Report

Portland Air Toxics Solutions Committee Report and Recommendations

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Department of Environmental Quality

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By: Sarah Armitage
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This report prepared by:

Oregon Department of Environmental Quality
811 SW 6th Avenue
Portland, OR 97204
1-800-452-4011
www.oregon.gov/deq

Contact:
Sarah Armitage
503-229-5186

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1. Executive Summary

1.1 Background and Purpose

Compared to other areas in Oregon, the Portland region has the highest risk to the population from air toxics due to business and population density. Along with national estimates of air toxics emissions, Portland monitoring studies confirm the presence of air toxics at levels that can cause adverse health effects. Forming individual airsheds based on geography allows the Department of Environmental Quality or DEQ to define problem areas for air toxics in Oregon. It also allows DEQ to prioritize and focus efforts to reduce air toxics. Under this geographic approach, DEQ and community members evaluate air toxics holistically in an area, striving for reductions from various sources roughly commensurate with their contributions.

DEQ created the Portland Air Toxics Solutions project, also called PATS, to work with local communities to develop an air toxics reduction plan for the Portland region. Ultimately DEQ seeks to reduce concentrations of air toxics to ambient benchmark concentrations, health based clean air goals established in state regulations. Between August 2009 and October 2011, DEQ collaborated with a diverse stakeholder committee called Portland Air Toxics Solutions Advisory Committee, known as PATSAC, to develop a foundation and framework for an air toxics reduction plan. In a series of 14 meetings, the committee and DEQ worked through the challenges of understanding and discussing air toxics problems and potential solutions in the Portland area, considering monitoring and modeling data, pollutants above health based benchmarks, sources of pollutants and potential emission reduction strategies.

1.2 Technical Study

To understand Portland air toxics problems and sources, DEQ produced a PATS modeling study that projects air toxics concentrations for 19 pollutants in 2017. The PATS model used the most current and detailed emissions information from industrial, mobile, and residential activities. The model also factored in economic conditions, population growth, topography, weather and new regulations to reduce pollution. PATSAC reviewed all stages of the PATS modeling and monitoring data and initiated technical advances that improved methodologies and data quality. In addition, DEQ and the advisory committee considered monitoring data from a 2005 regional monitoring study and performed a model to monitor comparison.

The PATS modeling study identified 14 of the 19 pollutants above health based benchmarks. Eight of the 14 pollutants cause the most risk. These pollutants are: 1, 3 butadiene, benzene, diesel particulate, 15 PAH, naphthalene, cadmium, acrolein, and formaldehyde. The study shows that most air toxics are found throughout the study area. Higher concentrations are found in densely populated neighborhoods, near busy roads and highways and in areas with business and industrial activity.

1.3 Portland Air Toxics Solutions Advisory Committee Contributions

The advisory committee provided DEQ with a wide diversity of opinion on the technical study and developing emission reduction options. DEQ fully considered and incorporated much of the committee's input. While the scientific complexity, need for additional stakeholder representation, and lack of consensus about air toxics in the study area prevented DEQ and PATSAC from developing the type of ten year plan envisioned in the project charter, PATSAC work resulted in ground-breaking analysis and understanding of toxics problems and potential solutions in the Portland area.

PATSAC and DEQ developed a framework for next steps, including:

- A priority list of air toxics source categories;
- White papers that lay an initial technical foundation for future emission reduction strategies;
- Definition of key considerations;
- Future steps for technical analysis; and
- Future steps for stakeholder involvement, including representation and consideration of environmental justice issues.

1.4 Priority Emission Source Categories

Five categories of emissions are high priority for near term follow up action, including stakeholder consultation, planning, and emission reduction actions. This prioritization is based on total modeled risk, practicability of emission reductions, and the directive in Oregon air toxics regulations to address both area wide and localized risk. The prioritized source categories will guide DEQ and partner actions to reduce toxics. However DEQ and others may take advantage of additional emission reduction opportunities as they arise. The five priority categories are:

- Residential Wood Combustion
- On Road Mobile Light Duty
- On Road Mobile Heavy Duty
- Construction
- Industrial Metals

For all priority categories, it is clear that additional stakeholder consultation will be necessary to thoroughly consider emission reductions. This consultation will allow development of more detailed technical information and more complete consideration of affected stakeholder interests. Future stakeholder processes will also evaluate strategies to achieve emission reductions, and recommend specific actions consistent with the PATSAC considerations, including cost effectiveness, feasibility and benefits analysis as well as options for ongoing improvement. Highlights of recommendations for the priority categories are summarized below.

1.4.1 Residential Wood Combustion

In the category of residential wood combustion, the next steps are to conduct a residential wood heating survey to refine DEQ emission estimates, to implement a regional public awareness campaign to promote cleaner burning techniques, and to improve implementation of the uncertified woodstove change out program, with emphasis on assistance to affected environmental justice communities. DEQ follow-up actions also include evaluation of opacity limits, finding long term funding for woodstove change out, and supporting stronger national standards for new wood heating devices.

1.4.2 On Road Mobile Light Duty Vehicles

For on road mobile emissions, DEQ plans to coordinate with Metro's ongoing regional transportation planning process to reduce vehicle miles traveled (VMT) from light duty vehicles. Under this effort, Metro, DEQ and partners would work to identify sustainable funding for VMT reduction, incorporate air toxics reductions into existing VMT reduction planning and strive to achieve a per capita reduction of 20% of light duty vehicle air toxics emissions by 2035. Other VMT reduction elements include transportation demand management, operation improvements and transit improvements. DEQ plans to advocate for strong national standards for light duty vehicles, adopt California LEV III standards and promote infrastructure for low emitting vehicles. Cleaner fuel recommendations include a life cycle evaluation of air toxics reductions from low carbon fuels, and an evaluation of reformulated gasoline.

1.4.3 On Road Mobile Heavy Duty Vehicles

General strategies to reduce emissions from on road mobile heavy duty vehicles are to identify opportunities for financial support of clean diesel activities and to identify the most effective use of education and outreach. To burn fuel cleaner, DEQ is directed to work with stakeholders to accelerate engine turnover, repowering, and retrofits. DEQ can also work with partners to assess the feasibility and effectiveness at all levels of government of incenting or requiring clean diesel fleets at publically funded projects. To burn cleaner fuel, DEQ can evaluate alternative fuels as well as the need for a technical clearinghouse on environmental benefits of alternative fuels. To burn less fuel DEQ can evaluate efficiency measures, and current idling restrictions in Oregon and other jurisdictions.

1.4.5 Construction Equipment

Recommendations in this category direct DEQ to conduct a survey of construction equipment in the Metro area. This would better define equipment characteristics, improve emission estimates, and inform reduction strategies. Other general strategies include evaluations of an equipment registration system and evaluation of the impacts of high emission equipment imported from California. DEQ can identify opportunities for financial support of clean diesel activities as well as the role of education in promoting clean diesel activities. Strategies to burn fuel cleaner include acceleration of engine turnover, repowering and retrofits, and evaluation of requiring clean diesel equipment on publically funded projects. To burn cleaner fuel, next steps include evaluation of alternative fuels and a technical clearinghouse on alternative fuels. To burn less fuel, DEQ and partners can evaluate efficiency measures and the feasibility of idle reduction for construction equipment, including private and other jurisdictions' idle reduction programs.

1.4.6 Industrial Metals

For industrial metals facilities DEQ would refine emission estimates using facility-specific models and improved emission characteristics. DEQ would encourage facilities with modeled impacts above benchmarks to make voluntary early reductions, and as with all the other high priority categories, convene a stakeholder process to identify and evaluate strategies to achieve emission reductions.

1.5 Additional Technical Information

The PATS process highlighted several areas in need of data refinement for better understanding of emissions, potential risks and possible emission reduction strategies. With assistance from EPA and other state and local partners, DEQ would develop additional and more accurate information in the following areas:

- Methylene chloride
- Secondary formation pollutants
- Cadmium
- Arsenic
- Additional Monitoring Studies

1.6 Next Steps

In collaboration with PATSAC, DEQ identified several important future considerations for implementing emission reduction strategies. For many categories of emissions there are common potential future needs:

1) continuous improvement in achieving emission reductions,
2) responding to growth in emissions,
3) providing the best quality information about air toxics, and
4) mitigating exposures in ways that complement reduction strategies.

DEQ understands through comments received and group discussion that many PATSAC members support the next steps stated in this section. However, the report and recommendations do not represent the views of all PATSAC members. DEQ will seek further comment from the public and stakeholders before finalizing this proposal for presentation to the Environmental Quality Commission.

At the time of this report, DEQ has exhausted the funding for ongoing air toxics work. However, because air toxics are produced by many of the same sources that produce particulate, ozone precursors and greenhouse gases, DEQ will link efforts to reduce all of these pollutants in a comprehensive approach. While DEQ will coordinate local air toxics reduction efforts, it is also relying on partnerships and collaborations with local agencies and communities for resources and for strategy implementation.

2. Introduction

2.1 Preamble

This report is a culmination of a two year effort by 29 Portland Air Toxics Solutions (PATS) advisory committee members and DEQ, representing the largest and most diverse stakeholder groups in DEQ's history. Between August 2009 and October 2011, the committee worked to develop a comprehensive air toxics plan with aggressive reduction goals for the Portland region. Developing the PATS emission reduction plan was a long and technically difficult process that is unique in Oregon and nationally. According to the committee charter, the goal for the final report was to catalogue a set of consensus recommendations. Throughout the two year process, committee members discussed and advised DEQ on methods of analysis, emission reduction goals, prioritization of emission sources, environmental justice impacts, potential actions, and a blueprint for next steps. DEQ drafted recommendation language for the committee in an attempt to capture the full range of committee member perspectives.

At their last meeting in October 2011, committee members and DEQ discussed the most accurate and beneficial way to represent committee discussions and accomplishments in the context of diverse opinions and the lack of consensus. DEQ initially proposed to author its own report incorporating the input of committee members. However, for greatest transparency, and to recognize the extensive contributions of committee members, DEQ has chosen to present the PATS report as a committee work product. While the recommendations included in the report reflect best efforts at consensus, the report does not imply endorsement by all members. Committee members' comments and letters are included in Appendix 12.13. In addition, DEQ will be conducting a public comment process on the PATS report and recommendations to be summarized and presented to the Environmental Quality Commission.

2.2 Background – Description of Community Based Air Toxics Reduction Project

2.2.1 Objectives and Progress

The Portland Air Toxics Solutions (PATS) project is a community-based air toxics reduction effort under the state Air Toxics Reduction Program in Oregon Administrative Rules 340-246-0010 through 0230. (see Appendix 12.1) The purpose of Portland Air Toxics Solutions (PATS) is to improve public health by meeting or making progress towards air toxics risk reduction goals. The objectives of PATS are to:

- Designate the Portland area as the first Air Toxics Geographic Planning Area;
- Use data to clearly describe emissions, risks and reduction opportunities;
- Conduct a representative stakeholder process that addresses Portland air toxics needs, regulatory requirements, and community values;
- Produce an emission reduction plan that meets OAR 340-246 criteria and is clear, realistic and measurable;
- Reduce risk from air toxics; and
- Develop a model geographic planning process that could be used in other Oregon communities.

To accomplish PATS objectives, DEQ formed Portland Air Toxics Solutions Advisory Committee (PATSAC), a broad based stakeholder group. The PATSAC membership is included in Table 1. PATSAC advised DEQ on a broad range of topics, including study methodology, data sources, and potential emission reduction strategies. EPA and DEQ data show that some sources of air toxics are area-wide, such as motor vehicles, wood stoves, and other citizen related activities. Other air toxics have impacts on localized areas. The dispersed, widespread nature of most of the emissions makes reducing air toxics challenging. In order to successfully reduce risk posed by area-wide air toxics, it is critical to involve local governments, nonprofits, business leaders, neighborhood groups, and residents in the area to form partnerships and collaborations that will reduce emissions in the community.

The 29 member PATSAC provided DEQ with a wide cross section of views and expertise, and helped DEQ develop a roadmap or next steps to address air toxics in the Portland area. DEQ and the committee had many challenging discussions about the fundamental science of air toxics, estimating emissions and risk, options for reducing emissions, and many other technical, economic and community considerations influencing strategy choices. DEQ's expertise in air toxics, as well as the state air toxics program greatly benefitted from this challenging work.

DEQ sincerely acknowledges and lauds the great progress and advances made as a direct result of PATSAC work. PATSAC reviewed the study methodology, data sources, emissions and modeling results. During review and discussion of the technical study, PATSAC members voiced many perspectives and suggested improvements that added high value to both the technical study and process of developing an emission reduction plan. While it proved difficult to accomplish all of the goals ambitiously stated in air toxics regulations, PATSAC enabled DEQ to analyze and develop an understanding of toxics problems and potential solutions in the Portland area. In addition to this analysis, PATSAC helped DEQ develop:

- A priority list of air toxics categories;
- White papers that lay an initial technical foundation for future emission reduction strategies;
- Definition of key considerations;
- Future steps for technical analysis; and
- Future steps for stakeholder involvement, including representation and consideration of environmental justice issues.

DEQ also acknowledges and values the many collateral advances resulting from PATSAC work. DEQ could not have achieved these significant results without the effort, expertise and perseverance of PATSAC members. These advances include:

- A practical approach to screening and understanding Toxics Release Inventory data for permitted facilities;
- An enduring data quality ranking system; and
- DEQ's first air quality Environmental Justice analysis using census and GIS based data.

The complexity and broad scope of air toxics in the study area were challenges to DEQ and the committee in developing a full and detailed air toxics reduction plan as originally envisioned under the Geographic Approach of the Oregon Air Toxics Regulations. DEQ and PATSAC spent ten of their fourteen meetings working through data issues to develop a common understanding of air toxics sources and problems in the study area. While the PATS advisory committee was large at 29 members, the broad spectrum of sources considered in the technical study included interests that went beyond committee representation. During the process it became clear to DEQ and PATSAC members that additional stakeholder consultation is needed to thoroughly consider emission reductions in individual priority categories. This consultation will allow development of more detailed technical information and more complete consideration of affected stakeholder interests.

In developing emission reduction plans for high priority categories, DEQ will continue to strive towards the objectives stated above and in the program regulations. Section 2.4 of this report discusses next steps for developing and implementing the Portland Air Toxics Solutions Plan. Section 9 includes identification of source categories, recommendations for emission reduction options and guidance for future stakeholder consultation.

2.2.2 Scientific Foundation for PATS

PATS began in response to knowledge gained from the U.S. Environmental Protection Agency's (EPA) National Air Toxics Assessment[1] (NATA) and the Portland Air Toxics Assessment[2] (PATA). NATA models pollution impacts on a nation-wide scale, and PATA modeled information specific to the Portland Metro area. Information on air toxics risk gained from both NATA and PATA helped in the selection of a geographic area for strategic reduction of air toxics.

Based on ranking of county air toxics risk statewide, DEQ selected the Portland area as the first community to participate in geographic air toxics reduction planning. While the risk from air toxics in the Portland region is similar to other large urban areas around the country, DEQ selected this area because it has the highest public health risk from air toxics in Oregon. The PATS project and study area includes portions of Multnomah, Clackamas and Washington Counties. DEQ also involved Clark County Washington near Vancouver and a portion of Yamhill County, since these areas share the same air shed as the Portland metro area.

Air toxics are pollutants suspected or known to cause serious health problems including cancer, birth defects, organ damage and respiratory irritation. Sensitive populations, which include children, older adults, people who work outdoors, athletes who exercise outdoors, people with asthma or other breathing problems and heart disease, are especially vulnerable to air toxic emissions.

There are many different pollutants in the Portland air shed, including criteria pollutants with federally mandated air quality standards and air toxics with no federal ambient standards. Pollution levels fluctuate with the season, weather, and community behavior patterns. While the Portland-Vancouver air shed met all existing federal standards for criteria pollutants at the time of this report, various air toxics are above Oregon benchmark levels, or are projected to be above benchmarks levels in 2017. In order to determine which pollutants will be above air toxics benchmarks and understand their emission sources, DEQ modeled air toxics for 2005 and a projected year of 2017, and considered monitoring data for the Portland area.

PATS is distinct from other air toxics control efforts to date because it evaluates risk holistically to produce an area-wide plan to decrease emissions from sources roughly commensurate with their contribution to problems. DEQ's collaboration with a diverse advisory committee and other interested stakeholders provides a representative public the opportunity to work with DEQ and build partnerships to implement the emission reduction strategies for the PATS study area.

At the time of this report, DEQ has exhausted the funding for ongoing air toxics work. However, because air toxics are produced by many of the same sources that produce, particulate, ozone precursors and greenhouse gases, DEQ will link efforts to reduce all of these pollutants in a comprehensive approach. While DEQ will coordinate local air toxics reduction plans, it is also relying on partnerships and collaborations with local agencies and communities for resources and for strategy implementation.

2.3 Program History and Context

Historically, EPA and DEQ have focused on criteria pollutants[3], which are six air pollutants with federal standards or limits. In the past, the criteria pollutants carbon monoxide, ground level ozone, and particulate matter were above federal ambient concentration standards in the Portland area. DEQ has successfully reduced these pollutants below federal standards, so that the Portland-Vancouver air shed currently meets all federal criteria pollutant air standards; and DEQ works with businesses and the public to maintain these air standards.

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[1] http://www.epa.gov/nata/

[2] http://www.deq.state.or.us/aq/toxics/pata.htm

[3] Criteria pollutants are ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur oxides and lead.

Air toxics make up a second category of pollutants that have no federal concentration limits but, through typically long term, low-level exposure, pose the risk of serious health problems such as cancer, organ, nervous system, or respiratory damage. As more science on air toxics emerged, EPA responded by developing national control requirements for various categories of industrial emissions. In the Federal Clean Air Act, the EPA lists 187 toxic or hazardous air pollutants to reduce from industry and business activity. At this level, EPA has established many regulations that specifically decrease air toxics from large industries to small businesses. EPA has also established many regulations for new on-road vehicles (like cars and trucks), off-road vehicles (like construction equipment, trains and recreational boats), and small portable engines (like generators and landscape equipment). While the focus of these regulations is to minimize the emission of criteria pollutants, they also reduce air toxics. The federal program is far-reaching; however, it does not address the emissions of air toxics from the larger pool of existing vehicles, equipment and other unregulated sources in communities, or risk from cumulative emissions caused by many sources in urban areas. Even with fully phased-in federal standards to reduce air toxics, communities will still experience levels of air toxics above Oregon's health-based benchmarks. To address the need to lower risk from air toxics, Oregon implements its own risk based air toxics program to supplement federal efforts.

To implement the state of Oregon program, DEQ employs a three-part system to address all sources of air toxics. First is a focus on categories of sources or activities that emit air toxics statewide, like woodstoves, diesel engines, and open burning. These are known as sector strategies. Second, the geographic strategy (such as the Portland Air Toxics Solutions) focuses on communities where people experience the most risk, in larger cities and highly populated areas. Third is an opportunity to address the rare case where pollutants from a specific facility are not fully controlled and pose problematic levels of risk to people living nearby.

In 2003, the Environmental Quality Commission[4] adopted Oregon's state air toxics program. (See Appendix 12.1 for air toxics regulations and program information) At the heart of the Oregon geographic strategy is the idea of evaluating risk holistically from all sources in an urban area, and developing an area-wide plan to reduce risk from point, area and mobile sources commensurate with their contribution to emissions above clean air goals. The program is also designed to address risk from source categories or individual sources that are not otherwise regulated by federal standards.

In 2006, the program took a major step forward when the Environmental Quality Commission adopted ambient benchmark concentrations (ABC) for 51 air toxics in Oregon. The benchmarks are set at levels protective of human health over a lifetime of exposure, and are based on recommendations of our Air Toxics Science Advisory Committee. The benchmarks serve as both measurement tools and goals, allowing analysis of air toxics problems, prioritization of projects, and tracking of progress in risk reduction in the absence of federal standards. The ABCs are expressed as annual average concentrations that would protect human health during a lifetime of exposure. The Air Toxics Science Advisory Committee reviews the ABCs at least every five years, or more frequently if important new health or scientific information arises.

2.4 PATSAC Purpose and Charter

In August 2009, DEQ convened PATSAC, a broad based stakeholder group tasked with recommending the elements of a Portland air toxics reduction plan to DEQ and the Environmental Quality Commission. The purpose of the committee was to conduct a representative stakeholder process to address Portland air toxics needs, regulatory requirements, and community values; and to produce a set of recommendations that met emission reduction goals and regulatory requirements and that are clear, realistic and measurable. DEQ met with this diverse advisory committee and other interested stakeholders to develop an air toxics reduction

[4] The Environmental Quality Commission is a five-member citizen panel appointed by the governor to four-year terms, serving as Department of Environmental Quality's (DEQ) policy and rulemaking board.

strategy that fosters innovation, improves partnerships, and builds support to carry out emission reduction strategies. PATSAC included representatives from neighborhoods, public interest organizations, government health and transportation departments and business. PATSAC considered the best available science and information available at the time. The PATSAC Charter and Operating Principles can be found in Appendix 12.2.

2.4.1 Process

Requirements for a local air toxics advisory committee, such as PATSAC, are contained in Oregon Administrative Rules 340-246-0170 (1) through (4). See Appendix 12.1 for Oregon rules related to air toxics. PATSAC met 14 times from August 2009 to October 2011. Throughout the process, the committee collaborated with DEQ to improve the quality of technical information, discuss prioritization of emission categories, and explore potential emission reduction options. A detailed description of the PATSAC process is found in section 2.4.1.2.

The PATS effort focused on air toxics measured or modeled above ambient benchmarks in the study area. While reducing the highest risk air toxics was a priority for PATSAC and DEQ, the committee also considered multi-pollutant benefits, including green house gas and criteria pollutant reductions, as well as many other considerations described in section 2.4.3.2 of this report. PATSAC evaluated air toxics emissions from all types of sources.

State air toxics regulations state that when feasible, PATS emission reduction plans will be designed to reach air toxics levels that are equal to or below ambient benchmark concentrations as expeditiously as possible, with a base goal of 10 years from the date of Environmental Quality Commission approval. Because emission reduction next steps reached the point of identifying priority categories, each with a roadmap for further stakeholder work and reductions, this report does not include a proposal for specific reduction requirements, milestones or ten year goals. These elements will be incorporated for each priority category in future collaboration with an additional stakeholder process.

"Feasibility" is not defined in DEQ's air toxics regulations, but is generally understood to require consideration of practical, economic, social, scientific, and health factors for each pollutant and associated source. Because diesel particulate matter, polycyclic aromatic hydrocarbons (PAH), and benzene are produced by engines and combustion sources, which are ubiquitous, it may not be feasible to reduce emissions quickly enough to reach benchmark levels within ten years from approval of an emission reduction plan. Background pollutants also affect the feasibility of reaching benchmarks, especially for pollutants with a high level of atmospheric formation, like formaldehyde and acetaldehyde.

Once DEQ and partners establish emission reduction plans, DEQ will periodically evaluate progress using both monitoring and modeling data. For pollutants that cannot be monitored, only modeling will be used. For those that can be monitored, DEQ will still rely primarily on modeling data and check it against monitored values. Unlike monitoring data, which is limited to measuring only the area near the monitor, modeling data provides estimates for every census block in the entire PATS study area.

2.4.1.1 Representation

DEQ greatly appreciates and values the time, interest and effort of PATSAC members and ex-officio members who attended 14 meetings over a two year period. Table I below shows PATS membership at the time of the committee's final meeting in October 2011. Workload and employment shifts caused some change in membership during the PATS project, but the majority of core interests were consistently represented. DEQ also thanks members who served on the committee for part of the process: Jeri Williams, Portland Office of Neighborhood Involvement, Jennifer Baldwin, American Lung Association of Oregon, Mark Turpel, Metro

Regional Government, Steve Mason, The Boeing Company and Charles Lapin, Western States Petroleum Association.

Table 1: PATS Advisory Committee Members as of October 17, 2011

Lisa Arkin, Oregon Toxics Alliance	Debra Dunn, Oregon Trucking Associations	Sandra Galganski, Oregon Metal Industry Council
Aubrey Baldwin, Pacific Environmental Advocacy Center	David Farrer, Oregon Public Health Division	Jim Norman, Oregon Department of Transportation
Nick Bouwes, North Portland	Warren Fish, Multnomah County Office of Sustainable Development	John Ostar, OPAL
Matt Bihn, Metro Regional Government	Toby Harris, Washington County Health Department	Mary Peveto, NW Portland Neighbors for Clean Air
Dan Bower, Portland Department of Transportation	Eric Hesse, TriMet	Eben Polk, Clackamas County Office of Sustainability
Dave Breen, Port of Portland	Dona Hippert, Oregon Toxics Alliance	Vivek Shandas, Portland State University
Daniela B. Cargill Southwest/Downtown Portland	Charles Lapin, Western States Petroleum Association	Scott Stewart, Intel Corporation
Ben Duncan, Multnomah County Health Department	Sia Lindstrom, Washington County Administrative Office	Carter Webb, Associated Oregon Industries
Carrie Nyssen, American Lung Association		

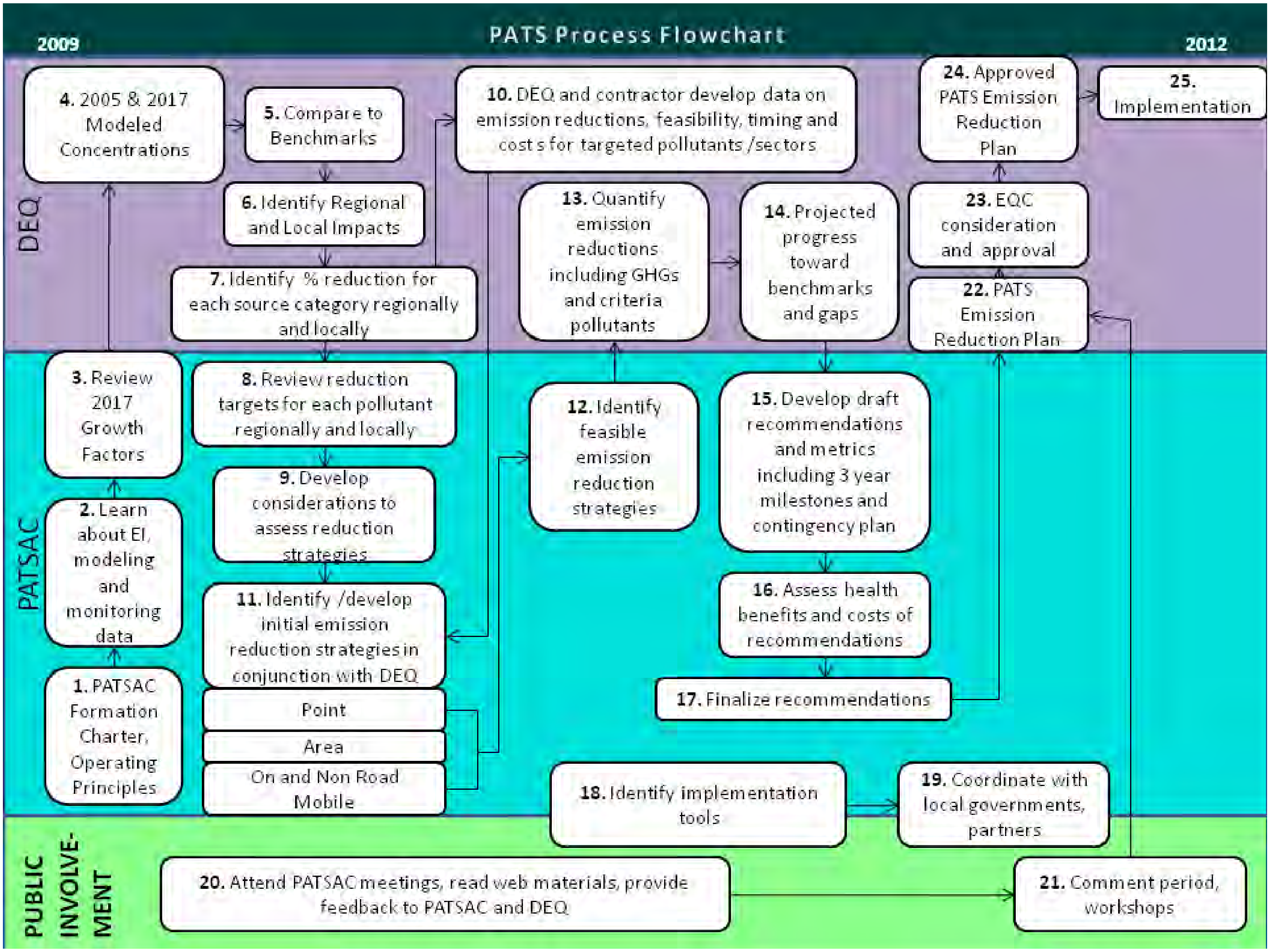
PATS Advisory Committee Ex-officio Members

Merlyn Hough, Lane Regional Air Protection Agency	Natalia Kreitzer, Southwest Clean Air Agency	Michael McNickel, Yamhill County Public Health
Bob Palzer, Sierra Club		

2.4.1.2 PATS Process Flowchart

Figure 1 illustrates the PATS process. The Process Flowchart is divided into three categories of activity: DEQ's, PATSAC's, and interested persons or the public. For reasons described in 2.2.1, Objectives and Progress, PATS reached partially into step 15 of the flowchart. The steps in the flowchart are described below.

Figure 1: PATS Process Flowchart



1. The first PATSAC step was formation, charter and operating principles. (See Appendix 2.2)
2. A concurrent early and ongoing step for the committee was building an understanding of data DEQ has developed to inform the PATS process. This data includes:
   - DEQ Air Toxics Benchmarks (See section 3.2)
   - Emission Inventory (2005 base year, 2017 projection) (See section 3.4)
   - Modeling (2005 base year, 2017 projection) (See section 3.5 for an overview and section 4 for modeling results)
   - Monitoring (2005 base year) (See section 3.6)
3. PATSAC and DEQ reviewed draft 2017 growth assumptions for air toxics in the PATS study area. (See section 3.4) This information is the foundation and base case for understanding source category contributions and emission reduction strategies. 2017 growth assumptions include:
   - Projections for economic recovery and growth, including population growth
   - Existing emission control regulations
   - Emission control regulations to be phased in from 2011 to 2017

4. After PATSAC gave DEQ feedback to fine-tune the 2017 growth assumptions, DEQ used the emission inventory and the PATS model to generate 2017 estimated concentrations. 2005 was used as a base to estimate 2017. (See section 3.5 for a modeling overview and section 4 for modeling results)
5. DEQ compared 2017 modeled concentrations throughout the PATS study area to ambient benchmark values, which serve as air toxics clean air goals. DEQ compared modeled concentrations rather than modeled exposures to the benchmarks. Air toxics regulations direct DEQ to use concentrations to determine progress toward benchmarks, which is more conservative and protective of human health. Modeled concentrations also compare better to monitoring data. See section 4 for further discussion of modeled concentrations vs. modeled exposure concentrations.
6. DEQ's analysis of modeling data considered average concentrations across all census tracts, as well as localized impacts in much smaller areas of one to several census tracts.

7. & 8. DEQ calculated how much emission reduction is needed for each pollutant for each source category both regionally and locally, expressed as percentages. The reduction targets for each category are roughly commensurate with source category emission contributions. The targets do not take feasibility or economics into consideration, but serve as starting point for proposed reductions.

9. PATSAC developed criteria or considerations to evaluate emission reduction strategies. Several emission reduction plan criteria are listed in the air toxics rules. PATSAC also developed other important considerations for implementing emission reduction strategies. Several considerations became core concepts to evaluate potential reduction strategies. (See section 2.4.3)

10. & 11. Through brainstorming, assistance from DEQ's contractor Eastern Research Group and consultation with partners, PATSAC and DEQ developed a comprehensive list of potential emission reduction strategies.(See section 6 and Appendix 12.9) DEQ and Eastern Research Group analyzed emission reduction strategies for priority categories in a series of white papers. This assured that PATSAC could consider a full array of emission reduction options and have more detail in technical areas than DEQ would otherwise be able to support. DEQ and the contractor developed white papers detailing potential emission reduction strategies. (See section 6 and Appendix 12.9)

12. PATSAC discussed roughly commensurate reductions from all categories and applying core considerations to engage in discussions towards draft recommendations. (for information on core considerations, see section 2.4.3) Because of the large number of sub-categories and pollutants, this was a high-level approach allowing a framework for future development.
13. The white papers quantify emission reductions from strategies where possible, including greenhouse gases, ozone and particulate. (See section 6 and Appendix 12.9).
14. The white papers contain information on potential emission reductions and potential gaps between emission reductions achievable and the target benchmarks. (See section 6 and Appendix 12.9)

15, 16 & 17. Considering committee comments, DEQ drafted the next steps for emission reductions. Health benefit assessment, milestones and contingency planning will follow as DEQ and partners are able to address emission reduction planning for priority categories.

18 &19. During development of the emission reduction plan, DEQ and the committee identified implementation tools and coordination with local governments and partners needed for implementation. DEQ requested that committee members begin the process of coordinating with their organizations and working to identify implementation tools early in the process.

20. In the area of public involvement, DEQ encouraged interested persons to engage in the meetings, become informed and provide feedback. A public comment period was held at every meeting. Committee members were responsible to engage with their affiliated colleagues and interested persons.

21. After assembling a draft proposal, DEQ will host public workshops and conduct a comment period on the recommended plan.
22. DEQ will take PATSAC recommendations and public input to form a final proposal for PATS emission reduction planning.

23 & 24. The Environmental Quality Commission will have an opportunity to learn about, discuss and approve the final PATS emission reduction plan.
25. Because air toxics are produced by many of the same sources that produce, particulate, ozone precursors and greenhouse gases, DEQ will work with partners to link efforts to reduce all of these pollutants in a comprehensive approach to maximize co-benefits.

2.4.2 Elements of the PATS Emission Reduction Plan

The following plan elements are identified in Oregon Administrative Rule (OAR) 340-246-0170. PATSAC considered each of these possible plan elements in discussing potential emission reduction strategies. These elements will continue to guide development of emission reduction strategies for priority categories.

Voluntary and Mandatory Strategies. The plan may contain a mix of voluntary and mandatory emission reduction strategies that may be administered region-wide or in separate jurisdictions. Depending on the type of source, the plan may include public education, pollution prevention, economic incentives and disincentives, technical assistance, local ordinances and DEQ regulations.

Proportionality. The plan must include emission reduction measures that are roughly commensurate with source contributions, considering relative emissions, toxicity, exposure, technical feasibility, cost effectiveness, public health and the economic impacts air toxics have on public health and equity. The plan will include commensurate reductions from point, area and mobile sources. The commensurate contribution from any particular source or source category will vary depending on whether the impacts are evaluated at a regional or local level. Both scales are valid and must be evaluated.

Milestones. The PATS emission reduction plan will include milestones to be evaluated by DEQ and PATSAC representatives. If DEQ finds lack of progress at designated milestones, it will consult with PATSAC to evaluate the need for corrective measures.

Regulatory Coordination. The plan elements must be coordinated with other local, state and federal requirements to the extent possible.

Data Elements. If necessary, the plan will include specific recommendations to develop ongoing emissions inventory or ambient monitoring to track local air toxics trends.

Address Wide-Spread and Localized Impacts. The plan must include strategies to reduce concentrations of air toxics above ambient benchmark concentrations in smaller portions of the geographic area, as well as pollutants causing risk above benchmarks throughout the study area.

Contingency Plan. The plan must include a contingency plan to be implemented if the year six evaluation shows lack of progress toward milestones and is projected to fall short of the ten year goals. The contingency plan must include, but is not limited to, re-evaluation of planning assumptions, evaluation of existing conditions and effectiveness of emission reduction strategies and new or progressively more stringent strategies to be considered.

2.4.2.1 Issues Included in PATSAC Consideration

In considering emission reduction strategies, PATSAC used monitoring and modeling analyses to understand air toxics in the study area, including distribution of concentrations, causes, and potential solutions. PATSAC considered solutions for the entire study area as well as smaller areas where people are exposed to air toxics above benchmarks because of localized source emissions. Based on DEQ's environmental justice analysis, PATSAC also began to consider adverse impacts on sensitive or vulnerable populations and environmental justice communities.

2.4.2.2 Issues not Directly Related to PATSAC Recommendations

To focus the scope of the PATS project, DEQ did not seek direct recommendations on the issues listed below. However, DEQ documented committee input on these issues and, when possible, will refer them for follow-up in an appropriate forum.

- Ambient benchmark concentrations
- Statewide air toxics regulations
- Conditions to be placed directly in the permit of a specific regulated source, though strategies may include pollution reductions from types of stationary sources identified as significant contributors to ambient concentrations and exposures above benchmarks.
- Worker exposure
- Measures specifically designed to improve indoor air quality

2.4.3 Emission Reduction Considerations/Criteria

The advisory committee and DEQ used "core" considerations, as well as a number of other important considerations, in developing recommendations. The core considerations include the magnitude of reductions achieved by a strategy, the timeframe to reduce emissions, the technical feasibility of a strategy, and the cost of a strategy. All of the considerations are listed in section 2.4.3.2.

2.4.3.1 PATS Threshold Regulatory Requirements

DEQ regulations directed DEQ and the advisory committee to focus in certain areas:

- The PATS emission reduction plan must focus on air toxics measured or modeled above ambient benchmarks in the PATS study area. (OAR 340-246-0170 (4)(1))
- Mandatory emissions reduction strategies must be commensurate with source contributions, considering relative emissions, toxicity, technical feasibility, cost-effectiveness and equity. (OAR 340-246-0170 4(f)). The methodology for considering percent reduction targets used percent contributions for each category and ranked them according to total risk achieved commensurate reduction goals.

2.4.3.2 Considerations

PATSAC and DEQ developed a list of considerations as an informal tool to evaluate toxics reduction strategies. DEQ expects that these considerations will be useful to future stakeholder groups tasked with developing emission reduction strategies.

1. **Effectiveness**
   a. **Magnitude**: amount of each air toxic reduced by the strategy.
   b. **Timeframe:** Length of time required by strategy to reduce emissions. How readily are results measureable? (OAR 340-246-0179 4(d))
   c. **Effect on exposures**: How well does the measure target spatial extent of the emissions? Some reductions may have more pronounced effects on localized concentrations; others may do more to reduce pollutants area-wide. (OAR 340-246-0170 4(g)). Ability to address short term or acute exposures if relevant.
   d. **Pollution prevention**: Where does the strategy fit in the pollution prevention hierarchy? 1. Modify the process, raw materials, or product to reduce the quantity and toxicity of air contaminants generated. 2. Capture and reuse air contaminants. 3. Treat to reduce the quantity and toxicity of air contaminants released. (OAR 340-246-0050)
   e. **Other pollutants**: Effect of measure on criteria pollutant emissions, greenhouse gas emissions, and

emissions of other priority toxic substances on the DEQ Agency Wide Toxics List

2. **Implementability/Feasibility/Barriers**
    a. **Legal authority**: Does the measure fall under existing regulations or are new laws/ rules required? Does federal pre-emption preclude new laws/rules? Is/will the proposed measure be addressed through other planned Federal, state, or local rulemaking or other processes?
    b. **Technical feasibility**: How well will the emission reduction measure work from an engineering and/or logistical perspective? Is the technology or fuel readily available? (OAR 340-246-0170 4(f)). Is the technology EPA or third party verified/certified?
    c. **Funding**: What is the cost to DEQ or other agency to implement the measure? How could the agency cost be funded? How certain is the funding mechanism?
    d. **Implementation**: Is there a ready structure for implementation or ability to coordinate with existing programs?
    e. **Acceptance**: Is there public and stakeholder support for the measure?
    f. **Non-regulatory approaches**: Could the measure be implemented through incentives or education? Is there an opportunity to implement the measure through a community-based multi-stakeholder collaborative process? Could the measure begin as voluntary and later become mandatory as necessary in a contingency plan?

3. **Cost**
    a. **Cost**: What is the cost of emission reduction measure and implementation (OAR 340-246-0170 4(f))? If the measure is a regulation, what is the cost of compliance? If the measure is an incentive, what is the cost of the incentives?
    b. **Cost effectiveness**: What is the cost per unit of air toxics reduced?
    c. **Other environmental impacts**: Potential for the emission reduction measure to transfer pollutants to soil or water, or cause harm to human health or the ecosystem.
    d. **Energy**: Effect of measure on energy use.
    e. **Public safety**: What is the affect of the measure on public safety? For example, would emission reductions restrict activities related to adequate lighting, heat, ventilation, signage or access to emergency services?
    f. **Indirect economic costs**: What are the potential indirect costs to communities, the local economy or business sectors?

4. **Benefits**
    a. **Health**: What are the health benefits of meeting the benchmarks? This could be measured as the number of cancer cases avoided and/or value of statistical life and medical costs avoided.
    b. **Livability**: Improved quality of life associated with improved nuisance conditions such as odor or noise.
    c. **Indirect economic benefits**: What are the potential benefits to communities, the local economy or business sectors?

5. **Distribution of Benefits and Costs**
    a. **Risk distribution**: Could the measure change the social distribution of risk in the PATS area, i.e. sensitive populations and environmental justice communities?
    b. **Cost distribution**: Could the measure impose disproportionate costs or economic impacts to environmental justice communities in the PATS study area?

2.5 Next Steps and Implementation

2.5.1 The Plan is a Framework

The framework of the Portland Air Toxics Solutions plan relies on three action pathways that strategies and recommendations can follow. These are: (1) strategies that are ready to implement, (2) strategies that need refinement prior to implementation, and (3) strategies to improve the information for a pollutant. The three action pathways are described in detail below and illustrated in Figure 2 on page 13. For information on the prioritized source categories and recommended strategies, please refer to section 9, "Next Steps." Given the reality of implementation timeframes and resource limitations, DEQ will only be able to commence strategies as resources allow.

2.5.1.1 Ready to Implement Emission Reduction Strategies

These strategies are well defined, do not require additional development or rule authority, and can be implemented immediately or have begun and are directly related to PATS goals. Examples include:

- Point – The ESCO metal facility "alternatives analysis" process. ESCO negotiated directly with the Northwest District Association and Neighbors for Clean Air regarding a number of emission control improvements. The final negotiated improvements and implementation schedule were incorporated into ESCO's Title V permit renewal.
- Area – Area source NESHAPs (recently adopted), Heat Smart Rules (wood stove rules). With NESHAPs, there is a three-year duration for the NESHAP inclusion into the permit and compliance by the source.

2.5.1.2 Strategies That Need Refinement

This action pathway includes strategies need further scoping, rulemaking, funding, development, or data refinement. This also includes source categories where a strategy or strategies needs to be selected to achieve emission reductions. In many cases, DEQ will need to convene advisory committees related to the specific source sectors, and possibly the source categories themselves. The members of these committees may include members of PATSAC, in addition to technical support staff and local government staff. Each of these committees would be tailored to the expertise that would be most appropriate for aiding in the development or selection of the strategy. Examples include:

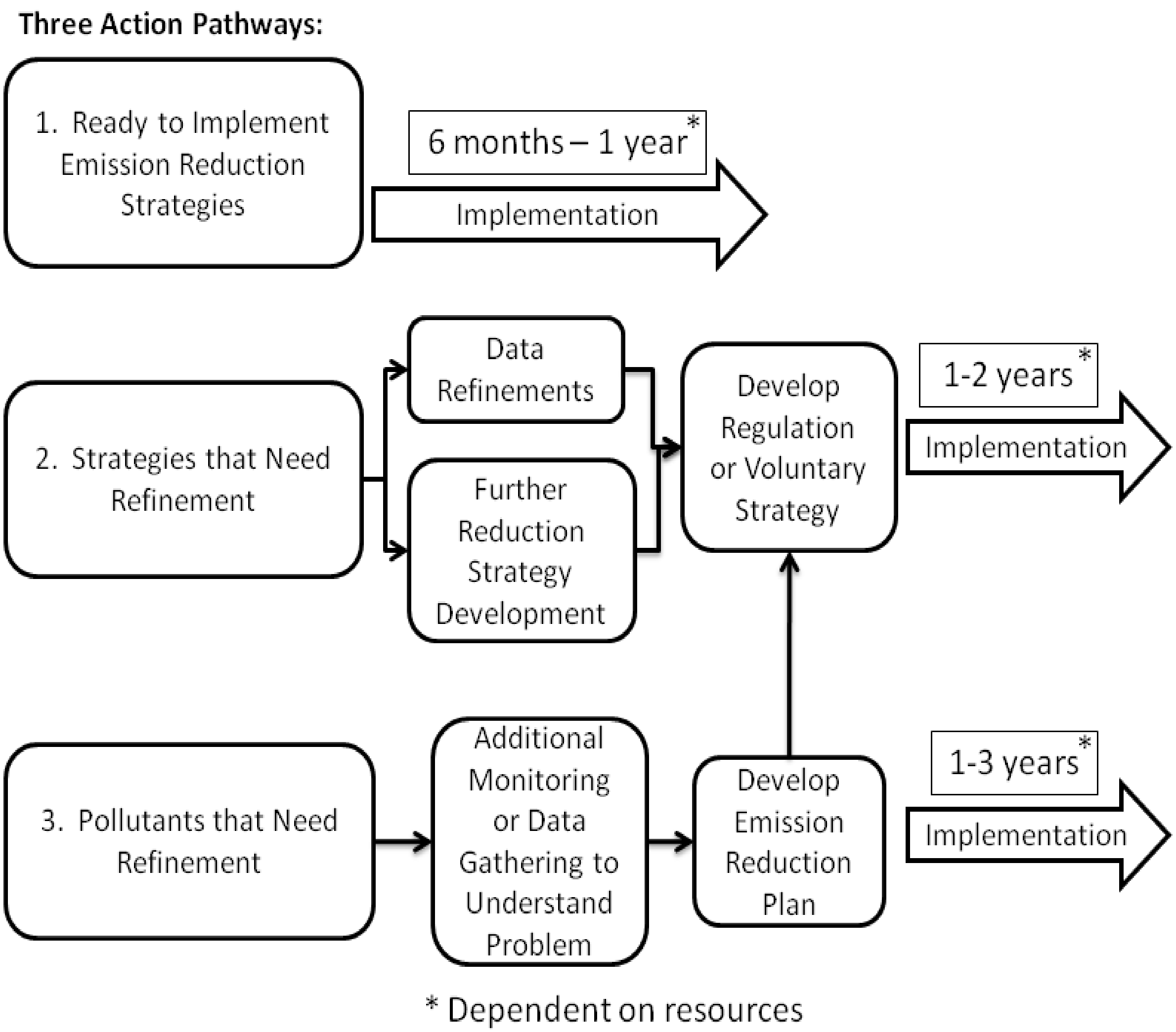
- Area – Strategy implementation of any rule or incentive program would require further development.
- Mobile – Vehicle miles travelled reduction strategies (Metro) are currently under development, but analysis will continue beyond 2011 (House Bill 2001).
- Point – The strategies will be identified here at the framework level, but will be referred to another advisory committee potentially resulting in a rule for the specific point source. It typically takes up to one year for data refinements, another year for the rule making, and up to a two additional years for compliance.

2.5.1.3 Pollutants That Need Refinement – Monitoring, Research, or Data Gathering to Understand Problem

This action pathway includes recommendations for additional monitoring or data gathering to understand various pollutants and problems. This implementation pathway is resource intensive, requiring analyses from agency staff as resources allow. Examples include:

- Methylene chloride – the emission factors from the EPA need refinement. DEQ will need to better understand how much methylene chloride is still in use in the Portland area.
- Cadmium – understanding emission sources in the PATS study area.

Figure 2: Three Action Pathways for PATS Recommendations



2.5.2 Environmental Quality Commission Approval and Public Comment

Following a notice and public comment period, DEQ will present the PATS air toxics emission reduction plan to the Environmental Quality Commission. Because the plan will address many pollutants from many source categories through many emission reduction strategies, it will serve as a framework for reducing air toxics within the PATS study area. If the Environmental Quality Commission approves the plan, DEQ will work with local governments, other state agencies, the Oregon Legislature, the federal government and others to develop the programs needed to implement the plan. This work will take additional time, and will include additional advisory committees engaged in recommending emission reduction strategies.

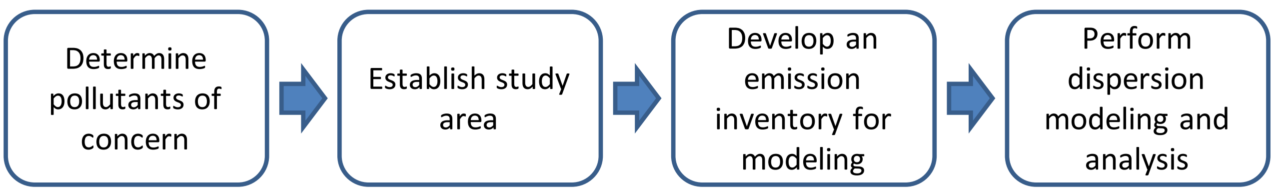
3. Study Methodology

3.1 Introduction to Study Methodology

The goal of PATS is to reduce concentrations of air toxics in the Portland metro area to Oregon's air toxics health benchmark levels in the future, where possible. DEQ has monitoring data to assess which pollutants currently exceed benchmarks near the existing air quality monitoring locations. However, monitoring locations are limited, and emissions change over time with population growth, economic growth, and regulatory emission controls. Therefore, DEQ used both modeling of future emissions and current monitoring to ascertain where air toxics concentrations are likely to exceed benchmarks in 2017. Oregon's benchmarks are described in section 3.2.

Air quality modeling allows DEQ to estimate concentrations in areas where there are no air monitors and to estimate concentrations for pollutants that are not or cannot be measured at monitors. Air quality dispersion modeling is a mathematical approximation or representation of air quality using emissions data, and information about how emissions are dispersed in air (mixed and transported by wind). Steps in the technical analysis are shown in the flowchart below, Figure 3:

Figure 3: Steps in the PATS Technical Analysis



See section 3.2 | See section 3.3 | See section 3.4 | See sections 3.5 and 4

An emissions inventory is a database, by source, of the amount of pollutants discharged into the atmosphere during a given period. An emissions inventory is used as an input to the 2017 model. The model will take the emissions inventory data, locate it spatially in our PATS geographic area, and, using modeling software, estimate pollution concentrations in 2017.

These four technical steps used to develop the 2017 model results are discussed in sections 3.2 through 3.5. Section 3.6 discusses data quality and emissions inventory improvements. Section 3.7 describes 2005 monitoring results, as well as a monitor to model comparison. Results of the air dispersion modeling are described in section 4.

PATS Includes the following components:

- 2005 calendar year emission inventories
- 2017 projected emission inventories
- 2005 air monitoring data for six sites
- 2006 through 2010 air monitoring data for one site
- Air dispersion modeling

3.2 Pollutants of Concern

3.2.1 Ambient Benchmark Concentrations

In 2006, the State of Oregon adopted ambient benchmark concentrations (ABCs) as goals, rather than as enforceable standards, to determine whether or not action is needed to reduce emissions of air toxics. Each air toxic of concern has a benchmark set based on its non-cancer or cancer causing effects, whichever level would be more protective. A carcinogen is any chemical for which there is sufficient evidence that exposure may result in cancer in humans or animals. Non-carcinogens are any chemicals that may cause non-cancer health effects such as respiratory irritation, nerve damage, or developmental problems. An ambient benchmark concentration is the annual average concentration of a toxic chemical in air that a person could breathe continuously for a lifetime without experiencing any non-cancer health effects or without increasing their excess cancer risk (i.e., their risk above the background cancer rate) by greater than one chance in a million.

Oregon's benchmarks were selected solely based on health protectiveness, without regard for economics or engineering feasibility. All of the benchmarks were set using several conservative assumptions, so that there is a large difference in concentration, a margin of safety, between where an effect was actually observed and the benchmark itself. Because of this margin of safety, all benchmarks are below concentrations at which adverse health effects in people most sensitive to air toxics are likely. Thus being above an ambient benchmark concentration does not mean an adverse health effect will occur; only that the margin of safety has been eroded and that additional work will be needed to identify, evaluate, and address a potential air toxics problem. Either modeled or monitored air toxic concentrations can be compared to the benchmarks. For more information on Oregon's air toxics benchmarks, please see Appendix 12.1.

3.2.2 Selection of Pollutants of Concern for 2017 Modeling

In order to determine which pollutants should be included in the 2017 modeling, the PATS team first reviewed monitoring data from calendar year 2005 to identify which toxics were monitored near or above Oregon ambient benchmark concentrations. Then the Portland Air Toxics Assessment (PATA) and EPA national modeling data were reviewed to identify which toxics were modeled near or above Oregon ambient benchmark concentrations. Finally, the team reviewed if any toxics had any new emissions information that would indicate a potential risk; in addition, any developing toxicity data that would be cause for concern was reviewed. After reviewing all the data and information, 19 air toxics were identified for inclusion in the Portland Air Toxics model. A list of toxics, including the rationale for including them, was sent out to persons who chose to be alerted of any news regarding air toxics and specifically, the PATS project. In addition, the list of toxics was made available for review and comment via the DEQ website. DEQ did not receive any substantive comments regarding any of the toxics to be modeled in PATS.

The nineteen toxic air pollutants were selected for air dispersion modeling for one of three reasons:

1) **2005 monitoring data showed the pollutant was near or above Oregon ambient benchmark concentrations.** DEQ analyzed the 2005 monitoring data from the six sites in the area. The following pollutants were identified as being near or above the Oregon ambient benchmark concentration: benzene, polycyclic aromatic hydrocarbons, 1, 3-butadiene, acetaldehyde, naphthalene, arsenic compounds, manganese compounds, cadmium compounds, para-dichlorobenzene, and trichloroethylene. For information on monitoring locations and results, please see section 3.6.

2) **PATA and EPA national modeling data showed the pollutant was modeled near or above Oregon ambient benchmark concentrations.** In addition to the 10 pollutants listed above, the following pollutants were selected based on NATA 2002 modeling results that demonstrated concentrations were near or above the Oregon ambient benchmark concentrations: diesel PM 2.5 (particulate matter 2.5 microns or less in diameter from combusting fuel in a diesel engine), methylene chloride, and 2,4-toluene diisocyanate.

3) Review of new emissions information or developing toxicity data indicated a potential risk. Lead compounds, ethylbenzene, formaldehyde, and perchloroethylene were reviewed by DEQ because of developing toxicity data that was cause for concern. Each pollutant's overall source, data collected and/or observed, and its relationship to the ambient benchmark concentration (ABC) are described below. For more details, please refer to the Air Toxics Pollutant Summary Appendix 12.7.

The pollutants selected for modeling were:

1,3 butadiene
1,4 Para-Dichlorobenzene
15 PAH
Acetaldehyde
Acrolein
Arsenic compounds
Benzene
Cadmium compounds
Chromium VI
Diesel PM 2.5
Ethylbenzene
Formaldehyde
Lead compounds
Manganese compounds
Methylene chloride
Naphthalene
Nickel compounds
Perchloroethylene
Trichloroethylene

After modeling was completed, methylene chloride was dropped from data summaries because of data quality concerns. Two other pollutants, perchloroethylene and trichloroethylene were also dropped from the summaries after modeling showed they would be below the benchmark throughout the PATS study area in 2017.

3.2.3 Description of Pollutants of Concern

This section describes the emission sources, health effects, benchmarks, and 2005 monitoring results for pollutants of concern in the PATS study area. For more information on monitoring, please see section 3.6 and the Monitoring Appendix 12.5.

3.2.3.1 1,3-Butadiene

1,3-butadiene is a pollutant resulting from incomplete combustion from on-road engines, nonroad engines (like lawn and garden equipment), and marine recreational vehicles. Additional sources include petroleum refining, production of rubber and copolymer plastics, forest fires, and cigarette smoke. Epidemiological studies have reported a possible association between 1,3-butadiene exposure and cardiovascular diseases. Epidemiological studies of workers in rubber plants have shown an association between 1,3-butadiene exposure and increased incidence of leukemia. Animal studies have reported tumors at various sites from 1,3-butadiene exposure. EPA has classified 1,3-butadiene as carcinogenic to humans by inhalation.

The ambient benchmark concentration (ABC) for this pollutant is 0.03 ug/m^3 (micrograms per cubic meter); however, 99% of the monitoring data from 2005 was below the minimum detection limit of 0.221 ug/m^3, so an accurate assessment for this pollutant is unknown, which is why DEQ chose to model this pollutant.

3.2.3.2 1,4-Dichlorobenzene

1,4-dichlorobenzene (also para- or p-dichlorobenzene) is used mainly as a fumigant for the control of moths, molds, and mildews, and as a space deodorant for toilets and refuse containers. It is also used as an intermediate in the production of other chemicals, in the control of tree-boring insects, and in the control of mold in tobacco seeds. The general population is mainly exposed through breathing vapors from para-dichlorobenzene products used in the home, such as mothballs and toilet deodorizer blocks. Chronic (long-term) 1,4-dichlorobenzene inhalation exposure in humans results in effects on the liver, skin, and central nervous system. No information is available on the reproductive, developmental, or carcinogenic effects of 1,4-dichlorobenzene in humans. A National Toxicology Program study reported that 1,4-dichlorobenzene caused kidney tumors in male rats and liver tumors in both sexes of mice by gavage (experimentally placing the chemical in their stomachs). EPA has classified 1,4-dichlorobenzene as a Group C, possible human carcinogen.

The monitoring data for this pollutant was below the minimum detection limit, which is 0.6 ug/m^3. Since the ABC is 0.09 ug/m^3, DEQ must rely on modeling data for evaluation.

3.2.3.3 Polycyclic Aromatic Hydrocarbons (15 PAH)

Polycyclic aromatic hydrocarbons: PAHs, like benzene, result primarily from incomplete combustion of carbon-containing materials and so sources again include industrial processes, on-road and nonroad engines, and residential wood combustion. Other sources include commercial wood burning, coal-fired power plants, and municipal waste incineration. Cancer is the major concern from exposure to PAHs. Epidemiologic studies have reported an increase in lung cancer in humans exposed to coke oven emissions, roofing tar emissions, and cigarette smoke; all of these mixtures contain PAH compounds. Animal studies have reported respiratory tract tumors from inhalation exposure to benzo[a]pyrene stomach tumors, leukemia, and lung tumors from oral exposure to benzo[a]pyrene. EPA has classified seven PAHs (benzo[*a*]pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene) as Group B2, probable human carcinogens.

The 2005 data shows that the annual average for PAHs is below the ABC, which is 0.0009 ug/m^3 for total (32) PAHs. PAHs are a group of compounds that have different levels of toxicity and may pose diverse health risks. Toxic equivalent factors were used to scale the individual hydrocarbons to the toxicity level of benzo[a]pyrene, which is the chemical more commonly monitored out of the PAHs.

3.2.3.4 Acetaldehyde

Like the pollutants listed above, acetaldehyde’s is primarily from incomplete combustion. It is also an intermediate in the synthesis of other chemicals (e.g. perfumes, dyes), food preservative, and a solvent in rubber and paper industries. Secondary sources include oxidation of hydrocarbons. Acetaldehyde’s destruction processes include photolysis, reaction with hydroxyls (OH), and wet deposition. Acetaldehyde is considered a probable human carcinogen (Group B2) based on inadequate human cancer studies and animal studies that have shown nasal tumors in rats and laryngeal tumors in hamsters. For 2005, acetaldehyde was measured at three times over the ABC, which is 0.45 ug/m^3.

3.2.3.5 Acrolein

Acrolein is primarily from wood burning, structural fires, and construction. Acrolein is extremely toxic to humans from inhalation and dermal exposure. Acute (short-term) inhalation exposure may result in upper respiratory tract irritation and congestion. No information is available on its reproductive, developmental, or carcinogenic effects in humans. The animal cancer data are limited, but one inhalation study resulted in nasal lesions in rats. EPA considers acrolein data are inadequate for an assessment of human carcinogenic potential. There is no mechanism for measuring acrolein at this time, so there is no monitoring data for 2005, so this pollutant was selected by DEQ for modeling. The ABC for this pollutant is 0.02 ug/m^3.

3.2.3.6 Arsenic

Sources of arsenic are both anthropogenic and natural. Our soils in the Pacific Northwest are naturally high in arsenic because of their volcanic origins. Nationally, sources of arsenic include coal combustion and copper smelting. In Oregon, metal processing, agricultural pesticides, and soil dust are sources of arsenic. An increase in lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. EPA has classified inorganic arsenic as a Group A, human carcinogen. Monitoring data showed North Roselawn and the Kelly and Curry monitoring sites to have peaks of uncertain origin. Since industrial activity is localized, perhaps an anthropogenic influence is present at these sites; however, due to the same reasoning, it is unlikely that the observed regional patterns may be explained by anthropogenic (i.e. industry) sources alone. Oil and natural gas combustion and on-road and nonroad engines are important sources of arsenic. The 2005 annual average was measured four to five times over the ABC, which is 0.0002 ug/m^3.

3.2.3.7 Benzene

Benzene is primarily from incomplete combustion from any burning, including industrial processes, on-road and nonroad engines and from residential wood combustion. Chronic (long-term) inhalation exposure has caused various disorders in the blood, including reduced numbers of red blood cells and aplastic anemia, in occupational settings. Reproductive effects have been reported for women exposed by inhalation to high levels, and adverse effects on the developing fetus have been observed in animal tests. Increased incidences of leukemia (cancer of the tissues that form white blood cells) have been observed in humans occupationally exposed to benzene. EPA has classified benzene as a Group A, human carcinogen. In 2005, Benzene was measured at concentrations six times over the ABC of 0.13 ug/m^3. Benzene has been measured over the ABC at the North Roselawn site since monitoring began in1999.

3.2.3.8 Cadmium

Cadmium is usually found as a mineral combined with other elements. It is produced by refining zinc ores. Most cadmium is used in batteries, pigments, metal coatings, and plastic. Although there is limited human data, an association between cadmium exposure and an increased risk of lung cancer has been reported from human studies, in particular from occupational studies of smelter workers. Cadmium has been shown to be a developmental toxicant in animals, resulting in fetal malformations and other effects. Animal studies have demonstrated an increase in lung cancer from long-term inhalation exposure to cadmium. EPA has classified cadmium as a Group B1, probable human carcinogen. The annual average for cadmium was measured below the ABC, which is 0.0006 ug/m^3 for 2005; but levels have exceeded the ABC on occasion, at both the North Roselawn and Kelly and Curry stations.

3.2.3.9 Chromium VI

Chromium VI is primarily from fossil fuels. It is also released from chemical manufacturing (paint dyes, rubber, and plastics), metal finishing, cement plants, and decomposition of brake linings. The respiratory tract is the major target organ for chromium (VI) toxicity, for acute (short-term) and chronic (long-term) inhalation exposures. Shortness of breath, coughing, and wheezing were reported from a case of acute exposure to chromium (VI), while perforations and ulcerations of the septum, bronchitis, decreased pulmonary function, pneumonia, and other respiratory effects have been noted from chronic exposure. Human studies have clearly established that inhaled chromium (VI) is a Group A, human carcinogen, resulting in an increased risk of lung cancer. Animal studies have shown chromium (VI) to cause lung tumors via inhalation exposure.
The ABC for this pollutant is 0.00008 ug/m^3; however, 94% of the monitoring data from 2005 was below the minimum detection limit of 0.0032 ug/m^3, so an accurate assessment for this pollutant is unknown, which is why DEQ chose to model this pollutant.

3.2.3.10 Diesel Particulate Matter

Diesel PM 2.5 (particulate matter 2.5 microns or less in diameter) is primarily from on-road and nonroad diesel engines, including cars and trucks, construction, marine, and rail sources. EPA states on their website that they have “concluded that diesel exhaust ranks with the other substances that the national-scale assessment suggests pose the greatest relative risk. First, a large number of human epidemiology studies show increased lung cancer associated with diesel exhaust. Furthermore, exposures in these epidemiology studies are in the same range as ambient exposures throughout the United States. In addition to the potential for lung cancer risk, there is a significant potential for non-cancer health effects as well, based on the contribution of diesel particulate matter to ambient levels of fine particles. Exposure to fine particles contributes to harmful respiratory and cardiovascular effects, and to premature mortality." EPA has not developed a cancer potency factor for diesel. There is no monitored data for diesel particulate. The ABC for this pollutant is 0.1 µg/m^3.

3.2.3.11 Ethylbenzene

Ethylbenzene is mainly used in the manufacturing of styrene. Occupational exposure to ethylbenzene occurs in factories that use ethylbenzene to produce other chemicals; in operations that include gas, oil, and varnish, workers, spray painters, and persons involved in gluing operations. Exposure to ethylbenzene occurs from the use of consumer products, gasoline, pesticides, solvents, carpet glues, varnishes, paints, and tobacco smoke. Chronic (long-term) exposure to ethylbenzene by inhalation in humans has shown conflicting results regarding its effects on the blood. Animal studies have reported effects on the blood, liver, and kidneys from chronic inhalation exposure to ethylbenzene. Limited information is available on the carcinogenic effects of ethylbenzene in humans. In a study by the National Toxicology Program, exposure to ethylbenzene by inhalation resulted in an increased incidence of kidney and testicular tumors in rats, and lung and liver tumors in mice. EPA has classified ethylbenzene as a Group D, not classifiable as to human carcinogenicity.
At the beginning of the PATS study, this pollutant did not have an ABC, but EPA's NATA 2002 modeling showed the pollutant in the Portland Metro area's air shed. DEQ wanted to model for this pollutant to assess if there is a cause for concern. The ABC for this pollutant is 0.4 ug/m^3, however due to an error, the benchmark should be 2000 ug/m^3, an adjustment DEQ will propose during the next phase of benchmark updates.

3.2.3.12 Formaldehyde

Formaldehyde is primarily from incomplete combustion from industry, on-road and nonroad engines, construction equipment, diesel fuel combustion, railroads, and airports, as well as from wood burning. It is used as a concrete and plaster additive, as a disinfectant, and as a wood preservative. Secondary sources include oxidation of hydrocarbons. Formaldehyde's destruction processes include photolysis, reaction with hydroxyls (OH), and wet deposition. Chronic (long-term) inhalation exposure to formaldehyde in humans can result in respiratory symptoms, and eye, nose, and throat irritation. Limited human studies have reported an association between formaldehyde exposure and lung and nasopharyngeal cancer. Animal inhalation studies have reported an increased incidence of nasal squamous cell cancer. EPA considers formaldehyde as a Group B1, probable human carcinogen. All 2005 annual averages for formaldehyde were measured below the ABC, which is 3 ug/m^3 and is based on non-cancer effects due to, at the time of this report, unresolved questions regarding the degree to which formaldehyde is a carcinogen. The highest annual average measured at the NW Post Office monitoring station.

3.2.3.13 Lead

Lead's primary use is in the manufacture of batteries and in the production of metal products, such as sheet lead, solder (but no longer in food cans), and pipes, and in ceramic glazes, paint, ammunition, cable covering, and other products. Lead is toxic, causing a variety of effects at low dose levels. Chronic (long-term) exposure to lead in humans results in effects on the blood, central nervous system, blood pressure, kidneys, and Vitamin D metabolism. Children are particularly sensitive to the chronic effects of lead, with slowed cognitive development, reduced growth and other effects reported. Reproductive effects, such as decreased sperm count in men and spontaneous abortions in women, have been associated with high lead exposure. The developing fetus is at particular risk from maternal lead exposure, with low birth weight and slowed postnatal neurobehavioral development noted. Human studies are inconclusive regarding lead exposure and cancer.
The 2005 annual average for lead, 0.0038 ug/m^3, measured below the current ABC, which is 0.15 ug/m^3. The annual average for 2005 is also well below this new proposed standard.

3.2.3.14 Manganese

Manganese is a naturally occurring metal found in rocks. Organic manganese compounds include pesticides and fuel additive for some gasolines. Compounds can enter the air from iron, steel, power plants, and coke ovens; as well as from dust from mining operations. Chronic (long-term) exposure to high levels of manganese by inhalation in humans may result in central nervous system effects. Visual reaction time, hand steadiness, and eye-hand coordination were affected in chronically-exposed workers. A syndrome named manganism may result from chronic exposure to higher levels; manganism is characterized by feelings of weakness and lethargy, tremors, a mask-like face, and psychological disturbances. Respiratory effects have also been noted in workers chronically exposed by inhalation. Impotence and loss of libido have been noted in male workers afflicted with manganism. The 2005 annual average for manganese was measured below the ABC, which is 0.09 ug/m^3. However, monitoring data shows that levels have, on occasion, exceeded the ABC at the Post Office monitoring station.

3.2.3.15 Methylene Chloride

Methylene chloride is predominantly used as a solvent in paint strippers and removers; as a process solvent in the manufacture of drugs, pharmaceuticals, and film coatings; as a metal cleaning and finishing solvent in electronics manufacturing; and as an agent in urethane foam blowing. It is also used as a propellant in aerosols for products such as paints, automotive products, and insect sprays. The effects of chronic (long-term) exposure to methylene chloride suggest that the central nervous system is a potential target in humans and animals. Human data is inconclusive regarding methylene chloride and cancer; EPA has classified methylene chloride as a Group B2, probable human carcinogen. Animal studies have shown increases in liver and lung cancer and benign mammary gland tumors following the inhalation of methylene chloride. The 2005 annual average for methylene chloride was measured below the ABC, which is 2.1 ug/m^3.

3.2.3.16 Naphthalene

Naphthalene’s primary use is in the production of phthalic anhydride, but other uses of naphthalene include carbamate insecticides, surface active agents and resins, as a dye intermediate, as a synthetic tanning agent, as a moth repellent, and in miscellaneous organic chemicals. Naphthalene is released to the air from the burning of coal and oil and from the use of mothballs. Chronic (long-term) exposure of workers and rodents to naphthalene has been reported to cause cataracts and damage to the retina. Hemolytic anemia has been reported in infants born to mothers who "sniffed" and ingested naphthalene (as mothballs) during pregnancy. Available data are inadequate to establish a causal relationship between exposure to naphthalene and cancer in humans. EPA has classified naphthalene as a Group C, possible human carcinogen. The 2005 annual average for naphthalene is below the ABC, which is 0.03 ug/m^3.

3.2.3.17 Nickel Compounds

Nickel is an abundant natural element found in soil and emitted from volcanoes. It can combine with other metals to form alloys for heat exchangers, along with other items. Nickel is most often used to make stainless steel and nickel compounds are used for nickel plating, to make some batteries, and as catalysts. Nickel is released into the air by industries that make or use nickel or nickel compounds. It is also released by oil-burning power plants and trash incinerators. Only two insoluble forms on nickel - refinery dust and the subsulfide from smelters - are considered to be known (Class A) human carcinogens. Soluble forms of nickel are more toxic to the respiratory track than less soluble forms but are not carcinogenic. Serious health effects from exposure to nickel, such as chronic bronchitis, reduced lung function, and cancer of the lung and nasal sinus, have occurred in people who have breathed dust containing certain nickel compounds while working in nickel refineries or nickel-processing plants. The levels of nickel in these workplaces are much higher than usual levels in the environment. Oregon has 3 ambient benchmark concentrations for nickel compounds: (1) 0.004 μg/m^3 for nickel refinery dust; (2) 0.002 μg/m^3 for nickel sub-sulfide; (3) 0.05 μg/m^3 for soluble nickel compounds. DEQ has performed monitoring and modeling only for soluble nickel compounds and modeling shows that some local areas of Portland may be above the benchmark for these compounds. There are no nickel smelters or refineries in the Portland area.

3.2.3.18 *Perchloroethylene (tetrachloroethylene):*

Perchloroethylene is widely used for dry-cleaning fabrics and metal degreasing operations. The main effects of perchloroethylene in humans are neurological, liver, and kidney effects following acute (short-term) and chronic (long-term) inhalation exposure. Adverse reproductive effects, such as spontaneous abortions, have been reported from occupational exposure to perchloroethylene; however, no definite conclusions can be made because of the limitations of the studies. Results from epidemiological studies of dry-cleaners occupationally exposed to perchloroethylene suggest increased risks for several types of cancer. Animal studies have reported an increased incidence of liver cancer in mice, via inhalation and gavage (experimentally placing the chemical in the stomach), and kidney and mononuclear cell leukemia in rats. In the mid-1980s, EPA considered the epidemiological and animal evidence on perchloroethylene as intermediate between a Group B and a Group C, probable and possible human carcinogen, respectively. EPA is currently reassessing its potential carcinogenicity. The monitoring data for this pollutant was below the minimum detection limit, which is 0.678 ug/m^3. Since the ABC is 35 ug/m^3, modeling and monitoring data, indicate that this pollutant is not as serious a concern as others may be. Although the ABC is currently based on a non-cancer value, perchloroethylene is considered a weak carcinogen.

3.2.3.19 *Trichloroethylene*

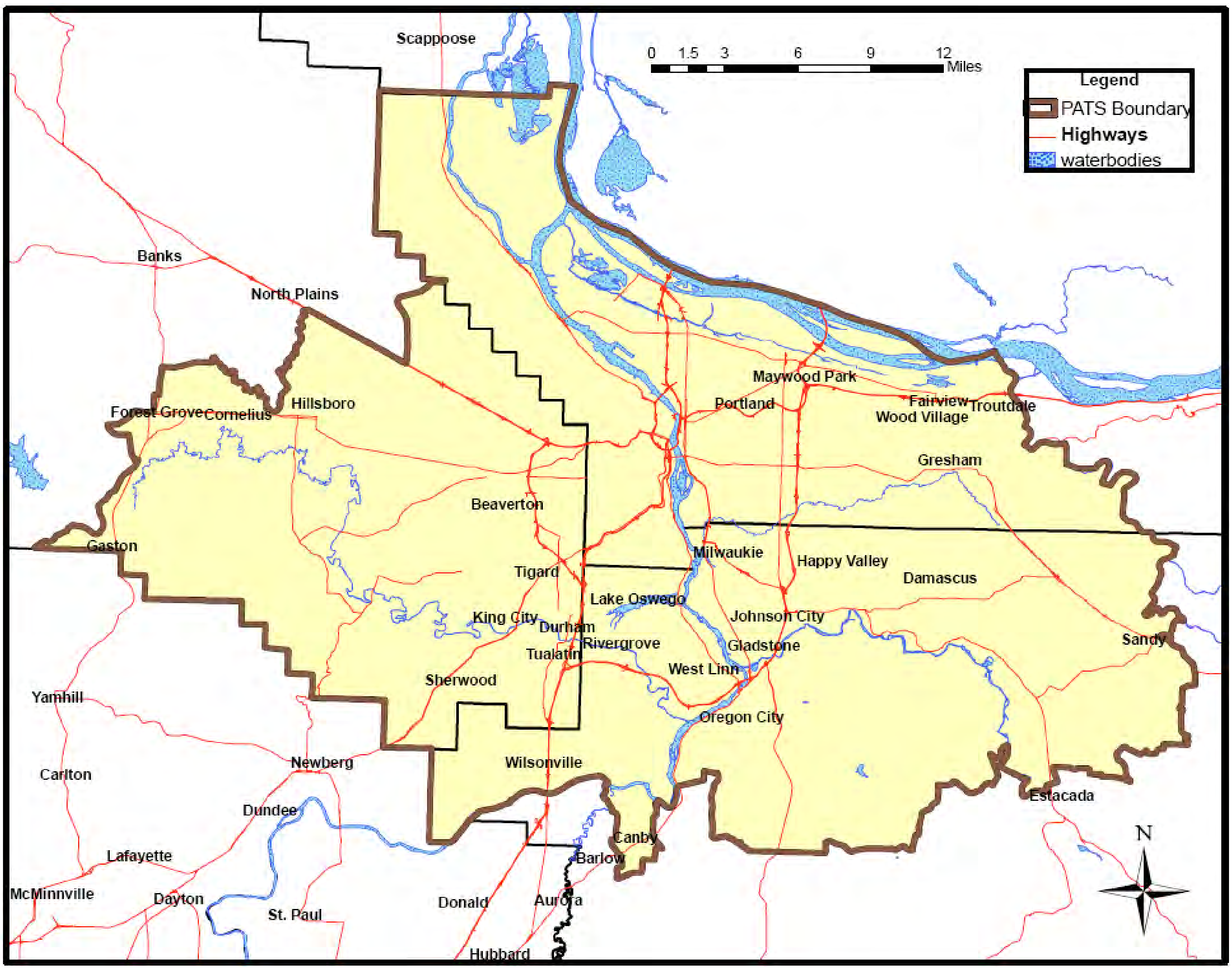
Trichloroethylene's main use is in the vapor degreasing of metal parts. Trichloroethylene is also used as an extraction solvent for greases, oils, fats, waxes, and tars, as a chemical intermediate in the production of other chemicals, and as a refrigerant. Trichloroethylene is used in consumer products such as typewriter correction fluids, paint removers/strippers, adhesives, spot removers, and rug-cleaning fluids. Chronic (long-term) inhalation exposure to trichloroethylene can affect the human central nervous system, with symptoms such as dizziness, headaches, confusion, euphoria, facial numbness, and weakness. Liver, kidney, immunological, endocrine, and developmental effects have also been reported in humans. A recent analysis of available epidemiological studies reports trichloroethylene exposure to be associated with several types of cancers in humans, especially kidney, liver, cervix, and lymphatic system. Animal studies have reported increases in lung, liver, kidney, and testicular tumors and lymphoma. EPA is currently reassessing the cancer classification of trichloroethylene. The 2005 monitoring data for trichloroethylene was below the minimum detection limit of 0.1 ug/m^3, which is below the benchmark of 0.5 ug/m^3. Modeling data estimates levels below the benchmark.

3.3 Establishing a Study Area

The PATS project and study area includes portions of Multnomah, Clackamas and Washington Counties (see Figure 4). In the analysis, DEQ also included portions of Clark County, Washington, near Vancouver, and portions of Yamhill, Marion, and Columbia Counties, since these areas share the same air shed as the Portland metro area.

DEQ delineated the Portland air toxics geographic area by including the Census tracts representing areas of higher air toxics risk, as shown in the 1999 EPA National Air Toxics Assessment (NATA) report. These areas are generally more densely populated or undergoing population growth and development. As a result, the PATS study area is based on locations where people are most exposed to air toxics. In addition, DEQ coordinated with the ozone pollution control area and took geography and topography into account. Figure 4 illustrates the PATS study area.

Figure 4 PATS Study Area



3.4 Emissions Inventory Overview

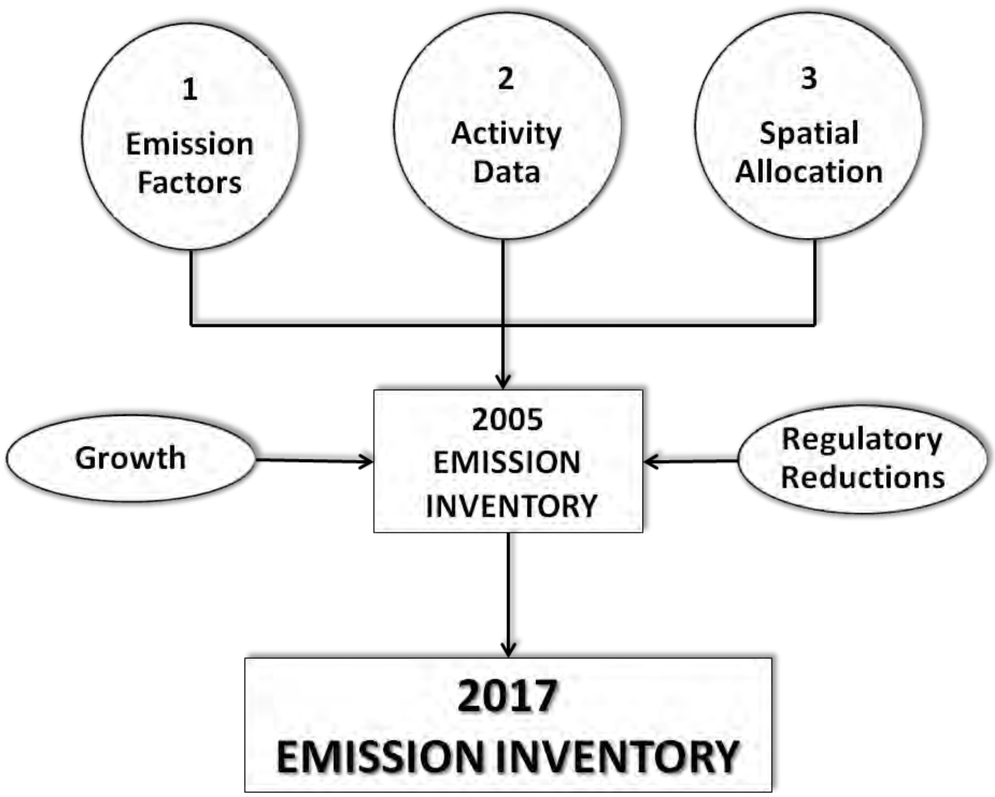
An emissions inventory is a comprehensive estimation of air pollutant emissions by source in a geographic area during a specific time period. DEQ has selected the 2005 inventory year as the base year for this project because that is the year for which DEQ has the most toxics monitoring data and a good emissions inventory data set. To create the projected 2017 emissions inventory, DEQ began with the 2005 emissions inventory, and updated it using:

- Population and employment growth factors obtained from Portland's Metropolitan Regional Government Organization (Metro) and from federal government agencies;
- Refinements from analytical improvements and more in-depth research; and
- Projected regulatory reductions associated with new regulations that have or will be enacted by 2017, such as National Emission Standards for Hazardous Air Pollutants (NESHAPs) and local programs.

The 2005 emissions inventory estimates emissions based on the amount of a specific air toxic generating activity occurring in the PATS area and the air toxics emission rate for that activity. The emissions are then spatially allocated within the PATS region for input into the CALPUFF model. Figure 5 illustrates the main emissions inventory elements of the 2005 base year inventory:

- Emission factor. An emission factor is an emissions rate per activity. An example would be the amount of benzene emitted per ton of wood fuel burned in a certified woodstove.
- Activity data. Activity data for woodstoves also comes from census and other survey data. In the case of residential wood combustion, it would be how much wood is burned and how many days of the year.
- Spatial allocation. The spatial allocation of woodstoves would be where DEQ places the emissions according to residential zones and the heating characteristics of census block groups as surveyed by the United States Census Bureau.

Figure 5: Emissions Inventory Elements



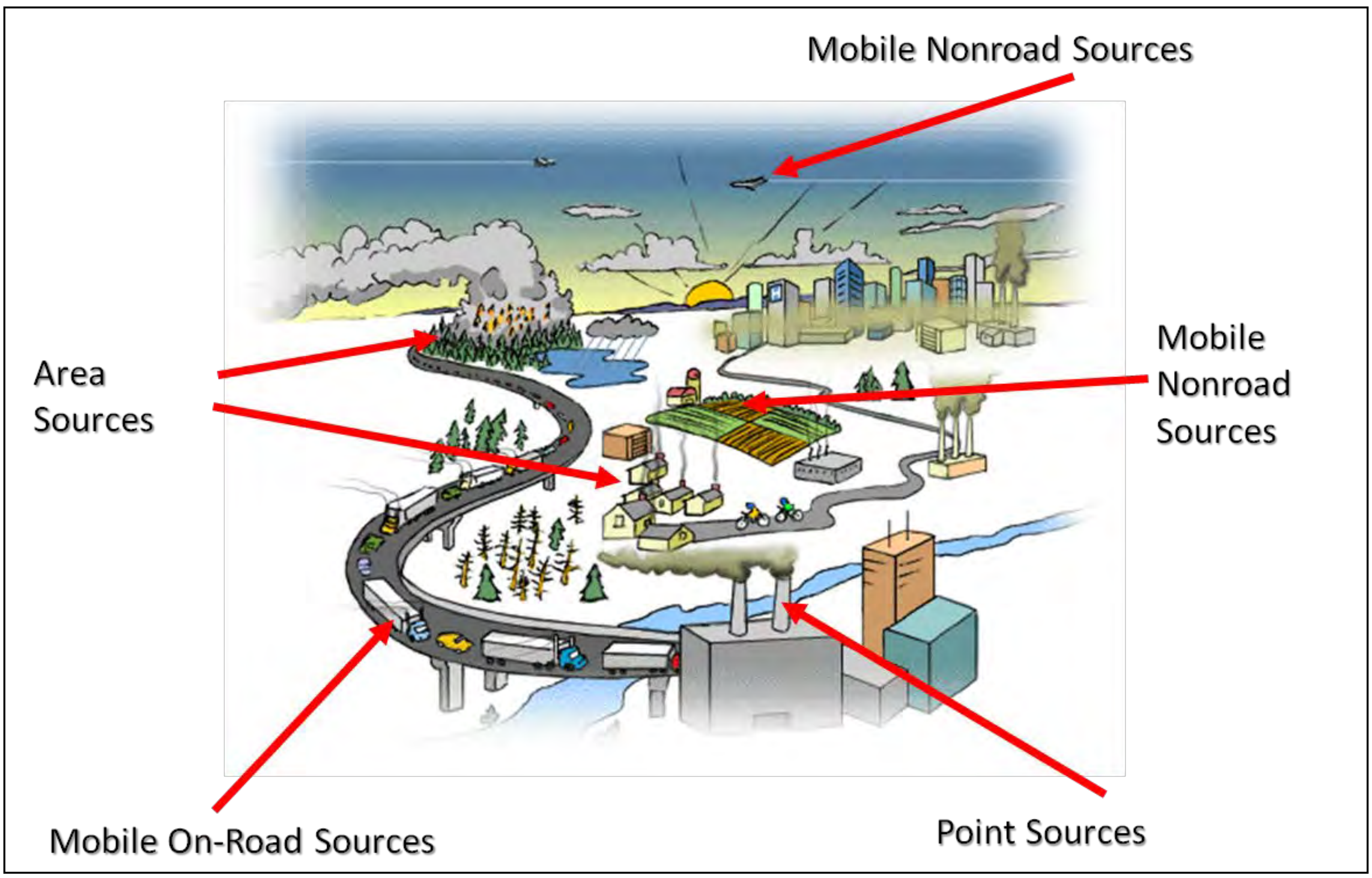
As illustrated in Figure 5, the 2017 forecast is produced by applying growth factors to 2005 emissions, and then subtracting any emissions controlled by federal and state air toxics regulations[1]. Examples of these regulatory controls include new National Emission Standards for Hazardous Air Pollutants (NESHAPs), Oregon's Heat Smart rules, new requirements for canisters in car fuel systems that capture benzene and other vapors, and new mobile source air toxics regulations reducing benzene in gasoline.

The following sections describe the emission source categories inventoried, the origin of data for the analysis, how DEQ allocated emissions spatially and temporally, how DEQ accounted for growth and regulatory controls, an evaluation of data quality, and improvements that were made to the emissions inventory prior to modeling the projected 2017 emissions. DEQ made many refinements and improvements in emissions data between the 2005 and 2017 estimates, including information from PATSAC. Refinements and improvements of emissions inventory data are described in section 3.4.5.

3.4.1 Emission Source Categories

Emissions in the PATS area originate from a variety of sources. These include pollutant emissions from area, on-road mobile, nonroad mobile, and point sources. Figure 6 illustrates examples of each type of emission source.

Figure 6: Types of Emission Sources Included in Emissions Inventory



[1] See section 3.2 for information on growth factors and regulatory controls.

The emission sources are further broken down into emission source categories for modeling. Modeled area emission source categories include:

- Residential wood combustion
- Residential open burning
- Residential/commercial/industrial non-permitted fuel use (heating, boilers, etc)
- Surface coating (painting, traffic markings)
- Household solvent use (spray paints, cleaners, auto aftermarket, etc)
- Consumer products
- Asphalt paving and use

Modeled on-road mobile emission source categories include:

- Gasoline and diesel cars
- Trucks
- Buses
- Motorcycles

Modeled non-road mobile emission source categories include:

- Diesel construction equipment
- Lawn and garden equipment
- Aircraft
- Recreational and Commercial Marine
- Rail

Modeled point sources include permitted industrial sources such as:

- Stationary Source Fuel Combustion (Natural Gas, Waste Oil, Liquid Petroleum Gas, etc.)
- Metals Facilities (Steel Foundries, Metal Fabrication, etc.)
- Wood Products (Pulp & Paper, Newsprint, etc.)
- Glass Manufacturing
- Petroleum and Gas Distribution and Storage
- Gas Stations
- Asphalt Manufacturing

3.4.2 Source of Data and Methods

Data for the emissions inventory was generated by Metro, DEQ, Southwest Clean Air Agency (SWCAA), EPA and the Washington Department of Ecology. The sources of the inventory data are shown in Table 2.

Table 2: Emissions Inventory Data Sources: 2017 Emissions Inventory

	--------------- Data Sources ---------------	
Emissions Inventory Category	**Oregon Counties**	**Clark County, Washington**
Residential Wood Combustion	DEQ	DEQ
All other area sources	DEQ, EPA	Washington Department of Ecology
Permitted Point	DEQ	SWCAA
Nonroad, including air, rail, marine	DEQ, Port of Portland	DEQ, Washington Department of Ecology
On-Road	Metro, DEQ	Metro

Emissions for all inventory source types were classified by EPA source classification code (SCC). A wide variety of methodologies were used to generate the inventory. The following gives a brief description of sources and methods; however for details please refer to the emissions inventory Appendix 12.3.

3.4.2.1 Nonpoint (Area) Sources

Area source emissions were estimated on a countywide level. A small amount of Oregon area source inventory data was generated by EPA for Oregon in the 2005 National Emissions Inventory. This EPA data was included in order to generate as complete an area source inventory as possible.
DEQ follows guidance from the US EPA to estimate emissions using a variety of methodologies:

- State Implementation Plan[2] (SIP) Development Guidelines (ex. EPA450/2-86-001)
- Survey (for example, residential wood combustion survey)
- Emissions Inventory Preparation (ex. EPA450/4-91-016)
- Emissions Inventory Improvement Project from STAPPA/ALAPCO (now National Association of Clean Air Agencies)
- EPA National Emissions Inventory documentation and references

Emissions estimates for nonpoint sources in Clark County in Clark County were developed by the Washington Department of Ecology and DEQ.

3.4.2.2 On-Road Mobile Sources

Portland's Metro provided on-road emission estimates for Multnomah, Washington, and Clackamas counties, as well as Clark County, Washington. Metro's estimates were generated using the EMME/2 travel demand model and US EPA's MOBILE6.2 emission factor model. The travel demand model models activity in the form of vehicle miles travelled, and then MOBILE6.2 generates emission factors. These included annual emission rates by roadway link for freeway and primary arterials, and by transportation analysis zone for secondary and local roadways. A link is a series of roads or streets that a vehicle takes to get from one location to another. A transportation analysis zone is a geographic unit used in travel demand models where trips begin or end. The model or study area is broken into sections. Each of these sections is called an analysis zone. Data on existing population, employment and trip-making patterns, and forecast population and employment is collected and used to determine the number of existing and future trips traveling to and from each transportation analysis zone. Startup and cool down emissions are assigned to these zones. Small portions of Columbia, Marion, and Yamhill counties falling within the modeling domain were not included in Metro's estimates and DEQ developed emission estimates for these areas. On-road emissions were estimated by DEQ using countywide vehicle miles traveled and EPA MOBILE6.2 for these areas.

3.4.2.3 Non road Mobile Sources

Aircraft, locomotive, and commercial marine emissions were estimated using local activity data specific to airport, marine terminal, and locomotive fuel consumption (by rail company and rail line). All other non road sources were modeled using the EPA emissions model NONROAD2008a. Non road sources were developed in the following categories:

- EPA Non road Model
- Non road, equipment & vehicles, recreational marine
- Airport/Aircraft: Port of Portland, Federal Aviation Administration, AirNAV, US Dept. of Transportation
- Locomotive: Class 1 fuel use, Class 2 & 3 survey
- Commercial Marine: Port of Portland, Lloyd's Register, US Army Corps of Engineers

[2] State Implementation Plans (SIPs) are a collection of regulations that explain how a State will clean up polluted areas under the Clean Air Act.

Emissions estimates for non road mobile sources in Clark County were developed by the Washington Department of Ecology and DEQ.

3.4.2.4 Permitted Point Sources

Major stationary point source data was estimated from activity and emission factors specific to each source. Emissions data included actual or estimated stack parameters (i.e., release height, release velocity, release temperature). Smaller point sources inventoried included permitted gasoline stations and registered perchlorethylene dry cleaners.

Emissions are estimated at the process level for each source. At each facility, there could be multiple emissions from different parts of the process. For example, at one facility the inventory could include air toxics estimated from energy sources such as boilers, product processing such as metal casting, surface coating lines and emissions that escape generally at ground level, or “fugitives”. The point source sector has the least amount of uncertainty of the emissions inventory sectors because data on emissions are obtained from:

- Title V Permitted Sources (Federal operating permit)
- Smaller, state permitted sources (Air Contaminant Discharge Permit)
- Emission calculations for each process at the source
- Source annual activity reports
- Rule limits, permit conditions, pollution control equipment are documented in facility permits

Emission factors are from EPA data and source testing. Emissions estimates in Clark County were developed by the Southwest Clean Air Agency and DEQ.

3.4.3 Spatial Allocation of Emissions

Spatial allocation prepares the emissions inventory data for input into the model. The model needs the location of emissions within the PATS area. In addition, chemical simulations in most atmospheric models require surface emissions in a specific form. Emissions from the inventory are spatially allocated to points, linear sources, and areas (polygons and grid cells) to prepare for input into the CALPUFF model. Linear sources include high capacity on-road vehicles and rail emissions. Polygons characterize emissions from sources where no single emissions point, such as a stack, exists, but where the emissions are located in a specific area, such as an airport or rail yard. Area sources include emission source categories where emissions are estimated for a county-wide area. Point sources include those sources for which the geographic location of the emissions are known, for example, for permitted industrial sources. For other source categories such as, residential wood combustion, the emissions are estimated countywide, and need to be allocated geographically within the PATS area. Table 3 lists the emissions inventory categories in order of location certainty.

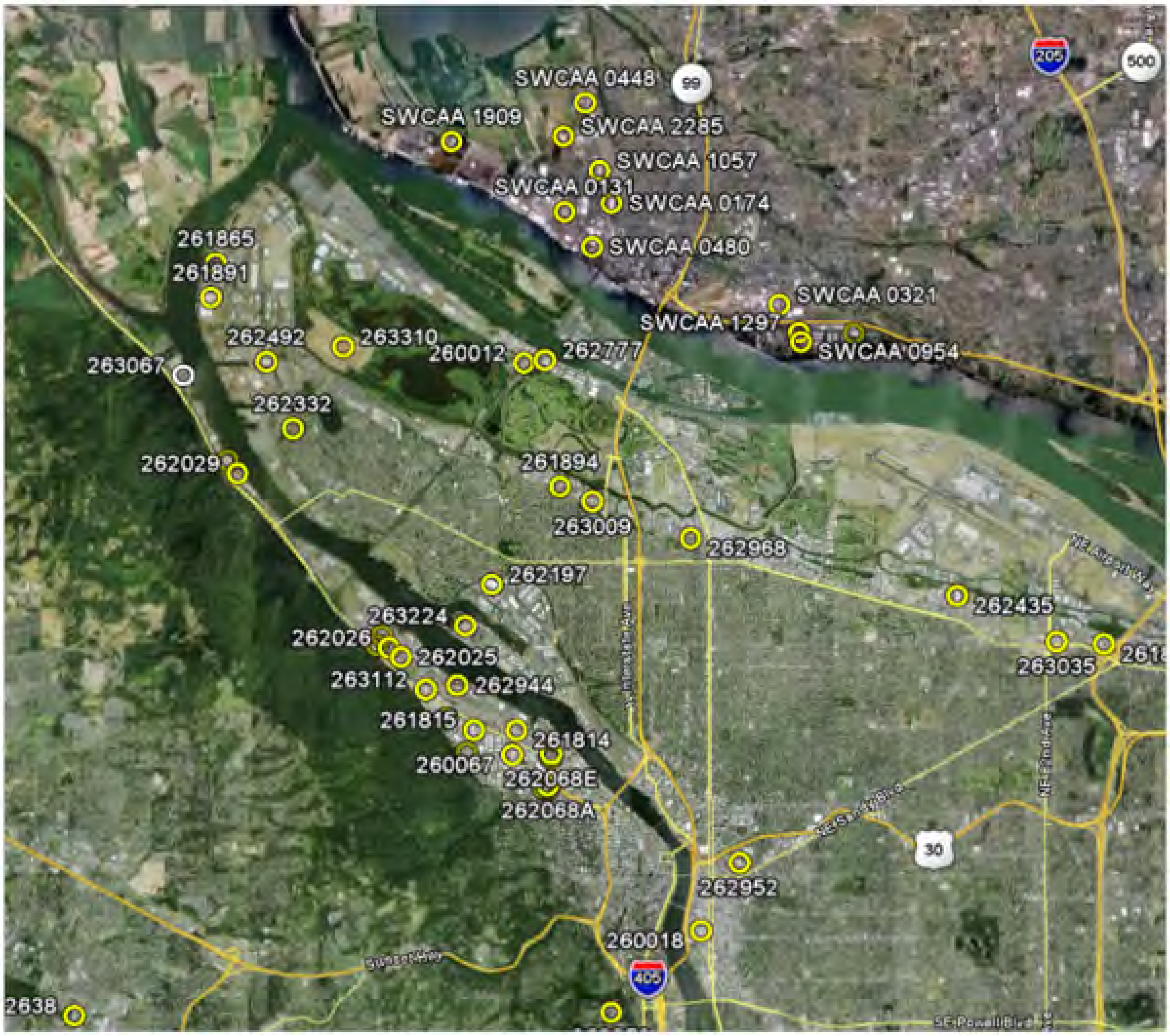
Table 3: Emissions Inventory Categories in Order of Location Certainty

Emissions Inventory Category	Certainty of Emission Location
Point	Location of emissions most certain
Permitted industrial sources	
Perchloroethylene drycleaners	
Gas stations	
Linear	
High emission on-road roadway segment "links"	
High capacity rail lines	
Polygon	
Airports	
Marine	
Rail yards	
POTWs & landfills	
Area	
Nonpoint	
Nonroad vehicles & equipment	
Transportation analysis zones	
• Low emission on-road links	
• Low emission rail lines	Exact location of emissions least certain
Recreational marine	

3.4.3.1 Point emission sources

For all permitted point sources, DEQ has spatial coordinates in latitude and longitude. Because of this, there are no intermediate steps between the emissions inventory and modeling. Some larger point sources have emissions located by stack, where each stack has its own set of coordinates. These include facilities with Oregon Title V permits and Oregon air contaminant discharge permits. DEQ also has the latitude and longitude of perchloroethylene dry cleaners, which are currently registered but not permitted in Oregon. Point sources were input at their location. Figure 7 illustrates the location of some of the point sources in the PATS area as verified using Google Earth. Southwest Clean Air Agency (SWCCA) provided the point source locations in Washington.

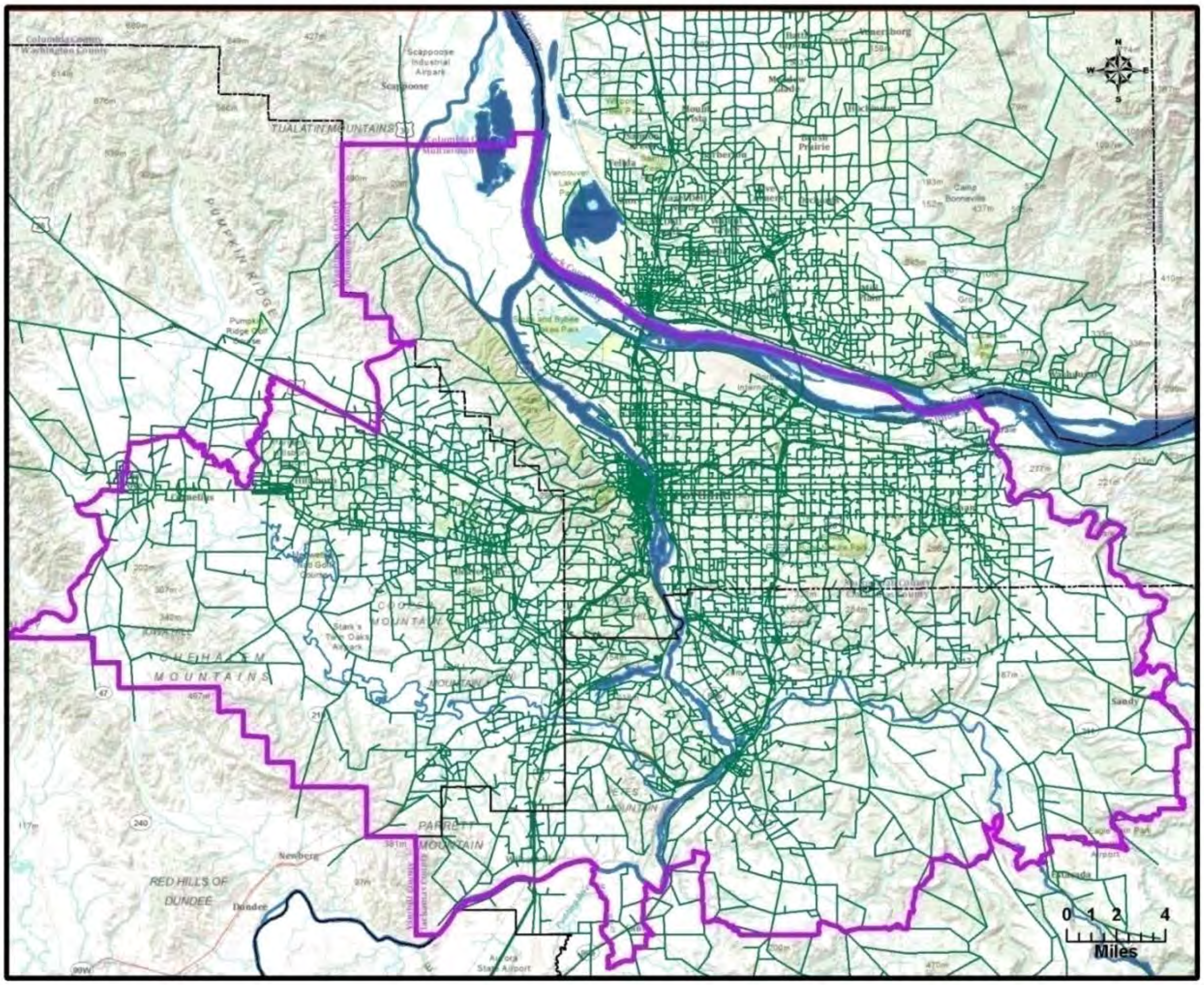
Figure 7: Point Source Coordinates Quality Checked via Google Earth



3.4.3.2 Linear Emission Sources

Linear emission sources include high capacity on-road and rail emissions. The following methodology is specific to on-road emissions data, however high capacity linear rail emissions were treated in a similar fashion. Traffic related emissions are one of the largest contributors to air toxics pollution in the PATS study area. Therefore, it is desirable to model these emissions with the highest accuracy possible. Metro spatially allocated on-road emissions data to approximately 29,000 roadway links. Figure 8 illustrates on-road links within the PATS modeling domain.

Figure 8: On-Road Emission Links from Metro



To reduce the amount of data for dispersion modeling input without losing the integrity of the emissions location, emissions by link were grouped and summed in the following fashion. Links were characterized as "hot", "warm", and "cold" by mapping the distribution of benzene emissions using ArcGIS. Emissions by link were then grouped into segments, and summed along each segment. As expected, higher emissions links resulting in hot and warm segments correlated to more heavily traveled highways and arterials. Figure 9 shows the hot and warm segments as determined through GIS mapping and link combination.

Figure 10 shows similar results for rail lines. For line-haul (road) locomotive emissions, emissions by rail company were assigned to track by track ownership. High volume track was grouped into segments in a similar fashion to on-road mobile. Low volume ("cold") links, Transportation Analysis Zones, and rail lines were spatially allocated to the emissions inventory grid. The development of the emissions inventory grid is detailed in section 3.4.3.4.

Figure 9: Hot (red) and Warm (orange) Traffic Links

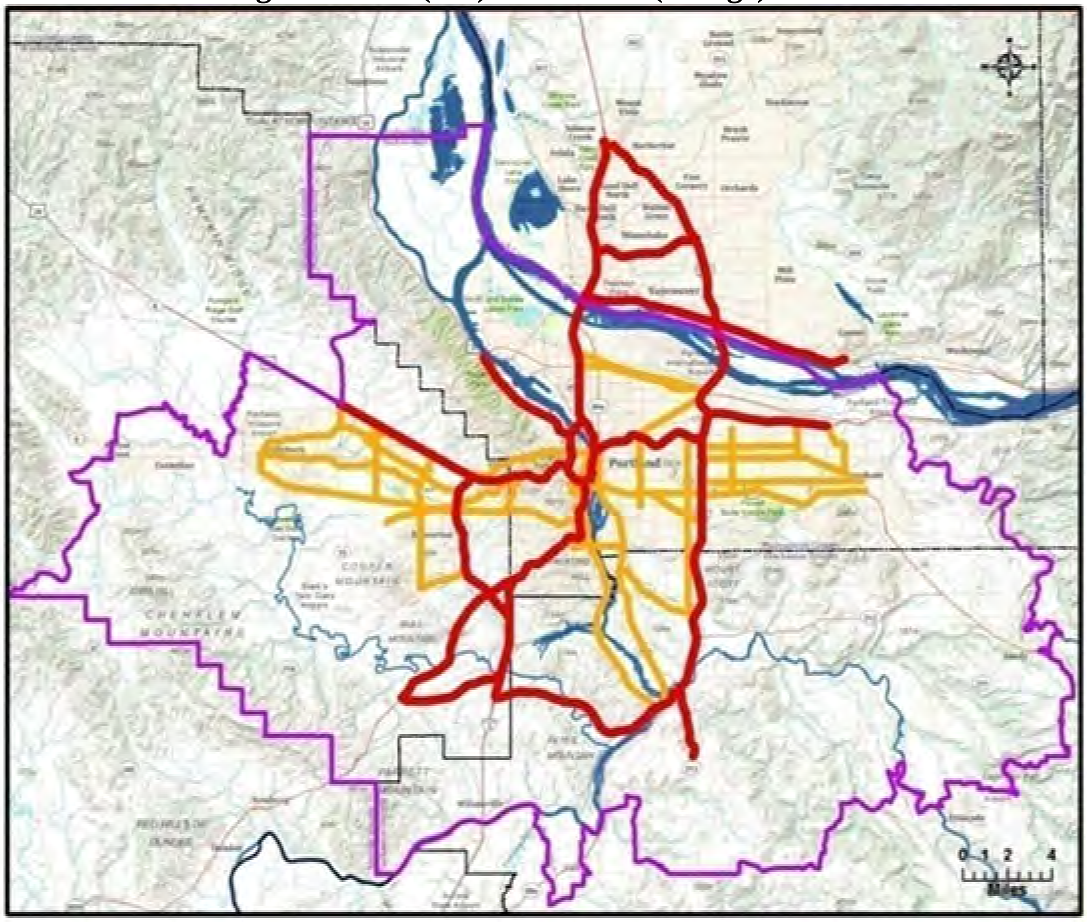
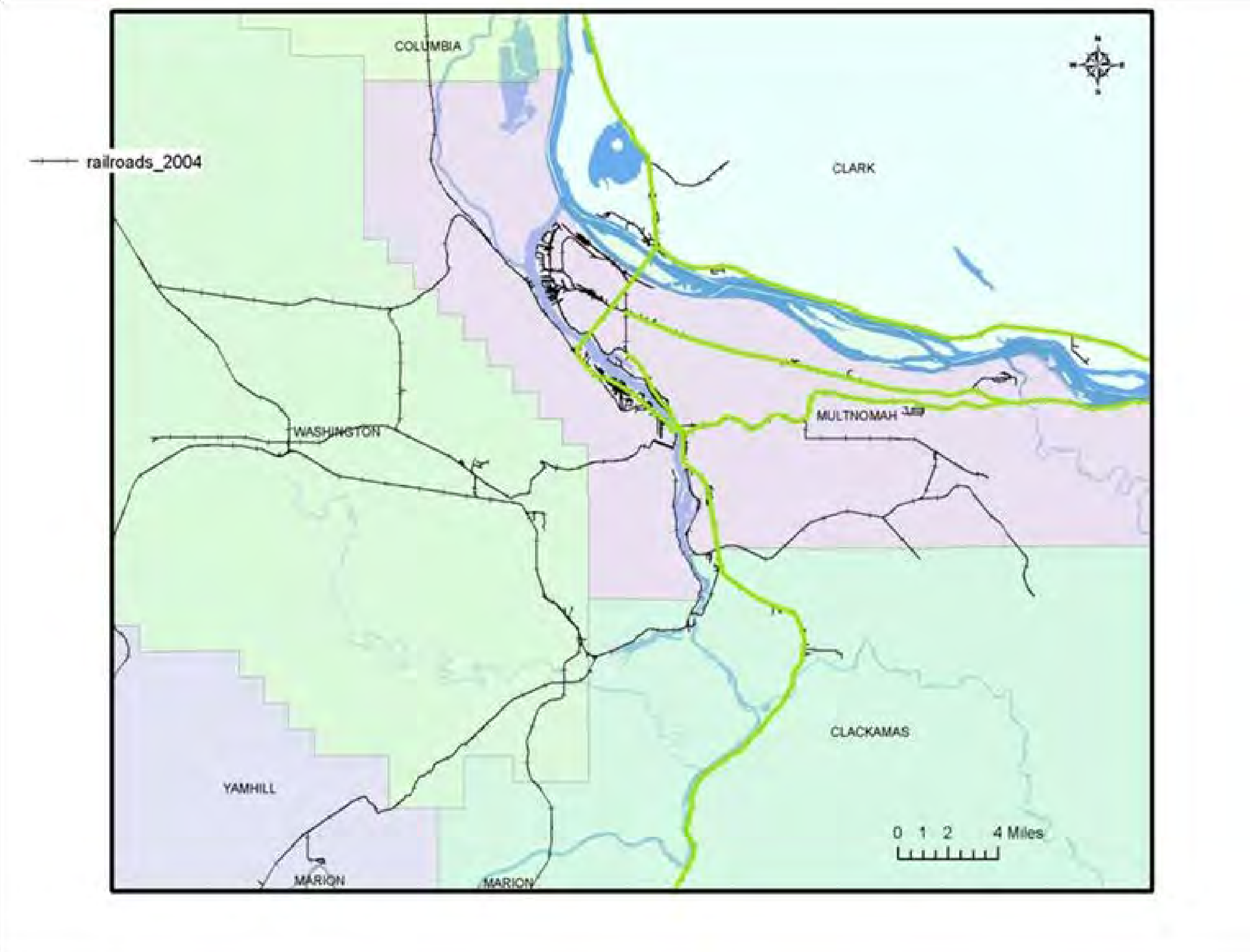


Figure 10: High Capacity Rail Links Grouped to Segments (green lines)

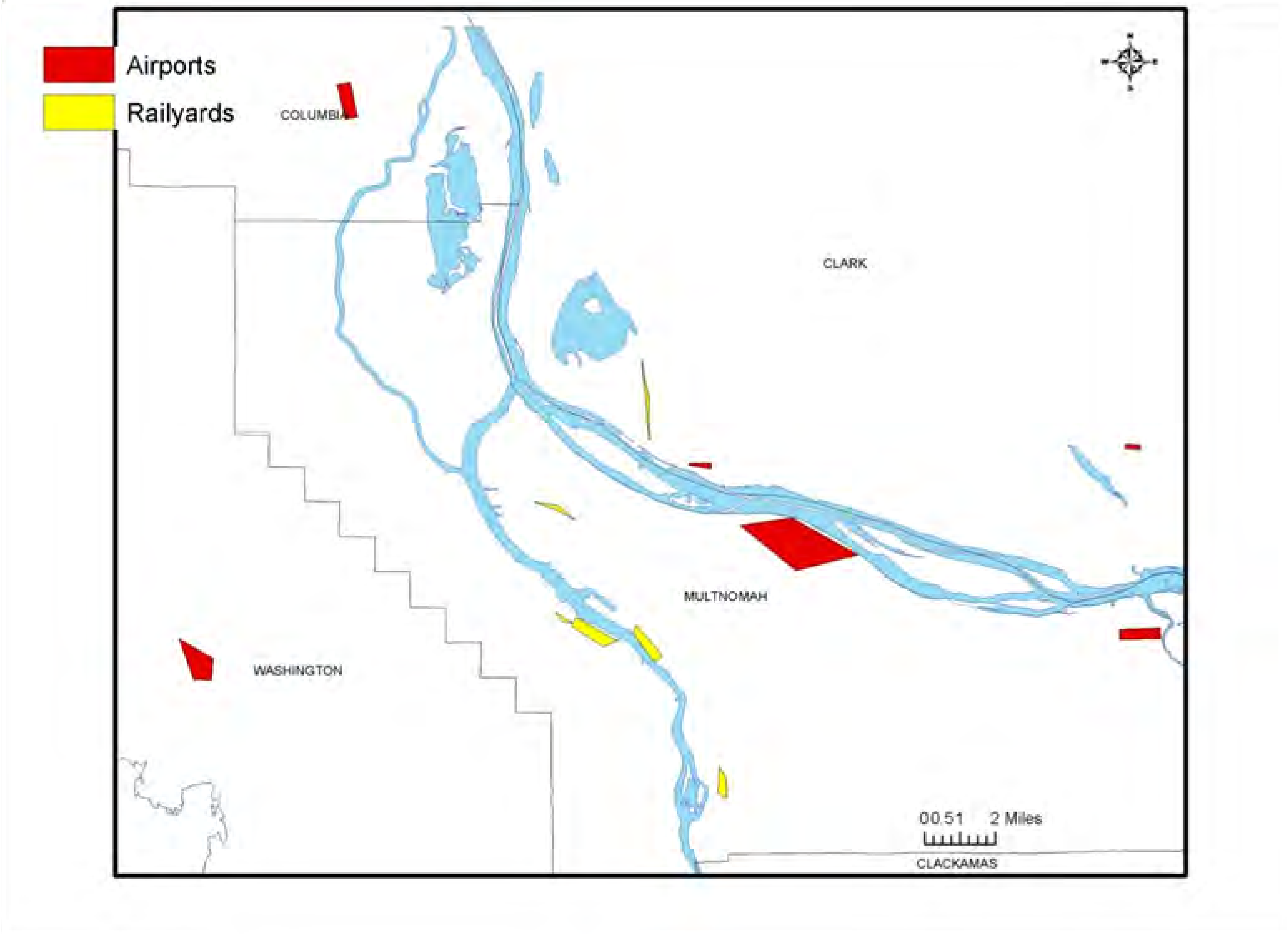


Emissions along high-volume link and rail segments were further refined for dispersion modeling by allocating the emissions data to points on each segment. The details of this refinement may be found in the modeling section of this report.

3.4.3.3 Polygon Emission Sources

Polygons are used to represent sources where there is not a single point source such as a stack, but where the emissions are located in a specific area. For these, latitude and longitude is known, and there are no intermediate steps between the emissions inventory and modeling. Figure 11 illustrates airports and rail yards mapped as polygons. Other emission sources mapped as polygons include commercial marine in-port (hotelling, maneuvering, and harbor craft), commercial marine in-transit, commercial marine barging, POTWs and landfills.

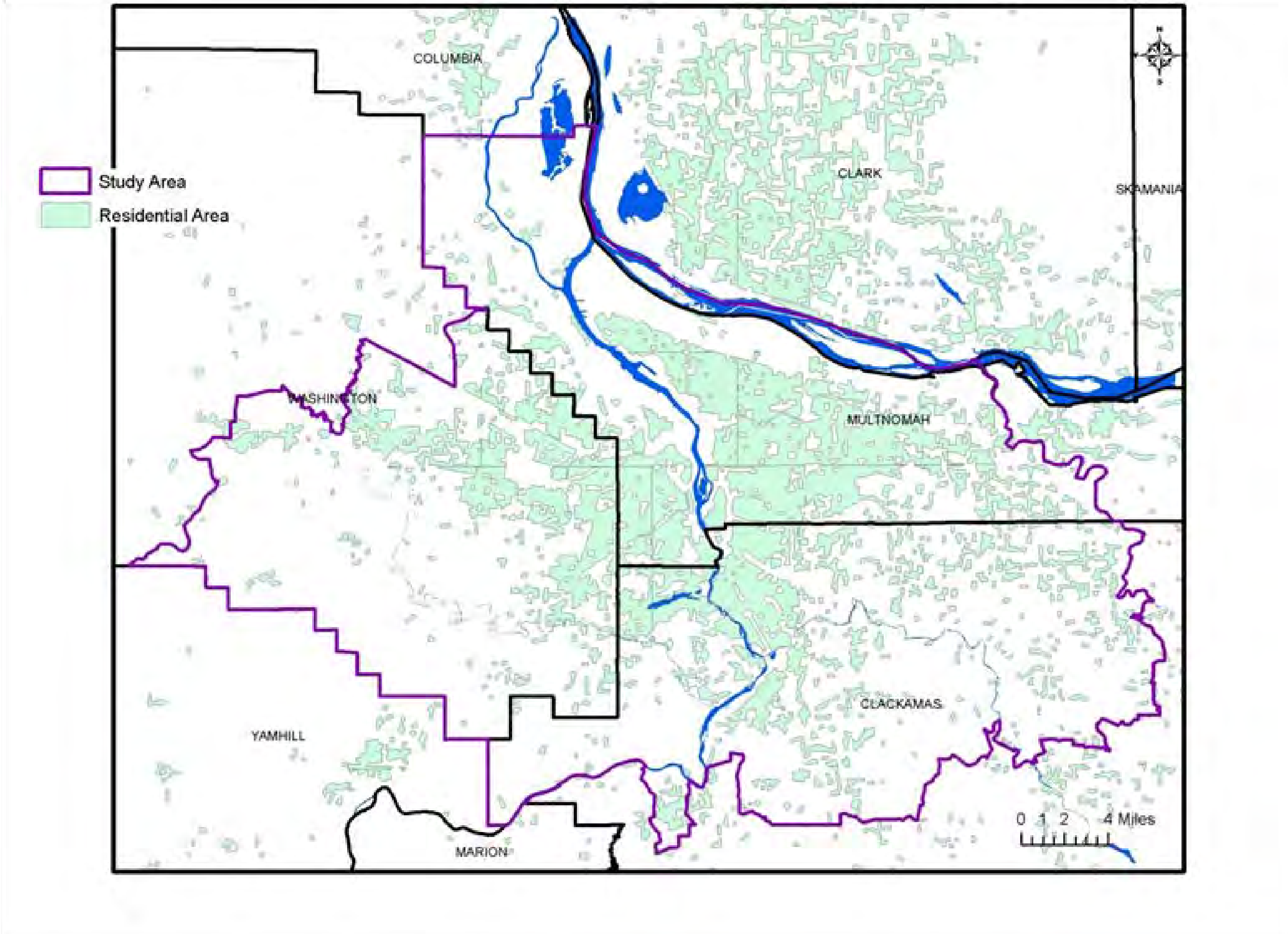
Figure 11: Polygon Sources Mapped in ArcGIS 9.3 and Google Earth



3.4.3.4 Area Emission Sources

Area emission sources are typically estimated on a per county basis in the emissions inventory. For example, residential heating fuel use comes from the Energy Information Administration at the state level and DEQ apportions emissions to each county based on the number of housing units within that county. However, emissions occur only in specific areas. As a result, DEQ needed to spatially allocate the countywide emissions to residentially zoned areas where the pollution most likely originates. Figure 12 illustrates residential areas wtihin the PATS study area. Similar maps can be made for commercial, industrial, agricultural, and mixed land uses.

Figure 12: Residential Land Use within PATS Study Area



For area emission sources, DEQ distributed the emissions from a county level inventory to finely gridded emission values. Distributing county level emissions to a finely gridded scale for modeling consists of two steps:

- Grid development
- Emission allocation to the grid cells based on the land use data (activity)

A. Grid development

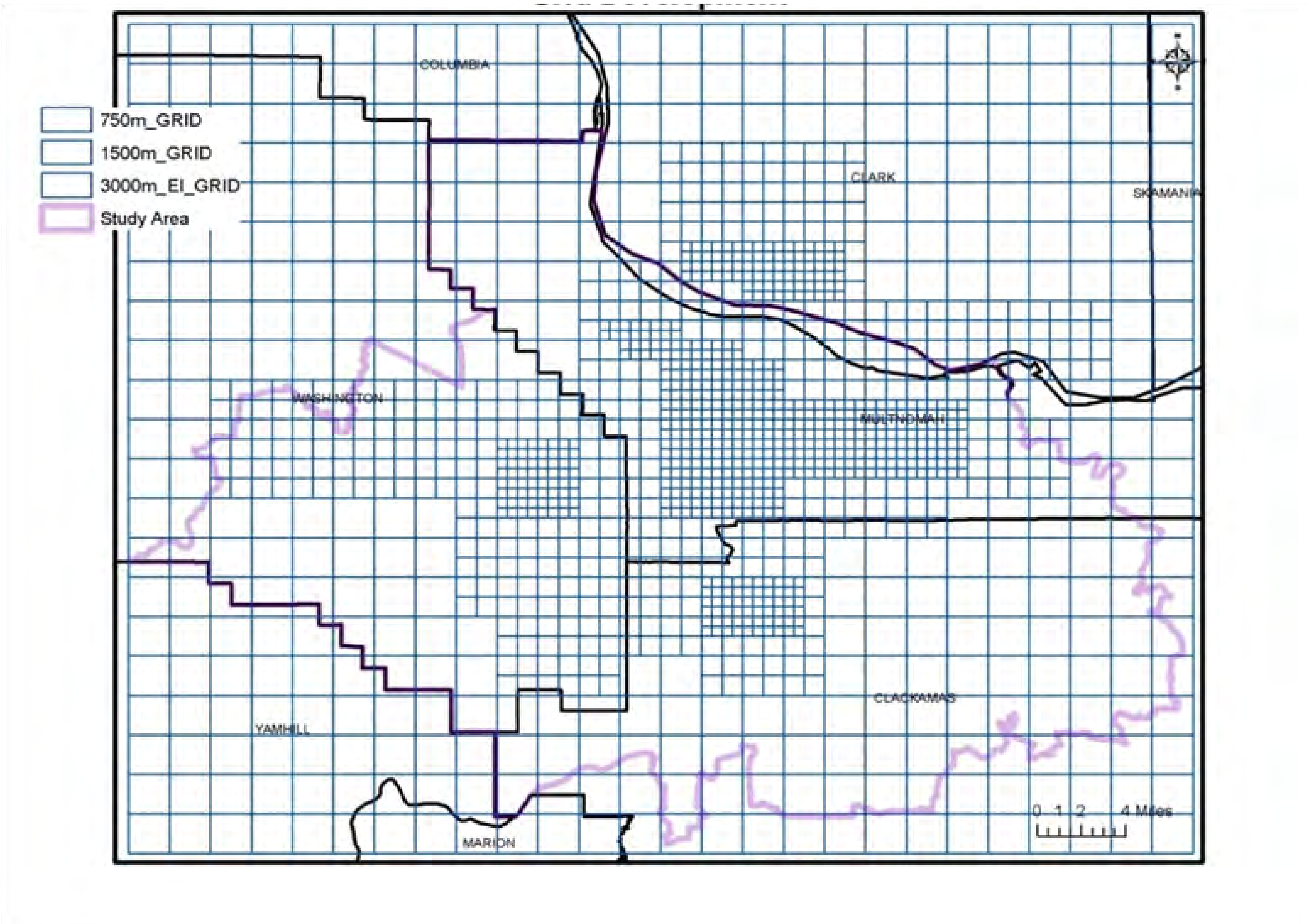
Two important but competing factors must be considered in grid development. Where there is higher population density, it would have been useful to have greater spatial resolution of pollutant concentrations. However, this requires smaller, and therefore more, grid cells. Having more grid cells meant that model run times would increase. That could not be done for the entire project area within the project timelines.

To address these conflicting objectives, DEQ created a fine grid over the densely populated areas and a more coarse grid in the more rural parts of the study area, for a total of 1446 grids. Figure 13 illustrates the three grid sizes developed:

- 750 meter grid cells placed over the highest population density areas;
- 1500 meter grid cells placed over less populated areas; and
- 3000 meter grid cells placed over the least populated areas.

The variable grid cell size offer the highest resolution in the high population density areas while preserving the model run time.

Figure 13: Grid Development



B. Emissions Allocation

County emissions data were allocated to land use, which were then allocated to a grid cell, using equations developed through ArcGIS, for input into the CALPUFF model. To allocate the emissions to grid cells, DEQ first developed an "allocation factor" for each grid cell by taking the area of specific land use (for example residential) within each grid cell and then dividing the grid cell land use area by the total area of that land use within the county. Next, DEQ estimated the emissions from each grid by multiplying the allocation factor by the county emissions. Figure 14 illustrates the residential areas within the modeling domain covered by the grid. Please note that the smallest grid cells are over the most populated areas, and the largest grid cells are over the least populated areas.

Figure 14: Residential Areas within PATS Covered by the Grid

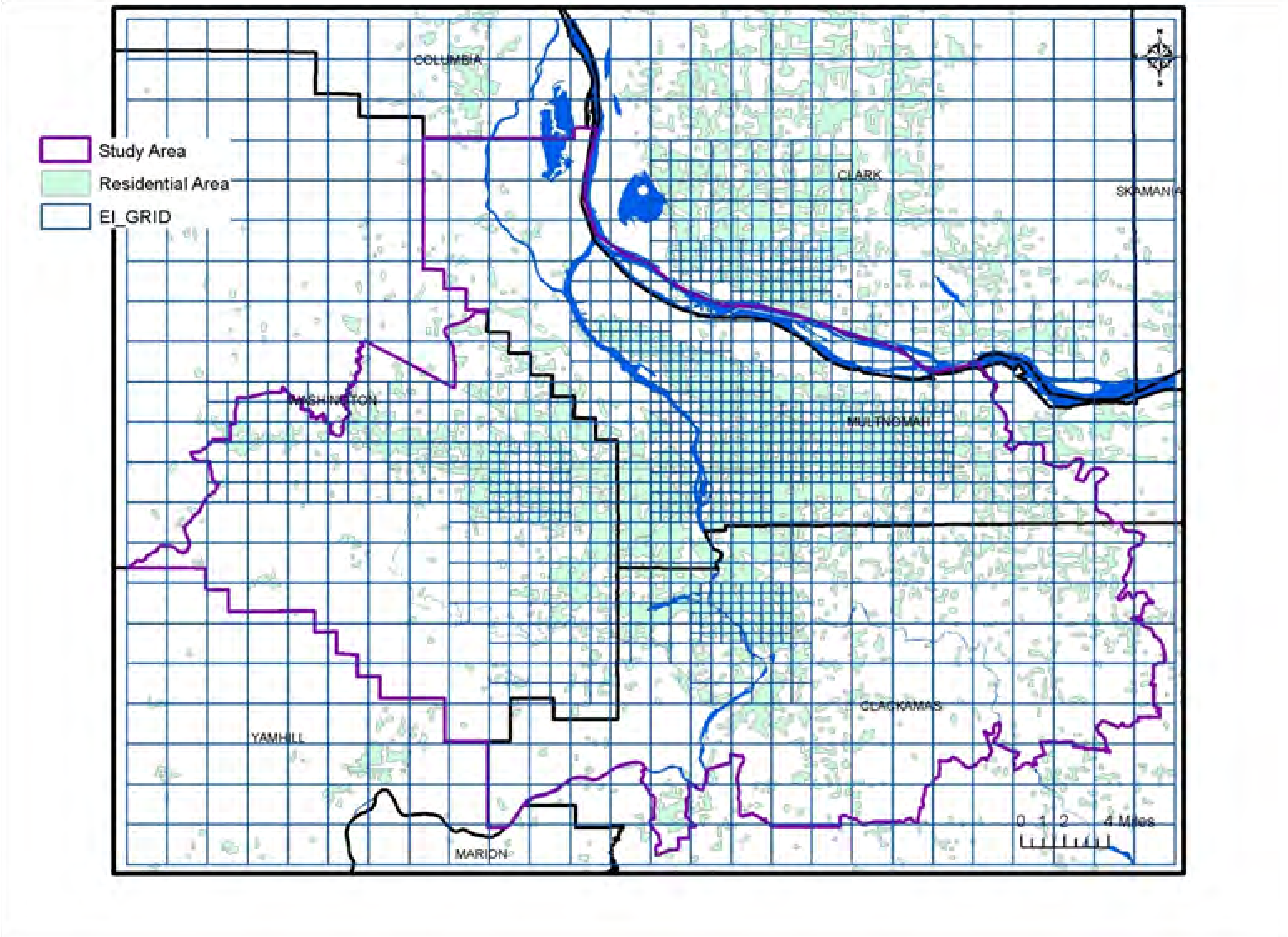
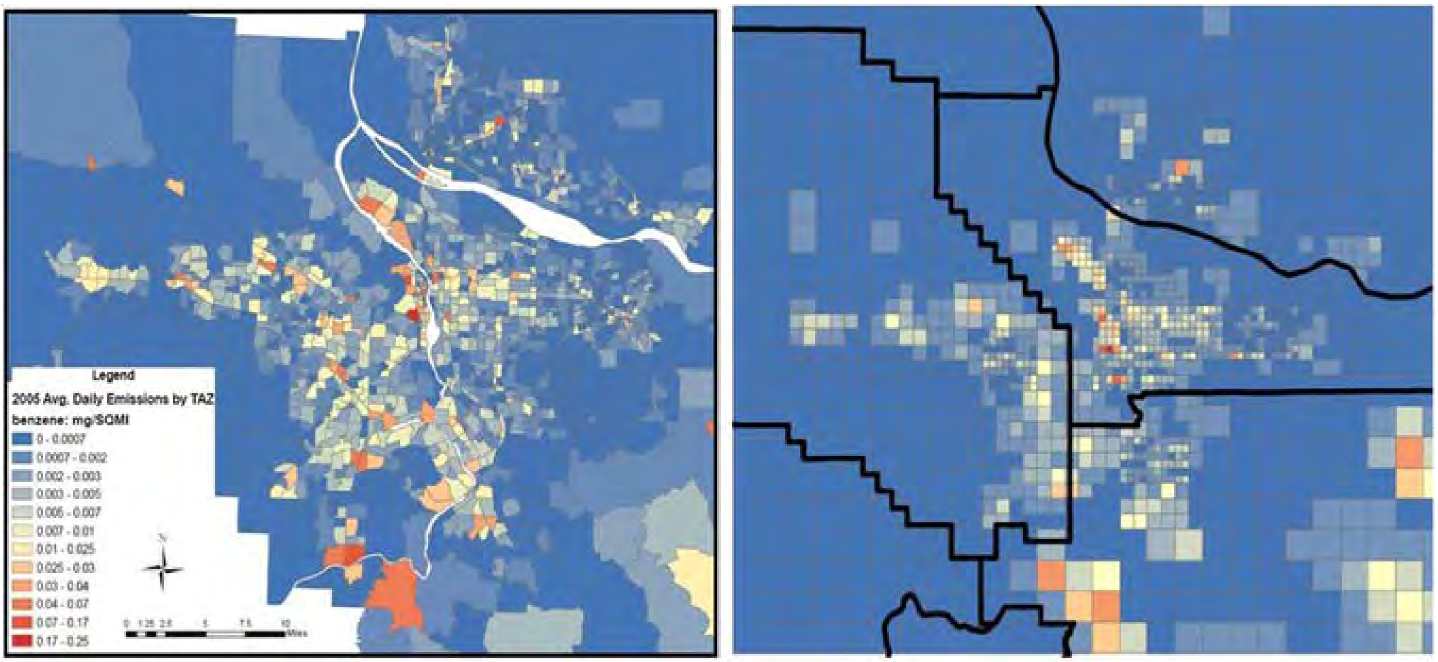


Figure 15 illustrates the resulting spatially allocated emissions of benzene from Metro transportation analysis zone emissions data. This is an example of the final spatial allocation product, which is used in the CALPUFF model.

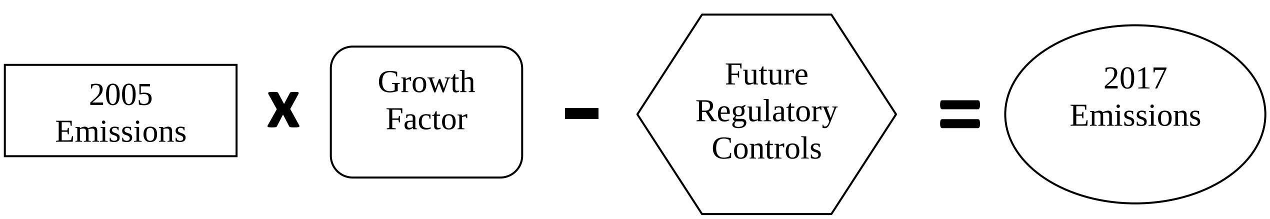
Figure 15: Transportation Analysis Zones Gridded Benzene Emissions Using GIS Analysis: A= Metro Data Normalized by Transportation Analysis Zone Area, B = Gridded Emissions Data Normalized by Grid Cell Area



3.4.4 Emissions Forecasting: Growth Factors and Future Regulatory Controls

In order to predict 2017 emissions, DEQ accounted for growth or decline in all emission source categories. Between the base year in 2005, and 2017, changes in population, jobs, and industry will increase some air toxic emissions and possibly decrease others. In addition, regulations that will be implemented prior to 2017 will reduce toxic emissions. Figure 16 illustrates that both growth and future regulatory controls are taken into account in the PATS process. To predict 2017 emissions, the 2005 emissions from each source category are multiplied by the source categories' growth factor[3]. Next, emission reductions expected from the implementation of future regulatory controls are subtracted, to give expected 2017 emissions.

Figure 16: Emissions Forecasting Process



To forecast 2017 emissions, DEQ used a variety of methods, depending on the inventory source category.

1. <u>Metro forecasting</u>. DEQ used growth factors developed by Metro, and applied the growth forecast to emission generating activities in the PATS area. Using Metro information ensures consistency with regional planning efforts. For PATS, the best information available is the Metro 2017 Regional Primary Metropolitan Statistical Area Forecast (for 7 Counties) - Unpublished - DEC. 2009. This forecast was adjusted for this project to account for the drastic impact the recession has had on the local economy. The Metro forecast covers cities and counties in the Portland-Vancouver metropolitan region (see Figure 17). The Metro forecast estimates the amount of growth that will occur between the base year of 2005 and 2017 within the

[3] A growth factor is a measure of how much a source category will grow or decline, based on a forecast.

Portland Metropolitan Statistical Area. Metro's forecast draws on several models, two that were directly important to forecasting growth from emission source categories in PATS were the Regional Economic Model and the Transportation Forecast.

2. <u>EPA NONROAD2008</u>**.** DEQ uses the EPA NONROAD2008a emissions model for forecasting emissions from nonroad equipment and vehicles. This model, developed by EPA, is more comprehensive than Metro growth factors for the nonroad source categories, in part because it accounts for engine age distribution and expected changes in fuel parameters. The model includes more than 80 basic and 260 specific types of nonroad equipment and vehicles, and further separates sources by horsepower rating and fuel types including gasoline, diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG). In estimating future year projections, the model includes growth and scrappage rates for equipment. NONROAD2008a does not include aircraft, marine or locomotives.

Figure 17: Portland Metro Primary Metropolitan Statistical Area

The following sections describe which forecast was used for which PATS emission source categories, as well as how future regulatory controls in those source categories are accounted for.

3.4.4.1 Metro Forecast: Permitted point sources; Area sources such as Residential Heating, Aircraft, Locomotives, Commercial Marine

DEQ used the Metro forecast to account for growth from the following source categories:

- Permitted point sources
- Residential Stationary Source Fuel Combustion
- Residential Wood Combustion
- Architectural Surface Coating
- Paint Stripping
- Non-Industrial Consumer & Commercial
- Portable Gas Can Evaporation, Permeation, Spillage
- Residential Open Burning
- Waste Disposal, Treatment & Recovery (Landfills & POTWs)
- Structure Fires
- Cremation (natural gas use)
- Commercial Cooking
- Industrial Stationary Source Fuel Combustion
- Miscellaneous Industrial Processes
- Surface Coating (excluding Architectural)
- Asphalt Production
- Aircraft
- Airport Ground Support Equipment
- Commercial Marine Vessels
- Locomotives
- Barging
- Truck Transport of Auto Gas

Figure 18 gives an example of the growth factor data for permitted point source growth for the following primary metals industries, as classified by their primary North American Industry Classification System (NAICS) code:

- Blast Furnaces & Steel Mills
- Grey & Ductile Iron Foundries
- Steel & Steel Investment Foundries
- Nonferrous Foundries

In Figure 18, percent change is the vertical axis, and time is along the horizontal axis. The two lines show Year-To-Year vs. compounded growth: For each type of growth, there is negative trend due to the recession followed by a positive change. Since the compounding factor takes into account the previous year's growth, it lags behind the year-to-year. The result is 4% compounded growth overall from 2005 to 2017. Thus, the final growth factor used to project emissions for primary metals industries from 2005 to 2017 is 1.04.

Figure 18: Metro Growth Factor Data: Primary Metals

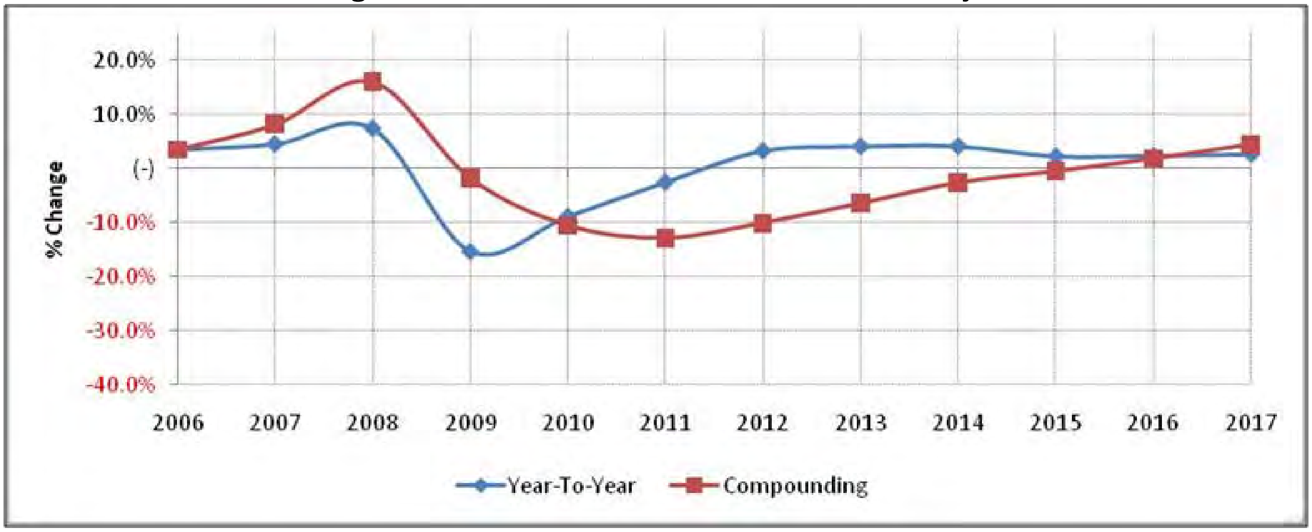
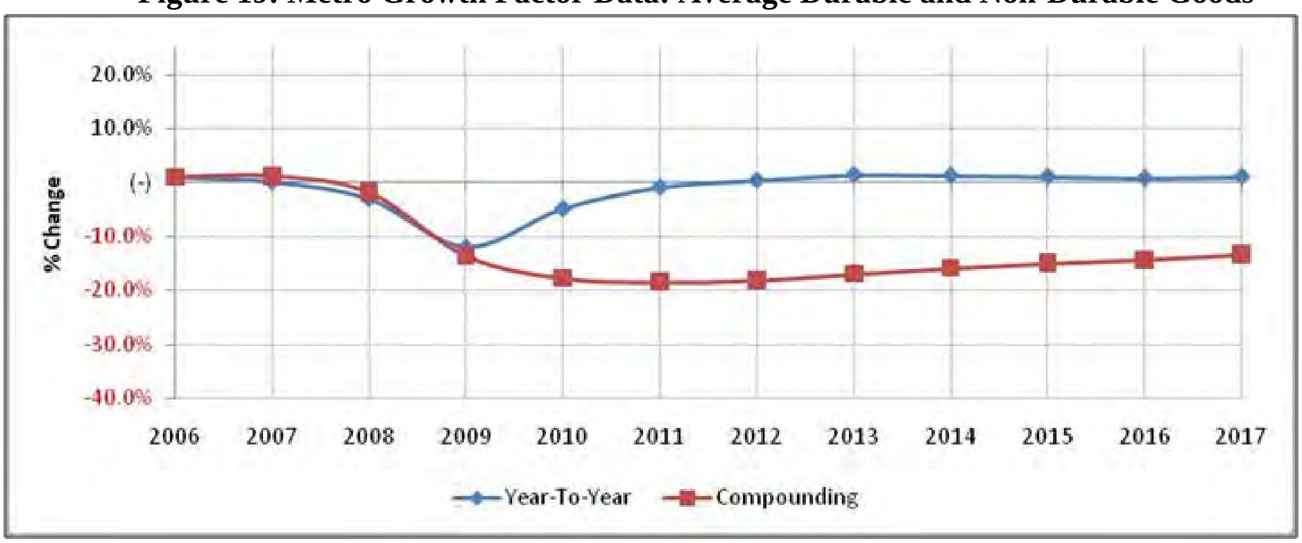


Figure 19 gives an example of the growth factor data for area sources for the following non-permitted area source emission categories:

- Industrial Stationary Source Fuel Combustion
- Miscellaneous Industrial Processes
- Surface Coating (excluding Architectural)
- Asphalt Production

DEQ has used the average of durable and non-durable goods here to represent specific commercial and industrial activities too small to be on permits. As you can see from the graph, reduction in activity during the 2008 recession is followed by near zero growth, resulting in an overall compounding reduction of 13%, and a final compounding applied growth factor of 0.87.

Figure 19: Metro Growth Factor Data: Average Durable and Non-Durable Goods



For details on all growth factors used to project 2017 emissions, please see Appendix 12.3.5.
DEQ accounted for emission reductions for future regulatory controls such as Oregon's Heat Smart rules and gasoline vapor recovery, and federal rules such as upcoming NESHAPs and Residual Risk and Technology:

- Oregon Heat Smart. As a regulatory change to the emissions inventory, DEQ's new Heat Smart program requires the removal of inefficient, uncertified stoves upon home sale, along with other requirements related to solid fuel burning devices. Heat Smart is expected to reduce emissions of pollutants of concern by between 4% and 12%, depending upon pollutant. (The reductions are based on DEQ staff expertise and knowledge in expected removal and replacement rates for uncertified devices in the region.) For more information, see Appendix 12.3.7.

- National Emission Standards for Hazardous Air Pollutants (NESHAP). A NESHAP is a federally mandated pollution control or standard that applies to certain industries or industrial processes. Several new NESHAP standards have been enacted since 2005 and need to be considered in our new model. Most significantly, EPA has created NESHAPs that apply to area, that is, smaller industrial sources. Several area source NESHAPs (such as ones for gas stations, dry cleaners, and autobody facilities) will reduce emissions for the 2017 emissions inventory, but were not in effect for the 2005 emissions inventory. The 2017 emissions inventory will also be reduced by new NESHAPs that will require emission reductions for industries such as polyurethane foam production (methylene chloride reduction), solvent utilization (nine metal fabrication facilities), and paint stripping and surface coating operations.
    - For solvents in particular, all reductions are the result several measures to reduce both metal and volatile organic compound[4] (VOC) emissions (metals – chromium VI, hazardous air pollutants, lead). In particular, the reduction of HAP-containing solvents and coatings use, increased use of filtered spray booths, and increased training are all measures that will contribute to these reductions.

    - Another NESHAP regulating halogenated solvent use caused sources to discontinue using trichloroethylene and perchloroethylene. For 2005, the PATS model estimated concentrations of these solvents above benchmarks at several industrial facilities using them for degreasing. In contrast, there were no areas with concentrations above the benchmarks for perchloroethylene and trichloroethylene in 2017 model projections, because facilities discontinued their use.

    - Since many industries in the Portland area have reduced their VOCs to comply with ozone regulations, DEQ found them to already be in compliance with some of the upcoming federal regulations to reduce air toxics.

- Commercial Marine. The International Maritime Organization has amended regulations in the North American Emission Control Area to require the use of cleaner fuels in ocean going vessels and some harbor craft vessels that will achieve reductions in particulate matter beginning in 2015. This reduction in particulate matter will also yield reductions in 15-PAH and metals.

- Rail. EPA has revised its emissions factors to reflect the turnover of older locomotives for newer more efficient ones. The new emission factors account for cleaner locomotive engines as they are phased in over the years. The EPA's Clean Air Nonroad Diesel Rule establishes standards for both hydrocarbons and PM, as well as CO and NOx. Essentially, these engine requirements result in reduced levels of all PATS pollutants attributed to rail.

[4] "Volatile organic compound (VOC)" means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions.

3.4.4.2 EPA NONROAD2008a: Nonroad Mobile Sources

As described above, DEQ uses EPA NONROAD2008a to model emissions growth in nonroad vehicles and equipment. This includes the following:

- Lawn and Garden
- Construction Equipment
- Agricultural Equipment
- Industrial Equipment
- Recreational Equipment
- Personal Watercraft

The nonroad model accounts for changes in equipment population over time. Data output is in emissions in tons per year, by source classification code (SCC), and by county. DEQ staff ran NONROAD2008a for all counties falling within the PATS emissions inventory grid. Fuel parameters specific to 2017, such as sulfur content, were accounted for in the model input. Additionally, in estimating future year projections, the model includes a variety of regulatory control options. NONROAD2008a accounts for the emission reductions associated with two rules finalized in 2008:

- Diesel recreational marine standards in the Locomotive/Marine final rule (May 6, 2008); and
- Small spark ignition lawn and garden and Recreational Marine engines (October 8, 2008).

NONROAD2008a also contains the effects for the nonroad diesel engine rule (construction); beginning with new engines in 2008 and fully phased in by 2015.

- Small engine standards. Small engine standards for spark ignition engines have been coming out from EPA. They will impact several area sources and are represented in the 2017 emissions inventory, and vary depending on the kind of engine or vehicle. The rules will create new standards for emissions of hydrocarbons, NOx, and CO for a variety of nonroad engines, equipment, and vessels that cause or contribute to air pollution.

3.4.4.3 Metro Forecast: On-Road Mobile Sources

Traffic related emissions are one of the largest contributors to the air toxics pollution in the PATS study area. The on-road mobile sources methodology combines the growth forecasts with known controls. Metro's Travel Demand Model provided forecasted vehicle miles traveled which Metro combined with EPA's MOBILE6.2 2017 emission factors to give 2017 air toxics emissions for every road link.

Forecasted growth is based on Portland's increased population, changing transportation modes, and location of jobs relative to housing. Future emission factors in MOBILE 6.2 include exhaust and evaporative emissions that are representative of the Federal Tier II emissions standards on new vehicles, the nationwide phase-in schedule, and Portland's current vehicle registration age. DEQ accounted for EPA's Mobile Source Air Toxics regulation by assuming 0.69 volume percent fuel benzene content. The outputs are pollutant emissions by link and transportation analysis zone.

While it is technically possible to model California's and Oregon's Low Emission Vehicle II standards with MOBILE6.2, this was not done due to the complexity of making such adjustments in comparison to the overall PATS work plan timelines and appropriate blueprint level of analysis. DEQ therefore performed an "off model" adjustment of 3% for VOCs (including PAHs) and 6% for Benzene, 1,3 –Butadiene, Acrolein, Acetaldehyde, and Formaldehyde to account for Low Emission Vehicle II standards in 2017**.** In addition, MOBILE6 has recently been replaced by EPA's MOVES model; however, Metro modeled the 2017 on-road emissions well before the release of MOVES, so any improvements in the MOVES model are not incorporated in the PATS study.

3.4.5 Data Quality and Emissions Inventory Improvements

In order to assist PATSAC with its work in understanding the science of air toxics and making recommendations, DEQ developed a qualitative approach to describing the data used in the emissions inventory. Through the development of the emissions inventory and collaboration with PATSAC members, DEQ staff made improvements to analytical methods. Section 3.4.5.1 outlines developments in assessing and describing data quality, and section 3.4.5.2 gives an overview of some of the more significant improvements to the emissions inventory. Improvements in modeling based on PATSAC recommendations can be found in the modeling section of this report.

3.4.5.1 Data Quality

DEQ and PATSAC used the best available science on air toxics to identify problems and recommend solutions. In the course of doing any scientific analysis, there are varying degrees of data quality. In response to committee interest, DEQ has developed a qualitative approach to describing PATS data quality. DEQ and PATSAC benefitted from a systematic approach to considering data quality in evaluating air toxics problems and developing emission reduction recommendations.

DEQ developed a comprehensive data quality rating tool to inform emission reduction decisions. In rating the data, DEQ considered published EPA ratings of data quality, past DEQ data quality ratings, and the source of the data. For example, for industrial emissions, DEQ may have actual measurements from facilities in known locations. This is the highest quality of data but only available for limited source categories. For area-source emissions like wood burning, the highest quality data available are estimates based on data from surveys and land use, because it is not possible to monitor the chimneys of homes where people burn wood.
Data quality for a source category is one consideration in the larger picture of emission contributions and solutions. In order to rate the data quality, DEQ rated the quality of the emission factor, the activity data, and the spatial allocation of the emission.

Table 4 summarizes the emissions inventory rating information. It combines DEQ and EPA rating definitions. The first row of information shows the range of quality for emission factors. Many emission factors come directly from EPA, and for those, DEQ has adopted EPA data quality ratings. Where EPA has no ratings or emission factors are not from EPA, DEQ generated its own data quality ratings. The “Lowest” emission factor rating was assigned to data defined by a single source test or possibly a surrogate source test. Emission factor ratings for each pollutant from each subcategory were averaged to get rating by pollutant for each source category.

The second row shows the range of quality for activity data. The “Highest” rating is for permitted point source activity reported to DEQ by sources and checked and verified by DEQ staff. The “Higher” rating is activity based on survey results or similar information. The rating of “Medium” activity data was assigned to data compiled by EPA as part of their models and approved for criteria pollutant work. A rating of “Lower” for activity data was assigned when a survey was not available and DEQ used per capita emission factors from EPA documentation. Consumer and commercial product use is an example.

The third row of information shows the range of quality for spatial allocation of emissions. The highest quality data has exact latitudes and longitudes. Lower quality but still acceptable data would be based on associations with other factors like housing or land use patterns.

Table 4: Guide to Emissions Inventory Rating System

Emissions Inventory Element	**A Highest**	**B Higher**	**C Medium**	**D Lower**	**E Lowest**
Emission Factor	Direct source test; primarily permitted point source emissions estimates.	EPA data, but also contractor and survey data.	From EPA documents and/or models.	EPA grades for surrogate data used.	Source tests do not represent a random sample of the industry or source category.
Activity Data	Throughput reported directly to DEQ by permitted facilities or another regulatory authority.	Survey results.	Activity based on models (for example EPA's nonroad model).	Population or number of employees based activity.	Limited information (e.g. National average)
Spatial Allocation	Exact latitude and longitude for a point or line where emissions occur is known (e.g. industrial facilities, highways).	Exact latitude and longitude for a polygon where emissions occur is known (e.g. airports).	Emission location is known and assigned to the area of a grid cell where the emissions occur (e.g. low traffic volume roadways).	Emissions are allocated to a grid cell based on land use qualification (e.g. residential open burning).	Emissions are allocated to a grid cell based on land use qualifications but emission location is variable (e.g. construction).

DEQ created a cumulative 2005 emissions inventory confidence based on the three emissions inventory elements.

Table 5 provides an example of the data quality rating chart for benzene. DEQ has summarized an average confidence for the 2005 emissions inventory. Lower grades are weighted heavier in the cumulative rating to illustrate that if one of the emissions inventory components is more qualitative, then predictive confidence in the emissions is lower. The rating scheme is as follows: **A** = Highest (1), **B** = Higher (2), **C** = Medium (4), **D**=Lower (8), **E**=Lowest (16). It is important to understand that a grade of "**C**" means meeting expectations, not at all unacceptable, and sufficient for emissions inventory purposes. Higher grades of "**B**" and "**A**" show where data quality increases. It is rare to have much "**A**" data in an emissions inventory. Most of the data used in PATS is in the range of "**B**" through "**D**", which is the best science available. For pollutants included in the PATS study, data quality is not a limiting factor in the PATS study. The exception to this is methylene chloride. A data quality chart for each pollutant can be found in the Emissions Inventory Appendix 10.3.6.

Table 5: Summary Data Quality Chart for Benzene

Benzene Data Quality					
Emission Source Category		**Emission Factors (2005)**	**Activity (2005)**	**Spatial Allocation (2005)**	**Cumulative 2005 Emissions Inventory Confidence**
Permitted Point sources		A	A	A	A = Highest
Dry Cleaners		-	-	-	-
Gas Stations		C	B	A	B = Higher
Airports		B	B	B	B = Higher
Residential Wood Combustion		C	B	C	C = Medium
Construction		C	C	E	D = Lower
Lawn and Garden		C	C	E	D = Lower
Marine	Recreational	C	C	B	C = Medium
	Commercial	C	B	B	B = Higher
Rail	High volume	C	A	A	B = Higher
	Low volume	C	C	C	C = Medium
Road	High volume	C	C	A	B = Higher
	Low volume	C	C	C	C = Medium
Landfills		C	C	A	B = Higher
Publicly Owned Treatment Works (POTW)		C	C	A	B = Higher
Other Nonroad		C	C	E	D = Lower
Residential Open Burning		C	B	D	C = Medium
Solvents		C	C	D	C = Medium
Area sources (general)		C	C	E	D = Lower

3.4.5.2 Emissions Inventory Improvements

A modeling project such as this is an iterative process. Based on PATSAC input, four main changes were made to the 2005 emissions inventory, described below. Improvements to the model are discussed in section 3.5. Ensuring that our projected 2017 emissions inventory is as complete and as comprehensive as possible is very important since this will be the foundation for all future recommendations with regards to achieving our goals. DEQ has spent considerable energy refining the projected 2017 emissions inventory to create a strong foundation for which to evaluate and recommend additional reduction measures. Updates to the 2005 and projected 2017 emissions inventory are described below. More detail on improvements to the emissions inventory can be found in Appendix 10.3.7.

3.4.6.2.1 2005 Emissions Inventory Updates

- Residential wood combustion emissions. In order to calculate 2005 emissions for residential wood combustion, DEQ used survey data collected in 2001. Shortly before the August, 2009 PATSAC meeting, Portland State researchers, under contract with DEQ, completed an updated statewide residential wood combustion survey. The new survey results indicated that the emissions were overestimated for 2005 based on the survey results. More specifically, the new survey incorporated the following improvements over the old survey:

a. Survey questions were more accurately ordered to separate respondents who owned wood burning devices but did not burn wood in those devices from respondents who burned wood in devices
b. Emission factors used were those reviewed and updated by the EPA Residential Wood Combustion workgroup in 2008
c. Emission factors specific to compressed firelogs were used
d. More detailed descriptions of cord sizes were provided to interviewers to better inform respondents
e. There were more completed survey interviews in the new survey
f. Additional survey questions asked in the new survey but not the old survey included
    i. Wood species and variety burned
    ii. Amount of pellets burned in inserts
    iii. Detailed questions to differentiate inserts from fireplaces

As a result, the 2005 residential wood combustion emissions inventory was recalculated based on the new survey results.

- Chrome plating emissions. The old emissions inventory method for emissions of hexavalent chromium - also called chromium VI - from chrome plating operations was based on estimations using emission factors, a process that had been carried forward from earlier inventories (1999). However, since 1999, DEQ evaluated actual source tests for every hard chrome electroplating facility in Oregon for a DEQ rulemaking. DEQ applied this source test data and the actual emissions were recalculated, which resulted in lower and more accurate emissions.

- Plastic parts coating. A review of the plastic parts coating emissions inventory methodology was triggered by the initial PATS modeling work. It was discovered that the risk from ethylbenzene in the PATS study area was being driven by 2005 emissions estimates for plastic parts coating. Emissions inventory methodology and EPA NESHAP documentation were subsequently reviewed, and it was found that emission factor calculations were incorrectly inflated through averaging of the NESHAP data. A change in factor calculation methodology resulted in emissions estimates being reduced by an order of magnitude.

- Additional industrial facilities from EPA's Toxic Release Inventory review. The original industrial facility inventory focused mainly on Title V sources and a handful of smaller sources that were in the original Portland Air Toxics Assessment and emit one of the 19 pollutants in the study. Concerns from PATSAC at the August 2009 PATSAC meeting led to an investigation by DEQ regarding the sources that were reported to the Toxic Release Inventory but were not included in the initial PATS inventory. Through a combination of staff discussions about sources that should be in the inventory and an investigation of which sources reported to the Toxics Release Inventory, DEQ found 25 additional sources that reported at least one of our 19 pollutants as a release to the air and has added them to the inventory. This brings the total number of major facilities to 103.

The improvements to the 2005 emissions inventory and modeling are further described in Appendix 10.3.7.

3.4.6.2.2 2017 Emissions Inventory Updates

- Residential wood combustion emissions. DEQ refined residential wood combustion emissions modeling by using more specific US Census Bureau home heating data information about where the emissions themselves are located.
- On road and non road emissions. The EPA Mobile Sources Air Toxics (MSAT) rule has been incorporated into the projected on-road mobile, non road mobile, and gas station emissions inventories.

- Gasoline station updates
    a. The Federal Mobile Source Air Toxics final rule is a two-step approach to reducing the benzene content of gasoline, ultimately requiring refineries to import and produce gasoline with specific volume percent benzene content. This reduction will be very important to achieving the ambient benchmark concentration for benzene. These new rules were enacted at the federal level, with amendments to assure reductions in Oregon as a result of intense lobbying by Oregon's congressional delegation.
    b. The increased use of electric and hybrid vehicles will impact emissions for gasoline stations by impacting their throughput of gasoline. DEQ used projections from the Energy Information Administration over Metro growth factors for 2017, because their data takes into account the changing composition of cars that will be on the road in the future (for example, gas, hybrid and electric). The Energy Information Administration data is published by a federal agency and is also being used for the low carbon fuel work at DEQ.
    c. Because of incompatibility during fueling, some types of vapor recovery systems actually result in an increase in emissions. For some newer cars the gas tank vacuum vapor capture system interferes with vapor controls at the gas pump, rendering them both ineffective. Eventually, the stations' controls will be phased out as more cars have their own systems, at which point there will be an emissions reduction.
    d. Some 15-PAH emissions were included in the 2005 emissions inventory but are eliminated for the projected 2017 emissions inventory. DEQ discovered an error in the Emissions Inventory Improvement Project emission factor for PAHs at gas stations, which was identified by a SWCAA and confirmed by EPA staff. The reason for the removal of 15-PAH from gas station volatile emissions is because PAH is in effect particulate matter, usually associated with combustion, and not a volatile compound. This error resulted in 9.1 tons per year of 15- PAH removed from the gasoline station inventory.
    e. Metals will increase for the on-road mobile source category. Metal emissions are modeled as a function of vehicle miles travelled (VMT). They are products of engine wear, trace level fuel and engine oil contamination, catalyst attrition, etc. Because EPA uses fixed emission factors, the inventory increases with VMT. Advanced emission controls (e.g. traps) will likely reduce emissions, but that is not accounted for in MOBILE6.2. Although we see an increase in metals for the on-road mobile category, they represent a negligible amount of the total metals for the overall emissions inventory.

- Point Sources. The PATS technical team performed a thorough review of all applicable NESHAPs for point sources. All point sources were already in compliance with NESHAPs in 2005 so no further reductions will occur due to these NESHAPs by 2017. During the review, DEQ identified a few sources with emissions that were not included in the 2005 emissions inventory. Additionally, some sources had discontinued certain emissions as well. These adjustments have been included for the 2017 emissions inventory.

3.5 Modeling Overview

3.5.1 Model Background

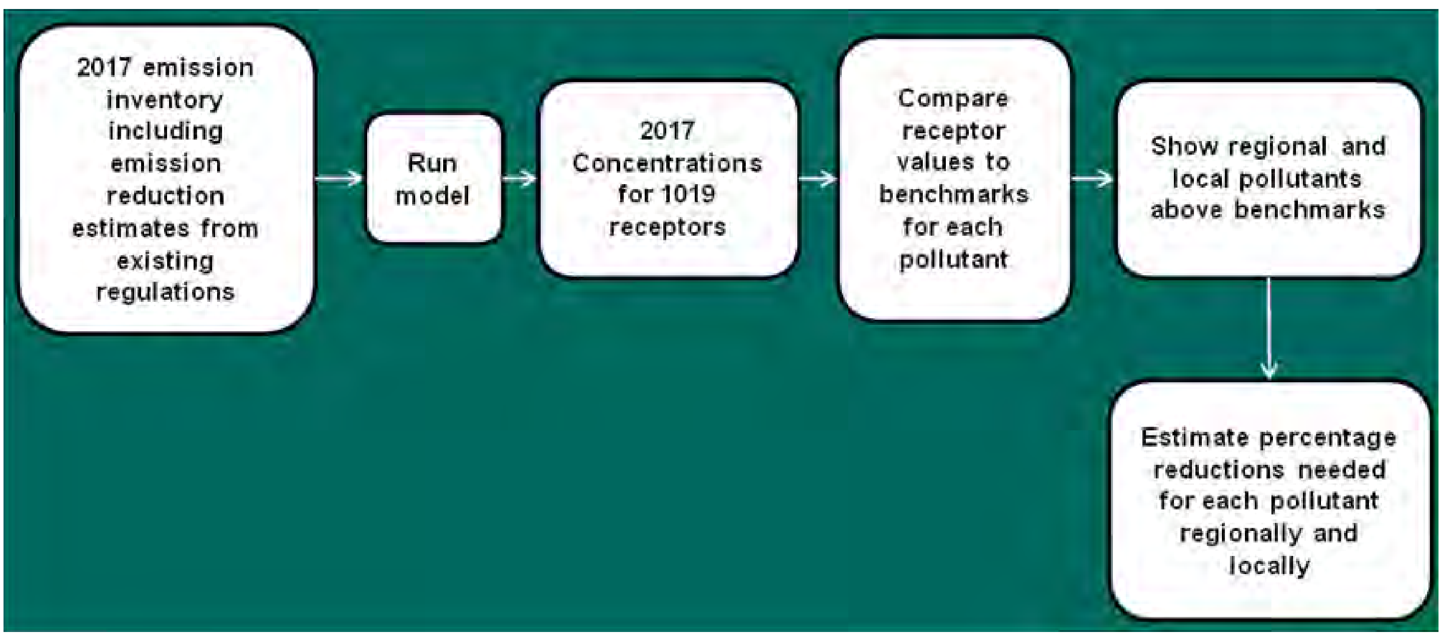
Air quality dispersion modeling is a mathematical approximation or representation of air quality using emissions data and information about how emissions are dispersed in the air, including the effects of terrain and mixing and transport by wind.

Modeling is an effective tool to estimate the impact of air toxics over a large region, such as the PATS study area. Modeling allows the estimation of pollutant concentrations in ambient air for which monitoring would be prohibitively costly to measure, or for which there are no effective methods. Once a model is established, DEQ can estimate the effect of future emissions changes and potential reductions.

In order to model air toxics in the PATS study area, DEQ determined the pollutants of concern, established study area boundaries, developed emissions information for all categories of sources, and then ran the dispersion model. The results of the model, expressed as annual average pollutant concentrations, were then compared to Oregon's ambient benchmark concentrations. DEQ started with 2005 emissions as a base year, which corresponded to available monitoring and air toxics emissions inventory data, and then projected these emissions to 2017 levels and re-ran the model.

The flow chart in Figure 20 shows the steps of assembling and interpreting the PATS model once 2017 emission projections were available.

Figure 20: 2017 Model Analysis



3.5.2 Model

Because of the diverse types of emissions sources in the PATS study area, including point sources (industrial facilities, gas stations), linear sources (roads, rail lines), delineated area sources (airports, shipping channels), and broad-spread area sources (diffuse population activities such as residential home heating), there was no model perfectly suited to estimate concentrations with great accuracy for all categories. DEQ selected CALPUFF to model concentrations because it performs generally well in estimating a broad range of emissions types. DEQ did not choose to use a Gaussian plume model (such as used in industrial source regulatory modeling) due to the size of the PATS modeling domain and its complex terrain of high hills, river channels, and broad valleys. The CALPUFF model as approved by EPA is the model of choice for long-range transport of pollutants in areas of complex terrain, as in the PATS domain. Moreover, DEQ used CALPUFF for Portland's first local scale air toxics modeling effort (the Portland Air Toxics Assessment, or PATA) in 2006. As a result, this previous experience with CALPUFF provided a basis for model performance, and allowed re-use of the on-site meteorological data for developing the CALMET windfields used in PATS.

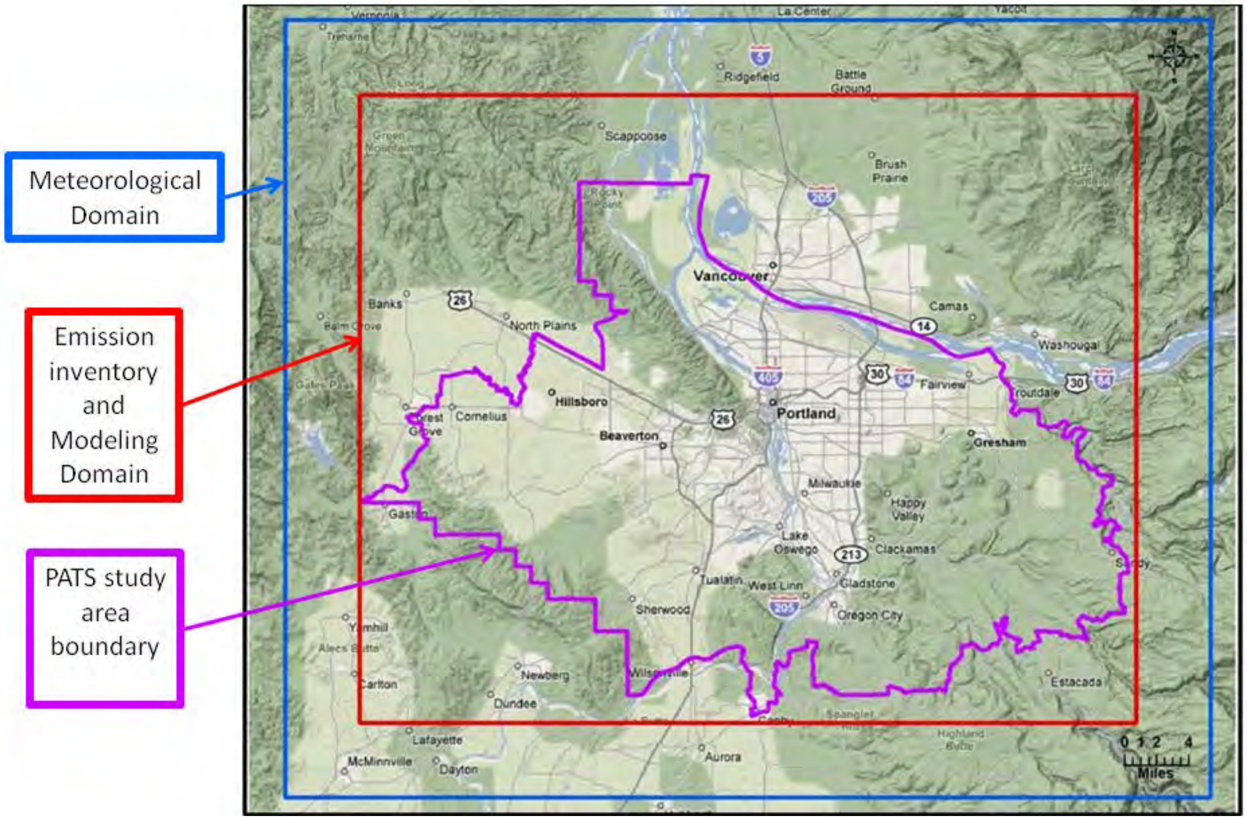
In general, CALPUFF can be described as a dispersion model that characterizes emissions and resulting modeled concentrations by creating a stream of pollutant puffs that wander across the domain in response to hourly changing windfields. The inputs to this model include dispersion parameters, meteorological data (windfields), and emissions data. There is no atmospheric chemistry in CALPUFF to model the formation in the atmosphere of secondary pollutants, such as formaldehyde, however a decay function was incorporated to allow for the short half lives of the more active toxics, such as 1,3 butadiene. Although there is no chemistry, CALPUFF does estimate modeled concentrations at a higher areal resolution than concentrations predicted by Eulerian grid chemical transport models, and this was an important consideration.

3.5.3 Modeling Domains

In order to prepare for the PATS project, DEQ analyzed the 1999 National Air Toxics Assessment (NATA) information showing air toxics risk at Portland area census tracts. Using this information along with community growth patterns, jurisdictional boundaries, and previous air quality boundaries for ozone and carbon monoxide, DEQ established a study area boundary intended to include potential air toxics concerns in the Portland area. DEQ made an effort to keep the boundary distinct from other jurisdictional entities that may want to initiate their own separate community based air toxics efforts, such as the Salem/Keizer area.

Figure 21 shows three different boundaries or domains in the PATS model. The purple line delineates the study area boundary and represents the area in which air toxics concentrations were to be modeled by CALPUFF, and where emission reduction targets would be estimated. The red boundary is the computational domain in which emissions data were entered. This domain is larger than the study area in order to include emission sources outside the study area that could potentially influence the study area. The blue line shows the meteorological domain. The larger meteorological domain allows for the recirculation of pollutant puffs back into the computational domain in response to changing wind patterns. The PATS project also included emission data for the Vancouver area as that area is part of the same airshed as Portland, and modeled concentrations from these emissions have the potential for impacting the PATS study area. In addition, DEQ is working in partnership with the Southwest Washington Clean Air Agency, and will share the PATS results with them. The models used in assessing air toxics are described in more detail in Appendix 10.4.

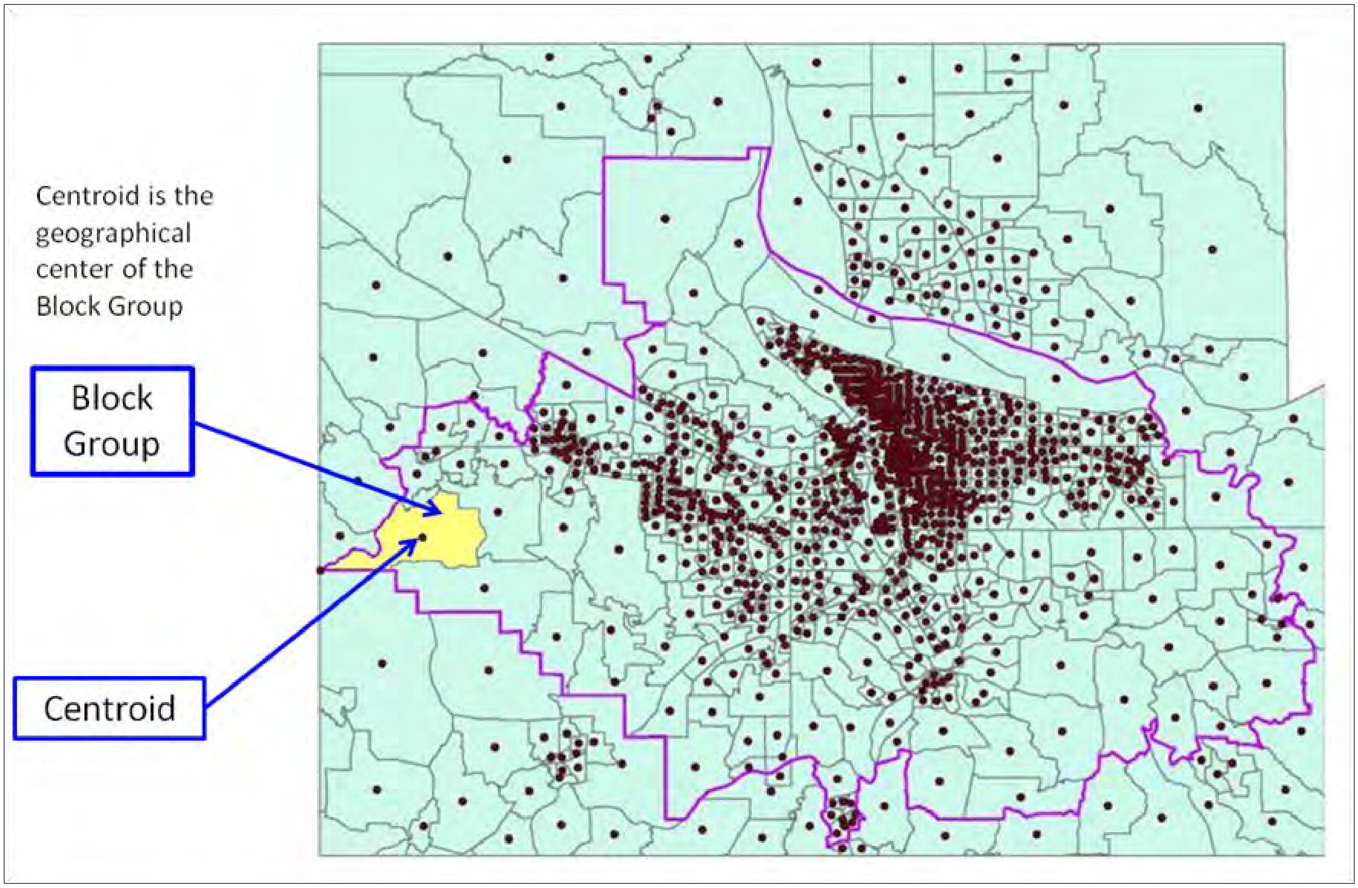
Figure 21: Modeling Domains



3.5.4 Receptors

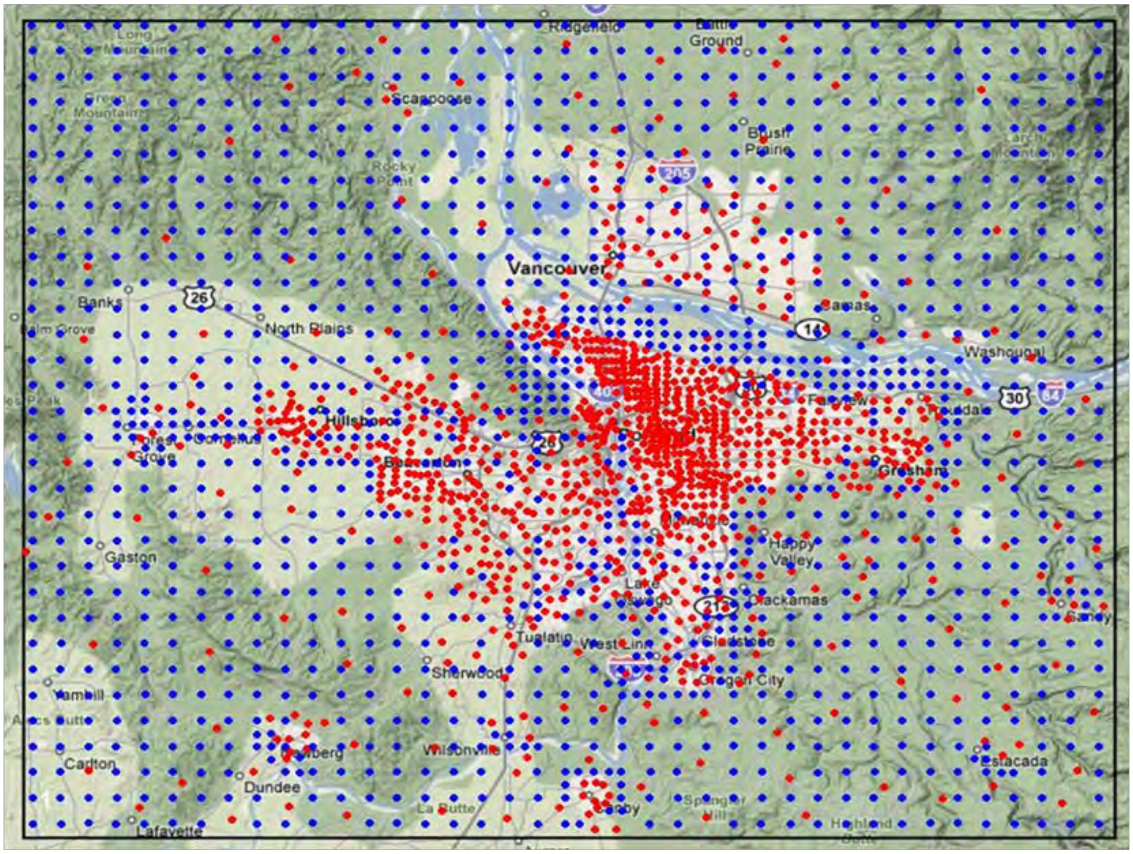
The primary locations used to estimate toxic concentrations in the PATS project are the geographic centers, or centroids, of the year 2000 census block groups in the study area. In the CALPUFF model, these 1019 locations are referred to as model receptors, and can be considered 1019 virtual monitors of the annual average concentrations for each of the 19 modeled PATS pollutant concentrations. Since census block group boundaries are drawn to contain roughly the same number of people, about 4,000, the largest number of modeling receptors occur in the areas of highest population. Figure 22 shows the locations of the block groups, and the CALPUFF receptors located at their centroids. As described in section 4 below, these modeling receptor concentrations can be analyzed to show regional and local concentration patterns, and the source categories that are significant contributors to these concentrations. The location of the highest toxic concentrations, and the source categories that are largely responsible for those concentrations, helps support the development of emission reduction strategies and where they will be effective. Placing receptors in census blocks also allows DEQ to analyze block group level population statistics collected by the U.S. Census Bureau, facilitating an initial analysis of potential environmental justice factors in the study area.

Figure 2: Census Block Groups and Block Group Model Receptors at Centroids



One disadvantage of using census block group locations is that in areas of low population density there are insufficient receptors to characterize pollutant concentrations over larger land areas. For example, the Forest Park area and the industrial land just south of the Columbia River are represented by fewer than a dozen receptors. Adding more modeling receptors to these areas will help the understanding of model performance. As a result, PATS added over 1,000 receptors to areas with less population density. The additional receptors were added in a gridded overlay to fill in areas in the domain with few census block groups. In addition, for some point source facilities, additional receptors were placed at the property line. The 2017 model run included estimated concentrations for both the original and additional receptors, although for consistency with census data, the final risk estimates analyzed to define levels above benchmarks used only the original 1019 census block group receptors. Figure 23 below illustrates original receptors in red and additional receptors in blue.

Figure 23: Updated Modeling Receptors



3.5.5 Model Runs

To understand impacts from the many source category emissions in the study area, DEQ developed the emissions inventory for PATS, formatted data for input to CALPUFF, and ran multiple model runs for each source category. Table 6 summarizes the modeled categories, the type of source (whether the source is modeled as point, area, or volume), if the type is "area", whether the source is a polygon, or is area-wide and gridded, and the number of sources. For a description of polygon and area sources, please see section 3.4.

Table 6: Source Category Modeling Types and Model Runs

Source Category	Type	Area Type	Number of Emission Sources
Stationary Sources			
Industrial Emissions	point		222
Industrial Emissions	volume		32
Dry Cleaners	volume		198
Gas Stations	volume		638
POTWs	area	polygons	27
Area Sources (general)	area	gridded	1446
Residential Wood Combustion (RWC)	area	gridded	1446
Residential Open Burning (ROB)	area	gridded	1446
Solvents	area	gridded	1446
Lawn & Garden	area	gridded	1446
On-Road Mobile (ORM)			
Hot Links	volume		2147
Warm Links	volume		5224
Cold Links	area	gridded	1446
TAZs	area	gridded	1446
Non-Road Mobile (NRM)			
Other	area	gridded	1446
Construction	area	gridded	1446
Airports	area	polygons	15
Airports	volume		1
Comm Marine: OGV in transit	area	polygons	
Comm Marine: hotelling/manuevering + harborcraft	area	polygons	
Comm Marine: Barge traffic	area	polygons	
Rec Marine: Large Water	area	polygons	
Rec Marine: Small Water	area	gridded	1446
Rail: Hot Links	volume		4360
Rail: Cold Links	area	gridded	1446
Rail: Yards	area	polygons	11

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.

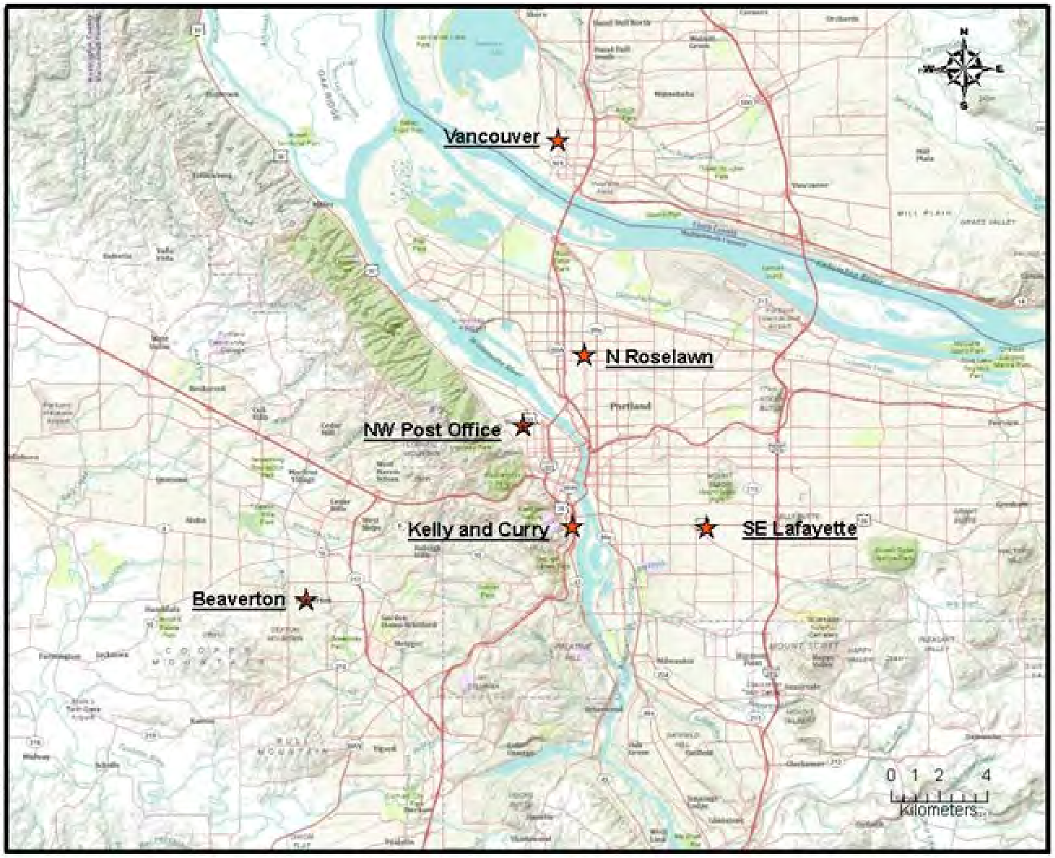
NW Post Office: This station is located in the Northwest quadrant of the city on a residential street and is on the boundary between a high-density residential area and a heavy industrial area. It is within a half kilometer of a small commercial area and numerous metal finishing operations. Railroad 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.

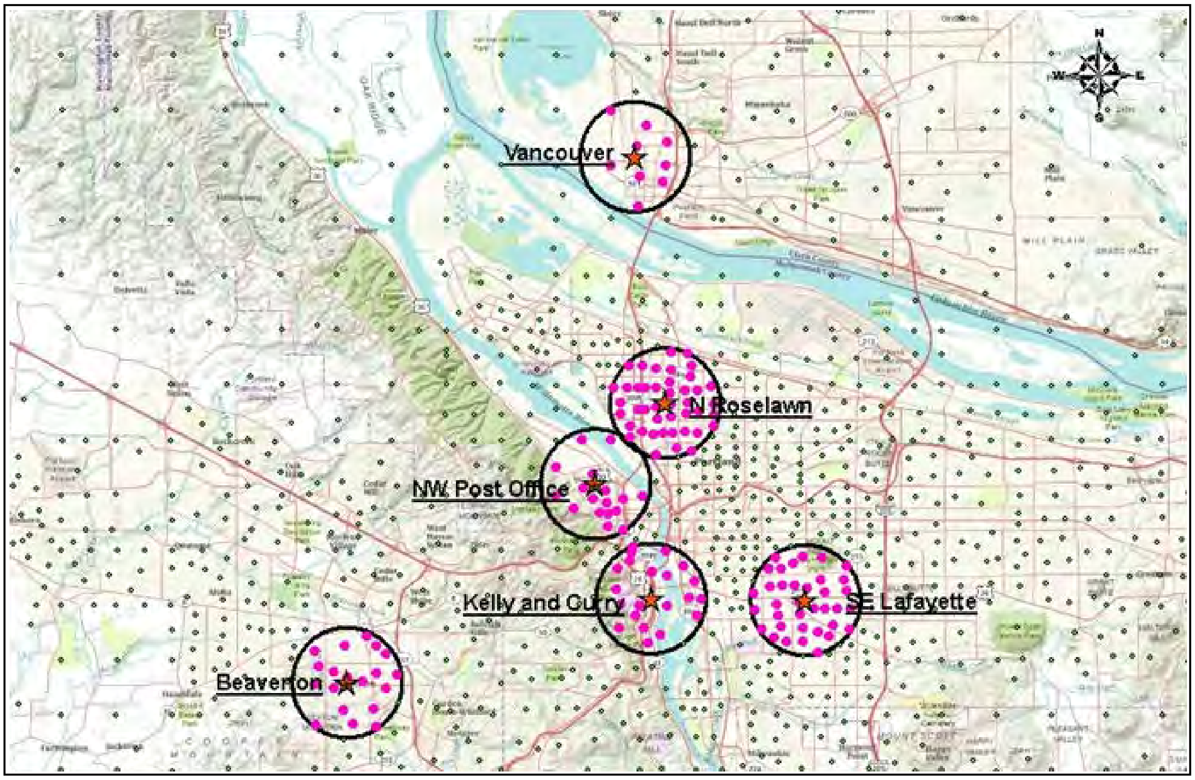
3.6.2.2 2005 Monitoring Study

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:

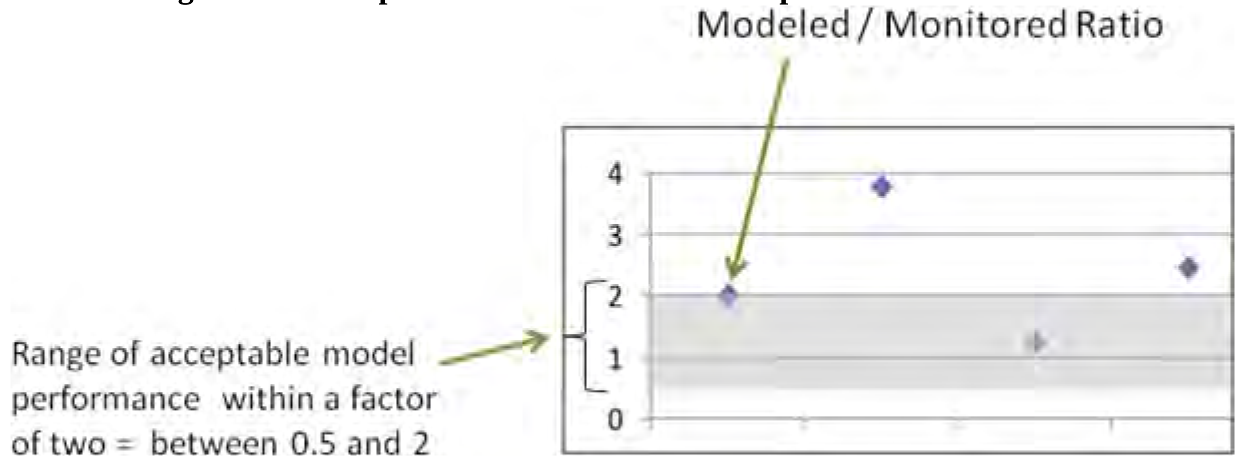
- Acetaldehyde 65%
- Arsenic 50%
- Benzene 25%
- Cadmium 23%
- Formaldehyde 55%
- Lead 42%
- Manganese 47%
- Nickel 25%

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.]

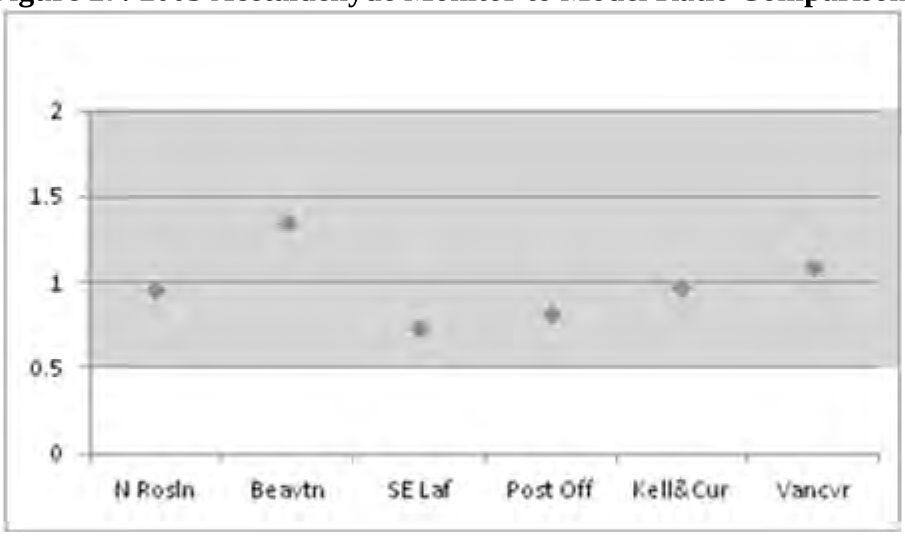
Figure 26: Example of Monitor to Model Comparison for a Pollutant



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.

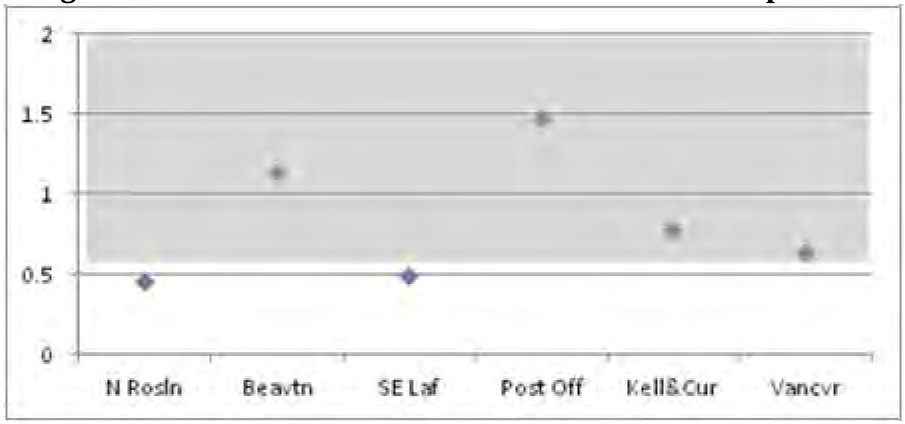
Figure 27: 2005 Acetaldehyde Monitor to Model Ratio Comparison



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.

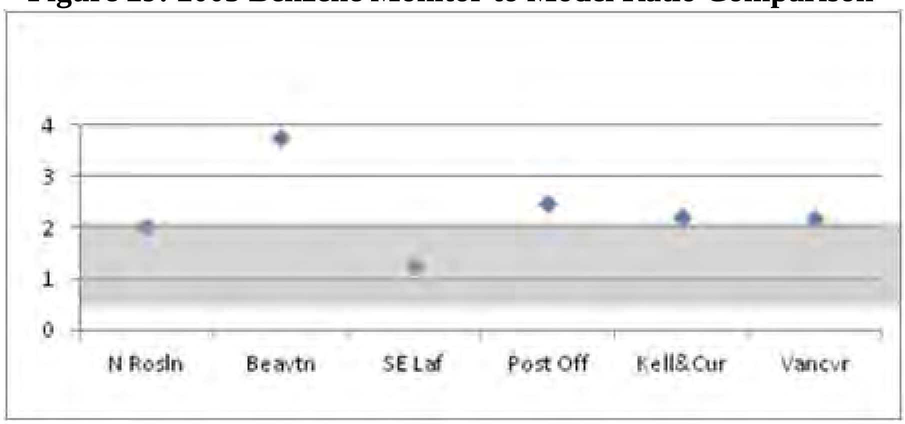
Figure 28: 2005 Arsenic Monitor to Model Ratio Comparison



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.

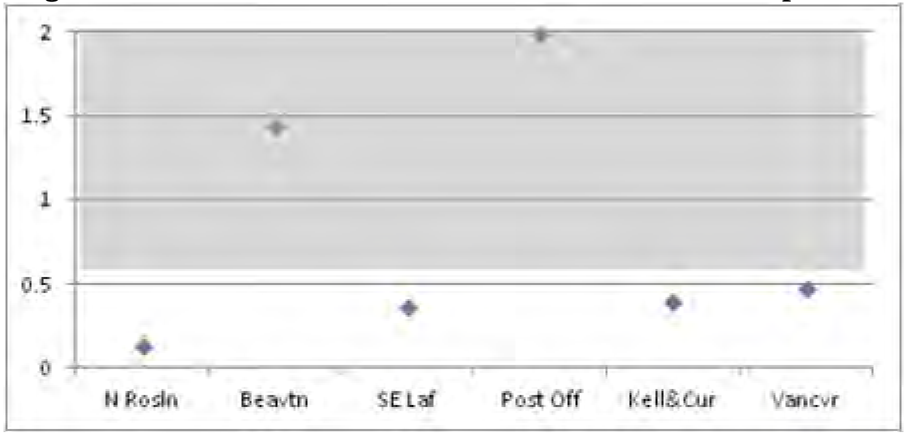
Figure 29: 2005 Benzene Monitor to Model Ratio Comparison



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.

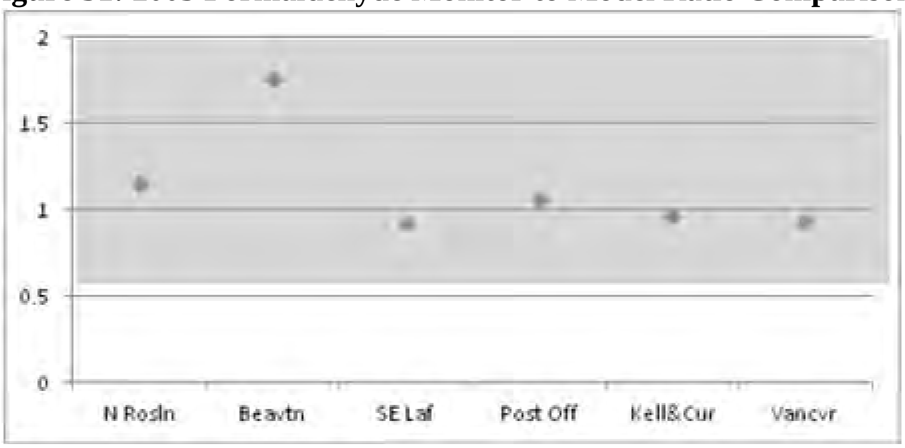
Figure 30: 2005 Cadmium Monitor to Model Ratio Comparison



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.

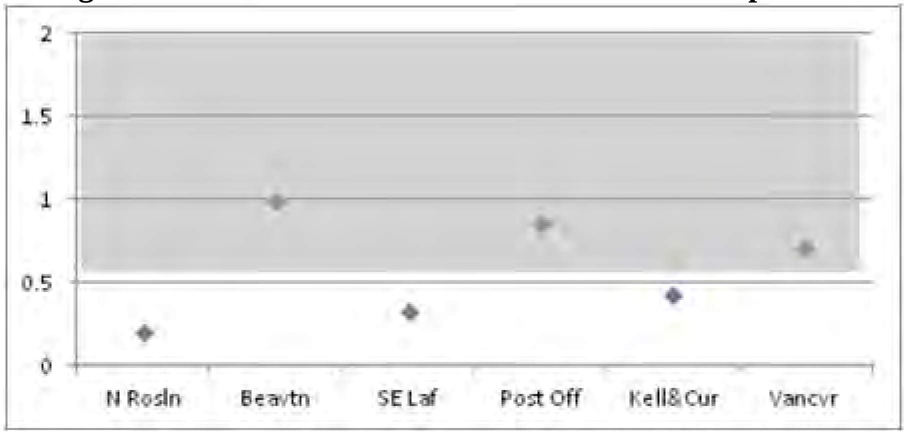
Figure 31: 2005 Formaldehyde Monitor to Model Ratio Comparison



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.

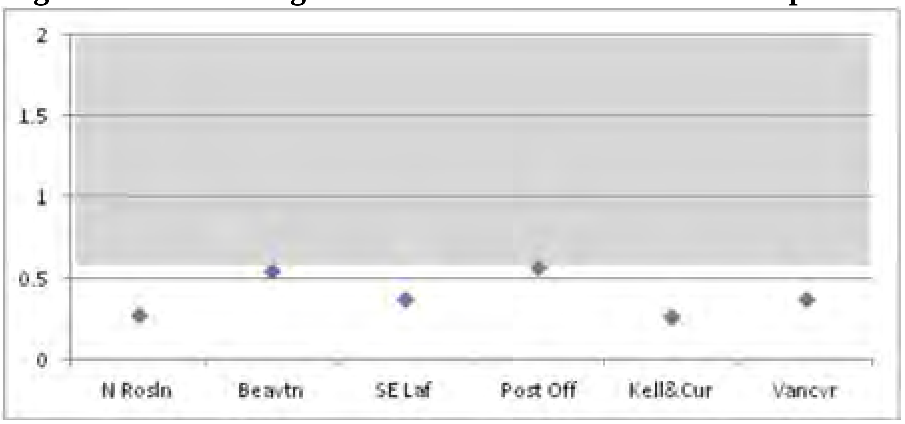
Figure 32: 2005 Lead Monitor to Model Ratio Comparison



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.

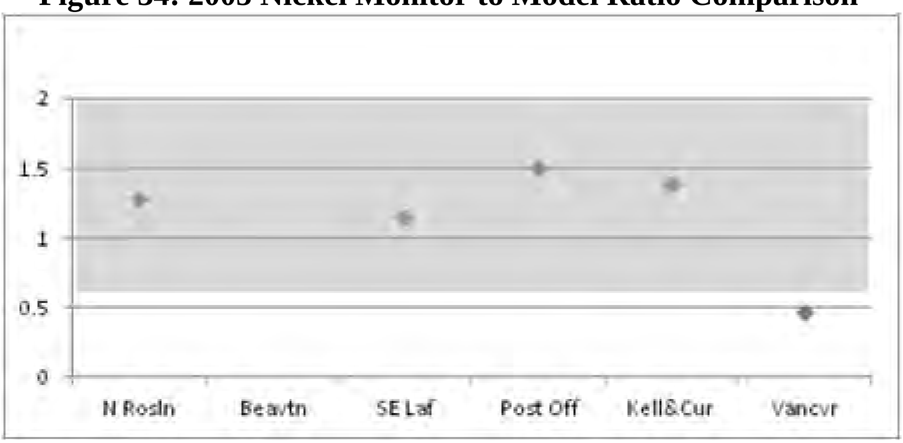
Figure 33: 2005 Manganese Monitor to Model Ratio Comparison



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.

4. Modeling Results

4.1 Overview of Modeling Results

The PATS 2017 model allows DEQ and stakeholders to understand the regional distribution of air toxic concentrations, the significant source categories responsible for these concentrations, and ways to estimate emission reduction targets and plan emission reduction strategies. Using GIS to map pollutant concentrations, DEQ has described various spatial patterns, identified risk drivers, and analyzed contributions from source categories. Table 7 summarizes spatial distribution of the modeled PATS pollutants. In general, the modeling showed that the majority of PATS pollutants are present both regionally and in zones of higher concentration corresponding to roadways and development. Several pollutants were modeled at levels of concern for the entire region, and several pollutants are strictly limited to localized impact areas.

Table 7 : Spatial Distribution of the Modeled PATS Pollutants

Region wide	Region wide with higher concentrations in defined zones	Limited to localized impact areas
Acetaldehyde Formaldehyde 15 PAH	Benzene 1,3 Butadiene Diesel Particulate Arsenic Chromium VI Naphthalene Acrolein Dichlorobenzene	Manganese Nickel Cadmium Lead (one receptor)

PATS pollutants can be categorized by their primary sources. Table 8 shows pollutants organized in this way. Even though PATS pollutants are associated with a primary source, most of them also come from a variety of other sources as well. For example, the largest source of benzene is motor vehicles but it is also produced by residential wood burning and some industrial facilities. However, the metals in the localized impact area category are produced almost exclusively by industrial processes. Pollutants in the Secondary Formation category come overwhelmingly from atmospheric chemical reactions.

Table 8: Primary Source of PATS Pollutants

Predominant Source of Emissions	PATS Pollutant
Mobile Sources	1,3 Butadiene Benzene Ethyl benzene Diesel particulate Arsenic Chromium VI
Residential Wood Combustion	15 PAH Naphthalene
Industry	Cadmium Manganese Nickel Lead
Solvents	Dichlorobenzene Methylene Chloride Perchloroethylene Trichloroethylene
Secondary Formation	Acetaldehyde Formaldehyde Acrolein

4.1.1 Pollutants above Benchmarks

For all receptors with values above DEQ benchmarks, PATS 2017 modeling estimated seven pollutants at levels more than ten times the benchmarks. Seven other pollutants were between one and 10 times above DEQ benchmarks. Table 9 summarizes PATS modeling results including times above the benchmarks, regional, zonal or localized impacts, and is also color coded based on predominant contributing source category. Three pollutants not included in this table were below benchmarks: perchloroethylene and trichloroethylene and ethylbenzene. Lead is not included because it exceeded the benchmark only at one receptor and needs further verification. Methylene chloride is not included because while levels were modeled above benchmarks, DEQ has extremely low confidence in the data quality and will follow-up by improving the emissions inventory. Table 10 summarizes average reductions needed to reach benchmarks.

Table 9: Summary of PATS 2017 Modeling Results

Pollutant	Region wide	Regionwide and zonal	Localized impact areas
More than10 X ABC			
1,3 Butadiene		●	
Benzene		●	
Diesel particulate		●	
15 PAH	●		
Naphthalene		●	
Cadmium			●
Formaldehyde	●		
Acrolein		●	
Between 1 and 10 x ABC			
Arsenic		●	
Manganese			●
Nickel			●
Chromium VI		●	
Dichlorobenzene		●	
Acetaldehyde	●		

Table 10: Average Reductions Needed to Meet Benchmark

Pollutant	Region wide	Region wide and zonal	Localized impact areas
Average Reduction Needed to Reach Benchmark – More than 10 X Ambient Benchmark Concentration			
1,3 Butadiene		85%	
Benzene		88%	
Diesel particulate		86%	
15 PAH	94%		
Naphthalene		77%	
Cadmium			70%
Acrolein		88%	
Formaldehyde	10%		

Average Reduction Needed to Reach Benchmark – Between 1 and 10 x Ambient Benchmark Concentration			
Arsenic		66%	
Chromium VI		37%	
Manganese			84%
Nickel			90%
Dichlorobenzene		45%	
Acetaldehyde	81%		

4.1.2 Secondary Formation and Background Pollutants

During the PATS modeling study and PATSAC advisory committee process, DEQ further investigated the role and importance of background and secondary pollutants. For three pollutants, acrolein, acetaldehyde and formaldehyde, the primary source is atmospheric formation from precursors such as 1,3 butadiene, toluene and xylene. For other pollutants, such as benzene, background sources from other locations and undocumented regional emissions make up a significant percentage of the total emissions. Figure 35 illustrates the sources of background and secondary air toxics concentrations. The PATS emissions inventory is composed of direct emissions. Because CALPUFF does not include estimates from atmospheric formation or chemical reactions, DEQ added secondary pollutant concentrations to the modeled concentrations to the extent information was available from EPA's 2005 National Air Toxics Assessment (NATA). Also, to form a complete estimate of concentrations in the Portland area, DEQ added the NATA levels of background concentrations when available. EPA has not yet been able to develop background concentrations for all air toxics.

Figure 35 Sources of Background and Secondary Air Toxics

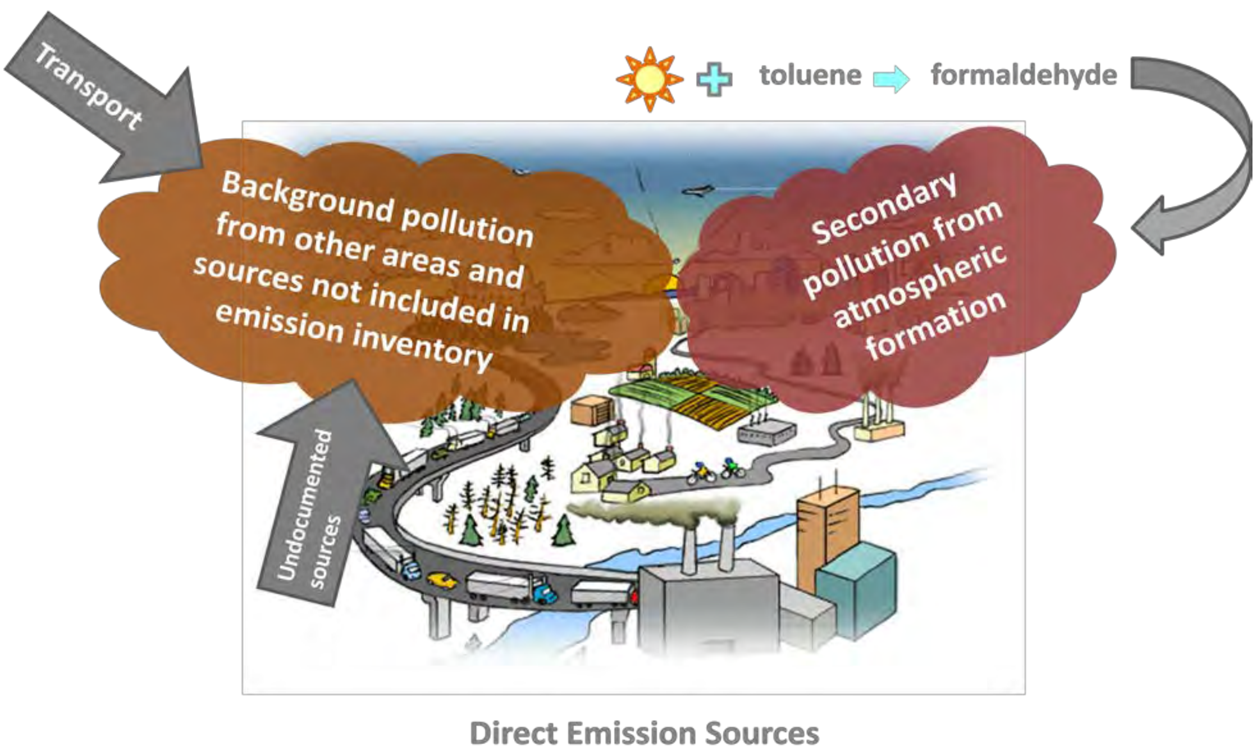


Table 11 shows the pollutants for which DEQ added background concentrations to the PATS model. Table 12 shows pollutants for which DEQ added secondary concentrations to the PATS model and also chief associated precursors.

Table 11 Background Concentration Included in Modeling

Background Concentration Data Included	Background Concentration Data Not Included
1,3 Butadiene	Diesel Particulate
Benzene	Ethylbenzene
Dichlorobenzene	15 PAH
Naphthalene	
Arsenic	
Chromium VI	
Cadmium	
Manganese	
Nickel	

Table 12: Secondary Concentrations Included in Modeling

Secondary Concentration Data Included	Chief Precursors
Acetaldehyde	Toluene and xylene from auto exhaust and vegetation
Formaldehyde	Toluene and xylene from auto exhaust and vegetation
Acrolein	1,3 Butadiene from auto exhaust

4.2 Concentrations vs. Exposures as Emission Reduction Targets

The PATS model estimates concentrations at block group centroids. In many modeled air toxics risk assessments, concentration estimates are followed by further estimates of exposure based on assumptions about how various population cohorts spend time in different locations. These exposure assumptions and estimates provide an understanding of how much of a particular modeled pollutant people are likely to breathe. In DEQ's previous air toxics model, Portland Air Toxics Assessment (PATA), exposure analysis generally decreased concentrations for individuals living in denser or more developed block groups and increased concentrations for individuals living in less populated and less developed block groups. These results come from assumptions that many people move daily out of their home block groups for work, school and other activities. In contrast, inclusion of assumptions about time spent traveling on roadways will increase exposure to mobile source air toxics.

Despite the availability of exposure analysis, DEQ opted to use modeled concentrations instead of exposure concentrations to characterize air toxics problems in the PATS study area. This simplifying assumption provides a starting point to understand air toxics problems and would likely be most protective for individuals or sensitive populations that do not move out of higher concentration areas. Using modeled concentrations rather than exposure concentrations is generally consistent with the method of reasonable worst case analysis that DEQ used to analyze modeling data. In addition, DEQ regulations in OAR 340-246-0170 indicate that local emission reduction plans will use modeled concentrations as targets. However, when air toxics rules were drafted in 2003, DEQ and others lacked experience modeling and estimating air toxics at a geographic level, and were not fully aware of the value of or potential role for exposure analysis. In emission reduction efforts that follow PATS, exposure concentrations can be used to further understand air toxics risk and to inform and fine-tune strategies. Exposure analysis may also lead to a more detailed understanding of environmental justice issues.

4.3 Summary of Concentration Results

4.3.1 Mobile Source Pollutants

There are six pollutants associated primarily with mobile sources: 1,3 butadiene, benzene, ethylbenzene, diesel particulate, arsenic and chromium VI. Benzene, 1,3 butadiene and diesel particulate are more than ten times above their benchmarks, arsenic and chromium VI are between one and ten times above their benchmarks. The sources associated with mobile source pollutants fall into two basic categories: on-road mobile and non road mobile. On-road mobile categories include gasoline and diesel fueled cars, trucks and busses. Non road mobile categories include diesel construction equipment, rail and marine engines.

4.3.1.1 1,3 Butadiene

1,3 butadiene is a colorless gas with a mild gasoline-like odor. It is a probable human carcinogen, possibly associated with heart diseases. Within the PATS area, it comes from incomplete combustion of fuels from cars and trucks, and off-road engines like lawn mowers and boats. Additional sources include production of rubber and plastics and forest fires. Figure 36 and Figure 37 are maps showing region-wide 1,3 butadiene modeled concentrations without and including background contributions compared to Oregon’s 1,3 butadiene ambient benchmark concentration.

Figure 36: 1,3 Butadiene 2017 Modeled Concentrations without Background Contributions

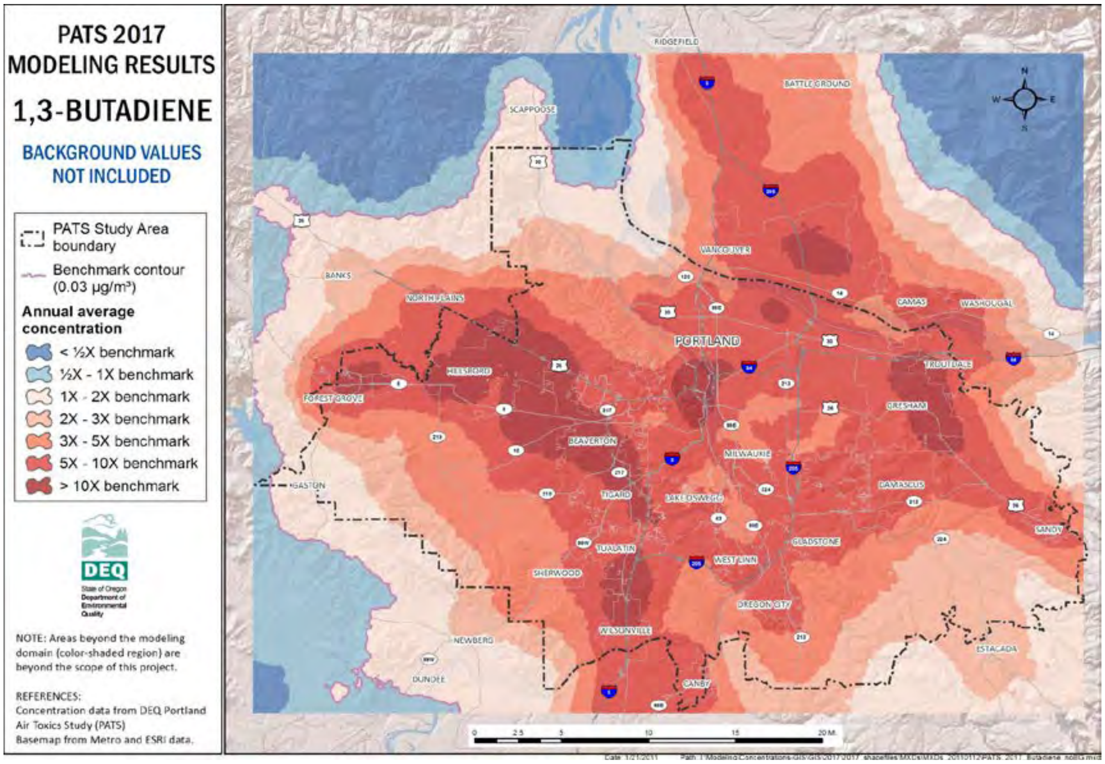
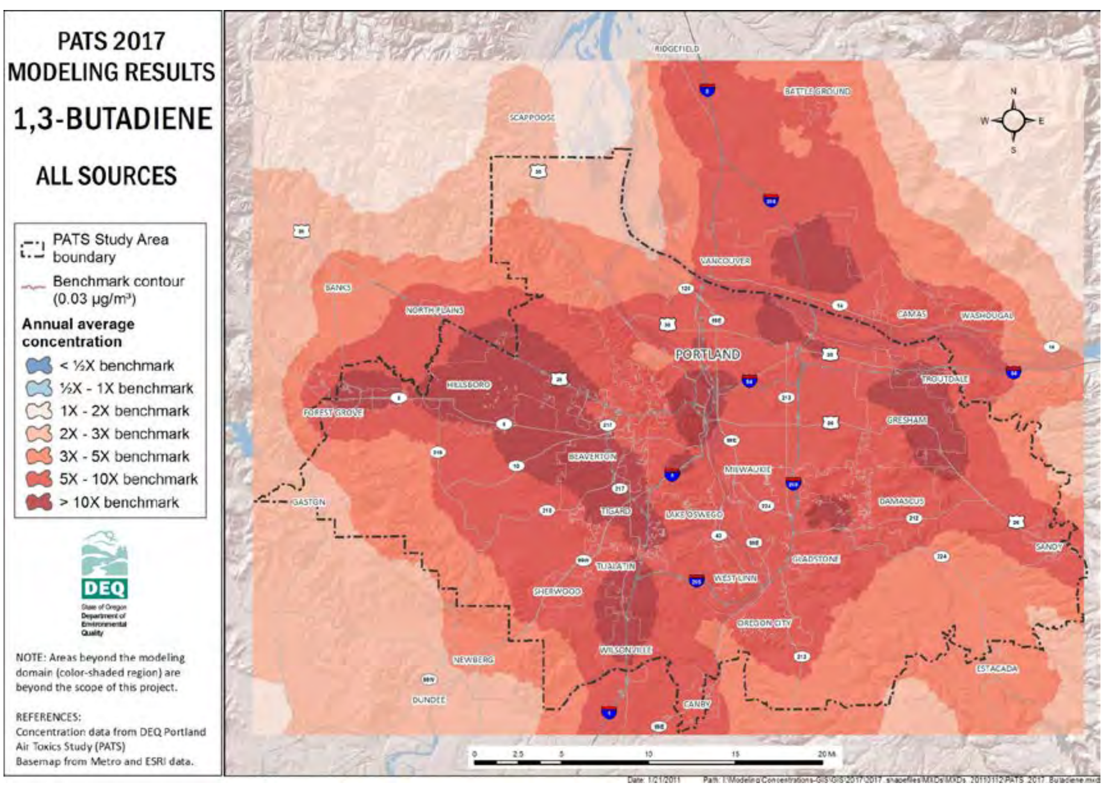


Figure 37: 1,3 Butadiene 2017 Modeled Concentrations Including Background Contributions



1,3 butadiene is a regional pollutant with higher concentrations in areas with high volume roadways. Figure 38 is a pie chart showing percentages of modeled contributions for 1,3 butadiene.

Figure 38: Modeled 2017 Sources of 1,3 Butadiene

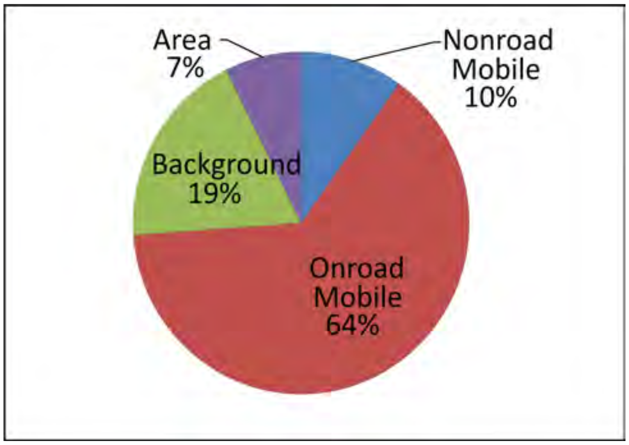
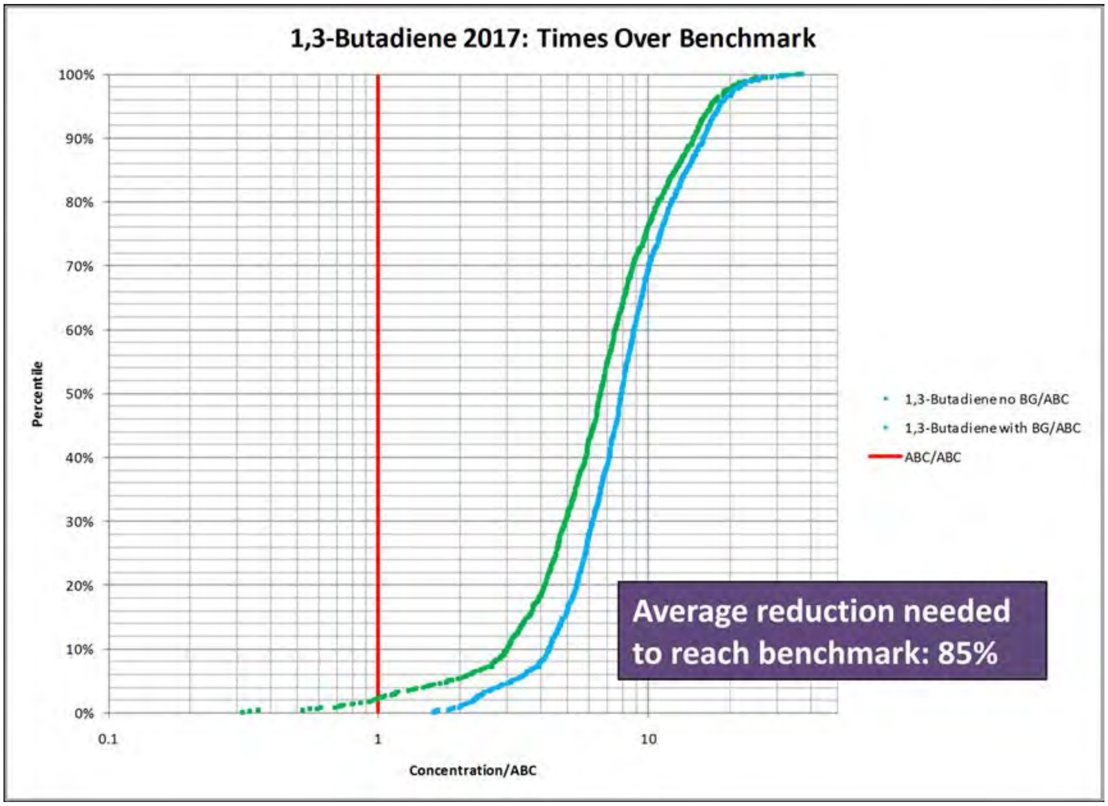


Figure 39 plots a distribution of modeled values for 1,3 butadiene with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without background concentration and the blue line is composed of all values including the background concentration. This graph, known as an S-curve, shows that most modeled 1,3 butadiene values are above the benchmark. The average reduction needed for 1,3 butadiene in order to reach the benchmark is 85%. This means that for those receptors whose modeled concentrations are greater than benchmark, the average reduction in concentration needed to meet the reduction target is 85%. Note that the 85% reduction is of the average concentration above the benchmark, not the highest modeled value. As a result, for 1,3 butadiene, an 85% reduction will still leave receptors with the highest modeled concentrations above the benchmark.

Figure 39: Distribution of 2017 Modeled Concentrations for 1, 3 Butadiene



4.3.1.2 Benzene

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities. Benzene is a known human carcinogen that causes blood disorders, and may cause anemia and genetic damage. Within the PATS area, Benzene is found in emissions from cars and trucks, wood smoke, evaporation from service stations, and industrial solvents. Figure 40 and Figure 41 are maps showing region wide benzene modeled concentrations without and including background contributions compared to Oregon's benzene benchmark.

Figure 40: Benzene 2017 Modeled Concentrations without Background Contributions

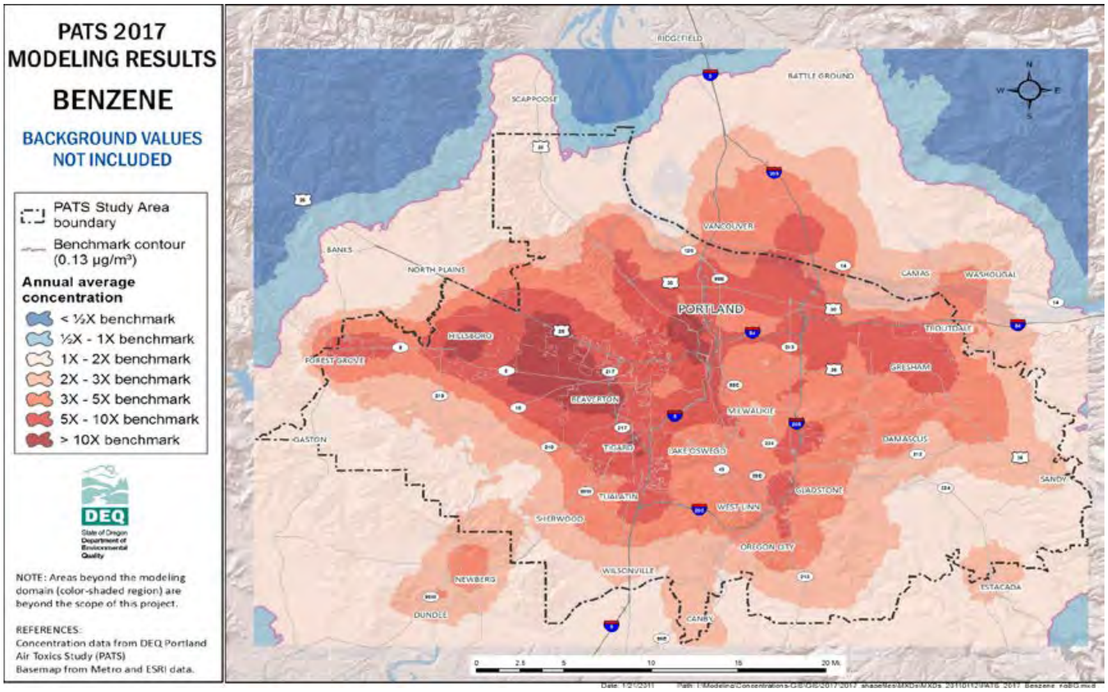
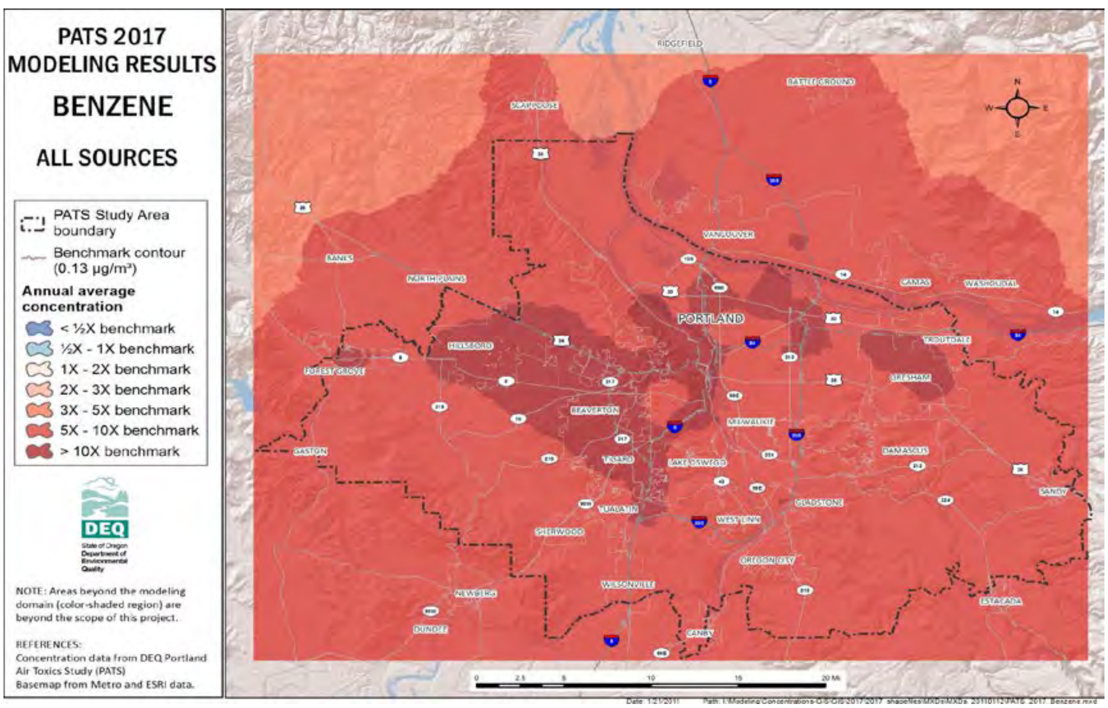


Figure 41: Benzene 2017 Modeled Concentrations Including Background Contributions



Benzene is a regional pollutant with higher concentrations in areas with high volume roadways. The benzene background contribution is significant. Figure 42 is a pie chart showing percentages of modeled contributions for benzene.

Figure 42: Modeled 2017 Sources of Benzene

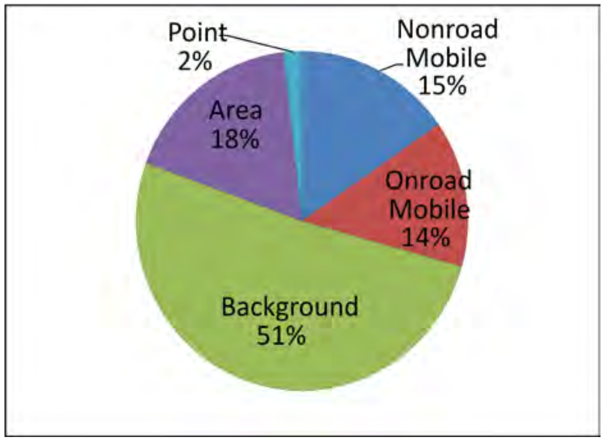
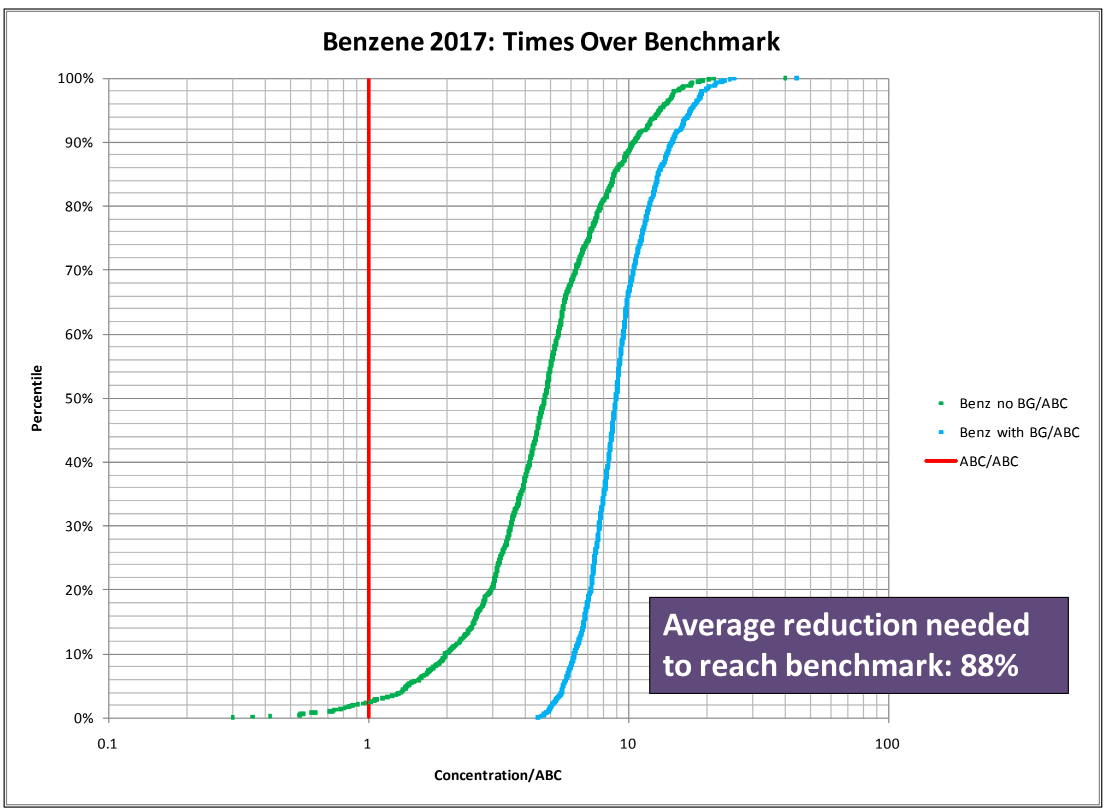


Figure 43 plots a distribution of modeled values for benzene with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without background concentration and the blue line is composed of all values including the background concentration. This graph, known as an S-curve, shows that most modeled benzene values are above the benchmark. The reduction in benzene concentration needed to reach the target is 88%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, an 88% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

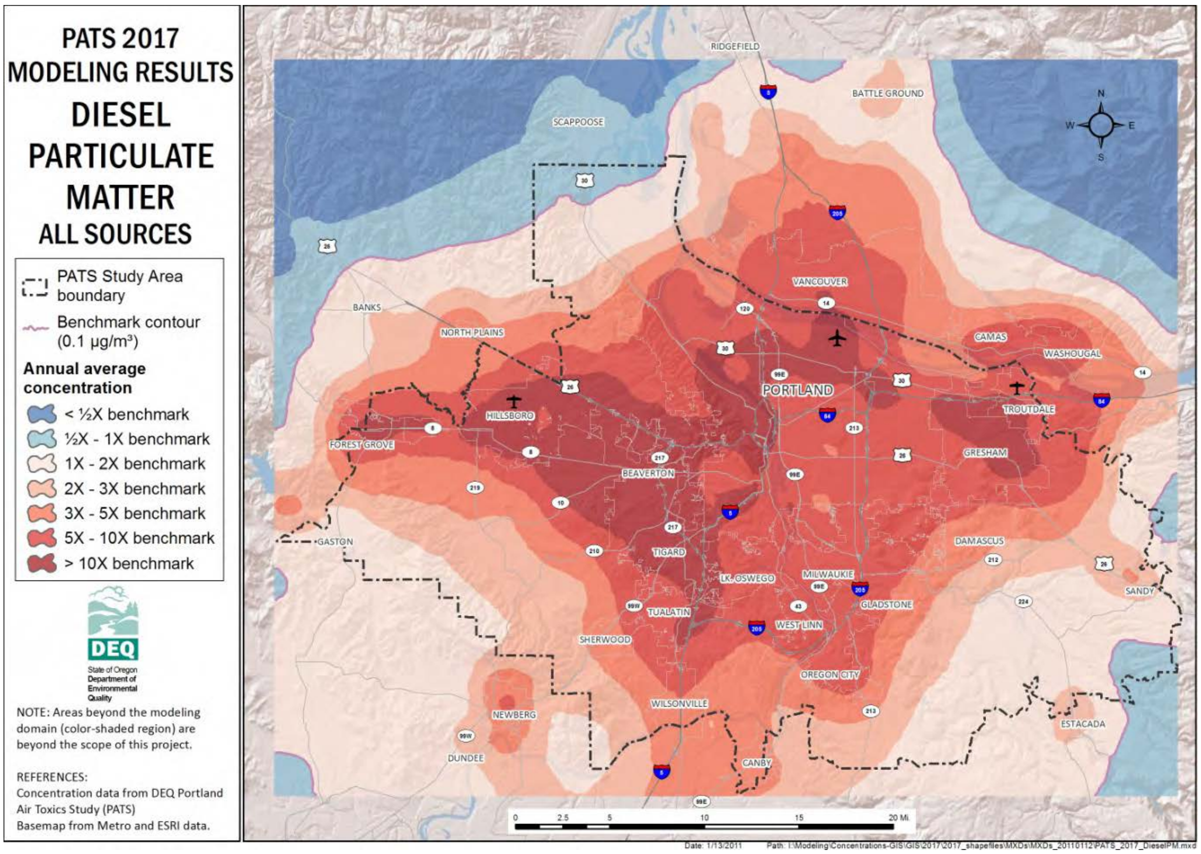
Figure 43: Distribution of 2017 Modeled Concentrations for Benzene



4.3.1.3 Diesel Particulate

Diesel particulate matter is not a specific chemical. It is a complex mixture of particles and various chemical compounds in, on, or around the particles. Diesel particulate matter is associated with increased lung cancer, breathing and heart problems. Within the PATS area, it comes mainly from on and off road diesel engines, including cars and trucks, construction equipment, ships, and rail sources. Figure 44 is a map showing region-wide diesel particulate modeled concentrations compared to the Oregon benchmark.

Figure 44: Diesel Particulate Matter 2017 Modeled Concentrations



Diesel particulate is a regional pollutant with higher concentrations in areas with high volume roadways and estimated construction activity. Figure 45 is a pie chart showing percentages of modeled contributions for diesel particulate.

Figure 45: Modeled 2017 Sources of Diesel Particulate

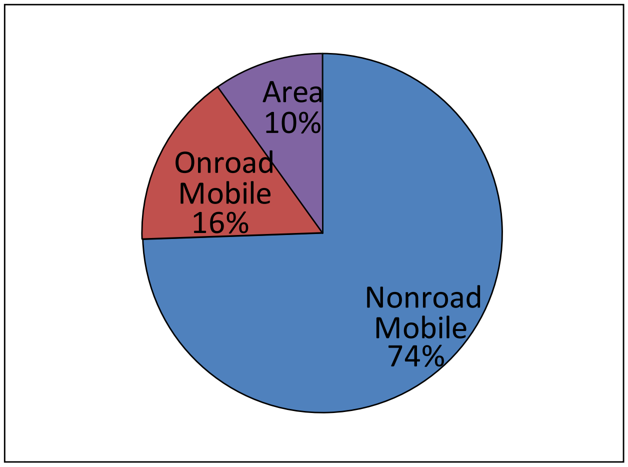
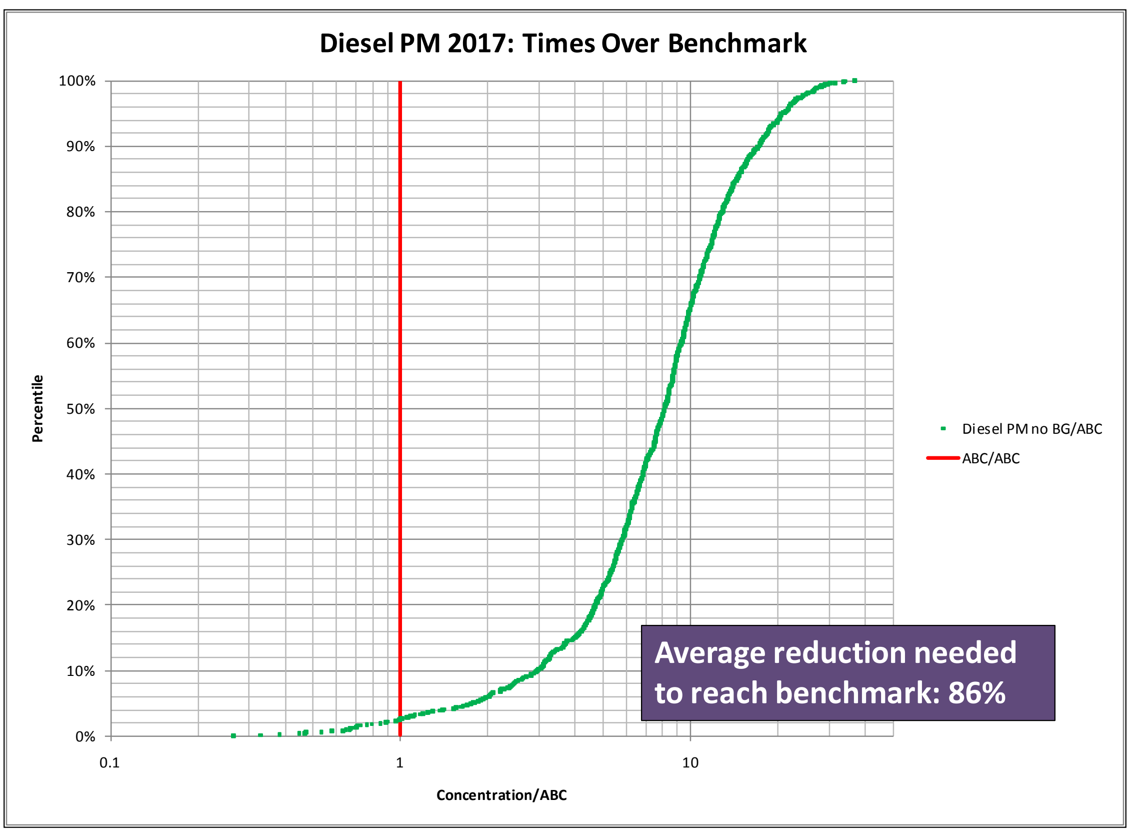


Figure 46 plots a distribution of modeled values for diesel particulate with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the modeled values. This graph, known as an S-curve, shows that most modeled diesel values are above the benchmark. There is no estimated background for diesel particulate at this time. The reduction in diesel particulate concentration needed to reach the target is 86%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, an 86% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

Figure 46: Distribution of 2017 Modeled Concentrations for Diesel Particulate Matter



4.3.1.4 Arsenic

Sources of arsenic are both human caused and natural. Our soils in the Pacific Northwest are naturally high in arsenic because of their volcanic origins. Arsenic is a known human carcinogen. In the PATS area, motor vehicle exhaust, oil and natural gas combustion, metal processing, agricultural pesticides, and soil dust are sources of arsenic. Figure 47 and Figure 48 are maps showing region-wide arsenic modeled concentrations without and including background contributions.

Figure 47: Arsenic 2017 Modeled Concentrations without Background Contributions

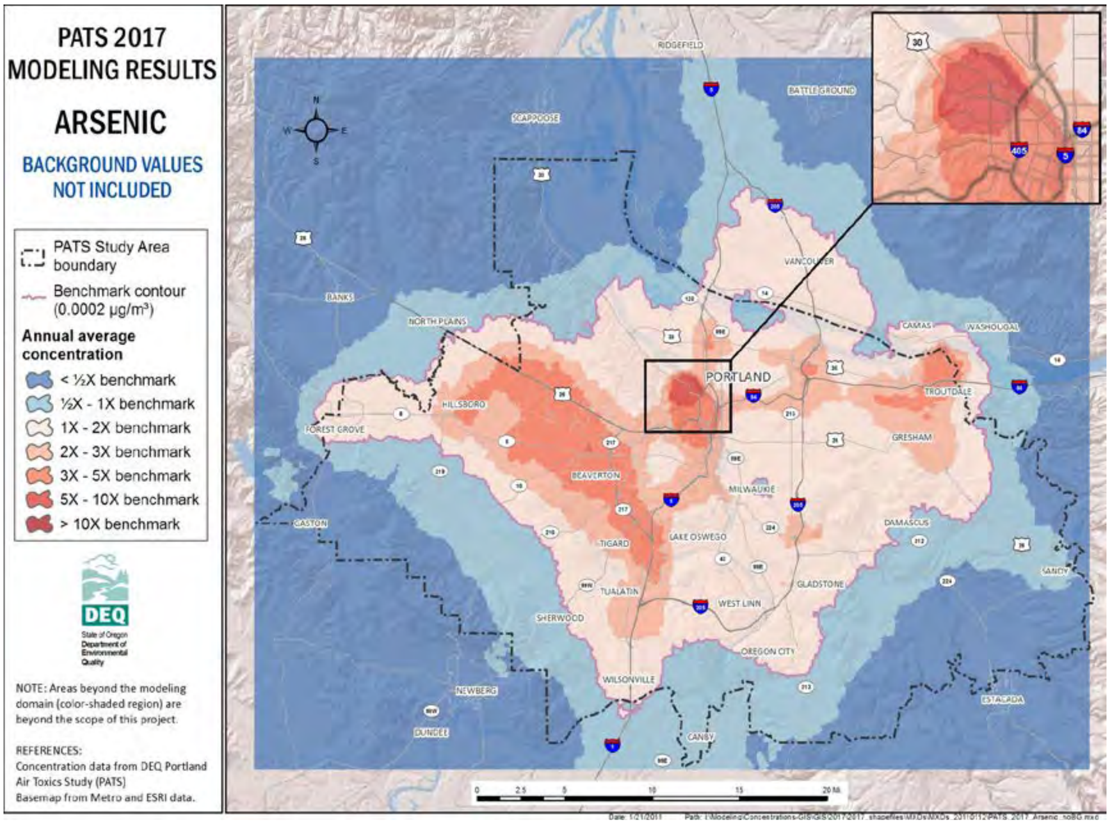
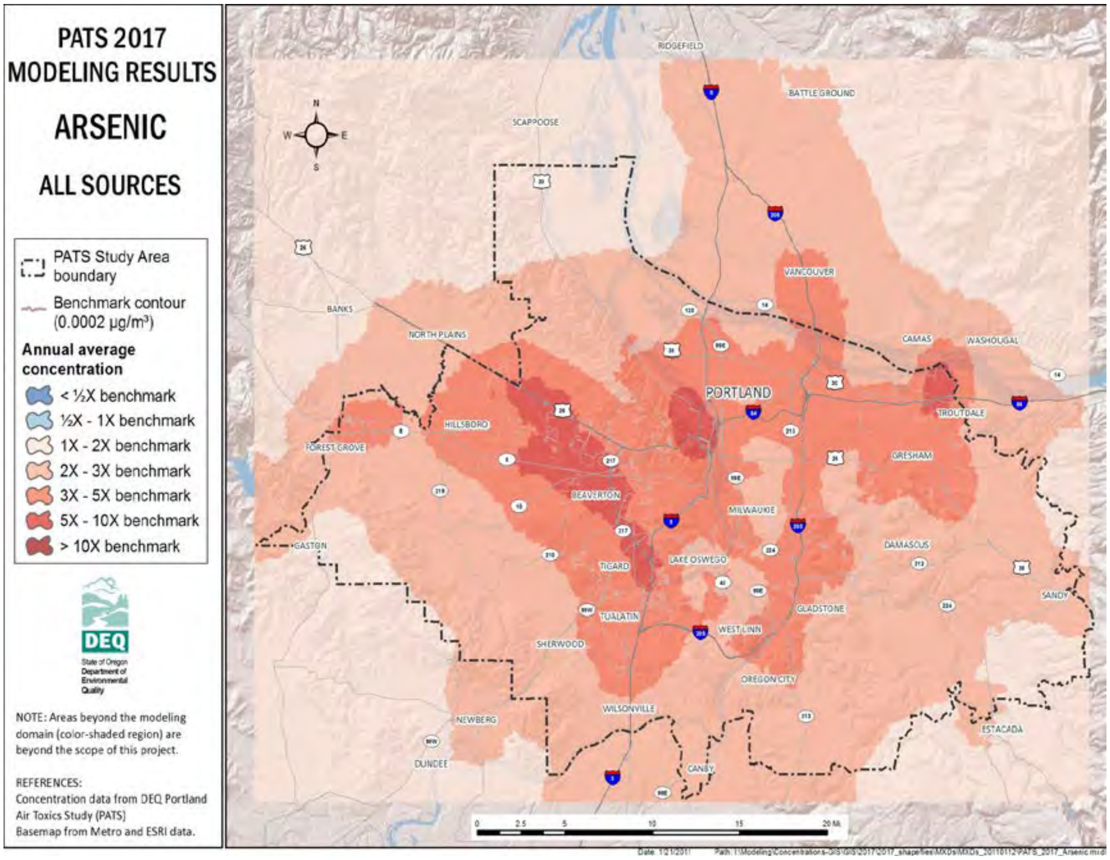


Figure 48: Arsenic 2017 Modeled Concentrations Including Background Contributions



Arsenic is a regional pollutant with higher concentrations in areas with high volume roadways and significant background contributions. Figure 49 is a pie chart showing percentages of modeled contributions for arsenic.

Figure 49: Modeled 2017 Sources of Arsenic

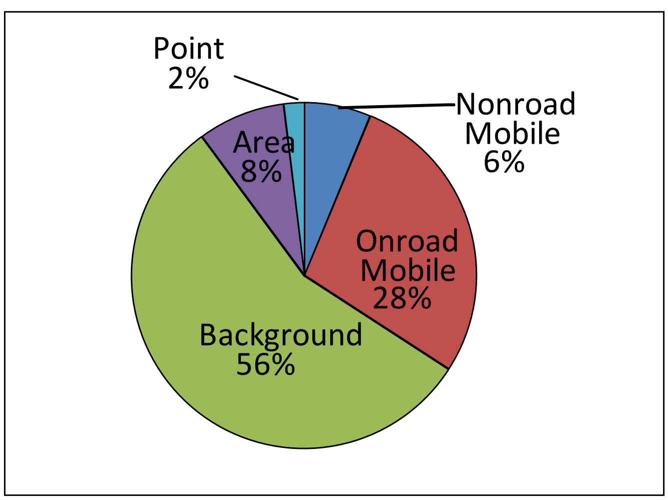
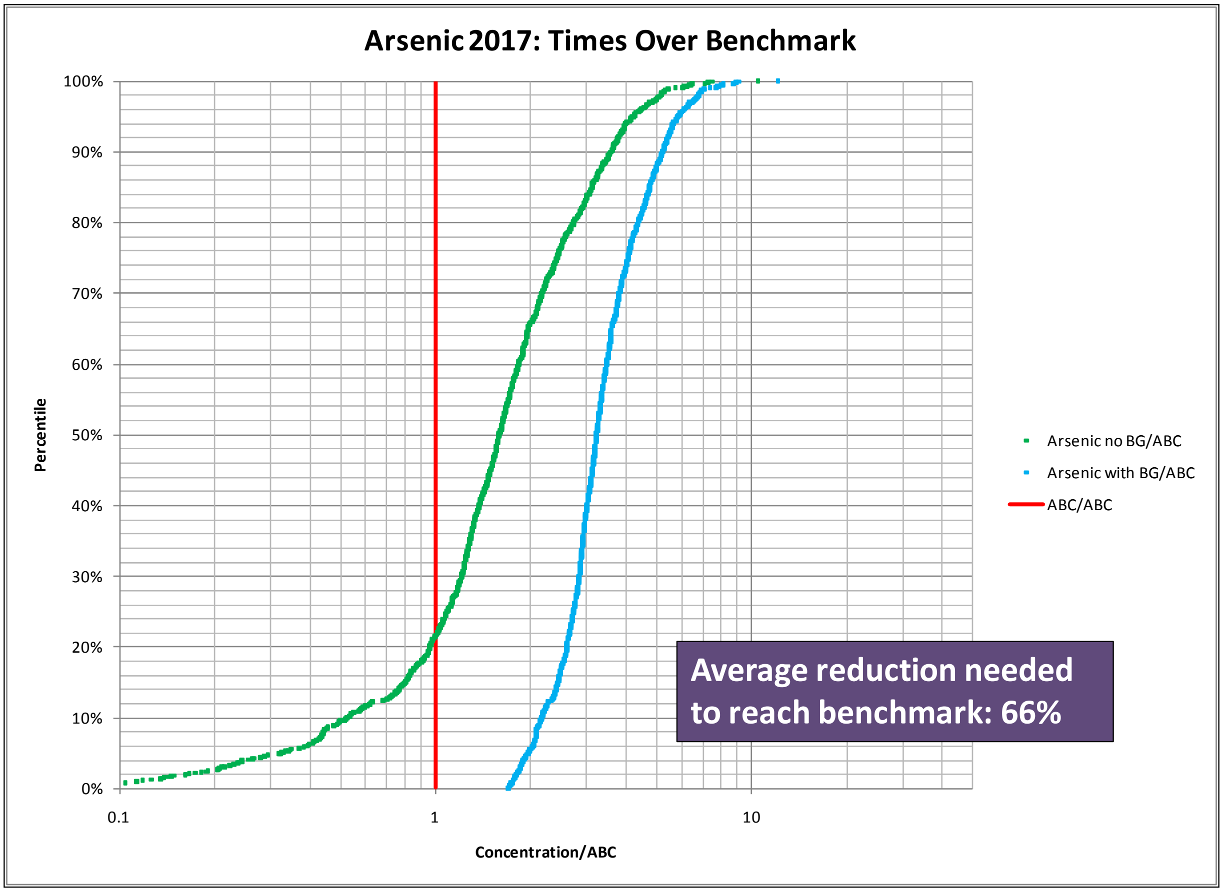


Figure 50 plots a distribution of modeled values for arsenic with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without background concentration and the blue line is composed of all values including the background concentration. This graph, known as an S-curve, shows that adding background concentrations puts all modeled arsenic values above the benchmark. The reduction in arsenic concentration needed to reach the target is 66%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, a 66% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

Figure 50: Distribution of 2017 Modeled Concentrations for Arsenic



4.3.1.5 Chromium VI

Hexavalent chromium – also called chromium VI – is a naturally occurring metal found in rocks, animals, plants, soil, and volcanic dust and gases. Chromium comes in several forms. Chromium VI is a form of chromium that can occur naturally but is most commonly produced by industrial processes and vehicle exhaust. Chromium VI is a known human carcinogen that causes damage to the respiratory tract. Figure 51 and Figure 52 are maps showing region wide chromium VI modeled concentrations without and including background contributions. Chromium is a regional pollutant with higher concentrations in areas with high volume roadways and industrial emissions.

Figure 51: Chromium VI 2017 Modeled Concentrations without Background Contributions

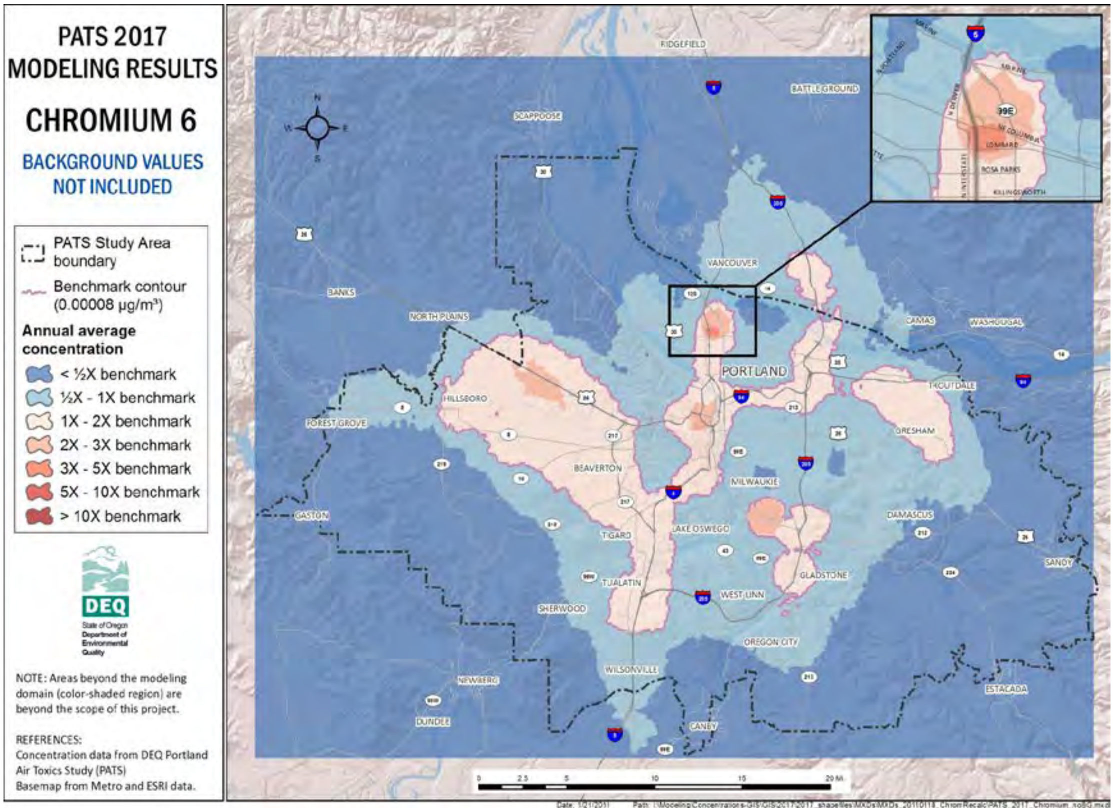


Figure 52: Chromium VI 2017 Modeled Concentrations Including Background Contributions

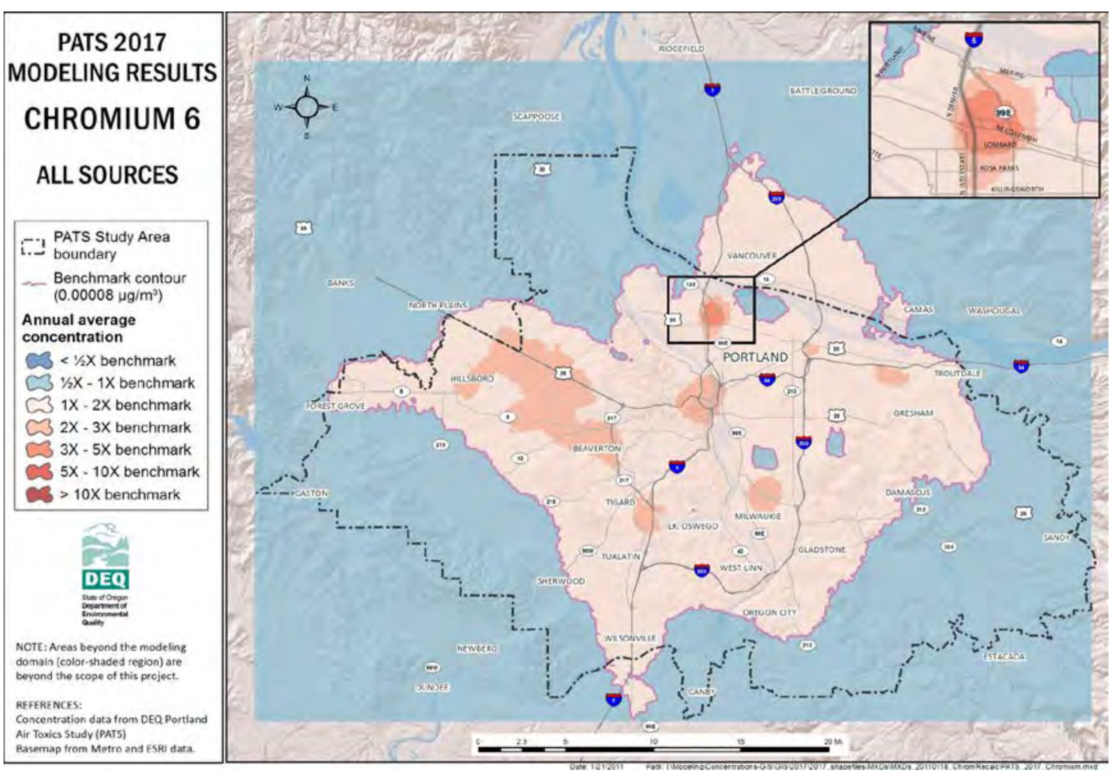


Figure 53 is a pie chart showing percentages of modeled contributions for chromium VI.

Figure 53: Modeled 2017 Sources of Chromium VI

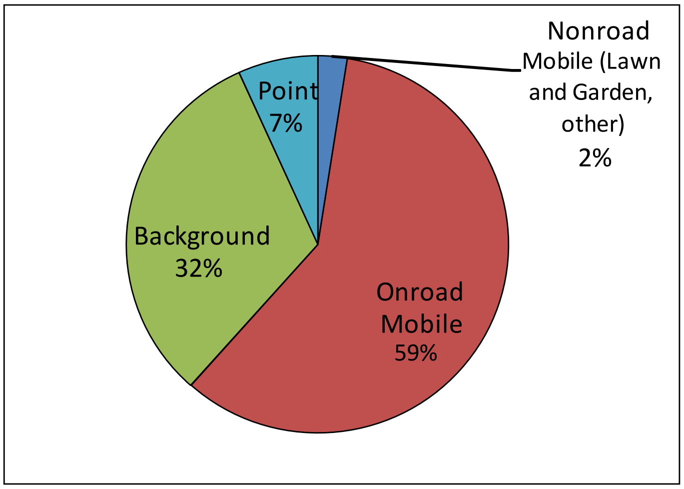
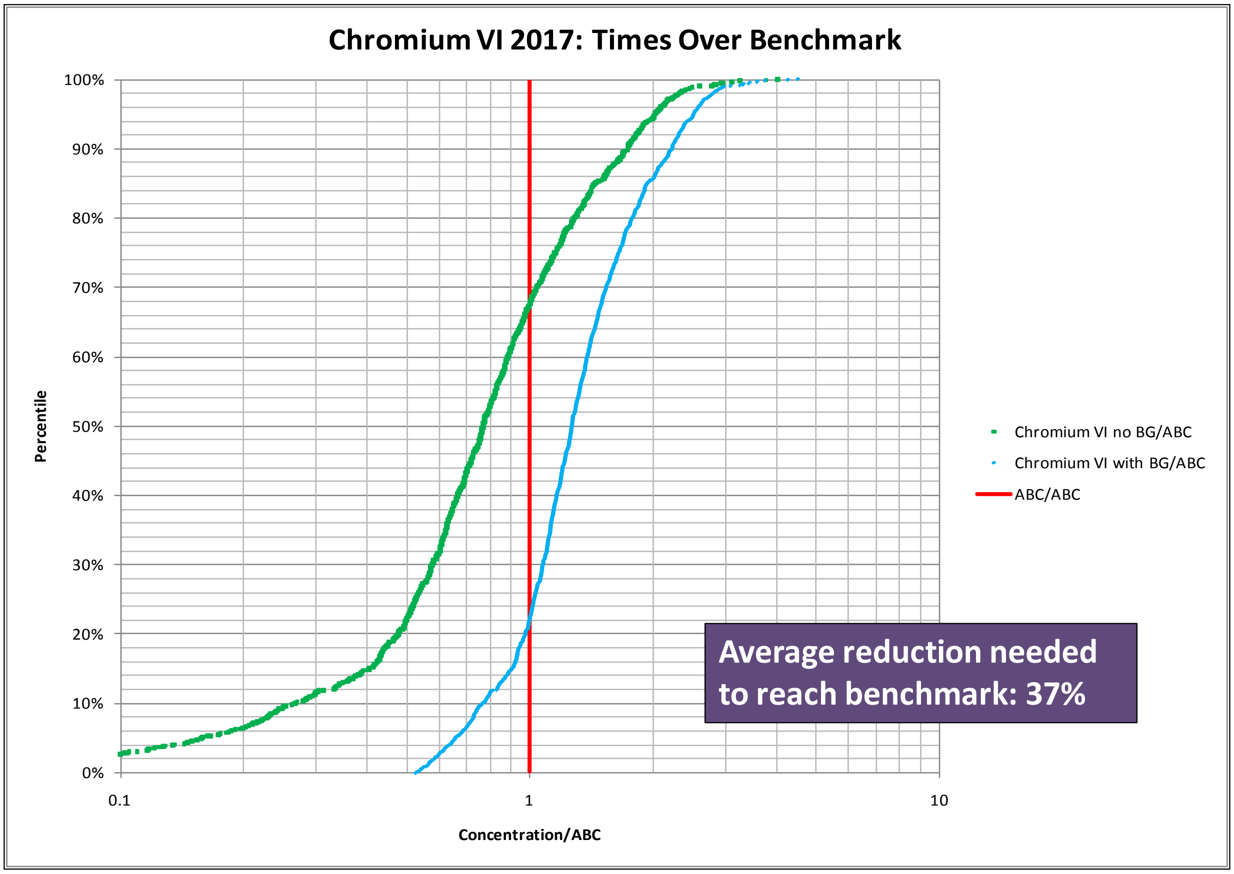


Figure 54 plots a distribution of modeled values for chromium VI with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the modeled values. This graph, known as an S-curve, shows that most modeled chromium VI values are above the benchmark. The reduction in chromium VI concentration needed to reach the target is 37%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, a 37% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

Figure 54: Distribution of 2017 Modeled Concentrations for Chromium VI



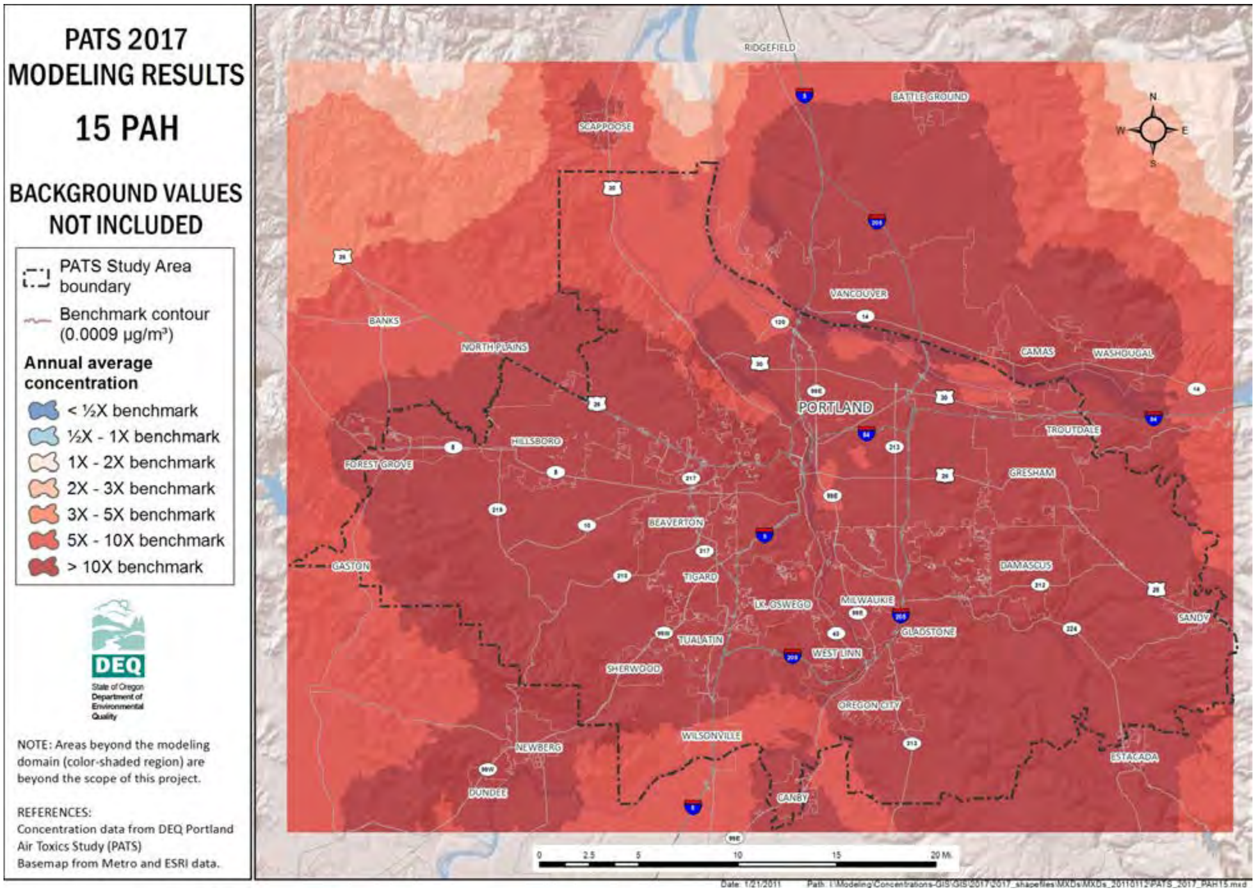
4.3.2 Area Source Pollutants

There are three pollutants associated primarily with area sources: 15 PAH, naphthalene and dichlorobenzene. Area sources emit many of the PATS pollutants, but these three drive the risk levels for area source categories. 15 PAH and naphthalene are more than ten times above the benchmarks and dichlorobenzene is between one and ten times above its benchmark. The source categories associated with area source pollutants fall into basic categories: residential wood combustion, industrial fuel use, consumer products, solvent and coating use, asphalt production and use, and several miscellaneous categories including publicly owned treatment works, landfills, and restaurants.

4.3.2.1 15 PAH

Polycyclic aromatic hydrocarbons, also called PAHs, are a group of chemicals that are formed during the incomplete burning of carbon-containing substances: wood, coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs, which are 4,000 or more individual chemical compounds, are usually found as a mixture containing two or more of these compounds. Figure 55 is a map showing region-wide 15 PAH modeled concentrations without and including background contributions compared to Oregon’s 15 PAH benchmark concentration.

Figure 55: 15 PAH 2017 Modeled Concentrations without Background Contributions



15 PAH is a regional pollutant with higher concentrations in some areas. Figure 56 contains a pie chart showing percentages of modeled contributions for 15 PAH. Figure 56 also plots a distribution of modeled values for 15 PAH with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without background concentration. This graph, known as an S-curve, shows that most modeled 15 PAH values are above the benchmark. At this time, there is no background estimate of 15 PAH. The reduction in 15 PAH concentration needed to reach the target is 94%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, a 94% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

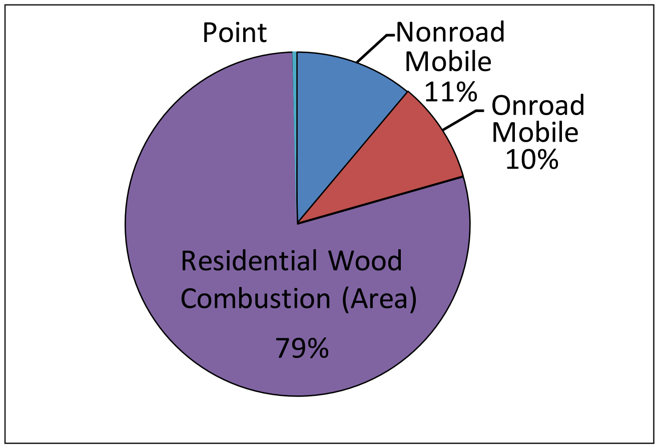


Figure 56: Distribution of 2017 Modeled Concentrations and Modeled 2017 Sources of 15 PAH

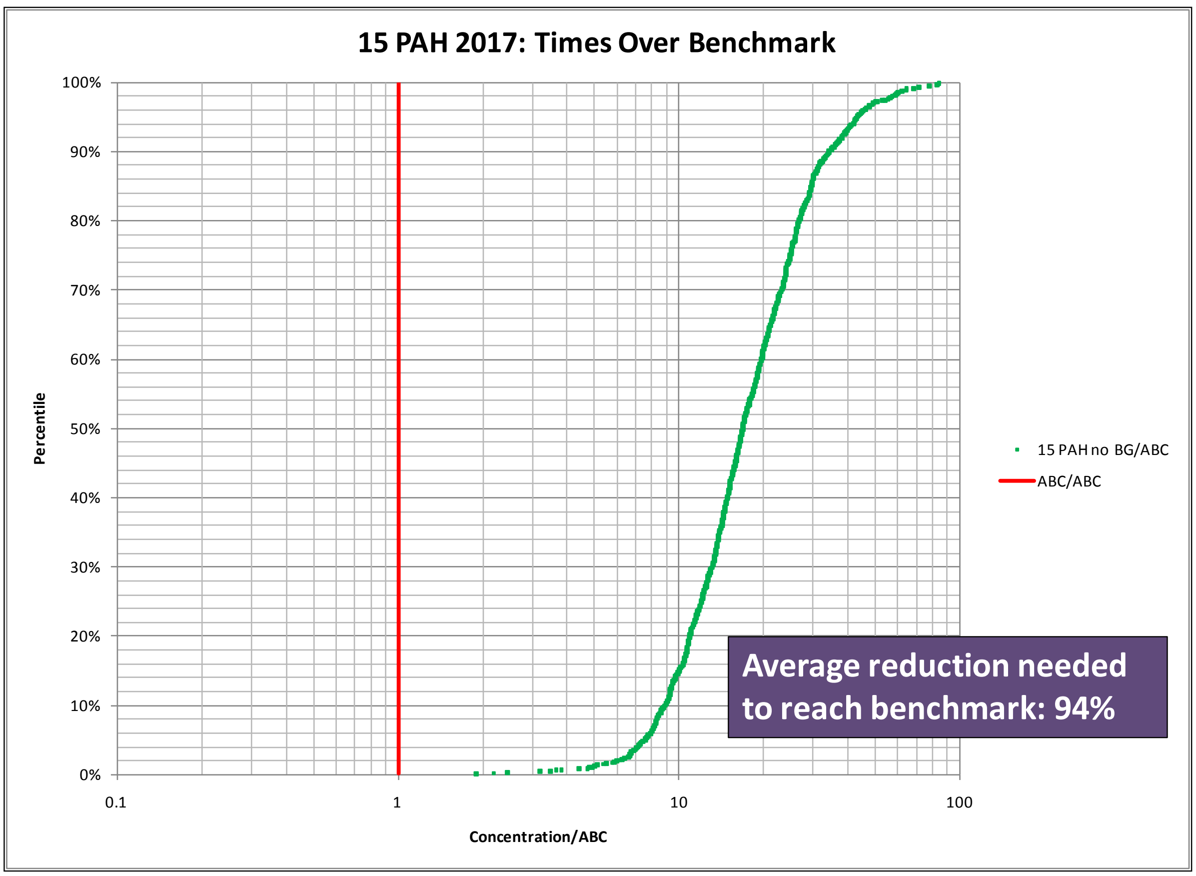


Figure 57: Distribution of 2017 Modeled Concentrations for 15 PAH

4.3.2.2 Naphthalene

Naphthalene is a white solid that evaporates easily and has a strong odor. Fuels such as petroleum and coal contain naphthalene. Burning tobacco or wood produces naphthalene. The major *commercial* use of naphthalene is in the manufacture of polyvinyl chloride (PVC) plastics. Its major *consumer* use is in moth repellents and toilet deodorant blocks. In the PATS area, naphthalene is released to the air from the burning of oil and from the use of mothballs. Figure 58 and Figure 59 are maps showing region-wide naphthalene modeled concentrations without and including background contributions compared to Oregon's naphthalene benchmark concentration.

Figure 58: Naphthalene 2017 Modeled Concentrations without Background Contributions

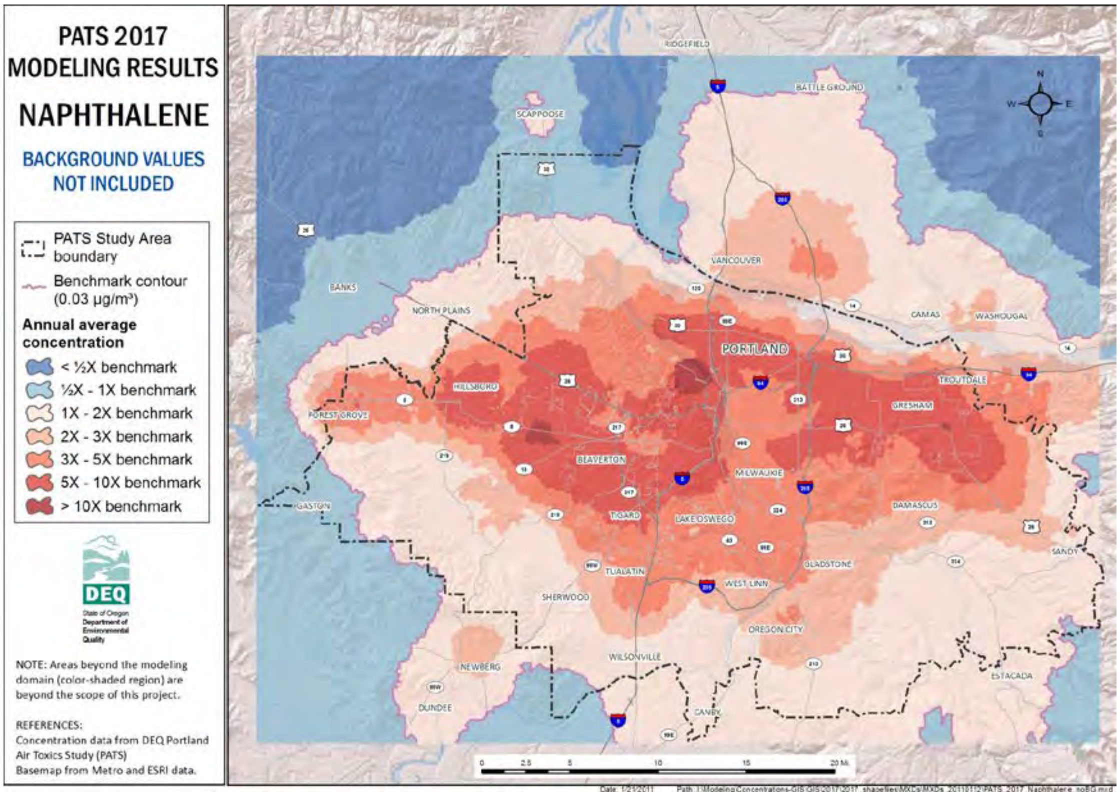
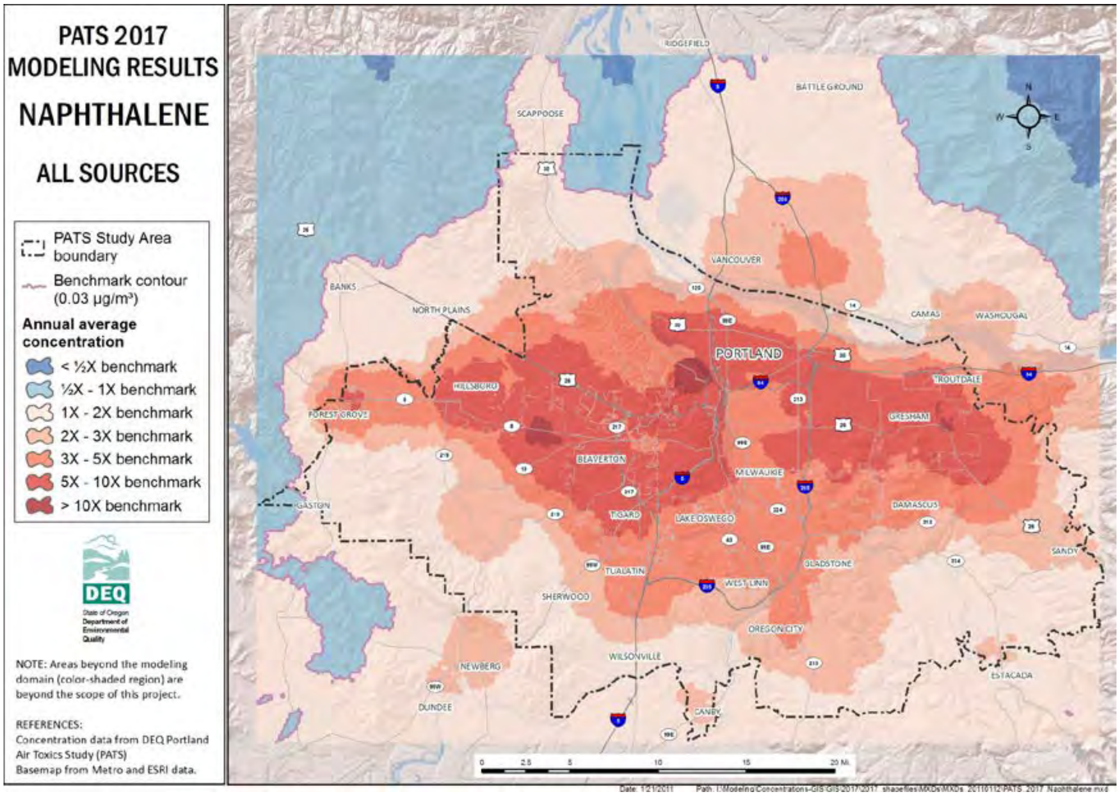
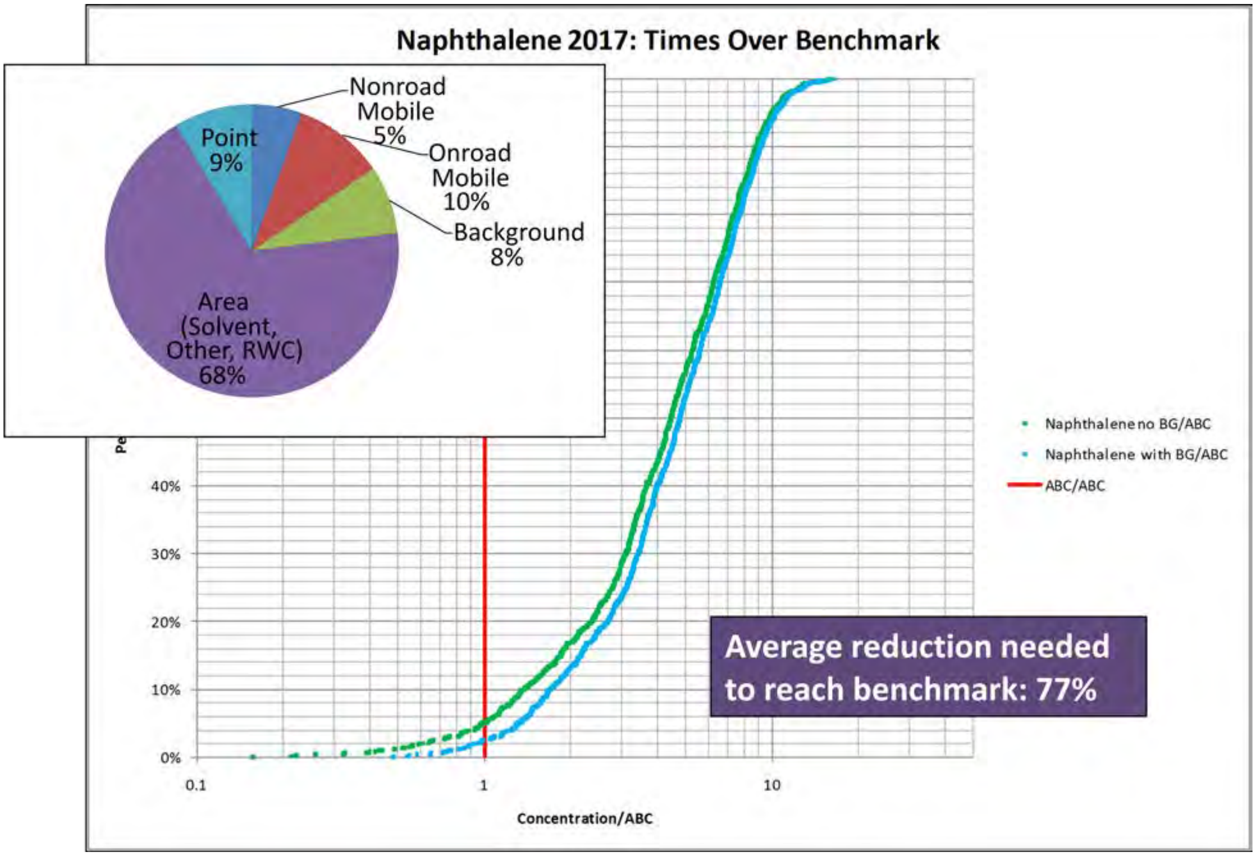


Figure 59: Naphthalene 2017 Modeled Concentrations Including Background Contributions



Naphthalene is a regional pollutant with higher concentrations in some areas. Figure 60 contains a pie chart showing percentages of modeled contributions for naphthalene. Figure 60 also plots a distribution of modeled values for naphthalene with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without background concentration and the blue line is composed of all values including the background concentration. This graph, known as an S-curve, shows that most modeled naphthalene values are above the benchmark. The reduction in naphthalene concentration needed to reach the target is 77%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, a 77% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

Figure 60: Distribution of 2017 Modeled Concentrations and Modeled 2017 Sources of Naphthalene



4.3.2.3 Dichlorobenzene

1,4-Dichlorobenzene, also called para-dichlorobenzene, is a colorless solid with a strong, distinctive smell. 1,4-Dichlorobenzene is used as a fumigant to control moths, molds and mildew. It is also used as a disinfectant in waste containers and restrooms and is the characteristic smell associated with urinal cakes. Figure 61 and Figure 62 are maps showing region-wide dichlorobenzene modeled concentrations without and including background contributions compared to Oregon's dichlorobenzene benchmark concentration.

Figure 61: Dichlorobenzene 2017 Modeled Concentrations without Background Contributions

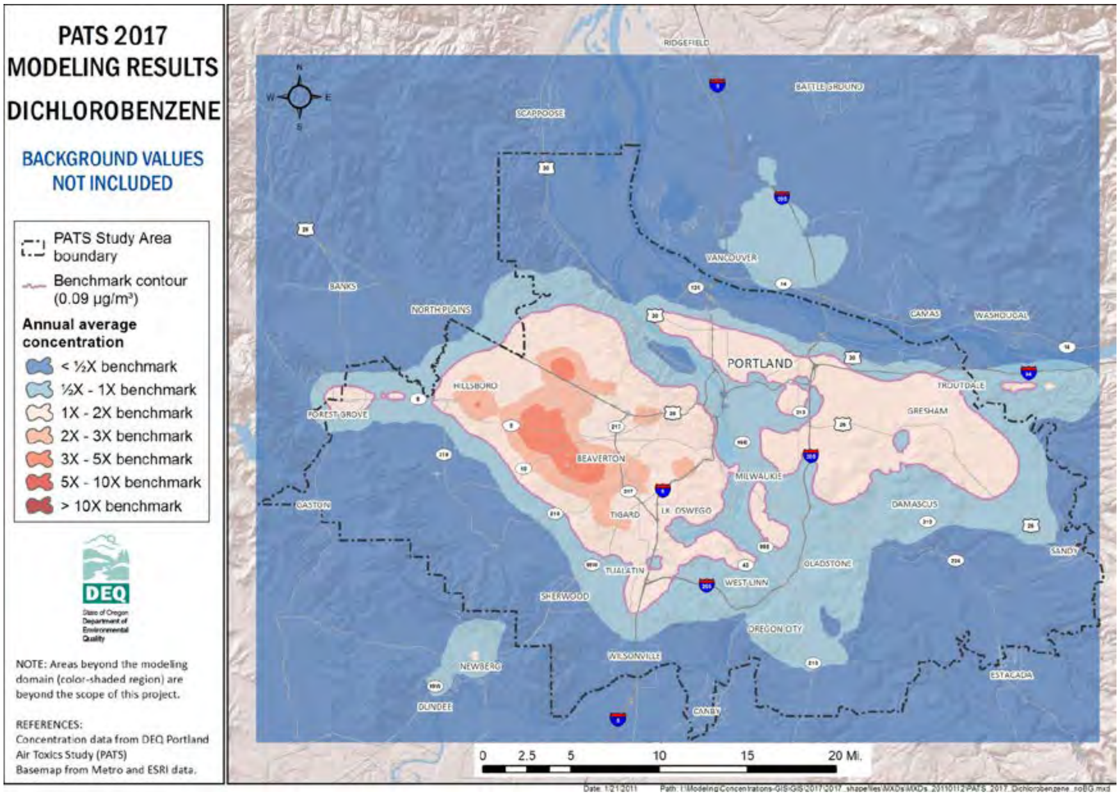
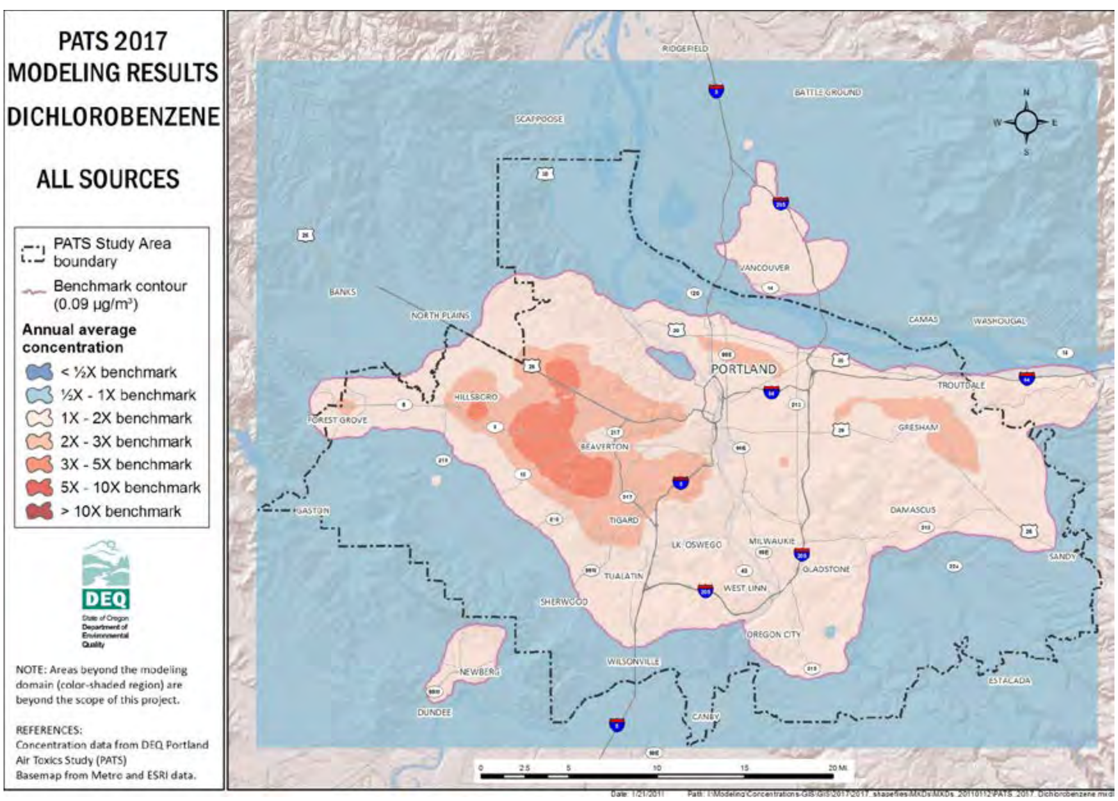
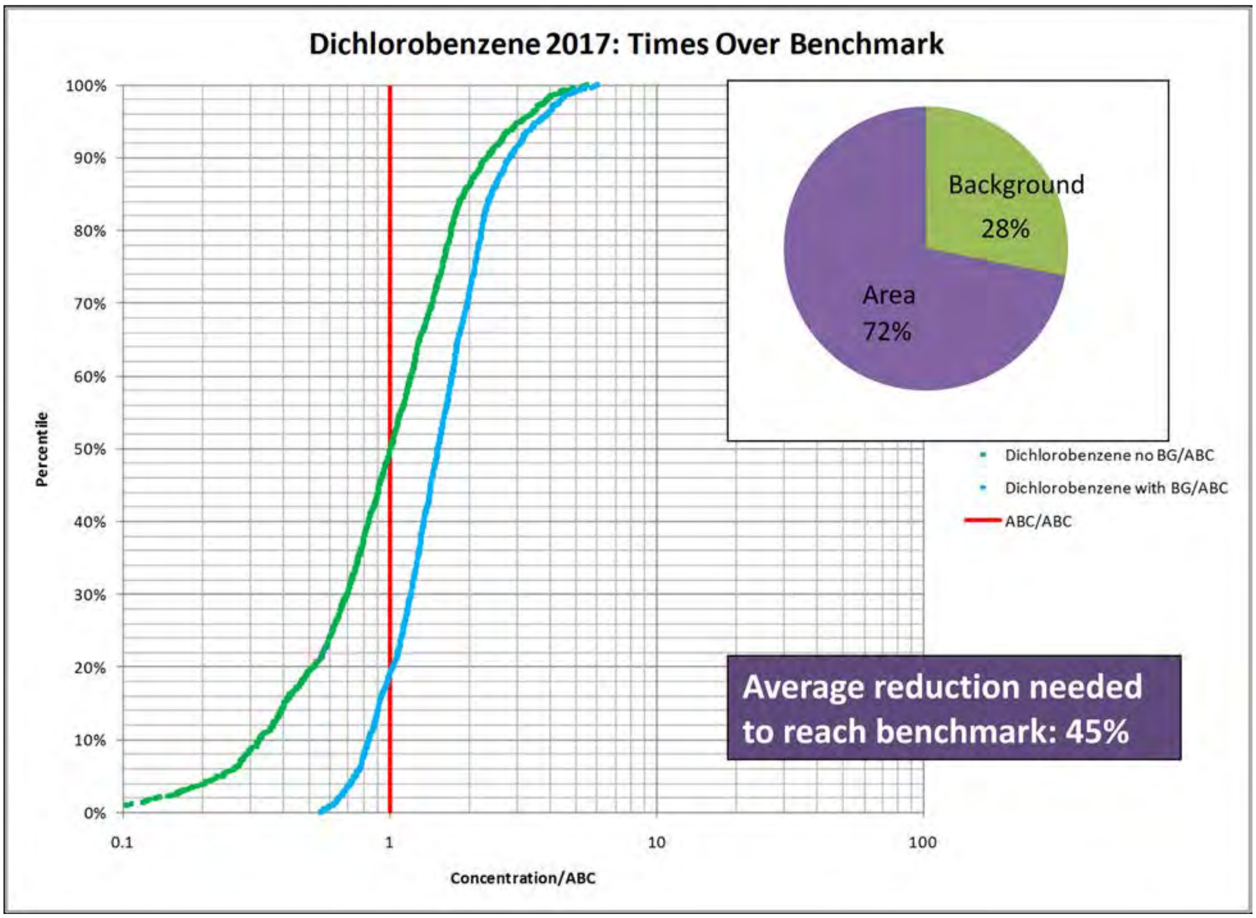


Figure 62: Dichlorobenzene 2017 Modeled Concentrations Including Background Contributions



Dichlorobenzene is a regional pollutant with higher concentrations in areas with high volume roadways. Figure 63 contains a pie chart showing percentages of modeled contributions for dichlorobenzene. Figure 63 also plots a distribution of modeled values for dichlorobenzene with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without background concentration and the blue line is composed of all values including the background concentration. This graph, known as an S-curve, shows that in general, about half of the modeled dichlorobenzene values are above the benchmark. The reduction in dichlorobenzene concentration needed to reach the target is 45%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, a 45% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

Figure 63: Distribution of 2017 Modeled Concentrations and Modeled 2017 Sources of Dichlorobenzene



4.3.3 Point Source Pollutants

There are three pollutants associated primarily with point sources: cadmium, manganese, and nickel. Cadmium is more than ten times above their benchmarks and manganese and nickel are between one and ten times above their benchmarks. The source categories associated with point source pollutants are industrial.

4.3.3.1 Cadmium

Cadmium is a relatively abundant soft, bluish-white metal. It is usually found as a mineral combined with other elements. Metals processing and burning fossil fuels for both residential and industrial use are major sources of cadmium in Portland’s air. Cadmium is also used to make batteries, pigments, metal coatings, and plastic.

Figure 64 and Figure 65 are maps showing region wide cadmium modeled concentrations without and including background contributions compared to Oregon's cadmium benchmark concentration.

Figure 64: Cadmium 2017 Modeled Concentrations without Background Contributions

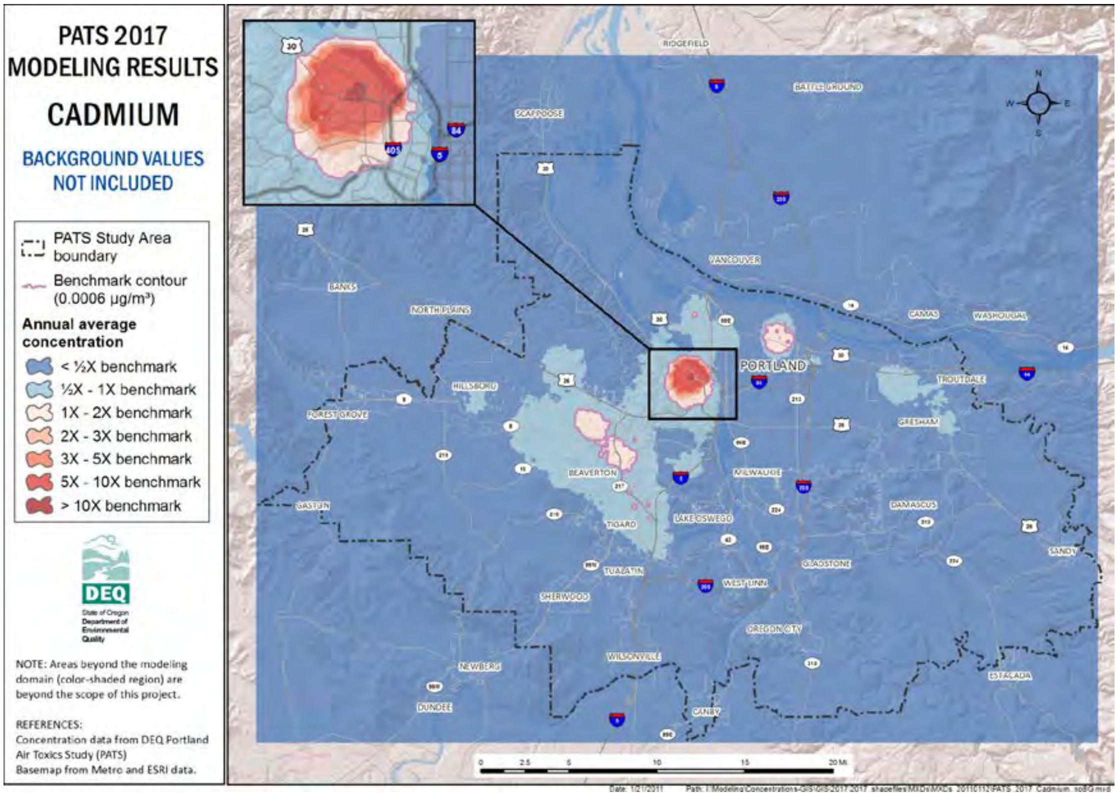
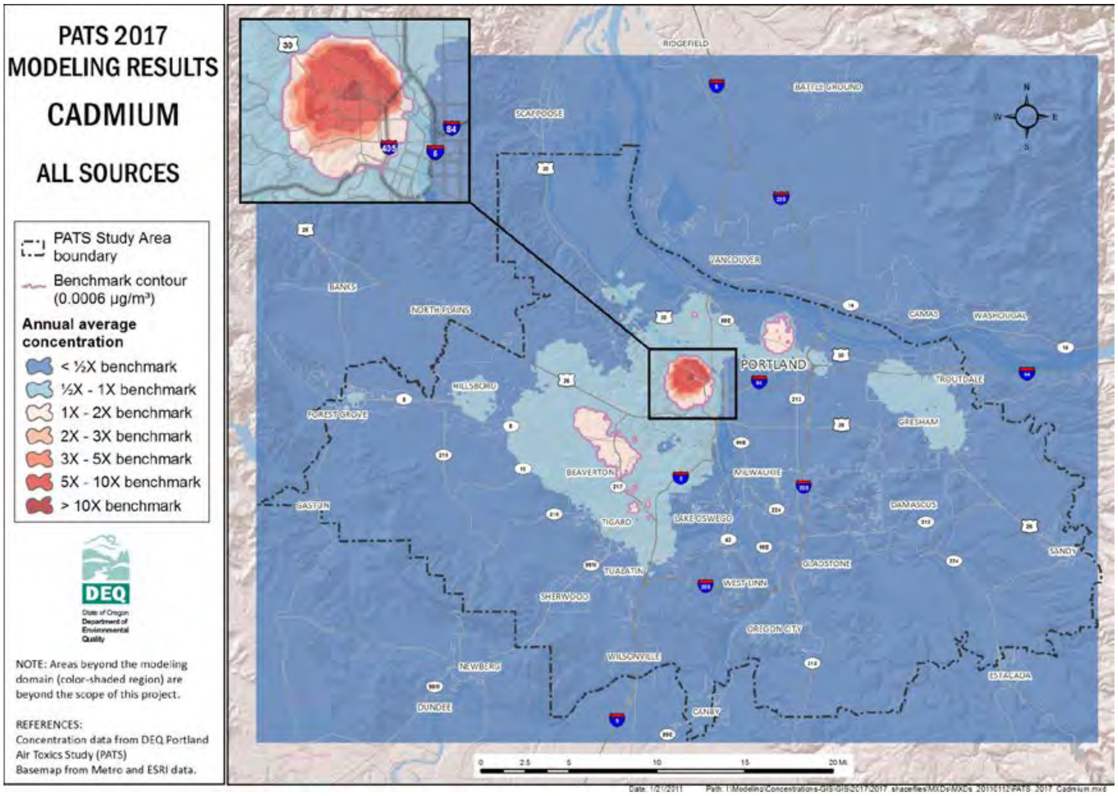
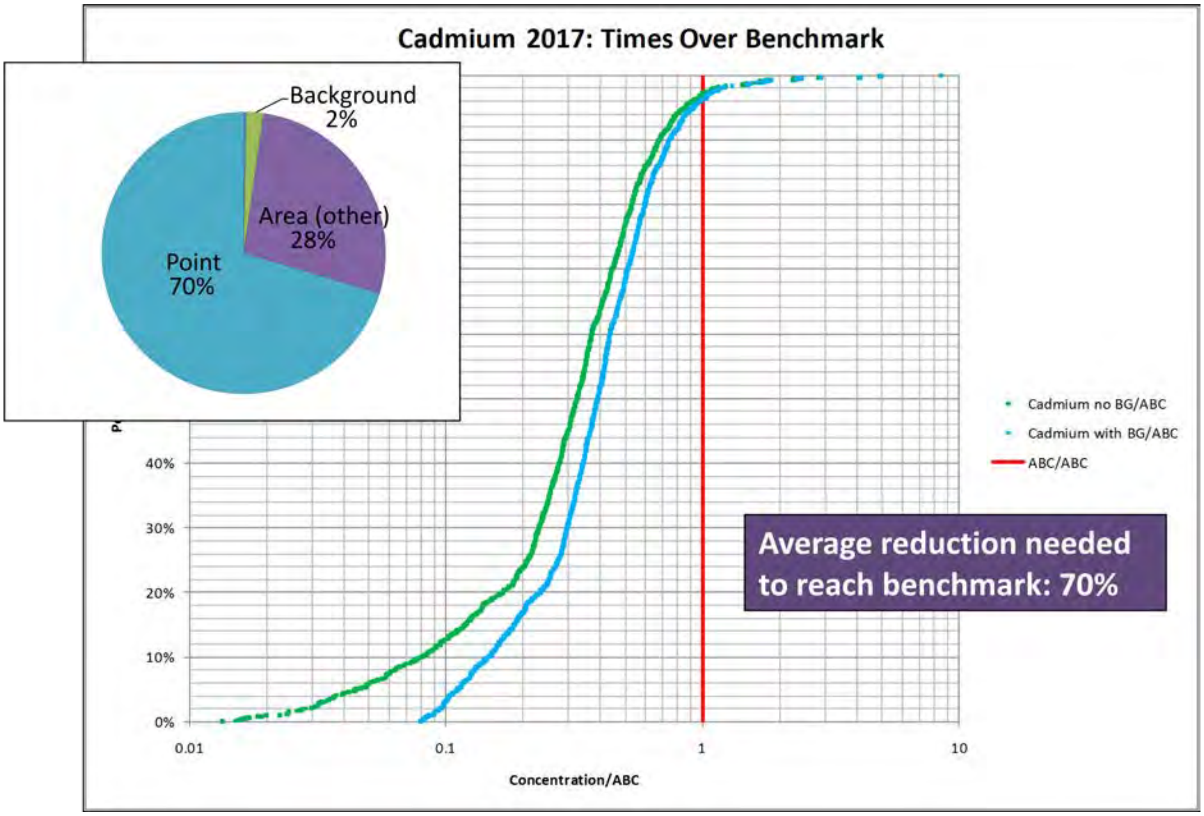


Figure 65: Cadmium 2017 Modeled Concentrations Including Background Contributions



Cadmium is impacts are limited to some zonal areas and also localized impacts with higher concentrations smaller areas. Figure 66 contains a pie chart showing percentages of modeled contributions for cadmium. Figure 66 also plots a distribution of modeled values for cadmium with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without background concentration and the blue line is composed of all values including the background concentration. This graph, known as an S-curve, shows that in general, most of the receptors in the PATS study area are below the benchmark and a few in the localized impact areas are above the benchmark. The reduction in cadmium concentration needed to reach the target is 70%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, a 70% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

Figure 66: Distribution of 2017 Modeled Concentrations for Cadmium, and Modeled 2017 Sources of Cadmium



4.3.3.1 Manganese

Manganese is a metal used primarily in steel production to improve hardness, stiffness, and strength. Manganese dioxide is used in the production of dry-cell batteries, matches, fireworks, and the production of other manganese compounds. The main source of manganese pollution in Portland comes from metals production containing steel and iron. Manganese is also a component of some pesticides and is used as a fuel additive in some gasoline. Figure 67 and Figure 68 are maps showing region-wide manganese modeled concentrations without and including background contributions compared to Oregon's manganese benchmark concentration.

Figure 67: Manganese 2017 Modeled Concentrations without Background Contributions

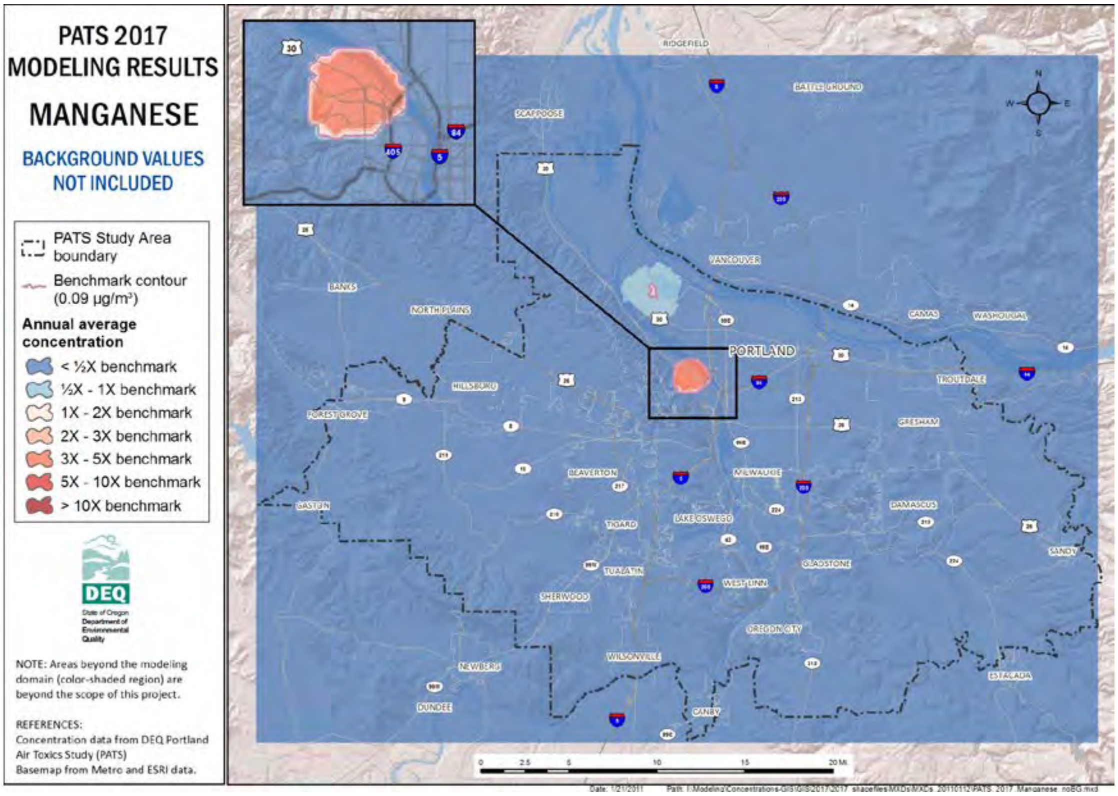
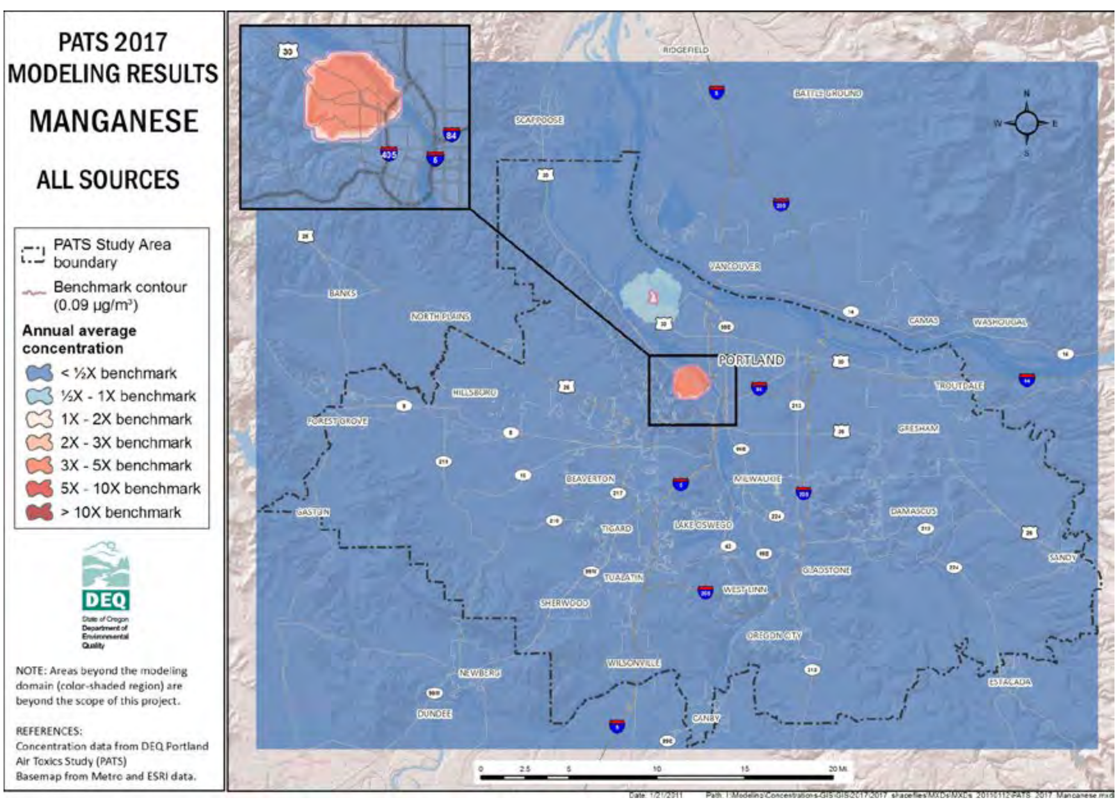
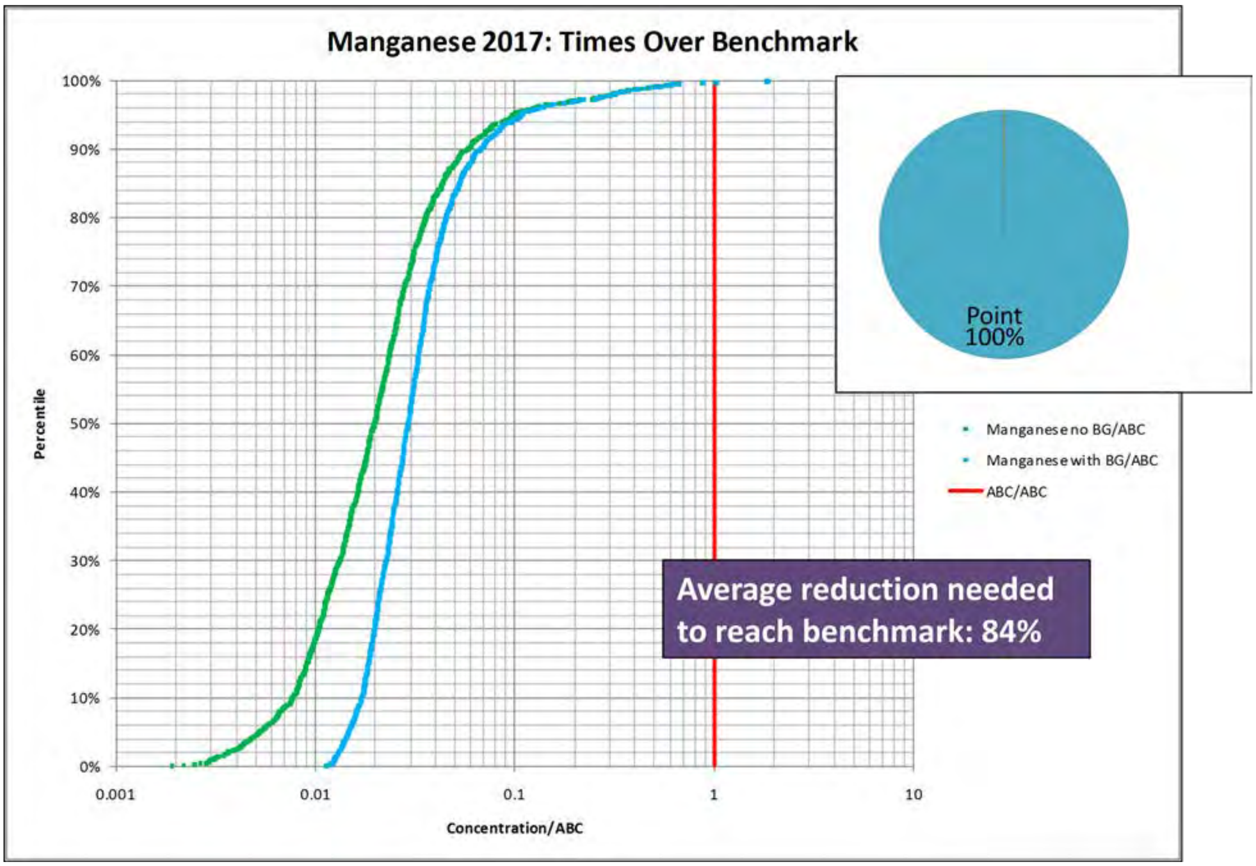


Figure 68: Manganese 2017 Modeled Concentrations Including Background Contributions



Manganese impacts are limited to localized impact areas. Figure 69 contains a pie chart showing percentages of modeled contributions for manganese. Figure 69 also plots a distribution of modeled values for manganese with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without background concentration and the blue line is composed of all values including the background concentration. This graph, known as an S-curve, shows that most of the modeled manganese values in our study area are below the benchmark and a few in the localized impact areas are above the benchmark. The reduction in manganese concentration needed to reach the target is 84%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, an 84% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

Figure 69: Distribution of 2017 Modeled Concentrations for Manganese, and Modeled 2017 Sources of Manganese



4.3.3.1 Nickel

Nickel is an abundant natural element found in soil and emitted from volcanoes. Nickel is most often used to make stainless steel and nickel compounds are used for nickel plating, to make some batteries, and as catalysts. Nickel is released into the air by industries that make or use nickel or nickel compounds. It is also released by oil- and coal-burning power plants and trash incinerators. Figure 70 and Figure 71 are maps showing region-wide nickel modeled concentrations without and including background contributions compared to Oregon's nickel benchmark concentration.

Figure 70: Nickel 2017 Modeled Concentrations without Background Contributions

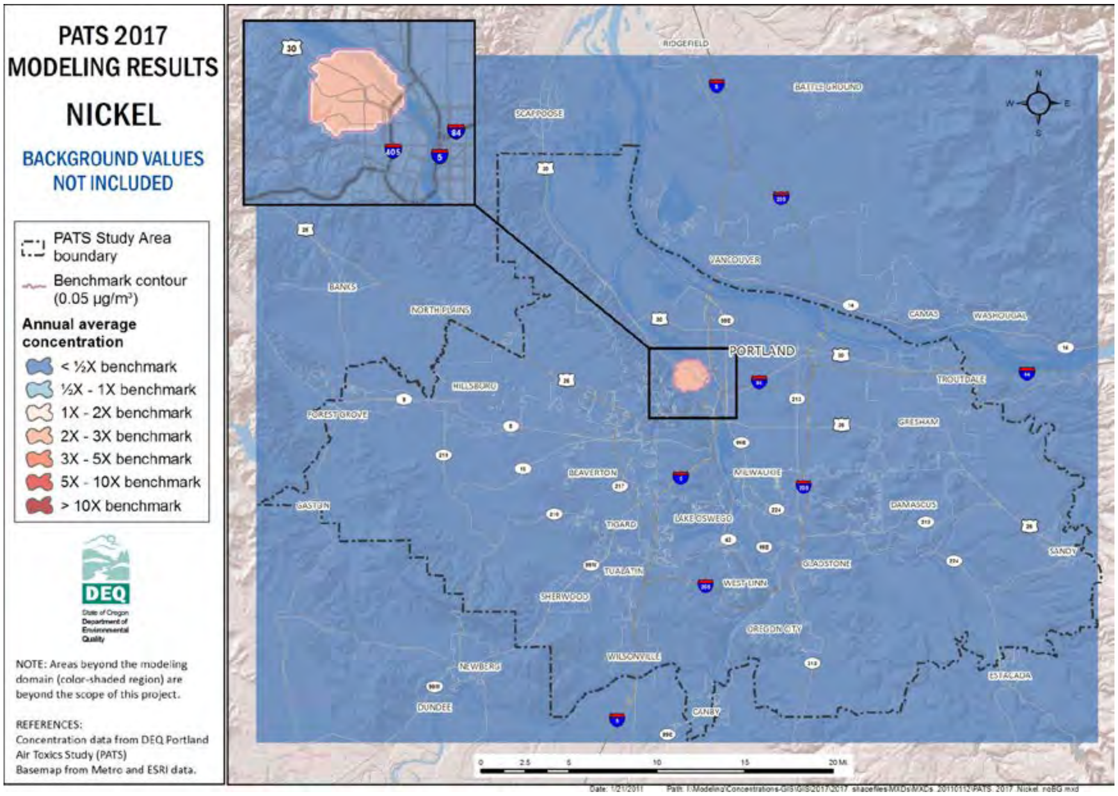
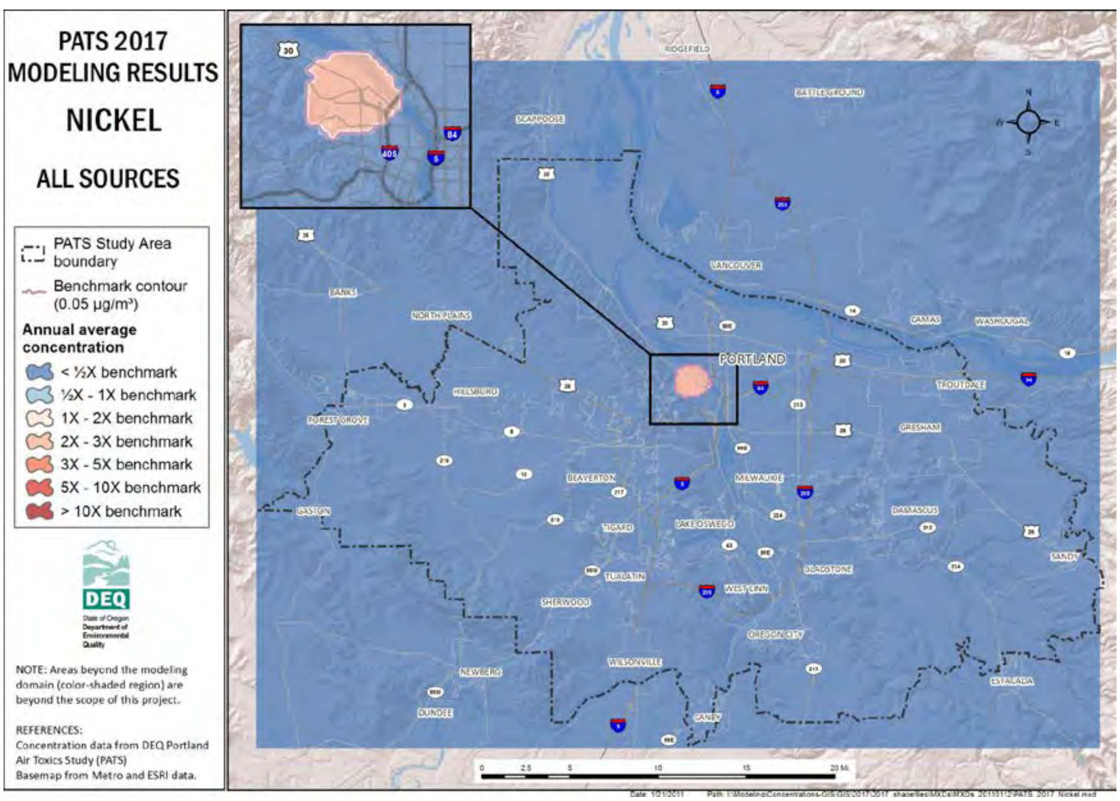
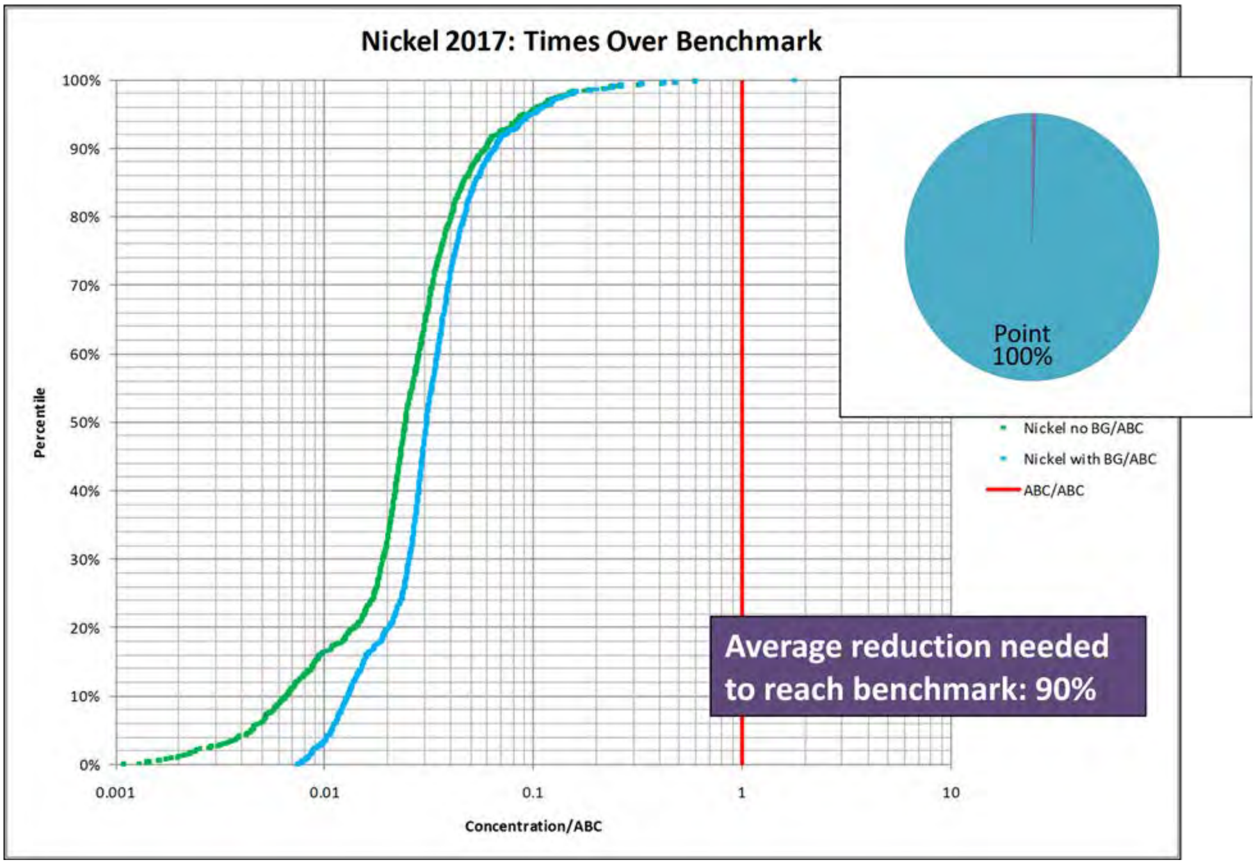


Figure 71: Nickel 2017 Modeled Concentrations Including Background Contributions



Nickel impacts are limited to one localized impact area as shown in the pollutant concentration maps. Figure 72 contains a pie chart showing percentages of modeled contributions for nickel. Figure 72 also plots a distribution of modeled values for nickel with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without background concentration and the blue line is composed of all values including the background concentration. This graph, known as an S-curve, shows that most of the modeled nickel values are below the benchmark a few in the localized impact areas are above the benchmark. The reduction in nickel concentration needed to reach the target is 90%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, a 90% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

Figure 72: Distribution of 2017 Modeled Concentrations and Sources of Nickel



4.3.3.1 Point Source Emission Reduction Targets

4.3.4 Secondary Source Pollutants

There are three pollutants associated primarily with secondary sources: Formaldehyde, acrolein, and acetaldehyde. Formaldehyde and acrolein are more than ten times above their benchmarks and acetaldehyde is between one and ten times above their benchmarks.

4.3.4.1 Formaldehyde

Formaldehyde comes from incomplete fuel combustion from industry, on and off-road engines, construction equipment, diesel fuel combustion, railroads, and airports, as well as from wood burning. It is used as a concrete and plaster additive, as a disinfectant, and as a wood preservative. The highest levels of airborne formaldehyde have been detected in indoor air, where it is released from various consumer products including paneling and carpets. Figure 73 and Figure 74 are maps showing region-wide formaldehyde modeled concentrations without and including secondary contributions compared to Oregon’s formaldehyde benchmark concentration.

Figure 73: Formaldehyde 2017 Modeled Concentrations without Secondary Contributions

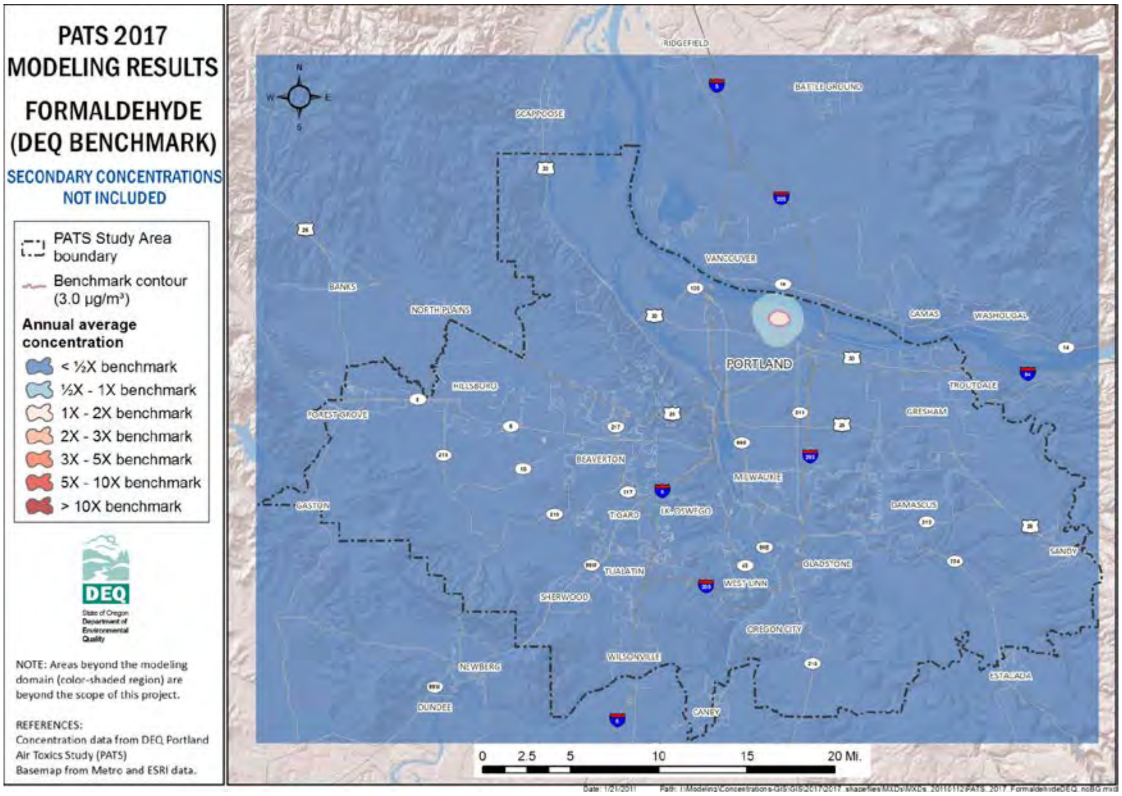


Figure 74: Formaldehyde 2017 Modeled Concentrations Including Secondary Contributions

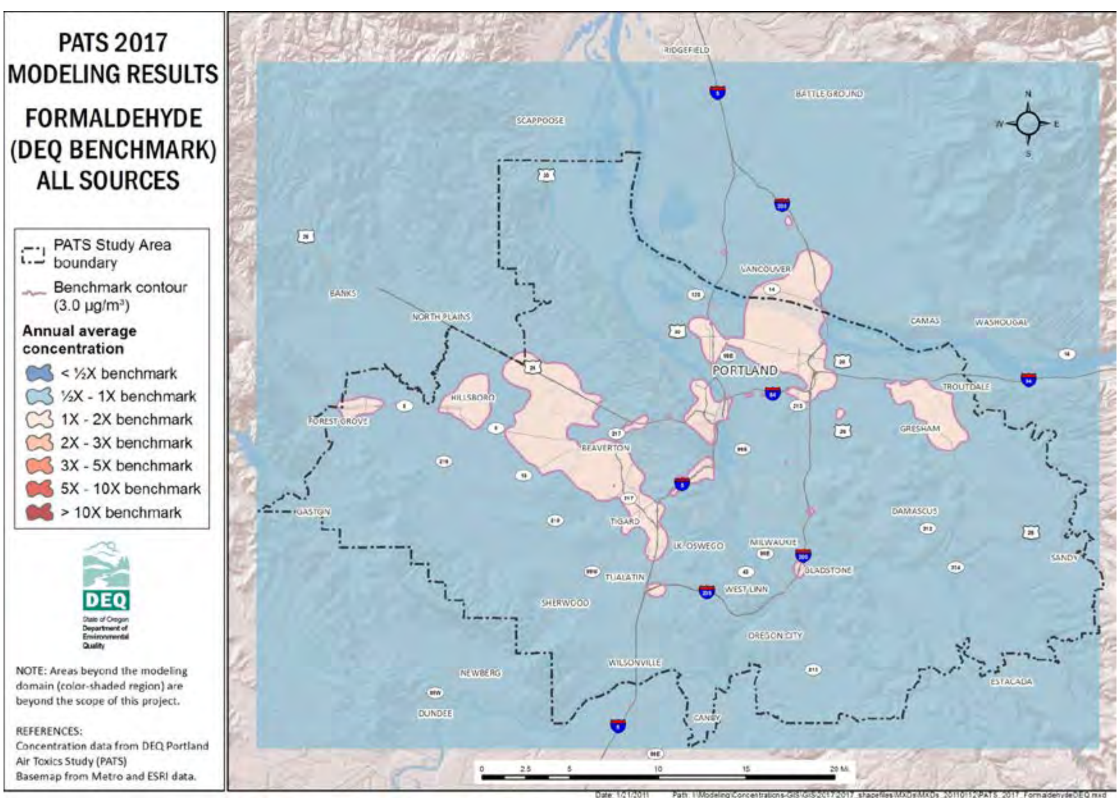


Figure 75 and Figure 76 are maps showing region-wide formaldehyde modeled concentrations without and including secondary contributions compared to EPA's formaldehyde benchmark.

Figure 75: Formaldehyde 2017 Modeled Concentrations without Secondary Contributions

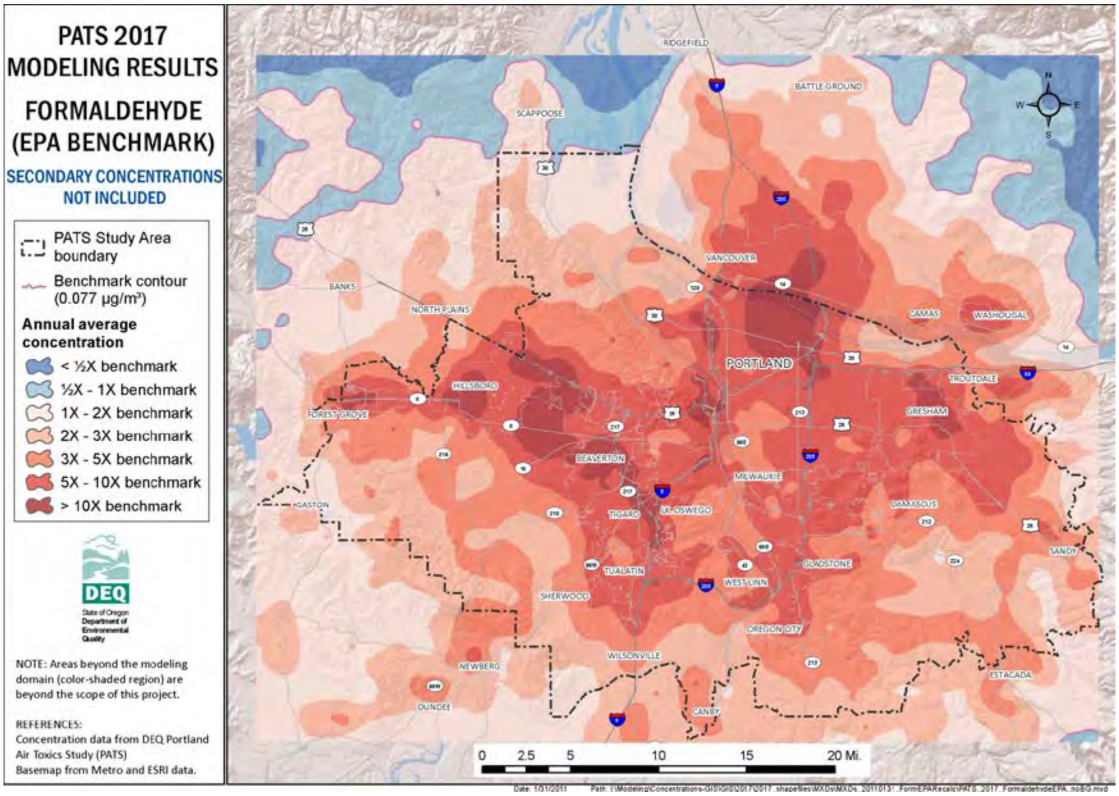
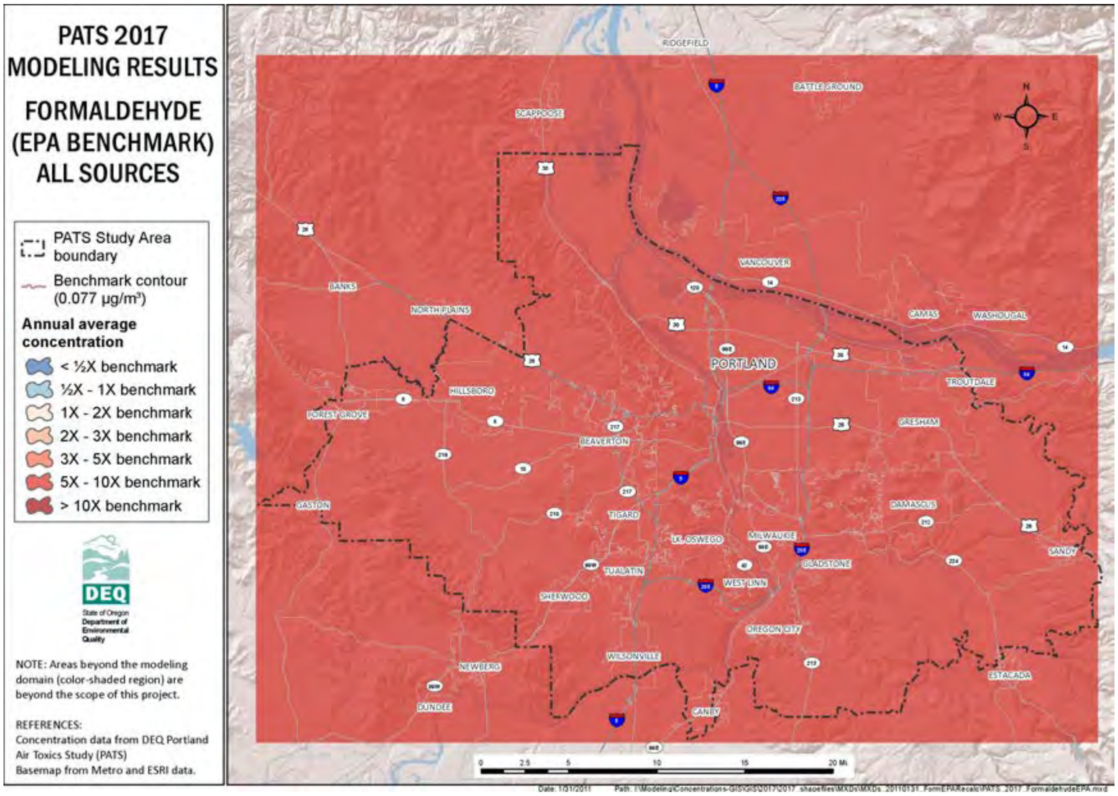
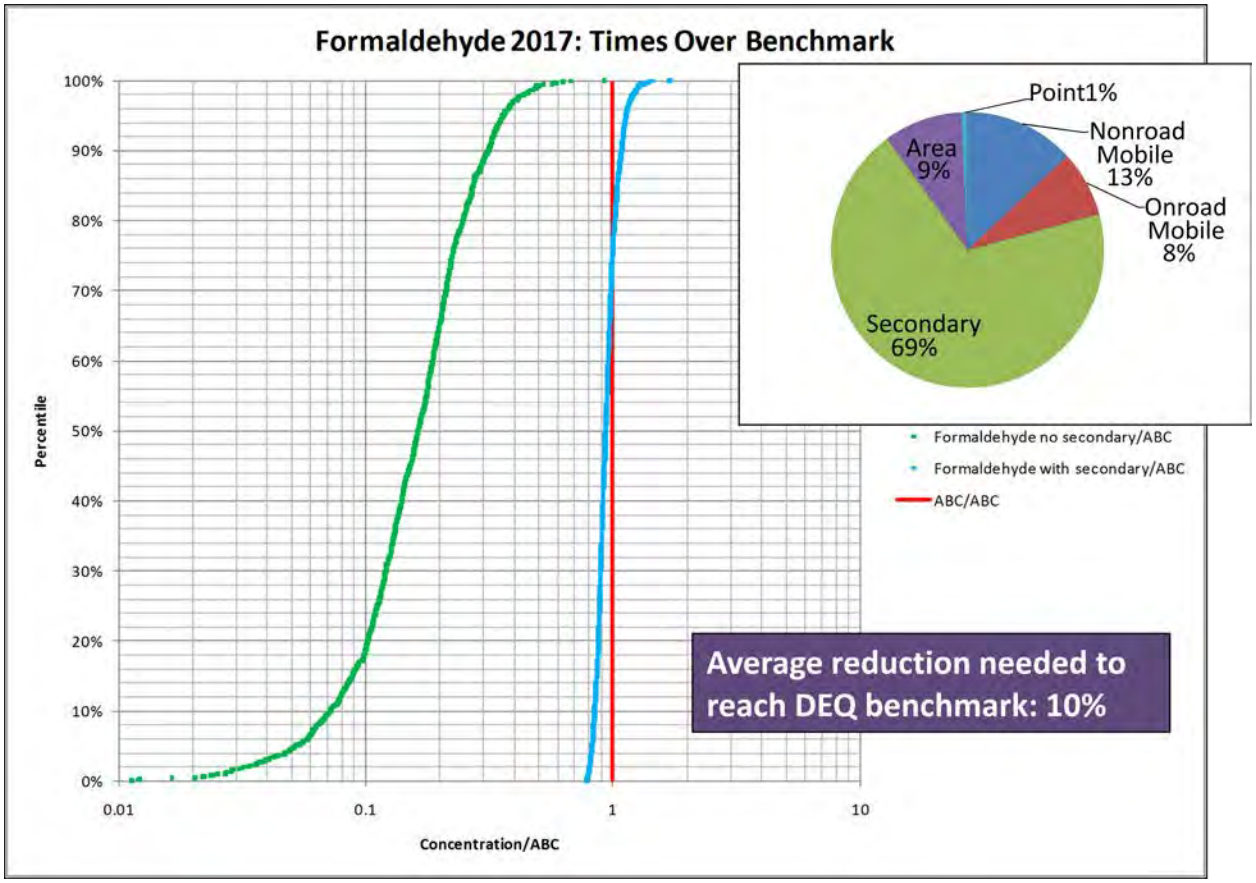


Figure 76: Formaldehyde 2017 Modeled Concentrations Including Secondary Contributions



Formaldehyde is a regional pollutant. Figure 77 contains a pie chart showing percentages of modeled contributions for formaldehyde. Figure 77 also plots a distribution of modeled values for formaldehyde compared to the DEQ benchmark, with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without background concentration and the blue line is composed of all values including the secondary concentration. This graph, known as an S-curve, shows that in general, most of the receptors in the PATS study area are below the benchmark and a few in the localized impact areas are above the benchmark. The reduction in formaldehyde concentration needed to reach the target is 10%. This represents the reduction of the average concentration above the DEQ benchmark to meet the DEQ benchmark, not the reduction of the highest modeled concentration to meet the DEQ benchmark. As a result, a 10% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

Figure 77: Distribution of 2017 Modeled Concentrations and Sources of Formaldehyde



4.3.4.2 Acrolein

Acrolein is a colorless or yellow liquid that evaporates quickly and burns easily. Acrolein has a strong, unpleasant odor. It reacts quickly when exposed to other substances. In the PATS area, acrolein enters the air mainly from wood burning, structural (house and building) fires and construction. Tobacco smoke is another source of acrolein. Figure 78 and Figure 79 are maps showing region wide acrolein modeled concentrations without and including secondary contributions compared to Oregon's acrolein benchmark concentration.

Figure 78: Acrolein 2017 Modeled Concentrations without Secondary Contributions

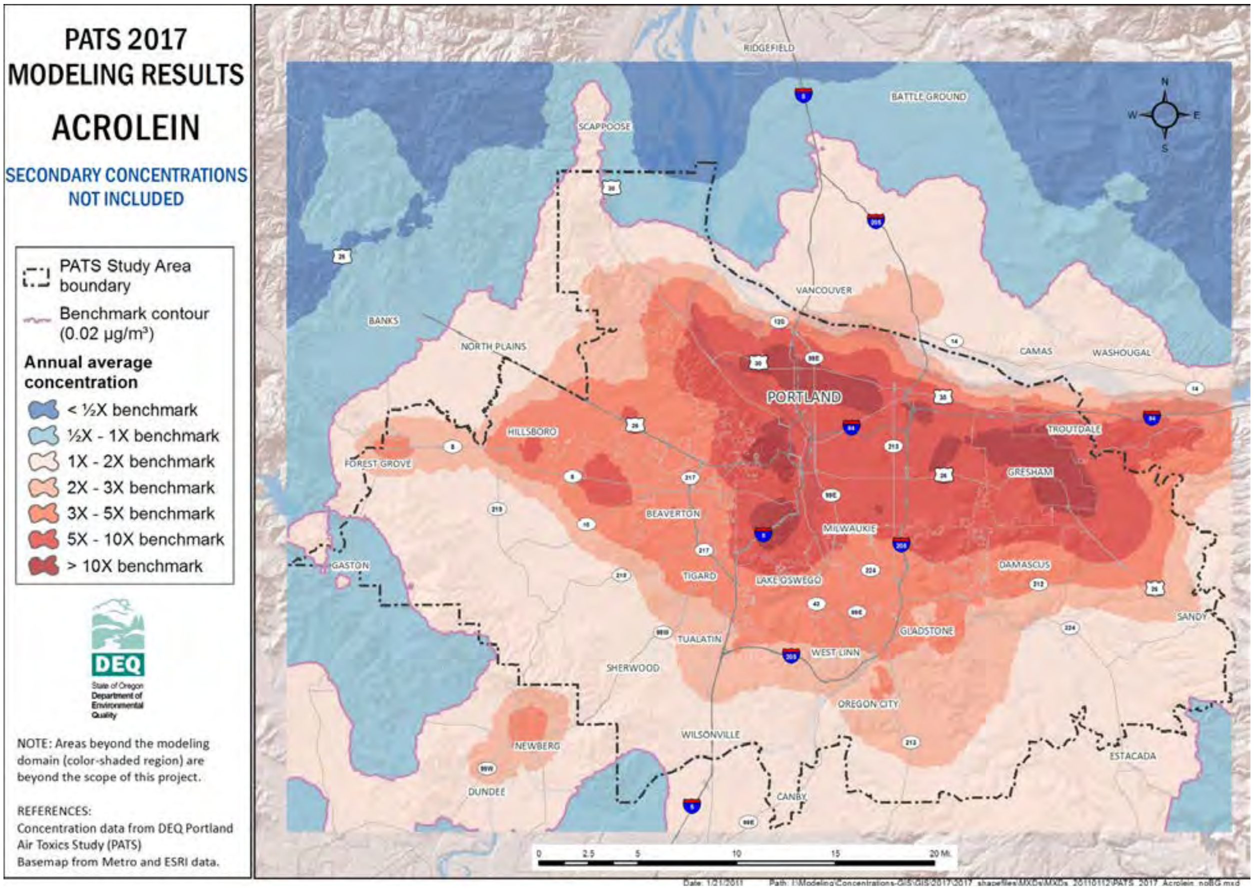
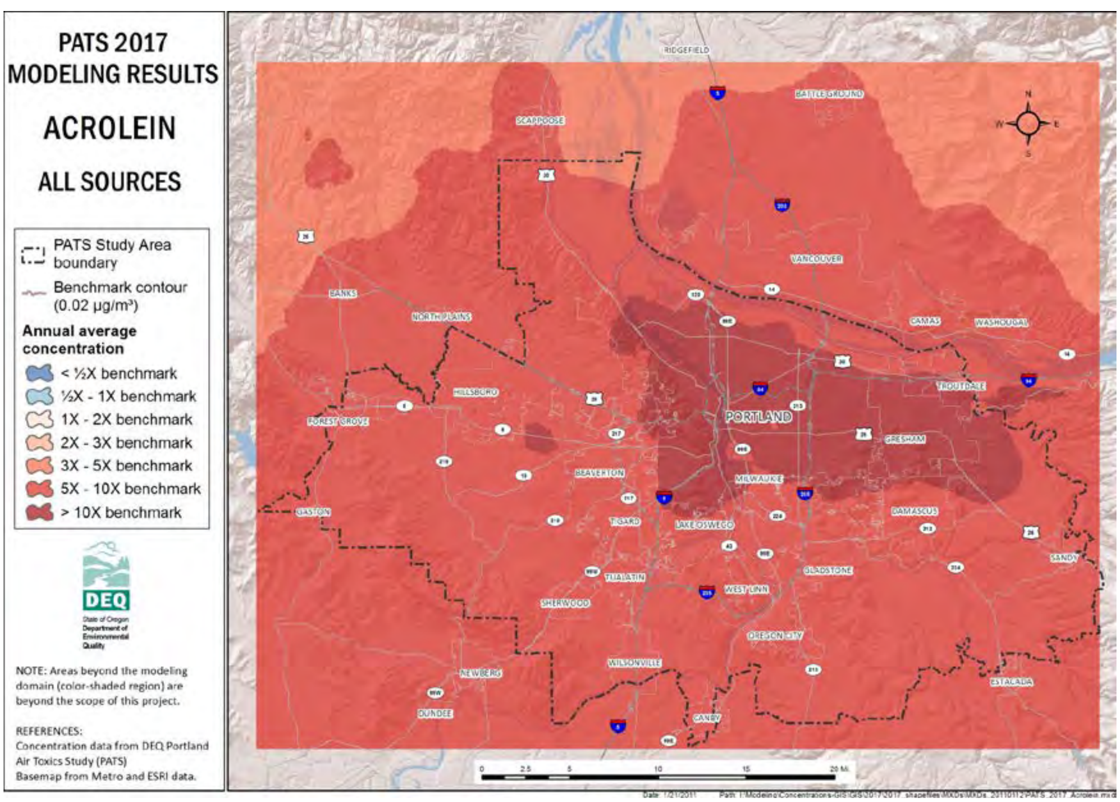
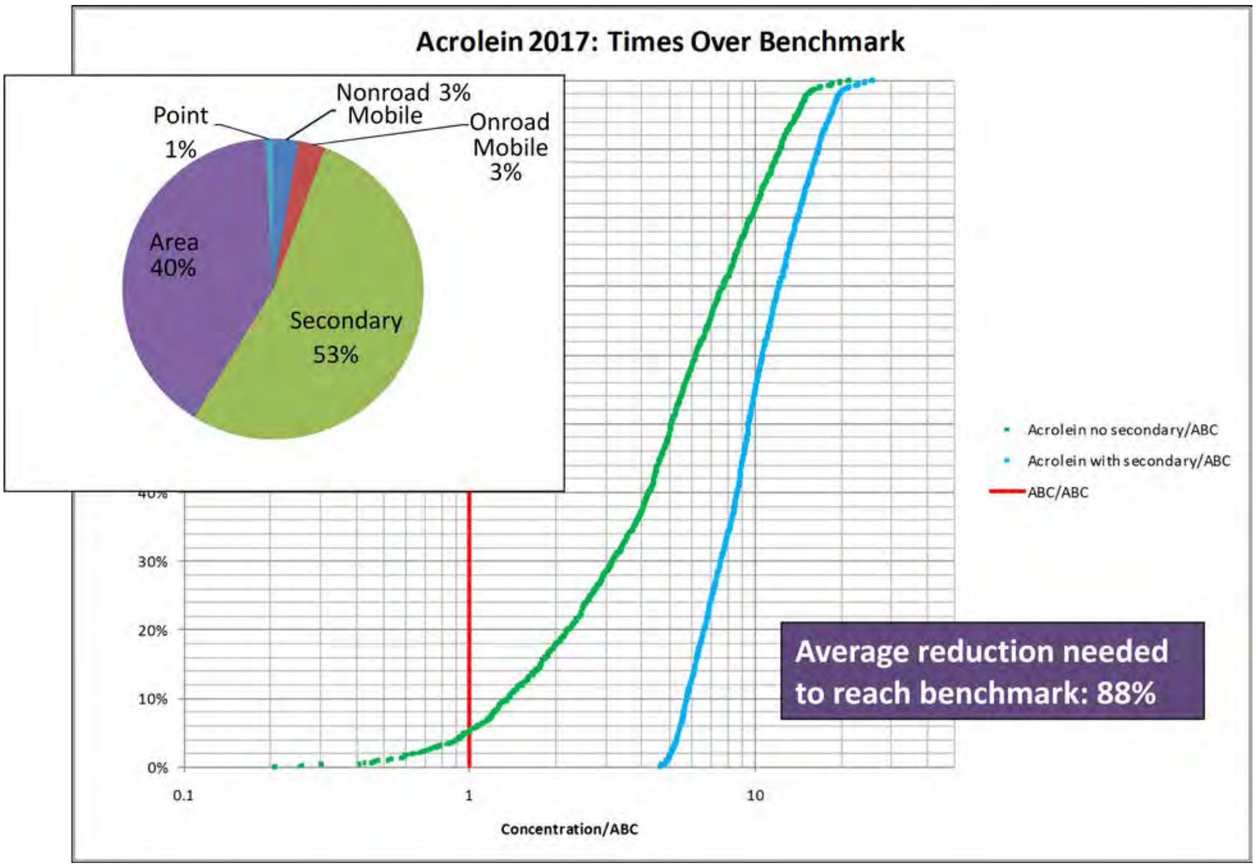


Figure 79: Acrolein 2017 Modeled Concentrations Including Secondary Contributions



Acrolein exists throughout the study area with higher concentrations in defined zones. The secondary concentration is 53 percent of the total for receptors above the benchmark. Figure 80 contains a pie chart showing percentages of modeled contributions for acrolein. Figure 80 also plots a distribution of modeled values for acrolein with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without secondary concentration and the blue line is composed of all values including the secondary concentration. This graph, known as an S-curve, shows that in general, most of the receptors in the PATS study area are above the benchmark. The reduction in acrolein concentration needed to reach the target is 88%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, an 88% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

Figure 80: Distribution of 2017 Modeled Concentrations and Sources of Acrolein



4.3.4.3 Acetaldehyde

Acetaldehyde is a colorless, flammable liquid that evaporates easily into the air. It is a product of incomplete combustion of fuels and wood, and is also used in the manufacture of other chemicals and products including perfumes and dyes. The dominant source of acetaldehyde in the Portland area is smoke from residential wood stoves and fireplaces, but much is also produced by engines. Figure 81 and Figure 82 are maps showing region-wide acetaldehyde modeled concentrations without and including secondary contributions compared to Oregon's acetaldehyde benchmark concentration.

Figure 81: Acetaldehyde 2017 Modeled Concentrations without Secondary Contributions

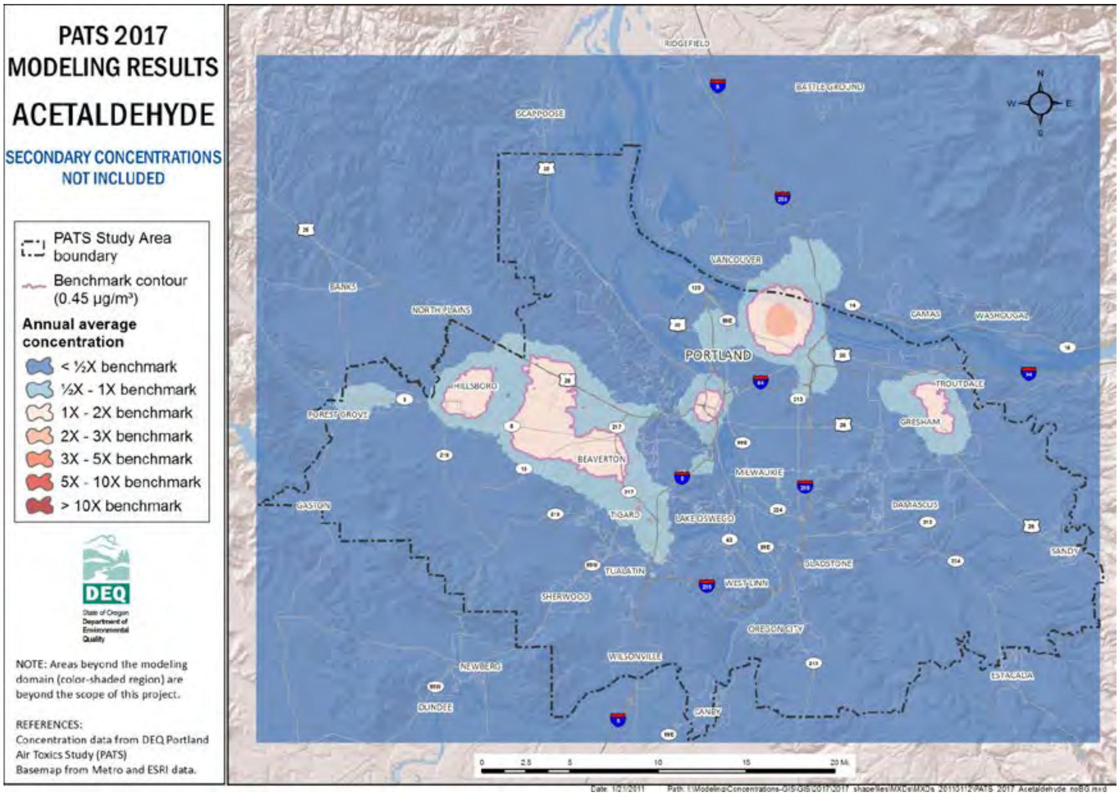
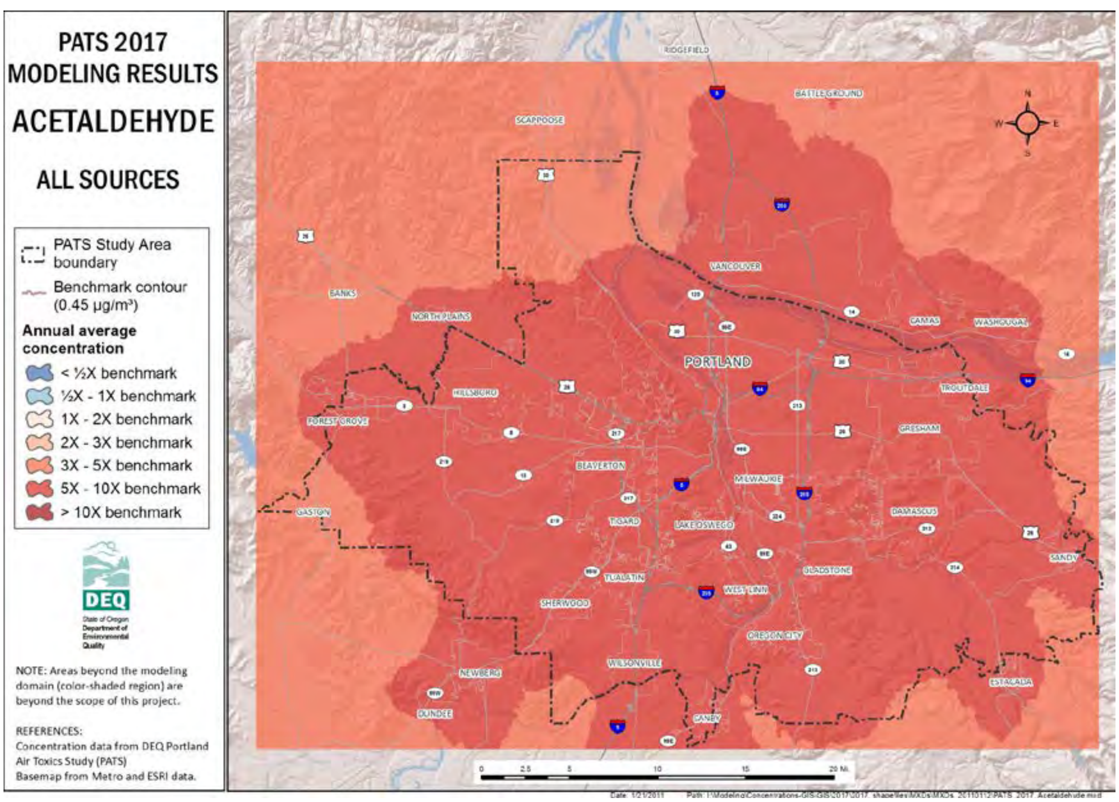
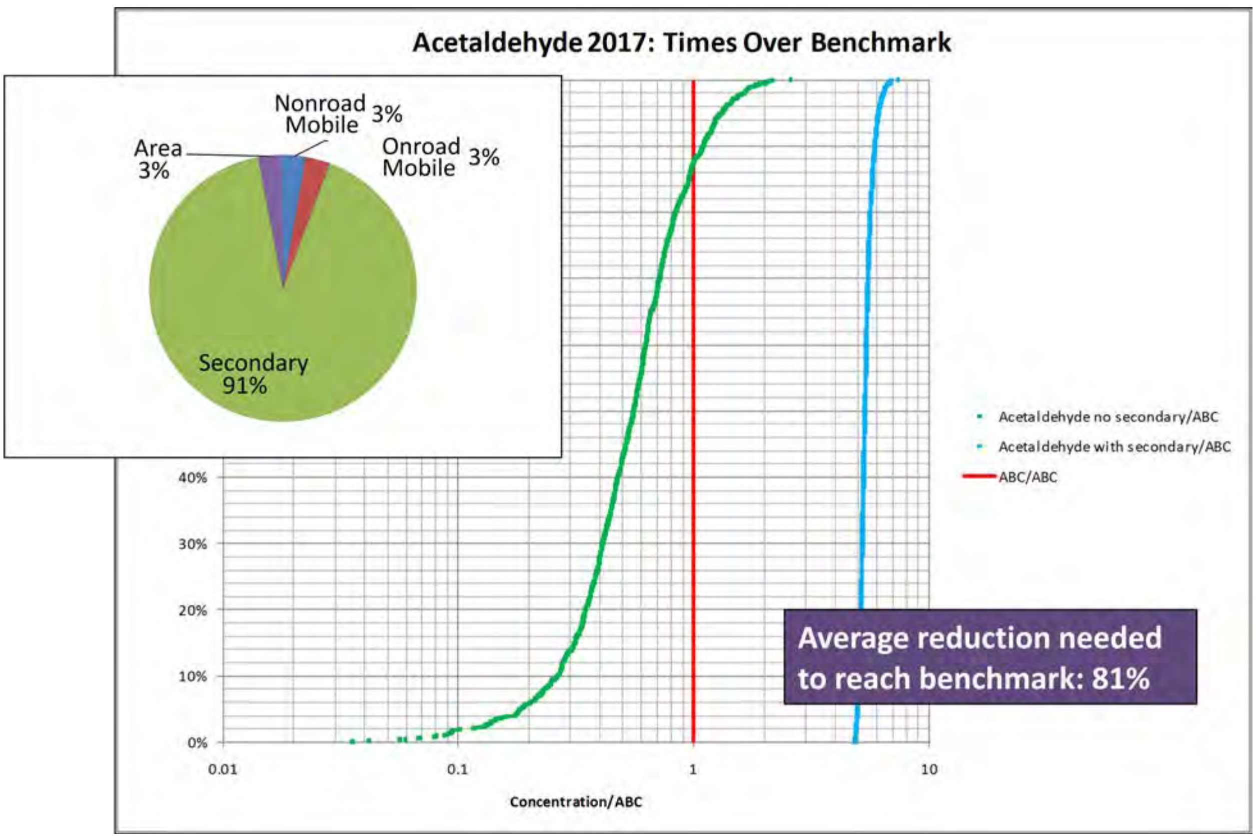


Figure 82: 2017 Acetaldehyde Modeled Concentrations Including Secondary Contributions



Acetaldehyde is a regional pollutant. There is a high secondary concentration of acetaldehyde, so including secondary sources brings levels up across the region. The secondary concentration is 91 percent of the total for receptors above the benchmark. Figure 83 contains a pie chart showing percentages of modeled contributions for cadmium. Figure 83 also plots a distribution of modeled values for cadmium with the y-axis showing the percentile value, the x-axis showing times above the benchmark, and the red vertical line representing the benchmark value. The green line is composed of all the values without background concentration and the blue line is composed of all values including the background concentration. This graph, known as an S-curve, shows that in general, most of the receptors in the PATS study area are below the benchmark and a few in the localized impact areas are above the benchmark. The reduction in acetaldehyde concentration needed to reach the target is 81%. This represents the reduction of the average concentration above the benchmark to meet the benchmark, not the reduction of the highest modeled concentration to meet the benchmark. As a result, an 81% reduction still leaves receptors with the highest modeled concentrations above the benchmark.

Figure 83: Distribution of 2017 Modeled Concentrations and Sources of Acetaldehyde



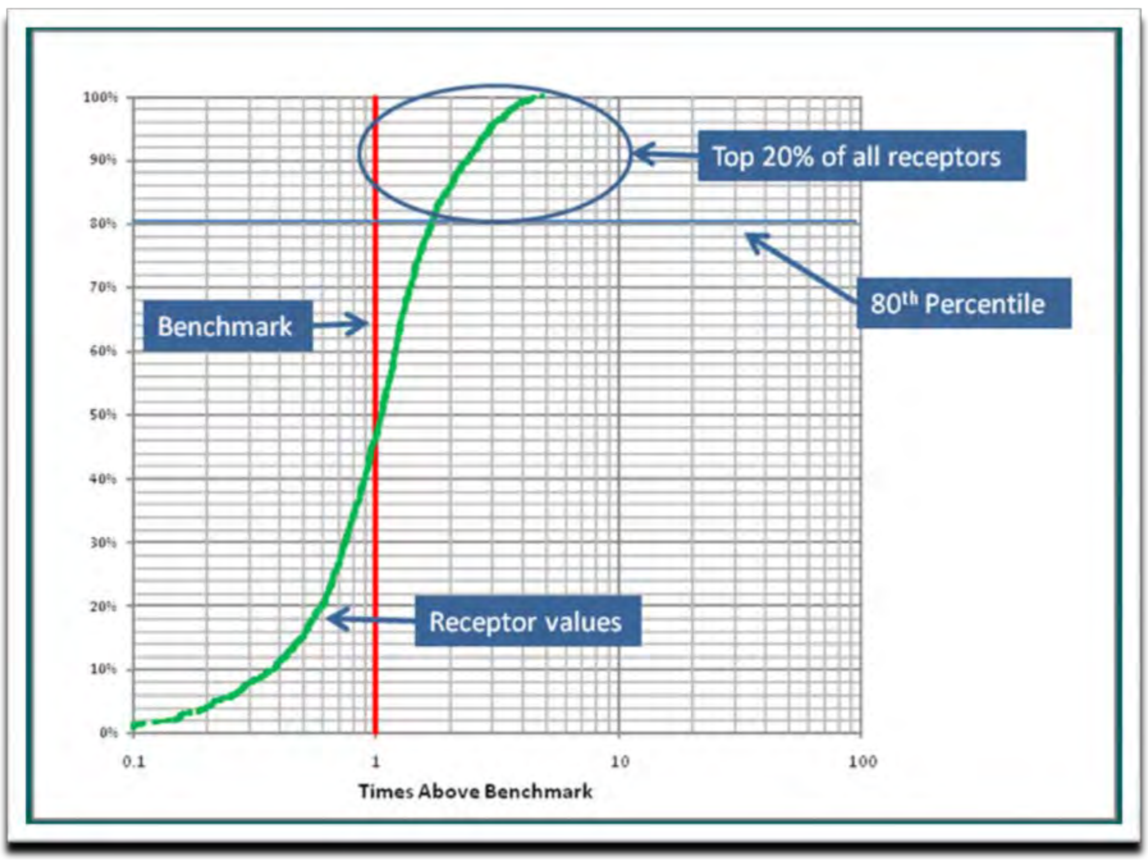
5. Emission Source Categories Ranked by Total Risk

DEQ sorted source categories by total risk based on area wide and localized impacts. This section describes the method and results of ranking source category emissions using total 2017 modeled risk. First, DEQ calculated total times above benchmark for all modeled source categories, which is described in section 5.1. In developing potential emission reduction strategies (described in the white papers in section 7 and Appendix 12.9), DEQ broke the modeling categories down further, and in some cases combined the modeling categories. For example, the modeling source category of "on-road mobile" was divided into two white papers: on-road gasoline and on-road diesel, because the potential emission reduction strategies for each are very different. DEQ then calculated the total times above benchmark for white paper categories, which is described in section 5.2.

5.1 Method

To rank emission source categories based on total risk, DEQ used the 80th percentile times above benchmark for all emission source categories and all pollutants. DEQ used the 98th or top percentile of the metals unique to point sources. The method employed here for the ranking of source categories based on total risk is different from the approach used to set reduction targets for the individual toxic pollutants as described in Section 4. Those toxic reduction targets were based on the average concentration of all receptors above the benchmark, not on a set percentile, for example the 80th percentile, of source category risk as used in the source category ranking. The S-curve in Figure 84 illustrates the percentile concept.

Figure 84: S Curve



The total risk rankings were developed for area and zonal sources using top 20% of receptors, which is consistent with the mobile and area source analysis. When DEQ analyzed emissions within 500 meters of roadways, the data set was almost the same as the 80th percentile.

Figure 85 shows the modeled source categories sorted against the times above benchmarks for all pollutants. Green shading and orange shading identify pollutants causing the highest risk, also known as risk driver pollutants. Rows in gray at the bottom of the table are for source categories that have a total risk less than 1.0, that is, concentrations that are below benchmarks. The large risk value for acrolein in the "Area Other" emission source category is from structural fires. In the PATS study area, there were 1,325 structural fires in 2005. A very small percentage of these are intentionally set for training purposes. The Portland Fire Department has approximately six practice burns per year. Since structural fires are not subject to emission control strategies, these emissions and concentrations could be included in background rather than considered as primary emissions.

Figure 85: Times above Benchmarks for 80th Percentile Receptors for Modeled Source Categories

Emission Source Category	Acetaldehyde	Acrolein	Butadiene	Formaldehyde	Naphthalene	Benzene	Dichlorobenzene	Diesel PM	Ethylbenzene	Trichloroethylene	Arsenic	Cadmium	Chromium	Lead	Manganese	Nickel	15 PAH	Total	Rank
RWC	0.32	0.77	1.30	3.93	1.53	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.75	37.60	1
On Road Mobile	0.48	0.75	11.80	3.90	1.16	3.89	0.00	3.04	0.85	0.00	2.50	0.00	1.65	0.00	0.00	0.01	4.44	34.48	2
Area Other*	0.08	10.36	0.01	1.60	3.31	0.90	0.00	1.81	0.11	0.00	0.68	0.52	0.00	0.00	0.00	0.03	4.49	23.89	3
Construction	0.15	0.19	0.12	1.85	0.02	0.32	0.00	8.75	0.04	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.73	12.38	4
NRM Other	0.13	0.21	0.97	0.95	0.30	1.62	0.00	4.05	0.23	0.00	0.13	0.00	0.04	0.00	0.00	0.00	1.93	10.55	5
Lawn & Garden	0.10	0.24	1.28	1.24	0.33	2.46	0.00	0.77	0.56	0.00	0.21	0.00	0.05	0.00	0.00	0.00	3.13	10.38	6
Solvent Use	0.00	0.00	0.00	0.05	3.48	0.82	2.20	0.00	0.68	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.32	7
Point	0.01	0.24	0.00	0.31	1.45	0.41	0.00	0.01	0.07	0.02	0.21	0.38	0.22	0.01	0.19	0.10	0.24	3.87	8
Airport	0.10	0.13	0.29	1.54	0.07	0.24	0.00	0.38	0.02	0.00	0.03	0.00	0.00	0.02	0.00	0.00	0.29	3.12	9
Rail	0.01	0.04	0.02	0.15	0.01	0.01	0.00	1.69	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.30	2.26	10
ROB	0.02	0.33	0.11	0.11	0.01	0.22	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	1.73	11
Marine	0.01	0.01	0.02	0.12	0.03	0.08	0.00	0.19	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.03	0.53	12
Gas Stations	0.00	0.00	0.00	0.00	0.06	0.15	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	13
POTW	0.00	0.01	0.00	0.00	0.01	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	14
Dry Cleaners	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15

Between 1 and 5 | Above 5 | * Acrolein from structural fires

No perchloroethylene or methylene chloride

Figure 86 shows the modeled source categories sorted against the times above benchmarks for cadmium, lead, manganese and nickel. While there are more pollutants from industrial sources than thee four metals, they are the most clear-cut examples of localized impacts. Sorting on the 98th percentile, Figure 85 shows how the categories lined up for these metals. Green shading identifies risk driver pollutants. Rows in gray are below benchmarks for those categories.

Figure 86: Average Times above Benchmarks for 98th Percentile Receptors from Localized Impact Pollutants for Modeled Source Categories

	Cadmium	Lead	Manganese	Nickel	Total	Rank
Point	2.94	0.08	1.26	0.64	4.93	1
Area Other	0.63	0.00	0.00	0.04	0.67	2
Airport	0.00	0.05	0.00	0.00	0.05	3
Rail	0.05	0.00	0.00	0.00	0.05	4
On Road Mobile	0.00	0.00	0.00	0.01	0.01	5
RWC	0.01	0.00	0.00	0.00	0.01	6
NRM Other	0.00	0.00	0.00	0.00	0.00	7
Construction	0.00	0.00	0.00	0.00	0.00	8
Lawn & Garden	0.00	0.00	0.00	0.00	0.00	9
Marine	0.00	0.00	0.00	0.00	0.00	10
POTW	0.00	0.00	0.00	0.00	0.00	11
Solvent Use	0.00	0.00	0.00	0.00	0.00	12
Gas Stations	0.00	0.00	0.00	0.00	0.00	13
ROB	0.00	0.00	0.00	0.00	0.00	14
Dry Cleaners	0.00	0.00	0.00	0.00	0.00	15

Between 1 and 5

Modeled emission source categories are different than emission source categories in the white papers. Some modeled source categories contributed relatively lower risk when compared with other categories (marine, gas stations, residential open burning, and dry cleaners), and for these, no white papers were developed. Reducing emissions from emission source categories without white papers could still reduce risk. Figure 87 shows the modeled emission source categories as compared to the white paper categories.

Figure 87: Crosswalk from Modeling Source Category to White Paper Source Category

Modeling Source Category	White Paper Source Category
On Road Mobile	On-Road Gasoline On-Road Diesel
Residential Wood Combustion	Residential Wood Combustion and Heating
Area Other (also includes structural fires, no white paper)	Industrial Fuel Use Residential Heat Non Wood (included in Residential Wood Combustion and Heating White Paper) Asphalt Use Restaurants (included in Miscellaneous White Paper)
Publicly Owned Treatment Works (POTWs) and Landfills	Miscellaneous (POTWs, Landfills, and Restaurants)
Construction	Non Road Diesel Non Road Gasoline
Non Road Mobile Other	
Lawn & Garden	
Solvent Use	Solvent-Coating Use – Paint Strippers & Architectural Consumer Products
Airport	No white paper written
Rail	Rail
Residential Open Burning	No white paper written
Marine	No white paper written
Gas Stations	No white paper written
Dry Cleaners	No white paper written

5.2 Total Risk Ranking by Source Category

Based on the 2017 PATS modeling results, DEQ ranked emission source categories by their total risk. DEQ developed separate rankings for sources with area wide impacts and for sources with localized impacts. Figure 88 contains the area wide ranking. The top total risk from air toxics are residential wood combustion and on-road gasoline for area wide sources. Figure 89 lists the ranking for localized impacts. The top total risk from air toxics for localized impacts is metal production.

Figure 88: PATS Domain Wide Rankings for White Paper Source Categories

White Paper Category Ranking	Times Above Benchmark 80th Percentile Receptors
1. RWC	37.6
2. On Road Mobile Gas	29.0
3. Construction Diesel	11.9
4. Lawn and Garden - Diesel	9.5
5. On Road Mobile Diesel	5.5
6. Non Road Mobile Other - Diesel	5.4
7. Non Road Mobile Other - Gas	5.2
8. Solvent-Coating	4.6
9. Point	3.9
10. Airport	3.1
11. Consumer Products	2.7
12. Rail	2.3
13. Industrial Fuel Use	2.2
14. Residential Open Burning	1.7
15. Residential Heat Non Wood	1.2
16. Asphalt Use	1.0
17. Lawn and Garden - Gas	0.9
18. Construction Gas	0.5

Figure 89: Localized Impact for White Paper Source Categories

White Paper Category Risk Drivers
Metal Production *(Cadmium, Manganese, Nickel, Benzene)*
Glass Manufacturing *(Arsenic)*
Electroplaters *(Chromium)*
Bulk Terminals *(Benzene)*
Surface Coating *(Ethylbenzene)*
Asphalt Roofing *(Benzene)*
Industrial Fuel Use *(Cadmium)*

6. Source Category Emission Reduction Targets

The PATS projected 2017 modeling results provide information about individual pollutant concentrations and associated risk, and the significant contributing emission source categories. DEQ analyzed the modeling data to understand the concentrations and spatial patterns of individual pollutants (see modeling results in Section 4). DEQ then analyzed the modeling data for individual source categories to identify relative ranking based on total risk for each category, risk driver pollutants and pollutant reduction targets. Source category analysis allowed DEQ and PATSAC to understand what reductions are roughly feasible for various categories and pollutants, and also to prioritize source categories for emission reductions.

This section describes emission reduction targets for the risk driver pollutants most predominantly associated with source categories. These pollutants generally cause the most risk from those source categories. Additional pollutant reduction targets for non risk driver pollutants can be found in Appendix 12.8. For On-Road Mobile, Area, and Point sources, DEQ tailored the analysis to match the characteristic spatial distributions and data quality for each category. For all categories, DEQ used a reasonable worst-case approach to set targets that would be the most protective for all individuals. No background or secondary concentrations were included in the emission reduction target analysis.

6.1 Mobile Sources

6.1.1 On-Road Mobile Source Pollutant Emission Reduction Targets

To develop reduction targets for on-road mobile air toxics, DEQ used values at receptors within 500 meters of major roadways. These values also fall within the top 20% of receptors for mobile source air toxics. This approach was supported by DEQ observations in mobile source air toxics studies and its own modeling showing that air toxics concentrations fall off steeply at 500 meters around busy roadways.

Figure 90 below shows concentrations of benzene along in three sections intersecting Interstate 5 in North Portland. Receptor locations are shown by red crosses, and the alignment of three cross-sections are also indicated. Concentrations along those cross-sections are plotted in Figure 91, and show distinctive concentration curves that flatten at about 500 meters from the roadway.

Figure 90: Benzene Concentrations at Receptors Adjacent to Interstate 5

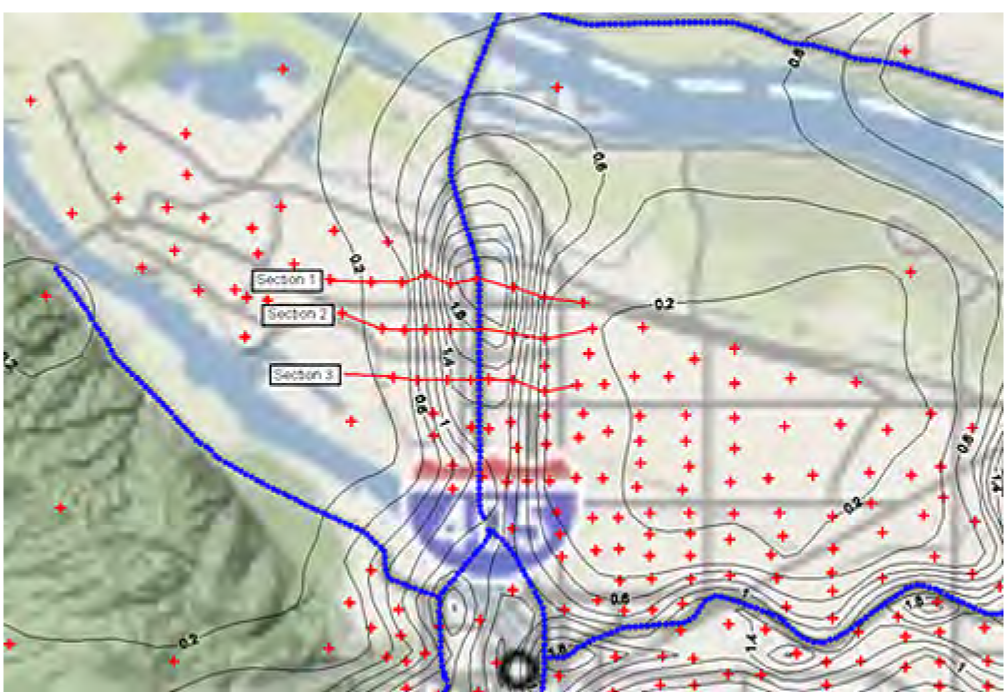


Figure 91: Roadway Concentration Curves from Receptors Adjacent to Interstate 5

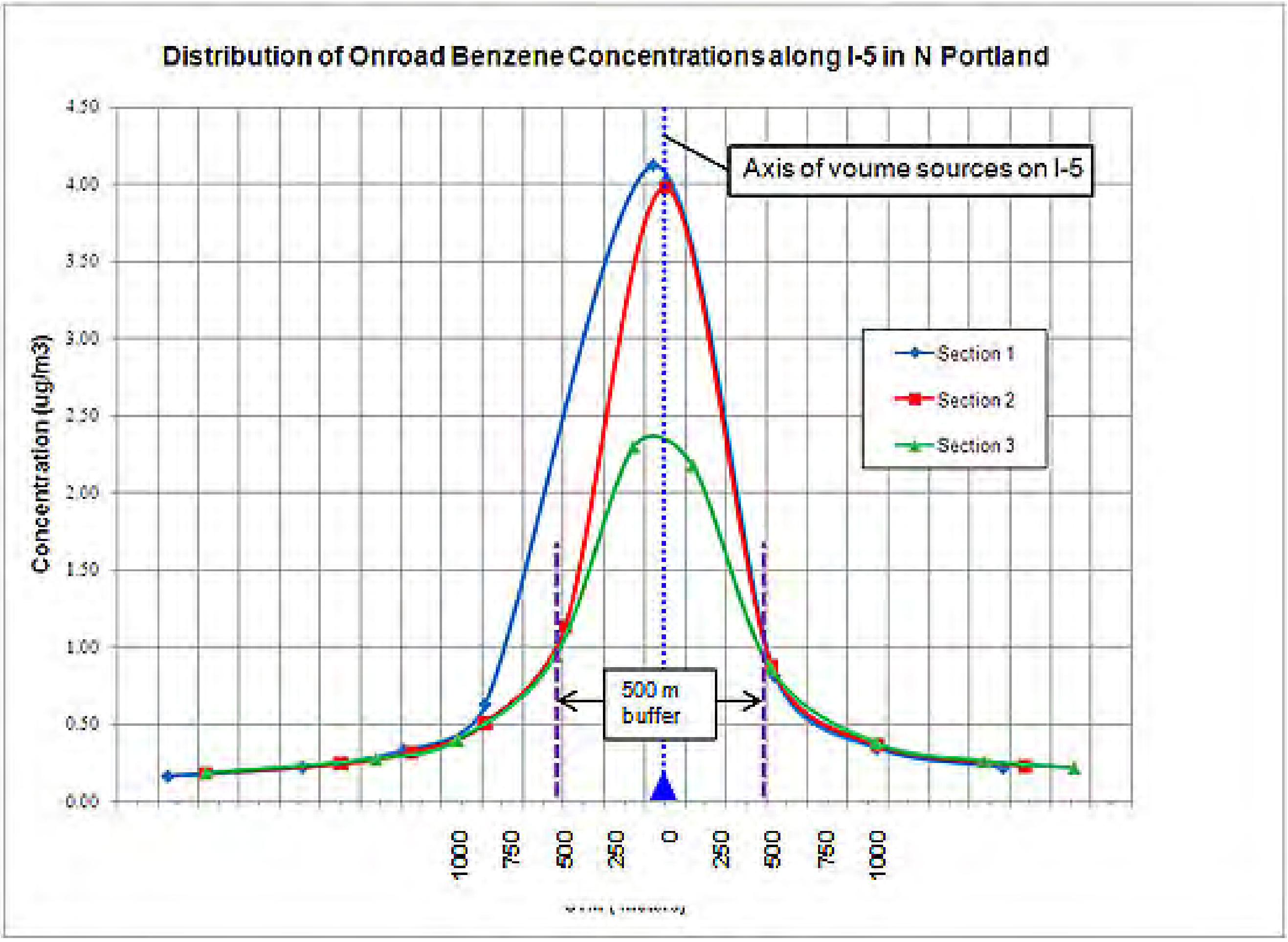


Figure 92: High Volume Roadway Receptors Used To Calculate Mobile Source Emission Reduction Targets

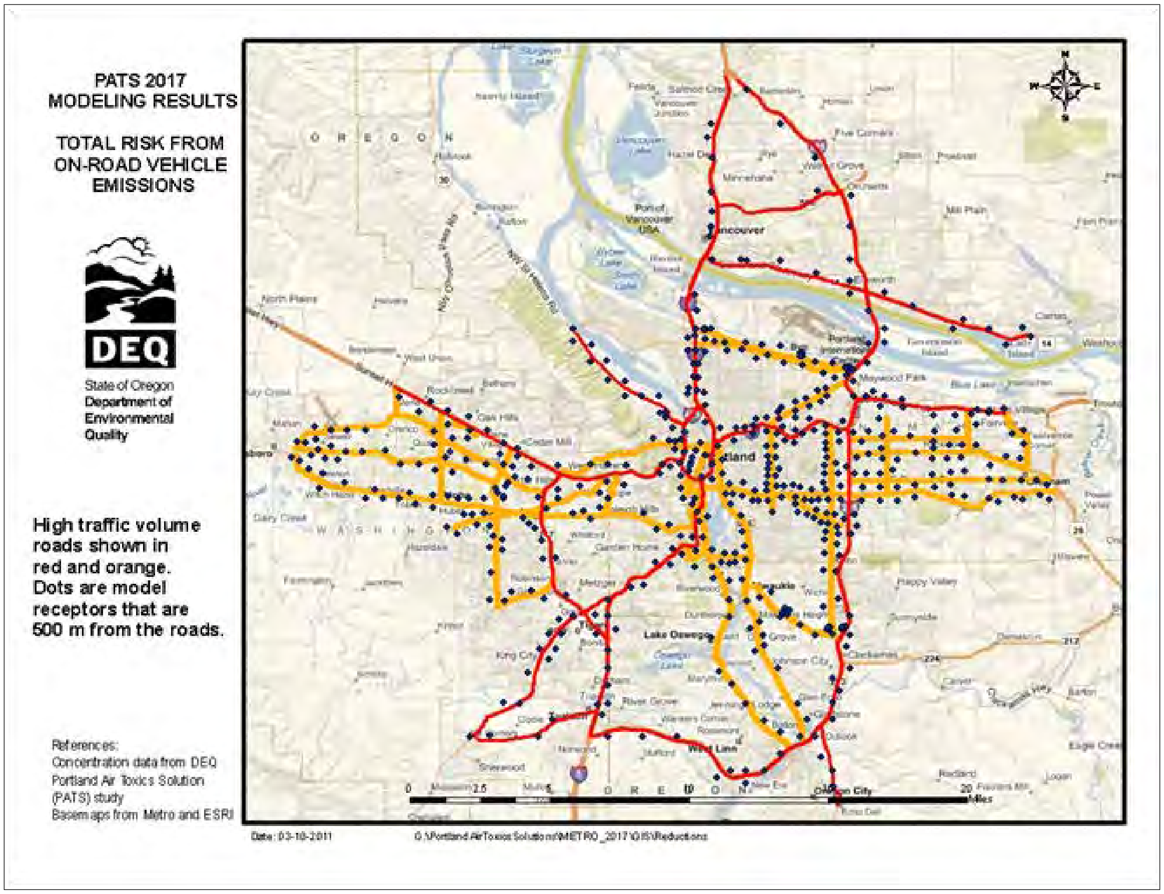


Figure 92 shows the high volume roadway receptors used to calculate mobile source emission reduction targets. On a neighborhood scale, these receptors are approximately within 1 to 7 blocks from roadways. Because major roadways in Portland run through densely settled neighborhoods, many people are exposed to the higher levels of air toxics from mobile sources.

In order to estimate proportional emissions reductions, DEQ first identified all receptors within 500 meters from these high volume roadways, and then determined the average contribution to concentrations at these receptors from the major category types (point, area, mobile). A percentage reduction was then developed for each pollutant emitted by mobile sources. Including emissions from all source categories at these receptors builds proportionality in to the emission reduction target for each source category. Percentage reductions can then be applied to emissions inventory values to estimate total tonnage to be reduced.

Table 13 shows these reduction targets for the pollutants associated predominantly with mobile sources. DEQ also developed mobile source reduction targets for other pollutants not shown on this chart: formaldehyde, acrolein, 15 PAH, and naphthalene.

Table 13: Reduction Targets for Pollutants Associated Predominantly with Mobile Sources

Impact around roadways: 500 meters	Average Concentration (ug/m3*)	Benchmark (ug/m3*)	Approximate Reduction Needed	Projected 2017 Emissions (tons per year)	Potential Reduction Needed (tons per year)
1,3-Butadiene	0.249	0.03	**88%**	25.55	22.5
Benzene	0.956	0.13	**86%**	205.98	177.1
Diesel PM	1.117	0.1	**91%**	81.72	74.4
Ethylbenzene	0.631	0.4	**37%**	85.61	31.7
Arsenic	0.000558	0.0002	**64%**	0.13	0.1
Chromium VI	0.000107	0.00008	**25%**	0.03	0.008

*ug/m3 = micrograms per cubic meter

6.1.2 Non Road Mobile Source Pollutant Emission Reduction Targets

For non road mobile sources, including construction equipment, rail and marine emissions, DEQ developed emission reduction targets by identifying the highest 20% of receptors. DEQ examined concentrations from all general emission sources (point, area, mobile) for these top 20% receptors, compared them to benchmarks, and generated percentage reductions needed for each pollutant by category. The reduction target percentage can then be applied to the emissions inventory tonnage to find an estimated reduction target for each pollutant by category. To understand the spatial distributions of pollutants from each category, DEQ mapped all pollutants from a category above benchmarks.

6.1.2.1 Construction

Figure 93 maps total risk from the construction category. Table 14 shows emission reduction targets for the construction category.

Figure 93: Total Risk from the Construction Category

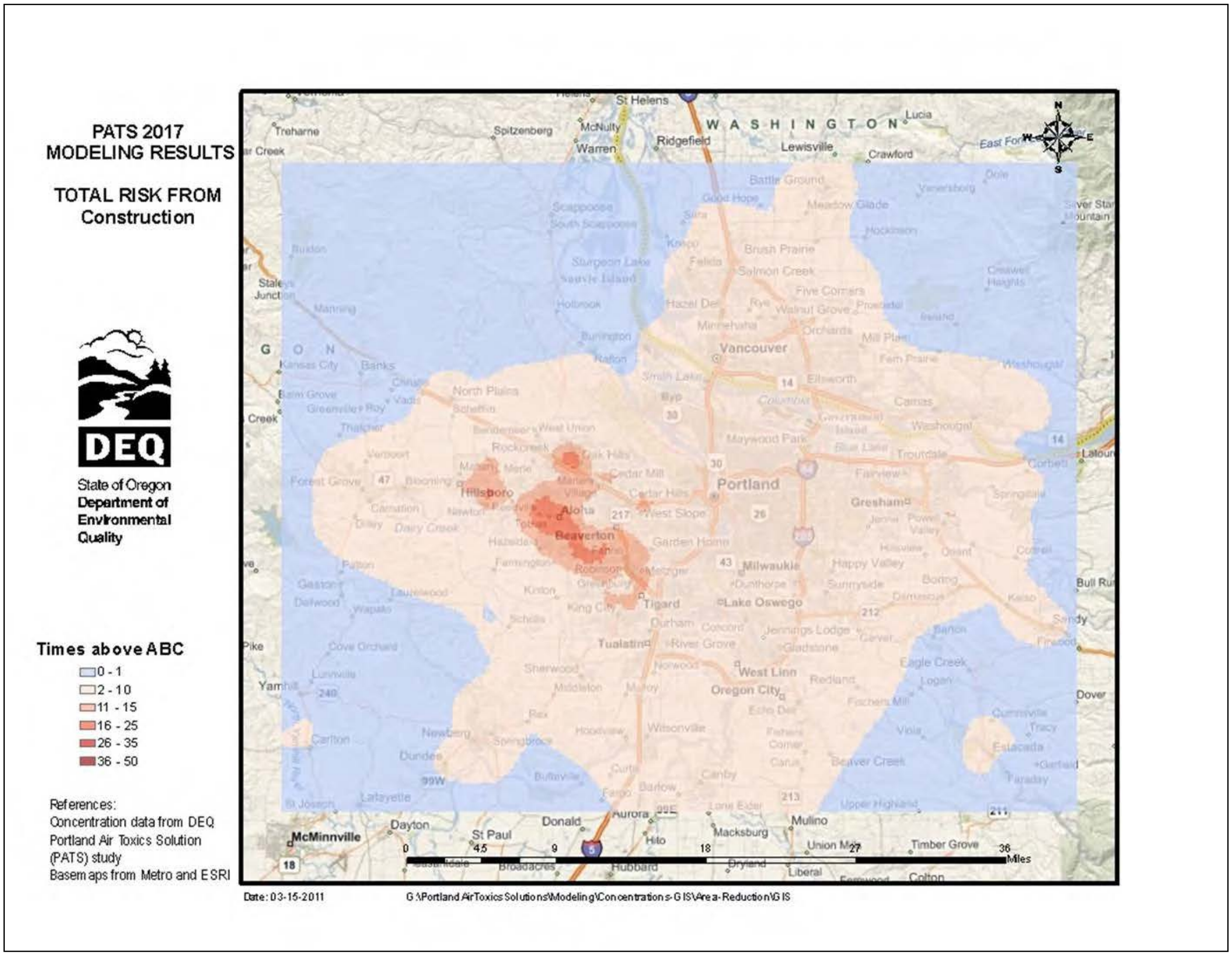


Table 14: Reduction Targets for Pollutants Associated Predominantly with Construction

Construction: analysis of the top 20% receptors					Area-Wide	
	All Source Categories				Construction Category	
	Average Concentration (ug/m3*)	Benchmark (ug/m3*)	Times above ambient benchmark concentration	Approx Reduction needed	Projected 2017 Emissions (tons per year)	Potential Reduction Needed (tons per year)
Diesel PM	1.2209	0.1	12.21	**92.5%**	247.3	228.7
PAH-15	0.0219	0.0009	24.33	**96.3%**	0.19	0.18

*ug/m3 = micrograms per cubic meter

6.1.2.2 Rail

Figure 94 shows total risk from the rail category. Table 15 shows emission reduction targets for the rail category.

Figure 94: Total Risk from the Rail Category

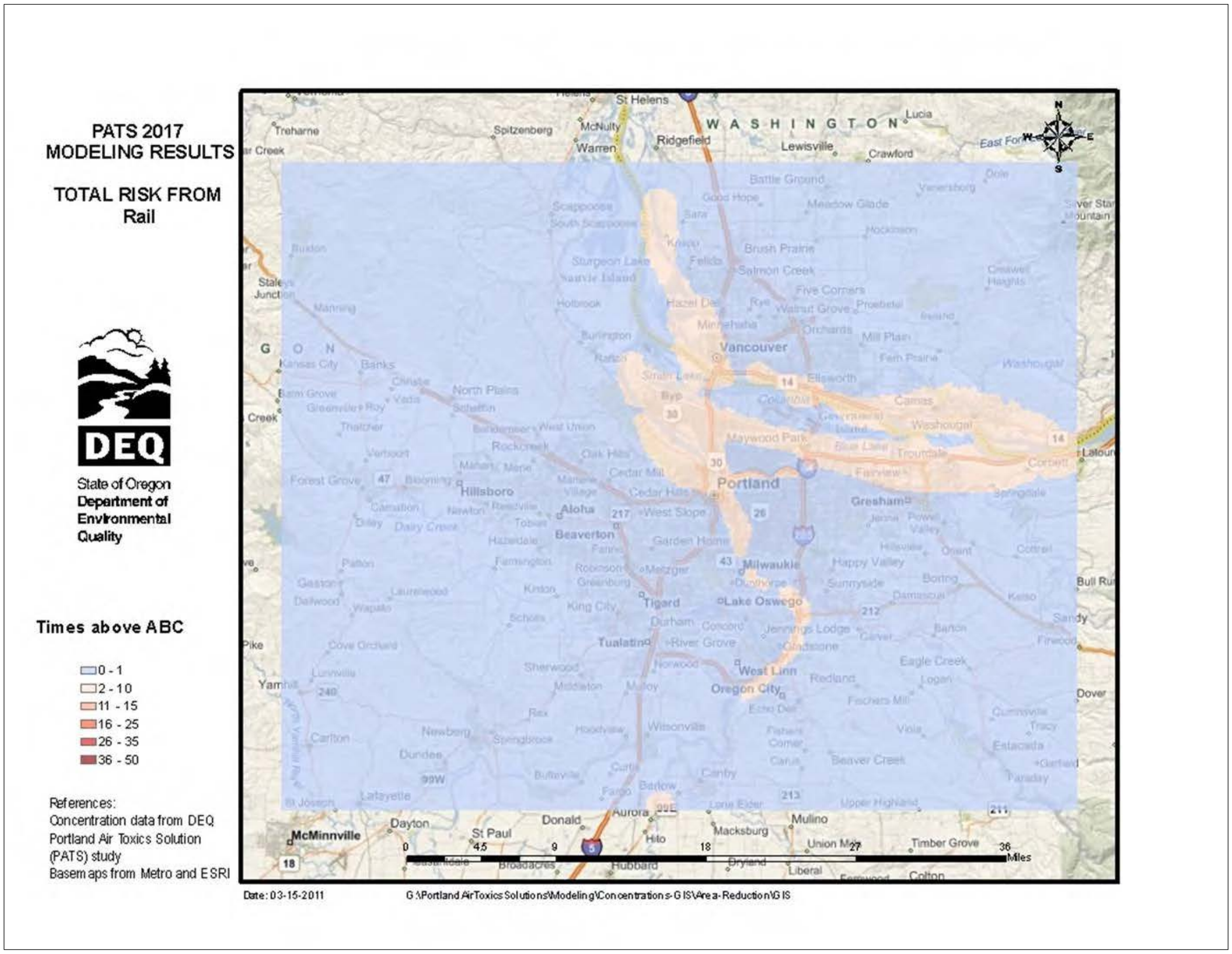


Table 15: Reduction Targets for Pollutants Associated Predominantly with Rail

Rail: analysis of the top 20 % of receptors					Rail Category	
	All Source Categories					
	Average Concentration (ug/m3*)	Benchmark (ug/m3*)	Times above ambient benchmark concentration	Approx. Reduction needed	Projected 2017 Emissions (tons per year)	Potential Reduction Needed (tons per year)
Diesel PM	0.9545	0.1	9.54	**91.8%**	38.8	35.6
PAH-15	0.0152	0.0009	16.89	**95.9%**	0.06	0.06

*ug/m3 = micrograms per cubic meter

6.1.2.3 Marine (Commercial and Recreational)

Figure 95 shows total risk from the marine category. Table 16 shows emission reduction targets for the marine category.

Figure 95: Total Risk from the Marine Category

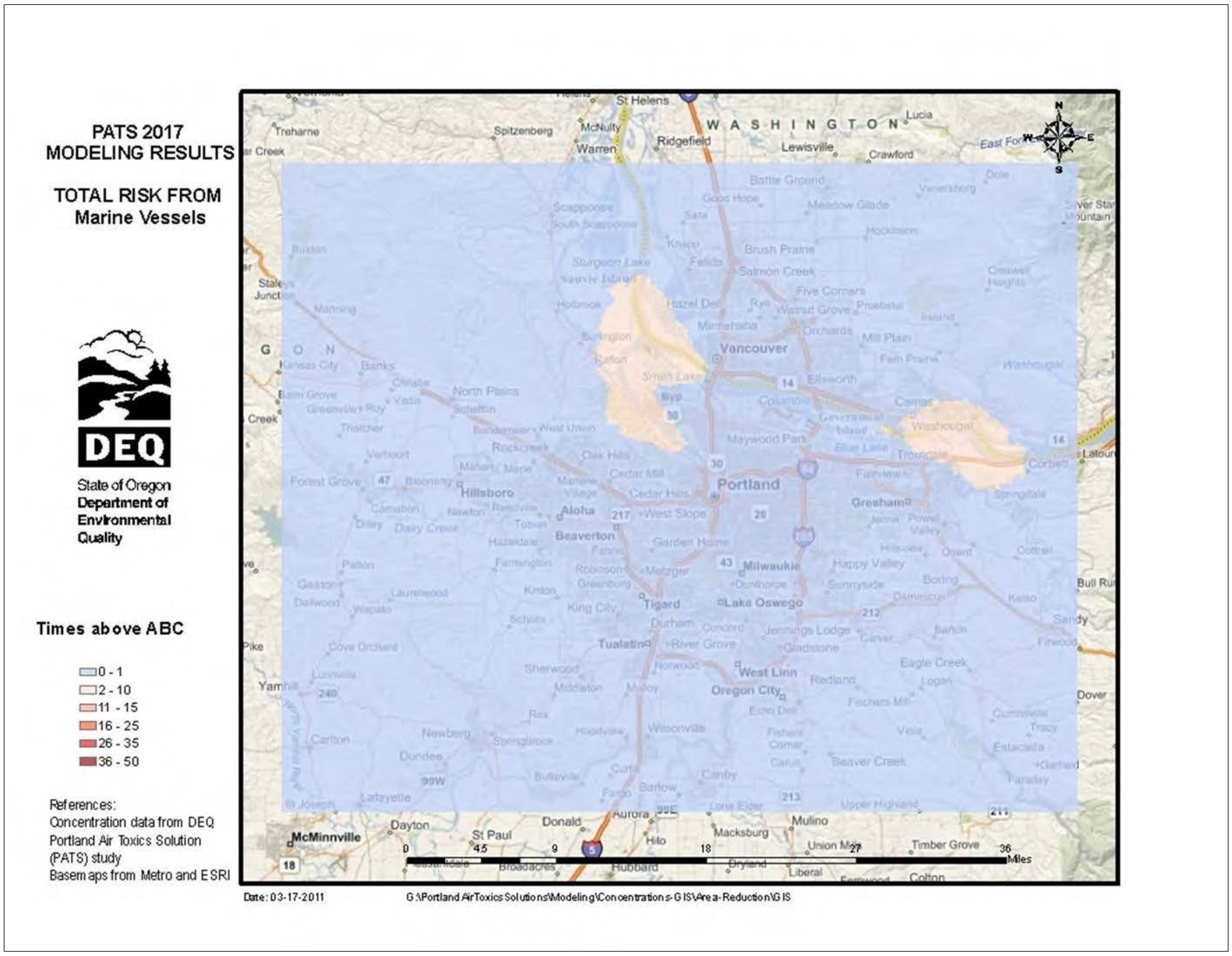


Table 16: Reduction Targets for Pollutants Associated Predominantly with Marine

Commercial & Recreational Marine: analysis of the top 20 % of receptors					**Marine Category**	
	All Source Categories					
	Average Concentration (ug/m3*)	**Benchmark (ug/m3*)**	**Times above ambient benchmark concentration**	**Approx. Reduction needed**	**Projected 2017 Emissions (tons per year)**	**Potential Reduction Needed (tons per year)**
Diesel PM	0.8191	0.1	8.19	**89.5%**	8.0	7.2
PAH-15	0.0126	0.0009	14.04	**94.1%**	0.012	0.012

*ug/m3 = micrograms per cubic meter

6.2 Area Source Emission Reduction Targets

DEQ used the same methodology for area sources (including residential wood combustion and solvent use) as it did for non road mobile sources. For each area source category DEQ identified the highest 20% of receptors. DEQ included concentrations from all emissions (point, area, mobile) for these top 20% receptors to find concentrations, compare them to benchmarks and generate percentage reductions needed for each pollutant by category. The reduction target percentage was then applied to the emissions inventory tonnage to find an estimated reduction target for each pollutant by category. Shown below are the area source categories that contribute more significantly to air toxics concentrations in the PATS area.

6.2.1 Residential Wood Combustion

Figure 96 shows total risk from the residential wood combustion category. Table 17 shows emission reduction targets for the residential wood combustion category.

Figure 96: Total Risk from the Residential Wood Combustion Category

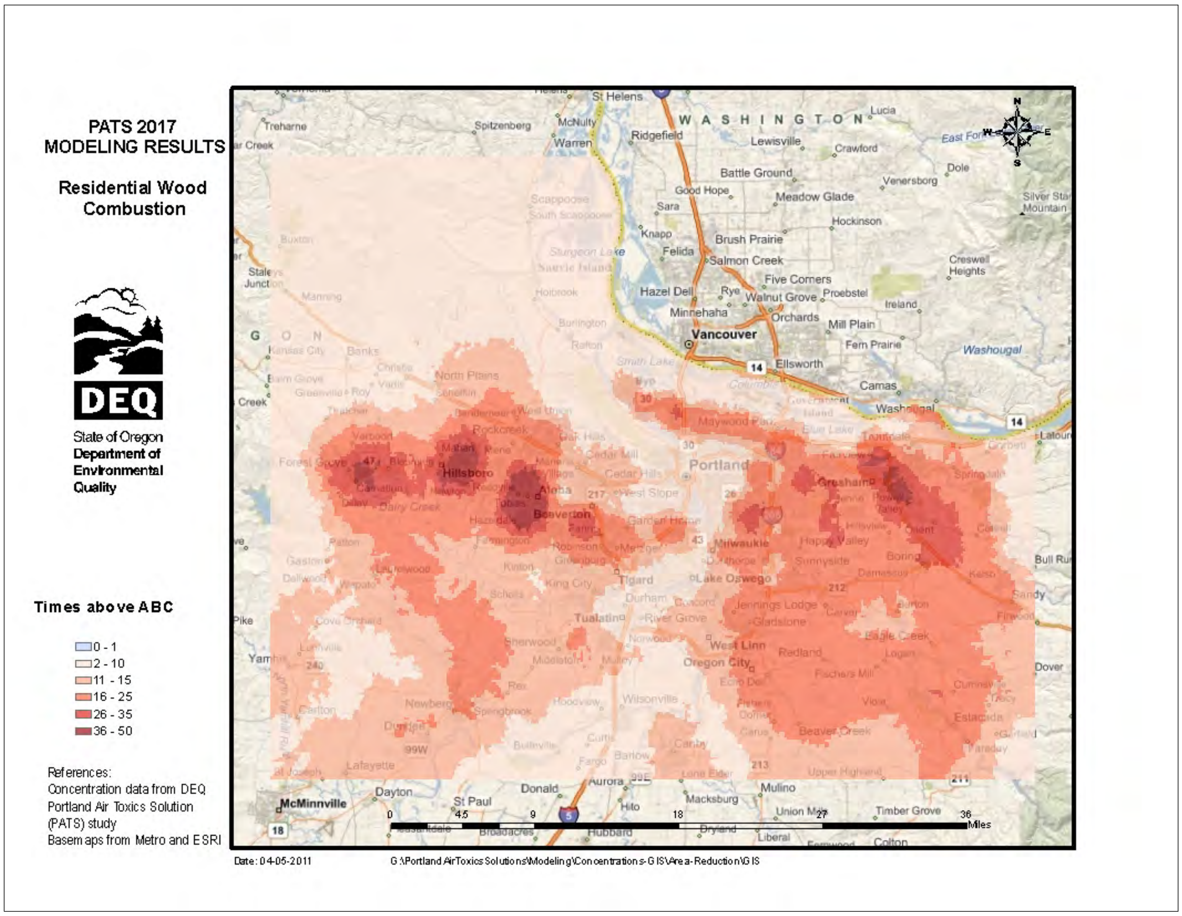


Table 17: Reduction Targets for Pollutants Associated Predominantly with Residential Wood Combustion

Residential Wood Combustion: analysis of the of the top 20% receptors					Residential Wood Combustion Category	
All Source Categories						
	Average Concentration (ug/m3*)	Benchmark (ug/m3*)	Times above ambient benchmark concentration	Approx. Reduction needed	Projected 2017 Emissions (tons per year)	Potential Reduction Needed (tons per year)
1,3 Butadiene	0.2872	0.03	9.57	**89.6%**	23.75	21.3
PAH-15	0.0280	0.0009	31.11	**96.8%**	12.59	12.18

*ug/m3 = micrograms per cubic meter

6.2.2 Lawn and Garden

Figure 97 shows total risk from the lawn and garden category.

Figure 97: Total Risk from the Lawn and Garden Category

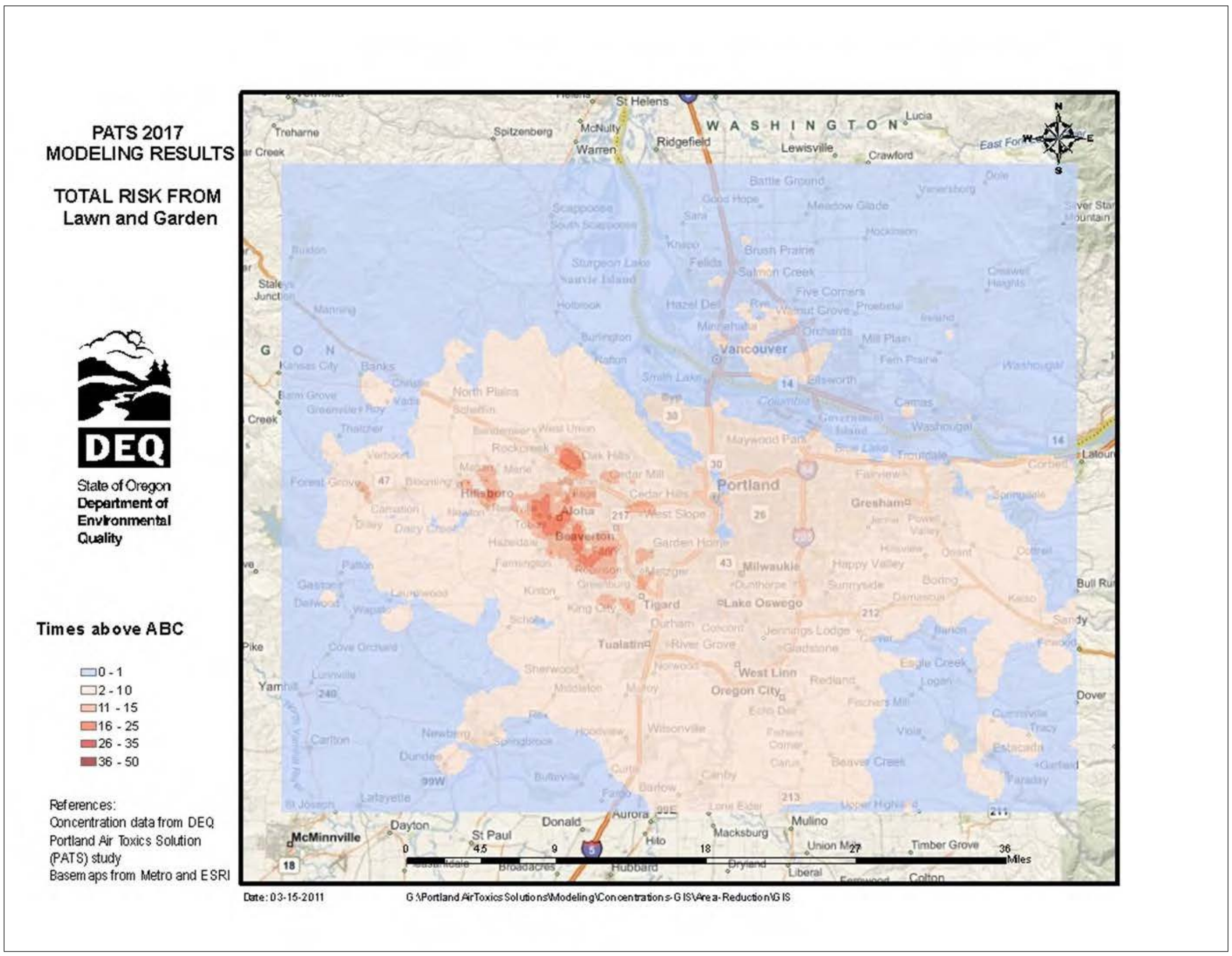


Table 18 below shows emission reduction targets for the lawn and garden category.

Table 18: Reduction Targets for Pollutants Associated Predominantly with Lawn and Garden

Lawn & Garden: analysis of the the top 20% receptors					Lawn and Garden Category	
	All Source Categories					
	Average Concentration (ug/m3*)	Benchmark (ug/m3*)	Times above ambient benchmark concentration	Approx. Reduction needed	Projected 2017 Emissions (tons per year)	Potential Reduction Needed (tons per year)
1,3 Butadiene	0.3163	0.03	10.54	**90.0%**	10.5	9.4
Formaldehyde	0.6940	0.077	9.01	**89.5%**	21.9	19.6
Diesel PM	1.3334	0.1	13.33	**92.3%**	15.1	14.0
PAH-15	0.0241	0.0009	26.81	**96.0%**	0.61	0.58

*ug/m3 = micrograms per cubic meter

6.2.3 Solvent Use

Figure 98 shows total risk from the solvent use category. Table 19 below shows emission reduction targets for the solvent use category.

Figure 98: Total Risk from the Solvent Use Category

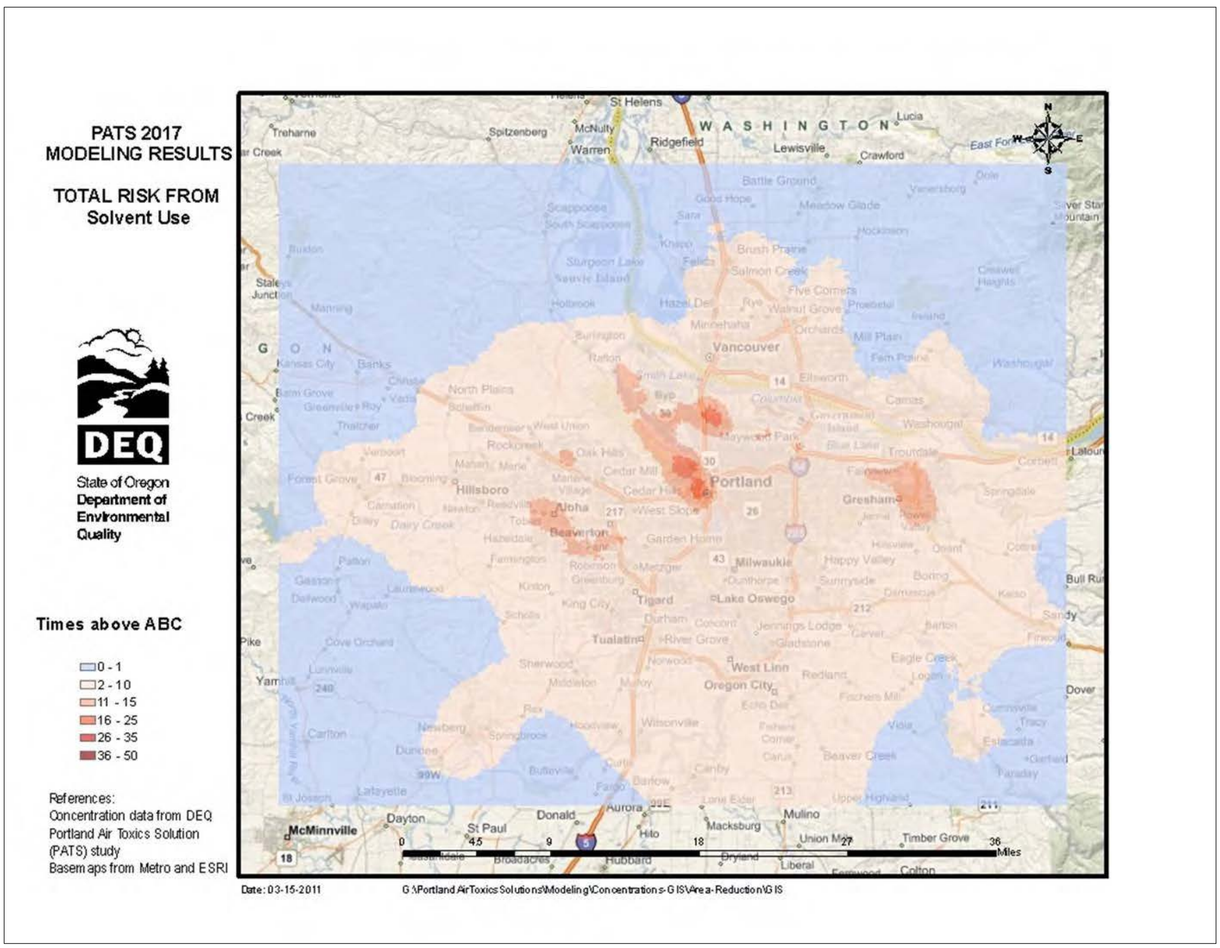


Table 19: Reduction Targets for Pollutants Associated Predominantly with Solvent Use

Solvent Use: analysis of the of the top 20% receptors					Solvent Use Category	
	All Source Categories					
	Average Concentration (ug/m3*)	Benchmark (ug/m3*)	Times above ambient benchmark concentration	Approx. Reduction needed	Projected 2017 Emissions (tons per year)	Potential Reduction Needed (tons per year)
Formaldehyde	0.7655	0.077	9.94	**89.9%**	1.4	1.3
Naphthalene	0.2580	0.03	8.60	**88.4%**	43.3	38.3
Benzene	1.1450	0.13	8.81	**88.6%**	20.4	18.1

*ug/m3 = micrograms per cubic meter

6.3 Point Source Emission Reduction Targets

There are 81 permitted facilities included in the PATS 2017 model. Because point source impacts are generally local in nature, DEQ focused point source reduction target analysis on concentrations at receptors closest to the facilities. To develop the approximate reductions needed for each facility, DEQ analyzed the receptor nearest to the facility with the highest impact from each of the four pollutants predominantly emitted by point sources: cadmium, manganese, nickel and lead. In addition, benzene was analyzed for point sources because it had several projected high concentrations at or near local receptors. This method is consistent with the mobile and area reasonable worst-case analyses that generated protective emission reduction targets. Reducing concentrations at the highest impacted receptors will also reduce impacts on surrounding receptors. No background or secondary concentrations were included in this analysis. The sections below show the approximate reductions needed at the highest impacted receptor for cadmium, manganese, nickel, lead, and benzene. For all point sources, refinements to emission inventories and modeling parameters could provide more accurate estimations of modeled concentrations. More information on point source emission reduction targets can be found in Appendix 12.8.

6.3.1 Cadmium

The map in Figure 99 shows total risk for cadmium from all sources. In the areas more than two times above the benchmark there is a 70% or higher contribution from industry. Table 20 lists the significant source categories that emit cadmium and approximate reduction needed. Model to monitor comparisons for cadmium suggest that there are additional cadmium sources in North Portland that are not included in the model. (See section 3.6) The elevated cadmium levels modeled in the Beaverton area are related to natural gas use.

Figure 99: Total Risk for Cadmium from All Sources (Point, Area, Mobile)

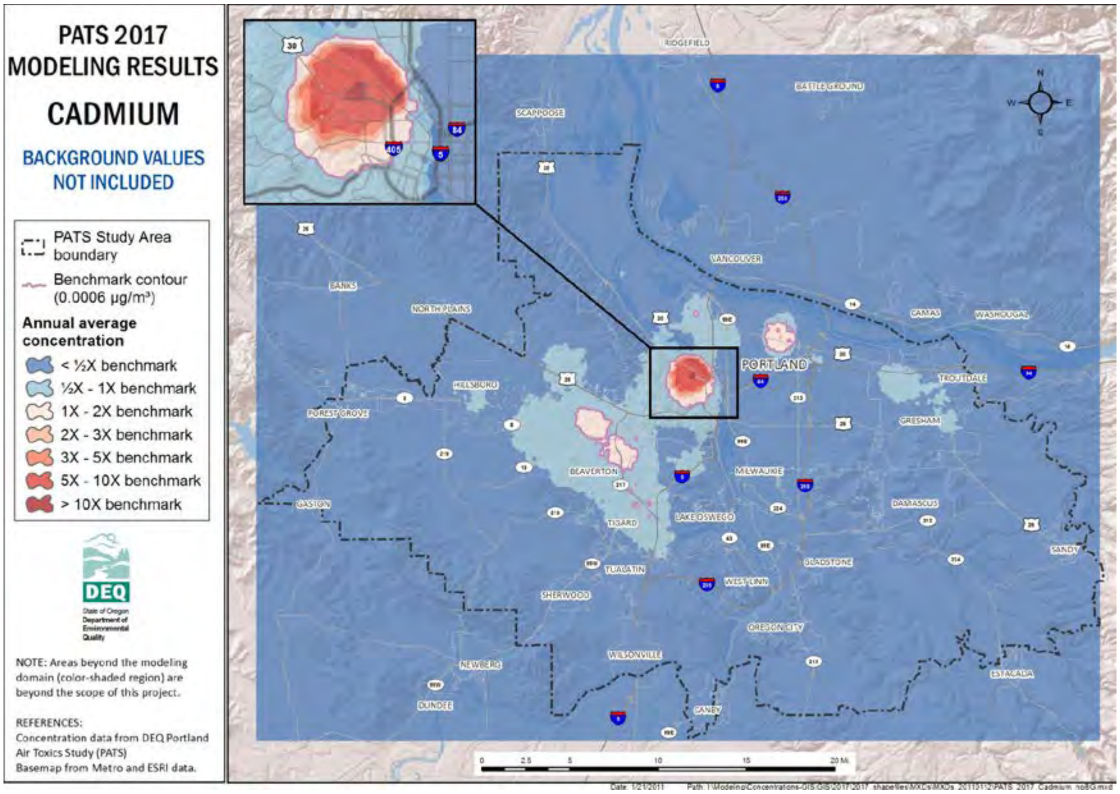


Table 20: Approximate Reduction Needed at Highest Impacted Receptor for Cadmium Point Sources

Source Category Description	Approximate Reduction Needed at Highest Impacted Receptor	Projected 2017 Emissions (lbs)	Potential Reduction (lbs)
Steel Foundries	96%	27	26
Heating Equipment Manufacturing	84%	11	9
Metal Coating, Engraving, and Allied Services to Manufacturers	94%	4	4
Asphalt Shingle and Coating Materials Manufacturing	66%	3	2

6.3.2 Manganese

The map in Figure 100 shows total risk for manganese from all sources. All areas above the benchmark for manganese have 100% of emission contributions from industrial sources. Table 21 lists the significant source categories that emit manganese and approximate reduction needed.

Figure 100: Total Risk for Manganese from All Sources (Point, Area, Mobile)

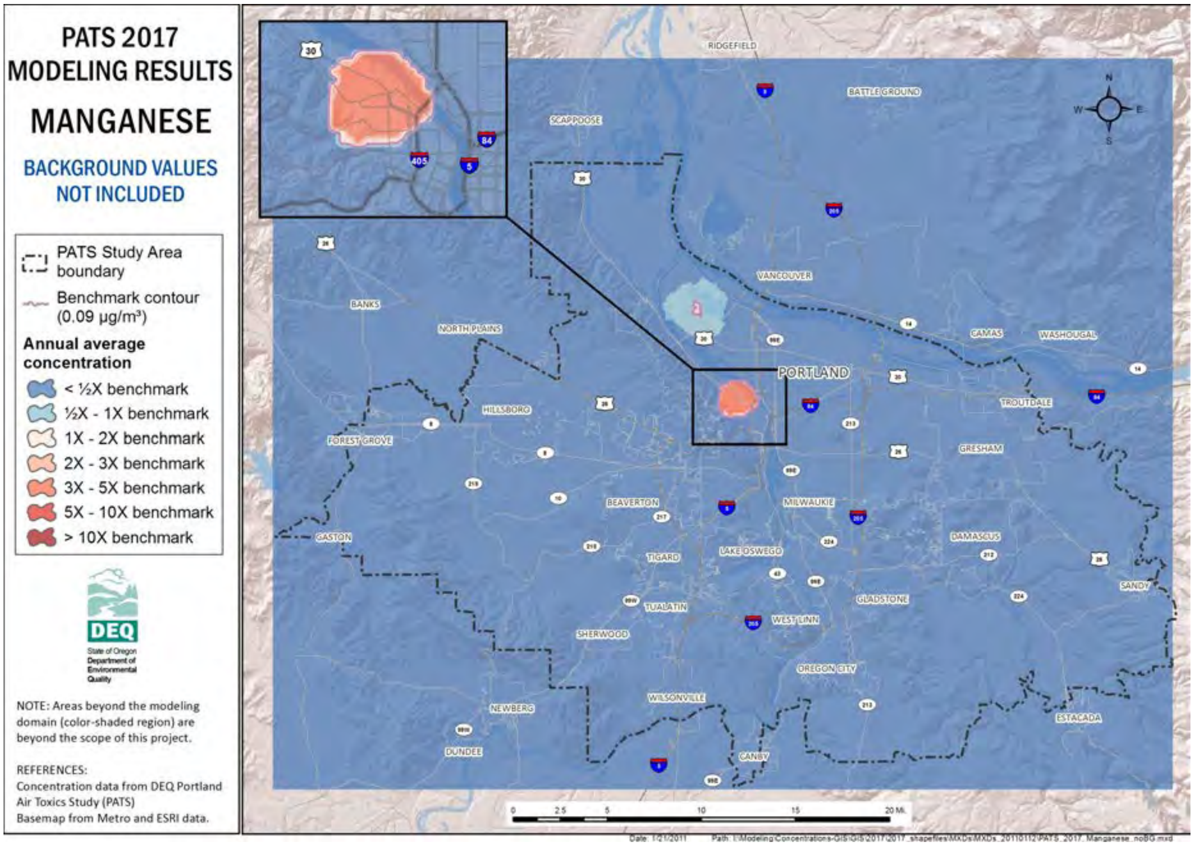


Table 21: Approximate Reduction Needed at Highest Impacted Receptor for Manganese Point Sources

Primary NAICS description	Approximate Reduction Needed at Highest Impacted Receptor	Projected 2017 Emissions (lbs)	Potential Reduction (lbs)
Steel Foundries	39% to 91%	816 to 1,951	743 to 753

6.3.3 Nickel

The map in Figure 101 shows total risk for nickel from all sources. All areas above the benchmark for nickel have 100% of emission contributions from industrial sources. Table 22 lists the significant source categories that emit nickel and approximate reduction needed.

Figure 101: Total Risk for Nickel from All Sources (Point, Area, Mobile)

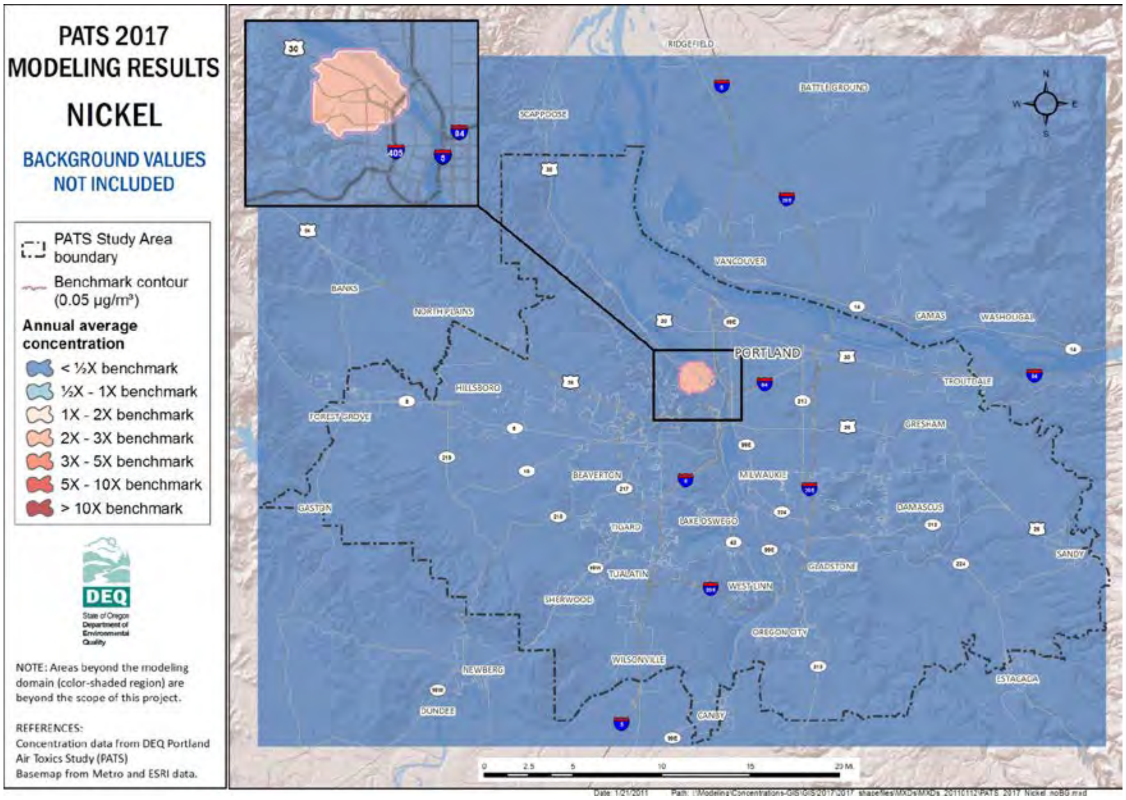


Table 22: Approximate Reduction Needed at Highest Impacted Receptor for Nickel Point Sources

Source Category Description	Approximate Reduction Needed at Highest Impacted Receptor	Projected 2017 Emissions (lbs)	Potential Reduction Needed (lbs)
Steel Foundries	72%	85	62

6.3.4 Lead

The map in Figure 102 shows total risk for lead from all sources. There was only one receptor showing a level above the lead benchmark. Due to the limitations of the mapping graphics, this receptor does not appear on the map. Table 23 lists the significant source category that emits lead and approximate reduction needed.

Figure 102: Total Risk for Lead from All Sources (Point, Area, Mobile)

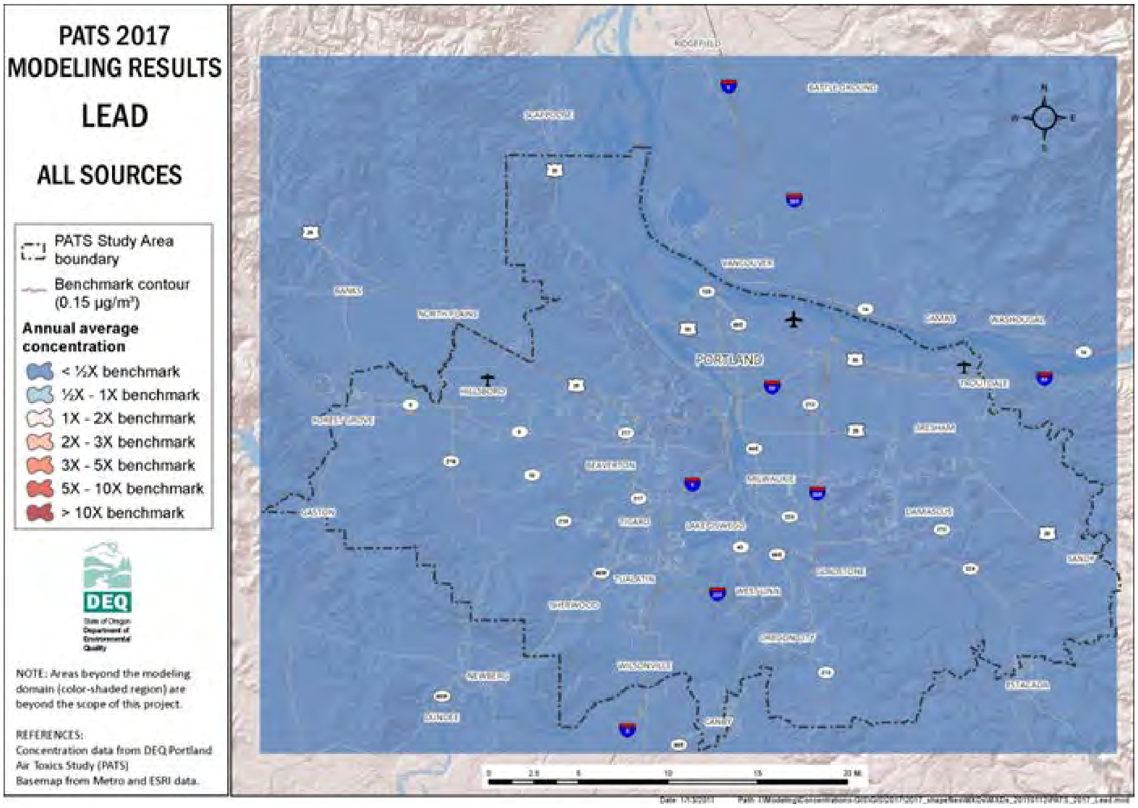


Table 23: Approximate Reduction Needed at Highest Impacted Receptor for Lead Point Sources

Source Category Description	Approximate Reduction Needed at Highest Impacted Receptor	Projected 2017 Emissions (lbs)	Potential Reduction (lbs)
Steel Foundries	49%	167	82

6.3.5 Benzene

The map in Figure 103 shows total risk for benzene from all sources. In the highest impacted areas, between two and 60% of the emission contributions come from industrial sources. Table 24 lists the significant source categories that emit benzene and approximate reduction needed.

Figure 103: Total Risk for Benzene from All Sources (Point, Area, Mobile)

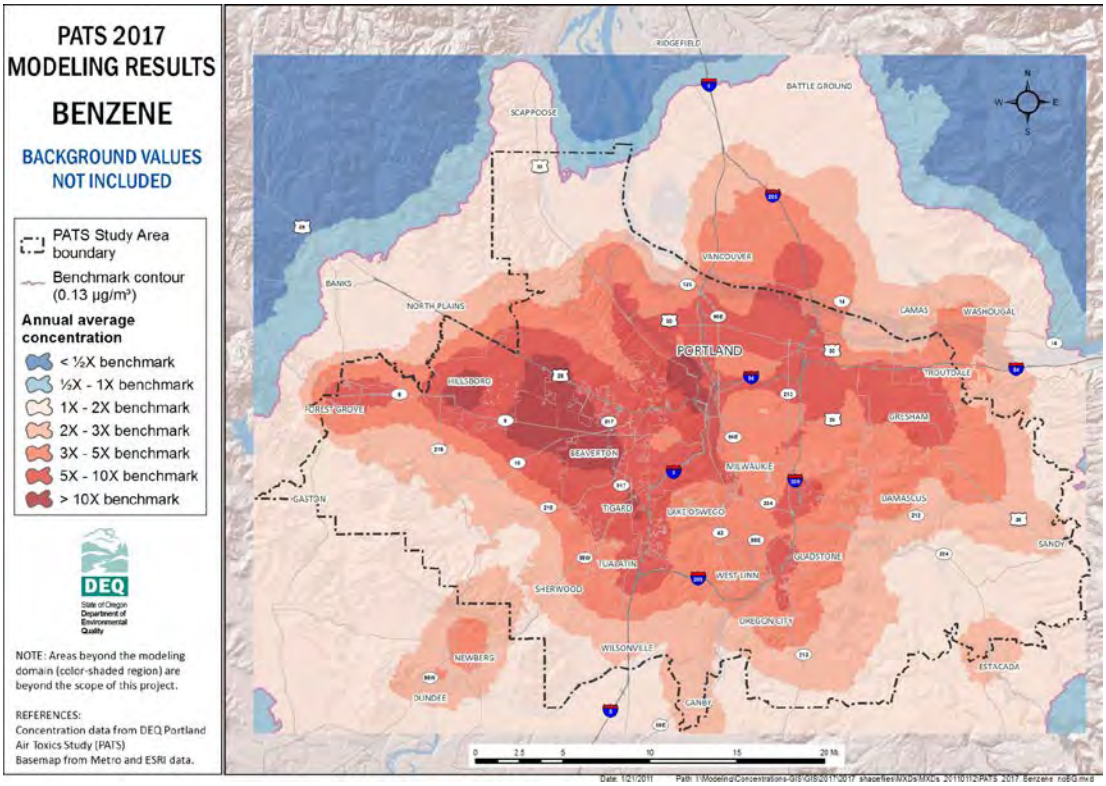


Table 24: Approximate Reduction Needed at Highest Impacted Receptor for Benzene Point Sources

Source Category Description	Approximate Reduction Needed at Highest Impacted Receptor	Projected 2017 Emissions (lbs)	Potential Reduction (lbs)
Steel Foundries	98%	5,269	5,156
Newsprint Mills	61%	7,517	4,559
Petroleum Refineries	93%	1,020	945
Petroleum Bulk Stations and Terminals	82% to 93%	44 to 1,567	35 to 1,309
General Warehousing and Storage	93%	677	627
Asphalt Shingle and Coating Materials Manufacturing	84% to 91%	122 to 505	102 to 457
Other Aircraft Parts and Auxiliary Equipment Manufacturing	85%	208	178
Pulp Mills	69%	221	152
Ship Building and Repairing	78%	143	111
Sawmills	29% to 84%	65 to 160	47 to 54
Pipeline Transportation of Natural Gas	48%	113	54
Heating Equipment (except Warm Air Furnaces) Manufacturing	88%	21	19
Iron and Steel Mills	48%	5	2
Paper (except Newsprint) Mills	69%	3	2
Semiconductor and Related Device Manufacturing	79%	2	2
Hazardous Waste Treatment and Disposal	90%	1	1

7. Assessment of High Priority Source Categories and Overview of White Papers

7.1 Introduction

DEQ and an independent Contractor, Eastern Research Group (ERG), performed PATS emission reduction strategy evaluation in two phases. In phase one, DEQ and ERG evaluated a list of emission source categories and toxic air pollutants provided by DEQ and created a priority list of categories to be evaluated for emission reduction strategies. In addition, DEQ, ERG, and PATSAC worked together to create an initial brainstorm list to identify potential new emission reduction measures. In phase two, in a series of white papers for priority categories, DEQ and ERG performed a comparative evaluation of the emission reduction strategies that are above and beyond existing local, state, and/or federal strategies.

DEQ and PATSAC worked in collaboration to create a clear and concise white paper format that will inform future committees in post-PATSAC efforts. The structure for each of the source category white papers includes, but is not limited to, the following:

- Source Category Description and Modeling Results
- Summary of Existing Emission Reduction Measures
- Summary of Potential New Emission Reduction Measures
- Details for each Potential New Emission Reduction Measure

DEQ and Contractor evaluated each new emission reduction measure in sections three and four of the white papers using the following four PATSAC considerations: magnitude of emission reductions, timeframe to reduce emissions, technical feasibility, and a cost summary. In addition to these four core considerations, PATSAC developed additional comprehensive factors to consider when developing emission reduction strategies (see section 2.3.3). The additional considerations include, but are not limited to, implementation, funding, non-regulatory approaches, effect on exposure, cost effectiveness, health benefits, and risk distribution. In the transition from Phase one to Phase two, there were several source categories that were not prioritized or included for evaluation due to their limited contribution to the projected 2017 emissions inventory, but they may still be considered as a means for additional emission reductions. All white paper strategies are draft and in need of further research, analysis and refinement. DEQ anticipates that the further refinement will occur in future stakeholder committees and related efforts.

The white papers are a collection of potential new emission reduction measures. The white papers provide a comparative analysis for each source category to help inform PATSAC and DEQ recommendations. Section 7.2 presents an overview of the area and mobile emission source categories in order of cumulative risk as determined from the 2017 projected modeling results. Section 7.3 presents an overview of the point source emission source categories in alphabetical order. The full white papers are included in the Strategy Development Appendix 12.9.

7.2 Area and Mobile Emission Source Categories

7.2.1 Residential Wood Combustion and Heating

1) <u>Residential Wood Combustion and Heating Description</u>

In the PATS study area, roughly 2% of housing units are heated by wood. The remaining 98% of the housing in the area is heated by oil, natural gas, electricity, kerosene, liquid or gas propane, solar, or other. Almost half of heating is done using natural gas (47%); 41% is electricity; and other fuels make up 9% or less of the total.

2) <u>Pollutant Risk Driver Summary</u>

Residential wood combustion is the source category that causes the most risk within the PATS study area. Most pollutants emitted by residential wood combustion are risk drivers for the PATS study area as a whole, but the pollutants causing at least 10% of the risk within this category are 15 PAH, 1,3-butadiene and formaldehyde.

Because of the overwhelming contribution of secondary formation to formaldehyde concentrations, the primary residential wood combustion pollutant capable of control is 15 PAH.

Residential wood combustion emits 75% of 15 PAH within the PATS area. **The target reduction for 15 PAH from residential wood combustion is 97%.** Residential heating other than wood also contributes risk in the form of cadmium emissions.

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

For residential wood combustion and heating, potential emission reduction measures include incentives or education to encourage purchase of new more efficient furnaces, heaters, boilers or woodstoves; maintaining and operating the equipment efficiently; weatherization programs to reduce fuel use; education programs to improve user practices; and several different regulations. Potential regulations include regulations to improve wood fuel quality (regulate moisture content); to improve user practices (opacity standard for wood smoke); to ban wood burning devices in new homes and to ban the use of uncertified woodstoves.

5) Matrix

The matrix in Table 25 summarizes information for potential strategies to reduce emissions from wood combustion.

Table 25: Core Evaluation of Residential Wood Combustion Strategies

Potential Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical Feasibility	Cost
#1: Create a stable and ongoing funding source for woodstove replacement	26 to 46% (15 PAH)	3-10 years	Feasible	50 to 150 million
#2: Ban all wood burning devices or wood burning fireplaces in new homes	0.1 to 9% (15 PAH)	1-5 years	Feasible	Cost of regulation
#3: Revive tax credits and other funding assistance for efficient home heating	Unknown	Immediate	Feasible	Depends on scope
#4: Ban uncertified woodstove use (with exceptions for low income or if wood is the primary heat source)	Not yet calculated	1-5 years	Feasible	Cost of regulation
#5: Weatherization incentives	Unknown	1-10 years	Feasible	Depends on scope
#6: Promote existing weatherization programs	Unknown	1-3 years	Feasible	Depends on scope
#7: Implement an education program to improve woodstove user practices	Unknown	1-3 years	Feasible	4,000 to 20,000
#8: Implement opacity standard for wood smoke	Unknown	1-5 years	Feasible	Cost of regulation
#9: Regulate wood fuel moisture content	Unknown	1-5 years	Feasible	Cost of regulation
#10: Research emission reductions from manufactured firelogs	Unknown	1-3 years	Feasible	Not calculated

There is a* ***gap of 51%* *between the target reductions for risk driver pollutants for this source category and the reductions achievable based on strategies where emission reductions have been quantified. Strategies where the emission reductions are unknown could reduce this gap.*

6) <u>Assumptions and Limitations</u>

This source category contributes the most risk within the PATS area, and the risk is area-wide. Several emission reduction measures are feasible and have successfully reduced emissions from residential wood combustion in other areas of the state, or in other states. Woodstove change out incentive programs have been effective in reducing emissions from woodstoves in several areas in Oregon. These programs can require large amounts of funding for woodstove replacements. Research is needed on the potential reductions from regulating moisture content, implementing an opacity standard, or from using manufactured fire logs in place of wood in fireplaces. Achieving emission reductions will require either funding or new regulations. Regulatory authority for DEQ or local government would need to be evaluated for any regulatory strategies.

The data quality for the residential wood combustion source category was rated C (good). The data quality for residential heating other than wood is D (acceptable).

7) PATSAC Member Feedback

- Get better emission factors for Fireplace 15PAH emissions in the future.
- Support weatherization that does not introduce materials that increase indoor air pollution.
- Do not promote fire log use since there are large uncertainties associated with it (precautionary principle). Change strategy to "research emission reductions from manufactured firelogs."
- Add strategy/description for geothermal heat pumps and passive solar space heating.
- For the weatherization strategy focus on low/no VOC construction, clarify strategy, and highlight the large co-benefits from weatherization.
- Check authority of local/state government on bans of fireplaces, etc.
- For the natural gas strategy, subtract cost of natural gas incentives from cost of strategy.
- Update costs summaries for switching to high-efficiency furnaces to capture programs that help pay for the changes.

7.2.2 On Road Gasoline

1) On Road Gasoline Description

Air toxic pollutants in this source category are generated by the use of gasoline in internal combustion engines. They occur throughout the Portland metropolitan region with the highest concentrations occurring in areas of high vehicle traffic. On road gasoline vehicles are subject to regulations that limit the emissions of new cars and trucks. To meet emission requirements automakers developed better engine designs, computerized engine controls and pollution control technology such as catalytic converters. These efforts reduced the emission of traditional pollutants to a fraction of what they were in the second half of the 20th century.

Corporate Average Fuel Economy standards and Oregon's greenhouse gas emission limits both reduce the amount of gasoline consumed by vehicles. They therefore reduce metallic air toxics that may be naturally present in gasoline and that are not reduced by pollution control equipment. These include arsenic, cadmium, chromium VI, manganese, and nickel.

2) Pollutant Risk Driver Summary

Most pollutants emitted by on road gasoline emissions are risk drivers for the PATS study area as a whole, but the pollutants causing at least 5% of the risk within this category are 15 PAH, benzene, 1,3 butadiene, formaldehyde, arsenic and chromium. Because of the overwhelming contribution of secondary formation to formaldehyde concentrations (69%), it is not a risk driver targeted in this category.

On road gasoline emissions are highest within 500 meters of high volume roadways. However, because much of the study area is developed, on road gasoline emissions influence risk in much of the PATS study area. **The target reductions for the on road gasoline source category are as follows: 15 PAH = 95%; benzene = 86%; 1,3 butadiene= 88%; Arsenic = 64%; and Chromium = 25%.**

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

Potential measures to reduce air toxic emissions from on-road gasoline vehicles are selected from policies that either are used in other areas, or are being developed for possible adoption to support other goals. The most noteworthy policy development efforts being considered in the Portland region are conducted by Metro, the Portland area's regional government, and the Oregon Department of Transportation to reduce greenhouse gas emissions. Under House Bill 2001 (2009 legislature) and Senate Bill 1059 (2010 legislature), Metro is beginning a "scenario planning" process targeted at cutting vehicle use per person about 21 percent. The process is beginning in 2011 and is scheduled for completion in 2014. At the same time, the Oregon

Transportation Commission will consider implementing additional “statewide measures” that can be applied throughout Oregon.

The potential policies listed by PATSAC to reduce air toxics coincide well with the “scenario planning” and “statewide measures.” Most policies being seriously considered by Metro and ODOT are those identified in a landmark report titled “Moving Cooler” released by the consulting firm of Cambridge Systematics in 2009. Substantial resources have been committed to investigate the feasibility and effectiveness of these measures. For example, ODOT created a sophisticated computer model dubbed GreenSTEP to estimate how different policies work in various combinations. ODOT is also working with Cambridge Systematics to develop a “tool kit” database that metropolitan areas can use to evaluate different strategies. The tool kit database is due to be released to the public in 2011, but a preliminary printout of its contents is included with the full on road gasoline white paper as Attachment A. Due to the availability of these resources and the strong possibility some will be adopted to reduce greenhouse gases, PATSAC’s strategies are organized in the format used by the larger ODOT/Metro undertaking.

5) Matrix

The matrix in Table 26 summarizes information for potential strategies to reduce emissions from on road gasoline engines.

Table 26: Core Evaluation of On Road Gasoline Strategies

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Cost
#1: Cleaner Vehicles			
#1a: Advanced Emission Standards: California Low Emission Vehicle III, or EPA Tier III Emission Limits (Greenhouse Gases and VOCs)	For new vehicles: VOCs=75% Metal Air Toxics=27% to 54%	2017 to 2025	Net Savings
#1b: Accelerated Fleet Turnover	0.8 to 1.8%	Long term	Variable
#1c: Fleet Vehicle Purchase Criteria	Low	Multi-year phase in	Low
#1d: Vehicle Scrappage Program	Undetermined	Near Term	High
#1e: Electric Vehicle Conversion	100% per vehicle	Near term	Approx. $10,000 per vehicle
#1f: Compressed Natural Gas Vehicle Conversion	VOCs: 75% per vehicle	Near term	$5,000 to $10,000 per vehicle
#1g: More Frequent Vehicle Inspections	VOCs 1%	1-2 Years	High
#2: Cleaner Fuels			
#2a: Reformulated Gasoline	Pending	Near Term	~$0.05 per gallon
#2b: Tier III/Lower Sulfur Gas	Necessary to achieve Advanced Emission Standards	2017 to 2025?	Low
#2c: Low Carbon Fuel Standard	Modest	10 yr. phase in	Net savings

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Cost
#2d: Increased Use of E 85 in Flex Fuel Vehicles[1]	~75% benzene reduction per vehicle	Mid term	Variable
#3: Vehicle Miles Travelled Reduction			
#3a: Metro's "Climate Smart Communities" Strategies	Reduce Vehicle Miles Travelled per capita up to 24% by 2035	2014 to 2035	Probable net saving
• Congestion Pricing (Toll)	0.8 to 1.8%	Near term	Net savings
• Parking Fees	0.8 to 1.8%	Near term	Net saving
• Transit Service Increase	Up to 1.1% Reduction	Variable	Cost exceeds savings
• Stronger Employee Commute Options Rules	<1.7%	Near term	
• Eco Driving Training	0.8% to 2.3%	Mid term	Net savings
• Personalized Total Demand Management Marketing			
• Anti-Idling	Likely Air Toxics Reduction (no data)	Immediate	Net savings
• Bike Improvements	0.09 – 0.28%	Long term	Variable
• Pedestrian Improvements	0.10 – 0.31%	Long term	Variable
• Operations/Transportation Management	0.1 to 0.6%	Multi year	Variable
#3b: OTC "Statewide Strategies"	High	2014 to 2035	Probable net saving
• 55 MPH Speed Limit	1.2 to 2.0%	Near term	Net savings
• Pay As You Drive (PAYD) Insurance for All	7% to 12%	Near term	Net savings
• Vehicle Miles Travelled Fee: 2 to 5 cents/mi.	0.8% to 2.3%	Near term	Net savings
• Gas Tax (Increased): \$0.60 by 2015, \$1.25 by 2050	Up to 17% in 2050	Quick initial effects	\$0.60 to \$1.25/gal.
• Gas Tax (European Level): \$2.40 by	Up to 28% in 2050	Quick effects	\$2.40 to \$5.00/gal.

[1] Flex fuel vehicles can use gasoline, a blend of 15% gasoline and 85% ethanol, or a mix of the two.

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Cost
2015, $5.00 by 2050			
• Bottleneck Relief	0.05% to 0.21% in limited applications	Multi Year	Variable
• Compact mixed-use development	0.2% to 3.9%	Long term	Net savings

** There is **an unknown gap** between the target reductions for risk driver pollutants for this source category and the reductions achievable that is difficult to quantify for this source category.*

6) Assumptions and Limitations
All strategies are technically feasible. Emission reductions indicated are approximate values that can be produced by the different strategies.

The data quality for risk driver pollutants from the on road gasoline source category is B (Very Good) for high volume roads and C (Good) for low-volume roads.

7) PATSAC Member Feedback

- Recent developments were not included in the Metro 2017 projection so the emissions situation may be better than DEQ projects.
- Consideration of strategies should capture biofuel disadvantages (indirect) and hybrids (mining impacts).
- Additional measures could include restricting drivers, i.e. raise driving age (look at European licensure age and its impact on vehicle miles travelled).
- Consider further review of the policy to allow Oregon Trails Card holders to use TriMet free or at a discount.
- Link the Federal Highway Administration table/study to the on road gasoline white paper.
- Evaluate the impact of studded tire use. Identify the impact to road repairs and congestion.
- Consider whether DEQ should have greater authority with respect to on road measures and rulemaking.
- Empower DEQ's voice to support agency involvement with how air pollution affects communities.
- Include local or state (depending on scope of project) public health officials in transportation and land use planning committees and commissions.

7.2.3 Non road Diesel

1) Non road Diesel Description
According to *OregonLaws.org*, the legal definition of non road Oregon diesel engines means "any Oregon diesel engine that was not designed primarily to propel a motor vehicle on public highways of this state." Non road diesel engines encompass a wide variety of equipment types and uses. Non road diesel engines can be found in construction, commercial, industrial, agricultural, logging, lawn and garden, and recreational equipment. Non road diesel engines are also found in locomotives and marine vessels. Given the variety of applications non road diesel engines are used in, they are widely dispersed across all areas of the state.

2) Pollutant Risk Driver Summary
Most pollutants emitted by non road diesel are risk drivers for the PATS study area as a whole, but the pollutants causing at least 10% of the risk within this category are diesel particulate matter (PM) and 15 PAH. **The target reduction for diesel PM from the non road diesel source category is 92%.**

3) List of Existing Emission Reduction Strategies
For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures
Potential strategies include increasing fleet turnover rates, use of alternative fuels, employing various retrofits, routine maintenance, and idle reduction strategies.

5) Matrix
The matrix in Table 27 summarizes information for potential strategies to reduce emissions from non road diesel engines.

Table 27: Core Evaluation of Non Road Diesel Strategies

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility[a]	Cost
#1: Accelerated retirement	Variable [b]	Immediate	High	Hundreds to tens of thousands[c]
#2: New vehicle purchase assistance	Variable [b]	Immediate	High	Hundreds to tens of thousands[c]
#3: Scrappage/takeback programs	Variable [b]	Immediate	High	Hundreds to tens of thousands[c]
#4: PM retrofits	25-90% (diesel PM)	Immediate	High[c]	Thousands to mid ten thousands per retrofit[c]
#5: SCR retrofits - SCR	50% (diesel PM)	Medium-Long term	High[c]	Low ten thousands per retrofit[c]
#6: Hybridization	Unknown	Med-Long	Low-Med	Unknown
#7: Biodiesel	16% (diesel PM)	Immediate	High	Low-medium (depends on fuel use)
#8: Electrification	100% (diesel PM)	Variable[c]	Variable[c]	Incremental cost – hundreds to low thousands for available equip types
#9: Conversion to CNG/LPG	85% (diesel PM)	Variable[c]	Variable[c]	Low ten thousands per conversion
#10: Engine repowering	Variable [b]	Immediate	High (large engines)	Hundreds to tens of thousands[c]
#11: Inspection & maintenance program	Some anticipated reductions	Med-term	Low	Millions of dollars
#12: Auxiliary power units	50% (diesel PM)	Immediate	High	$8,000
#13: Idle reduction measures	Variable [b]	Immediate	High	Variable – depends on program
#14: Fuel on-board heaters	13.6% (diesel PM)	Immediate	High	$1,000

** If Strategy #8 were implemented for every nonroad engine in the PATS area, there would be no gap between the target reductions for risk driver pollutants for this source category and the reductions achievable.*

[a]Not all strategies will be appropriate for all equipment types. This will largely be determined by use profiles, size of equipment, and configurational constraints.

[b] Reduction % dependent on equipment in question, annual use, and horsepower

[c] This is highly dependent upon the equipment type, size, and use profile.

6) Assumptions and Limitations

Nonroad diesel emissions are related to construction activity, which can occur in any part of the PATS study area. In the PATS model, construction activity was attributed to land use in the residential, commercial/institutional and industrial categories. This resulted in higher concentrations in the Western portion of the study area, providing an example of elevated concentrations that could be reasonably anticipated in various locations as future development and construction occur.

The reductions and cost described in the Matrix above for all strategies except #11 and 13 are per vehicle. It is unlikely that all vehicles in the PATS area could be addressed by a single strategy. There are many proven technologies available. Implementation of the strategies can include voluntary, incentive and mandatory approaches. Each of these approaches has differing strengths and weaknesses, e.g., availability of public financial assistance, costs for compliance and flexibility for the diesel owner, assurance that air quality targets are met and over what timeframe and staffing needs for implementation. All strategies are scalable and the extent of the reduction will depend upon the penetration of the strategy within the target sector, which will in turn depend upon the level of vigor and commitment behind the chosen implementation method displayed by the implementing agency, interested community groups and affected stakeholders.

The data quality for risk driver pollutants from the nonroad diesel source category is D (Acceptable).

7) PATSAC Member Feedback

- Include diesel as a significant (not part of aggregate insignificant) activity covered by air permits so that emissions are tracked and can be addressed.
- Government contracts should require clean engines and fuels.
- Review how the emissions are split for ultra-low sulfur vs. conventional diesel.
- Review how the bio-diesel mandate applies to nonroad diesel applications.
- Further review of the feasibility of PM retrofits.
- Clarify costs in table 8 regarding ‘hundreds to tens of thousands, depending on equipment type.
- Biodiesel – impacts to engine warranties, restrictions on percentage of biodiesel needs to be addressed.
- It would be helpful to have a breakdown of emissions inventory by medium/heavy duty.
- Review Selective Catalytic Reduction cost estimates, particularly with respect to return on investment (reference TriMet).
- Need to address variable costs in addition to capital costs.
- Review how congestion relief for truck traffic may be alleviated through marine corridors.
- Point sources may have the ability to incentivize how construction equipment/practices are performed and utilized. There may be an avenue to institute emissions limits through contract specifications.
- Promote the use of new technologies in industry.
- There is a need to overcome the challenges of financial incentives towards retrofits. Identified challenges: magnitude of incentive to affect change, improved relations/trust building from industry, reduced paperwork. Ultimately, design issues must be addressed to remove the barriers/challenges for success.
- Grants to retrofit garbage/recycling trucks could be recouped through rate increases.

7.2.4 On Road Diesel

1) On Road Diesel Description

This source category includes medium and heavy duty trucks, including trucks that make deliveries within the Portland metro area and trucks that are used mainly in interstate freight movement.

2) Pollutant Risk Driver Summary

Most pollutants emitted by on road diesel are risk drivers for the PATS study area as a whole, but the pollutants causing at least 5% of the risk within this category are diesel particulate matter, 15 PAH, benzene, 1,3 butadiene, arsenic and chromium. Because of the overwhelming contribution of secondary formation to formaldehyde concentrations (69%), it is not a risk driver targeted in this category. **The target reduction for diesel PM from the on-road diesel source category is 91%.**

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

Strategies include speeding turnover of fleet to cleaner, new diesel engines, increasing the fleet mix of alternate fuel engines and use of alternate fuels (CNG, biodiesel, propane, and electricity), retrofitting or repowering existing engines, maintaining engines, reducing idling, and improving efficiency.

5) Matrix

The matrix in Table 28 summarizes information for potential strategies to reduce emissions from on road diesel engines.

Table 28: Core Evaluation of On Road Diesel Strategies

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost[a]
#1: Speed turnover of fleet to cleaner engines	80% (Diesel PM)	Voluntary: Upon funding Mandated: Up to 17 years	Feasible	$5,000 - $131,000 per vehicle
#2: Increase fleet mix of alternate fuel engines	Compared to pre 2007 - 15-90% (Diesel PM)	Voluntary: Upon funding Mandated: Up to 17 years	Feasible	CNG: $30,000 - 80,000 per vehicle + fueling infrastructure B20: additional $0.25 per gal
#3: Retrofit: exhaust aftertreatment	90% (Diesel PM)	Voluntary: Upon funding Mandated: Up to 17 years	Feasible	$9,000 - 15,000 per truck;
#4: Repower existing engines	25% - 50% (Diesel PM)	Voluntary: Upon funding Mandated: Up to 10 years	Feasible	$30,000- 50,000 per truck
#5: Maintain Engines	Unknown	Voluntary: Upon funding Mandated: Up to 9 years	Feasible	Dependent on engine and frequency of inspection; costs

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost[a]
				could be offset by fuel consumption improvements
#6: Reduce Idling	Truck stop electrification: 100% of local emissions (diesel PM); Long duration idling, 8-10 hours a day may constitute up to 8% of all PM emissions on a daily basis.	Voluntary: Upon funding Mandated: Up to 11 years	Feasible	Truck stop electrification up to $10,000 per space Auxiliary Power Unit $8,500; Diesel fired heater, $1,600; Engine start/stop $3,800
#7: Improve Efficiency	Fuel efficiency improvements up to 40% with corresponding reductions in emissions	Voluntary: Upon funding Mandated: Up to 9 years	Feasible	Dependent on tactic, some with return on investment less than 12 months

** If Strategy #2 or 3 were implemented for every on-road engine in the PATS area, there would be a **1% gap** between the target reductions for risk driver pollutants for this source category and the reductions achievable. It is unlikely every vehicle could be affected, even by a mandatory strategy.*

6) <u>Assumptions and Limitations</u>

The risk from this source category is area wide, with higher risk along roadways with more diesel traffic. Understanding that many proven technologies are available, the method of implementation is a more critical factor in achieving air quality goals. That implementation method can include, either singly or in combination, voluntary, incentive and mandatory approaches. Each of these approaches has differing strengths and weaknesses that merit consideration in how the strategy is implemented, e.g., availability of public financial assistance, costs for compliance and flexibility for the diesel vehicle owner, assurance that air quality targets are met and over what timeframe and staffing needs for implementation, to name a few. Strategy selection should also take in to consideration that the Portland area is both a transportation and economic center for Oregon and SW Washington and that many diesel engines that travel into the region do not reside here. This can present challenges for jurisdiction and authority in designing either voluntary or regulatory strategies for these vehicles. All of these strategies are scalable and the extent of the reduction will depend upon the penetration of the strategy within the target sector, which will in turn depend upon the level of vigor and commitment behind the chosen implementation method displayed by the implementing agency, interested community groups and affected stakeholders.

The data quality for risk driver pollutants from the on-road diesel source category is B (Very Good) for high-volume roads and C (Good) for low-volume roads.

7) <u>PATSAC Member Feedback</u>

- Calculate toxicity-weighted health benefits.
- DEQ should follow up on the projected level of trucks in 2017 that have EPA approved 2007 or newer engines.
- The white paper needs to include DEQ's Low Carbon Fuel Standard and biodiesel mandate, as well as the proposed idling regulation. DEQ needs to ensure that their impacts are accounted for in the modeling.

- Improve consistency in the on road diesel White Paper. Particularly in Table 6 which indicates reductions compared with EPA estimates for 2007 or newer engines.
- Evaluate strategies based on a “least cost” approach.
- When developing priorities, all strategies should be included rather than segregating strategies based on fuel type or source.
- Include other measures: intelligent transportation systems such as signalization/scheduling for trucks, House Bill 2081 (idling), remove barriers to retrofits and new unit purchases, incent marine freight to take burden off highways and reduce congestion.
- Provide models where incentives have had success to understand effectiveness.
- How does electrification, and the shift of emissions to power plants compare to the emissions attributed to the current scenario?
- Review how non-technical measures (i.e. scheduling) might have mitigation impacts. One opportunity may be to improve signalization.

7.2.5 Nonroad Gasoline

1) Nonroad Gasoline description

Nonroad gasoline engines refer to 2-stroke and 4-stroke spark-ignition (SI) engines, as opposed to 2-stroke and 4-stroke diesel engines that are labeled as diesel in this report. These engines are regulated as large (>25 hp, 19 kW) or smaller types. The larger engines are primarily used in forklifts, but are also found in a variety of industrial and commercial applications. The smaller engines are found primarily in lawn and garden equipment, but are also found used in small generators, pumps (including pressure washers) and other portable equipment. In smaller engines, 2-stroke engines designs are often used when lower engine weight for the power is desired such as for handheld equipment including chainsaws, blowers, and trimmers. The SI engines typically use gasoline fuel; however, liquid petroleum gas (LPG) and compressed natural gas (CNG) are also used.

2) Pollutant risk driver summary

Most pollutants emitted by nonroad gasoline emissions are risk drivers for the PATS study area as a whole, but the pollutants causing at least 10% of the risk within this category are 15 PAH, benzene, 1,3 butadiene, and formaldehyde. Because of the overwhelming contribution of secondary formation to formaldehyde concentrations (69%), it is not a risk driver targeted in this category. **The target reductions for the nonroad gasoline source category are as follows: 15 PAH = 96%; benzene = 86%; and 1,3 butadiene= 90%.**

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

The spark-ignition (SI) nonroad engines are used in a wide array of commercial and personal equipment using small handheld, portable, or large self-propelled equipment. The three strategies reviewed account for the different approaches that could be used relative to the different equipment types and usage and include the California fleet average accelerated scrappage/retirement program, either new or replacement electric equipment use, and idle reduction measures.

5) Matrix

The matrix in Table 29 summarizes information for potential strategies to reduce emissions from non road gasoline engines.

Table 29: Core Evaluation of Non Road Gasoline Strategies

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: California/ Scrappage Controls	19% (15 PAH) 21% (Benzene) 24% (1,3 butadiene)	5-10 years	Feasible	$10,000 - $20,000 for larger equipment additional cost over replacement value of current equipment.
#2: Electrification Program	75% (15 PAH) 75% (Benzene) 75% (1,3 butadiene)	5-20 years	Feasibility depends upon the equipment type	$10,000 - $20,000 for larger industrial equipment (e.g. >25 hp forklifts) and as low as $20 for low power personal equipment (e.g. >1 hp trimmers) incremental to gasoline powered equipment.
#3: Idling reduction	5% (15 PAH) 5% (Benzene) 5% (1,3 butadiene)	1-5 years	Education programs and targeted automatic idle shut down devices.	Automatic systems for larger industrial equipment would have a cost.
#4: Reduced Use				

* *There is a **gap of 11% to 21%** between the target reductions for risk driver pollutants for this source category and the reductions achievable if Strategy #2 were applied to every nonroad gasoline engine in the PATS area.*

6) Assumptions and Limitations

Because of the wide variety of equipment types using these SI engines, it may be best to consider the equipment and its use to determine the most effective emission reduction strategies. To date, California has only considered large equipment types for forced mandatory replacement because the owner/operators are largely industrial. Smaller equipment may be owned by households or small businesses, and smaller equipment may be more easily replaced by electric equipment types. Finally, in the event that equipment cannot be scrapped or replaced with electric types, idle reduction may be the only emission reduction method available.
Strategy #4, which was suggested at the 4/14/2011 PATSAC meeting, has not yet been evaluated.
The data quality for risk driver pollutants from the nonroad gasoline source category is D (Acceptable).

7) PATSAC Member Feedback

- Review the other measures from the initial brainstorm list and consider how are these measures are integrated in the white papers
- Consider the utilization of non-powered alternatives (push mowers, rakes, etc.)
- There is a need to characterize the benefits/limitations of the use of propane as an alternative fuel
- How does the committee address formaldehyde reductions? What focus/recommendation should this committee have given the magnitude of secondary emissions?

7.2.6 Solvent/Coating Use-Paint Strippers & Architectural

1) Solvent/Coating Use – Paint Strippers and Architectural Description

Coatings include adhesives, paint, sealant, finishers, and other products that are applied to a surface. The pollutants in this source category are from commercial and industrial applications, as opposed to the solvents contained in consumer products. Solvents are typically used to remove paint or other coatings from metal, wood, and other surfaces. In most cases, the emissions are not released from a stack but are released as the product is used and are locally dispersed. In the case of furniture strippers, often a "dip tank" will be used, where the solvent is literally in a tank large enough to dip furniture.

2) Pollutant Risk Driver Summary
Most pollutants emitted by solvent use are risk drivers for the PATS study area as a whole, but the pollutant causing at least 10% of the risk within this category is naphthalene. **The target reduction for naphthalene from solvent/coating use is 88%.**

3) List of Existing Emission Reduction Strategies
For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures
Emission reductions could come from consumer education, improved work practices, or product specifications through regulation. Because of the nature of solvent and coating use, add-on controls are unlikely except in the case of large scale stripping operations. Substituting lower emitting components is a possible emission reduction strategy. DEQ's Ecological Business Solutions program, or EcoBiz could, be augmented by adding a business category for solvent/coating operations. Another potential reduction strategy is to adopt California rules, which contain VOC limits and product labeling laws.

5) Matrix
The matrix in Table 30 Core Evaluation of Solvent and Coating Strategies summarizes information for potential strategies to reduce emissions from solvents and coatings.

Table 30: Core Evaluation of Solvent and Coating Strategies

Potential Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Implement an education and outreach program	Unknown (naphthalene)	1-10 years	Feasible	Cost to agency to develop; results mean improved health/reduced health care costs
#2: EcoBiz Certification	Unknown (naphthalene)	1-10 years	Feasible	Companies who participate in the EcoBiz program receive free "advertising". Cost to agency to develop category.
#3: Research & develop alternative lower emitting components	Unknown (naphthalene)	1-10 years	Needs research	Unknown—cost of R&D; production costs could be less
#4: Adopt California Rules	Unknown (naphthalene)	1-3 years	Feasible	Cost of rulemaking
#5: Expand Oregon Health Authority capacity to regulate consumer products	Unknown (naphthalene)	2-4 years	Feasible	Cost of rulemaking and implementation of new authority

** There is potentially a **100% gap** between the target reductions for risk driver pollutant (naphthalene) for this source category.*

6) Assumptions and Limitations

The geographic distribution of consumer product emissions and exposures is widespread in the PATS study area, with higher estimated concentrations in residential and commercial areas. Some strategies have worked in other areas to reduce air toxics, such as the California VOC limits and labeling laws. These strategies are technically feasible. Further research would be required to implement strategy #4. For strategies 4 and 5, political support would be necessary for the Oregon legislature to make changes to law.

The data quality for risk driver pollutants from the Solvent/Coating Use – Paint Strippers and Architectural source category is C (Good).

7) <u>PATSAC Member Feedback</u>

- Add a strategy for (or include in Strategy #5): Consumer product labeling (California rules). Require labels, and use other methods, to provide information about toxic components in consumer products (right to know approach).
- Onus to protect the public from harmful ingredients should be on the product manufacturer/seller not the public.
- Review lessons learned from architectural spray coating effort in the 90s, resulting in no effect.
- Determine impact of furniture strippers on environmental justice communities.
- Support legislation that would give the Oregon Health Authority the authority to remove products from the market that cause chronic (as well as acute) hazards to public health.
- Expanding Oregon's statutory definition of "hazardous substance" would expand the ability of Oregon Health Authority (OHA) to require labeling, recall products, and otherwise regulate solvents classified as consumer products. Expanding OHAs authority to require manufacturers to provide information necessary to determine whether a product poses a health risk is also an important part of ensuring that OHA is able to protect public health. This would allow OHA to implement policies to promote the use of less toxic alternatives to products currently used.

7.2.7 Consumer Products

1) <u>Consumer Products description</u>

This category is broad and includes personal care products, nail salon products, automotive products, clothing, gas cans, paints, solvents, adhesives, adhesive removers, and other household cleaning and garden/landscape products. Most of these products are used in homes of all socio-economic groups and areas, so this category disperses air toxics throughout the PATS study area and populated regions of the state.

2) <u>Pollutant Risk Driver Summary</u>

Most pollutants emitted by consumer product use are risk drivers for the PATS study area as a whole, but the pollutants causing at least 10% of the risk within this category are naphthalene and dichlorobenzene. **The target reduction for naphthalene is 88% and for dichlorobenzene it is 44%.**

3) <u>List of Existing Emission Reduction Strategies</u>

For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) <u>Summary of Potential New Emission Reduction Measures</u>

Potential strategies to address emissions include a Portable Fueling Container Trade-Out Program; implementing regulations in Oregon such as the Safe Cosmetics Act of 2010, or a VOC limit and prohibition of certain toxics for consumer products and product labeling similar to California requirements; and to expand EcoBiz to include painters of residential and commercial buildings.

5) <u>Matrix</u>

The matrix in Table 31 summarizes information for potential strategies to reduce emissions from consumer products.

Table 31: Core Evaluation of Consumer Product Strategies

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Smart fuels portable fueling container trade-out program	Unknown (naphthalene, dichlorobenzene)	1-2 years	Feasible	Not calculated
#2: Safe Cosmetics Act 2010/ state requirements for personal care products in OR	Unknown (naphthalene, dichlorobenzene)	1-3 years	Feasible	Cost of regulation
#3: VOC limit legislation on general purpose cleaners and other consumer products/ prohibition of certain toxics from some common consumer products, product labeling (similar to California rules)	Unknown (naphthalene, dichlorobenzene)	1-4 years	Feasible	Cost of regulation
#4: Expand Oregon Health Authority Capacity to regulate consumer products	Unknown (naphthalene, dichlorobenzene)	2-4 years	Feasible	Cost of regulation
#5: Expand EcoBiz to new sectors	Unknown (naphthalene, dichlorobenzene)	1-3 years	Feasible	Participating companies receive free "advertising". Cost to agency to develop category.

** There is **an unknown gap** between the target reductions for risk driver pollutants for this source category*

6) Assumptions and Limitations

The geographic distribution of consumer product emissions and exposures is widespread in the PATS study area, with higher estimated concentrations in residential areas. Some of the strategies have worked in other areas to reduce air toxics, such as strategy #3, the VOC limits legislation and labeling laws. For strategies 2, 3, and 4, political support would be necessary for the Oregon legislature to make changes to law.
The data quality for the consumer products source category was rated D (acceptable).

7) PATSAC member feedback

- Support Legislature giving Oregon Health Authority the authority to remove products from the market that cause chronic (as well as acute) hazards to public health. Opportunity may be to expand Oregon Health Authority capacity to regulate consumer products.
- Require labels, and use other methods, to provide information about toxic components in consumer products (Right to Know approach).
- Onus to protect the public from harmful ingredients should be on the product manufacturer/seller not the public.
- Improve the source category organization. Consumer products sources are mixed with industrial sources.
- Track reforms in the Federal Toxic Substances Control Act which would encourage alternative formulations and zero VOC coatings.
- Review a more comprehensive approach to addressing education and advocacy focusing on consumer education and policy reform.
- Because of limitations with consumer education, better toxics reform is needed.
- Review a strategy to remove mothballs/flakes from stores.

7.2.8 Railroads

1) Railroad Description

Portland has considerable amount of rail activity as freight is transported east from the ports and north/south along the Pacific coast. Over 40 percent of the rail line-haul activity in Portland is cargo passing through the region. Pass through traffic originates and terminates at locations outside of the Portland metropolitan area. The railroad emissions in Portland result primarily from diesel fuel combustion in yard locomotives that disassemble and combine railcars into trains for the transport of freight and line haul locomotives that operate over longer distances and often outside the PATS area. Rail represents an efficient method of cargo transport, requiring on average less energy per ton of cargo moved. Locomotives have become about 16 percent more efficient over the last decade, but additional improvements can be made.

2) Pollutant Risk Driver Summary

Most pollutants emitted by rail are risk drivers for the PATS study area as a whole, but the pollutants causing at least 10% of the risk within this category are 15 PAH and diesel particulate.

The target reductions for railroads are 15 PAH 96% and diesel particulate 92%.

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

Rail yard idling is the most concentrated source of rail emissions in the PATS area. Potential strategies to minimize it include auxiliary power units, use of traction slugs, repowering locomotives, encouraging the use of engines configured with common rail fuel distribution systems, gensets, and hybrid yard engines.
However, idling diesel engines require low fuel levels, resulting in fewer emissions than working engines. The repowering, common rail, genset, hybrid and fuel-cell options offer reduced emissions when an engine is working as well as at idle, thus improving emission reductions and fuel usage more than idle reduction techniques alone.

5) Matrix

The matrix in Table 32 summarizes information for potential strategies to reduce emissions from railroads.

Table 32: Core Evaluation of Railroad Strategies

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Common Rail Diesel System	10[a] (PAH, Diesel PM)	Immediately available technology.	Currently feasible. Can be implemented during engine repower.	$400,000 retrofit/locomotive
#2: Genset Yard Locomotives	35-50[b,c] (PAH, Diesel PM)	Immediately available technology.	Currently feasible.	$600,000 – 1.2 million/retrofit locomotive
#3: Hybrid Yard Locomotives	35-60[b,c] (PAH, Diesel PM)	Immediately available technology.	Currently feasible.	$750,000 million/locomotive
#4: Fuel Cell Powered	~100[b.d] (PAH, Diesel PM)	Commercialization of	Under developme	$6 million/ locomotive

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
Locomotive		strategy unknown.	nt.	
#5: Emission Capture and Control	19[b] (PAH, Diesel PM)	Immediately available technology.	Currently feasible.	$2 million per yard
#6: APUs/Anti-idling Strategies	17[b] (PAH, Diesel PM)	Immediately available technology.	Currently feasible.	$27,500 to retrofit/locomotive
#7: Switcher Engine Repowering	10-60[b,c] (PAH, Diesel PM)	Immediately available technology.	Currently feasible.	$400,000 retrofit/locomotive
#8: Early Retirement of Older Engines	10-60[b,c] (PAH, Diesel PM)	Immediately available technology.	Currently feasible.	$2 million/locomotive
#9: Preventative Maintenance	Unknown	Immediately available technology.	Currently feasible.	$2 million/locomotive
#10: Alternative Fuels – Biodiesel	12[a,e] (PAH, Diesel PM)	Immediately available technology.	May require separate fuel tank and fueling system.	No retrofit cost, but fuel provides 10% less power, so efficiency is reduced.
#11: Alternative Fuels – Natural Gas	50[a] (PAH, Diesel PM)	Immediately available technology.	CNG applicable for yard operations.	$400,000 for retrofit/locomotive
#12: Encourage more Freight by Rail	Unknown	Immediately available technology.		
#13: Rail Efficiency Measures	Varies	Immediately available technology.		Varies

[a] Percent emission reductions applicable for line haul and yard operations.
[b] Percent emission reductions applicable for yard operations only.
[c] Emission reductions calculated using midpoint of range.
[d] 98% reduction assumed for fuel cell powered locomotives.
[e] Emission reductions applicable only for metal species.

6) Assumptions and Limitations

The rail strategies require changes in the locomotive fleet and operations, necessitating cooperation of the railroad companies that operate in the PATS area. Often this requires financial incentives to encourage implementation of these practices. In order to provide such incentives, Oregon would be competing with states such as Texas and California that offer very generous incentives – often fully covering the purchase price of new engines and locomotives, making many of the options in this section very costly to support.

Because locomotive emission sources are highly movable, it is sometimes a challenge to set up incentive programs or policies that encourage the application of technological controls. For example, if a control is installed on a specific locomotive and that locomotive leaves the PATS area, then the emission reduction associated with that locomotive is lost. Because yard locomotives are more likely to stay in the PATS area, strategies involving this type of equipment would likely be the most effective strategy.

The data quality for rail was rated B (very good) for high volume areas and C (good) for low volume areas.

7) PATSAC member feedback

- Measures should be keyed to the fact that over 40% of rail line-haul activity through Portland does not stop.
- Emissions reductions should be updated to include capture of arsenic.
- Consider other measures including potential indirect mobile source rule in Spokane, possible alignment of bikeways with rail lines for emission mitigation.
- Fuel cell technology is not yet available.

7. 2.9 Unpermitted Industrial Fuel Use

1) Unpermitted Industrial Fuel Use Description

The unpermitted industrial fuel use source category is comprised of four fuel-specific subcategories: natural gas, distillate fuel oil, residual oil, and other fuels (i.e., waste oil and kerosene). Unpermitted industrial fuel use emissions are primarily from distillate fuel oil; emissions from the natural gas, residual oil and other fuel subcategories are comparatively small. More than 80% of hazardous air pollutant emissions from this source category are from distillate oil combustion. Therefore, emission reduction strategies focus on distillate oil combustion units. The combustion units in this category could either be external (for example, boilers or heaters) or internal (for example engines or generators).

2) Pollutant Risk Driver Summary

Diesel PM is the main risk driver for this category. **The target reduction for Diesel particulate matter (PM) from unpermitted industrial fuel use is 92%.**

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

Control strategies include switching from distillate oil to cleaner fuels such as biodiesel or natural gas, installing add-on PM control devices such as fabric filters, and lowering the PM emission limits for engines.

5) Matrix

The matrix in Table 33 summarizes information in four core areas for potential strategies to reduce emissions from unpermitted industrial fuel use.

Table 33: Core Evaluation of Unpermitted Industrial Fuel Use Strategies

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Fuel switching - Biodiesel	55% (diesel PM)	Immediate	Feasible	Not calculated
#2: Fuel switching – Natural Gas	28% (diesel PM)	Immediate	Feasible	Not calculated
#3: Add-on PM Control Devices	80% (diesel PM)	Immediate	Feasible, dependent on engine	$80-$40,000 per device, dependent on the size of the engine.
#4: More Stringent PM Emission Limits	Depends on emission limit (diesel PM)	2-3 years, depending on rule making	Feasible	Cost of regulation

** There is a **gap of 12%** between the target reductions for risk driver pollutant for this source category and the reductions achievable if Strategy #3 was applied in the PATS area.*

6) <u>Assumptions and Limitations</u>
A limitation on implementing Strategy #1 is the supply of biodiesel in the PATS area. Replacing the existing distillate oil-fired units with natural gas-fired units (Strategy #2) may have a high capital cost. Converting the existing distillate oil-fired units to duel fuel combustion units (i.e., using both diesel and natural gas) is more cost-effective.

There is a 12% gap between the target reduction for the risk driver pollutant for this source category, if Strategy #3 were applied to every oil-fired unit in the PATS area. It is unlikely that these strategies could be applied to each instance of industrial fuel use in the PATS area.

The data quality for the unpermitted industrial fuel use source category was rated D (Acceptable).

7) <u>PATSAC Member Feedback</u>
- There were no additional responses in this category.

7. 2.10 Asphalt Use (non-permitted)

1) <u>Asphalt (non-permitted) Description</u>
Asphalt area source emissions inventory captures emission from solvent evaporation through non-permitted production and use of paving and roofing asphalt. Asphalt is used to pave, seal, and repair surfaces such as roads, parking lots, drives, walkways, and airport runways. Asphalt concrete is grouped into three general categories: hot mix, cutback, and emulsified. Because emissions from hot mix asphalt are low it is excluded from the emissions inventory. Emulsified asphalt is used in most of the same applications as cutback asphalts but is a lower emitting, energy saving, and safer alternative to the cutback asphalts (Moulthrop, et al. 1997). Since emulsified asphalt is used significantly more than cutback asphalt, emissions from emulsified asphalt account for 95% emissions from asphalt source category.

2) <u>Pollutant risk driver summary</u>
Asphalt use is a source of volatile organic compound (VOC) emissions. One of the toxic VOCs is naphthalene, which is the only PATS air toxic of concern for non-permitted asphalt category. **The target reduction for naphthalene from asphalt (non-permitted) is 88%.**

3) List of Existing Emission Reduction Strategies
For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures
The evaluated strategy considers lowering the VOC standards for all emulsified asphalt types. The reduction targets for naphthalene emissions from asphalt paving could be closely approached if the use of emulsified asphalt is limited to that which contains 0.5 mL or less of oil distillate from a 200 mL sample (as determined using American Society for Testing and Materials (ASTM) Method D244 – Test Methods for Emulsified Asphalts) regardless of application. This is equivalent to a VOC content of 0.25 percent (reduced from average 6% allowable VOC content).

5) Matrix
The matrix in Table 34 summarizes information for a potential strategy to reduce emissions from asphalt.

Table 34: Core Evaluation of Asphalt Strategies

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Lower VOC standards for all emulsified asphalt types	77% (naphthalene)	1-3 years	Feasible	Cost of regulation

*There is a **gap of 11%** between the target reductions for risk driver pollutants for this source category and the reductions achievable*

6) Assumptions and Limitations
The risk from this source category is area-wide, although emissions may be higher in localized impact areas near the asphalt paving activities. Strategy #1 (Lower VOC standards) is technically feasible, and is based on technical analysis done by the Ozone Transportation Commission.[2] Lower VOC alternatives are currently available. Regulatory authority for DEQ or local government would need to be evaluated. Three strategies (numbers 2-4) suggested at the 4/14/2011 PATSAC meeting have not yet been evaluated.
The data quality for the asphalt source category was rated D (acceptable).

7) PATSAC member feedback
- Include additional emission reduction strategies– reduce studded tire use so paving would need to occur less often, require same VOC limit on seal coats as for asphalt paving (perhaps same for roofing and for roof shingle manufacturing).
- Consider warm asphalt and increase use of permeable/porous pavement.
- Consider the use of concrete as an alternative road surface material.

7. 2.11 Miscellaneous (Publicly Owned Treatment Works, Landfills, and Restaurants)

1) Miscellaneous (Publicly Owned Treatment Works, Landfills, and Restaurants) Description
Miscellaneous sources include landfills, restaurants, and Publicly Owned Treatment Works[3] (POTWs). Emissions from landfills and POTWs include off-gassing of hazardous air pollutants from waste, not from any specific operations or product use at the facility. In the PATS study area, there are less than 20 POTWs. There

[2] The Ozone Transport Commission (OTC) is a multi-state organization created under the Clean Air Act (CAA). The OTC is responsible for advising the Environmental Protection Agency on transport issues and for developing and implementing regional solutions to the ground-level ozone problems.
[3] Wastewater treatment plants

are no active municipal landfills in the PATS study area although there are a number of closed sites, and one active landfill that takes only construction and demolition debris. There are thousands of restaurants in the Portland metro area. Restaurants emissions usually come from baking or frying and emissions are most often exhausted through a chimney or stack. Emissions are not regulated by DEQ, and vary greatly from one establishment to the next.

2) Pollutant Risk Driver Summary

The contribution of landfills, POTWs and restaurants to Ambient Benchmark Concentration exceedances is minimal.

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

Consumer education could be an effective strategy for reducing emissions from Publicly Owned Treatment Works. This is a pollution prevention strategy. This strategy could effectively reduce or eliminate pollutants from the water, reduce organic material and other (illegal) dumping.

Restaurant emissions are exempt from current permitting rules. Rules could be changed to include them. Outreach and education could also be an effective strategy for reducing restaurant emissions by encouraging owners/operators to voluntarily install afterburner type technology to their current stacks. Participation could be encouraged by creating a restaurant category in the EcoBiz program or with incentives such as a grant program or tax credit.

5) Matrix

The matrix in Table 35 summarizes information for potential strategies to reduce emissions from POTWs, landfills and restaurants.

Table 35: Core Evaluation of POTW, Landfill, and Restaurant Strategies

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Outreach and Education	Unknown	1-10 years	Feasible	Cost of staffing
#2: Rule change/ incentives/ EcoBiz for restaurants	Unknown	1-10 years	Feasible	Cost of incentive/ regulation / Ecobiz.

** There is **an unknown gap** between the target reductions for risk driver pollutants for this source category and the reductions achievable based on strategies where emission reductions have been quantified.*

6) Assumptions and Limitations

The distribution of emissions is area wide with potential localized impact areas. DEQ has had some experience with local impacts of specific restaurants and control strategies can include simple stack extensions, or process modifications to reduce smoke impacts. These strategies may affect annoying or nuisance conditions for neighbors, but only move the pollution elsewhere. Installing afterburners on restaurant stacks would reduce odorous VOC emissions, some of which may be hazardous air pollutants, but could increase other pollution. Afterburners require heat, so fuel is required to make the process work; as such, CO or CO_2 and NO_x emissions could increase. Regulatory authority for a rule change under Strategy #2 would need to be evaluated.
Data quality rating for landfills and POTWs are both A (excellent); and for restaurants is D (acceptable).

7) PATSAC Member Feedback

- Better understand area wide as opposed to localized impacts of sources in this category. For example, a landfill or POTWs could be significantly affecting its neighbors while not contributing significantly to total area wide concentrations.
- Further review low-cost strategies and their impacts.
- Improve the source category organization. Restaurants, landfills, and POTWs should be separate categories.
- Add a strategy to deal with closed landfills.
- Include outdoor BBQs in the analysis.

7.3 Point Source Emission Source Categories[4]

7.3.1 Asphalt Roofing Manufacturing

1) Asphalt Roofing Manufacturing Description

The asphalt roofing manufacturing source category consists of facilities that use a fibrous substrate and processed asphalt to manufacture roofing products. Facilities in this source category may manufacture shingles, laminated shingles, mineral-surfaced roll roofing, or saturated felt roll roofing. Asphalt roofing facilities may also have co-located asphalt processing operations, such as asphalt blowing stills, that prepare the raw asphalt material for application to the substrate.

2) Pollutant Risk Driver Summary

Asphalt roofing manufacturing facilities emit pollutants that drive risk in the PATS study area. However, those pollutants emitted by asphalt roofing manufacturing facilities, such as benzene, only contribute to risk in their immediate vicinity. **The target reduction for benzene from asphalt roofing manufacturing is 91%.**

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

The strategy evaluated for asphalt roofing manufacturing is the establishment of emission standards for benzene, PAH and formaldehyde. Currently, PM emission limits for process emissions are in place at facilities in this source category. Sources are typically able to meet these limits using PM control devices, such as high-efficiency fiber bed filters. The evaluated control strategy would replace filtration-type PM control devices with thermal oxidation of the process vent streams as the control for not only PM, but also vapor-phase organic HAP emissions.

5) Matrix

The matrix in Table 36 summarizes information for a potential strategy to reduce emissions from Asphalt Roofing Manufacturing.

[4] Point Source emission source categories are in alphabetical order as opposed to level of cumulative risk as seen with area/mobile in Section 7.2 .

Table 36: Core Evaluation of Asphalt Roofing Manufacturing Strategies

Framework Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Emission standards	95% (benzene)	5-10 years	Feasible	Cost of regulation. Major source NESHAP evaluation estimates a cost-effectiveness of thermal oxidation is on the order of $559,000 per ton of HAP reduced

** There is a gap of **0%** between the target reductions for the risk driver pollutant for this source category and the reductions achievable.*

6) Assumptions and Limitations

Thermal oxidation is the only technically available new emission reduction measure available that can be evaluated for this source category. The technology is available, but is only required of major sources of HAP emissions in this source category. The sources in the PATS area are minor sources and are not subject to the major source NESHAP requirements.

This control strategy could be implemented as a regulatory requirement in addition to those currently required in state and federal regulations. As there are no current regulations that require thermal oxidation for the existing sources, a strategy would need to provide ample time to consider regulations and for sources to investigate control strategies, purchase equipment, and perform installation and break-in of new control equipment.

In practice, the emission reductions would likely be less than 95 percent, since capture and control of all of the anticipated emissions may not be possible (i.e., depending upon the collection efficiency).
The data quality for asphalt roofing manufacturing was rated A (Excellent).

7) PATSAC Member Feedback

- The white paper should include a strategy to reduce the demand for asphalt roofing.
- Review the use of filters or thermal oxidizers on asphalt storage tanks as a means for emission reductions.
- Consider co-control of VOCs for ozone benefit.

7.3.2 Bulk Terminals

1) Bulk Terminals Description

Petroleum products are delivered by pipeline or marine vessel to a bulk terminal facility. At the bulk terminal facility the products are stored, blended and then delivered to another transfer point (e.g., bulk gasoline plant) or end consumer using railcars, barges, or tank trucks. Emissions from the bulk terminal source category are from loading operations, the storage of products, and the equipment leaks from sources such as pumps, valves, and flanges.

2) Pollutant Risk Driver Summary

Bulk terminals emit pollutants that drive risk in the PATS study area. However, those pollutants emitted by bulk terminals, such as benzene, only contribute significantly to risk in their immediate vicinity. **The target reduction for benzene from bulk terminals is 78 to 93%, depending on the specific facility.**

3) List of Existing Emission Reduction Strategies
For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures
The bulk gasoline terminals in the PATS area have several applicable regulations covering VOC or HAP emissions. Most of these rules specifically cover gasoline storage or loading. The strategies evaluated include controlling the storage or loading of non-gasoline materials and controlling emissions to a greater extent than what would be controlled by the existing rule.

5) Matrix
The matrix in Table 37 summarizes information for potential strategies to reduce emissions from bulk terminals.

Table 37: Core Evaluation of Bulk Terminal Strategies

Framework Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Standards for vapor loss during storage	10-23% (benzene)	3-5 years	Feasible	$75,000 for unit upgrade or $223,000 for new unit
#2: Leak detection and repair	0.4% (benzene)	2-3 years	Feasible	$1030 per monitoring event

** There is a gap of **59 to 70%** between the target reductions for risk driver pollutants for this source category and the reductions achievable*

6) Assumptions and Limitations
Current standards for vapor loss during storage require that emissions from the loading of gasoline are limited to 80 mg TOC/l by the State rule and by the NESHAP (subpart BBBBBB). For sources that are currently meeting the 80 mg TOC/l emission limit, limiting the gasoline loading emissions to <10 mg TOC/l would provide an 88% emission reduction for all PATS pollutants. Revising the state rule to incorporate this new limit would likely take 1 to 2 years to adopt and 2 to 3 years for the source compliance.

The NESHAP (Subpart BBBBBB) requires leak detection and repair monitoring using "sight, sound, and smell." This type of program, without the use of a TOC monitor, has limited effectiveness. The emission reduction potential for equipment leaks is relatively high for a leak detection and repair program where no monitoring is currently being performed. However, the emissions from equipment leaks are very small from bulk terminals. Five of the seven PATS area terminals have equipment leak emissions of 0.3 to 2.9 tons per year of VOC and a total from the five terminals of 6.4 tons of VOC. Assuming 0.27% for benzene content of gasoline, the greatest amount of benzene emissions available to be reduced is 35 pounds. A more in-depth review of emissions from the seven bulk terminals would be necessary if this control strategy was considered further. These strategies could be applied area-wide or could be targeted to sub-regions.
The data quality for the bulk terminals source category was rated A (Excellent).

7) PATSAC Member Feedback
- Two measures for standards for vapor loss during storage yield different reductions while the other considerations are identical. There is a recommendation to select the 10mg/L limit if the framework level strategy is chosen.

- Determine if Kinder Morgan should be added to the terminals and identify if subsequent additional reductions would be achievable with the evaluated strategies.
- Review controls for barge lightering (out gassing) in Oregon and Washington.
- Review "grandfather" clauses for floating roofs at older facilities.
- Review controls of emissions from venting upon tank clean-up.
- Review whether the leak detection strategy will pay for itself.
- Co-control VOCs for ozone benefit.

7.3.3 Glass Manufacturing

1) Glass Manufacturing Description

The products of the glass manufacturing industry are flat glass, container glass, and pressed and blown glass. Glass manufacturing of containers includes the following operations: raw material and cullet receiving and storage, materials blending and transport, glass melting furnaces, glass forming, final bottle treatment, and maintenance and support systems such as the boiler, heaters and storage tanks. The procedures for manufacturing other glass products are the same except they do not include forming and finishing.

2) Pollutant Risk Driver Summary

Glass manufacturing facilities emit pollutants that drive risk in the PATS study area. However, those pollutants emitted by glass manufacturing facilities, such as arsenic, only contribute to risk in their immediate vicinity. **The target reduction for arsenic from glass manufacturing is 71%.**

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

The glass manufacturing facility in the PATS area has several applicable regulations covering PM emissions. Most of these rules specifically cover glass melting furnaces. The strategy that was evaluated at the blueprint level focuses on emissions standards. This strategy reviews the required use of high-energy venturi scrubbers or electrostatic precipitators in combination with collection hoods to further control particulate emissions from molten glass.

5) Matrix

The matrix in Table 38 summarizes information for a potential strategy to reduce emissions from glass manufacturing.

Table 38: Core Evaluation of Glass Manufacturing Strategies

Framework Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Emission Standards	72% (As)	1-2 years	Feasible	Capital costs of $0.6 to $1.8M, with annual costs of about $0.5M

** There is a gap of **0 %** between the target reductions for the risk driver pollutant for this source category and the reductions achievable.*

6) Assumptions and Limitations

The risk for this source category is local. With respect to facilities contributing to benchmark exceedances, glass manufacturing accounts for roughly 22% of arsenic emissions for all industrial facilities based on the PATS 2017 projected emissions inventory and modeling studies. The white paper evaluation for glass manufacturing was performed by DEQ.   It was compiled after the committee review process and did not receive the same level of committee evaluation.

The data quality for the glass manufacturing source category was rated A (Excellent).

7) PATSAC Member Feedback

- There was no PATSAC feedback on this white paper.

7.3.4 Metals Facilities

1) Metals Facilities Description

The permitted metals facilities source category is comprised of two subcategories, which are electroplating and metals production. The electroplating subcategory includes hard chromium electroplating, decorative chromium electroplating, zinc galvanizing, and cadmium electroplating. The metals production subcategory includes primary steel production, secondary grey iron production, and secondary steel production.

2) Pollutant Risk Driver Summary

Metals facilities emit four pollutants that drive risk in the PATS study area. For all source sectors, metals facilities account for 100% of the manganese, nickel, lead, and 63% of the cadmium in projected 2017 emissions that contribute to benchmark exceedances. Other pollutants emitted by the metals facilities, such as arsenic, benzene, hexavalent chromium, and naphthalene may be potential risk drivers in their immediate vicinity. **The target reductions for metals facilities are: 39 to 91% for manganese, 72% for nickel, 49% for lead, 1 to 95% for chromium, and 94 to 96% for cadmium, depending on the specific facility.**

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to the Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

DEQ has evaluated a total of six reduction strategies for the permitted metals facilities source category. For electroplating facilities, DEQ evaluated three reduction strategies: housekeeping to focus on fugitive dust and chemical storage, fume suppressants as a wetting agent to reduce mist from plating baths, and HEPA filters as an air filtering device. For metals production facilities, DEQ evaluated three reduction strategies: more stringent emission capture requirements for steel foundries, process adjustments to reduce tap-to-tap time and electricity consumption, and incentives for utilizing vacuum casting for steel mills.

5) Matrix

The matrix in Table 39 summarizes information for potential strategies to reduce emissions from metals facilities.

Table 39: Core Evaluation of Metals Facility Strategies

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Housekeeping (hard chrome electroplating)	10% (Chromium VI,)	Immediate	Feasible	$1,315 (annual costs/facility), 12 applicable facilities
#2: Fume Suppressant (hard chrome electroplating)	21% (Cadmium)	3-5 years to unknown	Feasible	$1,200 (annual costs/facility)

Brainstorm Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#3: HEPA Filters (hard chrome electroplating)	0.1% (Chromium VI,), 21% (Cadmium)	Immediate	Feasible	$40,000-$270,000 depending on exhaust flow rate and existing on-site controls
#4: Improved PM capture (secondary metal production)	10% (Manganese, Cadmium, lead)	Significant – rules and upgrades	Feasible	Costs are highly variable depending on case-specific factors and can be significant
#5: Process adjustments for secondary metal production (secondary metal production)	Reduced energy demand will offset emissions associated with power generation	3-5+ years, can require permit approvals	Feasible	Costs can be estimated with melters capacity – see Table 14 in the metals facilities White Paper
#6: Incentive for utilizing vacuum casting for steel mills (secondary metal production)	Unknown	Unknown	Feasible	Unknown

** There is a gap of **89%** for manganese, **49%** for lead, **72%** for nickel **84 to 74%** for chromium, and **63 to 65%** for cadmium between the target reductions for risk driver pollutants for this source category and the reductions achievable.*

6) <u>Assumptions and Limitations</u>

The risk for this source category is local. The emissions from metals facilities can be broken into two subcategories, hard chrome electroplating and secondary metal production. With respect to facilities contributing to benchmark exceedances, electroplating accounts for roughly 51% of cadmium and 1% of manganese, nickel, and lead emissions, whereas secondary metal production accounts for roughly 49% of cadmium and 99% of manganese, nickel, and lead emissions for all metals facilities based on the PATS 2017 projected emissions inventory and modeling studies.

The White Paper evaluation for metals facilities was performed by a contractor whose information gathering and evaluation method were performed utilizing facility permits and conversations with DEQ staff. There are aspects of the evaluation that have been questioned by committee members that will need follow up to ensure that the metrics associated with various strategies are accurate.

The data quality for the metals facilities source category was rated A (Excellent).

7) <u>PATSAC Member Feedback</u>

- A control strategy that might work at one facility may not apply at another. Care should be taken in writing the descriptions of the control strategies to be clear that they can not be applied universally
- The costs and benefits associated with emission control strategies will depend on the specific equipment and process being controlled and the facility where it is applied. What may be cost effective at one facility may not be technically feasible at another

- When an impact from an emission control strategy has been demonstrated, DEQ should work with individual facilities to develop strategies that will work at those sites
- Future strategies should not be constrained by DEQ resources.
- Review the possibility of asking industry what they can do instead of trying to suggest actions.
- Since potential strategies may fall short of achieving benchmark concentrations, reduction efforts should consider local impacts and work that will mitigate emissions for the highest risk populations.
- The vacuum casting process for metals affects organics.

7.3.5 Permitted Industrial Fuel Use

1) Industrial Fuel Use Description

The permitted industrial fuel use source category is comprised of four fuel-specific subcategories: natural gas, wood waste, distillate fuel oil, and other fuels (i.e., residual fuel oil, process gas, refinery fuel gas, and solid waste). The emission units from permitted industrial fuel use source category are comprised of external combustion units (such as boilers and heaters) and internal combustion units (such as engines and turbines).

2) Pollutant Risk Driver Summary

The uses of fuel at industrial facilities emit pollutants that drive risk in the PATS study area. However, those pollutants emitted by fuel use at industrial facilities, such as arsenic, benzene, cadmium and acrolein, may only contribute significantly to risk in their immediate vicinity.

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

The three strategies for the industrial fuel use source category that were evaluated include the following: fuel switching, add-on PM control devices, and more stringent emission limits.

- Fuel switching uses a cleaner burning fuel in place of the existing fuel.
- Add-on PM control devices reduce particulate matter and non-mercury metallic HAP emissions from industrial fuel combustion.
- More stringent emission limits for wood-fired boilers would require existing boilers to comply with the more stringent PM and CO emission limits established in NESHAP subparts DDDDD and JJJJJJ for new/reconstructed units and for the units located at HAP major sources.

5) Matrix

The matrix in Table 40 summarizes information for potential strategies to reduce emissions from permitted industrial fuel use.

Table 40: Core Evaluation of Permitted Industrial Fuel Use Strategies

Framework Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Fuel switching	77% (acrolein) 89% (benzene) 6% (cadmium)	3-5 years	Readily available	Some capital cost would be required to modify the existing wood-fired boilers to accommodate the switch of fuel. In addition, there would be on-going costs associated with the purchasing of fuel.

Framework Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#2: Add-on PM control devices	1% (all pollutants)	3-5 years	Feasible	Capital, operation, maintenance, and stack testing costs
#3: More stringent emission limits	Depends on level of emission standards established	3-5 years	Feasible	Depends on level of emission standards established

** Some pollutants emitted by permitted industrial fuel use may be risk drivers for the PATS study area as a whole, but the facilities only contribute significantly to risk in the their immediate vicinity.*

6) Assumptions and Limitations

Fuel switching, as an effective reduction measure, applies only to emissions from wood waste as a fuel source. The requirement of add-on PM control devices will only control PM species, such as arsenic, cadmium, chromium VI, diesel PM 2.5, lead, manganese, and nickel. Applying more stringent emission limits from NESHAPs will tend to impact both PM and VOC species.

It is a potential control option to have existing wood-fired boilers comply with the more stringent PM and CO emission limits established in NESHAP (subparts DDDDD and JJJJJJ). However, this control option is only viable if the existing wood-fired boilers are located at HAP minor sources.

The data quality for the industrial fuel use source category was rated A (Excellent).

7) PATSAC Member Feedback

- Review and include the impact of EPA's new boiler Maximum Achievable Control Technology Rule in the White Paper and the 2017 emissions inventory and modeling.
- Consider reduction measure impacts to greenhouse gas emissions.
- Explore fuel switching as a strategy on the basis of the greatest emission reductions at a potentially lower cost.

7.3.6 Surface Coating

1) Surface Coating Description

The surface coating source category includes point source facilities that apply a material (such as paints, sealants, caulks, adhesives) to a substrate for decorative, protective, or functional purposes. The PATS study area includes sources performing paper coating, metal can coating, wood furniture coating, barge coating, rail car coating, heavy duty truck coating, and drum coating.

2) Pollutant Risk Driver Summary

Surface coating facilities emit pollutants that drive risk in the PATS study area. However, those pollutants emitted by surface coating facilities, such as naphthalene, only contribute to risk in their immediate vicinity. **The target reduction for naphthalene from surface coating is 74 to 86% depending on the specific facility.**

3) List of Existing Emission Reduction Strategies

For a description of existing emission reduction strategies, please refer to Appendix 12.9.

4) Summary of Potential New Emission Reduction Measures

DEQ has evaluated 14 brainstorm level strategies for reducing emissions from six different surface coating subcategories. The strategies are associated with the various application processes for surface coating. The 14 strategies are categorized at the blueprint level under the following three strategies: substituting lower emitting components, emissions standards, and improved application techniques.

5) Matrix

The matrix in Table 41 summarizes information for potential strategies to reduce emissions from surface coating.

Table 41: Core Evaluation of Surface Coating Strategies

Framework Level Strategy	Emission Reductions (risk driver pollutants)	Timeframe to reduce emissions	Technical feasibility	Cost
#1: Substitute lower emitting components	Rail/barge, drum, and metals parts coating: 100% (naphthalene)	1-2 years	Potentially feasible to Feasible, depending on sub-category	Low to significant based upon subcategory: Misc. metal parts coating – low cost
#2 Emission standards	Rail/barge and drum coating: 95-98% (naphthalene)	1-2 years	Feasible	Low to significant based upon subcategory: Rail/barge coating – $100K/booth (thermal ox) + operational expenses
#3 Improved application techniques	Drum coating: 60% (naphthalene)	1-2 years	Feasible	Low cost (e.g., a few thousand dollars)

** Some pollutants emitted by surface coating facilities may be risk drivers for the PATS study area as a whole, but the facilities only contribute significantly to risk in the their immediate vicinity.*

6) Assumptions and Limitations

The surface coating reduction measures focus on emission reductions from six separate types of surface coaters. The selection of any strategy evaluated would therefore focus on reductions for specific surface coating operations, as opposed to the entire inventory of surface coating facilities.

The single measure with the greatest impact on PATS HAP emissions for the surface coating source category would focus on a single facility that performs drum coating, which currently does not have any VOC or organic HAP controls. A single facility accounts for about 80 percent of the PATS HAP emissions from the surface coating source category in the inventory. Emissions from this facility could be reduced by about 95 percent through the installation and operation of a thermal oxidizer or similar device on the exhaust from the drum coating operation.

The data quality for surface coating was rated A (Excellent).

7) PATSAC Member Feedback

- Review the use of bio-filters as a reduction strategy.

- Review whether switching guns under improved application techniques provides a 60% reduction of naphthalene.
- Further review of applicable NESHAPs is needed for this source category.
- Drum coating is one area where it appears that technology has not been applied yet and may be an emission reduction opportunity.

7.3.7 Additional PATSAC Member Feedback on Point Sources

- In general for point sources (and potentially all source categories), technical feasibility, cost and other factors are often facility specific so organization by source categories and drawing conclusions on feasibility might simply be speculation.
- Point source categories need more in depth research for full understanding and stakeholder consideration.
- The cost and feasibility studies are often case studies from other regions that may not be comparable to Portland area point sources. Care should be taken in writing the descriptions of the control strategies to be clear that they cannot be applied universally
- What may be cost effective at one facility may not be technically feasible at another. Therefore, DEQ should not promote generalized emission control strategies but instead, when an impact has been demonstrated, DEQ should work with the individual facility to develop strategies that will work at that site.

8. Environmental Justice and Sensitive Populations

8.1 Introduction

8.1.2 Environmental Justice Defined

Environmental Justice entails the fair treatment and meaningful involvement of all people regardless of race, age, gender, national origin, education or income level, in the development, implementation and enforcement of environmental laws, regulations and policies. Since the early 1980s, there has been increasing awareness of disproportionate effects of environmental hazards on minority and low-income communities. Environmental justice will be achieved when everyone enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, play, and work.

8.1.3 Oregon Direction on Environmental Justice

In 2007, as a result of a sustained effort by Senator Avel Gordly, the Oregon Legislature passed Senate Bill 420 creating the Environmental Justice Task Force to advise the Governor and natural resource agencies on environmental justice issues. ORS 182.545 directs DEQ and all other natural resource agencies to (1) consider the effects of agency action on environmental justice issues; (2) hold hearings at times and in locations that are convenient for people in the communities that will be affected by the decisions stemming from the hearings; (3) engage in public outreach activities in the communities that will be affected by decisions of the agency; and (4) create a Citizen Advocate position that is responsible for encouraging public participation, ensuring the agency considers environmental justice in its decisions, and informs the agency of the effects of its decisions on low-income communities, communities of color and other populations traditionally underrepresented in agency decision-making.

DEQ first adopted an Environmental Justice policy in 1997 to guide the agency's work, including principles for making environmental justice inherent in the way DEQ does business. DEQ is committed to ensuring that its actions – including permitting, cleanup, policy and planning, outreach and education, and compliance and enforcement – address the interests of all Oregonians regardless of race, age, gender, national origin, education or income level. One of the considerations in developing an air toxics reduction plan for the Portland area is the effect of potential toxics reduction strategies on environmental justice communities. For more information on environmental justice at DEQ, visit http://www.deq.state.or.us/about/envjustice.htm.

8.1.4 Purpose of Environmental Justice Analysis in PATS

DEQ, with input from PATSAC, used 2017 modeling and demographic data to determine where there are disproportionate impacts from air toxics on low-income and minority populations in the PATS study area. The study area includes portions of Multnomah, Washington and Clackamas counties. Using four different methods of examining the data, DEQ concluded that low-income and minority communities are disproportionately impacted by higher concentrations of air toxics compared to mid to high income primarily white communities in the PATS study area. The details of analysis in this section demonstrate the degrees to which disparities exist.

8.1.5 Using Environmental Justice Information

The PATS environmental justice analysis is the first investigation that DEQ has performed to understand disparate impacts by pairing environmental data with demographic data from the Census. PATS committee members, EPA Region 10, and academic researchers assisted DEQ in conducting this analysis. DEQ plans to factor environmental justice considerations into future strategies to reduce emissions from priority categories (see section 9.3). The priority categories for emission reductions in the short term are residential wood combustion, on road light duty engines (mostly gasoline), on road heavy duty engines (mostly diesel), construction (mostly diesel engines) and industrial metals. This analysis is an important first step in planning emission reductions for the Portland area. It also serves as an example and foundation for similar efforts within DEQ and partner agencies.

8.2 PATS Environmental Justice Analysis

8.2.1 Summary of Environmental Justice Analysis

The PATS environmental justice analysis demonstrated the existence of disproportionate impacts from air toxics on minority and low-income populations in the Portland area. Different minority groups are affected by different types of emission sources. In general, DEQ found that the Hispanic/Latino population experienced the highest impacts from residential wood combustion emissions, the Asian population from on-road mobile emissions, the African American/Black population from area source emissions, and the population living below the poverty level from on-road mobile emissions. Non-road mobile emissions also significantly impact minority populations, while point sources disproportionately impact populations living below the poverty level. This information should be incorporated into emission reduction strategies and used by communities and local government to prioritize efforts to improve public health.

8.2.2 PATS Environmental Justice Methodology and Results

To determine the degree to which air toxics disproportionately impact environmental justice communities in the study area, DEQ took the following steps:

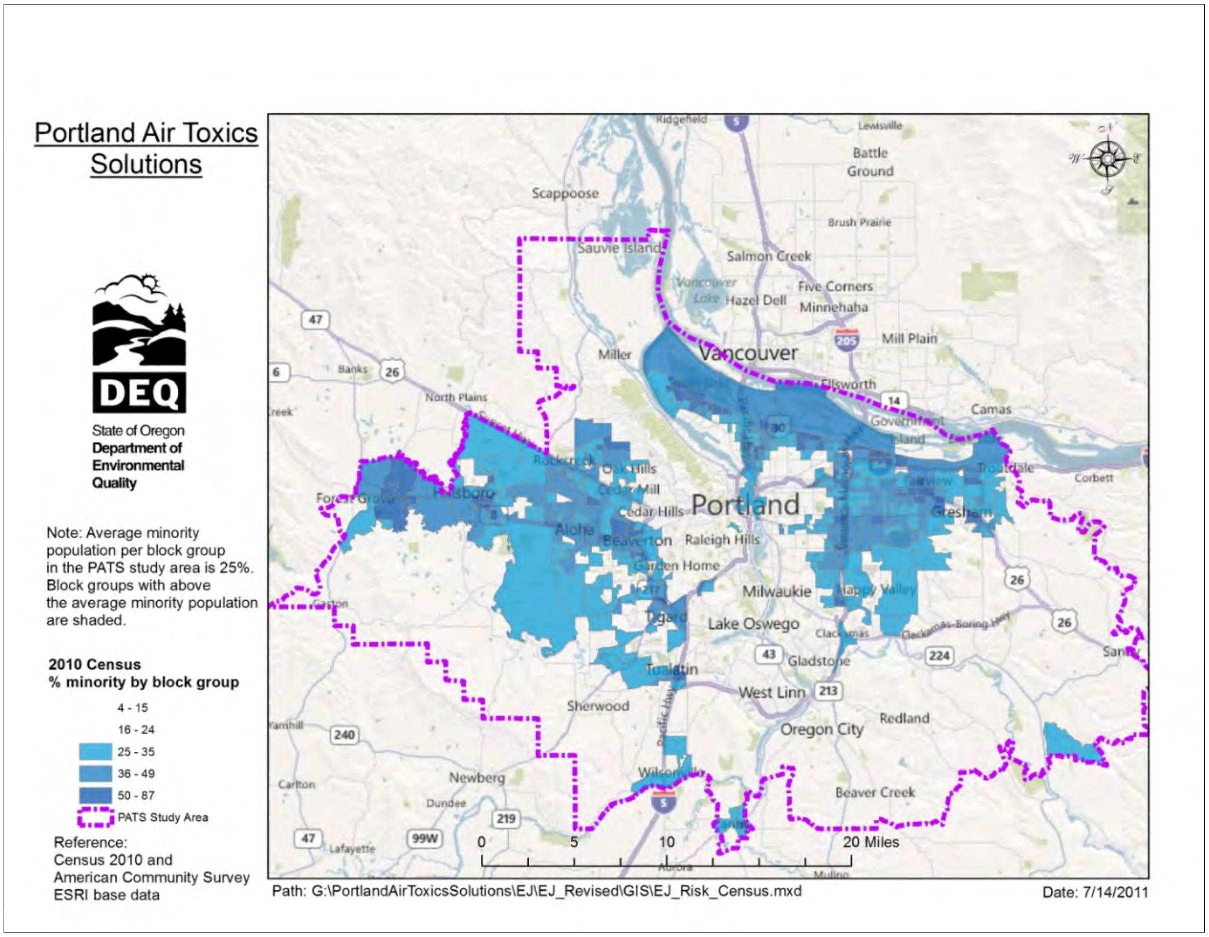
1. Visual inspection of maps created using GIS
2. Performing a cumulative distribution analysis of differences between minority and white populations
3. Using bar graphs to assess impacts in high minority and low income areas
4. Multivariate linear regression modeling to examine relationships between several factors at a time

For this analysis, DEQ used U.S. Census Bureau 2010 data at the block group level. Due to changes in the Census, income data is no longer available from the decennial Census data. DEQ relied on the American Community Survey (ACS) 5-year estimate (2005-2009) to determine median household income and an income to poverty ratio by block group. ACS is part of the assessment conducted by the U.S. Census Bureau with the primary purpose of measuring the changing social and economic characteristics of the U.S. population. The ACS collects data every year, but the ACS sample is smaller than that of the Census long-form sample. The ACS combines population or housing data from multiple years to produce reliable numbers for local areas. As a result of ACS data’s relatively large confidence intervals for smaller geographic areas, DEQ has more confidence in the analysis of race and ethnicity disparities than income level data.

8.2.2.1 Visual Inspection through GIS Mapping

To conduct a visual inspection of the extent to which minority populations were exposed to modeled levels of air toxics, DEQ created an overlay of minority populations on all pollutants above benchmarks in the 2017 model. DEQ mapped all potential EJ areas based on the percent of minority population. Minority status includes all persons not claiming single race non-Latino white status on the 2010 Census. In Portland, the average minority population is 25%. Therefore, potential EJ areas in this analysis are defined as having higher than 25% minority population. Figure 104shows the block groups that are identified as potential EJ areas based on minority status.

Figure 104: 2010 Census Minority Population by Block Group



In Figure 105 the block groups with minority populations above 25% are layered on a map showing total times above benchmarks for all PATS pollutants. Visual inspection of this overlay suggests that there is an overlap between high minority and high impact areas in some areas of the PATS study boundary. Those areas include Forest Grove, Hillsboro, Aloha, Beaverton, North Portland, East Portland and Gresham.

Figure 105: Cumulative Benchmark Exceedances from All Source Categories and Percent Minority by Block Group

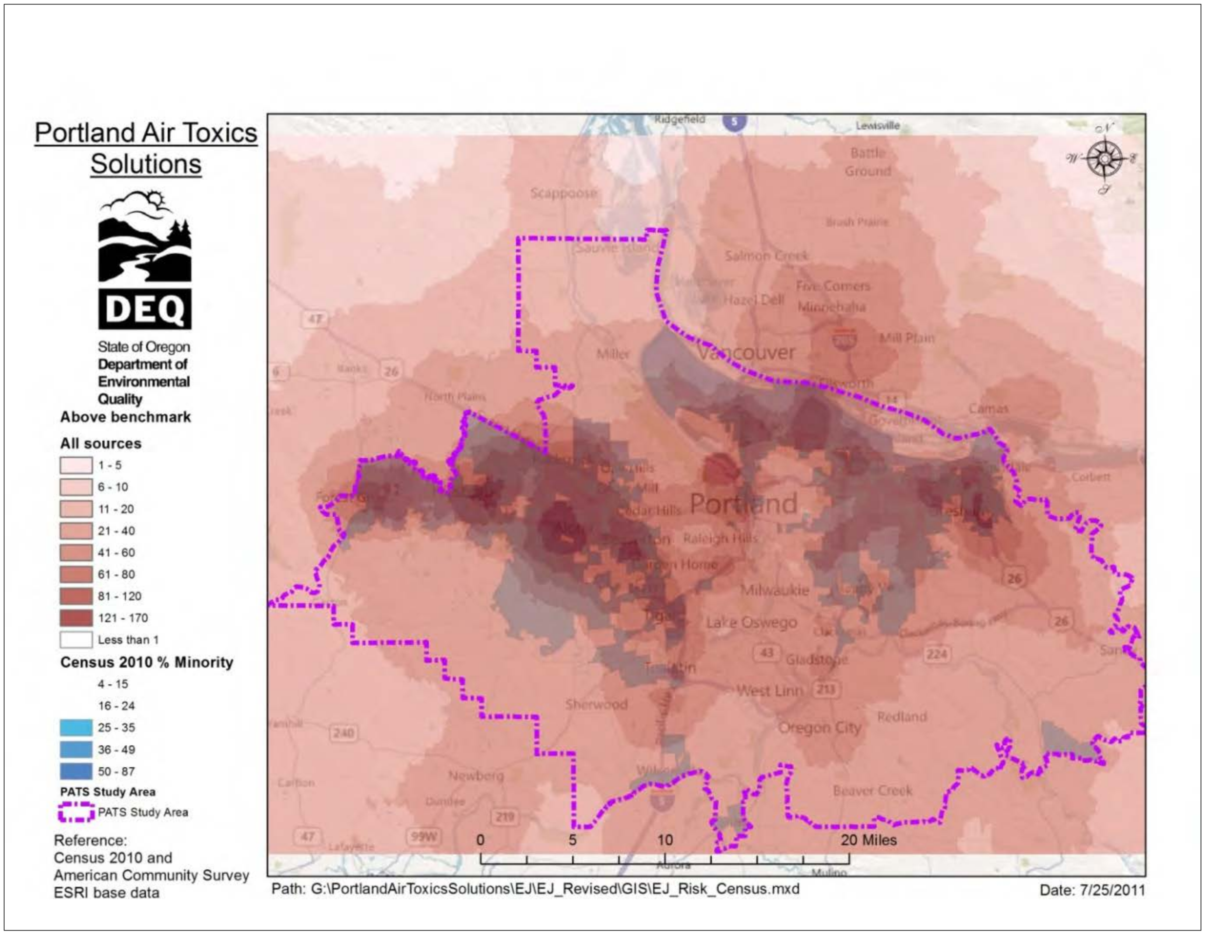


Figure 106 shows an overlay of minority populations on risk from residential wood combustion. Visual inspection of this overlay suggests a significant overlap between high minority populations and areas with elevated risk from wood combustion. By contrast, Figure 107 shows an overlay of minority populations and risk from industrial point sources with less overlap or impact on minority populations. Based on this step of visual inspection, PATSAC requested that DEQ conduct further analysis to quantify the extent of the disparity between the minority and white populations. Overlay maps for additional categories of emissions may be found in Appendix 10.14.

Figure 106: Cumulative Benchmark Exceedances from Residential Wood Combustion and Percent Minority by Block Group

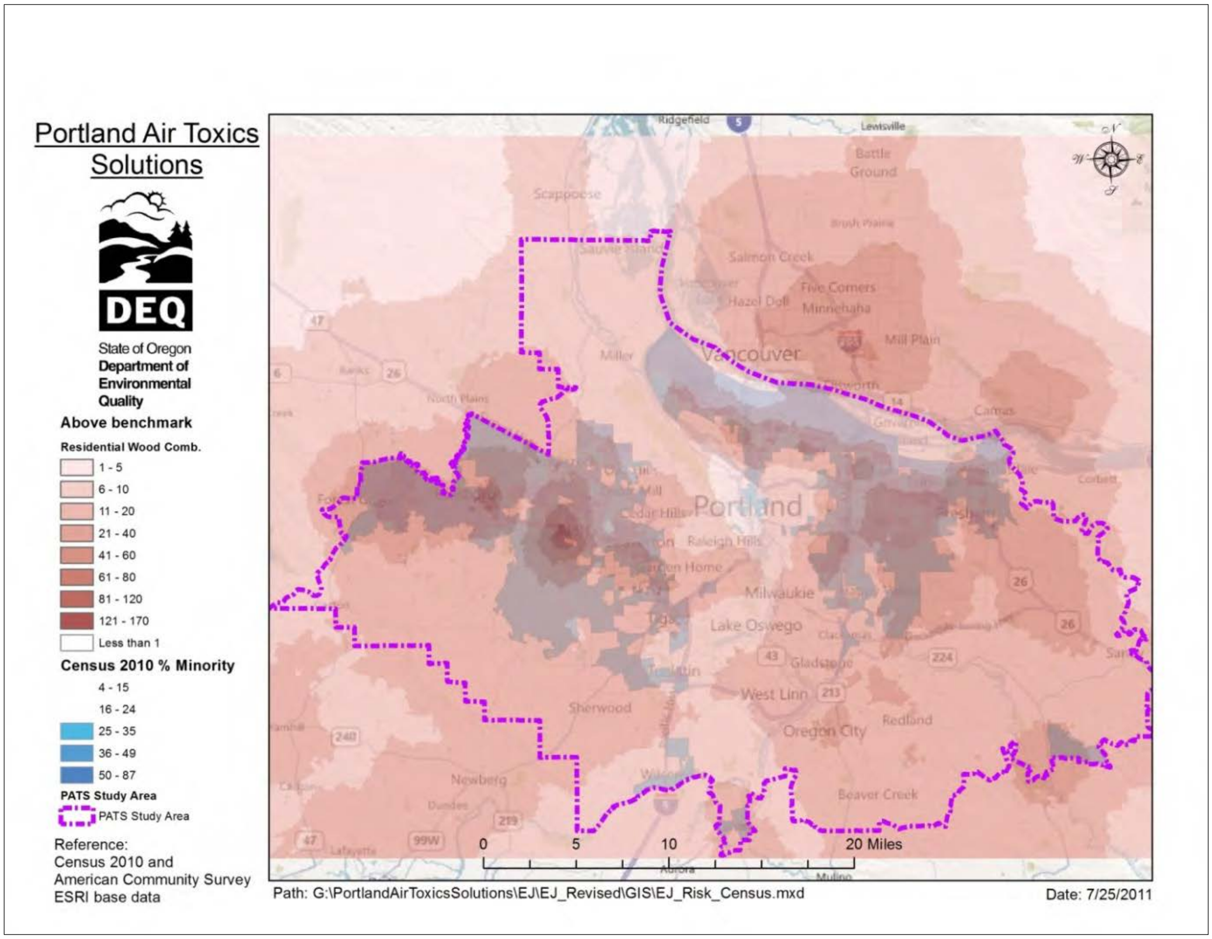
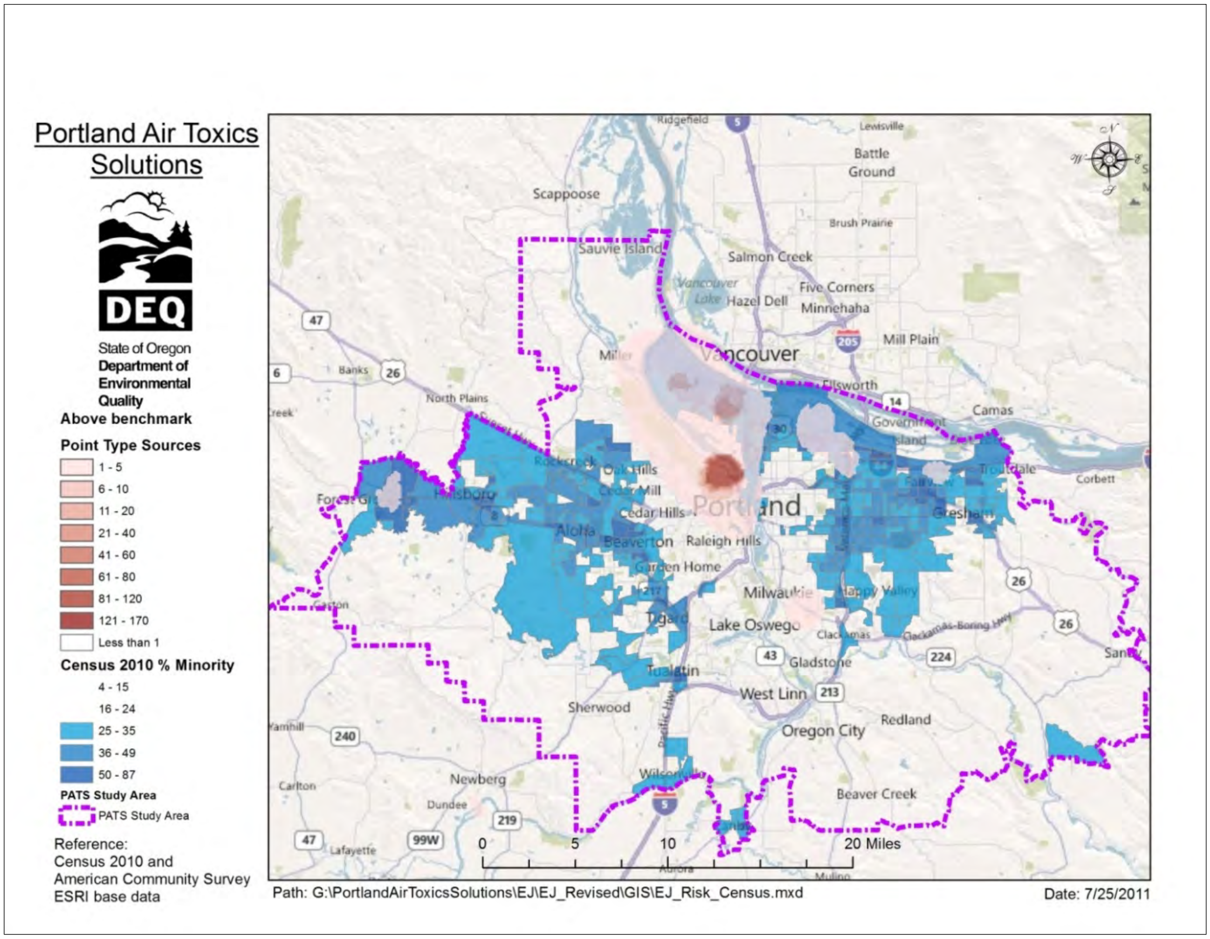


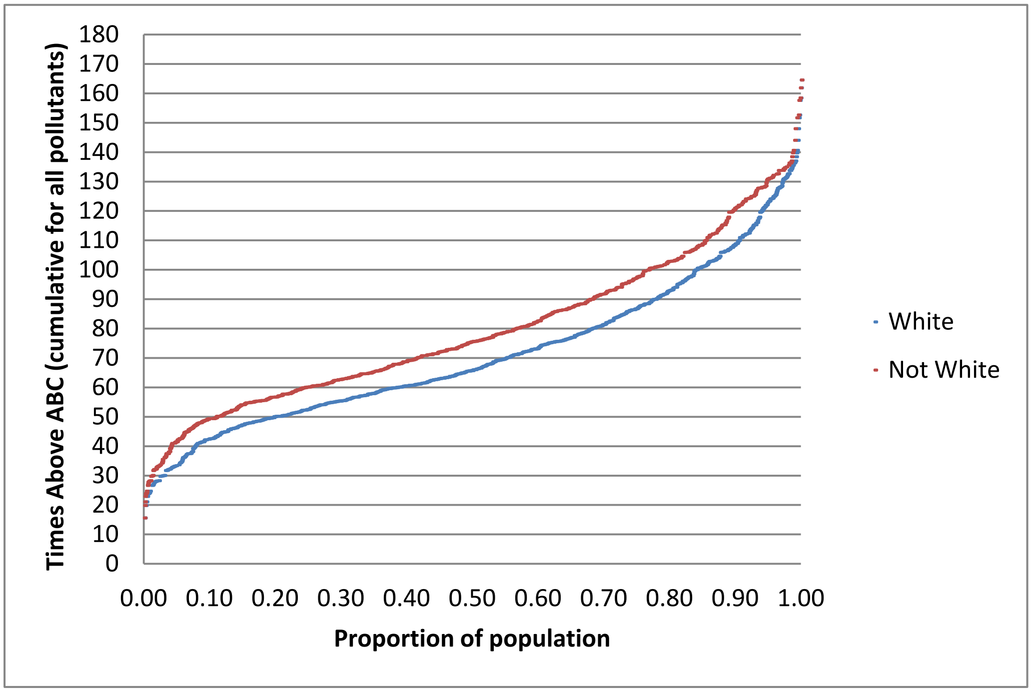
Figure 107: Cumulative Benchmark Exceedances from Point Sources and Percent Minority by Block Group



8.2.2.2 Performing a Cumulative Distribution Function

To gain a better quantitative understanding of environmental justice air toxics impacts in the Portland region, DEQ performed a cumulative distribution function (CDF) analysis (Waller et al.1999). DEQ analyzed the cumulative times above benchmark values at the block group level for white and minority populations. The y-axis represents cumulative times above benchmark values and the x-axis represents the fraction of the population exposed (from 0 to 1). Figure 108 shows the CDF curves for the two population subgroups. The gap between these two curves indicates that a larger proportion of minorities reside in block groups with higher risk. For example, 50% of white residents are exposed to levels of air toxics more than 65 times above health-based benchmarks, while 50% of minority residents are exposed to levels of air toxics more than 75 times above health-based benchmarks from all emission sources.

Figure 108: Cumulative Distribution Function of modeled air toxics impact from all source categories for White and Non-White Population: PATS 2017 Model Results: Cumulative Benchmark Exceedances From All Emission Source Categories



CDF analysis can be applied to individual source categories. Figure 109 and Figure 110 show results for two source categories: residential wood combustion and point sources. CDF curves of modeled residential wood combustion are similar to curves for all emission sources, although the disparity increases as wood smoke emissions increase. CDF curves of modeled point sources show that only 10% of the population in the study area experiences impacts above health-based benchmarks, with several block groups experiencing very high adverse impacts. CDF curves for whites and minority populations in Figure 110 do not indicate disproportionate impact on the non-white population.

Figure 109: Cumulative Distribution Function of modeled air toxics impact from residential wood combustion for White and Non-White Population

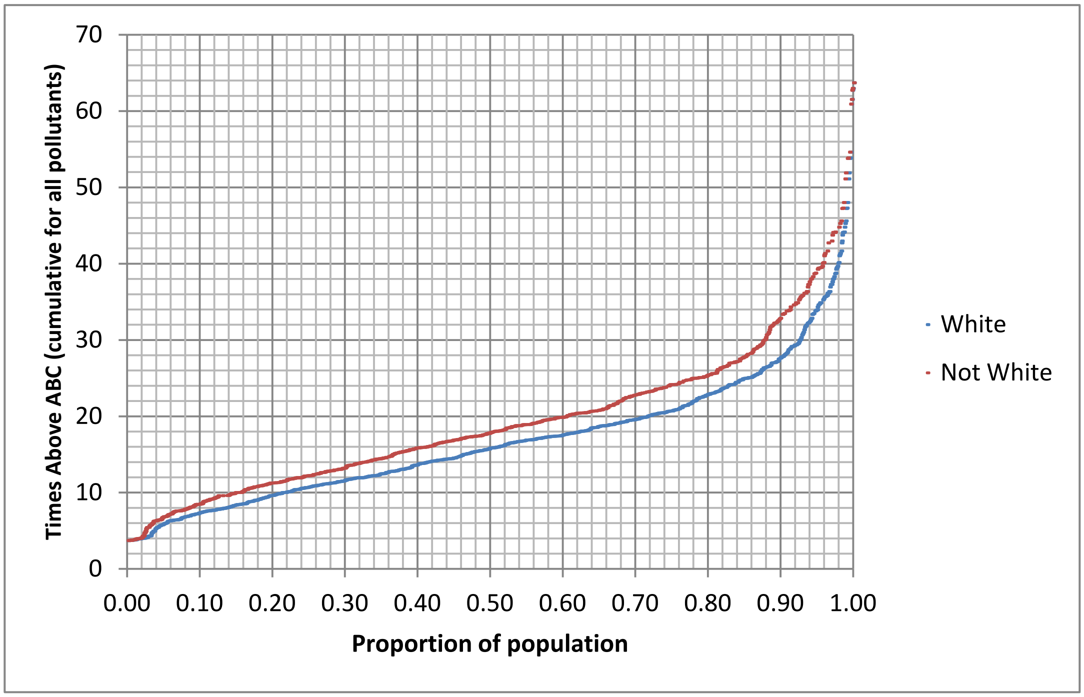
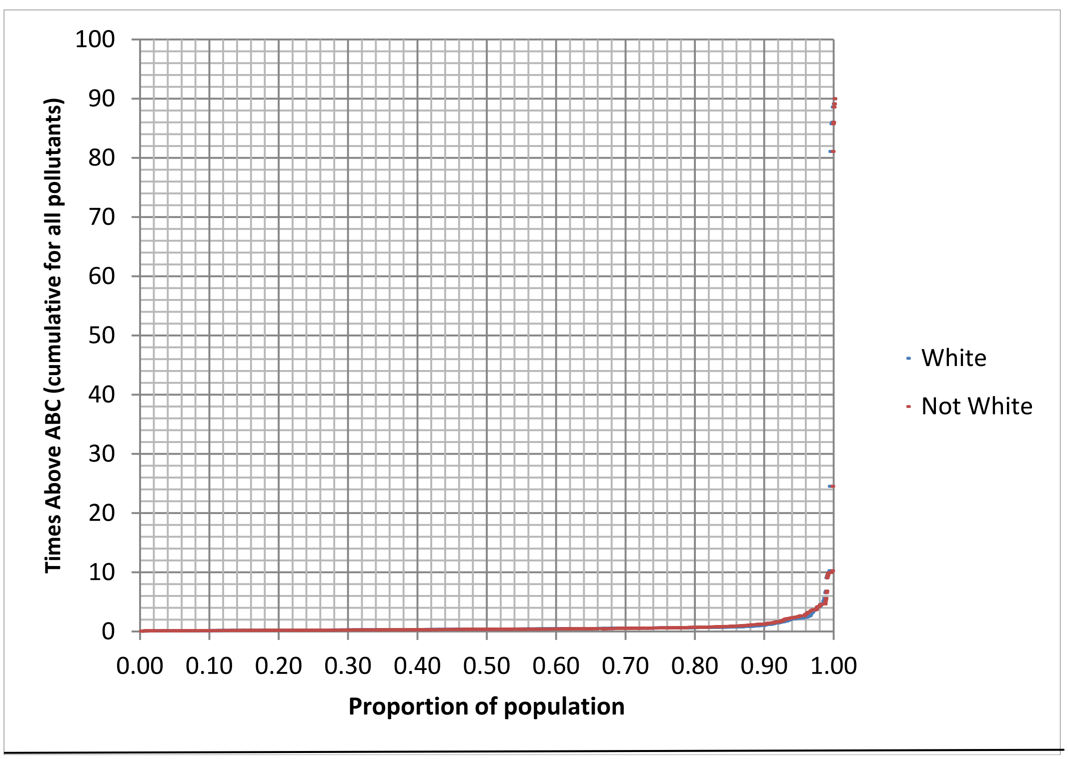


Figure 110: Cumulative Distribution Function of modeled air toxics impact from point sources for White and Non-White Population



8.2.2.3. Assessment of impacts in high minority and lowest income areas

Another way to consider EJ impacts is to focus on the areas with the highest minority and lowest income populations. DEQ selected ten block groups that rated highest for each of these two categories and compared the impacts in those block groups to the average impact within the PATS study area. Highest percent minority block groups were determined based on 2010 Census data, while lowest income block groups were determined based on ACS 12-month median household income data. Figure 111 shows the average benchmark exceedances from all sources and from individual source categories for the PATS study area and for the ten selected block groups for both race and socioeconomic status. The results indicate that the ten lowest income and ten highest minority block groups experience greater impacts from all sources of air toxics than the average block group in the PATS study area. This is also true for on-road mobile (ORM), non-road mobile (NRM), and area (excluding residential wood combustion) source categories. The block groups with the highest minority populations are exposed to residential wood combustion (RWC) emissions at greater levels than the average block group, while the lowest income block groups are exposed to less RWC emissions. Conversely, the lowest income block groups are disproportionately impacted from point source emissions than the average, while the block groups with the highest minority populations are impacted less than the average. Table 42 summarizes the ratios for average and top-ten values. The ratios show what source categories exhibit the largest deviations from average. A larger positive number in this table means a greater difference from the study area average, while a larger negative number means less exposure than the average for the study area.

Figure 111: Comparison of Times above Benchmark between 10 Selected Block Groups Based on Income and Percentage Minority and Average Times above Benchmark for all Block Groups within PATS Study Area

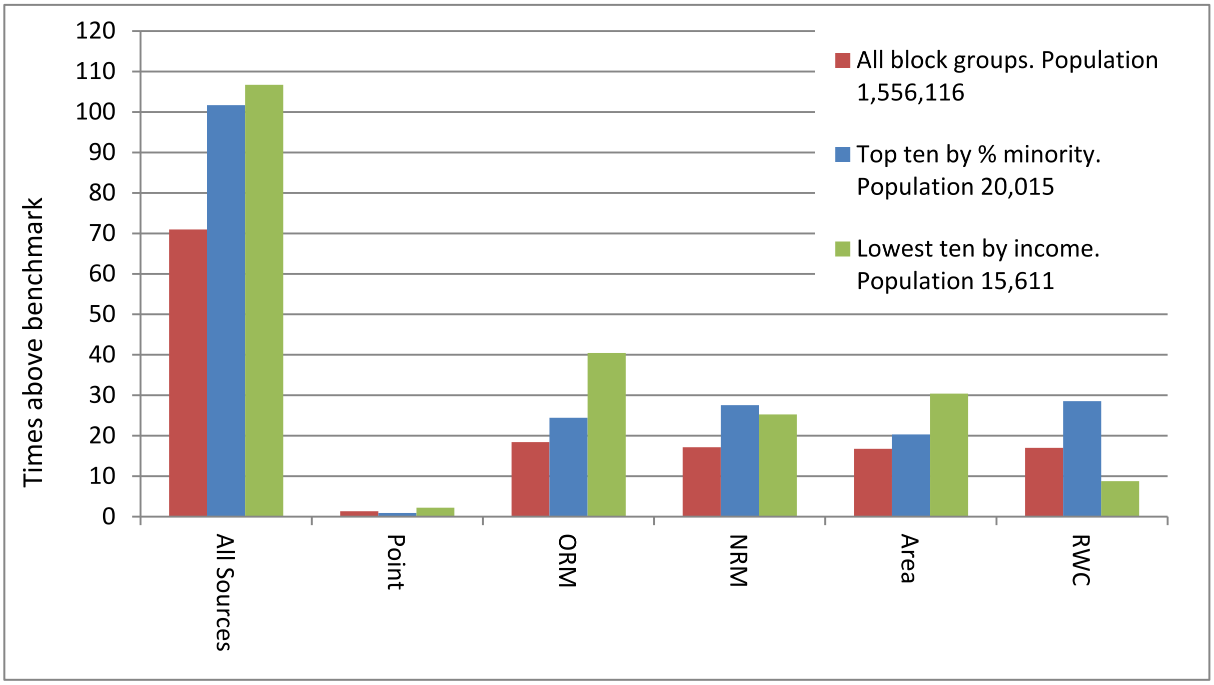
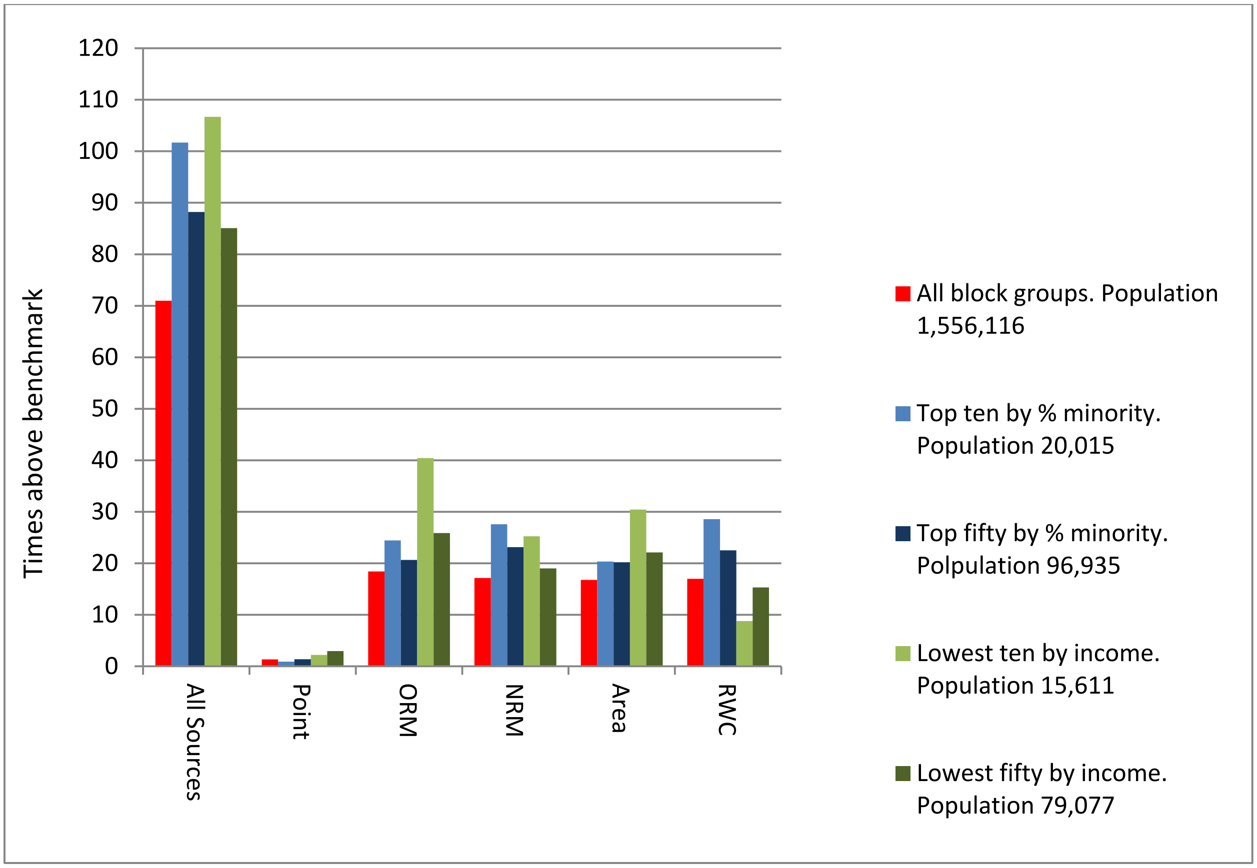


Table 42: Summary of Ratios Comparing Times above Benchmarks

	All Sources	Point Sources	On-road mobile ORM	Non-road mobile NRM	Area (other than residential wood combustion)	Residential Wood Combustion RWC
Top ten by % minority.	1.43	**0.68**	**1.33**	**1.61**	**1.21**	**1.68**
Lowest ten by income.	1.50	**1.65**	**2.20**	**1.47**	**1.81**	**0.52**

DEQ expanded the number of selected block groups from ten to fifty to determine if the disparate impact trend was consistent. Figure 112 shows that while differential exposure is still present when fifty selected block groups are compared to the average, this disparate exposure is less significant.

Figure 112: Comparison of Times above Benchmark between 10 and 50 Selected Block Groups Based on Income and Percentage Minority and Average Times above Benchmark for all Block Groups within PATS Study Area



The maps in Figure 113, Figure 114, Figure 115, and Figure 116 show the locations of the minority and income categories used in the comparisons of selected block groups.

Figure 113: Ten Lowest Income Block Groups

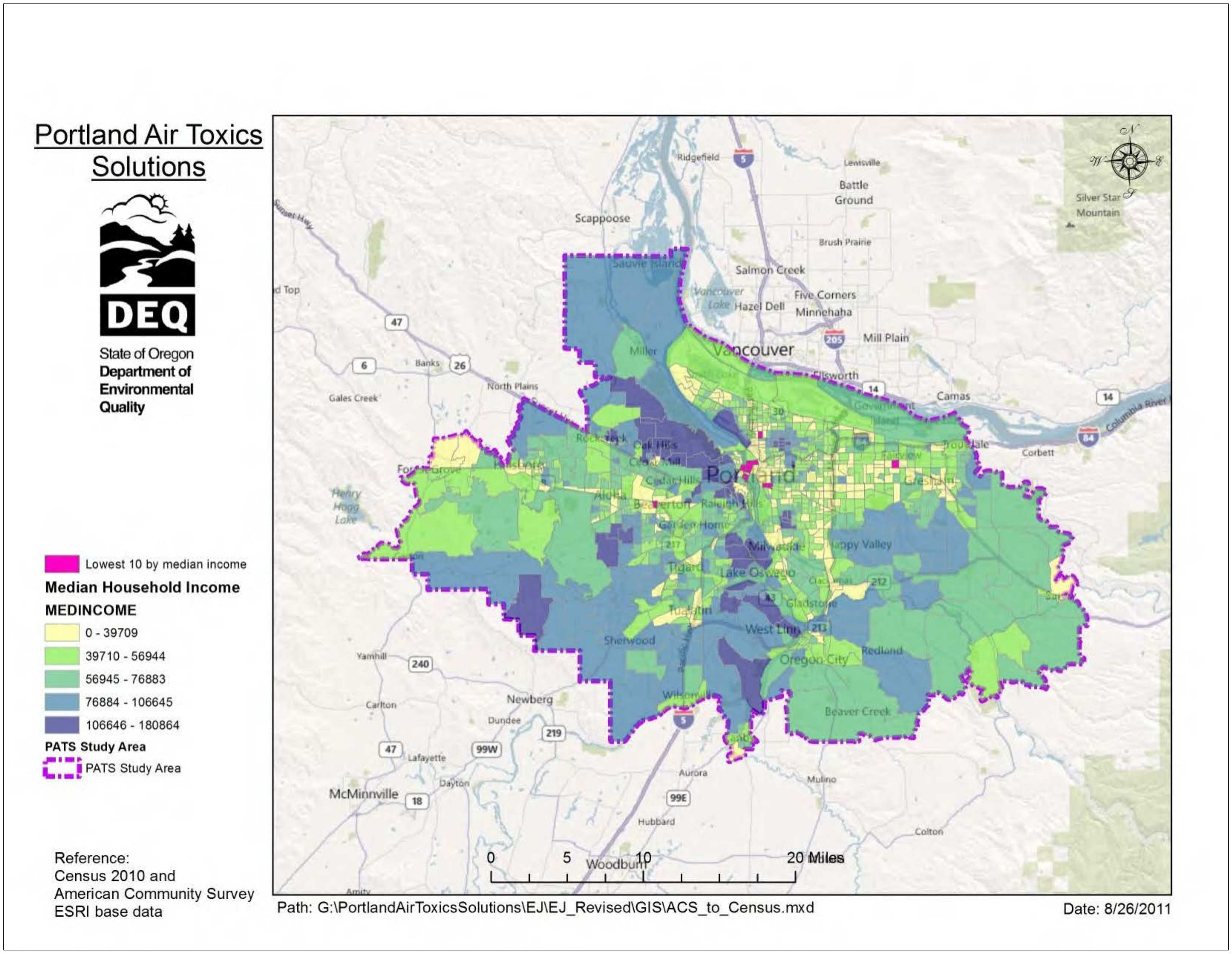


Figure 114: Fifty Lowest Income Block Groups

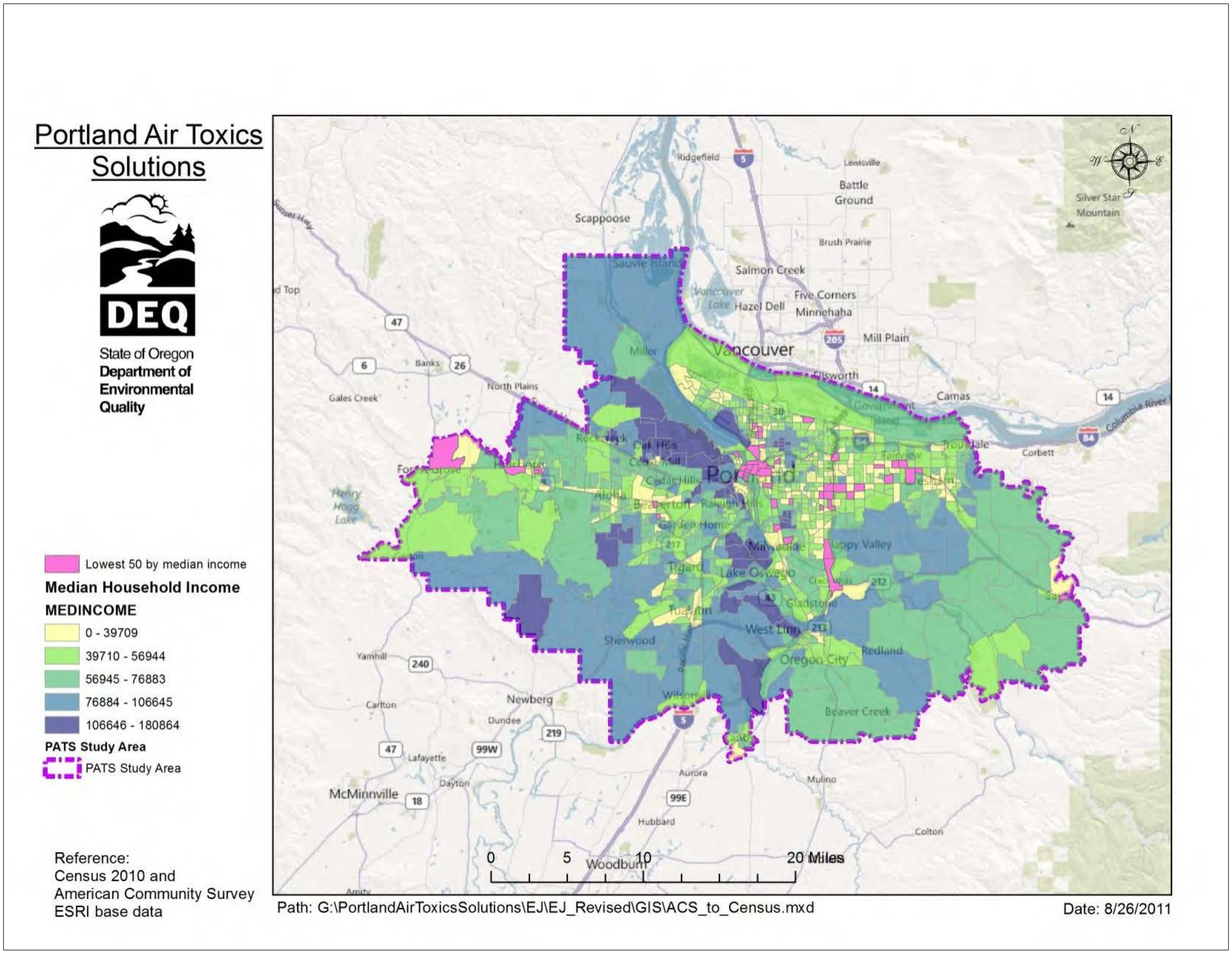


Figure 115: Highest Ten Block Groups by Percent Minority

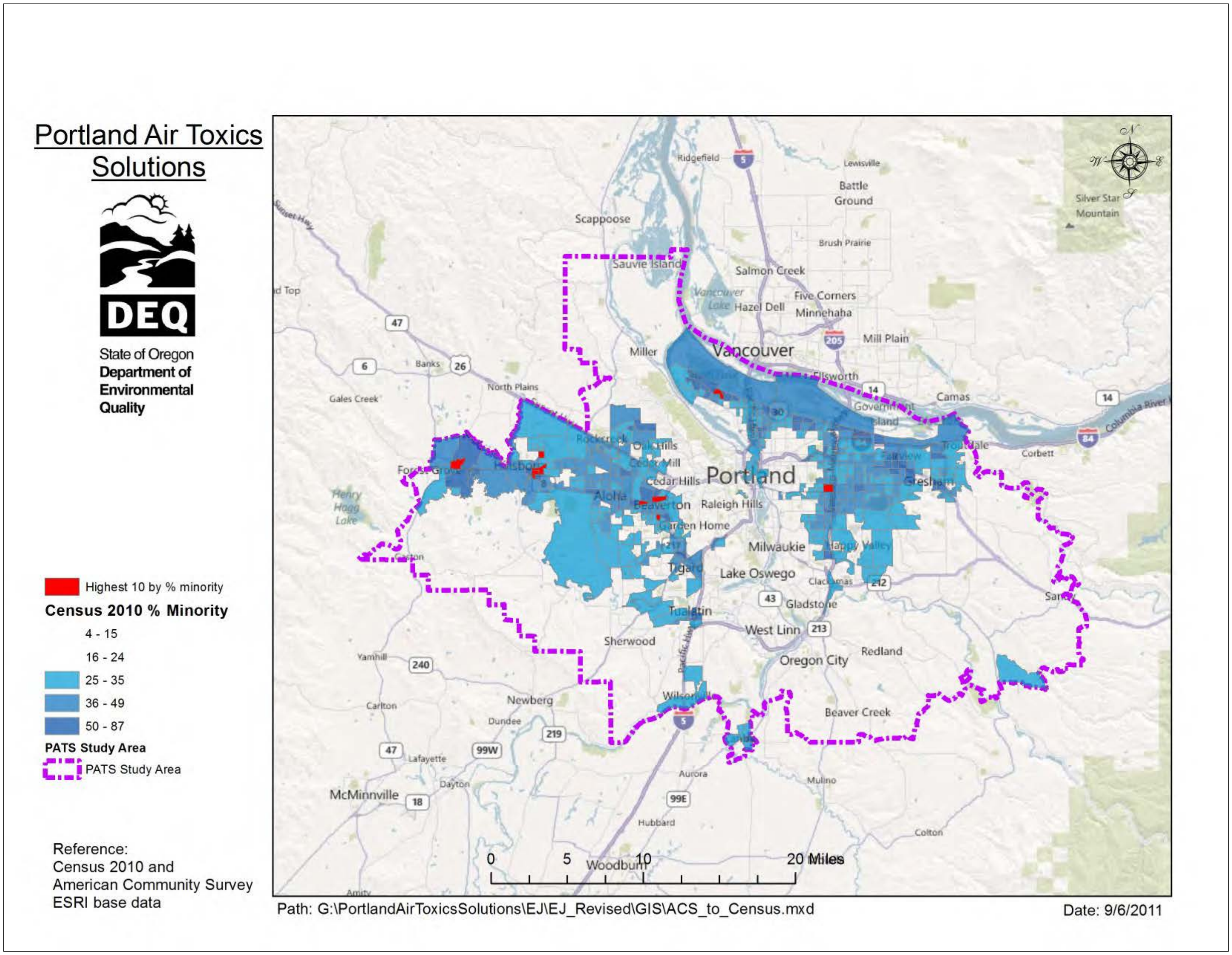
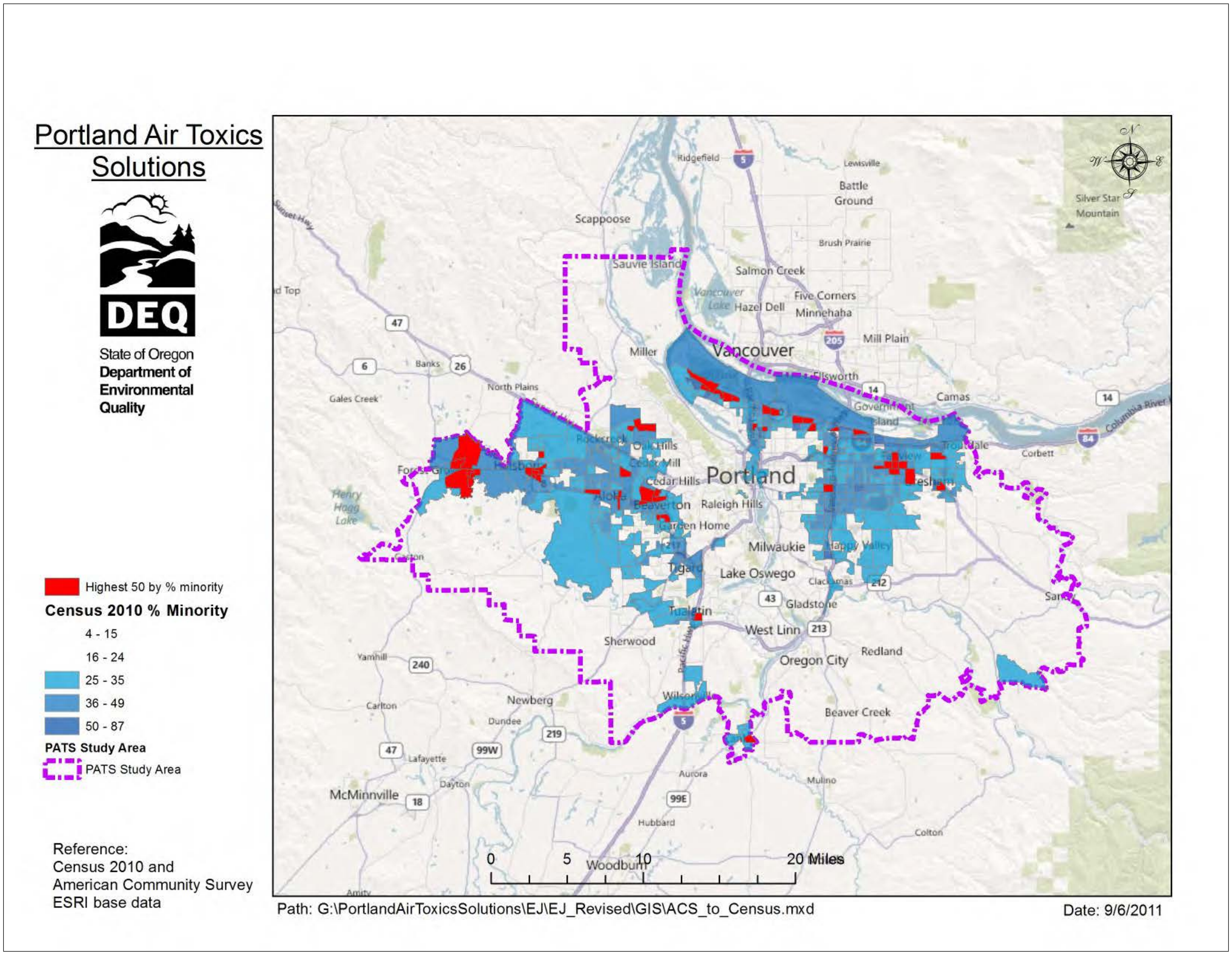


Figure 116: Highest Fifty Block Groups by Percent Minority



8.2.2.4 Multivariate linear regression modeling

DEQ also performed a statistical analysis of the PATS environmental justice information with a multivariate linear regression model. DEQ assessed multiple social, demographic, and income variables at once using the multiple linear regression (MLR) models. DEQ used MLR models to investigate whether the dependent variable - times above benchmark - is a function of, or is in relationship to the independent or explanatory variables - race and income. The explanatory variables DEQ included in the models are Hispanic/Latino, African American/Black, Asian, and below-poverty populations. Income was considered independently from race and minority status. Table 43 gives an overview of racial/ethnic and socioeconomic characteristics of the PATS study area and air toxics distribution from all sources and by major source category.

Table 43: Summary Descriptive Statistics for the Variables used in Multivariate Linear Regression Modeling

Summary Descriptive Statistics	Percent of Population by 2010 Census Block Group				Times Above Benchmark (TAB): cumulative for all PATS toxics					
	Hispanics/ Latino	*African American/ Black*	*Asian*	*Below Poverty*	*Total All Sources*	*Point Sources*	*On-Road Mobile*	*Non-Road Mobile*	*Area Sources*	*Residential Wood Comb.*
Mean	11.3	3.5	6.0	12.6	71.0	1.3	18.4	17.2	16.8	17.0
Standard Error	0.3	0.2	0.2	0.3	0.8	0.2	0.3	0.3	0.2	0.3
Median	7.4	1.6	4.2	9.8	65.3	0.5	16.4	14.8	16.3	15.8
Standard Deviation	10.5	5.2	5.4	10.5	26.1	6.8	8.5	8.4	6.8	9.4
Minimum	0.0	0.0	0.0	0.0	15.7	0.1	1.7	2.4	2.7	3.7
Maximum	83.0	38.2	45.1	59.8	171.6	89.9	50.5	66.4	36.4	63.7
Count	982	982	982	982	982	982	982	982	982	982

Within the PATS study area, an average of 11.3% Hispanic/Latinos, 3.5% African American/Blacks, 6% Asians, and 12.6% residents below the poverty line reside in each block group. Modeled concentrations are divided by the benchmarks to arrive at times above benchmark (TAB) values for each air toxic. Mean interpolated TAB values from all sources is 71, 1.3 from point sources, 18.4 from on-road mobile, 17.2 from non-road mobile, 16.8 from area sources, and 17 from residential wood combustion. A large standard deviation compared to the mean indicates that there is significant variation in the values by block groups. This can also be observed from the listed minimum and maximum values. A more detailed description of DEQ's statistical analysis may be found in Appendix 10.14.

Figure 117, Figure 118, Figure 119 and Figure 120 show the locations of Hispanic/Latino, African American/Black, Asian, and below poverty populations in the PATS study area.

Figure 117: Percent Hispanic/Latino Population by Block Group

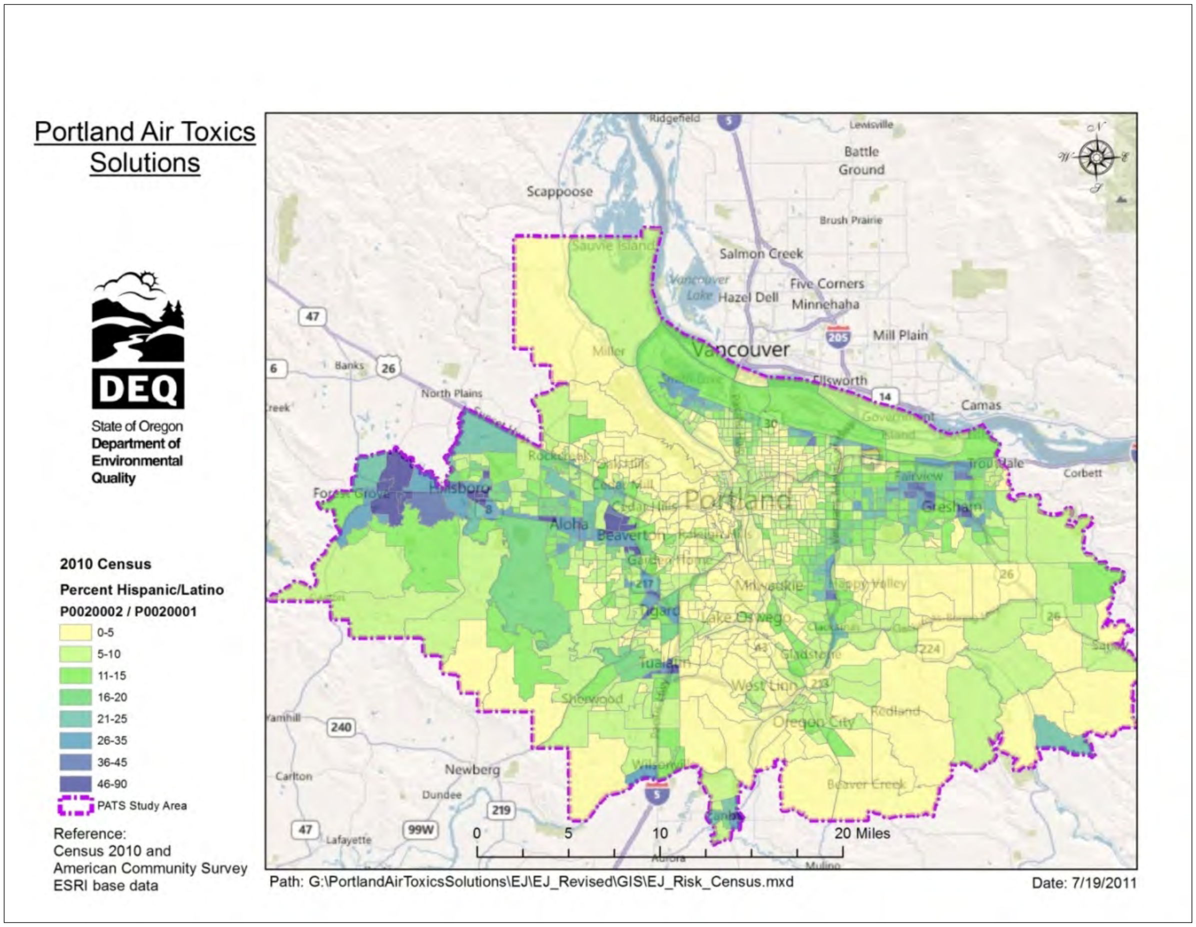


Figure 118: Percent African American/Black Population by Block Group

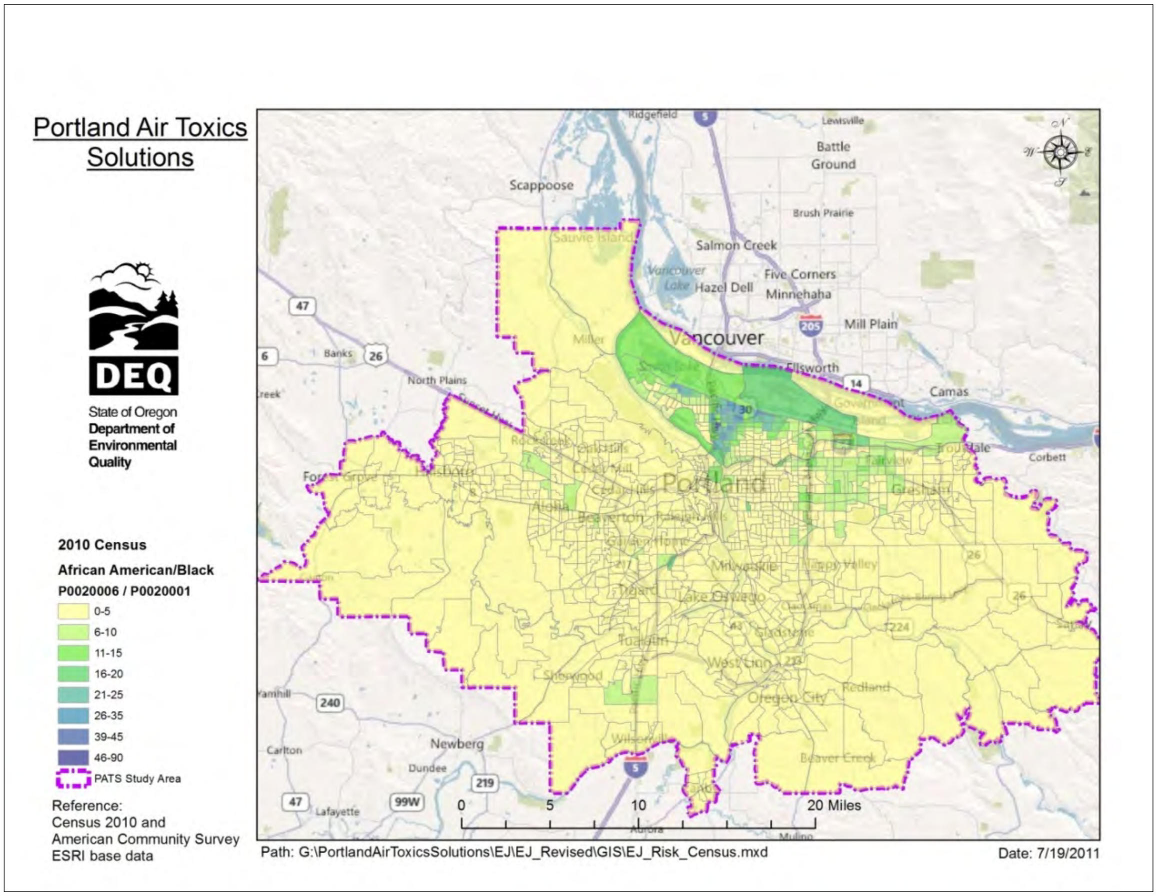


Figure 119: Percent Asian Population by Block Group

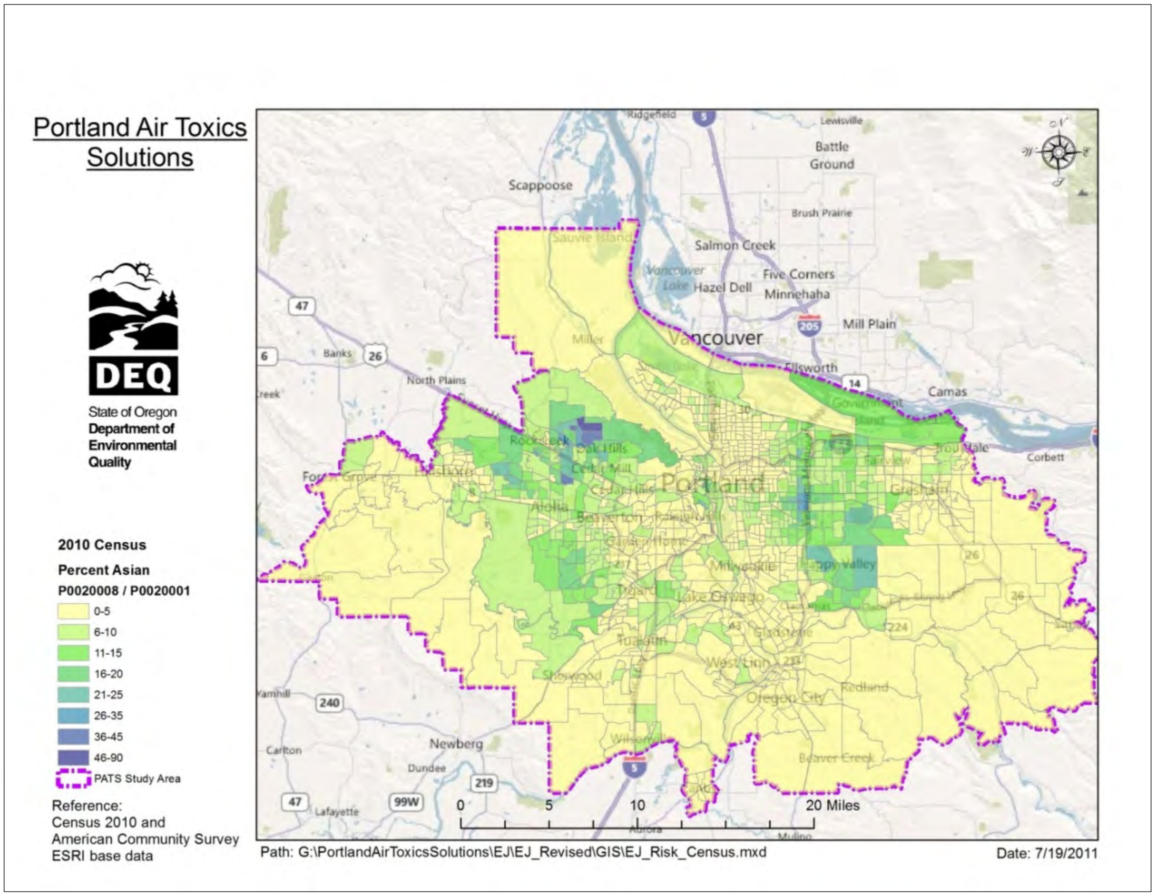


Figure 120: Percent Population below Poverty by Block Group

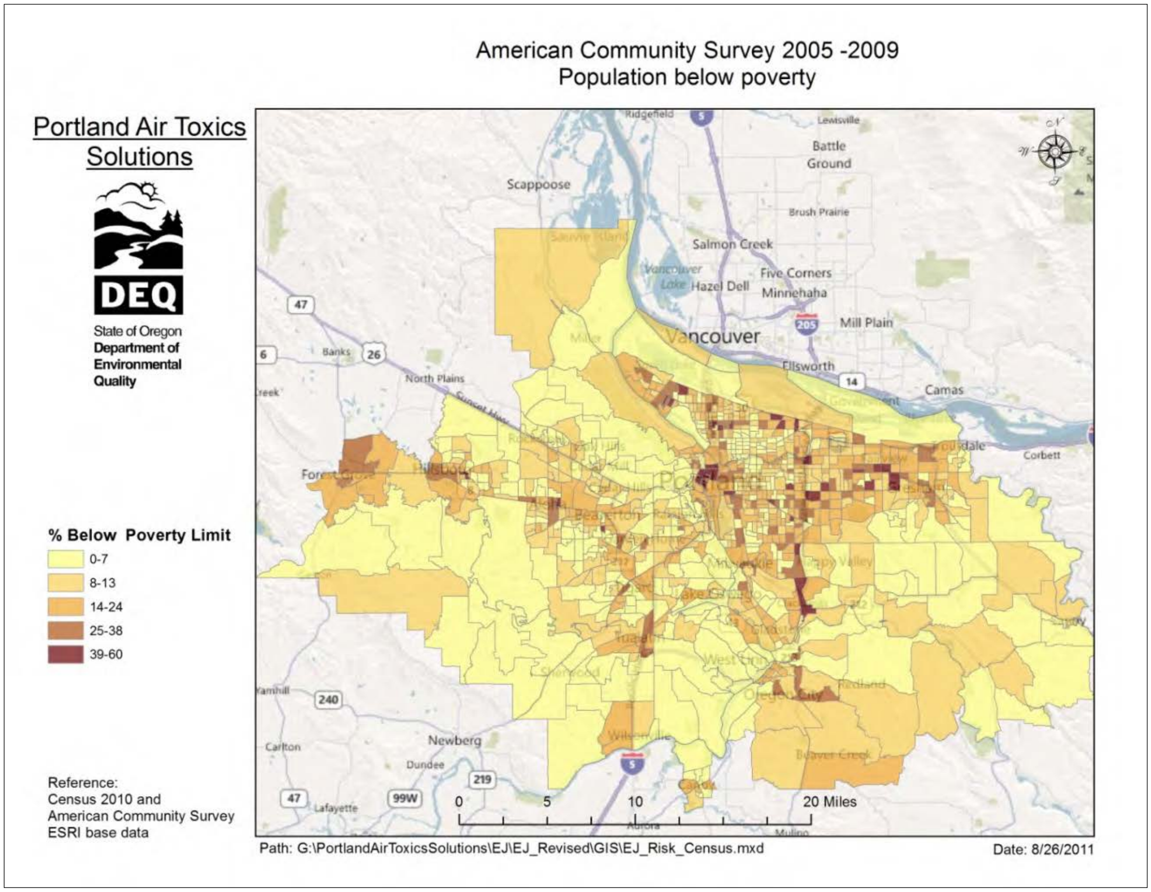


Figure 121 summarizes DEQ's findings from the multivariate regression modeling by source category. Residential wood combustion is the most significant source category affecting Hispanic/Latino population, while African American/Black populations tend to live in areas with least wood smoke. The most significant source category for African American/Black populations is area other, which includes all area sources except residential wood combustion. Asian populations are impacted mostly by on-road and non-road mobile categories. The impact decreases from left to right for all sources (e.g. the highest impact is associated with Hispanic/Latino and lowest with Below Poverty), and from top to bottom for source categories (e.g. residential wood combustion has the highest impact on Hispanic/Latino while area other sources have the least).

Figure 121: Summary findings from multivariate regression models

Disproportionate impact from all sources:
Higher → Lower

Disproportionate impact by source category: Higher → Lower

Hispanic/Latino	Asian	African American/Black	Below Poverty
Residential Wood Combustion	On-Road Mobile	Area	On-Road Mobile
Non-Road Mobile	Non-Road Mobile	Non-Road Mobile	Area
On-Road Mobile	Residential Wood Combustion		Point Sources
Area	Area		

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The multivariate regression analysis was the most sophisticated of the analytical approaches used in the environmental justice analysis. It produced statistically significant results that support earlier findings of disparate impacts using visual inspection, cumulative distribution and analysis in high minority and low income areas. All methods taken together confirm that there are disproportionate impacts from air toxics in minority and poor populations in the PATS study area. The regression analysis provides more detail by showing that different populations are affected differently by various sources of pollution. This information can be used to better understand and communicate public health risks as well as to target emission reductions.

9. PATS Emission Reduction Plan, Next Steps

9.1 Introduction

The PATSAC provided DEQ with valuable input and a wide diversity of opinion on the developing PATS emission reduction plan. Committee members participated in many challenging discussions on emerging science, problem definition and potential solutions, and as a result have helped inform and contribute to the proposal for emission reductions and implementation stated in this section. DEQ fully considered input from PATSAC and incorporated much of the committee's input in the technical study and emission reduction plan. DEQ understands through comments received and group discussion that many PATSAC members support the next steps stated in this section. However, this section does not represent the views of all PATSAC members and DEQ in no way implies that is endorsed by all members. Written PATSAC comments including letters of support and opposition received during the committee process are in Appendix 10.13. DEQ will seek further comment from the public and stakeholders before finalizing this proposal for presentation to the Environmental Quality Commission.

This emission reduction plan is organized in the following sections: a ranking of 2017 total risk from categories area wide and locally, a list of recommended actions, including ongoing and imminent actions, a prioritized set of categories needing follow up action expressed as a short term and longer term plan, and future process recommendations for high priority categories in the short term plan.

The prioritized source categories will guide DEQ and actions of partners to reduce toxics; however DEQ and others may take advantage of additional emission reduction opportunities as they arise. For example, revisions to the federal ozone standard could cause additional ozone planning in the Portland area. Reducing ozone precursors will reduce multiple air toxics in the Portland area. It can also reduce precursors to secondary formation air toxics such as formaldehyde and acetaldehyde. Oregon DEQ can also work with Washington air agencies to address significant levels of background pollutants that are transported regionally, such as benzene. In addition, many efforts to reduce greenhouse gases will also reduce air toxics, and there are opportunities to maximize co-benefits through coordinated planning.

Because many air toxics emission reductions are achievable only through partnerships, PATSAC and DEQ respectfully request the assistance from agencies and partners named in this report. For each one of the priority source categories needing follow up action, DEQ or partners will conduct additional stakeholder consultation and outreach to the affected sectors and public. This follow up consultation will be more detailed for each category and give stakeholders a chance to refine data, further investigate and analyze emission reduction options, and apply the full spectrum of PATSAC considerations (Appendix 10.2.3) in evaluating reduction plans.

9.2 Ranked Source Categories based on Modeled Total Risk

Oregon air toxics regulations outlining requirements for a local emission reduction plan specify that the plan will address both area wide and localized risk from air toxics emissions. The modeling results, source category rankings and emission reduction targets for both area wide and local impacts are detailed in chapters 4, 5 and 6 of this report. To perform an initial ranking or prioritization of source categories area wide, DEQ analyzed 2017 projected total risk for all source categories at the 80th percentile of emission concentrations. This is shown in the first column of Table 44 below. The second column shows the white paper categories that match the ranked source categories. After each category the number in parentheses shows a total times above benchmarks for all pollutants from that category. For each significant category of air toxics emissions, DEQ with the assistance of contractor Eastern Research Group developed white papers to provide a survey of initial information on existing and potential emission reduction strategies. The white papers are summarized in chapter 7 and are available as links in Appendix 10.9.

In the PATS model estimated air toxics concentrations are distributed in different patterns throughout the region. Some pollutants are distributed uniformly; others track roadways or residential density to form zones of higher concentrations. In a few areas, the PATS model estimates higher concentrations of pollutants from industrial activities causing local impacts. In the Portland area, the unique local industrial impacts are limited to several metals related to casting and metal production. To perform an initial ranking of these localized impacts, DEQ analyzed total risk for metals that were present only in isolated groups of census blocks. This analysis was performed at the 98th percentile to generate point source emission reduction targets at the highest and closest impacted receptors for metal pollutants. The localized impact results are in Table 45 , showing the category of point sources followed by the white paper category of metals facilities. While on road mobile and residential wood emissions also showed localized impacts in the concentration maps, the model output did not provide enough information to formally delineate these impacts. On road mobile emissions, while distributed throughout the study area, can result in elevated localized impacts in areas with high volume and congestion. Residential wood combustion causes some of the highest risks throughout the study area and can cause high localized impacts in denser residential areas with less air circulation where many residents burn wood, especially in older uncertified stoves. Further investigation and data refinement will lead to greater understanding of all localized impacts.

Table 44: 2017 Total Risk for all Source Categories at the 80th Percentile Emission Concentrations

Area Wide All Pollutant Ranking (Times Above Benchmark 80th Percentile)	White Paper Category Detail (Times Above Benchmark 80th Percentile)
1. Residential Wood Combustion (38)	Residential Wood Combustion (38)
2. On Road Mobile (35)	1. On Road Mobile Gas (29) 2. On Road Mobile Diesel (6)
3. Area Other (24) Note: risk in this category is dominated by structural fires, most of which are accidental. As a result, this category is not a top priority.	1. Industrial Fuel Use (2) 2. Residential Heat Non Wood (1) 3. Asphalt Use (1)
4. Construction (12)	1. Construction Diesel (11.5) 2. Construction Gas (0.5)
5. Non Road Mobile Other (11)	1. Non Road Mobile Diesel (6) 2. Non Road Mobile Gas (5)
6. Lawn & Garden (10)	1. Non Road Mobile Diesel (9) 2. Non Road Mobile Gas (1)
7. Solvent Use (7)	1. Solvent-Coating (4) 2. Consumer Products (3)
8. Point (5)	Point (5)
9. Airport (3)	Airport (3)
10. Rail (2)	Rail (2)
11. Residential Open Burning (2)	Residential Open Burning (2)

Table 45: 2017 Total Risk from Metals for all Source Categories at the 98th Percentile Emission Concentrations

Localized Impact Pollutant Ranking (Times Above Benchmark 98th Percentile)	White Paper Category Detail (Times Above Benchmark 98th Percentile)
Point (5)	Metals Facilities (5)

9.3 Ongoing or Imminent Strategies

DEQ recognizes that government partners implement multiple measures that currently or imminently will reduce air toxics in the Portland Area. The following section lists many of the actions that more directly affect air toxics. DEQ supports the continued implementation of these measures. Appendix 11.12 provides additional detail on some of these measures.

9.3.1 Removal of Uncertified Woodstoves upon Home Sale

Heat Smart is a DEQ program that accelerates the change out rate for older more polluting woodstoves. As directed by Oregon's Legislature, homeowners are required to remove and destroy any uncertified woodstove when they sell their home. As housing stock turns over, uncertified stoves will be slowly removed. This regulation is part of a program to help protect Oregonians from uncontrolled wood smoke that results from the use of old, polluting and inefficient uncertified woodstoves. It was adopted to help meet the federal fine particulate air quality standard, but will also help reduce air toxics like 15 PAH and benzene.

9.3.2 Low Emission Vehicles

Oregon’s Low Emission Vehicle (LEV) standards as adopted by DEQ took effect with the 2009 model year and will reduce greenhouse gas emissions from new light duty vehicles by 30% when fully effective in 2016. Reductions achieved a net savings to vehicle owners through improved fuel efficiency. The LEV rules also reduce traditional pollutants (VOC, NOx) and toxic air pollutants such as benzene, and include requirements for increasing numbers of Zero Emission Vehicles such as Battery Electric Vehicles and Plug-in Hybrids.

9.3.3 Oregon Low Carbon Fuels

Oregon statutes allow DEQ to adopt low carbon fuel standards, which would reduce the carbon intensity (i.e. greenhouse gas emissions per unit of fuel energy) of Oregon’s transportation fuels by 10% over a 10-year period. DEQ convened an advisory committee to provide input on the structure and design of a low carbon fuel standard program. DEQ and the advisory committee evaluated various scenarios that represent different ways (traditional and cellulosic biofuels, compressed natural gas, electricity as a transportation fuel, etc.) the state could comply with a low carbon fuel standard. Depending on the mixture of fuels, especially electricity, there is potential for low carbon fuels standards to decrease air toxics in the Portland area. Rulemaking to implement this program may be considered during 2012.

9.3.4 Land Use and Transportation Planning

Metro is responsible for long-range land use and transportation planning for the region and sets policy for the Portland region in cooperation with local governments and transit providers who need to implement the policy. Updates occur through the Regional Transportation Plan (RTP), which identifies specific transportation projects to be built over the next twenty years. Metro will update the RTP in 2013-2014 and incorporate measures to reduce greenhouse gas emissions from vehicles. Those measures will also reduce mobile source air toxics. Metro is also interested in quantifying air toxics reductions. Transportation and land use objectives are interdependent and therefore the two planning processes are coordinated at both the regional and local levels. Metro’s Regional Transportation Functional Plan and Urban Growth Management Functional Plan provide direction to local governments and other partners and are the basis for determining consistency with regional plans and policies. As a member of the Metro committee, DEQ participates in the transportation planning process.

Metro conducts many other activities that help reduce air toxics emissions by decreasing vehicle miles traveled, supporting transit use or tracking changes in air toxics emissions. These are summarized in Appendix 10.12, and include:

- The 2040 Growth Concept
- The Regional Travel Options Plan
- Metro's Transit Oriented Development Program
- The Regional Transportation Plan Update
- Drive Less Save More

TriMet, the region's transit authority, engages in transit planning through its Transit Investment Plan (TIP), a five year planning process updated annually on a rolling basis. TIP priorities help reduce air toxics emissions by increasing frequency, accessibility and connectivity of the regional transit system. The TIP describes the investments in service, capital projects and customer information necessary to meet regional transportation and livability goals. The TIP provides local governments with a guide for their planning processes so they can leverage TriMet's investment with transit-related infrastructure such as sidewalks and safe street crossings. The TIP includes the following four priorities:

1. Build the "Total Transit System" by enhancing customer information, access to transit, stop amenities, frequency, reliability, passenger comfort, safety and security;
2. Expand high-capacity transit by investing in light rail, commuter rail and streetcar service along key corridors to connect regional centers;
3. Expand Frequent Service by adding to TriMet's network of bus lines that run every 15 minutes or better;
4. Improve local service by working with local jurisdictions to improve transit service in specific local areas.

9.3.5 Oregon Greenhouse Gas Scenario Planning

The 2009 Oregon Legislature adopted HB 2001 which requires Metro to do greenhouse gas scenario planning. In 2010, the Legislature adopted SB 1059, a statewide, comprehensive bill aimed at reducing greenhouse gas emissions from transportation. This bill expanded voluntary scenario planning to the other five metropolitan planning organizations and required the Oregon Transportation Commission to adopt a statewide greenhouse gas strategy for transportation. The goal of Senate Bill 1059 is to set interim year 2035 goals to ensure that transportation and urban planning-related greenhouse gas reduction activities are on the trajectory to meet the statewide goal of reducing greenhouse gas emissions in the year 2050 by 75% of 1990 levels The Oregon Land Conservation and Development Department set light duty vehicle miles traveled reduction targets for the Metropolitan Planning Organizations in June 2011 in order to meet the 2035 goals. The strategies developed through greenhouse gas scenarios planning or the statewide greenhouse gas transportation strategy will likely have co-benefits for air toxics.

9.3.6 City of Portland and Multnomah County Clean Diesel Contracting Specifications

The City of Portland and Multnomah County are exploring opportunities to reduce diesel emissions associated with publicly funded construction projects. Potential strategies include financial incentives, as well as bid language and contract specifications encouraging private contractors working on City and County projects to utilize clean diesel equipment (e.g. new engines, exhaust retrofits). The City and County are currently pilot testing a variety of approaches to clean diesel contracting. The County has piloted a clean diesel contracting requirement at its East County Courthouse project, a $19.5 million construction project in the Rockwood neighborhood in Gresham. The knowledge and experience gained through these pilot projects, as well as ongoing engagement with stakeholders in the construction community, is helping the City and County identify viable clean diesel contracting options for the future that: are cost effective; ensure a fair bidding process; and mitigate impacts on small subcontractors and minority, women and emerging small businesses.

9.3.7 TriMet Fleet Improvements

TriMet has and continues to improve the operation of their bus fleet by reducing diesel fuel consumption and emissions, including air toxics. See Appendix 10.12 for more information on TriMet fleet improvements.

9.3.8 Washington County

Washington County designs roads and bridges to optimize traffic flow to save gas, reduce air pollution, and shorten commute time by using low impact designs wherever possible. These measures also reduce air toxics. New highway projects always include significant bicycle and pedestrian facilities. Other measures include road recycling, roundabouts, signal and streetlight efficiency, and development for cyclists and pedestrians.

Washington County's Long Range Planning Division provides community land use planning for rural and unincorporated Washington County. With transit corridor and station area planning, and bike and pedestrian planning, it integrates a mix of land uses and densities that result in more complete communities with multiple transportation options that could reduce VMT and air toxics.

Washington County's Department of Land Use and Transportation (LUT), supported by a U.S. Department of Energy (DOE) Energy Efficiency Community Block Grant (EECBG), is conducting a process to evaluate its land use and building codes to identify how energy efficient and sustainable development may be better supported. Improvements in both of these areas could reduce air toxics. (Source: Washington County website: http://www.co.washington.or.us/Support_Services/Sustainability/)

9.3.9 Clackamas County

Clackamas County has upgraded many of its heavy duty diesel vehicles for road construction and maintenance. Clackamas County is deploying grant funds to retrofit solid waste and recycling collection vehicles operating in the region. The Clackamas County weatherization program decreases air toxics emissions from home heating.

9.3.10 Other Ongoing DEQ Actions

DEQ implements several other regulatory, outreach and incentive programs that reduce air toxics in the Portland area on an ongoing basis. They include implementation of:

- National Emissions Standards for Hazardous Air Pollutants (NESHAPS) for many categories of industrial and commercial activities including autobody shops, gas stations and dry cleaners (http://www.deq.state.or.us/aq/bap/neshap.htm)
- A Small Business Assistance Program (http://www.deq.state.or.us/aq/bap/index.htm)

- The Vehicle Inspection Program (http://www.deq.state.or.us/aq/vip/)
- The Employee Commute Option Program (http://www.deq.state.or.us/nwr/ECO/eco.htm)
- As part of the Portland Ozone plan, permit limits on volatile organic compounds which are ozone precursors, and many of which are air toxics
- Agency-wide toxics coordination, prioritization and reduction planning

9.4 Priority Categories for Emission Reductions

In collaboration with PATSAC, DEQ has prioritized five categories of emission sources shown below for near term follow up action, including stakeholder consultation, planning and emission reduction actions. This prioritization is based on the categories shown in Table 44 and Table 45 according to total modeled risk, practicability of emission reductions, and the directive in Oregon air toxics regulations to address both area wide and localized risk. Even though it ranked third in level of modeled risk, the category called "Area Other" was not included in the top five categories because most of the emissions are from structural fires, which are unpredictable and not practicable to control. In general, DEQ anticipates that emission reduction planning will occur in the near term categories in one to five years as resources allow.

The emission reduction plan also prioritizes remaining emission categories for longer term follow up action, including stakeholder consultation and emission reduction actions. These categories may contribute significant risk in various locations, but overall contribute much less risk than the five categories recommended for near term action. DEQ anticipates that emission reduction planning in the longer term categories will occur in five to ten years, as resources allow. This recommended prioritization is intended to guide the work of DEQ and partners. In no way is it intended to preclude development and implementation of important toxics and emission reduction opportunities as they arise or are initiated by partner agencies.

In the near term categories below, DEQ has designated "lead" and "support" agencies. A lead designation means an agency is recommended to convene the stakeholder process and follow up on emission reduction planning for the related category. Supporting agencies are recommended to work in partnership with the lead agency to assist with the stakeholder process and follow up.

9.4.1 Near Term Plan

- Residential Wood Combustion (DEQ lead with city and county support)
- On Road Mobile Light Duty (Metro lead on VMT reductions, DEQ lead on cleaner vehicles)
- On Road Mobile Heavy Duty (DEQ lead)
- Construction (DEQ lead with local government support)
- Industrial Metals (DEQ lead)

9.4.2 Longer Term Plan

- Non Road Mobile Other
- Lawn and Garden
- Solvent Use
- Area Other
- Point
- Airport
- Rail

- Residential Open Burning

9.5 Future Process for Near Term Categories

9.5.1 Residential Wood Combustion (DEQ lead with city and county support)

9.5.1.1 Risk contributed by the category

Residential wood combustion emits 75% of 15 PAH within the PATS area and contributes to both area-wide risk and localized impacts. The target reduction for 15 PAH from this category is 97%. Approximately half of this target can be achieved by implementation of the strategies where emission reductions have been quantified. Strategies where the emission reductions are unknown could reduce this gap.

9.5.1.2 Emission reduction plan

9.5.1.2.1 General

- With city and county support DEQ will convene a stakeholder process to identify and evaluate strategies to achieve the maximum feasible emission reductions, and recommend specific actions consistent with the PATSAC considerations, including cost effectiveness, feasibility and benefits analysis and options for ongoing improvement. This process will consider all of the recommendations to follow in this category, with the purpose of further exploring, evaluating and selecting actions for implementation.
- Conduct a residential wood heating activity survey targeted to the Portland Metro area.
- Following validation of the wood heating activity survey, develop a targeted regional campaign to raise awareness that RWC is a significant contributor to air toxics risk in the Portland region.
- Improve implementation of the uncertified woodstove change out program including improved outreach and incentives or requirements for replacement appliances.

9.5.1.2.2 Cleaner Fuel, Cleaner Burning

The following actions are recommended to achieve cleaner fuel and cleaner burning:

- DEQ and partners to develop community-based education efforts (e.g. Clean Burn Ambassadors) to train residents to reach neighbors on clean-burn techniques (certify them to assess opacity, educate on wood moisture, etc.) and communicate voluntary curtailment days during stagnant air episodes as a routine component of local weather reporting.
- DEQ to evaluate effectiveness of other jurisdictions' opacity regulations.

9.5.1.2.3 Cleaner Appliances

The following actions are recommended to achieve cleaner appliances:

- Government and private partners to create a stable long term fund for replacement of uncertified wood stoves, with emphasis on funding replacement in affected environmental justice communities.
- DEQ to coordinate with partners to advocate for funding assistance for wood stove replacements and weatherization programs, with emphasis on assistance to affected environmental justice communities.

- DEQ to advocate for strong national standards for new wood heating devices based on the best current technology and performance. If EPA standards are not adequate, DEQ to adopt more stringent state standards for new wood heating devices.

9.5.1.2.3 Less Wood Burning

The following actions are recommended to achieve less wood burning:

- DEQ and partners to assess the need for and access to weatherization programs and incentives for those who frequently (or primarily) heat with wood. If needed, develop new funding or target existing funding to weatherize homes that primarily or frequently heat with wood, with emphasis on weatherization in affected environmental justice communities.

9.5.1.3 Issues

Future consideration of emission reduction in this category will include the following issues:

- More information is needed to evaluate whether fuel quality and opacity requirements would effectively reduce wood burning emissions.
- Because there is a large gap between the emission reduction target and achievable reductions for this category, once the initial feasible strategies are implemented, DEQ and partners will need to establish a follow up process to revisit strategies and recommend implementation of technological advances.

9.5.1.4 Stakeholders and Partners

Stakeholders and partners in this category will include citizens, realtors, developers, wood burning and other heating appliance vendors, oil, electric and natural gas companies, city and county government, including health departments, building code agencies and planning departments.

9.5.1.5 Data and white paper refinement needs

The following actions are recommended for data refinement:

- DEQ to develop more complete emission inventory information about PAH emissions from fireplace use.
- DEQ to develop more information on the composition of and emissions from artificial logs.

9.5.2 On Road Mobile Light Duty (Metro lead on VMT reductions, DEQ lead on cleaner vehicles)

9.5.2.1 Risk contributed by the category

The pollutants contributing the majority of the risk from this category and their associated on road mobile contributions are 15 PAH (10%), benzene (14%), 1, 3 butadiene (64%), arsenic (28%) and chromium (59%).

The target reductions for this category are 15 PAH 95%, benzene 86%, 1,3, butadiene 88%, arsenic 64% and chromium 24%. PATS modeling shows that emissions in this category contribute to concentrations above benchmarks area-wide, are higher in distinct zones near busy roadways, and present localized impacts in areas of the highest traffic volume and congestion. The reductions available for this category are complex and difficult to quantify at this time.

9.5.2.2 Emission reduction plan

9.5.2.2.1 General

Because Metro currently leads regional transportation planning in coordination with government partners and affected parties, the stakeholder process for this category can be conducted through existing committees and procedures.

- Metro and DEQ to identify authorities, roles and responsibilities for implementing cleaner vehicles, cleaner fuels and decreasing VMT. In evaluating various strategies, Metro and DEQ to determine the most effective ways to coordinate and utilize authorities to implement air toxics reduction strategies.

9.5.2.2.2 Reduced VMT from light duty vehicles

The following actions are recommended to achieve reduced VMT from light duty vehicles:

- State agencies, Metro, and other public and private partners to identify sustainable funding to reduce VMT from light duty vehicles.
- Metro and the Joint Policy Advisory Committee on Transportation (JPACT) to incorporate air toxics reductions into existing VMT reduction planning, including greenhouse gas scenario planning required by HB 2001 and the Regional Transportation Plan.
- Under state greenhouse gas planning scenarios, Metro and JPACT to strive to achieve a per capita reduction of 20% of air toxics emissions from light duty vehicles by 2035, considering all of the recommendations in this section, with the purpose of further exploring, evaluating and selecting them for implementation. Metro and JPACT to select strategies consistent with the PATSAC considerations including cost effectiveness, feasibility, benefits analysis and options for ongoing improvement (Note: this target is consistent with the per capita target for greenhouse gas reduction adopted by the Land Conservation and Development Commission. For a link to statewide greenhouse gas reduction targets see Appendix 10.12.2)
- In developing corridor plans, ODOT, Metro and JPACT to seek additional VMT reduction (or offsetting air toxics reductions) in localized air toxics corridors identified in Section 6 of this report.
- Metro, ODOT, cities and counties and other partners to implement transportation demand management and system operation improvements (traffic incident management, electronic traveler information, traffic signal coordination, etc.)
- Metro to integrate public health, environmental, and environmental justice considerations early in the metropolitan planning process (e.g. evaluating and developing transportation and land-use plans and projects),
- ODOT to integrate public health, environmental, and environmental justice considerations early in the statewide transportation planning process with FHWA
- Metro and JPACT in consultation with TriMet to assess the following specific VMT reduction measures, and incorporate into the RTP as appropriate:
    - A transit service standard based on a needs assessment of transit dependent communities

- Programs and fare incentives to increase use of public transportation, including finding sustainable funding for the youth pass transit program in Multnomah County, which influences the next generation's transit choices;
- Stronger Employee Commute Options incentives, regulations or other programs to reduce home to work trips;
- Funding operating costs to increase service by allowing more flexible use of state and federal capital resources.

9.5.2.2.3 Cleaner vehicles

The following actions are recommended to achieve cleaner vehicles:

- DEQ to advocate for EPA adoption of strong national air toxics reductions in the next phase of light duty vehicle standards (Tier 3) covering 2017 to 2025.
- DEQ to adopt California's LEV III standards for the same period as a backup to federal standards in coordination with Washington.
- DEQ in cooperation with ODOE and ODOT to promote and facilitate development of infrastructure for low emitting vehicles.

9.5.2.2.4 Cleaner fuel

The following actions are recommended to achieve cleaner fuel:

- DEQ to evaluate life cycle air toxics from low carbon fuels (eg, biofuels, electric) and encourage fuels with co-benefits.
- DEQ to evaluate air toxics reduction potential, co-benefits with ozone precursors, cost-effectiveness, and legal authorities for reformulated gasoline in Western Oregon, Western Oregon-Washington, or statewide Oregon-Washington.
- State agencies, Metro and other public and private partners to promote and facilitate development of infrastructure for low emitting vehicles.

9.5.2.3 Issues

Future consideration of emission reduction in this category will include the following issues:

- Consider full life-cycle impact of electric vehicles (source of electricity, mining impacts, etc.)
- Account for air toxics reductions needed from metals associated with wear and tear during vehicle operation.
- Update the emission inventory to include current Metro transportation modeling, including the final configuration for the Columbia River Crossing bridge
- Review and consider recent developments with low carbon fuel standards and biofuel requirements.
- Review and consider co-benefits and potential conflicts of measures to reduce greenhouse gases and toxics, and to increase use of biofuels.

9.5.2.4 Stakeholders and Partners

Stakeholders and planning partners include the 25 cities, three counties and affected special districts of the Portland region, Oregon Department of Transportation (ODOT), DEQ, The Port of Portland, South Metro Area Regional Transit (SMART), TriMet, automotive, trucking, business, freight, transit rider organizations and other interested community representatives. Metro also coordinates on bi-state issues with the City of Vancouver, Clark County Washington, the Port of Vancouver, the Southwest Washington Regional Transportation Council (RTC), C-Tran, the Washington Department of Transportation, the Southwest Washington Clean Air Agency (SWCAA) and other Clark County governments.

9.5.3 On Road Mobile Heavy Duty (DEQ lead)

9.5.3.1 Risk contributed by the category

Most pollutants emitted by on-road heavy duty engines are risk drivers for the PATS study area as a whole, and diesel particulate is the main risk driver for this category. The target reduction for diesel particulate from heavy duty on road engines is 91%. With the maximum amount of engine turnover and alternate fuel engines, along with other strategies identified in the white paper in Appendix 10.9.1, it would be technologically possible to achieve almost all of this target reduction. However, engine turnover and retrofit solutions are costly and funding is not currently available.

9.5.3.2 Emission reduction plan

9.5.3.2.1 General

- DEQ will convene a stakeholder process to identify and evaluate strategies to achieve the maximum feasible emission reductions, and recommend strategies consistent with the PATSAC considerations including cost effectiveness, feasibility, benefits analysis and options for ongoing improvement. This process will consider all of the recommendations to follow in this category, with the purpose of further exploring, evaluating and selecting them for implementation.
- DEQ and partners to identify authorities, roles and responsibilities for implementing cleaner vehicles, cleaner fuels and using less fuel. In evaluating various strategies, DEQ and partners to determine the most effective ways to coordinate and utilize authorities to implement air toxics reduction strategies.
- DEQ and partners to identify opportunities for financial support of clean diesel activities.
- DEQ and partners to identify what role education and outreach can play in building acceptance of and action toward clean diesel projects, including building citizen and consumer demand for clean diesel.

9.5.3.2.2 Burn Fuel Cleaner

The following actions are recommended to burn fuel cleaner:

- DEQ and partners to develop a strategy to accelerate engine turnover, repowering and retrofit. DEQ and partners to assess the feasibility and effectiveness at all levels of government to incent or require clean diesel fleets for publically funded projects, including franchised or contracted fleets. Important considerations include procurement and contracting rules, policy adoption processes, financial resources, and effects on small businesses.

9.5.3.2.3 Burn Cleaner Fuel

The following actions are recommended to burn cleaner fuel:

- DEQ and partners to evaluate alternatives and where effective, evaluate strategies to increase the fleet mix of alternative fuels and fuel engines.
- DEQ and partners to evaluate need for a technical clearinghouse on environmental benefits and effects of alternative fuels. See links in Appendix 10.11.

9.5.3.2.4 Burn Less Fuel

The following actions are recommended to burn less fuel:

- DEQ and partners to evaluate ways to increase efficiency on a gallons per ton mile or gallons per hour basis. This could include improving logistical and physical efficiency, for example Smartway, aerodynamics, scheduling and delivery, network efficiencies, truck only lanes, choice of other transportation modes.
- DEQ and partners to evaluate implementation of House Bill 2081 idling restrictions. If potential improvements are identified, DEQ and partners to present them to the Oregon Legislature for consideration.
- DEQ and partners to evaluate private and other jurisdictions' idle reduction programs that reduce air toxics concentrations in affected environmental justice communities.

9.5.3.3 Issues

Future consideration of emission reduction in this category will include the following issues:

- Upgrading older engines represents a very cost effective public health and environmental protection measure, but cost to individuals and businesses can be prohibitively high.
- With more advanced engines, maintenance is of increasing importance.

9.5.3.4 Stakeholders and Partners

Further work on this sector will require active participation and involvement by business and industry associations including the Oregon Trucking Association and Associated General Contractors, public health advocates, citizens and government, including ODOT, DEQ, the State Health Authority and local health agencies.

9.5.3.6 Data and white paper refinement needs

The following actions are recommended for data refinement:

- DEQ and partners to better understand the determinants of truck and vehicle turnover per duty cycle and application, e.g. medium versus heavy duty vehicles, drayage and short haul trucks, transit buses, school buses, specialty vehicles like refuse hauler trucks and cement trucks.
- DEQ and partners to evaluate the need for refinement of on road diesel data, including transit information.

9.5.4 Construction (DEQ lead with local government support)

9.5.4.1 Risk contributed by the category

Most of the risk from this category comes from diesel particulate and PAH. The reduction target for diesel particulate for this category is 92%. If every potential strategy were implemented, there would be no gap between the target and achievable reductions. However, engine turnover and retrofit solutions are costly and funding is extremely limited.

9.5.4.2 Emission reduction plan

9.5.4.2.1 General

- DEQ proposes that it will convene a stakeholder process to identify and evaluate strategies to achieve the maximum feasible emission reductions, and recommend strategies consistent with the PATSAC considerations including cost effectiveness, feasibility, benefits analysis and options for ongoing improvement. DEQ proposes that this process consider all of the recommendations to follow in this category, with the purpose of further exploring, evaluating and selecting them for implementation.
- DEQ and partners to identify and communicate authorities, roles and responsibilities for implementing cleaner engines, cleaner fuels and using less fuel. In evaluating various strategies, DEQ and partners to determine the most effective ways to coordinate and utilize authorities to implement air toxics reduction strategies.
- DEQ and partners to conduct a survey of construction equipment in the Metro area to better define the quantity, age activity levels and locations of each type of equipment. DEQ to use this information to improve the emission inventory and modeling, as appropriate, as well as target future emission reduction strategies.
- DEQ and partners to evaluate the design and effectiveness of a registration system to identify the use of equipment or construction projects within the Metro area.
- DEQ and partners to research the impact of high emitting used equipment that may be imported from California as a result of California's construction fleet emission standards. If this concern is significant, DEQ to identify options to address it.
- DEQ and partners to identify opportunities for financial support of clean diesel activities.
- DEQ and partners to identify what role education and outreach can play in building acceptance of and action toward clean diesel projects, including building citizen and consumer demand for clean diesel.

9.5.4.2.2 Burn Fuel Cleaner

The following actions are recommended to burn fuel cleaner:

- DEQ and partners to develop a strategy to accelerate engine turnover, repowering and retrofit.
- DEQ and partners to identify funding options in addition to DERA and Oregon tax credits, to retrofit and repower equipment and accelerate turnover to new equipment.
- DEQ and partners to assess the feasibility and effectiveness at all levels of government to incent or require clean diesel fleets and equipment for publically funded projects, including franchised or contracted fleets and equipment. Important considerations include procurement and contracting rules, policy adoption processes, and financial resources.

9.5.4.2.3 Burn Cleaner Fuel

The following actions are recommended to burn cleaner fuel:

- DEQ and partners to evaluate alternatives and where effective, evaluate strategies to increase the fleet mix of alternative fuels and fuel engines.
- DEQ and partners to evaluate the need for a technical clearinghouse on environmental benefits and effects of alternative fuels. See links in Appendix 10.11.

9.5.4.2.4 Burn Less Fuel

- DEQ proposes the following actions to burn less fuel: DEQ and partners to evaluate and assess the feasibility of idle reduction for construction equipment.
- DEQ and partners to evaluate private and other jurisdictions' idle reduction programs that reduce air toxics concentrations in affected environmental justice communities.
- DEQ and partners to explore options to reduce emissions per unit of work accomplished with efficiency measures.
- DEQ and partners to explore and communicate best practices with regard to operating and maintaining heavy equipment.

9.5.4.3 Issues

Future consideration of emission reduction in this category will include the following issues:

- There is uncertainty about emissions because of lack of information about equipment; an improved emission inventory is needed for this category.
- Most emissions in this category come from construction equipment with a slow turnover rate.
- With more advanced engines, maintenance is of increasing importance.
- Strategies involving use of biodiesel need to account for manufacturer warrantee restrictions.
- Contractors' equipment is tied to the valuation of their businesses so any measures need to consider effects on business valuation.
- Emission reduction strategies must consider special needs of small businesses.

9.5.4.4 Stakeholders and Partners

Further work on this sector will include active participation and involvement by business and industry associations and experts including the Associated General Contractors, construction, state and local government agencies, public health, neighborhood, and public interest representatives.

9.5.5 Industrial Metals Facilities (DEQ Lead)

9.5.5.1 Risk contributed by the category

Metals facilities account for essentially all of the manganese, nickel and lead, and most of the cadmium projected in 2017 concentrations that contribute to benchmark exceedances in localized impact areas. Other pollutants, such as arsenic, benzene, hexavalent chromium, and naphthalene emitted by metals facilities may be potential risk drivers in their immediate vicinity. Cadmium and arsenic are two pollutants with incomplete emission inventory data and in need of further refinement as described in 9.7. Depending on the local modeled impacts and varying between facilities, the target metals reductions from metals facilities are 39% to 91% for manganese, 72% for nickel, 49% for lead, 89% to 95% for chromium, and 94% to 96% for cadmium. (See Section 6 on emission reduction targets.) Based on the current analysis, technically feasible options for reducing these metals can achieve reductions of emissions that are between ten and thirty percent of the targets. (See Section 7 on the overview of white papers.)

9.5.5.2 Emission Reduction Plan

The following actions are recommended for the Industrial Metals Category:

- DEQ to refine emission estimates for metals facilities that modeled over or near benchmarks for 2017, using facility-specific models, improved emissions characteristics and more detailed receptor locations.
- DEQ to encourage facilities with modeled impacts above benchmarks to make voluntary early reductions.
- DEQ to convene a stakeholder process to identify, evaluate and recommend strategies to achieve the maximum feasible emission reductions, including facility or category specific strategies consistent with PATSAC considerations. These strategies should encourage ongoing improvements in emission reductions, and, where appropriate, performance-based approaches.

9.5.5.3 Issues

Future consideration of emission reduction in this category will include the following issues:

- Because there are significant gaps between targets and feasible reductions, there is a need for more information on potential emission reduction technologies.
- The follow up process for this category should include additional modeling designed for industrial facilities.

9.5.5.4 Stakeholders and Partners

The future process for this category will include technical experts, representatives from the affected facilities, neighbors and affected public, health authorities, local government and DEQ.

9.6 Milestones and Contingency Plans

Milestones for PATS will help to identify the stages of completion for the various phases of work necessary to achieve the ambient benchmark concentrations. A contingency plan for PATS will be any plan designed to respond to changes in conditions that will affect meeting milestones. Because this phase of PATSAC recommendations contains priority categories and considerations rather than imminent emission reduction actions, milestones and contingency plans will be developed in the next phase of planning to address the priority categories.

DEQ will strive to develop milestones and contingency plans for each priority source category strategy. Milestones will be based on a ten year timeframe. They may be linked to DEQ's three year emission inventory updates or other relevant planning and assessment cycles. Milestones may be procedural at first, e.g. surveying emissions or activity levels, but will ultimately relate to targeted emission reductions for risk driver pollutants in each priority category. Upon completion of each three year emission inventory cycle, DEQ may assess the projected modeled emissions reductions against the 10-yr goals for each priority category in the PATS project. Milestones will also be evaluated by analyzing any relevant monitoring data. Lack of progress in achieving emission reductions could result in re-convening PATSAC or other stakeholder group for re-evaluation of technical and planning assumptions.

A contingency plan may be designed to take effect at any time during PATS implementation, but at a minimum should be triggered during the sixth year of a ten year reduction plan based on lack of progress in reducing emissions or meeting milestones. Contingency plans will be developed in conjunction with milestones during development of emission reduction plans for each priority category. When developing contingency plans, government partners and stakeholders should consider the range of realistically possible scenarios including:

- What events may occur that require a response?
- What is the worst case scenario of events for the situation?
- What event would cause the greatest disruption of current activities and plans?
- What happens if changes occur that affect feasibility, for example changes in cost or technology?
- What happens in the event of change to an organization implementing parts of the emission reduction plan?

An example of an Ozone maintenance contingency plan triggered by an increase in vehicle miles traveled in the Portland region may be found at:
http://www.deq.state.or.us/aq/planning/docs/portlandSalemOzone.pdf.

9.7 Pollutants/Problems Needing Refinement

The PATS technical study highlighted several areas in need data refinement for better understanding of emissions, potential risks and possible emission reduction strategies. With assistance from EPA and other state and local partners, DEQ will follow up on developing more accurate information in the following areas:

9.7.1 Methylene Chloride

DEQ will work with EPA and stakeholders to develop a more accurate emission inventory for methylene chloride. This activity is linked to the DEQ 2011 air toxics emission inventory.

9.7.2 Secondary Formation Pollutants

DEQ will research literature on acrolein, formaldehyde and acetaldehyde to gain a full understanding of precursor chemicals and secondary formation of these pollutants in the PATS study area. In coordination with the Portland Ozone plan, DEQ will assess the effectiveness of reducing precursors to both ozone and secondary formation air toxics. DEQ will use the MOVES mobile source model for additional refinements for mobile source pollutants.

9.7.3 Cadmium

DEQ will use additional monitoring data, meteorological data and source data to better identify the sources of cadmium emissions in the PATS Study Area, especially in North Portland where monitoring data shows higher levels that do not correspond to modeled concentrations. See Model to Monitor Comparisons in Section 3.6.2 above. Once sources have been identified, additional cadmium reduction efforts may be included in the relevant source category follow up actions.

9.7.4 Arsenic

DEQ will use additional monitoring data, meteorological data and source data to better identify the sources of arsenic emissions in the PATS Study Area, especially in North Portland where levels are somewhat under predicted compared to monitoring data. See Model to Monitor Comparisons in Section 3.6.2. Once sources have been identified, additional arsenic reduction efforts may be included in the relevant source category follow up actions.

9.7.5 Additional Monitoring Studies

DEQ will continue to seek grant and other funding for additional air toxics monitoring to better characterize parts of the PATS study area and establish a more complete baseline for tracking future emission reductions.

9.8 Addressing Growth and Reduction Target Gaps

In discussion with PATSAC, DEQ has recognized several important future considerations for implementing emission reduction strategies. For many categories of emissions there are common potential future needs: 1) for continuous improvement in achieving emission reductions, 2) to respond to growth in emissions, 3) to provide the best quality information about air toxics, and 4) to mitigate exposures in ways that complement reduction strategies.

9.8.1 Reassess/Review Feasibility of Reductions to Address Gaps

In the categories of residential wood combustion and industrial metals emissions, technically feasible emission reduction measures were not sufficient to achieve reduction targets. While sufficient reductions are technically feasible in other categories, not all of these reductions may be consistent with the PATSAC considerations. However, through improved technologies additional reductions may be possible in the future. Methods to implement continuous improvement are therefore important to reach PATS emission reduction goals. Therefore, each strategy developed to reduce emissions from priority categories identified in section 9.3 will include a specific process for periodic review of improved technologies to address any gap between the target and the combined reduction actually achieved by all strategies for that category.

9.8.2 Address Growth that Exceeds 2017 Projections

The projected 2017 emissions inventory was created utilizing Metro growth factors. DEQ will need to periodically re-assess the actual growth and how that level of growth impacts emissions.

9.8.3 Improve Data and Access to Data on Source Contributions and Cumulative Impacts

DEQ used the best available technical information to estimate emissions from all sources in the Portland area. However the data contained many assumptions and in some cases was less certain. Along with partners, DEQ will work to improve the PATS emission inventory especially for priority categories with low quality and incomplete information. In addition, as more information and methods become available to assess cumulative impacts and risk from multiple air toxics, DEQ will use them to update the PATS technical study.

9.8.4 Find Opportunities to Mitigate Air Toxics Emissions

For some categories of emissions, stakeholders may want to consider mitigation measures to supplement emission reduction strategies. In general mitigation measures can include any actions that do not achieve quantifiable emission reductions but may decrease exposure or the impact of emissions. Examples of these actions are adjusting activity or production schedules to times when fewer people would experience exposures, planting trees that would potentially decrease exposures, and land use or other planning that would increase the distance between emissions and people.

10. Appendices

10.1 Oregon Air Toxics Regulations

10.1.1 Air Toxics Program Rules including Ambient Benchmark Concentrations

Oregon's air toxics program rules can be found in Oregon Administrative Rules 340-246-0010 through 340-246-0230. **http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_246.html**.

Two internal management directives provide guidance for DEQ staff in implementing the program:

- ***Document Title: Policy and Implementation Guidance for the Oregon Air Toxics Program.*** This Internal Management Directive describes the procedures and policies DEQ will use in implementing the Oregon Air Toxics Program, including guidance on implementing the Geographic Program, Source Category Rules and Strategies and Safety Net Program. http://www.deq.state.or.us/aq/toxics/docs/imdaq00014.pdf
- ***Document Title: Technical Analysis Tools and Guidance for Implementation of the Air Toxics Program.*** This Internal Management Directive describes the technical tools DEQ will use in implementing the Oregon Air Toxics Program, including guidance on Determining and Using Background Air Toxics Concentrations, Calculating Annual Average Concentrations of Air Toxics, Monitoring Ambient Air Toxics, Using Toxicity Equivalency Factors, and Assessing Exposure to Air Toxics. http://www.deq.state.or.us/aq/toxics/docs/imdaq00013.pdf.

10.1.2 Air Toxics Benchmarks

Because there are no federal health standards for air toxics, Oregon has adopted air toxics benchmarks designed to help focus pollution reduction efforts. These benchmarks help DEQ identify, evaluate and address air toxics problems. Oregon air toxics benchmarks are based on concentration levels that would result in a cancer risk of one in a million excess cancers based on a lifetime of exposure. For non-carcinogens, levels you could breathe for a lifetime without any non-cancer health effects.
The ambient benchmark concentrations for 52 air toxics of concern in Oregon, which can be found at http://www.deq.state.or.us/aq/toxics/benchmark.htm, are based on consensus recommendations from the Air Toxics Scientific Advisory Committee, a panel that provides advice on the state air toxics program that is scientifically and technically sound, independent and balanced. Information on the Air Toxics Scientific Advisory Committee can be found at: http://www.deq.state.or.us/aq/toxics/atsac.htm.
The benchmark concentrations are based on levels that protect the health of our most sensitive individuals. These benchmarks provide consistent health-based goals, as DEQ develops strategies to reduce air toxics. Benchmarks are expressed as micrograms of a specific toxic compound per cubic meter of air.

10.2 PATSAC Charter and Operating Principles

10.2.1 PATSAC Charter

Document Title: PATSAC Charter. The PATSAC Charter describes the purpose, goals, and process of PATSAC, gives background on selection of Portland as the first air toxics reduction planning location, and discusses issues that are included or excluded from PATSAC.

The PATSAC Charter last updated on June 3, 2010 is included in full below:

Portland Air Toxics Solutions
Advisory Committee
CHARTER
6/3/2010

PATSAC

The Portland Air Toxics Solutions Advisory Committee, or PATSAC, is a broad based stakeholder group tasked with recommending the elements of a Portland air toxics reduction plan to DEQ and the Environmental Quality Commission (EQC). DEQ is collaborating with a diverse advisory committee and interested persons to develop an air toxics reductions strategy that fosters innovation, improves partnerships, and builds support to carry out emission reduction strategies. PATSAC includes representatives from neighborhoods, public interest organizations, government health and transportation departments and business. The purpose of PATSAC is:

- To make recommendations to DEQ and the EQC on an air toxics reduction plan for the PATS study area;
- To develop this advice through a collaborative stakeholder process that considers the best available science and information and community values, seeking areas of consensus where possible and clearly identifying areas of disagreement.

In making recommendations for an air toxics reduction plan, PATSAC will strive to:

- Improve public health and reduce risk to public health by meeting or making progress towards air toxics benchmarks under a ten-year plan;
- Facilitate early actions and reduce pollution;
- Coordinate local governments, stakeholders and communities in their shared efforts to ensure clean air in the Portland area.

Background

Based on ranking of county air toxics risk data statewide, DEQ selected the Portland area as the first community to participate in geographic air toxics reduction planning. The PATS project and study area includes portions of Multnomah, Clackamas and Washington Counties (see Figure 1). DEQ is also involving Clark County Washington near Vancouver and a portion of Yamhill County, since these areas share the same air shed as the Portland metro area. DEQ invited representatives from both these areas to serve as ex-officio members on the Portland Air Toxics Advisory Committee. To include perspective from other communities with air toxics above benchmarks, DEQ also invited ex-officio members from Eugene/Springfield and Medford/Ashland.

DEQ designated the PATS study area based on locations where people are most exposed to air toxics, coordination with the ozone pollution control area, geography and topography. PATS is distinct from other air toxics control efforts to date because it evaluates risk holistically to produce an area-wide plan to decrease emissions from sources roughly commensurate with their contribution to problems. DEQ will be working with local authorities, governments and community partners to implement PATS emission reductions. After addressing Portland area air toxics, DEQ plans to initiate similar efforts in other Oregon communities exceeding target risk levels from air toxics.

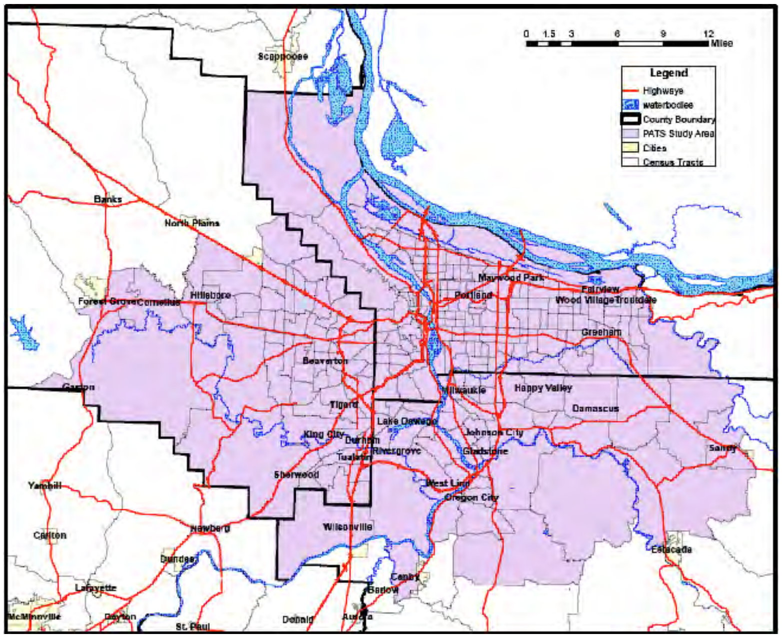


Figure 1 – PATS Study Area

1. Process

The PATSAC final report will include recommendations for an air toxics reduction plan, and will identify areas of consensus as well as areas of disagreement. Because of this, PATSAC will not make decisions by voting. DEQ expects the committee to operate in a collaborative fashion to help DEQ improve the quality of technical information and to explore the pros and cons of policy alternatives. The recommended emission reduction plan will be most useful to DEQ if it is clear, realistic, measurable and based on the best available science and information.

Requirements for a local air toxics advisory committee, such as PATSAC, are contained in Oregon Administrative Rules 340-246-0170 (1) through (4). Procedurally, the committee has a maximum of 18 months to recommend an air toxics reduction plan, with an opportunity to request an extension of time DEQ anticipates that PATSAC meetings will occur over a period of eighteen months or more. Because PATS is an innovative process based on developing science, additional time may be needed to address technical, policy and implementation challenges.

DEQ will use the PATSAC recommendations to develop an air toxics plan for presentation to the EQC following a public notice and comment period. Because the plan will address many pollutants from many source categories through many emission reduction strategies, it will serve as a blueprint or roadmap for reducing air toxics within the PATS study area. Following EQC approval of the plan, DEQ will work with local governments, other state agencies, the Oregon Legislature, the federal government and others to develop the programs needed to implement the plan. This work will take additional time, and will likely include additional advisory committees to develop specific regulations that will use the plan as a guide but incorporate specific implementation factors. The PATSAC report should include a recommended schedule for adopting new rules and ordinances, or seeking funding for new programs.

2. PATSAC Recommendations

a. Pollutants

The PATS emission reduction plan must focus on air toxics measured or modeled above ambient benchmarks in the study area. While reducing the highest risk air toxics will be a priority for PATSAC, it will also consider multi-pollutant benefits and health effects in air toxics reduction measures. PATSAC will evaluate air toxics emissions from all types of sources.

b. Analysis

PATS is part of Oregon's risk-based effort to reduce air toxics. It must be based on sound analysis of the best available scientific environmental and health data. Specifically, air toxics problems to be solved by PATS are based on ambient air monitoring at six Portland area locations, a detailed computer modeling study, and the air toxics ambient benchmark concentrations, which serve as clean air goals. DEQ will analyze emission reduction strategies considered by PATSAC to provide a general assessment of their effectiveness, benefits, and costs. Strategies included in the final plan will be analyzed in detail at a later time when implementing rules and programs are developed. DEQ will also assess the health costs and benefits of the plan as a whole.

The PATS computer model is DEQ's primary tool for estimating the impact of emission reduction strategies and making future year projections to understand the effects of changes that will come about as the result of regulatory programs (such as cleaner fuel regulations and industrial emission limits) and voluntary measures being phased in over time; as well as population growth, housing, transit and business development. Future air toxics modeling and monitoring will provide information to measure and confirm progress in reducing emissions.

c. Emission Reduction Goals and Strategies

The air toxics ambient benchmark concentrations adopted in OAR 340-246-0090 serve as emission reduction goals for PATS. In cases where a benchmark is under development but not yet adopted, PATSAC may consider the concentration recommended by the Air Toxics Science Advisory Committee. When feasible, the reduction plan will be designed to reach air toxics levels that are equal to or below ambient benchmark concentrations as expeditiously as possible, with a base goal of 10 years from the date the EQC approves the plan.

"Feasibility" is not defined in DEQ's air toxics regulations, but is generally understood to require consideration of practical, economic, social, scientific and health factors for each pollutant and associated source. Because diesel particulate matter, polycyclic aromatic hydrocarbons (PAH) and benzene, are produced by engines and combustion sources which are ubiquitous, it may not be feasible to reduce emissions quickly enough to reach benchmark levels in a ten year period.

PATSAC will analyze the potential timeframe for reaching benchmarks and make recommendations that achieve them in as expedient a manner possible. To develop the best strategies for successful emission reductions, PATS will also consider the relationship of the pollutants to their sources, to one another, and the chemical background associated with each. For example, there are strategies which may cause one pollutant's emissions to decrease, but another pollutant's to increase, as is the case with biodiesel, which reduces diesel particulate matter and increases nitrogen oxides.

d. Plan Elements

The following plan elements can be found in Oregon Administrative Rule (OAR) 340-246-0170. DEQ and PATSAC will strive to achieve the greatest benefits on the most expeditious timeline considering the effectiveness, benefits, and cost of emission reduction options.

<u>i. Voluntary and Mandatory</u>

The plan may contain a mix of voluntary and mandatory emission reduction measures that may be administered region-wide or in separate jurisdictions. Depending on the type of source, the plan may include public education, pollution prevention, economic incentives and disincentives, technical assistance, local ordinances and DEQ regulations.

ii. Proportionality

The plan must include emission reduction measures that are roughly commensurate with source contributions, considering relative emissions, toxicity, exposure, technical feasibility, cost effectiveness, public health and the economic impacts air toxics have on public health and equity. The plan will include commensurate reductions from point, area and mobile sources.

iii. Milestones

The PATS emission reduction plan will include three year milestones to be evaluated by DEQ and PATSAC representatives. If the Department finds lack of progress at year three, it will consult with PATSAC to evaluate the need for corrective measures. If the Department finds lack of progress at year six, and projects that ten year goals will not be met, it will implement the contingency plan.

iv. Regulatory Coordination

The plan elements must be coordinated with other local, state and federal requirements to the extent possible.

v. Data Elements

If necessary, the plan will include specific recommendations to develop ongoing emission inventory or ambient monitoring to track local air toxics trends.

vi. Address Wide-Spread and Localized Impacts

The plan must include strategies to reduce concentrations of air toxics above ambient benchmark concentrations in smaller portions of the geographic area, as well as pollutants causing risk above benchmarks throughout the study area.

vii. Contingency Plan

The plan must include a contingency plan to be implemented if the year six evaluation shows lack of progress toward milestones and is projected to fall short of the ten year goals. The contingency plan must include, but is not limited to, re-evaluation of planning assumptions, evaluation of existing conditions and effectiveness of emission reduction strategies and new or progressively more stringent strategies to be considered.

e. Evaluating Milestones

Every three years in coordination with DEQ's air toxics emission inventory updates, DEQ will evaluate progress under the PATS emission reduction plan. DEQ will use both monitoring and modeling data to evaluate progress. For pollutants that can't be monitored, only modeling will be used. For those that can be monitored, DEQ will also rely mainly on modeling data and check it against monitored values. Unlike monitoring data, which is limited to measuring only the area near the monitor, modeling data will cover the entire PATS study area.

Based on new information, DEQ may make recommendations for plan revision. New information could include adoption of a new or revised benchmark, new emission reduction technology or legal requirements. If DEQ finds lack of progress towards milestones, it will work with PATSAC representatives to provide corrective measures. If at year six DEQ finds lack of progress and projects that ten year goals will not be met, it will implement the PATS contingency plan. If at year nine DEQ determines the ten year goals will not be met, it will work with PATSAC representatives to adopt measures necessary to reach the goals.

3. Issues included/excluded from PATSAC consideration

To maximize its efficiency, PATSAC will focus its efforts as outlined in 340-246-0170 (1) through (4).

a. Issues included in PATSAC consideration

In developing recommendations, PATSAC will use monitoring and modeling analysis to understand air toxics in the study area, including distribution of concentrations, causes, and potential solutions.

PATSAC will consider and recommend solutions for the entire study area as well as smaller areas where people are exposed to air toxics above benchmarks because of localized source emissions. Strategies will address adverse impacts on sensitive or vulnerable populations and environmental justice communities.

b. Issues not directly related to PATSAC recommendations

To focus the scope of the PATS project, DEQ is not seeking direct recommendations on the issues listed below. However DEQ will document committee input on these issues and, when possible, will refer them for follow-up in an appropriate forum.

- Ambient benchmark concentrations.
- Statewide air toxics regulations.
- Conditions to be placed directly in the permit of a specific regulated source, though strategies may include pollution reductions from types of stationary sources identified as significant contributors to ambient concentrations and exposures above benchmarks.
- Worker exposure.
- Measures specifically designed to improve indoor air quality.

The committee is faced with various challenges in recommending a Portland Air Toxics Reduction Plan, including: multiple pollutants, technical and scientific complexity, a large geographic area, risk conceptualization and communication, difficulty affecting various emissions, and implementation needs. Despite these challenges, many factors align to make this a very opportune time to address air toxics in the Portland area. PATSAC can take advantage of increasing interest in and awareness of air toxics, initiatives for renewable and low carbon energy, upcoming improvements in transportation and development, and many other local efforts to improve livability and public health. In addition, data and understanding about air toxics has improved to the point where PATSAC will be able to describe the major air toxics problems, propose solutions and track progress toward improvements.

The following organizations and interests were represented on PATSAC:

Portland Office of Neighborhood Involvement	North Portland Neighborhoods	Southwest Portland Neighborhoods
NW Portland Neighbors for Clean Air	Pacific Environmental Advocacy Center	OPAL
American Lung Association of Oregon	Oregon Toxics Alliance	Multnomah County Health Department
Washington County Health Department	Commissioner Cogen’s Office	Oregon Health Authority

Clackamas County Sustainability Program	Metro	TriMet
Portland Department of Transportation	Oregon Department of Transportation	Port of Portland
Intel	Associated Oregon Industries	The Boeing Company
Oregon Trucking Association		

The following organizations and interests participated as ex-officio members of PATSAC:

Lane Regional Air Protection Agency	Sierra Club	Southwest Clean Air Agency

10.2.2 PATS Operating Principles

- ***Document Title: PATSAC Operating Principles.*** This document describes the process and procedures by which the PATSAC advisory committee governed its discussions, deliberations, and decision-making. Descriptions of the structure, member participation, meetings and materials, decision-making and commitments, process reminders/ground rules, and safeguards are included.
  The PATSAC Operating Principles last updated June 3, 2010 are included in full below:

Portland Air Toxics Solutions
Advisory Committee

OPERATING PRINCIPLES
6/3/2010

For any collaborative process to operate smoothly, it is necessary for those involved to agree at the outset on the purpose for the process and on the procedures by which the group will govern its discussions, deliberations, and decision-making.

I. Purpose of the Portland Air Toxics Solutions Advisory Committee

The primary purpose of the Portland Air Toxics Solutions Advisory Committee is to review air toxics data provided by DEQ and potential emission reduction strategies and recommend to the Department of Environmental Quality (DEQ) and/ or the Environmental Quality Commission (EQC) a plan to reduce air toxics in the Portland area as expeditiously as possible, with a base goal of 10 years.

II. Portland Air Toxics Solution Advisory Committee Structure

The Advisory Committee will be the advisory level forum for collaborative efforts related to development of a Portland air toxics reduction plan. The participants are voluntarily working together to achieve a mutually acceptable outcome that satisfies, to the greatest degree possible, the interests of all participants. The Advisory Committee will be responsible for all decisions and actions that are publicly identified as Advisory Committee products.

The Advisory Committee members (i.e., representatives, subgroup/team members, and alternates) will strive to:

- Work together to develop consensus on the components of an air toxics reduction plan;
- Agree on the desired level of specificity of plan components;
- Concur in all Advisory Committee decisions, as well as designate a signatory for the final agreement;
- Ensure integration of the scientific, technical, available health, economic (benefit/cost analyses), and policy information needed to begin the air toxics reduction plan to the maximum extent practicable; and

- Concur in decisions about the Advisory Committee process, including overseeing the implementation of these operating principles.

To focus the scope of the process, DEQ is not seeking recommendations on the issues listed below. However, DEQ will document committee input on these issues and, when possible, will refer them for follow-up in an appropriate forum.

- Ambient benchmark concentrations
- Statewide air toxics regulations
- Conditions to be placed directly in the permit of a specific regulated source, though strategies may include pollution reductions from classes and categories of sources identified as significant contributors to ambient concentrations and exposures above benchmarks.
- Worker exposure
- Measures specifically designed to improve indoor air quality

In order for this scope to be acceptable to and implementable by all authorities, those involved in this process agree to work together and will strive to produce recommendations that integrate the mandates, concerns, and ideas of all those significantly affected by the structure and implementation of the air toxics reduction plan.

Subgroups may be formed at the direction of the Advisory Committee, which will designate subgroup members as needed for the anticipated tasks and outcomes. At the direction of the Advisory Committee, subgroup members may develop draft products and make recommendations to the Advisory Committee. Subgroups will not make decisions on behalf of the Advisory Committee.

Scientific and Technical Input will be provided on an "as-needed" basis by Advisory Committee members' staff, consultants or other designated entities or experts as agreed upon by the Advisory Committee. To the extent an Advisory Committee member is relying on the expertise of scientific or technical staff, those scientific or technical staff must be made available for discussion with other members of the Advisory Committee if requested or needed. These technical advisers will not make decisions on behalf of the Advisory Committee.

Ex officio Members are invited to participate in discussions about the air toxics reduction plan and all related matters. Ex officio members may offer input but may not concur on procedural or substantive decisions, agree on specific elements of the plan or provide signatures on any PATSAC documents or recommendations. Ex officio members must abide by PATSAC operating principles.

III. Participation

Interests Represented. Advisory Committee parties, identified on the signature page for these Operating Principles, represent public and private entities that have an interest in the Portland Air Toxics Solutions project or an interest, role and/or responsibility in achieving an air toxics reduction plan.

Additional Parties. Additional entities may join the Portland Air Toxics Solutions Advisory Committee as appointed by the Director of DEQ. Any new party must agree (a) to abide by these Operating Principles, and (b) to accept the status of discussions as of the time of joining the Advisory Committee, unless otherwise agreed by the Advisory Committee.

Attendance at Meetings. Each member will make a good faith effort to attend each Advisory Committee meeting. If an Advisory Committee member cannot attend, he or she may designate a regular alternate to attend, and the alternate must be appointed as a committee member by the Director of DEQ. It is the responsibility of the member and alternate to stay fully briefed on all Advisory Committee meeting discussions and deliberations. It is the responsibility of the member to inform the alternate concerning the deliberations. All alternates are also bound by these Operating Principles.

Constituent Interests. Advisory Committee members are expected to consult with and represent the concerns and interests of the organizations and constituents they were appointed to represent. Members with established organizations and constituents are responsible for ensuring that all significant issues and concerns of their organizations and constituents are fully and clearly articulated during Advisory Committee meetings. These members are also responsible for ensuring that any eventual recommendations or agreements are communicated to their constituents and/or the agencies they were appointed to represent.

IV. Meetings and Materials

Agendas. Proposed meeting agendas will be drafted by the Project Team in consultation with Advisory Committee members. The Project Team will strive to circulate draft agendas for review at least one week in advance of Advisory Committee meetings. Agendas will be approved or revised at the beginning of each meeting.

Meeting Summaries. The facilitator will prepare Advisory Committee meeting summaries. They will be provided electronically in draft form to the DEQ website for review and comment within one week of the Advisory Committee meeting. Meeting summaries will be approved by the Advisory Committee at the following meeting. Final meeting summaries will also be posted on the project website.

Action Items. Action item lists will be prepared by the facilitator to assist the Advisory Committee in documenting its progress and activities. The facilitator will ensure that items included on the lists are tracked and that Advisory Committee members are informed of progress.

Breaks/Caucus. Meetings may be suspended at any time at the request of any member to allow consultation among group members. Requests should be respectful of all members' time. If the use of a caucus or break becomes disruptive, the Advisory Committee will revisit the process. The facilitator may be used to assist parties during the caucus if requested.

Facilitator. Advisory Committee meetings will be facilitated by Kearns & West. The facilitator will be funded by the Oregon Department of Environmental Quality through the Oregon Consensus Program but will remain independent and not take positions on the issues. The facilitator will work to ensure that the process runs smoothly. The facilitator's role usually includes developing draft agendas, distributing meeting materials, facilitating meetings, working to resolve any impasse that may arise, preparing action items and other tasks as requested. The facilitator will work directly with all Advisory Committee members to ensure their ability to represent the concerns and interests of their organizations and constituents. The facilitator will serve at the will of the group and may be replaced by another facilitator upon consensus by the members.

Materials. The Advisory Committee will have intensive work sessions. This format requires more extensive preparations for members. The Project Team will strive to circulate all draft materials for review at least two weeks in advance of Advisory Committee meetings, giving members the opportunity to raise initial questions for either the facilitator or Department of Environmental Quality staff.

V. Decision-Making and Commitments

Consensus. The Advisory Committee will strive to make decisions by consensus. Consensus is defined as all Advisory Committee members can live with the recommendation or decision. If the group cannot reach consensus, the differing views will be documented in the committee's final report.

Decision Making. Decisions throughout the PATS process will be made by Advisory Committee members present at each meeting. Major products, which would include any final components of the air toxics reduction plan, will be reached through discussion among all Advisory Committee members. Those absent from the meeting will be asked to provide written comments (by email or fax) within one week of a decision being conveyed to the absent members.

It is understood that Advisory Committee members are representing interests of their agency, organization, and/or constituents. As such, ultimate decision-making authority may reside with an individual not at the table. Advisory Committee members agree to regularly brief the decision-makers within their respective organizations to ensure support and buy-in for decisions developed through the Advisory Committee process, as well as the greatest likelihood of successfully implementing an agreement.

Commitments of Members. All Advisory Committee members agree to:

Attend meetings and follow through on promises and commitments;

Come to meetings prepared, having read all materials provided for the meeting;

Bring concerns from their interest group or organization up for discussion at the earliest point in the process;

Share all relevant information that will assist the group in achieving its goals;
Participate in a free, open, and mutually respectful exchange of ideas, views, and information prior to achieving consensus;
Resolve issues being addressed by the Advisory Committee within the Advisory Committee structure;
Articulate to the best of their ability interests that underlie issues and concerns in an effort to find common ground among the parties;
Communicate the expectation to subgroups and those providing scientific and technical input that these Operating Principles are also applicable to them;
Characterize individual, caucus, or subgroup viewpoints as fully and accurately as possible;
Keep the group or organization represented by the member informed of potential decisions and actions, in order to expedite approval for the final product; and
Support the products recommended by the Advisory Committee if the member concurred in the recommendation.

VI. Process Reminders/Ground rules

- Seek to learn and understand each other's perspective.
- Encourage respectful, candid and constructive discussions.
- Provide balance of speaking time.
- Seek to resolve differences and reach consensus.
- Discuss topics together rather than in isolation.
- Make every effort to avoid surprises.
- Limit side conversations.
- Turn off cell phones or place in the non-ring mode during formal meeting sessions.

VII. Safeguards

Good Faith. All members agree to act in good faith in all aspects of the collaborative effort. Specific offers made in open and frank problem solving conversations will not be used against any other member in future litigation or public relations. Personal attacks and prejudiced statements are not acceptable. Good faith requires that individuals not represent their personal or organization's views as views of the Advisory Committee, and that they express consistent views and opinions in the Advisory Committee and in other forums.

Open Meetings. Meetings of the Advisory Committee are open to the public and will include an opportunity for public comment. Notice of Advisory Committee meetings will be posted in advance of meetings on the DEQ website.

Public Comment. The facilitator will provide periodic public comment opportunities for non-Advisory Committee members during meetings. Comments from the public will be limited in time to allow sufficient opportunity to conduct the other portions of the Advisory Committee agenda. Citizens are encouraged to participate in the PATS process and to submit written comments to DEQ Staff for circulation to the full Advisory Committee.

Public Records and Confidentiality. Advisory Committee records, such as meeting documents, discussion drafts and meeting summaries are public records. Advisory Committee communications (oral, written, electronic, etc.) are not confidential and may be disclosed. However, the private documents of individual Advisory Committee members and the private documents of the facilitator that are not shared with the Advisory Committee are not considered public records and are not subject to disclosure under public records laws.

Press. Advisory Committee members will strive to keep each other apprised of communications with the press regarding the Portland Air Toxics Solution Advisory Committee process. Upon request, contact from the press related to the Advisory Committee process may also be referred to the DEQ project team.

Right toWithdraw. Any member may withdraw from the Advisory Committee at any time after discussing the reasons for withdrawal with the facilitator and Advisory Committee members. Any entity that withdraws from the Advisory Committee shall remain bound by the good faith and other provisions of these Operating Principles.

VIII. Schedule

The Advisory Committee as a whole will meet as needed to meet its responsibilities. It is anticipated that the Advisory Committee will complete its work by May, 2011.

10.2.3 PATS Considerations

PATSAC developed the following draft considerations for use in evaluating and selecting emission reduction strategies.

PATSAC DRAFT Considerations 2/7/11

I. PATS Threshold Regulatory Requirements
   1. The PATS emission reduction plan must focus on air toxics measured or modeled above ambient benchmarks in the PATS study area. (OAR 340-246-0170 (4)(1))
   2. Mandatory emissions reduction strategies must be commensurate with source contributions, considering relative emissions, toxicity, technical feasibility, cost-effectiveness and equity. (OAR 340-246-0170 4(f)). [Note: initially PATSAC will consider equal percent reductions for point, area and mobile sources, but may vary these percentages consistent with this rule.]

II. Considerations

   This list of considerations will be used by PATSAC as an informal tool to understand toxics reduction strategies. If the committee chooses, it may also use these considerations to shape its recommended package of strategies or implementation steps.

   1. Effectiveness – consider the following as appropriate:
      - **a.** Magnitude: amount of each air toxic reduced by the strategy.
      - **b.** Timeframe: Length of time required by measure to reduce emissions. How readily are results measureable? (OAR 340-246-0179 4(d))
      - **c.** Effect on exposures: How well does the measure target spatial extent of the emissions? Some reductions may have more pronounced effects on localized concentrations; others may do more to reduce pollutants area-wide. (OAR 340-246-0170 4(g)). Ability to address short term or acute exposures if relevant.
      - **d.** d. Pollution prevention: Where does the strategy fit in the pollution prevention hierarchy? 1. Modify the process, raw materials, or product to reduce the quantity and toxicity of air contaminants generated. 2. Capture and reuse air contaminants. 3. Treat to reduce the quantity and toxicity of air contaminants released. (OAR 340-246-0050)
      - **e.** e. Other pollutants: Effect of measure on criteria pollutant emissions, greenhouse gas emissions, and
      - **f.** emissions of other priority toxic substances on the DEQ Agency Wide Toxics List

   2. Implementability/Feasibility/Barriers – consider the following as appropriate:
      - **a.** Legal authority: Does the measure fall under existing regulations or are new laws/ rules required? Does federal pre-emption preclude new laws/rules? Is/will the proposed measure be addressed through other planned Federal, state, or local rulemaking or other processes?
      - **b.** Technical feasibility: How well will the emission reduction measure work from an engineering and/or logistical perspective? Is the technology or fuel readily available? (OAR 340-246-0170 4(f)). Is the technology EPA or third party verified/certified?
      - **c.** Funding: What is the cost to DEQ or other agency to implement the measure? How could the agency cost be funded? How certain is the funding mechanism?
      - **d.** Implementation: Is there a ready structure for implementation or ability to coordinate with existing programs?
      - **e.** Acceptance: Is there public and stakeholder support for the measure?

f. Non-regulatory approaches: Could the measure be implemented through incentives or education? Is there an opportunity to implement the measure through a community-based multi-stakeholder collaborative process? Could the measure begin as voluntary and later become mandatory as necessary in a contingency plan?

3. **Cost** – consider the following as appropriate:
   a. Cost: What is the cost of emission reduction measure and implementation (OAR 340-246-0170 4(f))? If the measure is a regulation, what is the cost of compliance? If the measure is an incentive, what is the cost of the incentives?
   b. Cost effectiveness: What is the cost per unit of air toxics reduced?
   c. Other environmental impacts: Potential for the emission reduction measure to transfer pollutants to soil or water, or cause harm to human health or the ecosystem.
   d. Energy: Effect of measure on energy use.
   e. Public safety: What is the affect of the measure on public safety? For example, would emission reductions restrict activities related to adequate lighting, heat, ventilation, signage or access to emergency services?
   f. Indirect economic costs: What are the potential indirect costs to communities, the local economy or business sectors?

4. **Benefits** - consider the following as appropriate:
   a. Health: What are the health benefits of meeting the benchmarks? This could be measured as the number of cancer cases avoided and/or value of statistical life and medical costs avoided.
   b. Livability: Improved quality of life associated with improved nuisance conditions such as odor or noise.
   c. Indirect economic benefits: What are the potential benefits to communities, the local economy or business sectors?

5. **Distribution of Benefits and Costs** - consider the following as appropriate:
   a. Risk distribution: Could the measure change the social distribution of risk in the PATS area, i.e. sensitive populations and environmental justice communities?
   b. Cost distribution: Could the measure impose disproportionate costs or economic impacts to environmental justice communities in the PATS study area?

10.3 Emission Inventory

The 2005 emission inventory was used for two purposes. First, to create 2005 model results for comparison with the 2005 monitored concentrations for pollutants in the PATS area. Second, the 2005 emission inventory was used to project a future 2017 emission inventory by taking into account future growth and emission reductions from regulations. At each step, DEQ improved the information based on PATSAC comments.

10.3.1 Emission Inventory List of Emission Source Categories

- ***Document Title: Emission Inventory List of Source Categories***. This spreadsheet lists the emission inventory emission source categories used for both 2005 and 2017 projections, and includes details. http://www.deq.state.or.us/aq/planning/report/appendix/2005EI.pdf

10.3.2 Special Categories

DEQ staff compared 1999, 2002, and 2005 emission inventory data and determined source categories to be modeled. The following categories listed in priority order were selected due to their potential contribution to air toxics in the PATS study area and also to the feasibility of addressing these toxics through strategies.

- **Residential Wood Combustion:**
  - Fireplaces
  - Inserts: Non-Certified
  - Inserts: Certified, Non-Catalytic
  - Inserts: Certified, Catalytic
  - Woodstoves: General (non-certified)
  - Woodstoves: Certified, Non-Catalytic
  - Woodstoves: Certified, Catalytic
  - Pellet Stoves

- **Residential Open Burning:**

As a category of emissions, residential open burning has not been well characterized. Because it is a known source of air toxics, DEQ made an effort to estimate emissions using available information and assumptions. DEQ's complaint database was queried for the record of illegal open burning complaints, the location of the complaint, the number of open burn permits issued by DEQ, if any, and what type of material was burned. There were no burn permits issued for 2005; in fact, the last burn permit issued by DEQ was in June 2002. The types of material burned were categorized into two types: garbage or yard debris, construction or demolition debris, and wood waste (y/w/c). The following complaints were on record for 2005 from the database; material burn type was smeared across the two categories to the best of DEQ personnel's ability.

- Clackamas County
  - Total = 36
  - Garbage = 16
  - Yard debris, construction or demolition debris, and wood waste = 20
- Washington County
  - Total = 43
  - Garbage = 17
  - Yard debris, construction or demolition debris, and wood waste = 26
- Multnomah County
  - Total = 49
  - Garbage = 28
  - Yard debris, construction or demolition debris, and wood waste = 21

An average burn pile size and pile density was used. Tonnage burned for both municipal (household) waste and yard debris were estimated based on: material and location provided by the database, average pile sizes from historical burn complaint data, and on densities from EPA and Emission Inventory Improvement Project documents. The activity within the burn ban boundary (from the complaints data) was divided by the county-wide activity (from the DEQ's emission inventory data). The assumptions for this was that roughly one in five illegal burns occurred within the burn ban boundary and were reported as a complaint and that illegal burning is equally distributed within the burn ban boundary, with the exception that no burning is occurring within downtown Portland.

- **Additional Area Sources:**
  - Stationary Source Fuel Combustion
  - Commercial Cooking
  - Non-Permitted Industrial Processes
  - Asphalt Production
  - Fuel Storage & Transport (small gas cans, truck transport)
  - Agricultural Field Burning
  - Orchard Heaters
  - Prescribed Burning

- Structure Fires
  - Cremation
  - Open Burning of Construction Debris

- **Lawn and Garden Commercial & Residential**
  - Rotary Tillers
  - Chainsaws
  - Trimmers/Edgers
  - Leafblowers
  - Snowblowers
  - Turf Equipment
  - Lawnmowers
  - Chippers/Stump Grinders
  - Shredders
  - Lawn & Garden Tractors

- **Solvent Use Specifically Including para Dichlorobenzene:**
  - Surface Coating: Architectural
  - Surface Coating: Plastic Products
  - Surface Coating: Misc. Manufacturing
  - Surface Coating: Industrial Maintenance
  - Surface Coating: Special Purpose
  - Graphic Arts
  - Misc. Industrial Solvent Use (non-permitted)
  - Consumer and Commercial Products (household, automotive, coatings/adhesives, FIFRA[1], misc)

10.3.3 Prepare Clark County Emission Inventory Data

For mobile sources, DEQ obtained on road annual and seasonal data for Clark County from Metro. For point sources, SWCAA provided point source toxics data for 2007 and criteria pollutant data for 2005. DEQ adjusted 2007 data to 2005 levels by comparing criteria pollutants. SWCAA provided specific drycleaner and gas station data. For area source data, Washington Department of Ecology provided area source calculations for 2005. DEQ ensured that marine vessel emissions in OR and WA were not double counted. Washington Department of Ecology provided rail emissions by line haul and yard; DEQ allocated the emissions by county.

10.3.5 Growth Factors

- ***Document Title: Portland Air Toxics Solutions 2017 Emission Inventory Forecast.*** This document contains graphs of growth factors from Metro's forecast correlated with emission inventory and modeling source categories. http://www.deq.state.or.us/aq/toxics/docs/pats/forecast.pdf

- ***Document Title: Unofficial Interim Metro 2017 Regional PMSA Forecast (7 Counties) - Unpublished - DEC. 2009. Metro Growth Categories and 2017 Compounded Growth Factor.*** This document details Metro's growth categories and the 2017 growth factors for those categories. http://www.deq.state.or.us/aq/planning/report/appendix/metroGFcompoundFactors.pdf

- ***Document Title: Draft PATS Modeling Growth Factors 5/7/2010 2005 PATS Area Source, Perc Drycleaner, Aircraft/Airport, Locomotive, Commercial Marine Emission Inventory: Source Category Matched to Metro Growth Factor.*** This spreadsheet contains growth factors for emission inventory

[1] Federal Insecticide, Fungicide and Rodenticide Act: http://www.epa.gov/regulations/laws/fifra.html

emission area source categories from the Metro forecast.
http://www.deq.state.or.us/aq/toxics/docs/pats/2005patsAreaSource.pdf

- ***Document Title: Draft PATS Modeling Growth Factors 5/7/20102005 PATS Point Source EI: Facility Matched to Metro Growth Factor Using Facility Primary NAICS Code and Growth Factor NAICS Code.*** This spreadsheet contains point source growth factors from the Metro forecast.
http://www.deq.state.or.us/aq/toxics/docs/pats/2005patsPointSource.pdf

10.3.6 Data Quality

- ***Document Title: Data Quality Summary Tables.*** DEQ has developed a qualitative approach to describing PATS data quality. This spreadsheet summarizes the 2005 data quality for all pollutants from all modeled source categories.
http://www.deq.state.or.us/aq/toxics/docs/pats/dataQualitySummary.pdf

10.3.7 Emission Inventory Improvements

- ***Document Title: PATS Emission Inventory Improvements: Point Sources Added.*** The emissions from twenty-five point sources were added to the 2005 emission inventory through review of the US EPA Toxics Release Inventory (TRI) and on the recommendation of DEQ regional staff. The emission inventory for point sources is a mixture of TRI data, DEQ estimates, and source calculations.
http://www.deq.state.or.us/aq/planning/report/appendix/2005EIchangesHandout.pdf

- ***Document Title: PATS 2005 Modeling Improvements Documentation.*** This document summarizes the iterative changes DEQ made to the PATS technical work from August 2009 through March 2010. This document includes both modeling improvements and emission inventory improvements.
http://www.deq.state.or.us/aq/toxics/docs/pats/finalReport2005model.pdf

- ***Document Title: Department of Environmental Quality Residential Wood Combustion Survey: Results Report.*** This report is a summary of a telephone survey of Oregonians' behaviors associated with residential wood burning. The Portland State University Survey Research Lab (SRL) conducted the survey between March 5th and March 14th, 2009. The Survey Research Lab simultaneously conducted a random statewide survey and oversamples of four specific Oregon communities (Klamath Falls, Lakeview, Medford, and the Burns/Hines/Paiute Tribe boundary area). A total of 1,298 respondents completed the survey, with 1,036 respondents from throughout the state and 262 respondents from the oversamples. The survey results were used to refine the residential wood combustion emission inventory.
http://www.deq.state.or.us/aq/toxics/docs/pats/octoberFollowUpSurvey.pdf

- ***Document Title: Formula for Calculating 2017 Residential Wood Combustion Emissions*** This document contains the formula for calculating 2017 residential wood combustion emissions using the *DEQ Residential Wood Combustion Survey: Results Report* and accounting for Oregon's Heat Smart regulation that requires removal of an uncertified wood stove upon sale of a home.
http://www.deq.state.or.us/aq/planning/report/appendix/2017griddedRWC.pdf

- ***Document Title: Benzene Reductions due to the Mobile Source Air Toxics Rule.*** This document describes how DEQ characterizes benzene emissions in light of the new EPA Mobile Source Air Toxics (MSAT) Rule.
http://www.deq.state.or.us/aq/planning/report/appendix/benzeneReductionDueMSAT.pdf

- Additional information on the mobile source air toxics rule is available on the Environmental Protection Agency's website: http://www.epa.gov/oms/toxics.htm#regs .

10.3.8 Emission Inventory Results

- ***Document Title: 2017 Emission Inventory Pollutant Matrix.*** This spreadsheet contains the 2017 emission inventory results. An emission inventory is a database, by source, of the amount of pollutants discharged into the atmosphere during a given period. The projected estimates for the Portland Air Toxics Solution geographic area (domain) for 2017 are shown in this spreadsheet. The projected 2017 emission inventory displayed in this spreadsheet represents the 19 pollutants studied in the Portland Air Toxics Solutions Project. This table is useful to see at a glance what sources are most responsible for emissions of each pollutant over the entire PATS domain. It should not be used to predict a toxic concentration at a specific location. Its primary purpose is as an input to the 2017 air quality model. The model transports and disperses pollutant emissions using characteristics of the atmosphere, including wind speed, wind direction, and turbulence, and predicts concentrations of these pollutants at specific locations. The model will be used to help determine both local and regional impact areas by illustrating the source contributions for each pollutant in the PATS study area.
  http://www.deq.state.or.us/aq/toxics/docs/pats/matrix.pdf

10.4 PATS 2017 Modeling

10.4.1 Model Overview

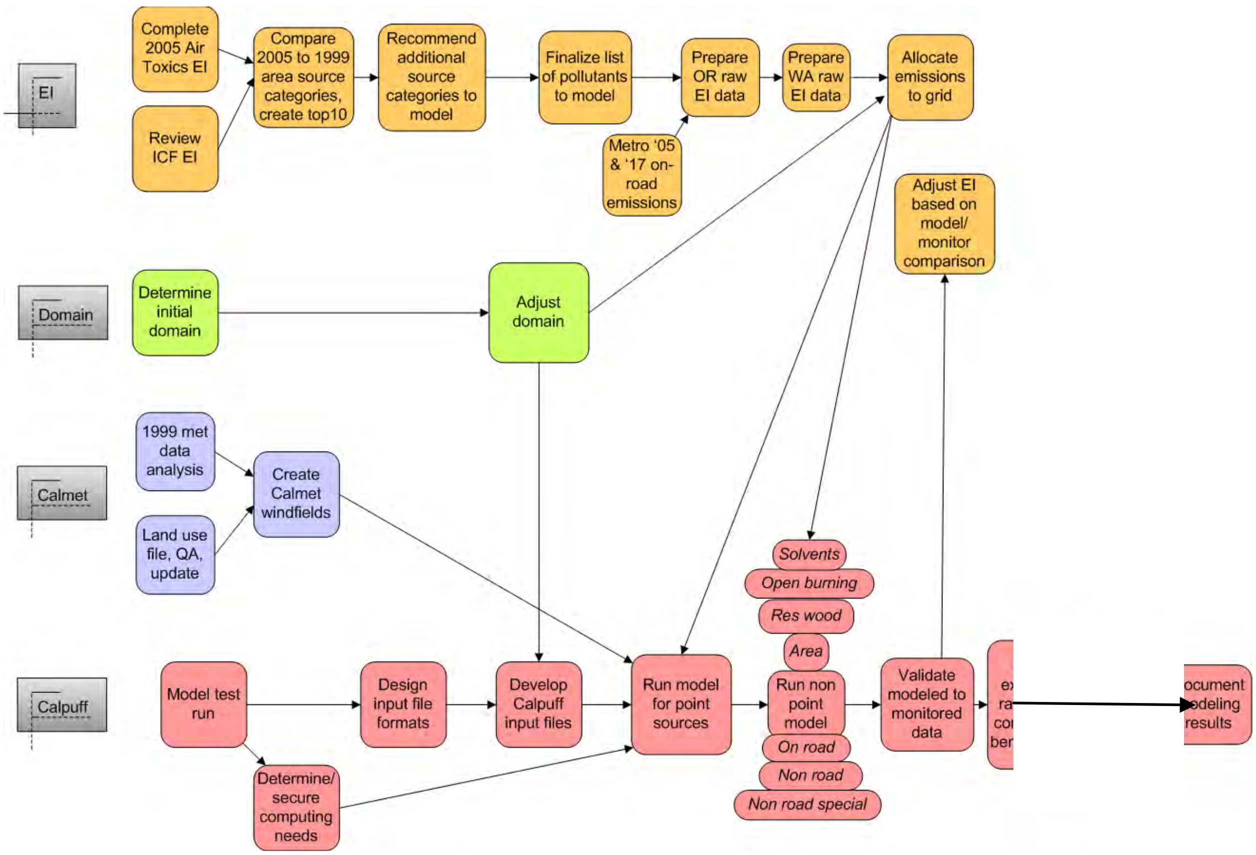
The dispersion model selected for PATS is called CALPUFF (version 5.8). The CALPUFF modeling system includes a meteorological model CALMET (version 5.8), a dispersion model CALPUFF (version 5.8), and a postprocessor CALPOST (version 5.394). This is the same modeling system that was used for Portland Air Toxics Assessment (PATA). CALPUFF is a non-steady-state Gausian puff dispersion model that simulates the effects of time and space varying meteorological conditions on pollution transport, transformation, and removal. The movement and dispersion of puffs occur within spatially and temporally varying wind fields that reflect complex terrain. CALPUFF contains simple chemistry mechanisms for daytime secondary aerosol formation, but does not contain more complex chemistry mechanisms needed to estimate several pollutants that form from reactions in the air. Up to 75% of measured formaldehyde can originate through secondary formation. Despite the lack of chemical mechanisms, this model was extensively evaluated in PATA study and was reselected in PATS as the best fit due to its ability to account for complex weather conditions, local terrain (such as mountains and rivers), and to handle various types of emission sources. DEQ's 2005 emission inventory and Metro's mobile data were used as input for CALPUFF. As with the PATA study, the PATS model runs used a combination of census tracts and block group data.

CALMET, which was used in PATA, was again used to handle the meteorological data. Since the 1999 meteorological data was comparable to 2005, the 1999 meteorological data was used for CALPUFF. DEQ reviewed the following factors to determine that the 1999 meteorological data was representative for a ten year period: surface meteorological stations, upper air data, geophysical data, terrain elevations, and land use. The meteorological data comes from nine sites in Portland, each containing nine vertical layers.

While PATSAC considered concentration rather than exposure data, DEQ has generated exposure data by applying ratios of concentrations and modeled exposure data from previous studies. This approach is the same used by EPA in the National Air Toxics Assessment (NATA). DEQ expects that exposure assessment information will be useful in developing emission reduction measures for priority emission categories.

Figure 98 below provides an overview of the steps in the PATS model.

Figure 98 PATS Modeling Flowchart



10.4.2 Dispersion Model

Sections 12.4.2.1 to 12.4.2.4 below outline the steps taken to prepare the PATS model.

10.4.2.1 Model Selection

CALPUFF version 5.8 was selected as the PATS dispersion model. It is a non steady-state Gaussian puff model that can model reactive decay and physical pollutant removal, or deposition. Due to the model's limited chemistry, it is unable to model secondary organic aerosols. However, the movement and dispersion of puffs occur within spatially and temporally varying wind fields that reflect complex terrain.

10.4.2.2 Modeling Domain

- Determine modeling domain based on risk, population and development.
- Adjust domain size and grid size based on land use, met review and census data.

10.4.2.3 Calpuff Modeling Data and Parameters

10.4.2.3.1 Calmet and Meteorology

- Determined 1999 meteorological data was representative for ten year period.
- Performed quality assurance of data and compared land use files, obtained updated land use file.
- Created Calmet windfields.

10.4.2.3.2 Calpuff Modeling Options

- Ran each source category separately.
- Identified and assigned receptor locations.
- Performed post processing.
  - Summed concentrations from all source categories.

10.4.2.3.3 Pollutants of concern to model

- Compared emission inventory 1999, 2002, and 2005 data for four counties and listed pollutants.
- Looked at estimates and compared to monitoring analysis.
- Sent list of pollutants to be modeled and description of why we selected each pollutant on GovDelivery list for public comment.

10.4.2.4 Quality Assurance/Quality Control

- Compared modeled to monitored data.
- Evaluated Confidence in Ambient Modeled Data.
- Adjusted emission inventory based on model to monitor comparison.

10.5 PATS Monitoring Analysis

10.5.1 Monitoring Sites

The Portland, Oregon and Vancouver, Washington metropolitan area has significant topographic features that separate the airshed into distinct sections. Located at the confluence of two rivers, much of it is within a broad valley/floodplain, with a range of hills on the west separating the central city from the western suburbs. The Columbia River on the north separates Portland from Vancouver, although it has traditionally been considered a single airshed for planning purposes. The Willamette River, which divides Portland into its east and west sides, influences air flow to some extent.

In 2005, there were six monitoring sites in the Portland metro area. Monitoring sites were located in all the major quadrants of the city, in order to provide information about the effect of topography as well as source influence. Each site, described below, met EPA's neighborhood-scale siting criteria, representing a mix of surrounding land uses, although in most cases neither point, area, or mobile sources predominated. An aerial photo of the Portland/Vancouver urban area with monitoring sites indicated is shown in Figure 99.

Figure 99 Portland / Vancouver Airshed with Monitoring Sites

10.5.2 Sample Collection and Analysis

DEQ's primary objective in the 1999 monitoring study was to determine annual average concentrations of air toxics to compare to exposure concentrations responsible for potential chronic health effects and cancer risk. Sampling for the project began in January 2005 and continued until February 2006. Several different sampling schedules were followed: carbonyls, volatile organics, PM_{10} metals, and chromium (VI) were done on a one in six day schedule, to coincide with the national particulate network; and semi-volatile organics (polycyclic aromatic hydrocarbons or PAH) on a one in 12 day schedule. DEQ collected integrated 24 hour samples for air toxics analyses that could then be averaged over a 12 month period. It is important to use standard methods along with adequate control and assessment to assure quality data collection. The Oregon Department of Environmental Quality has an agency-wide Quality Management Plan; the DEQ Laboratory Division has a Quality Management Plan for the ambient air monitoring program, including air toxics. Both Quality Management Plans have been reviewed and approved by EPA Region X.

EPA Compendium Methods for both sampling and analysis were used to measure gas phase pollutants, ensuring consistency with studies being done across the country. Method TO-14a (six liter Summa canisters) couples gas chromatography with mass spectrometry (GC/MS) to measure forty volatile organic pollutants. For PATA this sampling method included the air toxics benzene, 1, 3-butadiene, and tetrachloroethylene. For PATS, this sampling method is the same. Method TO-11 (DNPH cartridges) employs ion chromatography (IC) to measure sixteen carbonyls; PATA's focus was primarily on acetaldehyde and formaldehyde. GC/MS, Method TO-13A (PUF), was used to measure concentrations of twenty seven semi-volatile organics, including the fifteen carcinogenic PAHs.

Federal Reference Methods were used for particulate (PM 2.5) sampling and mass analysis, providing consistency with our historic data and with other national studies. After particulate mass was determined, samples were analyzed for their metal content (21 elements) using EPA Method IO-3, X-Ray Fluorescence (XRF) Spectroscopy. Over 100 individual chemical species were measured during this year-long monitoring study and included arsenic and nickel.

There was only one toxic that was outsourced and not processed and analyzed by the DEQ laboratory. A local contract Laboratory, certified by the National Environmental Laboratory Accreditation Program for hexavalent chromium, was responsible for the hexavalent chromium analysis.
There was no acceptable method for measuring acrolein or diesel particulate so there is no monitoring comparison for the model for these two air toxics.

10.5.3 Data Limitations and Results

Over 85% of the scheduled samples were collected and analyzed, and duplicate/replicate sample analyses indicated a better than 15% precision in results. Detection limits did not reach concentrations corresponding to the one in a million risk threshold for all the parameters measured. Accuracy was not always better than 15%, as measured by EPA coordinated inter-laboratory Performance Evaluation studies (PE). Between December 2004 and July 2006, when sample analyses were completed, the DEQ Lab participated in six PE for carbonyls, four PE for VOC, and three PE for metals. Analyses of formaldehyde and acetaldehyde were generally within 5% of the known values. Metals, except for beryllium, were usually within a few percent as well; although in May of 2006 reported values were high, as much as 15%. Accuracy of the volatile organics showed considerable variation over the course of the project, and with accuracy of measurement compound-specific. In late 2004, most of the reported values were much better than the 15% objective; some high and some low, indicating no particular bias in results. But studies in April and July of 2005 generally showed results to be low on the order of 20% or more across all pollutants. In December, most parameters were improved and were again less than 10% different from the known value, however they remained consistently low.

Table 46 compares the annual averages of core urban pollutants for all six sites. Annual averages were calculated from quarterly averages from January 2005 – February 2006. Quarterly median data was substituted for missing values to complete data sets. In particular, Beaverton had no 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 current. 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 VOC 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 current. Therefore, sufficient data for benzene is available for analyses.

Table 46 Annual Averages

Pollutant Name	**Units**	**Beaverton**	**SE Lafayette**	**Post Office**	**NE Roselawn**	**Kelly & Curry**	**Vancouver**
Acetaldehyde	ug/m3*	1.25	1.64	1.66	1.53	1.48	1.43
Formaldehyde	ug/m3*	1.58	2.14	2.4	2.17	2.16	1.97
1,3-butadiene	ppbv**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Carbon tetrachloride	ppbv**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Chloroform	ppbv**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
1,2-dichloropropane	ppbv**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Methylene Chloride	ppbv**	0.08	0.33	0.16	0.13	0.11	0.13
Tetrachloroethene	ppbv**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Trichloroethene	ppbv**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Vinyl chloride	ppbv**	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
o-Xylene	ppbv**	0.11	0.33	0.25	0.19	0.12	0.14
m,p-Xylene	ppbv**	0.28	0.51	0.69	0.55	0.33	0.39
Toluene	ppbv**	0.69	1.12	1.93	1.13	0.89	0.91
PAH	ug/m3*	0.00071	0.00085	0.00064	0.00062	0.00057	0.00085
Naphthalene	ug/m3*	0.0015	0.0014	0.0016	0.0012	0.0014	0.0019
Arsenic	ng/m3***	1.06	1.32	0.93	1.74	1.22	1.03
Beryllium	ng/m3***	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Cadmium	ng/m3***	0.38	0.50	0.63	2.57	0.92	0.49
Chromium	ng/m3***	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2
Chromium (VI)	ng/m3***	<0.042	<0.042	0.045	<0.042	<0.042	<0.042
Lead	ng/m3***	3.18	5.72	6.60	11.7	5.79	3.82
Manganese	ng/m3***	3.8	6.4	41.9	15.9	19.2	8.0
Nickel	ng/m3***	<1.0	1.75	4.24	1.76	1.78	1.09

*ug/m3 = micrograms per cubic meter – an air pollutant concentration
** ppb = parts per billion by volume – an air pollutant concentration
*** ng/m3 = nanograms per cubic meter – an air pollutant concentration

10.5.4 PATSAC Monitoring Presentation

- ***Document Title: Portland Air Toxics Solutions Air Monitoring*** A PowerPoint monitoring presentation for PATSAC including data plotted by year is available at: http://www.deq.state.or.us/aq/toxics/docs/PATSMonitoring.pdf .

10.5.4 Pollutant Monitoring Charts

- ***Document Title: 2005 Monitoring.*** This presentation contains graphs and ambient benchmark concentrations for PATS 2005 air toxics monitoring for PATS pollutants. http://www.deq.state.or.us/aq/toxics/docs/2005monitoringArsenic.pdf

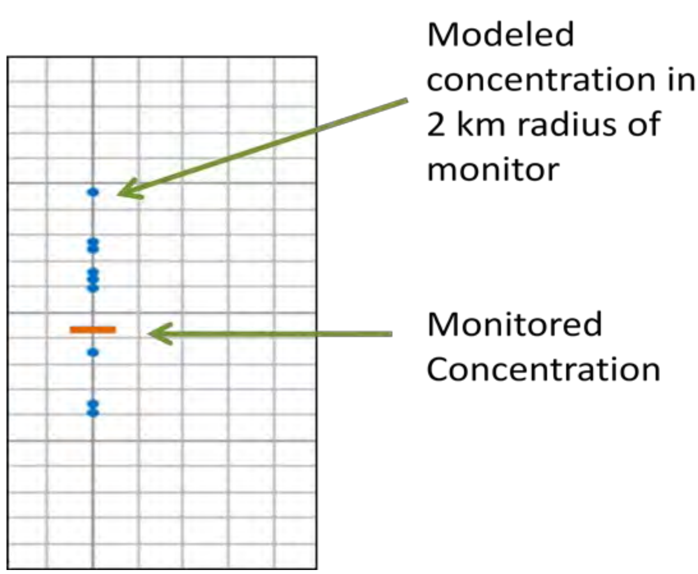
10.6 2005 Model to Monitor Comparison Results

Model to monitor comparison is usually conducted to validate model performance. Extensive work on 1999 model/ monitor comparison was done within the original PATS study and is described in PATS report. We compared the 2005 ambient concentrations with 2005 modeled concentrations. The difference between modeled and monitored concentrations may be attributed to underestimated, overestimated or missing emissions data and/or uncertainty in chemical transformation (for aldehydes).
2005 annual average ambient concentrations of eight air toxics (acetaldehyde, formaldehyde, benzene, arsenic, cadmium, lead, nickel, and manganese) were measured at six monitoring stations within the PATS domain.

10.6.1 Modeled data

In order to conduct a model to monitor comparison, the annual average 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. This approach was used to account for the variability in the spatial allocation of emissions, the variability in meteorological data quality, and the limitations inherent in matching paired-in-space-and-time concentrations.

Figure 100 Example Model to Monitor Comparison Results



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 Air Toxics Assessment (NATA), and are based on measured air toxics concentrations throughout the United States.

10.6.2 Meteorological data

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 for 2005.

Figure 101 Wind Speed, 1999 and 2005 Comparison

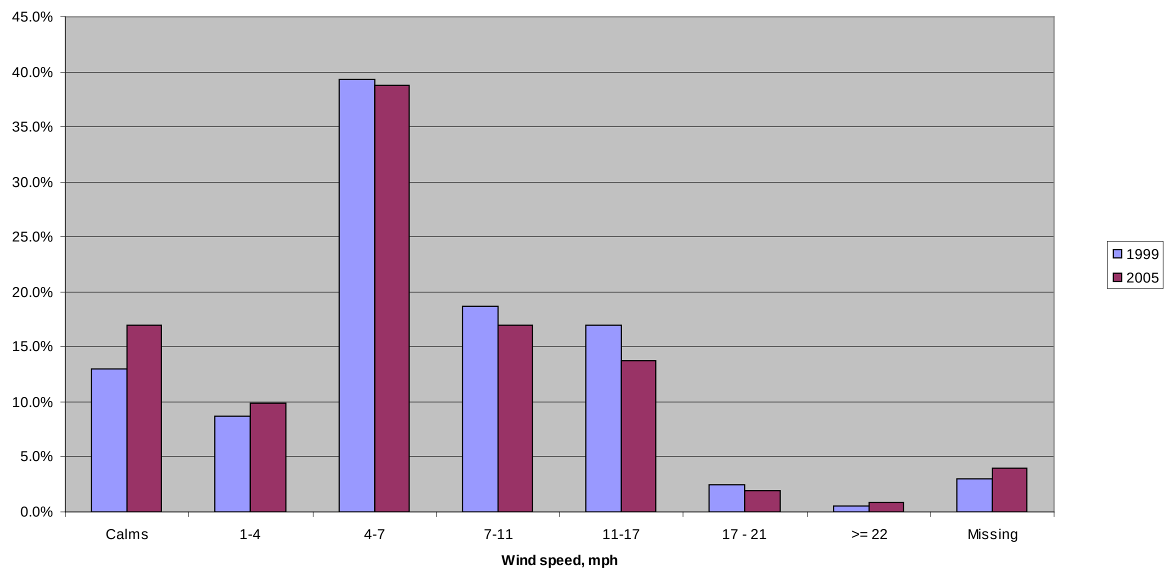
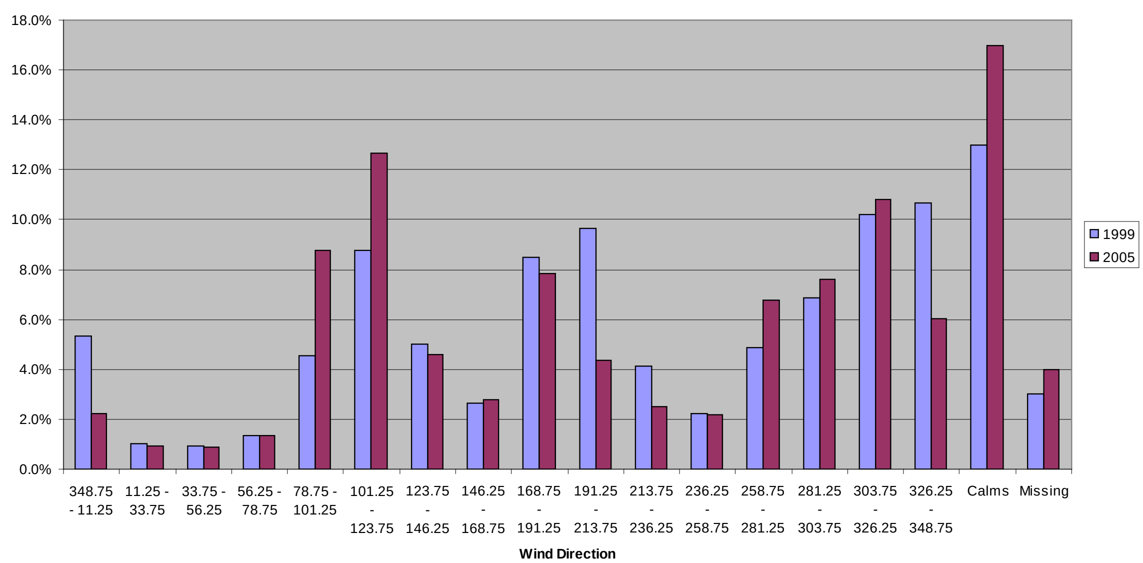


Figure 102 Wind Direction, 1999 and 2005 Comparison



10.6.3 Acetaldehyde and Formaldehyde

Ambient monitored concentrations of acetaldehyde and 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. In general, the corellation between modeled and monitored values is good for these two pollutants.

Figure 103: 2005 Acetaldehyde Model to Monitor Results

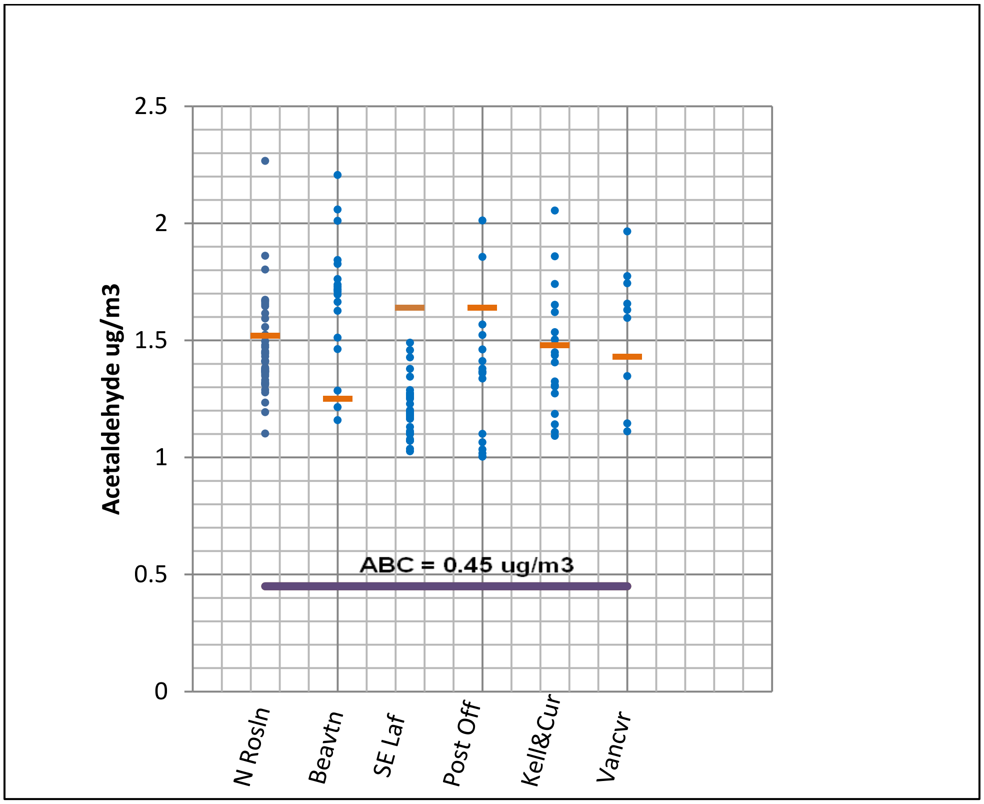
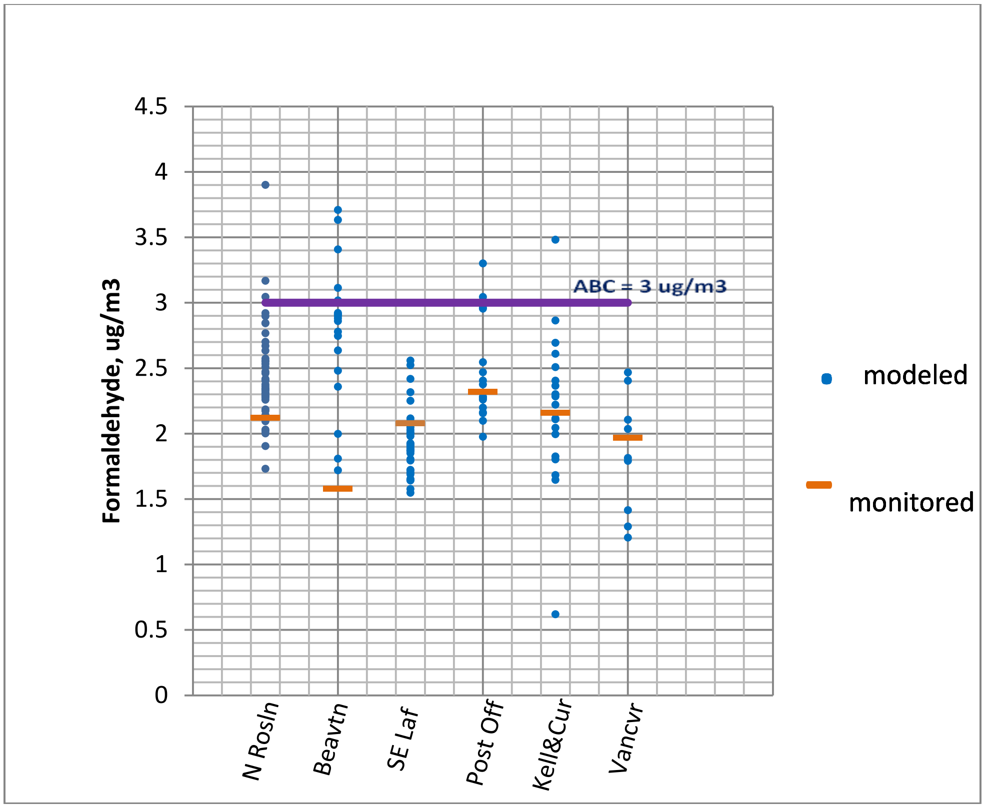


Figure 104: 2005 Formaldehyde Model to Monitor Results



10.6.4 Benzene and Nickel

Modeled concentrations of benzene are over predicted throughout the domain. With the exception of the NW Post Office, Vancouver, and possibly North Roselawn, nickel is also over predicted. Benzene is found in airborne emissions from burning coal and oil, motor vehicle exhaust, and evaporation from gas stations and industrial solvents. Nickel emissions can be from oil and coal combustion, nickel metal refining, sewage sludge incineration, manufacturing facilities, and other sources. It is not clear if there is a common cause of over-prediction for these two toxics.

Figure 105: 2005 Benzene Model to Monitor Results

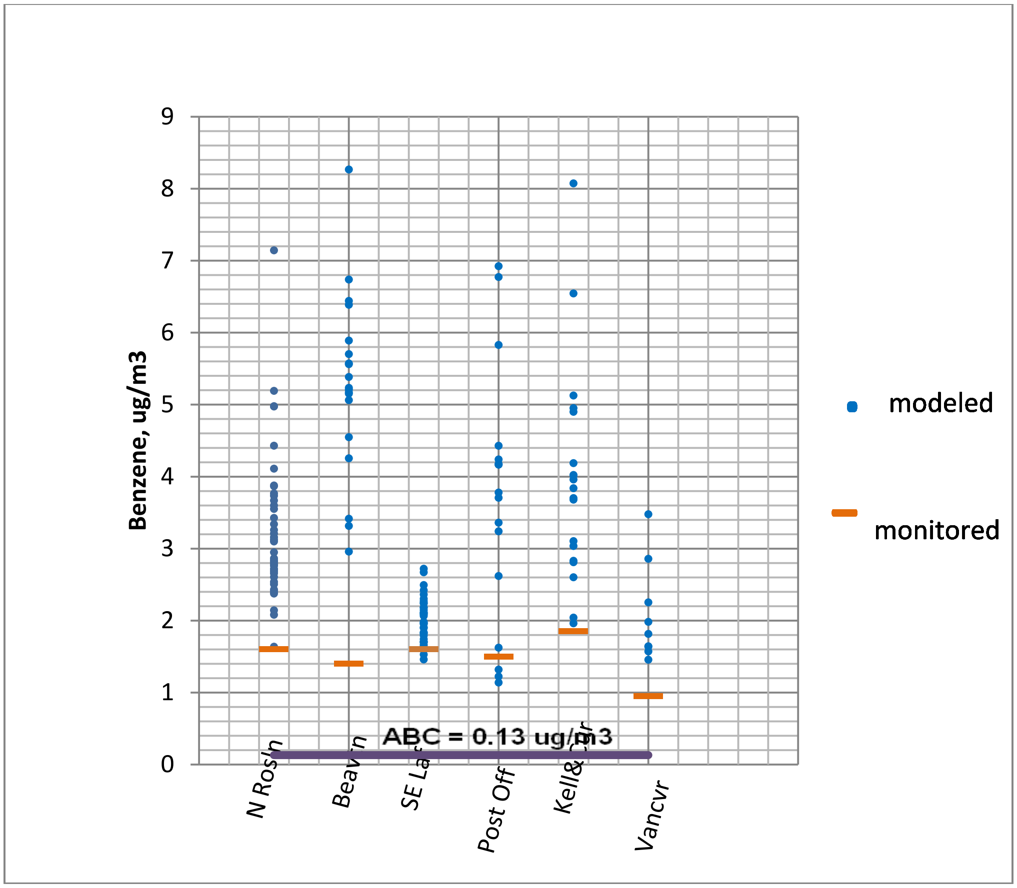
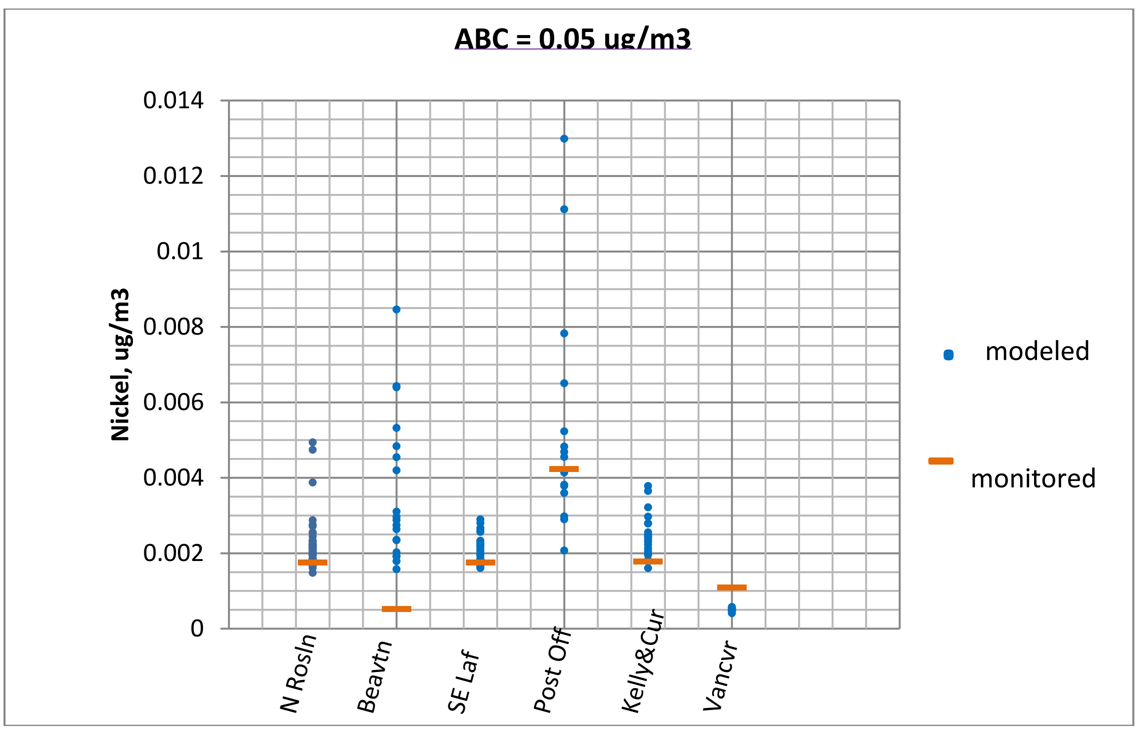


Figure 106: 2005 Nickel Model to Monitor Results



10.6.5 Arsenic, Cadmium, Lead and Manganese

The other metals (Lead, Arsenic, Manganese, and Cadmium) are under predicted at North Roselawn and SE Lafayette, cadmium and lead are also under predicted at Kelley & Curry, and manganese is under predicted throughout the domain.

Figure 107: 2005 Arsenic Model to Monitor Results

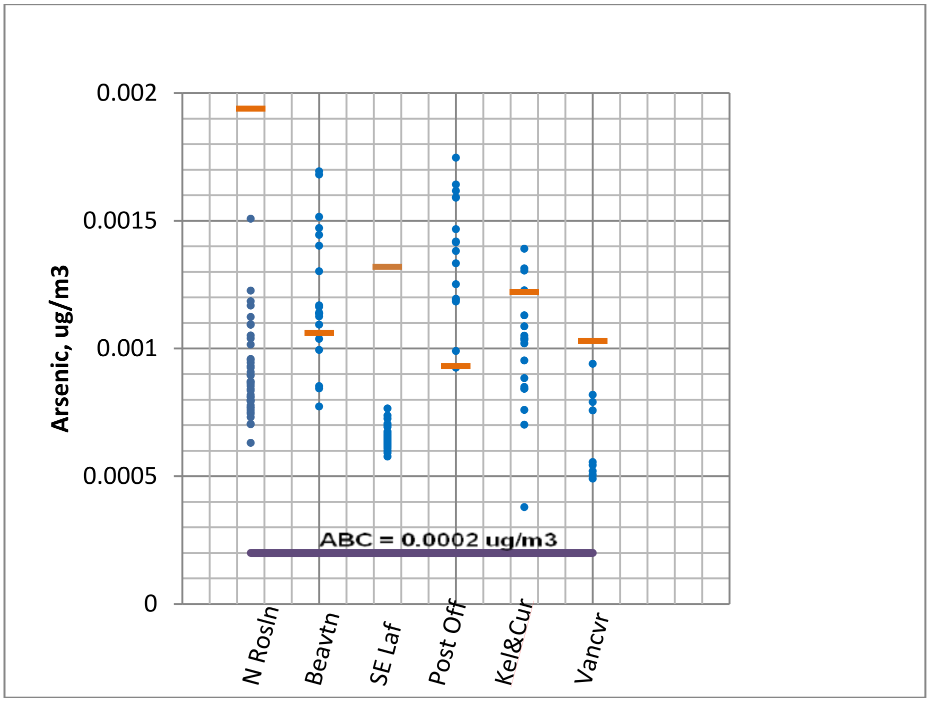


Figure 108: 2005 Cadmium Model to Monitor Results

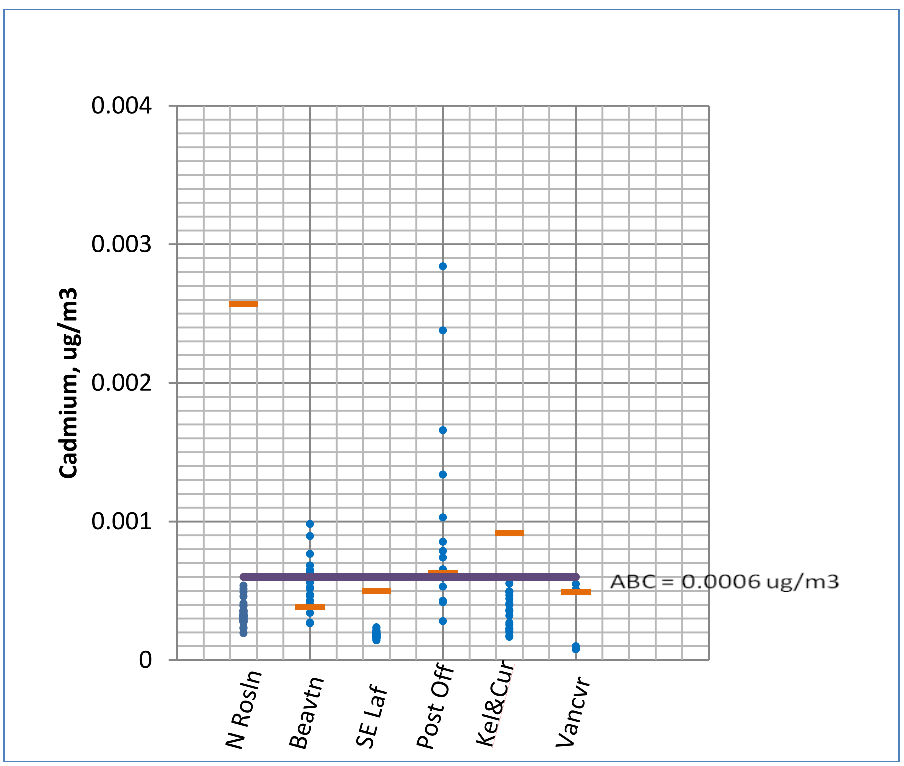


Figure 109: 2005 Lead Model to Monitor Results

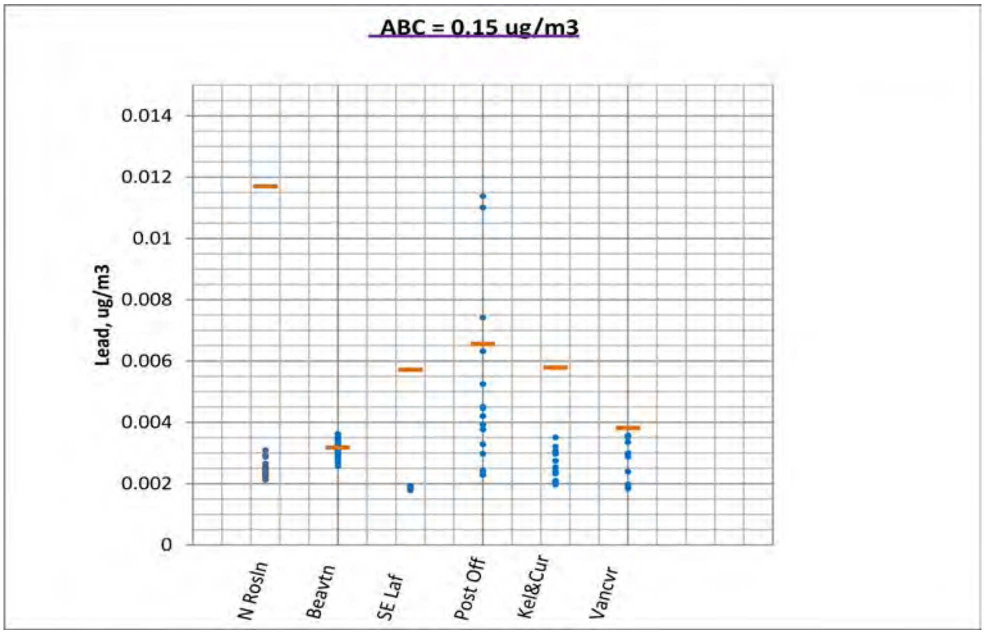


Figure 110: 2005 Manganese Model to Monitor Results

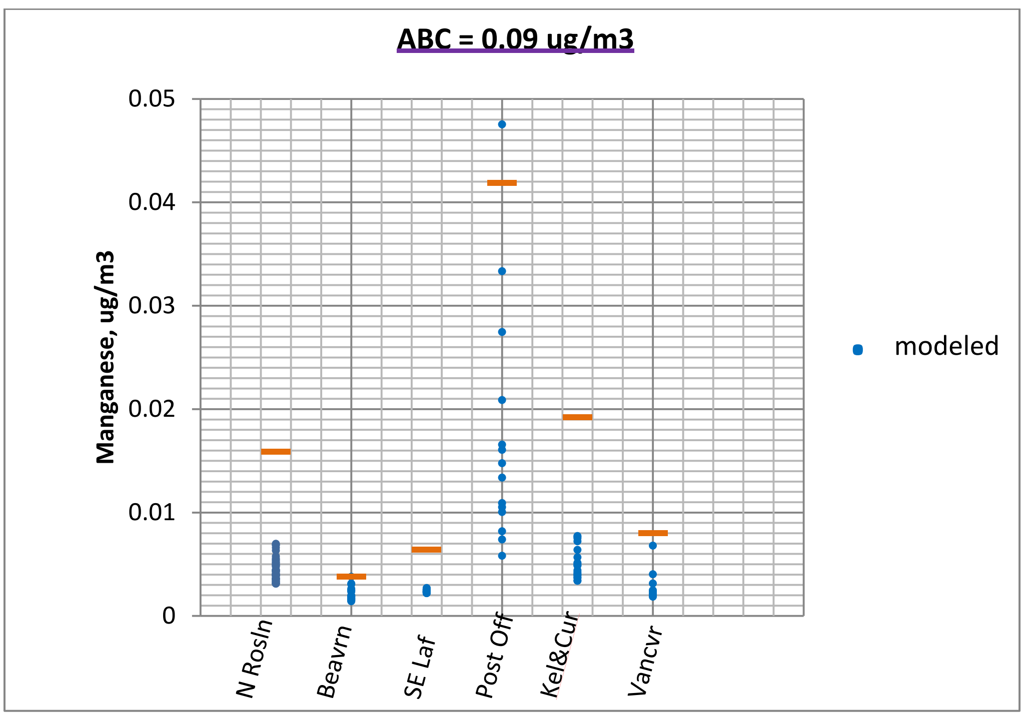
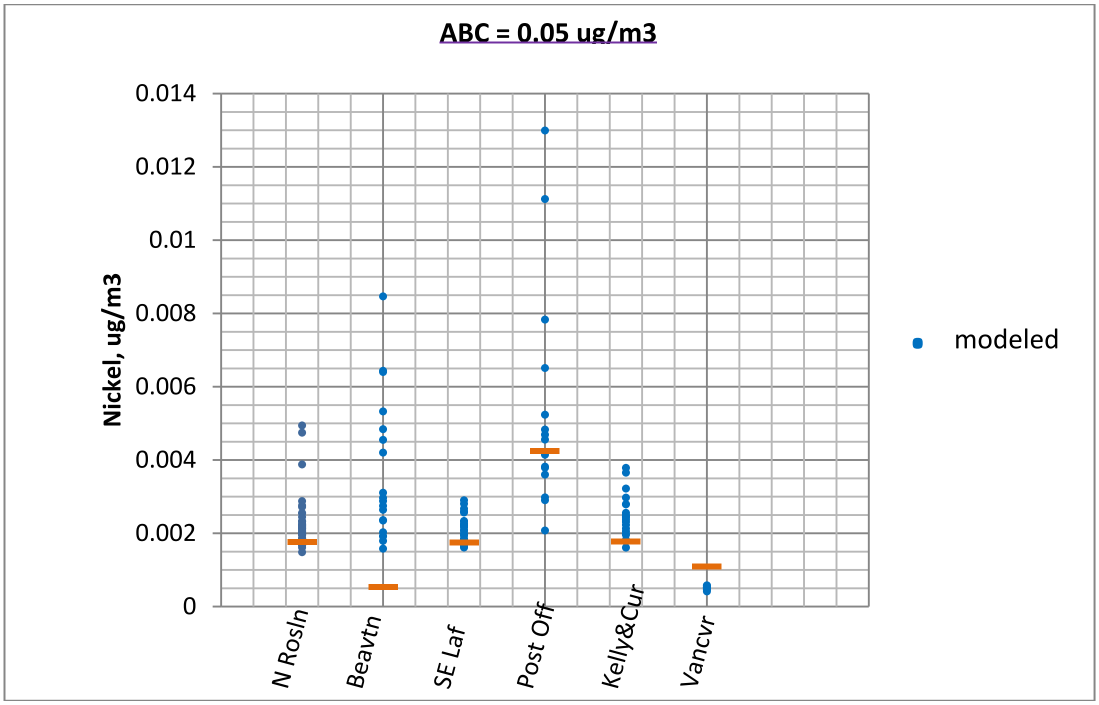


Figure 111: 2005 Nickel Model to Monitor Results



10.6.6 Monitor to Model Comparison Conclusions

According to US EPA (2201), studies of the performance of long-term air Quality models suggest that 90% of the estimated concentrations should be within a factor of two of those observed. This should be the case if the emissions are well characterized, chemical reactions that may form or remove pollutants do not occur, and the meteorological data are representative. In general, the results suggest that the CALPUFF model does a credible job of predicting ambient concentrations.

http://www.epa.gov/ttn/atw/sab/03-sab-nata-modeling.pdf

10.6.7 Cadmium Memo

- ***Document Title: North Portland Cadmium Source Investigation.*** As a follow-up to the modeling and monitoring comparison discussion of last meeting, this memo summarizes the history of DEQ's investigation into ambient air cadmium measurements in North Portland. http://www.deq.state.or.us/aq/toxics/docs/pats/cadmium.pdf

10.6.8 Additional Applications for Monitoring Information

- Reports on Oregon's air quality (http://www.deq.state.or.us/aq/forms/annrpt.htm);
- Air quality forecasting, wood stove burning advisories and air quality health alerts (http://www.deq.state.or.us/aq/advisories/index.htm);
- The Air Quality Index (http://www.deq.state.or.us/aqi/index.aspx);
- Forest fire smoke health alerts (http://www.deq.state.or.us/aq/burning/wildfires/neap.htm);
- The Wildfire Air Quality Rating (http://www.deq.state.or.us/aqi/wildfire/index.htm); and

- EPA's AIRNow nationwide website (http://www.airnow.gov/index.cfm?action=airnow.fcsummary&stateid=43).

10.7 Air Toxics Pollutant Summary

Document Title: Air toxics Pollutant Summaries. This document provides summaries of the best information DEQ has at this time. This document contains a general description of the pollutant, human-caused sources, health effects, the Oregon ambient benchmark concentration and whether each pollutant in Portland is above or below the benchmark based on modeling projections for 2017. The benchmark is the concentration of an air toxic in outdoor air that would result in an excess lifetime cancer risk level of one in a million or a non-cancer hazard quotient of one as established by the Air Toxics Science Advisory Committee. Each pollutant description includes a pie chart showing relative contributions from sources for each pollutant in the Portland area. http://www.deq.state.or.us/aq/factsheets/05-AQ-003_AirToxics.pdf

10.8 Emission Reduction Targets

The tables below provide additional emission reduction targets for mobile, area and point sources.

10.8.1 Mobile Sources

Table 47: On Road Mobile Potential Emission Reduction Targets

Impact around roadways: 500m	Average Concentration (ug/m3)	Benchmark (ug/m3)	Approximate Reduction Needed	Projected 2017 Emissions (tpy)	Potential Reduction Needed (tpy)
Acrolein	0.131	0.02	**85%**	4.12	3.5
1,3-Butadiene	0.249	0.03	**88%**	25.55	22.5
Formaldehyde	0.667	0.077	**88%**	80.82	71.1
Naphthalene	0.159	0.03	**81%**	9.15	7.4
Benzene	0.956	0.13	**86%**	205.98	177.1
Diesel PM	1.117	0.1	**91%**	81.72	74.4
Ethylbenzene	0.631	0.4	**37%**	85.61	31.7
Arsenic	0.000558	0.0002	**64%**	0.13	0.1
Chromium VI	0.000107	0.00008	**25%**	0.03	0.008
PAH - 15	0.018	0.0009	**95%**	1.04	0.98

Table 48: Non Road Mobile Construction Potential Emission Reduction Targets

Construction: analysis of the top 20% receptors					Area-Wide	
	All Source Categories				Construction Category	
	Average Concentration (ug/m3)	Benchmark (ug/m3)	Times> ABC	Approx Reduction needed	Projected 2017 Emissions (tpy)	Potential Reduction Needed (tpy)
Acrolein	0.1270	0.02	6.35	**84.1%**	1.1	0.95
1,3 Butadiene	0.2812	0.03	9.37	**90.5%**	1.3	1.1
Formaldehyde	0.6616	0.077	8.59	**88.9%**	42.6	37.9
Naphthalene	0.2105	0.03	7.02	**84.3%**	0.2	0.2
Benzene	0.9551	0.13	7.35	**87.4%**	11.7	10.2
Dichlorobenzene	0.1493	0.09	1.66	**48.4%**	0	0
Diesel PM	1.2209	0.1	12.21	**92.5%**	247.3	228.7
Ethylbenzene	0.6557	0.40	1.64	**46.7%**	4.2	2.0
Arsenic	0.0005	0.0002	2.40	**61.5%**	0.011	0.007
Chromium VI	0.0001	0.00008	1.11	**14.7%**	5.9E-05	8.7E-06
PAH-15	0.0219	0.0009	24.33	**96.3%**	0.19	0.18

Table 49: Non Road Mobile Rail Potential Emission Reduction Targets

Rail: analysis of the top 20 % of receptors					Rail Category	
	All Source Categories					
	Average Concentration (ug/m3)	Benchmark (ug/m3)	Times> ABC	Approx. Reduction needed	Projected 2017 Emissions (tpy)	Potential Reduction Needed (tpy)
Acrolein	0.1415	0.02	7.08	**84.2%**	0.20	0.17
1,3 Butadiene	0.2175	0.03	7.25	**89.3%**	0.21	0.18
Formaldehyde	0.5467	0.077	7.10	**88.4%**	2.8	2.5
Naphthalene	0.1806	0.03	6.02	**85.7%**	0.11	0.09
Benzene	0.7515	0.13	5.78	**86.4%**	0.20	0.17
Dichlorobenzene	0.0769	0.09	0.85	**39.7%**	0	0
Diesel PM	0.9545	0.1	9.54	**91.8%**	38.8	35.6
Ethylbenzene	0.4288	0.40	1.07	**39.0%**	0.16	0.06
Arsenic	0.0004	0.0002	2.05	**58.3%**	4.7E-05	2.7E-05
Chromium	0.0001	0.00008	1.00	**9.7%**	1.1E-07	1.1E-08
PAH-15	0.0152	0.0009	16.89	**95.9%**	0.06	0.06

Table 50: Non Road Mobile Marine Potential Emission Reduction Targets

Commercial & Recreational Marine: analysis of the top 20 % of receptors					Marine Category	
	All Source Categories					
	Average Concentration (ug/m3)	Benchmark (ug/m3)	Times> ABC	Approx. Reduction needed	Projected 2017 Emissions (tpy)	Potential Reduction Needed (tpy)
Acrolein	0.1180	0.02	5.90	**85.9%**	0.10	0.08
1,3, Butadiene	0.1893	0.03	6.31	**86.2%**	0.37	0.32
Formaldehyde	0.4712	0.077	6.12	**85.9%**	4.1	3.5
Naphthalene	0.1524	0.03	5.08	**83.4%**	0.54	0.45
Benzene	0.6374	0.13	4.90	**82.7%**	4.8	4.0
Diesel PM	0.8191	0.1	8.19	**89.5%**	8.0	7.2
Ethylbenzene	0.3752	0.40	0.94	**6.7%**	3.0	0.2
Arsenic	0.0003	0.0002	1.69	**51.3%**	0.0007	0.0004
PAH-15	0.0126	0.0009	14.04	**94.1%**	0.012	0.012

10.8.2 Area Sources

Table 51: Residential Wood Combustion Potential Emission Reduction Targets

RWC: analysis of the of the top 20% receptors					RWC Category	
All Source Categories						
	Average Concentration (ug/m3)	Benchmark (ug/m3)	Times> ABC	Approx. Reduction needed	Projected 2017 Emissions (tpy)	Potential Reduction Needed (tpy)
Acrolein	0.1273	0.02	6.36	**84.3%**	8.17	6.9
1,3 Butadiene	0.2872	0.03	9.57	**89.6%**	23.75	21.3
Formaldehyde	0.6576	0.077	8.54	**88.3%**	159.77	141.1
Naphthalene	0.1721	0.03	5.74	**82.6%**	25.20	20.8
Benzene	0.8335	0.13	6.41	**84.4%**	130.34	110.0
Dichlorobenzene	0.1304	0.09	1.45	**31.0%**	0	0
Diesel PM	0.9910	0.1	9.91	**89.9%**	0	0
Ethylbenzene	0.5463	0.40	1.37	**26.8%**	0	0
Arsenic	0.0004	0.0002	1.91	**47.6%**	0	0
PAH-15	0.0280	0.0009	31.11	**96.8%**	12.59	12.18

Table 52: Lawn and Garden Potential Emission Reduction Targets

Lawn & Garden: analysis of the the top 20% receptors					Lawn and Garden Category	
	All Source Categories					
	Average Concentration (ug/m3)	Benchmark (ug/m3)	Times> ABC	Approx. Reduction needed	Projected 2017 Emissions (tpy)	Potential Reduction Needed (tpy)
Acrolein	0.1261	0.02	6.30	**89.9%**	1.1	0.97
1,3 Butadiene	0.3163	0.03	10.54	**90.0%**	10.5	9.4
Formaldehyde	0.6940	0.077	9.01	**89.5%**	21.9	19.6
Naphthalene	0.1912	0.03	6.37	**88.3%**	2.5	2.2
Benzene	1.0311	0.13	7.93	**87.5%**	70.8	62.0
Dichlorobenzene	0.1744	0.09	1.94	**37.1%**	0	0
Diesel PM	1.3334	0.1	13.33	**92.3%**	15.1	14.0
Ethylbenzene	0.7506	0.40	1.88	**39.9%**	47.9	19.1
Arsenic	0.0005	0.0002	2.60	**63.3%**	0.009	0.006
Chromium	0.0001	0.00008	1.17	**17.7%**	0.0008	0.0001
PAH-15	0.0241	0.0009	26.81	**96.0%**	0.61	0.58

Table 53: Solvent Use Potential Emission Reduction Targets

Solvent Use: analysis of the of the top 20% receptors					Solvent Use Category	
	All Source Categories					
	Average Concentration (ug/m3)	Benchmark (ug/m3)	Times> ABC	Approx. Reduction needed	Projected 2017 Emissions (tpy)	Potential Reduction Needed (tpy)
Formaldehyde	0.7655	0.077	9.94	**89.9%**	1.4	1.3
Naphthalene	0.2580	0.03	8.60	**88.4%**	43.3	38.3
Benzene	1.1450	0.13	8.81	**88.6%**	20.4	18.1
Dichlorobenzene	0.1615	0.09	1.79	**44.3%**	80.7	35.7
Ethylbenzene	0.7489	0.40	1.87	**46.6%**	85.0	39.6

10.8.3 Point Source Emission Reduction Targets

10.8.3.1 Cadmium

The map in Figure 112 below shows pie charts for each industrial facility with significant cadmium emissions. Each pie chart shows relative contributions for the highest impact receptor near those facilities. The map also shows facility source numbers that correspond to the approximate reductions needed list in Table 48 below. Emission inventory and modeling refinements are needed to refine the approximate reductions listed in Table 48. Model to monitor comparisons for cadmium suggest that there are additional cadmium sources in North Portland that are not included in the model. (See section 3.6) The elevated cadmium levels modeled in the Beaverton area are related to natural gas use.

Figure 112: Total Risk from Cadmium From All Sources (Point, Area, Mobile) with Pie Charts for Point Source Cadmium Emissions

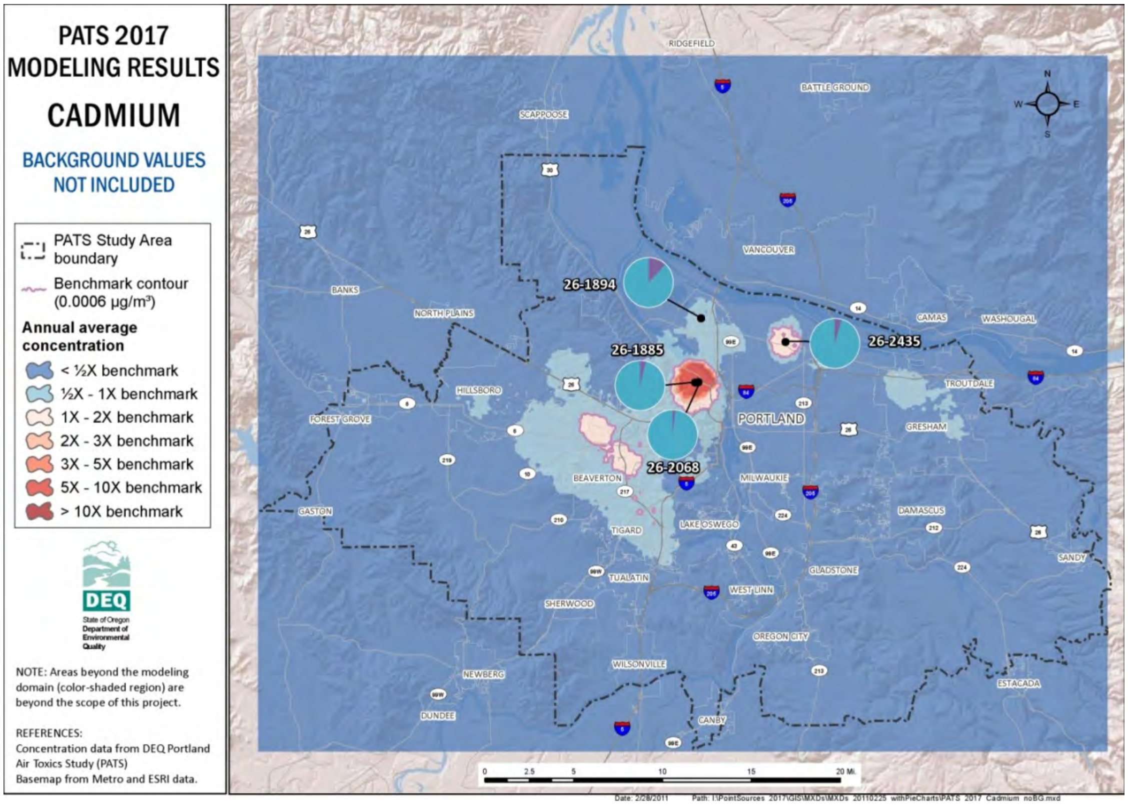


Table 54: Approximate Reduction Needed at Highest Impacted Receptor for Cadmium Point Sources

Source No.	Source Name	Source Category Description	Approximate Reduction Needed at Highest Impacted Receptor	Projected 2017 Emissions (lbs)	Potential Reduction (lbs)
26-2068	ESCO Corporation	Steel Foundries	96%	27	26
26-2435	Cardinal Aluminum	Heating Equipment Manufacturing	84%	11	9
26-1885	Galvanizers Co	Metal Coating, Engraving, and Allied Services to Manufacturers	94%	4	4
26-1894	Malarkey Roofing Company	Asphalt Shingle and Coating Materials Manufacturing	66%	3	2

10.8.3.2 Manganese

The map in Figure 113 below shows pie charts for each industrial facility with significant manganese emissions. Each pie chart shows relative contributions for the highest impact receptor near those facilities. The map also shows facility source numbers that correspond to the approximate reductions needed list in Table 55 below. Emission inventory and modeling refinements are needed to refine the approximate reductions.

Figure 113: Total Manganese Emissions From All Sources (Point, Area, Mobile) with Pie Charts for Point Source Manganese Emissions

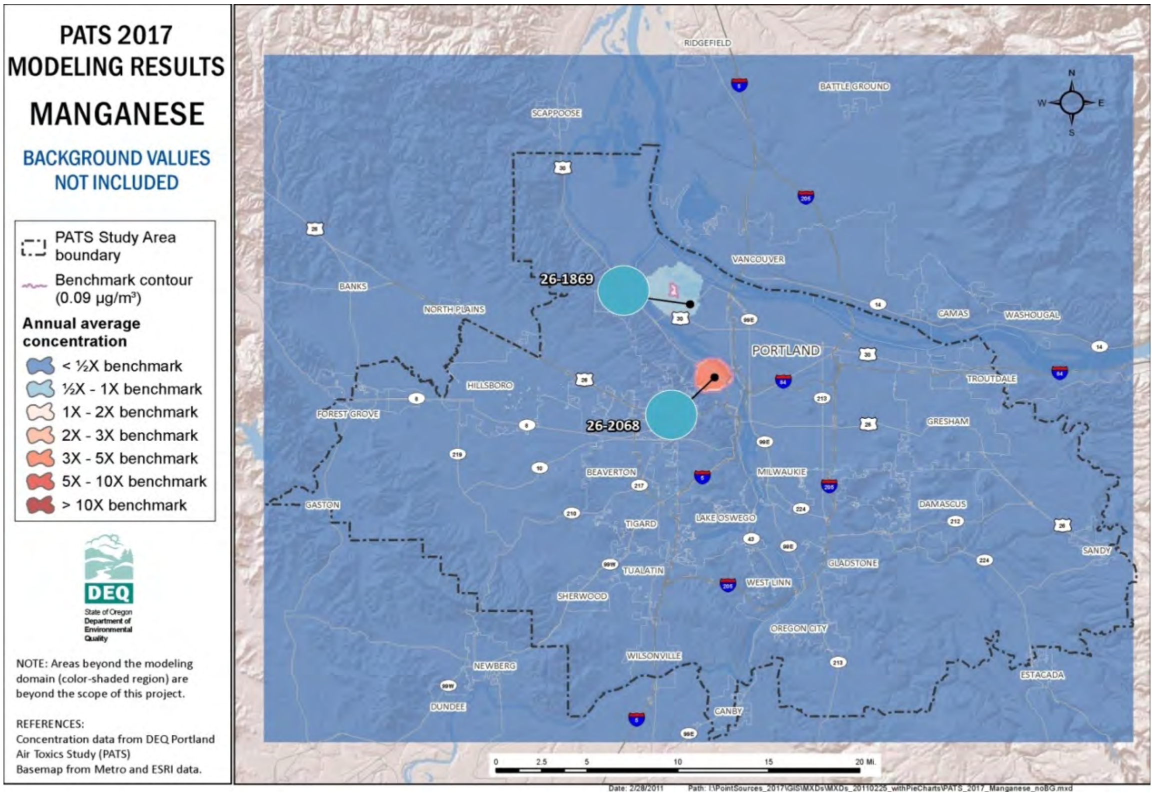


Table 55: Approximate Reduction Needed at Highest Impacted Receptor for Manganese Point Sources

Source No.	Source Name	Primary NAICS description	Approximate Reduction Needed at Highest Impacted Receptor	Projected 2017 Emissions (lbs)	Potential Reduction (lbs)
26-1869	Columbia Steel Casting Co Inc	Steel Foundries	39%	1,951	753
26-2068	ESCO Corporation	Steel Foundries	91%	816	743

10.8.3.3 Nickel

The map in Figure 114 below shows pie charts for each industrial facility with significant nickel emissions. Each pie chart shows relative contributions for the highest impact receptor near those facilities. The map also shows facility source numbers that correspond to the approximate reductions needed list in Table 56 below. Emission inventory and modeling refinements are needed to refine the approximate reductions.

Figure 114: Total Nickel Emissions From All Sources (Point, Area, Mobile) with Pie Charts for Point Source Nickel Emissions

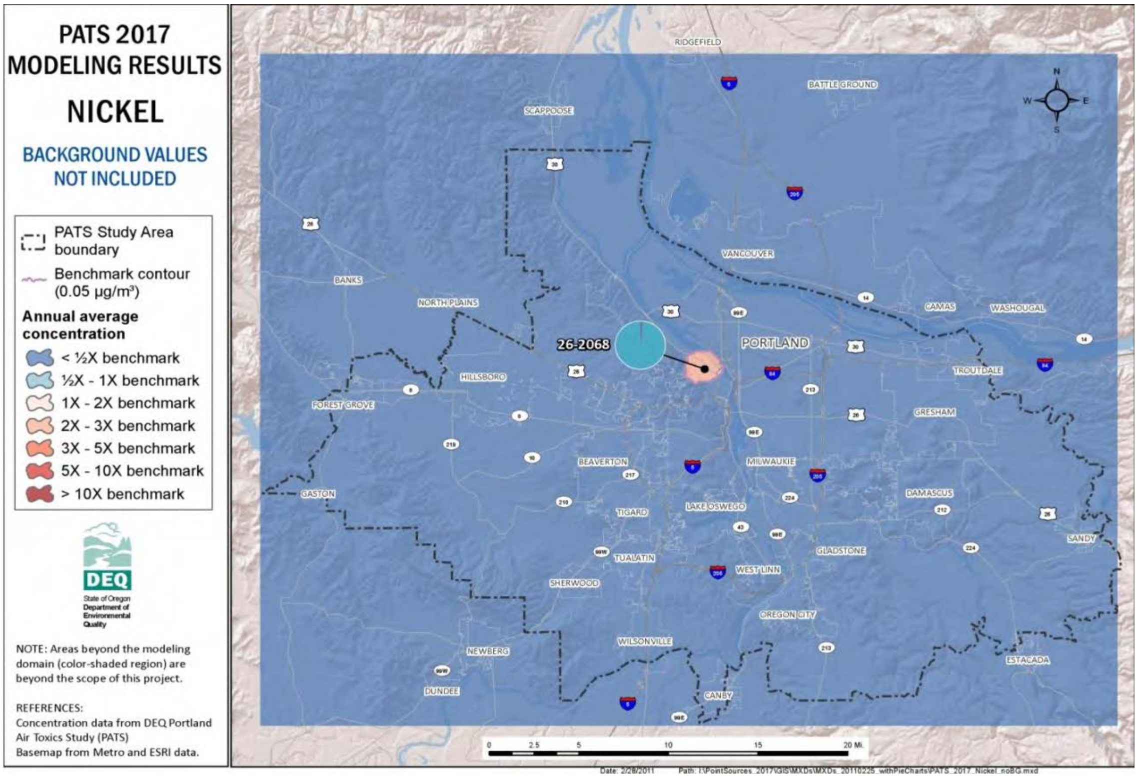


Table 56: Approximate Reduction Needed at Highest Impacted Receptor for Nickel Point Sources

Source No.	Source Name	Source Category Description	Approximate Reduction Needed at Highest Impacted Receptor	Projected 2017 Emissions (lbs)	Potential Reduction Needed (lbs)
26-2068	ESCO Corporation	Steel Foundries	72%	85	62

10.8.3.4 Lead

The map in Figure 115 below shows pie charts for the one industrial facility with lead emissions. There was only one receptor showing a level above the lead benchmark. The map also shows the facility source number that corresponds to the approximate reductions needed list in Table 57 below. Emission inventory and modeling refinements are needed to refine the approximate reductions.

Figure 115: Total Lead Emissions From All Sources (Point, Area, Mobile) with Pie Charts for Point Source Lead Emissions

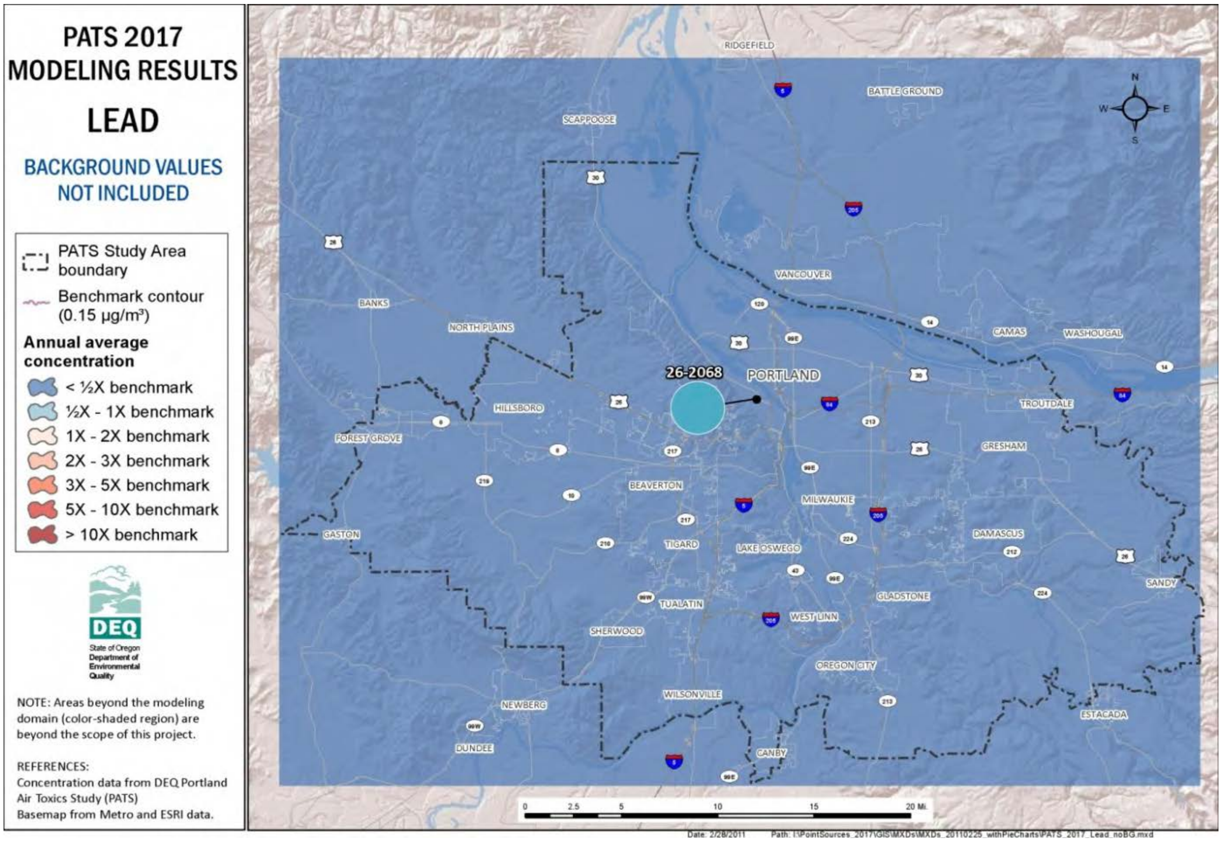


Table 57: Approximate Reduction Needed at Highest Impacted Receptor for Lead Point Sources

Source No.	Source Name	Source Category Description	Approximate Reduction Needed at Highest Impacted Receptor	Projected 2017 Emissions (lbs)	Potential Reduction (lbs)
26-2068	ESCO Corporation	Steel Foundries	49%	167	82

10.8.3.5 Benzene

The map in Figure 116 below shows pie charts for each industrial facility with significant benzene emissions. Each pie chart shows relative contributions for the highest impact receptor near those facilities. The map also shows facility source numbers that correspond to the approximate reductions needed list in Table 58 below. Emission inventory and modeling refinements are needed to refine the approximate reductions.

Figure 116: Total Benzene Emissions From All Sources (Point, Area, Mobile) with Pie Charts for Point Source Benzene Emissions

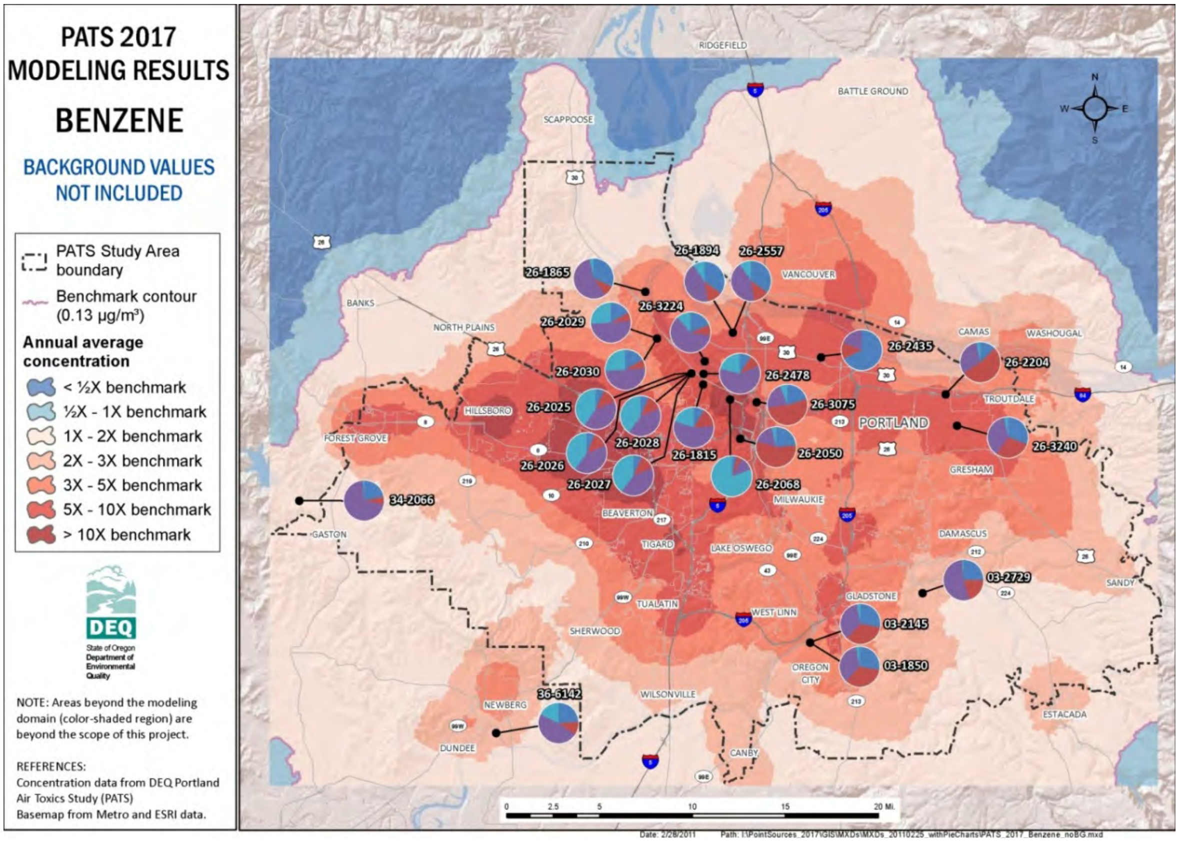


Table 58: Approximate Reduction Needed at Highest Impacted Receptor for Benzene Point Sources

Source No.	Source Name	Source Category Description	Approximate Reduction Needed at Highest Impacted Receptor	Projected 2017 Emissions (lbs)	Potential Reduction (lbs)
26-2068	ESCO Corporation	Steel Foundries	98%	5,269	5,156
36-6142	SP Newsprint Co.	Newsprint Mills	61%	7,517	4,559
26-2030	BP West Coast Products, LLC	Petroleum Bulk Stations and Terminals	84%	1,567	1,309
26-2025	Paramount Petroleum, Willbridge Refinery	Petroleum Refineries	93%	1,020	945
26-2027	Chevron Products Company	Petroleum Bulk Stations and Terminals	93%	1,018	943
26-2028	Kinder Morgan Energy Partners, L.P	General Warehousing and Storage	93%	677	627
26-2029	Shore Terminals LLC	Petroleum Bulk Stations and Terminals	84%	737	616
26-1815	Owens-Corning Corporation	Asphalt Shingle and Coating Materials Manufacturing	91%	505	457
26-2204	Boeing Company (The)	Other Aircraft Parts and Auxiliary Equipment Manufacturing	85%	208	178
03-1850	Blue Heron Paper Company	Pulp Mills	69%	221	152
26-2478	Equilon Enterprises LLC	Petroleum Bulk Stations and Terminals	88%	144	126
26-3224	Vigor Industrial, LLC	Ship Building and Repairing	78%	143	111
26-1894	Malarkey Roofing Company	Asphalt Shingle and Coating Materials Manufacturing	84%	122	102
26-2026	ConocoPhillips	Petroleum Bulk Stations and Terminals	93%	79	73
26-2557	Blasen Blasen Lumber	Sawmills	84%	65	54
03-2729	Northwest Pipeline Corporation	Pipeline Transportation of Natural Gas	48%	113	54
34-2066	Stimson Lumber Company	Sawmills	29%	160	47
26-3075	TARR ACQUISITION LLC	Petroleum Bulk Stations and Terminals	82%	44	35
26-2435	Cardinal Aluminum	Heating Equipment (except Warm Air Furnaces) Manufacturing	88%	21	19
26-1865	Oregon Steel Mills, Inc.	Iron and Steel Mills	48%	5	2
03-2145	West Linn Paper Company	Paper (except Newsprint) Mills	69%	3	2
26-3240	Microchip Technology, Inc.	Semiconductor and Related Device Manufacturing	79%	2	2
26-2050	Oregon Health Sciences University	Hazardous Waste Treatment and Disposal	90%	1	1
26-1876	Owens-Brockway Glass Container Inc.		84%	1	<1

10.9 White Paper Strategy Development

The white papers provide information to inform future committees in post-PATSAC efforts. The White Papers contain:

- A description of the emission source category
- Modeling results
- A summary of existing emission reduction measures
- A brainstorm list of potential new emission reduction measures, evaluated on the following PATSAC considerations: magnitude of emission reductions, timeframe to reduce emissions, technical feasibility, and a cost summary. See section 2.3.3 for the full list of PATSAC considerations.
- Details for each potential new emission reduction measure. There are a host of other PATSAC considerations that were utilized in the selection process for the recommendation framework. The additional considerations include, but not limited to, implementation, funding, non-regulatory approaches, effect on exposure, cost effectiveness, health benefits, and risk distribution. See section 2.3.3 for the full list of PATSAC considerations.

These White Papers are intended solely to provide initial background and survey-level findings for potential emissions reduction measures for the specific source category. The White Papers may contain prepared written statements in the Attachments that represent those group or individual positions only. Not all participants in the PATSAC process submitted comments to the White Papers. The content included in this White Paper was developed to inform future stakeholder work and may be further investigated and refined.

10.9.1 Area and Mobile Emission Source Categories

- ***Document Title:*** Residential Wood Combustion and Heating
- ***Document Title:*** On-Road Gasoline.
- ***Document Title:*** Nonroad Diesel.
- ***Document Title:*** On-Road Diesel.
- ***Document Title:*** Nonroad Gasoline.
- ***Document Title:*** Solvent/Coating Use-Paint Strippers & Architectural.
- ***Document Title:*** Consumer Products.
- ***Document Title:*** Railroads.
- ***Document Title:*** Unpermitted Industrial Fuel Use.
- ***Document Title:*** Asphalt Use (non-permitted).
- ***Document Title:*** Miscellaneous (Publicly Owned Treatment Works, Landfills, and Restaurants).

10.9.2 Point Source Emission Source Categories

- ***Document Title:*** Asphalt Roofing Manufacturing.
- ***Document Title:*** Bulk Terminals
- ***Document Title:*** Glass Manufacturing.
- ***Document Title:*** Metals Facilities.
- ***Document Title:*** Permitted Industrial Fuel Use.
- ***Document Title:*** Surface Coating.

10.10 Gaps and Growth Documents

10.10.1 PEAC Proposal **PEAC Point Source Recommendation.pdf**
10.10.2 PEAC Proposal Letter of Support **PEAC Point Source Letter of Support.pdf**
10.10.3 Gaps and Growth Matrix Gaps and Growth Matrix 51911.pdf
10.10.4 AOI and OMIC comments on Gaps and Growth Matrix AOI and OMIC.pdf

10.11 Meeting Summaries

1. **August 13, 2009:** http://www.deq.state.or.us/aq/toxics/docs/pats/SummaryMtg1.pdf
2. **April 20, 2010:** http://www.deq.state.or.us/aq/toxics/docs/pats/pATSACactionItems.pdf
3. **June 3, 2010:** http://www.deq.state.or.us/aq/toxics/docs/pats/actionItems6_3_10Meeting.pdf
4. **July 20, 2010:** http://www.deq.state.or.us/aq/toxics/docs/pats/kearnsWest.pdf
5. **October 27, 2010:** http://www.deq.state.or.us/aq/toxics/docs/pats/octoberActionItems.pdf
6. **December 1, 2010:** http://www.deq.state.or.us/aq/toxics/docs/pats/actionItemsMeeting%20Summary12_10.pdf
7. **January 25, 2011:** http://www.deq.state.or.us/aq/toxics/docs/pats/1_25_11ActionItems.pdf
8. **February 10, 2011 (work session, no notes)**
9. **March 2, 2011:** http://www.deq.state.or.us/aq/toxics/docs/pats/march2ActionItems.pdf

10. April 6, 2011: http://www.deq.state.or.us/aq/toxics/docs/pats/5_19_11memorandum.pdf

11. April 14, 2011: http://www.deq.state.or.us/aq/toxics/docs/pats/5_19_11memorandum2.pdf

12. May 19, 2011: http://www.deq.state.or.us/aq/toxics/docs/pats/5_19_11summary%20.pdf

13. June 21, 2011: http://www.deq.state.or.us/aq/toxics/docs/pats/6_21_11summary.pdf

14. October 17, 2011: http://www.deq.state.or.us/aq/toxics/docs/pats/10_17_11summary.pdf

10.11 Resources for Comparing Emissions from Alternative Fuels

- California has evaluated energy use, criteria pollutants, some air toxics and greenhouse gas emissions for alternative fuels, which covers on-road vehicles. http://www.energy.ca.gov/2007publications/CEC-600-2007-004/CEC-600-2007-004-REV.PDF
- Oregon fuels and alternative fuels would differ slightly for many reasons, including, but not limited to: different electricity sources, Oregon does not have reformulated gas, Oregon has more high carbon intensity crudes than California (which take more energy to refine) in our petroleum mix.
- There is also general info on this US Dept. of Energy website, which covers on-road vehicles: http://www.afdc.energy.gov/afdc/vehicles/emissions.html
- This Argonne National Laboratory study evaluated air toxics emissions of the following fuels and vehicle technologies: conventional gasoline, conventional diesel, federal reformulated gasoline, California reformulated gasoline, compressed natural gas, liquefied natural gas, methanol, ethanol, battery-powered electric vehicles, and hybrid electric vehicles. http://www.transportation.anl.gov/pdfs/TA/137.pdf

- EPA currently has a research project investigating alternative fuel emissions. Vehicles that use alternative fuels such as ethanol blend gasoline and biodiesel are the subject of ongoing research by air quality scientists in EPA's National Risk Management Research Laboratory. Emissions from these two most commonly available fuels are being examined for their potential impacts on environmental and human health. http://www.epa.gov/nrmrl/news/112010/news112010.html

10.12 Recommendations Section Supporting Documentation

10.12.1 Additional Ongoing and Imminent Strategies that will Reduce Air Toxics in the Portland Area

1. Additional Metro actions that will decrease air toxics

   - Since adoption in 1995, Metro, TriMet and local governments have implemented the 2040 Growth Concept, targeting development in those areas with access to local goods and services and transit connections to regional destinations. Among other desired outcomes, the 2040 Growth Concept and implementing regional and local plans aim to reduce and shorten vehicle trips, thereby decreasing VMT and their related emissions.

   - Since the late-90's, Metro's Regional Travel Options program has worked with large employers in the region to help them comply with the Employee Commute Options (ECO) rules by implementing transportation demand management (TDM) strategies. The RTO program also provided technical assistance to Transportation Management Associations (TMAs) in the region, including the Lloyd District TMA, Westside Transportation Alliance and Swan Island TMA; operated the Metro VanPool program and RideshareOnline (via Drive Less/Save More) in addition to partnering with cities to implement individualized marketing residential outreach along high capacity transit corridors in the region.

- Since 1998, Metro's Transit Oriented Development (TOD) program has worked with public and private partners to purchase land located near bus and light-rail stations to create high-density, mixed-use developments to help reduce the amount people drive in the region.

- Since 2006, the Oregon Department of Transportation (ODOT), Metro, TriMet, and other public and private partners have implemented the Drive Less/Save More Campaign to reduce drive-alone car trips in the region.

- Metro is responsible for conducting air quality conformity of regionally-significant transportation projects and programs as part of each RTP update and demonstrates compliance with Transportation Control Measures (TCM) that are included in the Carbon Monoxide Maintenance Plan in coordination with the DEQ and other partners. Air toxics began being reported in the 2035 RTP.

- Under the joint Metro-DEQ Region Clean Refuse Fleet Project, 40 garbage trucks have been tested for compatibility and 98% will be fitted with either a diesel particulate filter or a diesel oxidation catalyst. Testing on eighty additional trucks is pending, with a goal of 120 to 160 trucks eventually having a device installed.

2. Additional Multnomah County actions that will decrease air toxics

- Multnomah County has maintained an active energy program since 1994. This includes authorizing development of solar energy generation projects on County facilities, continuing investigation of the potential for water, wind, and additional solar energy generation projects, efficiency improvements through the retrofit and replacement of energy-using equipment in County facilities and optimizing the operation and control of existing building equipment. In 2001, Multnomah County joined the City of Portland in adopting a revised plan, the Local Action Plan on Global Warming, outlining 150 short- and long-term actions to reduce community-wide greenhouse gas emissions to 10 percent below 1990 levels by 2010.

- Sustainable transportation options are an essential part of our region's strategy to prevent pollution and reduce greenhouse gas emissions. Multnomah County supports the work of regional public transportation agency, Tri-Met and regional transportation planning agency, Metro to reduce greenhouse gases and other air pollutants, including air toxics. Multnomah County's Transportation Planning office manages the development of plans to address all modes of transportation at both the local and regional level.

- Multnomah County has an active Employee Commute Options program. Goals of the program are to reduce the need to drive, promote biking, promote walking, use transit, support carpooling, provide education, create incentives, manage parking, pursue funding, and measure progress. (Source: Multnomah County website: http://web.multco.us/sustainability)

3. Additional Washington County actions that will decrease air toxics

- Washington County's Fleet Services participated in DEQ's ARRA-funded State Clean Diesel grant and retrofitted 16 qualified vehicles with Diesel Particulate Filter Technology.

- Washington County participates in DEQ's Employee Commute Options program and fully subsidizes employees' annual TriMet passes in order to support alternative commute options

4. Additional TriMet actions that will decrease air toxics

- TriMet is the largest biodiesel user in Oregon. TriMet uses a B5 blend of five percent biodiesel and 95 percent petroleum-based diesel in all fixed route LIFT buses. TriMet also uses ultra-low sulfur diesel (ULSD), which is a cleaner petroleum-based diesel that reduces sulfur content by 97 percent. Combined, the biodiesel/ULSD blend reduces particulate emissions from buses up to 30 percent.

- TriMet is working to further improve its fuel economy by being the nation's first transit agency to test and operate buses cooled by a NASCAR-inspired system. Traditional systems draw up to 50 horsepower off the engine, draining power and consuming fuel. The system's electric fans use less engine power, resulting in five percent better fuel economy. The system also significantly cuts maintenance time and costs, and is safer to maintain. A drive train computer in the engine compartment of each bus saves fuel and improves driving safety. It monitors the engine, transmission, and braking system, and uses the data to adjust acceleration, braking, traction control and fuel injection. This technology can also be retrofitted to the existing fleet rather than waiting for a new bus purchase.
- TriMet is ordering four next-generation diesel-electric hybrid buses as part of the FY2012 bus order. With the new order, TriMet will be able to test and assess efficiency of these new generation hybrids and determine whether they could represent a cost savings in the future.

10.12.2 Greenhouse Gas Reduction Planning Information

The Land Conservation and Development Commission adopted new rules, codified as OAR 660-044,setting targets to guide long range planning by Oregon's largest urban areas to reduce greenhouse gas emissions from auto travel. The rule calls for local planners to explore ways to reduce emissions from auto and light truck travel by 17 percent to 21 percent per person by the year 2035.
http://www.oregon.gov/LCD/CLIMATECHANGE/metropolitan_greenhouse_gas_reduction_targets.shtml#LCDC_Adopts_GHG_Targets_to_Guide_Metropolitan_Planning

10.13 PATSAC Member Comments and Letters

PATSAC members provided oral and written input to the PATS process throughout the course of advisory committee meetings. After DEQ drafted the committee report, it requested that members submit any additional comments between September and November 2011. Those letters and comments are included below in alphabetical order by commenter and date received. Redline/strikeout editing to various versions of the draft report is not included because of length, but is available from DEQ.

10.13.1 Associated Oregon Industries

http://www.deq.state.or.us/aq/planning/report/appendix/aoi6-20-11.pdf
http://www.deq.state.or.us/aq/planning/report/appendix/aoi9-15-11.pdf
http://www.deq.state.or.us/aq/planning/report/appendix/aoiOMIC11-3-11.pdf

10.13.2 Daniela Cargill

http://www.deq.state.or.us/aq/planning/report/appendix/Cargill9-15-11.pdf

10.13.3. Metro

http://www.deq.state.or.us/aq/planning/report/appendix/mETRO1-5-12.pdf

10.13.4 Multnomah County Health Department

http://www.deq.state.or.us/aq/planning/report/appendix/MultCoHealth4-13-11.pdf
http://www.deq.state.or.us/aq/planning/report/appendix/MultCoHealth10-14-11.pdf
http://www.deq.state.or.us/aq/planning/report/appendix/MultCoHealth11-3-11.pdf

10.13.5 Oregon Health Authority
http://www.deq.state.or.us/aq/planning/report/appendix/OHA12-5-11.pdf

10.13.6 Oregon Metals Industry Council
http://www.deq.state.or.us/aq/planning/report/appendix/OMIC6-20-11.pdf
http://www.deq.state.or.us/aq/planning/report/appendix/OMIC9-14-11.pdf

10.13.7 OPAL
http://www.deq.state.or.us/aq/planning/report/appendix/OPAL10-13-11.pdf

10.13.8 Oregon Trucking Association
http://www.deq.state.or.us/aq/planning/report/appendix/OTA9-15-11.pdf
http://www.deq.state.or.us/aq/planning/report/appendix/ota7-18-11.pdf

10.13.9 Pacific Environmental Advocacy Center
http://www.deq.state.or.us/aq/planning/report/appendix/PEAC4-13-11.pdf

10.13.10 Port of Portland
http://www.deq.state.or.us/aq/planning/report/appendix/port11-4-11.pdf

10.13.11 Sierra Club (ex officio)
http://www.deq.state.or.us/aq/planning/report/appendix/SierraClub9-13-11.pdf

10.13.12 TriMet
http://www.deq.state.or.us/aq/planning/report/appendix/TriMet11-4-11.pdf

10.13.13 Washington County
http://www.deq.state.or.us/aq/planning/report/appendix/waCountyintro11-15-11.pdf
http://www.deq.state.or.us/aq/planning/report/appendix/waCounty11-15-11.pdf

10.14 Portland Air Toxics Solutions Environmental Justice Analysis

10.14.1 Introduction

DEQ used quantitative environmental justice analysis to explore statistical evidence of any air toxics inequity among people of different race or income level within the Portland Air Toxics Solutions (PATS) study area. With the help of the PATS advisory committee, DEQ conducted its first analysis of environmental justice. This appendix includes more technical details to supplement the primary environmental justice discussion in Chapter 8 of the PATS Report and Recommendations.

10.14.2 Background

DEQ reviewed the approaches that others have taken in assessing environmental justice issues from air pollution. A number of environmental justice studies have been limited by methods focusing on spatial proximity to pollution as a risk. This method ignores the quantity, toxicity, meteorological conditions and other factors that influence direction and distance traveled by pollutants. Environmental justice research also has a tendency to study a single pollution source, focusing primarily on industrial facilities. Previous studies have showed that pollution from other sources is equally important to consider, even if these sources emit fewer quantities of air toxics than large industrial facilities, they cumulatively contribute significant health risks. DEQ found this to be true in the PATS study area as well. Statistical methods such as multivariate regression have been used to examine the disparity by evaluating the association between magnitude of pollution and sociodemographics variables. Some critics highlight the challenges with conventional regression techniques, especially their inability to distinguish local variations in the relationships between dependent and independent variables. These critics promote the use of geographically weighted regression when assessing environmental justice on national, regional, or state level. The lack of geographic specificity can obscure underlying patterns when evaluating environmental justice over large areas. The PATS study area is relatively small, and DEQ thought that applying conventional regression techniques was an appropriate methodology. DEQ evaluated environmental justice on a census block group level which provides exceptional spatial resolution. One drawback of using block group level data is the fact that income data, obtained from the American Community Survey (ACS) 5-year average dataset, has relatively high margins of error. Therefore, DEQ's findings related to environmental justice and poverty intrinsically carry higher uncertainty than findings related to race and ethnicity for which data comes from the U.S. Census.

10.14.3 Study Area

The analysis focuses on the Portland Air Toxics Solutions study area, which represents a wide range of demographic and socioeconomic indicators, and variety of air toxics sources. Figure 4 in Chapter 3.3 shows the location and extent of the PATS study area.

10.14.4 Demographic Data

The regression analysis is based on 2010 ethnicity and race data from the U.S. Census Bureau and 2005-2009 five-year population below poverty data from the American Community Survey (ACS). ACS is part of the assessment conducted by the U.S. Census Bureau. Demographic data is provided at the block group level. There are 982 block groups within the PATS study area in 2010. PATSAC and DEQ discussed what would be the best dataset to use in the regression analysis to adequately represent the low income population. It is believed that federal poverty level is well below poverty level for the PATS study area, therefore use of the ACS below poverty data can neglect a number of people that are above the federal threshold but considered low income for this area. Low income guidelines for Portland Metro area are available from Portland Housing Authority and they are provided by a household size. ACS offers average household income data by block group but the link to the household size is not readily available. DEQ repeated the regression analysis using the ACS 2005-2009 median income data and found no significant differences in the final results (from ACS below poverty data), however there were fewer significant factors. DEQ selected the medium household income dataset to conduct comparison between the impacts on lowest ten (and fifty) block groups by income vs. average impact in the PATS study area.

The National Guidance explains that a minority population may be present if the minority population percentage of the affected area is "meaningfully greater" than the minority population percentage in the general population or other "appropriate unit of geographic analysis" (EPA 1998). The unit of geographic analysis was the PATS study area for which DEQ calculated an average percent minority population by block group (25%). "Meaningfully greater" was interpreted as simply greater than this average and Figure 80 Chapter 8 shows block groups that have greater than 25% minority. Minority is defined as everyone not claiming single race non-Hispanic white. This definition of minority is used in the two steps of analysis: mapping and cumulative distribution function.

10.14.5 Air Toxics Data

DEQ conducted comprehensive emission inventory and dispersion modeling of 19 air toxics of concern. DEQ has established a set of benchmarks for air toxics to serve as guidance for its programs. Modeled concentrations are divided by the benchmarks to get times above benchmark (TAB) value for each toxic. For each source category, these benchmark exceedances are accumulated into one value that represents the measure of pollution from a given source category. The results of the measure of pollution, or cumulative times above benchmark (CTAB) values, are provided at the block group centroids. Using the spatial analyst extension within GIS software, a smooth surface of CTAB values for each source category is created for the entire PATS study area. Although this interpolation step introduces an additional layer of uncertainty, the smooth surface depicts an array of CTAB values that is easy to interpret, which is very important for neighborhood-level analyses and community outreach. More detailed description of emission inventory and modeling methodology and results can be found in Chapters 3 and 4 and in Appendices.

For EJ analysis, the following source categories are used: On-Road Mobile (e.g., cars and trucks), Non-Road Mobile (e.g., rail, lawn movers, construction equipment), RWC (residential wood combustion), Area (e.g. household cleaners, industrial and commercial solvent use, paving), Point Type (permitted industrial facilities, gas stations, dry cleaners).

10.14.6 Merging Datasets

Demographics data and CTAB values are available for the same geographic area, but are not in the same geographic format. Demographics data is provided by 2010 Census block groups while model receptors with CTAB values are based on centroids of 2000 Census block groups plus additional receptors as described in the modeling appendix. In order to merge these two datasets, DEQ overlaid a smooth surface of CTAB values on 2010 Census block groups using GIS software, and read the CTAB value for each Census block centroid. This step determined CTAB values and demographics data for each 2010 Census block group.

10.14.7 Cumulative Distribution Functions

Cumulative distribution function (CDF) is used to address disparate air toxics impacts on non-white (also referred to in this text as minority) populations. Non-white includes everyone who did not state single race non-Latino white on 2010 census. The CDFs are created using CTAB values at block group level for white and for non-white populations. Figures 84-86 in Chapter 8 show results of this analysis for all sources and examples for residential wood combustion and point sources. The y-axis represents CTAB values, and the x-axis represents the fraction of the population (from 0 to 1).

10.14.8 Descriptive Statistics

Table 59: Correlation Matrix

		Percent (%)						Times above Benchmark (TAB)					
	Correlation Matrix	***Hispanic/ Latino***	***African American/ Black***	***Asian***	***White***	***Below Poverty***	***Above Poverty***	***Total All Sources***	***Point Sources***	***On-Road Mobile***	***Non-Road Mobile***	***Area Sources***	***Residential Wood Comb.***
Percent (%)	***Hispanic/Latino***	1.00											
	African American/Black	0.08	1.00										
	Asian	-0.09	-0.01	1.00									
	White	-0.79	-0.50	-0.35	1.00								
	Below Poverty	0.35	0.33	-0.03	-0.43	1.00							
	Above Poverty	-0.35	-0.33	0.03	0.43	-1.00	1.00						
Times above Benchmark (TAB)	***Total All Sources***	0.39	0.11	0.13	-0.42	0.20	-0.20	1.00					
	Point Sources	-0.05	0.00	-0.03	0.05	0.04	-0.04	0.30	1.00				
	On-Road Mobile	0.21	0.00	0.16	-0.25	0.22	-0.22	0.77	0.08	1.00			
	Non-Road Mobile	0.36	0.11	0.14	-0.39	0.09	-0.09	0.85	0.03	0.69	1.00		
	Area Sources	0.18	0.35	0.04	-0.33	0.31	-0.31	0.75	0.20	0.58	0.57	1.00	
	Residential Wood Comb.	0.47	-0.03	0.05	-0.38	0.05	-0.05	0.56	-0.14	0.13	0.42	0.22	1.00

Table 60: Descriptive Statistics for Independent and Dependent Variables used in Multiple Linear Regression Analysis

	Percent of Population by 2010 Census Block Group					*Cumulative Times Above Benchmark*					
Descriptive Statistics	Latino	Black	Asian	White	Below Poverty	Total All Sources	Point Sources	On-Road Mobile	Non-Road Mobile	Area Sources	Residential Wood Comb.
Mean	11.3	3.5	6.0	0.7	12.6	71.0	1.3	18.4	17.2	16.8	17.0
Standard Error	0.3	0.2	0.2	0.0	0.3	0.8	0.2	0.3	0.3	0.2	0.3
Median	7.4	1.6	4.2	0.8	9.8	65.3	0.5	16.4	14.8	16.3	15.8
Standard Deviation	10.5	5.2	5.4	0.1	10.5	26.1	6.8	8.5	8.4	6.8	9.4
Range	83.0	38.2	45.1	0.8	59.8	155.9	89.9	48.8	64.0	33.7	60.0
Minimum	0.0	0.0	0.0	0.1	0.0	15.7	0.1	1.7	2.4	2.7	3.7
Maximum	83.0	38.2	45.1	1.0	59.8	171.6	89.9	50.5	66.4	36.4	63.7
Count	982	982	982	982	982	982	982	982	982	982	982

10.14.9 Multiple Regression Analysis

Using multiple linear regression models (MLR), DEQ examined whether the minority population and the population below poverty have a greater likelihood of living in areas with high levels of air toxics pollution. Instead of grouping all minorities together, as in the mapping and cumulative distribution function steps, here the analysis separated Hispanics, African American/Blacks, and Asians as independent variables. Dependent variables are CTAB values by block group. The analysis consisted of two MLR models. The first model (Model 1) uses three independent variables: % Hispanics/Latino, % African American/Black, and % Asians. The second model (Model 2), in addition to the three independent variables from Model 1, adds % Below Poverty (regardless of ethnicity/race) as the fourth independent variable. In general, MLR equation expresses the relationship between the dependent variable and a combination of independent variables simultaneously in a single model:

$$(1) \qquad y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ \ldots \ + \beta_k X_k + \varepsilon.$$

Y is the dependent variable, $X_1, X_2, \ldots X_k$ are the independent variables, and $\beta_0, \beta_1, \beta_2, \ldots \beta_k$ are the model parameters. The model parameters indicate the nature and strength of the association between the particular independent variable and the dependent variable, negative or positive, when the effects of the other independent variables are also taken into account.

MLR produced six sets of models, one for each source category and one for total CTAB from all source categories. Results are shown in Table 55. For each model parameter, stars indicate the level of statistical significance. No stars indicate non-significant results.

MLR for all source models indicates that all of the examined independent variables have positive association with the CTAB values. In Model 2, % Below Poverty is a positive but not a statistically significant parameter. The R-squared for both models in this first set is 0.18.

MLR models associated with the different source categories indicate more variation in model parameters. The R-squared values range between 0.15 and 0.25 for all models except for Point Source and On-Road categories. Point Source models have the lowest R-squared values.

Comparison of Model 1 and Model 2 reveals no significant change in the sign or size of the parameters associated with Asian population in any of the model sets. However, there is some change for the Hispanic/Latino population and more significant change in parameters for the African American/Black population. This is likely due to higher correlation between these two population groups and poverty levels.

Table 61: Multiple Regression Analysis Results

Multiple Linear Regression ***Results***	All Sources		Major Source Categories: Residential Wood Combustion		Point Sources		On-road Mobile		Non-road Mobile		Area Other	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
	Coefficients express the change in risk for 1% change in one of explanatory variables, e.g. the model predicts that 10% increase in Hispanic/Latino adds additional 9.7 times above the benchmark to the final risk value from all sources.											
Hispanic/Latino (percent)	**0.97** *	**0.93** *	**0.43** *	**0.47** *	**-0.04** ***	**-0.05** **	**0.19** *	**0.14** *	**0.29** *	**0.31** *	**0.10** *	**0.06** *
African American/Black (percent)	**0.41** *	**0.33** **	**-0.13** *	-0.07	0.01	-0.01	-0.02	**-0.11** **	**0.13** *	**0.17** *	**0.45** *	**0.38** *
Asian (percent)	**0.80** *	**0.80** *	**0.17** *	**0.17** *	-0.04	-0.04	**0.29** *	**0.28** *	**0.27** *	**0.27** *	**0.07** ***	**0.06** ***
Below Poverty (percent)		0.13		**-0.11** *		**0.04** ***		**0.15** *		**-0.06** **		**0.12** *
*Sample size n = 982. Standard errors are in parentheses. Significance levels: *** p<0.1 ** p<0.05 * P<0.01 No stars indicate results are not significant.*												
Intercept (unit = times above benchmark)	54	53	12	12	2	2	15	14	12	12	14	13
R-squared	0.18	0.18	0.24	0.25	0.004	0.007	0.08	0.11	0.16	0.17	0.15	0.18

10.14.10 Caveats to Results

The results describe the pattern but do not imply causality.