DEPARTMENT OF
ECOLOGY
State of Washington

Health Impact Assessment Recommendation Document for

Yahoo! Data Center - Project Genesis
Quincy, Washington

Prepared by

Department of Ecology
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1. Executive Summary

This health impact assessment evaluates and summarizes the health risks from air pollutants emitted by twenty-five (25) new diesel engines at Yahoo! Data Center in Quincy. In general, toxic air pollutant impacts in the area near Yahoo! will not result in excessive risk or cause serious short- or long- term health effects. Ecology concluded that the health risk is acceptable and is recommending approval of the project.

Yahoo! proposes to build a new data center project, called Project Genesis, near their existing data center in Quincy. To ensure uninterrupted electrical power, Project Genesis will use:

- Twenty 2.0 megawatt diesel-powered emergency generators.
- Four 2.75 megawatt diesel-powered emergency generators used if primary engines fail.
- One 2.75 megawatt diesel-powered emergency generator to support the administration building during power outages.

While the proposed engines will only operate over intermittently (up to 100 hours per year per engine), the engines may emit two toxic air pollutants—diesel engine exhaust particulates and nitrogen dioxide—at rates above what is allowed without a health impact assessment. Because of these increased emissions, Yahoo! is required to submit a health impact assessment describing the increased health risks from their potential emissions.

Yahoo! hired Landau Associates to prepare a health impact assessment. Landau Associates estimated increased health risks associated with Project Genesis' diesel particles and other toxic air pollutant emissions. Because several data centers with many large diesel engines are located in Quincy, Landau Associates and Ecology also evaluated emissions from other nearby sources to determine the short-term and long-term health risks associated with cumulative exposure to diesel engine emissions.

Conclusions:

- Short-term: Nitrogen dioxide emitted during a power outage could rise to levels of short-term concern for sensitive people. Because power outages impacting several data centers at the same time are not expected to occur frequently, the concentrations responsible for these hazards are not expected to occur frequently or be sustained for long periods of time.
- Long-term:
    - Project Genesis diesel particle emissions result in an increased lifetime cancer risk of up to 7.2 in one million. The maximum risk was estimated near a home northeast of Project Genesis. In assessing this risk, Ecology assumes that a person is exposed to Project Genesis' emissions continuously during their entire lifetime. This risk can also be expressed as the number of cancers that might occur in addition to those

normally expected in a population of one million people. The cancer risk estimates reported here are for increases above a baseline lifetime cancer risk of about 40 percent in the United States.

- The maximum cumulative cancer risk to a person who lives near Project Genesis is about 62 in one million. Most of the exposure to diesel particles at this location comes from vehicles. Additionally, exposure to diesel particles in the area is not likely to result in long-term non-cancer health effects.

Ecology's Recommendations:

Ecology recommends:

- Approval of the project because:
  - the cancer risk from Project Genesis' toxic air pollutant emissions is less than the maximum risk (10 in one million) allowed by a second tier review, and
  - the non-cancer hazard is acceptable.
  - the cumulative risks to residents living near Project Genesis are below the cumulative risk threshold established by Ecology for permitting data centers in Quincy (100 per million or 100×10^{-6}).
- Yearly review of the frequency of power outages impacting Quincy data centers. This will help determine if assumptions used to characterize nitrogen dioxide hazards continue to be appropriate.

2. Second Tier Review Processing and Approval Criteria

The health impacts assessment (HIA) for Project Genesis submitted by Landau Associates on behalf of Yahoo! is part of the second tier toxics review process under WAC 173-460 (Landau Associates, 2015). Ecology is responsible for processing and approving second tier review petitions statewide.

2.1. Second Tier Review Processing Requirements

In order for Ecology to review the second tier petition, each of the following regulatory requirements under Chapter 173-460-090 must be satisfied:

(a) The permitting authority has determined that other conditions for processing the NOC 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 best available control technology for toxics (tBACT).

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

(d) The ambient impact of the emissions increase of each toxic air pollutant (TAP) that exceed 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, Ecology's project permit engineer satisfied item (a) and verified item (b) above on October 28, 2015.[1] Ecology approved an HIA protocol (item (c)), and the final HIA (item (e)) was received by Ecology on December 23, 2015. Ecology's modeler confirmed that refined modeling (item (d)) was conducted appropriately.[2]

All five processing requirements above are satisfied.

2.2. 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.

2.2.1. tBACT Determination

Ecology's permit engineer determined that Yahoo!'s proposed pollution control equipment satisfies the BACT and tBACT requirement for diesel engines powering backup generators at Project Genesis (Ecology, 2016a). BACT and tBACT was determined to be met through the restricted use of EPA Tier 2 certified engines if the engines are installed and operated as emergency engines, as defined at 40 CFR§60.4219; compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart IIII; and use of ultra-low sulfur diesel fuel containing no more than 15 parts per million by weight of sulfur. The permit will also require written verification from the engine manufacturer that each engine of the same make, model, and rated capacity installed at the facility uses the same electronic Programmable System Parameters (i.e., configuration parameters, in the electronic engine control unit).

[1] Gary Huitsing to Gary Palcisko, "RE: Memo with Recommendations for Yahoo! Project Genesis," e-mail message, January 7, 2016.
[2] Ranil Dhammapala, "HIA_and_NOC_modeling_review_checklist_Project_Genesis_Yahoo_2015.docx," e-mail message, November 12, 2015.

3. HIA 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 review 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 Genesis Project, the HIA focused on health risks attributable to diesel engine exhaust particulate (DEEP) and nitrogen dioxide (NO_2) exposure because these were the TAPs in which modeled concentration in ambient air exceeded an ASIL. Landau briefly described emissions and exposure to other TAPs (carbon monoxide (CO), benzene, 1-3 butadiene, acrolein and naphthalene) because these pollutants exceeded a small quantity emission rate (SQER), and Ecology requested that health hazards from exposure to these pollutants be quantified.

3.1. Health Effects Summary

The HIA prepared by Landau Associates quantifies the non-cancer hazards and increased cancer risks attributable to Project Genesis TAP emissions. The HIA focused on potential exposure to diesel particles and NO_2 as these were the two TAPs with emissions causing an exceedance of an ASIL.

DEEP Health Effects Summary

Diesel engines emit 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 or contribute to 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 has summarized these health effects in "Concerns about Adverse Health Effects of Diesel Engine Emissions" available at http://www.ecy.wa.gov/pubs/0802032.pdf.

NO_2

NO_2 is a red-brown gas that is present in diesel exhaust. It forms when nitrogen, present in diesel fuel and as a major component of air, combines with oxygen to produce oxides of nitrogen.

NO_2 and other oxides of nitrogen are of concern for ambient air quality because they are part of a complex chain of reactions responsible for the formation of ground-level ozone. Additionally, exposure to NO_2 can cause both long-term (chronic) and short-term (acute) health effects.

Long-term exposure to NO_2 can lead to chronic respiratory illness such as bronchitis and increase the frequency of respiratory illness due to respiratory infections.

Short-term exposure to extremely high concentrations (> 180,000 $\mu g/m^3$) of NO_2 may result in serious effects including death (National Research Council, 2012). Moderate levels (~30,000 $\mu g/m^3$) may severely irritate the eyes, nose, throat, and respiratory tract, and cause shortness of breath and extreme discomfort. Lower level NO_2 exposure (< 1,000 $\mu g/m^3$), such as that experienced near major roadways, or perhaps downwind from stationary sources of NO_2, may cause increased bronchial reactivity in some asthmatics, decreased lung function in patients with chronic obstructive pulmonary disease, and increased risk of respiratory infections, especially in young children (CalEPA, 2008). For this project, the maximum short-term ambient NO_2 concentration has been estimated to be 859 $\mu g/m^3$, 1-hour average.

Power outage emissions present the greatest potential for producing high enough short-term concentrations of NO_2 to be of concern for susceptible individuals, such as people with asthma. Landau and Ecology calculated numerical estimates of exposure and hazard reported later in this document.

3.2. 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, Landau Associates identified appropriate toxicity values for DEEP and NO_2.

3.2.1. DEEP

Landau 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 toxicity values are derived from studies of animals that were exposed to a known amount (concentration) of DEEP, or from epidemiological studies of exposed humans. They are intended to represent a level at or below which adverse non-cancer health effects are not expected, and a metric by which to quantify increased risk from exposure to a carcinogen. Table 1 shows the appropriate DEEP non-cancer and cancer toxicity values identified by Landau.

EPA's reference concentration (RfC) and OEHHA's reference exposure level (REL) for diesel engine exhaust (measured as DEEP) was derived from dose-response data on inflammation and changes in the lung 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 not expected to cause adverse non-cancer health effects.

National Ambient Air Quality Standards (NAAQS) and other regulatory toxicological values for short- and intermediate-term exposure to particulate matter have been promulgated, 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. The URF is based on a meta-analysis of several epidemiological studies of humans

occupationally exposed to DEEP. In these studies, DEEP exposure was estimated from measurements of elemental carbon and respirable particulate representing fresh diesel exhaust. Therefore, DEEP is defined as the filterable fraction of particulate emitted by diesel engines.[3] 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 are 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.

3.2.2. NO_2

OEHHA developed an acute reference exposure level for NO_2 based on inhalation studies of asthmatics exposed to NO_2. These studies found that some asthmatics exposed to about 0.25 ppm (i.e., 470 $\mu g/m^3$) experienced increased airway reactivity following inhalation exposure to NO_2 (CalEPA, 2008). Not all asthmatic subjects experienced an effect.

The acute REL derived for NO_2 does not contain any uncertainty factor adjustment, and therefore does not provide any additional buffer between the derived value and the exposure concentration at which effects have been observed in sensitive populations. This implies that exposure to NO_2 at levels equivalent to the acute REL (which is also the same as Ecology's ASIL) could result in increased airway reactivity in a subset of asthmatics. People without asthma or other respiratory disease are not likely to experience effects at NO_2 levels at or below the REL. OEHHA intended for acute RELs to be "for infrequent 1 hour exposures that occur no more than once every two weeks in a given year" (CalEPA, 2015).

EPA developed an annual and 1-hour NAAQS for NO_2. Compliance with these NAAQS was demonstrated as part of the NOC application process (Ecology, 2016b).

Table 1. Toxicity Values Used to Assess and Quantify Non-cancer Hazard and Cancer Risk

Pollutant	Agency	Non-cancer	Cancer
DEEP	U.S. Environmental Protection Agency	RfC = 5 µg/m3	N/A[1]
	California EPA–Office of Environmental Health Hazard Assessment	Chronic REL = 5 $\mu g/m^3$	URF = 0.0003 per $\mu g/m^3$
NO_2	California EPA–Office of Environmental Health Hazard Assessment	Acute REL = 470 $\mu g/m^3$	N/A

[1] EPA considers DEEP to be a probable human carcinogen, but has not established a cancer slope factor or URF.

[3] Condensable particulate is not considered to represent DEEP for the purposes assessing health risks from DEEP exposure, however, both the filterable and condensable fractions of PM are considered when determining compliance with NAAQS

3.3. Affected Community/Receptors

While Yahoo! Genesis is proposed to be built in an industrially zoned area surrounded largely by agricultural land uses and other data centers, air dispersion modeling indicated that proposed DEEP emissions could result in concentrations in excess of the ASIL at 57 parcels with residential land use codes (Figure 1) [Ecology, 2014; Grant County, 2015]. U.S. Census data show that approximately 669 people live in the Census Blocks intersected by the area in which DEEP concentrations are estimated to exceed the ASIL (U.S. Census Bureau, 2010).

For the purposes of assessing increased cancer risk and non-cancer hazards, Landau identified receptor locations where the highest exposure to project-related air pollutants could occur: at the project boundary, nearby residences, and nearby commercial locations (Figure 2). Landau also evaluated exposures that occur at Quincy High School.

Ecology's review of the HIA found that Landau identified appropriate receptors to capture the highest Genesis attributable exposures for residential, commercial, and fence line receptors.

3.4. Increased Cancer Risk

Landau Associates assessed the increased risk of cancer from lifetime exposure to DEEP emitted from Project Genesis' engines. Cumulative risks posed by other sources of DEEP in the area were also evaluated.

3.4.1. Cancer Risk Attributable to Genesis' DEEP and Other TAP Emissions

Table 2, adapted from the HIA, shows the estimated Genesis-specific cancer risk per million for residential, commercial, and fenceline receptors. Figure 3 shows the location of these receptors relative to Genesis. The highest increase in risks attributable to Genesis' emissions is 7.2 per million[4] and occurs near the closest edge of a property that contains an existing house to the northeast of Genesis Data Center.[5] A lower risk estimate of 6.0 per million occurs at the house location on the residential parcel. Landau also calculated risks posed by other carcinogenic TAPs (i.e., acetaldehyde, benzene, formaldehyde, 1,3-butadiene, and carcinogenic polycyclic aromatic hydrocarbons). They estimated a negligible increased risk attributable to these other TAPs of about 0.02 per million at the maximally impacted residential receptor (MIRR).

For non-residential exposure scenarios, workers at nearby facilities may have increased risks of about 3.5 per million, and increased cancer risks to potential bystanders exposed near the point of maximum off-site impact (i.e., fence line receptor) may be about 1.5 per million.

[4] 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.

[5] Landau Associates selected a location to represent the MIRR that occurs near a residential parcel. The location actually falls on Intuit Data Center property.

Table 2. Estimated Increased Cancer Risk for Residential, Commercial, and Boundary Receptors Attributable to Genesis' DEEP Emissions					
	Risk Per Million from DEEP Exposure at Various Receptor Locations				
Attributable to:	Fence Line Receptor (MIBR)[1]	Northeast Residence-Property (MIRR)[2]	Northeast Residence-Home[2]	North Residential Parcel[2]	C-1 Industrial Parcel (MICR)[3]
Genesis	1.5	7.2	6.0	6.3	3.5

[1] Fence line scenario assumes intermittent exposure 250 days per year, two hours per day for 30 years.

[2] Residential scenarios assume continuous lifetime exposure.

[3] Workplace scenarios assume exposure occurs 250 days per year, eight hours per day for 40 years.

3.4.2. Cancer Risk Attributable to Cumulative DEEP Emissions

As part of the HIA, Landau Associates conducted an analysis of cumulative exposure to DEEP in Quincy.[6] In total, the cumulative analysis includes allowable emissions estimates from:

- Yahoo! Data Center (including Project Genesis and requested permit changes to allowable emissions for the existing Yahoo! Data Center)
- Intuit Data Center
- Vantage Data Center
- Sabey Intergate-Quincy Data Center
- State Route 28

Ecology appended this analysis with results from west side data center emissions estimates (Microsoft Columbia, Microsoft Oxford, and Dell), SR 281 emissions estimates, and 2011 emissions estimates from locomotives on the BNSF rail line. These results were obtained from modeling conducted for a previous permitting project in Quincy (Ecology, 2014).

The cumulative cancer risk from all known sources of DEEP emissions in the vicinity[7] of Genesis (Table 3) is highest for a residential location on parcel south of SR 28. This parcel is about three-fourths mile south of the Yahoo! Data Center property boundary (Figure 3). The cumulative DEEP risk at this home is about 62 per million, and the majority (~77 percent) of exposure to DEEP is estimated to be attributable to emissions from vehicles travelling on SR 28.

[6] Landau Associates reported the concentrations obtained from the model which used five years of meteorological data, and reported cumulative risks associated with DEEP exposure in the area around Genesis.

[7] For the purposes of this analysis, the "vicinity" of Genesis encompasses the area in which Genesis' estimated impact exceeds the DEEP ASIL.

At the MIRR to the northeast of Yahoo!, potential emissions from Intuit Data Center contribute the most to cumulative DEEP risk (~40 percent) followed by Yahoo! (~18 percent) and Vantage Data Center (~17 percent).

Table 3. Estimated Cumulative Cancer Risk at Residential Locations near Yahoo! Data Center – Project Genesis

Attributable to:	Risk Per Million from DEEP Exposure at Various Residential Receptor Locations[1]		
	Residence Maximally Impacted by Genesis (MIRR)	South Residence (identified by Landau Assoc. in the HIA)	Maximum Cumulatively Exposed (identified by Ecology during the review of the HIA)
Genesis[2]	7.2	3.9	3.6
Sabey[2]	6.9	0.8	0.5
Vantage[2]	1.1	0.2	0.2
Intuit[2]	16	1.1	0.7
Yahoo! – Exisiting[2]	3.6	4.5	4.2
SR 28[3]	2.9	30	48
Rail[3]	1.4	3.2	2.9
Microsoft Columbia[2]	0.5	0.5	0.5
SR 281[3]	0.5	0.9	0.9
Microsoft Oxford[2]	0.2	0.2	0.2
Dell[2]	0.1	0.1	0.1
Cumulative	40	45	62

[1] Residential scenarios assume continuous lifetime exposure.

[2] Based on allowable emissions or requested emission limits. Actual emissions likely to be lower.

[3] Based on 2011 emissions estimates.

3.5. Non-cancer Hazard

Landau Associates evaluated chronic non-cancer hazards associated with long-term exposure to DEEP emitted from Genesis and other local sources. Table 4 shows that hazard quotients (HQs) associated with all receptors' exposure to Genesis-related and cumulative DEEP are much lower than unity (one). This indicates that chronic non-cancer hazards are not likely to occur as a result of exposure to DEEP in the vicinity of Genesis.

Landau also evaluated short-term exposures to NO_2 emitted from Genesis and nearby data center engines and determined that under outage scenarios, hazard indices could exceed unity at several locations. These hazards primarily result from NO_2 exposure.[8] The frequency of these potential occurrences is further discussed in Section 4.2.

Table 4. Estimated Short-term NO2 and Long-term DEEP Non-cancer Hazards Attributable to Genesis and (Cumulative) Emissions at Locations near Yahoo! Data Center

	Acute (short-term)			Chronic (long-term)		
Receptors	Max. 1-hr NO_2 (µg/m³)	NO_2 Acute REL (µg/m³)	HQ	Annual Avg. DEEP (µg/m³)	DEEP Chronic REL (µg/m³)	HQ
MIBR	859 [1015]	470	1.8 [2.2]	N/A	5	N/A
MICR	604 [675]		1.3 [1.5]	0.09 [0.23]		0.02 [0.05]
MIRR	564 [842]		1.2 [1.8]	0.02 [0.13]		<0.01 [0.03]
School	604 [1029]		1.3 [2.2]	0.04 [0.15]		0.02 [0.03]

4. Other Considerations

4.1. Short-Term Exposures to DEEP

Exposure to DEEP can cause both acute and chronic health effects. However, as discussed previously, reference toxicity values specifically for DEEP exposure at short-term or intermediate intervals do not currently exist. Therefore, Landau did not quantify short-term risks from DEEP exposure. Generally, Ecology assumes that compliance with the 24-hour $PM_{2.5}$ NAAQS is an indicator of acceptable short-term health effects from DEEP exposure. Ecology's technical support document (TSD) for the draft preliminary NOC approval concludes that Genesis' emissions are not expected to cause or contribute to an exceedance of any NAAQS (Ecology, 2016b).

4.2. Cumulative Short-Term NO_2 Hazard

Landau Associates evaluated short-term cumulative NO_X emissions as part of the second tier review. This analysis incorporated potential NO_X emission rates from each of the engines at all of Quincy's east side data centers during a power outage. [9] The analysis showed that while NO_2 levels could indeed rise to levels of concern[10] during a system-wide outage, the outage would

[8] Landau Associates also estimated acute hazards associated with CO, benzene, 1,3-butadiene, and acrolein. The combined hazard index of these pollutants (not including NO_2) was 0.2 or less for each of the evaluated receptors.
[9] Note that outage emissions from Sabey may have been overestimated by nearly a factor of two. Landau Associates assumed all of Sabey's engines would operate at 100 percent load (resulting in emissions of more than 1,800 lb NO_X/hr), but they will likely operate at a lower load and are only permitted to emit a maximum of 990 lb NO_X/hr.
[10] The level of concern in this case is 454 µg/m³. This represents California OEHHA's acute REL of 470 µg/m³ minus an estimated regional background concentration of 16 µg/m³.

have to occur at a time when the dispersion conditions were optimal for concentrating NO_2 at a given location. Ecology estimated the combined probability of a system-wide outage coinciding with unfavorable meteorology and found the likelihood of this occurrence to be relatively low throughout Quincy. The most frequent occurrence of NO_2 reaching a level of concern would occur near the boundaries of the data centers. Assuming eight hours of simultaneous outage per year, NO_2 levels of concern might occur once every two to three years at some locations near data center boundaries (Figure 6). Generally, recurrence becomes much less frequent with distance from the data centers.

5. 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 Genesis' emissions. The assumptions used 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 Project Genesis are exposure assumptions, emissions estimates, air dispersion modeling, and toxicity of DEEP.

5.1. Exposure

It is difficult to characterize the amount of time that people can be exposed to Genesis' DEEP emissions. For simplicity, Landau and Ecology assumed a residential receptor is at one location for 24 hours per day, 365 days per year for 70 years. These assumptions tend to overestimate exposure.

5.2. Emissions

The exact amount of DEEP emitted from Genesis' diesel-powered generators is uncertain. Landau Associates estimated emissions assuming engines would operate at a load that produces the most DEEP. In reality, the engines will operate at a variety of loads in which emissions may be lower than assumed. Landau Associates also attempted to account for higher emissions that would occur during initial start-up. The resulting values are considered to be an appropriate estimate of DEEP emissions.

Forecasting the amount of time Genesis and other Quincy data center engines are used under emergency conditions is also uncertain. Furthermore, forecasting events that might affect each of the data centers simultaneously is difficult. While future outages cannot be predicted, past outages affecting data centers in Quincy appear to be infrequent (Ecology, 2014), and Grant County PUD previously reported that the average total outage time for customers that experience an outage throughout PUD's service area is about 143 minutes per year (Coe, 2010). Additionally, Quincy's east and west side are handled by separate feeder lines reducing the likelihood of an outage affecting all of Quincy at the same time.

5.3. Air Modeling

The transport of pollutants through the air is a complex process. Regulatory air dispersion models are developed to estimate the transport and dispersion of pollutants as they travel through the air. The models are frequently updated as techniques that are more accurate become known, but are written to avoid underestimating the modeled impacts. Even if all of the numerous input parameters to an air dispersion model are known, random effects found in the real atmosphere will introduce uncertainty. Typical of the class of modern steady-state Gaussian dispersion models, the AERMOD model used for the Project Genesis analysis may slightly overestimate the short-term (1-hour average) impacts and somewhat underestimate the annual concentrations.

5.4. Toxicity

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 doses or concentrations that were observed to cause adverse non-cancer effects in animals or humans. Agencies apply these uncertainty factors so that they derive a toxicity value that is considered protective of humans including susceptible populations. In the case of DEEP exposure, the non-cancer reference values used in this assessment were generally derived from animal studies. These reference values are probably protective of the majority 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 $\mu g/m^3$. OEHHA's DEEP URF (3×10^{-4} per $\mu g/m^3$) 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 is relevant to current diesel engines.

6. Conclusions and Recommendation

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

a) The TAP emissions estimates presented by Landau Associates 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 increase of each TAP that exceeds ASILs has been quantified using appropriate refined air dispersion modeling techniques.

d) The HIA submitted by Landau Associates on behalf of Yahoo! adequately assesses project-related increased health risk attributable to TAP emissions.

In the HIA, Landau Associates estimated lifetime increased cancer risks attributable to Genesis DEEP and other TAP emissions. DEEP emissions resulted in an increase cancer risk of about seven in one million at the MIRR. The maximum risk was estimated near an undeveloped portion of a residential parcel that contains a house to the northeast of the Genesis. A lower risk estimate of about six per million occurs at the house location on the residential parcel.

Landau Associates also assessed chronic and acute non-cancer hazards attributable to the project's emissions and determined that Genesis emissions by themselves are not likely to result in long-term adverse non-cancer health effects. Acute respiratory hazards are possible during power outage scenarios that occur during periods of unfavorable pollutant dispersion. If they do occur, these impacts would occur briefly at some locations near Genesis and may affect sensitive individuals with existing respiratory conditions such as asthma.

Landau Associates and Ecology assessed the combined impacts of a power outage affecting all data centers on the east side of Quincy and determined that NO_2 emitted during a power outage could rise to levels of short-term concern for sensitive people. Because power outages affecting several data centers at the same time are not expected to occur frequently, the concentrations responsible for these hazards are not expected to occur frequently or be sustained for long periods of time.

Finally, Landau Associates and Ecology assessed the cumulative health risk by adding estimated concentrations attributable to Genesis emissions to an estimated background DEEP concentration. The maximum cumulative cancer risk from resident's exposure to DEEP in the vicinity of Yahoo! Data Center – Project Genesis is approximately **62 in one million**. Most of

the exposure to diesel particulate at this location comes from vehicles travelling on State Route 28. Additionally, exposure to DEEP in the area is not likely to result in non-cancer health effects. These DEEP-related health risks in the vicinity of Yahoo! Data Center – Project Genesis are generally much lower than those estimated in urban areas of Washington.

Because the increase in cancer risk attributable to the new data center 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 could be approvable under WAC 173-460-090. Furthermore, the cumulative risks to residents living near the Yahoo! Data Center Project Genesis are below the cumulative risk threshold established by Ecology for permitting data centers in Quincy (100 per million or 100×10^{-6}).

The project review team concludes that the HIA represents an appropriate estimate of potential increased health risks posed by Genesis' TAP emissions. The risk manager may recommend approval of the permit because total project-related health risks are permissible under WAC 173-460-090 and the cumulative risk from DEEP emissions in Quincy is less than the cumulative additional cancer risk threshold established by Ecology for permitting data centers in Quincy (100 per million or 100×10^{-6}). Ecology recommends periodically re-evaluating the frequency of power outages that affect Quincy data centers to determine if assumptions used to characterize NO_2 hazards continue to be appropriate.

7. References

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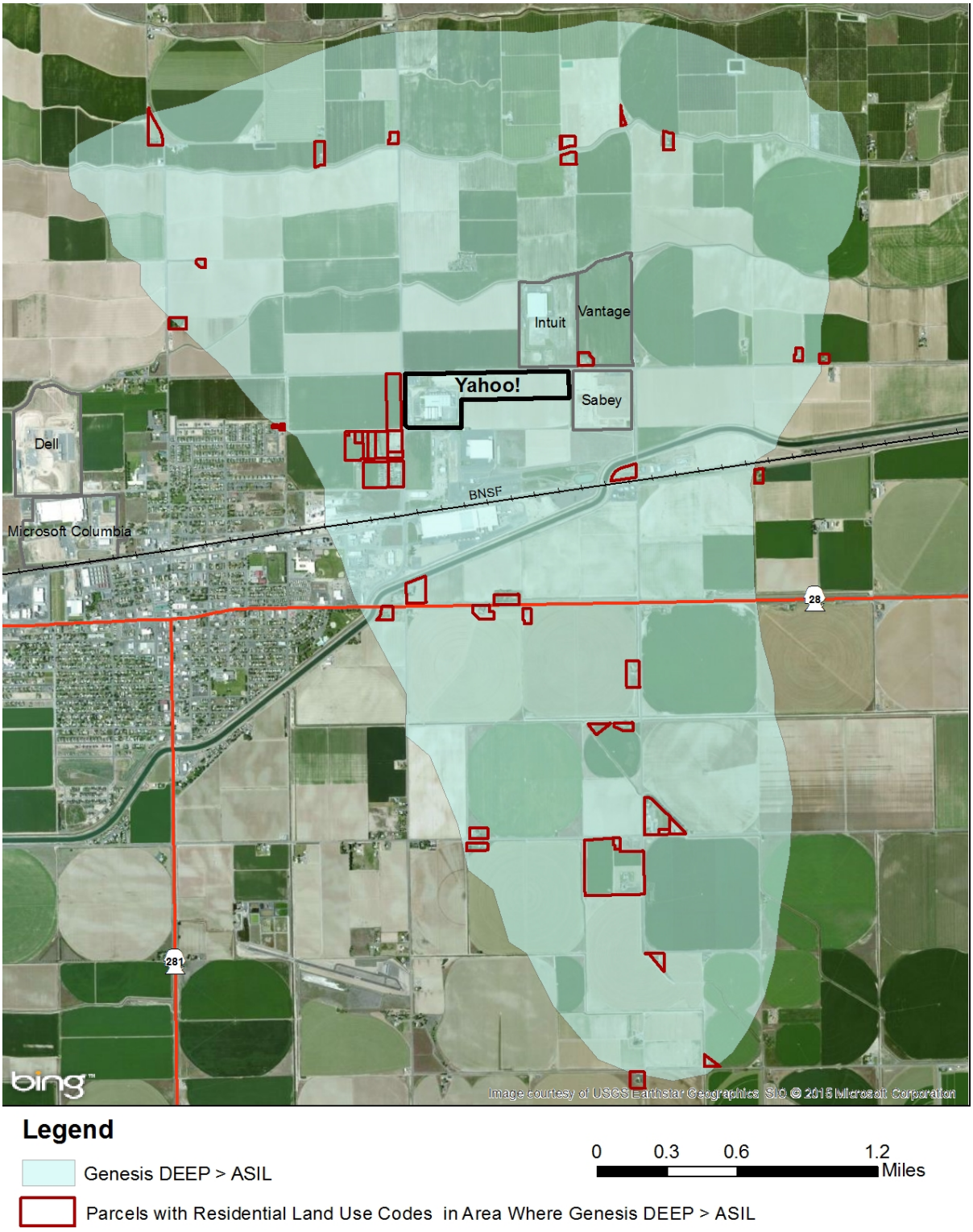

Figure 1. Residential parcels in the area where Genesis DEEP concentrations could exceed the ASIL

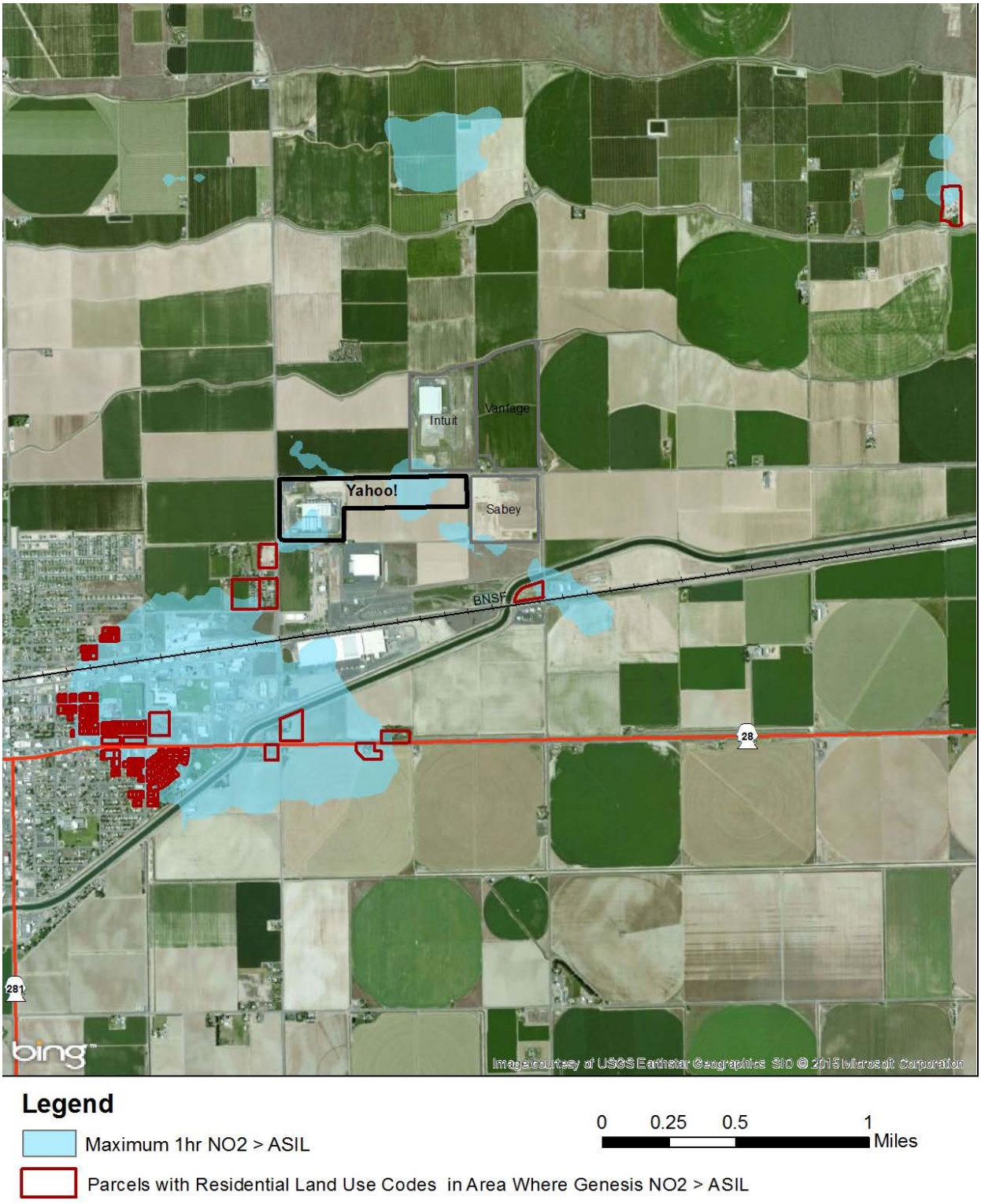

Figure 2. Residential parcels in the area where Genesis NO_2 concentrations could exceed the ASIL during a power outage

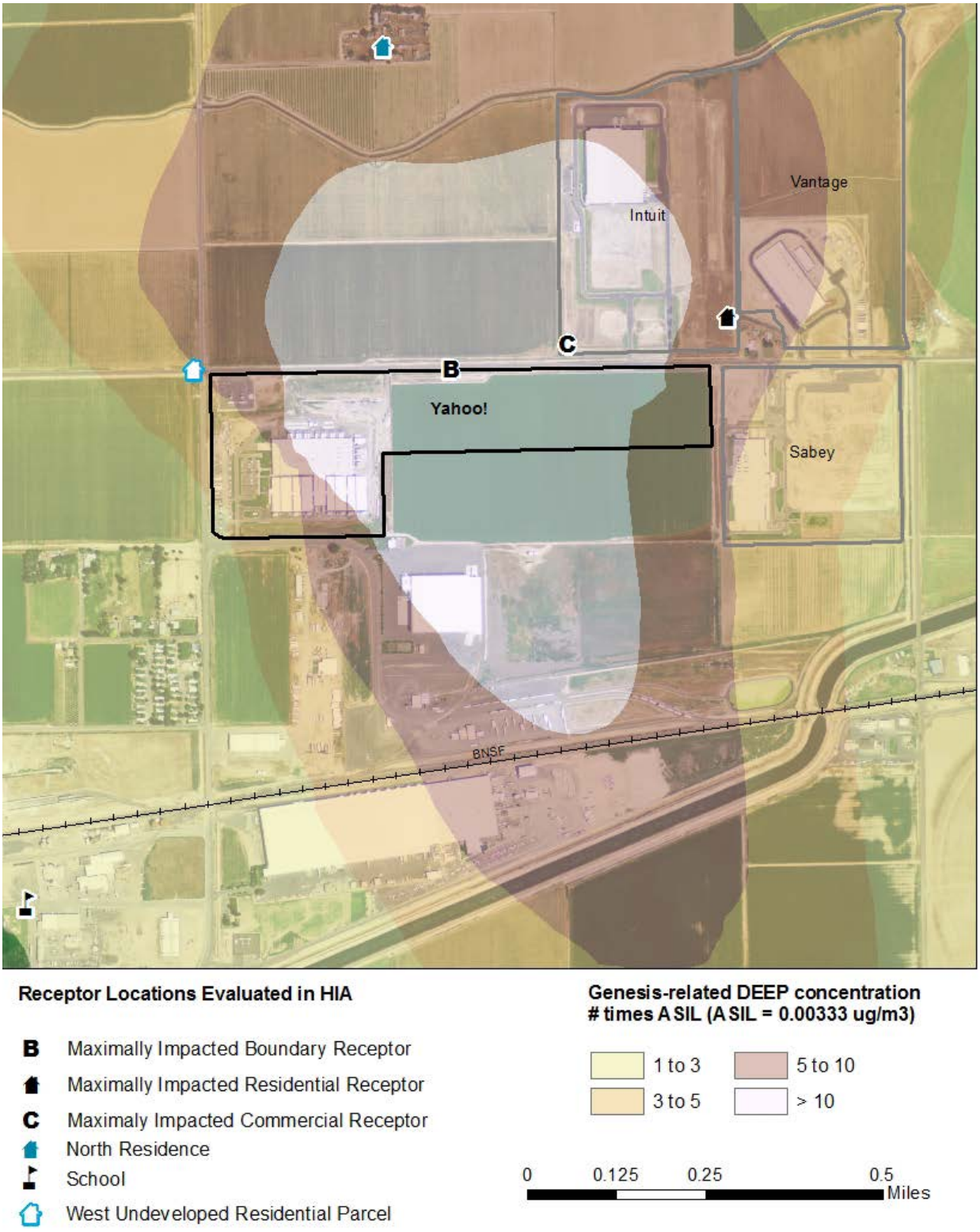

Figure 3. DEEP concentrations attributable to Genesis' engines and receptor locations evaluated in the HIA. Concentrations reported as the number of times higher than the ASIL.

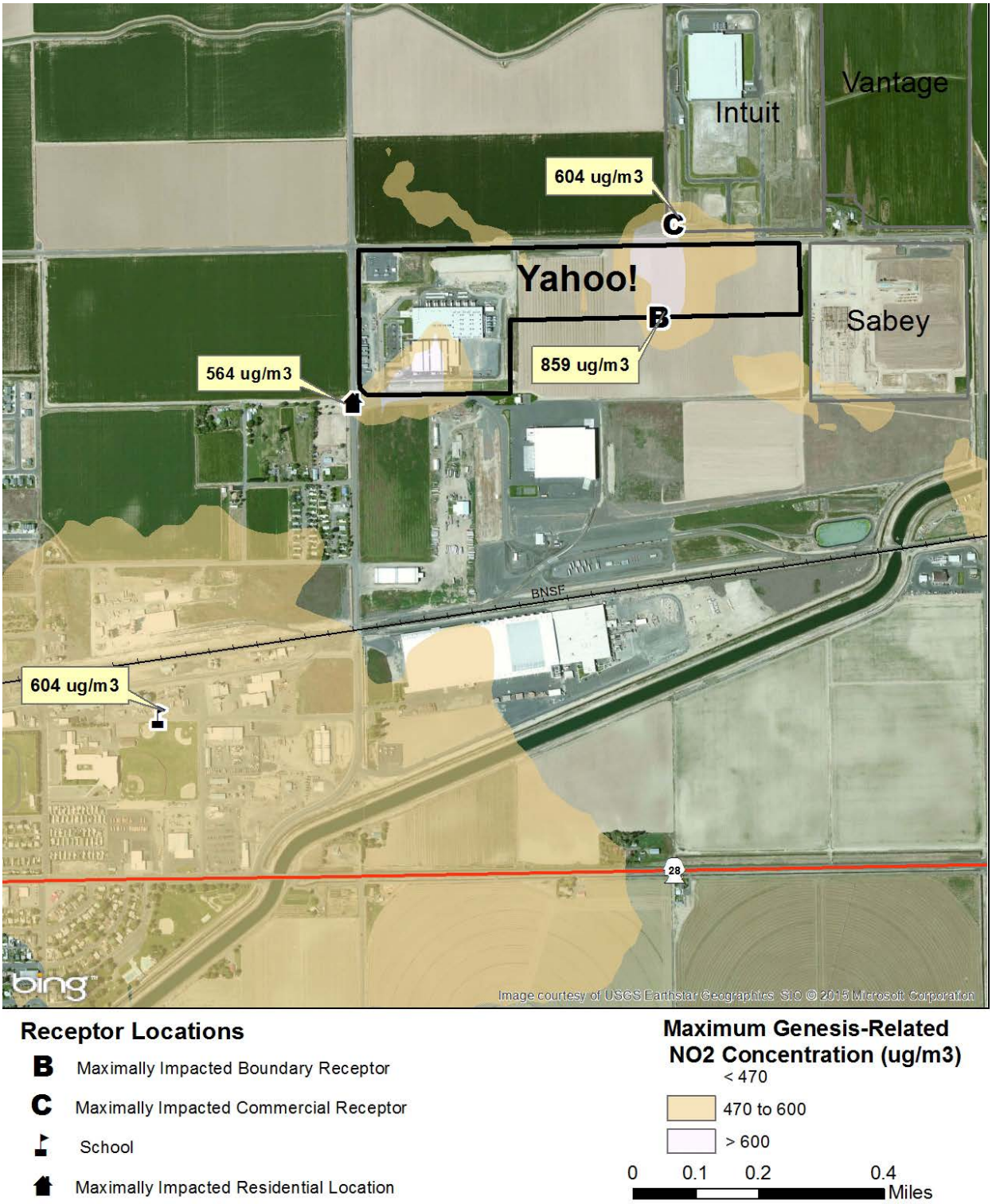

Figure 4. Maximum NO_2 concentrations attributable to Genesis' engines and receptor locations evaluated in the HIA

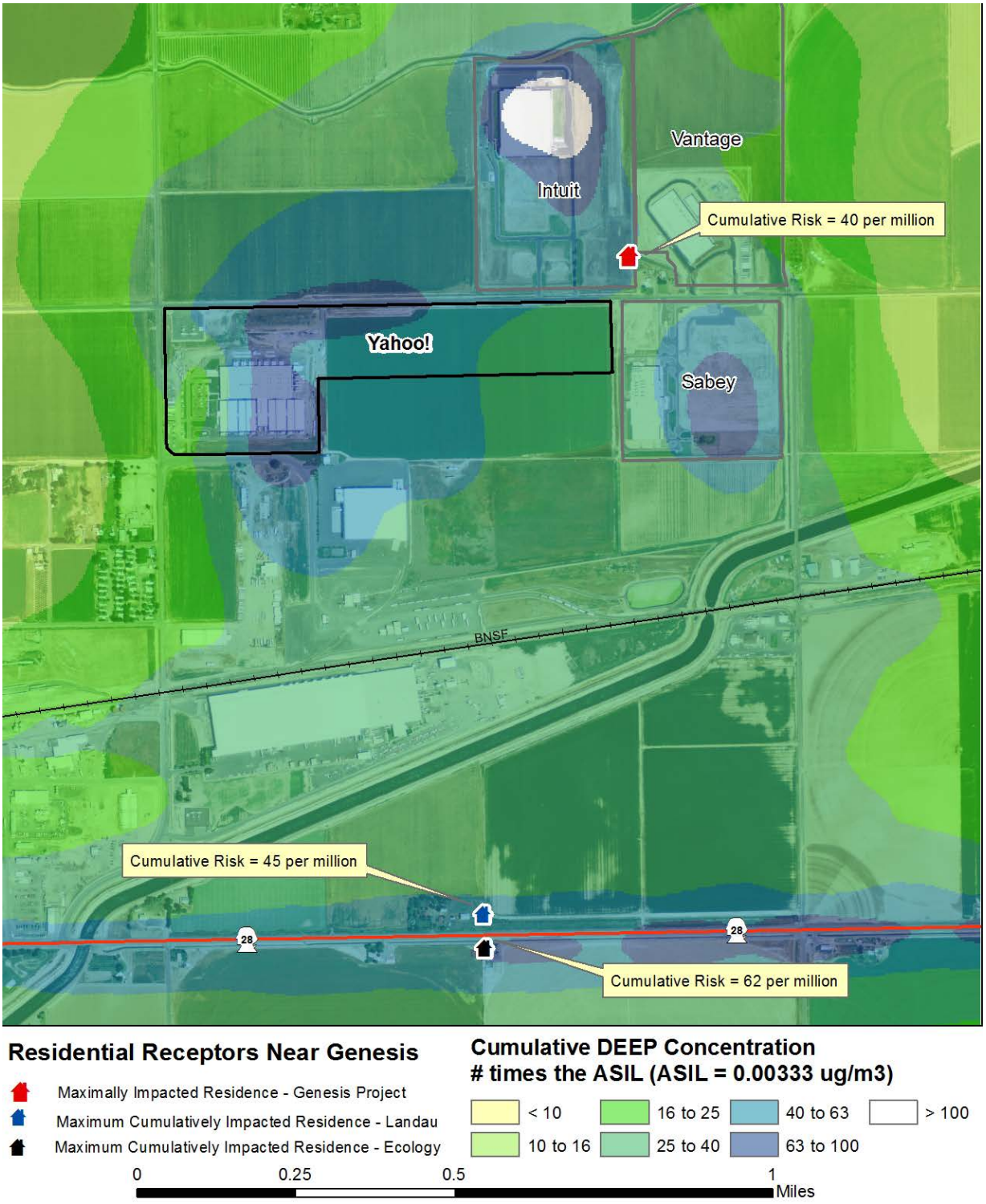

Figure 5. Cumulative risk from DEEP at residential locations (estimated by Landau and Ecology) in the vicinity of project Genesis

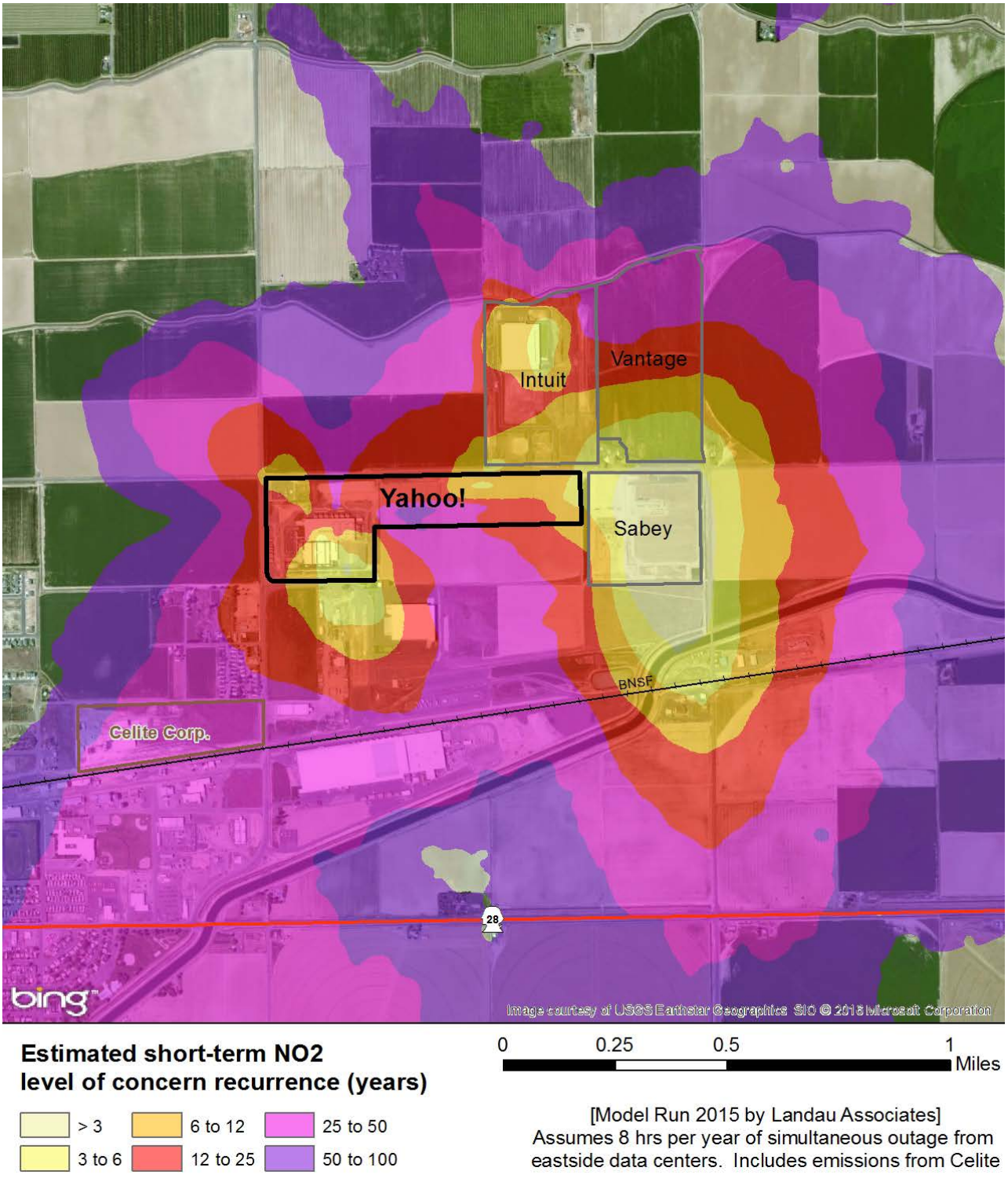

Figure 6. Estimated time interval between occurrences of 1-hr NO_2 concentrations greater than 454 µg/m^3 assuming eight hours of simultaneous eastside Quincy Data Center emergency engine outage emissions per year