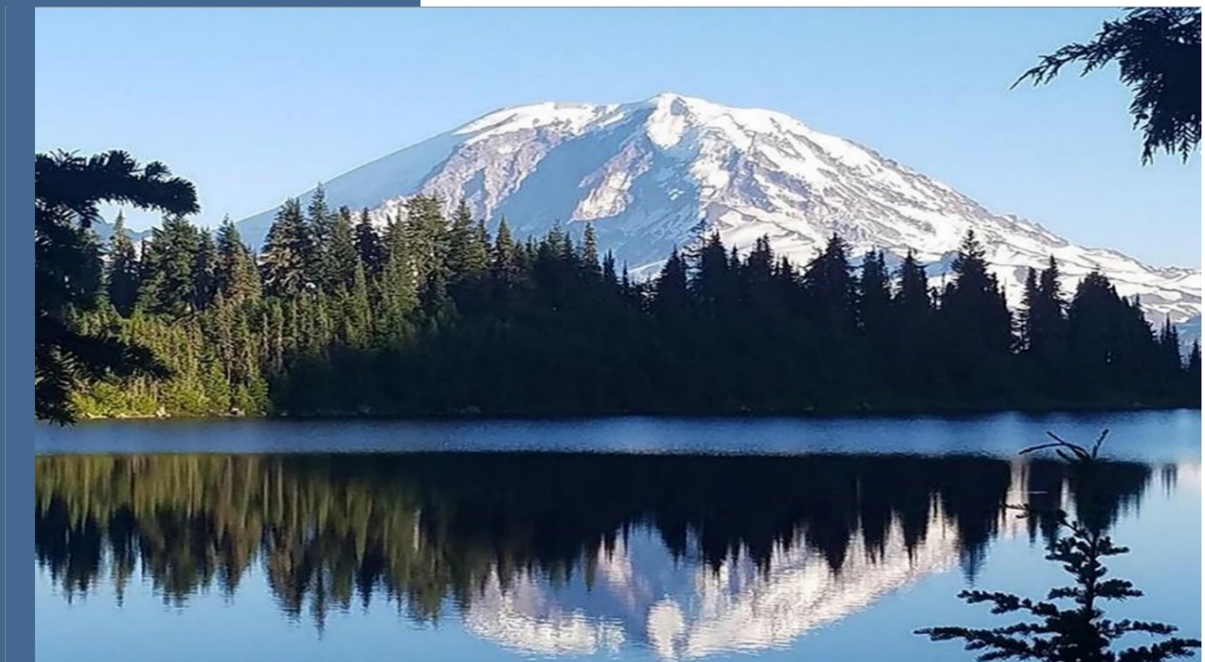

Health Impact Assessment Data Center General Order

Second Tier Air Toxics Review

Evaluation of increased health risks related to diesel particulate emitted from up to 21 diesel-powered emergency generators at data center facilities covered by a general order

Air Quality Program

Washington Department of Ecology

Olympia, Washington

August 2025

DEPARTMENT OF ECOLOGY
State of Washington

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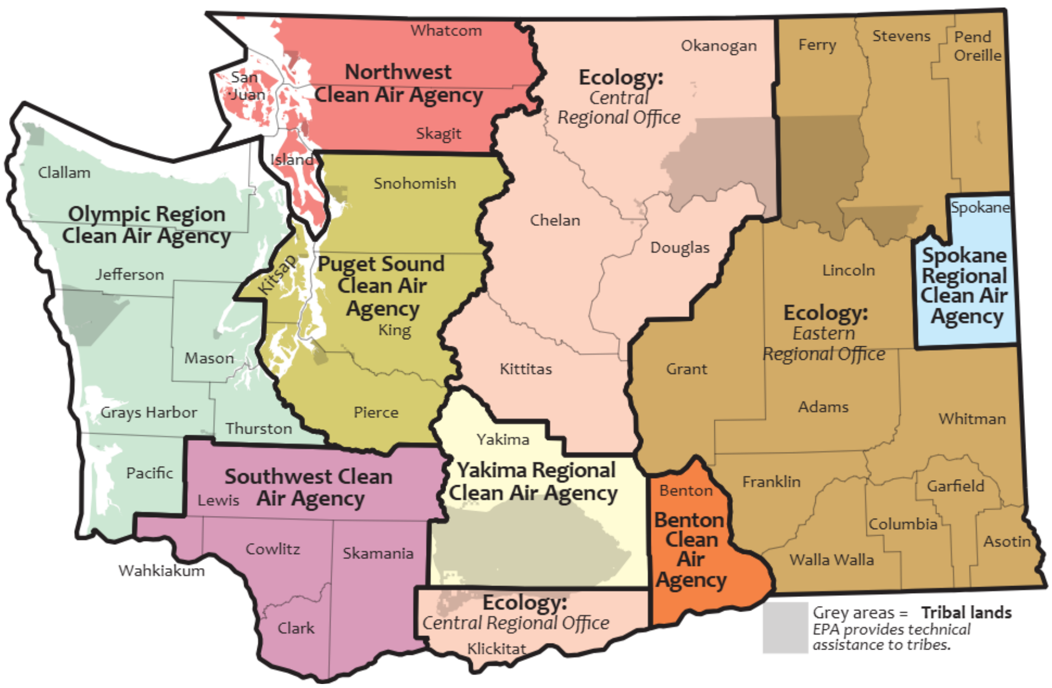
Department of Ecology's Regional Offices and Washington Clean Air Agencies

Map of Counties Served



Agency	Counties served
Benton Clean Air Agency	Benton
Ecology – Central Regional Office	Chelan, Douglas, Kittitas, Klickitat, Okanogan
Ecology – Eastern Regional Office	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Stevens, Walla Walla, Whitman
Ecology – Industrial Section	Statewide: Pulp mills, aluminum smelters
EPA Region 10	Tribal lands
Northwest Clean Air Agency	Island, San Juan, Skagit, Whatcom
Olympic Region Clean Air Agency	Clallam, Grays Harbor, Jefferson, Mason, Pacific, Thurston
Puget Sound Clean Air Agency	King, Kitsap, Pierce, Snohomish
Southwest Clean Air Agency	Clark, Cowlitz, Lewis, Skamania, Wahkiakum
Spokane Regional Clean Air Agency	Spokane
Yakima Regional Clean Air Agency	Yakima

Health Impact Assessment
Data Center General Order

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DEPARTMENT OF
ECOLOGY
State of Washington

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Executive Summary

Ecology proposes to develop a general order to allow the installation and operation of emergency engines at data centers in our air jurisdiction. Our jurisdiction covers counties that do not have a local clean air agency, specifically: Adams, Asotin, Chelan, Columbia, Douglas, Ferry, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Okanogan, Pend Oreille, Stevens, Walla Walla, and Whitman counties. We evaluated health impacts from diesel engine emissions to:

- Determine appropriate restrictions on how many hours each engine will be allowed to operate.
- Provide applicable requirements about how close engines can be to residences.

These restrictions and requirements are necessary to make sure emissions allowed under a general order stay within acceptable limits set by Chapter 173-460 WAC – Controls of New Sources of Toxic Air Pollutants.[3]

Data center emergency engines – general order

The proposed general order allows the installation and operation of up to 21 diesel-powered emergency generators at data centers in and around Quincy, East Wenatchee, and Malaga, Washington. Emissions of diesel engine exhaust particulate (DEEP) from these engines may cause air pollutant levels above acceptable source impact levels (ASILs), which trigger a health impact assessment (HIA). Ecology prepared this HIA as part of second tier air toxics review (Chapter 173-460-090 WAC).[4]

Health impacts evaluation

Ecology prepared an HIA to evaluate the potential non-cancer health hazards and cancer risks from operating diesel-powered generators. Ecology conducted several air dispersion modeling scenarios to determine the ambient impacts from emissions of these 21 diesel engines. For each of these scenarios, we identified how far the emergency engine stacks need to be from people to keep the risk at half the level of acceptable risk under second tier review. These distances will be used by Ecology to determine whether the General Order applies, and how many hours engines are allowed to operate on an annual basis.

Conclusion

Based on our assessment, we conclude that increased emissions from 21 new emergency engines at data centers will not likely result in long-term non-cancer health hazards. Increased

[3] https://app.leg.wa.gov/waC/default.aspx?cite=173-460
[4] https://app.leg.wa.gov/WAC/default.aspx?cite=173-460-090

cancer risk to people exposed to new emissions will be less than or equal to five in one million if the following criteria are met:

- Emission rates and other physical air dispersion modeling parameters are consistent with the scenarios modeled.
- Engine run time limits do not exceed 100 hours per engine per year. More stringent restrictions on engine use may be necessary depending on how close exhaust stacks are to residences.
    - 50 hours per engine per year – 120 to 180 meters from exhaust stack to residences
    - 75 hours per engine per year – 200 to 280 meters from exhaust stack to residences
    - 100 hours per engine per year – 320 to 400 meters from exhaust stack to residences

Since the increase in cancer risks from added emissions is below the second tier review limit of 10 in one million – and non-cancer health effects are unlikely – the 21 emergency engines covered by the general order can be approved under Chapter 173-460 WAC.

Data Center – General Order of Approval Description

Ecology is developing a general order of approval to allow the installation and operation of up to 21 diesel-powered emergency generators. An applicant may apply for a general order of approval that satisfies new source review requirements. Applicants for the data center general order of approval must meet the following key criteria:

- Each diesel-powered generator set must be rated at 3 MW or less.
- Engines must meet Tier IV emission standards (40 CFR 1039 Subpart B, Table 1 of 1039.101)
- The general order can be used only in locations relevant to East Wenatchee- and Quincy-area meteorology and terrain.
- Engines can operate 50 to 100 hours per engine per year, depending on the proximity of residential land to the facility's emergency engine exhaust stacks.
- Emergency engine stacks must be appropriately distant from residential land uses as determined by ambient impact analyses and HIA.

Permitting Requirements for New Sources of Toxic Air Pollutants

The general order will allow increased emissions of toxic air pollutants (TAPs), therefore, estimated emissions of TAPs must be reviewed. The requirements for performing a toxics review are established in Chapter 173-460 WAC. This rule requires a review of any non-de minimis[5] increase in TAP emissions for all new or modified stationary sources in the state of

[5] If the estimated increase of emissions of a TAP or TAPs from a new or modified project is below the de minimis emissions threshold(s) found in WAC 173-460-150, the project is exempt from review under Chapter 173-460 WAC.

Washington. Sources subject to review under this rule must apply best available control technology for toxics (tBACT) to control emissions of all TAPs subject to review.

Increased emissions and ambient impacts of TAPs are reviewed in three tiers:

(1) First tier (toxic screening)
(2) Second tier (health impacts assessment)
(3) Third tier (risk management decision)

All projects with emissions exceeding the de minimis rates are required to undergo a toxics screening (first tier review) as required by WAC 173-460-080. The objective of the toxics screening is to establish the systematic control of new sources emitting TAPs to prevent air pollution, reduce emissions to the extent reasonably possible, and maintain such levels of air quality to protect human health and safety. If modeled emissions exceed the trigger levels called ASILs, a second tier review is required.

As part of second tier review, described in WAC 173-460-090, the applicant submits a site-specific HIA. The objective of an HIA is to quantify the increase in lifetime cancer risk for persons exposed to the increased concentration of any carcinogen, and to quantify the increased health hazard from any non-carcinogen that would result from the proposed project. Once quantified, the cancer risk is compared to the maximum risk allowed by a second tier review, which is 10 in one million, and the concentration of any non-carcinogen that would result from the proposed project is compared to its threshold concentration.

If the increased emissions of a TAP subject to second tier review result in an increased cancer risk of greater than 10 in one million (equivalent to one in one hundred thousand), then an applicant may request Ecology perform a third tier review. For non-carcinogens, a similar path exists, but there is no bright line associated with when a third tier review is triggered.

A third tier review is a risk management decision in which Ecology decides that the risk of the project is acceptable based on a determination that emissions will be maximally reduced through available preventive measures, assessment of environmental benefit, disclosure of risk at a public hearing, and related factors associated with the facility and the surrounding community.

tBACT for Emergency Generators Covered Under the General Order

Ecology identified available technology for controlling criteria and TAPs emitted by diesel engines. Table 1 shows Ecology’s preliminary tBACT determination for TAPs emitted by diesel-powered emergency generators.

To facilitate a general order that will allow the installation of up to 21 large engines, Ecology decided that engines should have controls that are more stringent than those determined to meet the tBACT requirement; therefore, Ecology will require engines that meet EPA Tier-4 emission limits under a data center general order of approval.[6]

Table 1. tBACT Determination for TAPs Emitted by Emergency Diesel Engines

TAPs	tBACT Determination
DEEP, ammonia (slip), 1,3-butadiene, acetaldehyde, acrolein, benzene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, formaldehyde, hydrogen chloride, indeno(1,2,3-cd)pyrene, naphthalene, arsenic, cadmium, hexavalent chromium, manganese, mercury, nickel, total chromium	Restricted operation of EPA Tier-2 certified engines, and compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.
Nitrogen dioxide	Good combustion practices; an engine design that incorporates fuel injection timing retard, turbocharger, and a low-temperature after-cooler; EPA Tier-2 certified engines; and compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII.
Sulfur dioxide	Use of ultra-low sulfur diesel fuel containing no more than 15 parts per million by weight of sulfur.

First Tier Review Toxics Screening

Ecology used a combination of California, Ventura Air Pollution Control District, and EPA emission factors to estimate emissions of toxic air pollutants. Ecology also evaluated a variety of manufacturer specification sheets to estimate emission rates of diesel particulate matter and criteria pollutants that are also TAPs (i.e., nitrogen oxides (NO_X) and carbon monoxide (CO)) from diesel-powered generators (Ecology, 2025). Once emissions information is compiled, first tier review can be accomplished by:

- Comparing emission rates to small quantity emission rates (SQERs) in WAC 173-460-150.
- Use of AERSCREEN or other accepted screening model to estimate ambient concentrations to compare to ASILs.
- Use of AERMOD or other accepted refined dispersion model to compare ambient impact concentrations to ASILs.

[6] Ecology only evaluated higher control technology (i.e., engines that meet EPA Tier-4 emission limits) so that we can make the general order apply to more engines with fewer conditional restrictions relative to uncontrolled EPA Tier-2 certified engines. Furthermore, we wanted to make sure we had protections in place to minimize pollution because these engines will be used in locations not yet specified. Lastly, a higher level of control ensures that air quality impacts will be minimized if engines are needed for emergency purposes.

As demonstrated in the air modeling summary document (Ecology, 2025a), emissions of the following pollutants exceed SQERs (assuming 100 hours of operation per engine per year):

- DEEP
- Nitrogen dioxide
- 1,3-Butadiene
- Acetaldehyde
- Acrolein
- Benzene
- Benzo(a)pyrene
- Dibenz(a,h)anthracene
- Formaldehyde
- Hydrogen chloride
- Naphthalene
- Arsenic
- Cadmium
- Hexavalent chromium
- Mercury

Additional ambient impact analysis was required to compare modeled concentrations of these pollutants to respective ASILs. After refined modeling was conducted, only DEEP and nitrogen dioxide (NO_2) exceeded respective ASILs. Therefore, second tier review of these pollutants is required. In the case of NO_2, Ecology determined that the impacts from emergency engines under second tier review are not necessary, provided certain conditions are met (Ecology, 2025b).

Second Tier Review – Approval Criteria

The key component of second tier review is the preparation of an HIA. Typically, an applicant submits the HIA for Ecology's review, but in this case, Ecology assessed the health impacts of emissions from 21 emergency engines at data centers broadly located near Quincy and East Wenatchee, Washington.[7]

As specified in WAC 173-460-090(7), Ecology may recommend the 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.

[7] Applicability for coverage under the general order includes facilities sited in areas with similar meteorology and terrain as Quincy and East Wenatchee. For example, Malaga is located across the Columbia River from East Wenatchee, but meteorology and terrain are similar. Therefore, the general order may apply to facilities in Malaga.

(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.

Health Impact Assessment

The HIA prepared by Ecology was conducted according to the requirements of WAC 173-460-090. It addressed the public health risk associated with exposure to DEEP emitted by 21 new diesel-powered emergency generators near Quincy and East Wenatchee, Washington.

While the HIA is not a complete risk assessment, it loosely follows the four steps of the standard health risk assessment approach proposed by the National Academy of Sciences (NAS, 1983, 1994). These four steps are: (1) hazard identification, (2) exposure assessment, (3) dose-response assessment, and (4) risk characterization.

Hazard identification

Hazard identification involves gathering and evaluating toxicity data on the types of health injury or disease that may be produced by a chemical, and on the conditions of exposure under which injury or disease is produced. It may also involve characterization of the behavior of a chemical within the body and the interactions it undergoes with organs, cells, or even parts of cells. This information may be of value in determining whether the forms of toxicity known to be produced by a chemical agent in one population group or in experimental settings are also likely to be produced in human population groups of interest. Hazard identification is conducted to determine whether and to what degree it is scientifically correct to infer that toxic effects observed in one setting will occur in other settings (e.g., are chemicals found harmful to experimental animals also likely to be so in adequately exposed humans?).

Overview of DEEP toxicity

Diesel engines emit a mixture of pollutants including very small fine (<2.5 micrometers [µm]) and ultrafine (<0.1 µm) particles. These particles can easily enter deep into the lung when inhaled. Mounting evidence indicates that inhaling fine particles can cause numerous adverse health effects.

Studies of humans and animals specifically exposed to DEEP show that diesel particles can cause both acute and chronic health effects, including cancer. Ecology previously summarized these health effects in “Concerns about Adverse Health Effects of Diesel Engine Emissions” (Ecology, 2008).

The following health effects have been associated with exposure to diesel particles:

- Inflammation and irritation of the respiratory tract

- Eye, nose, and throat irritation along with coughing, labored breathing, chest tightness, and wheezing
- Decreased lung function
- Worsening of allergic reactions to inhaled allergens
- Asthma attacks and worsening of asthma symptoms
- Heart attacks and strokes in people with existing heart disease
- Lung cancer and other forms of cancer
- Increased likelihood of respiratory infections
- Male infertility
- Birth defects
- Impaired lung growth in children

It is important to note that the estimated levels of data center emergency engine-related DEEP emissions that will potentially impact people will be much lower than the levels associated with many of the health effects listed above. To determine whether the ambient impacts of emissions from the 21 engines allowed by the general order are acceptable, Ecology quantifies and presents non-cancer hazards and cancer risks in the remaining sections of this document.

Exposure assessment

Exposure assessment involves estimating the extent that the public is exposed to a chemical substance emitted from a facility. This includes:

- Identifying routes of exposure
- Estimating long- and/or short-term off-site pollutant concentrations
- Identifying exposed receptors
- Estimating the duration and frequency of receptors' exposure

Identifying routes of potential exposure

Humans can be exposed to chemicals in the environment through inhalation, ingestion, or dermal contact. The primary route of exposure to most air pollutants is inhalation; however, some air pollutants may also be absorbed through ingestion or dermal contact. Ecology uses guidance provided in California's Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments to determine which routes and pathways of exposure to assess for chemicals emitted from a facility (CalEPA, 2015). Table 2 shows the chemicals for which Ecology assesses multiple routes and pathways of exposure. It is possible that levels of polycyclic aromatic hydrocarbons (PAHs) and the few other persistent chemicals in DEEP will build up in food crops, soil, and drinking water sources near data centers covered under the general order. However, given the very low amounts of PAHs and other multi-exposure route type TAPs that will be emitted from these sources, quantifying exposures via pathways other than inhalation is very unlikely to yield significant concerns. Further, inhalation is the only route of exposure to DEEP that has received sufficient scientific study to be useful in human health risk assessment. In the case of emissions from diesel-powered emergency generators covered under a general order, Ecology evaluated only inhalation exposure to DEEP.

Table 2. California's Air Toxics Hotspots Risk Assessment Guidance on Specific Pathways to Analyze for Each Multi-pathway Substance

Substance	Soil	Dermal	Meat, Milk & Egg	Fish	Exposed Vegetable	Leafy Vegetable	Protected Vegetable	Root Vegetable	Water	Breast Milk
Arsenic & compounds	x	x	x	x	x	x	x	x	x	---
Beryllium	x	x	x	x	x	x	x	x	x	---
Cadmium	x	x	x	x	x	x	x	x	x	---
Chromium VI	x	x	x	x	---	---	---	---	---	---
Fluorides (soluble compounds)	x	x	x	---	x	x	x	x	x	---
Lead	x	x	x	x	x	x	x	x	x	x
Mercury	x	x	x	x	x	x	x	x	x	---
Nickel	x	x	x	x	x	x	x	x	x	---
Selenium	x	x	x	x	x	x	x	x	x	---
Creosotes	x	x	x	x	x	x	---	---	x	x
Diethylhexylphthalate	x	x	x	x	x	x	---	---	x	---
Hexachlorobenzene	x	x	x	x	x	x	---	---	x	---
Hexachlorocyclohexanes	x	x	x	x	x	x	---	---	x	---
4,4'-methylene dianiline	x	x	---	---	x	x	---	---	x	---
Polychlorinated biphenyls	x	x	x	x	x	x	---	---	x	x
Polychlorinated dibenzo-p-dioxins and dibenzofurans	---	x	x	x	x	x	---	---	x	x
Polycyclic aromatic hydrocarbons	x	x	x	x	x	x	---	---	x	x

Estimating pollutant concentrations

Pollutants emitted from data center emergency engines will be carried by the wind and possibly impact people living and working in the immediate area. The level of these pollutants downwind depends in part on how much is emitted, wind direction, and other weather-related variables at the time the pollutants are emitted. To estimate where pollutants will disperse after they are emitted from data center emergency engines, Ecology conducted air dispersion modeling (Ecology, 2025a). Air dispersion modeling incorporates emissions, meteorological, geographical, and terrain information to estimate pollutant concentrations downwind from a source.

Each of the 21 assumed diesel-powered generators was modeled as an individual discharge point. Ecology modeled long-term impacts to derive DEEP concentrations for the HIA. Ecology evaluated impacts at two key locations (Quincy and East Wenatchee) and a range of possible facility configurations. In total, four scenarios at each location involving different buildings and stack heights were evaluated when estimating ambient impacts (Table 3).

Table 3. Modeling Scenarios Used to Estimate Ambient Impacts

Scenario Name Abbreviated	Meteorology Data Location	Building Height	Stack Height	# Engines	Load	Emissions Rate	Hours per Year
Quincy – short + 10	Quincy	8	18	21	25% worst-case load	0.0202 g/s 0.16 lb/hr	50 to 100
Quincy – short + 13.95	Quincy	8	21.95	21	25% worst-case load	0.0202 g/s 0.16 lb/hr	50 to 100
Quincy – tall + 0	Quincy	18.29	18.29	21	25% worst-case load	0.0202 g/s 0.16 lb/hr	50 to 100
Quincy – tall + 3	Quincy	18.29	21.29	21	25% worst-case load	0.0202 g/s 0.16 lb/hr	50 to 100
E. Wenatchee – short + 10	E. Wenatchee	8.5	18.5	21	25% worst-case load	0.0202 g/s 0.16 lb/hr	50 to 100
E. Wenatchee – short + 13.95	E. Wenatchee	8.5	21.95	21	25% worst-case load	0.0202 g/s 0.16 lb/hr	50 to 100
E. Wenatchee – tall + 0	E. Wenatchee	18.29	18.29	21	25% worst-case load	0.0202 g/s 0.16 lb/hr	50 to 100
E. Wenatchee – tall + 3	E. Wenatchee	18.29	21.29	21	25% worst-case load	0.0202 g/s 0.16 lb/hr	50 to 100

Identifying potentially exposed receptors

Ecology typically identifies the following maximally impacted receptors based on current and planned land uses:

- Maximally impacted residential receptor
- Maximally impacted commercial receptor

- Maximally impacted boundary (or near boundary) receptor
- Other sensitive receptors, such as children at schools

Because the location of engines allowed under the general order cannot be pre-determined, Ecology cannot identify specific receptor locations at a given site. Instead, we used modeling to determine siting criteria (i.e., distances engines must be located relative to specific types of land uses) in the general order.

Exposure frequency and duration

The likelihood that someone is exposed to DEEP from data center emergency diesel engines depends on local wind patterns (meteorology), how often engines run, and how much time people spend in the immediate area. As discussed previously, the air dispersion model utilizes emissions and meteorological information (along with other assumptions) to determine ambient DEEP concentrations in the vicinity of the proposed general order emergency engines.

Ecology estimates the amount of time a given receptor could be exposed based on current and projected land use. For example, people are more likely to be exposed frequently and for a longer duration if the emissions impact residential locations because people spend much of their time at home. People working in offices or commercial buildings in the area are likely only exposed to data center-related emissions during the hours that they spend working near the facility. Table 4 shows the exposure frequency and durations assumed for various receptor types.

Table 4. Assumptions Used to Determine the Frequency and Length of Exposure for Various Receptor Types

Receptor Type	Exposure Time (hr/day)	Exposure Frequency (days/year)	Exposure Duration (years)
Residential	24	365	70 (i.e., lifetime)
Commercial	8	250	40
Boundary	2	150	30
School – Student K-12	8	200	13

Dose response assessment

Dose response assessment describes the quantitative relationship between the amounts of exposure to a substance (the dose) and the incidence or occurrence of injury (the response). The process often involves establishing a toxicity value or criterion to use in assessing potential health risk.

DEEP toxicity values

Ecology identified toxicity values for DEEP from two agencies: the U.S. Environmental Protection Agency (EPA) (EPA, 2002; EPA, 2003), and California EPA's Office of Environmental Health Hazard Assessment (OEHHA) (CalEPA, 1998). These agencies derived toxicity values from studies of animals exposed to a known amount (concentration) of DEEP, 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. Table 5 shows the appropriate DEEP non-cancer and cancer toxicity values.

EPA based its reference concentration (RfC) and OEHHA based its reference exposure level (REL) on diesel engine exhaust (measured as DEEP) using dose-response data on inflammation and changes in the lungs from rat inhalation studies. Each agency established a level of 5 $\mu g/m^3$ as the concentration of DEEP in air at which long-term exposure is unlikely to cause adverse non-cancer health effects.

EPA promulgated National Ambient Air Quality Standards (NAAQS) and other regulatory toxicological values for short- and intermediate-term exposure to particulate matter, but values specifically for DEEP exposure at these intervals do not currently exist.

OEHHA derived a unit risk factor (URF) for estimating cancer risk from exposure to DEEP. They based the URF on a meta-analysis of several epidemiological studies of humans occupationally exposed to DEEP. In these studies, researchers based exposure estimates on measurements of elemental carbon and respirable particulate representing fresh diesel exhaust. Therefore, we define DEEP as the filterable fraction of particulate emitted by diesel engines.[8] The URF is expressed as the upper-bound probability of developing cancer, assuming continuous lifetime exposure to a substance at a concentration of one microgram per cubic meter (1 $\mu g/m^3$) and is expressed in units of inverse concentration [i.e., $(\mu g/m^3)^{-1}$]. OEHHA's URF for DEEP is 0.0003 per $\mu g/m^3$, meaning that a lifetime of exposure to 1 $\mu g/m^3$ of DEEP results in an increased individual cancer risk of 0.03 percent or a population cancer risk of 300 excess cancer cases per million people exposed.

Table 5. Toxicity Values or Comparison Values Considered in Assessing and Quantifying Non-Cancer Hazard and Cancer Risk

Pollutant	Agency	Non-Cancer	Cancer
DEEP	U.S. Environmental Protection Agency	RfC[1] = 5 $\mu g/m^3$	NA[2]
DEEP	California EPA–Office of Environmental Health Hazard Assessment	Chronic REL[3] = 5 $\mu g/m^3$	URF[4] = 0.0003 per 5 $\mu g/m^3$

[1] RfC – Reference Concentration

[2] EPA considers DEEP to be a probable human carcinogen but has not established a cancer slope factor or unit risk factor.

[3] REL – Reference Exposure Level

[4] URF – Unit Risk Factor

[8] Condensable particulate does not represent DEEP to assess health risks from DEEP exposure; however, we consider both the filterable and condensable fractions of particulate when determining compliance with NAAQS.

Risk characterization

Risk characterization involves integrating data analyses from each step of the HIA to determine the likelihood that the human population in question will experience any of the various forms of toxicity associated with a chemical under its known or anticipated conditions of exposure. Ecology relied on equations from EPA guidance for inhalation risk assessment (EPA, 2009) to estimate non-cancer hazards and cancer risk attributable to diesel engine emissions.

Evaluating non-cancer hazards

Non-cancer hazards are evaluated using a hazard quotient (HQ) approach where:

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;[9]

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

An HQ greater than one (i.e., exceeds unity) indicates potential for adverse health effects. The magnitude of this potential can be inferred from the degree to which the HQ exceeds unity. However, it should be noted that an HQ above one is not necessarily indicative of health impacts due to the application of uncertainty factors in deriving toxicological reference values (e.g., RfC and REL). Conversely, an HQ of one or less indicates that the exposure to a substance is not likely to result in adverse non-cancer health effects.

Hazard quotient–DEEP

We calculated an HQ based on the highest annual average concentrations of all receptors in each of the modeled scenarios. Because chronic toxicity values (RfCs and RELs) are based on continuous exposure, an adjustment is sometimes necessary or appropriate to account for people working at commercial properties who are exposed for only eight hours per day, five days per week. For this evaluation, Ecology assumed continuous exposure to the highest modeled concentration within the modeling domain. The highest concentration typically occurs near the emission sources.

[9] EPA's guidance allows consideration of exposure frequency and exposure duration when determining exposure concentrations for chronic health effects, but for simplicity, Ecology assumed all receptors experience continuous exposure to the highest average annual impact concentration.

Table 6 shows chronic HQs at the maximally impacted receptor. HQs are much lower than one, indicating adverse non-cancer effects are not likely to result from chronic exposure to DEEP emitted by data center emergency engines covered by the general order.

Table 6. Chronic Non-Cancer Hazards Based on Continuous Exposure to the Highest Annual Average Concentration within the Domain of Each Modeled Scenario

Scenario	Highest Annual Average DPM Concentration in Modeling, Assuming 100 Hours of Operating per Year	RfC	HQ
Quincy – short + 10	0.093	5	0.02
Quincy – short + 13.95	0.079	5	0.02
Quincy – tall + 0	0.084	5	0.02
Quincy – tall + 3	0.080	5	0.02
E. Wenatchee – short + 10	0.081	5	0.02
E. Wenatchee – short + 13.95	0.074	5	0.01
E. Wenatchee – tall + 0	0.071	5	0.01
E. Wenatchee – tall + 3	0.069	5	0.01

Evaluating cancer risk

Increased cancer risk from exposure to TAPs is evaluated using the following approach:

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

And:

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

Where:

EC (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 (70 years x 365 days/year x 24 hours/day) = averaging time

Cancer risk–DEEP

Because the general order does not have specific receptors for which to evaluate exposure, Ecology chose to evaluate the concentrations necessary to result in a risk level of five in one million. This risk level is one-half of what is allowed under second tier review. We chose this risk level as the basis for determining appropriate siting requirements to be certain that engines installed under a general order would meet second tier approval criteria.

The only receptor for which estimated concentrations reach a risk level of five in one million is the residential receptor. Therefore, engines covered under a general order must be far enough away from residences to ensure risks can be approved under a second tier review. Table 7 shows the concentrations resulting in a risk of five in one million for each type of receptor.

Table 7. Average DEEP Concentrations Necessary to Produce a Lifetime Increased Cancer Risk of Five in One Million Based on Key Receptor-Specific Exposure Factors

Receptor	EF Days/Yr	ET Hr/Yr	ED Yr	AT (hr)	Annual DEEP Concentration (µg/m^3) Resulting in Five in One Million Lifetime Cancer Risk
MIRR	365	24	70	613200	0.0167
MICR	250	8	40	613200	0.128
MIBR	250	2	30	613200	0.68
School K-12	200	8	13	613200	0.49

Distances from engine exhaust stacks to a DEEP concentration that results in a lifetime increased cancer risk of five in one million

Ecology modeled emissions to determine ambient impacts from emergency engine emissions. Based on this modeling, we determined the concentration contour of 0.0167 µg/m^3 for each of the eight scenarios, assuming engines operate 50, 75, or 100 hours per year (Figures 1 through 6). We then estimated the maximum distance from the nearest engine to the concentration contour of 0.0167 µg/m^3 (which equates to an increased lifetime cancer risk of five in one million for a continuously exposed residential receptor).

Table 8 shows the estimated distances for each of the scenarios and annual hourly operation. Broadly, distances from engine exhaust stacks to a concentration of 0.0167 µg/m^3 (i.e., an increased cancer risk of five in one million for a continuously exposed receptor) range from 130m to 400m, depending on the number of assumed hours of engine operation and building and stack parameters. Fewer hours allowed by the general order equate to a shorter setback distance requirements from exhaust stacks to residential locations.

Table 8. Distances from Exhaust Stacks to Residential Locations Needed to Ensure Residential Receptors' Increased Cancer Risk is Less Than or Equal to Five in One Million

Scenario	Distance (m) from Exhaust Stacks to a Lifetime Increased Cancer Risk of Five in One Million, Assuming 100 Hours of Operation Per Engine Per Year	Distance (m) from Exhaust Stacks to a Lifetime Increased Cancer Risk of Five in One Million, Assuming 75 Hours of Operation Per Engine Per Year	Distance (m) from Exhaust Stacks to a Lifetime Increased Cancer Risk of Five in One Million, Assuming 50 Hours of Operation Per Engine Per Year
Quincy – short + 10	380	260	160
Quincy – short + 13.95	320	200	130
Quincy – tall + 0	390	250	180
Quincy – tall + 3	350	220	170
E. Wenatchee – short + 10	400	280	150
E. Wenatchee – short + 13.95	350	240	130
E. Wenatchee – tall + 0	350	230	160
E. Wenatchee – tall + 3	330	200	150

Other considerations

Short-term exposures to DEEP

As discussed previously, exposure to DEEP can cause both acute and chronic health effects. However, reference toxicological values specifically for DEEP exposure at short-term or intermediate intervals do not currently exist. Therefore, Ecology did not quantify short-term risks from DEEP exposure. By not quantifying short-term health risks in this document, Ecology does not imply that they have not been considered. Instead, we have assumed that compliance with the 24-hour $PM_{2.5}$ NAAQS is an indicator of acceptable short-term health effects from DEEP exposure.

Relevant to DEEP emissions, the 24-hour $PM_{2.5}$ NAAQS was set by EPA to protect people from short-term exposure to small particles (which include DEEP). Ecology determined that data center companies' adherence to the operational limitations and requirements in the general order complies with the $PM_{2.5}$ NAAQS. Therefore, short-term impacts from DEEP exposure were considered and found to be acceptable.

Short-term exposures to NO_2

Ecology acknowledges that data center emergency engines have the potential to emit NO_X at rates that may cause ambient impacts exceeding the NO_2 ASIL, especially if all engines operate simultaneously at worst-case loads. This situation would only occur if:

- The facility experiences a line power disruption.
- The dispersion conditions are optimum for producing high impacts.
- The electrical demand at the facility is high, meaning the emergency generators would need to operate at high loads, which produce higher NO_X emissions.

In past analyses of data center diesel engine emissions under line power outage scenarios in Quincy and East Wenatchee, we determined a very low likelihood of a line power disruption coinciding with unfavorable dispersion and emission conditions. We determined this to be especially true in areas where people are more likely to be present (e.g., residential areas). This is because the line power in Quincy and East Wenatchee has proven to be very stable, and the meteorological conditions that produce high ambient impacts do not occur frequently.

Cancer risk from other TAPs emitted by diesel engines

While DEEP was the only carcinogenic TAP that exceeded an ASIL, we also considered the cancer risk from 18 other TAPs. We identified the pollutant concentrations and unit risk factors for each of the other carcinogenic TAPs to calculate increased lifetime cancer risk from continuous exposure to these pollutants (Table 9). We also included early-life adjustment factors based on EPA's Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens.[10]

The total increased cancer risk from lifetime exposure to all TAPs (including DEEP) is about 5.3 in one million. It is important to note that the DEEP unit risk factor was derived in a manner that can be used to estimate cancer risk posed by a mixture of pollutants found in diesel exhaust, so there is probably some double-counting of risk when speciating all TAPs in diesel exhaust. Still, a risk of 5.3 in one million is well below the acceptable risk of 10 in one million allowed under second tier review.

[10] This guidance describes age-dependent adjustment factors as a way of addressing uncertainty related to an absence of toxicity data from exposures that occur during early life. EPA recommends using these factors because risk estimates based on exposures occurring at various life stages may not consider the potential for higher cancer risks from early-life exposures. EPA developed procedures for adjusting cancer potency estimates only for those carcinogens that act through a mutagenic mode of action.

Table 9. Concentrations of All Carcinogenic TAPs and Increased Cancer Risk Estimates Based on Continuous Lifetime Exposure

Pollutant	Concentration (µg/m^3)	Unit Risk Factor (µg/m^3)	Unit Risk Factor Source	Unit Risk Factor Early Life Adjusted	Increased Lifetime Cancer Risk (Risk per Million)
DEEP	0.0167	0.0003	OEHHA	NA	5.0
1,3-Butadiene	0.002483	3.03E-05	EPA	NA	0.075
Acetaldehyde	0.008947	2.7E-06	OEHHA	NA	0.024
Benzene	0.002128	7.8E-06	EPA	NA	0.017
Benz(a)anthracene	1.25E-05	0.00011	OEHHA	0.00018	0.0014
Benzo(a)pyrene	9.98E-06	0.0006	EPA	0.001	0.0060
Benzo(b)fluoranthene	2E-05	0.00011	OEHHA	0.00018	0.0022
Benzo(k)fluoranthene	1.95E-05	0.00011	OEHHA	0.00018	0.0021
Chrysene	1.1E-05	0.000011	OEHHA	1.8E-05	0.00012
Dibenz(a,h)anthracene	1.05E-05	0.0012	OEHHA	0.002	0.013
Ethyl benzene	0.000124	2.5E-06	OEHHA	NA	0.00031
Formaldehyde	0.019716	0.000006	OEHHA	NA	0.12
Indeno(1,2,3-cd)pyrene	1.05E-05	0.00011	OEHHA	0.00018	0.0012
Naphthalene	0.000408	0.000034	OEHHA	NA	0.014
Arsenic	5.49E-06	0.0033	OEHHA	NA	0.018
Cadmium	5.14E-06	0.0042	OEHHA	NA	0.022
Hexavalent chromium	3.43E-07	0.011	EPA	0.018	0.0038
Lead	2.85E-05	0.000012	OEHHA	NA	0.00034
Nickel	1.35E-05	0.00026	OEHHA	NA	0.0035
All pollutants					5.3

Uncertainty

Many factors of the HIA are prone to uncertainty. Uncertainty relates to the lack of exact knowledge regarding many of the assumptions used to estimate the human health impacts of DEEP emissions from data center emergency generators. The assumptions used in the face of uncertainty may tend to over or underestimate the health risks estimated in the HIA.

Emissions uncertainty

The exact amount of DEEP emitted from diesel-powered generators is uncertain. Ecology assumed engines operate only at loads that produce the highest ambient impacts, and that engines operate for the full extent of hours allowed in the general order year after year. The engines will operate at a variety of loads at which emissions may be lower than assumed. We consider the resulting values an appropriately conservative estimate of DEEP emissions for the ambient impact analysis.

Dispersion modeling uncertainty

The transport of pollutants through the air is a complex process. EPA recommends AERMOD as the regulatory model to calculate pollutant concentrations emitted by different types of sources, including point sources (such as exhaust stacks). It incorporates meteorology, building downwash, and terrain effects when calculating how pollutants disperse.

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. While models are imperfect, EPA updates and improves AERMOD when it identifies more accurate techniques. Generally, EPA developed AERMOD to avoid underestimating ambient impacts.

Exposure uncertainty

We cannot predict the amount of time people will be exposed to DEEP emitted by data center emergency engines. We generally use assumptions that are conservative to avoid underestimating exposure. Because the exact location of data centers using the general order is unknown, we identified specific distances from emergency engines in which a continuously exposed individual would have an increased cancer risk of about five in one million. We acknowledge that it is unlikely for a person to be at one location for their entire lifetime, but we consider this assumption to be reasonable for ensuring public health protection.

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. In the case of DEEP exposure, EPA and OEHHA derived non-cancer reference values used in this assessment from animal studies. These reference values are probably protective of most of the population, including sensitive individuals, but in the case of EPA's DEEP RfC, EPA acknowledges (EPA, 2002):

> "…the actual spectrum of the population that may have a greater susceptibility to diesel exhaust (DE) is unknown and cannot be better characterized until more information is available regarding the adverse effects of diesel particulate matter (DPM) in humans."

Quantifying DEEP cancer risk is also uncertain. Although EPA classifies DEEP as probably carcinogenic to humans, they have not established a URF for quantifying cancer risk. In their health assessment document, EPA determined that "human exposure-response data are too uncertain to derive a confident quantitative estimate of cancer unit risk based on existing studies." However, EPA suggested that a URF based on existing DEEP toxicity studies would range from $1x10^{-5}$ to 1×10^{-3} per µg/m^3. OEHHA's DEEP URF (3×10^{-4} per µg/m^3) falls within this range. Regarding the range of URFs, EPA states in their health assessment document for diesel exhaust (EPA, 2002):

> "Lower risks are possible and one cannot rule out zero risk. The risks could be zero because (a) some individuals within the population may have a high tolerance to exposure from [diesel exhaust] and therefore not be susceptible to the cancer risk from environmental exposure, and (b) although evidence of this has not been seen, there could be a threshold of exposure below which there is no cancer risk."

Other sources of uncertainty cited in EPA's health assessment document for diesel exhaust are:

- Lack of knowledge about the underlying mechanisms of DEEP toxicity.
- The question of whether toxicity studies of DEEP based on older engines are relevant to current diesel engines.

Regarding the second bullet above, California EPA's Office of Environmental Health Hazard Assessment evaluated experimental data from several new technology diesel engine emissions reflecting emission controls like those to be used by engines approved under the general order (CalEPA, 2012). They determined that although the quantity of pollutants emitted by newer technology diesel engines is reduced compared to older technology diesel engines, the mix of pollutants does not appear to be less hazardous. Therefore, the use of the unit risk factor for DEEP remains appropriate.

Conclusions and Recommendations

Ecology evaluated the non-cancer hazards and increased cancer risks posed by emissions of 21 new diesel-powered generators in areas near Quincy and East Wenatchee, Washington. The estimated health risks meet acceptability criteria in Chapter 173-460-090 provided the emergency engines:

- Do not exceed the emission rates relied upon for modeling ambient impacts.
- Are limited in annual hours of operation.
- Are sited far enough away from residential land uses.

Ecology chose a risk threshold of 5 in one million as the basis for establishing siting criteria in the general order. While WAC 173-460-090 allows a risk of 10 in one million from a new source of TAPs, we chose a lower threshold of risk to account for risks that may vary based on site-specific geographic features.

Ecology concludes that the evaluation of health risks satisfies the requirements for approval subject to the following requirements:

- Diesel-powered generators must be rated at 3 MW or less.
- Engines allowed under the general order must meet Tier IV emission standards and be limited to 50 to 100 hours per engine per year.
- Stack heights relative to buildings should be consistent with the dispersion modeling analysis.
- Before allowing a facility to use the general order, Ecology should:
    - determine if the proposed site placement is consistent with meteorology and terrain evaluated in the modeling analysis.
    - evaluate the distance to nearest residence or residential land use to determine whether the facility can operate each engine 50, 75, or 100 hours per year.

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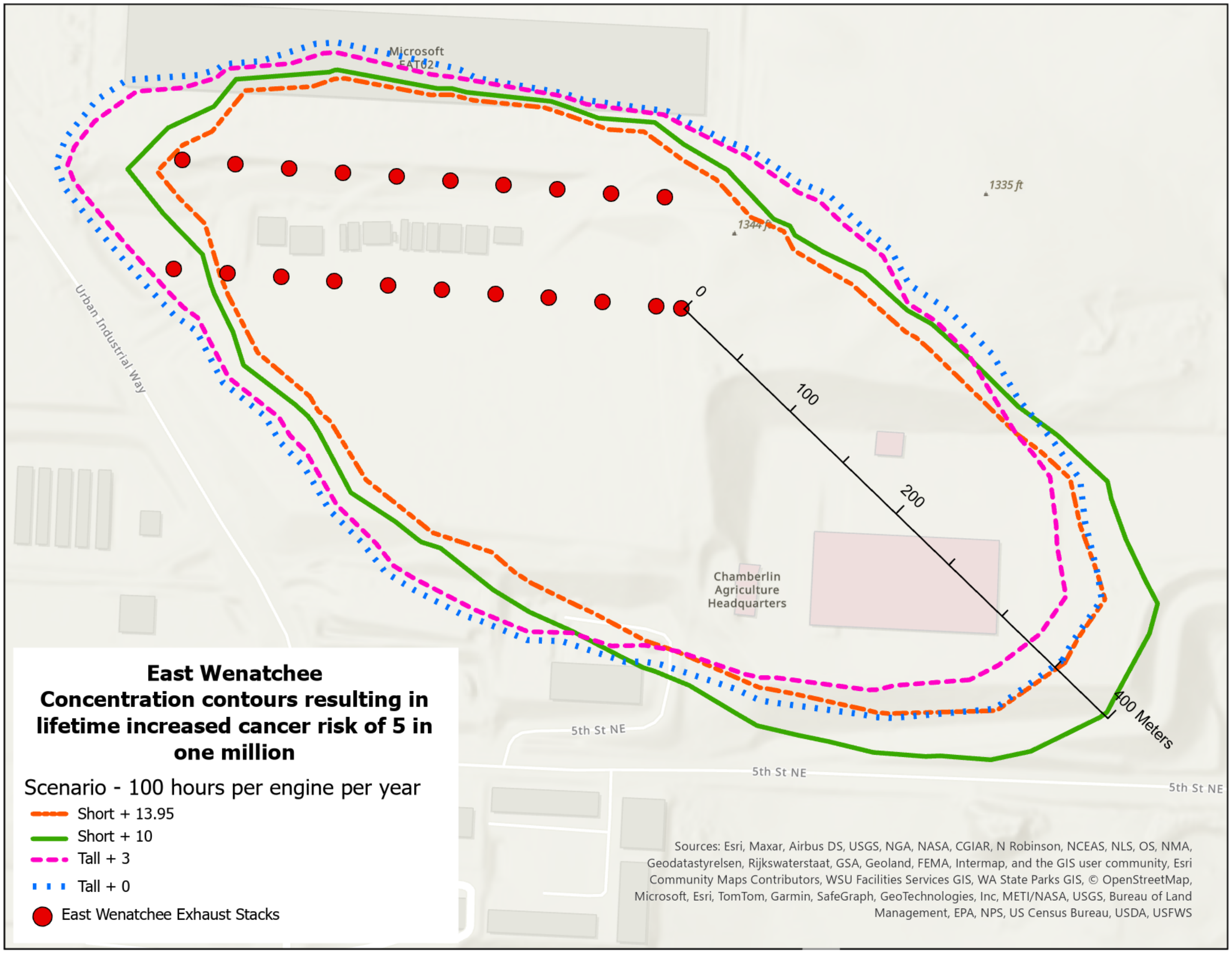

Figure 1. East Wenatchee – diesel particle concentration contours from four modeling scenarios assuming each engine operates 100 hours per year. Contours represent a lifetime increased cancer risk of five in one million

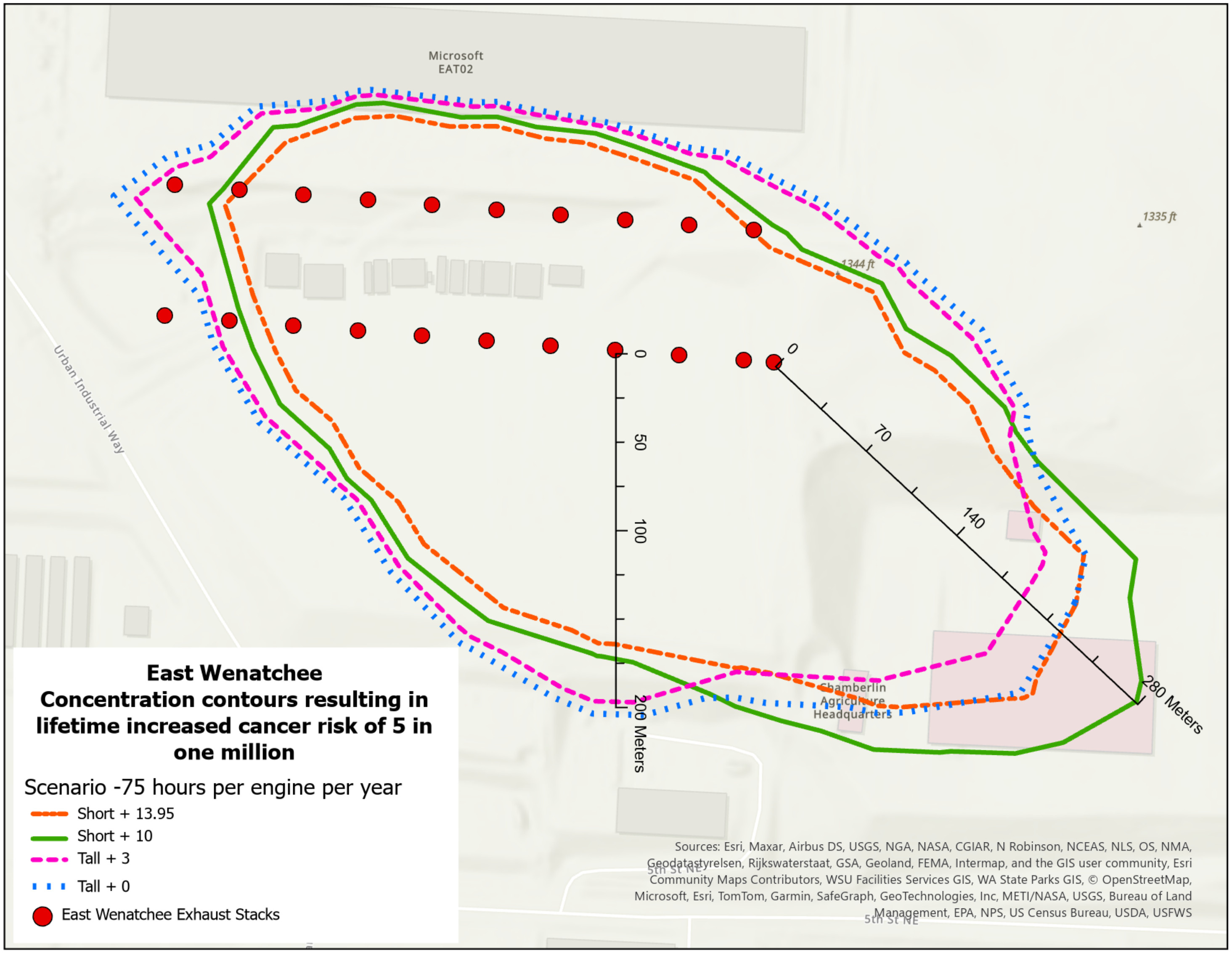

Figure 2. East Wenatchee – diesel particle concentration contours from four modeling scenarios assuming each engine operates 75 hours per year. Contours represent a lifetime increased cancer risk of five in one million

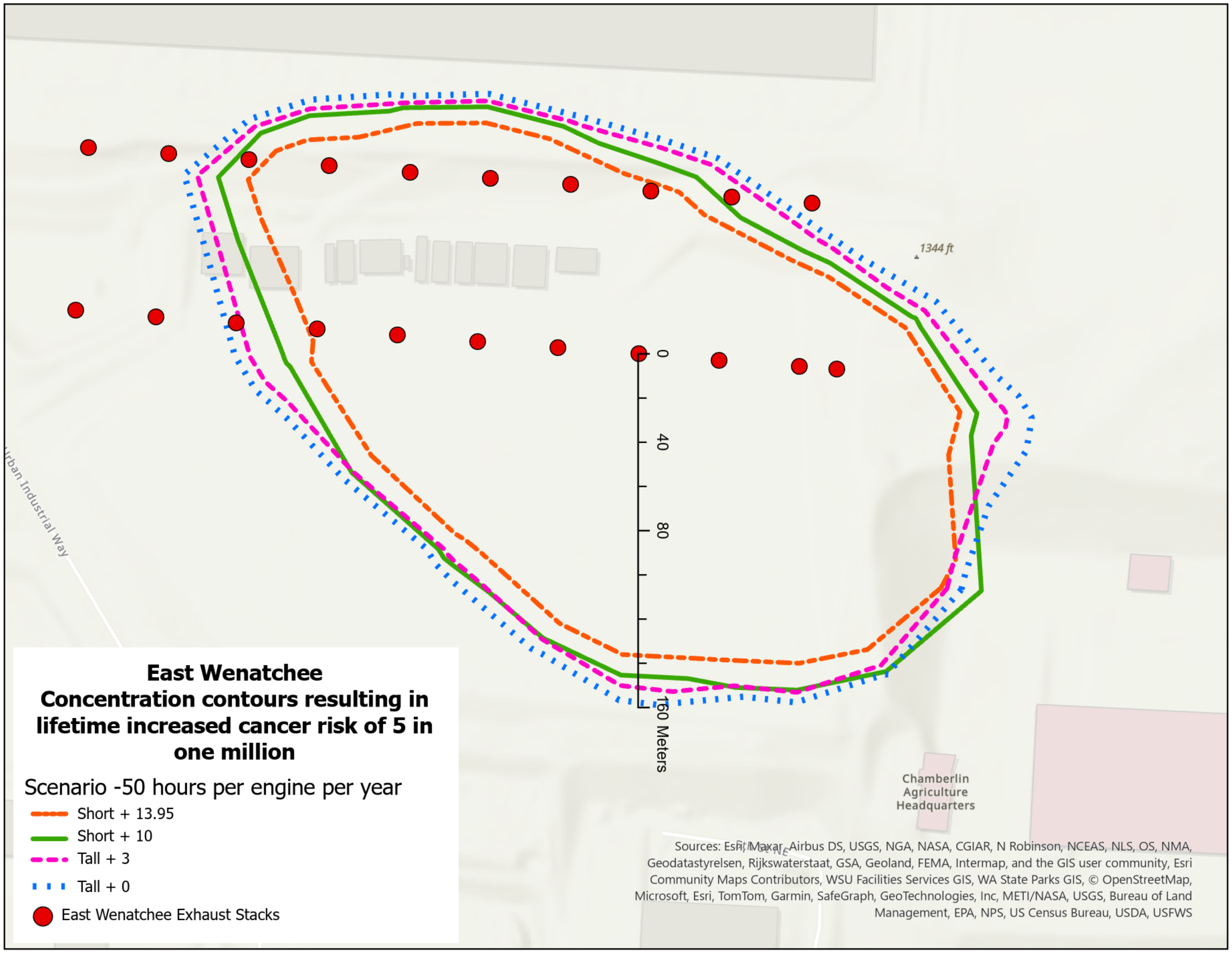

Figure 3. East Wenatchee – diesel particle concentration contours from four modeling scenarios assuming each engine operates 50 hours per year. Contours represent a lifetime increased cancer risk of five in one million

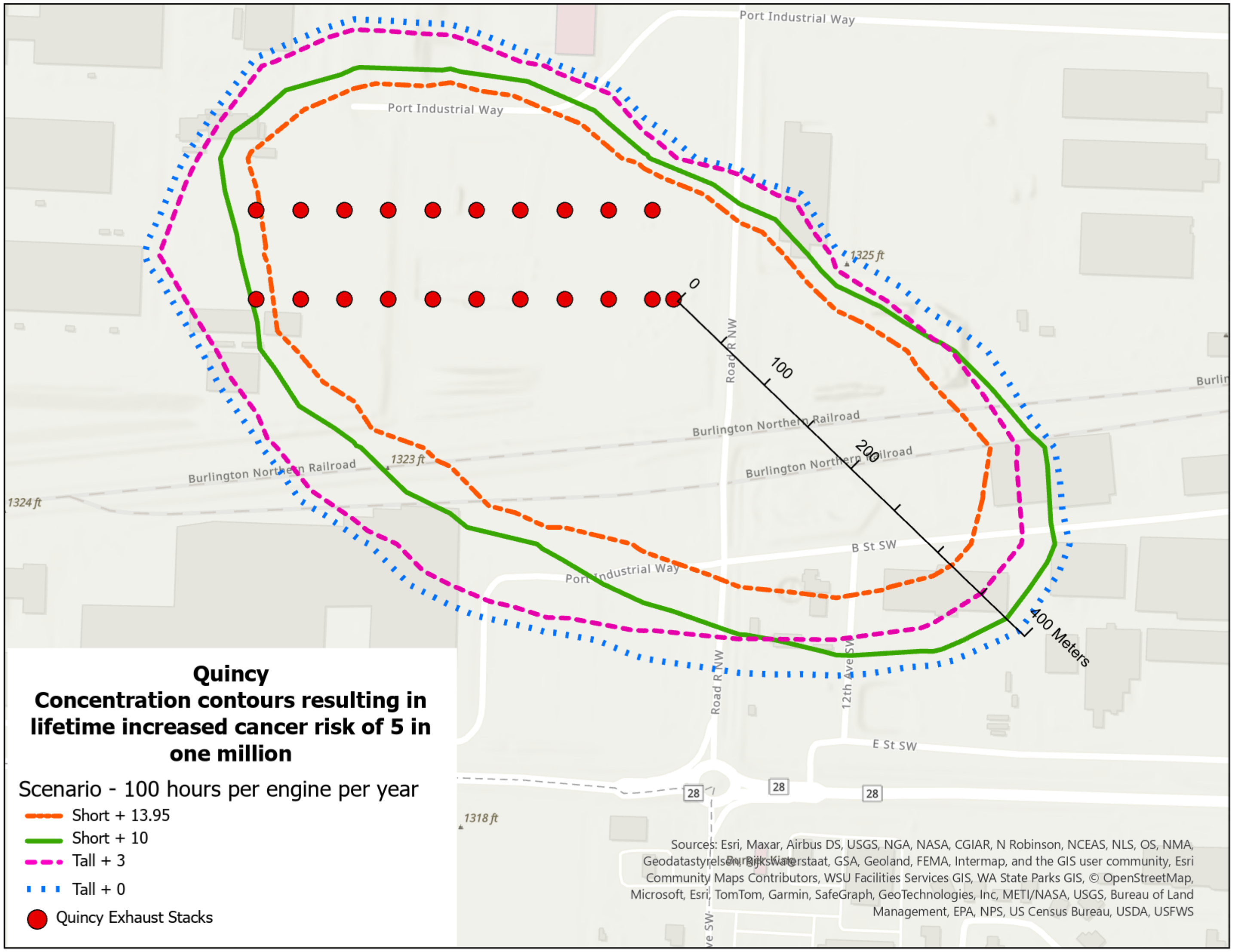

Figure 4. Quincy – diesel particle concentration contours from four modeling scenarios assuming each engine operates 100 hours per year. Contours represent a lifetime increased cancer risk of five in one million

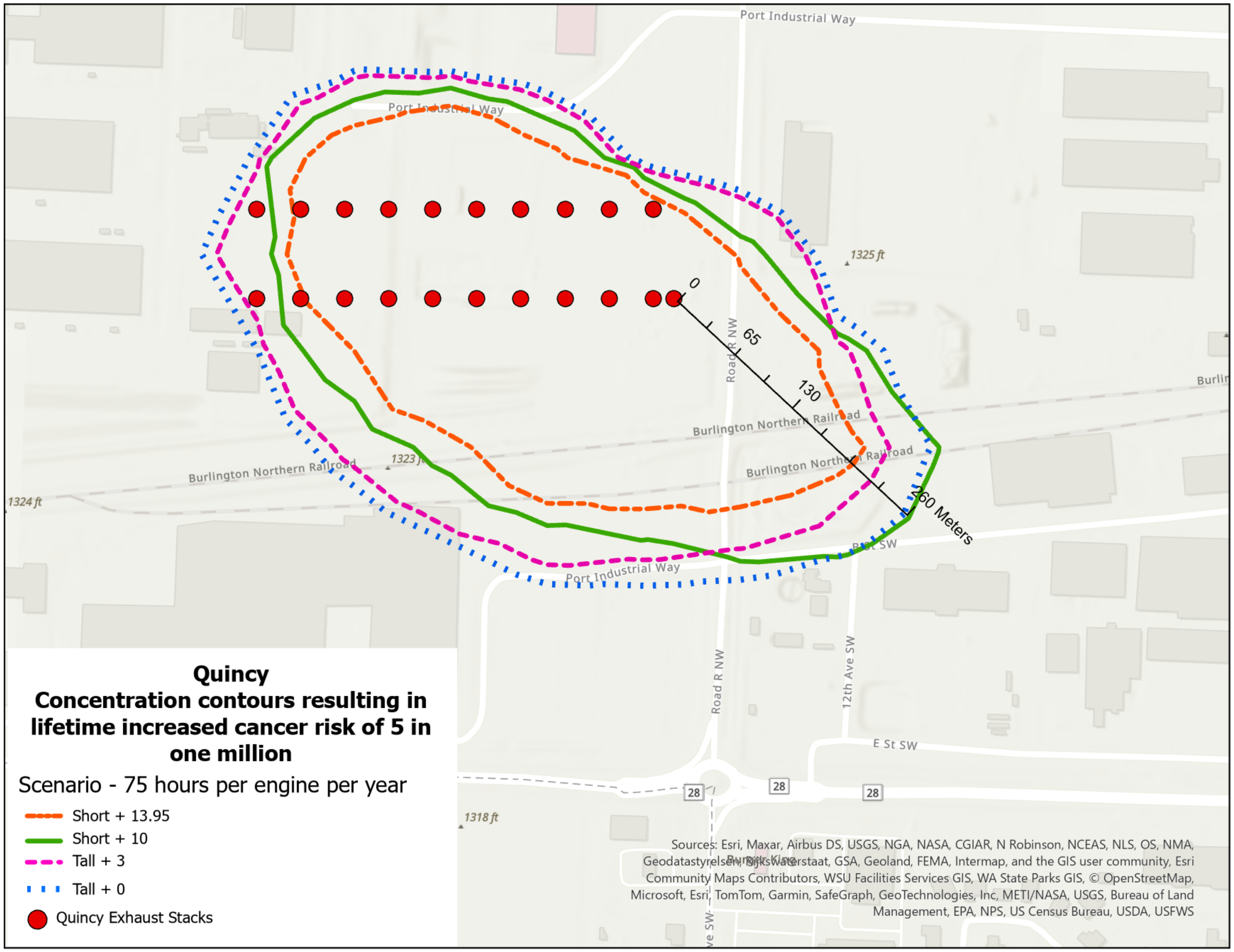

Figure 5. Quincy – diesel particle concentration contours from four modeling scenarios assuming each engine operates 75 hours per year. Contours represent a lifetime increased cancer risk of five in one million

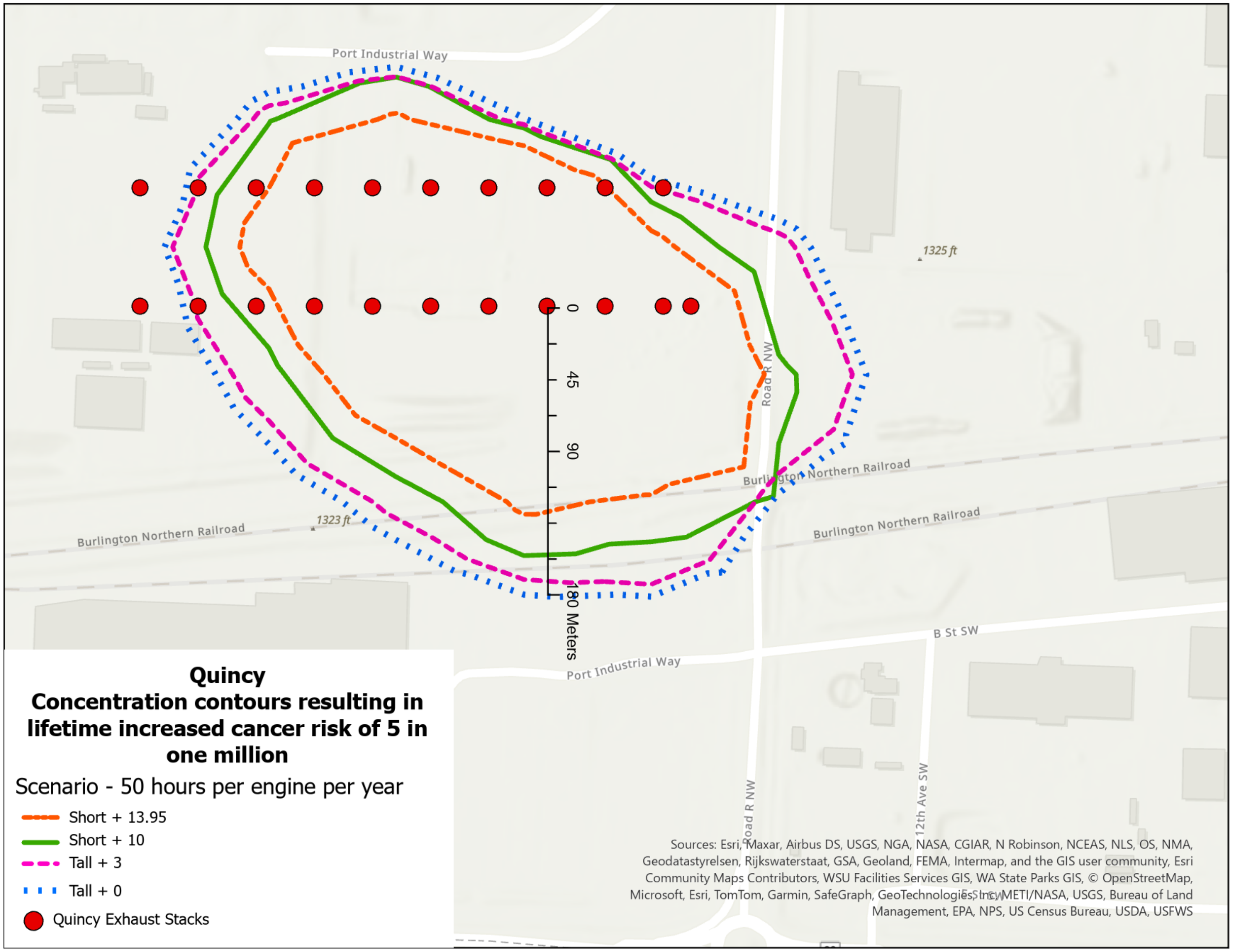

Figure 6. Quincy – diesel particle concentration contours from four modeling scenarios assuming each engine operates 50 hours per year. Contours represent a lifetime increased cancer risk of five in one million