



DEPARTMENT OF
ECOLOGY
State of Washington

Second Tier Review Recommendation Document for

**VMware Data Center
East Wenatchee, Washington**

May 14, 2013

1. Summary and Purpose

VMware, Inc. (VMware) proposes to install and operate four diesel-powered generators, each rated at 2,000 kW electrical output to provide backup power to their servers. VMware is currently one of four companies in East Wenatchee, WA, located at a data center complex called Intergate Columbia. The four new emergency engines proposed by VMware were part of a 2010 permit which allowed the installation of 10 engines, but, to date, VMware only installed six. Because nearly three years lapsed since Ecology issued the permit, Ecology determined that these remaining four engines must be permitted according to the requirements of current rules.

VMware's proposed four new engines will emit diesel engine exhaust particulate (DEEP) at an estimated rate that cause ambient impacts in excess of a regulatory trigger level called an acceptable source impact level (ASIL). VMware was therefore required to submit a second tier petition under WAC 173-460-090. A second tier petition requires a health impact assessment (HIA) quantifying the health risks posed by their emissions of DEEP.

VMware hired Landau Associates to prepare a HIA (Landau Associates, 2013). In this assessment, Landau Associates estimated lifetime increased cancer risks to individuals potentially exposed to VMware project-related DEEP emissions. The highest risk, approximately **six in one million**, occurs at residence approximately 100 meters southeast of the facility's closest property boundary (and about 250 meters southeast of the nearest project emission source). Chronic and acute non-cancer hazards attributable to VMware's increased DEEP and NO₂ emissions respectively were lower than unity (one) indicating that the proposed project's emissions by themselves were not likely to result in adverse non-cancer health effects.

Landau Associates also assessed the cumulative health risk by adding estimated DEEP concentrations attributable to VMware's emissions to an estimated background DEEP concentration. The highest cumulative cancer risk posed by DEEP to residents living in the vicinity of VMware was approximately **45 in one million**. Chronic non-cancer hazard quotients were much lower than one indicating that long-term 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 VMware are generally much lower than those estimated in urban areas of Washington.

Because the increase in cancer risk attributable to the new data center engines 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.

This summary document presents Ecology's review of the proposed VMware Data Center 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 (NOC) have been met, and has issued a preliminary approval order.
- (b) Emission controls contained in the preliminary NOC approval order represent at least tBACT.
- (c) The applicant has developed a HIA protocol that has been approved by Ecology.
- (d) The ambient impact of the emissions increase of each TAP that exceed ASILs has been quantified using refined air dispersion modeling techniques as approved in the HIA protocol.
- (e) The second tier review petition contains a HIA conducted in accordance with the approved HIA protocol.

Ecology provided comments to Landau Associate's HIA protocol (item (c)) on March 1, 2013. These comments were addressed as part of the submittal of draft and final health impact assessments (item (e)) received by Ecology on March 12, 2013, and April 11, 2013. Ecology's air dispersion modeler found the refined modeling conducted by VMware to be acceptable.¹

Acting as the "permitting authority" for this project, Ecology's Central Regional Office (CRO) satisfied items (a) and (b) above on May 9, 2013.² The applicant has therefore satisfied all of the five requirements above.

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.

¹ Clint Bowman, "VMware Review," e-mail message, addressed to Gary Palcisko and Lynnette Haller, March 29, 2013.

² Lynnette Haller, "RE: VMware – DRAFT 2nd Tier Docs," e-mail message, addressed to Gary Palcisko and Clint Bowman, May 9, 2013.

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

2.2.1. tBACT Determination

Ecology's CRO engineer determined that VMware's proposed pollution control equipment satisfies the BACT and t-BACT requirement for diesel engines powering backup generators VMware.³

2.2.2. 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 surrounding community's risk from a new project.

The HIA focused mainly on health risks attributable to DEEP exposure as this was the only TAP with a modeled concentration in ambient air that exceeded an ASIL. Landau Associates briefly described emissions and exposure to other TAPs (nitrogen dioxide and acrolein) because these pollutants exceeded a small quantity emission rate (SQER), and Ecology requested that acute respiratory health hazards from exposure to these pollutants be quantified.

While VMware is located in an industrially zoned area and largely surrounded by agricultural and unoccupied land, air dispersion modeling indicated that VMware's DEEP emissions resulted in concentrations in excess of the ASIL at approximately two residences. These residences are located to the southeast (~100 meters) and east-southeast (~450 meters) of the VMware property. Other nearby land uses are primarily made up of other facilities at the Intergate Columbia data center complex (Costco, Blackrock, and T-Mobile) and agricultural and undeveloped land.

For the purposes of assessing increased cancer risk and non-cancer hazards, Landau Associates identified receptor locations where the highest exposure to project-related air pollutants could occur: at the project boundary, three nearby residences, on-site tenants of a neighboring data center, and three off-site commercial areas (Figure 1).⁴ Landau Associates calculated both non-cancer hazards and cancer risks for each of these receptors, and they also estimated long-term cumulative risks attributable to and other known sources of DEEP.⁵ Finally, the HIA contained an evaluation of the combined cancer risk caused by numerous other carcinogens known to be emitted from diesel generators, but these chemicals did not exceed their respective ASILs. They

³ tBACT 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; or applicable emission standards found in 40 CFR Part 89.112 Table 1 and 40 CFR Part 1039.102 Tables 6 and 7 if Model Year 2011 or later engines are installed and operated as non-emergency engines; Compliance with the operation and maintenance restrictions of 40 CFR Part 60, Subpart III; and Use of ultra-low sulfur diesel fuel containing no more than 15 parts per million by weight of sulfur.

⁴ Landau Associates also identified sensitive receptor areas, but these were located outside the area of impact (i.e., ASIL was not exceeded in these locations).

⁵ Landau Associates modeled cumulative emissions from existing data centers' emergency engines (T-Mobile – 20 engines, Blackrock – 3 engines, Costco – 3 engines, and 6 existing engines at VMware) in addition to the four proposed VMware engines. They added these localized impacts to a regional estimate of background from EPA's National Scale Air Toxics Assessment (NATA).

concluded that the vast majority of increased cancer risk posed by the proposed project was caused by DEEP.

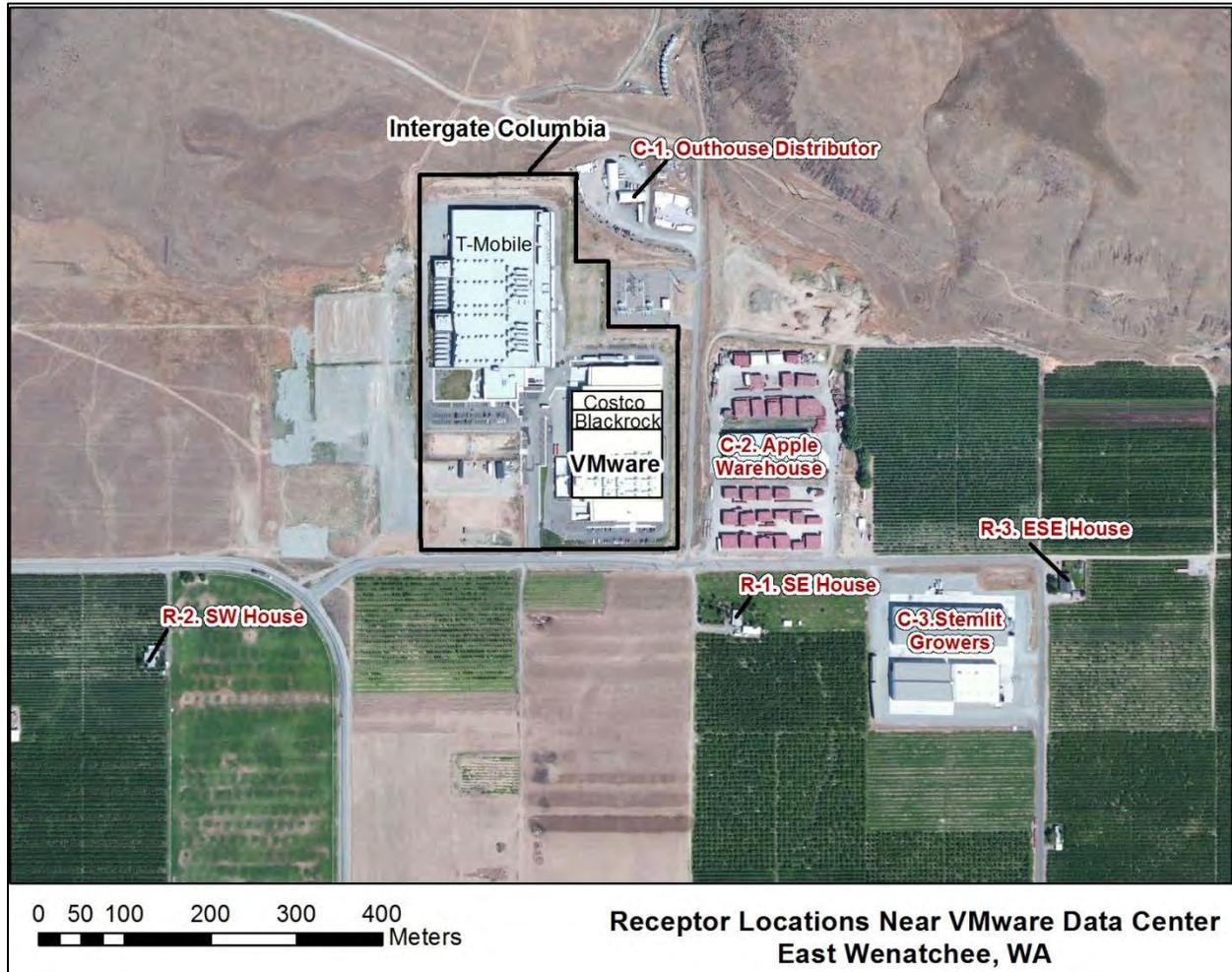


Figure 1. VMware Data Center vicinity and nearby receptors

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. Landau Associates also identified other potential sensitive receptor areas, but these areas were well outside the area impacted at levels above the ASIL, so Ecology did not require risks to be quantified at these locations.

Ecology’s review also found that Landau Associates used appropriate exposure assumptions and toxicity values to quantify and characterize non-cancer hazards and cancer risks. Landau Associates identified key areas of uncertainty regarding exposure assumptions, emissions estimates, modeling, and the chronic toxicity of DEEP. These uncertainties combined may result in an over—or under—estimate of actual health risk. For the purpose of protecting public health while making decisions, overestimates of risk are preferred over underestimates. Generally, the assumptions used in the HIA probably overestimate risk more than underestimate risk. One

exception is that the non-cancer hazards of DEEP may be underestimated primarily due to the uncertainty surrounding the non-cancer toxicity of DEEP for sensitive individuals.

2.2.3. Increased Cancer Risk

Table 1, adapted from HIA Table 4-11 (Landau Associates 2103), shows the estimated VMware project-specific and cumulative cancer risk per million at each of the receptors evaluated. The highest increase in risks attributable to project-related emissions of DEEP is 6.0 per million and occurs at a southeast residence located among orchard land. For non-residential exposure scenarios, tenants of the Blackrock Data Center may have increased risks of about 0.2 per million. Workers at nearby commercial areas may have increased risks ranging from 0.1 at the outhouse distributor to 2.1 at the Apple Warehouse. Increased cancer risks to potential bystanders exposed near the point of maximum impact (i.e., fence line receptor) may be about 0.6 per million.

The cumulative risk of all known sources of DEEP emissions in the vicinity of VMware is highest for two nearby residences. The cumulative DEEP risk at these two homes is about 45 per million at the MIRR residence and 43 per million for the residence to the east-southeast of VMware.⁶

Table 1. Estimated Increased Cancer Risk for Residential, Occupations, and Boundary Scenarios

Attributable To:	Risk Per Million From DEEP Exposure at Various Receptor Locations							
	Fence Line Receptor (MIBR) ^a	Blackrock Data Center Roof Vent ^c	R-1 SE House (MIRR) ^b	R-2 SW House	R-3 ESE House	C-1 Outhouse Distributor ^c	C-2 Apple Warehouse (MICR) ^c	C-3 Stemlit Growers
VMware's Four New Generators	0.6	0.2	6.0	0.5	4.1	0.1	2.1	1.0
Local Background	1.2	4.6	16	3.6	16	2.4	4.9	2.8
NATA Regional Background	0.6	2.9	23	23	23	2.9	2.9	2.9
Cumulative (Post-project)	2.4	7.7	45	27	43	5.3	9.9	6.7

a – assumes intermittent exposure 250 days per year, 2 hours per day for 30 years

b – residential scenarios assume continuous lifetime exposure

c – workplace scenarios assume exposure occurs 250 days per year, 8 hours per day for 40 years

MIBR – Maximally Impacted Boundary Receptor

MIRR – Maximally Impacted Residential Receptor

MICR – Maximally Impacted Commercial Receptor

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 0.01 per million at the MIRR.

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.

2.2.4. Non-Cancer Hazard

Landau Associates evaluated chronic hazards associated with long-term exposure to DEEP emitted from VMware's project plus other local and regional sources. Hazard quotients were much lower than one for all receptors' exposure to project-related and cumulative DEEP.⁷ This indicates that chronic non-cancer hazards are not likely to occur as a result of exposure to DEEP in the vicinity of VMware.

Landau Associates also evaluated acute hazards associated with short-term exposure to NO₂ and acrolein. Landau Associates evaluated scenarios where VMware was operating under full power outage mode because this is the time period when their emissions would be greatest. Hazard quotients and hazard indices for all receptors' exposures were below one indicating that acute adverse effects are not likely to be caused solely by VMware's project-related emissions during a power outage.⁸

3. Other Considerations

3.1. Cumulative Short-Term NO₂ Hazard

Although VMware project's emissions by themselves are not expected to result in acute non-cancer hazards, cumulative short-term emissions of multiple emergency engines operating under power outage conditions at the Intergate Columbia data center complex were not evaluated as part of this review. Based on Ecology's experience permitting data centers in Quincy, WA, NO₂ levels could rise to a level of concern during a system-wide outage coinciding with unfavorable dispersion conditions. If such an event were to occur, people with asthma who might be cumulatively exposed to NO₂ and DEEP from emergency engines and other sources may experience respiratory symptoms such as wheezing, shortness of breath, and reduced pulmonary function with airway constriction.

In Quincy, Ecology determined that there was a very low probability of both a system-wide power outage and unfavorable dispersion conditions happening at the same time. Given the infrequent occurrence of power outages (none reported by VMware since the facility was built in 2009)⁹ at the Intergate Columbia data center complex in East Wenatchee, and based on Ecology's evaluation of simultaneous emergency engine emissions at data centers in Quincy, WA, the likelihood of a system-wide outage coinciding with unfavorable meteorology is probably very low.

4. Conclusions and Recommendation

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

⁷ The highest chronic hazard quotient attributed to cumulative exposure to DEEP (0.07) occurred at the fence line receptor location (i.e., maximum impacted boundary receptor).

⁸ The highest acute hazard quotient of 0.6 occurred at the fence line receptor location (i.e., maximum impacted boundary receptor).

⁹ Personal communication with Jim Wilder, Landau Associates.

- a) The TAP emissions estimates presented in the HIA represent a reasonable estimate of the project's future emissions.
- b) Emission controls for the new and modified emission units meet the tBACT emission 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 VMware adequately assesses project-related increased health risk attributable to TAP emissions.

The project review team concludes that the HIA presents an appropriate estimate of potential increased health risks posed by VMware's TAP emissions. VMware's increased DEEP emissions could result in an increased cancer risk of up to six per million for people living full-time for 70 years at the maximally impacted residence. This risk falls below Ecology's threshold of maximum acceptable risk (i.e., one per one hundred thousand or 10 per million) as defined in Chapter 173-460 WAC. Furthermore, the chronic non-cancer hazards from exposure to project-related and cumulative DEEP are very low. This means that long-term exposure to DEEP in the area is not expected to result in adverse non-cancer health effects.

Although people at existing nearby residences are unlikely to experience non-cancer health effects from VMware project-related emissions, the cumulative effect of all Intergate Data Center Complex emergency engines operating simultaneously during a power outage that coincides with unfavorable dispersion conditions could potentially result in elevated short-term pollutant levels nearby. On these likely very rare occasions, people may experience respiratory irritation from cumulative exposure to VMware and other data center diesel engine emissions. This irritation may exacerbate asthma in some people. Other types of adverse non-cancer health problems among people at nearby areas are unlikely. While the likelihood of these acute non-cancer hazards appears to be very low, Ecology will need routine reports of power failures from VMware. If power outages at Intergate Columbia Data Center Complex appear to occur more frequently than expected, Ecology should consider enhancing communications with local government and people likely to be present in potentially impacted areas regarding potential short-term health concerns.

Based on the project team's review of the HIA, the risk manager may recommend approval of the proposed project because project-related health risks are permissible under WAC 173-460-090.

5. References

Landau Associates, (2013), Final Report: Second Tier Risk Analysis Technical Support Document, Four New Generators at VMware Pods 1 and 3, VMware Data Center, East Wenatchee, Washington, April 10, 2013.