Second Tier Review Recommendation for: Weyerhaeuser, Inc. Continuous Dry Kiln Project

Raymond, Washington

Air Quality Program
Washington Department of Ecology
Olympia, Washington

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DEPARTMENT OF ECOLOGY
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Executive Summary

This document presents and summarizes a review of health risks from increases in emissions of toxic air pollutants (TAPs) emitted by a new continuous dry kiln. This kiln will replace existing batch kilns and a wood-fired boiler at the facility. In general, toxic air pollutant impacts near Weyerhaeuser's facility will not result in excessive cancer risk or cause serious short- or long-term health effects. Ecology concludes that the health risk is acceptable and recommends approval of the project.

Weyerhaeuser proposes to build a new continuous lumber dry kiln at their existing facility in Raymond, WA. The new kiln will replace existing units, and allow them to dry more lumber:

- The new kiln will use direct heat from sawdust gasification burners to dry lumber.
- Increases in emissions will come from green sawdust gasification burners and Douglas fir lumber as it dries in the kiln. Emissions will be vented through vapor extraction points and openings at each end of the kiln.
- Weyerhauser assumed near continuous operation of the kiln will dry about 310 million board feet (MMbf) per year.
- The new kiln will replace eight existing indirect heated batch kilns and an existing hog fuel boiler. To determine which TAPs required additional review, Weyerhauser offset increased emissions from the proposed project with actual emissions from the existing units.
    - This approach is allowed under WAC 173-460-080, but the reductions in TAP emissions must be included in the approval order as an enforceable condition. In this case, the existing hog fuel boiler and batch kilns must be removed from service.

Weyerhaeuser's new continuous dry kiln project may cause an increased ambient impact of two TAPs—benzene and formaldehyde—at rates triggering a requirement to prepare a health impact assessment. A health impact assessment describes the increased health risks from exposure to TAPs.

Weyerhaeuser hired Trinity Consultants to prepare a health impact assessment. Trinity Consultants estimated increased health risks associated with benzene, formaldehyde, and other TAPs emitted from Weyerhaeuser's proposed continuous dry kiln.

Conclusions

- Long-term impacts:
    - Assuming Weyerhaeuser's kiln operates at full allowable annual limits, benzene, formaldehyde, and other toxic air pollutant emissions result in a maximum increased lifetime cancer risk of about 9.6 in one million. The

maximum risk occurs for residents of apartments directly east of Weyerhaeuser's property boundary. Ecology assumes residents are continuously exposed over a 70-year lifetime when assessing cancer risks for residents' exposure to project-related toxic air pollutant emissions.

        - Cancer risk can be expressed either as an increase in an individual's risk of disease or as the number of cancers that might occur in addition to those normally expected in a population of one million people. The reported estimates of project-attributable cancer risk represent increases above a baseline lifetime cancer risk of about 40 percent in the United States.
    - Lifetime exposure to "background" levels of benzene and formaldehyde in the area results in a risk of about 10 in one million.
    - Exposure to benzene, formaldehyde, and other TAPs in the area is not likely to result in long-term non-cancer health effects.

Ecology's recommendation

Ecology recommends approval of the project because:

- Emission controls for the new and modified emission units represent best available control technology for toxics (tBACT).
- The applicant demonstrated that the increase in emissions of TAPs is not likely to result in an increased cancer risk of more than one in one hundred thousand (10 in one million) which is the maximum risk allowed by a second tier review.
- The non-cancer hazard is acceptable.

Second Tier Review Processing and Approval Criteria

The health impacts assessment (HIA) for Weyerhaeuser submitted by Trinity Consultants is part of the second tier toxics review process under WAC 173-460 (Trinity Consultants, 2024). Ecology is responsible for processing and reviewing second tier review petitions statewide.

Second tier review processing requirements

Ecology's review of the second tier petition verifies that each of the following regulatory processing requirements under Chapter 173-460-090 is satisfied:

(a) The permitting authority has determined that other conditions for processing the Notice of Construction Order of Approval (NOC) have been met and has issued a preliminary approval order.

(b) Emission controls contained in the preliminary NOC approval order represent at least tBACT.

(c) The applicant has developed an HIA protocol that has been approved by Ecology.

(d) The ambient impact of the emissions increases of each toxic air pollutant (TAP) that exceeds acceptable source impact levels (ASILs) has been quantified using refined air dispersion modeling techniques as approved in the HIA protocol.

(e) The second tier review petition contains an HIA conducted in accordance with the approved HIA protocol.

Acting as the "permitting authority" for this project, Olympic Region Clean Air Agency's (ORCAA) project permit engineer satisfied item (a),[1] and Ecology's engineering team verified item (b) above.[2] Ecology approved an HIA protocol (item (c)), and the final HIA (item (e)) was received by Ecology on February 14, 2024. Ecology's modeler determined that Trinity Consultants conducted the refined modeling (item (d)) appropriately.[3]

All five processing requirements above are satisfied.

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[1] Aaron Manley, " Weyerhaeuser 23NOC1614 Preliminary Draft for Tier II Review", email with attachment, March 29, 2024.
2 Memgchiu Lim, "RE: Weyerhaeuser 23NOC1614 Preliminary Draft for Tier II Review", email April 1, 2024.
3 Beth Friedman, "RE: Weyerhaeuser Raymond CDK Health Impact Assessment," email message, December 20, 2023.

Second tier review approval criteria

As specified in WAC 173-460-090(7), Ecology may recommend approval of a project that is likely to cause an exceedance of ASILs for one or more TAPs only if it:

(a) Determines that the emission controls for the new and modified emission units represent tBACT.

(b) The applicant demonstrates that the increase in emissions of TAPs is not likely to result in an increased cancer risk of more than one in one hundred thousand.

(c) Ecology determines that the non-cancer hazard is acceptable.

tBACT determination

Weyerhaeuser's proposed pollution control equipment satisfies the tBACT requirements for continuous dry kilns. While pollution control options are feasible, they are not considered cost-effective, thus tBACT for benzene, formaldehyde, and other TAPs were determined to be met through:

- Good combustion practices.
- The installation of a kiln management system and in-kiln moisture management system to optimize drying efficiency.
- Limits on the lumber drying temperature (maintain lumber drying temperature <220˚F).
- The development of and adherence to an operation and maintenance plan to ensure equipment functions as designed.

Health Impact Assessment Review

As described above, the applicant is responsible for preparing the HIA under WAC 173-460-090. Ecology's project team consisting of an engineer, a toxicologist, and a modeler reviews the HIA to determine if the methods and assumptions are appropriate for assessing and quantifying risks to the surrounding community from a new project.

For the Weyerhaeuser continuous dry kiln project, the HIA focused on health risks attributable to benzene and formaldehyde exposure because the modeled ambient air concentrations exceeded respective ASILs. Trinity Consultants also described emissions and exposure to other TAPs to estimate the added risk and hazard posed by these pollutants.

Health effects summary

The HIA prepared by Trinity Consultants quantifies the non-cancer hazards and increased cancer risks attributable to Weyerhaeuser's TAP emissions. The HIA focused on potential exposure to benzene and formaldehyde as these were the two TAPs with emissions causing an exceedance of an ASIL, but Trinity Consultants also evaluated health impacts from other TAPs emitted above small quantity emission rates (SQERs).

Benzene health effects summary

Long- and short-term inhalation of benzene at sufficient levels may cause effects on the hematological system. Benzene specifically affects the bone marrow and may cause aplastic anemia and excessive bleeding. Because white blood cells may be damaged, benzene may also affect the immune system. Occupational health studies show an increased incidence of leukemia for workers exposed to benzene. The U.S. Environmental Protection Agency (EPA) has classified benzene as a known (Class A) human carcinogen (EPA, 2012).

Formaldehyde health effects summary

Low levels of formaldehyde can irritate the eyes, nose, throat, and skin. It is possible that people with asthma exposed to formaldehyde can experience respiratory symptoms such as wheezing, shortness of breath, and reduced pulmonary function consistent with bronchoconstriction (CalEPA, 2008). At concentrations that might occur in ambient air, effects occur in tissues where formaldehyde enters the body (i.e., nose or mouth). At higher levels such as those possibly experienced in occupational settings, coughing, wheezing, bronchitis, nasal obstruction, pulmonary edema, choking, dyspnea, and chest tightness may occur.

People chronically exposed to formaldehyde by inhalation have experienced respiratory symptoms and eye, nose, and throat irritation. Animal studies have reported effects on the nasal respiratory epithelium and lesions in the respiratory system from chronic inhalation exposure to formaldehyde. In animal studies, rats exposed to high levels of formaldehyde in air developed cancer in a type of epithelial cell in the nose (nasal

squamous cell carcinoma). Some studies of people exposed to formaldehyde in workplace air found more cases of cancer of the nose and throat than expected. The U.S. Department of Health and Human Services (DHHS) has determined that formaldehyde is a known human carcinogen based on human and animal inhalation studies (DHHS, 2021). EPA has classified formaldehyde as a Group B1, probable human carcinogen.

Other TAPs emitted above SQERs

As part of first tier toxics review, Trinity Consultants screened out pollutants by comparing emission rates (after pollutant offsetting) to SQERs in WAC 173-460-150. Then they used refined dispersion modeling to estimate the impact of remaining TAPs to compare ambient concentrations to ASILs. While benzene and formaldehyde were the only chemicals to exceed respective ASILs, Ecology requested that Trinity Consultants consider combined hazards and risks from these other TAPs emitted above SQERs but with ambient impacts less than ASILs. These other TAPs included:

- arsenic
- cadmium
- lead
- manganese
- nickel

Many of the TAPs listed above are carcinogenic or may pose long- and short-term non-cancer hazards adding to risk and hazards from benzene and formaldehyde.

Toxicity reference values

Agencies develop toxicity reference values for use in evaluating and characterizing exposures to chemicals in the environment. As part of the HIA, Trinity Consultants identified toxicity values for benzene, formaldehyde, and other TAPs from California EPA's Office of Environmental Health Hazard Assessment (OEHHA). Ecology also considered other toxicity values from EPA and the Agency for Toxic Substances and Disease Registry (ATSDR) (Table 1).[4] The agencies derive toxicity values from studies of animals exposed to a known amount (concentration) of pollutants, or from epidemiological studies of exposed humans. These values represent a level at or below which we do not expect adverse non-cancer health effects and a metric by which to quantify increased risk from exposure to a carcinogen.

[4] Trinity Consultants also identified toxicity values from OEHHA for other TAPs with emissions exceeding SQERs but with ambient impacts less than ASILs.

Benzene toxicity values

Trinity Consultants and Ecology identified toxicity values for benzene from three agencies: EPA (EPA, 1998; EPA, 2002), OEHHA (CalEPA, 2009; CalEPA, 2014), and ATSDR (ATSDR, 2007).

EPA derived a chronic reference concentration (RfC) (30 $\mu g/m^3$) based on decreased lymphocyte counts among workers exposed to benzene. ATSDR and OEHHA developed chronic and acute reference values for inhalation exposure to benzene. ATSDR's acute minimum risk level (MRL) (29 $\mu g/m^3$) is based on observations of reduced lymphocyte proliferation in mice after immune system stimulation. ATSDR's chronic MRL (9.6 $\mu g/m^3$) is based on significantly decreased counts of B-lymphocytes in workers of shoe manufacturing industries in Tianjin, China. OEHHA chronic REL (3 $\mu g/m^3$) is based on decreased peripheral blood cells in Chinese workers and the acute reference exposure level (REL) (27 $\mu g/m^3$) is based on effects on the blood of fetal and neonatal (i.e., developing) mice.

Both EPA and OEHHA-derived unit risk factors (URFs) for estimating cancer risk from exposure to benzene. EPA based its URF on a study of workers exposed to benzene while manufacturing pliofilm. Observed leukemia incidences in this cohort led EPA to derive a range of unit risk of 2.2×10^{-6} to 7.8×10^{-6} per $\mu g/m^3$. OEHHA evaluated several animal and human occupational studies to derive a unit risk value of 2.9×10^{-5} per $\mu g/m^3$.

Formaldehyde toxicity values

Trinity Consultants and Ecology identified toxicity values for formaldehyde from three agencies: EPA (EPA, 1991), OEHHA (CalEPA, 2008; CalEPA 2009), and ATSDR (ATSDR, 1999).

Both EPA and OEHHA-derived URFs for estimating cancer risk from exposure to formaldehyde. Each agency relied on a study of the incidence of nasal squamous carcinoma in rats after long-term exposure to formaldehyde. While the URFs are based on the same study, the values are slightly different because the agencies used different assumptions and techniques to establish the URF (Table 1).

ATSDR and OEHHA developed chronic and acute reference values for inhalation exposure to formaldehyde. The chronic toxicity values are based on long-term occupational studies in which workers experienced nasal and eye irritation (OEHHA REL = 9 $\mu g/m^3$) and changes to nasal tissue after long-term exposure (ATSDR MRL = 10 $\mu g/m^3$).

OEHHA derived the acute REL of 55 $\mu g/m^3$ based on eye irritation after short-term exposures. ATSDR's acute MRL (50 $\mu g/m^3$) is based on respiratory effects such as sneezing, congestion, and irritation of the eyes and nasal passages.

Table 1: Toxicity Values or Comparison Values Considered in Assessing and Quantifying Non-cancer Hazard and Cancer Risk

Pollutant	Agency	Non-cancer	Cancer
Benzene	EPA	Chronic RfC = 30 µg/m^3	URF = 7.8 E-6 per µg/m^3
Benzene	CalEPA-OEHHA	Chronic REL = 3 µg/m^3 Acute REL = 27 µg/m^3	URF = 2.9 E-5 per µg/m^3
Benzene	ATSDR	Chronic MRL = 9.6 µg/m^3 Intermediate MRL = 19 µg/m^3 Acute MRL = 29 µg/m^3	NA
Formaldehyde	EPA	NA	URF = 1.3 E-5 per µg/m^3
Formaldehyde	CalEPA-OEHHA	Chronic REL = 9 µg/m^3 Acute REL = 55 µg/m^3	URF = 6.6E-6 per µg/m^3
Formaldehyde	ATSDR	Chronic MRL = 10 µg/m^3 Intermediate MRL = 37 µg/m^3 Acute MRL = 50 µg/m^3	NA

Community/receptors

Weyerhaeuser's proposed continuous dry kiln is in an area zoned "heavy industrial" by the city of Raymond (City of Raymond, 2012). The facility is bounded by the Willapa River to the north and the South Willapa River to the west. An area of residentially zoned parcels is located along the east side of the facility boundary.

Air dispersion modeling indicated that proposed benzene and formaldehyde emissions would result in long-term concentrations greater than the ASIL at about 35 parcels with residential land use codes (Figure 1) [Ecology, 2023].

To assess increased cancer risk and non-cancer hazards, Trinity Consultants identified receptor locations where the highest exposure to project-related air pollutants could occur: at or near the project boundary and nearby residences (Table 2, Figure 2). Generally, the area of highest impact also happens to be near residential properties to the east of the facility, so the maximally impacted residential receptor will experience the most exposure and risk from project-related emissions.

Table 2: Estimated Annual Average Benzene and Formaldehyde Concentrations at Key Receptor Locations

Receptor	UTM Coordinate	Average Annual Benzene Concentration (µg/m^3)	Average Annual Formaldehyde Concentration µg/m^3)
MIRR	(443715.5, 5170720)	0.196016	0.373772
MIBR	(443715.5, 5170732)	0.200008	0.381372

MIRR – Maximally impacted residential receptor
MIBR – Maximally impacted boundary receptor

Background concentrations of TAPs in ambient air

When reviewing increases in TAP emissions under second tier review, WAC 173-460-090 specifies that:

> Background concentrations of TAPs will be considered as part of a second tier review. Background concentrations can be estimated using:
>
> - The latest National Air Toxics Assessment data for the appropriate census tracts; or
> - Ambient monitoring data for the project's location; or
> - Modeling of emissions of the TAPs subject to second tier review from all stationary sources within 1.5 kilometers of the source location.

Table 3 shows the background levels considered by Trinity Consultants in the HIA. For background benzene and formaldehyde levels, Trinity Consultants used the 2019 AirToxScreen to determine background concentrations (EPA, 2022).[5]

[5] AirToxScreen is the successor to the National Air Toxics Assessment.

Table 3: Estimated "Background" Concentrations of Benzene and Formaldehyde near Weyerhaeuser – Raymond

Source	Average Annual Benzene Concentration ($\mu g/m^3$)	Average Annual Formaldehyde Concentration ($\mu g/m^3$)
2019 AirToxScreen – Census Tract 53049950200	0.1323	0.7055

Increased cancer risk

Trinity Consultants assessed the increased risk of cancer from lifetime exposure to benzene and formaldehyde emitted from Weyerhaeuser's proposed continuous dry kiln. They characterized cancer risk in a manner consistent with EPA guidance for inhalation risk assessment (EPA, 2009) using the following equations:

Risk = IUR x EC

Where:

IUR $(\mu g/m^3)^{-1}$ = inhalation unit risk (i.e., unit risk factor); and

EC ($\mu g/m^3$) = exposure concentration

EC = (CA x ET x EF x ED)/AT

Where:

EC ($\mu g/m^3$) = exposure concentration;

CA ($\mu g/m^3$) = contaminant concentration in air;

ET (hours/day) = exposure time;

EF (days/year) = exposure frequency;

ED (years) = exposure duration; and

AT (ED in years x 365 days/year x 24 hours/day) = averaging time

Because we assume continuous lifetime exposure for residential receptors, the formula can be simplified to:

Risk = IUR x CA

Cancer risk attributable to Weyerhaeuser's increased benzene, formaldehyde, and other TAP emissions

Table 4, adapted from the HIA, shows the estimated Weyerhaeuser-specific cancer risk per million for residential receptors located near the facility using EPA and OEHHA unit risk factors. The maximally impacted residential receptor received the highest exposure to Weyerhaeuser-related TAP emissions. Figure 2 shows the location of this receptor relative to Weyerhaeuser. The highest increase in risks attributable to Weyerhaeuser's benzene and formaldehyde emissions is about 8.2 per million[6] for residents of apartments located east of Weyerhaeuser's property. Ecology also calculated risks posed by other carcinogenic TAPs (i.e., arsenic, cadmium, lead, and nickel). We estimated an additional risk of about 1.4 per million (total cancer risk of about 9.6 per million).

Table 4: Estimated Increased Cancer Risk for Residential and Commercial Receptors Attributable to Weyerhaeuser's Formaldehyde, Benzene, and other TAP Emissions

	Benzene	Formaldehyde	Arsenic	Cadmium	Lead	Nickel	Total Risk
Concentration in air from Weyerhaeuser emissions ($\mu g/m^3$)	0.196	0.374	2.06E-04	1.52E-04	1.71E-03	4.32E-04	NA
OEHHA URF $(\mu g/m^3)^{-1}$	2.9E-05	6.6E-06	3.30E-03	4.20E-03	1.20E-05	2.60E-04	NA
EPA URF $(\mu g/m3)^{-1}$	7.8E-06	1.3E-05	4.30E-03	1.80E-03	NA	NA	NA
OEHHA Risk	5.7E-06	2.5E-06	6.8E-07	6.4E-07	2.1E-08	1.1E-07	9.6E-06
EPA Risk	1.5E-06	4.9E-06	8.86E-07	2.74E-07	NA	NA	6.4E-06

Table 5 shows the estimated background benzene- and formaldehyde-attributable cancer risk per million for residential receptors located near the facility using EPA and OEHHA unit risk factors. Exposure to existing "background" levels of benzene and formaldehyde in the area results in a risk ranging from about 8.5 (using OEHHA unit risk factors) to 10 (using EPA risk factors) in one million for residential receptors.

[6] Number per million represents an upper-bound theoretical estimate of the number of excess cancers that might result in an exposed population of one million people compared to an unexposed population of one million people. Alternatively, an individual's increase in risk of one in one million means a person's chance of getting cancer in their lifetime increases by one in one-million or 0.0001 percent.

Table 5: Estimated Increased Cancer Risk Attributable to Background Benzene and Formaldehyde Levels

	Benzene	Formaldehyde	Total Risk
Background Concentration (µg/m^3)	0.1323	0.7055	NA
OEHHA URF (µg/m3)$^{-1}$	2.9E-05	6.6E-06	NA
EPA URF (µg/m3)$^{-1}$	7.8E-06	1.3E-05	NA
OEHHA Risk	3.8E-06	4.7E-06	8.5E-06
EPA Risk	1.03E-06	9.2E-06	1.0E-5

Non-cancer hazard

Trinity Consultants assessed the acute and chronic non-cancer hazards from exposure to benzene, formaldehyde, and other TAP emissions from Weyerhaeuser's proposed continuous dry kiln. They estimated non-cancer hazards consistent with EPA guidance for inhalation risk assessment (EPA, 2009) using the following equations:

HQ = EC/Toxicity Value

Where:

HQ (unitless) = hazard quotient;

EC (µg/m^3) = exposure concentration;

Toxicity Value (µg/m^3) = inhalation toxicity value (e.g., RfC, REL) that is appropriate for the exposure scenario (acute, subchronic, or chronic).

EC = CA

Where:

EC (µg/m^3) = exposure concentration;[7]

CA (µg/m^3) = contaminant concentration in air.

To assess the overall potential for non-cancer effects posed by more than one chemical, Trinity Consultants estimated additive acute effects from several TAPs that exceeded small quantity emission rates. They used EPA's hazard index (HI) approach in which the HI is equal to the sum of the HQs about the same health endpoint or impacted organ system (EPA, 1986). When the HI exceeds unity, there may be concern

[7] EPA's guidance allows for exposure frequency and exposure duration to be considered when determining exposure concentrations for chronic health effects, but for simplicity, Trinity Consultants assumed all receptors were exposed continuously to the average annual contaminant concentration in air at the relevant receptor locations.

for potential health effects, but health effects may not occur. The level of concern rises the more an HQ or HI exceeds unity.

$HI_{(immune)} = HQ_{(benzene)} + HQ_{(nickel)} + HQ_{(etc.)}$

Trinity Consultants evaluated short-term (acute) exposures to benzene, formaldehyde, and other TAPs. Hazard quotients (HQs) do not exceed unity (one) at any location (Table 6). Moreover, when considering additive hazards from other TAPs, hazard indices (HIs) do not exceed unity for any toxicological endpoint. This indicates that emissions of project-related TAPs are not likely to cause short-term non-cancer hazards.

Table 6: Estimated Short-term Benzene, Formaldehyde, and Other TAP Non-cancer Hazards Attributable to Weyerhaeuser Emissions

Pollutant	Maximum Concentration ($\mu g/m^3$)	REL	Organ System	HQ
Benzene	4.9	27	Reproductive/development, immune system, hematologic system	0.18
Formaldehyde	0.39	55	Eyes/respiratory	0.18
Arsenic	0.012	0.2	Reproductive/development, cardiovascular system, nervous system	0.06
Cadmium	3.6E-03	NA	NA	NA
Lead	0.04	NA	NA	NA
Manganese	0.15	NA	NA	NA
Nickel	0.01	0.2	Immune system	0.05

Trinity Consultants also evaluated chronic non-cancer hazards associated with long-term exposure to benzene, formaldehyde, and other TAPs emitted from Weyerhaeuser's proposed continuous dry kiln. Long-term exposure to benzene, formaldehyde, and other TAPs in the area results in HQs and HIs much lower than unity (Table 7). Additionally, non-cancer HIs would remain low even when considering "background" exposures (not shown in Table 7). This indicates that chronic non-cancer hazards due to exposure to benzene, formaldehyde, and other TAPs near Weyerhaeuser's facility are not likely to occur.

Table 7: Estimated Long-term Respiratory Non-cancer Hazards Attributable to Weyerhaeuser Emissions

Pollutant	Average Annual Concentration ($\mu g/m^3$)	REL	Organ System	HQ
Benzene	0.21	3	Hematologic system, nervous system, development	0.069
Formaldehyde	0.39	9	Respiratory system	0.044
Arsenic	2.1E-04	0.015	Reproductive/development; cardiovascular system; nervous system; lung; skin	0.014
Cadmium	1.5E-04	0.02	Kidney, respiratory system	7.6E-03
Lead	1.7E-03	NA	NA	NA
Manganese	5.1E-03	0.09	Nervous system	0.057
Nickel	4.3E-04	0.014	Respiratory system, hematologic system	0.031

Other Considerations

Other TAPs contribution to health risk/hazards

Under second tier toxics review (WAC 173-460-090), the applicant is required to assess the risk posed by TAPs that exceed an ASIL. In the case of Weyerhaeuser's continuous dry kiln project, Ecology requested that Trinity Consultants evaluate impacts from several other TAPs emitted from the continuous dry kiln. Although these TAPs were not emitted at levels that resulted in exceedance of respective ASILs, Ecology considered the potential additive effect of these pollutants' contribution to cancer risk and non-cancer hazards.

These other TAPs included:

- arsenic
- cadmium
- lead
- manganese
- mercury
- nickel

As mentioned previously, these other TAPs contributed very little to non-cancer hazards but resulted in an additional cancer risk of about 1.4 in one million.

Uncertainty

Many factors of the HIA are prone to uncertainty. Uncertainty relates to the lack of exact knowledge regarding many assumptions used to estimate the human health impacts of Weyerhaeuser's emissions. The assumptions in the face of uncertainty may tend to over- or underestimate the health risks estimated in the HIA. Key aspects of uncertainty in the HIA for Weyerhaeuser's proposed data center are exposure assumptions, emissions estimates, air dispersion modeling, and toxicity of air pollutants.

Table 8: Qualitative Summary of How Uncertainty Affects the Quantitative Estimate of Risks or Hazards Attributable to Weyerhaeuser Emissions

Source of Uncertainty	How Does it Affect the Estimated Risk of this Project?
Exposure assumptions	We typically assume that residential receptors are exposed to project-related emissions continuously for an entire lifetime. This assumption likely results in an overestimate of risk, but it is intended to avoid underestimating increased risk.
Emissions estimates	Emissions from continuous dry kilns are uncertain. Trinity used a reasonable approach to estimate TAP emissions. Actual emissions could be more or less than estimated.
Air modeling methods	Possible underestimate of average long-term ambient concentrations and overestimate of short-term ambient concentration.
Toxicity of TAPs at low concentrations	The toxicity of various pollutants at low exposure levels is uncertain. Most of the toxicity (and epidemiological) studies evaluate the health effects of exposure to various pollutants at levels much higher than those estimated in the ambient air near Weyerhaeuser. Agencies establish toxicity reference values in a manner that attempts to address various uncertainties to produce reference levels that are generally considered protective of the general population including sensitive individuals.

Exposure uncertainty

We can only estimate the amount of time over the course of an individual's lifetime that they will be exposed to Weyerhaeuser's toxic air pollutant emissions. Trinity Consultants used conservative estimates of exposure duration and frequency to ensure public health protection. We expect that the individual's exposure duration and frequency are probably less than estimated in the HIA.

Emissions uncertainty

The exact amount of TAPs emitted from combustion and lumber drying within Weyerhaeuser's direct-fired continuous dry kiln is uncertain. Trinity Consultants relied on several sources of information to compile emissions estimates.

- Benzene emissions from green sawdust combustion were based on emission factors in AP-42 Section 1.6: Wood Residue Combustion in Boilers (EPA, 2022).

- Other TAPs related to the combustion of green sawdust in the continuous dry kiln were estimated assuming the humidity inside the kiln acts similarly to wet scrubbers on wood-fired boilers (NCASI, 2013).
    - Additionally, Trinity Consultants amended arsenic emissions estimates by applying the arsenic: PM_{10} ratio to emission factors from the Georgia Environmental Protection Division[8] which is based on annual lumber throughput (MMBf) to determine emissions from both combustion and lumber drying.
- Regarding emissions of volatile TAPs from drying lumber, Trinity Consultants relied on EPA Region 10 HAP and VOC Emission Factors for Lumber Drying and scaled up emissions by the proportion of direct to indirect average batch kiln emission factors in the NCASI Wood Products Air Emission Factor Database.
- Trinity Consultants also considered emissions that would occur during initial start-up and idling. They assumed the start-up and idling activities would occur 360 hours per year at full burning capacity (i.e., 50 MMBtu/hr). Because a lower firing rate of about 1 MMBtu/hr is expected during these periods, start-up and idling emissions may be overestimated.
- Trinity Consultants assumed that the lumber kiln would operate at capacity near-continuously throughout the year. Actual operation and throughput may be lower than that used to estimate emissions.

The air regulatory authority, ORCAA, considered the emissions estimates to be reasonable, however, they included a fuel testing requirement in the draft permit to verify potential arsenic emissions.

Air dispersion uncertainty

The transport of pollutants through the air is a complex process. Agencies develop regulatory air dispersion models to estimate the transport and dispersion of pollutants as they travel through the air. They evaluate and update these models when more accurate techniques become known. Generally, agencies develop these models to avoid underestimating the modeled impacts. Even if we confidently know all the numerous input parameters to an air dispersion model, random effects found in the real atmosphere will introduce uncertainty.

[8] Georgia EPD Recommended Emission Factors for Lumber Kiln Permitting in Georgia. Document not provided.

Toxicity uncertainty

One of the largest sources of uncertainty in any risk evaluation is associated with the scientific community's limited understanding of the toxicity of most chemicals in humans following exposure to the low concentrations generally encountered in the environment. To account for uncertainty when developing toxicity values (e.g., RfCs), EPA and other agencies apply "uncertainty" factors to observed doses or concentrations that cause adverse non-cancer effects in animals or humans. Agencies apply these uncertainty factors so that they derive a toxicity value considered protective of humans including susceptible populations. These reference values are likely protective of most of the population including sensitive individuals.

Conclusions and Recommendation

The project review team has reviewed the HIA and determined that:

(a) The TAP emissions estimates presented by Trinity Consultants represent a reasonable estimate of the project's future emissions.

(b) Emission controls for the new and modified emission units meet the tBACT requirement.

(c) The ambient impact of the emissions increases of each TAP that exceeds ASILs has been quantified using appropriate refined air dispersion modeling techniques.

(d) The HIA submitted by Trinity Consultants on behalf of Weyerhaeuser adequately assesses project-related increased health risk attributable to TAP emissions.

In the HIA, Trinity Consultants estimated lifetime increased cancer risks attributable to Weyerhaeuser's benzene, formaldehyde, and other toxic air pollutant emissions. Increased TAP emissions resulted in an increase in cancer risk of about 9.6 in one million at the maximally impacted residential receptor. The location for this receptor is adjacent to Weyerhaeuser's east property boundary.

Trinity Consultants also assessed chronic and acute non-cancer hazards attributable to the project's emissions and determined that short- and long-term adverse non-cancer health effects from exposure to project-related TAPs are not likely to occur.

Finally, Trinity Consultants and Ecology assessed the cumulative health risk by adding estimated concentrations attributable to Weyerhaeuser's emissions to estimated background levels. The maximum cumulative cancer risk from residents' exposure to benzene and formaldehyde near Weyerhaeuser is approximately 10 in one million.

Because the increase in cancer risk attributable to the new emissions alone is less than the maximum risk allowed by a second tier review, which is 10 in one million, and the non-cancer hazard is acceptable, the project is approvable under WAC 173-460-090.

The project review team concludes that the HIA represents an appropriate estimate of potential increased health risks posed by Weyerhaeuser's TAP emissions. The risk manager may recommend approval of the permit because:

- The cancer risk from Weyerhaeuser's increased TAP emissions is less than the maximum risk (10 in one million) allowed by a second tier review.
- Ecology determined that the non-cancer hazard is acceptable.

References

ATSDR, Agency for Toxic Substances and Disease Registry, Toxicological Profile for Formaldehyde, July 1999, <https://www.atsdr.cdc.gov/toxprofiles/tp111.pdf>.

------, Toxicological Profile for Formaldehyde, August 2007, <https://www.atsdr.cdc.gov/toxprofiles/tp3.pdf>.

CalEPA, California Environmental Protection Agency Office of Environmental Health Hazard Assessment, "Technical Support Document for Noncancer RELs Appendix D2: Acute RELs and toxicity summaries using the previous version of the Hot Spots Risk Assessment guidelines," December 2008, <http://www.oehha.ca.gov/air/hot_spots/2008/AppendixD2_final.pdf>.

------, Office of Environmental Health Hazard Assessment, Air Toxics Hot Spots Program Technical Support Document for Cancer Potencies, Appendix B, Chemical-specific summaries of the information used to derive unit risk and cancer potency values, June 2009 (updated 2011).

------, Office of Environmental Health Hazard Assessment, Technical Supporting Document for Noncancer RELs, Appendix D1, December 2008 (updated July 2014).

------, Office of Environmental Health Hazard Assessment, "Risk Assessment Guidelines: Guidance Manual for Preparation of Health Risk Assessments," February 2015, <http://www.oehha.ca.gov/air/hot_spots/2015/2015GuidanceManual.pdf>.

City of Raymond, Zoning Map revised 2012, <https://cityofraymond.com/public-works/zoning/>.

United States Department of Health and Human Services (DHHS): National Toxicology Program, Report on Carcinogens, Fifteenth Edition: Formaldehyde, December 21, 2021, <https://ntp.niehs.nih.gov/sites/default/files/ntp/roc/content/profiles/formaldehyde.pdf>.

Ecology, Washington State Department of Ecology, Washington State Parcels Project: Digital Tax Parcel Information Containing Department of Revenue Land Use Codes, 2023.

EPA, United States Environmental Protection Agency, Guidelines for the Health Risk Assessment of Chemical Mixtures, EPA/630/R-98/002, September 1986.

------, Integrated Risk Information System chemical assessment summary for formaldehyde, last updated May 1, 1991.

------, Carcinogenic Effects of Benzene: An Update, EPA/600/P-97/001F, April 1998.

------, Toxicological Review of Benzene (Noncancer Effects), In support of summary information on the Integrated Risk Information System (IRIS), EPA/635/R-02/001F, October 2002, <https://iris.epa.gov/static/pdfs/0276tr.pdf>.

------, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment), January 2009, <https://www.epa.gov/sites/production/files/2015-09/documents/partf_200901_final.pdf>.

------, Air Toxics Screening Assessment: 2019 AirToxScreen Results, Released December 2022, <https://www.epa.gov/AirToxScreen/2019-airtoxscreen>.

------, Final Revision to AP-42 Chapter 1, Section 6 – Wood Residue Combustion in Boilers, March 2022, <https://www.epa.gov/system/files/documents/2022-03/c1s6_final.pdf>.

NCASI, National Council for Air and Stream Improvement, NCASI Technical Bulletin No. 1013: A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions, March 2013.

Trinity Consultants, Project Report: Health Impact Assessment Report / Raymond CDK, Weyerhaeuser, Inc. / Raymond, WA, December 2023, amended February 2024.

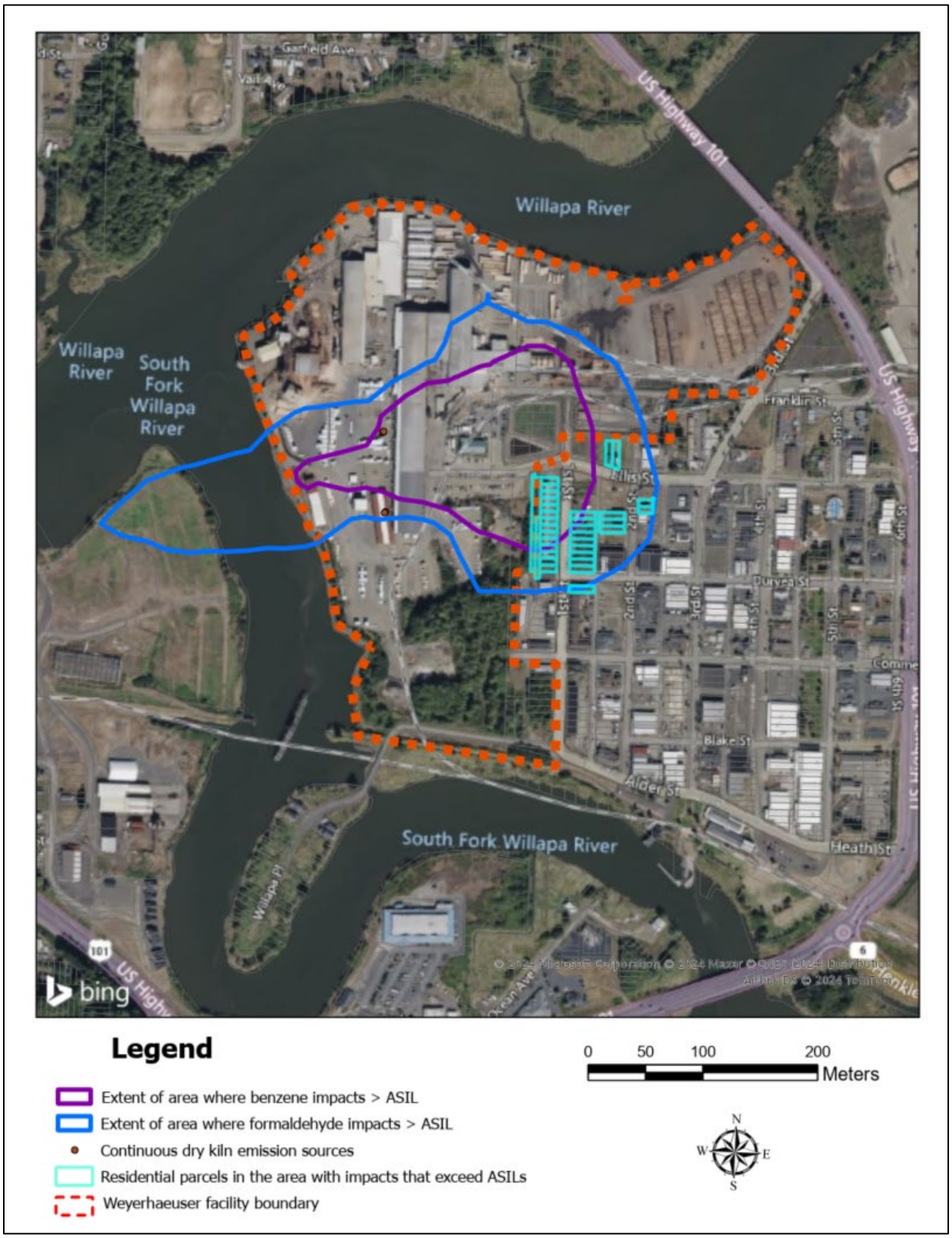

Figure 1: Residential parcels in the area where proposed Weyerhaeuser formaldehyde and benzene emissions may cause impacts that exceed the ASIL

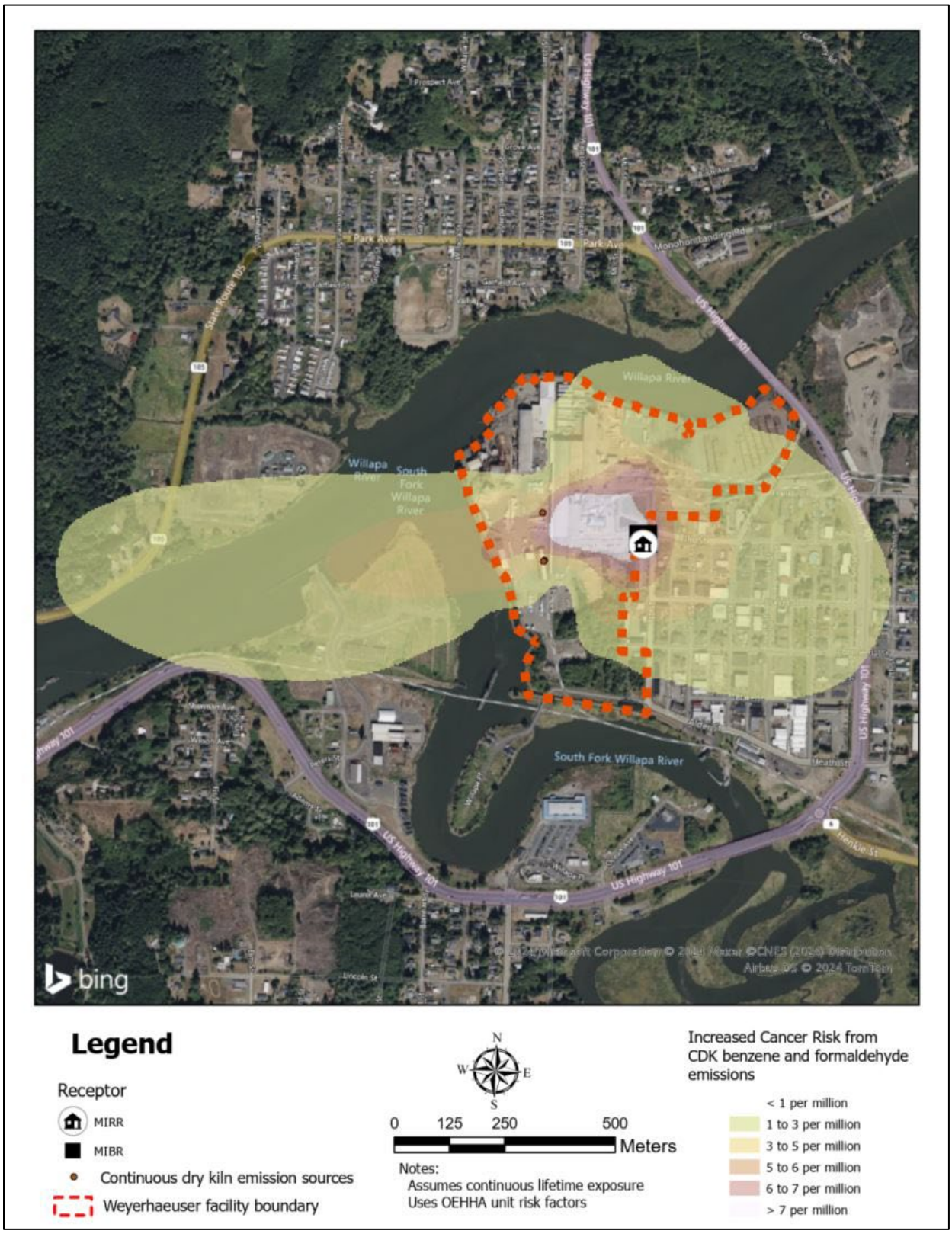

Figure 2: Weyerhaeuser project-related formaldehyde and benzene combined increased cancer risk and key receptor locations evaluated in the HIA