Rouge River

State of the Watershed Report

Air Quality

Goal: Air of a quality that protects human health, natural ecosystems and crops, and contributes to the reduction of global climate change.

Air Quality

Key Findings:

- “Good” to “Very Good” Air Quality Index scores 93 % of the time in 2001.
- Ozone was typically the pollutant responsible for poor conditions.
- Ground-level ozone levels tend to be higher in the rural parts of the watershed.
- The number of smog advisory days has been increasing, primarily due to elevated ground-level ozone levels and fine-particulate matter.
- York Region residents commute longer distances to work as compared to the average Ontario resident. Vehicle emissions are a primary source of greenhouse gases, which are contributing to global warming.
- Local human health conditions have been linked to poor air quality.
- Local studies have demonstrated that forests are effective moderators of air quality.

Summary of Current Conditions Ratings:

Objective:	*Overall Rating*
• Protect and restore air quality.	Fair

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Unique Rouge River Watershed Feature

Almost 20% of the forest benefits to air quality in the City of Toronto come from the Rouge River watershed.

CHAPTER

10

AIR QUALITY

10.0 AIR QUALITY

10.1 Introduction

Air, like groundwater, is usually invisible and is easily overlooked when assessing the impacts of human activities. However, air is an essential ingredient of life, and so plays a critical role in the functioning of the watershed. Air can be a medium for the spread of airborne contaminants. Air contaminants arise from natural and human activities and processes, and may be released from local, regional or even global sources, thereby complicating management efforts. Some air pollutants are also greenhouse gases, contributing to global warming of the atmosphere, also known as “climate change”.

This chapter assesses current air quality conditions, examines changes in air quality, and identifies key sources of pollution and their potential impacts on the Rouge River watershed. The data summarized in this report are derived from three local monitoring sites, although the atmospheric region of influence, or “airshed”, extends far beyond the watershed boundary. Situated in the densely populated Great Lakes Basin, the Toronto Region is affected by long range transport of pollutants from as far away as the Ohio Valley in the USA (Health Canada, 1997). Despite improvements in air quality over the last 30 years, smog remains a concern in southern Ontario, and concentrations of ozone and suspended particulates (major components of smog and greenhouse gases) frequently exceed provincial standards. On the positive side, the Rouge River watershed contains the largest forested area in Toronto which provides considerable benefits to air quality in the region.

10.2 Understanding the sources and impacts of air pollution

Air quality is measured on the basis of emissions of contaminants into the atmosphere from both human and natural activity, and from their atmospheric interactions. Although both natural and human sources contribute to air pollution, the main contribution comes from everyday human activity (City of Toronto, 2000). Pollutants are released through volcanic eruptions, dust storms, emissions from oceans and vegetation, forest fires, factories, power plants, smelters, planes, trains, and other vehicles. Air pollution can affect the health of humans and vegetation and the appearance and integrity of buildings and structures. Poor air quality may also contribute to climate change, through elevated levels of greenhouse gases in the atmosphere. Table 10-1 summarizes the links among various air quality issues and the pollutants discussed in this report: ozone, sulphur dioxide, carbon monoxide, nitrogen oxides, volatile organic compounds, and particulate matter. Table 10-2 provides further details on the sources and effects of pollutants that frequently exceed the Ontario Ambient Air Quality Criteria within the Rouge River watershed and surrounding area.

Table 10-1: Linkages Among Air Pollutants and Air Quality Issues

Pollutant	Smog	Global Warming	Urban Air Quality	Acid Deposition	Health	Aesthetics
Ozone	yes	yes	yes	yes	yes	
Sulphur Dioxide	yes	yes	yes	yes	yes	yes
Carbon Monoxide	yes	yes	yes		yes	no
Nitrogen Oxides	yes	yes	yes	yes	yes	yes
Volatile Organic Compounds	yes	yes	yes		yes	yes
Particulates	yes	yes	yes	yes	yes	yes

Source: Adapted from Ontario Ministry of the Environment, 2002.

Both urban and rural sources of air pollutants may contribute to poor air quality. For example, significant levels of methane and carbon dioxide may be emitted from large livestock operations. Urban air pollutants arise from a wide variety of sources, although they are mainly a result of combustion processes (Environment Canada, 2001). Today, the largest source of pollution in most urban areas is the motor vehicle, and to a lesser extent, industry (Ontario Ministry of the Environment (OMOE), 2004). As the urban trend for single occupancy vehicle use continues, more and more vehicles enter the road network, creating more trips per day and greater traffic congestion. Trip lengths in the Greater Toronto Area (GTA) will continue to rise as residents relocate to suburban areas and work in a regional economy. In comparison to the average Ontario resident, the residents of York Region commute longer distances to work, drive their cars to work more often, and make fewer trips by public transit, bicycle and walking (Region of York, 2000).

Air pollution affects living organisms and inanimate objects through direct contact with air, chemical loading via dry or wet deposition (i.e., precipitation), and through condensation and absorption processes. Many of the chemicals that are emitted to air settle on surfaces, such as soils or built features, and ultimately enter surface waters and groundwater. Water bodies adjacent to urban areas are impacted by air pollution due to atmospheric deposition. As water moves through the hydrological cycle, it falls as rain or snow and then evaporates to the atmosphere from the land and surface waters. Other substances, including toxic pollutants, follow this same path. Pollutants may evaporate to the atmosphere, where wind currents can carry them for long distances before depositing them.

Table 10-2: Pollutants that Frequently Exceeded the Ontario Ambient Air Quality Criteria in the Rouge River Watershed and Surrounding Area (2001 data)

Pollutant	Sources	Effects
Ozone (O_3)	It is a colourless gas produced by photochemical reaction between nitrogen oxides, volatile organic compounds (typically emitted from internal combustion engines) and air in the presence of sunlight. Ozone is not directly emitted into the atmosphere in significant amounts. Ozone is formed downwind of theses sources and is capable of traveling long distances. A large portion (over 50 percent or greater) of the ground-level ozone concentrations found in Ontario can be attributed to long range transport of ozone and its precursors from industrial states south of the Great Lakes. High levels generally occur from May to September between noon and early evening. In Ontario, the highest concentrations of ozone are on hot and sunny summer days. Ground-level ozone pollution is a primary component of smog.	Human: Ozone is a pulmonary irritant that affects the respiratory mucus membranes, other lung tissues, and respiratory functions. Studies have demonstrated that ozone impairs the normal function of the lungs, causing alterations in respiration rates, the most characteristic being shallow, rapid breathing. People with respiratory and heart problems are at higher risk. Exposure may result in chest tightness, coughing, and wheezing. Vegetation: injury to vegetation is an early sign of photochemical air pollution. Sensitive plants are useful biological indicators of this type of pollution. Visible signs of injury due to ozone are flecking and leaf discolouration.
Total Suspended Particulates (TSP) Suspended Particulates (SP)	TSP is a generic term for airborne particles including aerosols, smoke, fumes, dust, fly ash and pollen. The composition varies but normally includes soil particulate, organic matter, sulphur and nitrogen compounds and metals such as lead, carbon, or higher hydrocarbons formed by incomplete combustion of hydrocarbon fuels. Size range varies from 0.1 to 100 microns. SP is a relative measure of suspended particulate matter in the atmosphere most likely to reach the lungs (diameter generally less than 10 microns, PM10). These have the greatest effect on health. Particulate matter is emitted from industrial processes including combustion, incineration, construction, metal smelting and processing. In the urban airshed, motor vehicle exhaust, and road dust are major sources of particulate emissions. Natural sources of particulate matter include windblown soil, forest fires, ocean spray, and volcanic activities.	Human: The greatest impact on health is from particles less than 10 microns in diameter which can penetrate deep into the lungs and can aggravate bronchitis, asthma, and other respiratory diseases. More serious health effects may be associated with suspended particulate matter which contains toxic particulate component or which has adsorbed a gaseous pollutant on the surface of the particles. Other effects: Corrosion, soiling of materials, damage to vegetation, and visibility reduction are additional effects.

Source: Unless otherwise noted, Table 10-2 is adapted from Ontario Ministry of the Environment, 1997.

10.2.1 Human health

Poor ambient air quality has an adverse effect on public health. A study conducted by Toronto Public Health in 1999 estimated that there have been between 730 and 1400 premature deaths, and between 3,300 and 7,600 hospital admissions, each year in Toronto associated with air pollution (Toronto Public Health, 2000). The study suggested that nitrogen dioxide (NO_2) is the air pollutant with the greatest impact on human health, followed by carbon monoxide (CO) and sulphur dioxide (SO_2). More recent health research by the Ontario Medical Association (OMA) indicates that there is no "safe" level for common air pollutants such as ozone and particulate matter (OMA, 2001).

Individual reactions to air contaminants depend on several factors such as the type of pollutant, the degree of exposure and how much of the pollutant is present. Age and health are also important factors. Health and health-care system effects of ground-level ozone at levels that occur in Canada include lung inflammation, decreased lung function, airway hyper-reactivity, respiratory symptoms, possible increased medication use and physician/emergency room visits among individuals with heart or lung disease, reduced exercise capacity, increased hospital admissions and possible increased mortality. Similar effects are thought to occur in association with airborne particles, with the exception of inflammatory changes and with the additional effect of increased school absenteeism (OMA, 1998).

10.2.2 Terrestrial and aquatic health

Terrestrial and aquatic systems are affected by poor air quality through direct contact with polluted air. For example, ground-level ozone interferes with the ability of plants to produce and store food, so that growth, reproduction and overall plant life is compromised. Air pollution is a major concern for the agricultural industry. With crops marketed based on appearance and taste, damage such as that detailed in Table 10-3, can have a substantial effect on sales. How badly the crop is damaged will depend on how long the crop is exposed to the pollutant, the crop species and its stage of development, as well as the environmental factors that influence the build-up of the pollutant and the preconditioning of the plant. The Ontario Ministry of Agriculture (OMAF) has expressed concern for several crop types in Ontario that are susceptible to air pollution, including tomatoes, peppers, beans, potatoes, cucumber, lettuce, onions, sweet corn, spinach and grapes (OMAF, 2002). They have also found some species to be resistant to ozone damage, such as endive, apricot and pear.

Table 10-3: Potential Air Pollution Damages to Ontario's Crops

Pollutant	Symptoms/Injury to Crops
Ozone	Symptoms vary depending on the concentration of ozone in the air and the length of exposure. Ozone symptoms characteristically occur on the upper surface of affected leaves and appear as flecking, bronzing or bleaching of the leaf tissues. Although yield reductions are usually with visible foliar injury, crop loss can occur without any sign of pollutant stress. Conversely, some crops can sustain visible foliar injury without any adverse effect on yield. Injury tends to occurs on the most recently emerged leaves.

Pollutant	Symptoms/Injury to Crops
Sulphur Dioxides	Exposures to high levels will result in light tan to white necrotic areas and yields may be reduced.
Nitric Oxide	Depending on the concentration and extent of exposure, plants may suffer leaf lesions and reduced crop yield.
Peroxyacetyl nitrate (PAN)	Affects tissues on the lower leaf surface, typically causing a gradual glazing or silvering effect in bands or blotches, which may advance to bronzing within two to three days. Small plants and recently matured leaves are most susceptible to PAN injury.

Adapted from OMAF, 2002.

Deposition of pollutants, both wet and dry, into watershed systems also adversely affects terrestrial and aquatic ecosystems. For instance, acid deposition can alter the protective waxy surface of leaves, inhibit plant germination and reproduction, accelerate soil weathering and make some toxic elements, such as aluminum, more soluble which can prevent the uptake and use of nutrients by plants (Environment Canada, 2001). Since air pollution can weaken sensitive vegetation, it makes plants more susceptible to disease, pests, and environmental stresses.

Atmospheric deposition is a significant source of certain toxic pollutants in the aquatic system. In fact, as much as 90 percent of some toxic loadings to the Great Lakes are believed to be the result of airborne deposition (Great Lakes Information Network (GLIN), 2003). In Ontario, sulphur compounds account for approximately two-thirds of acid deposition while nitrogen compounds account for the remaining portion (Great Lakes Information Network (GLIN), 2003). Key sources of these emissions include gasoline powered vehicles, coal-fired generation of electricity and industrial combustion processes (OMOE, 2003). A large area of Ontario, including Toronto Region, receives acid deposition exceeding the critical load or the concentration above which deleterious effects on human health may occur (City of Toronto, 2000). However, it is unknown at this time what impact acid rain has had on terrestrial and aquatic systems In the GTA. Low pH (acidic conditions) has been linked to reproduction and death of aquatic species and consequent changes in quality and quantity of food for aquatic birds (GLIN, 2003).

With global habitat reduction, some of the natural sources of air pollutants are diminishing, but so are the air quality benefits that natural areas provide. Plants absorb carbon dioxide and release the oxygen that most organisms need to breathe. Forests, in particular, store large quantities of carbon and also sequester it, making them a “carbon sink”. They trap and absorb significant amounts of pollutants, as well (Kenney and Associates, 2001). These improvements to air quality help to counteract the effects of climate change, which results from high concentrations of greenhouse gases in the atmosphere.

Land clearing for rural and urban activities causes a corresponding reduction in the air quality benefits that the natural areas provide. It also results in higher air temperatures. Forests lower air temperature through shading and transpiration. Trees absorb great amounts of water and their leaf surfaces provide large surface areas from which water can evaporate. As a natural cooling process, the evaporation leaves a forest relatively cool. Trees return roughly three-quarters of the water they absorb to the atmosphere through evapotranspiration (Kenney and Associates, 2001). Increased temperatures play a role in accelerating the formation of ground level ozone (OMA, 2001).

10.2.3 The built environment

Artificial surfaces such as asphalt, concrete, roof tops and other manufactured materials, absorb much of the sun's energy and store it, remaining hot long after sunset. In a city where artificial surfaces are highly concentrated, this phenomenon produces a dome of elevated temperatures compared to the air over adjacent rural areas. The higher ambient temperatures of this "heat island" speed up the chemical reactions that produce smog (City of Toronto, 2000). The lower levels of evaporation in city environments are another contributing factor to the heat island effect. Urban surfaces do not hold water like natural ones do. When it rains, most water is collected and diverted into sewers, leaving the city dry and without an important cooling tool. The urban heat island effect is even further exacerbated by the added heat generated in running air conditioners and machinery, and from vehicle exhaust. The increased use of energy for cooling is not only more expensive, but also increases the pollution coming from power plants.

Poor air quality impacts the composition of artificial features in rural and urban landscapes. For example, acid deposition accelerates corrosion, fracturing, and discoloration of buildings, structures, and monuments (Environment Canada, 2001). Restoration of such features is only one of the many costs associated with air pollution in the rural and urban landscape. Lost productivity due to health concerns, increased hospital admissions and crop losses all have economic ramifications.

10.2.4 Climate change

Since the industrial revolution, significantly greater volumes and concentrations of carbon dioxide, methane, nitrous oxide, sulphur dioxide and chlorofluorocarbons (CFCs) have entered the Earth's atmosphere. These gases not only impact air quality, but also they trap outgoing radiation and raise the temperature of the Earth's lower atmosphere by creating a "greenhouse effect", resulting in changes to the Earth's climate. In fact, there is some evidence to suggest that climate change is already occurring, resulting in shorter winters, warmer annual average temperatures, shorter lake ice cover, and more frequent heavy rainstorms in the Great Lakes basin (Kling *et al.*, 2003).

Climate change has the potential to cause significant changes to the hydrological cycle in the Rouge River watershed, with associated impacts on land and water resources and human communities. Climate change studies for the Great Lakes region predict changes in the mean and seasonal distribution of precipitation and streamflows, and changes in the frequency and intensity of extreme weather events (e.g., droughts, floods, ice storms, heat waves) (Duncan *et al.*, 2001; Kling *et al.*, 2003).

Climate change may also intensify air pollution. Higher air temperatures combined with air pollutants may increase the concentration of ground-level ozone, thereby reducing air quality and exacerbating human respiratory, cardiovascular disorders and allergy problems (Intergovernmental Panel on Climate Change, 1996).

10.3 Measuring air quality

Ontario's air quality is monitored at a network of monitoring stations operated by the Ontario Ministry of the Environment. Of the 37 continuous monitoring sites across Ontario, there is only one site located within the Rouge River watershed. This York Region site (No. 48002) is located on Highway 47 just east of Highway 48. To the southeast and northeast of the watershed, there are two additional sites: Scarborough (No. 33003) and Toronto North (No. 34020) which for the purposes of this analysis are considered representative of conditions in the Rouge River watershed.

The Air Quality Index (AQI) measures hourly ambient concentrations of six key contaminants known to have adverse effects on human health and the environment: sulphur dioxide (SO_2), ozone (O_3), nitrogen dioxide (NO_2), total reduced sulphur (TRS) compounds, carbon monoxide (CO) and suspended particles (SP) (OMOE, 2003). AQI values are divided into five levels of severity (Table 10-4). Each level has an associated effect on human and ecological health. At the time that the air quality index was established, values of 0 – 31 were believed to have few or no known health effects. An AQI of 32 – 49 can damage vegetation and cause respiratory irritation in sensitive people when active. An AQI of 50 – 99 can cause decreased visibility, irritation for people with sensitive respiratory systems at rest, and damage to some plants. AQI values above 200 may cause severe odour, serious respiratory effects and disorientation, and extensive damage to vegetation. The Ontario Medical Association (2001) has supported the Toronto Public Health's call for a revised air quality index with recognition that all levels of air pollution are harmful. Section 10.4 presents AQI values for the Rouge River watershed.

Table 10-4: Air Quality Index Categories

Air Quality Index (AQI) value	Category
1-15	Very good
16-31	Good
32-49	Moderate
50-99	Poor
100+	Very poor

Source: Adapted from OMOE, 2002.

The presence or absence and changes in the abundance of certain arboreal (i.e., tree-living) lichen species can also be used to measure local air quality. Lichens are useful indicators of deteriorating air quality because their complete reliance on atmospheric sources of nutrition makes them inherently sensitive. The composition of arboreal lichen communities is one of the best biological indicators of nitrogen and sulfur-based air pollution in forests (Muir and McCune, 1988). In several studies, lichens have given much clearer responses to nitrogen and sulphur pollutants than either leaf symptoms or tree growth, and have been one of the few components of terrestrial ecosystems to show a clear response to gradients of acidic deposition in the eastern United States (e.g., Eversman, 1987; Muir and McCune, 1988).

Monitoring of six lichen species was initiated during the fall of 2002 by TRCA's Terrestrial Volunteer Monitoring Program. However, the resulting data are insufficient at this time to use in this assessment of air quality.

A complete analysis of air quality should include an examination of the potential benefits of vegetation. Improvements in air quality due to vegetation can be estimated based on scientific studies of the uptake and release of chemicals by plants.

10.3.1 Federal and provincial criteria

The Ministry of the Environment maintains a listing of more than 300 ambient air quality criteria (AAQC) and the corresponding point of impingement (POI) limits (Table 10-5). AAQC are used for assessing general air quality and the potential for causing an adverse effect. POI limits are used primarily to review applications for certificates of approval for emissions to air and to assess compliance with Ontario Regulation 346 (General - Air Pollution).

Many of Ontario's air standards were established more than 20 years ago. Since that time, the science of risk assessment has advanced significantly. Accordingly, in both this version of the standards-setting plan, *Setting Environmental Quality Standards in Ontario*, and the previous version, the ministry has placed particular emphasis on reviewing and updating existing air quality standards to ensure that they are current and provide for adequate protection of human and ecosystem health. Additionally, processes have been developed to identify new substances for which formal standards should be developed.

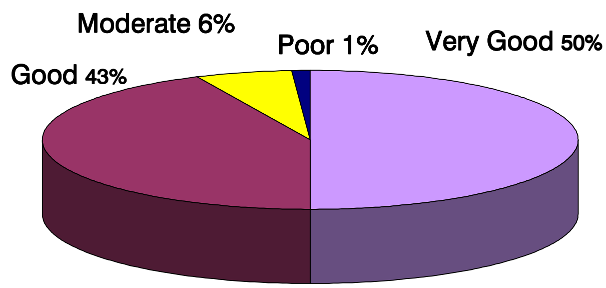
Table 10-5: Ambient Air Quality Criteria (AAQC) for Air Quality Index Pollutants.

Pollutant	1-hour AAQC	24-hour AAQC
Ozone	80 ppb	n/a
Nitrogen Dioxide (NO_2)	200 ppb	100 ppb
Carbon Monoxide (CO)	30 ppm	n/a
Sulphur Dioxide (SO_2)	250 ppb	100 ppb
Respirable Particles ($PM_{2.5}$)	n/a	30 ug/m^3

10.4 Existing conditions in the Rouge River watershed

According to the AQI scores for the Stouffville, Toronto East and Toronto North monitoring sites, the Rouge River watershed has "Good" air quality conditions the majority of the time (Figure 10-1). In 2001, scores of "Good" to "Very Good" (AQI values of 0-31) were recorded 93% of the time. Air quality was in the poor range (50-99) only 1% of the time. Recorded AQI levels exceeded 31 on an average of 3 hours at these sites. In each case, ozone was the pollutant responsible for the exceedance. The following sections report on levels of the key contributing pollutants to the AQI: sulphur dioxide, ozone, nitrogen dioxide, total reduced sulphur compounds, carbon monoxide (CO) and suspended particles (SP).

Figure 10-1: Air Quality Index Summary (2001 data) (OMOE, 2002)



Note: Percentages represent an average of Stouffville, Toronto East and Toronto North monitoring stations.

10.4.1 Ozone

Analysis of the data indicates that elevated ground-level ozone levels are by far the primary cause of air quality advisories. Unlike other air quality pollutants, ground-level ozone is not emitted directly into the atmosphere. Ozone results from chemical reactions between volatile organic compounds (VOCs) and nitrogen oxides (NOx) in the presence of heat and sunlight (OMOE, 2003). Nitrogen oxides and volatile organic compounds are emitted from a variety of sources, including internal combustion processes (e.g., vehicle use, power generation), consumer and commercial products, and many industrial processes. A colourless, odourless gas, ozone is a major component of smog. Figure 10-2 shows estimates of Ontario's VOC emissions by sector. In urban areas, such as Toronto, transportation sectors account for approximately 30% of VOC emissions.

Figure 10-2: VOC Emission Estimates in Ontario by Sector (OMOE, 2001)

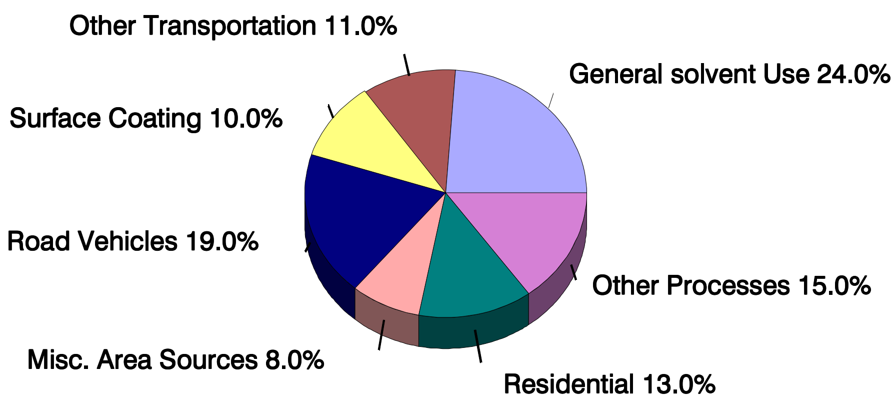


Table 10-6 summarizes ozone concentrations at sites within and around the watershed. The yearly ozone level has a slight, yet steady increase with the exception of 2000. Year to year, ozone levels are strongly influenced by weather. The sudden drop in ozone levels can be attributed to the cool, wet summer of 2000.

Ozone levels tend to be lower in urban areas than in rural areas, because urban areas generate pollutants which chemically react with ozone, destroying some of it. An examination of ozone exceedance days across the three local monitoring sites illustrates this point. The Ambient Air Quality Criteria for ozone is 80 parts per billion, averaged over a one hour period (OMOE, 2003). The rural Stouffville site consistently has the highest number of exceedance days compared to the urban Toronto East and Toronto North sites. Of the seven monitoring sites across the GTA, Stouffville has the highest levels of ozone year-round.

Short term (1 to 3 hours) and prolonged (6 to 8 hours) exposure to ambient ozone has been linked to a number of health effects. Ground-level ozone can inflame breathing passages, decreasing the working capacity of the lungs. Symptoms can include shortness of breath, pain when inhaling deeply, wheezing and coughing (Toronto Public Health, 2004). Ozone also affects vegetation and ecosystems, leading to reductions in agricultural and commercial forest yields, and reduced growth and survivability of tree seedlings. Ground-level ozone can decrease the aesthetic value of ornamental species, as well as the beauty of our parks and recreation areas.

10.4.2 Particulate matter

Not all pollutants are in gaseous form. Small solid particles and liquid droplets, collectively called particulates, are also present in the air. These particles, including aerosols, smoke, dust, fly ash and pollen, originate from many different sources. They may be emitted directly from a source or formed in the atmosphere by the transformation of gaseous emissions. Particles less than 10 microns in diameter are defined as inhalable particles (PM_{10}) and are primarily emitted from industrial sources and motor vehicle exhaust (Figure 10-3). In the urban airshed, motor vehicle exhaust is the major source of PM_{10} particles. Particles less than 2.5 microns in diameter are defined as respirable particles ($PM_{2.5}$) and originate primarily from chemical reactions in the atmosphere and through combustion. The effects of particulates on health are directly related to their size and chemical composition. Once emitted, suspended particulates can reduce visibility, produce soiling when settled, damage vegetation, increase corrosion and, if smaller than 10 microns, penetrate lungs and contribute to respiratory disease (OMOE, 2003). Table 10-7 summarizes inhalable particle (PM_{10}) concentrations at two of the local stations. Both stations occasionally exceed the provincial interim 24-hour criteria of 50 microns/L, a concentration limit for the protection of human health.

10.4.3 Sulphur dioxide

Sulphur dioxide (SO_2) is an atmospheric pollutant which results from combustion processes (mainly burning of fossil fuels containing sulphur), smelting operations, and pulp and paper processes. Sixty-nine percent of SO_2 emitted in Ontario in 2000 came from smelters and utilities, other industrial source include iron and steel mills, petroleum refineries, and pulp and paper mills (Figure 10-4). Historically, the highest concentrations of SO_2 in Ontario have been recorded in the vicinity of large industrial sources (OMOE, 2003).

Table 10-6: Annual Mean Concentrations of Ozone (ppb) and Exceedance days (>80ppb)

STATION	1997		1998		1999		2000		2001	
	Mean	# of times > criteria	Mean	# of times > criteria	Mean	# of times > criteria	Mean	# of times > criteria	Mean	# of times > criteria
Stouffville	30.1	54	31.4	95	31.2	102	27.5	15	30.5	64
Toronto East	18.0	31	20.6	59	21.5	77	19.6	11	21.7	63
Toronto North	21.6	26	22.0	34	22.8	43	20.6	8	23.4	55
Average	23.3	37	24.7	63	25.2	74	22.6	11	25.2	82

Source: Adapted from OMOE, 2002.

Table 10-7: Annual Mean Concentrations of Inhalable Particles (PM10) and 24 hour Exceedances (>50ug/m3)

STATION	1997		1998		1999		2000		2001	
	Mean	# of times > criteria	Mean	# of times > criteria	Mean	# of times > criteria	Mean	# of times > criteria	Mean	# of times > criteria
Stouffville	15.2	1	17.6	4	17.9	5	16.3	1	n/a	n/a
Toronto East	19.0	1	20.5	8	19.6	5	18.3	0	n/a	n/a
Average	17.1	1	19.1	6	18.8	5	17.3	0.5	n/a	n/a

Source: Adapted from OMOE, 2002.

Figure 10-3: Estimated Ontario PM10 Emissions by Sector (OMOE, 2002)

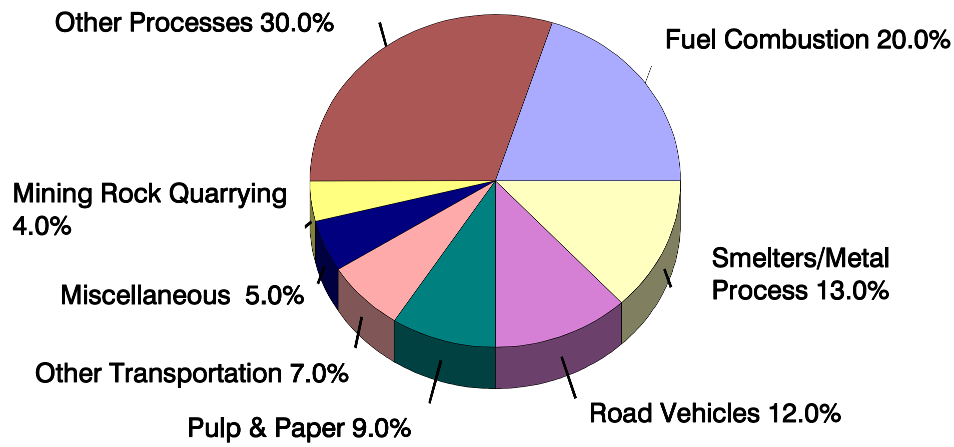
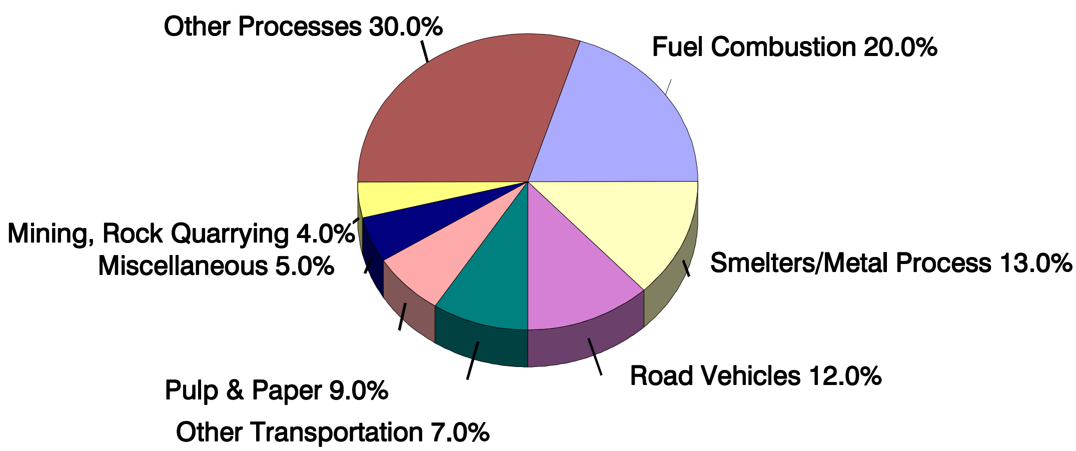


Figure 10-4: Estimated Sulphur Emissions in Ontario by Sector (OMOE, 2002)



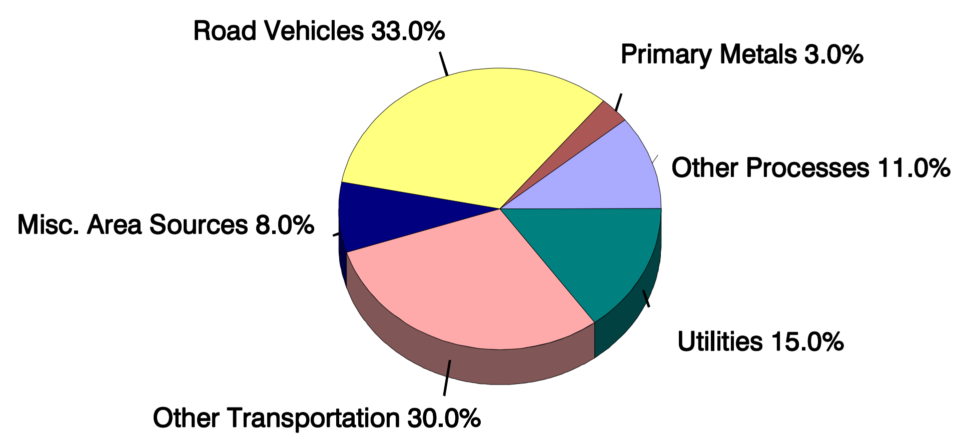
Repeated or prolonged exposure to moderate concentrations of sulphur dioxide may cause inflammation of the respiratory tract, wheezing and lung damage. It has also been observed to harm the reproductive systems of laboratory animals and cause developmental changes in their newborn. Even low concentrations of sulfur dioxide can harm plants and trees and reduce crop productivity. Acid deposition (i.e., acid rain) occurs when sulphur dioxide combines with water vapor and gets deposited through precipitation. Acid deposition is known to have many adverse affects on both aquatic and terrestrial ecosystem health.

The 3 local monitoring sites did not provide sufficient data to be used in the analysis of 1997-2001 conditions. However, levels of sulphur dioxide in the Rouge River watershed are not a problem as there were no incidences recorded within this period of levels above Ontario's Ambient Air Quality Criteria (20 ppb).

10.4.4 Nitrogen dioxide

Nitrogen gas (N_2) is an abundant and inert gas which makes up almost 80 percent of the earth's atmosphere. In this form, it is harmless to humans and essential to plant metabolism. Due to its abundance in the air, it is a frequent reactant in many combustion processes. When combustion temperatures are extremely high, as in the burning of coal, oil, gas and in automobile engines, atmospheric nitrogen (N_2) may combine with molecular oxygen (O_2) to form various oxides of nitrogen (NOx). Of these, nitric oxide (NO) and nitrogen dioxide (NO_2) are the most important contributors to air pollution. Nitric oxide is a colourless and odourless gas that contributes to haze and visibility reduction. It is also known to cause deterioration and fading of certain fabrics and damage to vegetation (OMOE, 2003). Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infection and its derivatives can damage trees and crops. Sources of nitrogen dioxide are shown in Figure 10-5.

Figure 10-5: Estimated Nitrogen Dioxide Emissions in Ontario by Sector (OMOE, 2002)



Provincial averages of NO_2 have remained relatively constant over the last decade (1991-2001) (OMOE, 2003). Average concentrations are highest in Ontario's larger urban centres such as the Greater Toronto Area (GTA). In 2001, six monitoring stations across the GTA were ranked in the top ten highest NO_2 concentrations in Ontario (OMOE 2003). The Toronto east and Toronto North monitoring stations, which are representative of air quality conditions within the Rouge River watershed, consistently rank within Ontario's top five stations with high $NO_{2.}$ However, as Table 10-8 demonstrates, there were no incidences recorded between 1997-2001 of levels above Ontario's ambient air quality criteria (1 hr- 200 ppb, 24 hr - 100 ppb).

Table 10-8: Annual Nitrogen Dioxide Mean Concentrations (ppb)

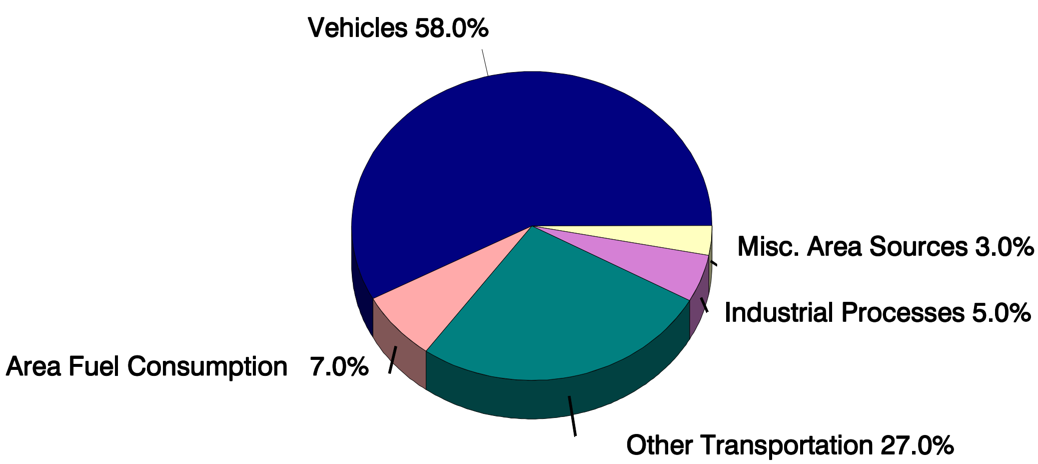
STATION	1997	1998	1999	2000	2001
Stouffville	8.7	11.5	12.4	12.8	n/a
Toronto East	23.4	25.5	24.6	23.7	22.9
Toronto North	20.2	23.4	24.3	22.7	22.0
Average	17.4	20.1	20.4	19.7	n/a

Source: Adapted from OMOE, 2002.

10.4.5 Carbon monoxide

Carbon monoxide (CO) is produced primarily by incomplete burning of fossil fuels. The major source of carbon monoxide is motor vehicles (Figure 10-6). The toxic effects of high concentrations of CO on the body are well known. CO is absorbed by the lungs and reacts with hemoglobin to form carboxyhemoglobin. This reaction reduces the oxygen carrying capacity of blood because the affinity of hemoglobin for CO is over 200 times that for oxygen. The higher the percentage of hemoglobin bound up in the form of carboxyhemoglobin, the more serious the health effect. Exposure to high levels of CO is linked with the impairment of vision, work capacity, learning ability and performance of difficult tasks.

Figure 10-6: Estimated Carbon Monoxide Emissions in Ontario by Sector (OMOE, 2002)



The three local monitoring sites did not provide sufficient data to be used in the analysis of 1997-2001 conditions. However, the highest annual averages of CO levels in Ontario were recorded in urban centres, including Toronto, Hamilton, Mississauga and Ottawa. There were no incidences recorded within this period of levels above Ontario's one-hour ambient air quality criteria (30 ppb).

10.4.6 Smog Advisories

Components in the formation of smog include nitrogen oxides, volatile organic compounds, ozone, particulates, sulphur dioxide and carbon monoxide. In southern Ontario, the main ingredients of smog are elevated concentrations of ground-level ozone and fine particulate matter (Region of York, 2003). Smog episodes are highly dependent on the weather and are more likely to occur in hot, sunny summers than in cool, wet ones (OMOE, 2003). In York Region, between 1996 and 2002, there were 31 smog alert advisories covering a total of 64 days (Table 10-9) (Region of York, 2003). The City of Toronto also recorded 31 smog alert advisories covering a total of 65 days (OMOE, 2004).

Unlike the Air Quality Index, which measures air pollutants in real time, smog advisories predict when elevated smog conditions are expected ahead of time. OMOE has two-levels of alerts. A "Smog Watch" is issued when 50% chance that widespread, elevated and persistent smog levels will be experienced within the following three days. A "Smog Advisory" is called when there is a strong likelihood that there will be widespread, elevated and persistent smog levels with the next 24 hours.

Table 10-9: Number of Smog Alert Advisories and Smog Days

	1996		1997		1998		1999		2000		2001		2002	
	# Adv	Days	# Adv	Days	# Adv	Days	# Adv	Days	# Adv	Days	# Adv	Days	# Adv	Days
City of Toronto	2	3	2	5	3	7	5	9	3	3	7	20	9	18
York Region	2	3	2	4	3	7	5	9	3	3	7	20	9	18

Source: Adapted from OMOE, 2002.

10.5 Objectives for Air Quality

Based on current watershed air quality conditions and issues, and with reference to the air quality goal, an objective of "protect and restore air quality" has been adopted for the Rouge River watershed. This is presented below, along with indicators, measures, targets and a rating for existing conditions in the watershed.

The rating of "Fair" is an average of a "Good" grade in air chemistry, due to a lack of exceedances in criteria except in ozone and particulates; and a "Poor" grade in smog due to an increase from 3-5 days/2-3 advisories from 1996 to 2000, to 20 & 18 days/7-9 advisories from 2001 to 2002.

Objective: Protect and restore air quality.		Overall Rating: Fair
Indicator	**Measure**	**Target**
Air Chemistry	Chemical Parameters including: ozone (ppb), particulates (ug/m^3), sulphur dioxide (ppb), carbon monoxide (ppb), nitrogen oxide (ppb)	AQI of "Very Good" (AQI does not exceed 15)
Smog	Number of smog days/advisories	0 smog days and smog advisories issued per year
Lichen (TBD)	Lichen diversity values; Occurrence, abundance, frequency, sensitivity of indicator species	Index of Atmospheric Purity (IAP) values (TBD)

10.6 Summary and Management Considerations

Clean air is important to health, the environment and the economy. Poor air quality can adversely affect the residents, terrestrial and aquatic communities, and built features of the Rouge River watershed. Air resource management considerations should be directed toward the protection, conservation and restoration of the air quality in the watershed, with the primary goal of protecting human and environmental health.

The Rouge River watershed received a rating of "Fair" due to exceedances in particulate pollutants and ground-level ozone on a number of occasions, particularly in the summer months. This is largely a consequence of vehicle, industrial and residential emissions, with a large amount of ground-level ozone originating from outside of the watershed.

Since smog, acid rain and climate change are caused primarily by the same pollutants, considerable benefit can be achieved by focusing remedial efforts on a single key source. In the Rouge River watershed, the greatest impact on maintaining and improving the air quality could be made by increasing public transportation opportunities within the City of Toronto and York Region. Other supportive actions include restoring natural cover and trees in particular, to rural and urban landscapes. Recent research has produced statistics for the forests within the City of Toronto (Kenney and Associates, 2001). Toronto's estimated 7.5 million trees store about 900,000 tonnes of carbon and sequester a net 28,000 tonnes of carbon each year. Through this research, it was also found that the treed areas of Toronto absorb:

- 614 tonnes of ozone per year,
- 117 tonnes of sulphur dioxide per year,
- 306 tonnes of nitrogen oxide per year, and
- 452 tonnes of particulate matter (of less than 10 microns) per year.

The Rouge River watershed, with almost 20% of the forest in the City of Toronto, provides a large part of this service. Finally, TRCA should coordinate air quality studies with other local, provincial and federal programs. Efforts would include ensuring that air quality and climate change, as non-traditional components, are incorporated into future planning decisions and management strategies.

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