



DEPARTMENT OF  
**ECOLOGY**  
State of Washington

## **Second Tier Review Recommendation Document for**

**Vaupell Industrial Plastics  
Everett, Washington**

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**January 16, 2014**

## 1. Summary and Purpose

Vaupell Industrial Plastics (Vaupell) operates a facility near Paine Field in Snohomish County, Washington (Figure 1). A Notice of Construction (NOC) Order of Approval (i.e., air permit) from Puget Sound Clean Air Agency (PSCAA) is required for Vaupell to apply paint to its products in four paint booths. These paints contain various solvents that are considered toxic air pollutants (TAPs) in Chapter 173-460 WAC. Vaupell estimated emissions of TAPs based on application rates required to meet projected customer demand. They determined that ethylbenzene emissions will occur at a rate that causes ambient impacts in excess of a regulatory trigger level called an acceptable source impact level (ASIL). Vaupell 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 Vaupell's emissions of ethylbenzene.

Vaupell hired ENVIRON International Corporation (ENVIRON) to prepare a HIA (ENVIRON, 2013). In this assessment, ENVIRON estimated long-term cancer risk and acute and chronic noncancer hazards to individuals potentially exposed to Vaupell's project-related emissions.

The highest increased risk, approximately **0.9 in one million**, occurs at the maximally impacted commercial receptor location near the Vaupell building. This risk takes into account that a worker's exposure occurs only during working hours, or about 40 hours per week on average. The highest increased risk to a resident is about **0.2 in one million** at a home about 675 meters south of Vaupell. Chronic and acute noncancer hazards attributable to Vaupell's increased ethylbenzene emissions were lower than unity (one) indicating that the proposed project's emissions by themselves were not likely to result in adverse noncancer health effects.

ENVIRON also assessed the cumulative health risk by adding estimated ethylbenzene concentrations attributable to Vaupell's emissions to an estimated background concentration. The highest cumulative cancer risk posed by ethylbenzene to residents living in the vicinity of Vaupell was approximately **one in one million**. Chronic noncancer hazard quotients (HQs) were much lower than unity indicating that long-term exposure to ethylbenzene in the area is not likely to result in noncancer health effects.

Because the increase in cancer risk attributable to Vaupell's ethylbenzene emissions alone is less than the maximum risk allowed by a second tier review, which is 10 in one million, and the noncancer hazard is acceptable, the project could be approvable under WAC 173-460-090.

This summary document presents Ecology's review of the proposed Vaupell 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 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 accepted ENVIRON's HIA protocol (item (c)) on November 4, 2013. Ecology found that the HIA protocol contained sufficient information and requested a final HIA. The final HIA (item (e)) was received by Ecology on November 27, 2013. Ecology's air dispersion modeler found the refined modeling conducted by ENVIRON to be acceptable (item (d)).<sup>1</sup>

Acting as the "permitting authority" for this project, PSCAA satisfied items (a) above on October 17, 2013,<sup>2</sup> and Ecology's second tier review engineer verified item (b).<sup>3</sup> 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 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.

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<sup>1</sup> Clint Bowman, "Vaupell\_20131223\_Review\_Checklist\_cb.docx Checklist," submitted to Gary Palcisko, January 9, 2014.

<sup>2</sup> Puget Sound Clean Air Agency Notice of Construction Worksheet, Vaupell Industrial Plastics, received October 17, 2013.

<sup>3</sup> Marc Crooks, "Vaupell Health Impact Assessment," e-mail message, addressed to Gary Palcisko, December 20, 2013.

### **2.2.1. tBACT Determination**

Ecology's second tier review engineer concurred with PSCAA's determination that Vaupell's proposed tBACT will be met through a combination of best management practices and operational limits including:

- Use of topcoat and primer with limited hazardous air pollutant (HAP) content.
- Use of spray equipment with high equivalent transfer efficiency (greater than or equal to 65 percent), such as high volume low pressure (HVLP) spray guns, etc. The overspray shall be controlled by a filter system that has a control efficiency of at least 98 percent.

### **3. HIA Review**

As described above, the applicant is responsible for preparing the HIA under WAC 173-460-090. Ecology's project team consisting of an engineer, a toxicologist, and a modeler review the HIA to determine if the methods and assumptions are appropriate for assessing and quantifying the surrounding community's risk from a new project.

The HIA focused on health risks attributable to ethylbenzene exposure as this was the only TAP with a modeled concentration in ambient air that exceeded an ASIL.<sup>4</sup>

#### **3.1. Ethylbenzene Health Effects Summary**

Short-term (acute) inhalation exposure to ethylbenzene at high concentrations may cause eye and respiratory irritation and neurological effects (dizziness). In animals, inhalation of ethylbenzene has been shown to cause effects on the kidneys, blood, and liver, as well as developmental toxicity. Studies of animals and humans exposed to ethylbenzene suggest that the nervous system, and particularly the auditory system, is sensitive to the toxic effects of ethylbenzene (ATSDR, 2010).

No association has been found between the occurrence of cancer in humans and occupational exposure to ethylbenzene. A National Toxicology Program (NTP) study, however, concluded that ethylbenzene showed evidence of carcinogenic activity in animals based on studies of rats and mice exposed to ethylbenzene. Rats (both sexes) had increased incidences of renal tubule (a distinct portion of the kidney) tumors and male rats had increased incidence of testicular tumors. Male mice had increased incidences of alveolar/bronchiolar tumors, and female mice had increased incidences of liver tumors (NTP, 1999). On the basis of the NTP study, the International Agency for Research on Cancer (IARC, 2000) classified ethylbenzene as a Group 2B carcinogen (possibly carcinogenic to humans).

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<sup>4</sup> ENVIRON reported that other TAPs are emitted, but none are emitted at rates in excess of respective small quantity emission rates (SQERs).

### 3.1.1. Ethylbenzene Toxicological Values

Several agencies developed toxicological values for assessing noncancer hazards and cancer risk from exposure to ethylbenzene (ATSDR, 2010; EPA, 1991; CalEPA, 2000). These values were derived largely from studies of animals that were exposed to a known amount (concentration) of ethylbenzene.<sup>5</sup> Table 1 shows ethylbenzene toxicity values considered by Ecology for quantifying potential health hazards.

To derive noncancer reference values for ethylbenzene, the agencies applied various uncertainty factors to toxic effect levels that were observed in animal studies. The resulting values (i.e., reference concentration [RfC], reference exposure level [REL], or minimal risk level [MRL]) are concentrations in air at or below which noncancer health effects are not expected from exposure to ethylbenzene.

The lowest toxicity value for assessing chronic noncancer exposures to ethylbenzene is the Agency for Toxic Substances and Disease Registry (ATSDR) MRL of 260  $\mu\text{g}/\text{m}^3$ . This value was based on a study of rats that showed increased kidney effects (i.e., nephropathy) at high exposure levels. Long-term exposure below the chronic MRL is not likely to result in noncancer health effects.

For sub-chronic exposures, ATSDR developed intermediate (8,700  $\mu\text{g}/\text{m}^3$ ) and acute (22,000  $\mu\text{g}/\text{m}^3$ ) MRLs based on toxicity in rats/mice exposed to ethylbenzene. ATSDR's intermediate MRL is considered protective of exposures that occur over the course of weeks to months (15–364 days), and the acute MRL is typically considered protective of exposure occurring over a duration of 1–15 days.

For assessing cancer risk from exposure to most potentially carcinogenic chemicals, there is theoretically no level of exposure for such a chemical that does not pose a small, but finite, probability of generating a carcinogenic response. To develop values for assessing cancer risk to ethylbenzene, agencies often extrapolate from high exposure concentrations that were used in animal experiments to the origin (where there are zero doses and zero response). The slope of the line is used to estimate risk at exposure levels that are much lower than those used in the animal experiments. This resulting slope is used to derive a unit risk factor for assessing cancer risk from exposure to very low levels that might be experienced in the environment.

California Environmental Protection Agency's (CalEPA) Office of Environmental Health Hazard Assessment (OEHHA) developed a slope factor, or unit risk factor, for ethylbenzene based on renal tubule carcinoma observed in exposed rats (CalEPA, 2007). The URF of  $2.5 \times 10^{-6}$  per  $\mu\text{g}/\text{m}^3$  means that an additional 2.5 cancers could result in a population of 1,000,000 people exposed to 1  $\mu\text{g}/\text{m}^3$  ethylbenzene over the duration of a lifetime.

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<sup>5</sup> Studies of humans occupationally exposed to ethylbenzene are available, but largely confounded by the presence of other toxic pollutants.

<b>Table 1. Toxicological Values Used to Assess and Quantify Noncancer Hazard from Ethylbenzene Exposure</b>			
<b>Agency</b>	<b>Chronic</b>	<b>Sub-chronic</b>	<b>Cancer</b>
U.S. Environmental Protection Agency	RfC = 1,000 µg/m <sup>3</sup> Developmental Toxicity	N/A	N/A <sup>a</sup>
California EPA–Office of Environmental Health Hazard Assessment	REL = 2,000 µg/m <sup>3</sup> Alimentary system (liver); kidney; endocrine system; development	N/A	2.5 x 10 <sup>-6</sup> per µg/m <sup>3</sup> (renal tubule carcinoma)
Agency for Toxic Substances and Disease Registry	MRL = 260 µg/m <sup>3</sup> Nephropathy (damage to kidney)	Intermediate MRL~ 8,700 µg/m <sup>3</sup> Acute MRL ~ 22,000 µg/m <sup>3</sup>  Ototoxicity	N/A
a – EPA classified ethylbenzene as Group D (not classifiable as to human carcinogenicity). EPA’s last carcinogenicity assessment of ethylbenzene occurred in 1991.			

### 3.2. Ambient Air Quality Analysis

ENVIRON modeled emissions of ethylbenzene from two of their four stacks. Only two stacks were modeled because Vaupell will apply ethylbenzene containing paints in only two of the four paint booths. ENVIRON presented maps showing estimated concentrations attributable to Vaupell’s ethylbenzene emissions (Figure 2). Ecology reviewed the modeling files and found them to represent an adequate ambient air quality analysis.

### 3.3. Land Use – Exposed Receptors

Vaupell operates in a multi-tenant building shared with other businesses. The facility is located in an area that is zoned light industrial. Paine Field Airport dominates the adjacent area extending approximately 1 kilometer (km) to the west and 3 km to the north. The nearest residence, situated in an area zoned as Business Park, is located approximately 0.4 km south-southeast of the facility.

Other residential areas lie approximately 0.6 km to the east, 0.8 km to the southeast, and 0.8 km to the south. ENVIRON also identified numerous land uses in the area that could house receptors sensitive to air pollution, but these land uses were located well outside the area impacted in excess of the ASIL.

To determine if the impacts of Vaupell’s emissions are acceptable, Ecology requires that sources estimate exposures and health risks for those that are most likely to receive the highest exposures. ENVIRON identified maximally impacted commercial and residential receptors for evaluating acute and chronic exposure to ethylbenzene emitted from their facility (Figure 3).

#### 4. Noncancer Hazard

In order to evaluate the potential for noncancer adverse health effects that may result from exposure to air pollutants, exposure concentrations at each receptor location are compared to relevant noncancer toxicological values (i.e., RfC, REL, and MRL). 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 hazard quotient (HQ) and is given by the equation below:

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

A HQ of one or less indicates that the exposure to a substance is not likely to result in adverse noncancer 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.

##### 4.1. HQs

ENVIRON evaluated chronic and acute hazards associated with exposure to ethylbenzene emitted from the paint booths. Table 2 shows the chronic and acute HQs for the maximally impacted residential receptor (MIRR), maximally impacted commercial receptor (MICR), and other receptor's exposure to ethylbenzene near Vaupell. The HQs are generally three orders of magnitude lower than unity for all receptors' acute and chronic exposure to ethylbenzene. These HQs include exposure to existing background levels of ethylbenzene in addition to that emitted from Vaupell. This indicates adverse noncancer effects are not likely to result from chronic exposure to ethylbenzene emitted from Vaupell.

Table 2. Chronic and Acute HQs at Maximally Impacted Locations Near Vaupell's Proposed Project						
Attributable To:	Chronic (annual average)			Acute (24 hr)		
	Maximum (MICR) <sup>a</sup>	Commercial Facility West of Vaupell <sup>b</sup>	SE House (MIRR) <sup>c</sup>	Maximum (MICR) <sup>a</sup>	Commercial Facility West of Vaupell <sup>b</sup>	SE House (MIRR) <sup>c</sup>
Vaupell ethylbenzene concentration ( $\mu\text{g}/\text{m}^3$ )	2.9	0.14	0.088	8.0	1.7	0.64
National Air Toxics Assessment (NATA) regional background ethylbenzene concentration ( $\mu\text{g}/\text{m}^3$ ) <sup>d</sup>	0.253			0.759		
Cumulative (post-project) ethylbenzene concentration ( $\mu\text{g}/\text{m}^3$ )	3.2	0.39	0.34	8.8	2.5	1.4
ATSDR MRL ( $\mu\text{g}/\text{m}^3$ )	260			22,000		
HQ	0.01	0.001	0.001	<0.001	<0.001	<0.001
<p>a – Vaupell is part of a multi-tenant building. The maximum annual concentration was used to assess long-term risk to neighboring commercial.</p> <p>b – Facility is not part of multi-tenant building.</p> <p>c – Residential scenarios assume continuous lifetime exposure.</p> <p>d – The background annual average is based on the level estimated by EPA in the 2005 NATA for the census tract in which Vaupell is located. The 24-hr concentration is the annual average scaled upward by a factor of three to approximate an upper percentile level of a 24-hr ethylbenzene exposure that could occur.</p> <p>MIRR – Scenario assumes continuous exposure to ethylbenzene for an entire lifetime.</p> <p>MICR – Scenario assumes intermittent exposure 8 hr/day, 250 days/year for 40 years.</p>						

## 5. Increased Cancer Risk

Table 3, adapted from the HIA (ENVIRON, 2013), shows the estimated Vaupell project-specific and cumulative increased cancer risk at each of the receptors evaluated. The highest increase in risk attributable to project-related emissions of ethylbenzene is 0.9 per million for workers at the

multi-tenant commercial property on which Vaupell is located.<sup>6</sup> For residential exposure scenarios, the MIRR may have increased risks of about 0.2 per million. Workers at a commercial area west of Vaupell may have increased risks of less than 0.1 per million.

Using background concentrations estimated in NATA, the cumulative risk of ethylbenzene exposure in the vicinity of Vaupell is highest for the commercial workers at the multi-tenant building in which Vaupell operates. The cumulative ethylbenzene risk at this location is about one per million.<sup>7</sup>

<b>Table 3. Estimated Increased Cancer Risk for Residential, Occupations, and Boundary Scenarios</b>			
<b>Attributable To:</b>	<b>Risk Per Million from Ethylbenzene Exposure at Various Receptor Locations</b>		
	<b>Maximum (MICR)<sup>a</sup></b>	<b>Commercial Facility West of Vaupell<sup>b</sup></b>	<b>SE House (MIRR)<sup>c</sup></b>
Vaupell	0.9	<0.1	0.2
NATA Regional Background	0.1	0.1	0.7
Cumulative (post-project)	1.0	0.1	0.9
a – Vaupell is part of a multi-tenant building. The maximum annual concentration was used to assess long-term risk to neighboring commercial workers. b – Facility is not part of multi-tenant building. c – Residential scenarios assume continuous lifetime exposure. MIRR – Scenario assumes continuous exposure to ethylbenzene for an entire lifetime. MICR – Scenario assumes intermittent exposure 8 hr/day, 250 days/year for 40 years.			

## 6. 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 Vaupell’s emissions. The assumptions used in the face of uncertainty may tend to over- or underestimate the health risks estimated in the HIA. ENVIRON identified several aspects of uncertainty related to the HIA.

<sup>6</sup> ENVIRON conservatively estimated potential increased risk of about six in one million from continuous exposure at the location of maximum impact (i.e., directly adjacent to the multi-tenant building in which Vaupell is located). Ecology considered this scenario to be extremely unlikely, so assumed a commercial receptor could be exposed at this location resulting in an increased risk of about 0.9 in one million.

<sup>7</sup> 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.

## **6.1. Emissions**

ENVIRON relied on Material Safety Datasheets (MSDSs) to determine the amount of ethylbenzene present in Vaupell's paint formulations. ENVIRON noted that they cannot be certain that these coatings contain the exact amount of ethylbenzene noted on the MSDSs, but given that "the coatings in question are carefully formulated by the manufacturers to meet performance standards, it is likely that the manufacturers would have detailed information on the contents and specification of the coatings, and be able to accurately transfer that information to the MSDS."

## **6.2. 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. With regard to the ambient impact analysis, Ecology's air dispersion modeler determined that ENVIRON appropriately modeled emissions of ethylbenzene from Vaupell.

## **6.3. Exposure Assumptions**

It is difficult to characterize the amount of time that people can be exposed to Vaupell's ethylbenzene emissions. For simplicity and to ensure protection of public health, Ecology assumes a residential receptor is at one location for 24 hours per day, 365 days per year for 70 years. Ecology also assumes that commercial receptors can be exposed 8 hours per day, 250 days per year, for 40 years. These assumptions tend to overestimate potential exposure to Vaupell related emissions of ethylbenzene.

## **6.4. 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., MRLs), 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 ethylbenzene exposure, the toxicity values used in the HIA were generally derived from experimental exposures on animals. The application of uncertainty factors to the toxic effect levels in these studies results in toxicity values that are probably protective of the majority of the population.

Because no associations between the occurrence of cancer in humans and exposure to ethylbenzene have been found, OEHHA relied solely on animal studies to derive a unit risk factor for assessing the increased risk of cancer from exposure to ethylbenzene. This process

involves some uncertainty, and in the case of ethylbenzene carcinogenicity, some criticism. For example, some have argued that the mode of action resulting in carcinogenicity animals exposed to ethylbenzene may not be relevant to humans. One author stated that because the increased incidence of kidney tumors in rats in the high-dose group was related to a chemical-induced exacerbation of chronic progressive nephropathy (CPN) and because CPN is an age-related disease of rodents without a counterpart in humans, the kidney results of the NTP study are not relevant to humans for risk assessment purposes (Hard, 2002). However, in an analysis of the association between CPN and renal tubule cell neoplasms in male F344 rats, Seely et al., concluded that the association between CPN and renal tubule cell neoplasms is marginal.

## **7. Conclusions and Recommendation**

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

- a) The TAP emissions estimates presented by ENVIRON represent a reasonable estimate of the project's future emissions.
- b) Emission controls for the new and modified emission units meet the tBACT requirement.
- c) The ambient impact of the emissions increase of each TAP that exceeds ASILs has been quantified using refined air dispersion modeling techniques as approved in the HIA protocol.
- d) The HIA submitted by ENVIRON on behalf of Vaupell 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 Vaupell's TAP emissions. Vaupell's increased ethylbenzene emissions could result in an increased cancer risk of up to 0.9 per million for workers employed at facilities located within the multi-tenant building in which Vaupell is located. Increased cancer risk to nearby residents is even lower at 0.2 per million. These risks fall 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 and acute noncancer hazards from exposure to project-related and cumulative ethylbenzene are very low. This means that long-term exposure to ethylbenzene in the area is not expected to result in adverse noncancer health effects.

The risk manager may recommend approval of the proposed project because project-related health risks are permissible under WAC 173-460-090.

## 8. References

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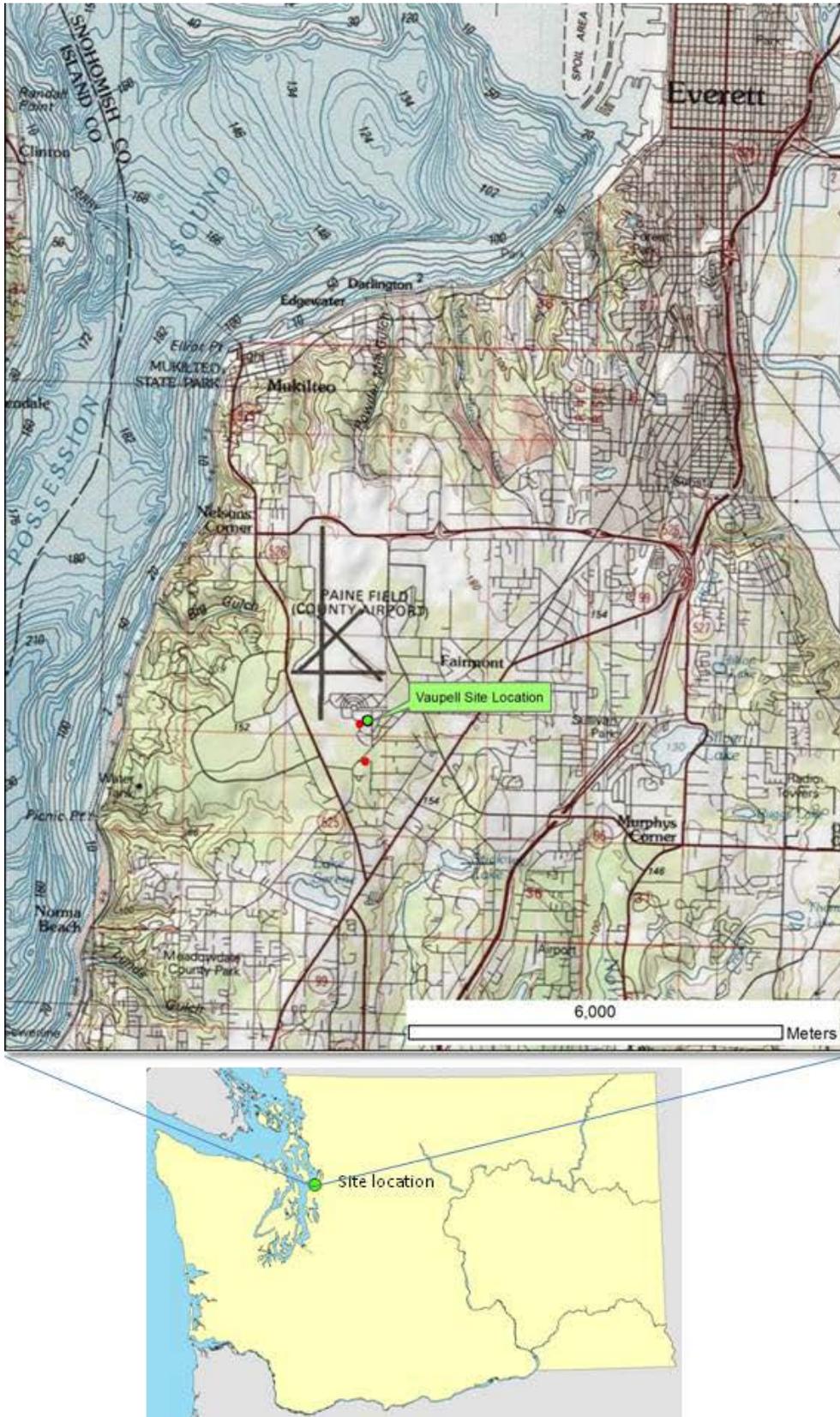
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<[http://ntp.niehs.nih.gov/ntp/htdocs/LT\\_rpts/tr466.pdf](http://ntp.niehs.nih.gov/ntp/htdocs/LT_rpts/tr466.pdf)>.

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United States Environmental Protection Agency (EPA), "Integrated Risk Information System Record for Ethylbenzene," last significant revision March 1, 1991,  
<<http://www.epa.gov/iris/subst/0051.htm>>.

**Figure 1.** The Vaupell Company, located in Snohomish County, WA.



**Figure 2.** Maximum Estimated Annual Average Ethylbenzene Concentrations ( $\mu\text{g}/\text{m}^3$ ) –Image adapted from HIA (ENVIRON, 2013): Red contour line indicates the concentration equal to the ASIL.

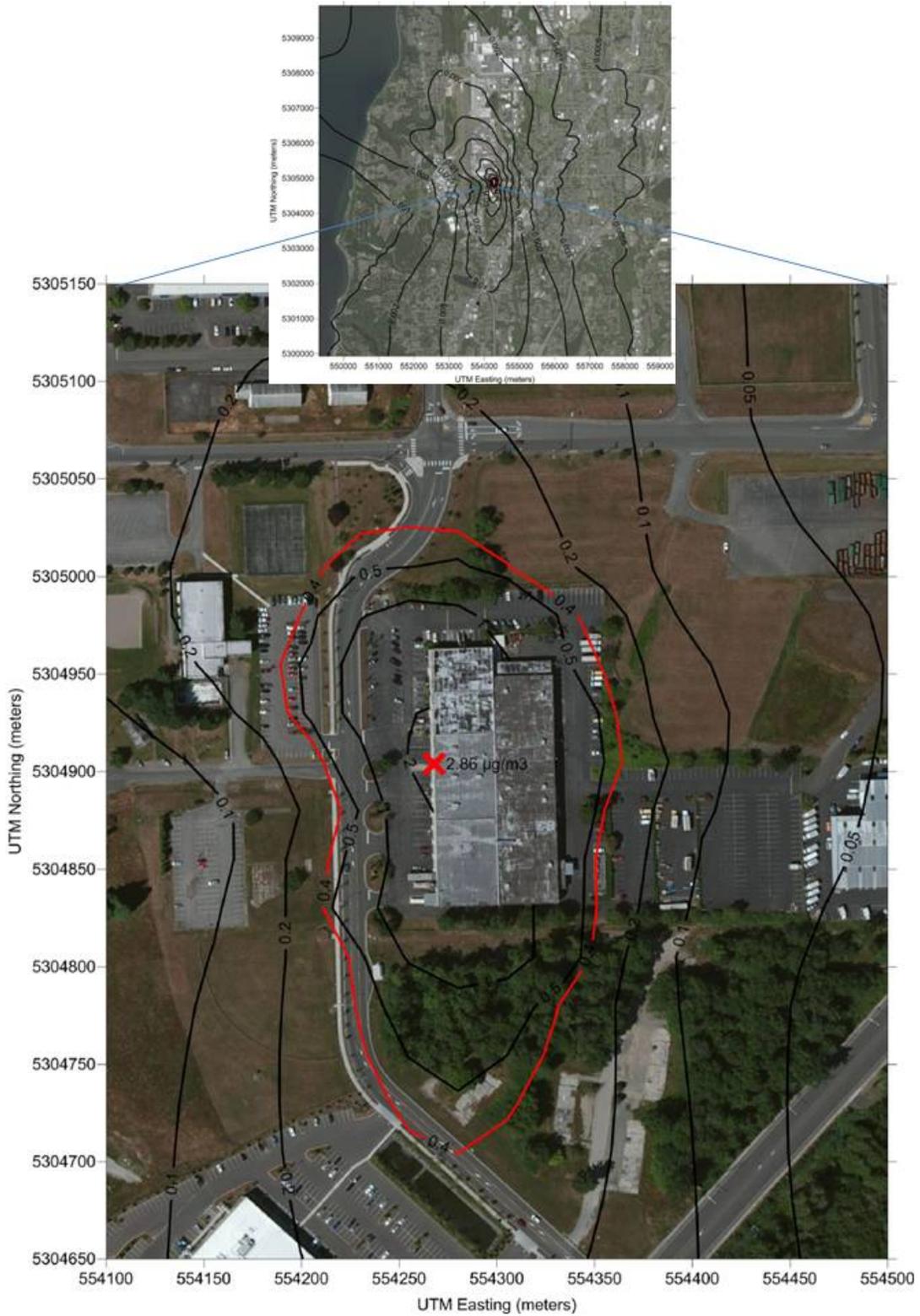


Figure 3. Receptor locations (red rectangles) evaluated in the HIA.

