Canada-wide Standards for Particulate Matter and Ozone:

Five Year Report: 2000-2005

PN 1374

November 2006

Canadian Council of Ministers of the Environment

INTRODUCTION

Purpose of the Report

This is an interim report on progress towards meeting the Canada-wide Standards (CWSs) for Particulate Matter (PM) and Ozone. Subsequent reports will focus on achievement of the CWSs applicable at that time. More information on the CWSs for PM and Ozone may be found on the Canadian Council of Ministers of the Environment (CCME) website at www.ccme.ca.

The Province of Quebec, while not a signatory to the Canada-wide Accord on Environmental Harmonization or Canada-wide Environmental Standards Sub-Agreement, has undertaken analogous efforts on environmental standards as those covered by the agreement, and has also developed working inter-jurisdictional arrangements on issues such as monitoring. Data and text referring to ambient levels and information on PM and ozone for the Province of Quebec has not been included in this report at the request of the province. For information on Quebec's progress on PM and ozone, please follow the web link below.

More specific information on CWSs progress and emissions data may be found on jurisdictional websites:

Alberta

British Columbia

Canada

Manitoba

Newfoundland and Labrador

New Brunswick

Northwest Territories

Nova Scotia

Nunavut

Ontario

Prince Edward Island

Quebec

Saskatchewan

Yukon

Canada-wide Standards for PM and Ozone

The long-term air quality management goal for PM and ozone is to minimize the risks of these pollutants to human health and the environment. There is clear evidence of the harmful effects of these pollutants throughout the range of concentrations to which Canadians are exposed. This means that any reduction in the ambient levels of these pollutants provides a reduction in population health risk. The CWSs for PM and Ozone were endorsed by CCME in June 2000. They represent a balance between the desire to achieve the best health and environmental protection possible in the relative near-term and the feasibility and costs of reducing the pollutant emissions that contribute to elevated levels of PM and ozone in ambient air.

The CWS and related provisions for PM are:

A CWS for $PM_{2.5}$ of 30 µg/m^3, 24-hour averaging time, by year 2010.
Achievement to be based on the 98th percentile ambient measurement annually, averaged over 3 consecutive years.

The CWS and related provisions for ozone are:

A CWS of 65 ppb, 8-hour averaging time, by 2010.
Achievement to be based on the 4th highest measurement annually, averaged over 3 consecutive years.

Implementation actions outlined in the CWSs include:

- development and implementation of jurisdictional implementation plans to achieve the CWSs;
- implementation of continuous improvement (CI), pollution prevention (P^2), and keeping-clean-areas-clean (KCAC) programs in areas with ambient concentrations below the CWS levels;
- in areas where jurisdictional implementation plans need to be augmented by reductions in transboundary flow of pollution from the United States or from other countries to achieve the CWSs, the federal government, with support from the provinces and territories, will aggressively pursue further reductions in the transboundary flow into Canada of PM and ozone and their precursor pollutants; and
- establishment and maintenance of the PM and ozone monitoring networks needed to characterise the PM and ozone air quality problems across Canada, design management programs, and track progress.

THE AMBIENT STANDARDS AND REPORTING ON PROGRESS

To guide jurisdictions in reporting on the achievement of the ambient standards in 2010, CCME has developed specific procedures and methodologies, which are outlined in the Guidance Document on Achievement Determination[1] (GDAD). The GDAD is intended as a reference tool for jurisdictions and the public and for ensuring consistency and comparability of data.

[1] http://www.ccme.ca/assets/pdf/gdad_eng_oct4.pdf

Under GDAD and the CWS, a community approach to reporting is used, based on communities identified by the Census Metropolitan Areas (CMA), Census Agglomerations (CA) and Census Subdivisions (CSD) defined by Statistics Canada.

Jurisdictions are to report on CWS achievement for communities with a population over 100,000 and may also choose to report on communities with populations of 100,000 or less.

To gain experience with the application of GDAD methodologies and analytical tools, and to explore where refinements may be needed in advance of the 2010 achievement date, four regional pilot projects were conducted across Canada to test and implement provisions of the GDAD. Lessons learned from these pilot studies were shared during two national stakeholder workshops, and the ensuing recommendations are being incorporated into ongoing revisions of GDAD.

The CWS states that the comprehensive reports will include an assessment of ambient levels and trends in communities within each jurisdiction, identifying those where ambient levels are exceeding or approaching the 2010 CWS levels. For the purposes of this report, the criterion for identifying communities where ambient levels are approaching the CWS has been defined as those within 10% of the CWS 2010 target levels. These communities are shown in yellow in Figures 1 and 2, while those exceeding the 2010 CWS target are shown in red.

In jurisdictions highly impacted by transboundary air pollution from the United States, achieving the CWSs will be strongly dependent on reductions of this transboundary contribution. Also, high background levels of PM and ozone that may occur through natural events (such as forest fires, natural formation and stratospheric intrusion) will need to be considered in assessing achievement of the CWSs.

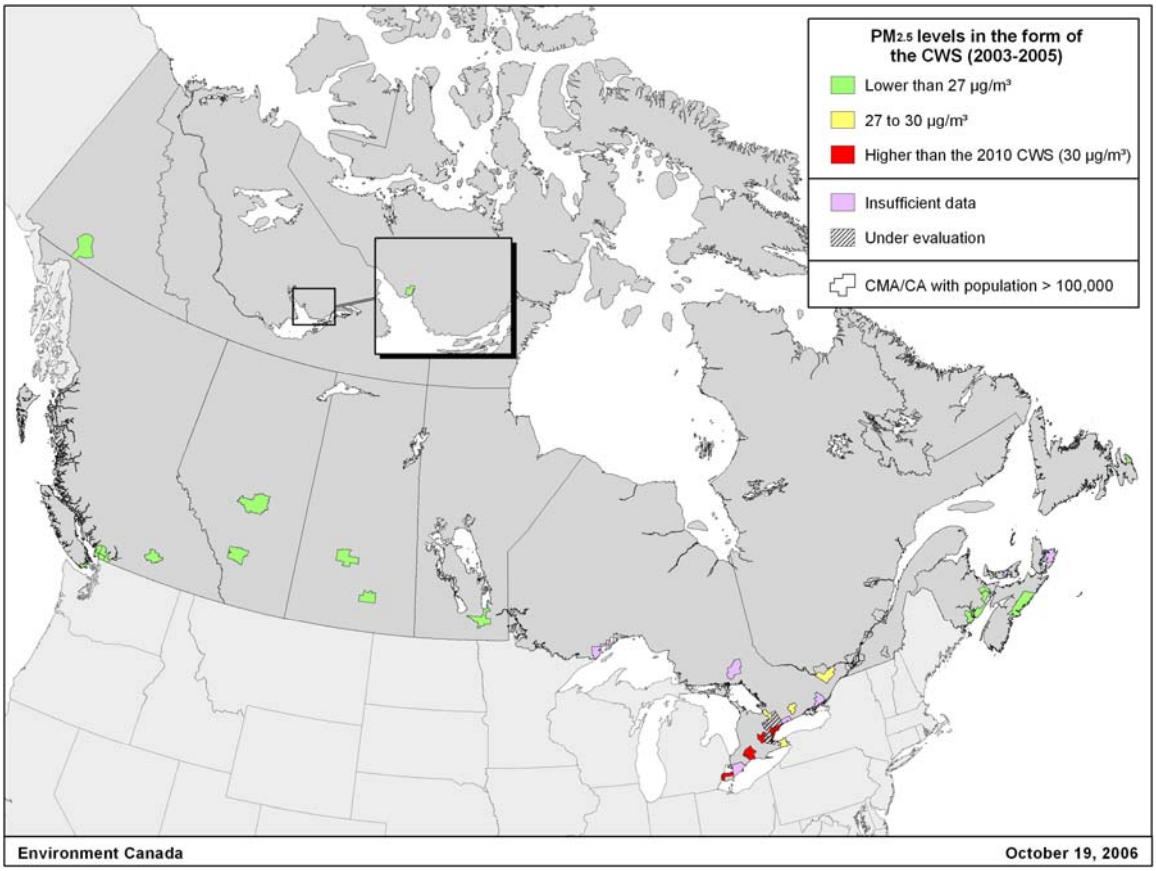
The CWS contain provisions for demonstrating the influence of transboundary flow and high background levels for communities whose continued exceedance of the CWS ambient levels is primarily due to one or both of these two circumstances. The ambient levels presented in this report are the levels as measured by the monitors, without any distinction between transboundary and local sources. Some jurisdictions have already begun to analyze the significance that these two regional circumstances contribute to their ambient levels of $PM_{2.5}$ and ozone.

$PM_{2.5}$ Levels in the Form of the CWS Target

Figures 1-3 show the $PM_{2.5}$ levels in the form of the CWS for Canadian communities and reporting sub-areas (RSA) for the period 2003-2005, as reported by provincial and territorial jurisdictions.

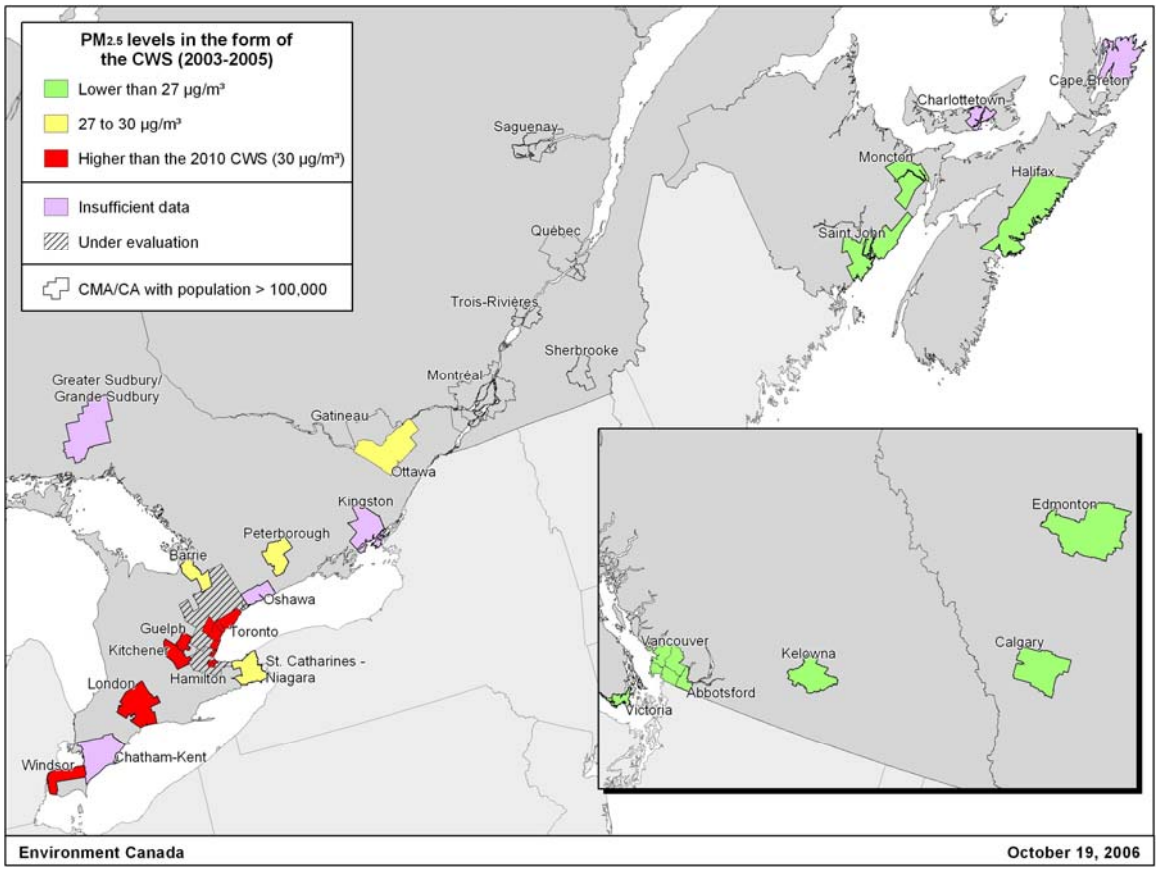
For the period 2003 to 2005, most of the locations with $PM_{2.5}$ levels above (red) or approaching 10% (yellow) of the 2010 CWS were in southern Ontario, with significant contributions from transboundary flow. Outside of Ontario, only two communities in the interior of British Columbia had levels above the standard, and none were within 10% of it. Levels ranged mostly between 9 and 26 µg/m^3 in Yukon, British Columbia and Alberta. In Saskatchewan, Manitoba and Atlantic Canada, levels were mostly in the 9 to 19 µg/m^3 range. In Ontario, most levels were either in the 27-30 µg/m^3 or the 31-34 µg/m^3 range.

Figure 1: $PM_{2.5}$ levels in the form of the 2010 CWS target for Census Metropolitan Areas (CMA) and Census Agglomerations (CA) with population over 100,000 (2003-2005).



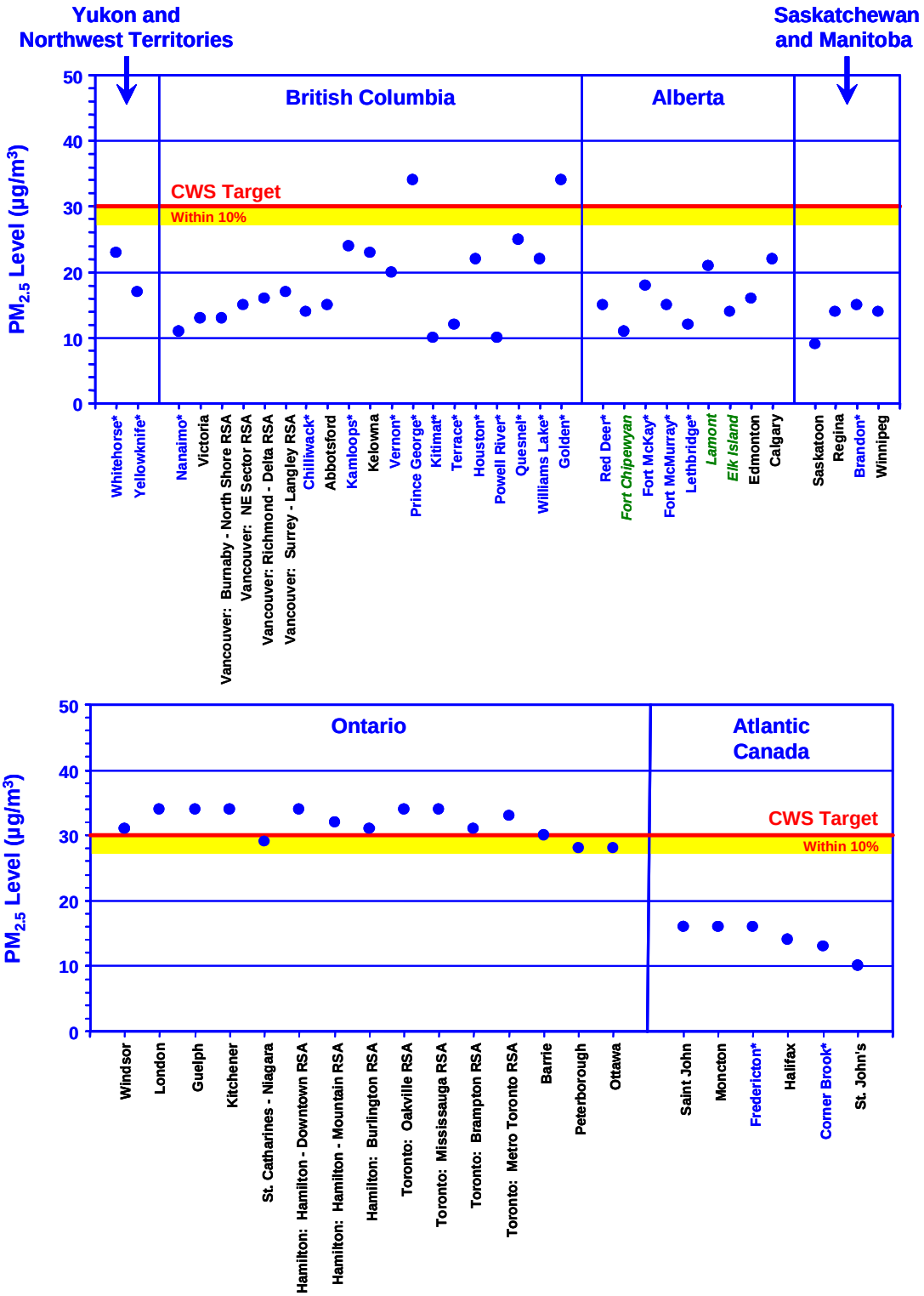
Notes: Values shown are the 3-year average of the annual 98th percentile of the daily 24-hour average $PM_{2.5}$ based on the procedures in GDAD. Purple-shaded areas have insufficient data. Hatched-line areas are under evaluation for future consideration of CWS reporting. Data are as provided by provincial and territorial jurisdictions, and collected through NAPS, the National Air Pollution Surveillance network. Data is preliminary and subject to change.

Figure 2: $PM_{2.5}$ levels in the form of the 2010 CWS target for selected areas in Atlantic, Central, and Western Canada (2003-2005).



Notes: Values shown are the 3-year average of the annual 98th percentile of the daily 24-hour average $PM_{2.5}$ based on the procedures in GDAD. Purple-shaded areas have insufficient data. Hatched-line areas are under evaluation for future consideration of CWS reporting. Data are as provided by provincial and territorial jurisdictions, and collected through NAPS. Data is preliminary and subject to change.

Figure 3: Actual $PM_{2.5}$ levels in the form of the 2010 CWS target (2003-2005).



Notes: Shown are the values of the 3-year average of the annual 98th percentiles of the daily 24-hour $PM_{2.5}$ based on the procedures in GDAD. The $PM_{2.5}$ levels shown are from continuous monitors, consisting of the TEOM® (the majority) and BAM monitors. In blue with * are communities with population of 100,000 or less that jurisdictions elected to report on, although not required under the CWS. In *green italic* are non-urban monitoring stations, and under the CWS these stations cannot be used for reporting on the CWS. Data provided by provincial and territorial jurisdictions, and generated from measurements collected through NAPS. Data are preliminary and subject to change following further data quality assurance reviews.

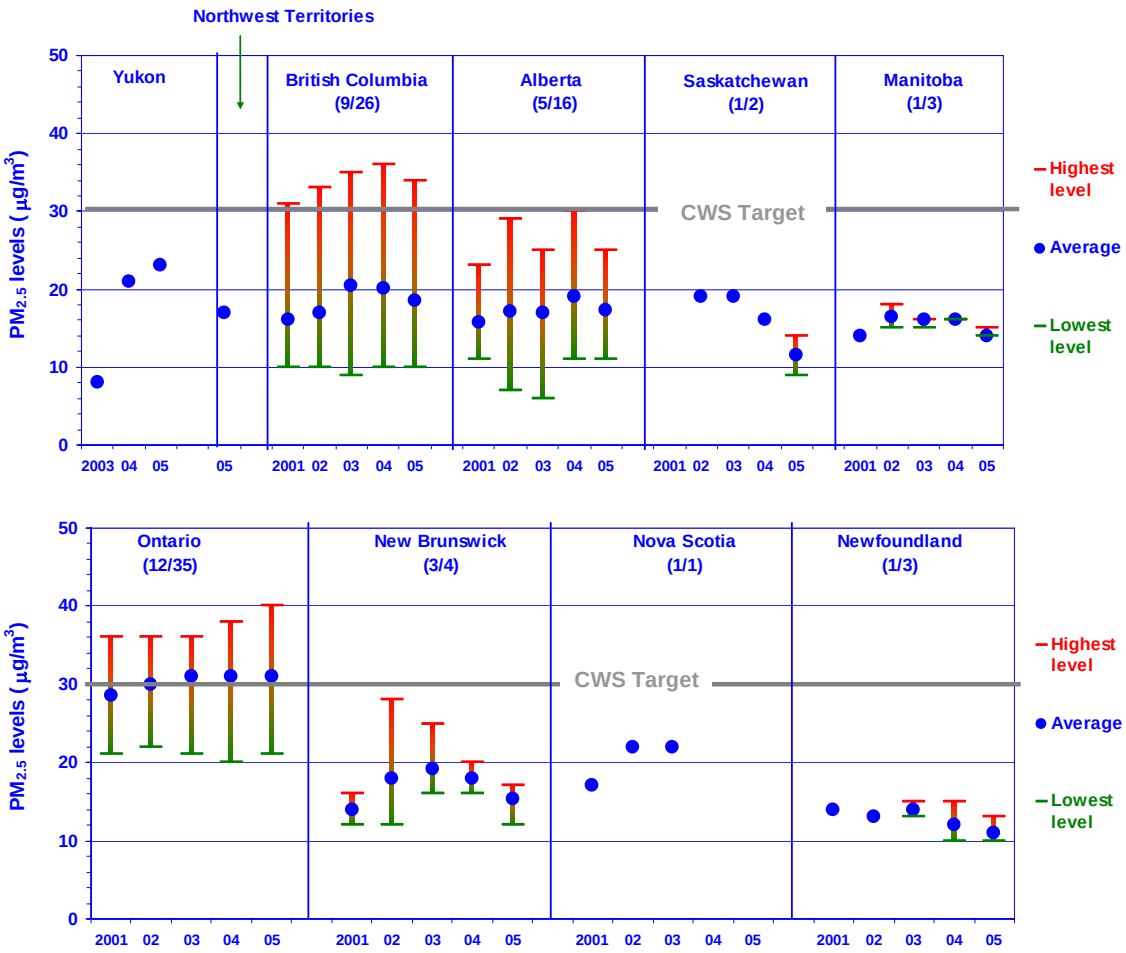
Annual Variation in $PM_{2.5}$ Levels

Daily monitoring of ambient $PM_{2.5}$ levels across all regions of Canada did not begin in earnest until the late 1990s, aided by the development and implementation of the CWS. As such, a sufficiently long term record of data does not exist to enable the evaluation of robust trends in $PM_{2.5}$ levels, though a qualitative indication of how the levels varied over the years is still possible. This is accomplished here by presenting the *regional range* in $PM_{2.5}$ levels in the form of the CWS for the period 2001 to 2005. The regional range for a given year is defined as being the lowest and highest values of all considered station-specific levels in the form of the CWS for that year, along with the average of all the station-specific levels.

From the late 1990s to 2005, the number of communities and areas covered by $PM_{2.5}$ monitoring gradually increased. To provide as broad as possible an indication of the $PM_{2.5}$ levels that prevailed in the regions, the number of communities and areas considered here was not constant, but was rather allowed to vary yearly depending on the availability of the data. For this reason, and also because the $PM_{2.5}$ levels presented here are not to be used for CWS achievement evaluation, the number of communities and areas considered in this section are higher than those considered in the previous section, and the two sections are therefore not comparable.

Figure 4 indicates the annual regional range (as defined above) in $PM_{2.5}$ levels in the form of the CWS. For most regions of Canada, average $PM_{2.5}$ levels ranged from 15 to 20 $\mu g/m^3$. Notable exceptions exist in southern Ontario, with significant contributions from transboundary flow, where regional averages either neared the 2010 CWS or exceeded it some years. In addition, $PM_{2.5}$ concentrations in a number of British Columbia communities, such as Golden, Vernon, Kamloops and Kelowna, were highly influenced by forest fires during this period. In both Ontario and British Columbia, the highest $PM_{2.5}$ level was above the CWS in every year. Elsewhere, the highest level was appreciably below the CWS except in Alberta and New Brunswick, where the highest levels approached the CWS in some years.

Figure 4: Regional range in $PM_{2.5}$ levels in the form of the CWS target (2001-2005).



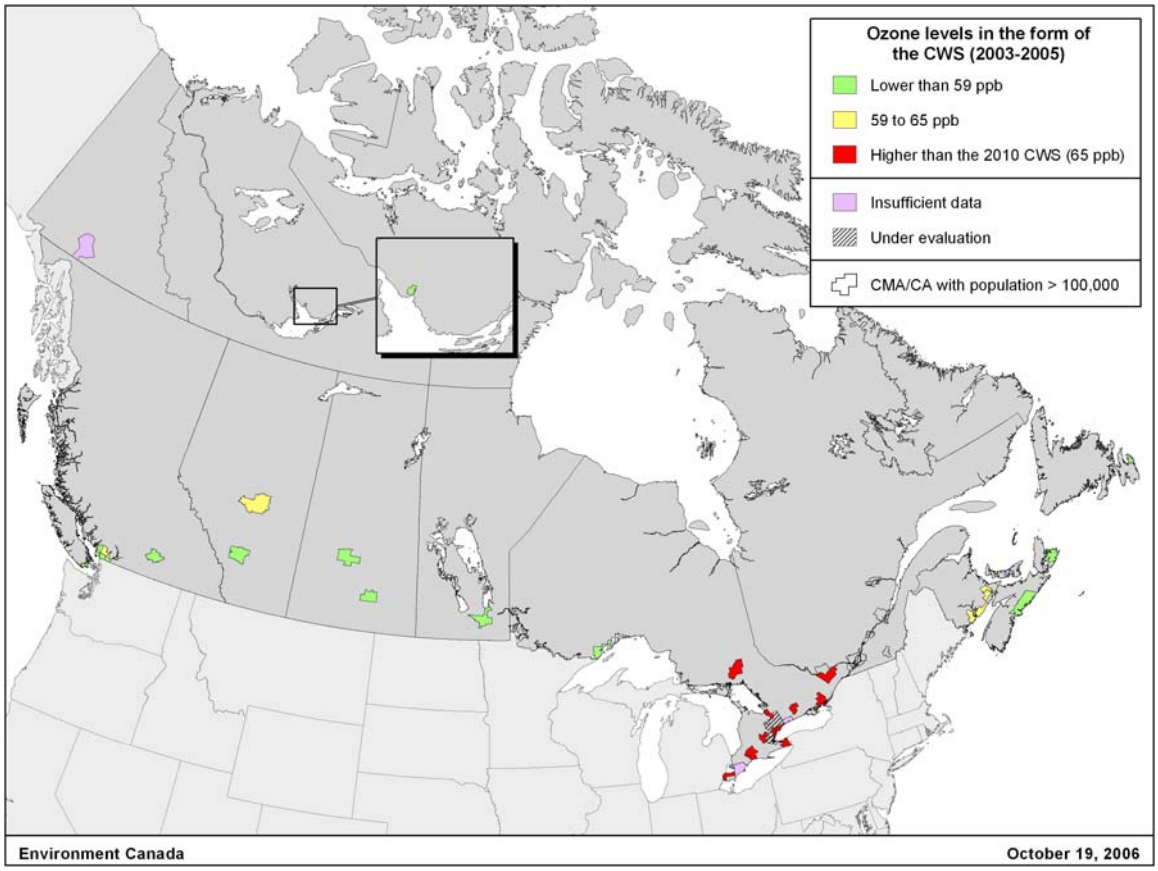
Notes: The $PM_{2.5}$ levels shown are from continuous monitors, consisting of mostly TEOM® and several BAM monitors. The highest and lowest levels shown are values of the 3-year average of the annual 98th percentiles of the daily 24-hour $PM_{2.5}$. These 3-year averages were computed for each monitoring station considered in the region and the highest and lowest of these were then extracted. The *Average* is simply the average of all the station-specific 3-year averages in the region. The numbers in brackets below the region's name (N1/N2) are the number of monitoring stations considered during the first (N1) and last (N2) year of the period; the number of stations considered for in-between years may have been fewer or greater than these. Years with only a circle and no range indicate that only one station was considered, and therefore no range is possible. The monitoring method configuration may have changed over the years in some regions; this may have affected the monitoring results and may have contributed to the annual variation in levels. Data used to generate the information was provided by NAPS.

Ozone Levels in the Form of the CWS Target

Figures 5-7 show the actual ozone levels in the form of the CWS for Canadian communities and reporting sub-areas (RSA) for the period 2003-2005, as reported by provincial and territorial jurisdictions.

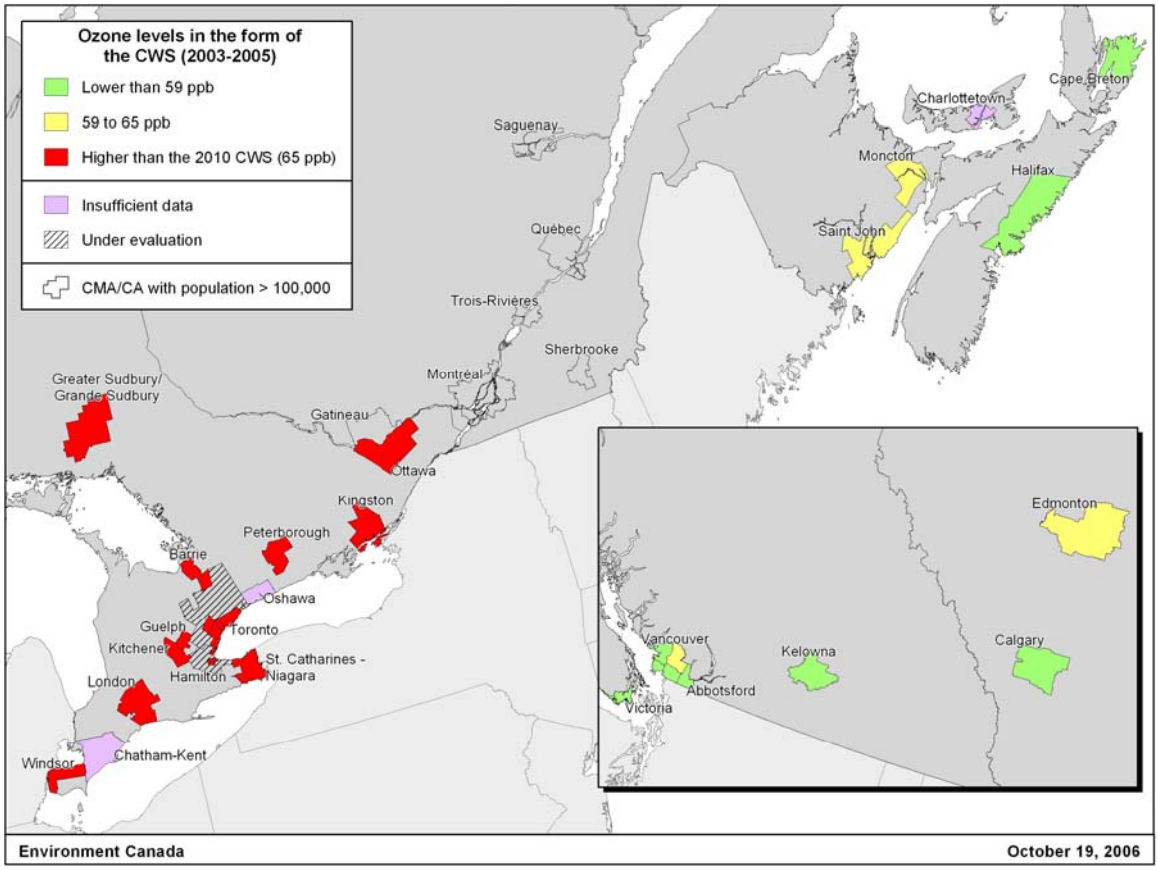
The majority of locations with ozone levels above the 2010 CWS were in southern and central Ontario, with significant contributions from transboundary flow. Elsewhere, only one community in BC and one non-urban area in Atlantic Canada had levels above the CWS. With the exception of Saskatchewan and Manitoba, all other regions had at least one location with levels within 10% of the CWS (yellow range). Levels ranged mostly from 44 to 65 ppb in BC and Alberta, 44 to 57 ppb in Saskatchewan and Manitoba, 58 to 82 ppb in Ontario, and 44 to 65 ppb in Atlantic Canada. The lone monitored community in the Northwest Territories – Yellowknife - had a level of 48 ppb. Although not shown here, in many communities of Ontario, levels of $PM_{2.5}$ and ozone above the numerical value of the 2010 CWS often occur on the same days.

Figure 5: Ozone levels in the form of the CWS target for Census Metropolitan Areas (CMA) and Census Agglomerations (CA) with population over 100,000 (2003-2005).



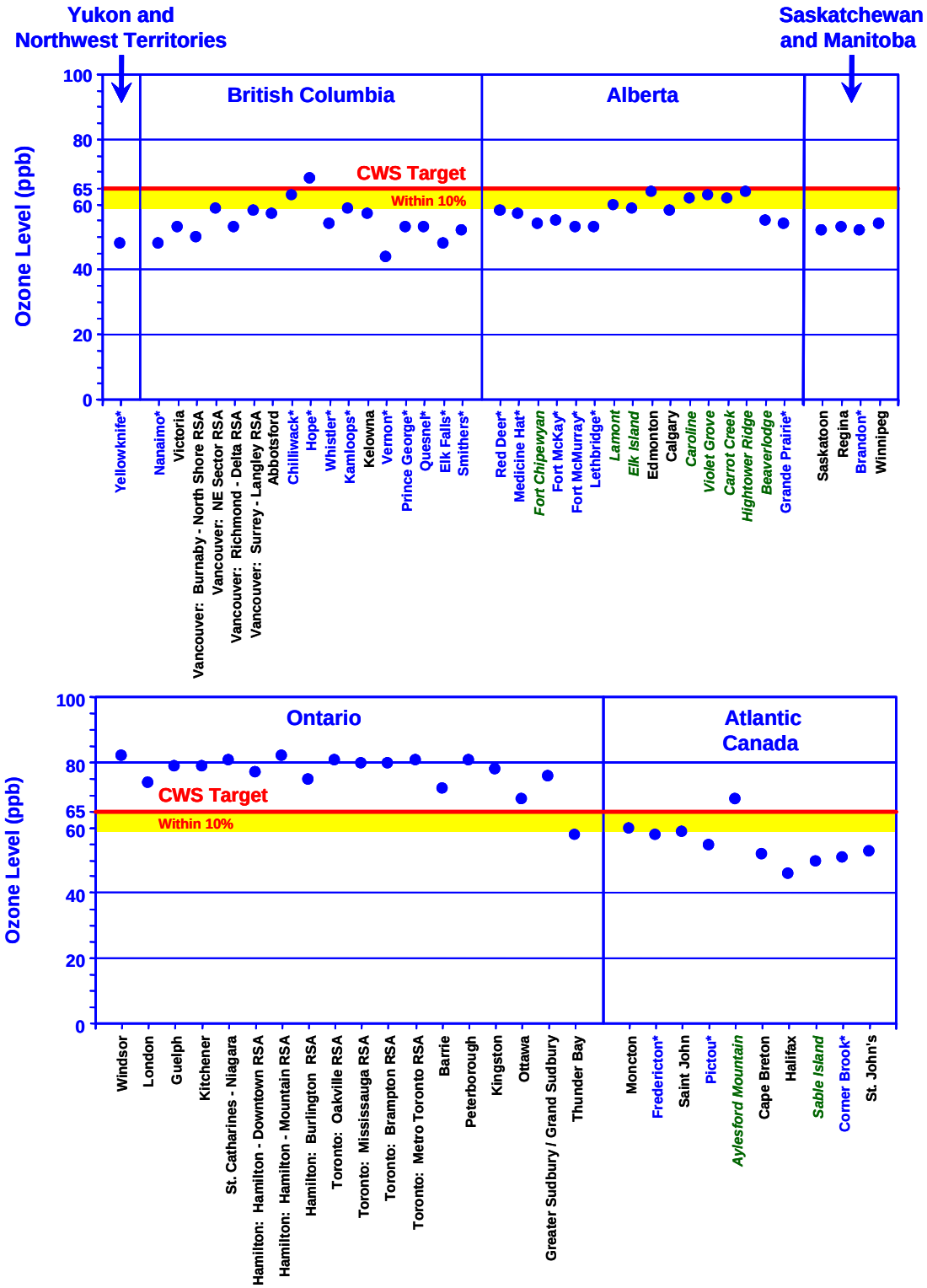
Notes: Values shown are the 3-year average of the annual 4th highest daily maximum 8-hour ozone based on the procedures in GDAD. Purple-shaded areas have insufficient data. Hatched-line areas are under evaluation for future consideration of CWS reporting. Data are as provided by provincial and territorial jurisdictions, and collected through NAPS. Data is preliminary and subject to change.

Figure 6: Ozone levels in the form of the 2010 CWS target for selected areas in Atlantic, Central, and Western Canada (2003-2005).



Notes: Values shown are the 3-year average of the annual 4th highest daily maximum 8-hour ozone based on the procedures in GDAD. Purple-shaded areas have insufficient data. Hatched-line areas are under evaluation for future consideration of CWS reporting. Data are as provided by provincial and territorial jurisdictions, and collected through NAPS. Data is preliminary and subject to change.

Figure 7: Actual ozone levels in the form of the CWS target (2003-2005).



Notes: Shown are the values of the 3-year average of the annual 4th highest daily maximum 8-hour average ozone based on the procedures in GDAD. In blue with * are communities with population of 100,000 or less that jurisdictions elected to report on, although not required under the CWS. In *green italic* are non-urban monitoring stations, and under the CWS these stations cannot be used for reporting on the CWS. Data provided by provincial and territorial jurisdictions, and generated from measurements collected through NAPS. Data are preliminary and subject to change following further data quality assurance reviews.

Trends in Ozone Levels

A regional annual average for a given year is simply the average over all stations considered in the region for that year, while the national average is the average over all stations considered from all regions. Despite variation, there may have been a main tendency in the values, that is, they may have tended to move upward or downward. This tendency is typically qualified by the slope (the rate of change) of a linear line fitted through the actual values, and it is this slope and the direction of change in values (*increasing* or *decreasing*) which is referred to as the *trend*.

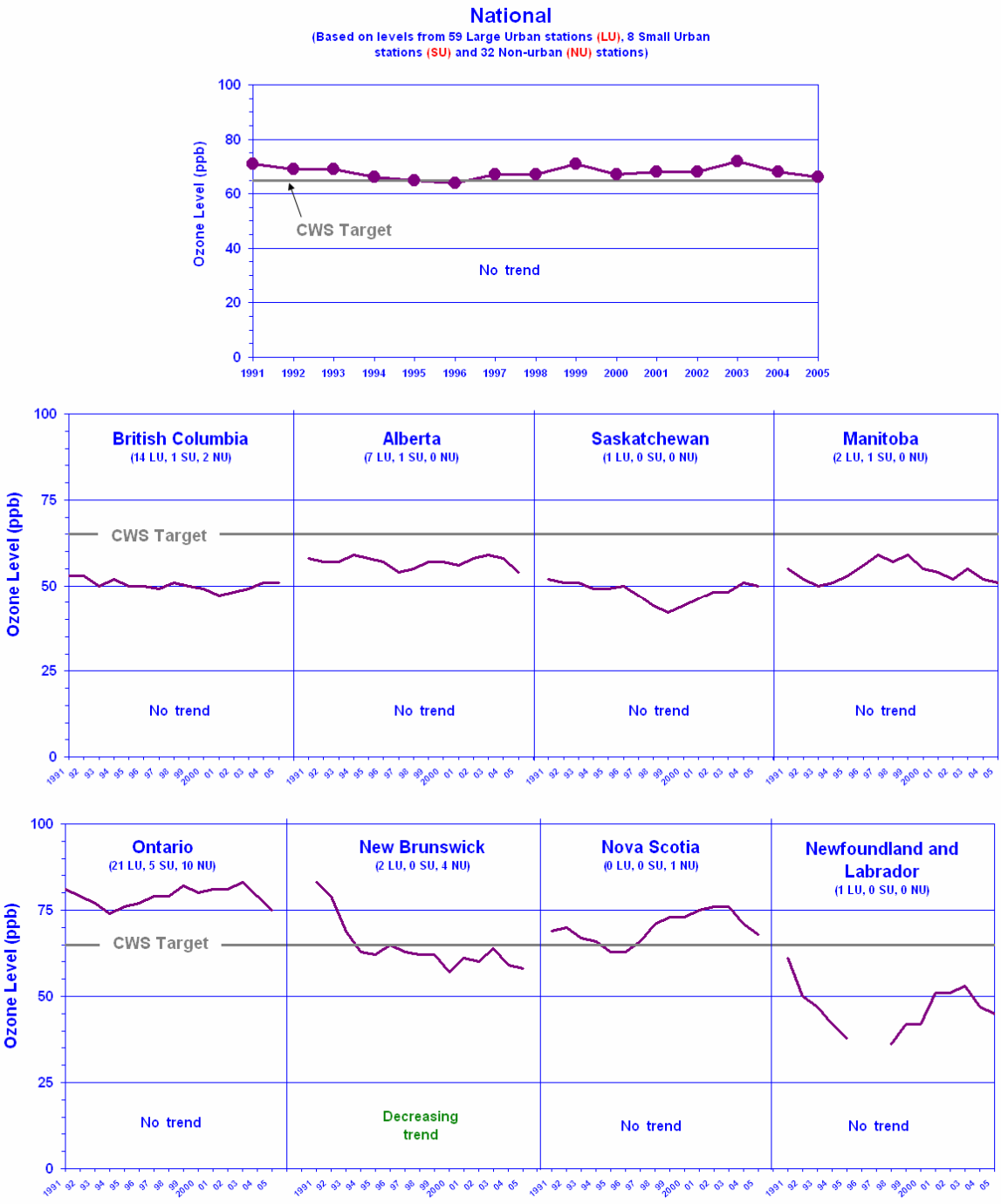
For this report, only the direction of the trend is indicated, and trends that are not statistically significant are reported as *No trend*.

Figure 8 shows how the annual national and regional average ozone levels in the form of the CWS varied over the 15-year period from 1991 to 2005. Only stations that satisfied the data completeness criteria of 75% (in the 3-year average of the annual 4th highest) were considered.

Except for New Brunswick, national and regional average ozone levels have remained more or less unchanged (i.e. the trends were not statistically different from zero) over the 15-year period. Levels in New Brunswick experienced a decreasing trend, although this is largely attributable to the substantial drop in peak levels at the beginning of the period.

Figure 8 also shows how the average ozone levels compare to the numerical value of the 2010 CWS target. This is shown only as a relative indication of the magnitude of the measured levels, and not as an indication of achievement of the CWS. The national average ozone levels were either just above or just below the CWS over most of the 15-year period. In the four western provinces, the regional averages have been consistently below the CWS, with highest levels found in Alberta. The regional average has been above the 2010 CWS every year in southern and central Ontario, with significant contributions from transboundary flow.

Figure 8: Trends in ozone levels in the form of the 2010 CWS target (1991-2005).



Notes: Indicated levels are consecutive 3-year averages. The ozone CWS is shown only as an indication of how the levels compare, on average, to the standard and not as an indication of achievement of the CWS over the years. The direction of the trend in levels (decreasing or increasing) is indicated only if the obtained value of the trend is statistically different from zero at the 95% confidence level. Otherwise it is indicated as "No trend". Data generated by Environment Canada from measurements collected through NAPS. Large urban (LU) stations are located in communities with population over 100,000; Small urban (SU) stations are located in communities with population of 100,000 or less; Non-urban (NU) stations are located in areas where the land-use is predominantly rural.

STATUS OF ACTIVITIES RELATED TO PM AND OZONE IMPLEMENTATION

Implementation Plans

Jurisdictional activities are the primary vehicle for CWSs implementation. Jurisdictional implementation plans outline more comprehensive actions being taken within each jurisdiction to achieve the standards by the 2010 target date. A different level and type of effort is required in each jurisdiction given that air quality varies significantly from region to region. Jurisdictions are required to develop implementation plans and as these plans are made public links will be posted on www.ccme.ca. If a jurisdiction does not have a public implementation plan it does not mean that it is not taking action on the CWS. Other studies and reports intended to serve as a foundational base for preparatory, planning and implementation activities are also available on the CCME website. As Québec is not a signatory to the Canada-wide Accord on Environmental Harmonization or the CWSs, Québec is not required to develop an implementation plan.

Jurisdictions with ambient levels below the CWSs are focusing their implementation measures on CI/KCAC. Jurisdictions with some ambient levels in excess of the CWSs are targeting emission reductions in those specific areas, while supporting CI/KCAC efforts in areas with ambient levels below the CWSs. In some areas, transboundary flows might be the key driver, so that local emission reductions alone would not resolve the problem.

Examples of jurisdictional implementation initiatives include:

- environmental licensing processes that require significant provincial sources to reduce emissions of PM, PM and ozone precursors, and other pollutants;
- community-based airshed planning through scientific expertise, technical support, direct funding, and tools development;
- establishing airshed management areas in industrialized regions;
- reviewing or developing legislation, policies, and programs aimed at sustainable environmental management;
- management planning, with the application of tools ranging from mandatory actions to voluntary actions;
- assessment of natural, background, or transboundary influences;
- exploring options for road dust control;
- cleaner energy and energy conservation;
- sustainable transportation;
- land use and natural resource protection;
- environmental monitoring and reporting;
- support for community-based environmental activities;
- education and awareness; and
- research and innovation.

Continuous Improvement / Keeping-Clean-Areas-Clean

In most areas of Canada, ambient levels are lower than the CWSs for PM and ozone. The CWSs call for implementation of continuous improvement (CI), pollution prevention (P^2), and keeping-clean-areas-clean (KCAC) programs in these areas.

The CWS levels are only a first step to subsequent reductions towards the lowest observable effects levels. There is a commitment to implementing CI/KCAC in the CWS agreement, so it would be misleading to convey the impression that no action is required in areas with ambient levels below the CWSs or that it would be acceptable to allow pollutant levels to rise to the CWSs levels. Jurisdictions are taking remedial and preventative actions to reduce emissions from anthropogenic sources in these areas to the extent practicable. Jurisdictions also recognize that polluting "up to a limit" is not acceptable either, and that the best strategy to avoid future problems is KCAC. Jurisdictions are currently developing and implementing a variety of programs that apply P^2 and best management practices.

To assist jurisdictions in designing and implementing their CI/KCAC programs, CCME is developing a guidance document that will:

- follow direction on principles, commitments, roles, and responsibilities in the *Canada-wide Accord on Environmental Harmonization* and its *Canada-wide Environmental Standards Sub-Agreement;*
- build on the general guidance provided in Annex A of the CWSs;
- provide concepts, definitions, and methodologies to ensure reasonable consistency in CI/KCAC programs throughout Canada; and
- describe optional air management approaches and tools that allow flexibility for jurisdictions to tailor their CI/KCAC programs to their particular circumstances.

Transboundary Flow and Background Levels

The CWS recognizes and takes into account two special circumstances which can affect the ability of a community to achieve a standard. These are: contributions to local ambient PM and ozone levels from the transboundary transport of air pollutants from other provinces and the United States; and high background levels of PM and ozone that may occur on occasion through natural events in some parts of the country. In these circumstances, the jurisdiction will need to demonstrate that: (1) these influences were primarily responsible for the community not being able to achieve a Standard; (2) it has implemented "best efforts" to reduce emissions within its jurisdiction.

Monitoring

Jurisdictions continue to expand or upgrade their air monitoring networks, with the focus often on enhancements to ambient monitoring networks. Jurisdictions are also undertaking shorter-term, special air quality monitoring projects in selected areas to better define the spatial and temporal distribution of ambient PM and ozone levels. Jurisdictional investments in monitoring and reporting set the stage for greater understanding of key air issues, as well as greater cooperation among jurisdictions over time.

The National Air Pollution Surveillance (NAPS) network is the joint federal, provincial, territorial and municipal network which measures urban air quality across Canada. The number of stations reporting both $PM_{2.5}$ and ozone has grown to 145, nearly a three-fold increase since the CWSs were endorsed in 2000. As a result of this investment, all communities in Canada with a population greater than 100,000 can now effectively monitor $PM_{2.5}$ and ozone levels.

CONCLUSION

Since the CWSs were signed in 2000, significant progress has been made towards creating the necessary infrastructure required to report on achievement of the Standards. This has included expansions to and upgrades of the monitoring networks needed to characterize PM and ozone air quality across Canada, leading to a three-fold increase in the number of co-located $PM_{2.5}$ and ozone monitors across the country. In 2002, the Guidance Document on Achievement Determination (GDAD) was released, which describes the specific procedures and methodologies for reporting on achievement of the Standards, including provisions related to accounting for transboundary flow and influence from background levels and natural events.

With this updated and expanded monitoring network, it is now possible to portray the extent of the current smog problem in Canada by estimating the portion of the Canadian population that is currently living in communities with ambient PM and ozone levels above the 2010 CWSs. Based on the population of communities where the current monitoring stations are located across Canada:

- At least 40% of Canadians live in communities where ambient ozone levels are above the target Canada-wide Standard, and;
- At least 30% of Canadians live in communities where ambient levels for $PM_{2.5}$ are above the target Canada-wide Standard.

Since the endorsement of the CWSs in 2000, various jurisdictions have implemented a variety of initiatives, both regulatory and non-regulatory, to reduce emissions from all sectors of the economy (industry, transportation, energy, land-use, etc) as a step towards achieving compliance with the CWSs and/or the CI/KCAC objectives.

This report for 2005 assesses progress towards meeting the CWSs. The next five-year comprehensive report will assess attainment of all provisions of the CWSs for the period 2008-2010, and is expected to be issued in September 2011. Also, beginning in 2011, jurisdictions are scheduled to begin issuing annual reports in the form of a standardized "report card", containing mainly summary information on levels and trends in ambient PM and ozone concentrations in communities within each jurisdiction, identifying communities where ambient levels are exceeding or approaching the CWS levels. Readers are encouraged to contact the various federal/provincial/territorial jurisdictions to obtain information on any progress reports that may be issued between now and 2010.