DEPARTMENT OF ECOLOGY
State of Washington

2nd Revised Health Impact Assessment Review Document for

Microsoft MWH (formerly Oxford) Data Center
Quincy, Washington

Prepared by

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September 27, 2016

1. Executive Summary

This document presents Ecology's review and summary of the health risks from air pollutants emitted by 45 diesel engines at the Microsoft MWH Data Center in Quincy. This document updates a previous review to reflect changes to the design of previously permitted engines' exhaust stacks and the addition of eight new engines.

In 2014, Ecology issued an air permit which allowed Microsoft to install and operate 37 diesel-powered generators that emit pollutants into the air at the MWH (previously known as Oxford) Data Center. In 2015, Ecology released a revised draft permit for public comment which allowed Microsoft greater flexibility in the way they operate the engines. Before that permit was finalized, Microsoft notified Ecology that they would likely need additional changes prompting Ecology to halt the finalization of the permit.

In January 2016, Microsoft resubmitted application materials to reflect emissions from the 37 engines originally permitted in 2014, and eight new engines. In total, Microsoft MWH's revised 2016 application included emissions from:

- Thirty-two (32) cooling towers
- Thirty-two (32) generators rated at 2,500 kilowatt (kW) electrical output
- Four (4) generators rated at 2,000 kW
- One (1) generator rated at 750 kW
- Eight (8) new generators rated at 2,500 kW

Because the application included changes to the design of existing stacks (shorter than previously permitted), new equipment (eight new engines), and an increase in emissions, Ecology required Microsoft to revise the health impact assessment (HIA) to evaluate the health risks from exposure to diesel engine exhaust particulates (DEEP).

Microsoft hired Landau Associates to revise the HIA (Landau Associates, 2016). In this assessment, Landau Associates estimated lifetime increased cancer risks associated with Microsoft's diesel particles and other toxic air pollutant (TAP) emissions.

The revised diesel particle emissions resulted in an increase lifetime cancer risk from the previous estimate of about 5.7 in one million to a new estimate of about 5.9 in one million. The maximum risk was estimated at a residential location north of MWH Data Center. This risk assumes that a person is exposed to MWH's emissions continuously during their entire lifetime. Ecology allows an increased risk of up to 10 in one million from new sources of air pollutants. The 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 risk of cancer of about 40 percent in the United States.

The increased cancer risk was quantified assuming that both filterable and condensable particles emitted from MWH's diesel engines constitute DEEP. Typically, only the filterable particles are considered when estimating the risk of exposure to diesel exhaust particles. This is because the studies about the health risk from diesel exposure used measurements of respirable particles from “fresh” diesel exhaust and elemental carbon to represent diesel exhaust emissions. The increased risk estimated by Landau Associates represents a conservatively high estimate. If emissions estimates were based on only filterable emissions (excluding the condensable particles), then the estimated risk would be about one in one million. Landau Associates also assessed chronic and acute noncancer hazards associated with the project’s emissions and determined that MWH’s emissions by themselves are not likely to result in adverse noncancer health effects.

To evaluate the cumulative effect of numerous sources of diesel particles in the area, Landau Associates assessed the cumulative health risk by adding estimated concentrations associated with MWH’s emissions to an estimated background concentration. The maximum cumulative cancer risk to a person who lives near MWH is about 41 in one million. Much of the exposure to diesel particles at this location comes from vehicles travelling on State Route 28. Additionally, exposure to diesel particles in the area is not likely to result in long-term noncancer health effects.

Finally, Landau Associates assessed short-term impacts of nitrogen dioxide (NO_2) emitted at the same time by all 110 permitted and proposed west Quincy data center backup diesel generators during a power outage affecting MWH, Microsoft Columbia, and Dell data centers. This evaluation indicated that elevated NO_2 levels could occur under some unfavorable meteorological conditions. The likelihood, however, of an outage coinciding with unfavorable meteorological conditions is very low.

Because the increase in cancer risk associated with the new data center alone is less than the maximum risk allowed under Ecology’s rules (10 in one million), and the noncancer hazard is low, the project is approvable under WAC 173-460-090. Furthermore, the cumulative risks to residents living near MWH Data Center are below the cumulative risk threshold established by Ecology for permitting data centers in Quincy (100 per million or 100×10^{-6}).

This summary document presents Ecology’s review of the Microsoft MWH Data Center’s revised HIA and other requirements under WAC 173-460.

2. Second Tier Review Processing and Approval Criteria

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 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 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 items (a) and (b) above on September 22, 2016 (Ecology, 2016). Landau Associates submitted an HIA protocol (item (c)) on December 20, 2013, and the revised final HIA (item (e)) on April 8, 2016. The revised refined air dispersion modeling for short-term NO_2 and annual DEEP emissions (item (d)) was conducted in November and December 2015, respectively. Therefore, 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 noncancer hazard is acceptable.

2.2.1. tBACT determination

Ecology’s permit engineer determined that Microsoft’s proposed pollution control equipment (i.e., Tier 2 engines equipped with diesel particulate filters, diesel oxidation catalysts, and selective catalytic reduction) more than satisfies the BACT and tBACT requirement for diesel engines powering backup generators at MWH Data Center (Ecology, 2016).[1]

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

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[1] BACT was determined to be met through the 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.

determine if the methods and assumptions are appropriate for assessing and quantifying the surrounding community's risk from a new project.

For the MWH project, the HIA focused on health risks attributable to DEEP and nitrogen dioxide exposure as these were the only TAPs with a modeled concentration in ambient air that exceeded respective ASILs. Landau Associates briefly described emissions and exposure to other TAPs (benzene, carbon monoxide (CO), ammonia,[2] and acrolein) 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. 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>.

3.2. NO_2 health effects summary

NO_2 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 $\mu g/m^3$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 the MWH project, the maximum short-term ambient NO_2 concentration has been estimated to be 606 $\mu g/m^3$, 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.

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[2] Some ammonia is released from the selective catalytic reduction equipment designed to reduce NO_X emissions.

Landau Associates and Ecology calculated numerical estimates of exposure and hazard reported later in this document.

3.3. 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.

3.3.1. DEEP toxicity reference values

To quantify noncancer hazards and cancer risk from exposure to DEEP, quantitative toxicity values must be identified. Landau Associates 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, and are intended to represent a level at or below which adverse noncancer 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 noncancer and cancer toxicity values identified by Landau Associates.

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 noncancer health effects.

National Ambient Air Quality Standards (NAAQS) and other regulatory toxicological values for short- and intermediate-term exposure to particulate matter have been established, 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. The URF is expressed as the estimate of the plausible upper limit (i.e., the 95th percentile upper confidence interval) of cancer risk, assuming continuous lifetime exposure to a substance at a concentration of one microgram per cubic meter (1 $\mu g/m^3$). It is expressed in units of inverse concentration [i.e., $(\mu g/m^3)^{-1}$]. OEHHA's URF for DEEP is 0.0003 $(\mu g/m^3)^{-1}$ 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.

3.3.2. NO_2 toxicity reference value

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 μg/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 value 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 Notice of Construction (NOC) application process (Ecology, 2016).

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

Pollutant	Agency	Noncancer	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 µg/m^3	URF = 0.0003 per µg/m^3
NO_2	California EPA–Office of Environmental Health Hazard Assessment	Acute REL = 470 µg/m^3	N/A

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

3.4. Affected community/receptors

While MWH Data Center is located in an industrially zoned area and surrounded largely by agricultural land uses, air dispersion modeling indicated that proposed DEEP emissions, assuming DEEP is represented by both condensable and filterable particulate, could result in concentrations in excess of the ASIL at roughly 203 parcels with residential land use codes (Figure 1) [Ecology, 2015; Grant County, 2015]. U.S. Census data show that approximately 710 people live in the area in which 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 noncancer hazards, Landau Associates identified receptor locations where the highest exposure to project-related air pollutants could occur: at the project boundary, a nearby residence, and off-site commercial areas. They also identified and evaluated exposures at other areas with sensitive populations such as schools and a hospital. Landau Associates calculated both noncancer hazards and cancer risks for each of these receptors, and estimated long-term cumulative risks attributable to other known sources of DEEP.[3]

Ecology's review of the HIA found that Landau Associates identified appropriate receptors to capture the highest exposures for residential, commercial, and fence line receptors (Figures 2 and Figure 3). Landau Associates also identified other potential sensitive receptor areas such as students at Monument Elementary and Quincy Valley Schools, and patients at Quincy Valley Hospital.

3.5. Increased cancer risk

3.5.1. Cancer risk attributable to MWH's DEEP and other TAP emissions

Table 2, adapted from the HIA, shows the estimated MWH Data Center-specific and cumulative cancer risk per million at each of the receptors evaluated. The highest increase in risks attributable to MWH Data Center's emissions is 5.9 per million[4] and occurs at residential property north of MWH. Landau Associates 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.

When estimating exposure to DEEP, Landau Associates assumed that both filterable and condensable particulate matter make up DEEP resulting in an estimated risk that errs on the side of overestimating risk.[5] Based on emissions estimates presented in the NOC application, filterable particles make up approximately 15 percent of the total filterable and condensable particulate matter.

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[3] Landau Associates and Ecology modeled cumulative emissions from existing data centers, railway, and highways. Results were incorporated into the review of proposed emissions from MWH Data Center.

[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] California Air Resources Board considers the front half (filterable) PM emissions to be consistent with the techniques used to establish diesel PM as a toxic air contaminant.

Table 2. Estimated Increased Cancer Risk for Residential, Occupational, and Student Scenarios Attributable to MWH's DEEP Emissions

Attributable to:	Risk Per Million from DEEP Exposure at Various Receptor Locations						
	Fence Line Receptor[1]	R-1 North Residence (MIRR)[2]	C-1 Industrial Building (MICR)[3]	Monument Elementary School		Patients at Quincy Valley Medical Center[6]	Maximally Cumulatively Impacted Residence within area > ASIL[2]
				Students[4]	Teachers[5]		
MWH (assumes filterable and condensable particulate are DEEP)	1.0	5.9	1.9	0.1	0.4	<0.1	2.4

[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.
[4] Student scenario assumes exposure occurs 180 days per year, eight hours per day for seven years.
[5] Teacher scenario assumes exposure occurs 200 days per year, eight hours per day for 40 years.
[6] Patient scenario assumes a patient is present at the hospital 365 days per year, 24 hours per day for one year.

Note: Landau Associates 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 TAPs of about 0.02 per million at the north residence (R-1).

3.5.2. Cancer risk attributable to cumulative DEEP emissions

Landau Associates conducted a separate analysis of cumulative exposure to DEEP in Quincy.

The cumulative risk of all known sources of DEEP emissions in the vicinity of MWH Data Center (Table 3 and Figure 4) is highest for a nearby residence south of State Route 28, and southeast of the proposed project. The cumulative DEEP risk at this home is about 41 per million.[6] The majority (~68 percent) of estimated DEEP exposure at this location is attributable to emissions from vehicles travelling on State Route 28.

[6] Note that residential receptors tend to be the most exposed (e.g., longest exposure duration and exposure frequency). Therefore, their risks tend to be higher than other types of receptors. For regulatory decision-making purposes, Ecology assumes that a resident is continuously exposed at their residence for their entire lifetime.

Table 3. Estimated Cumulative Cancer Risk at Residential Locations near MWH Data Center			
	Risk Per Million from DEEP Exposure at Various Residential Receptor Locations[1]		
Attributable to:	Residence Maximally Impacted by MWH (MIRR)	Maximum Cumulatively Exposed Residence in Modeling Domain (adjacent to HWY 281)	Maximum Cumulatively Exposed Residence within the Area in which MWH–related Emissions Result in Concentrations Greater than the ASIL
MWH[2]	5.9	2.4	0.5
Dell[2]	0.6	0.6	0.7
Microsoft Columbia[2]	0.7	0.9	1.6
SR 28[3]	3.1	27.9	3.9
Rail[3]	2.3	6.6	2.2
SR 281[3]	0.8	2.7	58.8
Cumulative	13.5	41.1	67.7

[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.

3.6. Noncancer hazard

Landau Associates evaluated chronic noncancer hazards associated with long-term exposure to DEEP emitted from MWH Data Center and other local sources (Table 4). Hazard quotients were much lower than unity (one) for all receptors' exposure to MWH Data Center-related and cumulative DEEP.[7] In addition, Landau Associates evaluated combined long-term exposure to DEEP, benzene, acrolein, and ammonia emitted from MWH and determined the hazard indices were much lower than unity for all receptors' exposure to MWH Data Center-related pollutants. This indicates that chronic noncancer hazards are not likely to occur as a result of exposure to DEEP and other project-related TAPs in the vicinity of MWH Data Center.

Landau Associates also evaluated acute hazards associated with short-term exposure to NO_2 (Table 4). Landau Associates evaluated scenarios where MWH Data Center was operating under full power outage mode because this is the time period when short-term emissions would be greatest. Hazard quotients and hazard indices for the MIBR exposures were above one indicating that acute adverse health effects may occur in people occupying areas near the MWH's property boundary during a power outage. All other receptors' noncancer hazards from exposure to MWH's NO_2 emissions were at or below unity.

[7] The highest chronic hazard quotient attributed to cumulative exposure to DEEP (0.07) occurred at the maximum impacted boundary receptor location.

Landau Associates also evaluated short-term exposures to NO_2 emitted from MWH 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 (Table 4).[8] The frequency of these potential occurrences is further discussed in Section 4.2.

Table 4. Estimated Short-term NO_2 and Long-term DEEP Noncancer Hazards Attributable to MWH and (Cumulative) Emissions at Locations near MWH Data Center

	Acute (short-term)			Chronic (long-term)		
Receptors	**Max. 1-hr NO_2 (µg/m^3)**	**NO_2 Acute REL (µg/m^3)**	**HQ**	**Annual Avg. DEEP (µg/m^3)**	**DEEP Chronic REL (µg/m^3)**	**HQ**
MIBR	606 (655)	470	1.3 (1.4)	0.42 (0.46)	5	0.083 (0.091)
MICR	454 (455)		1.0 (1.0)	0.16 (0.29)		0.031 (0.058)
MIRR	409 (655)		0.9 (1.4)	0.064 (0.09)		0.013 (0.018)
Hospital	300 (375)		0.6 (0.8)	0.016 (0.1)		0.003 (0.020)
School	258 (527)		0.6 (1.1)	0.038 (0.1)		0.008 (0.020)

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 Associates 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 MWH's emissions are not expected to cause or contribute to an exceedance of any NAAQS (Ecology, 2016).

4.2. Cumulative short-term NO_2 hazard

While MWH Data Center's NO_2 emissions by themselves are not likely to result in adverse noncancer health effects, Ecology recognizes that it is possible that cumulative impacts of multiple data center's emissions during a system-wide outage could potentially cause NO_2 levels to be a health concern. Landau Associates evaluated the short-term NO_2 impacts that could result from emergency engine operation during a system-wide power outage affecting:

[8] Hazard quotients attributable to other TAPs were extremely low and are not presented in Table 4.

- Dell Data Center
- Microsoft Columbia Data Center
- Microsoft MWH Data Center

While NO_2 levels could indeed rise to levels of concern[9] at various locations across the west side of Quincy, the outage would 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 west side Quincy system-wide outage coinciding with unfavorable dispersion conditions. Ecology found the likelihood of this occurrence to be relatively low.

To conduct this analysis, Landau Associates modeled emissions of:

- Simultaneous outage emissions of NO_X for all west side permitted (i.e., Dell Data Center and Microsoft Columbia Data Center)and proposed Microsoft MWH Data Center engines, during all meteorological conditions experienced throughout a five-year period.
- Each engine operates at loads specified in permits (for existing data centers) or permit applications (for MWH Data Center).
- Potential emissions from other NO_X sources on the west side of Quincy like State Route 28, State Route 281, and the BNSF railroad line.

Figure 5 shows the maximum 1-hour NO_2 concentrations that could occur in Quincy if all west side data centers' engines operated simultaneously under emergency conditions. Although the acute reference exposure level for NO_2 is 470 $\mu g/m^3$ (CalEPA, 2008), the figure shows only those concentrations that exceed 454 $\mu g/m^3$ because Ecology assumes that a NO_2 background concentration of 16 $\mu g/m^3$ exists in Quincy at any given time (NW AIRQUEST, 2016). It is important to note that the maximum 1-hour concentrations shown in Figure 5 do not all occur at the same time. The figure displays the worst-case concentration at each location in Quincy. Generally, this figure shows that concentrations of NO_2 could exceed a level of health concern in most areas on the west side of Quincy.

Ecology also analyzed the frequency (# of hours per year) meteorological conditions could result in a NO_2 concentration greater than 454 $\mu g/m^3$ at each receptor point within the west side Quincy modeling domain. If engines were run continuously during the course of a year, some areas near data centers could achieve concentrations of health concern for as often as 300 hours per year. In reality, these data centers were not permitted to continuously operate their engines. The engines are not expected to be used frequently under outage scenarios as the Grant County Public Utilities District (PUD) reported that from 2003 to 2009, the average total outage time for customers that

[9] The level of concern in this case is 454 $\mu g/m^3$. This represents California OEHHA's acute reference exposure level of 470 $\mu g/m^3$ minus an estimated regional background concentration of 16 $\mu g/m^3$.

experience an outage throughout Grant County PUD's service area is about 143 minutes per year (Coe, 2010).

Figure 6 shows the number of years between occurrences in which the NO_2 levels could exceed a level of concern assuming each west side data center operates each engine at outage load during eight hours of simultaneous outage per year. Generally, these occurrences are not likely to happen more than once per lifetime throughout much of Quincy's west side. More frequent occurrences may happen near the boundaries of Dell and Microsoft Columbia data centers. The most frequently impacted parcel may be impacted as often as once every three to six years. It is located west of the Dell property, is zoned industrial, and the 2015 tax parcel land use code is agricultural.

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 MWH's 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 MWH 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 MWH's DEEP emissions. For simplicity, Landau Associates 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.

The duration and frequency of power outages is also uncertain. From 2003 to 2009, the average outage for all Grant County PUD power customers was about 2.5 hours per year. While this small amount of power outage provides some evidence that power service is relatively stable, we cannot predict future outages with any degree of certainty.

5.2. Emissions

The exact amount of DEEP emitted from MWH's diesel-powered generators is uncertain. Landau Associates estimated emissions assuming that each engine operates at a load resulting in the highest emissions regardless of actual intended operational load. Landau Associates also attempted to account for higher emissions that would occur during initial start-up and before control equipment was fully warmed up. Finally, the emission estimates for DEEP include adjustment factors to account for condensable particulate in addition to filterable particles. The resulting values are considered to be a conservatively high estimate of DEEP emissions.

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 MWH 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 noncancer 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 noncancer 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 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 is relevant to current diesel engines.

Regarding the second bullet above, California EPA's Office of Environmental Health Hazard Assessment recently evaluated experimental data from several new technology diesel engine emissions reflecting emission controls similar to those proposed for MWH's engines (CalEPA, 2012).

> "These studies indicate that the reductions of some air toxics such as polycyclic aromatic hydrocarbons, benzene and 1,3- butadiene in new technology engine exhaust (often 80 – 90%) are not as great as the corresponding reductions in DEP [diesel engine particulate] (often 95 – 99%). The resulting air toxics/DEP ratios for NTE [new technology engine] exhaust may be greater than or equal to similar ratios found in exhaust from older diesel engines. As an example, an analysis of data from one published review indicated that the average 3-ring PAH, 1,3-butadiene and benzene/DEP ratios increased in NTE exhaust compared to older DEE [diesel engine emissions] by 2-, 10- and 4-fold, respectively. These data suggest that while the absolute amount of DEP (and thus estimated cancer risk) and air toxics is much reduced in NTE exhaust, the exhaust composition has not necessarily become less hazardous. Thus, the available data do not indicate that NTE exhaust should be considered to be fundamentally different in kind compared to older DEE for risk assessment purposes and suggests the TAC cancer unit risk value for DEP can continue to be applied to NTE exhaust risk assessments."

Table 5 presents a summary of how the uncertainty affects the quantitative estimate of risks or hazards.

Table 5. Qualitative Summary of How the Uncertainty Affects the Quantitative Estimate of Risks or Hazards

Source of Uncertainty	How Does it Affect Estimated Risk from this Project?
Exposure assumptions	Likely overestimate of exposure
Emissions estimates	Possible overestimate of emissions concentrations
Air modeling methods	Possible underestimate of average long-term ambient concentrations and overestimate of short-term ambient concentration
Toxicity of DEEP at low concentrations	Possible overestimate of cancer risk, possible underestimate of noncancer hazard for sensitive individuals

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 or exceed the tBACT requirement.

c) The ambient impact of the emissions increase of each TAP that exceeds ASILs has been quantified using refined air dispersion modeling techniques as approved in the HIA protocol.

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

In the HIA, Landau Associates estimated lifetime increased cancer risks attributable to MWH's DEEP and other TAP emissions. The revised HIA estimated a slight increase previous risk estimate of 5.7 in one million to a new estimate of 5.9 in one million. The maximum risk was estimated at a residential location north of MWH Data Center's property. This risk was quantified assuming that both filterable and condensable particulate emitted from MWH's engines constitutes DEEP. It is important to note that diesel particulate is typically quantified as only the filterable fraction. This is because the health studies that form the basis for quantifying the health risk from diesel exposure used measurements of respirable particulate from "fresh" diesel exhaust and elemental carbon as a surrogate for diesel exhaust emissions. Therefore, the increased risk estimated by Landau Associates represents a conservatively high estimate. Based on that filterable emissions are about 15 percent of MWH's filterable and condensable emissions, an estimated risk of about one in one million at that location is a more realistic estimate.

Landau Associates also assessed chronic and acute noncancer hazards attributable to the project's emissions and determined that MWH's emissions by themselves are not likely to result in adverse noncancer health effects.

Finally, Landau Associates and Ecology assessed the cumulative health risk by adding estimated concentrations attributable to Microsoft's emissions to an estimated background DEEP concentration. The maximum cumulative cancer risk from resident's exposure to DEEP in the vicinity of MWH is approximately 41 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 noncancer health effects.

The project review team concludes that the HIA represents an appropriate estimate of potential increased health risks posed by MWH Data Center's TAP emissions. The risk manager may recommend approval of the revised 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 x 10^{-6}) [Ecology, 2010].

Additionally, Ecology's analysis of short-term impacts from simultaneous outage emissions determined a very low likelihood of a west side Quincy system-wide power outage coinciding with unfavorable pollutant dispersion. While existing power outage reports from each of the data centers do not indicate power outages have simultaneously affected all Quincy data centers, Ecology should track outage reports from the data centers to ensure that assumptions used in the analysis remain plausible.

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

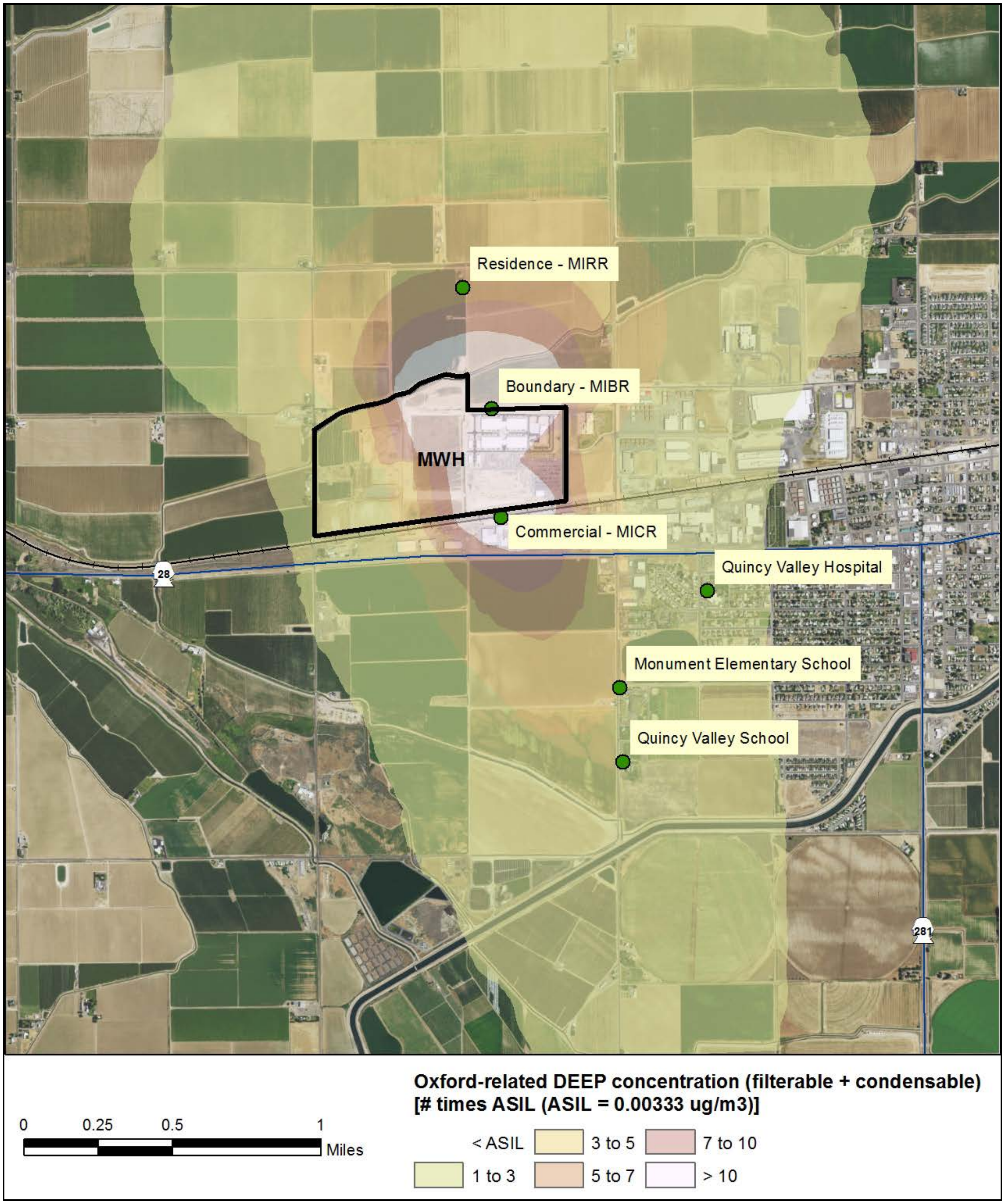

Figure 2. Receptor locations in relation to estimated DEEP concentrations (assuming both filterable and condensable fractions represent DEEP). Concentrations are reported as the number of times higher than the ASIL.

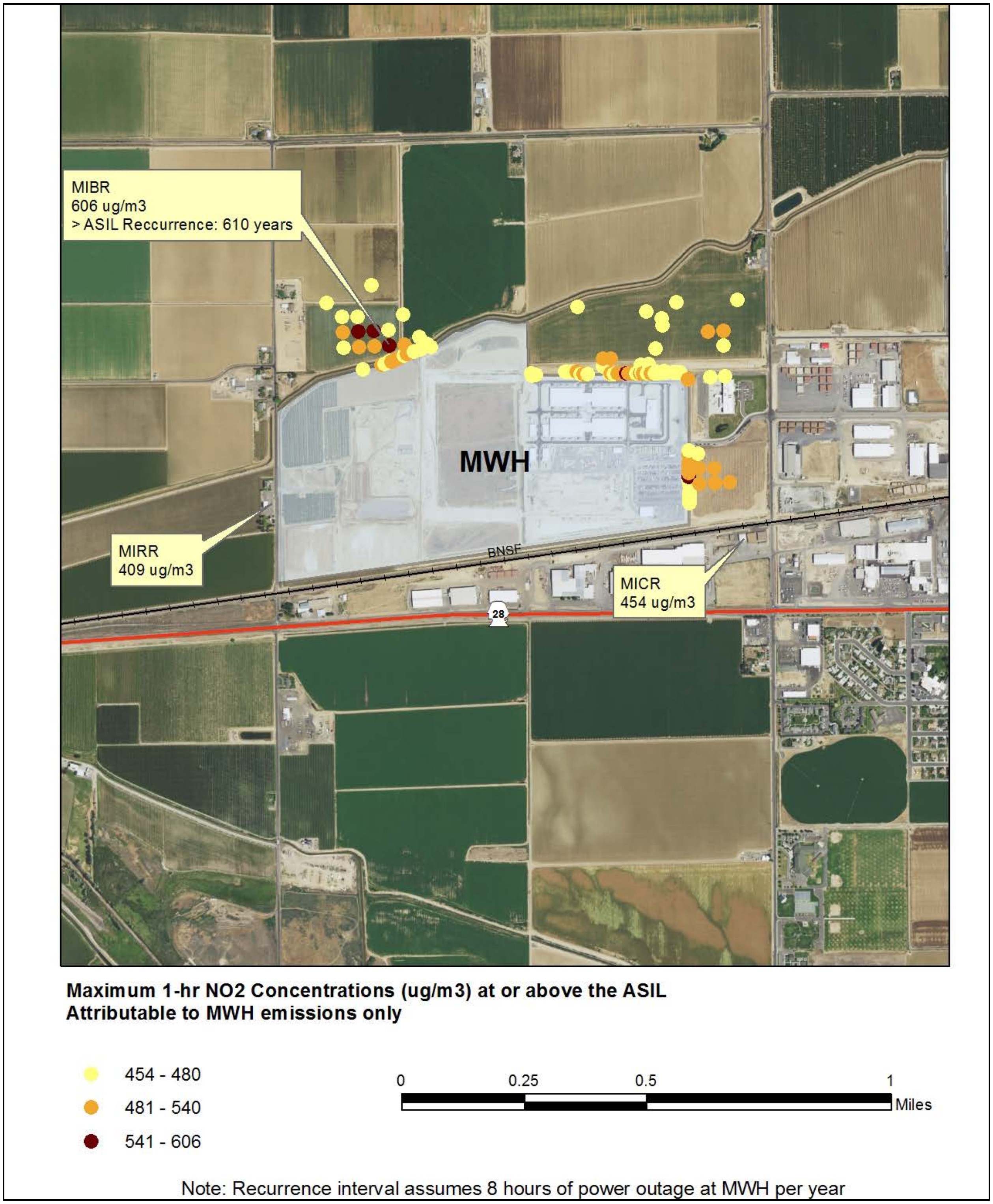

Figure 3. Receptor locations in relation to estimated 1-hour NO2 concentrations

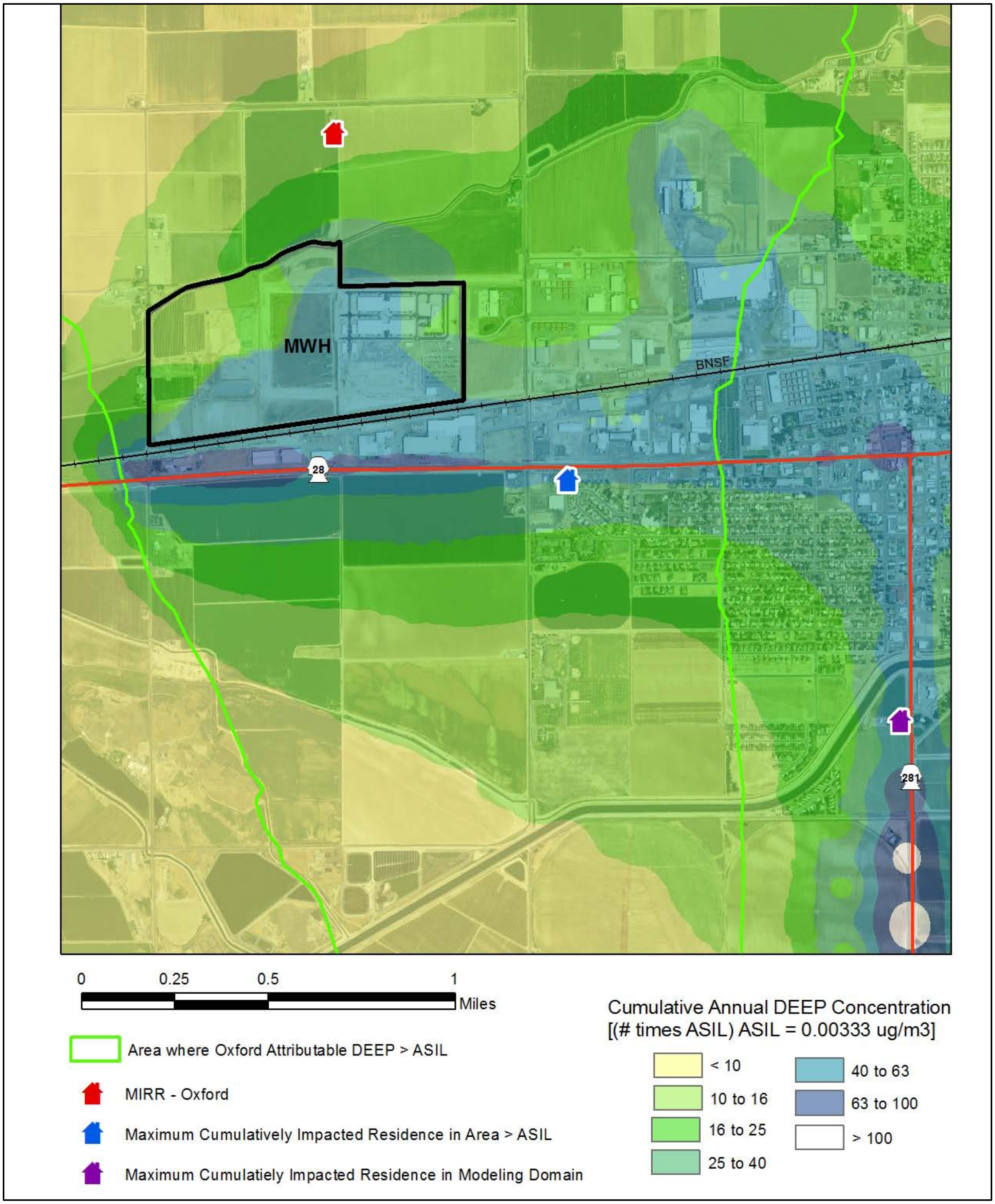

Figure 4. Cumulative DEEP concentrations (estimated by Landau Associates) in the MWH vicinity. Concentrations are reported as the number of times higher than the ASIL.

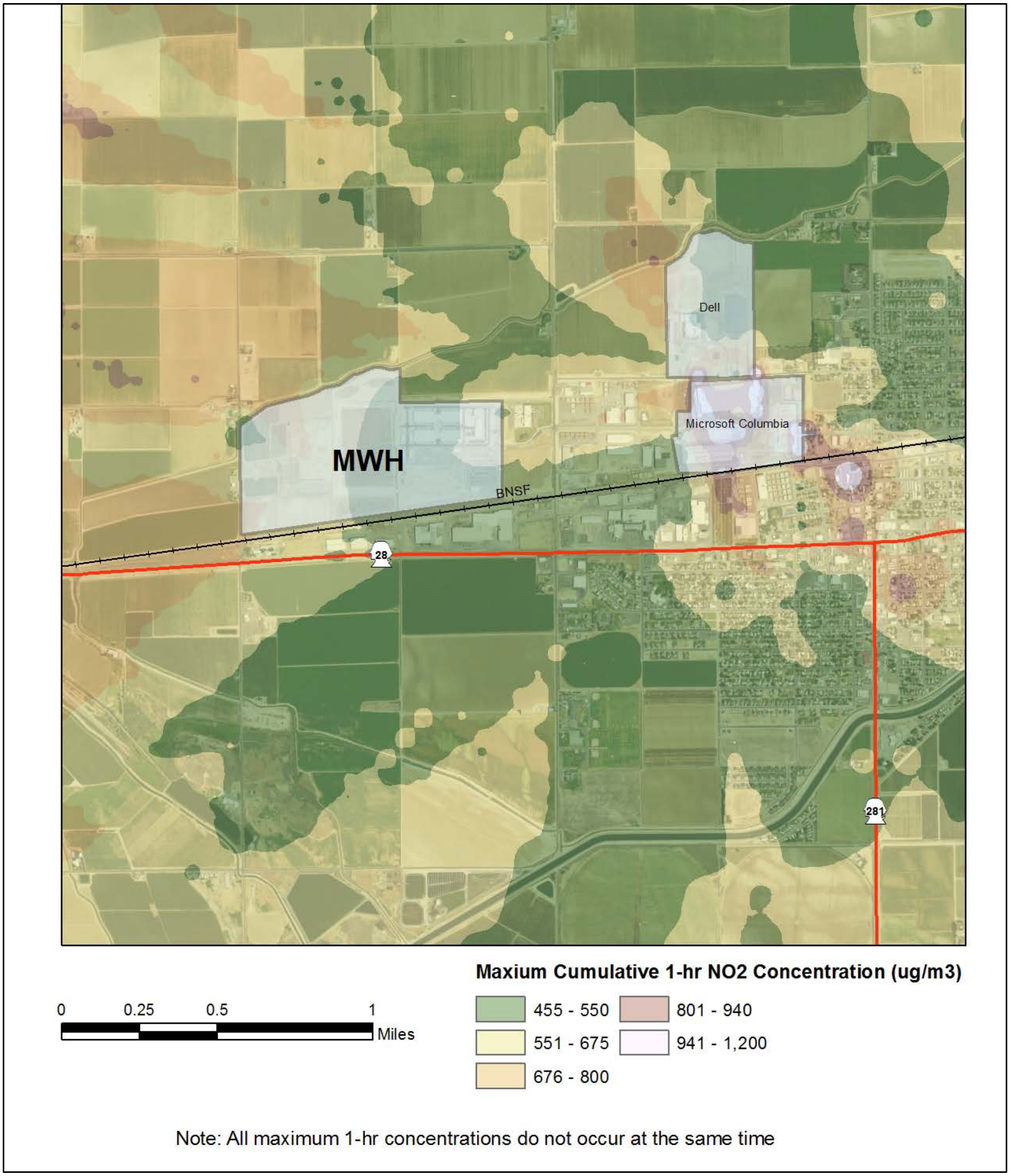

Figure 5. Estimated maximum 1-hr NO_2 concentrations resulting from cumulative NO_X emissions of all permitted and proposed data center engines during a simultaneous outage in Quincy. These maximum concentrations do not all occur at the same time.

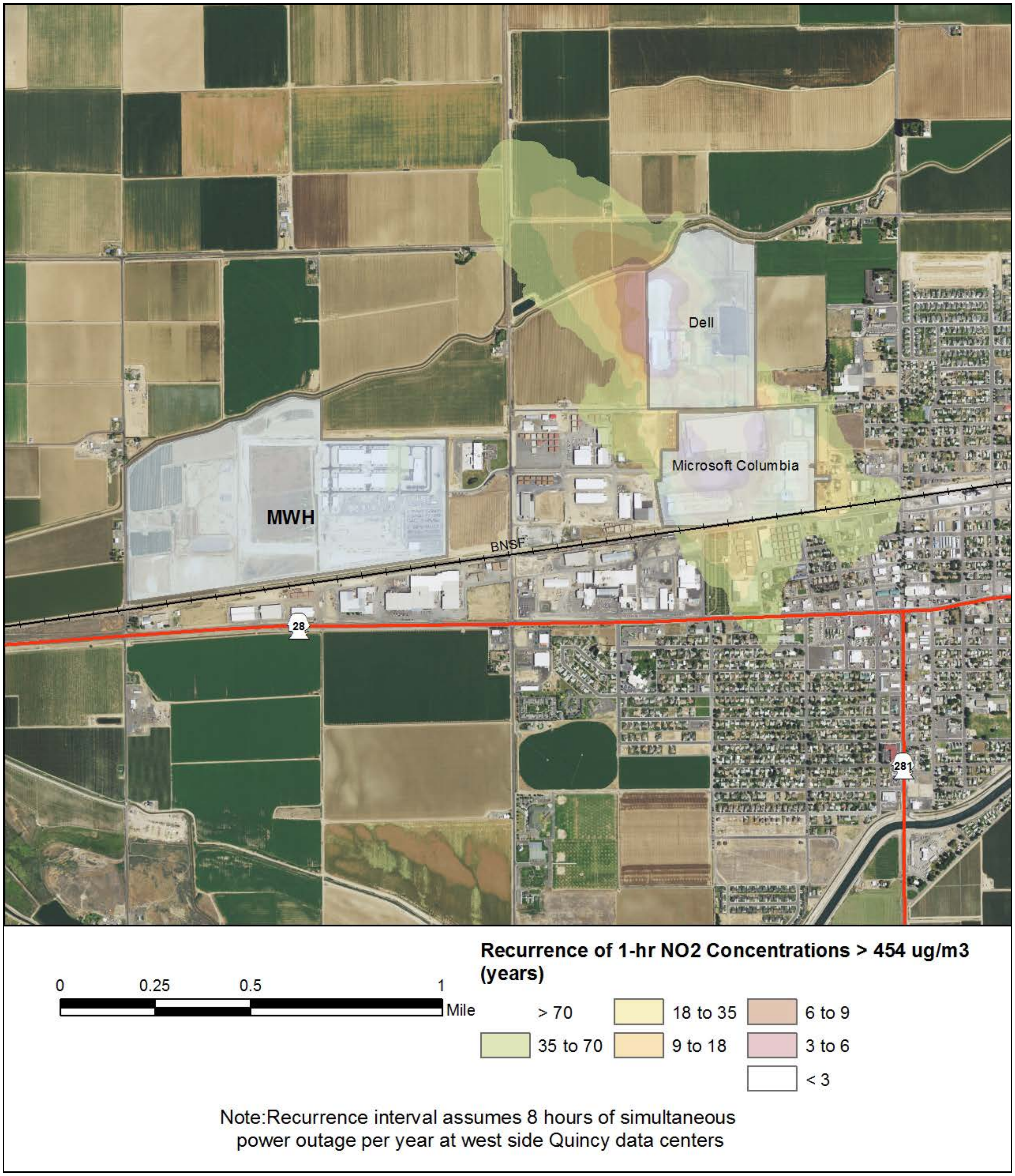

Figure 6. Estimated interval between occurrences of 1-hr NO_2 concentrations greater than 454 ug/m^3 assuming eight hours of simultaneous west Quincy data center emergency engine outage emissions per year.