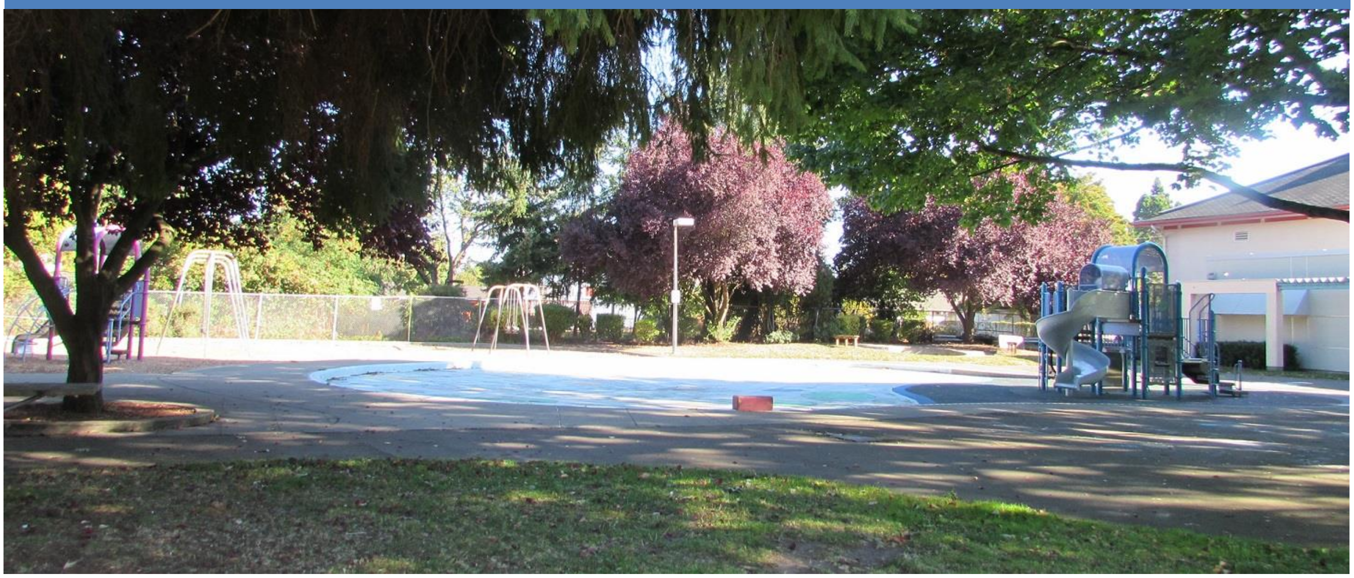
Public Health
Seattle & King County

South Park Community Center Open Space Design Plan:
Rapid Health Impact Assessment (HIA)
Findings and Recommendations



Healthy Community Planning Program
Environmental Health Services Division

February 8, 2017

This report was prepared by Sinang Lee and Amy Shumann of The Healthy Community Planning (HCP) Program at Public Health-Seattle & King County's Environmental Health Services Division. HCP believes where we live matters to our health. Our team of planners, health educators and environmental health investigators work with many partners to integrate health and equity principles into community planning. We deliver technical assistance, policy analysis, and education and outreach to local governments, agencies and residents on crosscutting community health issues, such as land-use, transportation, and housing.

Acknowledgements

The authors would like to acknowledge the expert panel, South Park residents, community groups and agencies involved in this process and that have documented conditions in South Park. The South Park community has been tireless in its work to improve the health and wellbeing of its residents and we want to acknowledge their commitment and contributions to planning efforts like the Seattle Parks Foundation's *South Park Green Space Vision Plan* and Just Health Action and Duwamish River Cleanup Coalition/TAG's *Duwamish Valley Cumulative Health Impacts Analysis*. These two planning documents guided this effort and we are grateful for the work that came before ours.

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Forward

A Health Impact Assessment (HIA) is a useful and adaptable tool to qualitatively assess how a proposed decision could affect community health. An HIA also provides the opportunity to engage communities in decisions that impact them. Public Health Seattle & King County's Environmental Health Services (EHS) Division staff conducted a rapid HIA to assess whether the proposed siting of the South Park Community Center play areas could adversely impact the health of children and other residents (e.g., people with existing respiratory conditions). EHS staff initiated this HIA after learning about the community concerns and that Seattle Parks & Recreation staff would welcome public health inputs during their planning and design phase.

South Park is one of Seattle's lowest income and most ethnically diverse communities. Residents live in an area with many health inequities that include lower life expectancy, poorer air quality, and higher childhood asthma hospitalizations; a result of long-standing racial and social inequities in land-use, economic, environmental, and education policies and decisions. With about one-tenth of the accessible green space available to the average King County resident, South Park residents have identified their Community Center as a high priority for improvements.

We are pleased that Seattle Parks & Recreation has focused attention on the South Park Community Center and are open to taking public health inputs into consideration. When opportunities arise to improve or expand limited parks space, we believe it is critical that community members (and public agencies) have full and meaningful engagement in planning processes and the information about community health and environmental conditions is available to make informed decisions. This effort to proactively identify opportunities to promote health equity aligns with the *King County Equity and Social Justice Ordinance*, *City of Seattle Race and Social Justice Initiative*, *Seattle Equity and Environment Agenda*, and *City of Seattle's Equitable Development Framework - Strategy 5: Develop healthy and safe neighborhoods and Seattle Parks and Recreation's commitment to Healthy People, a Healthy Environment and Strong Communities.*

We see this report not just as a resource for Seattle Parks & Recreation, but for the community and other agency partners as well. The high-level recommendations in this report are meant to serve as a starting point for discussions among agencies, the community and possible funders on how to redevelop a South Park Community Center open space that takes health into consideration. EHS staff is available to present and discuss in more detail the findings and recommendations to City of Seattle departments and community groups.

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Executive Summary

The Community

South Park is a vibrant Seattle neighborhood with assets that include engaged and active residents and the city's only river – the Duwamish. Another important asset, the South Park Community Center, provides open space and recreation opportunities that are heavily used and valued by the neighborhood.

South Park is one of Seattle's lowest income and most ethnically diverse communities. Residents live in an area with many health inequities, including lower life expectancy, poor air quality, higher childhood asthma hospitalizations, and one-tenth of the accessible green space available to the average King County resident. Community members expressed concerns about Seattle Parks & Recreation (SPR) proposed work at the South Park Community Center that is guided by a Seattle Parks Foundation (SPF) conceptual design plan. The plan includes adding new play structures for older kids (and an outdoor classroom) within 100 feet of State Route (SR) 99, a major highway with heavy truck traffic. The SPF design plan also calls for upgrading the existing play structures in their current location (about 250 feet from SR 99) on the west side of the community center building.

We have very high asthma rates in our community already. We can't expose our children to more pollution by placing a playground next to a highway. We deserve better.
- Paulina Lopez, South Park resident, parent, and community advocate

What we did

From August to October 2016, Environmental Health Services (EHS) staff conducted a rapid Health Impact Assessment (HIA) to provide health and safety considerations into the current design and planning phase for the South Park Community Center open space. Our rapid HIA process included a review of published literature, consultations with technical subject matter experts and community representatives, and a review of best practices and community recommendations. We focused on relevant health determinants including air pollution, environmental noise, crime and safety, social and mental health, physical activity, heat, and pedestrian safety.

What we found

Because of the existing health inequities and environmental burdens the community experiences, we determined that siting a *new play area* within 100 feet of the highway could have potential negative impacts related to air pollution, noise, crime and safety and social and mental health. Without mitigation, we do not recommend adding a new play area (or outdoor classroom) at the proposed location. We acknowledge a need for additional engagement with SPR, the South Park community, and other partners in a comprehensive review of the community center's open space to decide:

- Is there an opportunity to redesign the open space to allow for relocating the play areas away from the highway?
- What are the limitations, constraints, and trade-offs to consider?
- If the play areas cannot be relocated, how feasible is it to implement measures to mitigate air and noise pollution and enhance public safety features at their current location?

When we all stood out there together in the proposed location I felt an immense sense of dread that if this is the location we would be putting kids at risk of so many hazards.
- Cari Simson, parent, local business owner and neighborhood advocate

1.0 Introduction

Where we live, work, play and learn matters to our health. Healthy natural and built environments[1] support healthy personal choices. Neighborhood characteristics and amenities like parks, places to walk or be active, and sources of affordable, nutritious foods influence our health. Parks and playgrounds support community and individual well-being. Access to quality and safe parks and open space promotes health by increasing physical activity, supporting mental health, and fostering community and social interactions. Parks and playgrounds provide children with opportunities for play which is critical in the development of muscle strength and coordination, language, and cognitive abilities (TPL, 2006).

The conditions in which people live are shaped by broader economic, social, environmental, and political systems. South Park residents live in an area with many health inequities, including lower life expectancy, poorer air quality, and higher childhood asthma hospitalizations; a result of long-standing racial and social inequities in past land-use, economic, environmental, and education policies and decisions.

In 2014, South Park community prioritized improving their community center as part of the Seattle Parks Foundation's (SPF) *South Park Green Space Vision Plan* (SPF, 2014). This year, Seattle Parks & Recreation (SPR) began to plan how to upgrade and add new play structures at the community center. SPR used the SPF Conceptual Design Plan for the community center open space as a starting point (Figure 1). While the community welcomed the much needed attention, some residents raised concerns that the play areas would be too close to State Route (SR) 99, a major highway with heavy truck traffic that runs along the western border of the community center.

> ***We have very high asthma rates in our community already. We can't expose our children to more pollution by placing a playground next to a highway. We deserve better.***
>
> **- Paulina Lopez, South Park resident, parent, and community advocate**

After learning about the concerns, Environmental Health Services (EHS) staff with Public Health Seattle and King County (PHSKC) discussed with SPR staff about the opportunity to provide public health inputs[2]. SPR staff shared that they are in the planning and design phase and would welcome any public health inputs. With a two-month timeframe, EHS staff conducted a rapid Health Impact Assessment (HIA) to identify at a high-level whether the proposed siting of the play areas can potentially have unintended impacts on the health of South Park children and other residents (e.g., people with asthma).

[1] The built environment includes all of the physical parts of where we live and work (e.g., homes, buildings, streets, open spaces, and infrastructure) (CDC).

[2] Meeting between Sinang Lee (EHS) and Karimah Edwards (SPR) on July 27, 2016

Our goal for the HIA is to provide health information that can be taken into consideration during the design and planning phase, including relevant community engagement efforts. During the process, EHS staff gathered the best available evidence and convened a panel of technical Subject Matter Experts (SMEs) to conduct a site assessment. Based on the evidence gathered, we determined that the proposed design could have multiple negative health impacts, particularly related to air pollution, noise, crime and safety and social and mental health.

This report discusses the supporting evidence for the HIA findings and the recommendations to protect community health and wellbeing. Please note that this report does not make assumptions or recommendations about all parks near busy highways or arterials and the high-level findings and recommendations in the report are based on our understanding of the specific site conditions; community concerns; and proposed design plans at the time of this rapid assessment. It is beyond our scope and expertise to assess the feasibility of implementing the recommendations which will likely warrant more detailed design and assessment and additional engagement with agency partners and community. We will continue to gather related to the feasibility of our recommendations, including limitation and constraints; community priorities and interests; and possible opportunities and next steps.

The challenges that exist in the South Park community and the community center open space resulted from multiple decisions made by a variety of agencies and policies over a long period of time. Therefore, it will take a partnership among variety of agencies and community to identify opportunities to enhance health and wellbeing in the community. We see this report as a resource for SPR, the community, and other agency partners during the planning and design phase. The HIA and recommendations are meant to serve as a starting point for discussions among agencies, the community and possible funders on how to redevelop the South Park Community Center open space that takes health into consideration.

2.0 Approach

An HIA is a useful tool to assess how a proposed decision will affect the health of a population and whether overburdened populations are more likely to be impacted (CDC's Healthy Community Design Initiative). It is a systematic and evidence-based process that can be tailored to fit specific needs, timeline, and resources of each particular project. HIAs are typically carried out for plans, projects, and policies that fall outside traditional public health arenas, such as transportation and land use.

We focused our assessment on specific community concerns and experiences related to:

- air quality
- environmental noise
- crime and safety
- social and mental health
- physical activity
- heat
- pedestrian safety

2.1 Assumptions and Understanding of SPR Plans for South Park Community Center

The South Park Community Center has a 1980s era adobe-style building (14,000 square feet), one toddler play area/wading pool and two ball fields. The following outlines our understanding of SPR current redevelopment plans for the South Park Community Center[3]:

- SPR has $750,000 from Seattle Park District Maintenance Program to renovate the South Park Community Center play area due to old age (15+ years) and to comply with American Disability Act. SPR is in the planning and design phase now (2016 and 2017), with construction phase in 2018. There will be approximately $460,000 for the construction phase. SPR is conducting community engagement to capture input on the design of the play structures and play areas.

- SPR is referencing the Seattle Parks Foundation (SPF) "Final Conceptual Design Plan" as a starting point for their design (Figure 1). SPF produced the plan based on extensive community engagement during the South Park Green Space Visioning Process (SPF, 2014). However, no comprehensive health inputs informed the SPF final conceptual design plan.

- SPR is replacing the existing play structure and may add another play element for ages 5-12 in a nearby location on the west side of the park. During the design phase SPR will consider mitigation improvements such as carbon reducing plantings and trees.

- South Community Center Advisory Council was awarded $50,000 from the Seattle Park District Challenge Fund to assist with prioritizing and coordinating improvements for the park. That planning work will begin in 2017.

[3] Input provided by SPR.

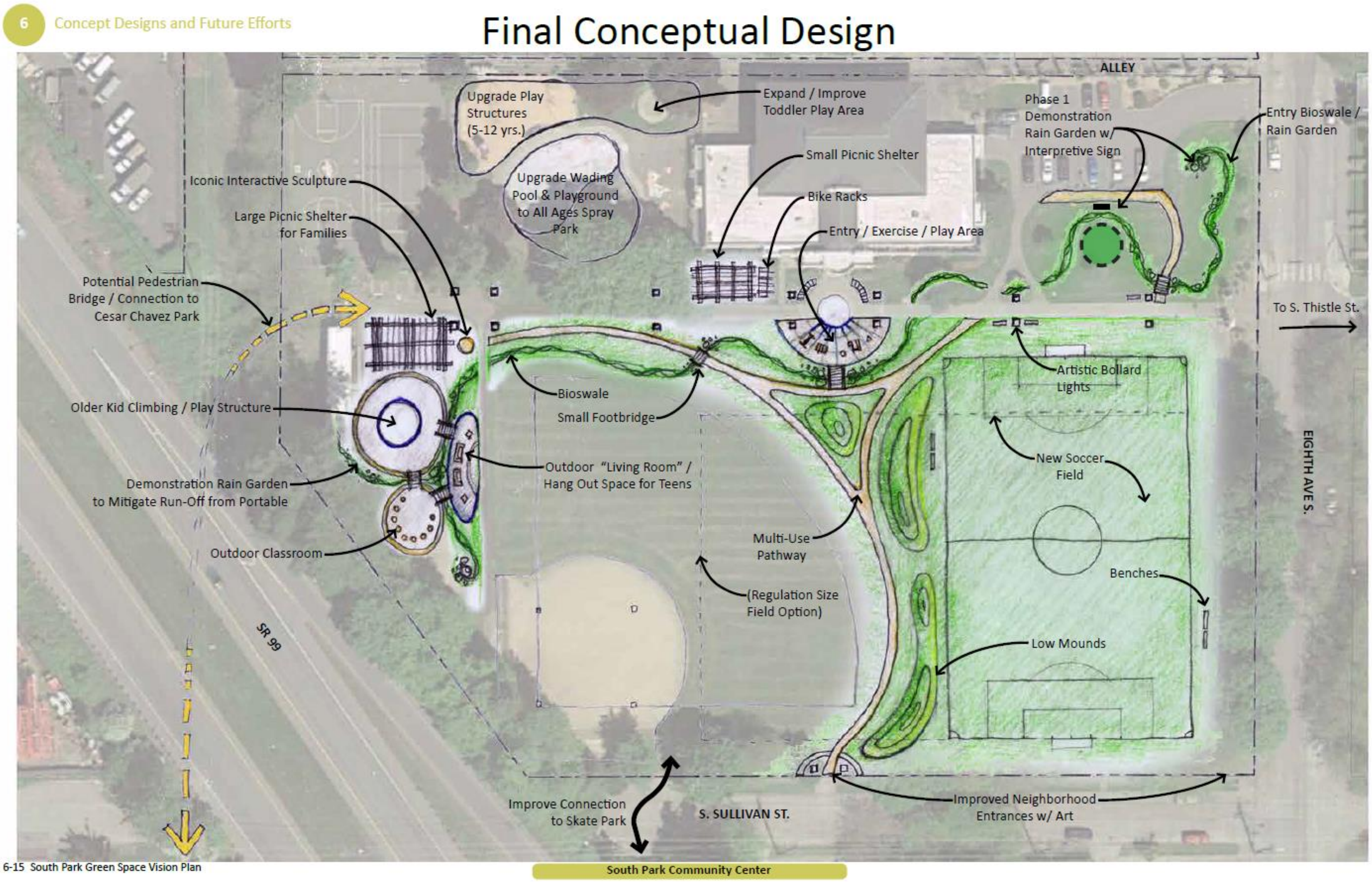


Figure 1 Seattle Parks Foundation's (SPF) Final Conceptual Design Plan (SPF, 2014).

2.2 Data Collection

HIAs draw on the best available evidence from research and reports and commonly include both qualitative and quantitative evidence. This information must also be supplemented with local and expert knowledge, policy information, and proposal-specific information. From August to September 2016, EHS staff gathered and reviewed data and information from various sources: (1) to understand existing community inequities; (2) to qualitatively assess the potential health impacts; and (3) to develop recommendations that can minimize adverse impacts while promoting positive health benefits.

- EHS staff conducted a review of available demographics and health statistics, relevant studies, recent neighborhood planning efforts, and literature on relevant mitigations and best practices. This information, along with data gaps, is included in a health impacts scoping table (Appendix A).
- Just Health Action (JHA) subcontractor conducted an extensive literature review on health effects from air pollution and noise (Appendix B).
- Puget Sound Clean Air Agency (PSCAA) staff collected ultrafine particle sampling over a 1.5-hour period at and around the community center on September 16, 2016 (Appendix C).
- EHS staff convened a panel of subject matter experts (SME) in air pollution, noise, public health, physical activity, healthy play areas, pedestrian safety, and local community knowledge on September 19, 2016 (Table 1, Appendix A). The SME panel toured the South Park Community Center to assess the site conditions and discuss potential impacts and recommendations. During the site assessment, the panel used a sound level meter[4] to capture decibel levels at the community center from 2pm to 3pm.
- EHS staff consulted with Mark Solomon, Crime Prevention Coordinator with Seattle Police Department, during a site visit on September 22, 2016.
- EHS staff consulted with Tari Nelson-Zagar of Seattle Neighborhood Group on public safety/CPTED on September 23, 2016.

SME Panel Site Visit on September 19, 2016

Please note that a robust community engagement was not done as part of this rapid HIA because of the limited time and resources and because a SPR community engagement process was underway.

[4] Radioshack 3300099 Digital Level Meter, range 30-130dB, accuracy of +/-2dB at 94dB sound pressure level

Table 1 Subject Matter Experts who participated in EHS's site assessment on September 19, 2016.

Panel Member	Organization	Subject Matter Expertise (SMEs)
1. Erik Saganić	Puget Sound Clean Air Agency	Air Pollution
2. Bill Daniell	UW's Department of Environmental & Occupational Health	Noise, Public Health
3. Brian Saelens	Seattle Children's Hospital	Physical Activity, Play Areas & Health
4. Linn Gould	Just Health Action	Green walls, Public Health
5. Andrew Schiffer	Just Health Action, Georgetown resident	Green walls, Trees
6. Shirlee Tan	Public Health Seattle & King County	Toxicology, Public Health
7. Paulina Lopez	Duwamish River Cleanup Coalition/TAG & South Park Parent/Resident	Community concerns & interests
8. Robin Pfohman	Public Health Seattle & King County	Heat, Climate and Community Resilience
9. Diane Wiatr	Seattle Department of Transportation	Active Transportation, Pedestrian Safety
10. Michelle Benetua	Seattle Parks Foundation	Community concerns & interests
11. John Barclay	Seattle Parks & Recreation	Community Center usage & plans

SME panel discusses potential impacts and recommendations on September 19.

3.0 Community Health Profile

A community health profile can serve as a useful profile of the potential users of the South Park Community Center. It provides an understanding of the underlying health inequities that can make the community more susceptible to adverse health impacts. With this knowledge, we can inform the project planning and design to find opportunities to improve the health of the community. This section provides a snapshot of the demographics, general health status, and relevant health inequities for the South Park neighborhood. Most of the available health statistics are reported for zip code 98108 (South Park, Georgetown, and Beacon Hill) and serves as a proxy for South Park neighborhood.

EHS relied on published data and reports on South Park history, existing conditions, needs, and priorities from several significant community engagement/planning processes conducted in the last several years. For more detailed information, please see:

- *South Park Green Space Vision Plan by* Seattle Parks Foundation (SPF, 2014). The report includes research about existing conditions and a set of recommendations for partnership opportunities, funding sources, and priority sites to improve over the next five years. https://www.seattleparksfoundation.org/2014-pages/step-up/south-park-green-spaces

- *Duwamish Valley Cumulative Health Impacts Analysis. Seattle, WA* by Linn Gould of Just Health Action and BJ Cummings of Duwamish River Cleanup Coalition/Technical Advisory Group (Gould and Cummings, 2013). Study examined a range of disproportionate health exposures and impacts affecting people in the Duwamish Valley. http://justhealthaction.org/resources/jha-publications/

- *Seattle 2035: Growth and Equity Analyzing Impacts on Displacement and Opportunity Related to Seattle's Growth Strategy, May 2016* by Seattle Office of Planning and Community Development (Seattle OPCD, 2016). Study conducted a Growth & Equity Analysis to identify impacts and mitigation associated with the recommended Growth Strategy in the Comprehensive Plan, and opportunities for equitable development. http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2427615.pdf

Other major sources of health statistics and demographic data came from recent *King County City Health Profile Seattle* (PHSKC, 2016).

3.1 South Park Demographics

The South Park neighborhood is in southwest Seattle, on the western bank of the lower Duwamish River and is an EPA Superfund cleanup site. It is the largest residential center of the Duwamish Valley industrial corridor with a population of 4,673 (WOFM, 2016). The South Park neighborhood is one of the lowest-income and most ethnically diverse communities in Seattle.

- Between 1990 and 2010, South Park saw a 31 percent increase in the people of color (Seattle OPCD, 2016). South Park is nearly 40 percent Latino, 17 percent Asian, 12 percent African-American, and 38 percent identify as other "non-white" or multiracial, including Pacific Islanders and Native Americans (WOFM, 2015). Approximately 23 percent of South Park residents report that they speak English "less than very well" (compared to 9 percent Seattle-wide) (ACS, 2014).

- Twenty-eight percent of South Park residents live below the poverty level (ACS, 2014); the 2016 federal poverty level is $24,300 for a family of 4. In 2013, the median household income in South Park was approximately 34 percent below the Seattle average (US Census Bureau, 2014). Seventy-eight percent of children enrolled at South Park's Concord Elementary School qualify for reduced price lunch (SPS, 2011).

- South Park has a higher than average percent of children compared to Seattle-wide. About 28 percent of South Park population is school-aged children (3 years or older and in K-12 schools) compared to 14 percent Seattle-wide (US Census Bureau, 2014).

3.2 Community Inequities for South Park and 98108

South Park residents live in an area with many health and environmental inequities relative to the rest of Seattle[5]. Tables 2 and 3 summarizes the relevant inequities for this HIA, which includes a lower life expectancy, poor air quality, higher childhood asthma hospitalizations, and one-tenth of the accessible green space available to the average King County resident. In 2011, 12 percent of adults from South Park, Georgetown and Beacon Hill reported "fair" or "poor" health, more than Seattle overall (9%), and much higher that NE Seattle area (5%) (Futurewise, 2016).

The general poorer health status and lower socio-economic status in this area is partly a result of land-use and policy decisions rooted in historical racial and social inequities that make it harder for residents to achieve an optimal quality of life. For example, at the time SR 99 was constructed in 1957, the community had to convince freeway engineers to bypass the playfield instead of going through it. As a result, a busy highway now borders one of the few parks in the neighborhood.

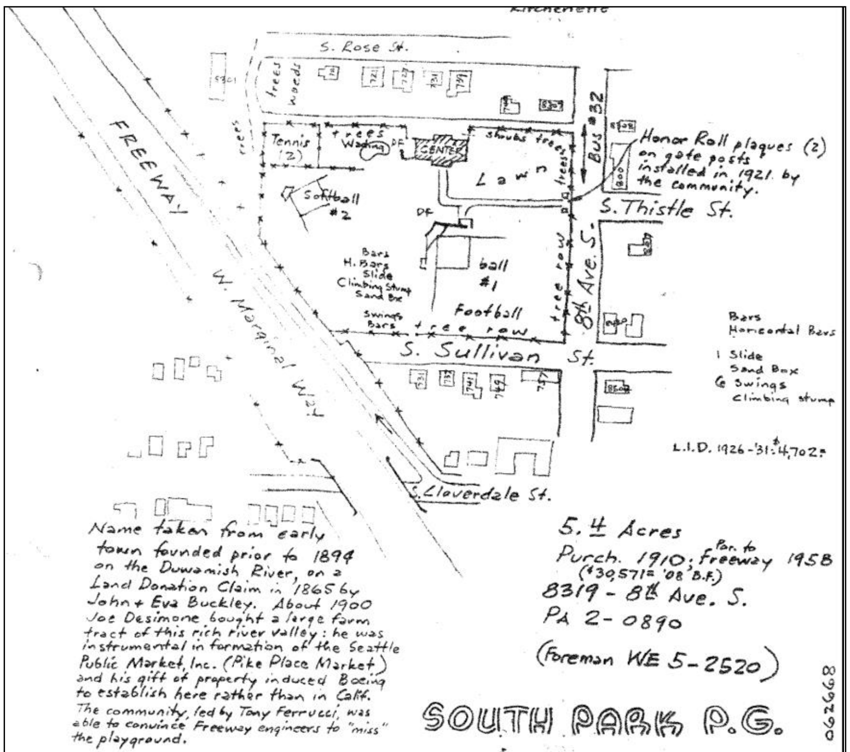
South Park, a part of the Duwamish Valley, has been documented as a community with environmental injustices; a community with disproportionately high environmental health burdens and risks and fewer positive environmental benefits than the rest of Seattle (Gould and Cummings, 2013). The Duwamish Valley ranks poorly for most environmental health factors and has the highest number of known or suspected contaminated waste sites and Toxic Release Inventory (TRI) sites in Seattle (Gould and Cummings, 2013). In addition, Puget Sound Clean Air Agency (PSCAA) identified the Duwamish Valley as a "Highly Impacted Area"; a geographic location characterized by degraded air quality whose residents face economic or historic barriers to participation in clean air decisions and solutions as well as having higher rates of hospitalizations for air-quality related health

[5] A health inequity is a "particular type of difference in health in which disadvantaged social groups - such as the poor, racial/ethnic minorities, women, or other groups who have persistently experienced social disadvantage or discrimination - systematically experience worse health or greater health risks than more advantaged social groups" (Braveman, 2006).

outcomes than the rest of Puget Sound (PSCAA 2012 and 2014). According to PSCAA, poor air quality in the Duwamish Valley is generally concentrated around industrial centers and transportation corridors. Trucks and other diesel exhaust, along with less wind and stagnant winter weather, contribute to the poor air quality.

South Park experiences relatively high levels of noise from heavy truck traffic along highways and roadways (e.g. SR 99, SR 509, and South Cloverdale Street) that are part of the freight network for the Port of Seattle and other industrial activity. In addition, South Park is below both SeaTac and Boeing Field flight corridors (King County, 2004).

Recently, the City of Seattle conducted an equity analysis of its Comprehensive Plan's Growth Strategy and identified South Park as "a Residential Urban Village with high displacement risk and low access to opportunity, regardless of the level of transit service" (Seattle OPCD, 2016). Figure 2 shows the maps produced by City of Seattle's OPCD for the Displacement Risk Index and Access to Opportunity Index.



SPR Sherwood File plan showing the purchase of the park in 1910 and freeway construction in 1958

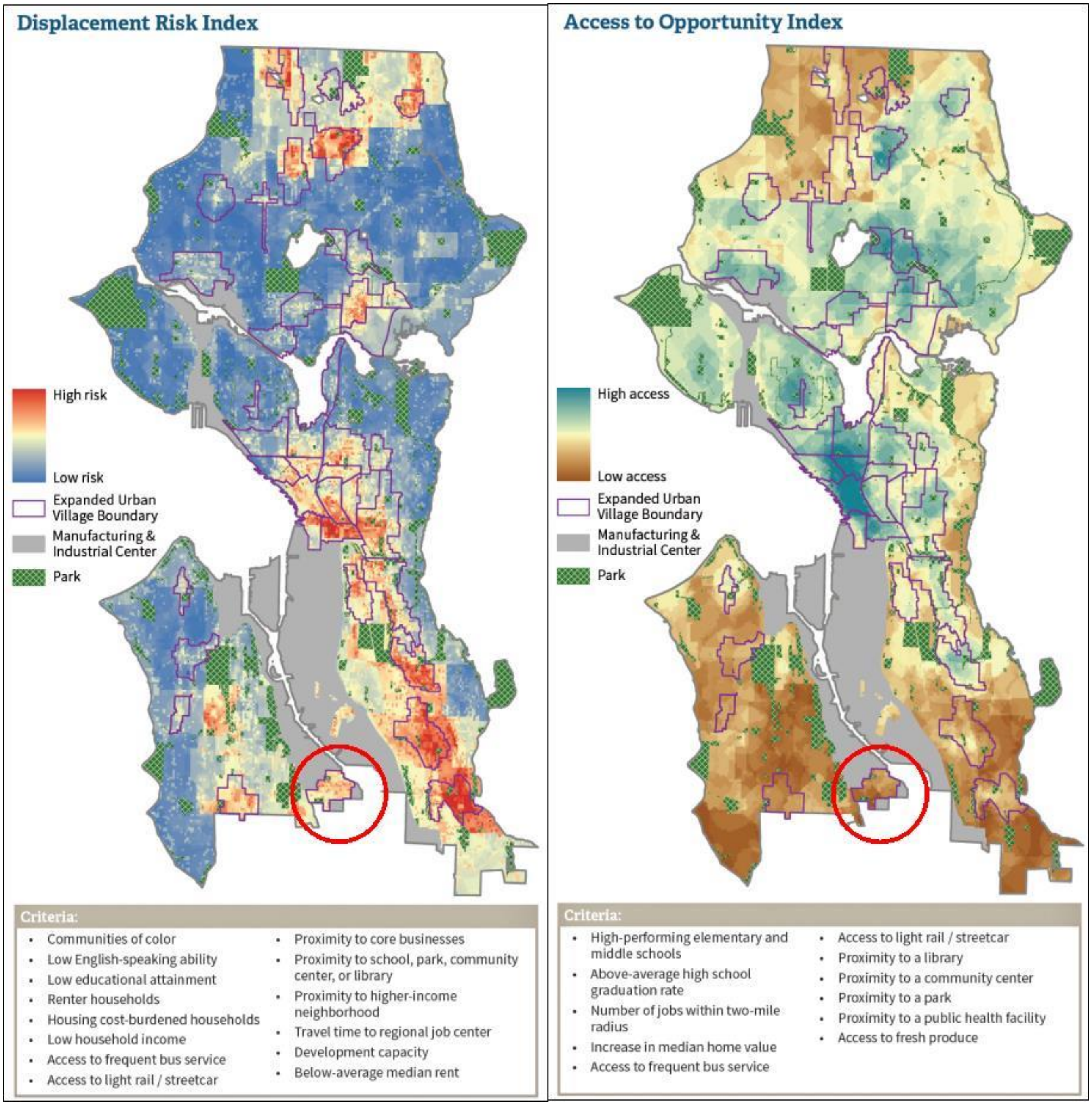


Figure 2 Maps of Displacement Risk Index and the Access to Opportunity Index in Seattle (Seattle OPCD, 2016). South Park is located within the red circle.

Table 2 Summary of Health Inequities in South Park or 98108

Health Indicator	Inequity	Supporting Data			
		South Park or 98108	*vs*	*Seattle or other*	*Data Source*
Life expectancy (years)	**Much Lower**	73.3 (South Park & Georgetown)		81.5 (Seattle) 86.4 (Laurelhurst)	Gould & Cummings (2013); Data period: 2005-2009
No Exercise (Adults) (%)	**Higher / Much Higher**	18 (98108)		13 (Seattle) 6 (Fremont & Green Lake)	PHSKC, 2016; Data period: 2010-2014
Obesity (Adults) (%)	**Same / Higher**	17 (98108)		17 (Seattle) 9 (Fremont & Green Lake)	PHSKC, 2016; Data period: 2010-2014
Diabetes (Adults) (%)	**Higher / Much Higher**	8 (98108)		6 (Seattle) 3 (Fremont & Green Lake)	PHSKC, 2016; Data period: 2010-2014
Lung Cancer (Adults) (deaths per 100,000 people)	**Higher**	41 (98108)		38 (Seattle)	Gould & Cummings (2013); Data period: 2006-2010
Heart Diseases Hospitalization Rate (per million per year)	**Much Higher**	10,628 (98108)		8,941 (Puget Sound)	PSCAA Community Air Tool (2012)
Frequent Mental Distress (%)	**Higher**	14 (98108)		11 (Seattle)	PHSKC, 2016; Data period: 2010-2014
COPD Hospitalization Rate (per million per year)	**Much Higher**	532 (98108)		471 (Puget Sound)	PSCAA Community Air Tool (2012)
Adult Asthma Hospitalization Rate (per million per year)	**Much Higher**	954 (98108)		493 (Puget Sound)	PSCAA Community Air Tool (2012)
Adult Asthma Prevalence (%)	**Higher**	12 (98108)		9 (Seattle)	PHSKC, 2016; Data period: 2010-2014
Childhood Asthma Hospitalization Rate (per 100,000 per year)	**Much Higher**	328 (98108)		212 (Seattle)	Gould & Cummings (2013); Data period: 2006-2010

Table 3 Summary of Environmental Inequities in South Park or 98108

Environmental Indicator	Inequity	Supporting Data			
		South Park or 98108	*vs*	*Seattle or other*	*Data Source*
Toxic Release Inventory (TRI) Sites (number)	**Highest**	**38** (98108)		**0-13** (all other Seattle neighborhoods)	Gould & Cummings (2013)
Air Pollution (annual average concentration of pollutant in human breathing zone, μg/m³)	**Among Highest**	*diesel particulate* **2.3** (98108) *benzene* **2.7** (98108)		*diesel particulate* **1.03** (King County) *benzene* **1.7** (King County)	Gould & Cummings (2013); data year: 2005
Noise (decibels, dBA)	**Much Higher**	**~65-80** (South Park Community Center)		**55-70** (range of WAC 173-60-040 state standards for environmental noise)	Sound level meter collected data during SME Site Visit on 9/19/16
		Observed multiple sources of noise in South Park: cars, trucks, airplanes, industries.			SME Site Visit on 9/9/16
Green Space (square feet of park area per resident)	**Median**	**454** (98108)		**175-1634** (range for Seattle)	Gould & Cummings (2013)
	Much Lower	South Park has about one-tenth of the accessible green space available to the average King County resident.			Seattle Parks Foundation (SPF, 2014)
Tree Canopy (%)	**Among Lowest**	**6** (98108)		**4-27** (range for Seattle)	Gould & Cummings (2013)
Walkability (score)	**Lower**	**62** somewhat walkable (South Park)		**83** very walkable (Green Lake)	Accessed on 10/11/16 at www.walkscore.com
Crime & Safety	**Lower sense of community safety**	High property crime rate & two homicides in past years likely contribute to perceptions of unsafety.			EHS consultation with Mark Solomon, Seattle Police Department on 9/22/16

4.0 Findings: Potential Health Impacts for Design Considerations

This section summarizes the potential key health impacts (negative, positive, or neutral) identified by EHS staff in collaboration with technical SMEs and community representatives, and based on the evidence reviewed. In light of the existing community inequities, the proposed siting of the play areas on the western side of the community center may have multiple negative impacts on children and other residents (e.g., people with asthma), particularly related to air quality, noise, crime and safety, and social and mental health (Table 4). Furthermore, we anticipate that the noise, air pollution and safety concerns may deter use of the play areas; and thereby, the proposed design will not likely increase physical activity substantially.

Table 4 Summary of Potential Health Impacts

Health Determinant	Community Health Inequities*	Potential Impact	Priority to Address
Air Quality	Higher air pollution levels, higher childhood asthma hospitalizations	NEGATIVE	HIGH
Environmental Noise	Higher levels of noise from heavy truck traffic and airplanes	NEGATIVE	HIGH
Crime & Safety	Lower sense of community safety and security	NEGATIVE	HIGH
Social & Mental Health	Higher stress among adults	NEGATIVE	HIGH
Physical Activity	Higher percentage of adults with chronic diseases and low physical activity	NEUTRAL	HIGH
Heat	Low tree canopy to provide shade; nearest spray parks are 2.5-3 miles away	*Not enough information about Seattle P&R' plans for the wading pool or spray park to assess*	MEDIUM
Pedestrian Safety	Low walkability	NEUTRAL	N/A

* See Section 3.0 for more details.

4.1 Air Quality

NEGATIVE IMPACT: Air pollution levels are highest closer to SR 99 and are expected generally to improve by about 200-500 yards. The community center is located within 150 yards from SR 99. The freeway on-ramp adjacent to the community center is likely a large source of air pollution because of accelerating cars. Therefore, the proposed siting of the play areas, particularly the new older kid play structure within 100 feet of SR 99, will likely expose children and others to higher levels of traffic pollution.

Multiple studies suggest that living and going to schools near busy roads and highways are not healthy and some people are particularly vulnerable (Appendix D). Children, pregnant women, and people with compromised heart/lung health are at greatest risks from health effects associated with air pollutants. Because of their fast growth and development, children are more susceptible to air pollution and their lungs are less able to repair themselves after injury (Bateson et al., 2007; Wang S. et al, 2009). One study suggest that higher traffic flows may be related to an increase in repeated medical visits for children with asthma that live within 183 yards (550 feet) of busy roads (English P et al., 1999).

Air pollution levels are highest closer to major roadways. Most pollution levels improve by about 200 yards (600 feet) from the road but some do not improve until 500 yards away (1,500 feet) (Appendix D; Karner et al. 2010). Studies show poor health outcomes as far as 500 yards away (Appendix D; Karner et al. 2010). The community center is within 150 yards (or 400-500 feet) from SR 99 with the current playground, tennis and basketball courts, and parts of the baseball field within 50-100 yards (150-300 feet) of SR 99 and its on-ramp. The proposed play areas will likely expose children and other residents (e.g., people with asthma) to higher levels of traffic pollution.

PSCAA captured some air quality data at the community center (Figure 3) during a 1.5-hour period on Friday, September 16, 2016. The monitoring[6] captured a small snapshot in time and levels may be better or worse at times depending on traffic volumes, wind direction, etc. Additionally, the measurements used were intended to understand the pollution gradient from the highway but not enough to correlate to any potential health effects.

However, with the limited dataset, the results indicate the on ramp entrance onto SR 99 is a source of air pollution due to a large volume of accelerating vehicles. According to Washington Department of Transportation (WSDOT), the adjacent on-ramp averages 1,300 vehicles per day and the annual average daily count along SR 99 was 31,000 in 2015. In addition, the building wall of the community center may act as a barrier in trapping air pollutants in the toddler play area.

[6] Air quality monitors captured: Black carbon concentration (microAeth AE51, measured unit: nanograms per cubic meter) and Ultrafine particle counts (Enmont PUFP C100, measured units: Ultrafine particle counts per cubic centimeter).

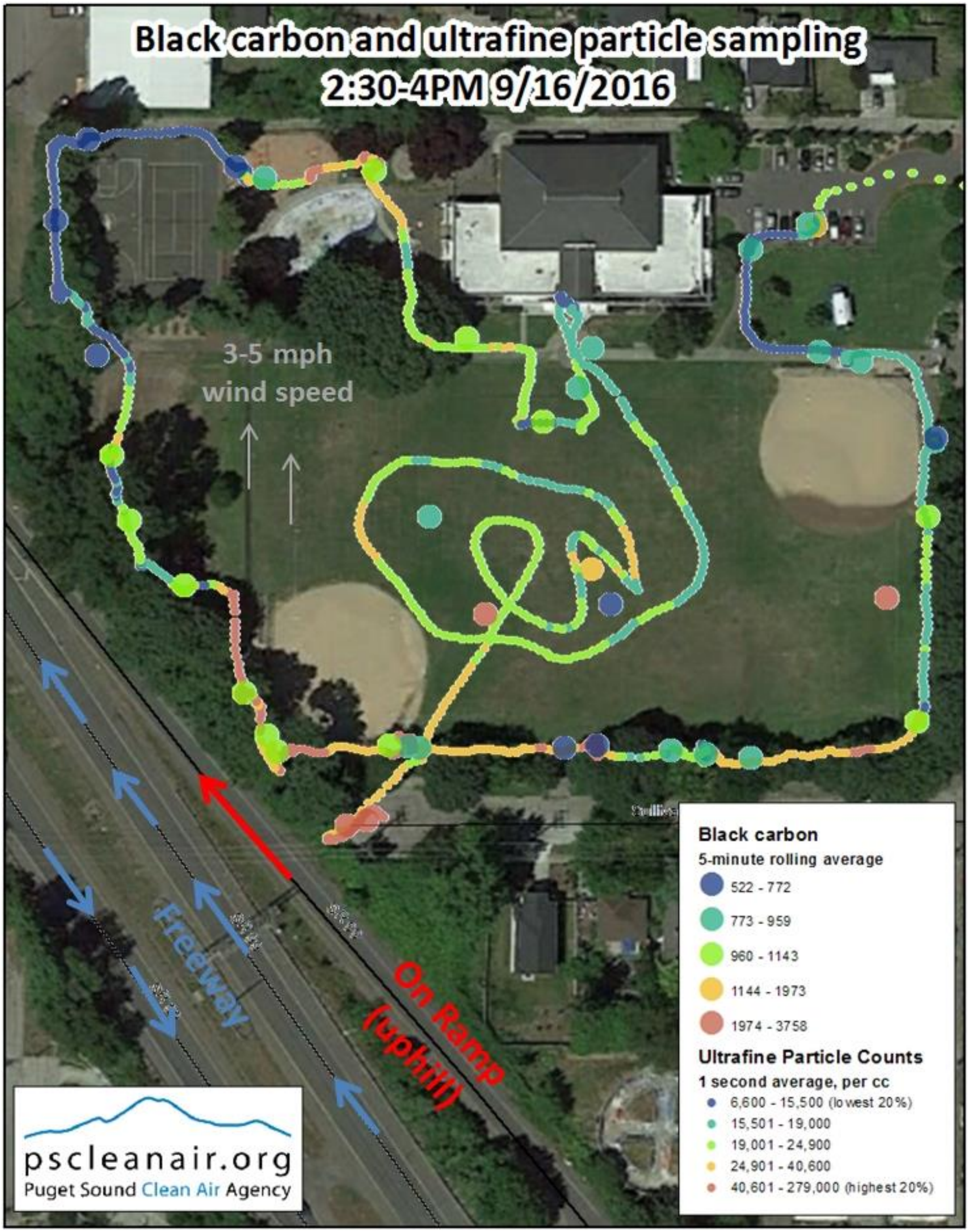


Figure 3 PSCAA's air quality monitoring at the community center on September 16, 2016.

There are approximately 500 children per day who visit the community center. Most children come by foot or bike. The play areas are mostly used in the afternoon and early evenings. This period coincides with rush hour traffic on SR 99 which puts users at potentially greater exposure to higher levels of vehicle emissions and noise.

The existing mature deciduous trees along the west boundary do not sufficiently screen out air pollutants or mitigate noise. According to Erik Saganic of PSCAA, air quality conditions are worse in the winter when the trees lose their leaves and when air currents tend to be more stagnant, especially evening through the morning hours.

A comprehensive review of the latest evidence on the impacts of pre- and post-natal exposure to air pollution on neuropsychological development in children concluded: "The public health impact of air pollutants cannot be ignored and the precautionary principle should be applied to protect children" (Suades-Gonzalez et al., 2015). In light of the existing community inequities (e.g., poor air quality, higher childhood asthma hospitalization rates), the play areas should be relocated as far from SR 99 as possible.

4.2 Environmental Noise

NEGATIVE IMPACT: The noise levels at the South Park Community Center's outdoor play areas and fields exceed the Washington State standard (WAC 173-60-040) for maximum permissible environmental noise levels for residential, commercial, and industrial areas. The proposed siting of the play areas, particularly the new older kids play structure within 100 feet, could put children at higher risk for stress and other health effects related to traffic and aircraft noise.

Noise levels in this neighborhood are relatively high due to its proximity to SR 99, area industry, and the flight paths of SeaTac airport and Boeing Field. Noise levels measured using a hand held sound level meter[7] during a non-rush hour site visit to the South Park neighborhood revealed noise levels from ~65-80 decibels (dBA). The noise measurements were loudest (~70-80 dBA) in the existing playground and wading pool area and in areas proposed for the older kids play areas, the outdoor classroom, and the hang-out space for teens. On the east side of the Community Center, furthest from SR 99, the noise measurements were the lowest detected during the site visit (~65 dBA). All technical SMEs during the site visit made note of the relatively high noise at the community center, particularly in the proposed play areas, and the difficulty having a conversation during the walk. Community representatives noted that the noise levels are higher during peak traffic times.

Noise levels in the South Park Community Center Park at non-peak traffic times exceed those outlined in WAC 173-60-040. The code states that: the maximum allowed amount of noise coming into a residential property is 55 dBA from another residential area, 57 dBA from a commercial area, and 60 dBA from and industrial area. The maximum allowed amount of noise coming into a commercial property is 57 dBA from a residential area, 60 dBA from another commercial area, and 65 dBA from an industrial area. The maximum allowed amount of noise coming into an industrial property is 60 dBA from a residential area, 65 dBA from a commercial area, and 70 dBA from another industrial area (WADOE, Table 5). It should be noted that exemptions to this law exist for certain vehicular traffic and airplane noise, and although the noise exceedance at this location may be exempt from state standards, levels of noise detected in the current play area are not recommended for residential, commercial, or even industrial areas.

[7] Radioshack 3300099 Digital Level Meter, range 30-130dB, accuracy of +/-2dB at 94dB sound pressure level

Table 5 Washington State Standards for Environmental Noise

Noise Source	Receiving Property		
	Residential	Commercial	Industrial
Residential	55 dBA	57 dBA	60 dBA
Commercial	57	60	65
Industrial	60	65	70

Most public health standards for noise are based on auditory damage and annoyance and the noise-levels sited above may not consider other known effects of noise on human health. Some reports suggest that the effects of noise and air pollution must be studied together as their effects are linked. It is difficult to separate the effects of one from the other and their health impacts are likely cumulative (European Commission, 2016). Low-income communities suffer from additional stressors and have been shown to suffer more health problems than wealthier communities from both air and noise pollution due to road traffic.

Major health impacts of noise and air pollution cited are respiratory health, cardiovascular health (hypertension, tachycardia, myocardial infarction), mental health, and sleep disturbance. Stress caused by excessive noise can cause elevated cortisol release, and the production of other hormones that lead to elevated blood pressure and hypertension. Chronic environmental noise can also be linked to annoyance, psychosocial-stress, noise-induced hearing loss, and endocrine effects (Hammer et al., 2014).

Because children go through periods of rapid growth and development and have higher metabolism rates, they are more vulnerable to environmental noise and associated pollutants than adults (Stansfield and Clark, 2015). School noise has clear effects on learning, concentration, school performance, behavior, reading comprehension, memory, and standardized test scores. Studies link traffic and aircraft noise exposures in children to general lowered wellbeing, greater annoyance responses, hearing loss, stress responses that include higher adrenaline and noradrenaline levels and higher blood pressure, increased hyperactivity symptoms, changes in cardiovascular function, and nervous and helpless feelings (Stansfeld and Clark, 2015; Hammer et al., 2014; Viet et al., 2015). An estimated 5.2 million children in the US suffer from irreversible noise-induced hearing impairment (Viet et al., 2015).

Natural areas and parks are known to have important benefits for mental health, providing quiet places for stress relief and exercise. Noise and related pollution are important considerations in parks and neighborhoods already impacted by health inequities.

4.3 Crime and Safety

NEGATIVE IMPACT: The northwestern portion of the community center, particularly the existing play area, poses safety concerns for children and other users. There is low natural surveillance ("eyes") on the current play area because it is blocked by the community center exterior wall. With a general low sense of community

safety and security in the neighborhood, parents/guardians may feel uneasy and unsafe when using the existing play area.

There is a general perception that South Park is unsafe, possibly due to the high property crime rate and other visible illicit activity (e.g. drug activity, illegal garbage dumping, homeless encampments). In addition, two very high-profile homicides in close proximity of the community center (2009 and 2015) continue to have significant impact on the community's sense of safety and security. Mark Solomon, Seattle Police Department, shared that violent crime rates in the South Park community are not significantly higher than the Seattle average but perceptions in the community are that violent crime is a significant problem. Tari Nelson-Zagar of Seattle Neighborhood Group shared that "many of the communities we work in have experienced a variety of traumas that must inform our approach to designing public space; including serious crime such as homicide, and history of other types of street crime. This site is one with traumatic events haunting it, including the past reputation for gang crime/activity, and violence and homicides that have shaken the community every few years."

The existing play area is tucked behind the western side of the community center building and bordered by an alley to the north. According to Tari, "the children's play area caters to the most vulnerable populations in the park – and those who use it range from elders bringing grandchildren to parents with several kids, to older siblings put in positions of responsibility for younger ones. Positive guardianship is supported by CPTED principles, including natural surveillance, access control, image/maintenance and reputation, territorial definition, and community activation."

Both Mark Solomon and Tari Nelson-Zagar informed EHS that the existing play area lacks important public safety features:

- ***Access Control Challenges:*** Mark Solomon noticed during our site assessment that the fence door was unlocked which indicates access control challenges. Tari Nelson-Zagar made similar observations during a separate site visit: "Access control challenges include the play area's proximity to an alleyway with easy access on the part of pedestrians, bicycles, and vehicles. While there is a fence running along the perimeter, and a locked gate, a Parks Dept. person told me that the padlocks on the gates leading into the play area from the alley are often cut, so access control at the entry point is lost at times. The day I visited the site last week, metal from some bleachers located at the rear of the playfield (west perimeter near the highway on-ramp) had been stolen, and although there was no indication of it being transported through the play area, it is not out of the question, if there were a waiting vehicle in the alley. Although, it is just as likely that the metal was transported out of the park by other paths – the neighborhood is quiet, and there is not great natural surveillance into the back area of the play field, even in daylight."

- ***Lack of Natural Surveillance ("Eyes"):*** Tari Nelson-Zagar shared that "From my observation of the physical layout of the site, the playground is isolated and lacks opportunities for natural surveillance on the part of anyone except someone specifically accompanying a child. There are few occupied windows on the back of the community center; the other activity areas are oriented to face away from the children's playground." PSCAA staff also attested to feelings of uneasiness when he was collecting air quality samples in the area and observed a couple of men "lurking behind the trees".

- ***Image/Maintenance, Reputation and Territorial Definition:*** Tari Nelson-Zagar shared: "The sense of isolation is striking; as I moved around behind the community center I really sensed a disconnect from others on the site who might be able to help if something were to go wrong. The way the site is 'declared' (its territorial definition) is also a bit odd. The building is oriented to face away from the most public and well-declared entrance and the main entrance is for vehicles; a parking lot on the east side of the building. The community center building itself "reads" as a utility structure to some degree because of the features on the east wall. The parking lot entrance/exit is narrow, and while brightly painted curbs help delineate where vehicles can go, the shape and layout of the driveway made it seem as those it were an exit only."

4.4 Social and Mental Health

NEGATIVE IMPACT: The potential adverse health impacts related to noise and crime and safety will likely also impact social and mental health.

See impacts discussion for noise and crime and safety.

4.5 Physical Activity

NEUTRAL IMPACT: The proposed plan will have a neutral impact on physical activity. The plan keeps the playground structure in an area of the park where some community members feel unsafe and where conditions are unpleasant and unhealthy (noise and air pollution). This may deter use for some children and their guardians. Without a comprehensive review and redesign of the open space, there could be missed opportunities to promote physical activity and improve access to much-needed play opportunities for all ages.

Parks and open space provide critical opportunities for physical activity and play. Research shows that proximity to parks significantly reduces the risk of being overweight or obese among children (Wolch et al, 2011). A study involving 1,556 adolescent girls found that teenage girls reported 33 additional minutes of physical activity per week for each park located within a half-mile from home. The teens were also more active when parks were lighted and had walking paths (Cohen et al, 2006). Creating new parks, renovating old ones, and improving all parks with features that promote organized and free play are proven strategies for improving health and reducing the costs associated with physical inactivity.

The current plan keeps the new children's play structure in an area of the park where some community members report feeling unsafe and where conditions are unpleasant and unhealthy (Sections 4.1, 4.2, and 4.3). According to Brian Saelens of Seattle Children's Hospital, studies (e.g. Tappe 2013) that sought to understand where children play (and where parents allow their children to play) found that parks and other proximal play spaces are highly valued. Studies also found that one of the important parts about parks is their perceived safety; influenced by how visible play areas and structures are to the surrounding neighborhood.

The proposed play area for older kids could provide new opportunities for play but the high levels of noise and public safety concerns in the planned location may deter use. In addition, community representatives shared that they are not able to keep the playground in sight when they use the walking path around the playfield.

Relocating the playfield to a location with less noise and air pollution and more visibility can create opportunities for adults and youth to get physical activity while younger children are in the playground area.

Very limited information is available about the cumulative health benefits of physical activity in parks compared to the potential risk from exposure to noise and air pollution. However, there is a growing literature about whether the physical activity benefits of switching to active transportation (bicycling, walking and transit) outweighs the health consequences of exposure to poor air quality. A recent HIA of active transportation (Mueller, 2015) found that the health benefits of being more active strongly outweigh the negative effects of being exposed to poor air quality and traffic incidents.

According to community representatives at the site visit on September 19, 2016, the current open space facilities are not fully utilized by the South Park community: the baseball field is being used by a few teams outside of the South Park community and the soccer field is not well maintained and does not have lighting for all-season play. Many low-income children and youth lack the resources to play on organized sports teams and many others are not interested in competitive team sports. Innovative uses of open space for recreation and free play for all include spray parks, futsal courts, adventure playgrounds, and mod soccer fields.

Engaging the community in a comprehensive review and innovative redesign of the entire community center open space will be essential to determining the best use of the open space, maintaining access to fields, and providing the most opportunities to promote physical activity and active play for all ages in the space available.

4.6 Heat

NOT ENOUGH INFORMATION TO ASSESS IMPACT. The proposed plan does not appear to increase heat-related impacts but may miss an important opportunity to improve community resiliency to climate change by providing additional shaded areas and water features (spray park). South Park has a higher than average percentage of children and opportunities for cooling during hot summer months are especially important.

The South Park Community is among the lowest in Seattle for tree canopy per acre (6% in 98108, in a range of 4-27% citywide) and has few shady green spaces or other places to cool off during warm weather. Seattle has had an increased number of heat alerts over recent summer periods and this trend is expected to continue. Residents in the South Park community requested a free and easily accessible place for children to cool off during hot days (SPF, 2014). The closest public pools to South Park are the Rainier Beach Pool (~6.4 miles away) and the Southwest Pool (~4 miles away). The closest spray parks are at the Georgetown Playfield and the Highland Park Playfield (~2.5 to 3 miles away). Important health considerations when determining what to install at the South Park Community Center include:

- Many residents do not have the funds for transportation and admission to public pools or spray parks in other neighborhoods across Seattle.
- Wading pools provide cooling and play opportunities for very young children.
- Spray parks provide cooling and play opportunities for people of all ages and abilities.
- Wading pools have important safety considerations due to drowning dangers and sanitary problems (e-coli).

- Spray parks have many moving parts that need regular inspection/maintenance and thorough analysis is needed during the planning process to ensure that any spray feature would be safe and sanitary (physical environment and parts are safe and the feature contains fresh (not recycled) water).
- A spray park or wading pool system at the South Park Community Center should be flushed with clean water at the start of each season due to high pollution levels at the site.

4.7 Pedestrian Safety

NEUTRAL IMPACT: The proposed plan does not directly affect pedestrian or bicycle safety but community members expressed concerns about the lack of a marked crosswalk and ADA accessible curb ramps at the 8th Ave. S. and Sullivan St. intersection.

The community center is bordered by 8th Ave. South to the east, Sullivan St. to the south, a driveway/alley to the north, and SR 99 to the west. Residents of South Park have a much lower average income and many depend on walking, biking, and transit for their daily transportation. Barriers to walking and biking in the community include heavy freight usage on local roads, lack of sidewalks and protected bike lanes, and SR 99 which impacts connectivity between the eastern and western halves of the neighborhood.

The *South Park Green Spaces Vision Plan* provided an analysis of transit access in the community and determined that accessibility was poor. Only one neighborhood in Seattle (Interbay) received a lower score than South Park. Community members shared that many children and youth access the park on foot or by bike. According to the website, www.Walkscore.com, South Park has a walkable score of 62 (somewhat walkable), compared to 83 in Green Lake (very walkable).

Providing quality bicycle and pedestrian facilities and improved transit access around the South Park Community Center could increase access to the park and improve safety for current users.

> ***When we all stood out there together in the proposed location I felt an immense sense of dread that if this is the location we would be putting kids at risk of so many hazards.***
>
> **- Cari Simson, parent, local business owner and neighborhood advocate**

5.0 Recommendations

The challenges that exist in the South Park community and the community center open space are the result of multiple decisions made by a variety of agencies and policies over a long period of time. Therefore, it will take a partnership among variety of agencies and community to identify opportunities to enhance health and wellbeing in the community. The high-level recommendations in this section are meant to serve as a starting point for discussions among agency partners, the community, and possible funders on how take health into consideration during the planning and design phase for the South Park Community Center open space.

EHS staff developed these recommendations in collaboration with technical SMEs and community representatives (Section 2.0) as possible measures to address the potential negative health impacts identified in Section 4.0. They are also based on published best practices and results from the *South Park Green Space Vision Plan* (SPF, 2014) and *Duwamish Valley Cumulative Health Impacts Analysis* (Gould and Cummings, 2013). They are based on our understanding of the specific site conditions, community concerns, and proposed design plans at the time of this rapid assessment.

We provide these recommendations for considerations during the planning and design phase, including relevant community engagement efforts. However, it is beyond our scope and expertise to assess the feasibility of implementing the recommendations. More detailed design and assessment along with additional engagement with agency partners and the community is needed. Our intention is that Table 6 will serve as an HIA management table (living document) to assess the feasibility of our recommendations based on input from agency partners and community about:

- limitations and constraints (technical or budget)
- community priorities and interests, and
- possible opportunities or next steps.

Recommendation #1: Continue to engage community and agency partners in a comprehensive review of the open space layout to inform decisions, such as:

- Is there an opportunity to redesign the open space to allow for relocating the play areas further away from the highway?
- What are the limitations/constraints and trade-offs to consider?
- If the play areas cannot be relocated, how feasible is it to implement measures to mitigate air and noise pollution and enhance public safety features at the current play area location?
- Is there community interest to redesign the ball field layout to promote greater use by residents (e.g., mod soccer, futsal courts, soccer)?

Recommendation #2: Consider NOT adding a *new* play area and outdoor classroom at the proposed location that is within 100 feet of SR 99. In light of the existing inequities the community currently experiences, we determined that siting a *new* play area within 100 feet of the highway could have potential negative impacts related to air pollution, noise, crime and safety, and social and mental health. Without mitigation, we do not recommend adding a new play area or outdoor classroom at the proposed location.

Recommendation #3: Consider relocating the existing play area as far from SR 99 as possible to reduce noise and air pollution exposure from SR 99; and improve real and perceived safety by increasing natural surveillance ("eyes on the playground"). This could result in more parents/guardians using the walking paths or participating in other physical activities nearby. Alternative locations include:

a. Grass are on the northeastern portion; currently not being used and located at the Community Center entrance
b. In front of the building door entrance (between the ball fields): To allow for safe play area at this location the ball fields will still need to be reconfigured or relocated.
c. Parking lot: The grass area will not be large enough to have both toddler and older kid play areas; therefore, we recommend considering relocating most of the parking lot to the space between the community center building and SR 99 (the location of the current playground). According to Mark Solomon, safety for kids is a priority and if the parking lot is moved to the back there will need to be increased lighting and other public safety features.

Figure 4 Alternative locations for play areas to mitigate air pollution and noise exposure

Recommendation #4: Consider constructing a concrete noise barrier wall along the SR 99 right-of-way to protect people from air pollution, noise pollution, and vehicular crashes. It is beyond the scope of this rapid HIA to assess the potential effectiveness of a concrete barrier at this location but in general, "highway traffic noise barriers can reduce the loudness of traffic noise by as much as half" (US Federal Highway Administration, 2011). Future planning of the South Park Community Center Open Space should include expert evaluation of noise barrier options and their potential effectiveness for reducing site noise exposures to acceptable levels.

In addition, consider installing vegetative barriers (i.e., green walls) where appropriate to filter air pollution. Green walls or other vegetative buffers will need to be designed with public safety in mind (e.g., hiding places, sightline). A barrier (vegetative or concrete) should be at least five meters in height to be effective for air pollution mitigation (EPA, 2016).

Recommendation #5: Consider building an all-ages spray park. Design and build play structures that are appropriate for a wide range of ages. In addition, design and build an all-ages spray park near the alternative locations for the play areas to promote more play and physical activity and protection from heat for adults, children, and youth in South Park. Integrate the play area into the other activity nodes in the park.

Recommendation #6: Consider strategically planting conifers and other green features (e.g., rain gardens) for noise and air quality mitigation. Preserve mature trees and strategically plant conifers to provide public health and environmental benefits (e.g., screen out air pollutants, provide shade, exposure to nature) while not creating unsafe features (e.g., hiding places, blocks sightline). Incorporate garden spaces throughout the park. Funds are available through the RainWise program (www.rainwise.seattle.gov) to install both a cistern that would capture rainwater from the Community Center roof and a garden that the water would irrigate. Such a system could add green space and an educational feature to the park. A RainWise garden was requested by the South Park community in the past.

Recommendation #7: Consider enhancing lighting around the community center building and along pathways. Integrating lighting into public spaces (CPTED) and along sidewalks is important to pedestrian safety and perceived safety. Adequate lighting allows park users to see others at a distance of at least 218 yards away. Additionally, the following recommendations from the SPF South Park Green Space Vision Plan (SPF, 2014) to improve public safety at the South Park Community Center should be considered in the design process:

- *Improve visibility between the building and surrounding gathering areas.*
- *The building turns its side to the street and does not provide a strong visual connection to the east, in the direction that most people come from.*
- *Concept design would benefit from central gathering areas/play areas that are visible from as much of the property as possible.*

Other general best practices to promote health benefits to consider in future planning work:

- Look for ways to integrate the history and culture of the community into the design of the park.
- Support community activation by addressing the cultural needs around childcare and any specific site-use patterns particular to the communities in South Park.
- Provide opportunities to strengthen the relationship between the park and the surrounding community.
- Design places within the park for relaxation and meditation to improve the mental health of community residents. Exposure to nature enhances the ability to cope with and recover from stress and observing

nature can restore concentration and improve productivity. Neighborhood green spaces are beneficial in reducing aggressive behaviors in adolescents who live in urban areas.

- Install amenities such as seating, shade, drinking fountains, bike racks, picnic tables, pavilions, and open lawns that promote opportunities for congregation and socialization.
- Implement traffic calming along park edges and routes to park that:
    - incorporate the preferences and requirements of residents and park users
    - reduce vehicular speeds
    - promote safe and pleasant conditions for bicyclists, pedestrians, and residents
    - improve the environment and livability of neighborhood streets
    - improve safety for bikes and pedestrians.
- Coordinate with KC Metro to improve transit access to the park.

Table 6 Assessing Feasibility of HIA Recommendations and Potential Next Steps

PHSKC Recommendations for Considerations in Planning & Design	Technical or Budget Limitations & Constraints	Community Input about Priorities & Interests	Potential Mitigations, Opportunities and/or Next Steps	Potential Agency/Community Partners
1. Continue to engage community and partners in a comprehensive review of the open space layout to inform decisions e.g.: • Is there an opportunity to redesign the open space to allow for relocating the play areas away from the highway? • What are the limitations/constraints and trade-offs to consider? • If the play areas cannot be relocated, how feasible is it to implement measures to mitigate air and noise pollution and enhance public safety features at the current play area location? • Is there community interest to redesign the ball field layout to promote greater use by residents (e.g., mod soccer, futsal courts, soccer)?	SPR is considering the development of strategies to mitigate the negative impact of noise and particulate at the South Park Community Center play area site. SPR will incorporate planning for mitigation both into the play area and the $50,000 study funded by the Challenge Fund. Designers will assess space constraints and location options for the ages 5-12 play element. In general, SPR does not fence play areas and directs play area siting away from streets and parking lots.	SPR held an open house at the Duwamish River Festival this summer as part of their outreach underrepresented community members. Approximately 80 adults and children stopped by to participate and input was also provided by teen program participants as well as from the South Park Community Center Advisory Council. Additional public engagement is planned for both the play area project and the Challenge Fund grant planning process.	SPR will continue to research effective mitigation of vehicle emissions, e.g. increased plantings and trees. All projects are approached using Crime Prevention Through Environmental Design (CPTED) and SPR is focused on activating the space to discourage negative activity.	• **South Park Community** • **Seattle Parks & Recreation (SPR)** • **Seattle Parks Foundation (SPF)** • **Public Health – Seattle & King County (PHKSC)** • **Seattle Office of Sustainability and Environment (OSE)** • **Seattle Neighborhood Group (SNG)** • **Duwamish River Clean-up Coalition Technical Advisory Group (DRCC/TAG)**
2. Consider NOT adding a new play area and outdoor classroom at the proposed location within 100 feet of SR 99.	SPR will explore the option to site the new 5-12 play element more than 100 feet from SR99 but still within the sight lines of the wading pool.	SPR will continue to provide opportunities for public involvement.	SPR will continue to look at mitigation options and the funding to support these actions.	• **South Park Community** • **SPR**

3. Consider relocating the existing play area to alternative locations, e.g.:	SPR will continue to consider the appropriate location and natural surveillance during the planning and design process.	SPR will continue to provide opportunities for public involvement.	SPR will continue to research mitigation options and the funding to support these actions.	• **South Park Community** • **SPR**
(a) Grass area on the northeastern part of the community center; and/or	SPR considers this not feasible			• **South Park Community** • **SPR**
(b) front of building door entrance; and/or	SPR considers this not feasible			• **South Park Community** • **SPR**
(c) parking lot area.	SPR considers this not feasible			• **South Park Community** • **SPR**
4. Consider constructing:				
(a) a concrete noise barrier along the SR 99 right-of-way bordering community center property; and/or	TBD	TBD	PHSKC will reach out to WSDOT and provide HIA information and contacts	• **WSDOT** • **SDOT** • **EPA** • **DRCC/TAG**
(b) vegetative barriers (i.e., green walls).	SPR could potentially include this in future projects.	TBD	TBD	• **Just Health Action (JHA)** • **DRCC/TAG** • **King County Dept. of Natural Resources and Parks (DNRP)** • **Seattle OSE** • **SPR**
5. Consider building an all ages spray park.	SPR currently has funding for the play area renovation project and the Challenge Fund planning study but has no budget to add new spray parks.	SPR will continue to provide opportunities for public involvement.	SPR will continue to look at mitigation options and the funding to support these actions.	• **SPR** • **SPF**

6. Consider strategically planting conifers and other green features (e.g., rain gardens) for noise and air quality mitigation.	SPR is committed to implementing strategies to improve noise and air quality.	SPR will continue to provide opportunities for public involvement.	SPR will continue to look at mitigation options and the funding to support these actions.	• **JHA** • **DRCC/TAG** • **DNRP** • **Seattle OSE**
7. Consider enhancing lighting around the community center building and along pathways.	SPR agrees that lighting elements should be considered during the planning process to improve the sense of safety for community members. SPR is the most appropriate agency to lead this conversation to ensure lighting plans are aligned with its policies. Funding would be needed for construction, operations, and maintenance.	SPR will continue to provide opportunities for public involvement.	TBD	• **SPR** • **SPD** • **Seattle Public Utilities** • **SNG** • **Seattle City Light** • **Neighbors**

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Appendix A - Environmental Health Services Division's SME Site Visit and Meeting at the South Park Community Center: Agenda and Scoping Table Example (9/19/16)

Public Health
Seattle & King County

Public Health Meeting & Site Visit

South Park Community Center
North Social Meeting Room
Monday, Sept 19
1:00-4:00pm

Purpose: Sinang Lee & Amy Shumann of PHSKC is convening a panel of SMEs on public health and community interests/concerns to rapidly identify the potential health and safety impacts of Seattle Parks' proposed redevelopment of the South Park Community Center (SPCC), specifically the play areas. Panel will also recommend mitigations and best practices.

Subject Matter Expert (SME) Panel:

Panel Member	Subject Matter Expertise (SMEs)
1. Erik Saganić, PSCAA	Air Pollution
2. Bill Daniell, UW	Noise, Public Health
3. Brian Saelens, Seattle Children's	Physical Activity, Play Areas & Health
4. Linn Gould, JHA	Greenwalls, Public Health
5. Shirlee Tan, PHSKC	Toxicology, Public Health
6. Paulina, DRCC & other community reps	Community concerns & interests
7. Tania Busch Isaksen	Heat, Climate Change
8. Diane Wiatr	Traffic & Pedestrian Safety
9. Officer Mark Solomon	Public Safety
10. Michelle Benetua	Community interests

Public Health
Seattle & King County

PROPOSED AGENDA

Facilitators: Sinang Lee & Amy Shumann

Approx. Time	Topic
1:00 – 2:00 ***Meeting Room***	• Introductions • Background/Context: Seattle Parks' plans/timeline & community concerns • PHSKC's "Rapid HIA" scoping process & tables • Existing community conditions: review & add inputs
2:00 – 3:00 ***Tour site***	• Overview of the tour portion • Background on Seattle Parks Foundation's Conceptual Design • Tour the grounds of the community center & discuss impacts
3:00 – 4:00 ***Meeting Room***	• Group Discussion: Impacts & Recommendations • Timeline for report development: - PH draft report, send out for panel review by Sept 26 - Panel submit comments to PH by Sept 30 - PH present findings with Seattle Parks in early Oct TBD (panel will be invited).

Public Health
Seattle & King County

EXAMPLE OF A SCOPING TABLE: EHS used a scoping table to capture desk-based research data and identify data/information gaps. EHS shared the working draft tables at the SME site visit and meeting on September 19, 2016; they served as guide for discussing the potential impacts and recommendations.

Health Determinant #2: Environmental Noise				
Existing conditions and health inequities 98108* *Data primarily covers 98108 includes Beacon hill, Georgetown, and South Park; unless otherwise noted.	POTENTIAL RISKS & IMPACTS How can the proposed conceptual design potentially impact the health determinant?		RECOMMENDATIONS Are there design alternatives, mitigations, or best practices to recommend? For each design alternative, are there tradeoffs?	PRIORITY Which issues are the most important to address?
	Negative Impacts	Positive Impacts		
Existing areas of health inequities: • South Park experiences noise from heavy truck traffic (Hwy 99) and SeaTac flight corridor. *Questions:* • Are there measurements of noise level in the SP community? Near highways? • Are there records of noise complaints?	low-level but chronic noise of moderate traffic can stress children and raise their blood pressure, heart rates and levels of stress hormones *Questions:* Could there be a negative impact on children at the proposed locations of the play areas (vs. siting the play areas further from Hwy 99)?		Minimum set-backs and barriers to major roads can help protect people from air pollution, noise pollution and vehicular crashes. *Questions:* • Do we recommend noise barriers or ways to reduce noise?	

Appendix B – Just Health Action (JHA) subcontractor conducted a literature review on health effects from air pollution and noise (9/15/16)

MEMORANDUM

To: Linn Gould/JHA
Hannah Kett/DRCC

From: Andrew Schiffer, MA

Subject: Annotated literature search on the impacts of air and noise pollution on children in relation to siting a playground near a major highway.

Date: September 15, 2016

Just Health Action (JHA) and Duwamish River Cleanup Coalition/TAG (DRCC/TAG) are interested in building a green wall project to reduce air pollution in the Seattle neighborhood of South Park. Based on community input, one of our prospective sites is at the South Park Community Center (SPCC). We met with Seattle Parks and Recreation, who are currently undertaking a playground redesign at the SPCC to discuss if the green wall could be integrated into their plans, and to ensure coordination of our projects. During one of these meetings we came to understand that the new playground design will locate the playground close to Highway 99. We at JHA and DRCC/TAG, as well as community residents, have all expressed concerns about the health effects and environmental equity of a playground being sited in such close proximity to Highway 99 in light of the air and noise pollution generated by the highway. These concerns have led us to consider and investigate the benefits of re-siting the playground. Are other playgrounds in Seattle located so close to a major highway without any significant noise and air pollution buffer?

This literature review is a compilation of articles (not extensive) that covers these issues in an effort to start the conversation regarding the siting of this and future playgrounds. This is a living document, and I welcome the addition of further research articles.

This literature search has been placed into categories highlighted in yellow.

EFFECTS OF AIR POLLUTION ON VARIOUS ASPECTS OF CHILDREN'S HEALTH

Bateson, Thomas F. & Joel Schwartz (2007) Children's Response to Air Pollutants, Journal of Toxicology and Environmental Health, Part A, 71:3, 238-243, DOI: 10.1080/15287390701598234
It is important to focus on children with respect to air pollution because (1) their lungs are not completely developed, (2) they can have greater exposures than adults, and (3) those exposures can deliver higher doses of different composition that may remain in the lung for greater duration. The undeveloped lung is more vulnerable to assault and less able to fully repair itself when injury disrupts morphogenesis. Children spend more time outside, where concentrations of combustion-generated air pollution are generally higher. Children have higher baseline ventilation rates and are more physically active than adults, thus exposing their lungs to more air pollution. Nasal breathing in adults reduces some pollution concentrations, but children are more typically mouth-breathers—suggesting that the composition of the exposure mixture at the alveolar level may be different. Finally, higher ventilation rates and mouth-breathing may pull air pollutants deeper into children's lungs, thereby making clearance slower and more difficult. Children also have immature immune systems, which plays a significant role in asthma. The observed consequences of early life exposure to adverse levels of air pollutants include diminished lung function and increased susceptibility to acute respiratory illness and

asthma. Exposure to diesel exhaust, in particular, is an area of concern for multiple endpoints, and deserves further research.

English, P., Neutra, R., Scalf, R., Sullivan, M., Waller, L., & Zhu, L. (1999). Examining associations between childhood asthma and traffic flow using a geographic information system. *Environmental Health Perspectives*, *107*(9), 761–767.
Using geographic information systems (GIS) and routinely collected data, we explored whether childhood residence near busy roads was associated with asthma in a low-income population in San Diego County, California. We examined the locations of residences of 5,996 children [less than/equal to] 14 years of age who were diagnosed with asthma in 1993 and compared them to a random control series of non-respiratory diagnoses (n = 2,284). Locations of the children's residences were linked to traffic count data at streets within 550 ft. We also examined the number of medical care visits in 1993 for children with asthma to determine if the number of visits was related to traffic flow. Analysis of the distribution of cases and controls by quintiles and by the 90th, 95th, and 99th percentiles of traffic flow at the highest traffic street, nearest street, and total of all streets within a 550-ft buffer region did not show any significantly elevated odds ratios. However, among cases, those residing near high traffic flows (measured at the nearest street) were more likely than those residing near lower traffic flows to have two or more medical care visits for asthma than to have only one visit for asthma during the year. The results of this exploratory study suggest that higher traffic flows may be related to an increase in repeated medical visits for asthmatic children. Repeated exposure to particulate matter and other air pollutants from traffic exhaust may aggravate asthmatic symptoms in individuals already diagnosed with asthma.

Gauderman, W., Avol, E., Lurmann, F., Kuenzli, N., Gilliland, F., Peters, J., & McConnell, R. (2005). Childhood Asthma and Exposure to Traffic and Nitrogen Dioxide. *Epidemiology, 16*(6), 737-743. Retrieved from http://www.jstor.org/stable/20486137
<u>Background</u>: Evidence for a causal relationship between traffic related air pollution and asthma has not been consistent across studies, and comparisons among studies have been difficult because of the use of different indicators of exposure.
<u>Methods</u>: We examined the association between traffic-related pollution and childhood asthma in 208 children from 10 southern California communities using multiple indicators of exposure. Study subjects were randomly selected from participants in the Children's Health Study. Outdoor nitrogen dioxide (NO2) was measured in summer and winter outside the home of each child. We also determined residential distance to the nearest freeway, traffic volumes on roadways within 150 meters, and model-based estimates of pollution from nearby roadways.
<u>Results</u>: Lifetime history of doctor-diagnosed asthma was associated with outdoor NO2; the odds ratio (OR) was 1.83 (95% confidence interval = 1.04-3.22) per increase of 1 interquartile range (IQR = 5.7 ppb) in exposure. We also observed increased asthma associated with closer residential distance to a freeway (1.89 per IQR; 1.19-3.02) and with model-based estimates of outdoor pollution from a freeway (2.22 per IQR; 1.36-3.63). These 2 indicators of freeway exposure and measured NO2 concentrations were also associated with wheezing and use of asthma medication. Asthma was not associated with traffic volumes on roadways within 150 meters of homes or with model-based estimates of pollution from non-freeway roads.

Kim, H. H., Lee, C. S., Yu, S. D., Lee, J. S., Chang, J. Y., Jeon, J. M., … Lim, Y. W. (2016). Near-Road Exposure and Impact of Air Pollution on Allergic Diseases in Elementary School Children: A Cross-Sectional Study. *Yonsei Medical Journal*, *57*(3), 698–713.
http://doi.org.offcampus.lib.washington.edu/10.3349/ymj.2016.57.3.698
The study aims to classify schools based on traffic pollutants and their complex sources, to assess the environment, to determine the state of allergic diseases among students using the International Study of Asthma and Allergies in children (ISAAC) questionnaire, and to assess their connection to air pollutants. A total of seven schools were divided into three categories according to the characteristics of their surrounding environments: three schools in traffic-related zones, two schools in complex source zones I (urban), and two schools in complex source zones II (industrial complex). ISAAC questionnaires were administered and the 4404 completed questionnaires were analyzed. The frequency of asthma treatment during the past 12 months showed a significant increase (p<0.05) with exposure to NO_2 [1.67, 95% confidence intervals (CIs) 1.03–2.71] in the complex source zones. The frequency of allergic rhinitis treatment during the past 12 months increased significantly with exposure to Black Carbon for all subjects. According to the results of the evaluation of the integrated data between the seven schools in Kim, et al.[1] and the seven schools in the present study, in the history of symptoms during the past 12 months, the risk of asthma, allergic rhinitis, and atopic dermatitis was higher among children in schools in traffic-related zones and complex source zones compared to the risks experienced by children in the school in the control group (S1). In terms of supporting children's health, care, and prevention related to major spaces for children, such as school zones, spaces used in coming to and leaving school, playgrounds, and classrooms are essential to ensuring not only the safety of children from traffic accidents but also their protection from local traffic pollutants and various hazardous environmental factors.

Kim, Janice J., Svetlana Smorodinsky, Michael Lipsett, Brett C. Singer, Alfred T. Hodgson, andBart Ostro "Traffic-related Air Pollution near Busy Roads", American Journal of Respiratory and Critical Care Medicine, Vol. 170, No. 5 (2004), pp. 520-526. doi: 10.1164/rccm.200403-281OC
Recent studies, primarily in Europe, have reported associations between respiratory symptoms and residential proximity to traffic; however, few have measured traffic pollutants or provided information about local air quality. We conducted a school-based, cross sectional study in the San Francisco Bay Area in 2001. Information on current bronchitis symptoms and asthma, home environment, and demographics was obtained by parental questionnaire (n 1,109). Concentrations of traffic pollutants (particulate matter, black carbon, total nitrogen oxides[NOX], and nitrogen dioxide [NO2])were measured at 10 school sites during several seasons. Although pollutant concentrations were relatively low, we observed differences in concentrations between schools nearby versus those more distant (or upwind) from major roads. Using a two-stage multiple-logistic regression model, we found associations between respiratory symptoms and traffic-related pollutants. Among those living at their current residence for at least 1 year, the adjusted odds ratio for asthma in relationship to an interquartile difference in NOX was 1.07 (95% confidence interval, 1.00–1.14). Thus, we found spatial variability in traffic pollutants and associated differences in respiratory symptoms in a region with good air quality. Our findings support the hypothesis that traffic-related pollution is associated with respiratory symptoms in children.

Pieters, N., Koppen, G., Van Poppel, M., De Prins, S., Cox, B., Dons, E., & ... Nawrot, T. S. (2015). Blood Pressure and Same-Day Exposure to Air Pollution at School: Associations with Nano-Sized to Coarse PM in Children.Environmental Health Perspectives, 123(7), 737-742. doi:10.1289/ehp.1408121
Background: Ultrafine particles (UFP) may contribute to the cardiovascular effects of particulate air pollution, partly because of their relatively efficient alveolar deposition.

Objective: In this study, we assessed associations between blood pressure and short-term exposure to air pollution in a population of schoolchildren.
Methods: In 130 children (6–12 years of age), blood pressure was determined during two periods (spring and fall 2011). We used mixed models to study the association between blood pressure and ambient concentrations of particulate matter and ultrafine particles measured in the schools' playground.
Results: Independent of sex, age, height, and weight of the child, parental education, neighborhood socioeconomic status, fish consumption, heart rate, school, day of the week, season, wind speed, relative humidity, and temperature on the morning of examination, an interquartile range (860 particles/cm3) increase in nano-sized UFP fraction (20–30 nm) was associated with a 6.35 mmHg (95% CI: 1.56, 11.14; p = 0.01) increase in systolic blood pressure. For the total UFP fraction, systolic blood pressure was 0.79 mmHg (95% CI: 0.07, 1.51; p = 0.03) higher, but no effects on systolic blood pressure were found for the nano-sized fractions with a diameter > 100 nm, nor PM2.5, PMcoarse, and PM10. Diastolic blood pressure was not associated with any of the studied particulate mass fractions.
Conclusion: Children attending school on days with higher UFP concentrations (diameter < 100 nm) had higher systolic blood pressure. The association was dependent on UFP size, and there was no association with the PM2.5 mass concentration.

EFFECTS OF AIR AND NOISE POLLUTION ON CHILDREN'S COGNITIVE DEVELOPMENT

Forns J, Dadvand P, Foraster M, Alvarez-Pedrerol M, Rivas I, López-Vicente M, Suades-Gonzalez E, Garcia-Esteban R, Esnaola M, Cirach M, Grellier J, Basagaña X, Querol X, Guxens M, Nieuwenhuijsen MJ, Sunyer J. 2016. Traffic-related air pollution, noise at school, and behavioral problems in Barcelona schoolchildren: a cross-sectional study. Environ Health Perspect 124:529–535; http://dx.doi.org/10.1289/ehp.1409449
Background: The available evidence of the effects of air pollution and noise on behavioral development is limited, and it overlooks exposure at schools, where children spend a considerable amount of time.
Objective: We aimed to investigate the associations of exposure to traffic-related air pollutants (TRAPs) and noise at school on behavioral development of schoolchildren.
Methods: We evaluated children 7–11 years of age in Barcelona (Catalonia, Spain) during 2012–2013 within the BREATHE project. Indoor and outdoor concentrations of elemental carbon (EC), black carbon (BC), and nitrogen dioxide (NO2) were measured at schools in two separate 1-week campaigns. In one campaign we also measured noise levels inside classrooms. Parents filled out the strengths and difficulties questionnaire (SDQ) to assess child behavioral development, while teachers completed the attention deficit/hyperactivity disorder criteria of the DSM-IV (ADHDDSM-IV) list to assess specific ADHD symptomatology. Negative binomial mixed-effects models were used to estimate associations between the exposures and behavioral development scores.
Results: Interquartile range (IQR) increases in indoor and outdoor EC, BC, and NO2 concentrations were positively associated with SDQ total difficulties scores (suggesting more frequent behavioral problems) in adjusted multivariate models, whereas noise was significantly associated with ADHD-DSM-IV scores.
Conclusion: In our study population of 7- to 11-year-old children residing in Barcelona, exposure to TRAPs at school was associated with increased behavioral problems in schoolchildren. Noise exposure at school was associated with more ADHD symptoms.

Suades-González, E., Gascon, M., Guxens, M., & Sunyer, J. (2015). Air Pollution and Neuropsychological Development: A Review of the Latest Evidence. *Endocrinology, 156*(10), 3473-3482. doi:10.1210/en.2015-1403
For the last decade, literature on the detrimental impacts of air pollution on brain, cognition and behavior has exponentially increased. Our aim is to review the latest epidemiologic literature on the

association between outdoor air pollution and neuropsychological developmental in children. Two independent researchers searched for published studies between January 1, 2012 and June 12, 2015 in MEDLINE, Web of Science, and Science direct using defined keywords on outdoor air pollution and neuropsychological development. Selection of articles was based on study eligibility criteria. We encountered sufficient evidence of detrimental effects of pre- or postnatal exposure to polycyclic aromatic hydrocarbons on global intelligence quotient. The evidence was also sufficient for the association between pre- or postnatal exposure to fine particulate matter (PM2.5) and autism spectrum disorder, and limited evidence was encountered between nitrogen oxides and autism spectrum disorder. For other exposure-outcome associations reviewed, the evidence was inadequate or insufficient. Although evidence is not yet conclusive and further research is needed, the latest epidemiological studies support the hypothesis that pre- or postnatal exposure to ambient pollution, particularly polycyclic aromatic hydrocarbons, PM2.5, and nitrogen oxides has a negative impact on the neuropsychological development of children. The public health impact of air pollutants cannot be ignored and the precautionary principle should be applied to protect children.

Sunyer, J., Esnaola, M., Alvarez-Pedrerol, M., Forns, J., Rivas, I., López-Vicente, M., … Querol, X. (2015). Association between Traffic-Related Air Pollution in Schools and Cognitive Development in Primary School Children: A Prospective Cohort Study. *PLoS Medicine*, *12*(3), e1001792. http://doi.org.offcampus.lib.washington.edu/10.1371/journal.pmed.1001792
Background**:** Air pollution is a suspected developmental neurotoxicant. Many schools are located in close proximity to busy roads, and traffic air pollution peaks when children are at school. We aimed to assess whether exposure of children in primary school to traffic-related air pollutants is associated with impaired cognitive development.
Methods and Findings**:** We conducted a prospective study of children (*n* = 2,715, aged 7 to 10 y) from 39 schools in Barcelona (Catalonia, Spain) exposed to high and low traffic-related air pollution, paired by school socioeconomic index; children were tested four times (i.e., to assess the 12-mo developmental trajectories) via computerized tests (*n* = 10,112). Chronic traffic air pollution (elemental carbon [EC], nitrogen dioxide [NO2], and ultrafine particle number [UFP; 10–700 nm]) was measured twice during 1-wk campaigns both in the courtyard (outdoor) and inside the classroom (indoor) simultaneously in each school pair. Cognitive development was assessed with the *n*-back and the attentional network tests, in particular, working memory (two-back detectability), superior working memory (three-back detectability), and inattentiveness (hit reaction time standard error). Linear mixed effects models were adjusted for age, sex, maternal education, socioeconomic status, and air pollution exposure at home. Children from highly polluted schools had a smaller growth in cognitive development than children from the paired lowly polluted schools, both in crude and adjusted models (e.g., 7.4% [95% CI 5.6%–8.8%] versus 11.5% [95% CI 8.9%–12.5%] improvement in working memory, *p* = 0.0024). Cogently, children attending schools with higher levels of EC, NO2, and UFP both indoors and outdoors experienced substantially smaller growth in all the cognitive measurements; for example, a change from the first to the fourth quartile in indoor EC reduced the gain in working memory by 13.0% (95% CI 4.2%–23.1%).
Conclusions**:** Children attending schools with higher traffic-related air pollution had a smaller improvement in cognitive development.

Wang, S., Zhang, J., iaodong6Zeng, Zeng, Y., Wang, S., & Chen, S. (2009). Association of Traffic-Related Air Pollution with Children's Neurobehavioral Functions in Quanzhou, China.Environmental Health Perspectives, 117(10), 1612-1618. doi:10.1289/ehp.0800023
Background: With the increase of motor vehicles, ambient air pollution related to traffic exhaust has become an important environmental issue in China. Because of their fast growth and development, children are more susceptible to ambient air pollution exposure. Many chemicals from traffic exhaust,

such as carbon monoxide, nitrogen dioxide, and lead, have been reported to show adverse effects on neurobehavioral functions. Several studies in China have suggested that traffic exhaust might affect neurobehavioral functions of adults who have occupational traffic exhaust exposure. However, few data have been reported on the effects on neurobehavioral function in children.
Objectives: The objective of this study was to explore the association between traffic-related air pollution exposure and its effects on neurobehavioral function in children.
Methods: This field study was conducted in Quanzhou, China, where two primary schools were chosen based on traffic density and monitoring data of ambient air pollutants. School A was located in a clear area and school B in a polluted area. We monitored NO2 and particulate matter with aerodynamic diameter ≤ 10 μm as indicators for traffic-related air pollution on the campuses and in classrooms for 2 consecutive days in May 2005. The children from second grade (8–9 years of age) and third grade (9–10 years of age) of the two schools (n = 928) participated in a questionnaire survey and manual assisted neurobehavioral testing. We selected 282 third-grade children (school A, 136; school B, 146) to participate in computer-assisted neurobehavioral testing. We conducted the fieldwork between May and June 2005. We used data from 861 participants (school A, 431; school B, 430) with manual neurobehavioral testing and from all participants with computerized testing for data analyses.
Results: Media concentrations of NO2 in school A and school B campus were 7 μg/m3 and 36 μg/ m3, respectively ($p < 0.05$). The ordinal logistic regression analyses showed that, after controlling the potential confounding factors, participants living in the polluted area showed poor performance on all testing; differences in results for six of nine tests (66.7%) achieved statistical significance: Visual Simple Reaction Time with preferred hand and with non-preferred hand, Continuous Performance, Digit Symbol, Pursuit Aiming, and Sign Register.
Conclusion: We found a significant relationship between chronic low-level traffic-related air pollution exposure and neurobehavioral function in exposed children. More studies are needed to explore the effects of traffic exhaust on neurobehavioral function and development.

EFFECTS OF NOISE POLLUTION ON HEALTH AND WELLBEING

Berglund, B., Lindvall, T., & Schwela, D. A. (1999). *Guidelines for community noise*. WHO.
This WHO document on the Guidelines for Community Noise is the outcome of the WHO expert task force meeting held in London, United Kingdom, in April 1999. It bases on the document entitled "Community Noise" that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute. I have listed below some of their final recommendations regarding noise pollution and communities.

The following recommendations were considered appropriate:
a. Governments should consider the protection of populations from community noise as an integral part of their policy for environmental protection.
b. Governments should consider implementing action plans with short-term, medium term and long-term objectives for reducing noise levels.
c. Governments should adopt the health guidelines for community noise as targets to be achieved in the long-term.
a. Governments should include noise as an important issue when assessing public health matters and support more research related to the health effects of noise exposure.
a. Legislation should be enacted to reduce sound pressure levels, and existing legislation should be enforced.
b. Municipalities should develop low-noise implementation plans.

c. Cost-effectiveness and cost-benefit analyses should be considered as potential instruments when making management decisions.
d. Governments should support more policy-relevant research into noise pollution (see section 6.3).

Elise E. M. M. Van Kempen, Kamp, I. V., Stellato, R. K., Lopez-Barrio, I., Haines, M. M., Nilsson, M. E., . . . Stansfeld, S. A. (2009). Children's annoyance reactions to aircraft and road traffic noise. *The Journal of the Acoustical Society of America J. Acoust. Soc. Am., 125*(2), 895. doi:10.1121/1.3058635
Since annoyance reactions of children to environmental noise have rarely been investigated, no source specific exposure-response relations are available. The aim of this paper is to investigate children's reactions to aircraft and road traffic noise and to derive exposure-response relations. To this end, children's annoyance reactions to aircraft and road traffic noise in both the home and the school setting were investigated using the data gathered in a cross-sectional multicenter study, carried out among 2844 children age 9 – 11 years attending 89 primary schools around three European airports. An exposure-response relation was demonstrated between exposure to aircraft noise at school LAeq,7–23 h and severe annoyance in children: after adjustment for confounders, the percentage severely annoyed children was predicted to increase from about 5.1% at 50 dB to about 12.1% at 60 dB. The findings were consistent across the three samples. Aircraft noise at home LAeq,7–23 h demonstrated a similar relation with severe annoyance. Children attending schools with higher road traffic noise LAeq,7–23 h were more annoyed. Although children were less annoyed at levels above 55 dB, the shapes of the exposure-response relations found among children were comparable to those found in their parents.

Hjortebjerg, D., Andersen, A. N., Christensen, J. S., Ketzel, M., Raaschou-Nielsen, O., Sunyer, J., & ... Sorensen, M. (2016). Exposure to Road Traffic Noise and Behavioral Problems in 7-Year-Old Children: A Cohort Study. Environmental Health Perspectives, 124(2), 228-234. doi:10.1289/ehp.1409430.
Background: Exposure to traffic noise has been associated with adverse effects on neuropsychological outcomes in children, but findings with regard to behavioral problems are inconsistent.
Objective: We investigated whether residential road traffic noise exposure is associated with behavioral problems in 7-year-old children.
Methods: We identified 46,940 children from the Danish National Birth Cohort with complete information on behavioral problems at 7 years of age and complete address history from conception to 7 years of age. Road traffic noise (Lden) was modeled at all present and historical addresses. Behavioral problems were assessed by the parent-reported Strengths and Difficulties Questionnaire (SDQ). Associations between pregnancy and childhood exposure to noise and behavioral problems were analyzed by multinomial or logistic regression and adjusted for potential confounders.
Results: A 10-dB increase in average time-weighted road traffic noise exposure from birth to 7 years of age was associated with a 7% increase (95% CI: 1.00, 1.14) in abnormal versus normal total difficulties scores; 5% (95% CI: 1.00, 1.10) and 9% (95% CI: 1.03, 1.18) increases in borderline and abnormal hyperactivity/inattention subscale scores, respectively; and 5% (95% CI: 0.98, 1.14) and 6% (95% CI: 0.99, 1.12) increases in abnormal conduct problem and peer relationship problem subscale scores, respectively. Exposure to road traffic noise during pregnancy was not associated with child behavioral problems at 7 years of age.
Conclusions: Residential road traffic noise in early childhood may be associated with behavioral problems, particularly hyperactivity/inattention symptoms.

Hygge, S., Evans, G., & Bullinger, M. (2002). A Prospective Study of Some Effects of Aircraft Noise on Cognitive Performance in Schoolchildren. *Psychological Science, 13*(5), 469-474. Retrieved from http://www.jstor.org/stable/40063882
This study looked at two groups of children, one group that lived near an airport in Munich that had just closed, and one group of children living where the new airport opened. Their conclusions were as follows: These longitudinal data complement nearly 20 cross-sectional studies showing adverse impacts of aircraft noise on reading in elementary- school children. Moreover, these effects occur prospectively and may be reversible. We have also demonstrated prospective impacts of chronic noise on long-term memory. More work is needed to determine the sensitivity of this effect to the duration of exposure, as well as children's age. This is also the first study to show prospective impacts of chronic noise on a cognitive process, long-term memory. Weaker evidence suggests noise-induced deficiencies in speech perception and short-term memory. Reading and long-term memory effects replicated, disappearing when the old airport closed and emerging after the new airport opened. This provides strong causal evidence for the vulnerability of central language processing to noise exposure, and the reversible nature of the impact. Additional research is needed to see whether the adverse noise effects on reading and recall continue over time. Note that at the new airport the negative effects were stronger at Wave 3 than at Wave 2, which suggests a cumulative noise effect. The speech perception findings warrant further research. Differences in speech perception did not mediate noise effects on reading. The lack of mediation is inconsistent with prior cross-sectional studies (Cohen et al., 1973, 1986; Evans & Maxwell, 1997). The present longitudinal data raise doubts about the validity of inattention, or "tuning out," as an explanatory mechanism for the adverse impacts of noise on reading performance. Furthermore, although children's reading worsened with cumulative noise exposure at the new airport and recovered following noise cessation at the old airport, speech perception deficits among noise- exposed children at the old airport did not recover. This suggests that speech perception did not mediate the noise effects on reading, a conclusion that is also indicated by the structural equation results. An ex- planation for this pattern of results may be the developmental timing of the noise exposure. Perhaps noise exposure damages the development of speech perception in different ways during the early and late portions of the reading-acquisition period.

Kempen, E. V., Fischer, P., Janssen, N., Houthuijs, D., Kamp, I. V., Stansfeld, S., & Cassee, F. (2012). Neurobehavioral effects of exposure to traffic-related air pollution and transportation noise in primary schoolchildren. *Environmental Research, 115*, 18-25. doi:10.1016/j.envres.2012.03.002
Background: Children living close to roads are exposed to both traffic noise and traffic-related air pollution. There are indications that both exposures affect cognitive functioning. So far, the effects of both exposures have only been investigated separately.
Objectives: To investigate the relationship between air pollution and transportation noise on the cognitive performance of primary schoolchildren in both the home and school setting.
Methods: Data acquired within RANCH from 553 children (aged 9–11 years) from 24 primary schools were analyzed using multilevel modelling with adjustment for a range of socio-economic and life-style factors.
Results: Exposure to NO2 (which is in urban areas an indicator for traffic-related air pollution) at school was statistically significantly associated with a decrease in the memory span length measured during DMST (w2¼6.8, df¼1, p¼0.01). This remained after additional adjustment for transportation noise. Statistically significant associations were observed between road and air traffic noise exposure at school and the number of errors made during the 'arrow' (w2¼7.5, df¼1, p¼0.006) and 'switch' (w2¼4.8, df¼1, p¼0.028) conditions of the SAT. This remained after adjustment for NO2. No effects of air pollution exposure or transportation noise exposure at home were observed. Combined exposure of air pollution

and road traffic noise had a significant effect on the reaction times measured during the SRTT and the 'block' and the 'arrow' conditions of the SAT.

Conclusions: Our results provide some support that prolonged exposure to traffic-related air pollution as well as to noise adversely affects cognitive functioning.

Tobías, A., Recio, A., Díaz, J., & Linares, C. (2015). Health impact assessment of traffic noise in Madrid (Spain). *Environmental Research, 137*, 136-140. doi:10.1016/j.envres.2014.12.011

The relationship between environmental noise and health has been examined in depth. In view of the sheer number of persons exposed, attention should be focused on road traffic noise. The city of Madrid (Spain) is a densely populated metropolitan area in which 80% of all environmental noise exposure is attributed to traffic. The aim of this study was to quantify avoidable deaths resulting from reducing the impact of equivalent diurnal noise levels (LeqD) on daily cardiovascular and respiratory mortality among people aged ≥65 years in Madrid. A health impact assessment of (average 24 h) LeqD and $PM_{2.5}$levels was conducted by using previously reported risk estimates of mortality rates for the period 2003–2005: For cardiovascular causes: LeqD 1.048 (1.005, 1.092) and $PM_{2.5}$1.041(1.020, 1.062) and for respiratory causes: LeqD 1.060 (1.000, 1.123) and $PM_{2.5}$1.030 (1.000, 1.062). The association found between LeqD exposure and mortality for both causes suggests an important health effect. A reduction of 1 dB(A) in LeqD implies an avoidable annual mortality of 284 (31, 523) cardiovascular- and 184 (0, 190) respiratory-related deaths in the study population. The magnitude of the health impact is similar to reducing average $PM_{2.5}$ levels by 10 μg/m^3. Regardless of air pollution, exposure to traffic noise should be considered an important environmental factor having a significant impact on health.

POLLUTION ISSUES IN PLAYGROUNDS AND SCHOOLS

Dadvand, P., Rivas, I., Basagaña, X., Alvarez-Pedrerol, M., Su, J., Pascual, M. D., . . . Nieuwenhuijsen, M. J. (2015). The association between greenness and traffic-related air pollution at schools. *Science of The Total Environment, 523*, 59-63. doi:10.1016/j.scitotenv.2015.03.103

Abstract: Greenness has been reported to improve mental and physical health. Reduction in exposure to air pollution has been suggested to underlie the health benefits

Conclusion: We found an inverse association between greenness within and surrounding school boundaries and indoor and outdoor TRAP levels at schools. There were some indications that the reduction in indoor TRAP levels could have been partly mediated by the reduction in outdoor TRAP levels associated with higher school greenness. We also observed some suggestions for stronger associations between school surrounding greenness and outdoor TRAP levels for schools with higher numbers of trees around them. Considering the high burden of health effects of TRAP exposure on schoolchildren, if our findings are confirmed by future studies, they might inform policymakers and health professionals about the importance of school and neighborhood greenness to avoid such burdens and at the same time to achieve other health co-benefits of greenness such as better behavioral development and school performance. Future studies could usefully include vegetation type and include other air pollutants such as ozone and VOC's in their analysis.

Daigle, C. C., Chalupa, D. C., Gibb, F. R., Morrow, P. E., Oberdorster, G., Utell, M. J., and Frampton, M. W. 2003. Ultrafine particle deposition in humans during rest and exercise. Inhal. Toxicol.15(6):539–552.

In this study, the researchers measured the deposition of various size particles during breathing at rest and exercise. They found that particle deposition increased as particle size decreased. They also found that deposition increased further with exercise, and it increased more than their models had predicted. They conclude that "The combination of increased particle intake, increased deposition, and the high deposition of UFP in the alveolar region indicates that UFP burden to the alveolar epithelium is significantly greater during exercise. This may have implications for the health of children and others exercising outdoors near highways or other sources of UFP." (pg. 551)

Minguillón, M., Rivas, I., Moreno, T., Alastuey, A., Font, O., Córdoba, P., . . . Querol, X. (2015). Road traffic and sandy playground influence on ambient pollutants in schools. *Atmospheric Environment, 111*, 94-102. doi:10.1016/j.atmosenv.2015.04.011

Urban air pollution has a greater impact on children's health compared to adults. In the framework of the BREATHE (BRain dEvelopment and Air polluTion ultrafine particles in scHool childrEn) project, the present work studies the impact of road traffic and the presence of sandy playgrounds on the outdoor air quality around schools. Four schools were selected for intensive campaigns of one month. $PM_{2.5}$ samples were collected daily from 8:00 to 20:00 and chemically analyzed. Real time measurements of NO_x, black carbon (BC), PM_1, $PM_{2.5}$ and PM_{10} concentrations were carried out. Sand samples from five school playgrounds were characterized. The results confirm the representativeness of the general BREATHE project campaigns (eight weekdays measurements at each of the 39 schools). NO_x, BC and PM_x concentrations were higher in the school located nearest to traffic in the city center with the daily pattern reflecting the traffic rush hours. The NO_x concentrations were found to decrease with distance to the main road. The road traffic influence on ambient pollutants was higher on weekdays than weekends. The PM_{10} concentrations at one of the schools were mainly driven by the influence of the sandy playground, with peaks up to 25, 57 and 12 times higher than night background concentrations during mid-morning break, lunch break and end of school day, respectively. The airborne mineral matter concentrations registered at this school further confirm this origin. Nevertheless the influence of the re-suspension from the sandy playground was very local and decreased drastically within a short distance.

Ng, S. L., Chan, L. S., Lam, K. C., & Chan, W. K. (2003). Heavy metal contents and magnetic properties of playground dust in Hong Kong. Environmental Monitoring And Assessment, 89(3), 221-232.

This study examined the levels of seven heavy metals (namely zinc, copper, cadmium, chromium, lead, manganese and iron) and their associations with magnetic properties in playground dust of Hong Kong. Results showed that the playground dust contained high concentrations of Zn (mean = 1883 μgg −1), Cu (mean = 143 μgg −1) and Cr (mean = 263 μgg −1). Qualitative examination of dust samples under microscope indicated local traffic as one of the important pollutant sources. Magnetic measurements indicated that these anthropogenic pollutants mainly consisted of coarse-grained multidomain (MD) ferrimagnetic minerals. Superparamagnetic (SP), stable single domain (SSD) ferrimagnetic grains and non-ferrimagnetic minerals were present in relatively small amounts. Significant correlations between heavy metals and various magnetic parameters indicated a strong affinity of heavy metals to magnetic minerals hence pointed out the potential of magnetic properties for simple and rapid proxy indications of heavy metal pollution in playground dust.

Rundell, K. W., Caviston, R., Hollenbach, A. M., & Murphy, K. (2006). Vehicular Air Pollution, Playgrounds, and Youth Athletic Fields. Inhalation Toxicology,18(8), 541-547. doi:10.1080/08958370600685640

In spite of epidemiological evidence concerning vehicular air pollution and adverse respiratory/cardiovascular health, many athletic fields and school playgrounds are adjacent to high traffic roadways and could present long-term health risks for exercising children and young adults. Particulate matter (PM1,0.02–1.0 μm diameter) number counts were taken serially at four elementary school athletic/playground fields and at one university soccer field. Lowest mean values were recorded at measurement sites furthest from the highway and followed a second-order logarithmic decay with distance away from the highway. Ozone increased with rising temperature and was highest in the warmer afternoon hours (R=.61). Although the consequence of daily recess play and athletic activities by school children and young athletes in high ambient [PM1] conditions has not yet been clearly defined, this study is a critical component to evaluating functional effects of chronic combustion-derived PM exposure on these exercising school children and young adults.

AIR POLLUTION AND DISTANCE FROM SOURCES

Brunekreef, B., Nicole A. H. Janssen, De Hartog, J., Harssema, H., Knape, M., & Van Vliet, P. (1997). Air Pollution from Truck Traffic and Lung Function in Children Living near Motorways. *Epidemiology, 8*(3), 298-303. Retrieved from http://www.jstor.org/stable/3702257

The contribution of motorized traffic to air pollution is widely recognized, but relatively few studies have looked at the respiratory health status of subjects living near busy roads. We studied children in six areas located near major motorways in the Netherlands. We measured lung function in the children, and we assessed their exposure to traffic-related air pollution using separate traffic counts for automobiles and trucks. We also measured air pollution in the children's schools. Lung function was associated with truck traffic density but had a
lesser association with automobile traffic density. The association was stronger in children living closest (<300 m) to the motorways. Lung function was also associated with the concentration of black smoke, measured inside the schools, as a proxy for diesel exhaust particles. The associations were stronger in girls than in boys. The results indicate that exposure to traffic-related air pollution, in particular diesel exhaust particles, may lead to reduced lung function in children living near major motorways.

Karner, Alex A., Douglas S. Eisinger, and Deb A. Niemeier, ''Near-Roadway Air Quality: Synthesizing the Findings from Real-World Data,'' Environmental Science and Technology 44 (July 15, 2010): 5334–44, doi:10.1021/es100008x.

Despite increasing regulatory attention and literature linking roadside air pollution to health outcomes, studies on near roadway air quality have not yet been well synthesized. We employ data collected from 1978 as reported in 41 roadside monitoring studies, encompassing more than 700 air pollutant concentration measurements, published as of June 2008. Two types of normalization, background and edge-of-road, were applied to the observed concentrations. Local regression models were specified to the concentration-distance relationship and analysis of variance was used to determine the statistical significance of trends. Using an edge-of-road normalization, almost all pollutants decay to background by 115-570 m from the edge of road; using the more standard background normalization, almost all pollutants decay to background by 160-570 m from the edge of road. Differences between the normalization methods arose due to the likely bias inherent in background normalization, since some reported background values tend to under predict (be lower than) actual background. Changes in pollutant concentrations with increasing distance from the road fell into one of three groups: at least a 50% decrease in peak/edge-of-road concentration by 150 m, followed by consistent but gradual decay toward background (e.g., carbon monoxide, some ultrafine particulate matter number concentrations); consistent decay or change over the entire distance range (e.g., benzene, nitrogen dioxide); or no trend with distance (e.g., particulate matter mass concentrations)

Lin S, Munsie J P, Hwang S A, Fitzgerald E, Cayo M R, 2002,``Childhood asthma hospitalization and residential exposure to state route traffic ''Environmental Research Section A 8873^81

This study investigated whether pediatric hospitalization for asthma was related to living near a road with heavy traffic. They studied children aged 0-14. After adjustments for age and poverty level were made, children hospitalized for asthma were more likely to live on roads with the highest tertile of vehicle miles. This study suggests that exposure to high volumes of traffic/trucks within 200m of homes contributes to childhood asthma hospitalizations.

Morgenstern, Verena, Anne Zutavern, Josef Cyrys, Inken Brockow, Sibylle Koletzko, Ursula Krämer, Heidrun Behrendt, Olf Herbarth, Andrea von Berg, Carl Peter Bauer, H.-Erich Wichmann, and Joachim Heinrich "Atopic Diseases, Allergic Sensitization, and Exposure to Traffic-related Air Pollution in Children", American Journal of Respiratory and Critical Care Medicine, Vol. 177, No. 12 (2008), pp. 1331-1337.
doi: 10.1164/rccm.200701-036OC
Rationale: In vitro studies, animal experiments, and human exposure studies have shown how ambient air pollution increases the risk of atopic diseases. However, results derived from observational studies are inconsistent.
Objectives: To assess the relationship between individual-based exposure to traffic-related air pollutants and allergic disease outcomes in a prospective birth cohort study during the first 6 years of life.
Methods: We studied 2,860 children at the age of 4 years and 3,061at the age of 6 years to investigate atopic diseases and allergic sensitization. Long-term exposure to particulate matter (PM2.5), PM2.5 absorbance, and long-term exposure to nitrogen dioxide(NO2) was assessed at residential addresses using geographic information systems based regression models and air pollution measurements. The distance to the nearest main road was used as a surrogate for traffic-related air pollutants.
Measurements and Main Results: Strong positive associations were found between the distance to the nearest main road and asthmatic bronchitis, hay fever, eczema, and sensitization. A distance-dependent relationship could be identified, with the highest odds ratios (ORs) for children living less than 50 m from busy streets. For PM2.5 absorbance, statistically significant effects were found for asthmatic bronchitis (OR, 1.56; 95% confidence interval [CI], 1.03–2.37), hay fever (OR, 1.59;95%CI,1.11–2.27), and allergic sensitization to pollen (OR,1.40;95%CI,1.20–1.64). NO2 exposure was associated with eczema, whereas no association was found for allergic sensitization.
Conclusions: This study provides strong evidence for increased risk of atopic diseases and allergic sensitization when children are exposed to ambient particulate matter.

Mori, J., Hanslin, H. M., Burchi, G., & Sæbø, A. (2015). Particulate matter and element accumulation on coniferous trees at different distances from a highway. *Urban Forestry & Urban Greening, 14*(1), 170-177. doi:10.1016/j.ufug.2014.09.005
Picea sitchensis (Bong.) Carrière (one- and two-year-old needles) and *Pinus sylvestris* L. (one-year-old needles), were tested for their capacity to accumulate particulate matter (PM) on the leaf surface or in waxes on the leaf surface. Element accumulation on needle surfaces was also analyzed. Sampling was carried out at four distances from a heavily trafficked road in South Western Norway in October 2012. *P. sitchensis* accumulated a higher quantity of coarse PM compared to *P. sylvestris.* Deposition of all fractions of PM increased with time, with largest amounts on two-year-old as compared to one-year-old needles of *P. sitchensis*. Surface content of 14 out of 25 analyzed elements were highest in *P. sitchensis* compared to *P. sylvestris*. A higher accumulation of coarse PM and elements therein (in 14 of 25 elements), was observed in samples taken closest to the road as compared to those from greater distances.

Zhu, Y., Hinds, W. C., Kim, S., & Sioutas, C. (2002). Concentration and size distribution of ultrafine particles near a major highway. *Journal of the Air & Waste Management Association, 52*(9), 1032-42. Retrieved from http://search.proquest.com.offcampus.lib.washington.edu/docview/214233318?accountid=14784.
Motor vehicle emissions usually constitute the most significant source of ultrafine particles (diameter <0.1 microm) in an urban environment, yet little is known about the concentration and size distribution of ultrafine particles in the vicinity of major highways. In the present study, particle number concentration and size distribution in the size range from 6 to 220 nm were measured by a condensation particle counter (CPC) and a scanning mobility particle sizer (SMPS), respectively. Measurements were taken 30, 60, 90, 150, and 300 m downwind, and 300 m upwind, from Interstate 405 at the Los Angeles National Cemetery. At each sampling location, concentrations of CO, black carbon (BC), and particle mass were also measured by a Dasibi CO monitor, an aethalometer, and a DataRam, respectively. The range of average concentration of CO, BC, total particle number, and mass concentration at 30 m was 1.7-2.2 ppm, 3.4-10.0 microg/m3, 1.3-2.0 x 10(5)/cm3, and 30.2-64.6 microg/m3, respectively. For the conditions of these measurements, relative concentrations of CO, BC, and particle number tracked each other well as distance from the freeway increased. Particle number concentration (6-220 nm) decreased exponentially with downwind distance from the freeway. Data showed that both atmospheric dispersion and coagulation contributed to the rapid decrease in particle number concentration and change in particle size distribution with increasing distance from the freeway. Average traffic flow during the sampling periods was 13,900 vehicles/hr. Ninety-three percent of vehicles were gasoline-powered cars or light trucks. The measured number concentration tracked traffic flow well. Thirty meters downwind from the freeway, three distinct ultrafine modes were observed with geometric mean diameters of 13, 27, and 65 nm. The smallest mode, with a peak concentration of 1.6 x 10(5)/cm3, disappeared at distances greater than 90 m from the freeway. Ultrafine particle number concentration measured 300 m downwind from the freeway was indistinguishable from upwind background concentration. These data may be used to estimate exposure to ultrafine particles in the vicinity of major highways.

AIR POLLUTION, COMMUNITIES, AND ENVIRONMENTAL JUSTICE CONCERNS

Bae, C. C., Sandlin, G., Bassok, A., & Kim, S. (2007). The exposure of disadvantaged populations in freeway air-pollution sheds: A case study of the Seattle and Portland regions. *Environment and Planning B: Planning and Design Environ. Plann. B, 34*(1), 154-170. doi:10.1068/b32124
Freeway-related air pollution and its harmful health risks have been observed in recent research in the environmental-health sciences. In this study we investigate the impact of freeway and arterial-road air pollution on vulnerable populations - for example, the poor, minorities, children, and the elderly - whose housing options are limited. Because many mobile-source emissions decay rapidly with distance, approaching background concentrations at 330ft from the freeway, populations living near limited access roads are most at risk from exposure. Furthermore, microscale air monitoring systems are rarely in place at these locations in the United States. In this research we will define freeway air-pollution sheds with the aid of a geographic information system analysis and determine populations that may be at risk from exposure to mobile-source pollutants in two West Coast metropolitan areas (Seattle and Portland).We then use cluster analysis to identify key neighborhoods at risk in Seattle. Subsequently, we apply a hedonic pricing model to understand the extent to which house price values in Seattle are related to freeway proximity. Finally, we discuss policy options, planning implications, and mitigation measures, including an assessment of air-quality monitoring needs and land-use prescriptions.
Conclusions: This research tested three related hypotheses: (1) minority and/or low-income households live disproportionately close to freeways compared with white and middle-income households; (2)

households in each category cluster together in local subhousing markets; and (3) negative environmental externalities near freeways (especially air pollution) are capitalized in house prices and rents. First, the results support all three hypotheses and their corollaries: the clustering of low-income and minority population near freeways, and the higher concentration of minority and/or poor students in FAPS. Health consequences for these children can be more harmful, because of the effects of pollution on their lung development. Second, the cluster analysis suggests that the residential choices of the minority and/or low-income population are limited. Third, locations within a FAPS are negatively associated with housing prices when other negative environmental factors such as traffic noise are accounted for. Of course, for people living in such locations, trade-offs may have to be made: cheaper housing versus higher health risks.

Brugge, D., Patton, A. P., Bob, A., Reisner, E., Lowe, L., Bright, O. M., . . . Zamore, W. (2015). Developing Community-Level Policy and Practice to Reduce Traffic-Related Air Pollution Exposure. *Environmental Justice, 8*(3), 95-104. doi:10.1089/env.2015.0007
The literature consistently shows associations of adverse cardiovascular and pulmonary outcomes with residential proximity to highways and major roadways. Air monitoring shows that traffic related air pollutants (TRAP) are elevated within 200–400 meters of these roads. Community-level tactics for reducing exposure include the following: 1) high-efficiency particulate arrestance (HEPA) filtration; 2) appropriate air-intake locations; 3) sound proofing, insulation; 4) land-use buffers; 5) vegetation or wall barriers; 6) street-side trees, hedges and vegetation; 7) decking over highways; 8) urban design including placement of buildings; 9) garden and park locations; and 10) active-travel locations, including bicycling and walking paths. A multidisciplinary design charrette was held to test the feasibility of incorporating these tactics into near-highway housing and school developments that were in the planning stages. The resulting designs successfully utilized many of the protective tactics and also led to engagement with the designers and developers of the sites. There is a need to increase awareness of TRAP in terms of building design and urban planning.
The growth of interest in ''green buildings'' and ''healthy homes'' has mostly focused on addressing indoor sources of air pollution. We show here that there is an equally important need to consider and prevent exposure to ambient pollutants that infiltrate into homes and schools. While there is a need for more research on the tactics described in this article, we feel that it is possible, with the evidence available now, to better protect people from TRAP emanating from high traffic roadways.

California Environmental Protection Agency., Air Resources Board. (2005). *Air quality and land use handbook: A community health perspective*. Sacramento, CA: California Environmental Protection Agency, Air Resources Board.
This handbook recommends that communities avoid siting new sensitive land uses such as residences, schools, daycare centers, playgrounds, or medical facilities within 500 feet of a freeway, urban roads with 100,000 vehicles per day, or rural roads with 50,000 vehicles/day. (pg. 4)
Recommendations are based primarily on data showing that the air pollution exposures addressed here (i.e. localized) can be reduced as much as 80% with the recommended separation. (pg. 5)

Sandlin, G. M., (2005). At the Microscale: Compact Growth and Adverse Health Impacts. *Informational Paper Prepared for Puget Sound Regional Council*
"Recently the California Air Resources Board issued a guidance document, citing Senate Bill 352 and previous research on the potential health impacts associated with proximity to air pollution sources, which included freeways and high traffic sources as risk factors (California Air Resources Board 2005). This document characterizes both sensitive populations and land uses. The former is described as "segments of the population most susceptible to poor air quality (i.e. children, the elderly and those

with pre-existing serious health problems affected by air quality).” (California Air Resources Board 2005 p 2). Sensitive land uses are described as residences, schools, day care centers, playgrounds and medical facilities. The recommendations are only advisory in nature and the guidance document does not address the topic of what to do about existing facilities. Nevertheless, the Air Quality and Land Use Handbook: A Community Health Perspective is a useful educational tool for planners concerned about the nexus between traffic, land use and local air quality impacts.” (pg. 12)

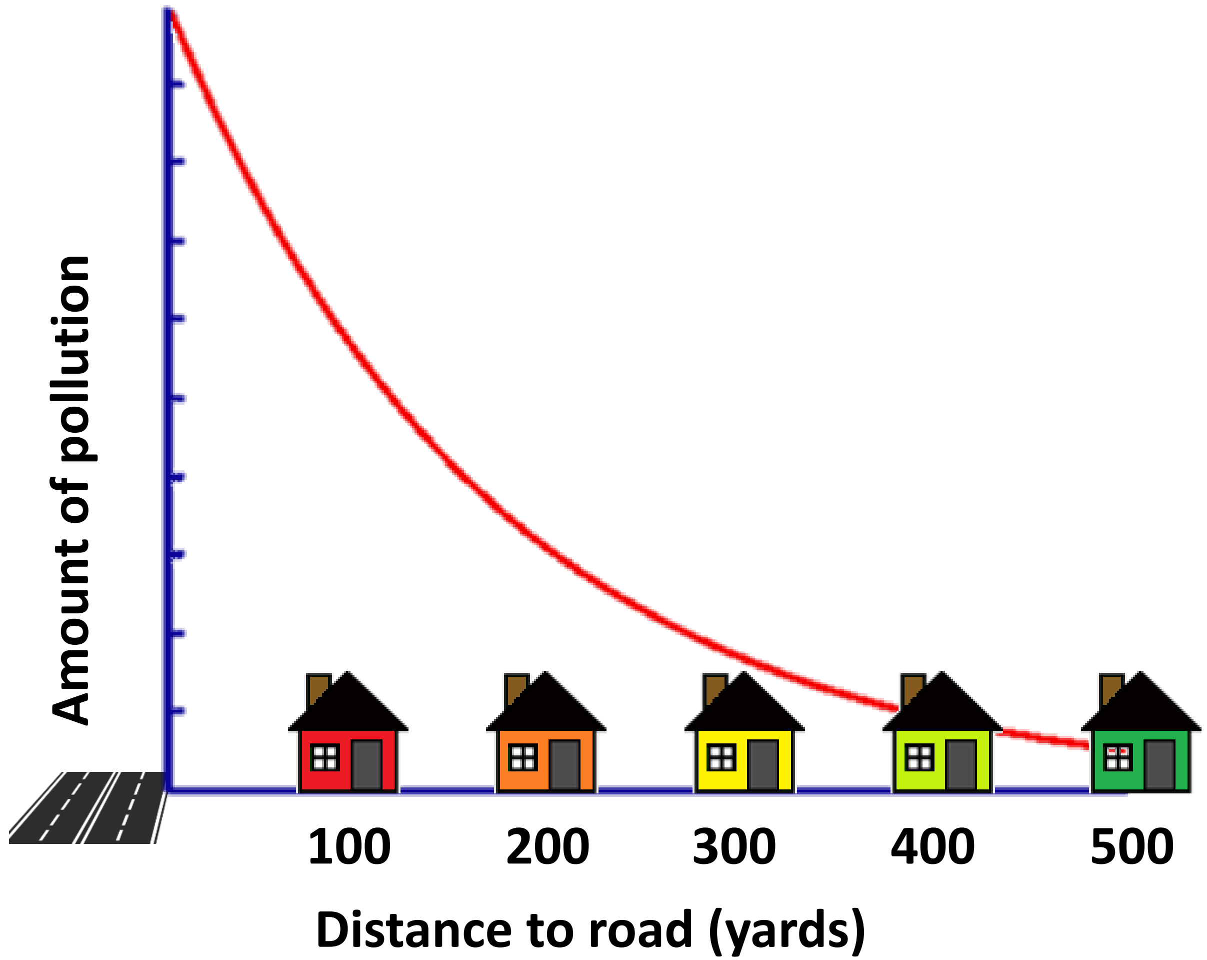
Appendix C – Puget Sound Clean Air presentation on Air Quality at the South Park Community Center (9/19/16)

PSCAA – air quality at the South Park Community Center

9-19-16

Erik Saganic

Vehicle pollution drops by 500 yards from the road



Karner et al 2010

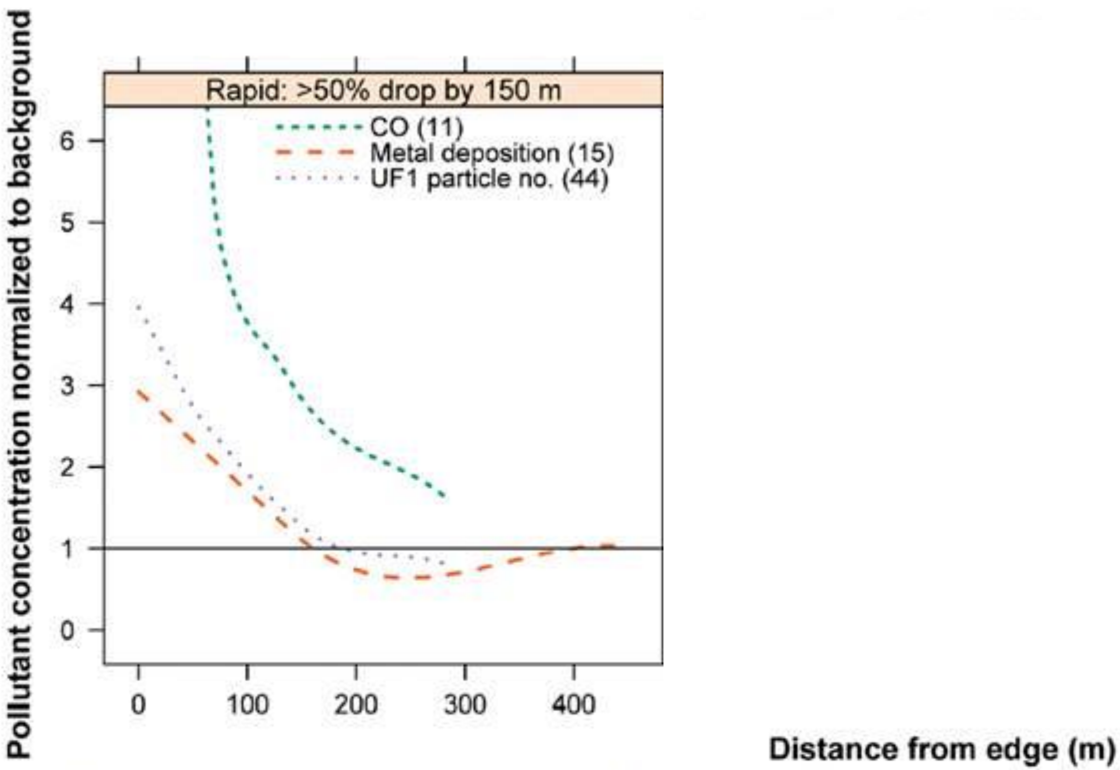
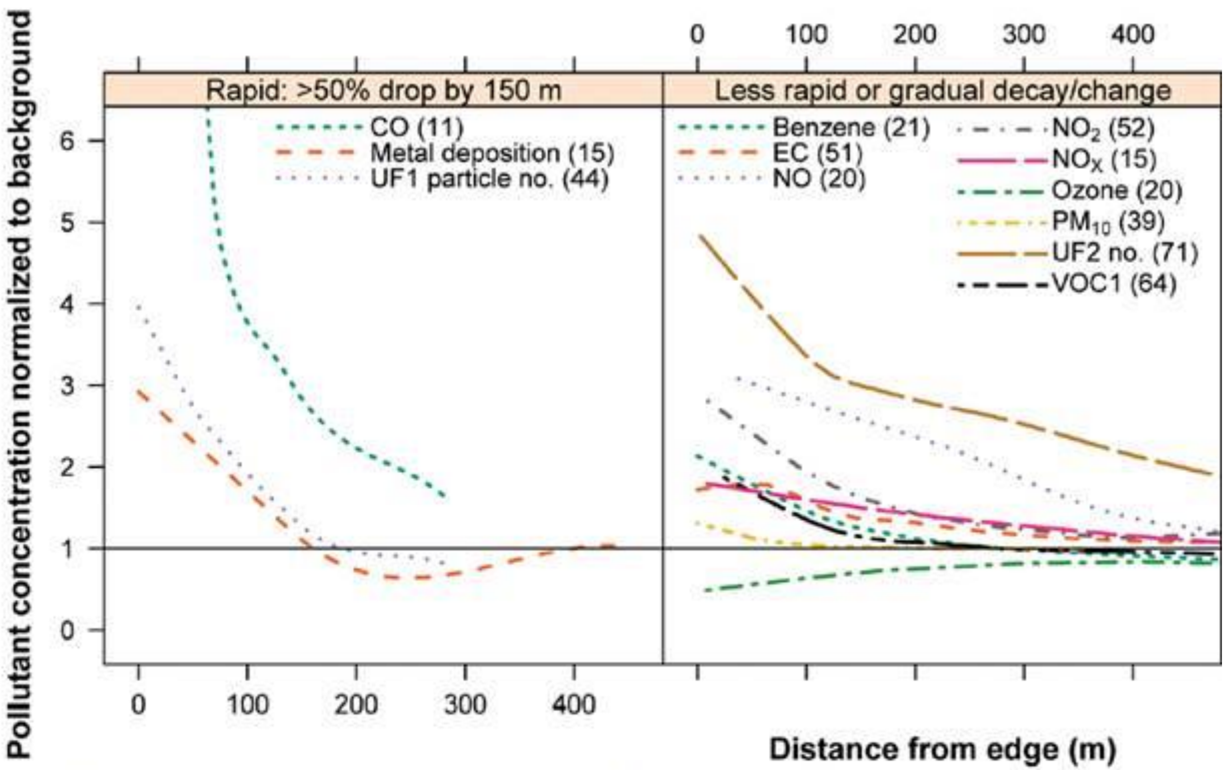


FIGURE 2. Local regression of background normalized concentrations on distance. The horizontal line indicates background concentration. A loess smoother (alpha =0.75, degree =1) is fitted to each pollutant which is placed into one of three groups. The regression sample size, n, is given in parentheses after each pollutant.

Karner et al 2010



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Karner et al 2010

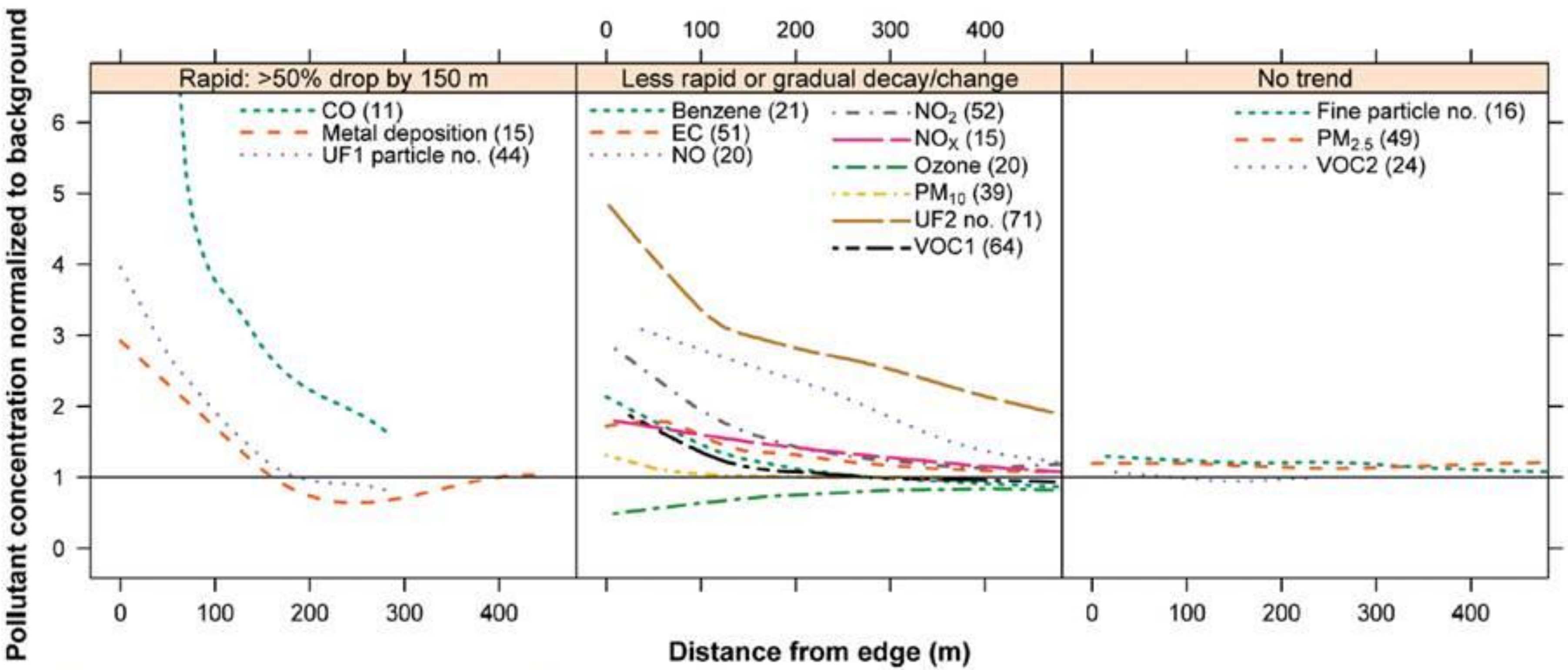


FIGURE 2. Local regression of background normalized concentrations on distance. The horizontal line indicates background concentration. A loess smoother (alpha =0.75, degree =1) is fitted to each pollutant which is placed into one of three groups. The regression sample size, n, is given in parentheses after each pollutant.

What is DEEDS?

- In 2013, UW and Puget Sound Sage modelled diesel exhaust in the South Park and Georgetown neighborhoods
- The model is based on monitoring data to validate the model they adopted
- Model is based on things like truck traffic counts, paved surfaces, etc

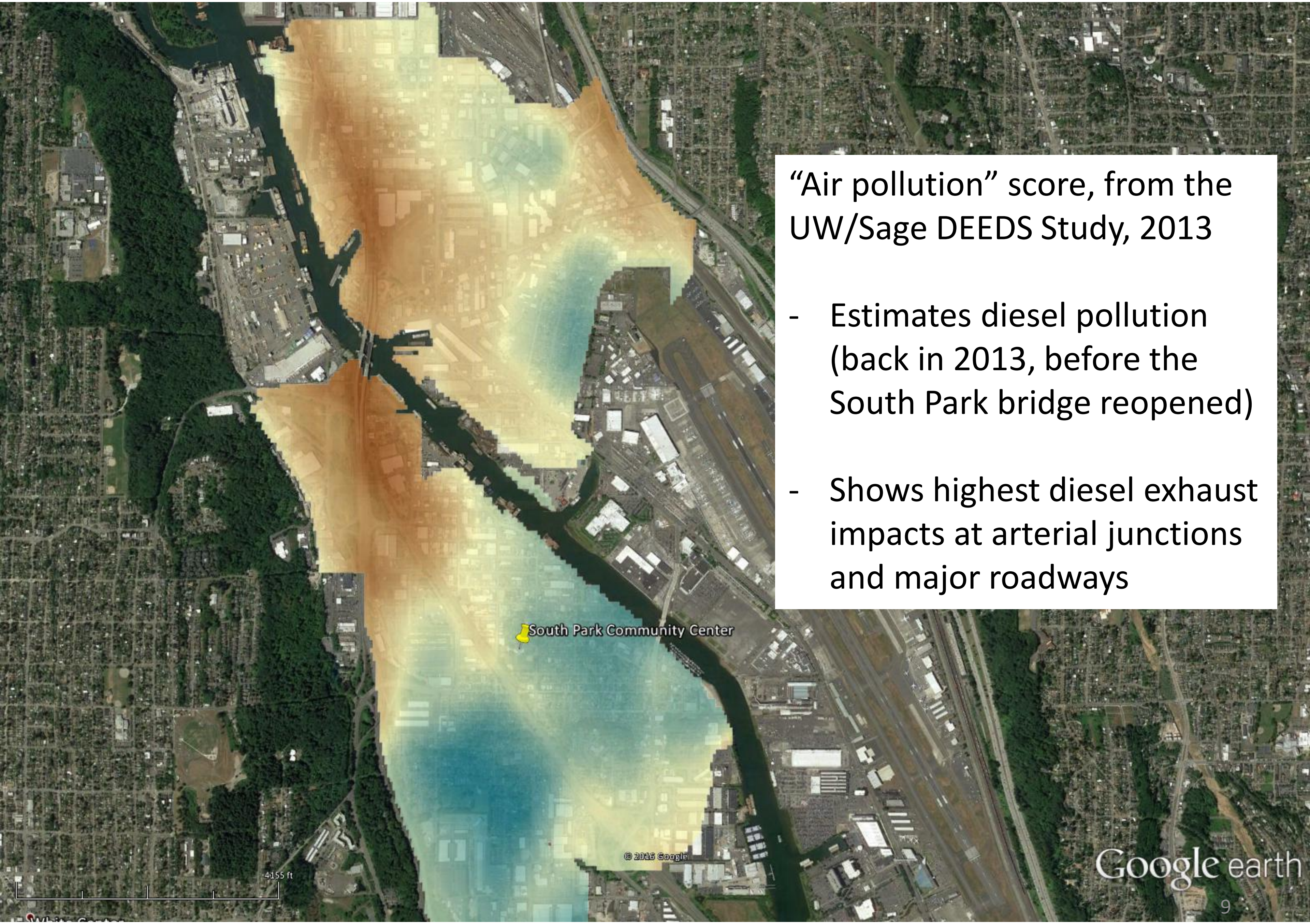
Caveats

- Not really intended for this sort of application (not for very high resolution results)
- The actual values are not very relevant here for this “big picture” application

Caveats 2

- For more information on how diesel exhaust pollution was measured, modeled and mapped, please see the DEEDS project webpage and technical report. Data were collected in summer and winter 2012, during the South Park bridge closure, and may not be representative of current air quality conditions.

- In fact, with the South Park bridge now open, there may be more traffic going from Cloverdale to SR-99 by the Community Center.

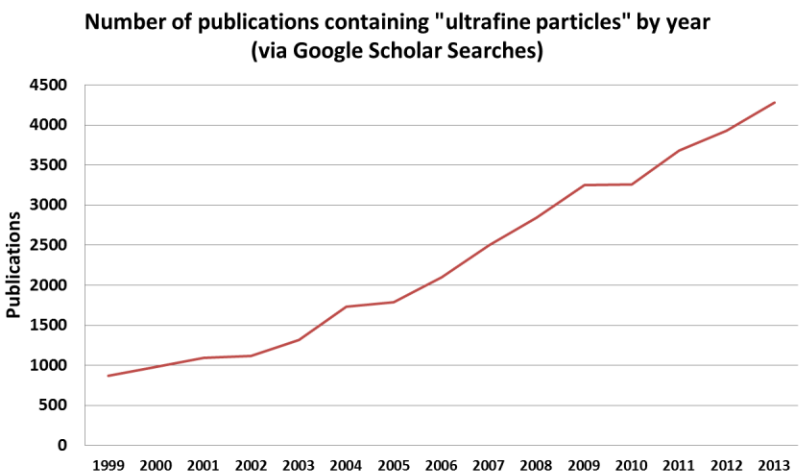


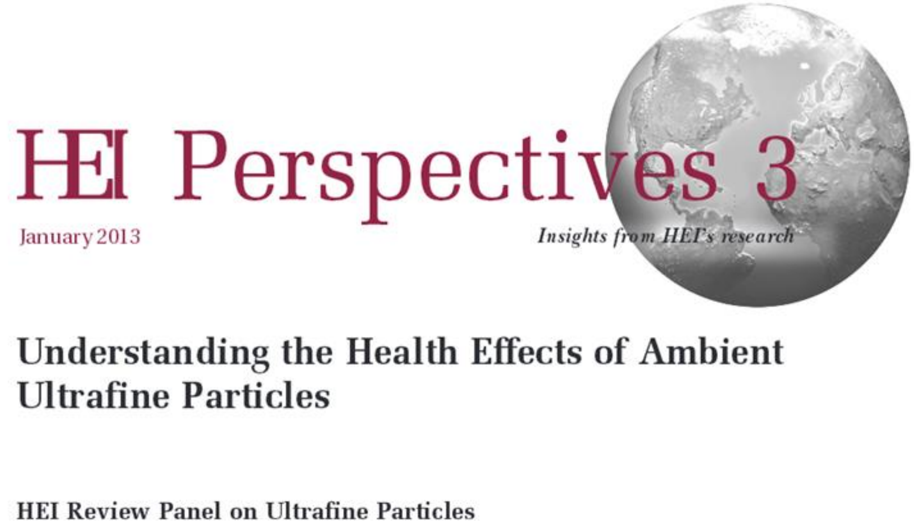
“Air pollution” score, from the UW/Sage DEEDS Study, 2013

- Estimates diesel pollution (back in 2013, before the South Park bridge reopened)
- Shows highest diesel exhaust impacts at arterial junctions and major roadways

Ultrafine particles --- more to learn

“Relatively few studies have directly compared UFPs with other particle size fractions. These factors constrain our ability to draw definitive conclusions about the specific consequences of exposure to UFPs.”




HEI Perspectives 3

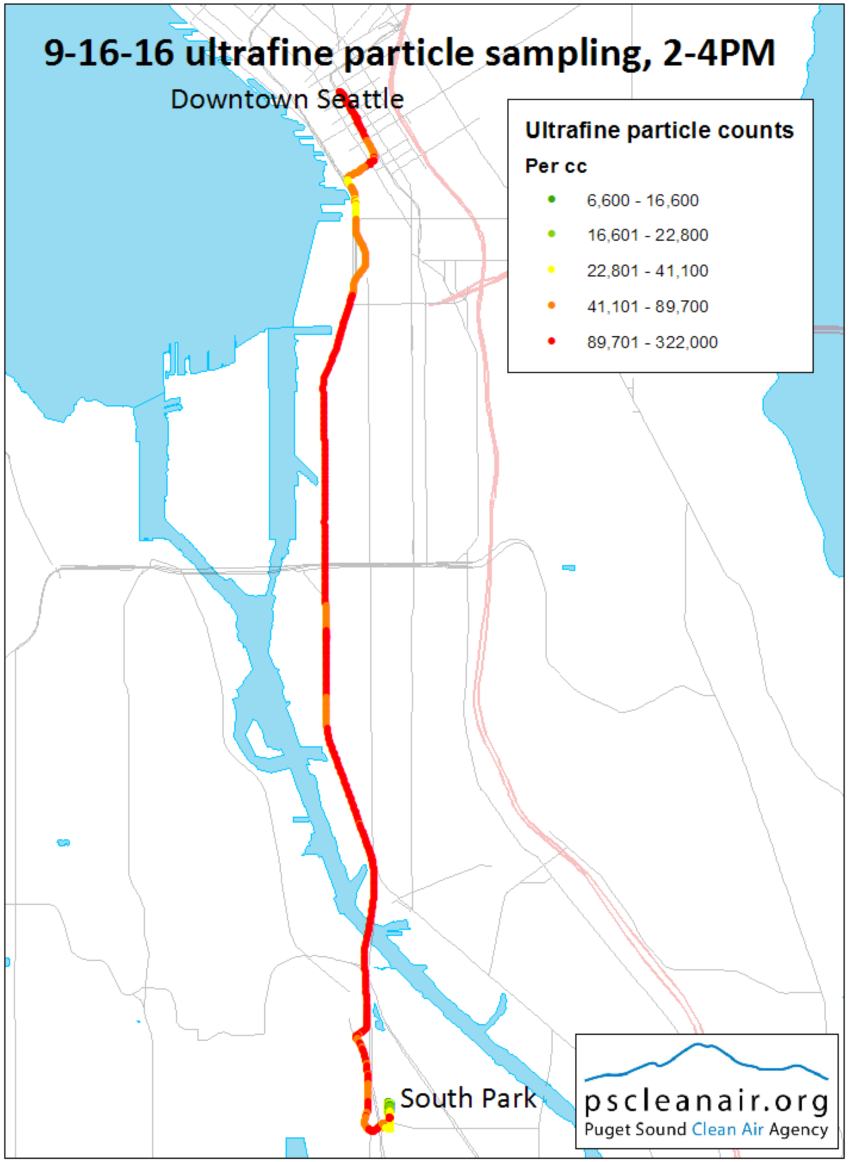
January 2013

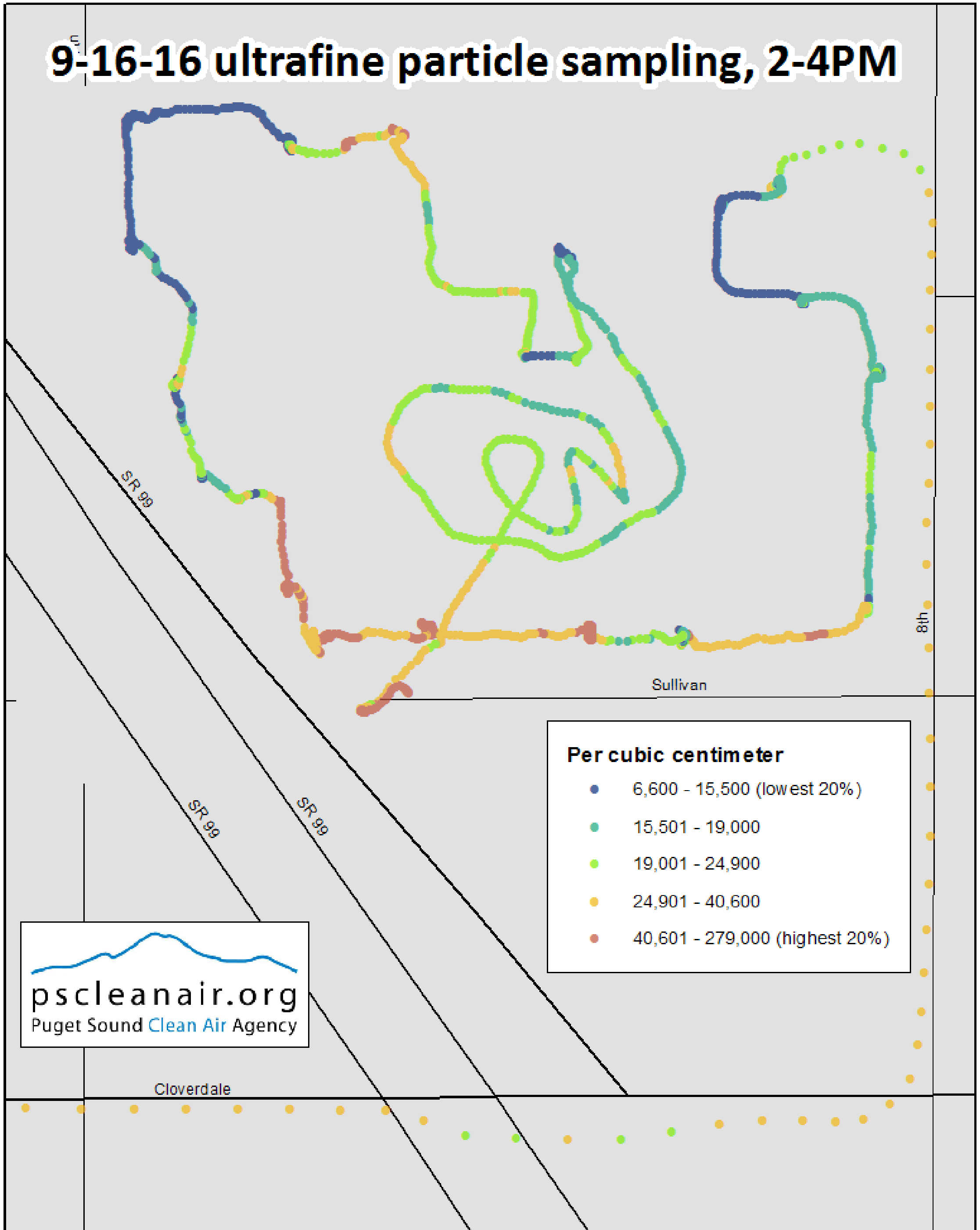
Insights from HEI's research

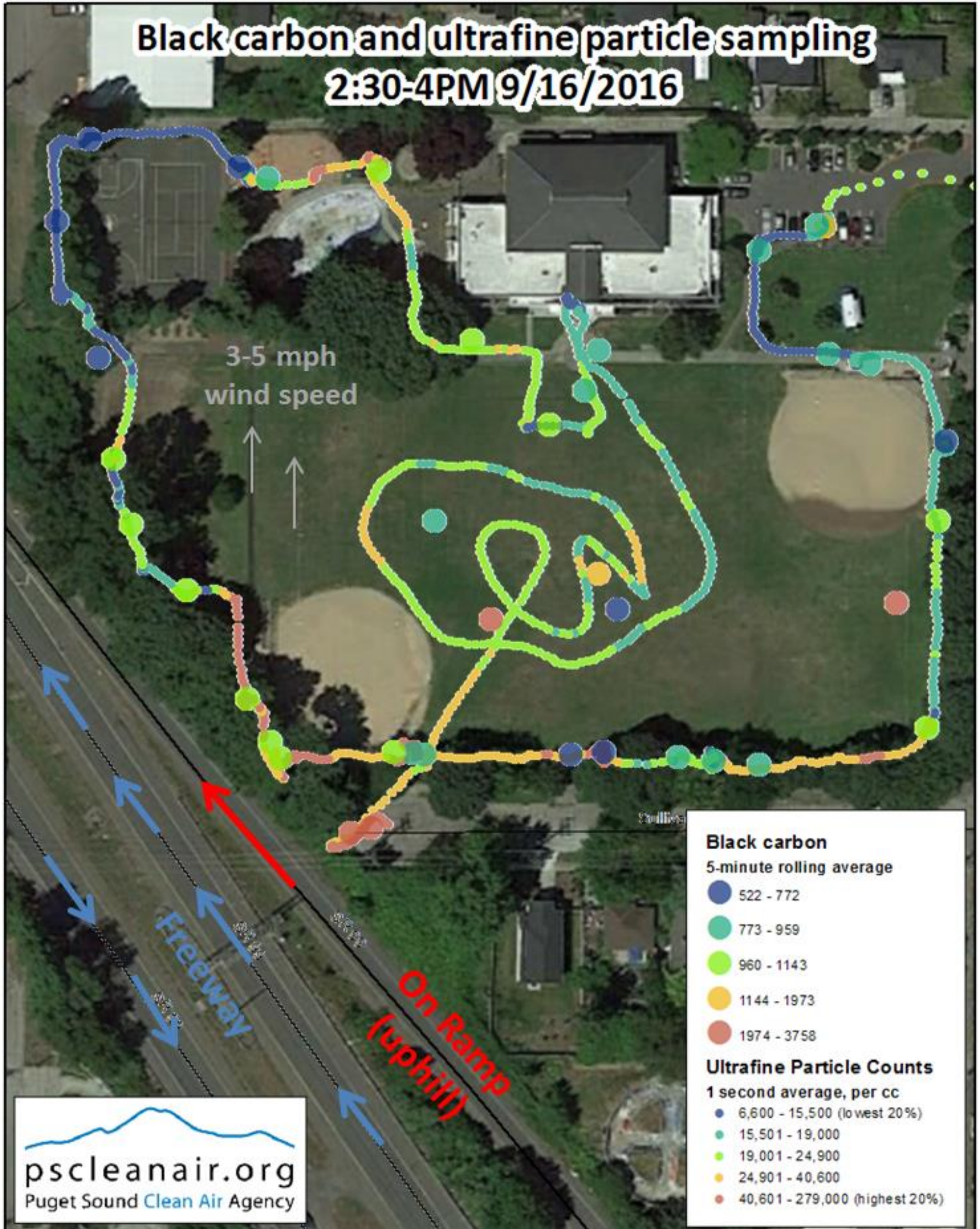
Understanding the Health Effects of Ambient Ultrafine Particles

HEI Review Panel on Ultrafine Particles

Many ultrafines along the road




9-16-16 ultrafine particle sampling, 2-4PM
Per cubic centimeter
6,600 - 15,500 (lowest 20%)
15,501 - 19,000
19,001 - 24,900
24,901 - 40,600
40,601 - 279,000 (highest 20%)
SR 99
SR 99
SR 99
Sullivan
8th
Cloverdale
pscleanair.org
Puget Sound Clean Air Agency


Black carbon and ultrafine particle sampling
2:30-4PM 9/16/2016
3-5 mph
wind speed
Freeway
On Ramp
(uphill)
pscleanair.org
Puget Sound Clean Air Agency
Black carbon
5-minute rolling average
522 - 772
773 - 959
960 - 1143
1144 - 1973
1974 - 3758
Ultrafine Particle Counts
1 second average, per cc
6,600 - 15,500 (lowest 20%)
15,501 - 19,000
19,001 - 24,900
24,901 - 40,600
40,601 - 279,000 (highest 20%)

Appendix D – EPA, Office of Transportation and Air Quality Near Roadway Air Pollution and Health: Frequently Asked Questions

Frequently Asked Questions

Near Roadway Air Pollution and Health: Frequently Asked Questions

With more than 45 million people in the United States living, working, or attending school within 300 feet of a major road, airport or railroad there is growing concern about the health impacts of roadway traffic. Below are frequently asked questions EPA receives concerning near roadway air pollution and what EPA is doing to address this important health issue.

What are the concerns associated with living, working, or attending school near major roads?

Air pollutants from cars, trucks and other motor vehicles are found in higher concentrations near major roads. People who live, work or attend school near major roads appear to have an increased incidence and severity of health problems associated with air pollution exposures related to roadway traffic including higher rates of asthma onset and aggravation, cardiovascular disease, impaired lung development in children, pre-term and low-birthweight infants, childhood leukemia, and premature death.

Pollutants directly emitted from cars, trucks and other motor vehicles are found in higher concentrations near major roads. Examples of directly emitted pollutants include particulate matter (PM), carbon monoxide (CO), oxides of nitrogen (NOx), and benzene, though hundreds of chemicals are emitted by motor vehicles. Motor vehicles also emit compounds that lead to the formation of other pollutants in the atmosphere, such as nitrogen dioxide (NO2), which is found in elevated concentrations near major roads, and ozone (O3), which forms further downwind. Beyond vehicles' tailpipe and evaporative emissions, roadway traffic also emits brake and tire debris and can throw road dust into the air. Individually and in combination, many of the pollutants found near roadways have been associated with adverse health effects.

United States Environmental Protection Agency

Office of Transportation and Air Quality
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People who live, work or attend school near major roads appear to have an increased incidence and severity of health problems that may be related to air pollution from roadway traffic. Health effects that have been associated with proximity to roads include asthma onset and aggravation, cardiovascular disease, reduced lung function, impaired lung development in children, pre-term and low-birthweight infants, childhood leukemia, and premature death. Other than air pollution, road noise may also play a role in the health problems associated with roadway exposure.

What is a "major road" and how close to a such a road do you have to live, work or attend school to be considered "near" it?

Research findings indicate that roadways generally influence air quality within a few hundred meters – about 500-600 feet downwind from the vicinity of heavily traveled roadways or along corridors with significant trucking traffic or rail activities. This distance will vary by location and time of day or year, prevailing meteorology, topography, nearby land use, traffic patterns, as well as the individual pollutant.

What influences air quality near major roadways?

The type of vehicles and fuel used, traffic activity, and the wind speed and direction can all have big effects on pollutant levels near major roadways. Generally, the more traffic, the higher the emissions; however, certain activities like congestion, stop-and-go movement or high-speed operations can increase emissions of certain pollutants. The combination of rush hour and calm winds in the morning often leads to the highest concentrations during this time of the day. Emissions can be elevated near major roadways and arise from multiple vehicle-related processes, including tailpipe exhaust, evaporation of fuel, brake and tire wear, and dust kicked up from traffic. Certain wind and terrain conditions, certain times of the day, including rush hours can result in elevated concentrations of air pollution near the road and air pollutants traveling farther from the road. The presence of sound walls, buildings and vegetation also has an impact on pollutant dispersion. Typically, pollutant concentrations decrease with distance away from traffic although the degree of this decrease varies.

- The highest concentrations of roadway pollutants occur on or just downwind of a roadway. With greater distance from a roadway, concentrations generally decrease to background levels within 500-600 feet. Pollutant concentrations tend to be higher when winds blow from the road and wind speeds are low.

- Traffic activity, wind speed, and direction can have a big influence on pollutant concentrations. Generally, the more traffic, the higher the emissions; however, certain activities like congestion, stop-and-go movement or high-speed operations can increase emissions of certain pollutants. The combination of rush hour and calm winds in the morning often leads to the highest concentrations during this time of the day. Other factors affecting pollutant concentrations include the mix of vehicles, roadway design, and nearby land uses.

Both heavy-duty trucks and light-duty gasoline vehicles emit a range of pollutants. However, their contributions to different types of compounds are not the same. Per vehicle, heavy-duty diesel trucks can emit more of certain pollutants (e.g., NOx and PM) and contribute disproportionately to the emissions from all motor vehicles. Gasoline-powered passenger cars generally emit more of other pollutants (e.g., CO, and benzene, a volatile organic compound (VOC)).

How many people live or spend time near major roads and other transportation facilities?

EPA estimated that in 2009, more than 45 million people in the United States lived within 300 feet of a highway with 4 or more lanes, a railroad, or an airport, and population trends suggest this number is increasing. Many schools and child care centers are located within a few hundred feet of highways, particularly in urban areas. Furthermore, every day, the average American spends more than an hour in travel, most of which takes place on major roadways

Are some people at greater risk from being close to major roadways or high traffic areas?

Children, older adults, people with preexisting cardiopulmonary disease, and people of low socioeconomic status are among those at higher risk for health impacts from air pollution near roadways.

Some people are known to be at greater risk of experiencing adverse health effects from air pollution, including those with asthma and other respiratory diseases and risk factors for heart attacks and strokes. Children, older adults, people with preexisting cardiopulmonary disease, and people of low socioeconomic status also are among those at higher risk for health impacts from some air pollutants associated with traffic emissions.

There are many factors being studied to better determine personal risk from air pollution generated from traffic. These include a person's current health status and age and the frequency and amount of exposure to air pollutants. EPA scientists and scientists funded through EPA grants continue to study the association between roadway air pollutants and potential health impacts. Studies are examining the role of traffic-related air pollutants on the initiation of asthma and other diseases in children and cardiovascular disease in adults.

What is EPA doing to address near-roadway air pollution?

Over the past three decades the U.S. EPA has worked to reduce harmful roadway-related emissions in a number of important ways. EPA has reduced pollution from new cars and trucks by establishing more stringent emission standards and cleaner fuel requirements. EPA also has a number of programs designed to reduce emissions from in-use vehicles not subject to the newest emission standards. In addition, EPA sets the health-based National Ambient Air Quality Standards (NAAQS) for pollutants that are emitted from on-road mobile sources and has recently required that air quality monitors be placed near high-traffic roadways for determining compliance with the NAAQS for NO2, CO, and PM2.5. Finally, EPA is conducting research to better understand the phenomenon of near roadway pollution, exposure and adverse health effects, and how to reduce air pollution near these high-traffic areas

EPA has addressed pollution from motor vehicles by establishing more stringent emission and fuel standards to reduce emissions of a variety of pollutants including PM, NOx, CO, and volatile organic compounds (VOC) such as benzene. EPA's standards apply to heavy-duty truck engines, light-duty passenger cars, buses, motorcycles, and other motor vehicles. EPA establishes and maintains standards for fuel quality to enable lower emissions from vehicles.

A new vehicle on the road today has more than 90% lower emissions than a vehicle on the road 30 years ago. Over the next two decades, as new standards phase in, motor vehicle and nonroad engine emissions will continue to decrease substantially. EPA's Office of Transportation and Air Quality (OTAQ) maintains information on national standards (www.epa.gov/otaq).

EPA also has a number of programs designed to reduce emissions from the existing fleet of vehicles that are not subject to the newest emission standards. For example, through the National Clean Diesel Campaign, EPA works with stakeholder coalitions to plan and finance diesel emission reduction programs across the country.

In addition, EPA sets health-based National Ambient Air Quality Standards (NAAQS) for several pollutants that are emitted from on-road mobile sources, including CO, NOx (with NO2 used as the indicator), and PM. Recently, EPA has required that air quality monitors be placed near high-traffic roadways for determining NAAQS compliance for NO2, CO, and PM2.5 in addition to those existing monitors located in neighborhoods and other locations farther away from pollution sources. EPA also works with state and local governments to ensure that Federally-sponsored and approved transportation activities are consistent with state efforts to attain the NAAQS. The Agency also supports state and local efforts to reduce the number of vehicle miles travelled by promoting public transit use, carpooling, active commuting (biking and walking) and other alternatives to commuting (e.g., teleworking).

EPA has a near-roadway research program to investigate emissions, exposures, health impacts and ways to reduce air pollution near major roadways and high traffic areas. EPA and EPA-supported researchers have published numerous articles characterizing near-road air quality, exposures, and health effects, as well as methods of mitigating these impacts. As this research continues, the results will assist federal and state regulators, community and transportation planners, and the public with making sound decisions to protect public health.

Are there other actions that may reduce air pollution concentrations and exposures near major roadways?

There are a number of approaches that appear promising for reducing the air pollution near roadways. In addition to reducing vehicle emissions, other approaches involve the design of transportation projects and designs of buildings and facilities near major roadways. For example, research suggests that sound walls, cut sections, and roadside vegetation can reduce traffic-related air pollutants immediately downwind of a roadway, although the extent of this reduction can vary by the dimension and type of feature. Research is still underway to quantify the specific impacts these features have in reducing air pollutants near-roadway areas. In addition, design and siting of new buildings, and the use of indoor air filtration, may also be a way to minimize exposures to pollutants while indoors.

Reducing the emissions of each vehicle on the road and the number of vehicle miles driven reduces air pollution. As noted above, EPA has established stringent fuel and emission standards for vehicles and non-road engines, and created other programs to further reduce diesel emissions from existing vehicle fleets.

Changing the design of transportation projects can also affect how and where air quality impacts occur. Research suggests that sound walls can reduce concentrations of traffic-related air pollutants immediately downwind of a roadway, although the extent of this reduction can vary by the wall height, length and distance from the road. Such barriers may also increase concentrations in the air on and immediately over the road as well as locations upwind and near the edges of the structure. For the same level of emissions, pollutant concentrations also are generally lower near cut section roads (roads below grade with steep walls) than near at-grade roads. Roadside vegetation, like trees and large bushes, can also impact air pollution concentrations. Studies suggest that the height, thickness, width, type of species, and continuity of the vegetation are all likely important factors in whether vegetation reduces pollutant concentrations in adjoining areas and communities. All of this research is promising, although further research is needed to be able to quantify the specific impacts of these features on reducing concentrations of traffic-related pollutants.

Building construction and location can also affect pollution exposures for residents. For mechanically-ventilated buildings near large roadways, air filtration devices installed in the ventilation systems can remove pollutants and improve indoor air quality. In addition, new buildings and facilities can be designed and located to minimize the time that at-risk people spend in near-roadway settings. For example, a school site could place maintenance and storage facilities closer to the road, while placing playgrounds, athletic fields, and classrooms as far from the road as possible.

What air pollution exposures occur in vehicles?

In-vehicle air quality is influenced by surrounding vehicles and sometimes emissions from the vehicle itself. Studies generally report higher concentrations of air pollutants in vehicles when following heavy-duty trucks and cars with visible tailpipe emissions. Tailgating and stopping very close to the vehicle in front during a traffic jam or at an intersection can increase air pollution in the following vehicle. A key factor in determining driver and passenger exposure is the vehicle's ventilation. Older diesel-powered buses also can have elevated concentrations of exhaust components inside the cabin.

Air quality in vehicles can be affected by traffic emissions on the roadway, with elevated concentrations inside vehicles of many of the same pollutants found outside the vehicle. Smoking in a vehicle creates concentrations of PM and other pollutants that generally dominate any other factors. However, in-vehicle air quality is influenced by the surrounding vehicles, particularly in vehicles with no tobacco smoke. Studies generally report higher concentrations of air pollutants in vehicles when following heavy-duty trucks or cars with visible tailpipe emissions. Tailgating and stopping very close to the vehicle in front during a traffic jam can increase air pollution in the following vehicle.

A key factor in determining driver and passenger exposure is the vehicle's ventilation. When windows are open, outdoor air enters the passenger compartment rapidly. When windows are closed, the settings on a vehicle's ventilation system have a larger effect on exposure. When the ventilation is set to bring in air from outside the vehicle, outdoor air enters rapidly. The recirculation setting reduces the turnover of outdoor air into the vehicle. In vehicles equipped with properly functioning cabin air filters, recirculation reduces PM concentrations from the outdoors, although this may not reduce concentrations in vehicles where people are smoking tobacco.

Older diesel-powered buses (including school and public transit buses) also can have elevated concentrations of exhaust components inside the cabin. Emissions from the tailpipe and from blow tubes that ventilate the crankcase can result in higher concentrations of PM and other air pollutants inside the cabin than found outside. As part of the National Clean Diesel Campaign, EPA's Clean School Bus USA provides funding to school districts to retrofit buses with verified emission reduction technologies. For more information see www.epa.gov/cleanschoolbus

What is EPA doing about railyard and port emissions?

EPA has established emission standards that will reduce emissions from each engine, including those for locomotives and marine vessels. Reducing idling also prevents emissions and improves nearby air quality. Features such as walls and vegetation may also reduce concentrations of air pollutants near these facilities, but little direct research exists for these locations.

A number of studies have reported air pollution in elevated concentrations near rail yards and marine ports. In general, diesel engines power the trains, trucks, and large marine vessels that are found in these facilities. Although the body of scientific literature about air quality and health near these locations is not as large as the number of studies done near major roadways, it is clear that pollutant concentrations are influenced by similar factors. For example, concentrations of directly-emitted pollutants are generally found in higher concentrations closer to these facilities than farther away. Higher volumes of trains, boats, and other engines are likely to be associated with higher pollutant concentrations.

EPA has established emission standards for a range of mobile sources found at marine ports or rail yard facilities. For locomotives and marine engines under 30 liters per cylinder, EPA standards are reducing per-engine CO, NOx, VOC, and PM, and sulfur levels in non-road diesel fuel to enable new emission control technologies. The most stringent standards for these engines take effect between 2012 and 2017.

For large ocean-going vessels (marine engines greater than 30 liters per cylinder displacement), EPA has worked closely with the International Maritime Organization (IMO) to establish an Emission Control Area (ECA) extending up to 200 nautical miles from the coasts of U.S., Canadian, and French territories in North America. The ECA requires that ships within it operate on lower sulfur fuel which lowers emissions of NOx, SO2, and PM from ships. EPA has also established new stringent standards to reduce NOx from the largest marine diesel engines, which apply beginning in 2016.

In addition to emission standards, measures to reduce idling also can reduce concentrations near ports and rail yards. For example, shore connection systems (SCS) allow maritime vessels and locomotives to plug into an electric power source rather than using onboard engines while docked at port or stopped in a rail yard. Features such as walls and vegetation may also reduce concentrations of air pollutants near these facilities, but little direct research exists for these locations.

The U.S. EPA is involved in a number of nonregulatory efforts that seek to address railyard and port emissions. For example, the Ports Initiative seeks to partner with ports to reduce climate risks and improve air quality, the SmartWay Program encourages trucks and locomotives to not idle, and provides technical information on the benefits of not idling, and the DERA Program provides funding for clean diesel projects at ports and railyards.

Research Links

What EPA research is being conducted on near-roadway air pollution?

EPA's near-roadway research program is an integrated, multidisciplinary effort to better understand how motor vehicle emissions influence air quality invehicle, near major roads and the health of nearby populations, including those with asthma and cardiovascular disease. The studies have been designed to answer questions about potential health risks and what can be done to reduce exposures both in-vehicle and near roadways to maximize improvements in public health.

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What kinds of air pollutants near roadways have the most significant impacts on human health?

- What is the full range of potential health effects associated with air pollutants near roadways including consideration of possible impacts on populations living, working, or going to school near roads? How far do air pollutants travel from roadways?

- Who is most at risk for experiencing health effects associated with air pollution near roadways?

- What can be done to reduce exposures near roadways to maximize improvements in public health?
- How can research support the improvement of existing tools and development of new tools for use in transportation and community planning?
- How can research help inform regulatory decisions to improve near-road air quality and reduce occurrences of adverse health effects?

Research includes:

- Health effect studies of human populations in neighborhoods near major roads
- Toxicological and human clinical studies in controlled exposure environments
- Air monitoring studies on and near roadways
- Laboratory studies to measure motor vehicle emissions and simulate roadway conditions
- Computer modeling to understand air quality and the dispersion of pollutants away from the roadway
- Field and laboratory studies on the ways to reduce near-road air pollutants and adverse health effects and
- Impacts of ports, railyards, and airports on nearby air quality and people's exposures.

For more information, see www.epa.gov/airscience/air-highwayresearch.htm

What has been the impact of near-roadway research?

Near-roadway research has led to a number of programs aimed at reducing pollutant concentrations and protecting public health. The research contributed to a body of evidence on the connections between roadway-associated exposures and adverse health effects, which led EPA to develop the requirement for a national near-road air quality monitoring network and supported EPA programs for modeling the near-road air quality impacts of diesel vehicles on transportation projects. In particular, the health studies helped to identify health impacts near roads, the field measurements identified where and how best to monitor these impacts, and the field and laboratory studies suggested ways to potentially model and mitigate these impacts.

Communities have used products of this research to inform decisions on school and other facility placement. For example, research studies were cited in the recent EPA School Siting

Guidelines, which help school districts evaluate potential environmental hazards when identifying new school locations, and identify roadway-related factors and mitigation options that may reduce exposures. For recommendations on addressing near-road air quality in school siting, see section 8 in EPA's School Siting Guidlines:
www.epa.gov/schools/guidelinestools/siting/download.html

This research has also led community planners and developers to consider how people may be exposed to traffic emissions, and what steps may be taken to reduce nearby populations' exposures and health impacts.

Where can I find published research?

- To find specific publications related to near roadway research, enter "roadway" or "road" in the search box on the main page of the Science Inventory at: http://cfpub.epa.gov/si/.
- EPA's near roadway research: www.epa.gov/airscience/air-highwayresearch.htm
- EPA also supports near roadway research conducted at other research institutions including the EPA Clean Air Research Centers and the Health Effects Institute (HEI). Information on near roadway research at these institutions can be found at the following sites:
    - Clean Air Research Centers: www.epa.gov/airscience/air-cleanairresearchcenters.htm
    - Health Effects Institute: www.healtheffects.org/