Border Air Quality Strategy

Maintaining Air Quality in a Transboundary Air Basin: Georgia Basin-Puget Sound

Canada-United States Air Quality Agreement

MAINTAINING AIR QUALITY IN A TRANSBOUNDARY AIR BASIN: GEORGIA BASIN-PUGET SOUND 2005 REPORT

A PILOT PROJECT UNDER THE CANADA-UNITED STATES BORDER AIR QUALITY STRATEGY

TABLE OF CONTENTS

EXECUTIVE SUMMARY[1]

Overview

This report was prepared by Environment Canada (EC) and the U.S. Environmental Protection Agency (EPA) with input from Health Canada. EPA and Environment Canada are the lead agencies for the U.S. – Canada Border Air Quality Strategy pilot project, *Maintaining Air Quality in a Transboundary Air Basin: Georgia Basin-Puget Sound*, announced by Environment Canada and the U.S. EPA in Washington D.C., in June 2003. A major focus of this pilot project has been the development of the Georgia Basin-Puget Sound International Airshed Strategy. The purpose of this report is to summarize actions and initiatives undertaken by the partners involved in this pilot.

Context

Over six million people live in the Georgia Basin (GB) region of British Columbia and the Puget Sound (PS) region of Washington State (Fig. 1). Air quality in the transboundary GB-PS airshed generally meets relevant federal standards on both sides of the border due in part to past and ongoing actions by various governments. Ongoing efforts to improve air quality are prompted by concerns about the human health and ecosystem effects, including degradation of visibility, which may occur at air pollution levels currently monitored in the airshed.

In the Greater Vancouver Regional District (GVRD), which includes the City of Vancouver and the surrounding metropolitan region, past actions by federal, provincial and local governments and industry and public stakeholders reduced emissions of sulfur oxides, carbon monoxide, particulate matter, volatile organic hydrocarbons and nitrogen oxides from all sources by 40 percent since 1985 (to 2000), despite a nearly 50 percent increase in population. Similar initiatives by the EPA, the State of Washington, the Puget Sound Clean Air Agency and other regional air quality agencies have resulted in comparable emission reductions in the Puget Sound region.

[1] Note that this report uses U.S. spelling.

Figure 1: The Georgia Basin – Puget Sound International Airshed

Despite these efforts, serious challenges remain in this transboundary area to further reducing air quality effects on human health, ecosystems, and visibility. For example, a 2003 air quality study by the Puget Sound Clean Air Agency found that air in the Seattle area has elevated levels of toxic air pollutants which contribute to increased cancer risk. In addition, the Vancouver, Seattle, and surrounding areas expect significant growth in population, economic activity, motor vehicle use and marine vessel and port operations that may well result in future increased air pollution. Forecasts predict that regional population will increase from 6 million in 2000 to 9 million by 2020.

Area and mobile sources are significant contributors of air emissions on both sides of the border. Large point sources are also important in some areas, including oil refineries in the northern part of Puget Sound, an electricity-generating station in the southern part, and pulp mills and cement plants in the Georgia Basin. These and other sources contribute to domestic and transboundary air quality issues in both countries. The efforts through the GB-PS International Airshed Strategy process emphasize continuous improvement and prevention of significant deterioration in a region in which air quality standards are typically met but future growth threatens to reduce the effectiveness of past efforts.

The key issues and challenges related to air quality in the transboundary GB-PS region include:

- Population growth and associated demands for increased transportation, energy and employment in the region.
- Significant projected increase in emissions from the marine sector.
- Growth of emissions from the agricultural sector, particularly in the Fraser Valley Regional District.
- Degraded visibility, an important quality-of-life variable in this transboundary area characterized by mountains and sea vistas, outdoor recreation and tourism.
- A fuel-switching trend, where increasing natural gas costs are prompting industries to burn other fuels and thus increase emissions of criteria air contaminants.
- Interaction of air pollutants with the confined topography of the region, which can cause significantly, degraded air quality during periods of stagnated air flow.

Past Collaboration

There is a long history of air quality management cooperation between the United States and Canada due to the strong value for clean air held by our two nations, and the commitment that emissions from one country should not impact another country. Successes include the 1941 Trail Smelter Arbitration, the major efforts of the 1970s and 80s that led to the development of the Canada-U.S. Air Quality Agreement and related Acid Rain Annex in 1991, and the addition of the Ozone Annex to this Agreement in the year 2000.

Achievements at the federal, state, provincial and regional levels in the area include the *1992 Environmental Cooperation Agreement* (BC Ministry of Environment (MoE), State of Washington (WA)); the *1994 Interagency Agreement* (BC MoE, WA, GVRD, and the Northwest Clean Air Agency); the *2000 Joint Statement of Cooperation on the GB-PS Ecosystem*; and the *2002 Statement of Intent on a GB-PS International Airshed Strategy*.

The GB-PS International Airshed Strategy

Environment Canada, the U.S. EPA and various partner agencies recognized a need for a forum to enhance information sharing and identify collaborative projects to strengthen air quality management in this transboundary airshed. The GB-PS International Airshed Strategy (IAS) Coordinating Committee provides this forum: an opportunity for air quality managers and scientists from different agencies in the GB-PS to meet and discuss issues of mutual interest. The Coordinating Committee has served as the implementing body for the Border Air Quality Strategy pilot project. EPA and Environment Canada are the lead agencies of the IAS Coordinating Committee.

The focus of this project is to: enhance information exchange on air pollution and related impacts (health and ecosystem); improve knowledge of regional air quality that may have transboundary

impacts; implement emission reduction efforts; and, examine policy options for improved collaboration and management in the region. This work also serves as a case-study for air quality management in a relatively clean area, where prevention of significant deterioration and continuous improvement of air quality are priorities.

This work responds to public concern about health effects of current and projected air quality and public support for cleaner air in the airshed. Such public support has been demonstrated by: strong opposition to some proposed new sources of air emissions; the adoption, by some agencies in the airshed, of air quality objectives more stringent than federal standards; and formal resolutions by several British Columbia municipalities in support of bilateral efforts to address transboundary air issues.

The purpose of the GB-PS International Airshed Strategy is, through international and regional cooperation to:

- Reduce the impacts of air pollution to human health, ecosystems, and visibility in the GB-PS airshed.
- Prevent future deterioration and work towards continuous improvement of air quality in the GB-PS region.
- Establish practical and effective instruments to address shared concerns regarding transboundary air pollution in the GB-PS region.

Organization and Members

The GB-PS International Airshed process has two lead agencies and consists of a Coordinating Committee, and several work groups. (Fig. 2)

FIGURE 2: Membership structure of GB-PS IAS

The Coordinating Committee comprises the participating governments and agencies involved on an ongoing basis and meets about every six months. These meetings are open to the public but new members must be approved by the lead agencies prior to the meeting.

Canadian agencies that participate in the Coordinating Committee include Environment Canada, Health Canada, British Columbia Ministry of Environment (BC MoE), the Greater Vancouver Regional District (GVRD), the Fraser Valley Regional District (FVRD), and First Nations.

U.S. agencies that participate in the Coordinating Committee include U.S. EPA (Region 10), WA Department of Ecology, the Puget Sound Clean Air Agency (PSCAA), the Northwest Clean Air Agency (NWCAA), the Olympic Region Clean Air Agency (ORCAA), U.S. National Park Service, and Tribes.

Work Groups address specific issues and facilitate collaborative work on initiatives (e.g., transboundary science). Group membership includes staff of participating agencies with an interest in the initiative, who meet as required between meetings of the Coordinating Committee to complete tasks. Corresponding Members (of Work Groups) are those who want to be informed of progress but are unable to regularly participate.

Early Actions

Partners initially identified various projects to improve collaborative air quality management and information sharing in the transboundary GB-PS airshed. These were then prioritized and the highest ranked were chosen for action (the "early actions"). The purpose of these early actions was to make short- and medium-term progress on issues of mutual concern while progress on longer-term issues was pursued. The six early actions were:

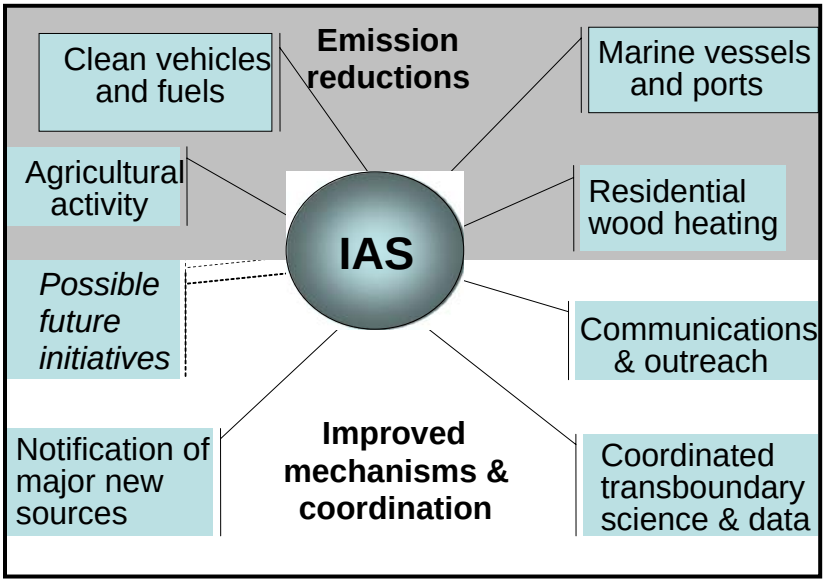
- The "Issues Ranking and Identification System" (IRIS) - a system to prioritize future air quality issues for collaborative action;
- The Airshed Characterization - a scientific assessment of air quality in the GB-PS and predictions of future conditions using best available computer modeling;
- The "TRansboundary Air Data Exchange" (TRADE) – a computer application to more efficiently exchange transboundary air quality data between agencies;
- The GB-PS International Airshed Strategy website - an internet-based source of information (hosted by Environment Canada) on best air quality management practices and related activities by partner agencies;
- Notification of new sources – an effort to improve notification and information sharing for proposed facilities that may affect transboundary air quality; and
- The clean vehicles and fuels initiative – efforts focused on on-road and marine vessels, especially the early introduction of cleaner vehicles and fuels in the region.

Initiatives

As the early action projects evolved, the Coordinating Committee refined them and grouped them under two themes: (i) emission reduction efforts; and (ii) improved air management coordination mechanisms. Those early actions still in progress were reformed, expanded and became known as "initiatives" (Fig. 3). These are carried out by work groups made up of staff from partner organizations that participate on the Coordinating Committee.

The core work of the International Airshed Strategy occurs via the initiative work groups.

Figure 3: The Initiatives of the GB-PS International Airshed Strategy



The GB-PS IAS Coordinating Committee acknowledges that the initiatives will progress at different rates and that some initiatives may be completed while emerging priorities may result in the creation of new initiatives and work groups.

Air Quality in the Airshed

The air quality in the GB-PS airshed currently meets relevant national standards in the United States and Canada. Research shows that there is apparently no clear threshold for health effects, particularly with respect to ozone and particulate matter, and that visibility is degraded by air pollution levels currently monitored in the region. Furthermore, a recent report by the BC Lung Association shows that significant social and economic benefits can be achieved from continuous improvement efforts in air quality.[2] Finally, the significant growth projected for the region threatens to overwhelm past successful efforts to improve air quality in the GB-PS International Airshed.

The pollutants of primary concern in the airshed are ozone and fine particulate matter (particles up to 2.5 microns in diameter ($PM_{2.5}$) and their precursors.

Emission Sources and Forecasts

In Southwest BC and Northwest Washington, sources of air pollutants include area sources, transportation, industry, and agriculture (Fig. 4).

The most recent emission inventory for the lower Fraser Valley (year 2000) documents the beginning of a change in important sources within the Georgia Basin airshed. Marine sector emissions account for 22% of the NO_X, with light-duty vehicles responsible for 23%. Marine sector sources emit 33% of the SO_2, the largest single source sector in the airshed. Agriculture is the dominant source of PM_{10} (21%), with space heating (including wood burning) emitting 20% of the $PM_{2.5}$

Past efforts, such as controls on stationary sources and on-road mobile sources, have substantially reduced concentrations of certain pollutants and concentrations of others are forecast to continue declining despite significant growth in the region (e.g., NO_X, VOC). However, ambient concentrations of other pollutants are forecast to increase significantly (e.g., SO_2, NH_3).

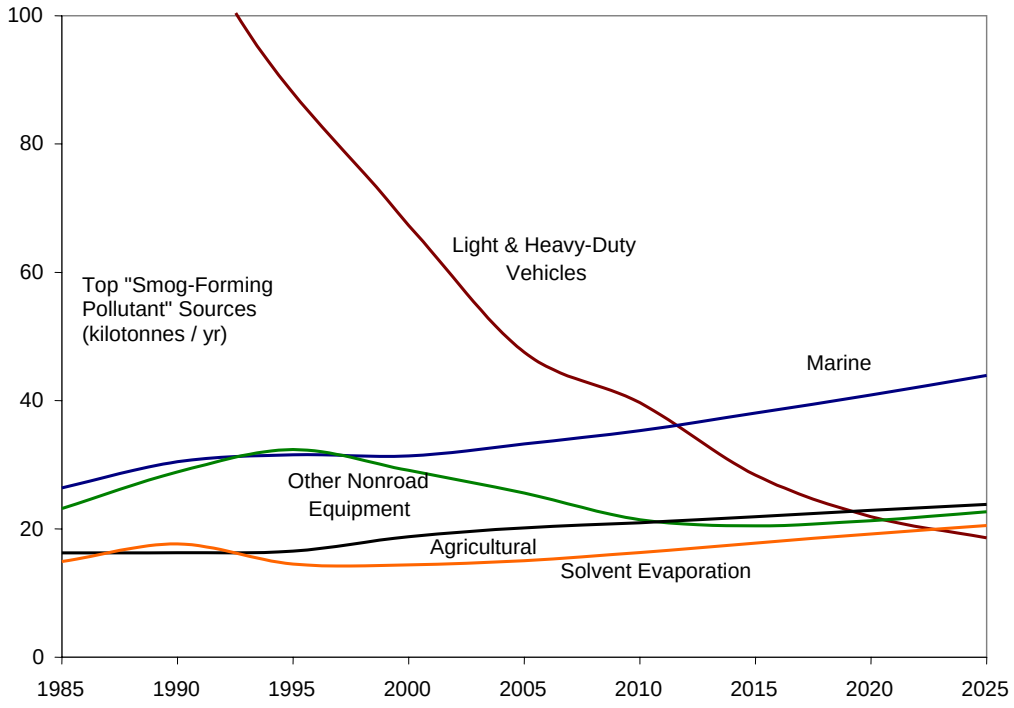
The emissions of smog-forming pollutants for the entire Puget Sound airshed are forecast to decrease by 20% from 1996 to 2018, based on the inventories and forecast available at the present time. The most recent forecasts for the Lower Fraser Valley portion of the Georgia Basin show similar decreases after 1996, but the trend slows, with overall smog-forming emissions showing slight increases after 2015 (Figure 5).

[2] Benefits to the medical system have been determined to be in the order of millions of dollars per year from relatively minor improvements in air quality (e.g., 10% decrease in ambient $PM_{2.5}$)

Figure 4: Dominant emission sectors in the GB-PS International Airshed

Contaminants	*Puget Sound*[3]	*Georgia Basin (LFV)*[4]
NO_x	• On-road mobile • Marine vessels	• On-road mobile • Marine vessels
VOC	• On-road mobile • Natural sources	• On-road mobile • Solvent evaporation • Stationary sources • Natural sources
SO_2	• Point industrial sources • Marine vessels	• Point industrial sources • Marine vessels
NH_3	• Agriculture	• Agriculture
PM_{10}	• Agriculture • Woodstoves and Fireplaces • Transportation (diesel)	• Agriculture • Transportation (diesel)
$PM_{2.5}$	• Woodstoves and Fireplaces • Transportation (diesel)	• Transportation (diesel)

Figure 5: Backcast & forecast of top smog-forming pollutants (Georgia Basin)[5]



[3] Washington Department of Ecology, 2001 Review of the Washington State Visibility Protection State Implementation Plan

[4] The Lower Fraser Valley (LFV) includes the Greater Vancouver Regional District (GVRD) and Fraser Valley Regional District (FVRD) in Canada, as well as Whatcom County in the U.S.

Future Directions

Growth in the GB-PS of population and the associated demands for land development, transportation, energy, employment and others will continue to stress the GB-PS ecosystem unless managed wisely.

The Future Directions chapter of this report focuses on three strategic approaches to emission reductions and improved air quality management in the transboundary GB-PS region. These strategies include continued multi-agency information sharing (e.g., increased access to transboundary inter-agency data); work on collaborative projects (e.g., transboundary efforts to reduce ammonia emissions); and, progress on joint policy efforts, as appropriate (e.g., exploration of clean transportation networks for the region, such as marine vessel emission reductions).

Conclusions

The two years of work on the BAQS pilot project, Maintaining Air Quality in a Transboundary Airshed: Georgia Basin-Puget Sound has enabled considerable progress in transboundary air quality management in this transboundary region; an area that seeks to continuously improve air quality to protect human health and environmental values.

Significant achievements have already been realized in the broad areas of science, leading to the completion of an extensive airshed characterization project, and of important progress in assessing and developing emission reduction measures to reduce diesel particulate from older buses and trucks and from marine vessels. Another important accomplishment is improved information exchange between agencies regarding air management policy, procedures for reviewing new sources, and other air management activities.

Further work is required to fully recognize the potential of this collaborative process and to achieve the objectives of improved human health and ecosystem protection for this transboundary region.

[5] Forecast and Backcast of the 2000 Emission Inventory for the LFV Airshed (1985-2025)", by the GVRD and FVRD, dated July 2003

INTRODUCTION AND CONTEXT [6]

Introduction

This report was prepared by Environment Canada (EC) and the U.S. Environmental Protection Agency (EPA) with input from Health Canada. Environment Canada and EPA are the lead agencies for the U.S.-Canada Border Air Quality Strategy (BAQS) pilot project, *Maintaining Air Quality in a Transboundary Air Basin: Georgia Basin-Puget Sound*, announced by Environment Canada and the U.S. EPA in Washington D.C., in June 2003. A major focus of this pilot project has been the development of the Georgia Basin-Puget Sound International Airshed Strategy.

The primary purpose of this report is to summarize actions and initiatives undertaken by the partners involved in this pilot since it was initiated in June 2003. Also included are Health Canada's studies on the impact of air pollution on health, and related collaborative efforts in the GB-PS before the BAQS pilot project began. This report provides an overview of the initiatives; lessons learned; opportunities for future collaboration; and, a summary of recommendations for further work in the GB-PS region.

Since 2001, governments and other agencies in the GB-PS region with an air quality management interest or mandate have met to discuss developing an International Airshed Strategy. This Strategy is a multi-agency initiative sponsored by Environment Canada and the U.S. EPA that works to enhance dialogue and information exchange between air quality management agencies in the GB-PS region.

Geographic Description of the GB-PS Area

The GB-PS region is located on the west coast of North America, straddling the international border between Canada and the United States. The Georgia Basin includes the Southwest portion of British Columbia as well as Whatcom and San Juan Counties, in the United States. The Puget Sound is exclusively in the United States. The largest communities in the region include Seattle, Vancouver, the provincial capital of BC (Victoria) and the state capital of Washington (Olympia). The population of the greater Seattle area is approximately 6 million while the population of the Greater Vancouver Regional District is approximately 2 million.

In Canada, the majority of residents live in an east-west band in the Lower Fraser Valley. In the United States, most residents live in a north-south band, along the I-5 corridor.

The Georgia Basin air basin comprises the Canadian portion of the GB-PS, including Whatcom and San Juan Counties and the southern coastline of the Strait of Juan de Fuca, while the Puget Sound air basin encompasses the counties to the south of Whatcom County in Washington State (see Figure 2.1). An important international transport region for airborne pollutants exists in the Lower Fraser Valley and along the southern edge of Haro Strait (situated at the eastern end of the Strait of Juan de Fuca).

[6] Portions of this section are from the "GB-PS International Airshed Strategy Discussion Paper" (2004) by RWDI West Inc. and Terry Nyman.

Context

The GB-PS region is a unique place; it is one of the most diverse regions of North America in terms of its ecology, landscape, and peoples. It is characterized by a spectacular mountain and island landscape dominated by a bountiful inland sea. The ecosystem provides vital habitat for millions of birds that migrate each year along the Pacific flyway. Its waters are home to five species of spawning salmon, a rich variety of other fish, whales, and seals. A hub of global trade and commerce, the region is a multicultural home to over six million people, drawn by the superb quality of life offered by the region – the beauty of the landscape and ocean, the mild climate, a richness of resources, and employment and investment opportunities.[7]

The air in the GB-PS is affected by emissions from urban, suburban, industrial, marine, and agricultural activities. Some of the main causes of air pollution in this region include combustion sources such as automobiles, trucks, buses, marine vessels, wood stoves, open burning of yard and wood waste, industrial boilers and heaters, and power plants.

Rapid population growth threatens the GB-PS ecosystem and particularly its airshed. The population of the region is expected to increase from the current six million to nine million by 2020. This will mean more vehicles on the roads, more residential and commercial heating, more power generation and more industry, in general. There is also a projected significant increase in marine vessel activity via the expansion of ports in Seattle/Tacoma and the GVRD. Such changes could result in significant increases in air emissions unless other measures are taken.

Future changes in air quality in the GB-PS region will depend on the balance between growth and improvements in energy efficiency, technology, fuel standards, and industrial processes. All levels of government, other stakeholders, and the general public wish to protect this special place and maintain the improvements in air quality that have been made over previous decades.

Currently, air quality in the region meets both U.S. and Canadian ambient standards and objectives. However, human and ecosystem health may be adversely affected at existing air pollution levels. of There are additional economic and quality-of-life incentives to improve air quality in terms of visibility, which can be degraded even though ambient standards are met.[8]

The GB-PS Airshed Characterization (see Section 4 of this report) showed that there is significant transboundary flow between the Georgia Basin and Puget Sound airsheds. The transboundary flow primarily occurs above the convergence zone of the Straight of Juan de Fuca, the Straight of Georgia, and Puget Sound. Significant flow also occurs between Whatcom County and the GVRD and FVRD. Less frequent exchange occurs between the larger Georgia Basin and Puget Sound areas. Because of the potential for air pollutants to be transported back and forth across the Canada-U.S. border, planning at an international level will improve the efficiency of efforts to maintain clean air in the region.

---

[7] Adapted from the Joint Statement of Cooperation of the GB-PS Ecosystem by the Minister of Environment Canada and the Administrator of the U.S. EPA http://www.pyr.ec.gc.ca/airshed/soc_e.shtm

[8] A study by Environment Canada indicated a loss of up to $8.8 million in GVRD and FVRD in future tourist revenue for every day of degraded visibility.

DEVELOPMENT OF THE INTERNATIONAL AIRSHED STRATEGY

Membership and Structure

The Georgia Basin – Puget Sound (GB-PS) International Airshed process has two lead agencies, a Coordinating Committee, and several work groups. (Figure 6)

Figure 6: Membership structure of GB-PS IAS

The leads agencies are Environment Canada and the U.S. EPA, which share responsibility for advancing the work under the GB-PS International Airshed Strategy

The Coordinating Committee comprises all participating governments, agencies and groups involved in the process. This group meets approximately every six months.

Work Groups focus on specific issues and consist of individuals working together to achieve a specific task (e.g., transboundary science). Agency leads assign staff to Work Groups. The Work Groups meet as required in between meetings of the Coordinating Committee to complete their tasks. Corresponding Members are individuals who wish to be kept informed but who are unable or uninterested in participating on a regular basis.

Membership in the GB-PS International Airshed Strategy Coordinating Committee is summarized in Figure 7.

Figure 7: Agency participation in the GB-PS International Airshed Strategy

Agency	*Lead agencies*		*Member*	
	Canadian	*U.S.*	*Canadian*	*U.S.*
BC Ministry of Water, Land & Air Protection			●	
Environment Canada (Vancouver office)	●			
Fraser Valley Regional District			●	
Greater Vancouver Regional District			●	
Health Canada			●	
Northwest Clean Air Agency				●
Olympic Region Clean Air Agency				●
Puget Sound Clean Air Agency				●
Stó:lō Nation			●	
Swinomish Tribe				●
Upper Skagit Tribe				●
U.S. Environmental Protection Agency (Reg. 10)		●		
U.S. Department of Interior, National Park Service				●
Washington State Department of Ecology				●

Timeline

While transboundary dialogue and cooperation in the GB-PS date back several decades, it is largely since the 1990s that significant accomplishments have been made. A chronology of accomplishments is below.

- 1992 - *Environmental Co-operation Agreement* - between Washington State and the Province of BC. This Agreement emphasized coordinated action and information sharing on environmental matters of mutual concern including air quality.
- 1994 - *Memorandum of Understanding* - between Washington State, the Province of British Columbia, the Greater Vancouver Regional District and the Northwest Clean Air Agency to ensure timely prior consultation on new sources of air pollution, as provided for in the U.S.-Canada Air Quality Agreement.
- 2000 - Environment Canada and the U.S. Environmental Protection Agency signed a *Joint Statement of Co-operation on the GB-PS Ecosystem*. This Statement outlines common goals and objectives, confirms the commitment and leadership of the two federal governments and recognizes the special interests of residents and their governments.
- 2002 – EC and the EPA signed the *Statement of Intent* for the GB-PS International Airshed work. This Statement pledges continued collaborative efforts regarding present and future air quality issues in the GB-PS airshed.
- 2003 – EC and EPA launched the Canada-U.S. *Border Air Quality Strategy* to explore mechanisms to address transboundary air quality issues.

Activities

Formal interagency agreements have facilitated strong project-level collaboration between agencies in Canada and the United States regarding air quality and other environmental issues in the GB-PS region. Substantial progress was achieved to reduce air emissions in the 1980s and 1990s, through combined unilateral and partnered efforts of the federal, state, provincial, and regional air quality management agencies in the GB-PS airshed. These efforts emphasized emission reduction programs for industrial operations, commercial sources, and motor vehicles and resulted in air quality improvements throughout this transboundary airshed.

Since the 1990s these interactions have been formalized in different agreements, statements of cooperation, and statements of intent. The GB-PS International Airshed Strategy process began in 2001 with a two-day workshop. The catalysts for this process included:

- Possible health effects at air quality levels currently measured in the GB-PS.
- Mounting public concern over the potential impacts of air emissions from proposed new energy developments on both sides of the border.
- Indications that projected regional growth in population, economic activity and motor vehicle use could result in increased air pollution in future years.

A Canada-United States air quality planning workshop was held at Bellingham, Washington in February 2001 to discuss these issues. Representatives of Environment Canada, the U.S. EPA, state, provincial, and local governments, air quality management agencies, and First Nations and Tribes attending this workshop agreed that clean air was a priority.

It was recognized that a collaborative transboundary air quality planning process would:

- Strengthen information sharing on best air management practices.
- Offer a collaborative opportunity to characterize the international airshed.
- Facilitate and explore improved processes for the review of new emission sources near the U.S.-Canada border (within the context of the U.S.-Canada Air Quality Agreement).
- Enable the development of joint project partnerships to reduce emissions.

A second international air quality meeting was held in Tsawwassen, BC in May 2001. At this meeting, it was agreed to identify clean air issues and challenges in the region. Another outcome of this meeting was a commitment to develop a path forward on international airshed planning that focused on the development of cooperative mechanisms for air quality management and reduction of emissions.

Early Actions

The participants at the May 2001 meeting developed a draft Statement of Intent on areas of future cooperation, which recognized that: the Georgia Basin and Puget Sound is a shared airshed; residents of this shared airshed have common goals for high levels of environmental quality, strong communities and healthy economies; and, a transboundary airshed management strategy for the GB-PS ecosystem should be developed.

A list of 14 air quality management priorities to improve information sharing and collaborative air quality management identified at the earlier Bellingham workshop was reviewed. It was agreed that all of the items on the list should be considered in the airshed management strategy. The list was also prioritized, and it was recommended that work on the six highest ranked priorities should begin as soon as possible. These became known as the "early actions". The purpose of these early actions was to make short- and medium-term progress on issues of mutual concern while progress on longer-term issues was underway.

The six early actions are:

- **Develop a system to prioritize future air quality issues for collaborative action.** This early action became known as the "Issues Ranking Information System" (IRIS). The IRIS project has been completed and is being used to assess the relative priority of transboundary air quality issues for collaborative planning.

- **Conduct a scientific characterization of current air quality in the airshed and predict future air quality by using computer models**. This early action evolved into the Georgia Basin / Puget Sound Airshed Characterization report, which was completed and released by Environment Canada and the U.S. Environmental Protection Agency in September of 2004. This report is discussed in more detail later in this document.

- **Work to more efficiently exchange transboundary air quality data between agencies.** This early action is now known as the "TRansboundary Air Data Exchange" (TRADE). The objectives of this project are to identify and evaluate available air quality data sets; and develop data exchange and access protocols to provide a Canadian equivalent to the U.S. EPA Rapid Access to Information System (RAINS). The TRADE early action has progressed to the point that it is accessible to Canadian users, however additional work is necessary to enable it to function in a transboundary mode.

- **Early action to provide information on air quality management practices via the internet.** This early action resulted in the creation of the GB-PS IAS Clearinghouse website[9]. The Clearinghouse website was launched in October 2002 and is maintained as part of the Environment Canada website. It is serving a key role in sharing and learning about best air quality management practices among air quality management partner agencies in the Puget Sound and the Georgia Basin. It is also a very effective communication and outreach tool to enable pubic access to information about the GB-PS International Airshed Strategy process and progress.

[9] http://www.pyr.ec.gc.ca/airshed/index_e.shtm

- **Early action to improve information sharing and notification procedures for proposed new facilities that may affect transboundary air quality**. This inter-agency work resulted in a report analyzing and providing recommendations for notification and assessment of new air emission sources in the region in accordance with the U.S.-Canada Air Quality Agreement. Work on this important issue is continuing as one of the initiatives in the GB-PS International Airshed Strategy.

- **Actively work towards the early introduction of cleaner vehicles and fuels in the region.** Priority for work on this early action focused on three key issues: on-road testing of heavy duty vehicle (truck and bus) emissions, the early introduction of cleaner motor vehicle fuels, and the reduction of marine vessel emissions in and near ports.

    - Collaborative work related to on-road testing of heavy duty vehicle (truck and bus) emissions focused on review of test program design, operation and effectiveness in various jurisdictions. This information resulted in the identification of best practices which were considered during program review and revision in the Georgia Basin.

    - The early introduction of cleaner motor vehicle fuels work involved review and documentation of motor vehicle clean fuel projects in the Puget Sound where the U.S. EPA, the Puget Sound Clean Air Agency and other partner agencies and stakeholders are promoting the use of ultra-low sulfur diesel fuel that will be required beginning in 2006 and 2007, and advising other Georgia Basin - Puget Sound International Airshed Strategy partners of the benefits of implementing similar projects. Biodiesel and ethanol projects were also included in this early action. This work is continuing as one of the initiatives related to the GB-PS International Airshed Strategy.

    - Early action for the reduction of marine vessel emissions in and near ports focused on the completion of emission inventories for marine vessels in the Georgia Basin and Puget Sound and the technical assessment and review of management options and emission reduction measures to reduce ship emissions. Work on the marine vessel emission management is continuing as one of the GB-PS International Airshed Strategy initiatives.

Initiatives

As the "early action" projects evolved, the Coordinating Committee focused the prioritized list into two themes: (i) emission reduction efforts, and (ii) improved coordination mechanisms. The early actions were restructured and expanded and became known as "initiatives". These initiatives are each led by workgroups made up of members of the Coordinating Committee. Since some projects were completed as early actions they were not adopted as initiatives.

The core activity of the GB-PS International Airshed Strategy occurs through the initiatives. The initiatives include emission reduction efforts and improved mechanisms and coordination.

The GB-PS Coordinating Committee acknowledges that each initiative will progress at different rates and that some initiatives may be finished while other new ones may be initiated.

While the work through the GB-PS International Airshed Strategy process began in 2001, it was significantly enhanced with its inclusion as one of three pilot projects under the Canada-U.S. Border Air Quality Strategy.

Further process-related opportunities may include the addition of new members (such as new regional districts, new Tribes and First Nations, and others with strong interest in air quality), the development of new initiatives to address issues of mutual concern, and the greater engagement of other stakeholders, such as the health community, businesses, and the public.

AIR QUALITY ISSUES AND CHALLENGES

Air Quality Issues and Challenges in the GB-PS

The key issues and challenges related to air quality in the transboundary GB-PS region include:

- Population growth and associated demands for increased transportation, energy and employment in the region, all of which may have significant air quality impacts.
- Significant projected expansion of marine vessels and the growth of this sector as the dominant source of smog-forming emissions.
- Growth of emissions from the agricultural sector, particularly in the Fraser Valley regional District.
- Degraded visibility, an important quality-of-life variable in this transboundary area characterized by mountains, sea, outdoor recreation, and tourism.
- Fuel-switching, where increasing natural gas costs are encouraging industries to burn other fuels and thus increase emissions of air pollution.
- Interaction of air pollutants with the confined topography of the region, which can cause significantly degraded air quality during periods of stagnated airflow.

Airshed Characterization

Further description of GB-PS air quality issues and challenges was provided by the collaborative *Characterization of the Georgia Basin-Puget Sound Airshed* ("Airshed Characterization") study and other sources. The Airshed Characterization study was undertaken by Environment Canada, EPA, and state, provincial, and local environmental agencies to characterize the air quality within the GB-PS airshed. Material in this chapter is drawn from the Airshed Characterization, available online at: http://www.pyr.ec.gc.ca/air/gb_ps_airshed/summary_e.htm.

The goal of the Airshed Characterization study was to establish a common understanding of the current status of and trends in air quality in the GB-PS airshed. Its specific objectives were to:

- Determine if significant transboundary transport of air pollution occurs in the GB-PS airshed.
- Identify and describe key factors (natural and anthropogenic) affecting regional air quality.
- Establish a current benchmark to measure changes in air quality over the next 10 years.
- Identify key gaps in air quality science for the GB-PS, especially for particulate matter, ozone and visibility, and including gaps, if any, in monitoring, inventory, and modeling approaches and systems.
- Model anticipated air quality results of specific air quality management scenarios.
- Provide the basis for the development of public education and communications materials designed to enhance citizen understanding of air quality in the region.

Although the area described and studied in this report is commonly known as the GB-PS airshed (Fig. 8), it is really two smaller airsheds (Georgia Basin and Puget Sound) that interact with one another. The GB airshed comprises the Canadian portion of the airshed, Whatcom and San Juan Counties in Washington State and the southern coastline of the Strait of Juan de Fuca. It should be noted that the southern boundary of the Georgia Basin airshed extends to the higher terrain of the north Cascades. The PS airshed encompasses the counties to the south of Whatcom County.

What Determines Air Quality?

In the GB-PS, air quality is largely determined by the weather patterns that circulate air throughout the airshed, and these in turn are influenced by the topography of the region. The air moves and disperses airborne chemicals that are emitted from a variety of human and natural sources, both from within and outside the airshed.

Periods of stagnation occur primarily in the summer and winter. At these times, the windflow patterns do not push air pollutants between the two airsheds, effectively isolating them from one another and allowing air pollutants to build up within each airshed.

Not all pollutants that affect the GB-PS originate within the airshed. Airborne chemicals from the Eurasian continent and California have been observed to add to the overall mixture of pollution within the airshed. Although these pollutants are usually well-dispersed by the time they arrive, they nevertheless add a small, but measurable, amount to the ozone and PM ambient concentrations. The most favorable time for air pollutants to enter the airshed from the Pacific Ocean is during the spring, particularly April and May. In addition, interactions between airborne pollutants can cause secondary air pollutants to form in the atmosphere.

Emissions

Emissions of air pollutants come from both natural and anthropogenic sources. These airborne pollutants may undergo chemical reactions in the atmosphere, creating new pollutants that can affect human and ecosystem health, and cause visibility problems. Emissions from anthropogenic sources can be controlled through regulation or the application of technology, but natural emissions are beyond human control.

Over the next decade, emissions of pollutants from the on-road vehicle sector are projected to decrease in both airsheds, but emissions from the marine sector and from agricultural practices are projected to increase.

The table below summarizes predicted emission trends and forecasts for several key air pollutants in the GB-PS airsheds. Actual future emission levels will depend on population and economic growth as well as on policy decisions taken by Canada and the United States.

Large decreases in SO_2 emissions in Puget Sound are projected due to significant point source reductions and proposed ultra-low-sulfur diesel requirements. By contrast, SO_2 emissions in the Georgia Basin are expected to increase significantly due to projected increases in marine traffic. The impact of increased marine traffic on Puget Sound emissions is not yet fully characterized. Agencies are undertaking a comprehensive marine emissions inventory in 2005. Significant portions of the VOC emissions within the airshed are biogenic and therefore cannot be controlled through regulation or technology.

Table 8: Emission trends and forecasts for the PS[10] and GB[11] airsheds

Pollutant	**Emission Trend and Forecast**	
	Puget Sound (1996-2018)	**Lower Fraser Valley** (2000-2020)
NO_x	-43%	-24%
SO_2	-61%	+21%
VOC	-11%	-12%
NH_3	+20%	+32%
PM_{10} (Includes road dust)	+23%	+19%
$PM_{2.5}$(Includes road dust)	+19%	+ 8%

Ambient Air Quality

- Airborne chemicals and the associated meteorology are measured at a number of sites throughout the GB-PS airshed to quantify air quality both in time and space. The ambient measurements indicate the effectiveness of various air quality management strategies. Research conducted in developing the *Characterization of the Georgia Basin – Puget Sound Airshed* found that the amount of ground-level ozone in the ambient air is primarily the result of photochemical reactions. Ozone and its precursors can be transported great distances. As a result, the highest ozone concentrations are often observed downwind of urban centers and at high elevations in rural areas.
- Rural areas are "NO_x-limited" in the summer months due to the relatively large amounts of naturally occurring VOC emissions and the small amounts of NO_x emissions. Reducing ozone in rural areas may require large reductions in anthropogenic NO_x emissions from urban areas.
- Ozone concentrations of 40 to 50 parts per billion (ppb) are often recorded at rural coastal locations in the spring and are identified as "background" concentrations. These concentrations are caused by emissions from both natural and anthropogenic sources,

[10] Source: Dept. of Ecology, 2001
[11] Source: GVRD, 2003, "Forecast and Backcast of the 2000 Emission Inventory for the Lower Fraser Valley Airshed (1985-2025)"

including a small but measurable amount transported from outside the airshed. Addressing these contributions to background from regions outside of the GB-PS airshed may require significant effort and resources.

- Fine particulate matter (dry mass) is dominated by carbonaceous material (organic compounds). In urban centers, nearly 50 per cent of the particle mass comes from combustion.
- Natural emissions of volatile organic compounds represent from one-third to one-half of the total VOC emissions in the airshed. The magnitude of natural emissions poses limits on achievable reductions in total VOC emissions and on the effectiveness of nitrogen oxide emissions controls in reducing ambient PM and ozone concentrations.
- SO_2, NO_X, and organic compounds are the dominant pollutants responsible for degraded visibility in the Puget Sound air basin. In the Georgia Basin SO_2 and NO_X are dominant; organic compounds are a likely contributor but the magnitude of the contribution is unknown because black carbon is not currently measured in the GVRD.

Social and Economic Context

Air quality is linked to many aspects of quality of life in the GB-PS including a healthy environment, a vibrant economy and social well-being. Air pollution is also related to a number of social and economic trends in the region, including increases in population, transportation demands, energy consumption, and shifts in industry. Air pollution causes significant social, environmental and economic impacts. Examples include:

- Health impacts ranging from eye, nose and throat irritation to decreased lung function and premature death.
- Damage to farm crops and vegetation, reducing yields of economically important crops.
- The reduction in visibility caused by the buildup of airborne particles in the air can have detrimental effects on tourism.[12]

Many sources of air pollution are also sources of greenhouse gases. Increasing concentrations of these heat trapping gases in the earth's atmosphere contribute to climate change, with potentially far reaching environmental, social, and economic consequences.

[12] For a single extreme visibility event, computer models estimate losses in future tourist revenue to be $7.45 million in the Greater Vancouver area and $32 million in the Fraser Valley.

Limits of Predictive Air Modeling

Significant gaps still exist in our knowledge of how specific air pollutants react with each other and impact human and environmental health within the GB-PS airshed. Methodologies used to compile emission inventories and to forecast emission trends rely on assumptions and computer modeling techniques that need further refinement.

Air quality computer models applied to the GB-PS airshed provide estimates of pollutant concentrations for days or weeks, but predictions of seasonal or annual concentrations are not available. The computer models being applied to the airshed need further evaluation, particularly for winter conditions. For this reason the GB-PS International Airshed Strategy includes an initiative on transboundary science and data that will enable partner agencies to continue working together to address these gaps (see Chapter 6 of this report).

Significance of Transboundary Transport

The Airshed Characterization found that there is sufficient transboundary airflow to transport airborne pollutants across the international boundary. In fact, windflow patterns move pollutants across the international border in both directions through all seasons of the year in the Georgia Basin airshed.

Furthermore, the results of computer-modeled simulations confirm that there is significant transboundary transport of air pollution in the southern portions of the Georgia Basin airshed. The main exchange of air and pollution between the GB-PS airsheds is through the "portal" situated to the south of Haro Strait, extending from south of Bellingham westward to Port Angeles. Flow through the portal is strongest in the fall.

Implications

The Airshed Characterization identified a variety of key implications for developing strategies to improve air quality in the GB-PS airshed. These are listed below.

- Because wind flow patterns move pollutants across the international border in both directions through all seasons of the year, the management of air pollution in the GB-PS airshed will be improved through coordinated attention by both Canada and the United States.
- The stagnant weather associated with episodes of poor air quality usually impacts the GB-PS airsheds simultaneously. During these episodic events, the movement of air pollutants between airsheds is extremely limited. However, strategies taken to address episodes of poor air quality will continue to benefit from coordinated international action in the GB-PS.

- Interactions between airborne pollutants can cause secondary air pollutants to form in the atmosphere. Emission reduction strategies will be most effective when the synergistic effects of emission changes on air chemistry and subsequent air pollutants are considered.
- The concentration of ambient air pollution is linked to social and economic trends, including increasing population, transportation demands, energy consumption and shifts in industry.
- Although emissions of pollutants from the on-road vehicle sector are projected to decrease over the next decade in both airsheds, emissions from the marine sector are increasing, as are emissions from agricultural practices. Emission reduction strategies directed toward those sectors where emissions are forecast to increase will have the largest positive impact on ambient air quality. Programs and strategies to reduce emissions and improve air quality will also assist with strategies to reduce greenhouse gas emissions.
- Because there is no clear threshold below which effects do not occur, ambient concentrations of air pollution, while they meet respective national standards in Canada and the United States, may have a negative impact on human health and the environment.
- Fine particulate matter (dry mass) is dominated by carbonaceous material. In urban centers, nearly 50 % of the particle mass is from combustion. The management of emissions from combustion sources should be a continuing priority to reduce fine particulate concentrations and related human health problems.
- SO_2, organic compounds, and NO_X are the dominant pollutants responsible for degraded visibility in the GB-PS. Improving visibility will require attention to all of these pollutants.
- The amount of ground-level ozone in the ambient air is primarily the result of photochemical reactions. Ozone and its precursors can be transported great distances. As a result, the highest ambient ozone concentrations are often observed downwind of urban centers and at high elevations in rural areas. The effectiveness of ozone control strategies needs to be evaluated by taking ambient measurements of ozone such appropriate locations.
- Natural emissions of VOC represent from one-third to one-half of the total VOC emissions in the airshed. The magnitude of natural emissions poses limits on achievable reductions in total VOC emissions in the airshed. Natural VOC emission levels also limit the effectiveness of NO_X emission controls in reducing ambient PM and ozone concentrations.
- Ozone concentrations of 40 to 50 parts per billion are often recorded at rural coastal locations in the spring and are identified as “background” concentrations. These concentrations are caused by emissions from both natural and anthropogenic sources, including transport from outside the airshed. Addressing these contributions to background from regions outside the GB-PS airshed may require significant effort and resources.
- Weather systems bringing airborne pollutants to the GB-PS move across the Pacific Ocean in three to five days. The impact of the long-range transport of pollutants from Asia is more often noted in the spring. Air pollutants from sources outside the airshed are usually well dispersed, although the impact on ambient air quality in the airshed is measurable. Ambient air quality strategies within the airshed need to consider the addition of pollutant concentrations from distant sources.

HUMAN HEALTH

Introduction

Since the 1970s, there has been growing concern about the health effects of air pollution and the short- and long-term effects on human respiratory and cardiovascular health. Epidemiology studies have consistently shown that certain levels of air pollution have a negative impact on human health. Many factors such as smoking, biological agents, and genetic predisposition may cause lung and heart illnesses, and it is well known that air pollution exacerbates these illnesses. However, the role air pollution plays as the underlying cause of both illness and premature death is still being studied.

Air pollution can affect our health in many ways with both short-term and long-term effects. Short-term effects of air pollution include irritation to the eyes, nose and throat, and upper respiratory infections such as bronchitis and pneumonia. While substantial uncertainties still exist in a number of areas and further research is needed, recent epidemiologic studies have shown statistically significant associations of various ambient PM indicators with a variety of cardiovascular and respiratory health endpoints, including mortality, hospital admissions, emergency department visits, other medical visits, respiratory illness and symptoms, physiological or biochemical changes related to the cardiovascular system, and physiologic changes in pulmonary function. Other symptoms can include headaches, nausea, and allergic reactions. Short-term exposure to air pollution can also aggravate the medical conditions of individuals with asthma and emphysema. Long-term health effects can include increased risk of mortality lung cancer, chronic respiratory disease, heart disease, damage to the brain, liver, and kidneys. Continual exposure affects the lungs of growing children and may aggravate or complicate medical conditions in the elderly and those with compromised immune systems.

The extent to which an individual is harmed by air pollution usually depends on the total exposure to the pollutant, that is, the length of time of the exposure and the concentration of the pollutant, the sources and composition of the air pollution mixture, and the health status of the individual. Pollutant levels and exposure to these pollutants vary from region to region. Topography (valleys and mountains), weather conditions and the activities that cause the emissions are all key factors in defining the ambient air quality.

This chapter outlines the health research being carried out in the Georgia Basin-Puget Sound (GB-PS) airshed to improve our understanding of the health effects of air pollution. This work was commissioned by Health Canada's Air Health Effects Division (AHED) under the U.S.-Canada Border Air Quality Strategy.

Background

The GB-PS pilot project is one of three cooperative projects under the Canada-United States Border Air Quality Strategy (BAQS). In Canada, BAQS will further assist in the development of the evidence base for new reductions in transboundary flows of air pollutants and help meet priority domestic commitments under the Canada-wide Standards process. From a public health perspective, BAQS will provide the regional health science knowledge needed to guide and justify measures to reduce air pollution and protect public health with a focus on the transboundary health effects of particulate matter.

The objectives established for Health Canada's BAQS activities include:

- Undertake health risk assessments and health impact economic analyses for the airshed;
- Examine region specific issues of concern to health, including transportation emissions, seasonality and unique regional exposures, with focus on particulate matter;
- Initiate health studies to examine the effects of short and long-term exposure to pollutants and their interactions. This includes the establishment of a population-based study group to examine the effects of longer-term exposure to air pollution including examination of susceptible sub-populations (children and the elderly). A key focus of this work is the transboundary health effects of particulate matter.

To assist in the design of the studies for the GB-PS airshed (Figure 12), Health Canada convened an experts-workshop in Vancouver on October 22, 2003 attended by approximately 30 researchers from both the United States and Canada. The workshop was an opportunity to establish research priorities, explore different approaches to cohort studies and invite proposals for the program of research.

The research reported in this chapter was carried out by the University of British Columbia, the University of Victoria and the University of Washington. The research was coordinated through a partnership between AHED and the British Columbia Centre for Disease Control, an agency of the British Columbia Ministry of Health Services. Three project coordination and progress reporting meetings were held involving research teams from the three universities and representatives of the air quality management agencies.

The health research projects carried out to date fall in one of two categories: first, the development of cohorts to evaluate health outcomes and secondly, the development of exposure assessment tools. These projects will form the base for more extensive work to be conducted in years 2005 to 2007. The established cohorts and the exposure assessment tools will be further linked to produce estimates of exposures to various air pollutants for each individual using validated exposure models that incorporate specific pollution sources. These models will allow assessment of the impact of these exposures on various health outcomes and the impact of alternative air quality management strategies on health outcomes. They will also allow evaluation of the impact of specific emissions sources on air quality and resulting health effects.

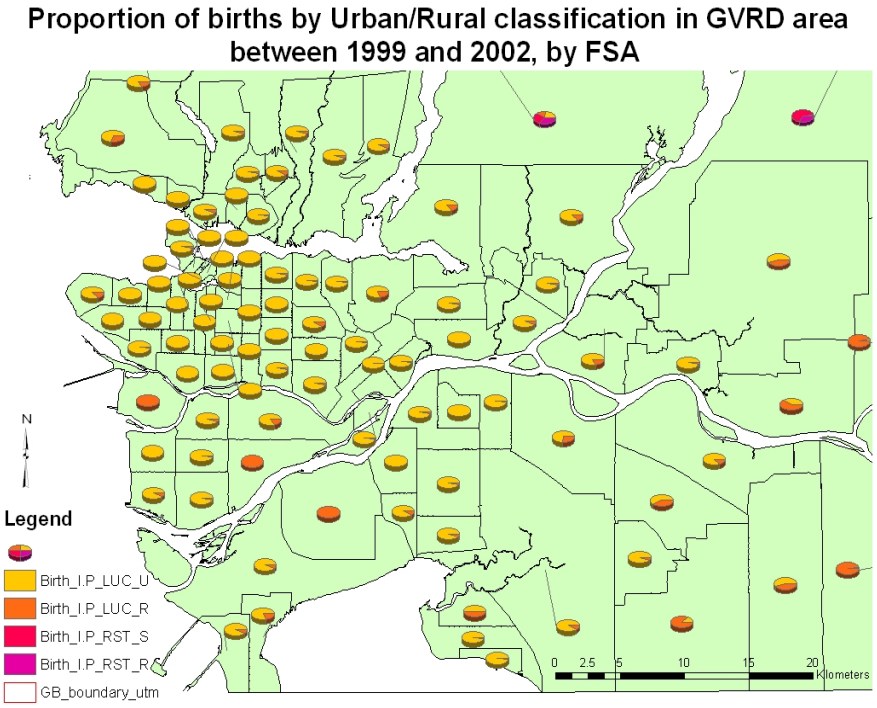
Health Research

Health research projects under BAQS completed since January 2004 provide the information needed to estimate an individual's exposure to air pollution in the airshed based on where an individual lives and compare that to specific health outcomes. Five projects were undertaken as follows:

A. **Establishment of a childhood respiratory disease cohort using the B.C. Linked Health Database (University of British Columbia)**

The ultimate objective of this study is to examine the relationship between changing levels of air pollutants (due to air quality management strategies and changes in emissions) and respiratory health among young children. Respiratory disease in children has been linked to air pollution exposure in numerous settings. This project established a birth cohort to evaluate the relationship between incidence of childhood respiratory disorders and exposure to air pollutants in the Georgia Basin Airshed (GBA). The analyses will focus on birth outcomes, asthma and bronchiolitis. The cohort includes 120,000 children born in the GBA. This cohort was then mapped according to geographic distribution of birth places (Figure 9). A reliability assessment on the residential history data was also performed.

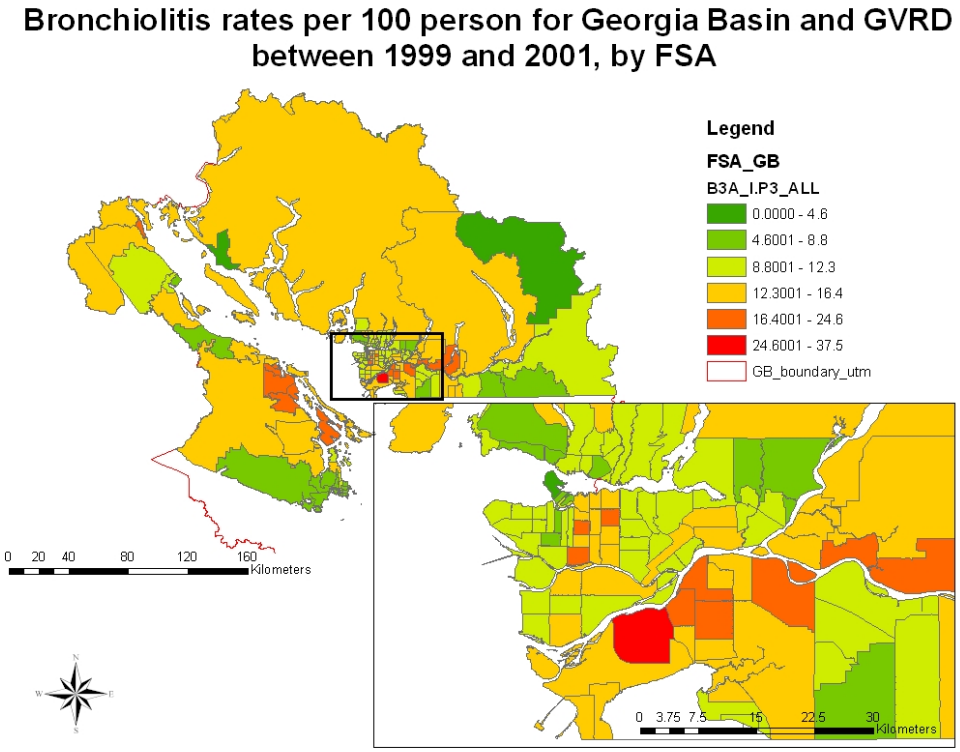
Figure 9: Birth distribution within GVRD



Using various sources of information, socioeconomic status indicators such as average income and unemployment rates were obtained to be used as covariates in better understanding the health effects of air quality on health outcomes.

Crude bronchiolitis and asthma rates were calculated for the overall cohort as a pilot for the full study. Figure 10 depicts the bronchiolitis rates for subjects born between 1999 and 2001 inclusive.

Figure 10: Bronchiolitis rates for subjects born between 1999-2001



B. **Analysis of birth outcomes in the Greater Vancouver Regional District (GVRD) using the BC Perinatal Database Registry and the BC Linked Health Database (University of British Columbia)**

The purpose of this project was to examine the relationship between adverse birth outcomes and exposure to air pollutants in the GVRD area using a subset of the respiratory disease cohort described earlier. Recent studies provided evidence of an association between adverse birth outcomes and air pollution. These studies suggest that birth outcomes may be an especially sensitive indicator of the health impacts of air pollution. This study has provided thus far:

- Summary statistics for preterm birth, low birthweight births and intrauterine growth retardation (IUGR) using BC Vital Statistics data.
- Map of all-births by case (low birthweight, preterm, IUGR)/control status

Summary reports and maps are provided in Appendix 2. Linkages to the BC Linked Health Database and the Perinatal Database Registry will be conducted during the 2005-2007 period along with the appropriate statistical analyses.

C. Data inventory and consolidation, evaluation of existing GIS data for Georgia Basin and Puget Sound Airshed (University of Victoria)

Different levels of Canadian and U.S. governments, working groups, academic researchers, and consultants have collected a broad range of information on air quality, pollution sources, geographical features and socioeconomic characteristics. This project consolidated the existing information for the GB-PS Airshed into a single GIS data inventory that will be used to support research on the effects of air pollution on health. This database will also be used to estimate an individual's exposure to air pollution in support for projects I and II. Information consolidated includes health data, socioeconomic data, pollutant exposure data (lead, ozone, particulate matter etc.), emission sources, topography and meteorology data.

The work identified data gaps and opportunities for improving data utilities. A Data Inventory website was developed and is available at http://www.geog.uvic.ca/AIR. The inventory contains information on sources of emissions, meteorology, topography, socioeconomic status, health databases, base mapping, and ambient air monitoring.

The data inventory identified studies that would be useful for increasing the spatial resolution of exposure estimates or associated data. These completed studies include:

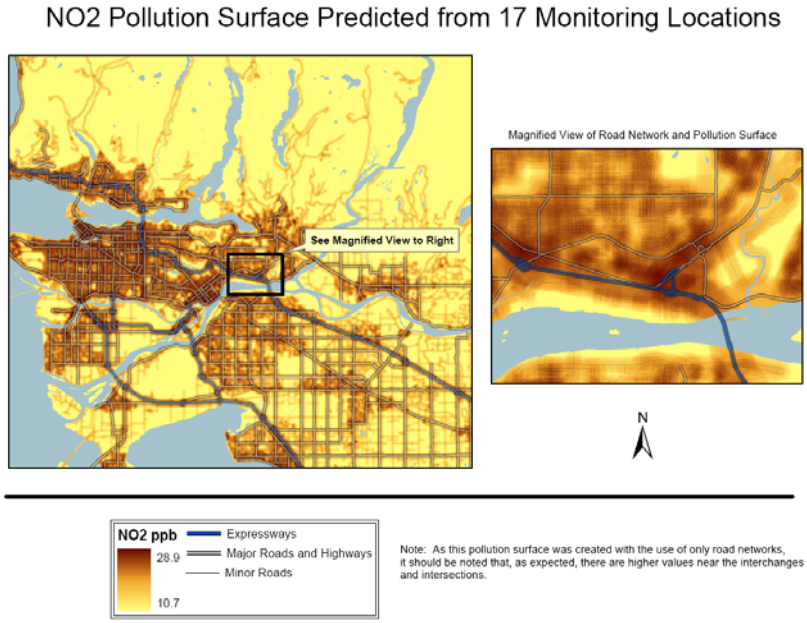
1. **Feasibility study of using MODIS data to indicate annual average concentrations of particulate matter for neighborhood areas**. Satellite data may be able to provide measurements of particulate matter throughout the airshed, without the need for additional permanent ground-level monitoring.
2. **Method development for using property assessment data to produce maps of land use, commercial and industrial locations, fireplace locations, and building age and type**. Assessment data for individual buildings can be used to better characterize neighborhoods.
3. **Validation of EMME2 traffic volume model and road classification comparison**. Modeled traffic volumes can be used to develop a road classification system that can be applied to areas without traffic counts or modeled traffic volumes.

D. Enhanced assessment of exposure to traffic and wood smoke and incorporation of meteorology (University of British Columbia)

This project refined the spatial analysis of population exposure to traffic and residential wood burning emissions in the GB-PS airshed. This involved a suite of related technologies including Geographic Information Systems, spatial data analysis, meteorology and fixed-site and mobile monitoring campaigns to model ambient concentrations and exposure. A key feature of this project is the development of modeled and validated exposures at fine spatial scales of resolution, such as the urban neighborhood. The ultimate goal of this project as it extends into years 2-3 is to develop the GB-PS Air Pollution GIS, a collection of databases and tools to aid in the determination of the association between exposure to air pollutants and health outcomes. This will assist policy formation around air quality management in the entire transboundary airshed. Key regional issues addressed in the project include household wood smoke, traffic emissions and incorporation of meteorology as follows:

- Household wood smoke: Ambient wood smoke emissions in the GVRD were estimated using wood smoke emissions surveys and other spatial databases. This stage of the research was meant to inform the spatial sampling of ambient wood smoke in a winter 2004-2005 fixed-site and mobile sampling campaign. Respondents were geo-coded using postal code information and their emissions, based on the prior winter burning season, were estimated at their place of residence using emissions factors from the provincial survey. These survey-based emissions estimates were then combined with a series of other geographic databases to estimate a surface of ambient winter wood smoke concentrations.
- Traffic emissions: As with the wood smoke modeling, the traffic emissions study was based first on the use of spatial databases to estimate emissions (NO_2 as a traffic marker) and target high population exposure locations for sampling and validation campaigns (Figure H4). Concentration estimates were based on a series of steps involving spatial data processing.

Figure 11: NO_2 Pollution surfaces in GVRD



- Meteorology: In order to estimate the influence of meteorological conditions on the local transport and dispersion of emissions, a highly parameterized source area model was developed. It uses meteorological data (hourly wind speed, wind direction, time of day and cloud cover) to determine emissions sources that influence a location's local air quality and the extent of their influence. The model uses cloud cover and wind to estimate the dispersive nature of the atmosphere. The model was tested and appears to capture the influence of wind speed, wind direction and stability on the dispersion and advection of emissions.

The wood smoke and traffic models were validated and refined using separate sampling campaigns.

E. Bronchiolitis and fine particulate air pollution in Puget Sound and Georgia Air Basin (University of Washington)

The goal of the first phase of this study was to identify a birth cohort in the Puget Sound Air Basin and develop a metric for regional traffic and wood smoke exposure. The hypothesis is that infants residing near busy highways or in areas impacted by wood smoke are more likely to be hospitalized for bronchiolitis during the first year of life than infants without these exposures.

A cohort of all infants born in the Puget Sound portion of the airshed was established and data on these infants including infant vital statistics data, birth hospitalization data, and first year of life hospitalization data indicating a discharge diagnosis of bronchiolitis (if applicable) have been obtained. Preliminary analysis of the dataset was explored for the primary variables that may be predictive of disease occurrence in the cohort.

Out of the cohort, 95% of the subjects with identified bronchiolitis hospitalizations were admitted between the months of November and May. The overall rate of bronchiolitis is 30% greater in subjects whose residential zip code is in an urban vs. rural area. The rate of bronchiolitis hospitalization is two-fold greater among infants whose mothers report active smoking during pregnancy compared to those who are self-described non smokers (Figure 13).

Figure 13: Bronchiolitis hospitalization rate by major risk factors - Puget Sound, WA

Risk Factors	Rate (per 100 infant-years)	N
Maternal smoking during pregnancy		
Yes	2.4	25,513
No	2	216,927
Unknown	1.8	5,604
Urban residence	3	230,760
Rural residence	1.0	17,284
Gestational Age (weeks)		
> 37 1/7	2	229,816
34 1/7 – 37	2.0	14,189
29 1/7 – 34	6	3110
25 – 29	3.6	879
Male	5	127,003
Female	1.0	121,041

Conclusion and Recommendations

Research to examine the association between health effects and ambient air quality in the GB-PS international airshed is a work in progress. The first phase of the three year project has established the foundation for subsequent studies to help provide the information needed to guide and justify measures for reducing air pollution and protect public health. This research will determine sources of greatest concern in each part of the airshed and develop a common basis of understanding between Canada and the United States regarding transboundary air quality conditions, potential future trends, and associated impacts on human health with special emphasis on particulate matter.

It is recommended that:

- Health Canada continue to fund the program of health studies begun during the BAQS pilot.
- Health Canada should consider continuing the BAQS health studies funding beyond the year 2007 to facilitate research on the long-term health implications.
- A committee with representatives from health agencies on both sides of the border should be struck to coordinate transboundary air health effects studies in the airshed.
- Communications and public outreach be carried out in order to address community concerns about air pollution issues and gain public support for the scientific research activities within the region.

GEORGIA BASIN-PUGET SOUND VOLUNTARY INITIATIVES

Introduction

Projects were initially identified for collaborative efforts (initially as "early actions" and later as initiatives) based on mutual transboundary interest. In addition, the Issue Ranking and Identification System (IRIS) was used to determine if initiatives should be addressed through the GB-PS International Airshed Strategy process.

As the early action projects of the GB-PS International Airshed Strategy evolved, the Steering Committee focused the prioritized list into two themes: (i) emission reduction efforts, and (ii) improved coordination mechanisms (Figure 9). Some of the early actions were restructured as initiatives that are each led by workgroups made up from members of the Steering Committee. Several projects were completed as early actions and were therefore not adopted as initiatives. Several initiatives are new, not previously identified as early actions but identified by the Coordinating Committee as concerns which should be addressed with a cross-border focus.

Not all of the IAS member agencies are represented on each initiative workgroup. Agencies provide members to the initiative workgroups according to their mandates, priorities, and resources. Workgroups generally seek voluntary and incentive-based programs to achieve emission reductions. They also seek opportunities to capitalize on the regulatory programs within the member agencies.

Summary of Initiatives

Marine Vessel and Port Emissions Reduction Initiative

The leads of this initiative are Environment Canada (Vancouver office) and the U.S. Environmental Protection Agency (EPA) (Region 10). Other partners include the BC Ministry of Environment (BC MoE); Fraser Valley Regional District (FVRD); Greater Vancouver Regional District (GVRD); Northwest Clean Air Agency; Olympic Region Clean Air Agency; Puget Sound Clean Air Agency; Swinomish Tribal Association; Washington State Department of Ecology.

Marine vessel and port activity in the GB-PS is projected to double, and for some ship and port activity sectors, to triple in the next 10 to 20 years. With the introduction of cleaner fuels and more stringent emission standards for on-road motor vehicles, marine vessels and ports may soon become the largest source sector of air emissions in many areas of the GB-PS international airshed.

The reduction of air emissions from marine vessel and port operations in the GB-PS airshed is necessary to ensure ongoing compliance with the respective national air ambient quality

standards on both the Canadian and the U.S. sides of the international border and to protect public health and the environment in the communities in the vicinity of and downwind from large port terminals and marine vessel shipping routes.

The purpose of this initiative is to:

- Explore new emission management opportunities and techniques by monitoring and sharing information about marine shipping and port air quality issues, and air emission reduction initiatives within the GB-PS airshed and other major national and international shipping locations.
- Facilitate research, feasibility studies, pilot testing and application of new ship and port emission reduction technologies and measures within the GB-PS airshed.
- Develop and implement improved methods and processes to record ship movements, port visits, engine characteristics, and fuel quality for application in future emission inventories.
- Prepare ship emission inventories for the year 2005 in the GB-PS airshed, which are as comprehensive and as accurate as possible within available data and budget resources.
- Participate and support, where possible, the evaluation of the feasibility and effectiveness of an IMO Annex VI Sulfur Emission Control Area (SECA) in collaboration with related initiatives on the west coast of North America and other coastal and Great Lakes regions in North America.

Many lessons were learned through this initiative. For instance, recent and projected marine vessel and port activity in the GB-PS showed that air emission management for this sector is increasingly important. Also the management of marine vessel and port air emissions is complicated by the international nature of ship ownership, operations, and regulatory authority.

Next steps for this initiative include:

- Completion of an accurate inventory of ship and port air emissions for the 2005 calendar year, a priority for continued assessment of air management options for this sector.
- Participation in the assessment of the proposed North American SECA, an important opportunity to ensure that the GB-PS region is included in this broad-based measure to reduce ship emissions if studies indicate that a SECA is a viable and cost-effective approach.
- Consideration of additional cost–effective measures for ship fuel quality and engine emissions as necessary.
- Evaluation of opportunities for increased support of collaborative emission reduction initiatives by ship owners/operators and port authorities.
- Continued reporting to the U.S.-Canada Air Quality Committee.

Clean Vehicles and Fuels Initiative

This initiative is led by Environment Canada and the Puget Sound Clean Air Agency. Participating agencies are Greater Vancouver Transportation Authority (TransLink), GVRD, Washington Department of Ecology, U.S. EPA, and Northwest Clean Air Agency.

Light-duty and heavy-duty motor vehicles are the source of significant quantities of smog-forming pollutants, air toxics and greenhouse gases within the Georgia Basin and Puget Sound. A 2003 Puget Sound Clean Air Agency evaluation of air toxics indicated that 70% of cancer risk from inhaled air toxics in Seattle arose from diesel exhaust (using the California Environmental Protection Agency's toxicity evaluation for diesel particulate).

The first steps for this initiative included preparing reports that evaluated emission reduction options for on- and off-road heavy duty diesel vehicles in the Lower Fraser Valley, understanding relevant existing programs including funding programs, and understanding the present availability of various fuels in Georgia Basin and Puget Sound.

This initiative benefits from several larger national and regional efforts aimed at reducing emissions from vehicles, such as:

- National emission standards, in the United States and Canada, for on- and off-road gasoline and diesel engines.
- National regulations in the United States and Canada, governing composition of gasoline and diesel fuel.
- Agreement between the Government of Canada and vehicle manufacturers to reduce vehicle greenhouse gas emissions.
- Washington State law adopting California vehicle emission standards.
- Mandatory vehicle inspection/maintenance programs in more-populated portions of the GB-PS.
- U.S. Clean Diesel Campaign, and the trucking and locomotive and rail sector work groups of the U.S. West Coast Collaborative.
- U.S. EPA Voluntary Diesel Retrofit Program.
- Retrofit and ultra-low sulfur fuel programs for school buses (e.g., Clean School Bus U.S.A which had school bus retrofit projects in 22 states in 2003) and other public fleets in Puget Sound Clean Air Agency and Northwest Clean Air Agency.
- Agreement between Canadian Urban Transit Association and Environment Canada to retrofit transit buses, including 50 buses in the Georgia Basin.
- Memorandum of Understanding between the Railway Association of Canada, Transport Canada and Environment Canada to reduce emissions.

Building on these successes, the initiative is now investigating the potential for:

- Extending outreach regarding school bus retrofits to suggest ways children and their families can reduce emissions in their own lives (e.g., anti-idling).
- Anti-idling technologies and practices for locomotives operating mostly within the airshed.
- Providing low vapor-pressure fuel in the border region.
- Sharing of insights in the design of on-board diagnostic (OLD) vehicle inspection and maintenance programs.
- Educating the motoring public about what actions to take in response to OBD indications.
- Other public outreach efforts.

Members of this initiative workgroup have learned that it takes time to develop relationships with different fleet categories, but once these relationships are developed, the opportunities for significant emissions reductions for fleet vehicles are generally limited by budget availability only. Well established off-the-shelf emission reduction solutions are readily available. Puget Sound participants have expressed a desire for a GB-PS specific fund to which projects could apply. Some existing EPA grant programs, such as the West Coast Collaborative, may provide similar coverage, though not specific to the GB-PS.

Notification of Major New Sources Initiative

The chairs of this initiative are Washington State Department of Ecology and BC MOE. Other partners include Environment Canada, FVRD, GVRD, U.S. EPA Region 10, U.S. National Park Service, and Health Canada

Environment Canada, U.S. EPA and partner agencies recognize the need to strengthen information sharing and collaboration in this transboundary airshed within the context of the existing notification requirements of the U.S.-Canada Air Quality Agreement.

The Notification of Major New Sources Initiative is a mechanism to explore refinements and improvements to the notification and consultation procedures for new sources of air emissions that may have a transboundary impact. This has been driven by public concern about large new sources of air pollution and by public support for continuous improvement of air quality in the region.

The scope of this work includes policy and regulatory analyses and recommendations.

Activities completed under this initiative include:

- Review of air approval procedures for new sources in BC and the northwest United States.
- Determination of key regulatory gaps and issues in the notification and consultation on new sources that may have a transboundary impact.
- Training, tools, and techniques to determine best available technology (BAT).

Key lessons learned from this initiative are that the issue is complicated due to the multi-party regulatory framework and somewhat overlapping mandates. In general, agencies feel that the current transboundary notification process is working well although there are strong concerns from some stakeholders and the public. This initiative may benefit from increased dialogue with energy assessment agencies.

Opportunities for cooperation and next steps include:

- Revising the GB-PS International Airshed Strategy website to provide more easily accessible information regarding proposed new sources in the region, or developing a separate website.
- Updating the 1994 Interagency Agreement on new source notifications between agencies in the GB-PS area.
- Working to bring regional energy project approval agencies into any revised notification agreement.
- Cooperation with industrial stakeholders (to determine if a streamlined approach to permitting is preferable, from a business perspective).

Transboundary Science and Data Initiative

The chairs of this initiative are the U.S. EPA (Region 10), Environment Canada (Vancouver office). Other members include Washington Department of Ecology, GVRD, Health Canada, BC MOE, Olympic Region Clean Air Agency, U.S. National Park Service, Washington State Department of Health

The purposes of this initiative are to:

- Adopt data sharing practices and data sharing tools to ensure free and efficient access to all air quality-related data sets between agencies by 2006.
- Ensure that jointly developed, current, and high-quality scientific knowledge about air quality and its health and ecosystem impacts is available to decision-makers.
- Develop principles (by 2006) for involving other participating agencies during the initial planning process of new scientific studies.
- Develop ongoing inter-agency studies to address knowledge gaps, such as those identified in the reports “Characterization of the GB-PS Airshed” and “Status of Air Quality and Effects of Atmospheric Pollutants on Ecosystems in the Pacific Northwest Region of the National Park Service”.

Policy recommendations of the GB-PS International Airshed Strategy must be based upon sound science to be credible. This initiative will ensure that science is conducted efficiently and transparently resulting in a common understanding of the issues.

Projects completed by this initiative include:

- The report entitled, "Characterization of the Georgia Basin/Puget Sound Airshed."
- TRansboundary Air Data Exchange (TRADE) – a web application to facilitate access, exchange, display and analysis of data and information.
- "Status of Air Quality and Effects of Atmospheric Pollutants on Ecosystems in the Pacific Northwest Region of the National Park Service".

The key lesson learned from this initiative is that air quality science benefits from strong cross-agency relationships among scientists. This facilitates data exchange, identification of mutual interest opportunities for collaboration and a deeper understanding of the science-related roles and responsibilities of air quality agencies in the GB-PS.

Next steps of this initiative may include developing of an inventory of: (i) existing air quality-related projects in which participating agencies are involved; (ii) data sharing tools participating agencies currently have available; (iii) prospective projects participating agencies are considering to undertake; and (iv) data gaps.

The workgroup notes that inter-agency scientific collaboration is supported under the U.S.-Canada Air Quality Agreement and seeks to build on this agreement to better understand transboundary air quality issues in the region. Such collaboration will strengthen the relationships between agencies, produce better science and be of value to decision-makers.

Communications and Outreach Initiative

The chairs of this initiative include Environment Canada (Vancouver office) and the Olympic Region Clean Air Agency. Other members include the Washington Department of Ecology, GVRD, Health Canada, BC MOE, U.S. National Park Service, Puget Sound Clean Air Agency, U.S. EPA (Region 10).

The purpose of this initiative is to build knowledge and understanding of new scientific and technical information by communicating IAS findings with key information user groups.

Agencies participating in the International Airshed Strategy can learn from the communications and outreach experiences of other agencies and leverage messages to more efficiently and effectively reach out to the public and other stakeholders.

This initiative has completed the development of several communications and outreach products related to the objectives of the GB-PS International Airshed Strategy.

Key lessons learned by this workgroup include: (i) the benefits of transboundary cooperation on communications and outreach efforts, since such efforts are transferable between agencies; and (ii) the benefit of a streamlined approach to communications and outreach services for the multiple agencies participating in the GB-PS International Airshed Strategy process.

Next steps include: address existing information needs with important stakeholder groups; conduct formal public polling (by Environment Canada) of GB-PS residents about air quality; and, coordinate and maximize the reach of IAS communications and outreach activities.

Agriculture Industry Emission Reductions Initiative

The chair of this initiative is the FVRD. Other partners include the BC Ministry of Agriculture Food and Fisheries, BC MOE, Environment Canada (Vancouver office), GVRD, U.S. National Park Service, Northwest Clean Air Agency, U.S. EPA (Region 10), and the Whatcom Conservation District.

The purpose of this initiative is to work with partner agencies and the agriculture industry to develop collaborative approaches or strategies for reducing emissions from agriculture sources in the GB-PS airshed.

Emissions from agriculture sources are projected to increase steadily, accounting for 76% of the total ammonia emissions and 32% of the total particulate matter emissions in the Lower Fraser Valley by 2025. Emissions forecasts predict that this will become the second most significant anthropogenic source of smog forming pollutants in the LFV by 2025.

Agricultural sources of primary particulate matter include road dust, diesel combustion and agricultural burning activities. Agricultural sources also contribute to the production of secondary particulates by the release of precursor pollutants. Ammonia is a significant concern as its main source is agricultural operations and practices (animal wastes, fertilizers and crop residues) and accounts for approximately 80% of the total agricultural emissions in the LFV. Greenhouse gas emissions, in the form of methane, are also significant and result mainly from livestock manure handling practices.

Projects completed by this initiative include:

- 2004 - Report - Analysis of Best Management Practices and Emission Inventory of Agriculture Sources in the Lower Fraser Valley. It is expected that this report will provide the foundation for future work.
- 2004 - Membership established and scoping activities conducted.
- 2005 - Workgroup teleconference to further define the goals, objectives and path forward for the initiative in the context of the GB-PS IAS.
- 2005 – Agriculture Partnership Committee Meeting – presentation and distribution of materials on the "Analysis of Best Management Practices and Emission Inventory of Agriculture Sources in the Lower Fraser Valley" report.

An important lesson from this initiative is that many environmental agencies have limited abilities to regulate air emissions from agricultural sources due to policies and legislation such as the British Columbia *Right to Farm Act*. Members recognize that actions taken by the agricultural sector will be most effective if conducted on a voluntary basis.

Next initiative steps include:

- Consider development of ammonia management strategy in consultation with agriculture industry.
- Look for mechanism to predict future ammonia emissions from industry sources.
- Seek opportunities to develop voluntary emission reduction programs with the agriculture sector.
- Encourage agriculture sector adoption of current control technologies and practices.
- Develop strategies to reduce emissions from agriculture burning.
- Develop communications materials addressing emission reduction actions for agriculture operations, and identifying the role of ammonia in fine particulate formation in the region.
- Work with the agriculture community to reduce odor emissions from their operations.
- Identify opportunities and mechanisms to engage the agriculture sector in the GB-PS IAS process. This may occur through representation by producer associations and or the BC Agriculture Council, together with similar organizations in the United States.
- Work in consultation with partner agencies and the agriculture sector/producers to develop achievable mechanisms for reducing air emissions from agriculture operations, in particular ammonia discharges.

Residential Wood Heating Emission Reductions Initiative

The co-leads of this initiative include the Swinomish Indian Tribal Community, Puget Sound Clean Air Agency, and the GVRD. Other partners include the Olympic Region Clean Air Agency, Environment Canada (Vancouver office), U.S. EPA (Region 10), BC MOE, and the Northwest Clean Air Agency.

The purpose of this initiative is to work with partner agencies in developing strategies and mechanisms to improve regional and local air quality by reducing emissions from residential wood heating activities.

Residential wood burning appliances and fireplaces emit significant amounts of air pollutants and contribute to poor visibility and degraded air quality in the GB-PS region. Wood smoke contains hundreds of chemical compounds such as NO_X, CO, organic gases and particulate matter which may contribute to elevated health effects particularly for sensitive individuals such as children, the elderly and pregnant women.

On an average annual basis in Washington State, wood stoves and fireplaces account for about 9% of the total air pollution emissions. It is estimated that approximately half of the homes have wood burning devices and contribute up to 80% of the air pollution recorded for residential areas, particularly at night and on weekends. Comparatively, on Tribal Reservations, where there is limited access to natural gas, it is estimated that 85% of the homes use wood heating appliances.

For the Georgia Basin, approximately one-third of all homes in the GVRD and FVRD have wood burning appliances, however, most are not primary sources of heating. Recent Environment Canada studies, in Montreal, comparing pollution levels of wood smoke in rural areas with those in urban areas found significantly higher levels of PAHs, dioxins, and furans in rural residential areas than the more urbanized areas. The highest concentrations were in the evenings and on weekends during the winter wood burning season.

The work completed in 2004 by this initiative includes the establishment of membership and scoping of future work activities. Key activities for 2005 include attending a 2-day conference sponsored by the U.S. EPA on woodstove change-outs; considering how the new Washington State $PM_{2.5}$ based burn ban provisions will be implemented in the Puget Sound; and, updating of the GVRD's draft Air Quality Management Plan (currently under review). Related actions include encouraging the BC government to update the wood burning appliance regulation and develop public education materials; and implementing strategies for voluntary emission reduction actions during air quality events.

Lessons learned include:

- It is difficult to develop collaborative strategies for reducing wood smoke emissions that are transboundary in nature because the regulatory responsibilities and capabilities in BC and Washington State differ significantly.
- Significant funding is needed for agencies to offer financial incentives to homeowners to replace older devices with cleaner technology (gas, propane, pellet, certified stoves).
- Without a regulatory imperative that requires change-out, financial incentive is the only way to reach most device users.

Next steps include:

- PSCAA and other Washington State agencies will begin implementing the new $PM_{2.5}$-based burn ban trigger.
- FVRD and GVRD will work to develop a program for voluntary burn bans when PM_{10} is measured at elevated levels. The implementation of the bans could involve a tiered approach.
- Partner agencies will look to cooperatively conduct outreach efforts to encourage the upgrading of old stoves to newer, cleaner burning models.
- PSCAA to explore the potential for reintroduction of Washington legislation that requires home owners to notify prospective buyers if stoves do not meet EPA standards.
- Partner agencies will explore the potential for development of strategies to encourage burning only in certified stoves or fireplace inserts.
- Tribes and other partners will explore potential development of wood stove change-out programs for Tribal communities in Whatcom and Skagit counties, and residential communities in the GVRD.
- Tribes and other partners will conduct a wood stove inventory for Tribal communities in Whatcom and Skagit Counties.

FUTURE DIRECTIONS

Context

Population growth in the GB-PS and the associated demands for land development, transportation, energy, employment and other resources will continue to stress the GB-PS ecosystem unless managed wisely. This section describes three thematic approaches to strengthen the GB-PS International Airshed Strategy and air quality management in this region. These approaches include participation in activities under the U.S.-Canada Air Quality Agreement, continued efforts on information sharing, collaborative actions and projects, and joint policy efforts.

Future Directions

Continued Multi-agency Information Sharing

Information sharing is necessary to successfully manage air quality in our transboundary airshed. Since multiple agencies on both sides of the border have mandates to manage air quality and many more have a role in our region's air quality, we must ensure that strong lines of communication are open and used to effectively exchange information.

To be fully utilized, information must be shared in diverse media and fora. While some tools can efficiently reach large audiences (e.g., the Internet), efforts must also be made to establish and strengthen networks emphasizing human contact and face-to-face communication. Organizations such as the GB-PS International Airshed Strategy Coordinating Committee serve as a valuable venue to explore better ways to manage air quality in our region under the umbrella of the U.S.-Canada Air Quality Agreement.

It is the experience of the GB-PS Coordinating Committee that periodic meetings, hosted alternately in Canada and the United States, have enhanced information exchange in this region.

GB-PS CASE STUDIES - Continued multi-agency information sharing

At the International Airshed Strategy meetings, agencies are able to announce significant new issues and programs. This is a useful mechanism to highlight best practices, such as:

- The success of the Puget Sound Clean Air Agency in the early introduction of clean diesel fuels to the region.
- The Greater Vancouver Regional District's work on their proposed new Air Quality Management Plan and associated ambient air quality objectives.
- The efforts of the Swinomish Tribe related to air quality monitoring.
- The multi-agency efforts to develop the TRansboundary Air Data Exchange (TRADE) application to share scientific data between agencies.

The continued opportunity to exchange information in the GB-PS International Airshed Strategy forum will reinforce existing agency relationships and allow new ones to develop. Such new relationships are already being developed through activities of the initiative working groups. These relationships will have long-lasting benefits for air quality management in the GB-PS.

Collaborative Projects

Collaborative project-level efforts to address issues of mutual concern are important in that they: (i) lead to a stronger project through the involvement of different agency perspectives, and; (ii) afford participating agencies an opportunity to increase their understanding of each other's mandate and roles. Collaborative projects are focused tasks that offer short- to medium-term opportunities for joint efforts.

GB-PS CASE STUDIES – Collaborative projects

An example of a major collaborative project through the GB-PS International Airshed Strategy process is the work on the notification of new sources.

Since the U.S.-Canada AQA provides for notification and consultation on major new sources with transboundary impacts, and permitting of new sources is conducted by several agencies, an opportunity was identified to collaborate on a related project. This work was initially undertaken by the Washington State Department of Ecology, the BC Ministry of Water, Land and Air Protection and Environment Canada's Vancouver office.

This notification of new sources collaborative work produced a report with recommendations to strengthen such procedures for the region. In addition, the agencies identified the preference for more learning opportunities about preferred technologies for permitting processes, which resulted in a training session for federal and provincial permitting staff.[13] The initiative on notification of new sources (described in Chapter 6) is intended to further this effort.

Other significant collaborative projects through the GB-PS International Airshed Strategy process include:

- The GB-PS Airshed Characterization to establish a common understanding of the current status of and trends in air quality in the GB-PS. Collaborative partners included the U.S. Forest Service; WA Department of Ecology; Fraser Basin Council; EPA Region 10; Northwest Clean Air Agency; Coast Salish Sea Initiative; Puget Sound Clean Air Agency; Environment Canada (Vancouver); Greater Vancouver Regional District (GVRD); and BC Ministry of Water, Land and Air Protection.
- Collaboration in which Health Canada and the academic community are pursuing research on the impacts of air pollution on human health.
- The project to quantify health impacts from air quality in the Lower Fraser Valley was convened through the BC Lung Association and involved BC Ministry of Water, Land and

[13] . Best Available Technology (BAT) Workshop (Vancouver, 2004).

Air Protection, Environment Canada (Vancouver), Health Canada, GVRD, Fraser Valley Regional District (FVRD), and University of BC.

- Work to identify emission reduction options for heavy-duty diesel fleet vehicles in the Lower Fraser Valley which involved: the GVRD; FVRD; BC Ministry of Water, Land and Air Protection; Environment Canada; Greater Vancouver Transportation Authority; and the Clean Air Research Fund.

Joint Policy Efforts

The GB-PS International Airshed Strategy Coordinating Committee recognizes that some issues require similar policies in both the Puget Sound and Georgia Basin to effectively address air quality management in this transboundary airshed. These efforts tend to be both broadly scoped and long-term efforts. Issues that require this approach tend to be of significant and mutual concern, and projected to worsen over time without intervention. While joint policy efforts may require significant dedication of staff by participating agencies, the benefits justify a joint policy approach such as outlined in the U.S.-Canada Air Quality Agreement.

CASE STUDIES – Joint policy efforts

An example of a joint policy effort is the analysis of emissions from marine vessels and ports.

This issue is significant in the region (sector emissions are expected to be nearly equal to those from light-duty vehicles by 2010). Since the marine sector is highly mobile and cost-sensitive, a unilateral approach (e.g., domestic regulations) is not preferred to address this sector. Instead, an approach is currently underway that emphasizes parallel efforts and works towards continuous improvements.

Environment Canada and the U.S. EPA have jointly explored mechanisms to address this issue at the regional and bilateral levels, and have also worked to engage industry stakeholders such as the Ports of Vancouver and Seattle. To further ensure a parallel approach, a single effort is being explored to assess the feasibility and effectiveness of an International Maritime Organization Sulfur Emission Control Area in the GB-PS international airshed in conjunction with other studies on the west coast, the Gulf coast, the east coast and the Great Lakes region of North America.

Future joint policy efforts may include issues related to:

- A jointly-planned transportation network of road, marine, and rail networks to minimize emissions. Examples could include truck stop electrification from the Washington State I-5 corridor to Vancouver and provision of low sulfur fuel at key locations in the airshed to ensure an adequate regional supply.
- Transboundary efforts that further the goals of both the GB-PS International Airshed Strategy and the West Coast Collaborative.
- Efforts related to land-use planning that emphasize continuous improvements in air quality. Participating agencies with a mandate for land-use planning could be involved to encourage voluntary adoption of such principles for the region.

Scientific Collaborative Opportunities

In addition to the scientific ventures described above, further collaborative efforts are required to better understand the complex air quality related processes in the GB-PS international airshed and their impact on human health. This includes work to:

- Develop tools to share air quality data and compare emissions inventories from Canada and the United States.
- Model transboundary flow of pollutants, including under different scenarios and for longer periods.
- More precisely forecast changes related to regional transboundary air quality, mainly from the significant growth expected in the GB-PS (for at least the next two decades).
- Continue the progression in the regional health research assessing the impacts of air pollution on health.

In addition, collaborative efforts to reduce air emissions and improve air quality should be concurrently pursued, with periodic reporting to the U.S.-Canada Air Quality Committee. Examples of this work include the leadership role of the Puget Sound Clean Air Agency and the subsequent partnership work to retrofit school buses to reduce diesel particulate emissions and the related exposure of schoolchildren.

APPENDIX 1

GEORGIA BASIN-PUGET SOUND INTERNATIONAL AIRSHED STRATEGY

Statement of Purpose

The purpose of the Georgia Basin-Puget Sound (GB-PS) International Airshed Strategy is, through international and regional co-operation and collaboration, to:

- Reduce the impacts of air pollution to human health, ecosystems, and visibility in the GB-PS airshed.

- Prevent future deterioration and work towards continuous improvement of air quality in the GB-PS region.

- Establish practical and effective instruments to address shared concerns regarding transboundary air pollution in the GB-PS region.

Operating Principles

The GB-PS International Airshed Strategy was developed by a coordinating committee, under the U.S.-Canada Border Air Quality Strategy, a cooperative effort to investigate barriers to reducing air pollution in transboundary air basins in North America developed under the auspices of the 1991 U.S.-Canada Air Quality Agreement. The Coordinating Committee is made up of members from regional, provincial, state and federal government agencies, and First Nations and Tribes. Environment Canada Pacific and Yukon Region (PYR) and the Environmental Protection Agency (EPA) Region 10 act as co-lead agencies, coordinating joint activities by the Committee.

Committee members can nominate new members, who are accepted by consensus. Meetings of the Committee are open to other agencies, the general public, and other interested parties who can attend as observers or associate member agencies.

The Committee meets approximately every six months, alternately in Canada and the United States. Canadian meetings are hosted by Environment Canada PYR and U.S. meetings are hosted by EPA Region 10. The work of the Committee is supported by staff resources, shared funding and in-kind contributions from member agencies.

The Committee recognizes that both inter-agency collaboration and unilateral initiatives are necessary to improve air quality in the region. In this regard, agencies may develop or use existing collaborative mechanisms, including:

- International frameworks between regional representatives of the federal governments (e.g., EC/EPA Joint Statement of Cooperation of the Georgia Basin and Puget Sound Ecosystem);
- Formal international agreements (e.g., the Canada-U.S. Air Quality Agreement);
- State-province agreements (e.g., B.C.-Washington Environmental Cooperation Agreement);
- Cooperative arrangements between regional agencies (e.g., cooperative air quality monitoring agreement between GVRD and FVRD);
- Others, such as the Georgia Basin Action Plan.

The GB-PS IAS Coordinating Committee will continue to meet biannually to review progress on commitments made through the initiatives of the International Airshed Strategy. These biannual meetings will also provide a forum to report progress on the IAS supporting initiatives, as described below.

Ongoing collaboration is required to ensure that air quality deterioration is prevented and continuous improvement is made despite the significant population growth that this region is predicted to experience for at least the next two decades. It is expected that as progress is made some initiatives may no longer need to be coordinated through the IAS process. In addition, new scientific information may identify other issues relevant in a transboundary airshed context that can best be addressed through the IAS approach and warrant addition as new initiatives. These may be identified through the Issues Ranking Identification (IRIS) process, developed as an "early action" of the IAS process and defined in the appendices.

Context

The GB-PS airshed is located in the western coastal region of the Canada-United States border. Seattle and Vancouver are the largest communities, and the provincial capital of British Columbia (Victoria) and the state capital of Washington (Olympia) are also located here.

Some significant sources of air emissions in the GB-PS include: marine vessels; automobiles, trucks and buses (particularly vehicles with diesel engines); agricultural operations; wood stoves and other space heating; open burning of yard and wood waste; industrial combustion sources; and thermal power plants.

Air quality in this region currently meets relevant national air quality standards on each side of the border. However, there are still important air quality concerns in this international airshed since research shows that visibility and ecosystem health are diminished and human health is affected at existing levels of air pollution.

The effects of air pollutants on human health can range from eye and throat irritation to difficulty breathing, wheezing, coughing and aggravation of existing respiratory and cardiac conditions. These effects can result in increased medication use, increased doctor or emergency room visits, more hospital admissions and even premature death. Ecosystem effects include reduced

visibility, atmospheric deposition to land and water ecosystems, and ozone damage of plant tissue, and others.

Projected significant growth in population, economic activity, motor vehicle use, and other transportation sources in Vancouver, Seattle and surrounding areas will increase air pollution if this growth is not well managed. Recent projections show that the regional population will grow from about six million in 2000 to nine million by 2020, a 50% increase in twenty years.

A major challenge faced by governments on both sides of the border is improving air quality even as the population grows. In addition, the region is home to world-renowned parks, reserves and vistas that contribute to strong tourism and a high quality of life for residents. Both the U.S. and Canadian governments have programs designed to protect air quality in areas that meet the national standards and to improve visibility. These are: the Prevention of Significant Deterioration (PSD) program and Regional Haze Rule in the United States, and in Canada, the "Keeping Clean Areas Clean" and "Continuous Improvement" components of the Canada-Wide Standards and the ongoing Canadian Council of Ministers for the Environment process.

Despite the challenge of managing air quality in a multi-jurisdictional, transboundary airshed, there is a long history of cooperation between the United States and Canada on environmental matters. Early successes included the 1941 Trail Smelter Arbitration. Significant progress in the 1970s and 80s led to the development of the Canada-U.S. Air Quality Agreement (AQA) in 1991. Other efforts have taken shape under the AQA including the 2000 Ozone Annex and the 2003 Border Air Quality Strategy. Accomplishments at the state, provincial and regional levels have included the 1992 Environmental Cooperation Agreement between British Columbia (BC) and the State of Washington (WA); the 1994 Interagency Agreement among BC, WA, the Greater Vancouver Regional District, and the Northwest Air Pollution Authority; the 2000 Joint Statement of Cooperation on the Georgia Basin and Puget Sound Ecosystem; and the 2002 Statement of Intent on a Georgia Basin and Puget Sound International Airshed Strategy.

For all of the agencies involved in the IAS, continued collaboration across jurisdictions is an important objective. In addition, the primary function of each agency is to manage air quality within its jurisdiction and according to its standards and objectives. Both missions require that current, high-quality scientific information be available to regulatory agencies to inform decision-making. A key science component of the GB-PS International Airshed Strategy is the characterization of the GB-PS Airshed. The initial characterization identified transboundary flow in the GB-PS area, with key findings based on meteorological patterns, ambient air quality data and the most recent inventories of air pollutant emissions. These were combined with emission forecasts and application of robust air quality computer models to describe future air pollutant concentrations. The report, "Characterization of the Georgia Basin/Puget Sound Airshed", and associated implications must be re-visited as new scientific information and results from modelled emission scenarios become available. The results of studies through the Border Air Quality Strategy, the Georgia Basin Action Plan and other initiatives will continue to provide continuing scientific support for the development and implementation of the International Airshed Strategy.

Other examples of important scientific work to develop knowledge about air quality and its relation to human health and ecosystems in the GB-PS airshed include:

- Lower Fraser Valley emission inventory for the year 2000, including an emissions forecast and backcast by the GVRD
- NWAPA Bellingham air toxics screening project (2000)
- EC PYR economic analysis of lost tourism revenue from degraded regional air quality (2000)
- Multi-agency Pacific 2001 air quality field study
- BC Lung Association report on air quality and health (2003)
- EPA Region 10 Northwest Air Summit consultation (2003)
- BC MoE/EC study on particulate matter in British Columbia (2003)
- 2003 Puget Sound toxics evaluation by the PSCAA
- FVRD analysis of best management practices to reduce ammonia emissions from the Lower Fraser Valley agricultural sector (2004)
- 2004 Western Airborne Contaminants Assessment project by the U.S. National Park Service (including Olympic National Park).
- Ongoing air quality monitoring by various government agencies, the Swinomish Tribe, Tsawwassen First Nation and Snuneymux (Nanaimo) First Nation.
- Ongoing air toxics monitoring program in Seattle by WA DoE.

Based on the co-operative scientific and policy analysis described above, the GB-PS International Airshed Strategy Coordinating Committee sought to inform its deliberations regarding possible transboundary airshed management mechanisms. This resulted in a report that identified the strengths and weaknesses of various mechanisms (Melious, 2004) and assisted the Coordinating Committee in its development of the GB-PS International Airshed Strategy.

Goals

As sister nations, Canada and the United States share many goals, including preserving and enhancing the welfare of natural systems and protecting the health of their citizens. The national governments of both countries have recognized that in many areas their airsheds have become degraded by the same pollutants – ozone and particulate matter, their precursors, and acid deposition. These contaminants know no boundaries and they exacerbate the difficulties and concerns of citizens on both sides of the border. Over the past decade, each country has established its own means of maintaining and enhancing these areas, with distinct mandates, goals and objectives within the context of its environmental programs.

Members of the GB-PS Coordinating Committee have identified these goals for improving air quality in the region through ongoing transboundary co-operation and collaboration.

1. Reduce the risk of adverse effects on human health and ecosystems.
2. Increase visibility and reduce regional haze in the airshed.

The GB-PS Coordinating Committee recognizes that some actions taken to achieve these goals may also reduce emissions of greenhouse gases in the region, an objective shared by many of the coordinating committee partners.

These goals and objectives are to be addressed within the context of each country's legal mandates, regulatory systems, and voluntary programs. This international airshed strategy recognizes, in particular, the potential of the Canadian programs for Continuous Improvement and Keeping Clean Areas Clean, and the U.S. programs for Prevention of Significant Deterioration and reducing regional haze to help met these goals.

These goals will be supported by a series of initiatives that will stress emissions reductions and improved air quality management. Initiatives will be chosen based on scientific information and where a greater response will be produced by collaborative efforts.

The Coordinating Committee will develop and revise the list of initiatives. In the future, the Coordinating Committee may decide to remove initiatives once they have achieved their objectives and further transboundary collaborative efforts are no longer required. The Committee may also add new initiatives where new information warrants action and such a cooperative transboundary approach is the preferred method to accomplish air quality improvements. The Issue Ranking and Identification System (see appendix F.) may be used to identify such new initiatives.

Appendix A – Georgia Basin-Puget Sound transboundary area

Appendix B – Acronyms

BC	British Columbia
BC MoE	British Columbia Ministry of the Environment (formerly BC WLAP)
BC WLAP	British Columbia Ministry of Water, Land and Air Protection (now BC MoE)
CAA	Clean Air Act
CCME	Canadian Council of Ministers for the Environment
CI	Continuous Improvement
CWS	Canada-Wide Standards
EC (PYR)	Environment Canada (Pacific-Yukon Region, i.e. Vancouver office)
ECE	Economic Commission for Europe
EPA	Environmental Protection Agency
FVRD	Fraser Valley Regional District
GB	Georgia Basin
GVRD	Greater Vancouver Regional District
IAS	International Airshed Strategy
IRIS	Issues Ranking and Identification System
KCAC	Keeping Clean Areas Clean
LFV	Lower Fraser Valley
NO_X	Nitrogen Dioxides
NSR	New Source Review
NWCAA	Northwest Clean Air Agency
ORCAA	Olympic Region Clean Air Agency
PM	Particulate Matter
PM_{10}	Particulate Matter less than 10 microns in size
$PM_{2.5}$	Particulate Matter less than 2.5 microns in size
Ppb	Parts per billion
Ppm	Parts per million
PS	Puget Sound
PSCAA	Puget Sound Clean Air Agency
PSD	Prevention of Significant Deterioration
RHR	Regional Haze Rule
SO_2	Sulphur dioxide
SO_X	Sulphur oxides
ug/m^3	micrograms per cubic metre
VOC	Volatile organic compounds
WA	Washington State
WA DoE	Washington State Department of Ecology

Appendix C - Air Quality Standards & Objectives

Since there are several agencies in the GB-PS area that have regulatory authority over air quality management, there are different standards and authorities for managing air contaminants. These include the:

- BC Air Quality Objectives
- GVRD Air Quality Objectives
- National Canada-Wide Standards (to be achieved by 2010)
- National Ambient Air Quality Standards for the United States
- Northwest Air Pollution Authority's Ambient Air Standards
- Puget Sound Clean Air Agency's Ambient Air Quality Standards
- U.S. Tribal Authority (Air) Rule*
- Washington State Ambient Air Quality Standards.

Other agencies in the area that have air quality planning and or regulatory authority include:

- Fraser Valley Regional District
- U.S. Tribes (as per the Tribal Authority (Air) Rule).

* The U.S. EPA Tribal Authority (Air) Rule states that the Clean Air Act (CAA) directs EPA to promulgate regulations specifying those provisions of the Act for which it is appropriate to treat Indian tribes in the same manner as states. For those provisions specified, a tribe may develop and implement one or more of its own air quality programs under the Act. This final rule sets forth the CAA provisions for which it is appropriate to treat Indian tribes in the same manner as states, establishes the requirements that Indian tribes must meet if they choose to seek such treatment, and provides for awards of federal financial assistance to tribes to address air quality problems. Note that in Canada, some First Nations have delegated authority from the federal Department of Indian Affairs and Northern Development (Indian Act Section 35) to manage land and environmental issues on reserve, including activities that relate to air quality.

Table 2 (below) summarizes the various air quality standards and objectives relevant to the GB-PS transboundary region.

Table 2: Air Quality Standards and Objectives in the GB-PS airshed

Agency	Ozone (ppb)	PM_{10} (ug/m^3)	$PM_{2.5}$ (ug/m^3)	SO_2 (ppm)	NO_2 (ppm)
Canadian					
• CCME CWS	65 [8h, 3ya4]	n/a	30 [24h, 3ya98]	n/a	n/a
• NAAQO**	82[1h] 25[24h] 15[a]	n/a	n/a	0.35[1h] 0.10[24h] 0.02[a]	0.21[1h] 0.11[24h] 0.05[a]
• BC MoE [LVLb]	As per CWS and NAAQO	50 [24h]	As per CWS	As per NAAQO	As per NAAQO
• GVRD*	As per CWS and NAAQO	50 [24h]/ 30 [g] (Annual objective)	As per CWS	As per NAAQO (Maximum acceptable level)	As per NAAQO (Maximum acceptable level)
U.S.					
• U.S. EPA NAAQS	80 [8h]	150 [24h]/ 50 [a]	65 [24h]/ 15 [a, 3ya]	0.03 [a]/ 0.14 [24h]	0.053 [a]
• WA DoE	As per EPA Standards	As per EPA Standards	As per EPA Standards	As per EPA Standards	As per EPA Standards
• NWCAA	As per EPA Standards	As per EPA Standards	As per EPA Standards	0.020 [a]/ 0.100 [24h] 0.800[5m]	0.050 [a]
• PSCAA	As per EPA Standards	As per EPA Standards	As per EPA Standards 25 [24h, Goal]	As per EPA Standards	As per EPA Standards

* - please note that GVRD objectives are currently under review as part of a new Air Quality Management Plan.
** - link to National Ambient Air Quality Objectives (NAAQO) http://www.hc-sc.gc.ca/hecs-sesc/air_quality/regulations.htm#3
a - based on the annual arithmetic mean
LVLb –The level "B" of the BC Ambient Air Quality Objectives is reported here. The BC MoE PM_{10} objective is meant to be equivalent to Level B.
g = based on the geometric mean
x – never to be exceeded
1h - 1 hour average
8h - 8 hour average
24h - 24 hour average (not to be exceeded more than once per year) Note: BC MoE objectives are treated as not to be exceeded numbers
5m – 5 minute average
3ya - to attain this standard, the 3-year average of the annual arithmetic mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15 ug/m3.
3ya98 – achievement to be based on the 98th percentile ambient measurement annually, averaged over three consecutive years
3ya4 – achievement to be based on 4th highest measurement annually, averaged over three consecutive years
Goal – goal approved by the board of directors

Appendix D – Definitions

1. “Air pollutant (or contaminant)", for the purposes of this Strategy, means a substance that is emitted into the air and that: injures or is capable of injuring the health or safety of a person, injures or is capable of injuring property or any life form, interferes or is capable of interfering with visibility, interferes or is capable of interfering with the normal conduct of business, causes or is capable of causing material physical discomfort to a person, or damages or is capable of damaging the environment;

2. “Air pollution” means the presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment;

3. “Environmental justice” means the fair treatment and meaningful involvement of all people. Therefore, no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local and tribal programs and policies;

4. “Georgia Basin” means the geographic area of southwestern British Columbia, adjacent to the International border with the United States, and defined by the watershed of the Straight of Georgia;

5. “Georgia Basin-Puget Sound” or “Georgia Basin-Puget Sound International Airshed” means the combined transboundary area of the Georgia Basin and Puget Sound (App. A);

6. “Characterization of the Georgia Basin-Puget Sound Airshed” means the scientific study of meteorological patterns, ambient air quality data and the most recent inventories of air pollutant emissions with emission forecasts and the application of state-of-the-science air quality computer models describing future air pollutant concentrations;

7. “Georgia Basin-Puget Sound International Airshed Strategy Coordinating Committee” means the members of the GB-PS International Airshed Strategy. Members are defined in Appendix E, below;

8. “Lower Fraser Valley”, for the purposes of this Strategy, means the geographic area defined by the Greater Vancouver Regional District and Fraser Valley Regional District in Canada and Whatcom County in the U.S.; and including the Strait of Juan de Fuca;

9. “Puget Sound” means the geographic area of northwestern Washington State, adjacent to the Georgia Basin airshed, and defined by the watershed boundaries of Puget Sound;

10. “Smog Forming Pollutants”, for the purposes of this Strategy, are those air contaminants which are routinely inventoried by regulatory agencies and are associated with visibility impairment and the formation of ground level ozone and fine particulate matter in the airshed, namely $PM_{2.5}$, NO_X, VOC, SO_X, and NH_3.

11. "Transboundary air pollution" means air pollution whose physical origin is situated wholly or in part within the area under the jurisdiction of one Party and which has adverse effects, other than effects of a global nature, in the area under the jurisdiction of the other Party;

Appendix E – Membership of the GB-PS International Airshed Strategy Coordinating Committee

Member agencies:

Canada

- British Columbia Ministry of Environment (formerly Water, Land and Air Protection)
- Coast Salish Sea Initiative
- Environment Canada (Pacific-Yukon Region)
- Fraser Valley Regional District
- Greater Vancouver Regional District
- Health Canada
- Stó:lô Tribal Council
- Tsawwassen First Nation

United States

- Northwest Clean Air Agency
- Puget Sound Clean Air Agency
- Olympic Region Clean Air Agency
- Swinomish Indian Tribal Community
- Upper Skagit tribe
- U.S. EPA (Region 10)
- U.S. Department of Interior, National Park Service
- Washington State Department of Ecology

Associate Member Agencies

Fraser Basin Council

Note - the GB-PS IAS Coordinating Committee has made efforts to invite participation by First Nations and Tribes throughout the GB-PS area.

Appendix F - Issue Ranking and Identification System (IRIS)

DECISION TREE FOR AIR QUALITY ISSUES	**Prepared by:** **Date:**

INSTRUCTIONS:

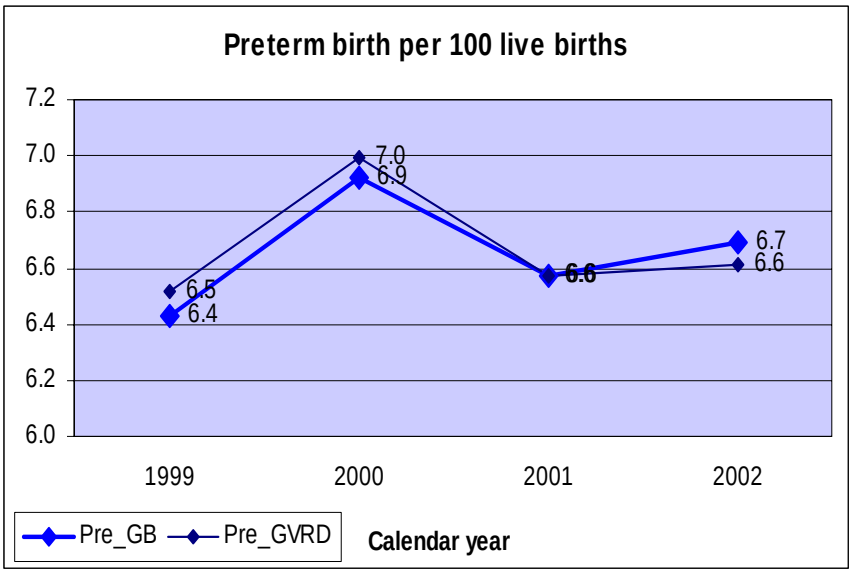
- Answer all questions to the best of your ability with readily-available information. The purpose of the Issue Ranking and Identification System (IRIS) is to assess, in a timely manner, whether an issue requires an International coordinated response or not. It is not meant to require major research to apply.
- Questions on "highlighted" lines are meant to elicit commentary – they are not part of the Yes/No decision-making tool.
- In order to qualify as an issue requiring an International coordinated response, the answer to all 4 questions must be "Yes".
- In the "Next Steps" section, outline what you think some logical next steps might be.
- Address any climate change co-benefits in the "comments" section

Name and Brief Description of the Issue		
Questions	**Answer**	**Comments**
1. Is this issue causing a negative impact on air quality? **2. Can we quantify or assess the importance of this impact?** **3. Does the issue or the impact have a cross-border dimension such that responses should be coordinated between Canadian and U.S. agencies and authorities?** • **If so, what would be the objectives of such a coordinated response?** **4. Are there promising approaches for reducing the impact?** • **If so, what are they?**		
Next Steps		

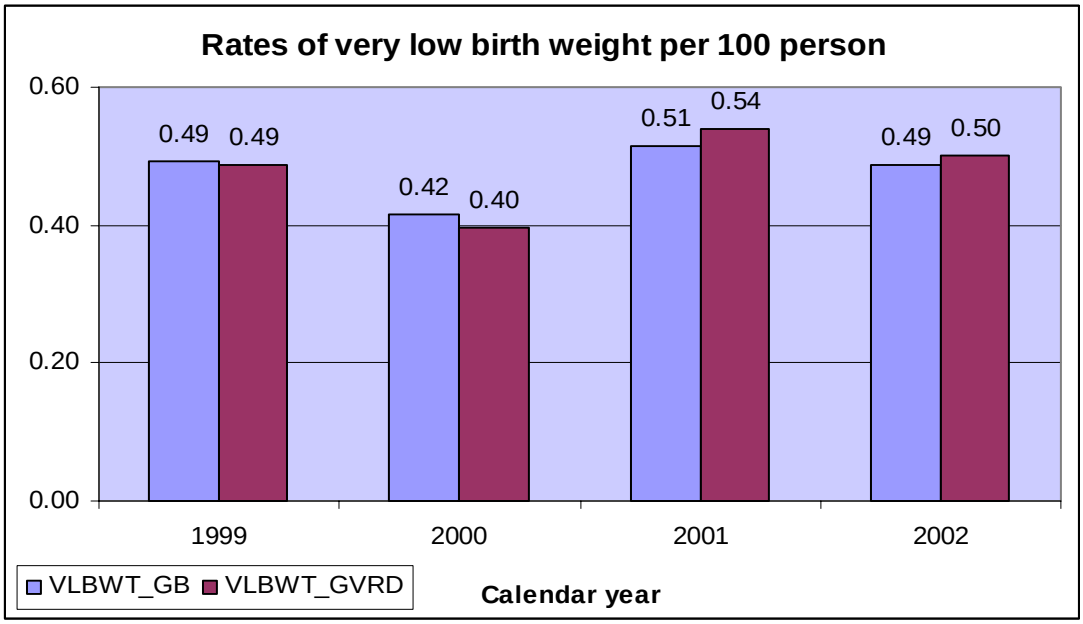
APPENDIX 2

HEALTH REPORT SUMMARY STATISTICS

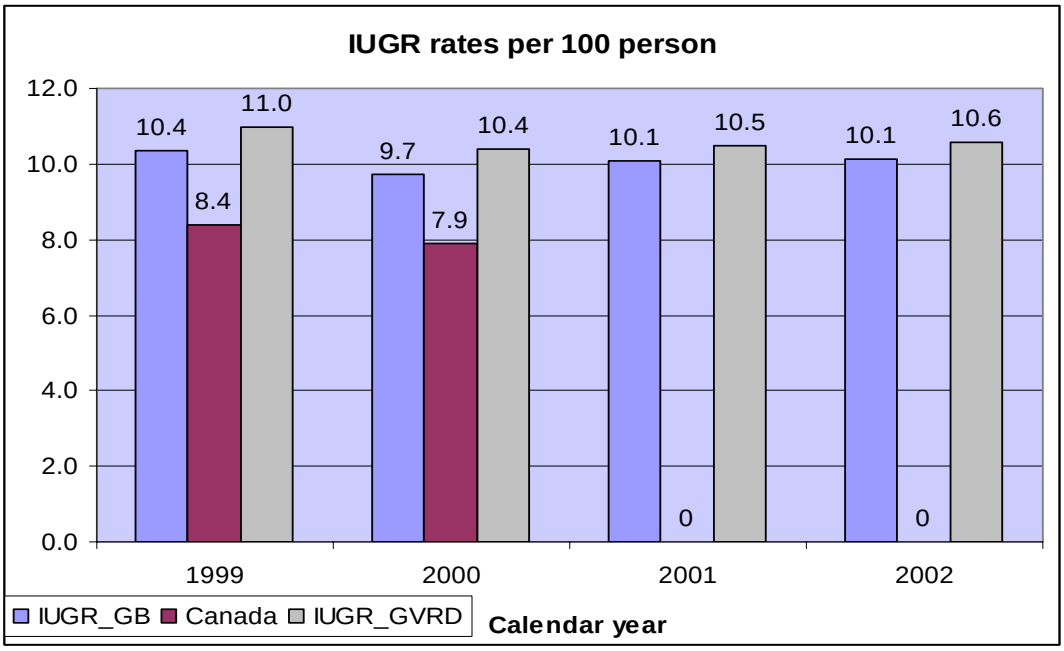
1. Summary statistics for preterm births in GVRD and Georgia Basin (GB) (1999-2002)



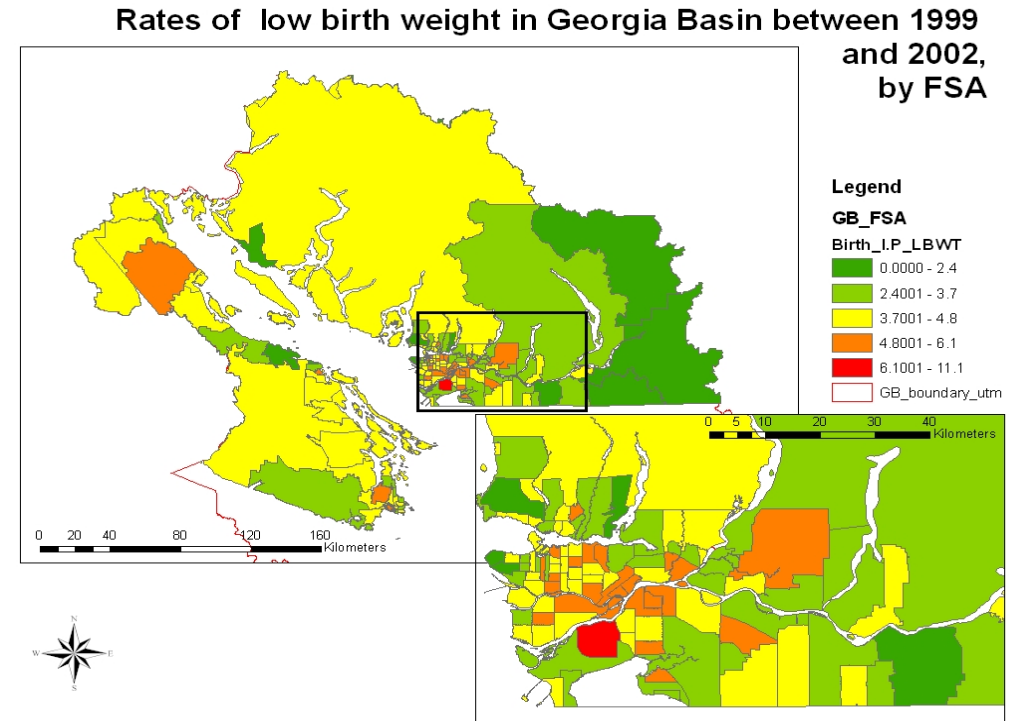
2. Summary statistics for very low birthweight in GB and GVRD (1999-2002) for singleton births without any congenital anomalies.

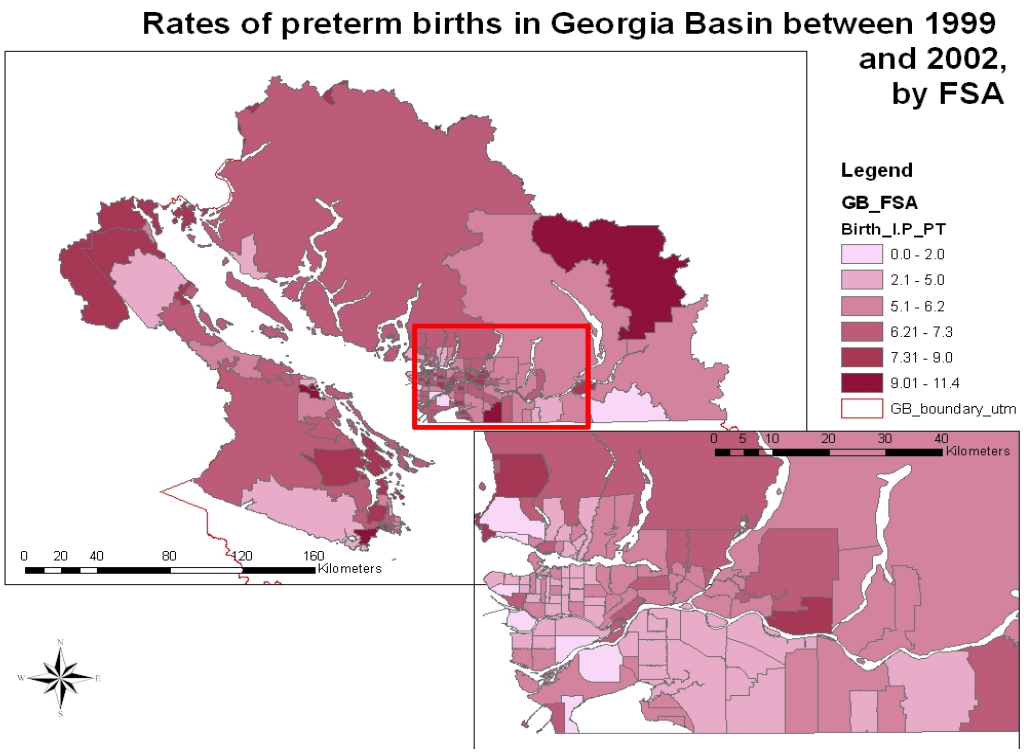


3. Summary statistics for IUGR in GVRD, GB and Canada (1999-2002)

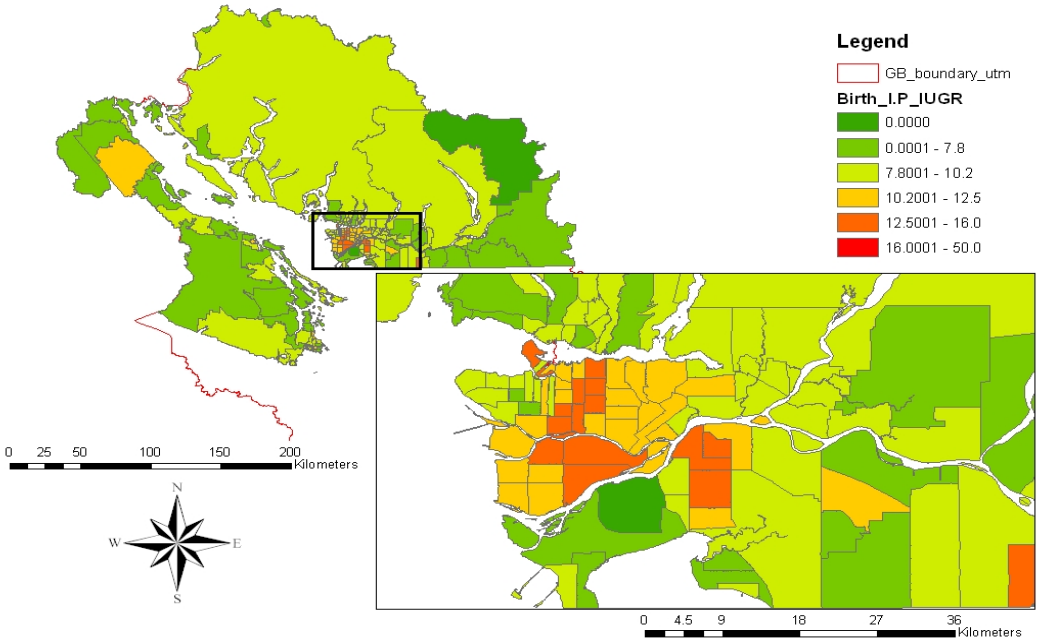


4. Map of all births by case (low birthweight, preterm, IUGR)/control





Rates of IUGR in Georgia Basin between 1999 and 2002, by FSA



APPENDIX 3

SUMMARY OF TECHNICAL REPORTS

The following summary of technical reports is included here to highlight the recent and considerable transboundary collaborative work in the GB-PS. While not all of these projects were collaborative binational efforts, they all contributed to knowledge of air quality management and science in the transboundary GB-PS region. They offer examples of best management practices for agencies who manage air quality in this transboundary region. Note that there are many studies and projects in addition to those described here that are not included for brevity.

Title	**IAS Website**
Theme	Communications & Outreach
Purpose	To provide a list of best management practices and to act as a clearinghouse of air quality-related information, including significant activities of IAS partners.
Partners	Lead: EC PYR Participants: all members of the IAS Coordinating Committee
Author	EC PYR (Mullan)
Product	Website, hosted by Environment Canada; presentations to IAS partners

Title	**Development of an Air Quality Objective for $PM_{2.5}$**
Theme	Improved management mechanisms
Purpose	To develop options for a new provincial $PM_{2.5}$ air quality objective to support Canada-wide Standards (CWS) implementation and airshed management.
Partners	BC MoE, EC PYR
Author	BC Lung Association
Product	Report, consultation

Title	**Dispersion Modeling Guidance Document**
Theme	Transboundary science and data
Purpose	To promote consistency in modeling air quality in BC
Partners	BC MOE, EC PYR
Author	RWDI Inc.
Product	Report, stakeholder consultation

Title	**Air Quality Primer**
Theme	Communications and outreach
Purpose	To help the public understand the terms used when discussing air quality, what factors affect air quality in our communities, and the management tools available to maintain and improve air quality in the future.
Partners	EC, BC MOE, BC Environmental Assessment Office, municipalities
Author	Staff from partner agencies, CH2M Hill
Product	Public document (>1500 copies), material for websites

Title	**First Nations and Air Issues Workshop**
Theme	Communications & outreach
Purpose	To identify mechanisms for aboriginal communities and their neighbors to address air quality issues
Partners	BC MOE, DIAND, EC PYR, Stó:lô Tribal Council
Author	West Coast Environmental Law
Product	Regulatory analysis report with recommendations; workshop; summary of workshop

Title	**Odor Management Issue – Path Forward**
Theme	Improved management mechanisms
Purpose	To develop an approach to deal with odor management in BC.
Partners	BC MOE, EC PYR
Author	RWDI AIR Inc
Product	Report, interagency committee on odor management

Title	**Air Quality Best Management Practices Guide for Local Government**
Theme	Communications & outreach
Purpose	To provide information to local governments on mechanisms to improve local and regional air quality. Local governments concerned about air quality often do not have the in-house expertise to address related issues.
Partners	BC MOE, EC PYR
Author	BC MOE
Product	Report

Title	**Cost-Benefit Analysis on Preferred Options from BC Lung Options Paper**
Theme	Health research
Purpose	To provide enhanced information for decision-makers regarding the costs and benefits of new air quality efforts
Partners	BC MOE, EC PYR, BC Lung Association
Author	BC MOE
Product	Report

Title	**Toolkit for Local Government on Air-Related Planning Processes**
Theme	Communications & Outreach
Purpose	To provide a suite of specific tools for local government and information about the role of other levels of government in air quality management.
Partners	BC MOE, EC PYR
Author	BC MOE
Product	Report

Title	**Sea to Sky Airshed Project**
Theme	Improved management mechanisms
Purpose	Develop an airshed management plan for the Sea to Sky corridor
Partners	BC MOE, EC PYR
Author	MOE Lower Mainland Regional Office
Product	Report

Title	**Health and Air Quality – Phase 1 - Methods for Estimating and Applying Relationships between Air Pollution and Health Effects**
Theme	Health
Purpose	To identify and recommend risk assessment methods to estimate the impacts of air pollution on human health for areas within British Columbia, as well as in select adjacent/ shared airsheds.
Partners	BC MOE, EC PYR, Health Canada, GVRD, FVRD, UBC
Author	RWDI Inc., BC Lung Association
Product	Report, presentations (agency and public)

Title	**Health Impacts from Air Quality in the Lower Fraser Valley Airshed**
Theme	Health
Purpose	To quantify the impacts from current and projected ambient air quality in the Lower Fraser Valley of British Columbia
Partners	BC MOE, EC PYR, Health Canada, GVRD, FVRD, UBC
Author	RWDI Inc., BC Lung Association
Product	Report, presentations

Title	**GB-PS Airshed Characterization**
Theme	Science
Purpose	The goal of the study was to establish a common understanding of the current status of and trends in air quality in the GB-PS.
Partners	U.S. Forest Service; WA Department of Ecology; Fraser Basin Council; EPA Region 10; Northwest Clean Air Agency; Coast Salish Sea Initiative; Puget Sound Clean Air Agency; Environment Canada (Vancouver office); GVRD; BC MOE
Author	Bruce Thomson, Environment Canada (Vancouver office)
Product	Report, presentations, web content

Title	**ANALYSIS OF BEST MANAGEMENT PRACTICES AND EMISSIONS INVENTORY OF AGRICULTURAL SOURCES IN THE LOWER FRASER VALLEY**
Theme	Agricultural emissions
Purpose	The purpose of the project was to: • Develop an updated and comprehensive emissions inventory for the agricultural sector in the Lower Fraser Valley; and • Review existing best management practices (BMPs) for agricultural sources of emissions and identify the preferred BMPs for voluntary application in the Lower Fraser Valley
Partners	Environment Canada; FVRD; GVRD; BC Ministry of Agriculture, Food & Fisheries
Author	Levelton Consultants Ltd. And Golder Associates Ltd.
Product	Report

Title	**GB-PS International Airshed Strategy Discussion Paper: Mandate, Priorities and Best Management Practices of Participating Agencies**
Theme	Improved management mechanisms
Purpose	The purpose of this Discussion Paper is to provide a link between the Airshed Characterization Report and the International Airshed Strategy. The objectives of the Discussion Paper are to identify and report on issues and current or planned management programs of individual agencies related to improving air quality within the study area.
Partners	Environment Canada (Pacific-Yukon Region); U.S. Environmental Protection Agency (Region 10); U.S. National Park Service; Stó:lō First Nation; Swinomish Tribe; BC Ministry of Water, Land and Air Protection; Washington State Department of Ecology; Greater Vancouver Regional District; Northwest Clean Air Agency; Fraser Valley Regional District; and Puget Sound Clean Air Agency.
Author	RWDI West Inc.
Product	Report

Title	**Transboundary Air Quality Management Models: Options for Western Canada/United States**
Theme	Improved management mechanisms
Purpose	This study proposes five options for cooperative approaches to transboundary air quality along the western Canada-United States border. The purpose of the study is to provide information to the Georgia Basin/Puget Sound International Airshed Coordinating Committee that will assist in the development of a strategy for future cooperative efforts.
Partners	GB-PS IAS Coordinating Committee
Author	Jean O. Melious (Western Washington University)
Product	Report, presentation

Title	**Best Available Technology (BAT) Workshop (Vancouver)**
Theme	Improved management mechanisms
Purpose	To train regulatory permit engineers on procedures for establishing Best Available Technology as part of the air emissions permitting process. Similar courses were held in Saskatoon and Edmonton in April 2004.
Partners	EC (PYR), BC MOE, GVRD
Author	MJ Bradley & Associates
Product	Workshop

Title	**New Source Review of Air Approval Procedures in BC and the Northwest United States**
Theme	Notification of new sources
Purpose	The objectives of the study were to: • identify existing Canadian and U.S. regulatory processes and practices for the review of new sources of air emissions by government agencies within the study area; • identify governmental procedures for NSR & related notifications for projects that have a transboundary air quality component within the study area, including stationary, energy, transportation, and other sectors; and • identify and report on issues related to improving air quality management within the study area with respect to inter-agency co-operation regarding NSR.
Partners	BC MOE, WA DoE, EC PYR
Author	RWDI West Inc. and Terry Nyman
Product	Report, presentations

Title	**Emissions of Dioxins, Furans and Other Contaminants from Wood-Waste Combustion**
Theme	Wood heating
Purpose	Assess the current use of wood residuals in British Columbia. Compare the expected emissions from in-use and emerging wood combustion technologies in British Columbia to Best Available Control Technology.
Partners	EC, GVRD, FVRD
Author	Levelton Engineering consultants
Product	Report

Title	**Fuel and Technology Options for Reducing Marine Vessel Emissions in the Georgia Basin**
Theme	Marine vessel emissions
Purpose	To present preliminary technical and cost-effectiveness assessment of various options for reducing emissions from ocean-going vessels, cruise ships, ferries and work boats.
Partners	Environment Canada
Author	Genesis Engineering Inc.
Product	Report: Fuel and Technology Options for Reducing Marine Vessel Emissions in the Georgia Basin

Title	**Management Options for Marine Vessel Air Emissions**
Theme	Marine vessel emissions
Purpose	To inform policy-makers/ stakeholders of the advantages/ disadvantages of different regulatory, economic and voluntary instruments for reducing marine vessel emissions of SO_X, NO_X and $PM_{2.5}$ in the GB-PS, and to recommend most-promising options.
Partners	Environment Canada
Author	BMT Fleet Technology Ltd.
Product	Report: Management Options for Marine Vessel Air Emissions

Title	**SO_X Emission Control Area (SECA) Application: Needs Assessment for the Pacific Coast of Canada**
Theme	Marine vessel emissions
Purpose	To assess the present state of knowledge regarding the Pacific coast of Canada, as compared to the information requirements set out in Annex VI for SECA applications ("gap analysis"). To propose a work program to fill any information gaps that could prevent the assessment described in Annex VI of the appropriateness of a SECA on the Pacific coast of Canada, or that prevent the development of a strong application.
Partners	Environment Canada
Author	Levelton Consultants Ltd.
Product	Report: SO_X Emission Control Area (SECA) Application: Needs Assessment for the Pacific Coast of Canada

Title	**Emission Reduction Options for Heavy-Duty Diesel Fleet Vehicles in the Lower Fraser Valley**
Theme	Clean Vehicles and Fuels
Purpose	To provide guidance to the GVRD, its member municipalities, the Greater Vancouver Transportation Authority and others on: • the most promising option(s) to reduce emissions from their existing heavy-duty diesel vehicles, and • future purchases of fleet vehicles / engines and fuels.
Partners	GVRD, FVRD, BC Ministry of Water, Land and Air Protection, Environment Canada, Greater Vancouver Transportation Authority, Clean Air Research Fund, Clean Energy
Author	Levelton Consultants Ltd.
Product	Report: Emission Reduction Options for Heavy Duty Diesel Fleet Vehicles in the Lower Fraser Valley

Title	**Air Toxics Emission Inventory and Evaluation**
Theme	Coordinated Transboundary Science and Data
Purpose	• Produce an inventory of emissions of air toxics from all sources in the Lower Fraser Valley Airshed in 2000, and forecast through 2025; • Evaluate risk to human health from air toxics in the Lower Fraser Valley, using currently available data and methods; and • Recommend methods to improve the human health risk assessment from air toxics in the Lower Fraser Valley and other regions.
Partners	EC (Vancouver office) and GVRD
Author	Levelton Consultants Ltd
Product	Report; Database - spatially distributed emission inventory and forecast.

Title	**Industrial and Energy Sector Air Emissions Outlook**
Theme	Notification of Major New Sources
Purpose	To provide a description and outlook of the major industrial sectors that are significant air emission emitters within the Georgia Basin-Puget Sound International Airshed.
Partners	EC-PYR
Author	Constable Associates
Product	Report

Title	**Case Study – BC Municipalities Biodiesel Pilot Project**
Theme	Clean Vehicles and Fuels
Purpose	Review the municipal field trial, and highlight issues that arose to inform future users of biodiesel.
Partners	Part of Fraser Basin Council's (FBC) *Biodiesel Market Development Project*. Partners include: FBC; Western Economic Diversification; Natural Resources Canada; EC-PYR; Province of BC (Ministries of Water, Land and Air Protection; Energy and Mines; and Agriculture); GVRD; City of Vancouver; West Coast Reduction; VanCity Savings Credit Union
Author	Fleet Challenge British Columbia / Fraser Basin Council Society
Product	Report

To Obtain Additional Information, Please Contact:

U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, WA 98101

www.epa.gov/r10earth

Environment Canada
Pacific Yukon Region
401 Burrard Street
Vancouver, BC
V6C 3S5
www.pyr.ec.gc.ca

Copies of this report can be obtained from:
www.ec.gc.ca/cleanair-airpur/Home-WS8C3F7D55-1_En.htm
or
www.epa.gov/airmarkets/usca

U.S. EPA Publication 910-R-05-900