

CLIMATE CHANGE and HEALTH in DURHAM REGION

Assessing the impact of poor air quality





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Assessing the impact of poor air quality

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Table of Contents

About this report	7
Executive summary	8
1. Why prioritize outdoor air quality?	12
2. What is the purpose of this assessment?	13
3. What determines vulnerability to outdoor air pollution?	14
4. How does poor outdoor air quality impact human health?	16
5. Understanding air pollution vulnerability in Durham Region	31
6. Next steps and priorities	66
7. Assessment methods and limitations	68
References	69
Appendix A: Acronyms, terms and definitions	75
Appendix B: Understanding the Air Quality Health Index	81

Figures and Tables

List of Figures

Figure 2.1 Purpose and objectives of DRHD's air quality and health vulnerability assessment	13
Figure 3.1 Climate Change and Health Vulnerability Adaptation Framework	15
Figure 4.1 Direct negative health outcomes associated with exposure to outdoor air pollution in Canada	17
Figure 4.2 Premature deaths per year, per 100,000 population associated with exposure to NO_2 , O_3 , and PM_{25} air pollution for census divisions in Ontario and Quebec, 2016	23
Figure 4.3 I What is the Air Quality Health Index?	24
Figure 5.1 Annual emissions by sector in Durham Region from 2015 to 2023	33
FIGURE 5.2 Per centage of Durham Region's population living near major roads and freeways, by LAM	36
Figure 5.3 Per centage of the population who live within (A) 50m of major roads and freeways, (B) 100m of major roads and 150m of freeways, and (C) 100m of major roads and 500m of freeways, by Health Neighbourhood (2021)	38
Figure 5.4 I Per centage tree canopy cover in the City of Oshawa and Town of Ajax for 2015	
Figure 5.5 Age and sex standardized asthma prevalence, children aged 0 to 14 years (2016) across Durham Region's 50 Health Neighbourhoods	48
Figure 5.6 \mid Annual age-standardized lung cancer incidence rates in Durham Region and Ontario from 2010 to 2020.	53
Figure 5.7 Age and sex standardized COPD prevalence, adults 35 years and older (2016) across Durham Region's 50 Health Neighbourhoods	54
Figure 5.8 Durham Region Transit annual ridership per capita from 2015 to 2024	62
Figure B.1. I Air Quality Health Index Scale	81
Figure D.1 I Major roads and freeways in Durham Region and their associated TRAP buffer zones	87
Figure D.2 I Different levels of geographic analysis used to calculate per centage of the population exposed to TRAPs	88
Figure D.3 I Each TRAP buffer was intersected with a Dissemination Block (DB), and the overlap area was used to determine the percentage of the DB's population within the TRAP buffer	89
Figure D.4 Illustration of possible overestimation or underestimation of TRAP population estimates based on the assumption that all individuals are evenly distributed within the Dissemination Block (DB)	90
Figure E.1 Per centage of Health Neighbourhood populations living within 50 metres of a major road or freeway and location of TRAP Buffer A, 2021	93
Figure E.2 Per centage of Health Neighbourhood populations living within 100m of a major road or 150m of a freeway and location of TRAP Buffer B, 2021	
Figure E.3 Per centage of Health Neighbourhood populations living within 100m of a major road or 500m of a freeway and location of TRAP Buffer C, 2021	95

List of Tables

Table 4.1 Estimated attributable morbidity and mortality associated with traffic-related emissions extrapolated to the GTHA	20
Table 4.2 Annual premature deaths attributable to air pollution in Canada and Ontario in 2016	22
Table 4.3 Unadjusted ED visit rates for respiratory and cardiovascular conditions among selected age groups for low AQHI years compared to high AQHI years, Durham Region (2015-2023)	25
Table 4.4 Unadjusted hospitalization rates for respiratory and cardiovascular conditions	
among selected age groups for low AQHI years compared to high AQHI years, Durham Region (2015-2023)	27
Table 4.5 Air pollution vulnerability factors and high-risk populations	29
Table 5.1.1 Proportion of municipal populations living close to major roads and freeways, 2021	35
Table 5.1.2 Top five Health Neighbourhoods with the highest per centage of the population living near major roads and freeways, 2021	39
Table 5.1.3 Proportion of Priority Neighbourhood populations living near major roads and freeways, 2021	41
Table 5.1.4 Percentage of Durham Region residents that are outdoor workers	43
Table 5.2.1 Air pollution vulnerability factors and potential health outcomes among older adults	46

About this report

This air quality report is the fourth in a series of Durham Region Health Department climate change and health vulnerability assessments.

Climate change is projected to increase the frequency, intensity, and duration of climate hazards such as air pollution, wildfires, and flooding. Significant action is required to mitigate and adapt to climate change to protect the livability of our planet and the places we call home.

In Canada, federal and provincial vulnerability assessments have been completed to determine the impact of climate change on health. Less is known about local health risks and vulnerabilities faced by Ontario municipalities. To fill this knowledge gap, the Durham Region Health Department (DRHD) initiated a series of climate change and health vulnerability assessments (CCHVA) to determine current and future impacts of climate hazards on the health and wellbeing of people who live within Durham Region. Each vulnerability assessment focuses on a specific climate hazard and has been written as a stand-alone report. This vulnerability assessment explores current and projected health impacts of poor air quality from climate change in Durham Region.

DRHD's climate change, air quality, and health vulnerability assessment will help our region to:

- Develop place-based strategies for protecting residents from air pollution. Examples include surveillance and warning systems and training of health professionals on climate-related air pollution and its health impacts.
- Champion health equity by prioritizing measures to reduce impacts to at-risk groups.
- Improve public engagement and local knowledge on how to prepare for and respond to the health risks of air pollution.
- Ensure a health lens is applied to broader regional climate action planning, policy, and program development.
- Promote community partnership development, including meaningful engagement with priority populations to understand barriers to climate adaptation measures as well as potential harms or unintended consequences of adaption plans.
- Establish health indicators and metrics for monitoring and mitigating air pollution and its health impacts.
- Identify intersectional adaptation interventions that offer numerous health co-benefits.
- Find opportunities for working across municipal sectors to deliver health benefits to residents within Durham Region.
- Weave Indigenous Knowledge Systems and place-based knowledge, which may reveal climate-health linkages not captured in provincial or federal data.
- Clarify roles and opportunities for First Nations-Regional coordination on shared priorities (e.g., wildfire smoke, urban heat, Rights-based harvesting safety).
- Inform policy updates in housing, transportation, zoning, and emergency planning to better protect community health in a changing climate. Better understand local health risks due to air pollution including those who may be most affected.

Detailed information about the CCHVA process, Durham Region's diverse environment and communities, and a high-level summary of the causes and impacts of our changing climate can be found in the previously published report: Climate Change and Health in Durham Region: Understanding the local health impacts of climate change, available at: durham.ca/ ClimateAndHealth

Executive summary

This fourth report in DRHD's CCHVA series, examines the health impacts of outdoor air pollution. Findings will help guide evidence-based adaptation strategies to protect residents' health.

Climate change is increasing exposure to traffic-related air pollutants, aeroallergens, and wildfire smoke.

- Despite a decline in per capita transportation emissions in Durham Region since 2015, overall exposure to air pollution is expected to increase due to climate change-driven factors:
 - o Rising temperatures due to climate change can increase traffic-related air pollutants.
 - o Warmer, more humid seasons are extending the aeroallergen season leading to higher pollen counts.
 - Rising temperatures caused by climate change leads to more stagnant air, which allows air pollution to linger for longer periods.
 - o Climate change increases the risk of wildfires and toxic smoke emissions.
 - o Canada's 2023 wildfire season was the worst on record.

Outdoor air pollutants contribute to increased rates of premature deaths, respiratory and heart diseases, hospitalizations, and mental health effects; straining health systems, especially when coinciding with extreme heat events.

- Outdoor air pollution is a leading cause of premature death in Canada.
- Durham Region's air pollution-related premature death rate is below the provincial average but above the national average.
- Traffic pollution contributes to increased rates of respiratory diseases, lung cancer, heart attacks, strokes, hypertension, and thousands of premature deaths annually in the Greater Toronto-Hamilton area.
- Aeroallergens increase respiratory and allergy symptoms, leading to more emergency visits, hospitalizations and reduced quality of life.
- Wildfire smoke can travel long distances and cause headaches, eye, nose and throat irritation, and exacerbate heart and lung conditions. It is also associated with negative mental health impacts, increased hospitalizations, and premature deaths.
- Poor air quality events that coincide with other climate hazards such as extreme heat can strain and overwhelm health systems.



Despite a decline in per capita transportation emissions in Durham Region from 2015 to 2023, traffic remains the leading source of air pollution, with exposure varying by location and disproportionately impacting outdoor workers and those residing near busy roads or with limited greenspace.

- The transportation sector, which comprises the greatest proportion of emissions in Durham Region, has shown a decrease in per capita emissions from 2015 to 2023.
- Traffic is Ontario's leading source of air pollution, with 11.5 per cent of Durham Region residents living near major roads or freeways, below the provincial average of 28 per cent.
- In Durham Region, traffic-related air pollution exposure varies by location, with southern urban areas
 experiencing the highest levels, particularly Pickering, while northern rural areas have lower exposure,
 except Scugog; priority populations in certain neighbourhoods face greater health risks due to proximity
 to major roads and freeways.
- Evidence of neighbourhood greenspace inequality suggests air pollution exposure inequality.
- Outdoor workers in Durham Region generally face higher exposure to air pollution.

Older adults, children, Indigenous Peoples, pregnant individuals, and those with pre-existing health conditions, are more susceptible to severe illness from poor air quality and there is evidence of a social gradient of air pollution-related health impacts.

- Evidence suggests that health and social inequalities play a greater role in air pollution-related deaths than simply differences in exposure, highlighting the need to address these disparities alongside efforts to reduce air pollution to prevent unequal health impacts.
- Poor air quality days are associated with increased emergency department visits and hospitalizations, especially among older adults and children:
 - In general, Durham Region's growing older adult population has a reduced ability to recover from the health effects of air pollution, especially among those experiencing low-income, chronic illness, or social isolation.
 - Over 8 per cent of Durham Region older adults live with low-income, with Oshawa and Brock having the highest proportions of older adults living alone.
 - Oshawa's Priority Neighbourhoods face greater air pollution-related health burdens due to higher rates of chronic disease and low-income.
 - Infants and children are highly sensitive to air pollution due to their developing body systems, with even greater risks among Durham Region children experiencing health and socioeconomic challenges like asthma or low-income.
 - o Childhood asthma prevalence rates in Durham Region's municipalities are significantly higher than the Ontario average of 14.2 per cent, ranging from 11.5 to 17.9 per cent.
 - Some Health Neighbourhoods may face greater air pollution-related health burdens due to a relatively higher prevalence of childhood asthma.¹
- Due to processes of colonialism and colonization in Canada, Indigenous Peoples experience ongoing
 health inequities which lead to disproportionate health disparities and risk of severe health outcomes
 from air pollution. Climate-driven ecological change, including poor air quality, disrupts the spiritual,
 emotional, mental, and physical determinants of Indigenous health, particularly in the context of Treaty
 Rights and harvesting practices. Given the disproportionate exposure risks among First Nations, Inuit,
 and Métis Peoples, it is essential to include Indigenous Knowledge and perspectives in air pollution
 assessments and planning.
- Exposure to traffic pollution, aeroallergens and wildfire smoke during pregnancy can increase the risk of adverse birth outcomes.
- People with pre-existing conditions, including cancer, lung or heart diseases, face heightened risks from air pollution and wildfire smoke. Lung cancer and chronic obstructive pulmonary disease (COPD) rates in Durham Region, particularly in Priority Neighbourhoods, exceed the Ontario averages.

¹ Durham Region has 50 Health Neighbourhoods. DRHD tracks 96 indicators by Health Neighbourhood and municipality to better understand the health of our communities. Learn more at: durham.ca/neighbourhoods

Air quality in Durham Region is influenced by federal, provincial, and local policies, with new government guidance emerging to fill gaps in public health information on wildfire smoke.

- Air quality in Durham Region is influenced by federal, provincial and local policies.
- Municipal governments can use tools such as bylaws, zoning, and health promotion programs to improve local air quality.
- Increases in wildfires have prompted new government guidance and calls for public health plans, including Ontario's Wildfire Smoke and Air Quality Health Reference Document.

Durham Region's strengths in air quality protection include:

- **Public awareness & health promotion:** High local awareness and DRHD's air quality alerts help residents respond to pollution risks.
- **Sustainable transit & mobility:** Active transportation, public transit initiatives, and growing adoption of electric vehicles reduce emissions and improve air quality.
- Natural air quality buffers: Extensive greenspaces, forests, and tree-planting programs contribute to air pollution reduction and public health benefits.

Although air quality has improved in recent years, poor air quality days persist in Durham Region, and there are several important action areas to further enhance air quality and protect public health in the face of climate change.² Possible actions include:

- Addressing social and health inequalities with an emphasis on Priority Neighbourhoods.
- Assessing air pollution exposure at finer geographic scales to identify priority areas and needs.
- Identifying and address greenspace inequality.
- Planning for additional climate hazards that may accompany poor air quality events.
- Promoting health protection strategies before and during aeroallergen season.
- Continuing monitoring the evolution of health protection guidance and interventions for wildfire smoke events.
- Collaborating with the Mississaugas of Scugog Island First Nation and other Rights-holding First Nations on identified priorities to protect air quality.

² More comprehensive community engagement is required to understand the full range of needs and opportunities, particularly among priority populations and the organizations that serve them.



Next steps and priorities:

This assessment informs residents and decision-makers about climate-related air pollution risks in Durham Region. Next steps focus on three key adaptation categories to reduce air pollution and enhance air quality in Durham Region:

- 1. Local knowledge and data such as monitoring and reporting air pollution and green space inequality at finer geographic scales.
- 2. Health promotion and education to support the ability of residents to assess their risk and the risk of those in their care and what actions to take.
- 3. Policies, programs, and services to help residents avoid air pollution and improve local air quality.

Table 6.1 provides examples of adaptation initiatives for each category. These are illustrative examples, yet to be assessed for feasibility or priority. Priorities will be identified through broad engagement initiatives with a focus on priority populations.



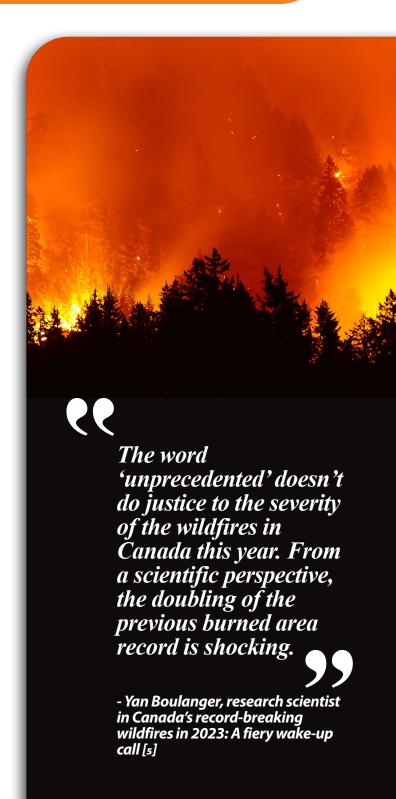
1. Why prioritize outdoor air quality?

Climate change is increasing health risks associated with outdoor air pollution. As climate change intensifies, so will the health burden from poor air quality.

Outdoor air pollution refers to the contamination of outdoor air by harmful substances such as gases and particulate matter, including plant pollen and wildfire smoke. Outdoor air pollution can cause or worsen respiratory diseases, cardiovascular conditions, seasonal allergies, and is also linked to premature death [1]. Current levels of air pollution in Canada contribute to an estimated 17,400 premature deaths per year, and health impacts valued at \$146 billion [2]. As climate change intensifies, so will the health burden from poor air quality.

Poor outdoor air quality is caused by a combination of air pollutants and weather conditions. Hotter temperatures due to a warming climate can increase the concentration of air pollutants such as groundlevel ozone and fine particulate matter [3]. Warmer seasons are also extending the aeroallergen season leading to higher pollen counts in Canada [4]. Climate change is also increasing the frequency, intensity, duration, and scope of wildfires and toxic smoke emissions. Canada's 2023 wildfire season was the most destructive on record, with more than 6,000 fires burning 15 million hectares of land, representing more than six times the historical average and a doubling of Canada's previous record [5]. That year, Ontario set a record of 741 confirmed wildfires, affecting over 440,000 hectares [6, 7]. Although Ontario experienced a below-average wildfire season in 2024, as of June 19, 2025, wildfire activity has increased, surpassing the 10-year average of 191 fires [8]. Nationally, the 2025 wildfire season is on track to be Canada's second worst on record [9].

Assessment of current and future health impacts of poor air quality, in the context of climate change, is essential for identifying key actions to protect and promote the health of Durham Region's residents, as well as the Mississaugas of Scugog Island and other Indigenous Peoples with whom we share this land.



2. What is the purpose of this assessment?

Findings will be used to support evidence-informed adaptation plans, policies, and communications to protect local communities from poor air quality.

The purpose and objectives of this vulnerability assessment are outlined in **Figure 2.1**. The assessment will also support community and municipal partner's climate change and air quality planning and adaptation processes.

AIR QUALITY AND HEALTH VULNERABILITY ASSESSMENT

PURPOSE

Protect and promote the health and well-being of Durham Region residents by characterizing current and future health impacts of poor air quality due to climate change in our region.

OBJECTIVES



Improve understanding of the associations between poor air quality and health.



Assess and report on available climate related air quality data and evidence expected to impact the health of Durham Region residents now and in the future.



Prioritize health equity by identifying people and communities most at-risk of negative health impacts from poor air quality.



Establish a baseline for analysis in which future changes in risks and adaptation measures may be monitored and assessed.

Figure 2.1 | Purpose and objectives of DRHD's air quality and health vulnerability assessment

3. What determines vulnerability to outdoor air pollution?

Health impacts are influenced by exposure, sensitivity, and adaptive capacity.

Figure 3.1³ illustrates three main factors of air pollution vulnerability: (1) **exposure** to air pollution, for example, a person who works outdoors or lives near a major roadway may have greater exposure to local air pollution; (2) **sensitivity** to air pollution, which is influenced by factors such as age, genetics and health status, for example, older adults, children and people with certain health conditions may be more sensitive to severe health consequences from poor air quality than others; and (3) **adaptive capacity**, which is the ability to take protective measures to avoid poor air quality, for example, a person living with lowincome may not have the capacity to avoid air pollution where they live.

Vulnerability to air pollution is influenced by upstream factors such as neighbourhood setting and working conditions, as well as a person's ability to gain sufficient income, access healthcare, and find safe and stable housing. Although factors of vulnerability are important for assessing health risk, the term vulnerable as a general label for people can be stigmatizing, harmful, and should be avoided [10, 11].

3 For a more detailed overview of this framework, please refer to the DRHD primer report: Climate Change and Health in Durham Region, available at www.durham.ca/ClimateAndHealth



The concept of vulnerability can be highly stigmatizing, so it is important to recognize that climate vulnerability is not a label for communities or

populations.

- Chief Public Health Officer of Canada's Report on the State of Public Health in Canada 2022

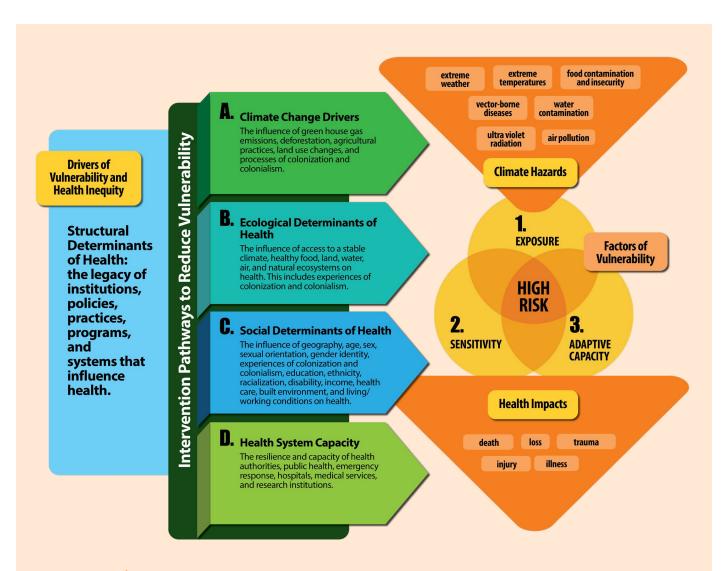


Figure 3.1 | Climate Change and Health Vulnerability Adaptation Framework (developed under guidance of Schnitter *et al.* 2022) [11]



4. How does poor outdoor air quality impact human health?

Outdoor air pollution is a leading cause of premature death in Canada and is also associated with increased incidence of lung and heart diseases, adverse birth outcomes, hospital visits, mental health impacts, allergies, and ear, nose and throat irritation [2].

Outdoor air pollution, also known as ambient air pollution, is one of the largest risk factors for premature death and disability in Canada [2, 12]. Poor outdoor air quality can cause or worsen breathing difficulties, ear, nose, and throat irritations, allergies, and heart and lung conditions. Exposure to outdoor air pollution is also associated with low birth weights and premature death from heart disease, stroke, and lung cancer [12-14]. In Ontario, an estimated 6,500 premature deaths per year are attributed to outdoor air pollution [2]. Poor air quality can also restrict opportunities and capacity to work, play, learn, and participate in daily life.

Indirect health impacts of air pollution are beyond the scope of this assessment but include detrimental impacts to wildlife, ecosystems, water supplies and food production. Examples include habitat degradation, disruption of pollinators, acidification and contamination of water, soil degradation and crop damage.





Air pollution

- Premature death
- Lung diseases
- Cardiovascular diseases
- Adverse birth outcomes
- Increased hospital visits
- Allergies and breathing difficulties
- Ear, nose and throat irritation
- Mental health impacts

- Premature death: exposure to ambient air pollution can increase mortality rates from respiratory and cardiovascular diseases [15].
- Lung disease: exposure to air pollution can increase the risk of lung cancer and other lung diseases. It can also trigger severe symptoms of many existing lung or respiratory conditions [15].
- Cardiovascular diseases: poor air quality can increase the risk of illness and mortality due to heart attacks, stroke, and other cardiovascular diseases [15].
- Adverse birth outcomes: exposure to some air pollutants is associated with adverse birth outcomes such as low birth weight and preterm birth [3, 16].
- Increased hospital visits: increased air pollution is associated with increased emergency department visits and hospital admissions [15].
- Allergies and breathing difficulties: reduced air quality can increase the development and exacerbation of allergies including coughing, wheezing, and skin reactions such as hives or eczema [15].
- Eye, nose and throat irritation [15].
- **Mental health impacts:** air pollution from wildfire smoke is associated with mental health impacts such as anxiety and depression [17].

Figure 4.1 | Direct negative health outcomes associated with exposure to outdoor air pollution in Canada

Climate change is expected to worsen health burdens from traffic-related air pollution, aeroallergens, and wildfire smoke.

Outdoor air pollution consists of a diverse mix of gases and particles from both industrial and natural sources. Further research is needed to better understand the health effects of various pollutants and their interactions. Current evidence suggests that the health burdens associated with traffic-related air pollution (TRAP), aeroallergens, and wildfire smoke are likely to rise as climate change intensifies⁴ [3].

TRAP has been linked to increased incidence and severity of respiratory diseases like asthma, bronchitis, and reduced lung function, as well as lung cancer. It also increases the risk of heart attacks, strokes, hypertension, and premature death.

TRAP originates from automobile emissions and consists of harmful gases and particulate matter. Among them, nitrogen oxides (NOx) play a key role in forming ground-level ozone (O_3) when they react with volatile organic compounds (VOCs) in sunlight [I_8]. O_3 is a significant contributor to smog. Strong evidence links long-term exposure to TRAP with an increased risk of non-accidental death [I_9].

Health impacts of particulate matter (PM)

PM refers to tiny particles or droplets suspended in the air, which can vary in size. The two main categories are $PM_{2.5}$ (fine particulates) and PM_{10} . Fine particulates have a diameter of 2.5 micrometres or less, which are small enough to penetrate deep into the lungs, enter the bloodstream, and even the brain [20]. Immediate exposure can cause coughing, breathing difficulties, and irritation of the eyes, nose, and throat. Longer-term exposure is associated with decreased lung function, development of cancer and ischemic heart disease, low birth weight, and premature death [14, 19].

 $PM_{2.5}$ is a classified carcinogen that causes lung cancer, leading to an estimated 560 lung cancer cases in Ontario per year [21, 22]. Out of all the air pollutants, $PM_{2.5}$ has been attributed to the greatest number of premature deaths provincially and nationally (**Table 4.2**). It is estimated that chronic exposure to $PM_{2.5}$ contributed to 8 per cent of all-cause nonaccidental deaths among Canadians over 25 years of age (equivalent to 10,000 deaths per year) [3]. $PM_{2.5}$ can exacerbate asthma and bronchitis and restrict activities. $PM_{2.5}$ exposure has been associated with an increase in respiratory and cardiovascular hospital admissions and emergency department (ED) visits [3].

PM₁₀ are particles with a diameter of ten micrometres or less which can be inhaled into the upper respiratory tract causing coughing, breathing difficulties, and asthma attacks. Long-term exposure can contribute to heart attacks, strokes, and premature death [3].



Health impacts of NOx

NOx refers to a group of highly reactive gases composed of nitrogen and oxygen, including nitric oxide (NO) and nitrogen dioxide (NO₂). These gases are commonly emitted by combustion engine vehicles powered by gasoline or diesel. Acute exposure to NO₂ is estimated to account for 0.9 per cent of all-cause non-accidental deaths among Canadians of all ages, equivalent to 1,300 deaths per year⁵ [3]. Short-term exposure can lead to respiratory issues such as breathing difficulties, increased vulnerability to lung infections, and worsening of pre-existing conditions like asthma and chronic obstructive pulmonary disease (COPD). Long-term exposure can result in reduced lung function, the onset of respiratory diseases, cardiovascular complications, and even premature death [3, 19].

Health impacts of O₃

Ground-level ozone is the primary air pollutant responsible for smog, a visible haze in the atmosphere. It can irritate and damage the lungs, worsen asthma, and impair lung function. Exposure is also linked to increased restricted activity days, ED visits, hospital admissions, and premature deaths [3, 19]. Acute exposure to O₃ is attributable to 2.7 per cent of all-cause nonaccidental mortality among Canadians of all ages (equivalent to 2,800 deaths per year) [3]. Ten per cent of respiratory-related deaths among Canadians over 30 years of age are attributable to long-term exposure to ground level O₃ (equivalent to 1,300 deaths per year) [3].

⁵ Based on population data for 2016 and air pollutant concentrations from 2014 to 2017.

TRAP leads to thousands of premature deaths per year in the Greater Toronto-Hamilton area.

Traffic-related emissions are estimated to cause 712 to 997 premature deaths and 2,812 to 3,939 hospitalizations annually in the Greater Toronto-Hamilton Area (GTHA), based on extrapolations from Toronto estimates using 2006 population data (**Table 4.1**).

Table 4.1 | Estimated attributable morbidity and mortality associated with traffic-related emissions extrapolated to the GTHA

Health impacts	Extrapolation by population	Extrapolation by distance vehicle driven
Premature deaths per year	712	997
Hospitalizations per year	2,812	3,939

These estimates were based on data for Toronto that were extrapolated to the Greater Toronto-Hamilton area (GTHA) based on 2006 populations.

Table adapted from: Improving health by Design in the Greater Toronto-Hamilton area. A report of medical officers of health in the GTHA; 2014 [23].



Aeroallergens cause respiratory and allergy symptoms and are associated with increased ED visits and hospitalization rates.

Aeroallergens are airborne substances that are a key component of air pollution. They include pollen (released by trees, grasses, and weeds), and fungal spores (such as mould spores that are released into the air, particularly in humid environments). The main health impacts are respiratory symptoms including sneezing, nasal congestion, coughing and wheezing, exacerbation of asthma, and skin reactions such as hives or eczema. Aeroallergen exposure is associated with increased ED visits and hospitalization [24].

Wildfire smoke can travel long distances and cause headaches, eye, nose and throat irritation, and exacerbate heart and lung conditions. It is also associated with negative mental health impacts, increased hospitalizations, and premature deaths.

Wildfire smoke consists of gases, fine particles, and water vapour generated by forest fires, that can travel long distances. Its composition varies based on the materials burned and weather conditions. Typically, wildfire smoke contains $PM_{2.5}$ and PM_{10} , carbon monoxide (CO), NOx, methane, O_3 , and VOCs [25]. Wildfire smoke can also contain toxins like benzene, formaldehyde, and other hazardous chemicals, depending on the buildings, industrial sites, or commercial areas burned in its path [17]. Evidence suggests PM from wildfires may pose greater risks to respiratory health than PM from other sources [26].

There is no known safe level of exposure to wildfire smoke, which means it can impact health even at low levels and even if you cannot see or smell smoke [25]. As smoke levels increase, so do the health risks. The health impacts of wildfire smoke are systemic, affecting the respiratory, cardiovascular, and neurological systems [27]. Short-term health impacts include headache, cough, eye, nose and throat irritation, dizziness, chest pain, difficulty breathing, heart palpitations, exacerbation of asthma and COPD, and premature death. Maternal exposure to wildfire smoke during late pregnancy is associated with reduced birth weight and preterm birth [28]. There is also preliminary evidence of increased hospitalizations and ED visits for cardiovascular concerns [17].

Long-term exposure to wildfire smoke has been linked to increased mortality from cardiovascular disease, respiratory illnesses, reduced lung function, and overall poorer health [29]. There is also evidence of mental health impacts associated with wildfire smoke exposure, including post-traumatic stress disorder, depression, and anxiety [17]. Between 2013 and 2018, an estimated 50 to 240 premature deaths per year in Canada were linked to short-term exposure to wildfire PM_{2.5}, while long-term wildfire smoke exposure was associated with 570 to 2,500 premature deaths annually [30]. While those near wildfires face the highest health risks, wildfire smoke can travel vast distances, affecting respiratory health even in communities thousands of kilometers away [31].

In Durham Region, premature death rates associated with air pollution are lower than the provincial average, but higher than the national average.

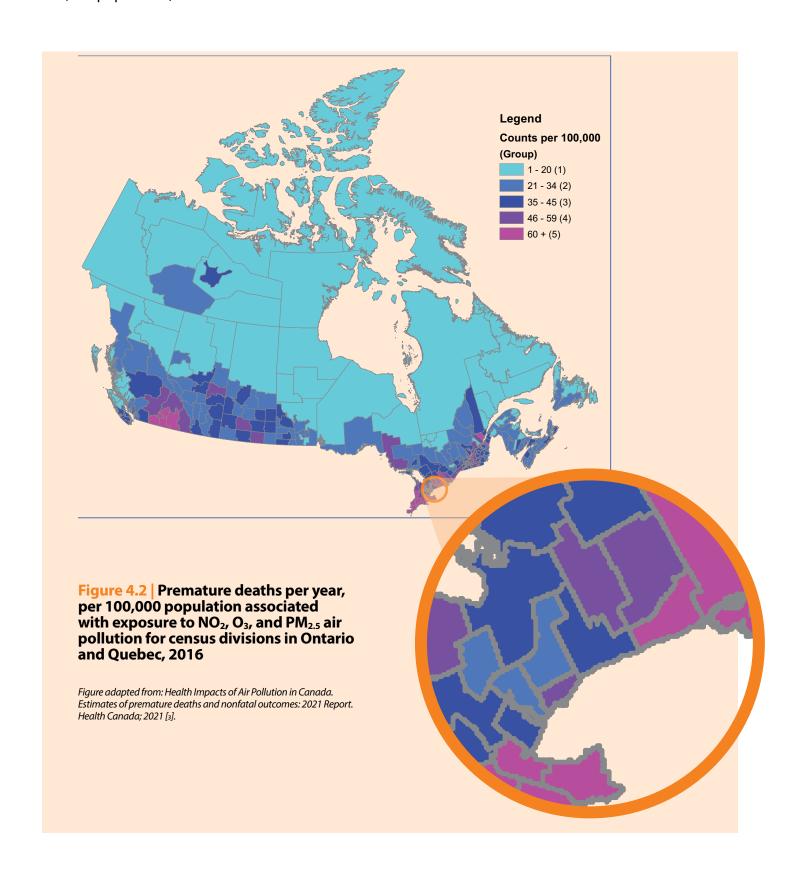
Based on 2016 estimates, air pollution is responsible for approximately 44 premature deaths per 100,000 people in Durham Region annually. This rate is lower than Ontario's average of 47 per 100,000 but higher than the national average of 42 per 100,000 (**Table 4.2**).

Table 4.2 | Annual premature deaths attributable to air pollution in Canada and Ontario in 2016

Region	Pollutant					Per 100,000 population
	NO ₂	PM _{2.5}	O₃ - annual	O₃ - summer	All	All
Canada	1,300	10,000	2,800	1,300	15,300	42
Ontario	570	4,200	1,200	580	6,600	47

Data source: Health Impacts of Air Pollution in Canada. Estimates of premature deaths and nonfatal outcomes: 2021 Report. Health Canada; 2021 [3].

Ontario has the second highest rate of premature deaths per 100,000 population of all the provinces and second only to Québec (48 premature deaths per 100,000) [3]. **Figure 4.2** shows that rates vary substantially for census divisions and that Durham Region falls within the third quintile (35 to 45 premature deaths per 100,000 population).



Local data indicate an association between poor air quality days and increased ED visits for respiratory conditions, which disproportionately affect children and older adults.⁶

Over the eight-year period from 2015 to 2023, ED visit rates were significantly higher for high Air Quality Health Index (AQHI) years compared to low AQHI years for all respiratory conditions among children (0-14 years) and older adults (65+ years) (**Table 4.3**). ED visit rates were also significantly higher for high AQHI years compared to low AQHI years for asthma among children (0-14 years) and COPD among older adults. No significant difference was observed between low AQHI years and high AQHI years for ED visits related to cardiovascular conditions (**Table 4.3**) [32].

The Air Quality Health Index combines data on three local air pollutants (O_3 , PM and NO_2) to provide hourly and forecasted calculations of health risks from air pollution in Durham Region. The index is communicated using a scale from 1 to 10; the higher the number, the greater the health risk associated with the air quality. Durham Region's AQHI monitoring station is in Oshawa. See **Appendix B** to learn more.

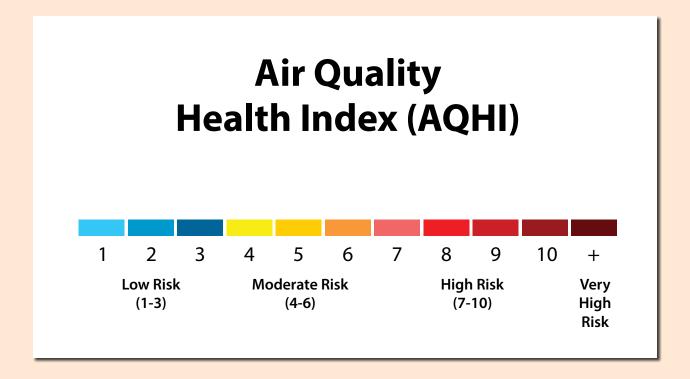


Figure 4.3 | What is the Air Quality Health Index?

Source: About the Air Quality Health Index, Government of Canada [32]

To assess the potential impacts of poor air quality on health in Durham Region, rates of emergency department visits and hospitalizations for respiratory and cardiovascular conditions were calculated and then compared for low AQHI years combined and high AQHI years combined. A statistically significant difference was reported if the 95 per cent confidence intervals (CI) for the two estimates did not overlap. See Appendix C for percentage of monitored days with an AQHI risk of moderate or higher in Durham Region from 2015 to 2023.

Table 4.3 Unadjusted ED visit rates for respiratory and cardiovascular conditions among selected age groups for low AQHI years compared to high AQHI years, Durham Region (2015-2023)⁷

Age group	Low AQHI years ⁸		High AQHI years ⁹		Comparison:	
	Rate	95% CI	Rate	95% CI	High vs. low	
All respiratory	conditions:					
Children	51.3 per 1,000	50.7—51.9	55.0 per 1,000	54.4—55.6	HIGHER	
Adults	20.1 per 1,000	19.9—20.3	20.3 per 1,000	20.1—20.4	No difference	
Older Adults	35.7 per 1,000	35.1—36.2	38.0 per 1,000	37.4—38.5	HIGHER	
Asthma						
Children	39.5 per 10,000	37.8—41.3	49.1 per 10,000	47.4—50.9	HIGHER	
Adults	15.9 per 10,000	15.4—16.5	17.0 per 10,000	16.5—17.5	No difference	
COPD	COPD					
Older Adults	12.3 per 1,000	12.0—12.6	13.7 per 1,000	13.4—14.0	HIGHER	
All cardiovascular conditions:						
Adults	17.1 per 1,000	16.9—17.3	17.4 per 1,000	17.3—17.6	No difference	
Older Adults	49.3 per 1,000	48.6—50.0	50.5 per 1,000	50.0—51.1	No difference	

Data source: Emergency department visit data: ED visits, 2015-2023, Ministry of Health and Long-Term Care, intelliHEALTH ONTARIO. All respiratory conditions data ID 10-CA: J00-J99; Asthma data ICD 10-CA: J45; COPD data ICD 10-CA: J40-44; All cardiovascular conditions data ICD 10-CA: I00-J99. Population denominators: Ontario Population Estimates 2015-2023, Statistics Canada, distributed by Ontario Ministry of Health.

⁷ Age groups were defined as follows: Children (0 to 14 years); Adults (20 years and over); Older adults (65 years and older).

⁸ Low AQHI years reflect years where the per centage of monitored days with an AQHI rating of 4 or higher was lower than the 2015-2023 average of 7.5 per cent, this included: 2018, 2019, 2020, and 2022.

⁹ High AQHI years reflect years where the per centage of monitored days with an AQHI rating of 4 or higher was higher than the 2015-2013 average of 7.5 per cent, this included: 2015, 2016, 2017, 2021, 2023.

Local data indicate an association between poor air quality days and increased hospitalizations for respiratory conditions, which disproportionately affect older adults.¹⁰

Table 4.4 presents hospitalization rates for respiratory and cardiovascular conditions among selected age groups in Durham Region over an eight-year period (2015–2023). It compares rates for low AQHI years to high AQHI years. During this period, older adults (65+) experienced significantly higher hospitalization rates for all respiratory conditions during high AQHI years compared to low AQHI years. COPD-related hospitalizations among older adults were also higher in high AQHI years. No significant differences were observed in hospitalization rates for asthma or cardiovascular conditions between high and low AQHI years.

To assess the potential impacts of poor air quality on health in Durham Region, rates of emergency department (ED) visits and hospitalizations for respiratory and cardiovascular conditions were calculated and then compared for low AQHI years combined and high AQHI years combined. A statistically significant difference was reported if the 95 per cent confidence intervals (CI) for the two estimates did not overlap. See Appendix C for percentage of monitored days with an AQHI risk of moderate or higher in Durham Region from 2015 to 2023.

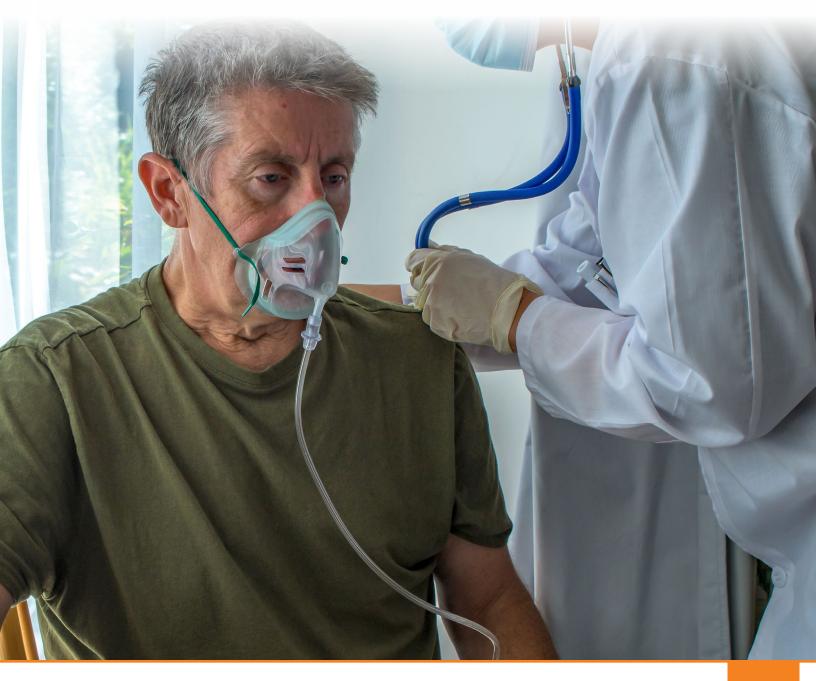


Table 4.4 | Unadjusted hospitalization rates for respiratory and cardiovascular conditions among selected age groups for low AQHI years compared to high AQHI years, Durham Region (2015-2023)¹¹

Age group	Low AQHI years ¹²		High AQHI years ¹³		Comparison:	
	Rate	95% CI	Rate	95% CI	High vs. low	
All respiratory	conditions:					
Children	48.7 per 10,000	46.8—50.6	46.6 per 10,000	44.9—48.4	No difference	
Adults	45.8 per 10,000	44.9—46.7	47.3 per 10,000	46.5—48.2	No difference	
Older adults	16.3 per 10,000	16.0—16.7	17.8 per 10,000	17.5—18.2	HIGHER	
Asthma						
Children	8.2 per 10,000	7.4—9.0	9.3 per 10,000	8.5—10.1	No difference	
Adults	1.3 per 10,000	1.1—1.4	1.3 per 10,000	1.2—1.5	No difference	
COPD						
Older adults	52.5 per 10,000	50.3—54.7	59.8 per 10,000	57.7—61.9	HIGHER	
All cardiovascular conditions:						
Adults	78.6 per 10,000	77.4—79.8	78.3 per 10,000	77.2—79.3	No difference	
Older adults	26.8 per 10,000	26.3—27.2	27.2 per 10,000	26.8—27.7	No difference	

Data source: Hospitalization data: Hospital In-Patient Discharges, 2015-2023, Ministry of Health and Long-Term Care, intelliHEALTH ONTARIO. All respiratory conditions data ICD 10-CA: J00-J99; Asthma data ICD 10-CA: J45; COPD data ICD 10-CA: J40-44; All cardiovascular conditions data ICD 10-CA: I00-J99. Population denominators: Ontario Population Estimates 2015-2023, Statistics Canada, distributed by Ontario Ministry of Health.

¹¹ Age groups were defined as follows: Children (0 to 14 years); Adults (20 years and over); Older adults (65 years and older).

¹² Low AQHI years reflect years where the per centage of monitored days with an AQHI rating of 4 or higher was lower than the 2015-2023 average of 7.5 per cent, this included: 2018, 2019, 2020, and 2022.

High AQHI years reflect years where the per centage of monitored days with an AQHI rating of 4 or higher was higher than the 2015-2013 average of 7.5 per cent, this included: 2015, 2016, 2017, 2021, 2023.

Associations between poor air quality days and increased ED visits and hospitalizations should be interpreted cautiously.

The data in **Tables 4.3** and **4.4** show a significant increase in ED visits and hospitalization rates for respiratory conditions among children and older adults during high AQHI years compared to low AQHI years. However, these findings should be interpreted with caution, as respiratory conditions like asthma and COPD can be exacerbated by multiple factors beyond poor air quality. While this data suggests a potential relationship between AQHI and illness burden, it does not establish causation. Additionally, Durham Region has only one air quality monitoring station, which may not fully capture variations in exposure across the region. Future research at a more localized level and over shorter timeframes would help clarify the impact of poor air quality on the burden of illness in Durham Region.

While air pollution affects everyone, certain individuals face a higher risk of serious harm due to a combination of factors, including increased exposure, heightened sensitivity, and limited ability to adapt.

Air pollution is harmful to everyone, but some individuals are at greater risk than others. **Table 4.5** outlines the factors contributing to outdoor air pollution vulnerability and identifies priority populations at higher risk. These groups are not distinct, and risk categories often overlap. Those experiencing all three vulnerability factors face the highest risk of negative health outcomes. These priority populations have increased exposure and sensitivity to outdoor air pollution, along with barriers that limit their ability to protect themselves. It is estimated that one-third of people in Canada have at least one risk factor that heightens their risk of adverse health effects from outdoor air pollution [33].

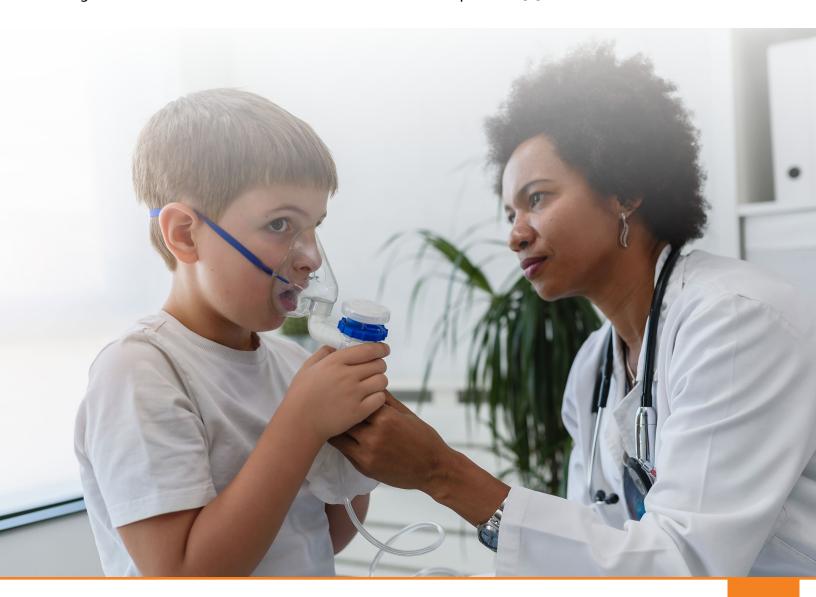
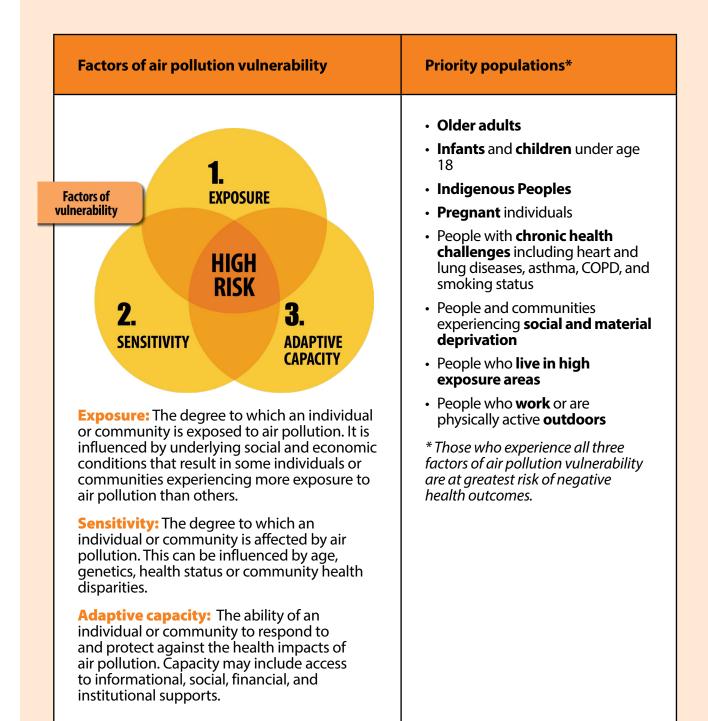


Table 4.5 | Air pollution vulnerability factors and high-risk populations [34, 15]



Poor air quality events that coincide with other climate hazards such as extreme heat may overwhelm or disrupt health systems.

Extreme heat often occurs alongside stagnant poor air quality leading to compounded negative health effects. Evidence suggests that co-exposure to wildfire smoke and extreme heat poses a greater health risk than either hazard alone, particularly for high-risk populations [35]. There is also evidence that the deadly impact of extreme heat is worse when air pollution levels are higher, especially for lung-related deaths [36]. As climate change intensifies, local health systems may be overwhelmed by overlapping climate hazards that may result in a diminished capacity to provide emergency health services to local communities [25].

Growing evidence highlights the negative mental health impacts of wildfires, which disproportionately affect Indigenous Peoples. However, mental and emotional health effects remain underexplored in climate and health literature. Indigenous-led Knowledge systems can help bridge this gap, offering valuable approaches to understanding, preventing, and responding to these broader health consequences.

Health research and air pollution surveillance primarily focus on contaminants and physical health effects, while the broader mental and emotional impacts remain underexplored. Emerging evidence suggests that wildfire smoke exposure is linked to stress, anxiety, and depression, especially in cases requiring evacuation [17, 37]. The Mississaugas of Scugog Island First Nation (MSIFN) emphasize the need to explore and address the impacts of rising air pollution and wildfire risks on the emotional, spiritual, mental, and cultural well-being of both Indigenous and non-Indigenous Peoples.

The following are examples provided by MSIFN:

Spiritual health: Many culturally significant vascular plants – like tobacco, sweetgrass, sage and cedar - are used in ceremony, offerings, purification, and prayer. The act of gathering them is itself a spiritual responsibility. Pollution degrades the land and air, creating a disconnect between Indigenous Peoples and the natural laws that guide spiritual balance. Additionally, smoke-filled skies or visibly sick plants can disrupt ceremonies and make Indigenous people feel that the land is "not safe," which may lead to cancelled or altered spiritual practices.

Emotional health: Being on the land and harvesting with family or community brings joy, belonging, and healing. Losing access to those practices – due to smog days, wildfire smoke, or loss of species – can trigger grief, anxiety and frustration.

The emotional toll of environmental loss – watching familiar harvesting sites change, plants disappear, or Elders struggle to breathe – can deepen trauma already carried by communities due to colonial displacement.

Mental health: The land is a site of learning, teaching, and purpose. Harvesting supports mental wellness by fostering routine, responsibility, and deep attentiveness to seasonal change and ecological cues. When air quality or climate shifts interfere with this, it becomes harder for people to engage in harvesting or cultural learning. This undermines mental clarity, cultural confidence, and a sense of continuity.

Physical health: Pollution directly harms physical health through asthma, cardiovascular stress, and heat-related illness, and indirectly through reduced access to traditional foods and medicines that are essential to the wellness of Indigenous Peoples. During smog events or wildfire smoke days, Indigenous Peoples cannot safely harvest, camp, or even travel on the land, especially those with pre-existing physical health conditions.

Given the disproportionate exposure risks among First Nations, Inuit, and Métis Peoples, it is essential to include Indigenous Knowledge and perspectives to air pollution assessments, prevention and response [37]. Indigenous Knowledge systems, in general, offer direct, extensive, multi-generational and long-term insight essential to preventing and adapting to climate hazards such as air pollution.¹⁴

¹⁴ To learn more see: Climate Change and Indigenous Peoples' Health in Canada, available at: https://www.nccih.ca/Publications/Lists/Publications/Attachments/10367/Climate_Change_and_Indigenous_Peoples_Health_EN_Web_2022-03-22.pdf

5. Understanding air pollution vulnerability in Durham Region

Reducing the negative health effects of poor air quality in Durham Region is possible by strengthening local capacity for prevention and protection.



1. EXPOSURE HIGH RISK 2. SENSITIVITY ADAPTIVE CAPACITY

5.1 Air pollution exposure in Durham Region

The transportation sector, which comprises the greatest proportion of emissions in Durham Region, has shown a decrease in per capita emissions from 2015 to 2023. 15

Emissions in Durham Region fall into five major sector categories: transportation, buildings, industrial, waste and agriculture. **Figure 5.1** shows that total emissions in Durham Region across all sectors was 5.7 million tonnes of carbon dioxide equivalent (MtCO2eq) in 2023, which is a decrease from the 2015 total of 6.1 MtCO2eq (**5.1 A**). From 2015 to 2023, there were noticeable decreases in the per capita emissions originating from the buildings (16% decrease), transportation (16% decrease) and industrial (26% decrease) sectors and per capita emissions from the waste and agricultural sectors remained relatively stable (**5.1 B**).

Transportation accounts for the largest share of emissions in Durham Region at approximately 40 per cent. The vast majority (93%) of fuel emissions come from gasoline combustion, compared to diesel (**5.1 D**). A sharp decline in transportation emissions occurred in 2020 and 2021 during the height of the COVID-19 pandemic response (**5.1 A**, **B**, **D**). Since then, total fuel emissions have steadily increased but remain below 2015 levels.



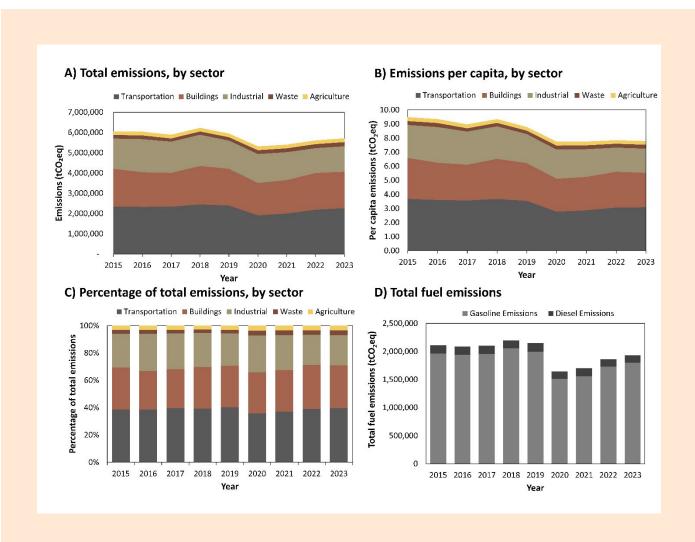


Figure 5.1 | Annual emissions by sector in Durham Region from 2015 to 2023

Data source: The Atmospheric Fund, 2023 Carbon Emissions Inventory for the Greater Toronto and Hamilton Area Published Nov 2024 [38].

Traffic is Ontario's top air pollution source, with the highest exposure near roads, affecting 28 per cent of residents.

Traffic is the leading source of air pollution in Ontario, with the highest pollutant levels near major roads and freeways [$_{39}$]. In general, exposure to TRAP is highest within 100 metres of a major road or 500 metres of a freeway, affecting about 28 per cent of Ontario residents [$_{39-41}$]. Air pollutant concentrations decrease with distance from roads, but the rate depends on the pollutant, with PM_{2.5} declining the slowest [$_{39}$].

In Durham Region, 11.5 per cent of residents live near major roads or freeways, below Ontario's 28 per cent average.

To assess TRAP exposure in Durham Region, the per centage of the population living near major roads and freeways was calculated at both the Health Neighbourhood (HN)¹⁷ and Local Area Municipality (LAM) levels using Public Health Ontario's methodology [42]. Appendix D outlines the methodology and discusses its limitations.

Three TRAP buffers were used in the analysis:

- Buffer A: 50 metres from major roads and freeways
- **Buffer B**: 100 metres from major roads and 150 metres from freeways
- **Buffer C**: 100 metres from major roads and 500 metres from freeways

The per centage of the population within each buffer was determined by dividing the number of residents in a TRAP zone by the 2021 population of the HN or LAM. Maps of these buffers are included in **Appendix E** (**Figures E1–E3**).

Results (**Table 5.1.1**) show that 11.5 per cent of Durham Region residents live within 100 metres of a major road or 500 metres of a freeway, below the Ontario average of 28 per cent [39].

Durham Region has 50 Health Neighbourhoods. DRHD tracks 96 indicators by Health Neighbourhood and municipality to better understand the health of our communities. Learn more at: durham.ca/neighbourhoods



¹⁶ Major roadways (e.g., Hwy 7, Hwy 12, Hwy 35) are arterial roads with medium to high traffic capacity, as defined by the Durham Region Single Line Road Network. Freeways (e.g., 400-series highways) are high-speed, controlled-access routes with no intersections.

Table 5.1.1 | Proportion of municipal populations living close to major roads and freeways, 2021

LAM	2021 Total population	Buffer A: % of total population living within 50m of major roads and freeways	Buffer B: % of total population living within 100m of major roads and 150m of freeways	Buffer C: % of total population living within 100m of major roads and 500m from freeways
Pickering	98,595	3.5%	8.0%	19.2%
Ajax	126,245	1.5%	3.8%	8.7%
Whitby	136,515	3.3%	7.1%	11.7%
Oshawa	174,160	3.3%	6.6%	11.0%
Clarington	100,720	3.2%	6.9%	11.2%
Scugog	21,440	6.6%	13.0%	13.0%
Uxbridge	21,365	0.9%	1.9%	1.9%
Brock	12,320	2.4%	4.6%	4.6%
Durham Region	696,992	3.0%	6.4%	11.5%

Data sources: The Atmospheric Fund, 2023 Carbon Emissions Inventory for the Greater Toronto and Hamilton Area Published Nov 2024 [38]; Statistics Canada Dissemination Block boundaries: Statistics Canada, "2021 Census - Geographic Attribute File." Ottawa, Apr. 16, 2025. [Online]. Available: https://open.canada.ca/data/en/dataset/1b3653d7-a48e-4001-8046-e6964bebe286; Population counts for Dissemination Blocks: Statistics Canada, "Dictionary, Census of Population, 2021 Dissemination Block (DB), [Census division]." Ottawa, Apr. 16, 2025. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/ref/dict/az/definition-eng.cfm?ID=geo014; Health Neighbourhood Population Counts: 2021 Census, Statistics Canada, Canadian Council on Social Development's Community Data Program; Durham Region boundary and population count: Statistics Canada, "Focus on Geography Series, 2021 Census - Durham [Census Division]." Ottawa, Apr.16, 2025. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/Page.cfm?lang=E&topic=1&dguid=2021A00033518; Roads: Durham Region Single Line Road Network, GIS Services Region of Durham, Regional Municipality of Durham, 2025. [Online]. Available: Road Network | Regional Municipality of Durham - Open Data

TRAP exposure in Durham Region is highest in southern urban areas and lower in northern rural areas, with the exception of Scugog.

TRAP exposure in Durham Region varies across the eight LAMs, with generally higher levels in southern urban areas and lower levels in northern rural areas, mainly due to the presence of freeways in urban municipalities. Scugog is an exception to this trend, with the highest percentage of residents living within 50 or 100 metres of a major road among all municipalities (**Table 5.1.1, Figure 5.2**).

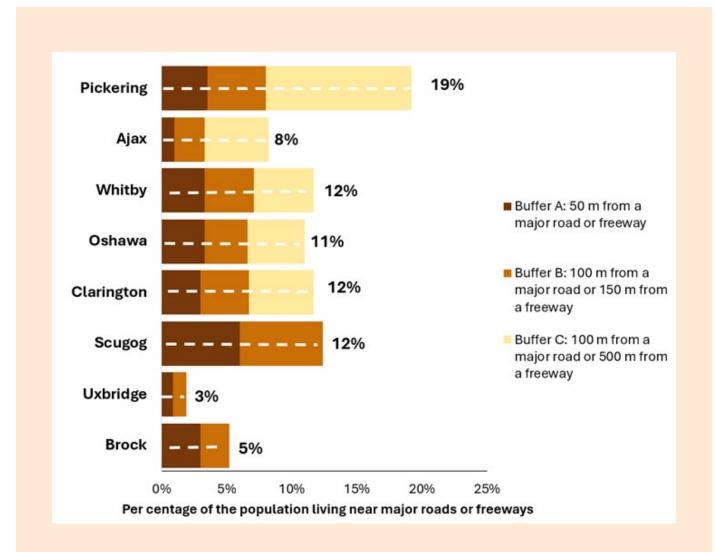


FIGURE 5.2 | Per centage of Durham Region's population living near major roads and freeways, by LAM

Data Sources: Statistics Canada Dissemination Block boundaries: Statistics Canada, "2021 Census - Geographic Attribute File." Ottawa, Apr. 16, 2025. [Online]. Available: https://open.canada.ca/data/en/dataset/1b3653d7-a48e-4001-8046-e6964bebe286; Population counts for Dissemination Blocks: Statistics Canada, "Dictionary, Census of Population, 2021 Dissemination Block (DB), [Census division]." Ottawa, Apr. 16, 2025. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/ref/dict/az/definition-eng.cfm?llD=geo014; Health Neighbourhood Population Counts: 2021 Census, Statistics Canada, Canadian Council on Social Development's Community Data Program; Durham Region boundary and population count: Statistics Canada, "Focus on Geography Series, 2021 Census - Durham [Census Division]." Ottawa, Apr.16, 2025. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/Page.cfm?lang=E&topic=1&dguid=2021A00033518; Roads: Durham Region Single Line Road Network, GIS Services Region of Durham, Regional Municipality of Durham, 2025. [Online]. Available: Road Network | Regional Municipality of Durham - Open Data

TRAP exposure varies across southern urban municipalities, with Pickering experiencing the highest levels and Ajax the lowest, influenced by freeway presence.

TRAP exposure in southern urban municipalities varies, with Pickering having the highest and Ajax the lowest across all buffers (**Table 5.1.1, Figure 5.2**). Whitby, Oshawa, and Clarington show similar exposure rates across all three TRAP buffers, indicating a relatively even distribution of residents living within 100 metres of a major road or 500 metres of a freeway. In contrast, Pickering and Ajax show a larger difference in exposure between Buffer B and C than between Buffer A and B, suggesting that residents near freeways in these municipalities tend to live farther away (150–500 metres). Lower exposure in Ajax may be due to having only one freeway, while other southern municipalities have at least two.

TRAP exposure in northern municipalities is evenly distributed along major roads, with Scugog experiencing the highest levels and Uxbridge the lowest.

TRAP exposure in northern municipalities increased steadily from Buffer A to B, with no change from B to C due to the absence of freeways (**Table 5.1.1, Figure 5.2**). This suggests a relatively even distribution of residents within 100 metres of a major road in these areas. Scugog has the highest proportion of residents near major roads, with 7 per cent living within 50 metres and 13 per cent within 100 metres. Uxbridge, in contrast, has the lowest exposure, with fewer than 2 per cent of residents living near a major road, regardless of buffer size (**Table 5.5.1, Figure 5.2**).

TRAP exposure varies across Durham Region's Health Neighbourhoods, with significant differences by location, placing some priority populations at greater risk.

Figure 5.3 illustrates TRAP exposure across Durham Region's HNs, showing the per centage of the population living near major roads or freeways, highlighting significant variation in TRAP exposure across Durham's HNs. Individual estimates for each HN are listed in **Appendix E, Table E.1**.

- **Buffer B** (100m from a major road or 150m from a freeway): Exposure ranged from zero to 20.8 per cent, with Oshawa showing the greatest variation within a single municipality (0.1% to 19.6%) (**Figure 5.3 B, Table E,1**).
- Buffer C (100m from a major road or 500m from a freeway): Ajax had the widest variation among municipalities, with HNs ranging from zero to 51.6 per cent, the highest among all 50 HNs (Figure 5.3 C, Table E.1).

Less variation across HNs was observed within municipalities for Buffer A (50m from a major road or freeway), likely due to the smaller population living within this range (**Figure 5.3 A**).

Results suggest that Port Perry, Beatrice North, Dryden East, and Brooklin East have larger populations living near major roads than other HNs. In contrast, Central Ajax, Pickering City Centre, Frenchman's Bay, and Amberlee have a higher proportion of residents living between 150 and 500 metres from freeways (**Table 5.2.2**). More than half of the residents of the Central Ajax HN and one third of residents of the Pickering City Centre and Frenchman's Bay HNs live within 100 metres of major roads or 500 metres of freeways (**Table 5.2.2**).

Several HNs with high TRAP exposure also have priority populations at greater risk of air pollution-related health effects:

- Port Perry and Pickering City Centre have larger older adult populations (65+ years) than Durham Region's average (29% and 22% respectively).
- Clarke has both a relatively larger older adult population (19%) and higher prevalence of COPD (11.2 cases per 100 people).
- Brooklin East has more infants and children aged 14 years and younger (24%) than Durham Region's average.
- Beatrice North has relatively higher rates of low-income households (16%) and COPD prevalence (14.6 cases per 100 people) compared to Durham Region's average.

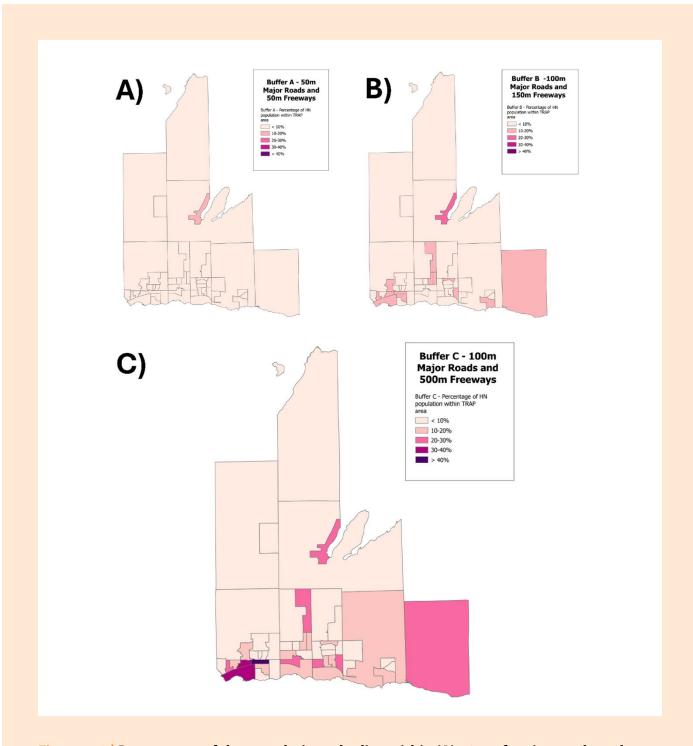


Figure 5.3 | Per centage of the population who live within (A) 50m of major roads and freeways, (B) 100m of major roads and 150m of freeways, and (C) 100m of major roads and 500m of freeways, by Health Neighbourhood (2021)

Data Sources: Statistics Canada Dissemination Block boundaries: Statistics Canada, "2021 Census - Geographic Attribute File." Population counts for Dissemination Blocks: Statistics Canada, "Dictionary, Census of Population, 2021 Dissemination Block (DB), [Census division]." Health Neighbourhood Population Counts: 2021 Census, Statistics Canada, Canadian Council on Social Development's Community Data Program. Durham Region boundary and population count: Statistics Canada, "Focus on Geography Series, 2021 Census - Durham [Census Division]." Roads: Durham Region Single Line Road Network, GIS Services Region of Durham, Regional Municipality of Durham, 2025.

Table 5.1.2 | Top five Health Neighbourhoods with the highest per centage of the population living near major roads and freeways, 2021

Rank	Buffer A: % of total population living within 50m of major roads and freeways		Buffer B: % of total population living within 100m of major roads and 150m of freeways		Buffer C: % of total population living within 100m of major roads and 500m from freeways	
	HN	%	HN	%	HN	%
1	Port Perry (S1)	10.6	Port Perry (S1)	20.8	Central Ajax (A4)	51.6
2	Beatrice North (O10)	9.9	Beatrice North (O10)	19.6	Pickering City Centre (P5)	37.6
3	Dryden East (W8)	7.2	Brooklin East (W9)	14.7	Frenchman's Bay (P1)	32.7
4	Brooklin East (W9)	6.8	Dryden East (W8)	14.2	Clarke (C7)	26.9
5	Clarke (C7)	5.9	Clarke (C7)	12.9	Amberlee (P3)	26.2

Data Sources: Statistics Canada Dissemination Block boundaries: Statistics Canada, "2021 Census - Geographic Attribute File." Ottawa, Apr. 16, 2025. [Online]. Available: https://open.canada.ca/data/en/dataset/1b3653d7-a48e-4001-8046-e6964bebe286; Population counts for Dissemination Blocks: Statistics Canada, "Dictionary, Census of Population, 2021 Dissemination Block (DB), [Census division]." Ottawa, Apr. 16, 2025. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/ref/dict/az/definition-eng.cfm?ID=geo014; Health Neighbourhood Population Counts: 2021 Census, Statistics Canada, Canadian Council on Social Development's Community Data Program; Durham Region boundary and population count: Statistics Canada, "Focus on Geography Series, 2021 Census - Durham [Census Division]." Ottawa, Apr. 16, 2025. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/Page.cfm?lang=E&topic=1&dguid=2021A00033518; Roads: Durham Region Single Line Road Network, GIS Services Region of Durham, Regional Municipality of Durham, 2025. [Online]. Available: Road Network | Regional Municipality of Durham - Open Data

Durham Region's seven Priority Neighbourhoods, have higher proportions of residents at greater risk of adverse health effects from air pollution, with varying levels of TRAP exposure influenced by proximity to major roads and freeways.

Among Durham Region's 50 HNs, seven have been identified as priority neighbourhoods for improving health and well-being. These are: 1) Downtown Ajax – Ajax, 2) Downtown Whitby – Whitby, 3) Lakeview – Oshawa, 4) Gibb West – Oshawa, 5) Downtown Oshawa – Oshawa, 6) Central Park – Oshawa, 7) Beatrice North – Oshawa.

These Priority Neighbourhoods (PNs) have a relatively high proportion of people at greater risk of adverse health effects from air pollution, based on higher rates of low-income and chronic health conditions, including COPD and cardiovascular disease. Additionally, Downtown Ajax and Downtown Whitby have significantly larger older adult populations (65+ years) than the Durham Region average.

As a greater per centage of these populations live in high TRAP exposure areas and may experience several compounding risk factors, they may be at even greater risk of experiencing adverse health effects from air pollution.

Most of the seven PNs had TRAP exposure levels similar to the Durham Region average for Buffers A and B (**Table 5.1.3**). Beatrice North was an exception, with a significantly higher proportion of its population living very close to major roads and freeways; about 10 per cent of residents live within 50 metres of a major road or freeway, and 20 per cent live within 100 metres of a major road or 150 metres of a freeway.

In contrast, most PNs had higher TRAP exposure for Buffer C, meaning a greater proportion of residents lived within 100 metres of a major road or 500 metres of a freeway compared to the Durham Region average. This suggests that approximately one in five residents of a PN, live near major roads and freeways (mainly between 150 and 500 metres away from a freeway).

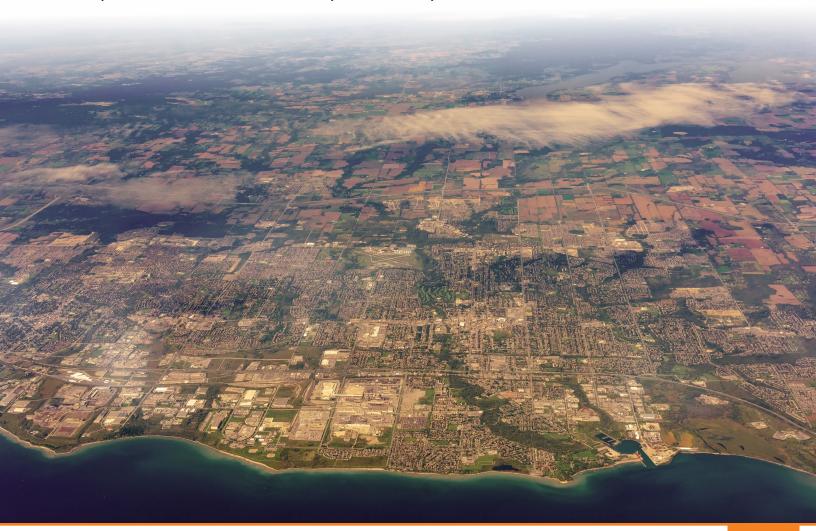


Table 5.1.3 | Proportion of Priority Neighbourhood populations living near major roads and freeways, 2021

Priority Neighbourhood	2021 Total population	Buffer A: % of total population living within 50m of major roads and freeways	Buffer B: % of total population living within 100m of major roads and 150m of freeways	Buffer C: % of total population living within 100m of major roads and 500m from freeways
Downtown Ajax	12,570	5.1%	10.7%	18.3%
Downtown Whitby	16,135	1.9%	5.7%	23.6%
Lakeview	18,720	5.6%	6.8%	15.1%
Gibb West	11,310	1.6%	5.4%	21.9%
Downtown Oshawa	12,080	1.5%	4.7%	18.7%
Central Park	11,785	3.1%	7.6%	14.9%
Beatrice North	10,720	9.9%	19.6% 19.6%	
Priority Neighbourhoods	93,320	4.1%	8.3% 18.8%	

Data Sources:Statistics Canada Dissemination Block boundaries: Statistics Canada, "2021 Census - Geographic Attribute File." Ottawa, Apr. 16, 2025. [Online]. Available: https://open.canada.ca/data/en/dataset/1b3653d7-a48e-4001-8046-e6964bebe286; Population counts for Dissemination Blocks: Statistics Canada, "Dictionary, Census of Population, 2021 Dissemination Block (DB), [Census division]." Ottawa, Apr. 16, 2025. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/ref/dict/az/definition-eng.cfm?ID=geo014; Health Neighbourhood Population Counts: 2021 Census, Statistics Canada, Canadian Council on Social Development's Community Data Program; Durham Region boundary and population count: Statistics Canada, "Focus on Geography Series, 2021 Census - Durham [Census Division]." Ottawa, Apr. 16, 2025. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/Page.cfm?lang=E&topic=1&dguid=2021A00033518; Roads: Durham Region Single Line Road Network, GIS Services Region of Durham, Regional Municipality of Durham, 2025. [Online]. Available: Road Network | Regional Municipality of Durham - Open Data

Unequal distribution of urban greenspace may contribute to disparities in air quality and health burdens across Durham Region neighbourhoods.

Greenspace density and spatial configuration within an urban forest, which includes all urban trees, shrubs, lawns, and soils, can influence local air quality. Evidence suggests that unequal greenspace distribution in urban neighbourhoods contributes to disproportionate heat exposure and air pollution-related health burdens [43]. Local trees and other greenspaces help mitigate air pollution by capturing particulate matter and other pollutants, distributing clean air, and improving airflow [44].

While air pollution data at the neighbourhood level is unavailable in Durham Region, disparities in greenspace distribution suggest possible inequalities in air pollution exposure [45]. In some Durham Region neighbourhoods, variations in tree canopy cover may result in poorer air quality for certain residents. Further analysis is needed to assess greenspace distribution and its impact on health equity. **Figure 5.4** illustrates two examples from the City of Oshawa and the Town of Ajax, where tree canopy cover ranges from as high as 71 per cent in some areas to as low as 12 per cent in others.



Figure 5.4 | Per centage tree canopy cover in the City of Oshawa and Town of Ajax for 2015

Data source: HealthyPlan.City, Dalla Lana School of Public Health [45].

Outdoor workers in Durham Region generally face higher exposure to air pollution.

Outdoor workers in Durham Region generally experience greater exposure to air pollution than the general population. According to 2021 census data, nearly 10 per cent of residents work outdoors (**Table 5.1.4**) [46]. However, this figure likely underestimates the total proportion, as it does not account for seasonal recreational workers, including lifeguards, camp counsellors, and landscapers.

Table 5.1.4 | Percentage of Durham Region residents that are outdoor workers

Industry classification	Per cent (%)	
Natural resources, agriculture and related production occupations	1.6	
Construction	8.1	
Total	9.7	

Data source: Statistics Canada. 2021. Durham Region Census Profile. 2021 Census.

Climate change is expected to worsen air pollution and health burdens through increased TRAP, aeroallergen, and wildfire smoke exposure, as well as rising temperatures and atmospheric stagnation.



Climate change-driven temperature increases can elevate TRAP exposure by accelerating chemical reactions that produce ground-level O_3 and enhancing $PM_{2.5}$ formation.



Climate change-driven warmth, humidity, and elevated carbon dioxide levels can extend allergen seasons, expand aeroallergen distribution, and increase pollen production, leading to higher allergy and asthma rates and greater health care burdens [14, 15].



Climate change intensifies wildfire risk, leading to longer smoke seasons, greater air pollution, and a projected 75 per cent increase in wildfire occurrence in Canada by century's end [47].



Climate change-driven rising temperatures and frequent heat waves increase atmospheric stagnation, leading to higher concentrations of local air pollutants [15, 24].

Factors of vulnerability EXPOSURE HIGH **SENSITIVITY**

5.2 Air pollution sensitivity in Durham Region

A commitment to health equity means prioritizing the needs and barriers of those at greatest risk of air pollution health impacts.

Some people are more susceptible to severe illness from poor air quality than others and there is evidence of a social gradient of airpollution-related health impacts.

Sensitivity to poor air quality is influenced by age, genetics, health status or other health inequalities. Our understanding of sensitivity to poor air quality is incomplete and evolving. This section provides an overview of six populations in our communities who, in general, face greater risks of harm from poor air quality: older adults; infants and young children; Indigenous Peoples, pregnant individuals, people with chronic heart and lung conditions, and people experiencing social and material deprivation [15, 47]. About one-third of Canadians have at least one risk factor that makes them more susceptible to air pollution [33].

Addressing social and heath inequalities is essential to preventing deaths attributable to air pollution.

Sensitive populations who experience multiple, often compounding health inequalities, are more likely to experience more severe health outcomes due to air pollution. For example, across Canada, a higher prevalence of lowincome and Indigenous identity (First Nations, Métis, or Inuit) is associated with significantly higher mortality attributable to air pollution [48]. Evidence from Canadian cities show that differences in deaths attributable to air pollution appear to be driven more by baseline mortality inequalities than by air pollution exposure inequalities [48]. This indicates that addressing health inequities in addition to air pollution exposure is essential to preventing unequal health impacts from air pollution and climate change.

5.2.1. Air pollution-sensitive populations in Durham Region

5.2.1.1 Older adults [15]

Table 5.2.1 Air pollution vulnerability factors and potential health outcomes among older adults

Factors of air pollution vulnerability	Examples of health outcomes		
 Sensitivity In general, older adults have a decreased ability to regulate environmental stressors making it harder for them to recover from pollution related health effects. Many also have pre-existing conditions, such as reduced lung function, which heightens their risk of hospitalization, worsening chronic illnesses, and even premature death due to air pollution exposure [49]. Interactions with other vulnerability factors: Exposure Greater potential exposure to air pollution among those who are racialized, experience low-income, work outdoors, or live in a densely urbanized neighbourhood with high traffic volumes [15, 47, 48, 50]. Adaptive capacity Low-income, sub-standard housing conditions, physical or social isolation and other barriers to the social determinants of health, limit older adult's capacity to protect against air pollution exposure [47 - 49]. 	Outdoor air pollution is associated with many negative health outcomes in older adults including [26, 49]: cardiovascular and circulatory mortality atrial fibrillation acute myocardial infarction stroke total cardiovascular morbidity coronary heart disease congestive heart failure hypertension respiratory mortality and morbidity COPD mortality and morbidity asthma pneumonia cancer neurological impacts diabetes		

Durham Region's growing older adult population faces heightened air pollution risks due to low-income, chronic illness, and social isolation.

By the year 2036, the age category of 65 years and older is projected to represent 24 per cent of Durham Region's population [46]. Over 8 per cent of Durham Region older adults live with a low-income. Oshawa and Brock have the highest proportion of older adults with low-incomes as well as the highest proportion that live alone [46]. Oshawa is also home to five of the Region's Priority Neighbourhoods where there is an overall higher prevalence of chronic diseases and low-incomes compared to other Durham Region HNs. The air pollution related health burdens among older adults may be higher in these HNs.

Table 5.2.2 | Air pollution vulnerability factors and potential health outcomes among infants and children

Factors of air pollution vulnerability Examples of health outcomes Exposure to TRAP is associated Sensitivity with asthma onset, lower Infants and children are more sensitive to respiratory infections, increased the negative health impacts of air pollution risk of cardiovascular disease, because their lungs, respiratory, and immune ED visits, hospitalizations, and systems are still developing and are therefore increased medication use for more vulnerable to harm and long-term health children [19, 53, 54]. impacts [52]. Air pollution is associated with Interactions with other vulnerability factors: childhood behavioral and **Exposure** cognitive development impacts [53, • Children typically spend more time outside 55, 56]. than adults which can increase their exposure Wildfire-PM_{2.5} may be 10 times to outdoor air pollution [52]. more harmful to respiratory health than PM2.5 from other sources, • Due to their higher breathing rates, infants and children inhale more air and pollutants relative particularly for children aged 0 to to their body weight, leading to greater overall 5 years [26, 27]. exposure to air pollution [52]. • Wildfire smoke exposure is associated with a significant Children and infants who are racialized. increase in respiratory ED visits experience low-income, or spend time in and asthma hospitalizations, densely urbanized areas with high traffic particularly in children under age volumes may face greater exposure to air pollution [15, 47, 48, 50]. 5 [27]. Aeroallergens have been **Adaptive capacity** associated with increased risk Infants and young children rely on caregiver of asthma-related and allergic awareness and knowledge to monitor rhinitis-related ED visits and air quality reports and take appropriate hospitalizations. In Canada nearly precautions on days with poor air quality. 50 per cent of children suffer from Limited financial resources, poor housing allergic rhinitis and over 20 per conditions, social or physical isolation, and cent have been diagnosed with other barriers to the social determinants of asthma and aeroallergens can health may reduce a family's ability to safeguard cause or worsen these conditions. against air pollution exposure [47 - 49]. [15, 57].

Due to health and socioeconomic disparities, such as asthma and low-income, some children in Durham Region face disproportionate health risks from air pollution.

Childhood asthma prevalence rates¹⁸ in Durham Region's municipalities are significantly higher than the Ontario average of 14.2 per cent, ranging from 11.5 to 17.9 per cent. The highest rates are found in the southern municipalities of Whitby, Ajax, Clarington, and Oshawa [58]. Health conditions such as asthma combined with socioeconomic risk factors including low-income and low-quality housing can increase the risk of poor health outcomes for children in general, including air-pollution related illness and disease [15, 50, 59]. For example, children and youth who experience hunger are more likely to suffer from chronic conditions including asthma [60]. In 2021, almost 9 per cent of Durham Region's children ages 5 and under were living with low-income with the highest proportion living in Oshawa (almost 15%) [46].

Figure 5.5 highlights the HNs with the highest observed childhood asthma rates, shown in dark red. Notably, Priority Neighborhood A2 (Downtown Ajax) appears in this category. Due to its high asthma rates and low-income levels, children in this HN may face a disproportionately high health burden from air pollution.

¹⁸ This indicator reflects the number of children aged 0 to 14 years diagnosed with asthma, per 100 children, based on 2016 estimates. The prevalence was standardized by age and sex using the 1991 Canadian Census population. Insurance Plan (OHIP) claims with an asthma diagnostic code or a hospital admission for asthma

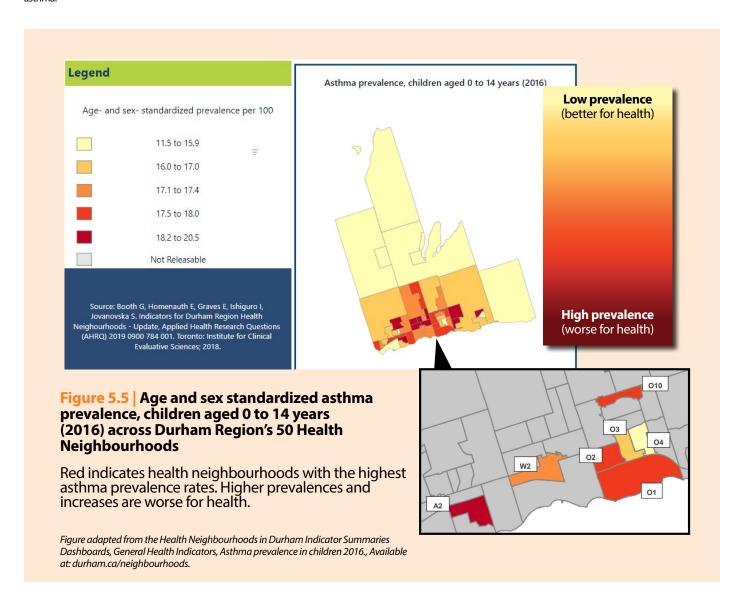


Table 5.2.3 Factors of air pollution vulnerability and potential health outcomes among Indigenous Peoples

Factors of air pollution vulnerability

Sensitivity

Due to the lasting effects of colonialism and colonization in Canada, Indigenous Peoples continue to face health inequities, increasing their risk of severe health outcomes from air pollution [37].

- First Nations, Inuit, and Métis Peoples experience greater health burdens of respiratory diseases (e.g., asthma and COPD) compared to non-Indigenous people in Canada [37].
- First Nations people living off-reserve and Métis have asthma rates 1.6 times higher than non-Indigenous people in Canada [15].
- First Nations and Inuit children experience higher rates of respiratory tract infections, including bronchitis, bronchiolitis, pneumonia, and tuberculosis, compared to non-Indigenous children [15].

Interactions with other vulnerability factors:

Exposure

- Disproportionate air pollution exposure among First Nations, Inuit, and Métis Peoples stems from a history of systemic racism and colonization, which has led to inequitable access to key determinants of health, including income, housing, and healthcare [15].
- First Nations communities account for approximately 42 per cent of wildfirerelated evacuations, despite representing only about 5 per cent of Canada's population [47].
- Exposure to O₃, PM_{2.5}, PM₁₀, and wildfire smoke while outdoors – especially during prolonged or seasonal land use.
- Episodic but intense exposure during wildfire season or summer heat waves

 disrupting community events and straining community-based health systems.

Examples of health outcomes

- Both short- and long-term exposure to air pollution increases the risk of hospitalization and death for individuals with pre-existing heart and lung conditions [61].
- In Canada, census tracts with higher rates of low-income and Indigenous identity show significantly higher air pollution-related mortality [48].
- Despite well-documented respiratory health inequalities among Indigenous Peoples in Canada, there is a lack of data on air pollution-related hospitalizations and deaths in these communities [62].
- For Indigenous Peoples, evacuations and separation from family and community due to wildfires can trigger re-traumatization linked to past genocidal practices, including forced relocations to residential schools and sanatoriums [63].
- Exacerbation of chronic conditions such as diabetes and autoimmune disorders due to inflammation from pollutant exposure.
- Disconnection from land-based healing or practices due to unsafe air conditions, leading to a loss of cultural identity, spiritual connection, and overall wellbeing.
- Interference with accessing Treaty and Traditional lands and witnessing environmental changes that threaten health can contribute to eco-anxiety, historical trauma, and intergenerational stress.

Factors of air pollution vulnerability

Examples of health outcomes

Adaptive capacity

- The ongoing impacts of colonization, including socio-economic and political marginalization, have led to systemic health inequities and barriers to adaptation, increasing the risk of health complications from poor air quality [37].
- Indigenous communities are frequently excluded from emergency preparedness and relief efforts, undermining their rights to self-determination and autonomy. For example, Indigenous Peoples are often left out of wildfire-related decision-making despite their extensive Knowledge of fire stewardship practices [47].
- Many Indigenous communities face a lack of culturally sensitive health information and services, as well as limited access to funding that could support their adaptive capacity [47].
- Loss of language and culture: MSIFN emphasises that clean air is not just a physical need – it supports healthy lands, waters, and medicines that are relied upon for food and cultural practices. Anishinaabemowin is deeply tied to the land and contains detailed ecological vocabularies and teachings that describe the behaviours of animals, plants, and seasonal changes. If poor air quality limits access to traditional territories, current and future generations lose opportunities to learn the language with fluent speakers through land-based practices like ceremony, harvesting, hunting, and medicine gathering.

Table 5.2.4 | Air pollution vulnerability factors and potential health outcomes among pregnant individuals

Factors of air pollution vulnerability	Examples of health outcomes
Maternal exposure to TRAP, aeroallergens, and wildfire smoke during pregnancy can increase the risk of adverse birth outcomes. Interactions with other vulnerability factors: Exposure Individuals who are racialized, experience low-income, work outdoors, or live in densely urbanized areas with high traffic volumes may have a greater risk of air pollution exposure [15, 47, 48, 50]. Adaptive capacity Limited financial resources, inadequate housing conditions, social or physical isolation, and other barriers to the social determinants of health may reduce a pregnant person's ability to protect against air pollution exposure [47 - 49].	 Aeroallergens—including tree pollen, grass pollen, ragweed pollen, and fungal spores—have been linked to earlier delivery among term pregnancies [15]. High aeroallergen counts during pregnancy have been associated with an increased risk of atopic disease in children later in life [15]. Maternal exposure to wildfire smoke in late pregnancy has been associated with low birth weight and preterm birth [28, 64]. PM_{2.5} exposure throughout pregnancy has been linked to low birth weight [16, 19]. Higher exposure to PM is associated with an increased risk of gestational diabetes mellitus, hypertensive pregnancy disorders, preeclampsia, gestational hypertension, spontaneous abortion, and postpartum depression [16].

Targeted prenatal health promotion and adaptation strategies to reduce air pollution exposure may help lower the risk of prenatal health complications, particularly among equity-deserving groups.

A better understanding of local exposure risks for pregnant individuals is needed. Incorporating more prenatal health promotion information into the AQHI and providing general guidance on minimizing air pollution exposure may help support prenatal health and reduce related health risks.

Table 5.2.5 | Air pollution vulnerability factors and potential health outcomes among people with chronic health conditions

Factors of air pollution vulnerability

Sensitivity

People with pre-existing health conditions face a higher risk of severe health impacts from air pollution, including wildfire smoke. These conditions include cancer, lung, or heart disease (such as asthma and COPD) a history of smoking, and diabetes [26].

Interactions with other vulnerability factors:

Exposure

 Individuals who are racialized, experience low-income, work outdoors, or live in densely urbanized areas with high traffic volumes may have a greater risk of air pollution exposure [15, 47, 48, 50].

Adaptive capacity

 Limited financial resources, inadequate housing conditions, social or physical isolation, and other barriers to the social determinants of health may reduce a pregnant person's ability to protect against air pollution exposure [47 - 49].

Examples of health outcomes

- Short-term exposure to poor air quality can worsen underlying health conditions, including asthma, COPD, heart attack, and heart failure [54].
- Individuals with coronary heart disease may have an increased risk of ventricular arrhythmias (abnormal heart rhythms) following exposure to air pollution [65].
- Both long- and short-term exposure to particulate-rich air pollution has been linked to increased COPD exacerbations, hospitalizations, and mortality [61].
- Aeroallergens can worsen asthma and allergic rhinitis, leading to increased illness and a reduced quality of life [66, 67].



Lung cancer remains the leading cause of cancer-related deaths in Durham Region, with incidence and mortality rates higher than Ontario's overall figures, despite significant declines between 2010 and 2020.

In Durham Region, lung cancer remains the leading cause of cancer-related deaths. Although incidence and mortality rates have declined, they remain higher than Ontario's overall rates. Between 2010 and 2020, 458 new lung cancer cases were diagnosed in Durham Region, accounting for 13 per cent of all new cancer cases—an incidence 1.1 times higher than Ontario's rate.^{19,20} The incidence of lung cancer in Durham Region declined significantly, dropping from 82.4 new cases per 100,000 in 2010 to 62.0 new cases per 100,000 in 2020 (**Figure 5.6**).²¹ From 2010 to 2020, lung cancer was the leading cause of cancer-related deaths in Durham Region, accounting for 25 per cent of all cancer deaths (304 deaths). The lung cancer mortality rate was almost 1.1 times higher than Ontario's rate.^{22,23} Lung cancer mortality rates in Durham Region significantly declined, dropping from 55.6 deaths per 100,000 in 2010 to 47.7 deaths per 100,000 in 2020 [68].

²³ This difference is statistically significant (P<0.001).

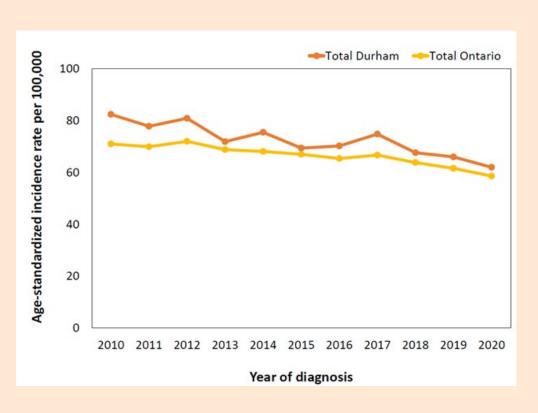


Figure 5.6

Annual agestandardized lung cancer incidence rates in Durham Region and Ontario from 2010 to 2020

Data source: Ontario Cancer Registry SEER*Stat Package – Release 13 – OCR (Dec. 2022). Pop Est Summary [Ministry of Health and Ministry of Long-Term Care: IntelliHEALTH ONTARIO, extracted March 2012 (1986-2000); Statistics Canada. Table 17-10-0134-01 Estimates of population (2016 Census and administrative data), by age group and sex for July 1st, Canada, provinces, territories, health regions (2018 boundaries) and peer groups (2001-2020).] Additional technical information available at durham.ca/cancerstats.

This estimate was based on Standardized Incidence Ratios (SIRs). SIRs reflect the ratio of the number of cases observed in a population of interest (in this case Durham Region) to the number of cases that would be expected if the population had the same age-specific incidence rates as the standard population (in this case Ontario). More information is available in the Technical Notes section of the Durham Region Cancer Data Tracker [68].

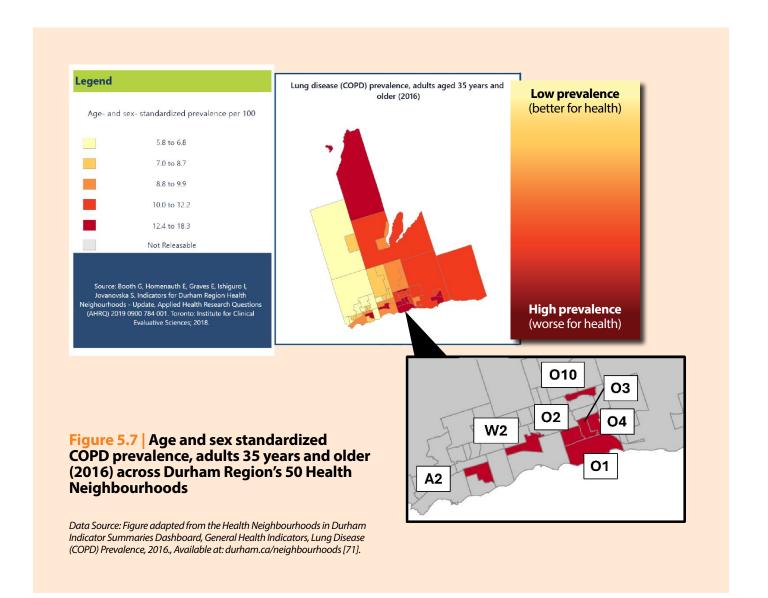
⁰ This difference is statistically significant (P<0.001).</p>

²¹ Incidence rates were age-adjusted to the 2016 Canadian population.

This estimate was based on Standardized Mortality Ratios (SMR). SMRs reflect the ratio of the number of deaths observed in a population of interest (in this case Durham Region) to the number of deaths that would be expected if the population had the same age-specific mortality rates as a standard population (in this case Ontario). More information is available in the Technical Notes section of the Durham Region Cancer Data Tracker [68].

Durham Region's COPD prevalence exceeds Ontario's average, with highest concentrations among Priority Neighbourhoods, where smoking remains a key risk factor.

Based on 2016 estimates, the prevalence of COPD among Durham Region residents aged 35 and older was 9.9 cases per 100 people, significantly higher than Ontario's average of 9.4 cases per 100 people. Oshawa (12.7 cases per 100 people), Clarington (11.4 cases per 100 people), and Brock (12.4 cases per 100 people) had the highest COPD prevalence among Durham's eight municipalities, exceeding the regional average. **Figure 5.7** highlights the HNs with the highest COPD prevalence (worst for health), shown in dark red based on 2016 estimates. COPD prevalence is highest in Durham Region's Priority Neighbourhoods, averaging 14.7 cases per 100 people, with Downtown Oshawa reporting the highest rate (18.3 cases per 100 people). Smoking remains the primary risk factor for COPD. According to 2023 public health survey data, 13 per cent of Durham Region adults (18+) currently smoke cigarettes [69, 70].²⁴



^{24 (95%} CI: 11-15%)



Table 5.2.6 | Air pollution vulnerability factors and potential health outcomes among people experiencing social and material deprivation

Factors of air pollution vulnerability	Examples of health outcomes
 Sensitivity Social and material deprivation, including lowincome, barriers to education and employment, housing insecurity, substandard housing, and under-resourced communities, is linked to an increased risk of negative health outcomes from air pollution [15, 48, 64]. Interactions with other vulnerability factors: Exposure Individuals who are racialized, experience low-income, work outdoors, or live in densely urbanized areas with high traffic volumes face a greater risk of air pollution exposure [15, 47, 48, 50]. Adaptive capacity Socioeconomic barriers can limit protective measures against air pollution exposure, such as staying indoors on poor air quality days, using air filtration, and avoiding heavy traffic areas. 	 Children and youth experiencing hunger are more likely to have asthma, increasing their vulnerability to air pollution-related health risks [49, 60]. Living in under-resourced communities is associated with higher PM_{2.5} exposure, contributing to an increased risk of cardiovascular disease [54]. Socioeconomic health barriers, such as housing instability or poor indoor ventilation, are linked to adverse mental health effects, as well as respiratory and cardiovascular diseases [47].

Financial hardship, inadequate housing, and limited social support increase air pollution-related health risks for Durham Region residents, including people experiencing homelessness, many of whom lived in unsheltered public spaces.

Approximately 45,000 Durham Region residents live with low-income [46]. **Table 5.2.7** presents the 2020 per centage of low-income residents by age category across Durham's municipalities [46]. Children and older adults are disproportionately affected by low-income and are also more vulnerable to air pollution than other age groups. In Durham Region, 17 per cent of older adults (65+) live alone [46]. Homelessness rates in Durham Region are difficult to quantify, but data suggests a significant increase since 2019. Between October 20 and 21, 2021, 573 people were experiencing homelessness, 20 per cent of whom were homeless with children [74]. Among those experiencing homelessness, 40 per cent lived in unsheltered public spaces. For more in-depth data on homelessness in the region see **section 5.1.4.3** of the primer report: Climate Change and Health in Durham Region, available at: **www.durham.ca/ClimateAndHealth**

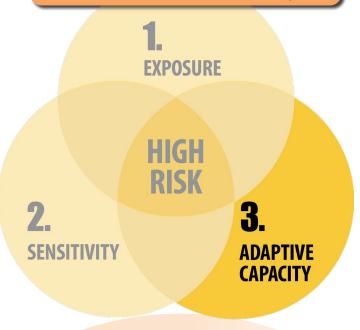
TABLE 5.2.7 | Percentage of children, older adults, and the total population in households with low-income, based on the low-income measure, after tax (LIM-AT)²⁵, by municipality

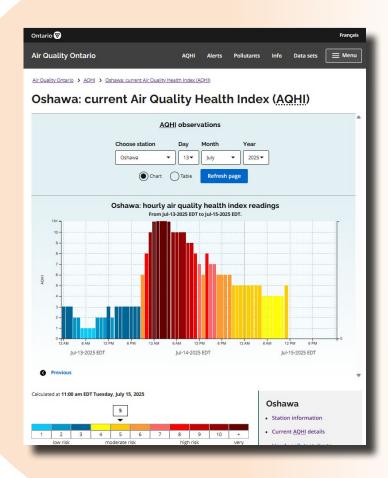
	AGE GROUP				
	Children 5 years and under	Older adults 65 years and older	Total population all ages		
MUNICIPALITY	,	2021			
Pickering	7.2%	6.4%	5.3%%		
Ajax	8.0%	8.4%	5.5%		
Whitby	7.3%	7.8%	5.4%		
Oshawa	14.9%	10.0%	10.2%		
Clarington	5.1%	6.4%	4.8%		
Scugog	3.9%	7.5%	6.5%		
Uxbridge	4.0%	9.3%	5.9%		
Brock	4.2%	14.8%	8.7%		
Durham Region	8.8%	8.3%	6.6%		

Data source: Statistics Canada, 2016 & 2021 Census of Population. [46]

²⁵ The LIM-AT is based on the median adjusted after tax income of all households in Canada. A household is considered to be living with low-income if their income after tax is lower than the Canadian median income after tax for a household of the same size.

Factors of vulnerability





5.3 Adaptive capacity and poor air quality in Durham Region

All Durham Region residents should have equal ability to protect themselves from poor air quality.

Air pollution exposure is shaped by factors such as neighborhood conditions, income, housing, and occupation. Combining air pollution mitigation with targeted support and communication for priority populations can strengthen communities' ability to adapt. Prioritizing adaptive capacity offers immediate and long-term health benefits by reducing pollution, illness, and premature death while also contributing to climate change mitigation.

The Air Quality Management System (AQMS) coordinates federal, provincial, and territorial efforts to monitor air quality, set standards, and align regulations, while municipal and regional authorities, including Durham Region, manage local air pollution through planning and public health initiatives.

The AQMS is a collaborative approach by federal, provincial and territorial governments to protect human health through monitoring air quality, assessing pollutant levels, and guiding strategies to protect ambient air quality [75]. Under the system, the Canadian Ambient Air Quality Standards (CAAQS) establish air quality objectives for outdoor pollutants using non-regulatory health and environmental-based quidelines [76].

Under the AQMS, a network of air quality monitoring stations collects data on key pollutants (like O₃, PM_{2.5}, and NOx) to ensure compliance with provincial and federal standards. The AQMS helps ensure that provincial actions align with national standards set by federal regulations, such as those under the Canadian Environmental Protection Act, 1999 [77]. The AQMS supports Ontario's regulatory framework by providing the evidence needed to enforce air quality standards, establish emission limits, and assess air quality interventions.

Durham Region and area municipality jurisdiction:

Under the Ontario Public Health Standards (Ontario's Health Hazard Response Protocol, 2019 and the Emergency Management Guidelines, 2024) DRHD must monitor environmental factors like air quality and work with community partners to minimize exposure to poor air quality events [78]. Data from Ontario's Ministry of the Environment, Conservation and Parks (MECP) monitoring station in Oshawa provides hourly AQHI readings, which DRHD uses to track and report on local air quality [79].

Municipal governments can improve local air quality through tools like bylaws, zoning, and health promotion programs. Under Bill 23, effective January 1, 2025, the Province designates the Region of Durham as an "upper-tier municipality without planning responsibilities". While the upper-tier planning function remains, Durham's area municipalities now hold approval authority for most Planning Act decisions, except where prescribed by the Ministry of Municipal Affairs and Housing. As a result, efforts to reduce local air pollution largely depend on each area municipality's planning priorities and decisions [80].

The 2023 wildfire season revealed gaps in public health guidance, prompting the development of new resources to help authorities prepare for and mitigate health risks from wildfire smoke.

The 2023 wildfire season highlighted gaps in public health guidance for wildfire events. In response, new guidance documents have been developed to help public health authorities prepare for and mitigate health risks from wildfire smoke. Examples include:

- The Government of Ontario's Wildfire Smoke and Air Quality Health Reference Document [78].
- The Public Health Agency of Canada's Wildfires in Canada: Toolkit for Public Health Authorities [64].
- A rapid review by the National Collaborating Centre for Methods and Tools and the National Collaborating Centre for Environmental Health on the effectiveness of public health interventions in reducing wildfire-related health impacts [81].



5.3.1 Local strengths and opportunities that support adaptive capacity to poor air quality in Durham Region

The following section highlights Durham Region's key strengths and opportunities for protecting residents' health from air pollution and improving local air quality.

High local awareness of air pollution risks.

Awareness of air pollution's health risks increases the likelihood of following health protection alerts and advice [15]. A recent local public health survey found that 69 per cent of Durham residents (18+) view poor outdoor air quality as a major or moderate health risk in the region.²⁶

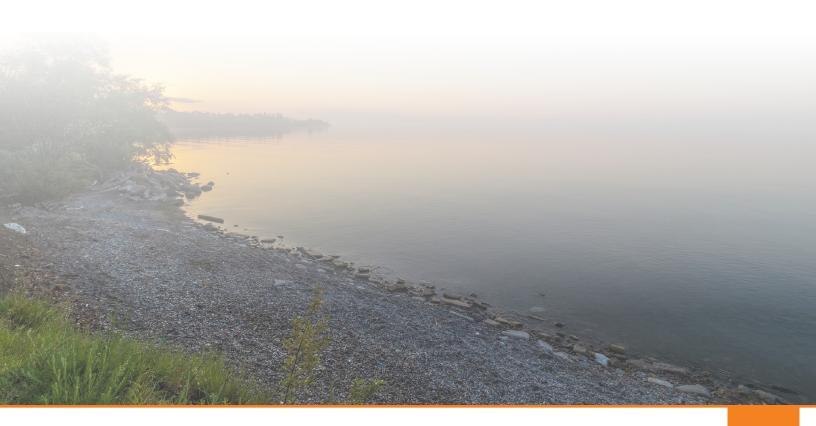
Durham Region Health Department's air quality alerts and health promotion efforts help residents stay aware of risks and protective actions.

Air quality monitoring, alert systems, and health protection guidance are essential for safeguarding community health, especially for those more vulnerable to air pollution [11]. DRHD notifies local municipalities and community partners of poor air quality based on guidance from MECP and Environment and Climate Change Canada (ECCC):

- **Special Air Quality Statement (SAQS)** Issued when the AQHI is forecast to reach the high-risk category.
- Air Quality Warning (AQW) Issued when the AQHI is expected to reach the very high-risk category.

DRHD shares alerts via its webpage, social media, and an email distribution list that reaches community partners serving individuals at higher health risk due to air pollution. The webpage provides information on using the AQHI, minimizing pollution exposure, and reducing local air pollution. It also features a special section on wildfire smoke, addressing the growing need for public health guidance as climate change intensifies.

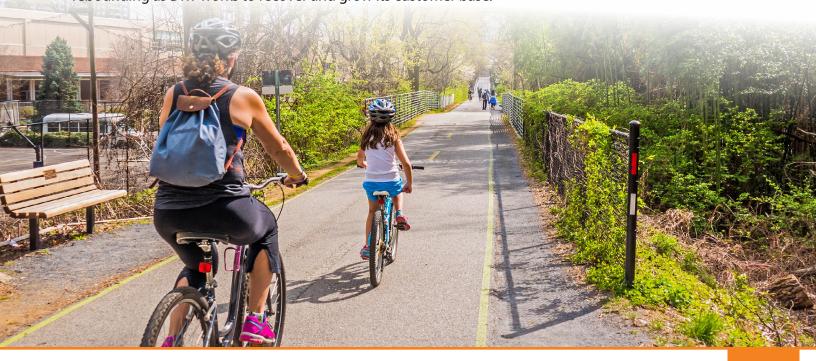
DRHD collects information about public perception of exposures relevant to climate change, including poor outdoor air quality, though the RRFSS telephone survey. This survey collects data among Durham Region adults (18+). During the survey, respondents were asked "does poor outdoor air quality pose a major risk, a moderate risk, a minor risk, or no risk at all to the health of people living in Durham Region".



Active transportation and sustainable transit initiatives in Durham Region reduce air pollution, support public health, and foster more connected, resilient communities.

The following section outlines Durham Region initiatives that reduce community-level air pollution while enhancing public health, well-being, and the development of more connected, vibrant communities [82].

- Health promotion to expand active transportation: DRHD supports the implementation of Active and Sustainable School Travel (ASST) initiatives across all Durham Region schools. This includes promotion throughout the year with all schools through their Public Health Nurses (PHNs), and collaboration with Ontario Active School Travel (OAST) and Public, Active, Clean and Equitable (PACE) Mobility Group. PHNs work with their assigned schools to develop a comprehensive approach to active school travel through the year and develop activities during Bike to School Week. DRHD also promotes walking and wheeling to school and collaborates closely with Durham Region's Community Growth and Economic Development (CGED) department. Each year, CGED's transportation planning staff select 4 to 8 schools to participate in the preparation of School Travel Plans as part of the ASST.
- The Durham Transportation Master Plan (TMP): The TMP sets goals for increasing the use of walking, cycling, transit, and carpooling in specific areas of the Region during the morning rush hour (6:30 AM–9:30 AM) by 2031 [83]. The Region aims to have 37 per cent of trips made by walking, cycling, transit, or carpooling by 2031. As of 2022, the Transportation Tomorrow Survey (TTS) shows a 26 per cent sustainable mode share during the morning rush hour, reflecting ongoing recovery from pandemic-related travel disruptions [84, 85]. Meeting Durham Region's sustainable transportation goals will reduce vehicle emissions, improve air quality, and enhance community resilience as climate change progresses.
- Durham Region Cycling Plan: In 2021, Durham Region, in collaboration with area municipalities and community partners, updated its Regional Cycling Plan (RCP) to guide efforts in creating a high-quality, well-connected, and safe cycling network for all ages and abilities. The plan establishes a Primary Cycling Network (PCN) and outlines the phased installation of 162 km of cycling infrastructure along roads under the Region's jurisdiction, with completion targeted by 2031 [86]. The RCP promotes active transportation while supporting public health by reducing TRAP. By encouraging more cycling and walking trips and expanding sustainable transportation options, the RCP helps improve air quality and create healthier communities.
- Durham Region Transit ridership recovery and initiation of E-Mission Zero Program: Figure 5.8 shows the average number of transit rides per person in Durham Region (total number of annual rides divided by the total annual population). Over the past decade, Durham Region Transit (DRT) has seen a generally stable trend in ridership. Average annual rides per capita increased modestly by four per cent, from 16 per cent in 2015 to 16.6 per cent in 2024. However, this period includes a significant decrease in ridership from 2020 to 2022 due to the COVID-19 pandemic. Since 2023, ridership has been steadily rebounding as DRT works to recover and grow its customer base.



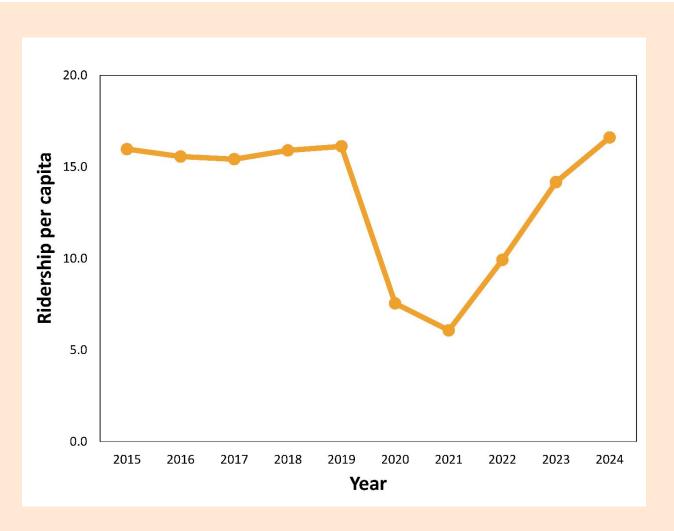


Figure 5.8 | Durham Region Transit annual ridership per capita from 2015 to 2024

Data source: Canadian Urban Transit Association, Fact books 2018-2022 Durham Region Transit, 2015-2024 Ridership Figures. Durham Region Population Estimates 2015-2024, Statistics Canada, distributed by the Ontario Ministry of Health.

In 2024, DRT took a significant step toward a more sustainable future with the introduction of six battery electric buses to its fleet. This initiative is a key component of DRT's long-term vision to achieve zero greenhouse gas emissions from its fleet and facilities by 2045. The battery electric buses are currently operating on high-ridership routes, including the 900 PULSE Highway 2 and 901 PULSE Simcoe, as part of a broader pilot supported by Federal Gas Tax funding approved in 2019. E-Mission Zero represents a transformative shift in DRT's approach to mobility, aligning with Durham Region's Corporate Climate Change Action Plan and Community Energy Plan. The program aims to build a fully sustainable transit network through the adoption of clean technologies, including renewable energy, electric vehicles, and smart infrastructure. A comprehensive feasibility study and infrastructure assessment is currently underway to guide the development of a full fleet transition plan. The introduction of these buses is part of a broader feasibility study and infrastructure assessment to inform the requirements and prepare a transition plan for the fleet and supporting infrastructure to achieve zero-emissions [87].

• Smart Mobility Durham Portfolio: Transforming Transportation Choices: Smart Mobility Durham is the umbrella initiative for Durham Region's three Transportation Demand Management (TDM) programs: Smart Commute Durham, Cycle Durham, and the ASST Program. These programs aim to reduce single-occupancy vehicle trips by promoting more active, sustainable transportation options, such as walking, cycling and public transit.

Each program targets specific groups and behaviors to promote long-term shifts in travel habits:

- o Smart Commute Durham supports commuters and employers in adopting sustainable commuting options, such as transit, carpooling, and teleworking.
- o Cycle Durham promotes cycling through education, infrastructure awareness and community events.
- o The ASST Program focuses on increasing active travel among school-aged children through school engagement, safety initiatives, and route planning.

The Region's Smart Mobility Durham portfolio helps create a shift in travel behaviour, supporting a reduction in vehicle pollution and supporting healthier, more connected communities.

Positive trend in the uptake of electric vehicles in Durham Region.

Emerging evidence suggests that increased adoption of electric vehicles (EVs) can reduce air pollution and asthma-related emergency department visits [88]. Between 2022 and 2023, Durham Region saw a significant rise in EV ownership, with battery electric vehicles (BEVs) increasing by 56 per cent and plugin hybrid electric vehicles (PHEVs) by 32 per cent. **Table 5.3.1** shows that in 2023, nearly 8,000 EVs were registered in the region, with BEVs being approximately three times more common than PHEVs.

Table 5.3.1 | Number of registered electric vehicles in Durham Region from 2022 to 2023*

	BEV		PHEV			
	2022	2023	% Change	2022	2023	% Change
Durham Region	3,760	5,849	56	1,435	1,887	32

^{*}A BEV is powered solely by electricity and a PHEV has both an electric motor and a gas engine Data source: 2023 Carbon Emissions Inventory for the Greater Toronto and Hamilton Area [38]

Durham Region's extensive Greenbelt and tree planting initiatives help improve air quality and support public health by reducing pollution-related health risks.

Over 80 per cent of Durham Region is within the provincially designated Greenbelt, featuring forests, wetlands, and grasslands that help maintain air quality. Emerging evidence highlights the health benefits of trees, including lower lung cancer rates linked to residential tree cover, reduced childhood asthma associated with greater street tree density, and fewer asthma hospitalizations during periods of high pollution in areas with higher tree density [89]. Since 2020, the Region and local area municipalities have partnered with Local Enhancement & Appreciation of Forests (LEAF) to plant approximately 1,300 native trees and shrubs. LEAF planting program offers a subsidized rate through the Backyard Tree Planting Program for residents, multi-unit, and commercial properties in participating municipalities. LEAF community tree plantings have added an additional 4,300 trees and shrubs [90]. In 2021, Durham Region and its five conservation authorities launched Durham TREES, a subsidized rural tree-planting program resulting in approximately 525,000 trees planted by year end 2024.

5.3.2 Improving Local Adaptive Capacity to Poor Air Quality

Although air quality has improved over recent years, poor air quality days still occur in Durham Region. The following section highlights key areas for strengthening local adaptation and promoting health. Broader community engagement is needed to better understand needs and opportunities, especially for priority populations and the organizations that support them.

Address social and health inequalities with an emphasis on Priority Neighbourhoods.

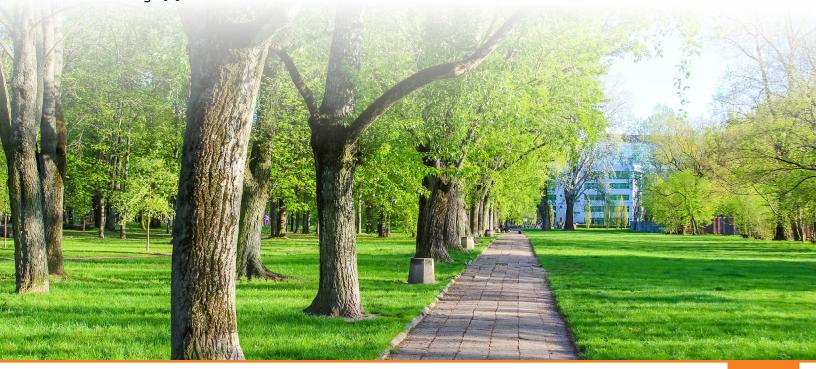
While reducing air pollution is key to protecting health under a future of climate change, differences in the number of deaths attributable to air pollution appear to be driven more by baseline mortality inequalities than by air pollution exposure inequalities. In other words, differences in deaths linked to air pollution appear to be attributed more to differences in people's overall health than by differences in how much air pollution people are exposed to. A study of seven Canadian cities, found that neighbourhoods with a higher prevalence of low-income and Indigenous identity had significantly higher air pollution attributable mortality [48]. These trends suggest that addressing health inequalities and underlying health inequities is key to increasing resilience to poor air quality. Negative health impacts from air pollution and the need for upstream health supports may be greatest among Durham's seven Priority Neighbourhoods.

Assess air pollution at finer geographic scales to identify priority areas and needs.

Durham Region has only one air quality monitoring station, located in Oshawa, which may not fully represent pollution exposure across the region. Areas farther north, away from major roads and highways, and those near high-traffic routes may experience different pollution levels. A more detailed assessment at finer geographic scales could help identify local exposure inequalities and guide targeted interventions.

Identify and address greenspace inequality.

Planting trees and selecting low-allergen species can help reduce air pollution risks. Vegetation barriers along busy roads limit pollutant transfer to nearby areas and provide cooling, mitigating health risks during hot, high air pollution days [15]. Equitable access to green spaces is crucial for health and climate resilience, requiring efforts to assess and address disparities. Collaboration among conservation authorities, municipalities, foresters, planners, and the DRHD can help identify high-need areas and integrate green infrastructure into urban planning, strengthening community adaptation to worsening air quality due to climate change [15].



Plan for additional climate hazards that may accompany poor air quality events.

As climate change worsens, local communities may face multiple climate threats more often, with extreme heat alerts and air quality warnings, including those for wildfire smoke, occurring together more frequently [35, 91]. For example, the AQHI does not account for the health effects of pollen, dust, heat, or humidity, and evidence suggests that combined exposures, such as air pollution and extreme heat, pose greater health risks than each factor alone [15]. Public health guidance for addressing multi-hazard events is still emerging with growing recognition of the need to assess and manage co-exposures [35]. To mitigate these risks, accurate, coordinated messaging and interventions are essential. Regular monitoring, reviews, and updates of public health data, evidence, and guidance are needed, particularly regarding the combined effects of air pollution and heat.

Promote health protection strategies before and during aeroallergen season.

DRHD does not issue pollen advisories, but daily aeroallergen forecasts in Canada are available from Aerobiology Research Laboratories (ARL) and shared through various weather channels. Social media reminders can help residents prepare for aeroallergen season by monitoring forecasts and ensuring they or family members have necessary medications, potentially reducing illness and healthcare burdens [15].

Continue monitoring the evolution of health protection guidance and interventions for wildfire smoke events.

Health protection measures against wildfire smoke include evacuation orders, air quality monitoring, public alerts, mask guidance, indoor safety recommendations, and clean air shelters. However, few interventions have been assessed for effectiveness or unintended consequences. For example, while wildfire smoke forecasts and air quality indices help inform evacuation decisions, evacuations can lead to stress, anxiety, depression, and disrupted access to healthcare and medications, which must be weighed against smoke exposure risks [92]. Staying indoors may not be sufficient protection without proper air filtration, especially for high-risk populations, yet there is uncertainty about effective filtration methods and accessibility [92]. Ongoing research and monitoring of health guidance related to wildfire smoke are essential.

Collaborate with the Mississaugas of Scugog Island First Nation and other Rights-holding First Nations on identified priorities.

MSIFN have identified several key priority actions to support air quality, including:

- Mapping and assessing current regulating services (especially vegetation and soil-based air filtration).
- Identifying nature-based solutions that can enhance air quality services in priority areas (Priority Neighbourhoods, cultural harvesting sites, transportation corridors, riparian buffers, etc.) and where there is greenspace inequality.
- Collaborating with MSIFN and other Rights-holding First Nations to include Treaty-informed and Indigenous Knowledge-based nature-based solutions priorities.
- Co-developing a regional nature-based solutions policy with clear funding streams, performance indicators, and equity considerations.
- Considering "access to nature" as a key right of all residents and provide planning advice to all area municipalities to ensure planning departments do not remove or negatively impact existing greenspaces.
- Leveraging First Nations' access to capital, grants, and culturally rooted stewardship models, to codevelop nature-based solutions that improve air quality, support climate health goals, and uphold Treaty responsibilities.



6. Next steps and priorities

This air quality vulnerability assessment characterized air pollution exposure, priority populations, and adaptive capacity in Durham Region. As climate change worsens, residents may face increased air pollution. Broad health promotion efforts are needed to help all residents protect themselves, while tailored strategies must address the unique needs of priority populations most affected by air quality disparities.

Durham Region can improve adaptive capacity to reduce health impacts from air pollution through data and knowledge gathering, health promotion strategies, and local services and policies.

- 1. **Local knowledge and data** such as monitoring and reporting poor air quality events and associated local health impacts on people and health systems.
- 2. **Health promotion and education** to support the ability of Durham Region residents to assess their risk and the risk of those in their care and what actions to take.
- 3. **Policies, programs, and services** to help residents avoid or escape poor air quality [93, 94]. Plans may include addressing green space inequality, the provision of clean air centres and urban planning that reduces car dependency.

Table 6.1 provides examples of adaptation initiatives for each category. These are illustrative examples only and have yet to be assessed for feasibility or priority. Priorities will be identified through broad engagement initiatives with a focus on priority populations.

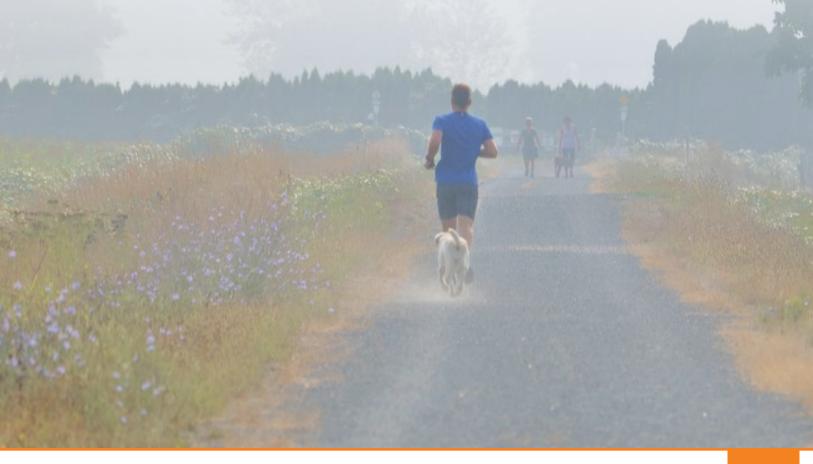


TABLE 6.1 | Examples of adaptation initiatives* [64]

Local knowledge and data	 Wildfire smoke forecasting Air quality assessment (Air Quality Health Index) Public health surveys (e.g., RRFSS modules) to understand awareness of AQHI, risks of air pollution, and barriers to protection Monitoring and surveillance of local health impacts due to poor air quality Assessment of local health and social service capacity during wildfire smoke events Survey of at-risk community members to understand coping strategies and needs during poor air quality events, including rural or isolated populations Survey of community partners who serve at-risk residents to identify key barriers to health during poor air quality events Inventory of municipal actions to reduce local air pollution Mapping of air pollution-vulnerable communities (e.g., TRAP and greenspace exposure) Inventory of municipal or community air pollution mitigation activities Monitoring of air quality at finer geographic scale
Health promotion and education	 Public messaging on AQHI and associated guidance tailored for key audiences (e.g., outdoor workers, childcare settings, and congregate care settings) Messaging on monitoring and preparing for aeroallergen season Personal protection guidance, including activity planning, masking, air filtration, and checking on friends and family Promotion of the benefits of trees and plants for air quality protection Development of guidance on clean air shelters Dedicated health fact sheets and information on wildfire smoke, including advice for protecting indoor air Development of wildfire smoke thresholds with corresponding health protection advice (e.g., canceling outdoor activities) Promotion of the health co-benefits of active transportation
Programs, policies or services	 Air Quality Alerts Evacuation plans and policies in case of a severe wildfire smoke event Air pollution mitigation programs and policies Clean air centers for residents on poor air quality days Tree and vegetation planting Incentives for using public transportation, active transportation, and electric vehicles Expansion of public transit Anti-idling policies

^{*}Sample initiatives are illustrative only and have yet to be assessed for feasibility or priority.

7. Assessment methods and limitations

Durham Region Health Department's CCHVA approach is adapted from the MOHLTC's Guidelines for Ontario [95 - 97] and Health Canada's adaptation workbook [98]. Assessment of air quality risk is examined through the three factors of vulnerability: exposure, sensitivity and adaptive capacity and draws on empirical studies, social theory and local data on health, socioeconomic disparities, the built environment, and climate trends [59]. For a complete description of the assessment process, scope, and limitations, please see Appendix 3.1 of the primer report: Climate Change and Health in Durham Region (durham.ca/ClimateAndHealth).

Additional limitations of this assessment are listed below.

- The AQHI may require further evaluation for effectiveness in the context of wildfires [15].
- The AQHI does not measure the effects of pollen or dust, representing a health knowledge and communications gap.
- There is limited evidence of the effectiveness of air quality forecast programs, such as the AQHI, in reducing population health risks [15].
- It is not possible to determine the exact number of cancer cases linked to exposure to a specific carcinogen, as this report is based on a probabilistic approach. Many exposure data sources provide average levels of exposure rather than capturing potentially high exposures experienced by individuals or specific groups. Some estimates may not fully account for variations in susceptibility to carcinogens among different populations. Additionally, it is not feasible to assess the impact of all environmental carcinogens and exposure pathways, meaning some results may underestimate the true environmental burden of cancer [22].



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Appendix A: Acronyms, terms and definitions

Acronyms & abbreviations

AQHI Air Quality Health Index

AQMS Air Quality Management System

AQW Air Quality Warning

ASST Active and Sustainable School Travel
ARL Aerobiology Research Laboratories

BEV Battery electric vehicle

CAAQS Canadian Ambient Air Quality Standards

CCHS Canadian Community Health Survey

CCHVA Climate change and health vulnerability assessment

CGED Community Growth and Economic Development

CO Carbon monoxide

COPD Chronic obstructive pulmonary disease

DB Dissemination Block

DRHD Durham Region Health Department

DRT Durham Region Transit

ECCC Environment and Climate Change Canada

ED Emergency Department

EV Electric vehicle

GTHA Greater Toronto-Hamilton Area

HN Health Neighbourhood

ICES Institute for Clinical Evaluative Sciences

LAM Local area municipality

LEAF Local Enhancement and Appreciation of Forests

LIM-AT Low-income measure, after tax

MECP Ministry of the Environment, Conservation and Parks

MSIFN Mississaugas of Scugog Island First Nation

MtCO2eq Million tonnes of carbon dioxide equivalent

NOx Nitrogen oxides

O₃ Ground-level ozone

OAST Ontario Active School Travel

PACE Public, Active, Clean and Equitable

PCN Primary Cycling Network

PHEV Plug-in hybrid electric vehicle

PHN Public Health Nurse
PM₁₀ Particulate matter 10

PM_{2.5} Fine particulate matter 2.5PCN Primary Cycling NetworkPN Priority Neighbourhood

RCP Regional Cycling Plan

SAQS Special Air Quality Statement

SLRN Single Line Road Network

TMP Durham Transportation Master Plan

TRAP Traffic-related air pollution

TDM Transportation Demand Management

TTS Transportation Tomorrow Survey

VOC Volatile organic compounds

Terms and definitions

A more complete list of terms and definitions related to climate change and health can be found in our primer report: Climate Change and Health in Durham Region: Understanding the local health impacts of climate change, available at: **durham.ca/ClimateAndHealth**

ACUTE MYOCARDIAL INFARCTION

Also known as a heart attack, the sudden blockage of blood flow to the heart muscle, usually due to a blood clot in a coronary artery, leading to tissue damage or death.

ADAPTIVE CAPACITY

The ability of an individual or community to respond to and protect against climate hazards such as air pollution. Capacity may include access to informational, social, financial, and institutional supports.

AIR QUALITY

The condition of the air based on the presence of pollutants such as dust, chemicals, and gases which can impact human health and the environment.

AIR QUALITY HEALTH INDEX

A scale that measures air pollution levels and their potential health effects; helping people make informed decisions to protect their health, especially those at risk.

ALLERGIC RHINITIS

An allergic reaction causing inflammation of the nasal passages leading to symptoms like sneezing, runny nose, congestion, and itching; often triggered by pollen, dust, or pet dander.

AMBIENT AIR POLLUTION

The contamination of outdoor air by harmful substances such as gases and particulate matter, including plant pollen and wildfire smoke.

ASTHMA

A chronic respiratory condition characterized by airway inflammation, bronchoconstriction, and mucus production, causing symptoms like wheezing, shortness of breath, coughing, and chest tightness.

ATOPIC DISEASE

A group of immune related conditions, including asthma, allergic rhinitis and atopic dermatitis, characterized by heightened immune response to allergens, leading to inflammation and allergic symptoms.

ATRIAL FIBRILLATION

An often-rapid heart rhythm caused by chaotic electrical signal in the atria, increasing the risk of stroke, heart failure and other complications.

CARCINOGEN

Any substance, radiation, or agent that can cause cancer by damaging DNA or disrupting cellular processes.

CARDIOVASCULAR DISEASE

A group of disorders affecting the heart and blood vessels, including conditions like coronary artery disease, heart attacks, strokes, heart failure and hypertension.

CLIMATE VULNERABILITY

The predisposition for health to be adversely affected by climate change. Climate vulnerability is determined by differential exposure, sensitivity, and capacity to adapt to climate hazards. In public health, the concept of vulnerability can be highly stigmatizing, so it is important to emphasize that vulnerability is not a label for communities or populations [1, 2, 3].

COMBUSTION ENGINE VEHICLES

Vehicles powered by an internal combustion engine that burns fossil fuels such as gasoline or diesel and contributes to traffic related air pollution.

CONGESTIVE HEART FAILURE

A condition in which the heart's ability to pump blood effectively has weakened, leading to a buildup of fluid in the lungs and other parts of the body.

CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

COPD is a progressive lung condition that causes breathing difficulties due to airflow obstruction.

CORONARY HEART DISEASE

A condition where the coronary arteries become narrowed or blocked due to plaque buildup, reducing blood flow to the heart muscle and increasing the risk of heart attacks.

EQUITY DESERVING

Populations or communities that experience significant collective barriers to participating in society often due to historical and structural disadvantages, inequities, and underrepresentation.

EXPOSURE

The degree to which an individual or community encounters climate hazards. It is influenced by underlying social and economic conditions that result in some individuals or communities experiencing more exposure to climate hazards than others.

GESTATIONAL DIABETES MELLITIUS

A type of diabetes that develops during pregnancy when the blood cannot effectively regulate blood sugar levels.

GESTATIONAL HYPERTENSION

High blood pressure that develops during pregnancy without the presence of protein in the urine or other signs of preeclampsia.

HEALTH EQUITY

Health equity means that everyone has a fair opportunity to enjoy their full health potential and are not disadvantaged by unfair social, economic, and environmental conditions. Many factors outside the health care system influence health. Health equity is achieved when health inequalities between groups that are due to unfair social and structural factors are eliminated [4, 5].

HEALTH INEQUITY

Differences in health outcomes that are unfair, unjust, and avoidable. Health differences result from social, economic, demographic, geographic, or environmental disadvantages.

HEALTH NEIGHBOURHOODS

Durham Region has 50 Health Neighbourhoods and presents health and demographic information at the neighbourhood level to better understand the demographics and health of Durham Region communities.

HYPERTENSION

A condition characterized by persistently high blood pressure against the walls of the arteries.

INDIGENOUS PEOPLES

A collective term for the original peoples of North America and their descendants. The term encompasses First Nations, Inuit and Métis Peoples [6].

ISCHAEMIC HEART DISEASE

A condition caused by reduced blood flow to the heart muscle due to narrowed or blocked coronary arteries, often leading to chest pain or heart attacks.

MILLION TONNES OF CARBON DIOXIDE EQUIVALENT

A metric used to measure and compare the impact of different greenhouse gases based on their global warming potential, expressing them as an equivalent amount of CO_2 .

MYOCARDIAL INFARCTION

Also known as a heart attack which occurs when blood flow to a part of the heart is blocked causing damage to the heart muscle.

PREECLAMPSIA

A complication during pregnancy characterized by high blood pressure and signs of organ damage, usually affecting the liver and kidneys, typically occurring after the 20th week of pregnancy.

RAPID RISK FACTOR SURVEILLANCE SYSTEM (RRFSS)

RRFSS is an online and telephone survey that collects health-related behaviour data among Ontario adults 18-years and older. These data provide important information that helps support public health units in planning and evaluating local programs and services, and informing education, awareness and advocacy efforts related to health behaviours.

RESPIRATORY DISEASE

A range of conditions that affects the lungs or airways, impairing breathing and oxygen exchange.

RESPIRATORY TRACT INFECTIONS

An umbrella term to describe infections affecting the respiratory system, including the nose, throat, airways, and lungs. They can be classified as upper (such as the common cold), or lower (pneumonia) and includes bronchitis, bronchiolitis, pneumonia, and tuberculosis.

SENSITIVITY

The relative extent to which individuals or a population are affected by the health impacts of climate change. It is influenced by biologic and social factors within the population, such as age, sex, chronic illness, or socioeconomic status.

STROKE

A medical emergency that occurs when blood flow to part of the brain is interrupted or reduced.

SYSTEMIC RACISM

Patterns of behaviour, policies or practices that are part of the social or administrative structures of an organization, and which create or perpetuate a position of relative disadvantage for racialized persons [7].

TOTAL CARDIOVASCULAR MORBIDITY

The overall incidence of diseases affecting the heart and blood vessels, such as heart attacks, strokes, and heart failure.

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Appendix B: Understanding the Air Quality Health Index

What is the Air Quality Health Index (AQHI)?

The AQHI is a tool that measures air quality and provides a health risk rating on a scale of 1 to 10+. The higher the AQHI, the greater the health risk (**Figure B.1**).

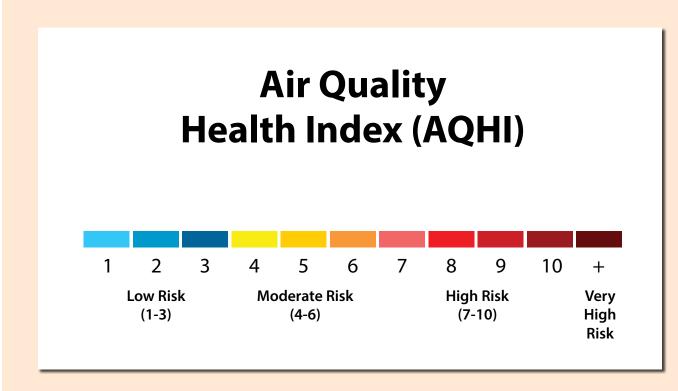


Figure B.1. I Air Quality Health Index Scale

How is the AQHI calculated?

The AQHI is calculated based on the relative risks of a combination of common air pollutants that is known to harm human health. These pollutants are:

- Ozone (O₃) at ground level,
- Particulate matter (PM_{2.5}/PM₁₀), and
- Nitrogen dioxide (NO₂).

How should I use the AQHI?

Before heading outdoors, check your local air quality by looking up the AQHI forecast at weather.gc.ca or by checking your local weather forecast information. You can find current hourly AQHI readings, as well as maximum forecast values for the day, evening and the next day.

Plan outdoor activities during times when the air quality is better. **Table B.1** provides general guidance on actions to consider based on the AQHI. If you or someone in your care for is at higher risk of health problems when exposed to air pollution, pay attention to the health messages under the **at-risk populations** category.

Table B.1 I Health messages based on the AQHI

Health Risk	Air quality health index	At-risk population	General population
Low risk	1-3	Enjoy your usual outdoor activities.	Ideal air quality for outdoor activities.
Moderate risk	4-6	Consider reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms	No need to modify your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High risk	7-10	Reduce or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.	Consider reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very high risk	Above 10	Avoid strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	Reduce or reschedule strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.

Who should be considered within the at-risk population category?

The following list shows that many people are included in the at-risk population category and may experience more severe health problems than others when exposed to air pollution, including wildfire smoke. These categories often overlap, and special attention should be given to people with multiple risk factors, for example, a child with asthma or an older adult with a heart condition.

- Older adults
- Indigenous Peoples
- People living in rural and remote areas
- Pregnant people
- People who smoke
- Infants and young children
- People who work outdoors
- People involved in strenuous outdoor exercise
- People experiencing socio-economic barriers
- People with an existing illness or chronic health condition, such as:
 - o Cancer
 - Diabetes
 - Lung or heart conditions

What additional actions should be considered during wildfire smoke events?



Speak with your health care provider about developing a management plan for wildfire smoke events and maintain a supply of necessary medications at home; always carry these medications with you during wildfire season.



At-risk populations should stay indoors if they have conditions that could be exacerbated by wildfire smoke.



Stop or reduce your activity level if breathing becomes uncomfortable or you or someone in your care feels unwell.



Contact your health care provider or local health authority if you develop severe symptoms or need advice.

What to do when extreme heat and wildfire smoke happen together?

Your top priority should be keeping cool because heat can pose more immediate health risks:



Stay indoors if possible and close windows.



Use AC and a quality air filter, if you have them. If you don't have AC, open windows when outdoor air is cooler than inside.



Seek out local cooler, cleaner air spaces for some relief if you don't have AC and it's too hot indoors.



Sip water and use cold showers to stay cool.

Appendix C: Percentage of monitored days with an AQHI risk of moderate or higher in Durham Region from 2015 to 2023.

Daily average AQHI reading data from 2015 to 2023 were analyzed to assess the per centage of monitored days each year with an AQHI risk of moderate or higher (AQHI reading of 4 or higher). Over this time (2015 to 2023) the average percentage of moderate to high risk AQHI days was 7.5 per cent (**Table C.1**). Years were categorized into low and high AQHI risk years by comparing the per centage of moderate to high risk AQHI days in that year to the 9-year average of 7.5 per cent. Years with a lower proportion were categorized as low AQHI years and years with a higher proportion were categorized as high AQHI years.

Table C.1 | Percentage of monitored days with an AQHI risk of moderate or higher in Durham Region from 2015 to 2023

Year	Percentage of moderate to high risk AQHI days*
2015 to 2023	7.5%
2015	11.6%
2016	8.4%
2017	8.9%
2018	7.2%
2019	0.8%
2020	7.0%
2021	7.9%
2022	5.2%
2023	10.8%

^{*}Moderate to high risk AQHI days were defined as an AQHI reading of 4 or higher.

Data source: Air Quality Health Index (AQHI) Historical Data, Oshawa Station 2015-2023, Ontario Ministry of the Environment, Conservation and Parks. Accessed: February 3, 2025

Appendix D: Geospatial analysis methodology for analyzing traffic-related air pollution exposure

To understand population-level traffic-related air pollution (TRAP) exposure within Durham Region, the per centage of the population living near major roads and freeways was estimated based on the methodology developed by Public Health Ontario [1].

Indicator definition:		
	Population living in TRAP exposure zones	
	Total population	* 100

Three categories were analyzed based on distance from a major road or freeway (Table D1):

Table D.1 | TRAP area buffers

Buffer	Distance from major road	Distance from freeway	
Α	50 m	50 m	
В	100 m	150 m	
С	100 m	500 m	

Major roads classification

The Region of Durham's Single Line Road Network (SLRN) dataset served as the foundation for the TRAP area buffer analysis, with buffer area calculated based on proximity to major roads and freeways. Roads classified as 'A-arterial' were considered major roads, defined as thoroughfares with medium to large traffic capacity, such as Highway 7, Highway 12, Highway 35, and Highway 115. Freeways, including the 400 series highways, are unimpeded, high-speed controlled-access routes designed for through traffic, typically without at-grade intersections or direct property access, and are accessed via ramps. Pedestrian access is prohibited.

Three distinct TRAP buffers were created for analysis: (A) 50 metres from major roads and freeways, (B) 100 metres from major roads and 150 metres from freeways, and (C) 100 metres from major roads and 500 metres from freeways (**Figure D.1, Table D.1**).

Source population counts

Area populations were derived for four (4) geographic levels (**Figure D.2**).

- 1. 2021 Statistics Canada Dissemination Blocks (DBs) [2]: population counts were derived from the 2021 Census Geographic Attribute File [3].
- 2. Durham Region's Health Neighbourhoods (HN): population counts were based on an internal dataset produced by Durham Region's Health Department.
- 3. Local Area Municipalities boundaries: population counts were based on an internal dataset produced by Durham Region's Health Department.
- 4. Durham Region boundary: population count was based on the 2021 Statistics Canada Census of Population, Focus on Geography Series page for Durham Region municipality. [4]

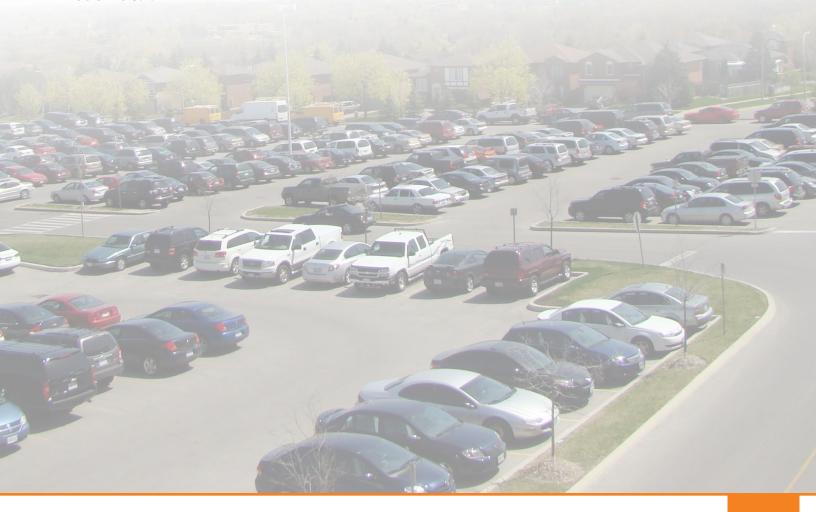
Intersection of buffer area(s) and Dissemination Blocks:

For each TRAP buffer area, an overlay analysis was performed on every DB at least partially within the buffer. The percentage of overlap was calculated and applied to the population counts of the selected DBs. These modified populations were often represented as small values, occasionally falling below one person, particularly in areas with minimal reported populations. The DB geometries were intersected and adjusted to match only the overlapping area (**Figure D.3**).

Population aggregations by Health Neighbourhood, Local Area Municipality, and Durham Region

All intersected DB geometries and their modified populations were then aggregated by summation within each HN, reported for each TRAP buffer area (i.e., area A, B, or C). Aggregations were completed for each Local Area Municipality and Durham Region as a whole.

All geospatial processing was completed with FME Desktop 2022.2 software. Maps were produced using ArcGIS Pro 3.1.



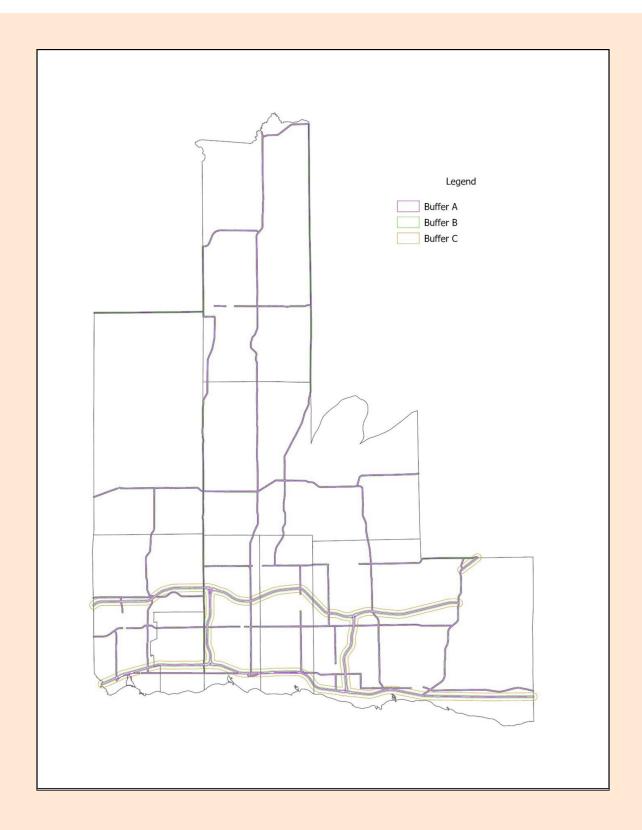


Figure D.1 I Major roads and freeways in Durham Region and their associated TRAP buffer zones

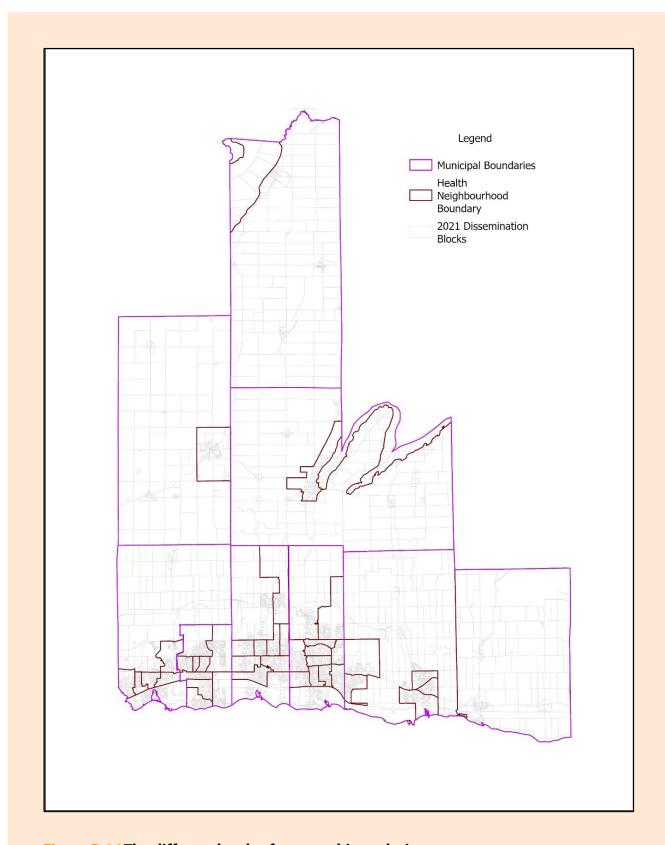


Figure D.2 I The different levels of geographic analysis

Note: Durham Region's boundary is not displayed.

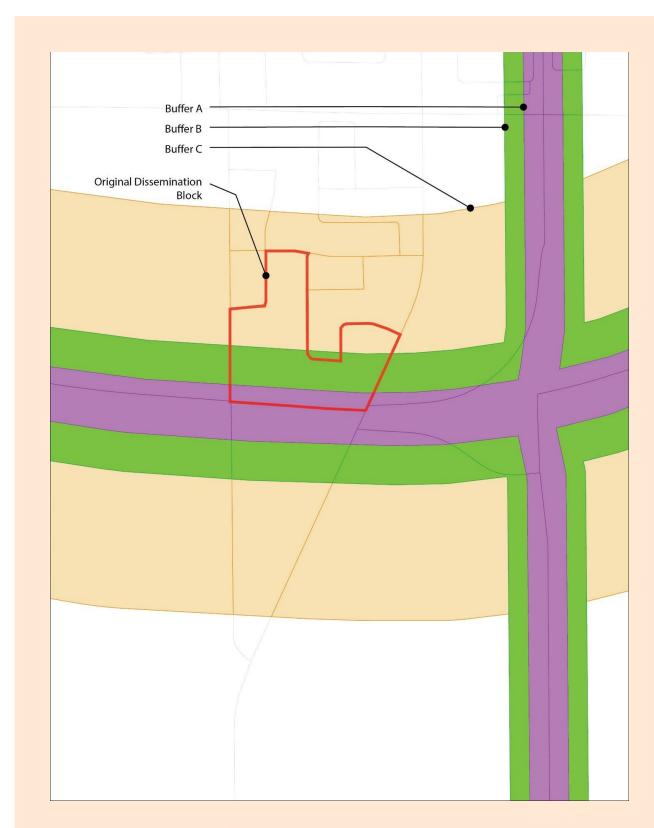


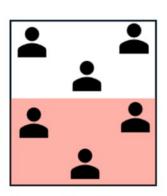
Figure D.3 I Each TRAP buffer was intersected with a Dissemination Block (DB), and the overlap area was used to determine the percentage of the DB's population within the TRAP buffer

Limitations

Population counts for DBs from the 2021 Census were used to estimate the number of people within TRAP buffer zones, assuming an even population distribution within each DB's geographic boundaries. Any uneven population distribution may have led to over-or-underestimation of exposure percentages.

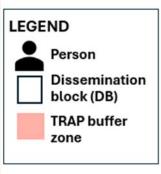
- **Figure D.4** illustrates two exaggerated scenarios: overestimation when populations are concentrated outside the buffer zone and underestimation when concentrated within it.
- Since DBs are the second smallest Census geography, any inaccuracies from uneven distribution are likely minimal compared to larger geographies like Census Tracts or Postal Codes.

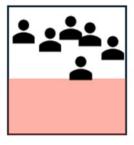
Because annual average daily traffic volumes were unavailable for individual geographic areas, the classification of major roads and highways served as a proxy for traffic volume in Durham Region. However, some non-major roads may experience high traffic and some highways, particularly in northern municipalities, may have lower traffic volumes than expected.



Assumption: All people are evenly distributed within the DB.

% within TRAP zone = 3/6 or 50%





% within TRAP zone = 0%

The estimate on the left would OVERESTIMATE the % within the TRAP zone if the population were concentrated mostly outside of the TRAP zone.



% within TRAP zone = 100%

The estimate on the left would **UNDERESTIMATE** the % within the TRAP zone if the population were concentrated mostly within the TRAP zone.

Figure D.4

Illustration of possible overestimation or underestimation of TRAP population estimates based on the assumption that all individuals are evenly distributed within the Dissemination Block (DB)

References

- [1] Public Health Ontario, "Traffic-Related Air Pollution: Avoiding the TRAP Zone", Toronto, May 28, 2025. [Online]. Available: https://www.publichealthontario.ca/-/media/documents/o/2016/ohp-trap.pdf
- [2] Statistics Canada, "Dictionary, Census of Population, 2021 Dissemination Block (DB), [Census division]." Ottawa, Apr. 16, 2025. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/ref/dict/az/definition-eng. cfm?ID=geo014
- [3] Statistics Canada, "2021 Census Geographic Attribute File." Ottawa, Apr. 16, 2025. [Online]. Available: https://open.canada.ca/data/en/dataset/1b3653d7-a48e-4001-8046-e6964bebe286
- [4] Statistics Canada, "Focus on Geography Series, 2021 Census Durham [Census Division]." Ottawa, Apr.16, 2025. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/Page.cfm?lang=E&topic=1&dguid=2021A00033518

Appendix E: Exposures to Traffic Related Air Pollution among Durham Region Residents

To understand population-level traffic related air pollution (TRAP) exposure within Durham Region, the per centage of the population living near major roads and freeways was calculated based on the methodology developed by Public Health Ontario.¹ An explanation of the methodology and how it was used can be found in **Appendix D**.

Figures E.1- E.3 present maps of the locations of Buffer A, B and C, Health Neighbourhood (HN) and 2021 Census Dissemination Block (DB) boundaries, and the per centage of each HN population living within the relevant TRAP buffer zones. **Table E.1** provides estimates of the proportion of municipal and HN populations living near major roads and freeways for the three TRAP buffer zones based on 2021 Census populations.

¹ Traffic-related air pollution: Avoiding the TRAP zone. Public Health Ontario. Definition of Indicators, p.14.





Figure E.1 | Per centage of Health Neighbourhood populations living within 50 metres of a major road or freeway and location of TRAP Buffer A, 2021

Data Sources: Statistics Canada Dissemination Block boundaries: Statistics Canada, "2021 Census - Geographic Attribute File." Population counts for Dissemination Blocks: Statistics Canada, "Dictionary, Census of Population, 2021 Dissemination Block (DB), [Census division]." Health Neighbourhood Population Counts: 2021 Census, Statistics Canada, Canadian Council on Social Development's Community Data Program. Durham Region boundary and population count: Statistics Canada, "Focus on Geography Series, 2021 Census - Durham [Census Division]." Roads: Durham Region Single Line Road Network, GIS Services Region of Durham, Regional Municipality of Durham, 2025.



Figure E.2 | Per centage of Health Neighbourhood populations living within 100m of a major road or 150m of a freeway and location of TRAP Buffer B, 2021

Data Sources: Statistics Canada Dissemination Block boundaries: Statistics Canada, "2021 Census - Geographic Attribute File." Population counts for Dissemination Blocks: Statistics Canada, "Dictionary, Census of Population, 2021 Dissemination Block (DB), [Census division]." Health Neighbourhood Population Counts: 2021 Census, Statistics Canada, Canadian Council on Social Development's Community Data Program. Durham Region boundary and population count: Statistics Canada, "Focus on Geography Series, 2021 Census - Durham [Census Division]." Roads: Durham Region Single Line Road Network, GIS Services Region of Durham, Regional Municipality of Durham, 2025.

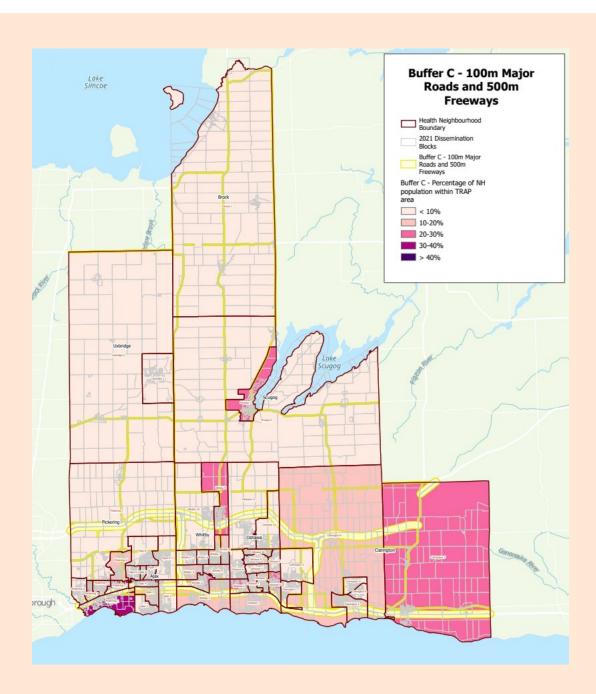


Figure E.3 | Per centage of Health Neighbourhood populations living within 100m of a major road or 500m of a freeway and location of TRAP Buffer C, 2021

Data Sources: Statistics Canada Dissemination Block boundaries: Statistics Canada, "2021 Census - Geographic Attribute File." Population counts for Dissemination Blocks: Statistics Canada, "Dictionary, Census of Population, 2021 Dissemination Block (DB), [Census division]." Health Neighbourhood Population Counts: 2021 Census, Statistics Canada, Canadian Council on Social Development's Community Data Program. Durham Region boundary and population count: Statistics Canada, "Focus on Geography Series, 2021 Census - Durham [Census Division]." Roads: Durham Region Single Line Road Network, GIS Services Region of Durham, Regional Municipality of Durham, 2025.

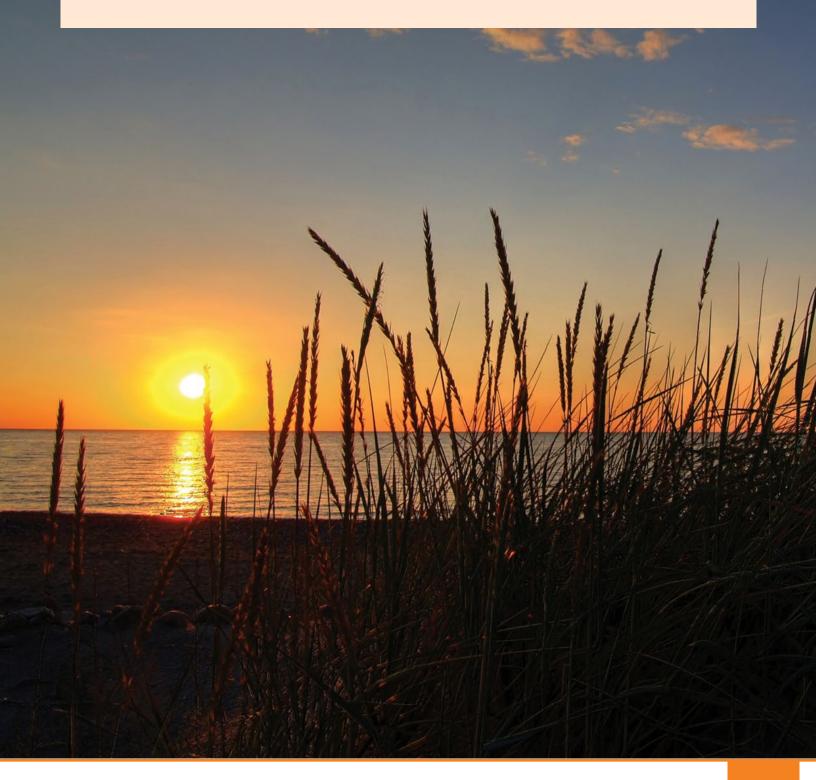
TABLE E.1 | Proportion of municipal and Health Neighbourhood populations living near major roads and freeways, 2021

Municipality or Health Neighbourhood	2021 Population	Buffer A: % of total population living within 50m of major roads and freeways	Buffer B: % of total population living within 100m of major roads and 150m of freeways	Buffer C: % of total population living within 100m of major roads and 500m from freeways
Pickering	98,595	3.5%	8.0%	19.2%
Frenchman's Bay (P1)	18,245	5.2%	10.8%	32.7%
West Rouge (P2)	14,315	0.0%	0.2%	5.7%
Amberlee (P3)	9,750	5.2%	10.6%	26.2%
Dunbarton (P4)	13,640	2.1%	5.3%	12.4%
Pickering City Centre (P5)	14,110	4.4%	11.8%	37.6%
Brock Ridge Pickering (P6)	14,750	4.6%	10.6%	10.6%
Pickering North (P7)	13,785	2.9%	6.3%	7.5%
Ajax	126,245	1.4%	3.7%	8.4%
Ajax Waterfront (A1)	10,825	0.1%	0.2%	0.2%
Downtown Ajax (A2)	12,570	5.1%	10.7%	18.3%
Carruthers (A3)	14,455	1.4%	2.9%	5.9%
Central Ajax (A4)	11,685	2.7%	12.6%	51.6%
Riverside-Hermitage (A5)	12,600	0%	0%	0%
Westney Heights (A6)	8,255	0%	0%	0%
Applecroft (A7)	11,690	0%	0%	0%
Ajax Northwest (A8)	19,445	0.7%	1.5%	1.5%
Ajax Northeast (A9)	24,720	1.9%	4.4%	4.4%
Whitby	136,515	3.3%	7.2%	11.9%
Whitby South (W1)	15,570	4.2%	9.1%	11.0%
Downtown Whitby (W2)	16,135	1.9%	5.7%	23.6%
Cochrane South (W3)	11,180	0.1%	0.2%	11.0%
Manning (W4)	14,900	2.6%	5.4%	5.4%
Williamsburg (W5)	11,430	2.6%	5.7%	7.5%
Whitby Brock North (W6)	11,775	2.2%	4.4%	4.4%
Dryden-Anderson (W7)	11,950	4.6%	10.1%	10.1%
Dryden East (W8)	12,920	7.2%	14.2%	14.2%
Brooklin East (W9)	13,890	6.8%	14.7%	21.6%
Brooklin West (W10)	16,765	0.9%	2.1	7.3

Municipality or Health Neighbourhood	2021 Population	Buffer A: % of total population living within 50m	Buffer B: % of total population living within	Buffer C: % of total population living within
		of major roads	100m of major	100m of major
		and freeways	roads and 150m of freeways	roads and 500m from freeways
Oshawa	174,160	3.1%	6.4%	10.7%
Lakeview (O1)	18,720	5.6%	6.8%	15.1%
Gibb West (O2)	11,310	1.6%	5.4%	21.9%
Downtown Oshawa (O3)	12,080	1.5%	4.7%	18.7%
Central Park (O4)	11,785	3.1%	7.6%	14.9%
Grandview South (O5)	11,140	4.9%	12.2%	23.8%
Stevenson North (O6)	17,225	0.1%	0.1%	0.1%
Hillsdale (O7)	10,975	2.1%	4.3%	4.3%
Beatrice South (O8)	13,180	1.3%	2.5%	2.5%
Grandview North (O9)	13,075	3.0%	6.3%	6.3%
Beatrice North (O10)	10,720	9.9%	19.6%	19.6%
Oshawa Northwest (O11)	21,815	1.9%	3.8%	4.8%
Oshawa Northeast (O12)	22,135	3.8%	8.1%	8.2%
Clarington	100,720	3.4%	7.3%	11.8%
Courtice South (C1)	17,195	3.5%	6.8%	7.3%
Courtice North (C2)	11,355	2.8%	5.7%	7.7%
Bowmanville South (C3)	16,780	5.4%	11.0%	14.4%
Bowmanville Central (C4)	9,470	0%	0%	0%
Bowmanville North (C5)	13,785	0.6%	1.2%	1.2%
Darlington (C6)	14,780	3.4%	8.7%	16.9%
Clarke (C7)	17,355	5.9%	12.9%	26.9%
Scugog	21,440	6.3%	12.4%	12.4%
Port Perry (S1)	9,055	10.6%	20.8%	20.8%
Rural Scugog (S2)	12,385	3.2%	6.2%	6.2%
Uxbridge	21,365	1.2%	2.5%	2.5%
Urban Uxbridge (U1)	12,415	0.4%	0.8%	0.8%
Rural Uxbridge (U2)	8,950	2.4%	4.8%	4.8%
Brock	12,320	2.5%	4.8%	4.8%
Brock (1)	12,320	2.5%	4.8%	4.8%
Durham Region	691,360	3.0%	6.4%	11.6%

Data Sources:

- Statistics Canada Dissemination Block boundaries: Statistics Canada, "2021 Census Geographic Attribute File." Ottawa, Apr. 16, 2025. [Online]. Available: https://open.canada.ca/data/en/dataset/1b3653d7-a48e-4001-8046-e6964bebe286
- Population counts for Dissemination Blocks: Statistics Canada, "Dictionary, Census of Population, 2021 Dissemination Block (DB), [Census division]." Ottawa, Apr. 16, 2025. [Online]. Available: https://www12.statcan.gc.ca/census-recensement/2021/ref/dict/az/definition-eng.cfm?ID=geo014
- Health Neighbourhood Population Counts: 2021 Census, Statistics Canada, Canadian Council on Social Development's Community Data Program.
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- Roads: Durham Region Single Line Road Network, GIS Services Region of Durham, Regional Municipality of Durham, 2025. [Online]. Available: Road Network | Regional Municipality of Durham Open Data





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