DEPARTMENT OF
ECOLOGY
State of Washington

Second Tier Review Recommendation Document for

PACCAR Technical Center
Skagit County, Washington

August 1, 2013

1. Summary and Purpose

PACCAR Technical Center (PACCAR) proposes to construct a third engine test laboratory at their facility near Mt. Vernon, WA (Figures 1 and 2). The test laboratory will contain three engine test cells and one power train test cell. The proposed test cells will be used to test the performance of various diesel-fueled engines up to 620 bhp.

Estimated diesel engine exhaust particulate (DEEP) emissions from this project occur at a rate that causes ambient impacts in excess of a regulatory trigger level called an acceptable source impact level (ASIL). PACCAR 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 PACCAR's increased emissions of DEEP.

PACCAR 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 PACCAR project-related DEEP emissions. The highest increased risk, approximately **5.1 in one million**, occurs at residence approximately 500 meters to the southwest of the proposed emission source and about 100 meters from the facility's closest property boundary. Chronic non-cancer hazards attributable to PACCAR's increased DEEP emissions were much lower than unity (one) indicating that the proposed project's emissions 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 PACCAR's proposed emissions to an estimated background DEEP concentration. The highest cumulative cancer risk posed by DEEP to residents living in the vicinity of PACCAR was approximately **46 in one million**. Chronic non-cancer hazard quotients (HQs) 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 PACCAR are generally much lower than those estimated in urban areas of Washington.

Because the increase in cancer risk attributable to the new engine test laboratory 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 PACCAR Technical 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 Associates regarding the HIA protocol (item (c)) on May 24, 2013. Ecology found that the HIA protocol demonstrated an appropriate methodology for estimating potential health impacts from PACCAR's proposed project. The HIA (item (e)) was received by Ecology on June 11, 2013. Ecology's air dispersion modeler found the refined modeling conducted by Landau Associates to be acceptable (item (d)).[1]

Acting as the "permitting authority" for this project, Northwest Clean Air Agency satisfied items (a) above on July 23, 2013, and Ecology's second tier review engineer verified item (b).[2] The applicant has satisfied all 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 toxic air pollutants (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

One purpose of PACCAR's engine testing laboratory is to demonstrate compliance with the United States Environmental Protection Agency (EPA) and European engine emission standards. These standards generally require the use of control devices to minimize emissions. Controls in addition to those needed to meet emission standards would defeat the purpose of conducting these tests. Thus, Ecology's second tier review engineer determined that PACCAR's proposed tBACT is reasonable.

[1] Dhammapala, Ranil, "PACCAR_Modeling Review Checklist.docx" Checklist submitted to Gary Palcisko, June 17, 2013.
[2] Marc Crooks, "RE: PACCAR Technical Center - Health Impact Assessment," e-mail message, addressed to Gary Palcisko, July 3, 2013.

3. Health Impact Assessment 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 (naphthalene, benzene, and 1-3'Butadiene) because they chose to quantify the additional risk posed by these chemicals to derive a conservative risk estimate. Although not required, Landau also evaluated other carcinogenic TAPs (naphthalene, benzene, and 1-3'Butadiene, formaldehyde, acetaldehyde, and several carcinogenic polycyclic aromatic hydrocarbons) emitted by PACCAR's proposed project and quantified their contribution to overall cancer risk.

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 lungs when inhaled. Mounting evidence indicates that inhaling fine particles can cause numerous adverse health effects.

Studies of humans and animals specifically exposed to DEEP show that diesel particles can cause both acute and chronic health effects including cancer. Ecology has summarized these health effects in a document titled "Concerns about Adverse Health Effects of Diesel Engine Emissions" (Ecology, 2008a). Ecology also ranked DEEP as the highest priority TAP because widespread exposure to DEEP is a significant public health concern (Ecology, 2008b).

3.1.1. DEEP Toxicological Reference Values

The EPA and California Office of Environmental Health Hazard Assessment (OEHHA) developed toxicological values for DEEP evaluated in this project (EPA, 2002; EPA, 2003; CalEPA, 1998). These toxicological 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 non-cancer health effects are not expected, and a metric by which to quantify increased risk from exposure to a carcinogen. Table 1 shows DEEP non-cancer and cancer toxicity values.

The 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.
NAAQS and other regulatory toxicological values for short- and intermediate-term exposure to

particulate matter has been promulgated, but values specifically for DEEP exposure at these exposure 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 in which increased rates of lung cancer were observed among humans occupationally exposed to DEEP. URFs are expressed as the upper-bound probability of developing cancer, assuming continuous lifetime exposure to a substance at a concentration of 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 $(\mu g/m^3)^{-1}$ meaning that a lifetime of exposure to 1 $\mu g/m^3$ of DEEP results in an increased individual lifetime cancer risk 0.03 percent. On a population basis, if one million people were exposed to DEEP at a level of 1 $\mu g/m^3$, then there could be 300 additional cancers resulting from that exposure compared to an unexposed population.

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

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

a EPA determined that DEEP is probably carcinogenic to humans, but has not developed a URF.

3.2. Ambient Air Quality Analysis

Landau Associates modeled emissions of DEEP and other TAPs from PACCAR's proposed test laboratory. Ecology reviewed the AERMOD modeling input and output files and found them to represent an adequate ambient air quality analysis. Figure 3 shows the estimated project-related annual average concentration contours near the PACCAR facility.

3.3. Land Use – Exposed Receptors

PACCAR's facility is located on a 240-acre parcel in an area of limited development. The surrounding land use is mostly rural including undeveloped land, low density residential, agricultural, and industrial uses. Skagit County Regional Airport occupies the bulk of the land directly to the east of PACCAR. 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, two nearby residences, and three off-site commercial areas (Figure 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.[3] Ecology's review of the

[3] Landau Associates modeled cumulative emissions from existing test laboratories in addition to the proposed laboratory. They added these localized impacts to a regional estimate of background from EPA's National Scale Air Toxics Assessment (NATA).

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.

3.4. Non-Cancer Hazard

In order to evaluate the potential for non-cancer adverse health effects that may result from exposure to air pollutants, exposure concentrations at each receptor location are compared to relevant non-cancer toxicological values (i.e., RfC or REL). If a concentration exceeds the toxicological value, this indicates only the potential for adverse health effects. The magnitude of this potential can be inferred from the degree to which this value is exceeded. This comparison is known as a HQ and is given by the equation below:

$$\frac{\text{HQ = time weighted average concentration of pollutant in air (µg/m3)}}{\text{time interval specific RfC or REL (µg/m}^3\text{)}}$$

A HQ of one or less indicates that the exposure to a substance is not likely to result in adverse non-cancer health effects. As the HQ increases above one, the probability of human health effects increases by an undefined amount. However, it should be noted that a HQ above one is not necessarily indicative of health impacts due to the application of uncertainty factors in deriving toxicological reference values.

3.4.1. Chronic Hazard Quotient

Landau evaluated chronic hazards associated with exposure to DEEP emitted from PACCAR's proposed test laboratory. Chronic HQs were calculated for each receptor's exposure to project-related DEEP emissions as well as local and regional background DEEP concentrations. HQs were generally more than an order of magnitude lower than unity for all receptors' exposure to DEEP. This indicates that receptors near PACCAR are not likely to experience adverse non-cancer effects from chronic exposure to DEEP emitted from the PACCAR's proposed project and other local and regional sources.

3.5. Increased Cancer Risk

Cancer risk is estimated by determining the concentration of DEEP at each receptor point and multiplying it by its respective URF. Because URFs are based on a continuous exposure over a 70-year lifetime, exposure duration and exposure frequency are important considerations.

Table 2, adapted from HIA Table 4-10 (Landau Associates, 2013), shows the estimated PACCAR 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 5.1 per million and occurs at a southwest residence located about 500 meters from proposed emission sources. Residents living at a home to the northwest of PACCAR may be exposed to DEEP at a level that increases their lifetime cancer risk by 3.3 in one million. Increased cancer

risks to potential bystanders exposed near the point of maximum impact (i.e., fence line receptor) may be about 0.3 per million, and risks to nearby commercial receptors are similarly low (ranging from 0.2 to 0.4 per million).

The cumulative risk of all known sources of DEEP emissions in the vicinity of PACCAR is highest for two nearby residences. The cumulative DEEP risk at these two homes is about 46 per million at the MIRR residence and 44 per million for the residence to the northwest of PACCAR.[4]

Table 2. 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]	**R-1 SW House (MIRR)[b]**	**R-2 NW House[b]**	**C-1 Tank Farm[c]**	**C-2 Airport Building[c]**	**C-3 Agricultural Buildings[c]**
Proposed 4 ETL III Test Cells	0.32	**5.1**	3.3	0.38	0.31	0.22
Existing 8 ETL I and II Test Cells	0.45	3.6	3.6	0.45	0.3	0.16
NATA Regional Background	0.91	37	37	4.7	4.7	4.7
Cumulative (Post-project)	**1.7**	**46**	**44**	**5.5**	**5.3**	**5.1**

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 0.1 per million at the MIRR.

[4] 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.

4. Conclusions and Recommendation

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

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 PACCAR 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 PACCAR's TAP emissions. PACCAR's increased DEEP emissions could result in an increased cancer risk of up to five 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.

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

California Environmental Protection Agency (CalEPA): Air Resources Board and Office of Environmental Health Hazard Assessment, "Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant," 1998, <http://www.arb.ca.gov/toxics/dieseltac/staffrpt.pdf>.

Landau Associates, "Tier 2 Health Impact Assessment, Engine Test Laboratory III," PACCAR Technical Center, Skagit County, Washington, June 11, 2013.

United States Environmental Protection Agency (EPA), "Health Assessment Document for Diesel Exhaust," EPA/600/8-90/057F, <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060>, May 2002.

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Washington State Department of Ecology Air Quality Program (Ecology), "Concerns about Adverse Health Effects of Diesel Engine Emissions," 2008a, Publication No. 08-02-032, <https://fortress.wa.gov/ecy/publications/publications/0802032.pdf>, December 3, 2008.

-----, "Washington State Toxic Air Pollutants Priorities Study," 2008b, Publication No. 08-02-030, <https://fortress.wa.gov/ecy/publications/publications/0802030.pdf>, November 12, 2008.

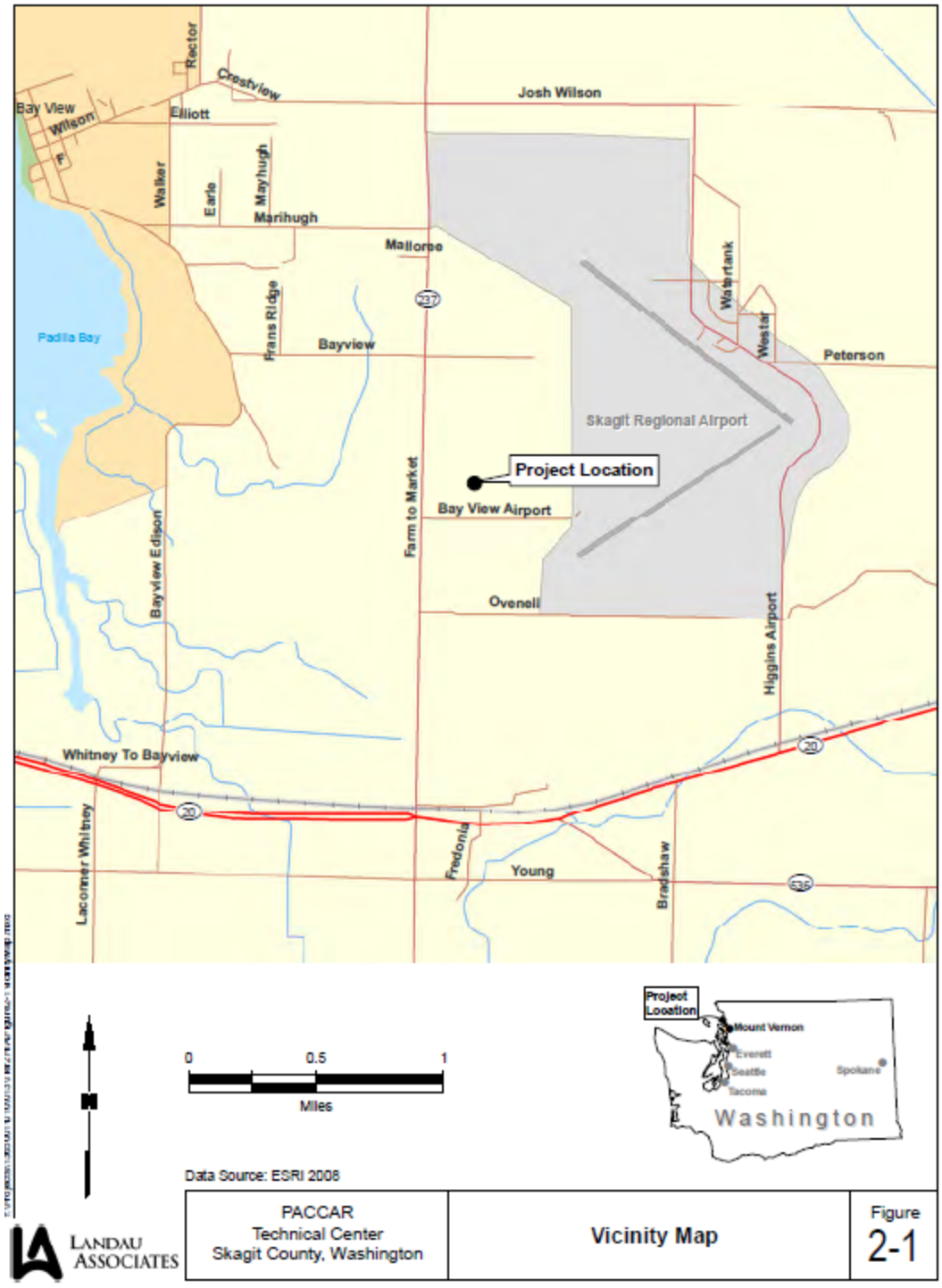

Figure1. PACCAR project location (image copied from Landau Associates, 2013)

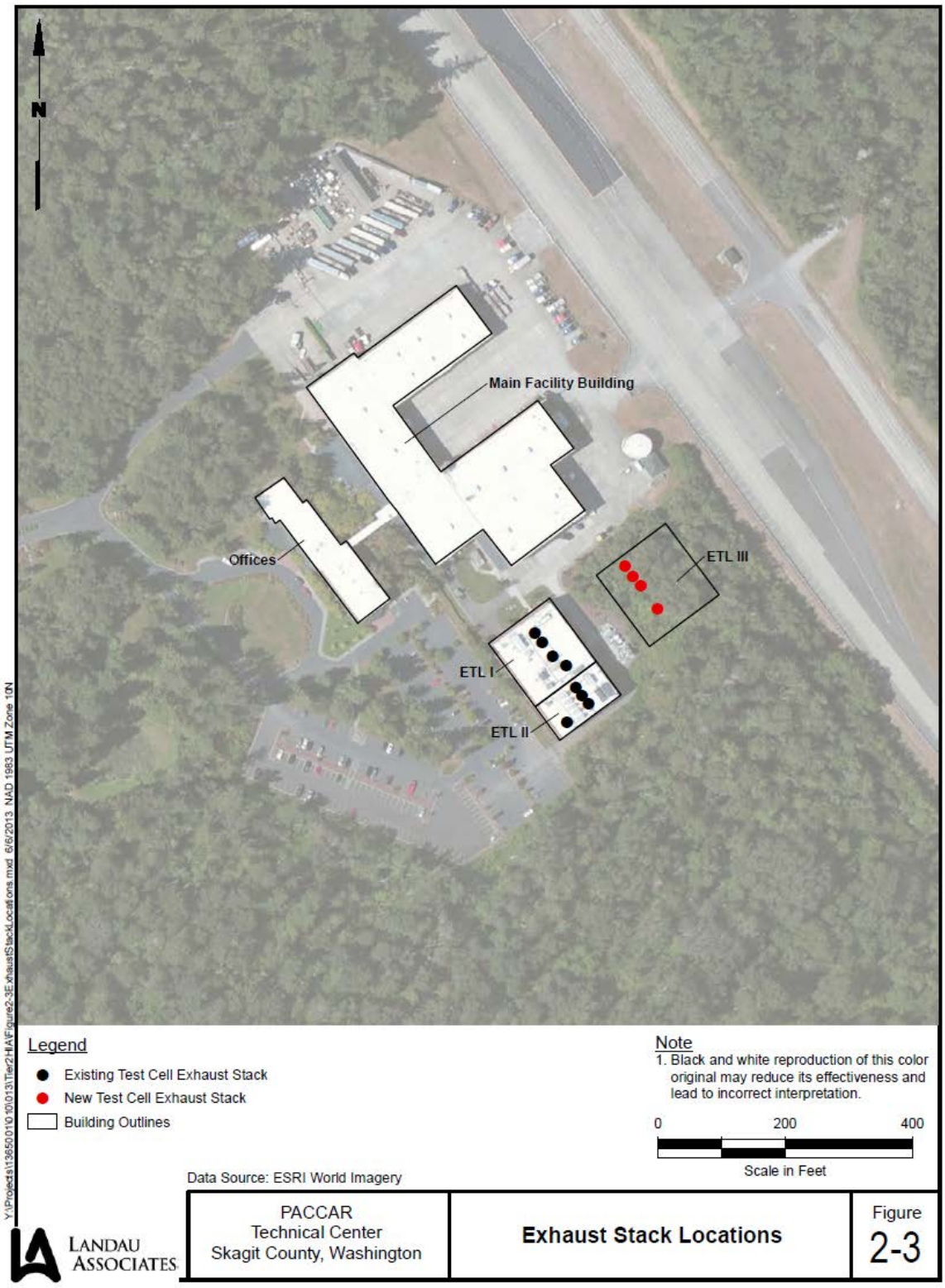

Figure 2. PACCAR facility layout displaying existing and proposed stack locations (image copied from Landau Associates, 2013)

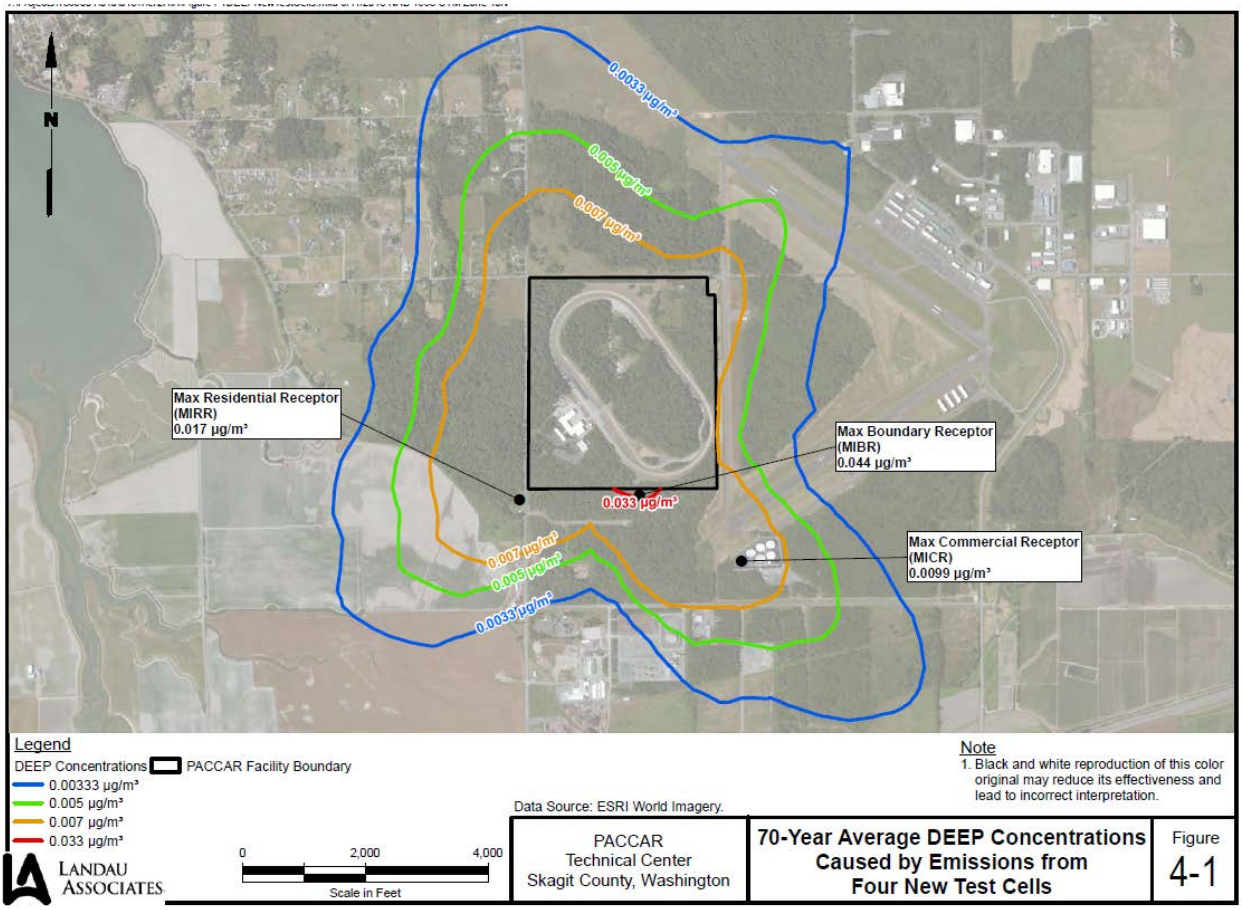

Figure 3. Estimated increased DEEP concentrations resulting from PACCAR's proposed test laboratory (image copied from Landau Associates, 2013)

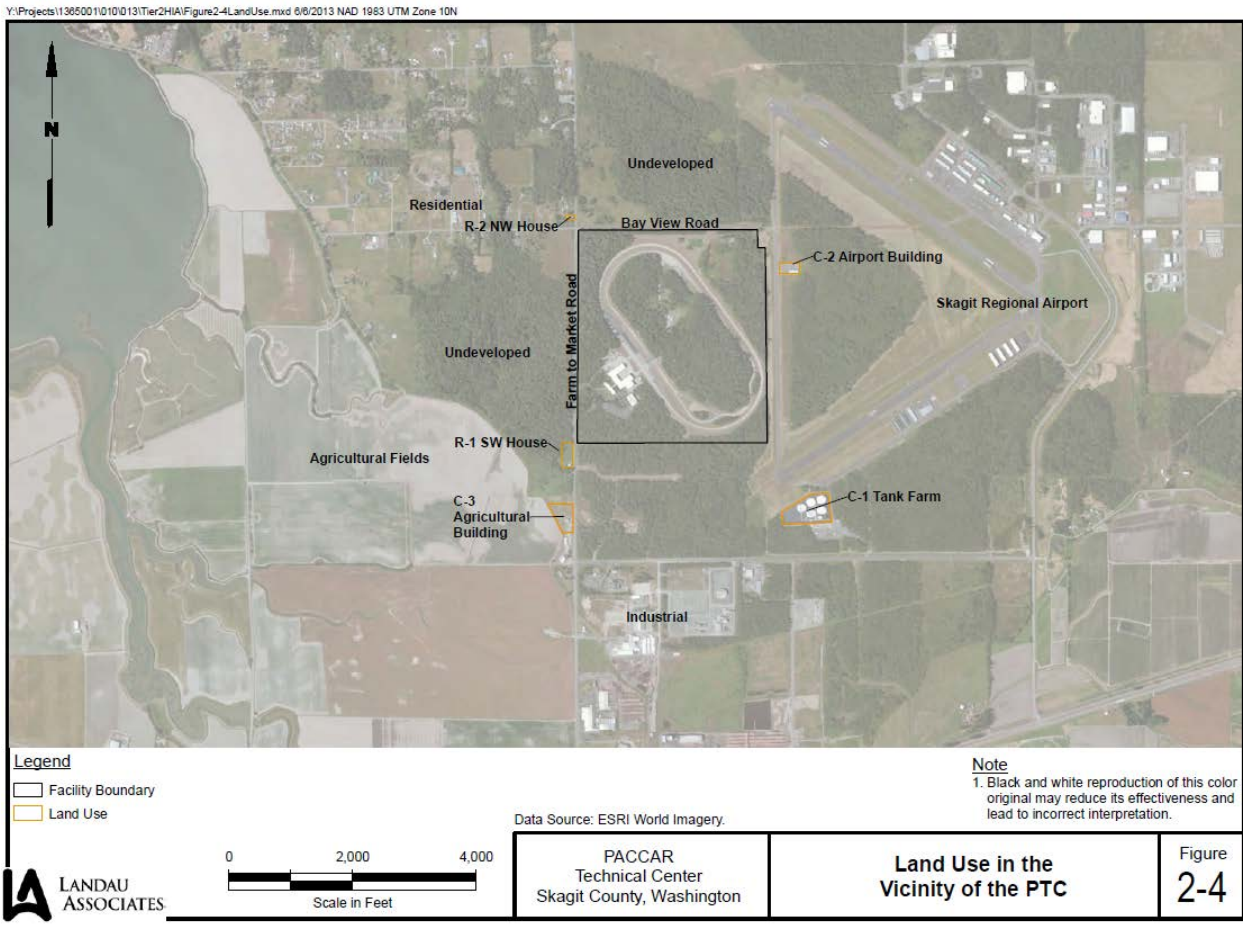

Figure 4. Land use and receptor locations (image copied from Landau Associates, 2013)