Technical Memorandum

TO: Gary Palcisko, Washington State Department of Ecology

FROM: Mark Brunner

DATE: March 7, 2016

RE: **Second-Tier Health Impact Assessment Protocol**
Vantage Data Center
Quincy, Washington

Introduction

This Second-Tier Health Impact Assessment (HIA) Protocol technical memorandum outlines the methods and procedures to be followed in conducting emissions analysis and air quality modeling to support the development of an air quality permit application for 17 emergency generators at Vantage Data Centers' (Vantage) facility in Quincy, Washington. All of the emergency generators will comply with emission standards set by the US Environmental Protection Agency (EPA) for Tier 2 certification. This protocol document is intended to provide a basis for study participants to review and comment on all aspects of the permit analysis including the key assumptions used in estimating the emissions, air quality modeling tools and methodologies, quality assurance procedures, schedule, and communication structures. The emission estimates and air quality modeling practices were designed to be consistent, wherever applicable, with current EPA and Washington State Department of Ecology (Ecology) guidelines for air quality permit modeling.

Overall Template for Health Impact Assessment

Landau Associates will follow the general format and level of detail that Ecology has approved previously in the Second-Tier HIA reports for other data center development projects in Grant County, Washington. Project-related emissions will trigger second-tier review for diesel engine exhaust particulate matter (DEEP) and nitrogen dioxide (NO_2), as modeled impacts are estimated to be greater than the acceptable source impact levels (ASILs).

Background and Objectives

The Second-Tier HIA will be prepared to support the installation of backup electrical generators at Vantage and will include estimates of the emissions for the backup generators and their potential air quality impacts for a variety of meteorological conditions and a range of routine testing and power outage scenarios. From an air quality perspective, the assessment will examine the impacts of emissions of criteria pollutants [coarse particulate matter (PM_{10}[1]) , fine particulate matter ($PM_{2.5}$[2]) , and NO_2], DEEP, and toxic air pollutants (TAPs) whose emissions exceed the small-quantity emission rate (SQER) thresholds.

---

[1] Particulate matter with an aerodynamic diameter less than or equal to 10 microns
[2] Particulate matter with an aerodynamic diameter less than or equal to 2.5 microns

Landau Associates

130 2nd Avenue South • Edmonds, Washington 98020 • (425) 778-0907

Key air quality criteria that will be considered as part of this assessment include the National Ambient Air Quality Standards (NAAQS) for:

- PM_{10}
  - Based on the 4th-highest 24-hour average PM_{10} concentration
  - NAAQS limit (including background) is 150 micrograms per cubic meter (µg/m^3)
- 24-hour $PM_{2.5}$
  - Based on the 3-year average of the 98th percentile (8th-highest) daily 24-hour $PM_{2.5}$ concentration
  - NAAQS limit (including background) is 35 µg/m^3
- 1-hour NO_2
  - Based on the 3-year average of the 98th percentile (8th-highest) 1-hour NO_2 concentration
  - NAAQS limit (including background) is 188 µg/m^3.

In addition, ASILs, as designated by Ecology, will also be considered for the following:

- Annual-average DEEP
  - Annual-average concentration, highest of 5 years of meteorological data
  - ASIL is 0.00333 µg/m^3
- 1-hour NO_2
  - Maximum 1-hour concentration in 5 years caused by a facility-wide power outage
  - ASIL is 470 µg/m^3
- Other TAPs whose emission rates exceed the SQER emission thresholds
  - These may include benzene; 1,3-butadiene; naphthalene; propylene; NO_2; carbon monoxide (CO); and acrolein.

From a health-based risk assessment perspective, the assessment will examine pollutant concentrations and estimated cancer risks for reasonable maximum exposure (RME) receptor locations within the surrounding region including adjacent homes, schools, and businesses beyond the proposed project boundary.

Overview of the Methodologies

Excel-based spreadsheet tools will be used to calculate the emissions based on a variety of information including generator specifications, runtime estimates, and species-specific emission factors.

Air quality impacts will be estimated using the American Meteorological Society (AMS)/EPA regulatory model (AERMOD) dispersion model, with the EPA's plume rise model enhancement (PRIME) algorithm for building downwash. For NO_2, the plume volume molar ratio method (PVMRM) module will also be used, in accordance with current Ecology guidelines. AERMOD is a steady-state Gaussian dispersion model designed to simulate the local-scale dispersion of pollutants from low-level or elevated sources in simple or complex terrain; it is an EPA "preferred" model (40 CFR Part 51, Appendix W, Guideline on Air Quality Models).

Schedule

We anticipate submitting the Notice of Construction (NOC) application in late April 2016 and the Second-Tier HIA in mid-May 2016.

Deliverables

Deliverables will include an NOC application report summarizing the technical analysis, a Second-Tier HIA for DEEP and NO_2, graphics consistent with this protocol, and any administrative forms and certification forms required to complete the application process. It is expected that conference calls and meetings will be held as needed with Ecology to discuss the methods, assumptions, and results.

Facility Configuration

Vantage is permitted to build a data center complex located at 2101 M Street NE in Quincy, Washington. At full build-out, the facility would be composed of five buildings (one office building and four buildings to house the server equipment) and 17 diesel-powered emergency backup generators. Each generator will include a diesel-powered engine that drives an alternator section to produce electricity. The alternator section does not emit any air pollutants, so the overall emissions from a diesel generator are produced only from the diesel engine. The terms "generator" and "engine" are used interchangeably in this document. The generators are permitted to provide backup power to the facility in the event of disruption of the Grant County Public Utility District (PUD) electrical power service. Construction of the data center complex will be completed in phases. The first phase of construction, which has been completed, comprises a computer server building and a building that houses five emergency generators. Future expansion plans may include two additional emergency generators in the existing building that houses generators, and up to four additional computer server buildings that would be served by 10 additional emergency generators.

The original proposal was for 17 3.0-megawatt (MW) generators to be equipped with EPA Tier 4-certified emission controls, including a catalyzed diesel particulate filter, a urea-injection selective catalytic reduction system, and a diesel oxidation catalyst. The latest compliance tests performed on the five installed engines (April 2015) indicate that particulate matter (PM) emissions are higher with the Tier 4 control units than they would be without the Tier 4 controls (i.e., engines that comply with EPA Tier 2 emission standards). Multiple attempts to repair and/or optimize the Tier 4 control units have failed; therefore, Vantage has elected to request a permit modification to allow for removal of the add-on controls from the existing engines and that all future permitted engines to be installed be certified to comply with EPA Tier 2 standards.

Land Use and Sensitive Receptors

The Second-Tier HIA report will show the zoning and land use near the Vantage Data Center. We will provide figures showing the locations of all sensitive receptors inside the 1-per-million DEEP cancer risk contour and the 1-hour average NO_2 ASIL boundary. We will also evaluate the DEEP and NO_2 impacts at the nearest school.

Generator Runtime Scenarios

Table 1 shows the forecast generator runtimes for each operating mode. These runtimes will be used to develop the inputs for the AERMOD modeling and will be provided along with the permit analysis documentation. The maximum annual-average emission calculations will assume a total of approximately 66 runtime hours per year per generator (see Table 1), consisting of unplanned power outages, scheduled monthly engine testing, electrical bypass/maintenance, and annual load bank testing. The annual runtime estimates are subject to change based on the results of preliminary modeling results. The maximum 1-hour average emission calculations for evaluating impacts compared to ASILs with a 1-hour averaging period will assume the worst-case scenario of an unplanned power outage.

Emission Factors for Cold-Start Conditions

Load-specific emission rates will be developed from generator manufacturer estimates of “Not to Exceed” emissions data for nitrogen oxides (NO_x), PM, CO, and total volatile organic compounds. We have also developed conservative factors to estimate the “back-half” condensable fraction of the emitted PM for evaluating compliance with the NAAQS. The emission factor for DEEP will be composed of the front-half fraction (i.e., filterable particulates) only. For the TAPs other than DEEP, we will use emission factors from AP-42 Sections 3.3 and 3.4 (EPA 1995).

Our emission rate estimates for NO_x, PM, and petroleum hydrocarbons will account for added emissions during cold-start operating conditions and the “back-half” condensable fraction of the emitted PM for evaluating compliance with the NAAQS. This will account for the 60-second “black puff” that occurs during each cold start, using the same methodology that was used for previous data center permit applications (the cold-start factors are based on measurements taken by the California Energy Commission as described in its 2005 document, Implications of Backup Emergency Generators in California [Lents et al. 2005]).

Facility-Wide Emission Rates

The forecast facility-wide potential-to-emit (PTE) will be calculated for all TAPs emitted by diesel engines and reported for any TAP that exceeds the Washington *de minimis* threshold. Our Second-Tier HIA will focus primarily on TAPs that have a PTE that could exceed the SQERs.

Air Dispersion Modeling

As noted above, air quality impacts will be estimated using the EPA's AERMOD dispersion model, with the PRIME algorithm for building downwash. AERMOD will be used to simulate airborne concentrations of PM_{10}, $PM_{2.5}$, NO_2, and any TAP that has an emission rate that exceeds the SQER. Air modeling will be completed under a variety of emission scenarios that capture the worst-case impacts for each of these pollutants. For NO_2, the PVMRM module will be used.

The 5-year AERMOD simulation period will be 2001 to 2005. Meteorological input files for this period have been developed using AERMET, the standard AERMOD meteorological processor. The meteorological inputs are based on 5 years of surface meteorological data from Grant County International Airport and upper air data from Spokane.

Digital topographical data (in the form of Shuttle Radar Topography Mission [SRTM] files) for the analysis region will be obtained from the www.webgis.com website and processed for use in AERMOD. All generator stacks will be vertical. We will digitize the building dimensions within the facility.

The receptor grid beyond the facility boundary consists of Cartesian flagpole receptor grids placed at a height of 1.5 meters (m) above ground. The grid spacing will vary with distance from the facility boundary, as listed below:

- 12.5-m spacing from emission source to 150 m
- 25-m spacing from 150 m to 400 m
- 50-m spacing from 400 m to 900 m
- 100-m spacing from 900 m to 2,000 m
- 300-m spacing beyond 2,000 m.

Regional Background Concentrations

At Ecology's request, regional background concentrations for all species were obtained from the Washington State University Northwest International Air Quality Environmental Science and Technology Consortium website (WSU website 2016). The "Lookup 2009-2011 Design Values" obtained on September 22, 2015 for coordinates within the project boundary are as follows:

- PM_{10} (24-hour average) 62 µg/m^3
- $PM_{2.5}$ (24-hour average) 21 µg/m^3
- NO_2 (1-hour average) 8.3 parts per billion.

Local Background DEEP and NO_2 Impacts Caused by Nearby Industrial Facilities

The Vantage Data Center will be within 1 mile of the following local background DEEP and NO_2 sources:

- On-road diesel trucks traveling on State Route (SR) 28 and SR 281, which are south of the Vantage Data Center
- Diesel locomotives on the rail line that is about ½ mile south of the Vantage Data Center
- Currently permitted diesel generators at the Yahoo! Data Center
- Currently permitted diesel generators at the Intuit Data Center
- Currently permitted diesel generators at the Sabey Data Center.

For the purpose of estimating the cumulative DEEP cancer risk and NO_2 1-hour average impacts, the spatial patterns of contaminant concentrations will be derived by modeling the DEEP and NO_2 emissions from Vantage Data Center and the currently permitted DEEP and NO_2 emissions from the Yahoo!, Intuit, and Sabey Data Centers, and line-source emissions from SR 28 and SR 281 and the rail line. Note, for efficiency, point sources at local background facilities may be modeled assuming one centrally located stack at each facility, with the emission rate set as the facility-wide PTE.

Multi-Pathway Risk Assessment Is Not Proposed

No multi-pathway risk assessments are proposed. DEEP is an aerosol that consists mainly of particles smaller than 1 micron. At that small size, DEEP particles behave the same as gases, and would exhibit negligible tendency to settle by gravity or adsorb onto the ground or plant surfaces in the immediate vicinity of the emission source. Therefore, there is negligible risk of DEEP intake by either ingestion or skin absorption.

NO_2 is an off-gas produced from the use of emergency generators; it is produced in gas phase and flows freely to the atmosphere. NO_2 does not present any cross-media impact potential as there are no impacts to soil or water.

Methods for DEEP and NO_2 Modeling and Risk Assessment

Since a Second-Tier HIA will be required for DEEP and NO_2, additional information on the evaluation of those compounds is provided in this section.

Averaging Periods and Reference Exposure Levels

We will quantify DEEP ambient inhalation risks for the following averaging periods and exposure limits:

- Lifetime cancer risk will be established using the modeled impacts of the "70-Year Average" annual DEEP emission rate and comparing those impacts to the unit risk factors listed in Table 2. This information is identical to that used for the previous Grant County data center air permit applications. Our qualitative toxicity profile discussion will include a summary of toxicological information from the EPA's Integrated Risk Information System (IRIS) database.
- Chronic non-cancer health hazard will be established using the maximum annual-average DEEP emission rate and comparing it to the most recent California Office of Environmental Health Hazard Assessment (OEHHA) chronic (annual-average) reference exposure level (REL) of 5 $\mu g/m^3$.

We will quantify NO_2 ambient inhalation risks for the following averaging period and exposure limit:

- Acute non-cancer health hazard will be established using the maximum impact of the peak NO_2 emission rate and comparing that to the OEHHA acute (1-hour) REL of 470 $\mu g/m^3$.

Contour Maps and Key Receptors

To illustrate the DEEP impacts caused solely by Vantage emissions, we will prepare a DEEP concentration isopleth map, with the following annual-average contours: 0.0033 $\mu g/m^3$; 0.005 $\mu g/m^3$; 0.007 $\mu g/m^3$; 0.01 $\mu g/m^3$; 0.02 $\mu g/m^3$; and 0.030 $\mu g/m^3$. Likewise, we will prepare an NO_2 concentration isopleth map of 1-hour average impacts. On the contour maps and in summary tables, we will show the predicted impacts to the following key receptors:

- Maximum impacted boundary receptor (MIBR)
- Maximum impacted residential receptor (MIRR)
- Maximum impacted commercial receptor (MICR), assumed to be the maximally impacted industrial building
- Maximally impacted school.

At each discrete receptor, we will indicate the project-only impact, and the DEEP cancer risk attributable to the project.

To illustrate how the project will affect cumulative DEEP and NO_2 concentrations in the vicinity, we will model and show on figures the local DEEP and NO_2 concentrations caused by the local background DEEP sources, with the emission rates based on each facility's allowable permit limits. We will also prepare tables itemizing the modeled cumulative DEEP and NO_2 impacts at each key receptor.

Cumulative Cancer Risk Contribution by Other Carcinogens Emitted

We will account for the cancer risk caused by the other carcinogens (in addition to DEEP) emitted from the project by quantifying each constituent's maximum cancer risk at the key receptors.

Non-Cancer Risk Assessment

For chronic (annual-average) project impact evaluations, we will use the maximum annual-average emission rates. For 1-hour acute project impact evaluations, we will use the peak hourly emission rate during an unplanned power outage. These impacts will be used to quantify the hazard quotients (HQs) for DEEP (applicable to chronic annual exposure) and NO_2 (applicable to a 1-hour acute exposure) at the corresponding MIBR, MICR, MIRR, and any identified maximally impacted sensitive receptor locations.

If the NO_2 impact exceeds an HQ of 1 (during the worst-case operating power outage scenario), the frequency of that event will be established from AERMOD (assuming that a system-wide power outage occurs continuously throughout the year). This will address the probability that "prime" meteorological conditions (conditions necessary to incur an acute HQ greater than 1) could occur in any given year. A recurrence interval will also be calculated (based on the probability of a system-wide power outage) to demonstrate the anticipated frequency that any key receptor may incur impacts that would exceed an HQ of 1.

We will also quantify a multi-pollutant hazard index (HI). If the toxic effect of any project TAP with expected emissions that exceed the SQER also has an acute (1-hour) or chronic (annual) health hazard and that toxic effect targets the same biological organ or system as does NO_2 or DEEP, that TAP will be included in the multi-pollutant hazard index.

Quality Assurance

Emissions for AERMOD modeling will be computed based on generator manufacturer specifications as well as runtime schedules provided by the facility operators. Once the emission computations are complete, individual values will be compared to the original information to ensure that the data were entered correctly into the computation spreadsheets, the calculations will be checked for errors, and the resulting emission values will be checked for reasonableness. These checks will be conducted by members of the assessment team who are not directly involved in the preparation of the emission spreadsheets.

Once the emissions have been checked for quality, they will be passed to the team member responsible for running AERMOD to be used directly as input to the model. The AERMOD emission inputs will be double-checked against the original emissions by the team member responsible for preparing the emissions modeling.

Similarly, the AERMOD outputs will undergo quality checking by members of the air quality assessment team who are not involved in running the model. The outputs will be checked for completeness in representing the receptors and pollutants, consistency with the assumptions and emissions, and reasonableness.

All documentation prepared as part of this assessment will undergo technical editing and review.

Data Archival Procedures

The data, input, and output files prepared for this assessment will be backed up and archived by Landau Associates. Copies of the emissions data files and the AERMOD inputs and outputs will be provided to Ecology.

Summary of 'No' Responses on Health Impact Assessment Completeness Checklist

Due to site-specific conditions, Landau Associates' Second-Tier HIA report will not include some of the generic information requested by Ecology under the following items from the Health Impact Assessment Completeness Checklist. These items are discussed below.

Item 18: Risk-Based Concentrations (RBCs) for Alternate Averaging Periods

As described previously, we will evaluate only the following averaging periods:

- DEEP: Annual
- NO_2: 1-hour.

Item 19: Other 'Conflicting RBCs'

We do not propose to compare and contrast "conflicting RBCs." We will restrict our analysis to the published values listed in this protocol.

Item 20: Air, Water, and Soil Transport and Fate Data

As described in this protocol, we will restrict our analysis to inhalation risk caused by direct emissions from the project stacks. We will briefly summarize the EPA's $PM_{2.5}$ criteria document information on $PM_{2.5}$ fate and half-life in the atmosphere, but we will not attempt to quantify the half-life of DEEP's individual constituents or each constituents' overall toxicity.

Item 22: Non-Inhalation Pathways

As described in this protocol, both DEEP and NO_2 are expected to behave as gases with minimal deposition or adsorption on the ground or vegetation. We will not evaluate non-inhalation pathways.

Item 23: Alternate Averaging Periods and Conflicting RBCs

We will analyze the annual-average DEEP concentrations and the 1-hour NO_2 concentrations described in this protocol. We do not propose to research alternate averaging periods other than those specifically described in this protocol.

* * * * *

This technical memorandum presents the HIA protocol to support the second-tier air toxics review for the Vantage Data Center in Quincy, Washington. If you have any questions regarding this protocol, please contact Mark Brunner at (206) 631-8695 or via email at mbrunner@landauinc.com.

LANDAU ASSOCIATES, INC.

Mark Brunner
Senior Planner

CO/MWB/ccy
\\edmdata01\projects\1499\001\R\HIA Protocol\LAI Client-Review Draft Vantage HIA Protocol_tm - 03-01-16.docx

References

EPA. 1995. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. Fifth Edition. AP-42. Office of Air Quality Planning and Standards, Office of Air and Radiation, US Environmental Protection Agency. January.

Lents, J.M., L. Arth, M. Boretz, M. Chitjian, K. Cocker, N. Davis, K. Johnson, Y. Long, J.W. Miller, U. Mondragon, R.M. Nikkila, M. Omary, D. Pacocha, Y. Qin, S. Shah, G. Tonnesen, Z.S. Wang, M. Wehrey, and X. Zhu. 2005. Air Quality Implications of Backup Generators in California – Volume One: Generation Scenarios, Emissions and Atmospheric Modeling, and Health Risk Analysis. California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2005-048. March.

WSU website. 2016. NW Airquest. http://lar.wsu.edu/nw-airquest/lookup.html. Northwest International Air Quality Environmental Science and Technology Consortium, Washington State University. Accessed February 24.

Attachments

Table 1: Potential Generator Annual Runtimes
Table 2: Exposure Assumptions and Unit Risk Factors for DEEP

TABLE 1
POTENTIAL GENERATOR ANNUAL RUNTIMES
VANTAGE DATA CENTER
QUINCY, WASHINGTON

Activity	Max. Annual Operating Hours (per generator)	Operating Load	Max. No. Generators to Operate Concurrently
Monthly Maintenance Testing	12	≤100%	1
Annual Load Testing	4	≤100%	1
Electrical Bypass/ Emergency Power Outage	50	≤100%	≤ 17

TABLE 2
EXPOSURE ASSUMPTIONS AND UNIT RISK FACTORS FOR DEEP
VANTAGE DATA CENTER
QUINCY, WASHINGTON

Receptor Type	Annual Exposure	Exposure Duration	DEEP Cancer Unit Risk Factor (risk per million, per annual µg/m³ DEEP)
Unoccupied Land	2 hours/day 250 days/year	30 years	7.3-per-million cancer risk per µg/m³ DEEP
Residences	24 hours/day 365 days/year	70 years	300-per-million cancer risk per µg/m³ DEEP
Schools (College Students)	40 hours/week 40 weeks/year	4 years	3.1-per million risk per µg/m³ DEEP
Schools (High School Students)	40 hours/week 40 weeks/year	4 years	3.1-per-million risk per µg/m³ DEEP
Schools (Elementary School Students)	40 hours/week 40 weeks/year	7 years	5.5-per-million risk per µg/m³ DEEP
Schools (All Teachers)	40 hours/week 40 weeks/year	40 years	31-per-million risk per µg/m³ DEEP
Churches	2 hours/week 52 weeks/year	40 years	2-per-million risk per µg/m³ DEEP
Businesses (including employees of hospitals)	8 hours/day 250 days/year	40 years	38-per-million risk per µg/m³ DEEP

µg/m³ = Micrograms per cubic meter
DEEP = Diesel engine exhaust particulate matter