Sulfur	12.0 JN				No

CREG - ATSDR's Cancer Risk Evaluation Guide (child)

RMEG - ATSDR's Reference Dose Media Evaluation Guide (child)

EMEG - ATSDR's Environmental Media Evaluation Guide (child)

IM EMEG - ATSDR's Intermediate Environmental Media Evaluation Guide (child)

UJ K - data qualifier: The analyte was not detected at or above the reported estimated result. The associated numerical value is an estimate of the quantitation limit of the analyte in this sample. Unknown Bias

JN - data qualifier: There is evidence that the analyte is present. The associated numerical result is an estimate

B2 - EPA: Probable human carcinogen (inadequate human, sufficient animal studies)

D - EPA: Not classifiable as to health carcinogenicity

E - EPA: Evidence of noncarcinogenicity in humans

MTCA B – Washington State Department of Ecology: Model Toxics Control Act

* Fluoranthene RMEG value was used as a surrogate for Benzo(g,h,I)perylene

cPAH - carcinogenic Polycyclic Aromatic Hydrocarbons

(cPAH) – See appendix D - Polycyclic Aromatic Hydrocarbons

Evaluating non-cancer hazards

To evaluate the potential for non-cancer adverse health effects that could result from exposure to contaminated media (i.e., air, water, soil, and sediment), a dose is estimated for each contaminant of concern. These doses are calculated for situations (scenarios) in which nearby residents might come into contact with the contaminated media. The estimated dose for each contaminant under each scenario is then compared with ATSDR's minimal risk level (MRL) or EPA's oral reference dose (RfD). MRLs and RfDs are doses below which non-cancer adverse health effects are not expected to occur (i.e., so-called "safe" doses). They are derived from toxic effect levels obtained from human studies and from laboratory animal studies. These toxic effect levels can be either the lowest-observed adverse effect level (LOAEL) or a no-observed adverse effect level (NOAEL). In human or animal studies, the LOAEL is the lowest dose at which an adverse health effect is seen, while the NOAEL is the highest dose not resulting in any adverse health effects.

Because of uncertainty in these data, the toxic effect level is divided by "safety factors" to produce the lower — and more protective — MRL or RfD. If a dose exceeds the MRL or RfD, this indicates only the potential for adverse health effects. The magnitude of this potential can be inferred from the degree to which this value is exceeded. If the estimated exposure dose is only slightly above the MRL or RfD, then that dose will fall well below the toxic effect level. The higher the estimated dose is above the MRL or RfD, the closer it will be to the actual toxic effect level. This comparison is called a hazard quotient (HQ), expressed by the equation below:

$$HQ = \frac{\text{Estimated Dose (mg/kg/day)}}{\text{Rfd (mg/kg/day)}}$$

Estimated exposure doses, exposure assumptions, and hazard quotients are presented in Appendices A and B for COCs found in soil and groundwater including arsenic, and antimony manganese. *Estimated doses from exposure to contaminants in soil at Nike site #92 do not result in hazard quotients in excess of one for any chemical.* This indicates that non-cancer adverse health effects are not likely to result from exposure to COCs in soil at the site.

Evaluating Cancer Risk

Some chemicals have the ability to cause cancer in humans. Cancer risk is estimated by calculating a dose similar to that described above, and multiplying it by a cancer potency factor, also known as the cancer slope factor. Some cancer potency factors are derived from human population data. Others are derived from laboratory animal studies involving doses much higher than those encountered in the environment. Use of animal data requires extrapolation of the cancer potency obtained from these high-dose studies to get down to real-world exposures. This process involves much uncertainty.

Current regulatory practice suggests there is no "safe dose" of a carcinogen, and that a very small dose of a carcinogen will result in a very small cancer risk. Cancer risk estimates are, therefore, not yes/no answers; rather, they are measures of chance (probability). Such measures, however uncertain, are useful in determining the magnitude of a cancer threat — any level of a carcinogenic contaminant carries an associated risk. The validity of the "no safe dose" assumption for all cancer-causing chemicals is not clear. Some evidence suggests that certain chemicals considered to be carcinogenic must exceed a threshold of tolerance before initiating cancer. For such chemicals, risk estimates are not appropriate. More recent guidelines on cancer risk from EPA reflect the potential that thresholds for some carcinogenesis exist. However, EPA still assumes no threshold unless sufficient data indicate otherwise [12].

This document describes cancer risk that is attributable to site-related contaminants in qualitative terms like low, very low, slight and no significant increase in cancer risk. These terms can be better understood by considering the population size required for such an estimate to result in a single cancer case. For example, a low increase in cancer risk indicates an estimate in the range of one cancer case per ten thousand persons exposed over a lifetime. A very low estimate might result in one cancer case per several tens of thousands exposed over a lifetime and a slight estimate would require an exposed population of several hundreds of thousands to result in a single case. DOH considers cancer risk insignificant when the estimate results in less than one cancer per one million exposed over a lifetime. The reader should note that these estimates are for excess cancers that might result, in addition to those normally expected in an unexposed population.

Cancer Risk

Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this risk are defined below as the number of excess cancers expected in a lifetime:

Term	# of Excess Cancers	
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000
insignificant	is less than	1 in 1,000,000

Cancer is a common illness and its occurrence in a population increases with age. Depending on the type of cancer, a population with no known environmental exposure could be expected to have a substantial number of cancer cases. There are many different forms of cancer that result from a variety of causes; not all are fatal. Approximately ¼ to ⅓ of people living in the United States will develop cancer at some point in their lives [13].

Cancer risk from exposure to on-site soils was calculated for arsenic only — no other carcinogenic COC was identified in soil. The lifetime increase of cancer risk associated with exposure to arsenic in soil at the Nike Kingston site is low to very low (8.36×10^{-5}) or (8 in 100,000). Arsenic levels found in on-site soils are similar to those found naturally throughout the state (i.e., background). In fact, large areas of Washington State contain higher levels of arsenic in soil due to past contamination from the Tacoma smelter and former use of lead-arsenate pesticides in the apple orchards of Eastern Washington. The legacy of arsenic and lead in these areas was addressed by the Area-wide Task Force, which provided recommendations for action to the Departments of Ecology and Health [14].

Chemical Specific Information

Arsenic

Arsenic is a naturally occurring element in the earth's soil. Background soil-arsenic concentrations in the Puget Sound Basin range from about 1 to 17 parts per million (ppm), which is the same as milligrams per kilogram (mg/kg) [15]. That said, however, the widespread use of arsenic-containing pesticides and the emissions from certain smelters has resulted in significantly higher levels of arsenic on many properties in the state. There are two forms of arsenic, organic and inorganic. The EPA established RfD for arsenic is 0.0003 mg/kg/day based on skin color changes and excessive growth of tissue (human data) [16]. EPA classifies the inorganic form of arsenic as a human carcinogen.

Antimony

Antimony is a naturally occurring element in the earth's soil. Background soil-antimony concentrations range between 3.1 and 7.6 ppm in Washington [15]. The main routes of exposure to antimony are from inhaling contaminated soil or dust particles, and ingesting contaminated water or food. Antimony-contaminated soil can accidentally be ingested by hand-to-mouth activity that could increase exposure. EPA established a reference dose (RfD) for antimony of 0.0004 mg/kg/day based on animal studies that showed it can cause decreases in blood glucose levels and can alter cholesterol levels [17]. EPA has not classified antimony as to human health carcinogenicity.

Manganese

Manganese is a naturally occurring metal found in many types of rocks. It is an essential trace element necessary for good health and can be found in several food items, including grains, cereals, and tea.

Manganese also occurs naturally in groundwater and was detected in drinking water from some private wells near Kingston Nike site # 92. The Kingston area is known to have high manganese levels; therefore, the elevated manganese in area groundwater could be natural [18]. The maximum level of manganese found in one well exceeded EPA’s aesthetic drinking water standard, known as the Secondary Maximum Contaminant Level (SMCL). The SMCL for manganese is based on concentrations that can stain clothes or plumbing fixtures; SMCLs are not based on health impacts.

Multiple Chemical Exposures

A person can be exposed to more than one chemical through more than one pathway. Exposure to a chemical through multiple pathways occurs if a contaminant is present in more than one medium (i.e., air, soil, surface water, groundwater, and sediment). For example, the dose of a contaminant received from drinking water might be combined with the dose of the same contaminant received from soil contact.

For many chemicals, much information is available on how an individual chemical produces human health effects. But it is much more difficult to assess exposure to multiple chemicals. Due to the large number of chemicals in the environment, it is impossible to measure all of the possible interactions between these chemicals. These chemicals can interact in the body and increase or decrease the potential for adverse health effects. Given that they are measures of probability, individual cancer risk estimates can be additive. when estimating non-cancer risk, however, similarities must exist between the chemicals if the doses are to be added together. Groups of chemicals with similar toxic effects can be added, such as volatile organic compounds (VOCs), which cause liver toxicity. Polycyclic aromatic hydrocarbons (PAHs) are another group of compounds that can be assessed as one combined dose based on similarities in chemical structure and metabolites. Although some chemicals can interact to cause a toxic effect greater than the additive effect, there is little evidence demonstrating this at concentrations commonly found in the environment.

Combined exposures to COCs at the Nike Kingston site are not expected to result in adverse health effects. The COCs evaluated above do not have similar endpoints of toxicity, thus they are not expected to have additive health effects.

Radionuclides

Several community members expressed concern that warheads might have left residual radioactive contamination at the site. Even though the military would neither confirm nor deny whether nuclear weapons were at any given site, it is reasonable to assume that at one time nuclear warheads were present at Nike launch Site #92. DOH researched the operational history of Nike Site #92 in particular and Nike Hercules sites in general, and concluded that there was no reason to suspect that past operations would have left radioactive contamination. By way of validating the conclusions drawn from the research, DOH chose to conduct a radiological survey of the site and to sample its groundwater.

DOH Office of Radiation Protection and EPA contractor Ecology and Environmental Inc (E&E) conducted a field investigation of the site. Survey instruments designed to detect alpha and beta particles and gamma rays were used. The location of the now-buried missile magazines, weapons maintenance and assembly facilities, and connecting roadways were surveyed. The measurements obtained were entirely consistent with background readings for Western Washington. The readings gave no reason to suspect that any radioactive material remained on the site beyond that which is to be expected due to naturally occurring material in the soil and world-wide atmospheric fallout. There was no indication of radioactive contamination at the site.

Additionally, groundwater was sampled from several nearby wells. The water was analyzed for isotopes most likely associated with nuclear warheads. The analysis of these samples found no detectable levels of the isotopes of interest. This further supports the contention that past operations on the site resulted in no radiological impact.

Using its knowledge of nuclear weapons, its research on the operations of Nike sites in general and Nike Site #92 in particular, and its radiological survey and sampling at the site, the Office of Radiation Protection concludes there is no reason to believe that past operations at Nike Site #92 caused any radioactive contamination of that site.

Health Outcome Data Evaluation for Nike # 92

Members of the Kingston community have raised concerns about a suspected cancer cluster. When several people within close geographic proximity develop cancer, a cancer cluster is often reported. A cluster is the occurrence of a greater-than-expected number of cases of a particular disease within a group of people, within a geographic area, or within a specified period of time. A suspected cancer cluster is more likely to be a fact if it involves 1) a large number of cases of one type of cancer, 2) a rare type of cancer, or 3) cancer cases in age groups not usually affected by that type of cancer [19].

Cancer is a common disease that will affect about ⅓ of the people in the United States. The cause of many types of cancer is unknown; however, numerous factors, including diet, lifestyle, environmental exposure, and genetics might be associated with the occurrence of cancer. Additionally, cancer risk increases with age.

While cancer is often spoken of in a general sense, as if all forms of cancer were manifestations of the same disease, scientists and health professionals acknowledge that there are many different types of cancer that result from many different causal mechanisms. Because it is a common disease, most of us know people who have been affected by cancer. Even when a greater-than-expected number of specific cancer types is identified, this “cluster” usually occurs by chance, rather than the result of an identifiable cancer-causing mechanism.

In the case of the suspected cancer cluster near Kingston Nike site # 92, it is unlikely that cancers in the area are caused by chemical or radiological contamination from the Nike site. A person would have to be exposed frequently to significant levels of a cancer-causing chemical or to radiation for long periods (i.e., years) to increase cancer risk significantly. Chemicals in the site soil are not at levels that would result in concern for increased cancer incidence resulting from environmental exposures. Even exposure to the maximum level of arsenic, the main carcinogenic contaminant of concern on-site, would only cause a very low increase in cancer risk, which might not result in cancer. In addition, this level of arsenic exposure is not distinguishable from the general population.

Most states, including Washington State, currently have central registries that collect data on cancer incidence (i.e., the number of new cancer cases reported). The data in these registries can be used to compare expected cancer incidence rates in certain categories, such as a geographic area, with incidence rates reported in a suspected cancer cluster to determine whether the presence of a true excess of cases. DOH looked at the cancer history for the Kingston area (surrounding the Nike site) and found no statistically meaningful elevations in cancer incidence for Kingston area or Kitsap County (See Appendix E for the description of the methodology).

Children’s Health Concerns

The unique vulnerabilities of infants and children demand special attention in communities that have contamination of their water, food, soil, or air. The potential for exposure and subsequent adverse health effects often increases for younger children compared with older children or adults. ATSDR and DOH recognize that children are susceptible to developmental toxicity that can occur even when contaminant levels are much lower than those that cause other types of toxicity.

New draft guidance from EPA recognizes that early life exposures associated with some chemicals requires special consideration with regard to cancer risk [20, 21]. Mutagenic chemicals, in particular, have been identified as causing higher cancer risks when exposure occurs early in life, compared with the same amount of exposure during adulthood. Adjustment factors have been established to compensate for higher risks from early life exposures to these chemicals. A factor of 10 is used to adjust early life exposures before age 2, and a factor of 3 is used to adjust exposures between the ages of 2 and 15 [21]. With regard to contaminants present at Nike Site # 92, arsenic has been identified as a potentially mutagenic contaminant of concern. The appropriate adjustment factors were applied with regard to young children and high school-aged children exposed to arsenic in soil at the future high school (Appendix A).

At this site, the estimated risks for a child were a little higher than the risk for an older child or an adult, but they are not expected to result in any adverse health effects.

Community Health Concerns

Residents have raised several health concerns during meetings with, local agencies, community leaders, and NKSD meetings, and in local newspapers and e-mail communications.

Community health concerns are summarized and responded to below:

Q: Is there a high cancer incidence around the Kingston Nike site, higher than expected incidences of cancer among residents living in the Kingston area?

> **A:** No. After reviewing cancer incidence in the census tracts in the Kingston area, there does not appear to be any excess incidence of cancer among these residents when compared with Kitsap County and the State of Washington as a whole.

Q: Are the chemical contaminations on site at the Kingston Nike site adequate to explain any observed excess cancers?

> **A:** No. Chemical contaminant levels in soil and groundwater at or near the site are generally low, and not at levels that would result in excess cancers. Risk assessment was used to estimate the increased cancer risk the site poses to the exposed population. A very low increased cancer risk was associated with the site.

Q: Would you look at current cancer cases among children at school?

> **A:** After reviewing the relevant information, such an investigation is not warranted. The cancer risk assessment of the site indicates that even if a person were exposed to the site, such as attending a daycare or a high school, or teaching at the high school to retirement, the cancer risk is very low. Cancer risk assessment of the site indicates a very low increased cancer risk.

Q: How will a “qualitative” health consultation be effectively done? (Sic)

> A: DOH will evaluate existing site sampling data, as well as new environmental sampling data generated by EPA. The results of DOH’s evaluation are presented in this health consultation.

Q: What about carcinogens Kane reported under bus barn? (Sic)

> **A:** The cPAHs found in the soil under the bus barn were well below their respective comparison value; therefore, no adverse health effects would be expected. No other chemicals above health comparison values were found in soil under the bus barn.

Q: Nike Site #92 was equipped with nuclear warheads, what about the radiation levels on-site?

> **A:** The military neither confirmed nor denied EPA’s inquiry regarding whether nuclear warheads ever present at the site. DOH proceeded as if nuclear warheads had been present. A radiation survey conducted by DOH Office of Radiation Protection and EPA revealed no radiation levels in surface soil at the Nike site, and drinking water from nearby wells was at or below background.

Q: How about lead and mercury levels on-site soil being higher than the average background in the Puget Sound Basin?

A: While lead and mercury levels were above average Puget Sound background levels in some samples, all are below Washington State clean-up levels for these two contaminants. In both cases the maximum level detected for lead and mercury was the only soil-sample level found that high. The maximum lead level also falls within the range of background lead levels in the Puget Sound Basin. See extra discussion on lead and mercury in Appendix D.

Q: Cadmium and Chromium contaminated groundwater was identified in the 1988 US ACE study. Why aren't they considered contaminants of concern?

A: Neither chemical was detected in unfiltered water sample analyzed for total cadmium nor total chromium in the regular drinking water well used as a monitoring well. This well water sample is indicative of what humans would be drinking in the area.

The other four monitoring wells were 2-inch diameter monitoring wells sample using a bailer and had turbidity problems. To minimize sample disturbance during sample collection it is recommended that a low flow rate of 0.2 to 0.3 liters/minute (not using a bailer) be used for ground water samples collected for metals analysis with no filtration. Also, acidification which is the initial preservation step for total metals samples causes the absorbed cations to go into solution from the soil particles thus elevating the total metals.

Q: Do you intend to identify the relative amount of Chromium VI versus Chromium III?

A: The KEI soil sampling results indicated Chromium VI versus Chromium III. Furthermore, when chromium analytical results are reported as "total chromium", it is assumed that all of the chromium is in the more toxic state (hexavalent). All chromium levels were below comparison values.

Q: Are you going to assume that it is 100% Chromium VI to maintain the highest level of safety?

A: The KEI soil sampling results reported chromium species (hexavalent or trivalent). Results that were reported as total chromium were assumed to be hexavalent chromium.

Q: Why would you look for the presence of certain isotopes of Uranium and Plutonium, but were concerned about "naturally" occurring incidence of those isotopes?" (Sic)

A: Uranium occurs naturally at low levels in most rocks and soils, and it is not unusual to find low levels of uranium in groundwater. Naturally occurring uranium has a very different ratio of isotopes than does uranium that has been processed for use in warheads. By analyzing for the different isotopes of uranium, it can be determined with great certainty whether any uranium detected in the samples is naturally occurring or has been processed, and presumably entered the groundwater from the Nike site.

Q: Plutonium is probably the key issue that we need to be very specific in understanding when it occurs "naturally" and under what conditions as well as other breakdown elements. (Sic)

A: There are, with few exceptions, no naturally occurring isotopes of plutonium on Earth. There is a small amount of plutonium in the environment from fallout caused by atmospheric nuclear weapons testing in the 1940s through 1970s. It is unlikely that such fallout would reach the groundwater in detectable concentrations. If plutonium were found in the groundwater, it may be attributable to the Nike site, but no plutonium was found in samples of drinking water taken from near the site.

Q: Can you describe what you're looking for with some precision before you do so and why certain isotopes are analyzed and not others? (Sic)

A: There are only a few isotopes that are used in nuclear weapons. They include isotopes of uranium and plutonium. While these isotopes produce other radioactive isotopes as they decay, the half-life of these isotopes is so long (25,000 years or more) that enough time has not passed to build up a detectable inventory of decay products.

Q: What might have happened if a warhead had been dropped…(Sic)

A: First, great attention is paid to not drop nuclear warheads. While on a very few occasions that has happened, it is rare.

Second, the radioactive material is deep within the body of the warhead. Even if the warhead were dropped, it is unlikely that the parts of the weapon made from the radioactive material would be damaged or would break apart. Also, the material is solid metal and not easily dispersed in a plume, as would be the case with a powder, vapor, or liquid.

Third, if some event happened that resulted in contamination being released, it would be cleaned up. Radioactive contamination is actually not that difficult to clean up, especially in a small, contained area, such as the inside of a missile magazine. Unlike chemical contamination of soil, water, or air, radiation can be measured instantly and cleaned up thoroughly [22].

Q: Why were the silos and magazines sealed, if there was nothing in the silos?

A: The most likely answer is to prevent people from entering so they do not get hurt. It would be easy for people, especially children, to get hurt if they entered a deep, unlit, concrete structure. The easiest and best way to prevent this is to seal the structure so tightly that it would take heavy equipment to enter it again.

Q: If the fire department didn't do anything wrong, then by definition the Core of Engineers sealed the magazines because there was bad, bad stuff down there from its use as a Missile silo. (Sic)

A: The most likely reason that the Corps of Engineers sealed the magazines is that they were no longer of any use to them, and sealing them was the easiest way to restrict trespassers from accessing them and getting hurt.

Q: How do we view or can we view your work, with respect to seeing the study, the analysis and the data?

A: Our standard process is to publish an agency-review draft of the health consultation prior to sending it for final approval to ATSDR. We generally do not solicit public comment on our health consultations. Due, however, to the interest some members of the community have expressed regarding this site, we will issue a draft for public comment. The cancer and non-cancer analysis will be part of that document. It will include all the details of how we conducted the analysis.

Q: In addition, how do you deal with someone that developed a cancer while in the study area, but then went to die at a hospice, or simply moved before the death or curing of the cancer?

A: The Cancer Registry documents the physical address (State, county, and zip code) of the person at the time of diagnosis.

Q: It would seem that interviewing the neighbors would winnow out this sort of detail rather than relying on the database.

A: Performing a survey would be considered if the conditions at the site met certain criteria for us to consider an active surveillance (interviewing residents):

1) We must have evidence of cancer-causing contaminants on the site at levels of concern; and 2), we must have evidence that a population was exposed to those chemicals or 3), If a preliminary analysis of the cancer registry data showed an increase rate of cancer in the study area. None of these criteria were met. Thus, conducting a detailed survey of residents in the area would not produce useful information.

Q: Are there plans to examine medical data / longitudinal health surveys on those with greatest exposure (Spectrum Community School students) to the existing site?

A: No. There are two criteria that must be met before we would conduct a survey of the students: 1) a contaminant of concern on the site at levels that could result in adverse health outcomes to humans; and 2), completed exposure pathway to the students.

The contaminants levels at the site are low, and estimated cancer risk from exposure to contaminants is very low. Cancer incidence for Kingston area is not significantly different from either Kitsap County's or the State of Washington's incidence of cancer. Therefore no reason exists to conclude that cancer is a likely endpoint of exposure.

Q: Cancer is not the only illness that can arise -- for example, with mercury levels being well above Puget Sound background levels, more birth defects and miscarriages are possible manifestations resulting from exposure to this chemical.

A: A non-cancer hazard assessment from chemicals is a standard part of a health consultation. No adverse non-cancer health effects are likely to occur as a result of exposure to chemicals at or near the site, including mercury in soil and drinking water.

Q: Is it correct that the lead level on the site is approximately 6 times the normal lead level of uncontaminated land in the Puget Sound?

A: No. It is incorrect that the lead level on the site is approximately six times the normal lead level of uncontaminated land in the Puget Sound. The maximum lead level (147 ppm) found on site falls within the range of background lead levels in the Puget Sound Basin. (See Table 1 for soil background range).

Q: Would this site be completely acceptable without reservations for a school in its present state in all EPA jurisdictions? (The Cal-Modified PRG for lead is 130 mg/kg, which the current site exceeds - it is 147 ppm for lead on the site).

A: None of the soil levels for any on-site contaminants exceed MTCA clean-up levels for unrestricted land use. MTCA clean-up levels are protective of human health or of the environment and are part of the law applicable to Washington State. Although one sample for lead exceeded a modified PRG, it was within the range of Puget Sound background. Furthermore, the average lead level of all samples is very low (7.52 ppm).

In the state of Washington the Area-wide soil contamination Task Force recommended that the following statewide strategy to respond to low to moderate-level arsenic and lead soil contamination [14]:

a) For schools, childcare centers, and residential land uses, in general, Ecology considers total arsenic concentrations of up to 100 ppm and total lead concentrations of up to 500–700 ppm to be within the low-to-moderate range.

b) For properties where exposure of children is less likely or less frequent, such as commercial properties, parks, and camps, Ecology considers total arsenic concentrations of up to 200 ppm and total lead concentrations of up to 700–1,000 ppm to be within the low-to-moderate range.

Q: Would this site be completely acceptable without reservations for a school in its present state in all states of the Union? (Minnesota current standard is 100 ppm for lead. California's modified PRG is 130 ppm)

A: Soil levels are generally much lower than PRGs and MTCA clean-up levels. These values are design to be protective of human health and are applicable in dealing with cleanup of hazardous sites in WA (See previous answer to question 23).

Q: The EPA has issued guidance [Document OSWER 9355.4-24, December 2002] concerning adjusting levels where it is anticipated that the soil may be played upon in wet weather [a common occurrence with school playing fields]. The Guidance suggests that the safe levels be reduced to 35% of the usual value. If this is the case, then 35% of Washington's standard of 250ppm for lead would be reduced to 88ppm, well below the 147ppm for lead discovered on the site indicated in table 8-1. Please confirm that this is a correct interpretation of this guidance, if not, please indicate what the level should be used according to this guidance? [Please supply the calculation and their sources]

A: This is an incorrect interpretation of the guidance. The guidance states that an adherence factor (AF) (a measure of the tendency for soil to stick to skin) of 0.2 for children and 0.07 for adults when evaluating dermal exposure pathway. This factor is not intended to adjust cleanup values. It is one of several factors used to determine how much of a chemical is absorbed through skin through dermal contact with contaminated soil (see equation Appendix A). It should be noted that metals do not easily pass through skin, so dermal absorption is not the main route of exposure with regard to lead-contaminated soil. The MTCA level of 250 ppm is based on preventing unacceptable blood lead levels in Washington. The PRG is an estimate of the amount of lead in the bare soil in a residential area that might contribute to 5% of exposed children exceeding a blood lead level of 10 micrograms per deciliter (ug/dl).

Q: The EPA states concerning **lead** "a risk-based cleanup level would have no more than a 5% probability of exceeding the level of concern." With a planned student population of 1200, 5% translates into a level that may be of concern to 60 students (or their parents). Is this a correct interpretation, if not, with a population of 1200, how many students are expected to fall into this level of concern [Please show details of and source for the calculations]?

A: This is an incorrect interpretation based on the scenario. EPA developed its risk-based numbers using its Integrated Exposure Uptake Biokinetic Model (IEUBK) to predict blood lead levels (in children from birth to 7 years of age) from soil-lead concentrations. Children tend to have highest exposure to lead in soil and dust between the ages of 18 months to 3 years, and exposure tends to decrease in older children. Using the default assumptions in the model, it predicts that when the soil-lead concentration is about 350 ppm, about 5% of children would have blood lead levels exceeding 10 micrograms per deciliter (the level of concern for EPA, based on an evaluation by the Centers for Disease Control and Prevention). But two of the default assumptions in the IEUBK model do not apply to children exposed to lead-contaminated soil at school: the model assumes that children are exposed from birth to 7 years of age, and are exposed for 365 days per year.

It is probably closer to the truth that the children who are exposed or will be exposed are mostly High School age (14 to 18 years old) and are exposed only about 200 days per year. Therefore, this model would not be used to predict blood lead level in High School-aged children. If, however, the model is used to evaluate daily exposure for children less than 7 years of age, but still assumes exposure of 365 days per year and 147 ppm soil lead level, it makes two predictions (See extra discussion on lead in Appendix D):

1. About 0.46 % of children under 7 years of age would have blood lead levels exceeding 10 micrograms per deciliter, and
2. The average blood lead levels of children under 7 who play frequently in this area would be 2.9 μg/dl.

Q: Is it correct that the mercury levels on the site are approximately 14 times the normal mercury levels of uncontaminated land in the Puget Sound?

A: No. The assumption the mercury levels on the site are approximately 14 times the normal mercury levels of uncontaminated land in the Puget Sound is incorrect. The average background mercury level in the Puget Sound is 0.05 ppm, and the average mercury level found on site is 0.05 ppm (See Table. 1 for soil background range).

Q: Various studies have found that the "total dose absorbed is directly proportional to the concentration in inspired air, and for a given concentration, body burden increases with duration and frequency of exposure, *and with exercise* (U.S. EPA, 1985)." Since the area is planned to be used as sports fields with lots of exercise and direct student contact with wet soil (football practice) this results in significantly greater exposure than in the residential situation that the PRGs targeted – what does the literature/EPA indicate about how to adjust for playing fields?

Would you recommend that the playing fields not be used when they are wet?

A: While this maybe true for some chemicals, the quote is taken out of context and is based on inhalation of trichloroethene (TCE) — a volatile organic compound (VOC) — not inhalation of contaminated soil particles. For contaminants found on site, ingestion and dermal pathways outweigh the inhalation pathway even if the inhalation rate is doubled or tripled. Furthermore, a wet playing field would limit the amount of soil suspended in the air and subsequently inhaled. There are no recommendations against using playing fields when they are wet.

Q: California requires ongoing monitoring during construction of schools on brownfields. With lead and mercury being items of concern and very cheap tests, would you recommend *daily testing of the soil* whenever there is significant movement of soil?

Would you recommend an immediate stop of soil movement whenever tests indicate soil exceeds recommended levels until an investigation occurs?

A: Soil-lead and mercury levels are below state clean-up levels and are not at levels of health concern (See extra discussion on lead and mercury in Appendix D). There are no recommendations for daily monitoring on site during construction. Still, as with all construction sites, dust suppression and erosion prevention measures should be put in place.

Q: Some students have compromised immune systems. Are there any authorities that would deem the concentration found unadvisable for such students?

A: Using exposure scenarios contianed in Appendix A, children's exposure to chemicals in soil at the site does not result in a dose that exceeds EPA's oral reference dose (RfD) or ATSDR's minimal risk level (MRL). These doses are protective of the human population (including sensitive subgroups) and are below doses likely to result in adverse health effects, even for people with compromised immune systems.

Q: The FDA writes, "At levels once thought to be acceptable, there now is evidence that lead may cause learning and behavioral disorders in children and also affect growth". There is an existing school on the site, Spectrum, which have written standardized tests (WASL) for the several years with consistently the worst learning results for North Kitsap School District. Coincidentally, a letter from a student at this school appeared in the Bremerton Sun about the site, it is interesting to note that this student's home page starts with "I'm constantly Tired….", a condition known to be associated with many chemical contaminants. Would you recommend that all students at Spectrum (past and current) be check for lead, mercury and other chemicals?

A: Neither mercury or lead have been found on-site at levels that would indicate the need to test children's blood for markers of exposure. Other chemicals on-site have not been found at levels that indicate a health threat to past, current, or future students at Spectrum.

Spectrum Community School standardized test (WASL) scores are comparable to all other Alternative High Schools in the state of Washington

Q: Is it correct that there is a proposal within the EPA to have the level for children set to 1/3 of the adult levels for children between 2 and 15?

a). A recent memorandum (EPA 1995a) issued by the EPA Administrator 'articulates the importance of good risk characterization, emphasizing "transparency, clarity, consistency and reasonableness." All analyses, conclusions, resulting decisions and criteria employed to arrive at such decisions must be made obvious and be clearly presented.' The failure to clearly address the issue of *children* using the proposed *playing fields* on this site appears to fly in the face of this memorandum and has raised doubts about this report. Please comment.

b). Teenage pregnancy is a reality and there is a growing tendency for school to supply daycare facilities on campus. The same proposal cited above suggests the level be reduced to 1/10 of adults for children below 2. Is there any risk or *uncertainty* about the safety of this site if an infant care facility is added to this site?

A: The question above relates to the March 2003 Draft Final Guidelines for Carcinogen Risk Assessment; the March 2003 draft Supplemental Guidance for Assessing Cancer Susceptibility from Early-Life Exposure to Carcinogens are unavailable. This guidance suggests implementing adjustment in slope factor (i.e., cancer potency factor) to account for susceptibility of children to toxic insults at early ages, from chemicals that are mutagenic. The only carcinogenic COC at the site is soil-arsenic and the adjustment in slope factor would not apply in the non-cancer risk evaluation. Adjustments in slope factor were applied in the cancer risk assessment for children and school-aged children.

(Please see Child Health Consideration Section – page 20).

Q: The EPA acknowledges using different standards for different states. The report cites a PRG for lead of 400 ppm while the Washington Department of Ecology sets a limit of 250ppm (Oregon limit is 200ppm and California's is 130ppm). Why was the higher value used and not the value set by Washington State?

The current standard in some EU countries (i.e. Sweden) is 30 ppm.

A: See previous answer to question 23.

Q: The Center for Health, Environment and Justice has testified before the Senate and has been cited as a resource by the EPA. The Center has advocated and proposed separate standards for schools.

a). Would you recommend that the site be cleaned up to their proposed standards (which are the standards for New York State – the site of Love Canal)?

b). Are there school specific standards from an alternative organization that you would recommend?

c). The Brownfields 2002 Conference had a paper accepted and presented on school construction and brownfields, would you recommend that the guidance of this paper be followed?

A: The state of Washington has developed clean-up levels for contaminants in soil for unrestricted land use based on human health considerations and natural background concentrations. None of the contaminants at this site exceed these levels.

Q: There is a difference between *required actions (binding,* enforceable regulatory standard*)* and *recommendations* (non-binding that would be desirable to *some authorities*). Would you / EPA recommends the following actions (in an ideal world):

a). The site should have all chemicals reduced to below 1/3 of the residential PRGs (see 6 above)

b). The site should have all chemicals reduced to below 35% of the residential PRGs (see 3 above)

c). The site should have all chemicals reduced to 12% of the residential PRGs or the levels found on uncontaminated soil in the Puget Sound (compounding 3 and 6 above) d). The site fully met the levels advocated by CHEJ (8 above).

e). That reducing the level of all chemicals to the level of a pristine site ("greenfield") would result in the least risk to children.

> **A:** MTCA standards are not only binding (i.e., enforceable), but they are protective of human health. Although a few on-site contaminants exceeded health based comparison values, scenarios indicative of a child's vulnerability to chemicals did not result in adverse health outcomes.

Q: What actions would you recommend to absolutely minimize the risk to children on the site; insure that the site will meet or exceed potential changes of standards that may occur in the future thus saving the cost of needing to clean up and rebuild the playing fields and school. Some foreseeable examples include Washington adopting the California, Minnesota or Swedish standards or the EPA bringing in standards specific for children or for playgrounds.

> **A:** No actions are needed. Please refer to the answers provided to questions (23, 33 and 34) above.

Conclusions

After a thorough evaluation of available environmental information, DOH has reached the following conclusions:

No current or future apparent public health hazard exists for children exposed to chemicals in soil at Nike Site # 92 in Kingston, WA.

- Few chemicals in soil at the Kingston Nike site were detected above health-based comparison values. Children's exposure to chemicals in on-site soil through dermal contact, inhalation, and incidental ingestion is unlikely to result in adverse non-cancer or cancer health effects.

No apparent public health hazard exists from exposure to chemicals in drinking water near Nike Site # 92 in Kingston, WA.

a. Six drinking water wells (5 private, 1 public) were tested for numerous chemicals and radiation. Only manganese was present above health-based comparison values.
b. Exposure to manganese in drinking water results in a dose less than 3 times EPA's reference dose (safe dose), and therefore is unlikely to result in adverse health effects.
c. Several inorganic and organic compounds were found in the perched groundwater (Appendix C - Table C2 and C3). Chemicals identified in this sample were not considered as contaminants of concern because suspended soil particles and other solids were present in this sample. These suspended solids can cause high metal concentration when analyzed and are not indicative of drinking water in the area. Furthermore, the perched groundwater is not used as a source of drinking water.
d. After an evaluation of all cancer types in the area, DOH found no statistically meaningful elevations in cancer incidence for Kingston area or Kitsap County.

Recommendations

Because no current or future public health hazards at the Nike Site #92 have been established, DOH has no recommendations at this time.

Public Health Action Plan

Actions Completed

1. DOH attended two EPA-sponsored public meetings in Kingston, Washington. Staff provided educational material to, and solicited health concerns from, community members present at the meeting, including
   - private wells drinking water and manganese commonly asked questions
   - health consultation fact sheet, and
   - community health concerns form.
2. In August 2004, DOH and EPA contractor conducted a radiation survey at Nike Site #92.
3. DOH e-mailed a draft health consultation to concerned parties and provided hard copies to repositories located at
   - Kingston Library 11212 State Hwy 104, Kingston, WA 98346 (360)-297-3330

- Little Boston Library - 31980 Little Boston Road NE, Kingston, WA 98346 (360) 297-2670

4. DOH created and mailed a fact sheet to the concerned parties and residents of potential students to the new Kingston High School.

Actions Planned

DOH will follow-up with a full detailed report on the analysis of the Cancer Registry data.

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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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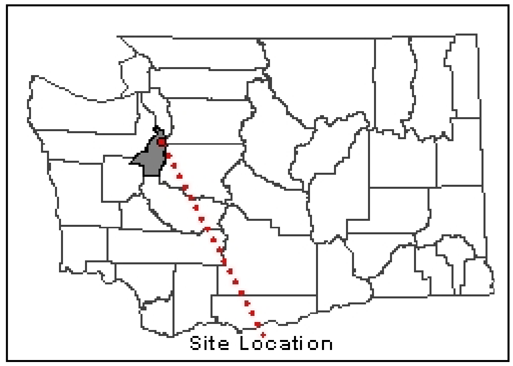
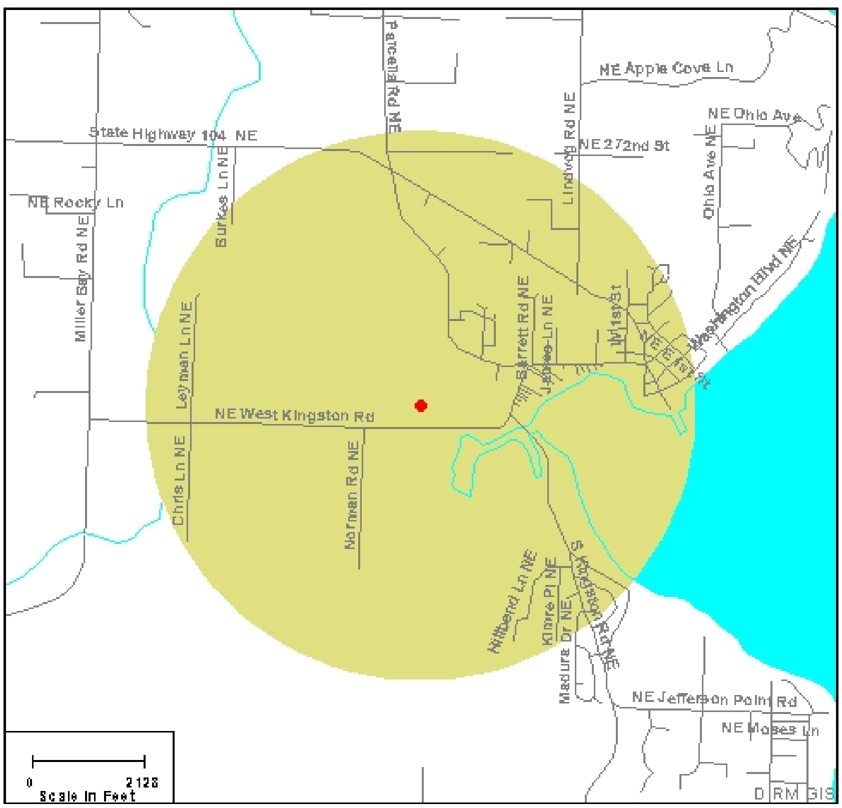
Figure 1. Demographic Statistics Within One Mile of the Site* - Kingston, Kitsap County

Total Population	**1153**
White	**1069**
Black	**1**
American Indian, Eskimo, Aleut	**17**
Asian or Pacific Islander	**23**
Other Race	**13**
Hispanic Origin	**31**
Children Aged 6 and Younger	**125**
Adults Aged 65 and Older	**125**
Females Aged 15 – 44	**242**
Total Aged over 18	**836**
Total Aged under 18	**317**
Total Housing Units	**488**





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

Appendix A

This section provides calculated exposure doses and assumptions used for exposure to chemicals in soil at the Kingston Nike site. Three different exposure scenarios were developed to model exposures that might occur at the site as a result of converting the site to a high school. These scenarios were devised to represent exposures to 1) a child (0-5 yrs) in the unlikely event that a daycare should be opened on-site, 2) a high-school aged child, and 3) an adult teacher. The following exposure parameters and dose equations were used to estimate exposure doses from direct contact with chemicals in soil.

Exposure to chemicals in soil via ingestion, inhalation, and dermal absorption.

Total dose $_{\text{(non-cancer)}}$ = Ingested dose + inhaled dose + dermally absorbed dose

Ingestion Route

$$\text{Dose}_{\text{(non-cancer (mg/kg-day)}} = \frac{C \times CF \times IR \times EF \times ED}{BW \times AT_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{C \times CF \times IR \times EF \times CPF \times ED}{BW \times AT_{\text{cancer}}}$$

Dermal Route

$$\text{Dermal Transfer (DT)} = \frac{C \times AF \times ABS \times AD \times CF}{ORAF}$$

$$\text{Dose}_{\text{(non-cancer (mg/kg-day)}} = \frac{DT \times SA \times EF \times ED}{BW \times AT_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{DT \times SA \times EF \times CPF \times ED}{BW \times AT_{\text{cancer}}}$$

Inhalation of Particulate from Soil Route

$$Dose_{non\text{-}cancer\ (mg/kg\text{-}day)} = \frac{C \times SMF \times IHR \times EF \times ED \times 1/PEF}{BW \times AT_{non\text{-}cancer}}$$

$$Cancer\ Risk = \frac{C \times SMF \times IHR \times EF \times ED \times CPF \times 1/PEF}{BW \times AT_{cancer}}$$

Table A1. Exposure Assumptions for exposure to chemicals in soil at Kingston Nike site #92, Kingston, Kitsap County, WA.

Parameter	***Value***	***Unit***	***Comments***
Concentration (C)	Variable	mg/kg	Maximum detected value
Conversion Factor (CF)	0.000001	kg/mg	Converts contaminant concentration from milligrams (mg) to kilograms (kg)
Ingestion Rate (IR) – adult	50	mg/day	Exposure Factors Handbook [23]
Ingestion Rate (IR) – older child	50		
Ingestion Rate (IR) - child	200		
Exposure Frequency (EF)	200	days/year	Average days in school year
Exposure Duration (Ed)	(5, 5, 30)	years	Number of years at school (child, high school age child, adult - teacher).
Body Weight (BW) - adult	72	kg	Adult mean body weight
Body Weight (BW) – older child	41		Older child mean body weight
Body Weight (BW) - child	15		0-5 year-old child average body weight
Surface area (SA) - adult	5700	cm^2	Exposure Factors Handbook
Surface area (SA) – older child	2900		
Surface area (SA) - child	2900		
Averaging Time$_{non-cancer}$ (AT)	1825	days	5 years
Averaging Time$_{cancer}$ (AT)	27375	days	75 years
Cancer Potency Factor (CPF)	Variable	$mg/kg\text{-}day^{-1}$	Source: EPA: CPF are presented in Table A 3
24 hr. absorption factor (ABS)	Variable	unitless	Source: EPA Chemical Specific Arsenic – 0.03 Inorganic – 0.001 Organic – 0.01
Oral route adjustment factor (ORAF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Adherence duration (AD)	1	days	Source: EPA
Adherence factor (AF)	0.2	mg/cm^2	Child, older child
	0.07		Adult
Inhalation rate (IHR) - adult	15.2	m^3/day	Exposure Factors Handbook
Inhalation rate (IHR) – older child	14		
Inhalation rate (IHR) - child	8.3		
Soil matrix factor (SMF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Particulate emission factor (PEF)	1.45E+7	m^3/kg	Model Parameters

Soil Ingestion Route of Exposure – Non-cancer

Table A2. Non-cancer hazard calculations resulting from exposure to contaminants of concern in soil at Kingston Nike site – Kingston, Kitsap County, Washington.

Contaminant	Max Concentration (ppm) (mg/kg)	Scenarios	Estimated Dose (mg/kg/day)			Total Dose	RfD (mg/kg/day)	Hazard quotient
			Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates			
Arsenic	18.1	Child	1.32E-4	1.15E-5	3.79E-7	1.44E-4	3E-4	0.48
		High School age child	1.21E-5	4.21E-6	2.34E-7	1.65E-5		0.06
		Adult - Teacher	6.89E-6	1.65E-6	1.44E-7	8.68E-6		0.03
Antimony	33.7	Child	2.46E-4	7.14E-7	7.05E-7	2.47E-4	4E-4	0.62
		High School age child	2.25E-5	2.61E-7	4.35E-7	2.32E-5		0.06
		Adult - Teacher	1.28E-5	1.02E-7	2.69E-7	1.32E-5		0.03

Soil Ingestion Route of Exposure — Cancer

Table A3. Cancer risk resulting from exposure to contaminants of concern in soil samples from Kingston Nike site – Kingston, Kitsap County, Washington.

Contaminant	Max Concentration (ppm)	EPA cancer Group	Cancer Potency Factor (mg/kg-day^{-1})	Scenarios	Increased Cancer Risk			Total Cancer Risk
					Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates	
Arsenic	18.1	A	15	Child 0-2	5.29E-5	4.60E-6	1.51E-7	8.36 E-5*
			4.5	Child 3-5	2.38E-5	2.07E-6	6.81E-8	
			1.5	High School age child	1.21E-6	4.21E-7	2.34E-8	1.65E-6
				Adult - Teacher	4.13E-6	9.89E-6	8.67E-8	1.41E-5
Antimony	33.7	D	NA	Child	NA	NA	NA	NA
				High School age child				
				Adult - Teacher				

- Total theoretical cancer risk for a child 0 – 5 years old

Appendix B

This section provides calculated exposure doses and assumptions used for exposure to chemicals in drinking water near the Kingston Nike site. The following exposure parameters and dose equations were used to estimate exposure doses from ingesting chemicals in drinking water.

$$\text{Dose}_{(\text{non-cancer (mg/kg-day)})} = \frac{Cw \times IR \times EF \times ED}{BW \times AT_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{Cw \times CSF \times IR \times EF \times ED}{BW \times AT_{\text{cancer}}}$$

Table B1. Exposure Assumptions for exposure to chemicals in drinking water near Kingston Nike site #92, Kingston, Kitsap County, WA.

Parameter	Value	Unit	Comments
Concentration (Cw) – maximum	Variable	mg/L	Maximum detected value
Ingestion Rate (IR) – adult	1.4	l/day	Exposure Factors Handbook
Ingestion Rate (IR) – older child	1.0		
Ingestion Rate (IR) - child	0.9		
Exposure Frequency (EF)	350	days/year	Number of days at a residence (one year minus two weeks vacation)
Exposure Duration (ED)	30 (5, 10, 15)	years	Number of years at one residence (child, older child, adult yrs).
Body Weight (BW) - adult	72	kg	Adult mean body weight
Body Weight (BW) – older child	41		Older child mean body weight
Body Weight (BW) - child	15		0-5 year-old child average body weight
Averaging Time$_{\text{non-cancer}}$ (AT)	1825	days	5 years
Averaging Time$_{\text{cancer}}$ (AT)	27375	days	75 years
Oral Cancer Slope Factor (CSF)	Variable	mg/kg-day^{-1}	Source: EPA

Drinking water Ingestion Route of Exposure – Non-cancer

Table B2. Non-cancer hazard calculations resulting from exposure to contaminants of concern in drinking water near Kingston Nike site #92– Kingston, Kitsap County, Washington.

Contaminant	Max Concentration (ppb)		Estimated Ingested Dose (mg/kg/day)	RfD (mg/kg/day)	Hazard quotient
Manganese	924	Child	5.3E-2	1.4E-1	0.38
		Older child	2.16E-2		0.15
		Adult	1.7E-2		0.12

Appendix C: Other Chemicals Reported Without Comparison Values.

(Many are known to be constituents of plant and animal matter).

Table C1. Maximum concentrations of other organic compounds detected in soil at the Kingston Nike # 92 site without comparison values in Kitsap County, Kingston, WA.

Organic Compounds	Maximum Concentration (ppm)	Organic Compounds	Maximum Concentration (ppm)	Organic Compounds	Maximum Concentration (ppm)
Acetic acid, methyl ester	0.0021 UJK	Propanal, 2-methyl-	0.0049 JN	1-Heptadecanol, Acetate	0.83 JN
Dimethyl disulfide	0.0066 JN	Butanal	0.0021 JN	2-Phenanthrenol, 4B,5,6,7,8,	5.9 JN
3-Octanone	0.0059 JN	Benzoic acid, 2-[(trimethylsilyl)o	0.003 JN	9-Hexacosene	4.8 JN
Oxirane,		Methanethiol	0.0062 JN	2-Nonacosanone	4.6 JN
Benzene, (1-methylethyl)	0.011 JN	Methane, thiobis-	0.04 JN	1-Octadecanethiol	3.2 JN
Bicyclo[3.1.0]hex-2-ene, 2-methyl	0.0048 JN	3-Nitroaniline	4.6 UJK	9-Octadecenamide, (Z)-	0.1 JN
Beta-phellandrene	0.051 JN	4-Nitrophenol	4.6 UJK	Phenanthrene, 7-ethenyl-1,2,	1.0 JN
Beta-pinene	0.011 JN	Benzenepropanoic acid	0.45 JN	17-Norkaur-15-ene, 13-methyl	0.39 JN
Bicyclo[4.1.0]hept-2-ene, 3,7,7-tr	0.009 JN	Octadecane, 1-Chlroro-	0.86 JN	17-Pentatriacontene	0.55 JN
Cyclohexane, 1-methyl-	0.014 JN	1-Docosene	7.7 JN	Taraxerol	3.0 JN
Benzene, 1-methyl-3-(1-methylethyl)	0.0098 JN	17-Octadecenal	6.5 JN	Benzene, 1-methyl-2-(1-methylethyl)	0.012 JN
1,4-Cyclohexadiene, 1-methyl-4-(1 -methylethyl)	0.014 JN	16-Octadecenal	3.7 JN	1,3,6-Octatriene, 3,7-dimethyl-	0.024 JN
Cyclohexane, 1-methyl-4-(1-methylethylidene)	0.0089 JN	2-Heptacosanone	4.8 JN	Cyclohexane, 1,2-dimethyl-, tran	0.0078 JN
Bicyclo[3.1.0]hexan-3-one, 4-met	0.041 JN	1-Hexacosanal	3.9 JN	Benzeneethanamine, N-[(pentafl	0.001 JN
Thujone	0.022 JN	D-Friedoolean-14-en-3-one	9.7 JN	Tetradecanoic acid	0.58 JN
Cyclohexanone, 2-methyl-5-(1-m	0.29 JN	D:C-Friedoolean-8-en-3-one	3.8 JN	Ethanol, 2-(9-Octadecenyloxy	1.6 JN
Benzene, 2-propenyl-	0.014 JN	Stigmast-4-en-3-one	3.9 JN	Acetic acid, Octadecyl ester	1.0 JN
1-Hydroxymethyl-2-methyl-1-cy	0.0079 JN	Lupeol	3.3 JN	1-Nonadecanol	1.1 JN

UJK- data qualifier: The analyte was not detected at or above the reported estimated result. The associated numerical value is an estimate of the quantitation limit of the analyte in this sample. Unknown Bias

JN - data qualifier: There is evidence that the analyte is present. The associated numerical result is an estimate

D - EPA: Not classifiable as to health carcinogenicity

Table C2. Maximum concentrations of inorganic compounds detected in Perched Groundwater at the Kingston Nike # 92 site in Kitsap County, Kingston, Washington.

Inorganic Compounds	Maximum Concentration (ppb)	Comparison Value (ppb)	EPA Cancer Class	Comparison Value Reference	Contaminant of Concern
Aluminum	24800	20000*		IM EMEG	No
Antimony	0.49 J	4	D	RMEG	No
Barium	21.4 J	700	D	RMEG	No
Beryllium	0.42 J	20		EMEG	No
Calcium	164000				No
Chromium III	104	20000	D	RMEG	No
Copper	46.1	300	D	IM EMEG	No
Iron	36500				No
Lead	5.8 J	5		MTCA	No
Magnesium	21200				No
Manganese	488	500	D	RMEG	No
Nickel	107	200		RMEG	No
Potassium	3190 JK				No
Sodium	9860				No
Vanadium	88.9	30*		IM EMEG	No
Zinc	101	3000	D	EMEG	No

*Drinking water value

RMEG - ATSDR's Reference Dose Media Evaluation Guide (child)

EMEG - ATSDR's Environmental Media Evaluation Guide (child)

IM EMEG - ATSDR's Intermediate Environmental Media Evaluation Guide (child)

J - data qualifier: The analyte was positively identified. The associated numerical result is an estimate

JK - data qualifier: The analyte was positively identified. The associated numerical result is an estimate. Unknown Bias

D - EPA: Not classifiable as to health carcinogenicity

MTCA – Washington State Department of Ecology: Model Toxics Control Act

Table C3.Maximum concentrations of organic compounds detected in Perched Groundwater at the Kingston Nike # 92 site in Kitsap County, Kingston, Washington.

Organic Compounds	Maximum Concentration (ppb)	Comparison Value (ppb)	EPA Cancer Class	Comparison Value Reference	Contaminant of Concern
2-Butanone	4.4	6000		RMEG	No
2-Propanone	21 JH	20000		IM EMEG	No
Methylene Chloride	0.67 UJK	5	B2	CREG	No
Caprolactam	2.7 JQ	5000		RMEG	No
Benzo(b)fluoranthene	5.0 UJK		B2		No (cPAH)
Benzo(k)fluoranthene	5.0 UJK		B2		No (cPAH)
Benzo(a)pyrene	5.0 UJK	0.005	B2	CREG	No (cPAH)
Indeno (1,2,3-cd)- pyrene	5.0 UJK		B2		No (cPAH)
Dibenzo(a,h)anthracene	5.0 UJK		B2		No (cPAH)
Benzo(g,h,I)perylene	5.0 UJK	400*	D		No
2,2,6,6-tetramethylheptane-3,5-d	0.36 JN				No
3,5-dimethyl-heptane	0.62 JN				No
Glycocyanidine	0.44 JN				No
Butanal	0.16 JN				No
2,2'-oxybis (1-chloropropane)	5.1 UJK	400	D	RMEG	No
4-Nitroaniline	21.0 UJK				No

CREG - ATSDR's Cancer Risk Evaluation Guide (child)

RMEG - ATSDR's Reference Dose Media Evaluation Guide (child)

IM EMEG - ATSDR's Intermediate Environmental Media Evaluation Guide (child)

JH - data qualifier: The analyte was positively identified. The associated numerical result is an estimate. High Bias

JQ - data qualifier: The analyte was positively identified. The associated numerical result is an estimate. The result is estimated because the concentration is below the contract required quantitation limits

UJK - data qualifier: The analyte was not detected at or above the reported estimated result. The associated numerical value is an estimate of the quantitation limit of the analyte in this sample. Unknown Bias

JN - data qualifier: There is evidence that the analyte is present. The associated numerical result is an estimate

B2 - EPA: Probable human carcinogen (inadequate human, sufficient animal studies)

D - EPA: Not classifiable as to health carcinogenicity

* Fluoranthene RMEG value was used as a surrogate for Benzo(g,h,I)perylene

(cPAH) – See appendix D - Polycyclic Aromatic Hydrocarbons

Appendix D: Additional Discussion of Lead, Mercury and PAHs

Lead: Occurrence, Health Concerns, and Risks

Lead is a naturally occurring chemical element that is normally found in soil. In the Puget Sound Basin, background concentrations range from 2.1 – 207.5 parts per million (ppm) [15]. However, the widespread use of certain products (such as leaded gasoline, lead-containing pesticides, and lead-based paint) and the emissions from certain industrial operations (such as smelters) has resulted in significantly higher levels of lead in many areas the state.

Elimination of lead in gasoline and solder used in food and beverage cans has greatly reduced exposure to lead. Currently, the main pathways of lead exposure in children are ingestion of paint chips, contaminated soil and house dust, and drinking water in homes with lead plumbing.

Children less than 7 years of age are particularly vulnerable to the effects of lead. Compared with older children and adults, they tend to ingest more dust and soil, absorb significantly more of the lead they swallow, and more of the lead that they absorb can enter their developing brains. Pregnant women and women of childbearing age should also be aware of lead in their environment because lead ingested by a mother can affect the unborn fetus.

Health effects

Exposure to lead can be monitored by measuring the level of lead in the blood. In general, blood lead rises 3–7 micrograms of lead per deciliter of blood (μg/dl) for every 1,000 ppm increases in soil or dust concentration [24]. For children, the Centers for Disease Control and Prevention (CDC) has defined an elevated blood lead level (BLL) as greater than or equal to 10 (μg/dl) [25]. Growing evidence, however, suggests that damage to the central nervous system resulting in learning problems can occur at blood lead levels less than 10 μg/dl. About 2.2 percent of children in the United States have blood lead levels greater than 10 μg/dl.

Lead poisoning can affect almost every system of the body and often occurs with no obvious or distinctive symptoms. Depending on the amount of exposure a child has, lead can cause behavior and learning problems, central nervous system damage, kidney damage, reduced growth, hearing impairment, and anemia [26].

In adults, lead can cause health problems such as high blood pressure, kidney damage, nerve disorders, memory and concentration problems, difficulties during pregnancy, digestive problems, and pain in the muscles and joints [26]. These have usually been associated with blood lead levels greater than 30 μg/dl.

Because of chemical similarities to calcium, lead can be stored in bone for many years. Even after exposure to environmental lead has been reduced, lead stored in bone can be released back into the blood where it can have harmful effects. Normally this release occurs relatively slowly. Butt certain conditions such as pregnancy, lactation, menopause, and hyperthyroidism can cause a more rapid lead release, which could lead to a significant increase in blood lead level [27].

Health risk evaluation – The IEUBK model

To evaluate the potential for harm, public health agencies often use a computer model that can estimate blood lead levels in children younger than 7 years of age who are exposed to lead-contaminated soil. This model (developed by the EPA and called the Integrated Exposure Uptake

Biokinetic Model, or IEUBK model) uses the concentration of lead in soil to predict blood lead levels in children [28]. It is intended to help evaluate the risk of lead poisoning for an average group of young children who are exposed to lead in their environment. The IEUBK model can also be used to determine what concentration of lead in soil could cause an unacceptable risk of elevated blood lead levels in an average group of young children. It is often used in this way to set soil clean-up levels for lead. It is important to note that the IEUBK model is not expected to predict accurately the blood lead level of a child (or a small group of children) at a specific point in time. This is in part because a child (or group of children) can behave differently. Thus individual children can have different amounts of exposure to contaminated soil and dust than the average group of children used by the model to calculate blood lead levels. For example, the model does not take into account reductions in exposure that could result from community education programs. Despite this limitation, the IEUBK model is a useful tool to help prevent lead poisoning because of the information it can provide about the hazards of environmental lead exposure.

For children who are regularly exposed to lead-contaminated soil the IEUBK model can estimate the percentage of young children who are likely to have blood lead concentrations that exceed a level that may be associated with health problems (usually 10 μg/dl).

Soil lead concentration and estimated blood lead levels at the Nike Site # 92

The IEUBK model was used to estimate the percentage of children who could have elevated blood lead levels if they play frequently in areas with lead contamination and exhibit typical behaviors that result in ingestion of soil. These percentages were calculated using the maximum soil-lead concentrations measured on site. This is expected to be an overestimate — most or all children at the Nike site # 92 are likely to have regular exposure only to soil containing less than the maximum amount of lead. Nonetheless, this estimate is useful in determining the potential hazard for those children who could be exposed to the most contaminated area.

The maximum concentration of lead detected at the Nike site # 92 was 147 ppm. For children less than seven years old who have daily exposure to soil containing 147 ppm lead, IEUBK model calculations (win Version 1.0 build 255) indicate that about 0.46 % will have blood lead levels greater than 10 μg/dl. The model also predicts that the average blood lead levels of children under seven who play frequently in this area would be 2.9 μg/dl. About 2.2 percent of children in the United States have blood lead levels greater than 10 μg/dl. most children at the Nike site are. however, unlikely to have daily exposure to the soil on this property, and the actual percentage of children with elevated blood lead levels from exposure to on-site soil is expected to be less than 0.46 %.

Mercury

Mercury is a naturally occurring element in the earth's soil. In the Puget Sound Basin background soil mercury concentration ranges between 0.012 and 0.094 ppm [15]. The MTCA clean-up level for mercury is 1 ppm [29]. Mercury exists in the environment in three forms: elemental, inorganic, and organic.

Inorganic mercury-contaminated soil can be accidentally ingested by hand to mouth activity that could increase exposure. About 10 to 40 percent of the ingested inorganic mercury entering the body can be absorbed through the stomach and intestines, and only a small amount will pass through the skin [30]. Ingested inorganic mercury then enters the bloodstream and moves to different tissues, including the kidneys. Inorganic mercury slowly leaves the body in the urine and feces [30].

Non-cancer effects

Exposure for children is estimated to be about 0.0000056 milligrams of mercury per kilogram of body weight per day. The calculated hazard quotient (using methlymercury RfD as a surrogate) is about 0.048 for a child (Table 15). Therefore, would not result in any non-carcinogenic adverse health effects.

Cancer effects

The EPA classifies mercury as Group D (not classifiable as to human carcinogenicity). Epidemiological studies failed to show a correlation between exposure to mercury and carcinogenicity. Therefore, no carcinogenic adverse health effects would be expected, as a result of mercury exposure.

Soil Ingestion Route of Exposure – Non-cancer

Table D1. Estimated dose calculations from exposure to Mercury in soil at the Kingston Nike site # 92– Kingston, Kitsap County, Washington.

Contaminant	Max Concentration (ppm)		Estimated Dose (mg/kg/day)			RfD (mg/kg/day)	Hazard quotient
			Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates		
Mercury	0.51	Child	3.73E-6	1.08E-6	1.07E-8	1E-4#	0.048
		Older child	6.82E-7	3.95E-7	6.58E-9		0.011
		Adult	3.88E-7	1.55E-7	4.07E-9		0.0055

#- RfD for Methylmercury (the most toxic form of mercury)

Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are generated by the incomplete combustion of organic matter, including oil, wood, and coal. They are found in materials such as creosote, coal, coal tar, and used motor oil. Given the structural similarities, metabolism and toxicity, PAHs are often grouped together when one is evaluating their potential for adverse health effects. The EPA has classified some PAHs as probable human carcinogens (B2), as a result of *sufficient* evidence of carcinogenicity in animals and *inadequate* evidence in humans [31]. That group of PAHs is known as carcinogenic polycyclic aromatic hydrocarbons (cPAH).

Benzo(a)pyrene is the only cPAH for which EPA has derived a cancer slope factor. Benzo(a)pyrene cancer slope factor was used as surrogate to estimate the total cancer risk of cPAHs in water. It should be noted, benzo(a)pyrene is considered the most carcinogenic of the cPAHs. The use of its cancer slope factor as a surrogate for total cPAH carcinogenicity could overestimate risk. To address this issue, DOH made an adjustment for each cPAH based on the relative potency to benzo(a)pyrene.

Dietary sources make up a large percentage of PAH exposure in the U.S. population, and smoked or barbecued meats and fish contain relatively high levels of PAHs. The majority of dietary exposure to PAHs for the average person comes from ingestion of vegetables and grains (cereals) [32].

The detection limits used in the drinking water and groundwater analyses were not adequate to distinguish the level of PAH contamination found in water. PAHs are non-polar and hydrophobic compounds with very low solubility in water. Therefore, it is highly unlikely that PAH were actually detected in the water since there is not a comparable source of PAHs in the soil.

Appendix E: Summary of the Methodology Used in Reviewing the Washington State's Cancer Registry Data 1992 – 2001 for Kingston Area, Kitsap County, and Washington State.

Methods and Subjects:

Design:

The report involves analyses of the longitudinally gathered cancer incidence data from 1992 through 2001 in the Washington State's Cancer Registry.

Considered Geographical Areas:

Three geographical areas are considered for a relative comparison[1] of the respective cancer(s) incidence rates: 1) Washington State, 2) Kitsap County[2], and 3) Kingston area. (Kingston area is defined *for the purpose of this evaluation* as the census tracts (090101, 090102, 090601, 090602, and 090700) that include Kingston and additional four census tracts that are adjacent to Kingston.

Type(s) of cancer evaluated:

This analysis examined cancers (all sites combined) according to the age-specific group structure in 5 year intervals for the three defined geographic areas. There are two reasons why we chose to look at all sites combined 1) From past and current site assessment reports on contaminants potentially present at the former Nike Missile Site # 92, there was no indication that a particular site specific cancer should be targeted. The practice of blind screening of all site-specific cancers is not recommended; it is a fishing expedition that would produce any outstanding site-specific cancer only by chance, with no help in identifying a common cause to address the concern expressed by the Kingston community; 2) An initial frequency run of incident cancer cases in Kingston area and Kitsap County showed very few observed cancer cases across age groups. Therefore, the observed incident cancer cases are insufficient to categorize according to other characteristics, such as site-specific cancers, sex, and race. Thus combing all site-specific cancer(s) was the only feasible approach in analyzing the data at hand.

Data analysis:

Using the Washington State's cancer registry data from 1992 through 2001, the number of new cancer cases, incidence rates, standardized incidence ratios, and their respective confidence intervals were calculated for Kingston area, for Kitsap County, and for Washington State. For the Kingston area, the sum of observed cases from five census tract-specific populations was used as a denominator after multiplying it by 3, as it is the only calendar year that has census-tract based population counts.

The expected (Exp) numbers of incident cases were calculated using 1) Kitsap county age group-specific incidence rates 2) Washington State age group-specific incidence rates for the respective calendar years, and multiplying them by the corresponding age group-specific population of the geographical area where we wanted to calculate the expected numbers. Standardized Incidence

[1] Kingston area, Kitsap County and Washington State are used for comparison.

[2] Kingston area is located within Kitsap County.

Ratios (SIR) were then determined by dividing the observed (Obs) cases of cancer for the respective age groups by the respective expected number of cases.

The observed and expected numbers were interpreted by looking at the ratio between them. If the observed numbers of incident cases is less than the expected number of cases, the SIR is less than one and implies fewer cases were observed than expected. When the SIR is greater than one, it implies more cases were observed than expected.

To account for random variation for the estimated SIR from unity, a statistical significance of the uncertainty was evaluated using a 95% confidence interval (CI). The 95% CI was to evaluate the probability that the SIR could be greater or less than 1.0 due to chance alone.

The formula (Breslow and Day 1987 used a generic formula, except that the expression we used is based on one instead of 100) shown below was used to calculate the upper and lower limits for the respective SIRs that approximate the exact test for the poison distribution.

Lower Limit of the SIR: $\{Obs \times [1-((1 \div (9 \times Obs))-(Z_{\alpha/2} \div (3 \times Obs^{0.5})))]^3\} \div Exp$

Upper Limit of the SIR: $\{(Obs+1) \times [1-((1 \div (9 \times Obs))-(Z_{\alpha/2} \div (3 \times Obs^{0.5})))]^3\} \div Exp$

For calculations involving Kingston area, the upper and lower limits *for small numbers* were additionally examined using directly the observed numbers and ran through a program written in a SAS program language, following Leslie Daly, "Simple SAS macros for the calculation of exact binomial and Poisson Confidence limits." Comput Biol Med 1992;22(5):351–361.

The upper and lower limits of the SIRs were determined as follows:

Lower Limit of the SIR: Lower Confidence Intervals of the Counts ÷ Exp

Upper Limit of the SIR: Upper Confidence Intervals of the Counts ÷ Exp

Figures 2 and 3 depict the main findings of our analysis that is specific to the Kingston area, and are pulled into this summary as complementary. Overall, the results indicated no statistically significant difference between the occurrence of cancer(s) in Kingston area and the occurrence of cancer in Kitsap county or Washington State. However, tables and figures that list specific numbers are omitted for confidentiality reasons, because many cells hold small numbers that are less than five.

Figure 2. Kingston Area Standardized Incidece Ratios(SIR) Compared to Kitsap County and the Corresponding 95% Upper and Lower Confidence Limits (UCL, LCL) by age groups, 1999-2001

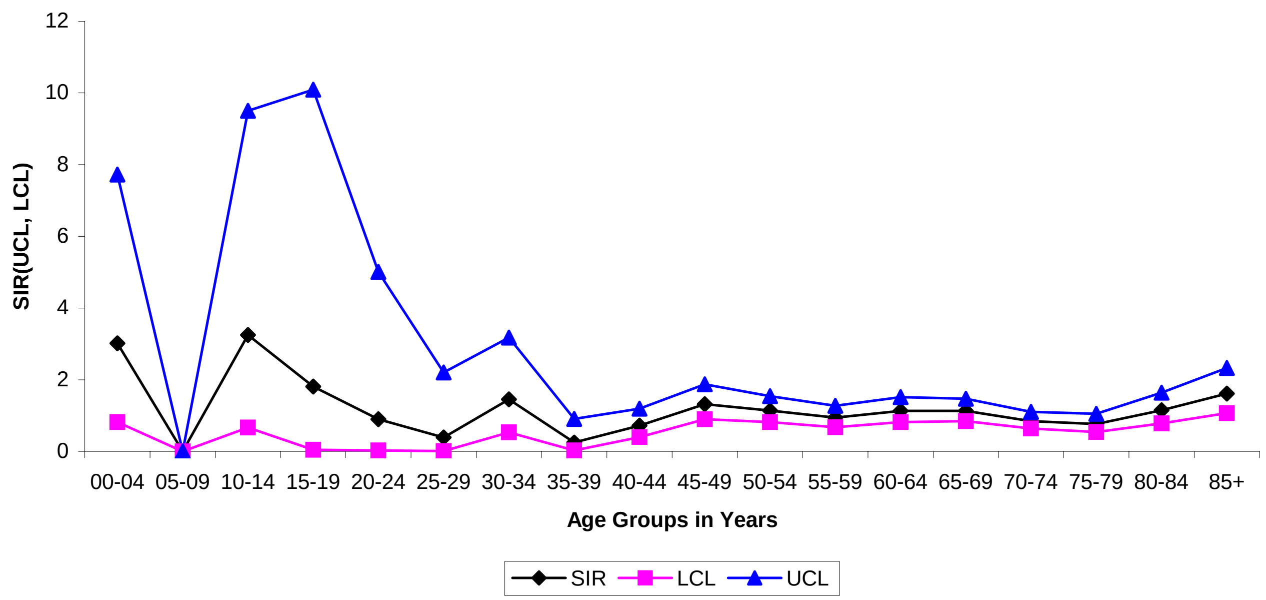


Figure 3. Kingstaon Area Standardized Incidence Ratios(SIR) Compared to Washington State and the Corresponding 95% Upper & Lower Confidence Limits (UCL, LCL) by age groups, 1999-2001