

3.6 Monitoring Overview and Model to Monitor Comparison

There are several ambient air quality monitoring stations in the Portland area. In order to evaluate model performance and to investigate any potential deficiencies in the input data, DEQ conducted a model to monitor comparison of the 2005 air quality monitoring data with the 2005 modeled results for eight pollutants. The model to monitor comparisons are yet another factor PATSAC considered when developing emission reduction strategies.

3.6.1 Monitoring Locations

In 2005, there were six monitoring stations in the Portland area: Vancouver, North Roselawn, NW Post office, SW Kelly and Curry, Southeast Lafayette, and Beaverton. In 2009, DEQ operated two stations in the area at North Roselawn and SE Lafayette. Figure 24 is a map of monitoring locations. In addition, the North Roselawn station has been in continuous operation from 1999 to 2011. Each station represents a different type of neighborhood and mix of activities as described below:

Vancouver: This station is located in a residential area within less than a half kilometer of the Columbia River. Residents of this neighborhood have expressed concerns about air toxics released as aircraft approach the Portland airport just across the river. A major railroad line runs between the neighborhood and the river, and barge traffic on the river is significant. This neighborhood is more than 2 km away from major industrial and port facilities, but the nature of wind movement in the Columbia Gorge can episodically bring pollutants in from some distance away.

North Roselawn: This station is DEQ's primary air toxics monitoring site since 1999, located in the North/Northeast quadrant of the city, this station is representative of a typical inner city neighborhood. This area is within a half kilometer of a variety of commercial businesses, some light manufacturing, and city arterial streets. About a kilometer away is the busiest transportation corridor (Interstate 5) in the city. Major industrial and Port facilities on both sides of the Willamette River are on the west, two to four kilometers away. There is another industrial/Port area about the same distance to the north along the Columbia River.

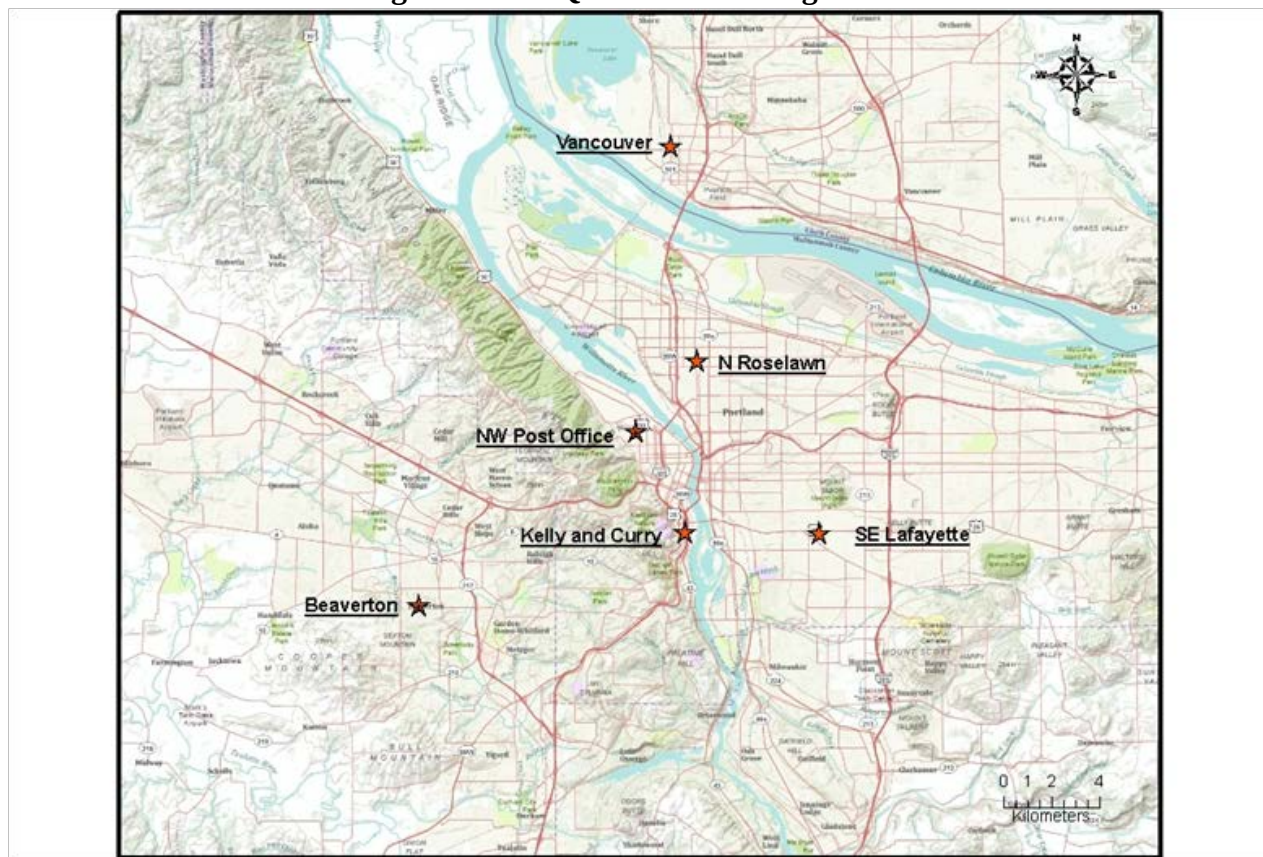
NW Post Office: This station is located in the Northwest quadrant of the city on a residential street and is on the boundary between a high-density residential area and a heavy industrial area. It is within a half kilometer of a small commercial area and numerous metal finishing operations. Railroad yards, Port operations, fuel handling facilities, wood products and other manufacturing businesses, and a major traffic thoroughfare are within a kilometer. The West Hills, less than a half kilometer from this site, create a barrier to air movement to the west and restrict dispersion of pollution.

Beaverton: This station is located in a suburban residential area west of the West Hills, making it spatially distinct from the central city and the east side. However, model estimates indicate that it may be in an area of elevated ambient concentrations, resulting primarily from area and mobile sources located in these western suburbs. Some industry can be found more than a kilometer away to the north and east.

SW Kelly and Curry: This station is located near the central business district. Modeling estimates from an earlier study suggested this location as having the highest impact of anywhere in the city from traffic volume and congestion. No significant industrial facilities are within 4 km.

SE Lafayette: This station is located in Southeast and has been DEQ's primary criteria pollutant neighborhood site for over 20 years. This was one of the first places in the country where woodstove impacts on ambient fine particulate concentrations were recognized. Large traffic arterials, with some commercial activity, can be found within a half kilometer. A high volume Interstate link (I-205) is 1-2 km away. No significant industrial facilities are within 4 km.

Figure 24: DEQ 2005 Monitoring Locations



3.6.2 2005 Monitoring Results

Annual averages were calculated from quarterly averages from January 2005 through February 2006. Quarterly median data was substituted for missing values to complete data sets. In particular, Beaverton had no valid benzene data for the 3rd quarter, so the annual average was calculated based on the 1st, 2nd, and 4th quarters only. However, benzene has been measured since 1997 until the present. For some pollutants, monitoring began in February 2005 and ran until February 2006 since not all the equipment was set up for all sites within the month of January. In these cases, January 2006 data was used instead of January 2005 data for annual averages. Regardless, all averages were calculated per DEQ protocol. Many of the core VOCs were never, or seldom, measured above the minimum reporting limit. This includes 1,3-butadiene, carbon tetrachloride, chloroform, 1,2-dichloropropane, tetrachloroethene, trichloroethene, and vinyl chloride. Where the annual average was less than the minimum reporting limit it is reported as < minimum reporting limit.

The PAH annual average values are questionable because quality controls (holding times and surrogate recoveries) were not always within acceptable limits, resulting in down-graded reported results. All valid samples were used in calculating the annual averages.

Benzene's annual average was not calculated due to a pump contamination issue, which affect sampling. Since more than 75% of the samples in three of the calendar quarters of 2005 were determined to be invalid, an annual average was not calculated. The sampling problems encountered with these VOC canisters were identified because of the Laboratory's comprehensive quality controls. Although benzene data values are not complete for calendar year 2005, this pollutant has been measured at the NE Roselawn site since 1997 until the present.

Therefore, sufficient data for benzene is available for analyses. For more information on the sample collection and analysis, and all other associated monitoring information, please refer to the [Monitoring Appendix 10.5](#).

3.6.2 2005 Monitor to Model Comparison

To evaluate air quality model prediction performance, DEQ performed two rounds of model to monitor comparisons. The first round was done within the Portland Air Toxics Assessment project and used 1999 data. The second round was conducted by DEQ and used the 2005 data. The 1999 model to monitor comparison is described in the [Portland Air Toxics Assessment report](#). The 1999 model to monitor comparison resulted in reassessment and in some cases, revision of emissions estimates prior to the final model runs. In general, the results indicate that the CALPUFF model very credibly predicted ambient concentrations where there were measurements for comparison.

DEQ compared the 2005 ambient concentrations with 2005 modeled concentrations for eight air toxics that DEQ could accurately sample. These eight air toxics included acetaldehyde, arsenic, benzene, cadmium, formaldehyde, lead, manganese, and nickel. In general, 1999 model evaluation and the results of the 2005 model to monitor comparison suggest that the PATS model credibly predicts ambient concentrations. The difference between modeled and monitored concentrations may be attributed to underestimated, overestimated or missing emissions data and, for some pollutants, uncertainty about rates of chemical transformation.

3.6.2.1 Acceptable Model Performance

According to US EPA studies of the performance of long-term air quality models, if the emissions are well characterized, then 90% of the estimated concentrations should be within a factor of two of those observed. This means that a model can predict a concentration twice as high or half as low as a monitored concentration and be deemed acceptable.

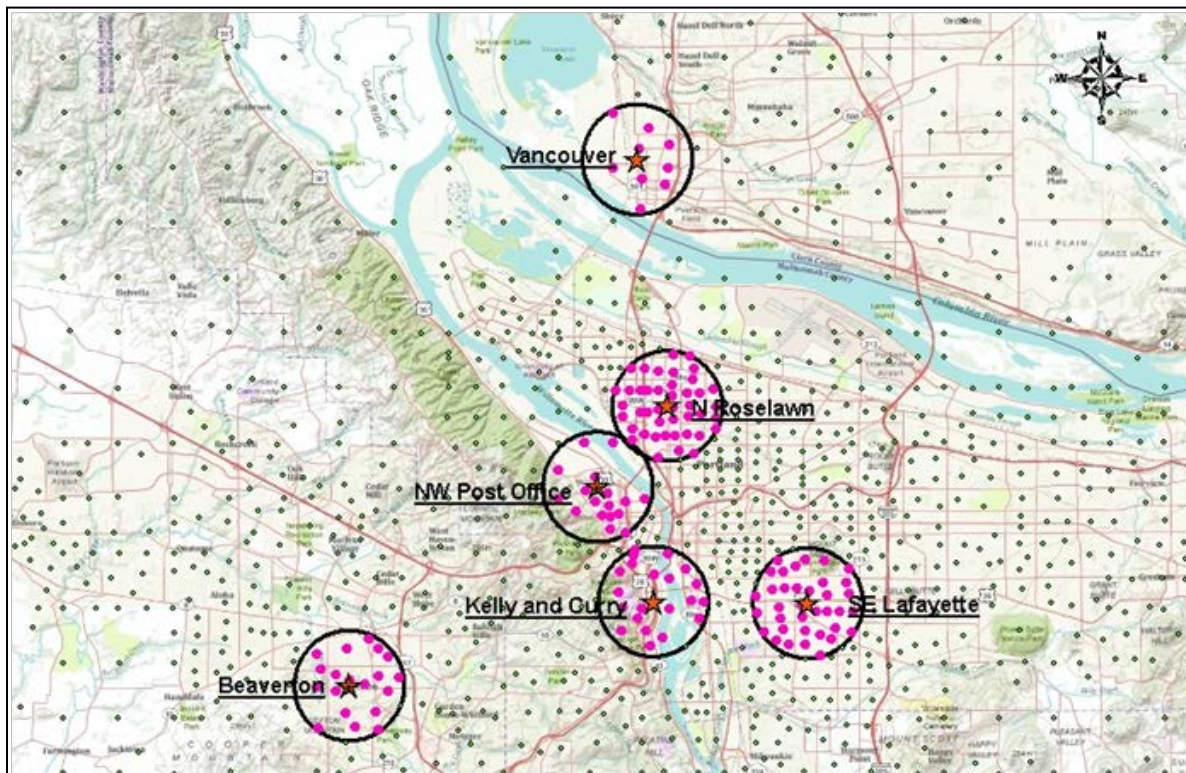
3.6.2.2 2005 Monitoring Study

In 2005, DEQ conducted a monitoring study for 19 different pollutants. The DEQ Laboratory conducted all sample handling and analysis following EPA protocols used in the National Air Toxics Trends Site network. Twenty-four hour samples were collected on a 1 in 6 day schedule. Samples were collected during all four seasons to capture different meteorology and sources. Because the ambient benchmark concentrations are for chronic lifetime exposure, the annual averages were calculated. For more information on the sample collection and analysis, and all other associated monitoring information, please refer to the [Monitoring Appendix 12.5](#).

3.6.2.3 2005 Modeling Methods

Using the 2005 emissions inventory as the base for modeling, DEQ modeled pollutant concentrations for a receptor at each census block group centroid throughout the PATS area. In order to conduct a model to monitor comparison, the annual averages of model estimates at all receptors within a radius of 2km of the monitor were compared to the annual average concentrations measured by the monitor. DEQ used this approach to account for the variability in the spatial allocation of emissions, the variability in meteorological data, and the limitations inherent in matching paired-in-space-and-time concentrations. Figure 25 illustrates receptors included in 2 km radii for model to monitor comparisons.

Figure 25: 2005 Model Receptors within 2 Kilometers of a Monitoring Station



Background concentrations were added to all modeled values to account for transport of regional emissions from outside the PATS study area, unidentified emission sources, natural emission sources, and for the aldehydes, the secondary formation through chemical transformation. These background estimates were developed by EPA for the 2002 National-scale Air Toxics Assessment, and are based on measured air toxics concentrations throughout the United States. Domain-wide average background contributions are expressed as percentages of the total concentration as follows:

- Acetaldehyde 65%
- Arsenic 50%
- Benzene 25%
- Cadmium 23%
- Formaldehyde 55%
- Lead 42%
- Manganese 47%
- Nickel 25%

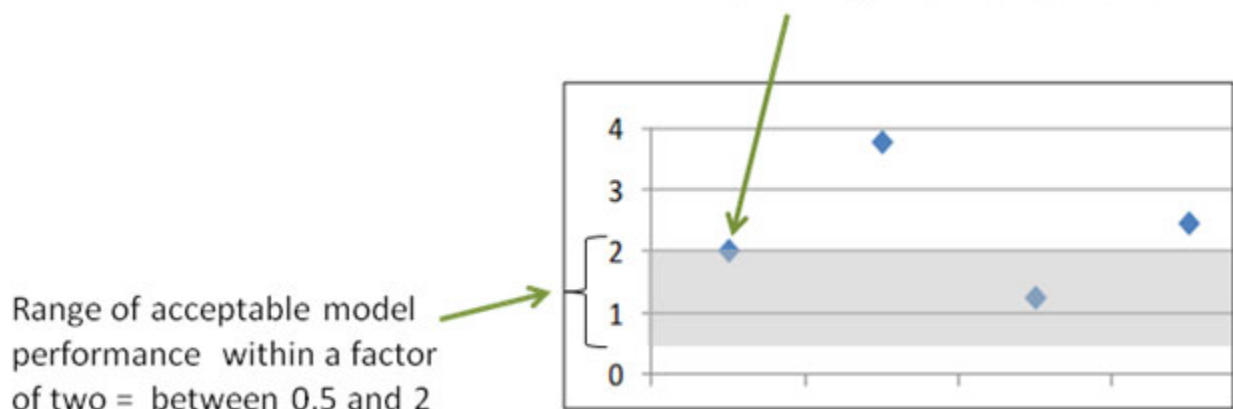
In this analysis, the annual average modeled concentrations, which were developed using 1999 meteorology, are compared to monitored concentrations measured during 2005. However, an analysis of annual average meteorology for 1999 and 2005 showed no significant differences, and the 1999 meteorological data is considered representative of 2005.

3.6.2.4 Monitor to Model Comparison Results

In order to evaluate whether the model performance is acceptable, DEQ used the criteria listed in section 3.6.2.1 from the US EPA's December 2010 Final Report on Results of the [2005 National Air Toxics Assessment](#) (NATA) Model-to-Monitor Comparison. Figure 26 is an example of the acceptable model range compared with ambient monitoring results. Blue diamonds show the ratio between the modeled and monitored concentrations. The grayed area shows the acceptable performance range between 0.5 and 2, or within a factor of 2. The first

diamond is on the edge of the acceptable range. The second one shows a location where the model over predicted concentrations relative to the monitored value. The third one is right in the desirable range of good performance. The fourth diamond shows a location where there was a slight over prediction. For more details, as well as monitored and modeled values, please refer to the [Monitoring Appendix 10.5](#).

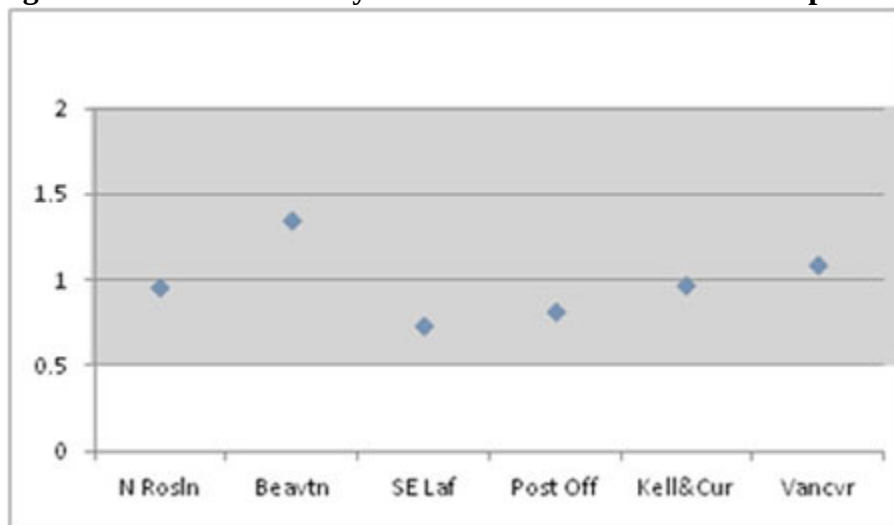
Figure 26: Example of Monitor to Model Comparison for a Pollutant
Modeled / Monitored Ratio



3.6.2.4.1 Acetaldehyde

In general, the correlation between modeled and monitored values is good for acetaldehyde. The comparisons are illustrated in Figure 27. Monitored concentrations of acetaldehyde are largely the result of secondary formation from precursor VOC emissions. DEQ added background acetaldehyde emissions to modeled values to account for secondary formation.

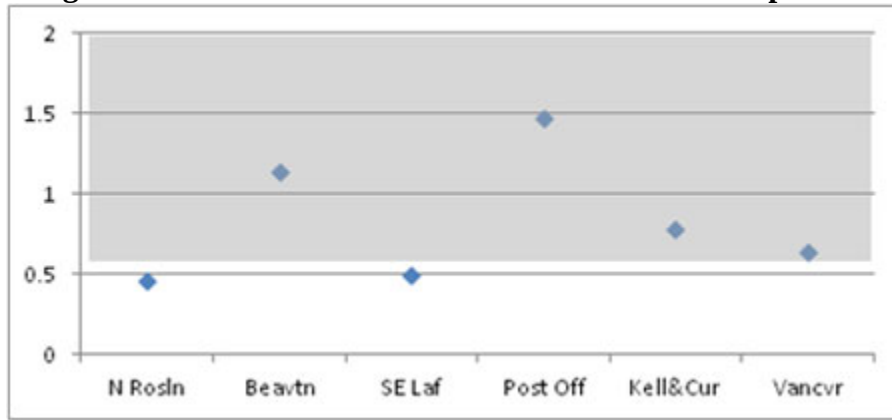
Figure 27: 2005 Acetaldehyde Monitor to Model Ratio Comparison



3.6.2.4.2 Arsenic

For arsenic illustrated in Figure 28, agreement between the model and monitored values is fair. It is under predicted at North Roselawn and SE Lafayette but within a factor of two for five out of six monitors.

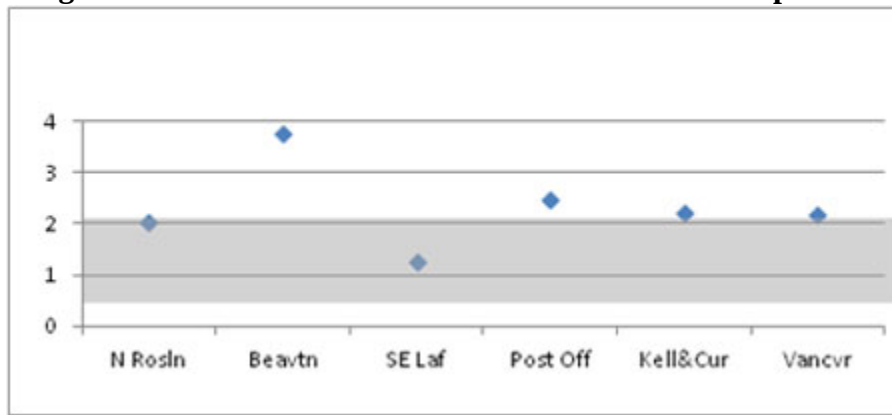
Figure 28: 2005 Arsenic Monitor to Model Ratio Comparison



3.6.2.4.2 Benzene

Modeled concentrations of benzene, illustrated in Figure 29, are generally over predicted throughout the domain. SE Lafayette has good agreement. The lawn and garden and residential wood combustion emissions inventory, which has been adjusted in the 2017 modeling, may have caused some of the benzene over prediction. Even though benzene modeled values appear to be high, monitoring shows values at least 10 times above the benchmark.

Figure 29: 2005 Benzene Monitor to Model Ratio Comparison



3.6.2.4.3 Cadmium

Overall, the model approximates the monitored values for cadmium as illustrated in Figure 30. However, at North Roselawn there is high monitored cadmium compared to the model. DEQ has known about these values since summer of 2010 and has been investigating potential sources of emissions. DEQ has found no explanation for cadmium emissions to date. Emissions may be coming from an area source or an unpermitted commercial facility. DEQ intends to investigate this further. Additional monitoring by EPA planned for Tubman Middle School could help increase understanding of the local sources of cadmium.

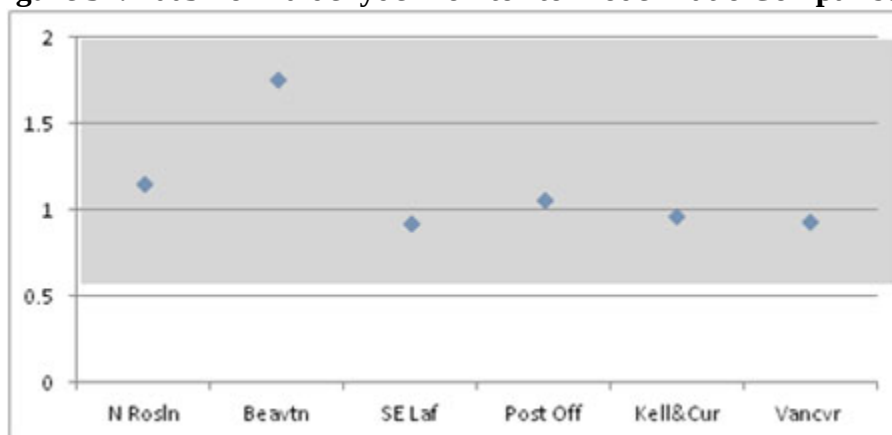
Figure 30: 2005 Cadmium Monitor to Model Ratio Comparison



3.6.2.4.4 Formaldehyde

In general, the correlation between modeled and monitored values is good for formaldehyde, illustrated in Figure 31. Like Acetaldehyde, ambient monitored concentrations of formaldehyde are largely the result of secondary formation from precursor VOC emissions. Modeled concentrations are of primary emissions only, and the 2002 NATA background concentrations have been added to the primary concentrations in order to account for the contribution from the secondary formation.

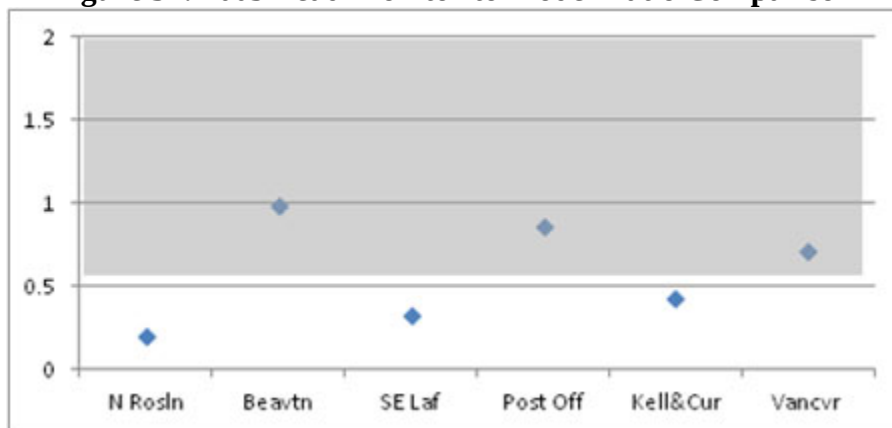
Figure 31: 2005 Formaldehyde Monitor to Model Ratio Comparison



3.6.2.4.5 Lead

Lead, illustrated in Figure 32, is well characterized at the following monitoring locations: Beaverton, NW Post Office, and Vancouver. Lead values at North Roselawn, SE Lafayette and Kelley & Curry are under predicted.

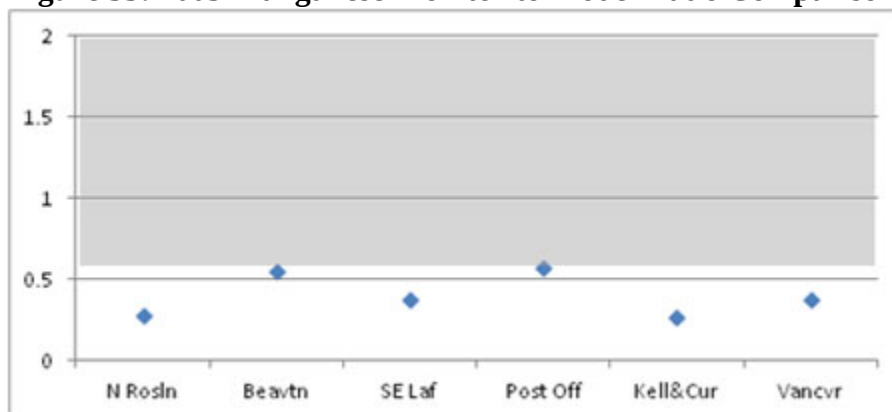
Figure 32: 2005 Lead Monitor to Model Ratio Comparison



3.6.2.4.6 Manganese

In general, the model under predicts manganese, illustrated in Figure 33. The best agreement is at the Post Office site.

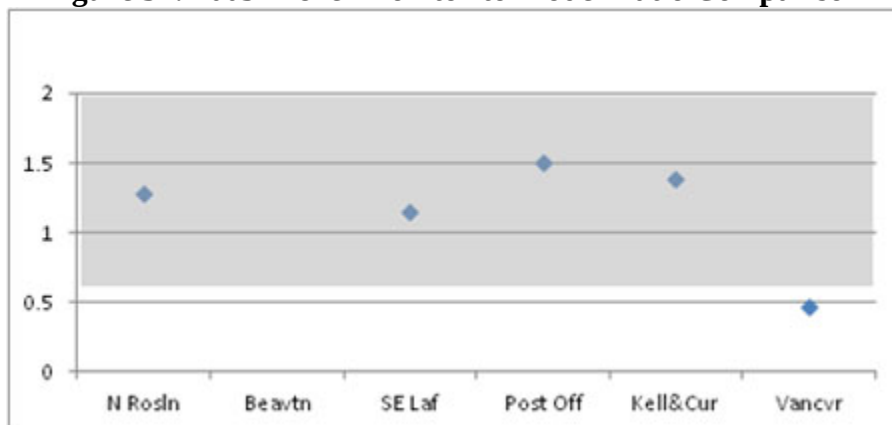
Figure 33: 2005 Manganese Monitor to Model Ratio Comparison



3.6.2.4.7 Nickel

Nickel, illustrated in Figure 34 is well predicted at four sites: SE Lafayette, NW Post Office, Kelley & Curry, and North Roselawn. Nickel is over predicted at Beaverton. Residential fossil fuel combustion emissions may be overestimated.

Figure 34: 2005 Nickel Monitor to Model Ratio Comparison



In conclusion, model to monitor comparisons show that overall there is a good agreement between modeled air toxics values and the monitored values. For several metals, the model has under predicted values, the most pronounced being cadmium. This indicates a need to investigate emission sources and refine the cadmium emissions inventory. For more details on the monitor to model comparison, please [see Appendix 12.6](#).

3.6.3 Ongoing Air Quality Monitoring

DEQ measures air pollutant levels by operating a network of monitoring and sampling equipment at sites throughout the State of Oregon. These sites are operated and maintained by DEQ air monitoring technicians with the goal of collecting complete and accurate air quality data. The equipment at an air monitoring station a complex array of continuous air monitors that operate 24 hours a day year-round to a single sampler with a filter that captures particulates once a week. Some of the monitors have real-time information, which can be accessed at <http://www.deq.state.or.us/lab/aqm/rt/rtHourlyConc.aspx>. DEQ moves some monitors periodically based on information needs. DEQ air quality monitoring is limited by resources and funding, so DEQ periodically seeks additional air quality monitoring funding to address air quality information needs.

DEQ monitors for Federal Clean Air Act pollutants including Carbon Monoxide, Nitrogen Dioxide, Sulfur Dioxide, Ozone, Total Suspended Particulate, Fine Particulate (PM10 and PM 2.5), and Lead. Other pollutants or compounds are measured as part of Air Toxics or particulate sampling. DEQ uses air sampling methods designated by the U.S. EPA as Federal Reference Methods. Much of the data collected from the air monitoring network is submitted to the EPA database for use in determining air pollution trends and air quality compliance of the national ambient air quality health standards. DEQ monitors air pollution to ensure that communities meet the national ambient air quality health standards, to report hourly health levels to the public, and to protect Oregon's pristine views.