

# Health Consultation

City of Algonia – 2013 Residential Indoor Air Results  
Boeing Commercial Airplanes Fabrication Division  
Auburn, King County, Washington

January 16, 2014

**Prepared by**

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



## **Foreword**

The Washington State Department of Health (DOH) prepared this health consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services. ATSDR is responsible for health issues related to hazardous substances.

The purpose of a health consultation is to assess the health threat posed by hazardous substances in the environment. If needed, a health consultation will also recommend steps or actions to protect public health. Health consultations are initiated in response to health concerns raised by residents or agencies about exposure to hazardous substances.

This health consultation was prepared in accordance with ATSDR methodologies and guidelines. However, the report has not been reviewed and cleared by ATSDR. The findings in this report are relevant to conditions at the site during the time the report was written. It should not be relied upon if site conditions or land use changes in the future.

Use of trade names is for identification only and does not imply endorsement by state or federal health agencies.

For additional information, please contact us at 1-877-485-7316 or visit our web site at [www.doh.wa.gov/consults](http://www.doh.wa.gov/consults).

For persons with disabilities this document is available on request in other formats. To submit a request, please call 1-800-525-0127 (TDD/TTY call 711).

For more information about ATSDR, contact the CDC Information Center at 1-800-CDC-INFO (1-800-232-4636) or visit the agency's web site at [www.atsdr.cdc.gov](http://www.atsdr.cdc.gov).

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## **Summary**

### **Introduction**

At the request of the Washington Department of Ecology (Ecology), the Washington Department of Health (DOH) evaluated indoor air data collected by The Boeing Company (Boeing) from homes located in the northern part of the City of Algona. Boeing tested the homes between July and November 2013. The testing was done because shallow contaminated groundwater associated with the nearby Boeing Commercial Airplanes Fabrication Division facility contains chemicals that may evaporate and move into the indoor air of nearby homes.

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### **Conclusions**

DOH concludes that breathing the chemicals at the concentrations found in indoor air in 2013 is not expected to cause harmful health effects.

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### **Basis for Decision**

The concentrations of chemicals found in indoor air are below levels expected to cause harmful non-cancer health effects. The cancer risk associated with these chemicals is below a level considered a health threat.

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### **Next Steps**

1. DOH will mail the health consultation report to property owners and tenants whose homes were tested, City of Algona, Ecology, Public Health Seattle and King County, and Boeing.
2. DOH will provide fact sheets summarizing the health consultation report findings to property owners and tenants whose homes were tested, City of Algona, City of Algona residents, Ecology, Public Health Seattle and King County, and Boeing.
3. DOH will post the health consultation report on its website.
4. Boeing will offer another round of indoor air testing to the same 24 homes. The testing will occur during the first quarter of 2014.
5. DOH will evaluate future indoor air data to see if conditions have changed and determine if harmful health effects are possible.

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### **For More Information**

If you have any questions about this health consultation contact Barbara Trejo at 360-236-3373 or 1-877-485-7316 at Washington State Department of Health. For more information about ATSDR, contact the Center for Disease Control and Prevention (CDC) Information Center at 1-800-CDC-INFO (1-800-232-4636) or visit the agency's web site at [www.atsdr.cdc.gov](http://www.atsdr.cdc.gov).

## **Purpose and Statement of Issues**

At the request of the Washington Department of Ecology (Ecology), the Washington Department of Health (DOH) evaluated indoor air data collected by The Boeing Company (Boeing) from homes located in the northern part of the City of Algona. Boeing tested the homes between July and November 2013. The testing was done because shallow contaminated groundwater associated with the nearby Boeing Commercial Airplanes Fabrication Division facility contains chemicals that may evaporate and move into the indoor air of nearby homes. DOH conducts health consultations in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR).

## **Background**

The Boeing Commercial Airplanes Fabrication Division facility is located at 700 15<sup>th</sup> Street Southwest; Auburn, Washington (Boeing Auburn). The facility lies within the city limits of Auburn and Algona. It is bounded by 15<sup>th</sup> Street SW to the north, the General Services Administration (GSA) property to the east, Ellingson Road and the Safeway property to the south in the City of Pacific, and Perimeter Road to the west (Figure 1). The facility includes numerous manufacturing and office buildings, warehouses, support buildings, roads, and employee parking areas. The facility produces parts, tools, and assemblies for commercial aircraft.

Past releases of solvents from the facility have resulted in two plumes of solvent contaminated groundwater (western plume and Area 1 Plume). Both plumes have traveled off the Boeing property in a generally north/northwest direction. No one is drinking the contaminated groundwater. However, where the shallowest groundwater contains solvents, it may pose a health threat to people if the chemicals evaporate and move into the indoor air of nearby buildings.

In January 2013, Boeing discovered the western plume had traveled below a residential area in the north part of the City of Algona. Boeing took samples at forty-nine locations in Algona in April 2013 to investigate the depth and boundaries of the plume. This was done by collecting and testing groundwater at various depths in the area. Four solvents were found in the shallowest groundwater in the northeastern part of the residential area:

- Trichloroethylene (TCE);
- Vinyl chloride;
- Cis 1,2-dichloroethylene (cis 1,2-DCE); and
- Trans 1,2-dichloroethylene (trans 1,2-DCE).(1)

Based on the concentrations of these chemicals in shallow groundwater, health threats to people in nearby homes were not expected. Air testing was done to confirm this. The first round of indoor air testing was conducted between July and November 2013. This work was done by Boeing under Ecology oversight.

Boeing, Ecology, and DOH reviewed the indoor air data for each home as it became available. Based on DOH's preliminary review of the data, no immediate health concerns were expected at any of the homes tested. DOH's preliminary health findings were included in letters sent by Boeing and Ecology to each of the property owners/tenants explaining the results of the testing. Each letter explained that DOH would be conducting further evaluation of the data.

A second round of testing is planned for the first quarter of 2014 when groundwater in the area is higher and closer to the building foundation.

### **July to November 2013 Indoor Air Testing**

Twenty-four property owners/tenants were offered an opportunity to have the air inside and outside their homes tested for the chemicals found in the groundwater. These properties were selected because Ecology determined, based on how close they were to the shallow contaminated groundwater, there was a chance that the chemicals could affect indoor air. Twenty-three of the 24 buildings are residential buildings; one building is used as a garage. Only 14 of the 24 property owners/tenants chose to participate in the testing.

Air testing occurred at various locations on each property:

- Living space (such as living rooms and bedrooms)
- Basement
- Crawlspace
- Below concrete slab
- Outdoor

Crawlspace, basement, and air below concrete slab foundations were tested because they are located closest to the contaminated groundwater. Outdoor air was also tested to evaluate air around the homes. These test results help determine if any chemicals found in living spaces are coming from groundwater, outdoor air, or chemical used or stored in the home.

Most of the air testing was done using Summa canisters. This is a common method for testing air. The indoor and outdoor air tests were conducted for 24-hours while the sub-slab tests were conducted for about 30 minutes. These are typical timeframes for collecting indoor, outdoor, and sub-slab air samples at residential properties. The air collected in the canisters was tested for TCE, vinyl chloride, cis-1,2-DCE, and trans-1,2-DCE. Twenty-one day air samples were also collected in living spaces and crawlspaces of homes located nearest to the groundwater with the highest concentrations of TCE. The 21-day samples were collected using Radiello samplers. The Radiello samplers were only tested for TCE because they currently do not provide accurate results for the other three chemicals.

Appendix B, Table B-1, provides a summary of the Summa canister and Radiello air testing results for each property tested. The property addresses have not been included. However, each property tested has been assigned a unique number, which was provided to the owner/tenant. As shown in Table B-1, neither vinyl chloride; cis-1,2-DCE; nor trans-1,2-DCE were detected in indoor or outdoor air. TCE was detected; however, it was only found at five of the 14 homes

tested. Three of the five homes had TCE only in the living space; one home had it only in the crawlspace; and one had it in both. TCE was also found at one outdoor location. Neither TCE; vinyl chloride; cis 1,2-DCE; nor trans 1,2-DCE were detected in air below concrete slabs. However, there were some problems with the sub-slab sampling at a few homes. As a result, there is some uncertainty about the accuracy of the sub-slab results at those locations. The property owners/tenants at those locations were made aware of the situation.

## Community Health Concerns

Some Algona residents are concerned the chemicals found in the contaminated groundwater may evaporate and move into their indoor air affecting their family's health.

## Discussion

An exposure pathway evaluation was conducted to begin assessing the possible indoor air health threat posed by the contaminated groundwater. An exposure pathway evaluation helps us determine ways in which people might come into contact with the chemicals. An exposure pathway is the route a chemical takes from where it began (source) to where it ends, and how people can come into contact with it. An exposure pathway has five parts:

- **Source of contamination** (such as groundwater, outdoor air, or consumer products containing a chemical);
- **Environmental media and transport mechanism** (such as movement of a chemical evaporating from groundwater near a building and moving into indoor air, outdoor air containing a chemical that moves into indoor air, or a chemical evaporating from some consumer product used in the home);
- **Point of exposure** (such as living space air );
- **Route of exposure** (such as breathing in chemical vapors); and
- **Receptor population** (people potentially or actually exposed to a chemical).

When all five parts are present, it is considered a completed exposure pathway. A potential exposure pathway exists if one or more parts are missing.

There are many factors that determine if an exposure will cause health effects. These factors include:

- Dose (how much),
- Duration (how long),
- Exposure (how someone comes in contact with the chemicals such as breathing in a chemical), and
- Person's age and the number of chemicals they are exposed.

## Indoor Air Exposure Pathway

A completed exposure pathway occurred at five of the 14 buildings tested (RES006, RES010, RES011, RES012, and RES023). A potential exposure pathway exists at the remaining buildings.

## Chemicals of Health Concern

To identify chemicals that might be of health concern, DOH compared the highest concentrations of each chemical found in living space air to health comparison values. The air results from the living space represent what people could breathe in throughout the day. *Health comparison values are concentrations of chemicals that are unlikely to cause people to get sick. This is done to be protective of the most sensitive individuals (i.e., children and older adults). It is also done to account for our lack of certainty regarding the adverse health effects of low levels of chemical exposure.* If a chemical was noted as being less than a reporting limit<sup>a</sup>, DOH compared the reporting limit to the health comparison values.

The primary health comparison values for air used by DOH were ATSDR's cancer risk evaluation guides (CREGs) and environmental media evaluation guides (EMEGs).(2) The air CREG is the concentration of a chemical in air that is expected to cause no more than one additional cancer in a million persons exposed over a lifetime. An EMEG is a concentration in air below which adverse non-cancer health effects are not expected to occur. If no ATSDR health comparison values were available, DOH used an Environmental Protection Agency (EPA) reference concentration (RfC) or EPA regional screening levels (RSLs) for air.(3) An EPA RfC is an estimate of a continuous human inhalation exposure (including sensitive subgroups) that is likely to be without significant risk of harmful non-cancer effects during a lifetime. The EPA RSLs are as protective as ATSDR's EMEGs.

If a chemical was present but did not exceed the health comparison value, no further evaluation of that chemical is necessary. This is because we do not expect those chemicals will pose a health threat. When a chemical is found to be above a health comparison value, further evaluation of that chemical is needed. *However, just because a chemical was found above the comparison value does not necessarily mean it will cause people to get sick.* When a chemical does not have a health comparison value available, a health comparison value for a chemical similar in structure may be used as a substitute. If no substitute is available, the chemical is further evaluated.

As shown in Table 1, none of the four chemicals tested in the living space were found above non-cancer comparison values. As a result, no further assessment of the non-cancer health effects associated with these chemicals is necessary. Only TCE exceeded the ATSDR cancer comparison values. As a result, further assessment of the carcinogenic health threat posed by the TCE is needed. *It is important to understand that exceeding the cancer comparison value does not imply that people will develop cancer when exposed to these levels.* A more complete discussion of cancer risk follows.

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<sup>a</sup> Reporting limits are the lowest concentration at which a chemical can be detected in a sample and its concentration can be reported with a reasonable degree of accuracy and precision.

Table 1: Boeing Auburn, Auburn, Washington - Comparison of Maximum Algona Living Space Air Results with ATSDR Health Comparison Values.

Chemical	EPA Cancer Class	Maximum Living Space Air Concentration (ug/m <sup>3</sup> )	Health Comparison Value (ug/m <sup>3</sup> )	Health Comparison Value Reference	Chemical of Health Concern
TCE	CH	1.20	2 0.24	Chronic EMEG CREG	NC -No C - <b>Yes</b>
Vinyl Chloride	KL	<0.10	100 0.11	EPA RfC CREG	NC - No C - No
Cis 1,2-DCE	IN	<0.32	6.3	EPA RSL for trans-1,2, DCE	NC - No
Trans 1,2-DCE	IN	<1.6	6.3 <sup>a</sup>	EPA RSL	NC - No

ug/m<sup>3</sup> – micrograms per cubic meter

< - less than the value reported

NC – Non Cancer

C – Cancer

TCE – trichloroethylene

Cis-1,2 DCE – cis 1,2 dichloroethene

Trans-1,2 DCE – trans 1,2 dichloroethene

CH – EPA: Carcinogenic to humans

KL – EPA: Known/Likely human carcinogen

IN – EPA: Inadequate information to assess carcinogenic potential

Chronic EMEG - ATSDR's Environmental Media Evaluation Guides (child) – Non-cancer

CREG – ATSDR's Cancer Risk Evaluation Guides

EPA – U.S. Environmental Protection Agency

EPA RfC – EPA reference concentration

EPA RSL – EPA regional screening level

<sup>a</sup> –target hazard quotient of 0.1

## TCE

TCE is a volatile organic compound (VOC). VOCs evaporate easily into the air. TCE is used mainly as a raw material for producing a refrigerant called HFC-134a. It is also used for metal degreasing. However, its use for degreasing metal parts has dropped because of increased environmental regulations regarding its emissions.(4) It can be found in products such as adhesives, paint removers, and spot removers.

### Evaluation of Non-Cancer Health Effects

Human and animal studies show that exposure to low levels of TCE may cause effects to the immune system and heart-related health effects to unborn babies.(4) However, as noted above, *the concentrations of TCE found in the homes tested in 2013 are not expected to be high enough to result in non-cancer health effects.*

## Evaluation of Cancer Risk

The EPA and National Toxicology Program say TCE can cause cancer.(5;6) Worker exposure to TCE has been associated with liver cancer, non-Hodgkin's lymphoma, and kidney cancer.(7) There is some evidence that suggests exposure to TCE can cause other types of cancer, such as lung cancer. However, the evidence for other types of cancer is weaker than for kidney and liver cancers and non-Hodgkin's lymphoma.(4)

Some chemicals, like TCE, have the potential to increase people's risk of developing cancer. Current risk assessment practice assumes there is no "safe dose" of a carcinogen. Any dose of a carcinogen will result in some additional estimated cancer risk. Cancer risk estimates are not yes/no answers but measures of chance (probability). Such measures, however uncertain, are useful in determining the magnitude of a cancer threat.

Cancer is a common illness and its occurrence in a population increases with the age of the population. There are many different forms of cancer resulting from a variety of causes. Not all are fatal. Approximately 1 in 2 to 1 in 3 people living in the United States will develop cancer at some point in their lives.(8)

### **Estimated 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 cancer cases for the number of persons similarly exposed over a lifetime:

<u>Term</u>		<u># of Excess Cancers</u>
moderate	is approximately equal to	1 in 1,000
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

This document describes estimated 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, as shown in the Estimated Cancer Risk box, a low increase in cancer risk indicates a risk estimate in the range of 1 additional cancer case developing per 10,000 persons similarly exposed over a lifetime. A very low estimate might result in 1 additional cancer case per 100,000 similarly exposed persons over a lifetime and a slight estimate might result in 1 additional cancer per 1,000,000 similarly exposed persons. DOH considers estimated cancer risk insignificant when the estimate results in less than 1 cancer per 1,000,000 similarly exposed persons over a lifetime.

## **Living Space Air**

TCE was only found above the cancer comparison value in the living spaces of RES006, RES010, RES011, and RES023. When looking at a number of factors, it does not appear that the TCE found in these homes is related to the contaminated groundwater. A brief discussion about the possible source of the TCE found at these homes is provided in Table 2. Table 2 also provides the number of living space samples collected, number of samples where TCE was greater than the health comparison value, and the maximum concentration of TCE found at each of the four homes.

Table 2: Boeing Auburn, Auburn, Washington – Evaluation of Algona Homes with TCE above Health Comparison Values.

Residence	Number of samples collected in living spaces	Number of Samples with TCE above the Health Comparison Value	Maximum Living Space TCE Concentration ( $\mu\text{g}/\text{m}^3$ )	TCE Source Evaluation
RES006	2	1	<0.27	TCE was not found above the reporting limit at this home. However, because the reporting limit for one of the living space samples was slightly higher than the health comparison value, DOH included this home in its assessment. (9)
RES010	6	1	1.20	TCE was found at $1.20 \mu\text{g}/\text{m}^3$ in one of three living space samples collected during the initial testing. The living space was retested shortly after the initial testing. TCE was not found during the retesting. A number of chemicals were stored in this home prior to the initial testing. These chemicals may be the source of the TCE found in indoor air.(10)
RES011	3	1	0.30	TCE was found in one living space sample but was not found in the crawlspace at this residence. For the TCE found in living space to be from the groundwater, it would have to pass through the crawlspace. The absence of TCE in the crawlspace suggests groundwater is not the likely source. Activities associated with painting and carpet replacement at this home prior to the testing may be the source of TCE found in the living space.(11)
RES023	2	2	0.81	TCE was not found below the building slab but was found in two living space samples. The absence of TCE below the slab suggests that groundwater is not the source of the TCE found in the living space. TCE, however, was found at a higher level in outdoor air than in the living space air during the testing. Together these findings suggest that outdoor air, not groundwater, is a possible source of the TCE found in the living space.(12) Outdoor air was retested for TCE to further investigate the results. TCE was not found above the reporting limit during the retesting.

$\mu\text{g}/\text{m}^3$  – micrograms per cubic meter

TCE – trichloroethylene

< - less than the value reported

Since TCE concentrations varied throughout the living spaces in these four homes, DOH does not expect residents to be exposed to the maximum concentration of TCE; however, we used the maximum concentrations to provide a conservative estimate of the possible cancer risk. Cancer risks were estimated for the following age groups:

- Children (birth to less (<) than 6 years old,
- Older children (6 to <16 years old),
- Adults (16 to 70 years old), and
- Lifetime (birth to 70 years old).

Appendix C contains information about how the cancer risks were estimated and the results. A summary of those results are provided in Table 3.

Table 3: Boeing Auburn, Auburn, Washington – Estimated TCE Cancer Risk for Algona Homes.

Residence	Estimated Cancer Risk	
RES006	2 additional cancer cases per 10,000,000 similarly exposed children	Insignificant
	2 additional cancer cases per 10,000,000 similarly exposed older children	Insignificant
	9 additional cancer cases per 10,000,000 similarly exposed adults	Insignificant
	This is a <b>lifetime cancer risk</b> of 1 additional case for every 1,000,000 similarly exposed people.	Slight
RES010	9 additional cancer cases per 10,000,000 similarly exposed children	Insignificant
	1 additional cancer cases per 1,000,000 similarly exposed older children	Slight
	4 additional cancer cases per 1,000,000 similarly exposed adults	Slight
	This is a <b>lifetime cancer risk</b> of 6 additional cases for every 1,000,000 similarly exposed people.	Slight
RES011	2 additional cancer cases per 10,000,000 similarly exposed children	Insignificant
	3 additional cancer cases per 10,000,000 similarly exposed older children	Insignificant
	9 additional cancer cases per 10,000,000 similarly exposed adults	Insignificant
	This is a <b>lifetime cancer risk</b> of 1 additional case for every 1,000,000 similarly exposed people.	Slight
RES023	6 additional cancer cases per 10,000,000 similarly exposed children	Insignificant
	7 additional cancer cases per 10,000,000 similarly exposed older children	Insignificant
	3 additional cancer cases per 1,000,000 similarly exposed adults	Slight
	This is a <b>lifetime cancer risk</b> of 4 additional cases for every 1,000,000 similarly exposed people.	Slight

*These cancer risk levels are all below a level DOH considers a health threat.<sup>b</sup> It is important to note that these estimates are for excess cancers that might occur in addition to those normally expected in an unexposed population. It is also important to note that these are risk estimates and the actual risk could be as low as zero.*

<sup>b</sup> DOH generally considers there to be an increased health threat when an assessment shows 1 additional cancer to develop in a population of 10,000 similarly exposed people.

## **Children's Health Considerations**

The potential for exposure and subsequent adverse health effects often increases for younger children compared with older children or adults. The following factors contribute to this vulnerability:

- Children are smaller and receive higher doses of chemical exposure per body weight.
- Children's developing bodies or systems are more vulnerable to toxic exposures, especially during critical growth stages in which permanent damage may occur.

Children's health was considered during this health consultation. Based on DOH's comparison of the highest indoor air concentration to conservative non-cancer comparison values, adverse non-cancer health effects are not expected from the chemicals found in indoor air at the homes in Algona. The estimated cancer risk levels are all below a level DOH considers a health threat. The actual risk, however, could be as low as zero.

## **Conclusions**

DOH concludes that breathing the chemicals at the concentrations found in indoor air in 2013 is not expected to cause harmful health effects.

## **Recommendations**

Although the chemicals found in indoor air in 2013 are not expected to cause harmful health effects, DOH recommends that Ecology continue monitoring indoor air in the northern part of the City of Algona. The occurrence and frequency of the testing and type of analysis should be based on site specific conditions (e.g., changes in subsurface conditions, such as increases or decreases in soil gas, soil, or groundwater contaminant concentrations).

## **Public Health Action Plan**

1. DOH will mail the health consultation report to property owners and tenants whose homes were tested, City of Algona, Ecology, Public Health Seattle and King County, and Boeing.
2. DOH will provide fact sheets summarizing the health consultation report findings to property owners and tenants whose homes were tested, City of Algona, City of Algona residents Ecology, Public Health Seattle and King County, and Boeing.
3. DOH will post the health consultation report on its website.
4. Boeing will offer another round of indoor air testing to the same 24 homes. The testing will occur during the first quarter of 2014.
5. DOH will evaluate future indoor air data to see if conditions have changed and determine if harmful health effects are possible.

## **Report Preparation**

This Health Consultation for the Boeing Auburn site was prepared by the Washington State Department of Health (DOH) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, and procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. This report was supported by funds from a cooperative agreement with the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services. This document has not been reviewed and cleared by ATSDR.

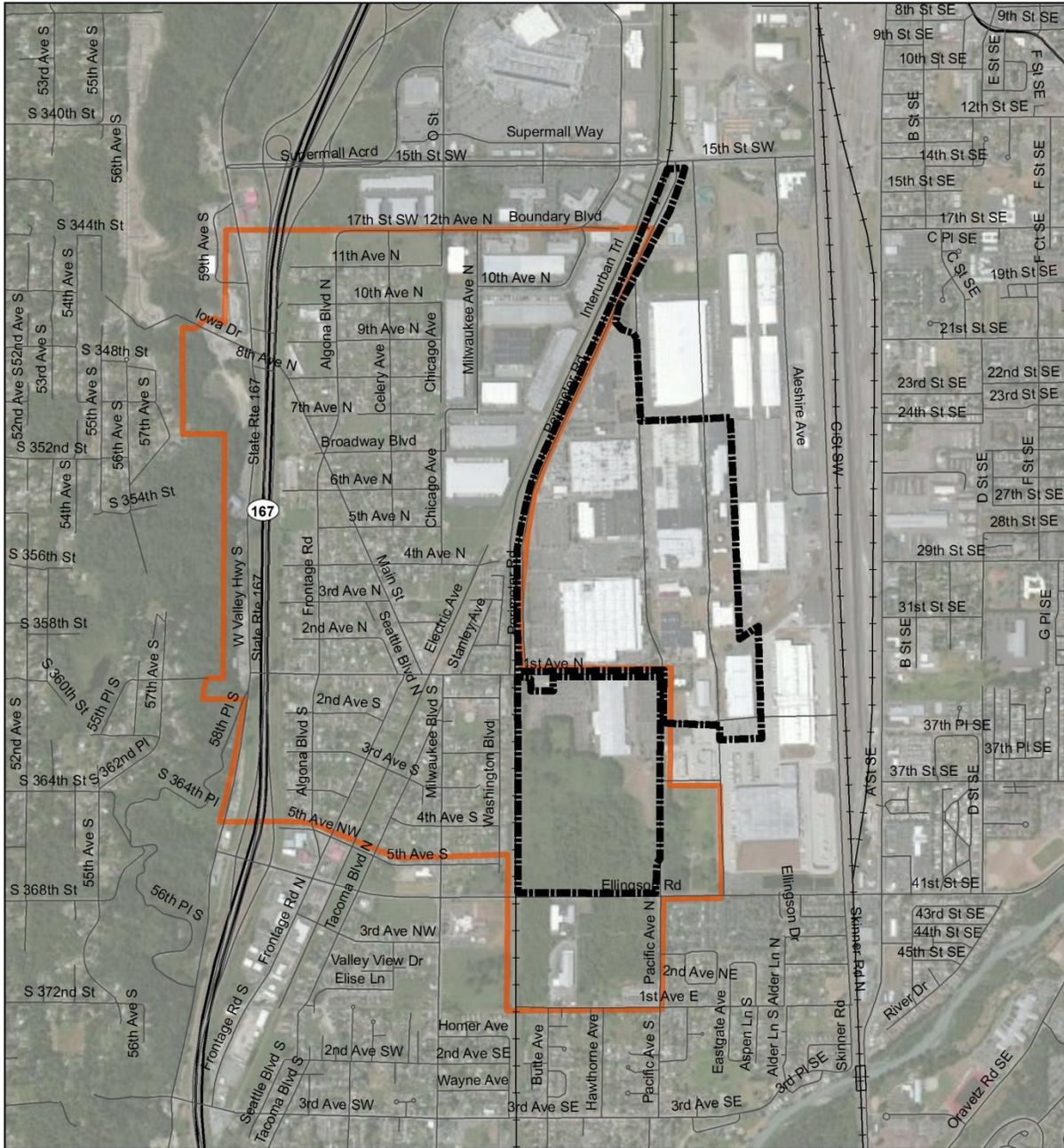
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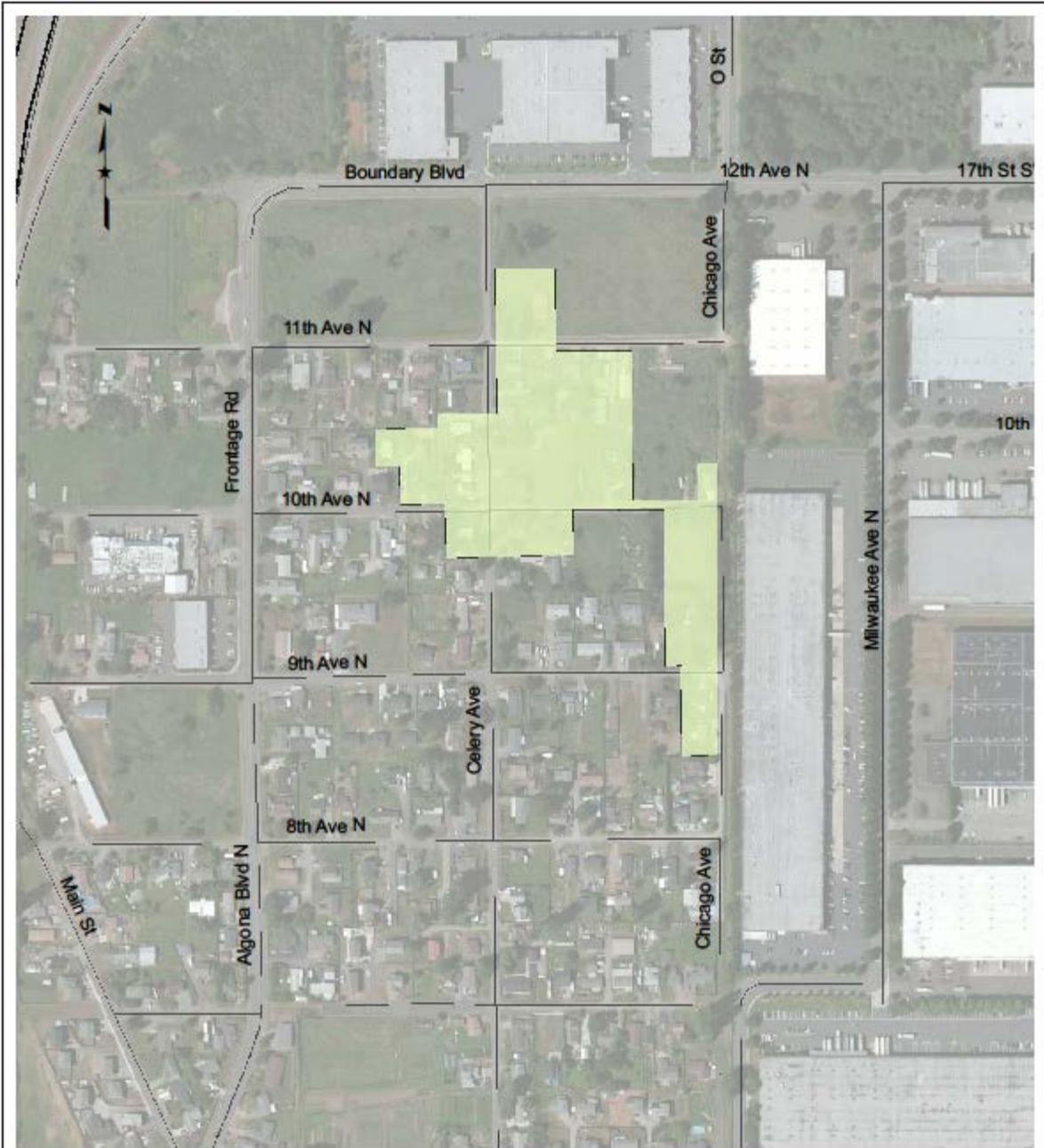
**Legend**

Boeing Facility

City of Algona

0 0.2 0.4  
 Miles

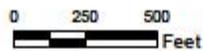
Vicinity Map Boeing Auburn	Figure 1
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**Legend**

 Vapor Intrusion Assessment Area



City of Algona  
 Vapor Intrusion Assessment  
 Boeing Auburn

Figure  
 2

## Appendices

## Appendix A - Glossary

<b>Acute</b>	Occurring over a short time [compare with <b>chronic</b> ].
<b>Agency for Toxic Substances and Disease Registry (ATSDR)</b>	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.
<b>Cancer Risk Evaluation Guide (CREG)</b>	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 <i>comparison value</i> used to select contaminants of potential health concern and is based on the <i>cancer slope factor</i> (CSF).
<b>Cancer Slope Factor (CSF)</b>	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
<b>Carcinogen</b>	Any substance that causes cancer.
<b>Chronic</b>	Occurring over a long time (more than 1 year) [compare with <b>acute</b> ].
<b>Comparison Value (CV)</b>	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.
<b>Contaminant</b>	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.

<b>Dermal Contact</b>	Contact with (touching) the skin [see <b>route of exposure</b> ].
<b>Dose (for chemicals that are not radioactive)</b>	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.
<b>Environmental Media Evaluation Guide (EMEG)</b>	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).
<b>Environmental Protection Agency (EPA)</b>	United States Environmental Protection Agency.
<b>Exposure</b>	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [see <b>acute exposure</b> ], of intermediate duration, or long-term [see <b>chronic exposure</b> ].
<b>Groundwater</b>	Water beneath the earth’s surface in the spaces between soil particles and between rock surfaces [compare with <b>surface water</b> ].
<b>Hazardous Substance</b>	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.
<b>Ingestion</b>	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see <b>route of exposure</b> ].

<b>Inhalation</b>	The act of breathing. A hazardous substance can enter the body this way [see <b>route of exposure</b> ].
<b>Media</b>	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
<b>Minimal Risk Level (MRL)</b>	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 <b>reference dose</b> ].
<b>Organic</b>	Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.
<b>Plume</b>	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.
<b>Route of Exposure</b>	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [see <b>inhalation</b> ], eating or drinking [see <b>ingestion</b> ], or contact with the skin [see <b>dermal contact</b> ].
<b>Surface Water</b>	Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with <b>groundwater</b> ].

## Appendix B – Residence and Ambient Air Results

Table B-1: Boeing Auburn - Range of Chemical Results for Properties Tested Summer/Fall 2013 in the City of Algona.

Building Number	Location	Number of Samples	Sample Type	Chemical Range ( $\mu\text{g}/\text{m}^3$ )			
				TCE	Vinyl Chloride	cis-1,2 DCE	trans-1,2 DCE
RES003	Living Space	3	Summa	<0.15 - <0.18	<0.036 - <0.042	<0.11 - <0.13	<0.57 - <0.65
	Sub-slab	2	Summa	<0.16	<0.039	<0.12	<0.60 - <0.61
	Outdoor Air	1	Summa	<0.17	<0.040	<0.12	<0.61
	Living Space	3	Radiello	<0.048	NA	NA	NA
RES004	Living Space	6	Summa	<0.15 - <0.19	<0.035 - <0.046	<0.11 - < 0.14	<0.54 - <0.72
	Sub-Slab	2	Summa	<0.15 - <0.17	<0.036 - <0.040	<0.11 - <0.12	<0.57 - <0.63
	Crawlspace	2	Summa	<0.17 - <b>0.19</b>	<0.040 - <0.042	<0.13 - <0.14	<0.61 - <0.66
	Outdoor Air	2	Summa	<0.17 - <0.18	<0.040 - <0.042	<0.12 - <0.13	<0.61 - <0.65
	Living Space	3	Radiello	<0.050	NA	NA	NA
	Crawlspace	1	Radiello	<0.050	NA	NA	NA
RES005	Living Space	3	Summa	<0.18 - <0.20	<0.043 - <0.045	<0.13 - < 0.14	<0.67 - <0.72
	Crawlspace	1	Summa	< 0.20	< 0.047	< 0.14	< 0.72
	Outdoor Air	1	Summa	< 0.19	< 0.046	< 0.14	< 0.71
	Living Space	3	Radiello	<0.048	NA	NA	NA
	Crawlspace	1	Radiello	<0.048	NA	NA	NA
RES006	Living Space	2	Summa	<0.19 - <0.27	<0.045 - <0.064	<0.14 - <0.20	<0.69 - <1.0
	Sub-slab	1	Summa	<0.42	<0.099	<0.31	<1.5
	Outdoor Air	1	Summa	<0.20	<0.047	<0.14	<0.72
RES009	Living Space	3	Summa	<0.17 - <0.19	<0.040 - <0.045	<0.12 - <0.14	<0.62 - <0.70
	Crawlspace	1	Summa	<0.17	<0.041	<0.13	<0.63
	Outdoor Air	1	Summa	<0.17	<0.040	<0.12	<0.62
	Living Space	3	Radiello	<0.052	NA	NA	NA
	Crawlspace	1	Radiello	<0.052	NA	NA	NA

Table B-1: Boeing Auburn - Range of Chemical Results for Properties Tested Summer/Fall 2013 in the City of Algona (continued)

Building Number	Location	Number of Samples	Sample Type	Chemical Range ( $\mu\text{g}/\text{m}^3$ )			
				TCE	Vinyl Chloride	cis-1,2 DCE	trans-1,2 DCE
RES010	Living Space	4	Summa	<0.17 - <b>1.20</b>	<0.039 - <0.046	<0.12 - <0.14	<0.60 - <0.71
	Basement	3	Summa	<0.16 - <0.17	<0.039 - <0.041	<0.12 - <0.13	<0.60 - <0.63
	Sub-slab	2	Summa	<0.16 - <0.33	<0.038 - <0.078	<0.12 - <0.24	<0.59 - <1.2
	Outdoor Air	2	Summa	<0.15 - <0.18	<0.036 - <0.042	<0.11 - <0.13	<0.56 - <0.65
RES011	Living Space	3	Summa	<0.16 - <b>0.30</b>	<0.038 - <0.050	<0.12 - <0.15	<0.59 - <0.77
	Crawlspace	1	Summa	<0.18	<0.043	<0.13	<0.67
	Outdoor Air	2	Summa	<0.16 - <0.17	<0.039 - <0.041	<0.12 - <0.13	<0.61 - <0.63
RES012	Living Space	1	Summa	<0.16	<0.038	<0.12	<0.58
	Sub-Slab	1	Summa	<0.34	<0.081	<0.25	<1.2
	Crawlspace	1	Summa	<0.16	<0.038	<0.12	<0.59
	Outdoor Air	1	Summa	<0.16	<0.038	<0.12	<0.59
	Living Space	1	Radiello	<b>0.18</b>	NA	NA	NA
	Crawlspace	1	Radiello	<b>0.055</b>	NA	NA	NA
RES015	Living Space	4	Summa	<0.17 - <0.19	<0.040 - <0.045	<0.12 - <0.14	<0.63 - <0.70
	Crawlspace	1	Summa	<0.17	<0.040	<0.12	<0.63
	Outdoor Air	1	Summa	<0.14	<0.034	<0.11	<0.54
RES016	Living Space	2	Summa	<0.18	<0.043 - <0.44	<0.13 - <0.14	<0.67 - <0.68
	Crawlspace	1	Summa	<0.18	<0.042	<0.13	<0.66
	Outdoor Air	1	Summa	<0.21	<0.050	<0.16	<0.78
RES018	Living Space	3	Summa	<0.18 - < 0.19	<0.043 - <0.046	<0.13 - <0.14	<0.66 - < 0.71
	Crawlspace	1	Summa	<0.16	<0.039	<0.12	<0.61
	Sub-slab	1	Summa	<1.6	<0.38	<1.2	<0.59
	Outdoor Air	1	Summa	<0.17	<0.040	<0.12	<0.61

Table B-1: Boeing Auburn - Range of Chemical Results for Properties Tested Summer/Fall 2013 in the City of Algona (continued)

Building Number	Location	Number of Samples	Sample Type	Chemical Range ( $\mu\text{g}/\text{m}^3$ )			
				TCE	Vinyl Chloride	cis-1,2 DCE	trans-1,2 DCE
RES019	Living Space (includes the basement)	3	Summa	<0.18	<0.042 - <0.043	<0.13	<0.65 - <0.67
	Outdoor Air	1	Summa	<0.18	<0.042	<0.13	<0.65
RES021 (building used as garage and for storage only)	Sub-slab	2	Summa	<0.16 - <0.82	<0.039 - <0.20	<0.12 - <0.61	<0.61 - <3.0
RES023	Living Space	2	Summa	<b>0.54 - 0.81</b>	<0.045 - <0.10	<0.14 - <0.32	<0.70 - <1.6
	Sub-slab	1	Summa	<0.17	<0.040	<0.12	<0.62
	Outdoor Air	2	Summa	<0.16 - <b>1.1</b>	<0.038 - <0.042	<0.12 - <0.13	<0.59 - <0.66

TCE – trichloroethylene

Cis-1,2 DCE – cis 1,2 dichloroethene

Trans-1,2 DCE – trans 1,2 dichloroethene

$\mu\text{g}/\text{m}^3$  – micrograms per cubic meter

< less than the value reported

NA – not analyzed

**Bold** – detected chemical

## Appendix C – Cancer Risk Estimate Equations and Results

DOH used the U.S. Environmental Protection Agency's (EPA) spreadsheet template to estimate the lifetime TCE cancer risk for the four homes where TCE exceeded the health comparison value (RES006, RES010, RES011, and RES023). The spreadsheet allows the user to apply the Age-Determinant Adjustment Factors (ADAFs) to account for kidney cancer mutagenicity and early life-stage susceptibility to TCE.(13) Using the template, risk estimates for different exposure scenarios can be obtained by changing the exposure amounts (including possibly zero for some age groups). The steps in the calculation outlined below were extracted from EPA's 2011 Toxicological Review of Trichloroethylene - Chapter 5, Section 5.2.3.3.1.(6)

“(1) Separate the kidney cancer contribution from the NHL[Non Hodgkin's Lymphoma] + liver cancer contribution to the inhalation unit risk estimate. From Section 5.2.2.1.4, the kidney lifetime unit risk is  $1.0 \times 10^{-6}$  per  $\mu\text{g}/\text{m}^3$  in air. Subtracting this from the total lifetime unit risk of  $4.1 \times 10^{-6}$  per  $\mu\text{g}/\text{m}^3$  from Section 5.2.2.2 results in the estimated contribution of NHL + liver cancer being  $3.1 \times 10^{-6}$  per  $\mu\text{g}/\text{m}^3$ .

(2) Assign a lifetime unit risk estimate for each age group. The template shows the recommended age groupings from U.S. EPA (2005c) in Column A (augmented by additional age groups from U.S. EPA, 2008c, and for assessing 30 year exposures), along with the age group duration (Column D), and the fraction of lifetime each age group represents (Column E; used as a duration adjustment). For each age group, the (unadjusted) lifetime unit risk estimates for kidney cancer, total cancer, and NHL + liver cancer are shown in Column F, I, and J, respectively.

(3) For each age group, the kidney cancer inhalation unit risk estimate (Column F) is multiplied by the risk per  $\mu\text{g}/\text{m}^3$  equivalence (Column B), the exposure concentration (Column C), the duration adjustment (Column E), and the ADAF (Column G), to obtain the partial risk from exposure during those ages (Column H). For inhalation exposures, a —risk per  $\mu\text{g}/\text{m}^3$  equivalencel of 1 is assumed across age groups (i.e., equivalent risk from equivalent exposure levels in air, independent of body size), as shown in Column B.

(4) For each age group, the NHL + liver cancer unit risk estimate (Column J) is multiplied by the risk per  $\mu\text{g}/\text{m}^3$  equivalence (Column B), the exposure concentration (Column C), and the duration adjustment (Column E), to obtain the partial risk from exposure during those ages (Column K).

(5) For each age group, the ADAF-adjusted partial risk for kidney cancer (Column H) is added to the partial risk for NHL + liver cancer (Column K), resulting in the total partial risk (Column L).

(6) The age-group-specific partial risks are added together to obtain the estimated total lifetime risk (bottom of Column L).”

Tables C-1 to C-4 provide the estimated lifetime cancer risks for the maximum TCE levels at each of the four homes during Summer/Fall 2013.

Table C-1: Estimated TCE Cancer Risk for Maximum Level of TCE at RES006

Note:	Highlighted	cells can be adjusted depending on exposure scenario (e.g., in Col C, set to 0 for age groups without exposure)													
<b>Inhalation (concentration-equivalence across age groups)</b>															
Col A	Col B	Col C	Col D	Col E	Col F	Col G	Col H	Col I	Col J	Col K	Col L				
	Exposure scenario parameters				Dose-response assessment calculations										
<b>Units:</b>		(µg/m <sup>3</sup> air)	year	-	(µg/m <sup>3</sup> air) <sup>-1</sup>	-	-	(µg/m <sup>3</sup> air) <sup>-1</sup>	(µg/m <sup>3</sup> air) <sup>-1</sup>	-	-				
<b>Age group</b>	risk per µg/m <sup>3</sup> air equivalence	Exposure concentration	Age group duration	Duration adjustment (Col D / 70 year)	Kidney unadjusted lifetime unit risk (p 5-137 [5.2.2.1.4])	Kidney cancer default ADAF	<b>Kidney ADAF-adjusted partial risk (Col B x Col C x Col E x Col F x Col G)</b>	Kidney+NHL+ liver unadjusted lifetime unit risk (p 5-139 [5.2.2.2])	NHL+ liver lifetime unit risk (Col I - Col F)	<b>NHL and liver partial risk (Col B x Col C x Col E x Col J)</b>	<b>Total partial risk (Col H + Col K)</b>	<b>Child, Older Child, and Adult Cancer Risk</b>			
Birth to <1 month	1	0.270	0.083	0.0012	1.0E-06	10	3.2E-09	4.1E-06	3.1E-06	1.0E-09	4.2E-09	2.0E-07			
1 to <3 months	1	0.270	0.167	0.0024	1.0E-06	10	6.4E-09	4.1E-06	3.1E-06	2.0E-09	8.4E-09				
3 to <6 months	1	0.270	0.250	0.0036	1.0E-06	10	9.6E-09	4.1E-06	3.1E-06	3.0E-09	1.3E-08				
6 to <12 months	1	0.270	0.500	0.0071	1.0E-06	10	1.9E-08	4.1E-06	3.1E-06	6.0E-09	2.5E-08				
1 to <2 years	1	0.270	1.000	0.0143	1.0E-06	10	3.9E-08	4.1E-06	3.1E-06	1.2E-08	5.1E-08				
2 to <3 years	1	0.270	1.000	0.0143	1.0E-06	3	1.2E-08	4.1E-06	3.1E-06	1.2E-08	2.4E-08				
3 to <6 years	1	0.270	3.000	0.0429	1.0E-06	3	3.5E-08	4.1E-06	3.1E-06	3.6E-08	7.1E-08	2.4E-07			
6 to <11 years	1	0.270	5.000	0.0714	1.0E-06	3	5.8E-08	4.1E-06	3.1E-06	6.0E-08	1.2E-07				
11 to <16 years	1	0.270	5.000	0.0714	1.0E-06	3	5.8E-08	4.1E-06	3.1E-06	6.0E-08	1.2E-07				
16 to <18 years	1	0.270	2.000	0.0286	1.0E-06	1	7.7E-09	4.1E-06	3.1E-06	2.4E-08	3.2E-08	8.5E-07			
18 to <21 years	1	0.270	3.000	0.0429	1.0E-06	1	1.2E-08	4.1E-06	3.1E-06	3.6E-08	4.7E-08				
21 to <30 years	1	0.270	9.000	0.1286	1.0E-06	1	3.5E-08	4.1E-06	3.1E-06	1.1E-07	1.4E-07				
30 to 70 years	1	0.270	40.000	0.5714	1.0E-06	1	1.5E-07	4.1E-06	3.1E-06	4.8E-07	6.3E-07				
										<b>Total unit risk:</b>	<b>1.3E-06</b>				

ug/m<sup>3</sup> – micrograms per cubic meter  
 ADAF: Age-Determinant Adjustment Factors

Table C-2: Estimated TCE Cancer Risk for Maximum Level of TCE at RES010

Note:	Highlighted	cells can be adjusted depending on exposure scenario (e.g., in Col C, set to 0 for age groups without exposure)										
<b>Inhalation (concentration-equivalence across age groups)</b>												
Col A	Col B	Col C	Col D	Col E	Col F	Col G	Col H	Col I	Col J	Col K	Col L	
Exposure scenario parameters				Dose-response assessment calculations								
<b>Units:</b>		( $\mu\text{g}/\text{m}^3$ air)	year	-	( $\mu\text{g}/\text{m}^3$ air) <sup>-1</sup>	-	-	( $\mu\text{g}/\text{m}^3$ air) <sup>-1</sup>	( $\mu\text{g}/\text{m}^3$ air) <sup>-1</sup>	-	-	
<b>Age group</b>	risk per $\mu\text{g}/\text{m}^3$ air equivalence	Exposure concentration	Age group duration	Duration adjustment (Col D / 70 year)	Kidney unadjusted lifetime unit risk (p 5-137 [5.2.2.1.4])	Kidney cancer default ADAF	<b>Kidney ADAF-adjusted partial risk (Col B x Col C x Col E x Col F x Col G)</b>	Kidney+NHL+ liver unadjusted lifetime unit risk (p 5-139 [5.2.2.2])	NHL+ liver lifetime unit risk (Col I - Col F)	<b>NHL and liver partial risk (Col B x Col C x Col E x Col J)</b>	<b>Total partial risk (Col H + Col K)</b>	<b>Child, Older Child, and Adult Cancer Risk</b>
Birth to <1 month	1	1.2	0.083	0.0012	1.0E-06	10	1.4E-08	4.1E-06	3.1E-06	4.4E-09	1.9E-08	8.7E-07
1 to <3 months	1	1.2	0.167	0.0024	1.0E-06	10	2.9E-08	4.1E-06	3.1E-06	8.9E-09	3.7E-08	
3 to <6 months	1	1.2	0.250	0.0036	1.0E-06	10	4.3E-08	4.1E-06	3.1E-06	1.3E-08	5.6E-08	
6 to <12 months	1	1.2	0.500	0.0071	1.0E-06	10	8.6E-08	4.1E-06	3.1E-06	2.7E-08	1.1E-07	
1 to <2 years	1	1.2	1.000	0.0143	1.0E-06	10	1.7E-07	4.1E-06	3.1E-06	5.3E-08	2.2E-07	
2 to <3 years	1	1.2	1.000	0.0143	1.0E-06	3	5.1E-08	4.1E-06	3.1E-06	5.3E-08	1.0E-07	
3 to <6 years	1	1.2	3.000	0.0429	1.0E-06	3	1.5E-07	4.1E-06	3.1E-06	1.6E-07	3.1E-07	
6 to <11 years	1	1.2	5.000	0.0714	1.0E-06	3	2.6E-07	4.1E-06	3.1E-06	2.7E-07	5.2E-07	1.0E-06
11 to <16 years	1	1.2	5.000	0.0714	1.0E-06	3	2.6E-07	4.1E-06	3.1E-06	2.7E-07	5.2E-07	3.8E-06
16 to <18 years	1	1.2	2.000	0.0286	1.0E-06	1	3.4E-08	4.1E-06	3.1E-06	1.1E-07	1.4E-07	
18 to <21 years	1	1.2	3.000	0.0429	1.0E-06	1	5.1E-08	4.1E-06	3.1E-06	1.6E-07	2.1E-07	
21 to <30 years	1	1.2	9.000	0.1286	1.0E-06	1	1.5E-07	4.1E-06	3.1E-06	4.8E-07	6.3E-07	
30 to 70 years	1	1.2	40.000	0.5714	1.0E-06	1	6.9E-07	4.1E-06	3.1E-06	2.1E-06	2.8E-06	
<b>Total unit risk:</b>											<b>5.7E-06</b>	

$\mu\text{g}/\text{m}^3$  - micrograms per cubic meter  
 ADAF: Age-Determinant Adjustment Factors

Table C-3: Estimated TCE Cancer Risk for Maximum Level of TCE at RES011

Note:	Highlighted	cells can be adjusted depending on exposure scenario (e.g., in Col C, set to 0 for age groups without exposure)										
<b>Inhalation (concentration-equivalence across age groups)</b>												
Col A	Col B	Col C	Col D	Col E	Col F	Col G	Col H	Col I	Col J	Col K	Col L	
	Exposure scenario parameters				Dose-response assessment calculations							
<b>Units:</b>		(µg/m <sup>3</sup> air)	year	-	(µg/m <sup>3</sup> air) <sup>-1</sup>	-	-	(µg/m <sup>3</sup> air) <sup>-1</sup>	(µg/m <sup>3</sup> air) <sup>-1</sup>	-	-	
<b>Age group</b>	risk per µg/m <sup>3</sup> air equivalence	Exposure concentration	Age group duration	Duration adjustment (Col D / 70 year)	Kidney unadjusted lifetime unit risk (p 5-137 [5.2.2.1.4])	Kidney cancer default ADAF	<b>Kidney ADAF-adjusted partial risk (Col B x Col C x Col E x Col F x Col G)</b>	Kidney+NHL+ liver unadjusted lifetime unit risk (p 5-139 [5.2.2.2])	NHL+ liver lifetime unit risk (Col I - Col F)	<b>NHL and liver partial risk (Col B x Col C x Col E x Col J)</b>	<b>Total partial risk (Col H + Col K)</b>	<b>Child, Older Child, and Adult Cancer Risk</b>
Birth to <1 month	1	0.300	0.083	0.0012	1.0E-06	10	3.6E-09	4.1E-06	3.1E-06	1.1E-09	4.7E-09	2.2E-07
1 to <3 months	1	0.300	0.167	0.0024	1.0E-06	10	7.1E-09	4.1E-06	3.1E-06	2.2E-09	9.4E-09	
3 to <6 months	1	0.300	0.250	0.0036	1.0E-06	10	1.1E-08	4.1E-06	3.1E-06	3.3E-09	1.4E-08	
6 to <12 months	1	0.300	0.500	0.0071	1.0E-06	10	2.1E-08	4.1E-06	3.1E-06	6.6E-09	2.8E-08	
1 to <2 years	1	0.300	1.000	0.0143	1.0E-06	10	4.3E-08	4.1E-06	3.1E-06	1.3E-08	5.6E-08	
2 to <3 years	1	0.300	1.000	0.0143	1.0E-06	3	1.3E-08	4.1E-06	3.1E-06	1.3E-08	2.6E-08	
3 to <6 years	1	0.300	3.000	0.0429	1.0E-06	3	3.9E-08	4.1E-06	3.1E-06	4.0E-08	7.8E-08	
6 to <11 years	1	0.300	5.000	0.0714	1.0E-06	3	6.4E-08	4.1E-06	3.1E-06	6.6E-08	1.3E-07	2.6E-07
11 to <16 years	1	0.300	5.000	0.0714	1.0E-06	3	6.4E-08	4.1E-06	3.1E-06	6.6E-08	1.3E-07	9.5E-07
16 to <18 years	1	0.300	2.000	0.0286	1.0E-06	1	8.6E-09	4.1E-06	3.1E-06	2.7E-08	3.5E-08	
18 to <21 years	1	0.300	3.000	0.0429	1.0E-06	1	1.3E-08	4.1E-06	3.1E-06	4.0E-08	5.3E-08	
21 to <30 years	1	0.300	9.000	0.1286	1.0E-06	1	3.9E-08	4.1E-06	3.1E-06	1.2E-07	1.6E-07	
30 to 70 years	1	0.300	40.000	0.5714	1.0E-06	1	1.7E-07	4.1E-06	3.1E-06	5.3E-07	7.0E-07	
										<b>Total unit risk:</b>	<b>1.4E-06</b>	

ug/m<sup>3</sup> – micrograms per cubic meter  
 ADAF: Age-Determinant Adjustment Factors

Table C-4: Estimated TCE Cancer Risk for Maximum Level of TCE at RES023

Note:	Highlighted	cells can be adjusted depending on exposure scenario (e.g., in Col C, set to 0 for age groups without exposure)										
<b>Inhalation (concentration-equivalence across age groups)</b>												
Col A	Col B	Col C	Col D	Col E	Col F	Col G	Col H	Col I	Col J	Col K	Col L	
Exposure scenario parameters				Dose-response assessment calculations								
<b>Units:</b>		(µg/m <sup>3</sup> air)	year	-	(µg/m <sup>3</sup> air) <sup>-1</sup>	-	-	(µg/m <sup>3</sup> air) <sup>-1</sup>	(µg/m <sup>3</sup> air) <sup>-1</sup>	-	-	
<b>Age group</b>	risk per µg/m <sup>3</sup> air equivalence	Exposure concentration	Age group duration	Duration adjustment (Col D / 70 year)	Kidney unadjusted lifetime unit risk (p 5-137 [5.2.2.1.4])	Kidney cancer default ADAF	<b>Kidney ADAF-adjusted partial risk (Col B x Col C x Col E x Col F x Col G)</b>	Kidney+NHL+ liver unadjusted lifetime unit risk (p 5-139 [5.2.2.2])	NHL+ liver lifetime unit risk (Col I - Col F)	<b>NHL and liver partial risk (Col B x Col C x Col E x Col J)</b>	<b>Total partial risk (Col H + Col K)</b>	<b>Child, Older Child, and Adult Cancer Risk</b>
Birth to <1 month	1	0.81	0.083	0.0012	1.0E-06	10	9.6E-09	4.1E-06	3.1E-06	3.0E-09	1.3E-08	5.9E-07
1 to <3 months	1	0.81	0.167	0.0024	1.0E-06	10	1.9E-08	4.1E-06	3.1E-06	6.0E-09	2.5E-08	
3 to <6 months	1	0.81	0.250	0.0036	1.0E-06	10	2.9E-08	4.1E-06	3.1E-06	9.0E-09	3.8E-08	
6 to <12 months	1	0.81	0.500	0.0071	1.0E-06	10	5.8E-08	4.1E-06	3.1E-06	1.8E-08	7.6E-08	
1 to <2 years	1	0.81	1.000	0.0143	1.0E-06	10	1.2E-07	4.1E-06	3.1E-06	3.6E-08	1.5E-07	
2 to <3 years	1	0.81	1.000	0.0143	1.0E-06	3	3.5E-08	4.1E-06	3.1E-06	3.6E-08	7.1E-08	
3 to <6 years	1	0.81	3.000	0.0429	1.0E-06	3	1.0E-07	4.1E-06	3.1E-06	1.1E-07	2.1E-07	
6 to <11 years	1	0.81	5.000	0.0714	1.0E-06	3	1.7E-07	4.1E-06	3.1E-06	1.8E-07	3.5E-07	7.1E-07
11 to <16 years	1	0.81	5.000	0.0714	1.0E-06	3	1.7E-07	4.1E-06	3.1E-06	1.8E-07	3.5E-07	2.6E-06
16 to <18 years	1	0.81	2.000	0.0286	1.0E-06	1	2.3E-08	4.1E-06	3.1E-06	7.2E-08	9.5E-08	
18 to <21 years	1	0.81	3.000	0.0429	1.0E-06	1	3.5E-08	4.1E-06	3.1E-06	1.1E-07	1.4E-07	
21 to <30 years	1	0.81	9.000	0.1286	1.0E-06	1	1.0E-07	4.1E-06	3.1E-06	3.2E-07	4.3E-07	
30 to 70 years	1	0.81	40.000	0.5714	1.0E-06	1	4.6E-07	4.1E-06	3.1E-06	1.4E-06	1.9E-06	
<b>Total unit risk:</b>											<b>3.9E-06</b>	

ug/m<sup>3</sup> – micrograms per cubic meter  
 ADAF: Age-Determinant Adjustment Factors

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