

Air Quality Monitoring Program for Northwest Portland  
Final Report - by Robert Amundson, PhD  
March 2002 – August 2002

## **Monitoring Activity**

Five air quality-monitoring activities occurred during this reporting period. First, standard particulate fallout samplers collected dust at three or four locations during March, May and July-August. Second, glass-beaker dust collectors were placed at 12 locations throughout the neighborhood during May and July-August to determine sites with elevated levels of metals (“hot spots”). Third, neighbors sampled for volatile organic compound (VOC) concentrations associated with noxious odors with SUMMA Canisters. Fourth, during July and August, hourly concentrations of VOCs were characterized by two VOC analyzers located at sites with histories of strong industrial odors. Finally, neighbors continued to file complaint forms when they smelled noxious odors.

## **Rationale for Monitoring**

The current Northwest-neighborhood air-quality sampling program builds on information collected by neighbors since 1997 and adds to information generated by DEQ from previous hazardous air quality sampling programs. This air-quality sampling study has focused on three issues: What toxic compounds and their concentrations are in the air? What are their sources? Are the concentrations high enough to be of concern?

## **Methods and Materials**

**Metals contents of dust.** When the surface area of a dust collector is known, metals contents of the dust can be reported as amount of metal deposited per area (micrograms per square foot). This convention of metals contents in micrograms per square foot is used for ease of comparison with the Environmental Protection Agency’s (EPA) standard for lead in household dust (40 micrograms per square foot).

When the amount of dust can be determined per sample then a concentration of metal can be reported (e.g. mg of metal per kg of dust). Concentrations of metals in soils are used, in part, to identify EPA “super fund” sites. If metals concentrations of soils are high enough to pose a health risk, federal law mandates action to reduce the concentrations of the metals. To be clear, the higher the metal content per surface area or the higher the metal concentration in a sample of dust, the greater the risk of injury from metals such as lead and arsenic. Other metals may be essential to good health at low concentrations, but can cause problems when elevated above their health threshold (e.g. chromium, copper, manganese, and zinc). A particular concern of the neighbors is the presence of chromium. At this time, we are unable to determine how much of the very toxic chromium VI contributes to the elevated levels of chromium that are found in the neighborhood.

Standard particulate dust fall collectors (PFOs) were used to sample for metals in dust at three locations from 4 March to 8 April 2002. Dust was collected in 500-ml glass beakers at 12 houses and in 4 PFO collectors at four other locations from 2 to 30 May 2002 and from 1 July to 26 August 2002 to determine “hot spots” with elevated levels of metals.

**Volatile Organic Compounds.** On two occasions, EPA certified SUMMA canisters were used to characterize VOCs in odors coming from the ESCO Foundry. To better characterize the dynamics of air toxics concentrations, the project manager and the neighborhood advisory group chose to use a new technology developed by scientists at Portland State University to monitor for VOCs. The instrument takes an air sample every hour to detect concentrations of VOCs. Two of these new instruments were located where industrial odors had been frequently noted in the past. The instruments sampled air from about July 11 to August 27<sup>th</sup>. Both instruments were relocated once.

**Odor complaints.** Neighbors recorded odor complaints and Robert Davies and Caroline Skinner compiled them. These data are available on the NWDA website.

## **Results and Discussion**

### **Metals Contents of Dust in NW Portland**

#### **Metal Deposition 4 March to 8 April 2002.**

Four PFO buckets located at 3 sites collected dust from 4 March to 8 April 2002. Two PFO buckets were located at 2100 NW 24th to determine the variability in deposition of metals at a presumed metals hot spot. The amounts of metals collected in both PFO buckets at that location were remarkably similar (Table 1). Both PFO buckets located across the street from the ESCO Foundry had at least twice the amounts of aluminum, barium, boron, calcium, iron, magnesium, manganese, molybdenum and nickel than did the collector at the site with the next highest levels of these metals (2400 NW Thurman). In addition, copper deposition was about 30% higher at the site closest to the ESCO Foundry compared to that at the 2400 Thurman site. In contrast, lead was three times higher and zinc was 5 times higher at the 2400 NW Thurman site than at the site nearest the ESCO Foundry. Consistently, the lowest levels of metals were found in the 2500 block of NW Savier.

#### **Metal Deposition 2 – 30 May 2002.**

Four PFO buckets and 12 500 ml glass beakers collected dust at 16 sites in NW Portland from 2 to 30 May 2002. Four beakers were contaminated with excess amounts of tree seeds and one beaker was stolen. Thus, metals deposited at 11 sites are shown in Table 2.

In general, deposition of metals was lower in May 2002 than found during all other sample periods in this two year study. The highest levels of barium, cadmium, calcium, cobalt, copper, manganese, nickel and zinc were found at 2100 NW 24th located across

the street from the ESCO Foundry. The highest levels of lead and magnesium were found at the site on 2400 NW Thurman while the highest levels of aluminum, beryllium, chromium, iron, silver and vanadium were found in the 1600 block of NW 24<sup>th</sup>. All of these sites are within the metals “hot spot” previously reported in this study.

### **Metal Deposition 1 July – 25 August 2002.**

Four PFO buckets and 12 500 ml glass beakers collected dust at 16 sites in NW Portland from 1 July to 26 August 2002. Most dust collection periods have been approximately one month. Because of budget constraints the longer collection interval was used.

One beaker was contaminated with vegetation and not analyzed. A PFO bucket located at 2400 NW Thurman was tipped over and a small but unknown amount of water was spilled. Thus, some of the dust collected up to that date was also lost. This sample was still analyzed because the site has had some of the highest levels of metals to date. Because of the partial loss of the sample, actual metals deposition for this site are reported as “greater than” the analyzed value. Metals deposited at 15 sites are shown in Table 3.

This collection period covered almost a two-month interval, thus, values are high relative to values previously reported for 30-day collection periods. The highest levels of arsenic, barium, beryllium, calcium, copper, nickel, and strontium were found at 1800 NW 24<sup>th</sup> Place (Table 3). The highest levels of aluminum, antimony, chromium, iron, magnesium, manganese, molybdenum and zinc were found at 2100 NW 24<sup>th</sup> (Table 3).

Six sites had levels of lead greater than twice EPA’s standard for lead in household dust (40 micrograms per square foot). These six sites are located on a trajectory downwind of the ESCO Foundry (Figure 1). During the months of July and August wind is predominantly out of the NW. The distribution of the sites with the highest levels of lead (Figure 1) suggest that emissions from the ESCO Foundry are being channeled down NW 24<sup>th</sup>. Furthermore, in support of the idea that emissions from the ESCO Foundry are channeled down NW 24<sup>th</sup>, most metals analyzed had a similar pattern of deposition to that of lead. For example, the four highest levels of deposition of aluminum, antimony, barium, beryllium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, strontium, uranium, vanadium and zinc were found at sites located along NW 24<sup>th</sup> from NW Wilson to NW Quimby (Table 3).

### **Metal Deposition over 57 and 195-Day Intervals**

Dust was collected on a porch in the 2500 block of NW Savier from 12 February to 26 August and from 1 July to 26 August 2002. Neighbors have complained of dust accumulation on their porches for years. Neighbors assume that more dust falls on their porches in the summer because winds more consistently push emissions from the industrial area into the neighborhood during that time of year.

This assumption is supported by the data. A relatively higher proportion of metal deposition was found over a collection period of 57 days starting on 1 July and ending on

26 August compared to the amount of metals deposited over a 195 day period from 12 February to 26 August. The amount of metal deposition in July and August accounted for 39 percent of total deposition from February through August while this time period is only 29 percent of the total interval. The site sampled in the 2500 block of NW Savier borders the metals “hot spot” area.

### **Metals Composition of Dust**

Dust was collected from a porch in the 2500 block of NW Savier on 26 August 2002 and analyzed for concentrations of metals (Table 5). Copper, lead and zinc concentrations of 576, 249 and 941 mg/kg, respectively, were comparable to those values found in dust collected from the same porch in March 2001 (Table 5, originally reported in Interim Report #2). These concentrations of copper, lead and zinc are about ten times higher than average concentrations found in soil in Clark County, Washington (State of Washington Publication #94-115, Natural Background Soil Metals Concentrations in Washington State). Iron had the highest concentration of all metals analyzed in the March 2001 sample while calcium had the highest concentration in the August 2002 sample (Table 5). The high variability in metals concentrations in dust at this site indicates that dust deposited at this location is not from normal background dust. The site sampled in the 2500 block of NW Savier borders the metals “hot spot” area. One could expect even higher concentrations of metals such as copper, lead and zinc at locations within the metals “hot spot”.

### **Volatile Organic Compounds (VOCs)**

#### **Volatile Organic Compounds in Odor Events.**

On two occasions, SUMMA canisters were used to sample air during ESCO odor events. The samples were taken just south of NW Vaughn on NW 24<sup>th</sup> and NW 24<sup>th</sup> Place. The suite of VOCs differed slightly between the samples (Table 6). In both samples, two VOCs, acrolein and benzene, tested above EPA health benchmarks.

Acrolein is generated from incomplete combustion and is associated with emissions from automobiles and trucks as well as industrial processes and cigarette smoke. The acute (short-term) and chronic (long-term) effects of acrolein in humans consist mainly of effects on the lung, such as upper respiratory tract irritation and congestion and eye irritation. It also appears that acrolein may exacerbate asthma.

The acrolein concentrations of the two samples (5 and 2.3 micrograms per cubic meter) are 250 and 160 times EPA’s reference concentration (Rfc) for chronic exposure. The U.S. Environmental Protection Agency estimates that inhalation of the reference concentration or less, over a lifetime, would not likely result in the occurrence of chronic, noncancer effects. California has also set an acute reference exposure level (REL) for acrolein of 2.5 microgram per cubic meter. The higher concentration monitored in this study was twice that concentration.

Acrolein has been modeled by EPA scientists to occur routinely over the health benchmark of 0.02 micrograms per cubic meter in most cities. The major source of acrolein in urban air is from mobile sources. In these two samples taken in the presence of the typical “ESCO odor”, acrolein concentrations were 2.3 and 5 micrograms per cubic meter. It is hard to determine the proportion of acrolein monitored in these samples that was emitted from the ESCO Foundry or was present due to automobile exhaust. However, the evidence suggests that acrolein concentrations are significantly elevated over background concentrations during odor events because most VOC samples taken in the absence of strong odors have not had acrolein concentrations above the detection limit of 1 microgram per cubic meter.

Benzene concentrations in the two samples (2.6 and 1.9 micrograms per cubic meter) were 22 and 16 times over EPA’s cancer health benchmark of 0.12 micrograms per cubic meter. The cancer benchmark is a concentration above which one would expect an additional 1 cancer per 1 million people after a lifetime of exposure. Since both samples had benzene concentrations within the range of concentrations monitored in the absence of the ESCO odor, it is doubtful that emissions of benzene from ESCO can be detected above those of mobile source emissions during odor events.

#### **Hourly VOC concentrations monitored from 10 July to 27 August 2002.**

The new VOC analyzers sampled hourly from early July until late August 2002 except for brief periods of maintenance, calibration or relocation. Specifically, one analyzer sampled at 3200 NW Wilson from 10 July until 8 August and was moved to 2300 NW Lovejoy on 10 August and sampled until 30 August. The other analyzer sampled at 2100 NW 24<sup>th</sup> from 12 July to 13 August and then was moved to 2400 NW Thurman on 14 August and sampled until 27 August. A total of about 2000 air samples were analyzed at these four locations during July and August. Locations of the monitoring sites are shown in Figure 2.

Acrolein was routinely monitored at the 2100 NW 24<sup>th</sup> site across the street from the ESCO Foundry. The acrolein/acetone/ethanol readings measured at the 2100 NW 24<sup>th</sup> site is a mixture of three unresolved peaks. However, the instrument does give a reliable measure of acetone concentrations with a second column in the instrument. Therefore, the developers of the instrument estimate that the actual acrolein concentration is about 10% of the acrolein/acetone/ethanol peak shown in Figure 3. With that estimate, the concentrations illustrated in Figure 3 would vary between 0.1 to 2.3 micrograms per cubic meter.

Acrolein may also have been present at the 2400 NW Thurman site. However, acetone was found in higher concentrations at the 2400 NW Thurman site compared to the 2100 NW 24<sup>th</sup> site and thus made detection of any acrolein concentrations at that site impossible.

Benzene concentrations varied between sites and, as expected, averaged well above the cancer benchmark of 0.12 micrograms per cubic meter (Table 7). These data indicate how concentrations of compounds such as benzene vary with proximity to nearby traffic

intensity. During the first sampling interval, benzene concentrations were higher at the 2100 NW 24<sup>th</sup> site compared to the 3200 NW Wilson site (Table 7, Figures 4 and 5). This is not surprising since the 3200 NW Wilson site is located on a minimally traveled street while the 2100 NW 24<sup>th</sup> site is next to the heavily used NW Vaughn corridor.

Benzene concentrations averaged higher for the second sampling period compared to the first; however, relocation of both monitors does not allow for comparisons between the sampling times. Significantly higher average benzene concentrations were monitored in the 2400 block of NW Thurman compared to concentrations in the 2300 block of NW Lovejoy (Table 7, Figures 6 and 7). A reasonable explanation for the higher concentrations at 2400 NW Thurman is that the site is close to NW 25<sup>th</sup> and NW Vaughn, streets with high levels of traffic as well as the traffic on NW Thurman.

**Factors Influencing Why Infants and Children Might be more Susceptible than Adults.**

*There is a growing body of evidence that children receive greater doses of environmental toxicants on a body weight basis than adults through common exposure pathways (such as inhalation and ingestion). These greater doses stem from greater exposures, from unique exposures, and from factors influencing the amounts of toxicants available at body sites where absorption occurs.*

*A primary physiological difference between children and adults is the higher breathing rates of children. This difference in breathing rates is due to the greater oxygen consumption rates of children, a result of their increased energy expenditure levels. Children expend more energy primarily because of their rapid growth and high levels of physical activity. Children also expend more energy for thermogenesis because they have a larger body surface area relative to their weight than adults.*

*Another factor influencing inhalation exposure, in particular for particle exposures, is the difference in alveolar surface area between children and adults. Bronchioles develop completely prenatally but 85% of alveoli develop in the postnatal period. A newborn infant may have as few as 10 million alveoli while adults have up to 300 million ---. This represents a greater than 20-fold increase in alveolar surface area. For particles, when viewed as a dose (number of impacted particles) per alveolar surface area, the disparities between the adult and infant/young child are even greater than on a body weight basis. The number of alveoli reaches about 90% of adult values by age three. \**

**\*Prioritization of Toxic Air Contaminants Under the Children's Environmental Health Protection Act.** Office of Environmental Health Hazard Assessment. California Environmental Protection Agency. March 2001.

## **Conclusions:**

1. A “hot spot” for elevated levels of metals in dust is located directly downwind of the ESCO Foundry.
2. NW 24<sup>th</sup> street acts as a corridor for metal-laden dust from the ESCO facility.
3. Lead levels in dust on porches in the metals “hot spot” are significantly higher than EPA’s 40 micrograms per square foot benchmark for lead on floors indoors.
4. Lead levels in dust on porches outside the metals “hot spot” are routinely higher than EPA’s 40 micrograms per square foot benchmark for lead on floors indoors.
5. Other metals such as aluminum, arsenic, barium, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, strontium, uranium, vanadium and zinc are elevated in the metals “hot spot”.
6. Acrolein concentrations in the ESCO odor are above EPA’s reference concentration for chronic exposure and at times exceeds California’s acute exposure benchmark.
7. Benzene concentrations were consistently over EPA’s cancer benchmark throughout July and August.
8. Benzene concentrations were higher at locations with higher traffic.
9. Those most at risk to these pollutants are young children and individuals with respiratory problems. Children are more likely to ingest lead-tainted dust while those with respiratory problems are more vulnerable to compounds such as acrolein.
10. People living in the neighborhood are exposed to several pollutants at levels above accepted health benchmarks.

Air Quality Monitoring Program for Northwest Portland  
Interim Report #3 - by Robert Amundson, PhD  
September 2001 – February 2002

## **Monitoring Activity**

Five air quality-monitoring activities occurred during this reporting period. First, glass-beaker dust collectors were placed at 12 locations throughout the neighborhood during October to determine sites with elevated levels of metals (“hot spots”). Second, standard particulate fallout samplers collected dust at three locations during one mid-winter interval. Third, neighbors sampled for volatile organic compound (VOC) concentrations associated with noxious odors. Fourth, during one 30-day period, hourly concentrations of VOCs were characterized at a location with a history of odor events. Finally, neighbors continued to fill out odor response forms.

## **Rationale for Monitoring**

The current Northwest-neighborhood air-quality sampling program builds on information collected by neighbors since 1997 and adds to information generated by DEQ from previous hazardous air quality sampling programs. This air quality sampling study has focused on three issues: What toxic compounds and their concentrations are in the air? What are their sources? Are the concentrations high enough to be of concern?

## **Methods and Materials**

**Metals contents of dust.** When the surface area of the collection device is known, metals contents can be reported as amount of metal deposited per area (micrograms per square foot). This convention of metals contents in micrograms per square foot is used for ease of comparison with the Environmental Protection Agency’s standard for lead in household dust (40 micrograms per square foot).

Dust was collected in 500-ml glass beakers at 12 houses from 1 to 25 October 2001 to determine “hot spots” with elevated levels of metals. In addition, standard particulate dust fall collectors (PFOs) were used to sample for metals in dust at three locations from January 11 until February 12. The “PFO buckets” are routinely used for particulate fallout deposition by Oregon’s Department of Environmental Quality. We used these standard dust collectors, in part, to be able to compare “PFO” metal deposition values with those generated by the smaller and more easily used glass collectors.

**Volatile Organic Compounds.** The project manager and the neighborhood advisory group chose to use a new technology developed by scientists at Portland State University to monitor for VOCs. The instrument samples 24 times per day to detect concentrations of VOCs. We located the instrument at a residence near the industrial area where a great



number of odor events had been noted. Additionally, neighbors used SUMMA canisters to detect VOCs associated with six separate odor events.

**Odor complaints.** Neighbors recorded odor complaints and Robert Davies and Caroline Skinner compiled them.

## **Results and Discussion**

### **Metal deposition in NW Portland from 1 – 25 October 2001.**

Metals collected in twelve 500-ml beakers from 1 – 25 October are shown in Table 1. Two sites, one located in the 2100 block of NW 23rd and the other located in the 1600 block of NW 24<sup>th</sup>, had the highest levels of aluminum, barium, chromium, cobalt, copper, iron, manganese, nickel and vanadium. In addition, the location in the 2100 block of NW 23<sup>rd</sup> ranked second for deposition of antimony, while the location in the 1600 block of NW 24<sup>th</sup> ranked first or second for deposition of arsenic, cadmium, magnesium, selenium and silver. A site located in the 2400 block of NW Thurman ranked at least fourth highest for levels of aluminum, antimony, barium, chromium, cobalt, copper, iron, manganese, nickel, silver, vanadium and zinc. A fourth site located close to these other 3 sites ranked at least fourth highest for levels of aluminum, antimony, arsenic, barium, chromium, iron, nickel selenium and vanadium. These four sites demark a “hot spot” for metals deposition in Northwest Portland. The distributions of lead, chromium and nickel deposited at the 12 sites in NW Portland from 1 – 25 October are shown in Figures 1-3.

The maps showing the deposition of chromium and nickel illustrate the metals “hot spot” next to the ESCO foundry. In contrast, the map showing deposition of lead indicates the highest reading was found in the 3200 block of NW Wilson. Deposition of lead is of great concern to the neighborhood because of the high levels being found. Eight of the 12 sites monitored during this time period collected levels of lead that are higher than the indoor-standard for lead in dust on floors.

This is the first time that the site in the 3200 block of NW Wilson had the highest deposition of lead. For the three previous periods when twelve locations were sampled for lead deposition (6-22 August 1999, September 17 – October 11, 1999, and July 11 – August 23, 2001), the highest levels of lead found were predominantly within the metals “hot spot”. However, the highest level of lead ever recorded was found in the 2800 block of NW Thurman. It is possible that high outlier concentrations may be from some environmental contaminant of lead; however, it is just as likely that single emission events contribute to the extremely high levels found within a few blocks of NW Vaughn. The source of the high lead levels deposited outside the metals hotspot is unknown. In the 4 samples with the highest levels of nickel and chromium (Figures 2 & 3), their relative values fluctuate together; thus, a common source is indicated.

## **Metal deposition in NW Portland from Jan. 11 to Feb. 12, 2002.**

Four PFO buckets were used in January-February 2002 to collect dust in the neighborhood. A PFO bucket and two glass dust collectors were used for comparison of deposition values derived from the two types of dust collectors (Table 2). These two types of collectors were located on a porch in the 2500 block of NW Savier. Deposition of aluminum, antimony, barium, calcium, chromium, cobalt, copper, iron, lead, molybdenum, nickel and silver were similar between the PFO collector and the two glass dish collectors. The glass dishes also collected low but detectable levels of arsenic, beryllium, cadmium, strontium, tin and vanadium that were not detected with the PFO collectors. A possible explanation for the higher sensitivity in detection of these compounds is that the glass dishes are dry while the PFO buckets contain several liters of water to make certain they do not blow over. The added volume of water may reduce the detection limit for some compounds collected with the PFO buckets. In contrast, the PFO buckets showed a 10 fold higher deposition of boron and a 2 – 2.5-fold higher deposition of magnesium than was found with the glass dishes. Similarly, deposition appeared to be 2 fold higher for tin and about 50% higher for manganese in the PFO bucket compared to the glass dishes. A simple explanation for these differences between the PFO bucket and the glass dishes is not apparent.

Deposition of metals at the site in the 2400 block of NW Thurman was highest for aluminum, antimony, arsenic, barium, boron, cadmium, calcium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, vanadium and zinc. Only deposition of chromium, silver and tin were similar between the NW Thurman and NW Wilson sites. The deposition of lead was alarmingly high; as was the deposition of zinc at the 2400 NW Thurman site. The level of zinc deposition defies explanation; whereas, high levels of lead deposition were found previously at this location and at other sites in the neighborhood.

Duplicate samples were taken at a site within 200 feet of the ESCO bag house and although levels of deposition varied between the two PFO buckets, they were similar.

## **Volatile Organic Compounds in Odor events.**

Neighbors sampled for VOCs during six noxious odor events. Four events were identified as ESCO-like odors, which are most commonly described as burnt rubber or burnt metal. These samples were taken on 30 August, 13 and 14 of September and February 11, 2002. An event on October 6 was associated with a sweet solvent and gas-like odor; while an event on December 7 was described as a very strong fuel/gasoline mixture.

The December 7<sup>th</sup> event described as a very strong fuel/gasoline mixture had the highest recorded levels of benzene ( $6.1 \mu\text{g m}^{-3}$ ), toluene ( $24 \mu\text{g m}^{-3}$ ), and total xylenes ( $12.8 \mu\text{g m}^{-3}$ ), all components of gasoline (Table 3). Furthermore, this event also had by far the highest amount of low molecular weight hydrocarbons such as acetaldehyde, n-butane and 2 methylbutane. These compounds are associated with incomplete combustion of

hydrocarbons. These strong odor events occur frequently at this location and the high monitored concentrations of VOCs indicate a need for preventing these emissions from impacting this area.

An odor event sampled on 6 October was described as a mixture of gasoline and sweet solvent. It was also described as being different from a typical ESCO odor event. In this sample, both acetone ( $52 \mu\text{g m}^{-3}$ ) and tetrachloroethene ( $3.7 \mu\text{g m}^{-3}$ ) had the highest concentrations of all six samples and may have contributed to the sweet solvent odor. In contrast, compounds normally associated with gasoline were at the low end of the concentrations measured in these six samples. The source of the odor is unknown; however, tetrachloroethene is a known carcinogen and is frequently used as a solvent in dry cleaning, electroplating, paint stripping, and as a metal degreaser.

Acrolein was present in all four samples described as having an ESCO-like odor (Table 3). The concentrations of acrolein in these four samples ranged from 1.9 to  $4.6 \mu\text{g m}^{-3}$ . The Office of Environmental Health Hazard Assessment has set an acute Reference Exposure Level (REL) for acrolein of  $0.19 \mu\text{g m}^{-3}$  for a one-hour exposure. At this concentration ( $0.19 \mu\text{g m}^{-3}$ ), mild eye irritation is predicted. The lowest concentration monitored was 10 times the REL. This compound has been suggested as being part of the ESCO odor in previous reports (Interim #2). Not all monitored acrolein can be from ESCO, because it has been shown, through modeling, to be found throughout the greater Portland airshed. However, acrolein is a known emission from ESCO and these emissions, most likely, contribute to the elevated concentrations monitored during odor events.

The VOC sample taken closest to ESCO had more compounds and higher concentrations of high molecular weight hydrocarbons than were found at the other three locations. It is possible that these compounds are associated with fugitive emissions; while at the other locations, the contaminants may be coming predominantly from the newly elevated stack on NW Wilson.

A potential health hazard is the presence of both methylene chloride and n-hexane in two of the samples. N-hexane is a neurotoxicant and its effects have been shown to be enhanced by the presence of methylene chloride which is toxic by itself.

#### **Hourly VOC concentrations monitored from Sept. 6 to Oct. 7, 2001.**

The new VOC analyzer sampled hourly from 6 September to 7 October except for periods associated with maintenance and calibration. The analyzer was located in the 2400 block of NW Thurman. Benzene, a class A carcinogen was present in every sample and the highest benzene concentration measured was near  $10 \mu\text{g m}^{-3}$  (Figure 4). The EPA cancer benchmark for benzene is  $0.12 \mu\text{g m}^{-3}$ , while the California cancer benchmark for benzene is  $0.03 \mu\text{g m}^{-3}$ . Clearly, benzene was well above these benchmarks almost continuously for this sample period.

During the month of hourly sampling, approximately 30 events with elevated levels of VOCs were detected. These 30 events were associated with non-mobile sources of VOC. On occasion, levels of VOCs peaked during one sample. If the elevated VOCs had the same mix of VOCs as mobile sources, those events were not counted

**Odor complaints.**

Odor complaints were compiled by Caroline Skinner and Bob Davies. Odor complaints can now be electronically logged through the NWDA web site.

**Table 1. Metals in dust collected at 12 locations in NW Portland from 1 - 25 October 2001.**

Location	site number	Metals in Dust (micrograms per square foot)									
		Aluminum	Sb	As	Ba	Be	Cd	Cr	Co	Cu	Fe
		Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	
1800 NW 24th Place	1	3000	2.7	10	92	nd	0.3	24	2.25	41	2250
1600 NW 24th	2	3450	2.7	9	117	nd	1.05	45	21	95	3450
2400 NW Thurman	3	2850	3.8	nd	80	nd	0.15	32	2.7	75	2850
2100 NW 23rd	4	4650	3.3	nd	119	nd	nd	54	3.6	86	3900
2500 NW Savier	6	1950	1.8	3.3	48	nd	0.45	15	1.65	36	1650
2800 NW Thurman	7	2550	2.4	2.1	51	nd	0.6	17	2.1	36	1950
3200 NW Wilson	8	1800	nd	nd	53	nd	0.45	17	2.4	24	1950
2700 NW Pettigrove	9	1320	nd	nd	50	nd	0.3	14	1.05	35	1380
2200 NW Johnson	10	945	1.5	0.5	27	nd	nd	12	0.75	23	1200
2800 NW Upshur	14	915	nd	2	53	nd	nd	11	2.4	27	1155
2400 NW Quimby	15	2100	2.7	nd	57	0.2	0.75	20	1.95	50	2250
2900 NW 53rd	16	990	nd	7.05	21	0.4	nd	15	0.75	12	990

**Table 1. Metals in dust collected at 12 locations in NW Portland from 1 - 25 October 2001.**(cont.)

Location		Metals in Dust (micrograms per square foot)												
site	Pb	Mg	Mn	Ni	K	Se	Ag	Na	Tl	V	Zn			
	Lead	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc			
1800 NW 24th Place	41	945	149	26	1230	18	2.7	1650	nd	13	165			
1600 NW 24th	57	1245	375	44	1020	14	1.7	2250	nd	15	1395			
2400 NW Thurman	65	780	165	21	660	nd	1.1	1290	nd	9	435			
2100 NW 23rd	60	1215	210	53	960	nd	0.8	1800	nd	18	330			
2500 NW Savier	33	495	101	9	465	nd	0.5	975	nd	8	165			
2800 NW Thurman	54	690	138	11	720	11	0.5	1800	nd	12	270			
3200 NW Wilson	180	450	134	10	495	7.5	1.1	930	nd	4.7	195			
2700 NW Pettigrove	21	975	98	11	1500	nd	0.7	1500	nd	6	180			
2200 NW Johnson	24	285	75	8	465	8	0.8	705	nd	nd	129			
2800 NW Upshur	45	915	96	11	1185	nd	0.4	4950	nd	3	240			
2400 NW Quimby	45	1800	180	18	27000	12	0.8	7050	0.7	9	210			
2900 NW 53rd	8	315*	165	nd	435	11	0.3	600	nd	nd	33			

**Table 2. Metals in Dust collected at 3 locations in NW Portland from 11 Jan. - 12 Feb. 2002.**

	Metals in Dust (micrograms per square foot)					
	2300 NW Wilson sample 1 PFO	sample 2 PFO	2400 NW Thurman PFO	2500 NW Savier PFO	2500 NW Savier sample 1 Glass dish	sample 2 Glass dish
Aluminum	1391	1327	2686	324	543	453
Antimony	3.8	3	39	1	1	1
Arsenic			13		1	1
Barium	73	112	157	39	31	30
Beryllium					0	0
Boron	19	44	64	25	2	2
Cadmium	2	3	7		1	1
Calcium	4953	3747	17209	1714	2070	1890
Chromium	8	15	13	3	3	2
Cobalt	2	2	69	1	1	1
Copper	144	150	215	58	63	57
Iron	2813	3512	5461	572	788	680
Lead	56	42	583	15	21	17
Magnesium	730	1410	3874	629	263	228
Manganese	58	104	347	37	27	24
Molybdenum	3	4	5	2	1	1
Nickel	11	12	22	4	4	3
Silver	4	3	2	2	1	1
Strontium					12	14
Thallium						
Tin	6		2		2	1
Vanadium	6	9	13		2	2
Zinc	711	552	32893	191	106	89





**Table 3. Volatile Organic Compound Concentrations Monitored during Odor Events.**

75-27-4	Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
79-01-6	Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
123-91-1	1,4-Dioxane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
106-89-8	Epichlorohydrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
10061-01-	cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2	1.0
108-10-1	4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
10061-02-	trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
79-00-5	1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
108-88-3	Toluene	9.4	5.8	5.5	4.4	24	11	4.4	24	11	4.4	1.0
591-78-6	2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
124-48-1	Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
106-93-4	1,2-Dibromoethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
123-86-4	Butyl Acetate	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.3	1.0
127-18-4	Tetrachloroethene	ND	ND	ND	3.7	1.4	1.4	3.7	1.4	1.4	1.4	1.0
108-90-7	Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
100-41-4	Ethylbenzene	1.4	ND	ND	ND	ND	ND	ND	2.7	2.0	2.0	1.0
136777-61	<i>m,p</i> -Xylenes	4.2	3.3	5.8	2.7	9.6	6.9	2.7	9.6	6.9	2.7	1.0
75-25-2	Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
100-42-5	Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
95-47-6	<i>o</i> -Xylene	1.5	ND	1.7	ND	3.2	2.1	ND	3.2	2.1	2.1	1.0
111-84-2	<i>n</i> -Nonane	ND	ND	ND	ND	ND	ND	ND	1.7	ND	ND	1.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
98-82-8	Cumene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
80-56-8	<i>a</i> -pinene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
622-96-8	4-Ethyltoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
108-67-8	1,3,5-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
95-63-6	1,2,4-Trimethylbenzene	ND	ND	ND	ND	ND	ND	ND	2.3	1.8	1.8	1.0
100-44-7	Benzyl Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
541-73-1	1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
106-46-7	1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
95-50-1	1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
5989-27-5	<i>d</i> -Limonene	ND	ND	2.0	ND	ND	ND	ND	ND	ND	ND	1.0
96-12-8	1,2-Dibromo-3-Chloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
120-82-1	1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0
91-2-3	Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.3	1.0
87-68-3	Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.0

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.

**Table 3. Volatile Organic Compound Concentrations Monitored during Odor Events.**

NWDA-13-01 2700 NW Wilson 8/30/01  
 NWDA-11-01 2200 NW Johnson 9/13/01  
 NWDA-12-01 1800 NW 24th Place 9/14/01  
 NWDA-16-01 2800 NW Thurman 6/10/01  
 NWDA-14-01 3200 NW Wilson 12/7/01  
 NWDA-1-02 3200 NW Wilson 1/2/02

GC /MS Ret. Time	Tentatively identified compound						Concentrations (micrograms per cubic meter)					
4.50	Propene + Propane	6	4	7	20	7						
4.96	Acetaldehyde	6	10	5	90	10						
5.25	n-Butane	6		10	200	20						
6.38	2-Methylbutane				100							
6.77	C5H10 compound			3								
6.87	n-Pentane	6	4	10	60	8						
7.03	C5H10 compound			3								
7.34	C5H10 compound			4								
7.83	Unidentified	5										
8.50	siloxane (Possible Artifact)		5	20								
8.61	2,3-Dimethylbutane			2								
8.69	Butanal	6	6	7	30	5						
8.73	2-methylpentane											
8.86	Butanal		5									
9.18	3-methylpentane			3	10							
9.47	Acetic Acid	30	30									
10.31	Tetrahydrofuran			2								
10.77	Methylcyclopentane				9							
11.52	1-Butanol		4	3								
12.34	C5H10O Aldehyde +				5	5						
12.58	3-Methylhexane				9							
13.82	n-Butyl Formate		8									
16.43	Hexanal				10	5						
17.98	siloxane (Possible Artifact)					7						
18.29	siloxane (Possible Artifact)	20	20	60	20							
19.56	Dimethyl sulfone	6	6									
19.78	3-Heptanone				7	7						
19.86	2-Heptanone				6	6						
20.01	C7H14O Ketone		5									
20.47	Heptanal			7	20	8						
20.72	2-Butoxyethanol		3									
22.01	C9H10 branched alkane										20	
22.19	Benzaldehyde	10	7	10	3							

**Table 3. Volatile Organic Compound Concentrations Monitored during Odor Events.**

GC / MS Ret. Time compound	NWDA-13-01 2700 NW Wilson 8/30/01	NWDA-11-01 2200 NW Johnson 9/13/01	NWDA-12-01 1800 NW 24th Place 9/14/01	NWDA-16-01 2800 NW Thurman 6/10/01	NWDA-14-01 3200 NW Wilson 12/7/01	NWDA-1-02 3200 NW Wilson 1/2/02
	Concentrations (micrograms per cubic meter)					
23.39			10		30	10
23.61	20	20	60		20	
23.80				8		
24.12	5		50			20
25.71			7		20	7
25.95	4		40	20		
26.32	6		6			
26.86			9			
27.59		7	70	5		
27.81			5			
28.91			20			