



Quesnel Airshed Management Plan Review - 2011

Final Report

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Prepared for

The Quesnel Air Quality Roundtable



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Finally, thanks to Earle Plain former Air Quality Meteorologist, Cariboo Region (now working for MOE on Vancouver Island) and Natalie Suzuki (Air Quality Science Specialist, MOE, Victoria) for their valuable review of the draft report.

EXECUTIVE SUMMARY

The City of Quesnel continues to have the worst air quality in the province of BC in terms of fine particulate. In a report by the BC Lung Association (2010), it was found that in 2009 Quesnel was the only community to exceed the BC Annual Objective of 8 ug/m^3 , and one of two communities to exceed the BC 24 Hr. Objective of 25 ug/m^3 , based on continuous TEOM¹ monitoring measurements.

The Quesnel Airshed Management Plan (QAMP) was completed in 2004 by a multi stakeholder group: the Quesnel Air Quality Roundtable (QAQRT), and this group also oversees implementation of the plan. It is a 10 year plan with established goals for air quality to 2010 (Figure 1). The QAMP stated that air quality goals for 2014 were to be established following a major review of the QAMP in 2010. The review was envisioned to be a review of any changes in the Health Reference Levels (a guidance level for ambient air quality used in part to establish the original QAMP goals), potential new technology, and other related information (Figure 1). This report comprises that review, which was undertaken under the guidance of a Project Review Team from the QAQRT.

A suite of general performance indicators developed by the Province of BC were used to evaluate the QAMP and while some potential weaknesses were noted, the QAMP was found to have all of the key elements for an airshed plan to be successful.

Additional performance indicators were developed in consultation with the Project Review Team and included a review of QAQRT member's activities under the plan, an evaluation of implementation of the plan recommendations, and a review of air quality trends. Successes under the plan were highlighted as well as challenges evident to full implementation of the plan. It was found from this part of the review that while all stakeholders had done *something* to reduce emissions, none of the stakeholders have *completely* fulfilled their commitments under the QAMP. Given that the QAMP was a 10 year plan and implementation is only a little more than half way through, there are still opportunities to implement outstanding recommendations. Extending the airshed plan to 2016 could help accommodate implementation of the recommendations.

Air quality trends from plan inception in 2004 through 2010 as reported by MOE were examined and reveal marginally improving trends in PM_{10} and $\text{PM}_{2.5}$. However, PM_{10} remains high in the airshed resulting in dust advisories being issued for the City, and both PM_{10} and $\text{PM}_{2.5}$ only meet QAMP air quality goals in West Quesnel. Since the air quality assessment completed in 2004 determined that all sectors were contributing to fine particulate air pollution, and that all of the measures in the modelled scenarios would need to be undertaken, it is not surprising that air quality has only marginally improved.

A review was done of current relevant technical knowledge and it was determined that emissions have not changed enough to warrant further impact assessment and that the conclusions of the 2004 assessment upon which the plan recommendations were based are still valid. Further, current health information on fine particulates indicates there is no threshold level above which is considered safe,

¹ Continuous monitoring technology is discussed in Section 3.3.3 and Appendix II

therefore the plan should consider adopting the principle of continuous improvement. Options for setting 2014 ambient air targets were discussed as well as current knowledge concerning air monitoring technology.

Stakeholder engagement was examined and it was found that the QAQRT air quality education program has been successful however public and QAQRT member surveys indicate a number of areas needing improvement.

Finally, options for governance of the QAQRT were reviewed and it was suggested that the partnership with the Baker Cr. Enhancement Society be expanded.

The conclusions of the review were as follows:

1. The Quesnel Airshed Management Plan (QAMP) has been established on a solid footing from which to move forward. It has all of the key elements to make an airshed plan successful.
2. Some weaknesses have been highlighted by application of Performance Indicators, and these will be addressed in the recommendations.
3. Air quality has shown a slightly improving trend since implementation of the QAMP, however the plan still falls short of both roundtable and community expectations. Present emissions in the Quesnel area have been reviewed by MOE in relation to the original emissions inventory that was part of the air quality assessment for the airshed plan. Changes in emissions that have occurred are not expected to be substantial enough to result in changes to the conclusions of the 2004 impact assessment. Primary parameters of concern continue to be PM₁₀ and PM_{2.5}, and to a lesser extent Total Reduced Sulphur (TRS).
4. That air quality has only marginally improved is not surprising since stakeholders have not implemented all or many of the recommendations that were projected from air quality assessment and computer dispersion modelling to be required to achieve the air quality goals.
5. At the time of this review, it appears *most* stakeholders have done *something* toward meeting the goals of the airshed plan; however none of the stakeholders have done *everything* they committed to. Based on the original modeling results, it is clear that *substantial* improvements must be made to emission sources from *all* sectors (Plain, Pers. Comm.)
6. A stronger commitment is required from industry to implement the necessary emission control upgrades that the modelled scenarios showed were required to meet the AMP ambient goals. Other stakeholders responsible for managing diffuse PM sources and fugitive dust should likewise make this commitment.
7. The QAMP has considerable 'resiliency' as it is has the flexibility to adapt to the swings prevalent in the economy because it is voluntary and stakeholders can incorporate improvements into their business planning 'as opportunities arise'. In that sense, it is an excellent tool for a community to achieve both environmental and economic sustainability.
8. There has been no evaluation of the effectiveness of public education activities.
9. The QAMP implementation process lacks a clear mechanism for the public to participate and there is evidence that the public is feeling disenfranchised from the process and that they feel air quality is not improving.

10. There is evidence that due to retirements and staff changes, many of the people involved in the implementation of the QAMP no longer have the technical knowledge of the results of the original air quality assessment. This can be a problem with getting people to support actions that will improve air quality.
11. There is no advantage to the QAQRT forming a new environmental related non profit society in Quesnel because of the existing successful partnership with the Baker Cr. Enhancement Society.
12. There is potential for efficiencies and funding opportunities if airshed related processes were to be integrated in the Quesnel airshed e.g. through a potential partnership with the City who is eligible for BC Smart Planning Funding.
13. There is no on-going evaluation of the relative effectiveness of the measures reported in the annual reports of stakeholders. Considerable effort is required on the part of all of the stakeholders for the remainder of the plan life to make it a success.
14. The QAQRT should review its' membership at one of its' meetings and invite others to join as appropriate.
15. Strong leadership is essential to a successful airshed plan – this is a problem for the QAQRT as the long time chair is retiring in 2011.
16. The report by Rankin (2007) is excellent, however has not been properly considered by the QAQRT.
17. Existing PM monitoring equipment (1400 AB TEOMs) will be supported by Thermo for parts for another 9 years.
18. Given that Quesnel is seeing only a marginal improvement in air quality, the QAQRT may want to consider options for limiting new emissions sources.

Twenty three recommendations were made to assist the QAQRT in moving forward for the remainder of the plan implementation period and to help achieve the objectives of the QAMP.

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1.0 Introduction

The City of Quesnel continues to have the worst air quality in the province of BC in terms of fine particulate. In a report by the BC Lung Association (2010), it was found that in 2009 Quesnel was the only community to exceed the BC Annual Objective of 8 ug/m^3 , and one of two communities to exceed the BC 24 Hr. Objective of 25 ug/m^3 , based on continuous TEOM² monitoring measurements.

The Quesnel Airshed Management Plan (QAMP) was completed in 2004 by a multi stakeholder group: the Quesnel Air Quality Roundtable (QAQRT), and this group also oversees implementation of the plan. It is a 10 year plan with established goals for air quality to 2010 (Figure 1). The QAMP stated that air quality goals for 2014 were to be established following a major review of the QAMP in 2010. The review was envisioned to be a review of any changes in the Health Reference Levels (a guidance level for ambient air quality used in part to establish the original QAMP goals), potential new technology, and other related information (Figure 1). This report comprises that review.

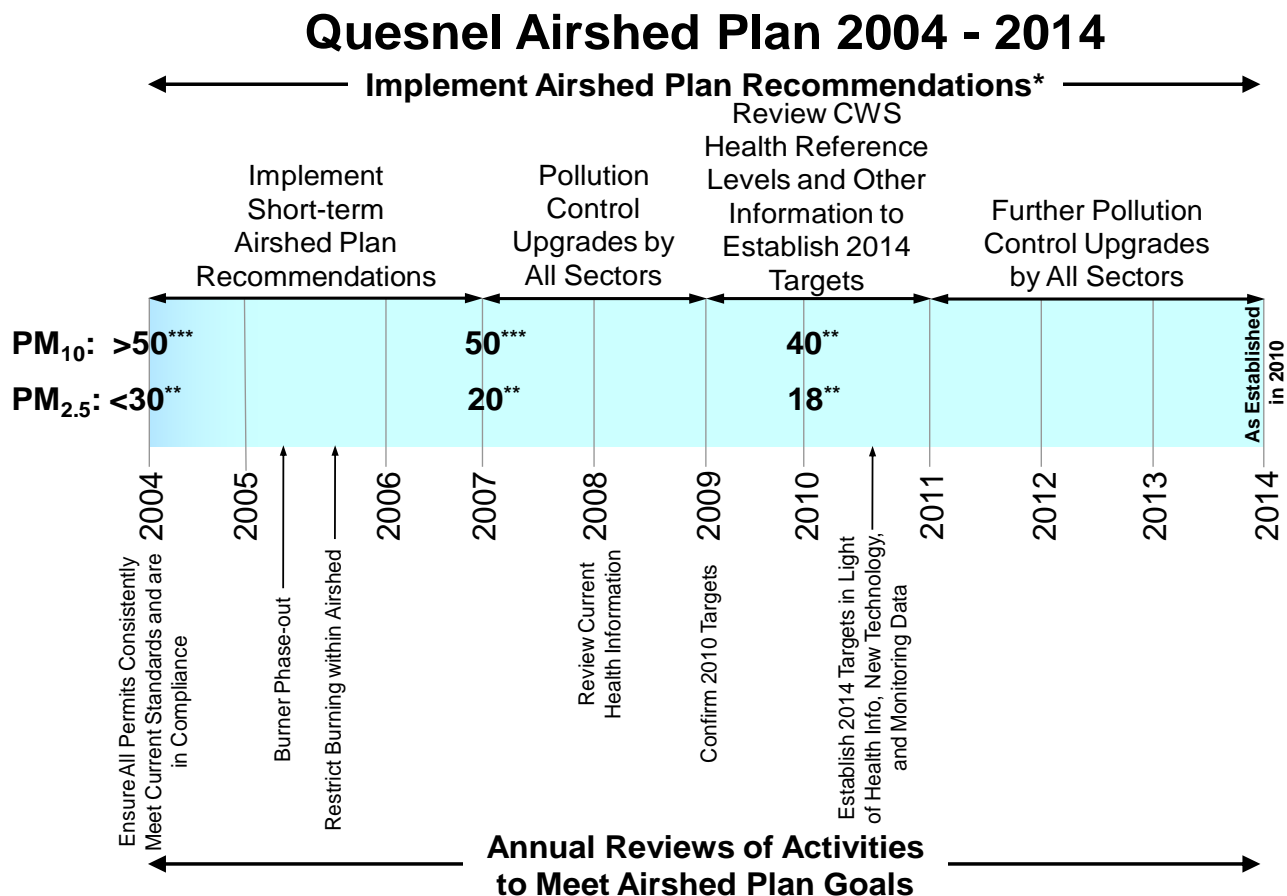
In order to meet the objectives of the review, the QAQRT established a Project Review Team at its' Fall 2010 meeting. The team consists of the following members: Dora McMillan (Roundtable Chair), Barbara Oke (Northern Health Authority), Anna Rankin (Environmental Coordinator, Quesnel R. Pulp), Graham Veale (Air Quality Meteorologist, Ministry of Environment), Wayne Strang (Environmental Supervisor, Cariboo Pulp and Paper), and Laurie-Ann Roodenburg (Councillor, City of Quesnel). The Project Review Team reviewed and contributed to this report throughout its' development.

The QAMP was based on a comprehensive environmental impact assessment that included an emissions inventory, computer dispersion modeling, and monitoring of ambient air quality. The impact assessment found that all sectors were contributing to a cumulative problem and that no one sector such as industry, could solve the air quality problem on its' own. As a result, a comprehensive set of recommendations was developed by the Quesnel Air Quality Roundtable. Implementation of these recommendations is voluntary and to be done "as opportunities arise" over the 10 year period. It was envisioned that there would be a declining trend over that period in levels of fine particulate air pollution. A key goal was to improve air quality without job loss as a result of actions taken.

Prior to the development of the QAMP, there was considerable "polarization" on air quality issues in the City of Quesnel. This was particularly evident in the permitting by the Ministry of Environment of a fiberboard plant in Quesnel in the mid 1990s, which was very controversial (McMillan, pers. comm.). Also at the time of the development of the QAMP, permitted sources were generally in compliance with permits and emission standards, however the cumulative impact of these and other sources (e.g. transportation, wood stoves) were found to be contributing to the overall air quality problem. Some of these non permitted sources are not readily regulated by the MOE permitting system.

² Continuous monitoring technology is discussed in Section 3.3.3 and Appendix II

Figure 1: Quesnel Airshed Plan 2004-2014



*: Incorporate into community and industry planning as opportunities arise.

** : µg/m³; based on a 24-hour average, and achievement is based on the 98th percentile ambient measurement annually, averaged over three consecutive years (allows for seven days of exceedances each year).

***: µg/m³; 24-hour average not to be exceeded.

Airshed management planning addresses three key areas of air quality management:

- Reducing or eliminating “polarization” over issues through partnerships that facilitate different sectors working together, e.g. industry and environmental groups
- Providing a mechanism to deal with the cumulative impacts from multiple sources that individually meet permit requirements or emission standards
- Providing a way to address sources of pollution that are not readily regulated by MOE e.g. impacts of individuals

This review will evaluate the success to date of the Quesnel Airshed Management Plan (QAMP) based on the first six years of the ten year implementation period and provide recommendations on future priorities and direction for the Quesnel Air Quality Roundtable. The report will include conclusions on:

- the relevancy of existing AMP Recommendations and Goals in light of all components of the review
- the need to update the emissions inventory and/or dispersion modelling data
- options for approaching new and emerging emission sources or changes to existing emission sources in the airshed
- whether there are any new programs/initiatives at the federal/provincial level that the Quesnel AMP can potentially benefit from
- how to re-engage stakeholders and the public in the QAMP process

2.0 Airshed Planning in BC

A framework for airshed planning in BC was developed in consultation with the Province of BC by Ellen F. Battle Consulting Inc. (2007) and was meant to guide future airshed planning initiatives in B.C. The purpose was to ensure greater consistency and resource efficiency in planning processes and to promote guiding principles from the provincial perspective:

- shared stewardship
- sustainable development
- integrated planning
- CI/KCAC (Continuous Improvement/Keeping Clean Areas Clean)
- flexibility, adaptive and innovative management.

Six major elements or "stages" have been identified for the airshed planning process

1. Evaluate the need for a plan
2. Identify and engage stakeholders
3. Investigate planning synergies
4. Determine priority sources
5. Develop the plan
6. Implement, monitor, and report

The Quesnel Airshed Management Plan is well into Stage 6 and the QAQRT is conducting this review of its success to date and looking for recommendations on the best way to move forward.

Airshed planning in BC was reviewed for the Province of BC in a report entitled: *A Review of Airshed Planning in BC* by Levelton Consultants (2009). The report was a review of all (13) of the Airshed Plans undertaken to date in BC and the overall objective was to examine the plans with respect to achievements, roadblocks to progress, approach, effectiveness and to make recommendations to the Province on how to best support these initiatives.

Key elements to a successful airshed plan were found to be:

- A strong team and a good leader
- Developing and adhering to an appropriate process
- Engagement of the community and ongoing commitment to keep them informed
- Financial support from external sources

In order to help assess the likelihood that an airshed plan would be successful, a suite of performance indicators were developed and applied to the 13 airshed plans, including Quesnel.

A number of recommendations were made to the province to maintain and enhance support for airshed planning in BC.

2.1 General Performance Indicators

The general performance indicators noted above can be found in Table 1. These were reviewed by Cariboo Environmental Quality Consulting Ltd. (CEQC) with the QAQRT Project Review Team and it was determined that all of these were applicable to the Quesnel process, and therefore should be used in this review. Application and updating of the results obtained by Levelton (2009) can be found in Section 3.1.

2.2 Quesnel Air Quality Roundtable Performance Indicators

CEQC and the QAQRT Project Team developed the following performance indicators for evaluating implementation of the QAMP:

1. Review and summarize what stakeholder's have done under the Quesnel Airshed Management Plan (QAMP) in relation to the *Rationale for Recommendations* found in the QAMP. The annual reports of stakeholders will be summarized and reviewed with stakeholders.
2. The QAMP Recommendations will be reviewed in terms of whether they have been implemented.
3. Ambient air quality trends will be reviewed in relation to the ambient goals in the QAMP. This will be taken from the MOE Air Quality Meteorologist's report to the roundtable and reviewed in terms of the existing monitoring technology.

The air quality trends are the most important performance indicator as this is the ultimate goal in terms of the objective of the airshed plan. Ultimately it was anticipated in the plan that all of the actions taken

would result in an improvement in air quality over time. These trends are also important in relation to the ambient air quality goals identified in the plan and highlighted in Section 1.0 (Figure 1).

The review of the performance indicators unique to this review can be found in Section 3.2.

3.0 Application of Performance Indicators/Plan Review

3.1 General Performance Indicators

The Quesnel Airshed Management Plan (QAMP) was reviewed against the General Performance Indicators in Table 1. These performance indicators were taken from the report entitled *A Review of Airshed Planning in BC*, done for the Province of BC by Levelton Consultants (2009) which was discussed in Section 2.0. The results in the Levelton report were updated in Table 1.

As can be seen from Table 1, while some potential weaknesses were noted, the QAMP met virtually all of the General Performance Indicators of the likelihood of an airshed plan being successful. Thus the plan has the elements deemed necessary for success.

Potential weaknesses are as follows:

- no tangible measure of public opinion change
- only partial records of attendance at events
- objectives that only partially incorporate other air related planning activities such as Greenhouse Gas (GHG) reduction and community sustainability planning
- limited accountability for stakeholders responsible for implementation of Plan recommendations, resulting in recommendations only partially implemented as yet (e.g. industrial emission control upgrades; there has only been burning by law development within the City i.e. nothing in the fringe area)
- presently no 'champion' in local government, partially because the representatives from local government on the roundtable have recently changed and do so quite often

In addition, it is evident from Table 1, that funding is a concern as only a portion of the original partnership funding remains. The only on-going funding available to the group is the annual contribution from the Ministry of Environment of \$6,000-8,000/yr. for the part time Air Quality Education activities being done by the Baker Cr. Enhancement Society, a local non profit society that carries out environmental projects in the Quesnel area.

While the QAMP exhibits all of the four key elements for a successful airshed plan noted in Section 2.0, there is some evidence that these may be weakening. For example, the QAMP has had very good leadership since its beginnings in 1999, however the present chair has indicated she will be retiring in 2011 (McMillan, Pers. Comm.).

Table 1: General Performance Indicators for the Quesnel Airshed Plan

Activity	Indicator	Fulfilled (yes/no/partial)	Comment(s)
Planning and Implementation	<ul style="list-style-type: none"> Is the plan fundamentally (a) Issue driven or (b) proactive e.g. no current issues but establishing controls to mitigate future AQ issues? 		a) Issue Driven
	<ul style="list-style-type: none"> Have high level goals and expectations been documented? 	Yes	
	<ul style="list-style-type: none"> Do objectives also incorporate: (a) GHGs, (b) sustainability, (c) neither? 	Partially	GHGs (but only as co-benefits) and sustainability (economic & environmental)
	<ul style="list-style-type: none"> Does the airshed planning group have a 'champion' in local government? 	No	
	<ul style="list-style-type: none"> Is the plan incorporated into other municipal plans or processes? 	Partially	Incorporated into the City Official Community Plan, not the CRD Fringe Area OCP
	<ul style="list-style-type: none"> Have specific, quantifiable objectives been defined (either source emission, or receptor concentration or both)? 	Yes	Air quality goals have been established
	<ul style="list-style-type: none"> Has an emissions inventory been conducted? 	Yes	Major sources identified and emissions quantified (2001).
	<ul style="list-style-type: none"> Funding breakdown %MoE, % other. Total \$\$ if available. 	No	No ongoing funding
	<ul style="list-style-type: none"> Have milestones been established (specific activities towards implementation including end dates)? 	Partially	Implementation is 'results based'. Air quality goals are the primary milestone.
	<ul style="list-style-type: none"> If so, has progress been made towards implementation [% milestones reached or (a) on schedule, (b) behind schedule]? 	Partially	Slightly improving trend in air quality, but did not meet air quality goals
	<ul style="list-style-type: none"> Have amendments been made to legislation e.g. Permit amendments, burning bylaws etc.? 	Partially	City of Quesnel has bylaws addressing open burning, woodstoves & outdoor wood boilers, the CRD does not.
	<ul style="list-style-type: none"> Have scientific studies been conducted e.g. to quantify emissions, dispersion modeling, local or regional health studies? 	Yes	Emissions Inventory, CALMET/CALPUFF modeling, monitoring.
	<ul style="list-style-type: none"> Was a thorough literature review conducted? 	Yes	
	<ul style="list-style-type: none"> Have any other technical / scientific studies been conducted? 	Yes	Speciation monitoring 2007-2009; data analysis and modelling report pending.
	<ul style="list-style-type: none"> Have any regional programs been implemented e.g. Woodstove change-out, idle free, scrap it 	Yes	Woodstove Exchange is biannual.

Table 1 (continued): General Performance Indicators for the Quesnel Airshed Plan

Activity	Indicator	Fulfilled (yes/no/partial)	Comment(s)
Public Outreach	• Has an outreach program been established?	Yes	MOE has been funding this.
	• If so, how frequently are stewardship reports issued to community?		Annually and at community events.
	• It there an airshed web page? Are 'hits' measured over a given period?	Yes; No	Hits not measured
	• Is the web page linked to other sites for public engagement e.g. AQI etc.	Yes	AQHI; City, CRD, & MOE websites have links to the QAQRT website
	• Are there any tangible measures of public opinion change?	No	However a 2010 City survey confirmed air quality is a big issue.
	• Are there attendance records from scheduled events e.g. Clean Air Day?	Partially	Attendance recorded at some events.
	• Is there a hotline to report air quality concerns - odour complaints etc.?	No	However, Roundtable Chair is available by phone and there is a provincial government <i>Report All Poachers and Polluters (RAPP)</i> line available 24 hr/day, 7 days per week
Stakeholder Engagement	• Has an airshed committee been established?	Yes	Quesnel Air Quality Roundtable
	• Membership - Industry, public, municipal / provincial govt. members?		19 Stakeholders
	• Membership trends (a) increasing, (b) static, (c) decreasing?		Static
	• Is the committee active (ongoing activities)?	Yes	Meets 2x/year

Modified from: *A Review of Airshed Planning in BC*. Levelton Consultants Ltd. (2009)

3.2 Quesnel Air Quality Roundtable Performance Indicators

3.2.1 Review of QAQRT Member's (Stakeholders) Activities under the QAMP

QAQRT member's activities under the airshed plan were reviewed by searching through the QAQRT annual meeting minutes and the reports submitted by the stakeholders. This was done with reference to the rationale for recommendations found in the airshed plan. The focus is an overview of successes and challenges in implementing the recommendations. Stakeholders were given the opportunity to review the results to ensure accuracy and that no 'successes' or 'challenges' were overlooked. A summary of successes and challenges can be found in Sections 3.2.4 and 3.2.5.

3.2.2 Implementation of QAMP Recommendations

Reporting (QAMP Recommendation #1)

Recommendation # 1 of the QAMP was that all stakeholders submit an annual written update on their activities and plans with regard to their contributions towards the community meeting the air quality goals as laid out in the Quesnel Airshed Management Plan, commencing in 2005. Statistics on the submission of these reports are shown in Table 2.

From 2004 through 2008, on average 84% (79 – 89%) of stakeholders reported, however this dropped to 61% for both 2009 and 2010. Of reports submitted, the number of written report versus verbal reporting at the annual meeting varied widely, from 19% to 73% written reports of total reports made. The variation in written reports may be explained by reminders from the Chair of the Roundtable which then resulted in an improvement for the short term. Written reports tend to be more thorough and have more content. It is clear however, that reporting fell somewhat in 2009 and 2010 over previous years.

The criteria for the reports were specified in the airshed plan were to revolve around three questions:

1. What have you done in the past 12 months?
2. What are you planning to do in the next 12 months?
3. What are your long term plans for meeting the 2014 goals

The reports submitted over the years of implementation of the QAMP were reviewed and it was found that there was considerable variation in whether all three of these questions were addressed and to what extent. Question 3 was very rarely addressed and it is this long term planning approach that is most likely to result in implementing some of the more difficult recommendations required if the ambient air goals of the Plan are to be met.

Often it is unclear to what extent different measures will reduce fine particulate emissions. If all reports were to be written following a standard format, there would be better consistency in submissions. It would also be helpful if reports could identify which recommendations in the QAMP are being addressed and estimate their impact on emission reduction for the particular operation e.g. % reduction in PM_{2.5} anticipated or a High, Medium, or Low estimate of reduction in PM_{2.5}. This could be verified by a sub-committee of the QAQRT in a subjective way only, as there wouldn't be modelling available for each reporting.

QAMP Recommendations #2-28

Recommendations #2 through #28, and actions taken to date can be found in Table 3. It is evident from Tables 2 and 3, that virtually all stakeholders have done *something* to reduce emissions. However, none of the stakeholders have *completely* fulfilled their commitments under the QAMP. Given that the QAMP was a 10 year plan and we are only a little more than half way through, there are still opportunities to implement outstanding recommendations. Extending the airshed plan to 2016 could help accommodate implementation of the recommendations.

The air quality assessment that formed the basis of the airshed plan (Plain and Zirnhelt, 2004) concluded, based on modelled emission reduction scenarios, the following would need to be undertaken to achieve airshed goals: significant reductions in dust and point source emissions such as cyclones converted to baghouses and dry electrostatic precipitators installed on major point source emissions. Based on the original modelling results, it is clear that *substantial* improvements must be made to emission sources from *all* sectors (Plain, Pers. Comm.)

The key findings of the air quality assessment in 2004 were³:

- *The air pollution potential in the Quesnel area is high due to topography and local weather conditions. This leads to periods when air quality is poor and 24-hour fine particulate levels can be elevated. For example, the following table is from Quesnel Secondary School - 2002:*

	Maximum 24-hour Value	24-Hour Provincial Level B Objective	24-Hour Federal Health Reference Level
<i>PM₁₀</i>	<i>91.5µg/m³</i>	<i>50µg/m³</i>	<i>25µg/m³</i>
<i>Exceedances (number of days)</i>	<i>N/A</i>	<i>15 days</i>	<i>113 days</i>
<i>PM_{2.5}</i>	<i>62.5µg/m³</i>	<i>N/A</i>	<i>15µg/m³</i>
<i>Exceedances (number of days)</i>	<i>N/A</i>	<i>N/A</i>	<i>46 days</i>

- *Pollutants considered to be a priority at this time from a public health perspective include PM₁₀ and PM_{2.5}.*

³ The findings are repeated here verbatim from the original impact assessment (italics)

Air Quality Monitoring

- *Operational changes at both Quesnel pulp mills have resulted in a significant reduction in exceedances of air quality objectives for total reduced sulphur (annual compliance with the provincial Level A objective 99.5% of the time each year in the downtown area since 1999). However, trend analysis indicates relatively little change in annual average total reduced sulphur (TRS) concentrations at residential sites. Although ambient objective exceedances are relatively low, TRS emissions still generate complaints from the public. As such, TRS needs to be a continued focus for area pulp mills.*
- *Air quality as measured by fine particulates, is not improving and there are no statistically significant trends evident at any of the continuous fine particulate monitoring sites. In 1998, Quesnel was ranked the poorest for PM₁₀ levels in BC out of 28 communities that had continuous monitoring stations. This trend continues to date, with Quesnel ranking in the top three for the province from 1999 to 2002.*
- *Human activities have a large influence on fine particulate levels in Quesnel. This is shown in the hebdomadal (day of the week) analysis, as the lowest levels are recorded on the weekend while the highest levels are recorded during weekdays. Industrial, commercial, and transportation activity is lowest during the weekends.*
- *A study of air pollutant particle types in the spring of 1995 identified a number of sources that contribute to elevated spring time PM₁₀/PM_{2.5} levels. These include soot particles from wood burning (industrial, commercial, and residential), road dust, pulp mill emissions, diesel exhaust (particularly in the downtown area), and automobile exhaust.*
- *Several indicators point to fugitive dust from industrial operations (particularly in the Two Mile Flat area), and road dust (from both paved and unpaved surfaces) as being major contributors to PM₁₀ and to some extent PM_{2.5} across the airshed:*
 - *Dustfall measurements indicate that industrial activity, particularly in the Two Mile Flat area, contributes significantly to the dust problem in Quesnel. Dustfall monitoring sites closer to the Two Mile Flat industrial area record the highest dustfall values at nearly twice the level that is experienced in the downtown area. On average, the provincial Level A objective for dustfall was exceeded between 62% and 96% of the time between 1994 and 2002 depending on location.*
 - *The highest frequency of elevated hourly PM₁₀ values at the Pinecrest monitoring site occur when winds are out of the south east sector. This sector includes emissions from the Two Mile Flat industrial area and the Cariboo Pulp and Paper mill.*
 - *PM₁₀ levels are elevated during the early spring months at all monitoring sites. Analysis indicates that there is a large coarse component driving these numbers. The elevated coarse component of PM₁₀ in the early spring is largely attributable to road dust being re-entrained by passing vehicles. Over the winter months, the material that is deposited on roadways (i.e.*

road sand, bark/chips, etc.) is ground up into a fine dust. Once the ice and snow melts, this material is exposed to vehicle traffic which “kicks up” the fine dust into the air.

- *The coarse component of PM₁₀ is elevated throughout most of the non-winter months at all monitoring sites indicating that road dust has a large impact throughout the airshed. It is evident from the monitoring results that effective control of road dust alone could result in dramatic reductions in PM₁₀ concentrations across the community.*
- *At the residential monitoring locations of Maple Drive and Quesnel Senior Secondary (QSS), high hourly average PM₁₀ levels are recorded regardless of wind direction. This indicates that there are a large number of sources that contribute to the levels recorded at these sites (i.e. industrial, commercial, residential, mobile and area sources in all directions from the site).*
- *Between 1995 and 2002, PM₁₀ concentrations were above the federal health reference level of 25µg/m³ an average of 32% of the time at Pinecrest, 30% of the time at QSS, 16% of the time at Maple Drive, and 10% of the time at Correlieu. Over the same time period, PM₁₀ levels were above the provincial Level B objective of 50 µg/m³ an average of 6% of the time at Pinecrest, 5% of the time at QSS, 1.5% of the time at Maple Drive, and 0.6% of the time at Correlieu School. Higher pollution levels occur at Pinecrest and the downtown area than in Red Bluff and West Quesnel.*
- *The PM₁₀ federal health reference level of 25µg/m³ is exceeded more frequently at Maple Drive during the winter months than at the other monitoring locations. This suggests that localized sources such as woodstoves or open burning are contributing in addition to impacts from industrial emissions.*
- *A significant portion of PM₁₀ objective exceedances occur during air quality episodes. Management efforts targeted at sources that contribute most significantly to episodes should reduce the overall number of exceedances, reduce the annual average PM₁₀ value and result in improved air quality.*
- *On average between 2000 and 2002, PM_{2.5} concentrations were above the federal health reference level of 15µg/m³ 12% of the time at QSS, 6.5% of the time at Pinecrest, 10% of the time at Maple Drive, and 4% of the time at Correlieu.*
- *Diurnal (hour of the day) patterns of fine particulate concentrations at three of the four monitoring locations show that highs and lows generally correspond well with traffic patterns (road dust and exhaust emissions) as well as the formation and break-up of night-time inversions. Patterns at the Pinecrest monitoring site indicate that industrial emissions have a larger influence in this area.*
- *At the downtown monitoring site, sulphate concentrations accounted for up to 70% of the PM_{2.5} in 1999 and up to 31% of the PM_{2.5} in 2000. These values highlight the importance of secondary particle contributions to fine particulate concentrations in the airshed.*

Emissions Inventory

- *Permitted sources emit the most carbon monoxide, sulphur oxides, nitrogen oxides, volatile organic compounds, total reduced sulphur, and fine particulate matter (PM₁₀ and PM_{2.5}) to the Quesnel airshed.*
- *Road dust contributes the most total particulate (TPT) to the airshed. Road dust also contributes significantly to PM₁₀, and to a lesser degree contributes to PM_{2.5}.*

Source Apportionment/Computer Modelling

- *Computer modelling confirms that road dust contributions to PM₁₀ are significant throughout the airshed.*
- *Computer modelling shows that permitted sources such as Cariboo Pulp and Paper, Quesnel Waste Disposal, West Fraser Mills, Tolko Industries, and Slocan Forest Products can have an effect as far out as Bouchie Lake. However each of these sources contributes relatively small amounts to the total at this location.*
- *Computer modelling confirms that emissions from all sectors contribute to fine particulate concentrations in the downtown core. When road dust is excluded at the QSS monitoring site, approximately 43% of the PM_{2.5} is from permitted sources, 21% is from commercial, 19% is from automobiles/trucks/rail, 11% is from secondary particles (e.g. nitrates and sulphates), and 6% is from commercial/residential sources.*
- *Computer modelling shows that fine particulate concentrations in the Two Mile Flat area are primarily from permitted source emissions and road dust.*
- *Computer modelling indicates that in some locations, permitted sources contribute a significant portion of the PM₁₀ and PM_{2.5}, whether or not road dust was included in the model. It was also confirmed that residential contributions can have a large impact in some areas, such as Bouchie Lake, Barlow Creek, and Quesnel Canyon Road.*
- *Computer modelling indicates that the transportation sector contributes up to 18% of the PM_{2.5} mass in the downtown core when road dust is excluded from the model.*

Main Conclusion of the Air Quality Assessment

The Quesnel air quality problem is the result of the combined impact of a large number of sources. Analysis indicates that there is no one source that can be targeted to completely solve the air quality problem.

To improve fine particulate levels in the community, reductions are required from permitted sources as well as fugitive and road dust sources, residential sources, commercial sources, and the transportation sector.

Table 2: Reporting by Quesnel Airshed Roundtable Stakeholders (QAMP Recommendation #1)

STAKEHOLDER	2005	2006	2007	2008	2009	2010
Baker Creek Enhancement	R	C	R	C	R	N
C & C	C	N	N	C	N	N
Canfor Quesnel	C	C	R	C	N	N
City of Quesnel	R	C	R	C	R	N
CPP	C	R	R	R	R	R
CRD	N	C	C	C	N	N
MoE – EM – R. Grimm; R.	R	C	C	R	R	R
MoE – EQ – Plain; Veale	C	C	N	R	R	R
MoF	N	N	N	N	N	N
HMC	R	R	R	C	R	R
MoTH	R	R	R	C	R	R
North Star Lumber/West	R	C	R	C	N	N
Northern Health	R	N	N	C	R	R
QRP	R	C	C	C	R	R
Quesnel Plywood	R	C	C	C	R	R
Quesnel Waste Disposal	R	C	R	C	N/A	N/A
Tolko Quest Wood Div	N	C	R	C	R	R
West Fraser Mills Quesnel	R	C	R	N	N	R
Westpine MDF	C	C	R	R	R	R
No. of C/Total;%	5/19;26	13/19;68	4/19;21	13/19;68	0/18;0	0/18;0
No. of R/Total;%	11/19;58	3/19;16	11/19;58	4/19;21	11/18;61	11/18;61
No. of N/Total;%	3/19;16	3/19;16	4/19;21	2/19;11	7/18;39	7/18;39
% Stakeholders reporting	84	84	79	89	61	61
% Written Reports/Total	67	19	73	24	39	39

R = hardcopy of report on file

C = report/comments in Summary or QRT Rpt

N = Nothing on file

Table 3: Implementation of Airshed Plan Recommendations (#2-28)

Recommendation	Responsibility	Implemented (Yes/No/Partially)	Comment
2. Ensure permits in compliance	MOE	Yes	Permits are generally in compliance, however the 5 year compliance plan needs review and updating. Continued follow through needed on initiatives such as mill cyclone assessment.
3. Phase out Woodwaste Burner	Quesnel Waste Disposal	Yes	Phased Out December, 2007
4. Improve 2 Mi Flat Drainage & Dust Control	City/Industry	No	The City plans to upgrade storm drainage on Brownmiller and Macleod Roads within the next 36 months.
5a. Dust suppression within City & fringe area	City/MOT	Partially	A new 2010 Elgin Crosswind Regenerative Air Street Sweeper purchased which uses air as opposed to brushes, resulting in a better first pass and less dust in the air. City owned parking areas, roads and lanes that are unpaved continue to be treated with dust suppressant and street sweepers continue to operate year round. The City will continue to deploy its street sweepers as it has in the past. The City will also continue to treat the unpaved areas as it has in the past.
5b. Investigate track out from unpaved roads & lots	City/MOT/ Others	No	
5c. Require dust control for new development	City	Yes	Section 5.7.4 of the City of Quesnel Zoning Bylaw requires off-street parking areas be surfaced with a permanent surface of asphalt, concrete or similar pavement so as to provide a surface that is durable and maintained for the purposes intended;
5d. Dust suppressing in existing unpaved alleys	City	Yes	City owned parking areas, roads and lanes that are unpaved continue to be treated with dust suppressant and street sweepers continue to operate year round.

Table 3 (continued): Implementation of Airshed Plan Recommendations (#2-28)

Recommendation	Responsibility	Implemented (Yes/No/Partially)	Comment
5e. Increase street sweeping during non winter months	City/MOT	Yes	The City has increased its' sweeping schedule and continues to use a coarser traction material in the downtown area. 3/8 minus traction material used in all other areas is mixed with Magnesium Chloride. The City continues its aggressive cleanup of roadways in early Spring. Anti-icing for bridges will be done when required using an available contractor. The City will continue using special traction material in the downtown core and its aggressive Spring clean up. The City is considering a Bylaw to require other property owners to clean their parking lots and use coarser traction material in the downtown area.
6a. Apply coarser traction material and deicing	City/MOT	Yes	The City continues to use a coarser traction material in the downtown area. 3/8 minus traction material used in all other areas is mixed with Magnesium Chloride. The City continues its aggressive cleanup of roadways in early Spring.
6b. Anti icing program feasibility	City/MOT	Yes	Anti-icing for bridges will be done when required using an available contractor. The City will continue using special traction material in the downtown core and continue it's aggressive Spring clean up.
6c. Continue to improve winter road maintenance	City/MOT	Yes	See 6a&b
6d. Timely Spring clean up of roads & parking lots	City/MOT	Partially	See 6a&b
7. Investigate use of liquid de-icers/wet sweeper	City/MOT	Yes	The City continues to use Magnesium Chloride as a liquid pre-wetting agent in its initial clean up.
8. Bylaw requiring businesses to sweep, clean up and suppress dust from their parking lots & roadways	City	No	The City is considering a Bylaw to require other property owners to clean their parking lots and use coarser traction material in the downtown area.

Table 3 (continued): Implementation of Airshed Plan Recommendations (#2-28)

Recommendation	Responsibility	Implemented (Yes/No/Partially)	Comment
9. Issue Stage 1 & 2 burning advisories (at lower PM levels than present)	MOE	No	The original Recommendation was based on the lack of a BC AQO for PM2.5. ⁴
10. Bylaw outside of the City to regulate grass burning & fires during air quality advisories (excl. campfires)	CRD	No	
11. Revise Quesnel Forest District Burn Plan to develop further restrictions on burns within the airshed	MOE/MOF	No	MOE is looking into whether this is necessary. All burn plans will require updating once the OBSCR is amended.
12. Bylaw restricting Outdoor Wood Boilers within City & fringe area	City/CRD	Partially	Within the City, all new installations that have had a permit issued have complied with the Bylaw to require any wood-fired boiler or furnace to meet CSA or EPA emission standards. The City will be reviewing this bylaw this year and will be investigating a sunset clause for any existing boilers. The CRD has rejected this for the Fringe area.
13. Bylaw restricting wood burning appliances during air quality advisories within City & fringe area	City/CRD	No	The City will be reviewing the Solid Fuel Burning Bylaw and will consider a clause that restricts burning during advisory days. No indications that the CRD will consider this
14. Bylaw lists prohibited burning materials within City & fringe area	City/CRD	Partially	The City will be reviewing the Solid Fuel Burning Bylaw and will consider a list of prohibited materials in the update, within the City. The CRD has not implemented anything in the Fringe area.
15. Education programs on residential wood burning/nuisance bylaw	Roundtable/CRD	Yes	On going education activities by the Baker Cr. Enhancement Society (BCES) on behalf of the Roundtable
16. Woodstove Exchange Program	Roundtable	Yes	Coordinated by the BCES

⁴ Since adoption of the BCAQO for PM2.5 an exceedence of the numerical concentration (25ug/m3) results in an air quality advisory (equivalent to the Stage II Burning Advisory in the AMP). Emission management actions associated with an air quality advisory include a mandatory ban on open burning (under the OBSCR) and a voluntary reduction in woodstove use.

Implementing the proposed Stage I advisory would provide a useful preventative approach but to be effective would need to be tied to by-law development related to woodstove use and other burning activities (see QAMP Recommendations 10 and 13)

Table 3 (continued): Implementation of Airshed Plan Recommendations (#2-28)

Recommendation	Responsibility	Implemented (Yes/No/Partially)	Comment
17. N-S/E-W Connector feasibility	City/MOT	Partially	The City of Quesnel commissioned a report to evaluate route options for the North/South Connector. Council continued to lobby the Ministry for some progress on this issue. The Ministry of Transportation and Infrastructure has committed to completing traffic studies to further this work.
18. Bike lanes on all new roads/enhance trails	City/MOT	Partially	The City of Quesnel continues to enhance bicycle trails and has been successful in establishing a number of new routes; Bryce Trail, College Connector, and Underpass.
19. Optimize public transit	City/CRD	Yes	Council expanded the transit route and schedule in 2008. Transit will continue to be supported by the City and additional routes and schedules will be considered.
20. Biennial Vehicle Emissions Clinics	Roundtable	Yes	Conducted by BCES on behalf of the Roundtable
21. Update emissions inventory & CALPUFF modeling platform	MOE	No	MOE will consider this once the speciation study has been completed
22a. Industry to use Best Available Control Technology (BACT)	Industry/MOE	Partially	New facilities are required to meet more stringent emission standards. Some industrial process changes have not upgraded air quality emission controls
22b. New industrial & expansion proposals to use CALPUFF	Industry/MOE	Partially	CALPUFF/CALMET Requires Updating to be useful in future.
23. Incorporate the QAMP in all levels of planning	City/CRD	Partially	The City Official Community Plan recognizes the QAMP, the CRD Fringe Area does not.
24. Zoning for Industry to use the QAMP Air Quality Assessment results	City/CRD/MOE	Yes	Followed through by City/CRD/MOE
25. Implement public education programs re: lifestyle impacts on air quality	Roundtable	Yes	See S.3.4.1
26. Information bulletin on wood boilers & furnaces	Roundtable	Partially	No brochure <i>per se</i> , but information distributed via press releases and newspaper articles
27. Public education program on open burning	Roundtable	Yes	See S.3.4.1
28. Continue monitoring air quality to evaluate the effectiveness of QAMP implementation initiatives	MOE/Industry/ Roundtable	Yes	On-going

3.2.3 Ambient Air Quality Trends 2004-2010

Undoubtedly the single most important success indicator for the QAMP is whether or not air quality has improved since plan inception in 2004. The QAMP envisioned a slow, continuous improvement in both PM_{2.5} and PM₁₀ over the life of the 10 year implementation period as measures were taken to decrease emissions from various sources.

The graphs on the following pages were taken from a presentation developed by the Ministry of Environment (Veale, Pers. Comm.) which concluded the following:

- There is a continued overall improvement in PM_{2.5} concentrations across the airshed
- All stations were meeting short and long term BC and Federal PM_{2.5} air quality objectives in 2010
- West Quesnel (Correliou station) is meeting the PM₁₀ and PM_{2.5} goals of the QAMP (PM₁₀ not illustrated), however the other stations are not meeting the goals of the QAMP
- There are declining overall trends evident i.e. improving air quality
- Periods of 'poor' air quality have been reduced (reduction in # of exceedences of BCAQO's)
- There has been a marginal improvement in PM₁₀ concentrations across the airshed, however these levels remain high
- The Maple Drive (MD) Station is not meeting the PM₁₀ QAMP goal for 2010 or the BC AQO, and this is likely true for Quesnel Sr. Secondary (QSS) given the trend projection
- The QSS & MD are not meeting the PM_{2.5} QAMP goal for 2010
- Quesnel residents are still exposed to particulate concentrations with known health effects.

Since the air quality assessment determined that all sectors were contributing to fine particulate air pollution, and that all of the measures in the modelled scenarios would need to be undertaken, it is not surprising that air quality has only marginally improved (see Section 3.2.2). However, there are still opportunities under the QAMP timeline to implement further improvements.

Figure 2: Quesnel: 3-Year Rolling Average 98th Percentile Daily PM_{2.5}

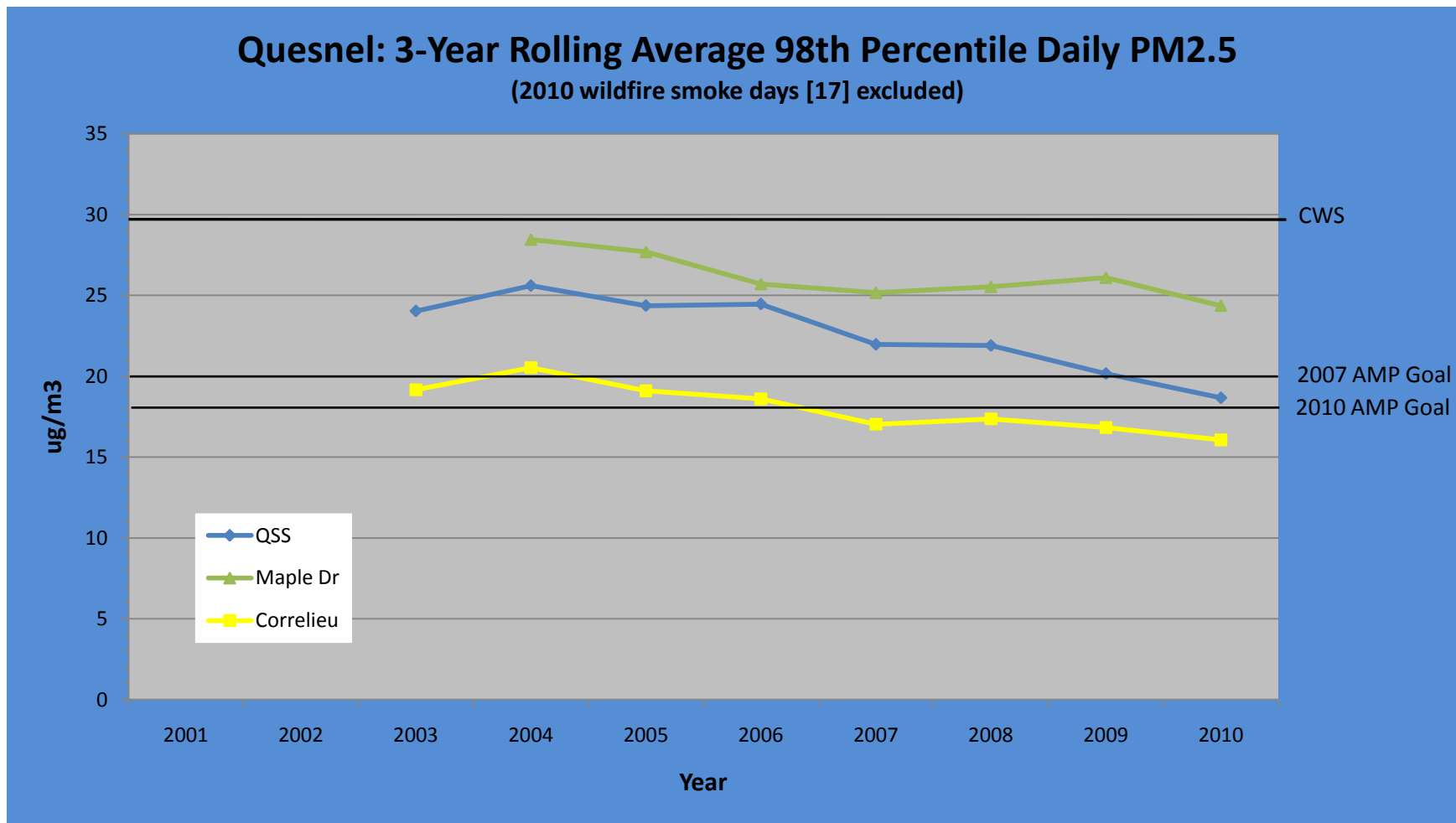


Figure 3: Quesnel: 98th Percentile Daily PM_{2.5}

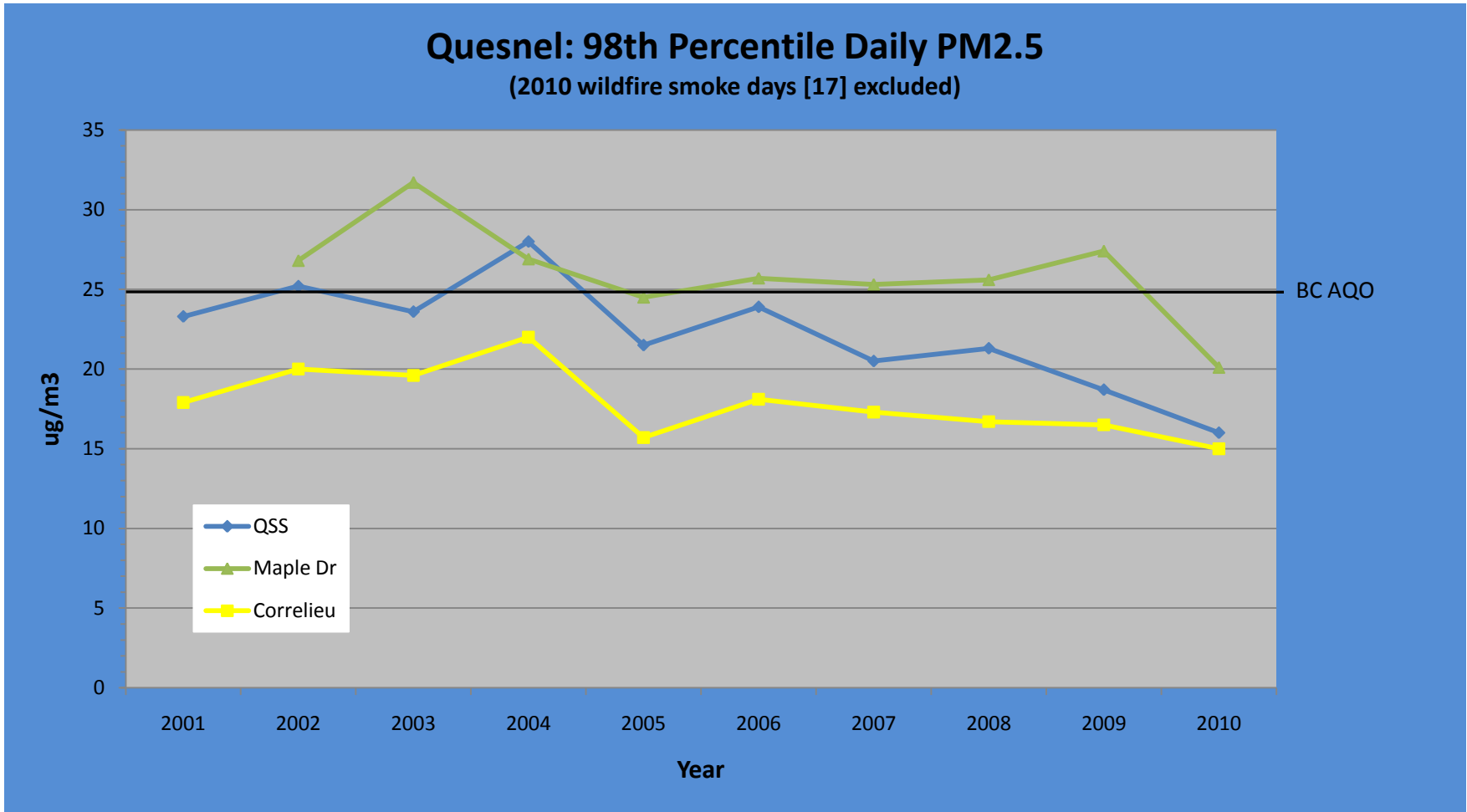
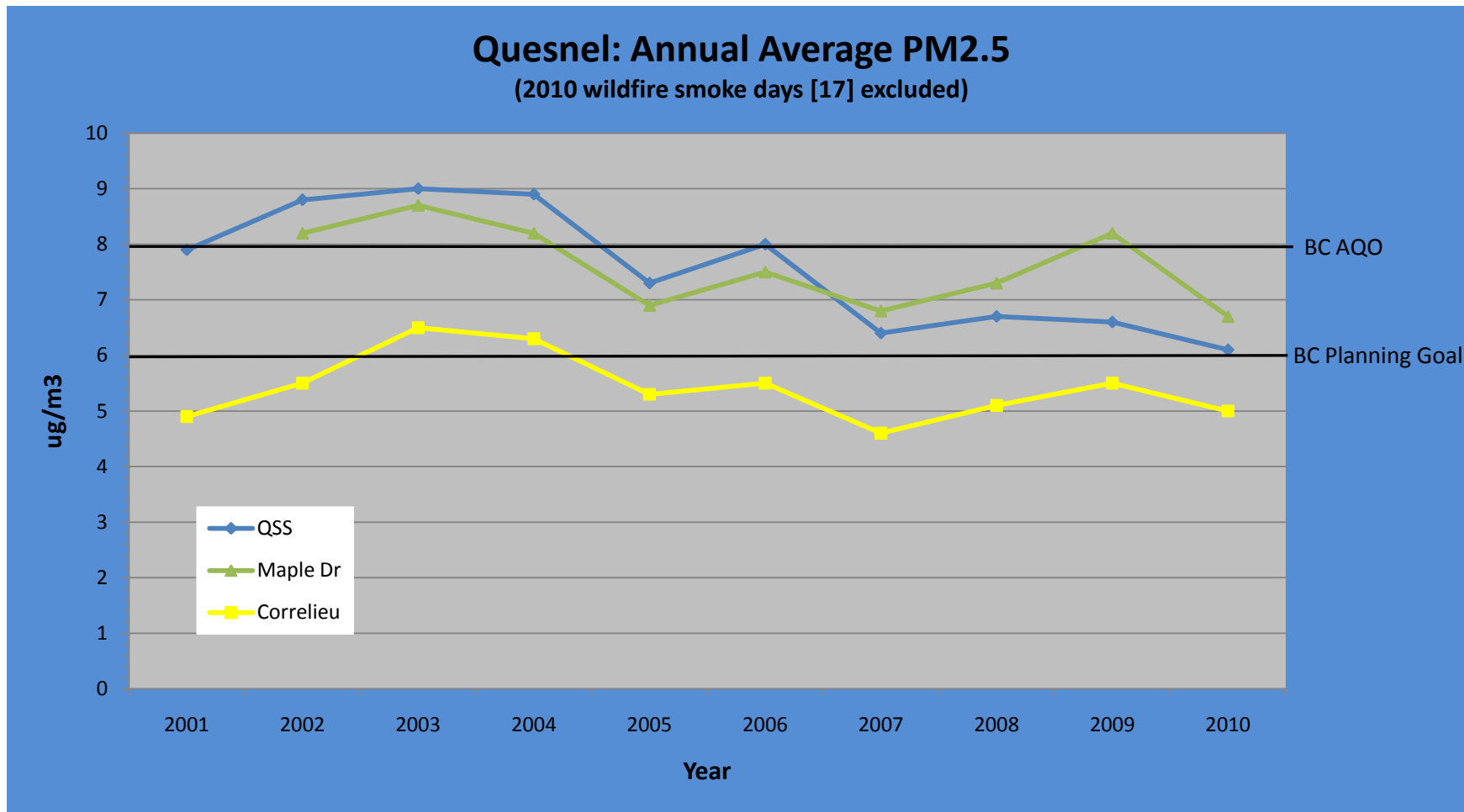


Figure 4: Quesnel: Annual Average PM_{2.5}



3.2.4 Successes⁵

Stakeholders have undertaken a number of initiatives that should result in improvements to air quality and these are considered successes under the QAMP. The airshed plan envisioned that the recommendations would be implemented over a 10 year period and that these would be implemented 'as opportunities arise' (QAMP, 2004). The idea was that as stakeholders made changes in their operations e.g. a process change, consideration would be given to the airshed plan. A very good example would be installing a baghouse to replace a cyclone (better treatment for particulate emissions). Implementing changes this way, i.e. incorporating them into business planning cycles, was expected to reduce the financial burden.

Following are successes under the airshed plan:

- The woodwaste burner on Two Mile Flat was phased out in December, 2007.
- West Fraser Mills constructed a new mill and installed an ESP on its' energy system in 2007.
- C&C Wood Products upgraded a poor performing cyclone with a fabric filter baghouse in 2009.
- MOE has been conducting a 5 year compliance plan - permits are generally in compliance
- Most mills sweep paved areas and employ suppressants to reduce dust
- Many industrial operations have reduced energy consumption in various ways which should slightly reduce particulate emissions (efficiency, travel, vehicles)
- MOT is studying ways to improve traffic movement through downtown
- MOT partnered on a pedestrian underpass at Racing Rd. (bicycle/walking paths)
- Quesnel R. Pulp has GHG reduction programs underway that will reduce emissions
- West Fraser Mills installed a baghouse rather than a cyclone on its' planer expansion
- Quesnel R. Pulp has eliminated sulphur dioxide emissions
- MOT has made efforts to improve tracking of road material from road accesses under permit
- MOT has employed liquid deicers and other ways, such as wet sweeping to reduce dust from traction materials
- Westpine MDF has eliminated formaldehyde from its' process
- Air Quality Education Programs are on-going and successfully carried out by the Baker Cr. Enhancement Society
- The Woodstove Exchange Program has changed out over 200 smoky woodstoves to EPA emissions certified units
- Industry pays for two of three monitoring stations in Quesnel under the Quesnel Ambient Air Monitoring Agreement
- The City has enhanced dust control measures and bicycle/walking paths

⁵ The successes were taken from a review of the reports submitted at the annual QAQRT meetings however it is recognized that some of these are driven at least in part by other factors e.g. federal or provincial regulations, as well as efforts to reduce operational costs

- Burning bylaw development by the City of Quesnel addresses Woodstoves, Furnaces, and Outdoor Wood Boilers *within the City only*
- CPP has added new collector plates to the Joy Precipitator on the Recovery Boiler and has reduced emissions from this source
- CPP has improved scrubber operation on the Power Boiler and as well has improved trouble shooting controls and maintenance
- CPP has improved scrubber control on the Limekiln and continues efforts to minimize TRS emissions

It is apparent from the review of successes in light of the *Rationale for Recommendations* in the QAMP, stakeholders may benefit from a review of the justification for the recommendations and consideration of what they can do to further implement the recommendations that apply to them. As mentioned in part in S.3.2.2, at the time of this review, it appears *most* stakeholders have done *something* toward meeting the goals of the airshed plan; however none of the stakeholders have done *everything* they committed to.

3.2.5 Challenges

There are a number of possible reasons that not all of the recommendations of the airshed plan have been implemented as determined by consultation with the Project Review Team. First and foremost is that the airshed plan is a ten year plan and so this review is being undertaken a little more than one half way through the implementation period. Secondly, implementation is voluntary. Thirdly, there is little accountability in the annual reporting process as the stakeholder reports are not reviewed nor assessed (Section 3.2.2). There also seems to be little long term planning among stakeholders for the implementation of recommendations. Finally, much of the recent implementation period has been during a world recession and in addition, a prolonged forest industry downturn – this has resulted in less capital available to implement changes at industrial operations.

Following are some specific challenges that have come to light in this review:

- Only two of five Quesnel wood fired energy systems employ dry electrostatic precipitators (ESPs) to treat emissions
- Many industries still employ cyclone treatment for emission control as opposed to baghouse controls
- The major sources of industrial fine particulate emissions identified in the Air Quality Impact Assessment in 2003 have not changed substantially
- Soft markets have hampered forest industry capital projects for emissions reductions
- Permits are generally in compliance, however emissions permits vary across the province and may need to be reexamined by MOE for Quesnel
- Dust is still problematic in Quesnel (dust advisory issued in Spring of 2011)
- Processing of dry beetle killed wood is hampering efforts at fugitive dust control
- Some dust sources such as logging trucks have not improved

- Dust sources are difficult to monitor without a webcam
- No woodstove, outdoor wood boiler, or burning bylaw development by the CRD for the fringe area
- The MOE needs an increased presence in the airshed for auditing and impact assessment
- There is no way of quantifying at this time i.e. without updating the air quality assessment, how much the measures that have been undertaken to date have contributed to the slight improvement in air quality
- There is evidence from surveys that due to retirements and staff changes, many of the people involved in the implementation of the QAMP no longer have the technical knowledge of the results of the original air quality assessment. This can be a problem with getting people to support actions that will improve air quality.
- New and emerging emission sources may further deteriorate air quality. When the airshed plan was developed, it was anticipated that as the plan was implemented, there would be an improvement in air quality that would result in capacity for further development in the airshed. Recommendations 22 a & b (Table 3) were expected to be sufficient to accommodate new development and encourage economic growth.

Given that Quesnel is seeing only a marginal improvement in air quality, the QAQRT may want to consider options for recommending limiting new emissions sources.

Possible solutions to these challenges are presented in the recommendations in Section 5.0.

3.3 State of Technical Knowledge Review

The QAMP called for “a review of the Canada Wide Standards (CWS), Federal Health Reference Levels, and other information to establish 2014 targets.” The QAMP did not establish numeric goals or targets for 2014, rather stated that they would be established in 2010 in light of health information, new technology, and monitoring data.

3.3.1 State of Emissions in the Quesnel Airshed

Present emissions in the Quesnel area have been reviewed by MOE in relation to the original emissions inventory that was part of the air quality assessment for the airshed plan (Veale, Pers. Comm.). While there have been some minor changes in point source emissions, they almost certainly would not change the findings of the air quality assessment (see also Section 3.2.2). For this reason, the QAMP recommendations remain soundly based and should be implemented during the remaining years of the plan.

None the less, it is warranted to update the emission inventory that was last done in 2000 as is recommended in the QAMP to be done every 5 years. It is possible the updated emission inventory combined with the results of the chemical speciation study done by MOE, and to be reported on in the

near future, may be cause for more immediate re-evaluation (or confirmation) of the original air quality assessment.

The CALPUFF/CALMET computer dispersion modelling platform was, according to the QAMP, to be kept up to date and made available for more sophisticated assessment of new emission sources in the Quesnel Airshed. This has not been done.

3.3.2 Health Impacts of Fine Particulates

This section is intended to be an update based on consultation with health professionals. A comprehensive literature review of recent science on health impacts is beyond the scope of this report. It is also unnecessary for the purposes of the QAMP.

Health researchers are clear that there is no threshold or safe level for fine particulates (Brauer, 2011) and this was a view prevalent at a recent workshop with experts in the field (Air Quality and Health Workshop, 2011). The goal should be continuous improvement rather than a specific level (Brauer, 2011). The following information on health effects of fine particulate is from the Northern Health Authority (Oke, Pers. Comm.):

“Exposure to particulate matter can have both immediate and long-term effects. Short-term exposure to elevated levels of $PM_{2.5}$ and ozone can trigger breathing problems, increase the severity and occurrences of asthma attacks, trigger heart attacks and cause eye, nose and throat irritation for those at risk. Children, the elderly, pregnant women and those with pre-existing heart and lung conditions are most at risk from the harmful effects of poor air quality.

Scientists believe that there are no safe levels of PM and being exposed to particulate matter over the long-term (even at relatively low concentrations) can have even more significant health risks. These health effects can include damage to lung tissues and the development of heart and other lung diseases, including chronic bronchitis, emphysema, pneumonia, and lung cancer as well as death. Long-term exposure to air pollutants such as $PM_{2.5}$ has also been linked to pre-term births, low birth weight babies and acute respiratory infections and middle ear infections in children.

The World Health Organization estimates that air pollution causes approximately 2 million premature deaths worldwide each year. It is estimated that 14 deaths each year in Quesnel are caused by poor air quality related to elevated long term PM concentrations.

Coarse particles i.e. particles between $PM_{2.5}$ and PM_{10} , are upper respiratory irritants and have been shown to exacerbate existing conditions, but are not thought to cause disease e.g. they can cause asthma attacks, but are not thought to cause someone to develop asthma”.

Giving consideration to the foregoing, Health Reference Levels are just one set of criteria that can be used to set ambient air quality goals. This will be discussed further in Section 3.3.4.

3.3.3 Air Quality Monitoring Technology Review

MOE and Environment Canada are currently addressing a problem with historical PM measurements. It was discovered a number of years ago that TEOM instruments do not capture the volatile portion of the measurement and therefore read lower than the actual concentration in the air. This means that when new monitoring technology is employed that corrects for this problem, there will be an increase in the readings due to the change in instrumentation that will make data sets appear to have a step change increase, when in reality, they do not.

Another aspect to this problem is the quantification of how much of a difference to apply to historical data bases for the purposes of trend analysis⁶. MOE has been running different instruments on a trial basis across the province and attempting to obtain correlations with existing instrumentation for the purposes of correcting historical data sets. This situation was taken into consideration in reviewing monitoring technology in Quesnel. Monitoring technology was reviewed by Grover Christiansen, Monitoring Technician, and the results are found in Appendix II.

Thermo will support 1400AB TEOM parts for another 9 years giving Quesnel the maximum 'bang for their buck' on original AB TEOM's purchased⁷. Since the 8500C FDMS is an accepted Federal Equivalency Method (FEM) technology according to the National Air Pollution Surveillance network (see Appendix II), it is the most cost effective approach at this time, taking all factors including installation, into consideration. It would also provide the 47 mm cooler filter which can be analyzed following an event to help speciate/quantify the volatile portion. The Sharps & other Beta technologies have improved greatly due to the efforts of Thermo & technical specialists in the field such Dave Pengilly of the Greater Vancouver Regional District (GVRD), however there is still room for improvement.

Taking into consideration the existing TEOM's & technology being used in the Quesnel area, it is suggested to go to the 8500C FDMS until other technologies are perfected and proven in the Canadian monitoring environment.

This discussion is relevant to the Quesnel Airshed Management Plan Review in that readings with new instrumentation will make the ambient goals in the QAMP more difficult to achieve because there will likely be an apparent increase in PM as a result of the new instrumentation i.e. the ambient goals were based on what could be achieved by applying source reduction scenarios to existing ambient readings

⁶ The intention is not to alter archived data. Each data set will be 'tagged' with the associated monitoring technology so that it can be 'adjusted' for reporting purposes if desired.

⁷ Worst case scenario accounts for new mother board & mass transducer assembly – basically a new control unit with FDMS. 8500Cs have been installed on TEOM's that have not required mother boards or mass transducers, and both will be supplied for 9 years. Maintenance would be the same as it has been and they would run a long time. New technologies such as Beta/light scatter do not guarantee decreased servicing or prevention of data loss – they can sometimes create more.

(Section 3.2.2). Given that the MOE is currently determining which instrument the Province will endorse, the QAQRT may want to consider holding off on making any changes until this has been determined. MOE presently indicates the old TEOM AB units at MOE stations will be phased out by the end of 2012, and by the end of 2013 for industry stations (Veale, Pers. Comm.). This should be discussed by the QAQRT in the context of the Quesnel Ambient Air Monitoring Network Agreement (QAQRT, 2007), when it is reviewed.

When this is considered in light of health professionals endorsing the concept of *Continuous Improvement* rather than using Health Reference Levels or ambient objectives, it becomes evident that the present ambient goals in the QAMP should be examined with this in mind when establishing 2014 targets. This will be elaborated on in the next section, 3.3.4.

3.3.4 Air Quality Goals

The objective of this section is to examine the relevancy of the air quality goals in light of current information. The Health Reference Levels (HRLs) are part of documentation used in development of Canada Wide Standards for PM and are:

PM ₁₀ (24 Hr)	25 ug/m ³
PM _{2.5} (24 Hr)	15ug/m ³

The HRLs are non-statutory limits based on “an estimate of the lowest ambient levels at which statistically significant increases in health responses can be detected, and not at a level where impacts will not occur” (CEPA/FPAC, 1999; as cited in QAMP, 2004). In other words, there is no threshold level below which there are no health outcomes because people vary widely in their sensitivity to air pollution.

Various air quality goals are shown in Table 4 and an explanation of these follows.

Table 4: Comparison of Various Ambient Air Quality Goals

GOAL	PM _{2.5} (ug/m ³)	PM ₁₀ (ug/m ³)	Achievement Metric ⁸	Pros	Cons
Canada Wide Standards (24 Hr.)	30	N/A	98 th percentile annually; 3-yr running ave.	Already achieved	Minimum standard i.e. not a desirable goal. Would not drive improvements. Not applicable to communities with less than 100,000 residents ⁹
Health Reference Levels (24 Hr.)	15	25	N/A	More stringent than the BC AQO and could drive improvements. While there is no threshold level for PM _{2.5} , at levels above this there are statistically significant health outcomes. Lack of a complicated 'achievement metric' make them more easily understood	May be difficult to achieve
Williams Lake Airshed Management Plan 2012 Goals (24 Hr)	18	40	98 th percentile annually; 3-yr running ave.	N/A	N/A

⁸ Achievement is based on existing TEOM monitoring technology

⁹ However, the Province of BC has committed to meeting CWS levels in all communities

Table 4 (continued): Comparison of Various Ambient Air Quality Goals

GOAL	PM _{2.5} (ug/m ³)	PM ₁₀ (ug/m ³)	Achievement Metric ¹⁰	Pros	Cons
BC Air Quality Objective (24 Hr)	25	50 ¹¹	98 th percentile annually	Almost achieving these As with HRLs, PM10 AQO has no complicated 'achievement metric'. Also may be the most effective approach to dealing with short term dust episodes	Almost achieving these
BC Air Quality Objective	8	N/A	Ann. Average	Achieving this	Current achievement is borderline
Quesnel Airshed Management Plan 2010 Goals (24 Hr)	18	40 ¹²	98 th percentile annually; 3-yr running ave.	Potentially more stringent than the BC AQO and could drive improvements. The Air Quality Assessment (2004) indicated this could be achieved in Quesnel if all of the recommendations were implemented Already achieved in West Quesnel	May be difficult to achieve
BC Air Quality Objective Long Term Planning Goal ¹³	6	N/A	Annual Average	Would help drive improvements Already achieved in West Quesnel	May be difficult to achieve

¹⁰ Achievement is based on existing TEOM monitoring technology

¹¹ 24 Hr maximum

¹² Changing the calculation from a 98th percentile, 3 yr rolling average to a 24 hr maximum would be more stringent

¹³ Note: West Quesnel is already achieving this, therefore it is realistic that other parts of Quesnel could as well

Canada Wide Standards (CWS)¹⁴

Canada Wide Standards (CWS) are considered *minimum* standards i.e. areas should not be higher than this, rather should strive to be lower. This is clear in the following excerpt from the CWS Guidance Document (CCME, 2007):

“The overall objective of the CWSs is to reduce the adverse health and environmental effects of PM and ozone. Therefore, allowing PM and ozone ambient levels to increase up to the current numerical CWS targets is counterproductive, and unacceptable in light of the absence of any apparent lower threshold for adverse effects and the knowledge that the numerical CWS targets may not be fully protective”.

Health Reference Levels

As discussed in Section 3.2.2, Health Reference Levels are “an estimate of the lowest ambient levels at which statistically significant increases in health responses can be detected, and not at a level where impacts will not occur” (CEPA/FPAC, 1999; as cited in QAMP, 2004).

Williams Lake Airshed Management Plan 2012 Goals

These goals were chosen by the Williams Lake Air Quality Roundtable as to what they felt achievable given *expected* improvements in emissions in light of the air quality assessment that formed the basis of the airshed plan.

Quesnel Airshed Management Plan 2010 Goals

These goals were chosen by the Quesnel Air Quality Roundtable as to what they felt achievable with *substantial* improvements in emissions in light of the air quality assessment that formed the basis of the airshed plan.

BC Air Quality Objectives for PM_{2.5} (24 Hr & Annual Average) & PM₁₀ (24 Hr Average)

These levels were adopted by the Province of BC in 2009. The 24-hour and annual air-quality PM_{2.5} objectives (AQOs) are the primary air management tool, used to guide decisions on environmental impact assessments and authorizations, airshed planning efforts and regulatory development. The 24-hour PM_{2.5} AQO is also used to guide decisions on whether or not to issue an *air quality advisory*, while the 24 hour PM₁₀ AQO is used to guide decisions on a whether or not to issue a *dust advisory*.

¹⁴ Note that as part of the ongoing Canadian Council of Ministers of Environment (CCME) driven Canadian Air Management System (CAMS), the CWS for PM_{2.5} is likely to be revised under the new Canadian Ambient Air Quality Standards (CAAQS) development process.

BC Air Quality Objective Long Term Planning Goal (Annual Average)

The planning goal is intended as a voluntary target to guide airshed planning efforts and encourage communities to maintain good air quality in the face of economic growth and development.

Implications for the QAMP Ambient Goals

As noted above, when the Quesnel and Williams Lake Airshed Plans were developed, there were no BC air quality objectives for $PM_{2.5}$, so the Roundtables chose numerical ambient targets that were thought to be achievable and would drive continuous improvement.

As discussed in Section 3.3.2, health professionals are advocating *Continuous Improvement* as a management objective. Since BC's planning goal is in keeping with that concept, it is suggested that the QAQRT adopt this as a long term goal. Presently, West Quesnel is meeting the goal, while other areas of the City are not, therefore it is realistic that the rest of Quesnel can also achieve this.¹⁵

It is also suggested that the QAQRT could adopt the new BC Air Quality Objective (24 Hr) for $PM_{2.5}$ as the future target because this is BC's primary management tool for issuing air quality advisories and for guidance on environmental regulatory decision making. This air quality objective was not available in 2004 when the Quesnel airshed plan was developed. It is also suggested the QAQRT embrace the concept of *Continuous Improvement* as the primary guiding principle for the QAMP, partially because Quesnel still has the distinction of having close to the worst air quality in BC. The PM_{10} goal could remain unchanged to help drive dust levels down in light of recent dust advisories being issued for Quesnel. Consideration should be given to removing the 98th percentile, 3-year averaging achievement metric as this tends to eliminate the highest values and 'smooth' the trend.

These suggested air quality goals are illustrated in Figure 2 and Table 4.

3.4 Stakeholder Engagement

A review of the stakeholders participating in the QAMP reveals that there are some key stakeholders not part of the process. For example the Quesnel Chamber of Commerce, Quesnel Redi Mix; Downtown, West Side, and South Hills business associations; and others. There may be some who either potentially impact air quality (CN Rail) or who have a stake in the success of a process that embraces both economic and environmental sustainability (Chamber of Commerce).

¹⁵ Note: all of this discussion is based on existing TEOM monitoring technology

3.4.1 Air Quality Education Program

In 2005, one year after adoption of the Quesnel Airshed Management Plan, the QAQRT partnered with the Baker Cr. Enhancement Society (BCES) to implement the Public Education Recommendations, #25-27. This program has been minimally funded by MOE. The following reflects the activities of the BCES in this regard.

Public education programs have been implemented concerning lifestyle impacts on air quality, through the use of a website and:

- a. the media. For example: provision of links to the Air Quality Index on a daily basis, and Air Quality Advisories during periods of degraded air quality; use of channel 10 to show live clips or the “Burn It Smart” video;
- b. informational brochures, posters, and billboards; displays on air quality offered/set up in schools, libraries, and other public places;
- c. the City and CRD websites with links to other air quality resources;
- d. in-school presentations and the inclusion of air quality in the local science curriculum for elementary- and high school students;
- e. wood burning/air quality information stations at community events such as Winter Festival, Home Trade Shows, Move for Health Day
- f. coordination of Clean Air Day and Commuter Challenge activities
- g. participation in community planning such as OCP, Economic Development Planning to bring forward air quality issues
- h. co-ordination of a Green Energy Fair.
- i. anti-idling education within School District #28 and for the community at large, identification of idling hot spots
- j. research into parking lot cleaning schedule
- k. the development of a brochure with open burning information, handed out at various events throughout the years. Have done some Shaw TV spots on this and some school programs including this information
- l. continuing to work with groups to encourage or facilitate composting rather than burning through our support to The Climate Action Group, the Community Garden and composting workshops
- m. co-ordination of a demonstration of a industrial mulcher for forestry work as an alternative to burning brush piles. We also initiated a review of an agricultural plastic recycling program with the CRD.

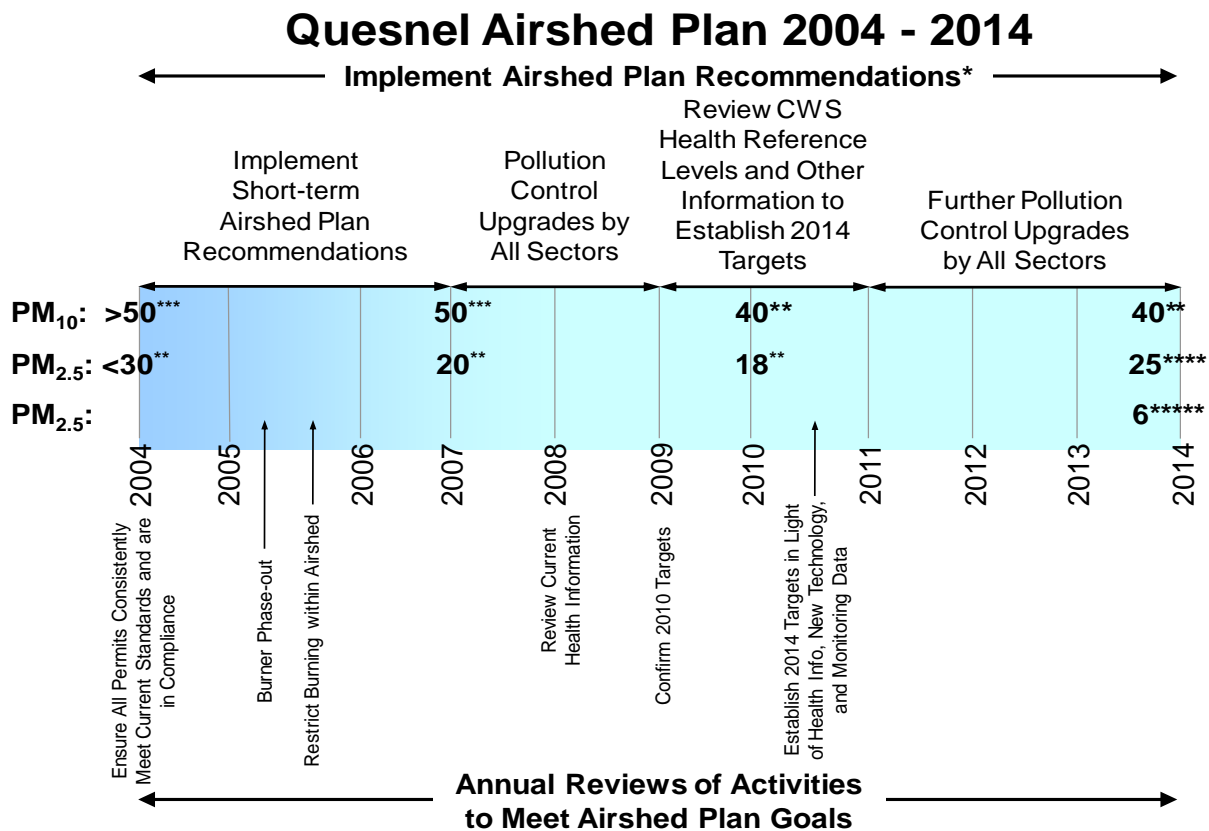
In 2010, a portion of the funds for this program had to be used to support the Woodstove Exchange Program because that fund did not provide as much money for coordination activities as it had in the past.

In addition to the BCES activities above, the MOE has conducted advertising and increased audit frequency of the Open Burning Smoke Control Regulation during especially during the early years of the the airshed plan (Hill, Pers. Comm.)

The CEQC evaluation of the public education/engagement aspect of airshed plan implementation was conducted by reviewing the activities of the BCES and MOE from their reports to the QAQRT, and by speaking with representatives of those organizations. The activities were evaluated relative to the airshed plan recommendations #25, 26, & 27 (See also Table 3). Virtually all of the recommendations have been implemented to some degree.

One substantial weakness in this area noted by Bond (Pers. Comm.) is the difficulty BCES has had with the lack of consistent funding for their organization. It is difficult to be consistently effective due to staff turnover. Funding will be discussed further in Section 3.5. Other weaknesses noted in Tables 1 & 3 are a lack of evaluation of the effectiveness of the public education program (no tangible measure of public opinion change), only partial records are kept of attendance at events, and the website doesn't have a hit counter.

Figure 5: Possible 2014 Air Quality Goals



*: Incorporate into community and industry planning as opportunities arise

** : µg/m³; based on a 24-hour average, and achievement is based on the 98th percentile ambient measurement annually, averaged over three consecutive years (allows for seven days of exceedances each year)

***: µg/m³; 24-hour average not to be exceeded

****: µg/m³; 24-hour average; achievement based on 98th percentile

*****: µg/m³; annual average

3.4.2 Public and Stakeholder Surveys

Both public and stakeholder surveys were conducted by Anna Rankin in a comprehensive study entitled *Quesnel Community Airshed Improvement Initiatives: Stakeholder Perspectives*, which was undertaken as an MA thesis (Rankin, 2007).

The overall objective of the project was to assist stakeholders in implementing plans to improve air quality in the Quesnel Airshed, and as such was an in depth analysis of the QAMP process. The specific research questions were:

- What values & relationships guide implementation of action plans?
- How do stakeholders see their actions in terms of problems & solutions with respect to air quality in the region?
- Do stakeholders have the necessary technical information & knowledge about air quality to make informed decisions to move forward?

A public survey was conducted by Rankin (2007) to determine the views of the public on progress made by the QAQRT and there was a stakeholder interview process i.e. of QAQRT members. The QAQRT process was examined in the context of society's present day approaches to consultation in environmental decision making. The conclusions were:

The QAMP has tremendous potential to succeed however four barriers to action were identified:

1. The desire to preserve relationships may prevent an adaptive approach to implementing action
2. The influence of technical experts may result in less technical stakeholders feeling like they may not have the depth of understanding to challenge results
3. Some industrial stakeholders do not believe reductions in permitted emissions will significantly improve air quality. This diverges from the public perception and may negatively influence efforts to build relationships with the public, which has the potential to affect public agency i.e. the capacity of people collectively to transform existing states of affairs.
4. Divergent opinions about health impacts of PM_{2.5} may divert the focus from actions to discussions about the 'right' targets

The following recommendations are taken from Rankin (2007):

1. Leadership is required from industrial stakeholders. The community is unlikely to participate in individual behavior to improve air quality unless industry provides united, clear, public, accountable leadership in improving air quality.
2. Recommit to targets in 2007. Move forward based on the consensus that air quality needs improvement.

3. Continue to provide clear and public recognition that *all* stakeholders are accountable for air quality improvement.
4. An objective third party who is not a stakeholder at the table should review the technical data compiled to date and provide a short, readable summary for the public. This may serve to build trust and transparency with the community.
5. Summarize the air quality priorities for the public in a short, readable pamphlet. Consider including current industrial permitted emissions (T/yr) and targets for improvement.
6. Use an adaptive management approach for implementation of action plans. Require a consistent format for reporting emissions reductions to the stakeholder group. Meet more than once per year and provide a mechanism for the group to question those reporting and provide feedback. Brainstorm alternative actions.
7. Establish a website for an individual air emissions calculator based on lifestyle choices. Express emissions as kg or T/yr. Include a hypothetical 'cumulative emissions' summary for all individual households based on the airshed population.
8. Provide an educational component on the website.
9. Establish a weekly emissions challenge in local newspapers offering suggestions for individual emission improvements. Advertise the website in the newspaper and on local radio. Challenge the public to improve their emissions results. Include a component for GHG emissions.
10. Publish regular updates in the local newspaper for industrial emissions expressed in T/yr. Include estimated dust emissions and the emissions from other sources i.e. transportation.
11. Develop a plan to share progress on air quality improvements province wide.
12. Develop strong electronic or face-to-face networks with communities near and far that have developed sustainable alternatives in their communities.

It appears from the QAQRT minutes that Anna Rankin's report was not given full consideration and therefore not utilized to any real extent. Although conducted in 2007, it is unlikely that the results of the same surveys would be substantially different in 2011, simply because very little has been done to address the specific concerns of the public or the stakeholders since that time. Furthermore, in 2010, evidence of some of the public's distrust of the effectiveness of the QAMP surfaced with comments to the Chair and at a public meeting of the QAQRT over a series of air quality incidents in early 2010. Another public survey conducted for the City of Quesnel (Discovery Research, 2010) found that although jobs and the economy ranked higher at a mean of 8.8 out of 10 as the most important issue facing the city, environmental issues were ranked 8.3. In addition, 61% ranked air quality as the most important environmental concern in the City.

The results of the surveys done by Rankin (2007), and the City (Discovery Research, 2010), suggest that better public engagement is needed and actions should be taken by the QAQRT to address the identified issues.

3.5 Governance Model Evaluation

The QAQRT Project Team felt that it was timely during this review to evaluate whether or not the present process for implementation of the QAMP could be better served by a different model of governance, and/or whether there should be integration with other air quality processes in Quesnel.

Quesnel Air Quality Roundtable Process

The Quesnel Air Quality Roundtable developed the QAMP and agreed on the recommendations by consensus with a lot of good will at the table. This was done with on going technical support from the Ministry of Environment. The review of the General Performance Indicators in Section 3.1 found that the QAMP process has all of the key elements considered necessary for an airshed plan to be a success. Some recommendations for improving implementation have been developed as a result of the review of the performance indicators specific to the QAMP in Sections 3.2 and 3.3 (Tables 2 and 3), however overall Quesnel has an excellent process.

All levels of government contributed financially to the fund for the development of the airshed plan. Industry covers air quality monitoring costs and all stakeholders have taken on the responsibility of implementing measures to improve air quality. There are presently some funds remaining from the original partnership for various projects to do with implementation, however there is no on going financial support for implementation. The MOE has been funding the Woodstove Exchange and Air Quality Education programs, but It is not known whether this funding will continue indefinitely.

Non-Profit Society Model

One option considered for the QAMP was to form a non profit society for implementation. This has been done in other areas of BC including for the Bulkley Valley – Lakes Airshed Management Plan, Prince George, and recently the Sea-to Sky Airshed. The relative merits of forming a non profit society was discussed with Ione Smith, Airshed Coordinator for the Sea to Sky Airshed Management Society, and Ben Weinstein, Air Quality Meteorologist, Smithers (Bulkley Valley – Lakes Airshed Management Society).

Society formation has two primary advantages:

1. Putting an organizational structure in place to hire staff to facilitate implementation of airshed plans and,
2. Non profit societies, particularly those with charitable status are eligible for funding sources that are only available to non profit societies.

The QAQRT has an organizational model¹⁶ that, while not a formal society, has performed very well to this date. Also, the QAQRT has had a successful partnership with a well respected local non profit society, the Baker Cr. Enhancement Society (BCES), for implementation of the public education recommendations of the QAMP (Section 3.4.1) and the Woodstove Exchange Program. The BCES has charitable status and is eligible for those restricted funds.

There is considerable potential for the QAQRT to expand its' partnership with the BCES, rather than forming another society in Quesnel with potentially the same people taking positions with the new society, as well as considerable duplication of effort on the part of everyone involved.

Integration with Other Air Quality Related Processes in Quesnel

Many activities within an airshed can affect air quality and there is considerable potential overlap of processes to address them.

In Quesnel, air related initiatives include the implementation of the Quesnel Airshed Management Plan, Community Energy Planning and municipal Greenhouse Gas (GHG) reduction targets, Integrated Community Sustainability Planning, and the Climate Action Forum. While there has been no formal integration of these processes, members of the QAQRT, including the Chair, sit on these other committees. In addition, in the past the QAQRT felt it had its' hands full with attempting to reduce particulate.

One important aspect of initiatives to reduce GHG emissions is that natural gas, a fossil fuel, is generally cleaner burning in terms of particulate emissions than wood, so the potential exists to *reduce* GHGs and *increase* particulate unless emission controls are adequate on the facility reducing natural gas and increasing wood as a fuel source.

The current initiative on the part of the City of Quesnel is the Integrated Community Sustainability Plan (ICSP), expected to be completed by 2015. It is expected to have an air quality focus and the implementation is expected to be action oriented, linking in this way to the airshed plan implementation (Turner, Pers.Comm.). A key aspect to ICSP is potential funding opportunities under the Gas Tax Agreement Funding. This is administered by the Union of BC Municipalities (UBCM) and funding can be used for *Smart Planning* projects. Administered by the Fraser Basin Council, *Smart Planning for Communities* is a BC-wide collaborative initiative to assist local and First Nations governments in

¹⁶ The QAQRT model is a group of stakeholders who have agreed to work together to improve air quality. The group was initiated by the Quesnel Environmental Society in the late 1990s who have chaired the QAQRT since then. Decisions have always been by consensus and are recorded in the meeting minutes. Funding to develop the QAMP was from the three levels of government: federal, provincial, and municipal (the City & the Cariboo Regional District). The MOE has provided administrative, technical, & financial support however there is no on-going funding for implementation.

addressing their long term sustainability challenges, by providing resources and tools for planning socially, culturally, economically and environmentally sustainable communities.

The Integrated Energy, Air Quality and Greenhouse Management Plan developed by Whistler represents the first planning document in Canada to integrate the three approaches. In Whistler, more than 90% of air pollutants come from energy consumption, therefore managing energy and GHG emissions can largely address air pollution. Whistler is obviously unique in that it is a resort municipality with virtually no industrial base as in Quesnel, however more exploration of opportunities for integration may be warranted in connection with airshed plan implementation.

There are opportunities for funding under BC CLEAR <http://www.fraserbasin.bc.ca/programs/clear.html> however this is limited to research rather than implementation of airshed plans *per se*.

4.0 Conclusions

1. The Quesnel Airshed Management Plan (QAMP) has been established on a solid footing from which to move forward. It has all of the key elements to make an airshed plan successful.
2. Some weaknesses have been highlighted by application of Performance Indicators, and these will be addressed in the recommendations.
3. Air quality has shown a slightly improving trend since implementation of the QAMP, however the plan still falls short of both roundtable and community expectations. Present emissions in the Quesnel area have been reviewed by MOE in relation to the original emissions inventory that was part of the air quality assessment for the airshed plan. Changes in emissions that have occurred are not expected to be substantial enough to result in changes to the conclusions of the 2004 impact assessment. Primary parameters of concern continue to be PM₁₀ and PM_{2.5}, and to a lesser extent Total Reduced Sulphur (TRS).
4. That air quality has only marginally improved is not surprising since stakeholders have not implemented all or many of the recommendations that were projected from air quality assessment and computer dispersion modelling to be required to achieve the air quality goals.
5. At the time of this review, it appears *most* stakeholders have done *something* toward meeting the goals of the airshed plan; however none of the stakeholders have done *everything* they committed to. Based on the original modeling results, it is clear that *substantial* improvements must be made to emission sources from *all* sectors (Plain, Pers. Comm.)
6. A stronger commitment is required from industry to implement the necessary emission control upgrades that the modelled scenarios showed were required to meet the AMP ambient goals. Other stakeholders responsible for managing diffuse PM sources and fugitive dust should likewise make this commitment.
7. The QAMP has considerable 'resiliency' as it has the flexibility to adapt to the swings prevalent in the economy because it is voluntary and stakeholders can incorporate improvements into their business planning 'as opportunities arise'. In that sense, it is an excellent tool for a community to achieve both environmental and economic sustainability.
8. There has been no evaluation of the effectiveness of public education activities.

9. The QAMP implementation process lacks a clear mechanism for the public to participate and there is evidence that the public is feeling disenfranchised from the process and that they feel air quality is not improving.
10. There is evidence that due to retirements and staff changes, many of the people involved in the implementation of the QAMP no longer have the technical knowledge of the results of the original air quality assessment. This can be a problem with getting people to support actions that will improve air quality.
11. There is no advantage to the QAQRT forming a new environmental related non profit society in Quesnel because of the existing successful partnership with the Baker Cr. Enhancement Society.
12. There is potential for efficiencies and funding opportunities if airshed related processes were to be integrated in the Quesnel airshed e.g. through a potential partnership with the City who is eligible for BC Smart Planning Funding.
13. There is no on-going evaluation of the relative effectiveness of the measures reported in the annual reports of stakeholders. Considerable effort is required on the part of all of the stakeholders for the remainder of the plan life to make it a success.
14. The QAQRT should review its' membership at one of its' meetings and invite others to join as appropriate.
15. Strong leadership is essential to a successful airshed plan – this is a problem for the QAQRT as the long time chair is retiring in 2011.
16. The report by Rankin (2007) is excellent, however has not been properly considered by the QAQRT.
17. Existing PM monitoring equipment (1400 AB TEOMs) will be supported by Thermo for parts for another 9 years, however down time could be an issue as the equipment is aging.
18. Given that Quesnel is seeing only a marginal improvement in air quality, the QAQRT may want to consider options for limiting new emissions sources.

5.0 Recommendations

1. The QAMP should be extended to the end of 2016 to allow stakeholders to fully implement the recommendations. A two year extension is suggested because the planned 2010 review will not be completed until mid 2011. A review report should be done in 2016 to evaluate the overall success of the QAMP.
2. The public at large (i.e. no affiliation) should be invited to have a representative on the roundtable i.e. someone not affiliated with any particular organization.
3. Following the annual roundtable meeting, an additional public meeting should be held to gain public input. Information from the annual stakeholder reports should be publicized to help ensure the public is aware of the work being done toward improving air quality.
4. The QAQRT should invite high profile guest speakers e.g. air quality research scientists such as Dr. Michael Brauer of UBC, to attend annual air quality forums in order to better engage the public.
5. The Quesnel Chamber of Commerce should be approached for endorsement of the QAMP because the airshed plan is an excellent instrument for the community to achieve economic and environmental sustainability without job loss. The plan is only likely to succeed if it is fully supported by the community. If successful, there will be subsequent economic benefits to the

community in terms of Quesnel being a desirable place to live and subsequent new business activity.

6. Invitations to participate to other stakeholder's should be considered by the QAQRT. Suggestions include CN Rail, Quesnel Redi mix, Truck Logger's Association, South Hills, Downtown, and West Side business associations. Roundtable members should be canvassed for suggestions for additional stakeholders.
7. An education program should be undertaken to make community leaders in all sectors (local government, business, and industry) aware of the results of the air quality assessment and what is required to improve air quality. This program should be conducted on an on-going basis as new people become involved. This could be led by the BCES with support from the MOE Air Quality Meteorologist. Where a company or organization has multiple emission sources, consideration should be given to taking a strategic corporate view of emission reduction expenditures.
8. The QAQRT should expand its' partnership with the Baker Cr. Enhancement Society as per the suggestions in Appendix I.
9. The QAQRT should explore the possibility of integrating the airshed plan implementation process with other related processes in Quesnel.
10. Due to the technical nature and complexity of the air quality issue in Quesnel, the City and the CRD should be encouraged to have their representatives on the Roundtable as long as possible so that they will be more effective in their roles.
11. With the current and long time Chair retiring, a rotating Chair is recommended. This will be more effective with on-going administrative support and facilitation by the Baker Cr. Enhancement Society. This will require defining the chair's duties to ensure consistency.
12. A standard, written report template should be developed for annual stakeholder reports for better consistency. These reports should be sent to the Roundtable members ahead of the annual roundtable meeting to facilitate questions at the meeting. The reports should be reviewed by a sub-committee of the roundtable and assessed for their overall effectiveness.
13. An air quality 'hotline' should be established, and the MOE RAPP Line (*Report All Poachers and Polluters*) should be well publicized.
14. The CALMET/CALPUFF modelling platform should be updated so that it can be used for impact assessment for new industry and process changes at existing industry.
15. The results of the speciation study should be used to assess whether or not there should be an update to the air quality assessment.
16. The MOE should maintain high priority on the Quesnel airshed with a focus on continual improvement, to help make the plan a success. The MOE should commit resources to compliance initiatives, auditing, air quality assessment, and reviewing emission performance to ensure industrial operations are employing the best management practices and technology due to the sensitivity of the Quesnel airshed.
17. MOE should consider installing a webcam to help distinguish dust sources
18. The relevant recommendations in the report by Rankin (2007) should be followed up by the QAQRT (see Section 3.4.2). Once these have been fully implemented for a period of time, opinion surveys should be repeated for both the public and the QAQRT members.
19. Cities such as Prince George, Quesnel, and Williams Lake should collaborate on BC CLEAR funding for areas of mutual research needs. This should be co-ordinated by MOE as they have the technical expertise and knowledge with regard.

20. The QAQRT should consider the various options for air quality goals outlined in Table 4 and Section 3.3.4.
21. The existing monitoring equipment should be kept in place until MOE resolves which instruments the province will endorse following trials currently underway. In the short term, the program could benefit from the installation of an 8500C FDMS unit, however this should be done in consultation with MOE in the context of a review of the *Quesnel Airshed Management Plan Ambient Air Monitoring Network Agreement 2007-2010*.
22. All stakeholders responsible for managing diffuse sources of PM and fugitive dust should make a strong commitment to implementing control measures.
23. The QAQRT should consider an option for limiting new emission sources i.e. approach MOE and request that PM₁₀ and PM_{2.5} emissions be 'capped' at present levels.

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Appendix I: Existing and Potentially Expanded Duties for the Baker Cr. Enhancement Society (BCES)

1. Continue the Air Quality Education Program
2. Continue coordinating the biennial Woodstove Exchange Program
3. Continue coordinating vehicle emissions clinics and anti-idling programs
4. Continue to represent Air Quality on various planning initiatives e.g. Climate Action Group, to facilitate working relationships with like minded groups for short term projects and long term planning.
5. Ensure stakeholder organizations are appointing members
6. Work with the MOE Air Quality Meteorologist to develop an orientation package as required for new Roundtable members. Present orientation as required.
7. Organize and facilitate Roundtable meetings
8. Apply for funds as appropriate, to enhance and further the implementation of the airshed plan
9. Follow up on recommendations from *Quesnel Community Airshed Improvement Initiatives: Stakeholder Perspectives* (Rankin, 2007) to address identified issues with public education & public participation in the process

Appendix II: Monitoring Instrumentation Considerations

NAPS Approved FEMs¹⁷

Instrument	Pros	Cons	Cost
<p>Thermo Sharp 5030(i) Sharp 5014(i) This unit can be upgraded to 5030(i) FH62C14: This unit has basically been up-graded to the 5014i listed above.</p>	<ul style="list-style-type: none"> • Principal of Operation: SHARP (Synchronized Hybrid Ambient Real-time Particulate) <ul style="list-style-type: none"> – Hybrid SHARP combines 2 technologies: light scattering & beta. – Light Scattering Nephelometer. Light scattered is proportional to the particle concentration. • Fast response, high precision, very low detection limit. • Combines accuracy of beta with fast response of light scattering. • Based upon the ratio of the average nephelometer signal & average beta response. • Dynamic heating to mitigate volatile losses and water bias. • High time resolution, one-minute measurements. • Digital dynamic filtering. • Continuous, non-stepwise measurement provides long-term unattended operation. • Enhanced user interface and <i>iPort</i> communication software. • If problems noted in the Con's column have been addressed the 5030(i) & 5014(i) have the capability of running 6 to 8 months unattended aside from recommended routine maintenance & BCMOE suggested calibration schedule. 	<ul style="list-style-type: none"> • Heater Control: It was found that changes in ambient RH could cause fast changes in the heater temperature, which in turn could cause shifts in the nephelometer response. Changes were made in the software to reduce the heater rate of change to mitigate the shifts in data. • Temperature Correction: Both the beta attenuation and the nephelometer have a temperature dependency. It was found that the generic correction factor applied to all of the nephelometers (0.25000) was not adequate. A procedure was developed to allow the user to recalculate the correction factor for both the nephelometer and the beta attenuation. • Correction factor: In normal operation, the hybrid output is determined by applying a correction factor to the nephelometer 1-minute rolling average. The correction factor (CE) is the dynamic beta concentration divided by the dynamic nephelometer concentration ("dynamic" is averaged between 2 and 8 hours). When the nephelometer readings are quite low, < 2 ug/m³, the correction factor is "frozen" until the readings go above 2 ug. Unfortunately, although the correction factor that was being applied to the nephelometer readings was frozen, the "behind-the-scenes" correction factor was still being calculated. This led to a possible situation where the correction 	<p>Sharp 5030i: \$24,019.00</p> <ul style="list-style-type: none"> – Calibration Foil Set: \$695.00 (Required) <p>Sharp 5014i: \$17,820.00</p> <ul style="list-style-type: none"> – Calibration Foil Set: \$1,190.00 (Required) <p>Consumables: 1 roll filter tape last 6 – 8 months, (17 meter length); use ~2 rolls/year @ \$75/roll list price = \$150 annual consumable cost</p>

¹⁷ NAPS, FEM, and FRM are explained at the end of Appendix II

Appendix II (continued): Monitoring Instrumentation Considerations

Instrument	Pros	Cons	Cost
	<ul style="list-style-type: none"> The 5030(i) & 5014(i) are acceptable FEM's for both NAPS & USEPA programs. 	<p>factor could suddenly go from 0.5, when the neph was below 2 ug, to a factor of 10 when the neph rose above 2 ug. Changes to the software now "freeze" the calculation of the correction factor until the nephelometer rises above the 2 ug limit.</p> <ul style="list-style-type: none"> Faulty Detectors: Early problems we had on a couple of Sharps were very large spikes, up to 200 or 300 ug/m3. This might have been related to faulty radiation detectors. We were told that the rejection rate on detectors went as high as 50% compared to a previous level of about 3%. They have recently switched to a different supplier. The problem was infrequent and Thermo was not able to duplicate the issue when we returned the samplers to them, but it is still a strong possibility. Leak Test Procedure: Previously the Sharp had suffered from the lack of a leak test procedure. On the top of every new Sharp is a label stating: "Attention: Don't shut the inlet while pump is switched on! Otherwise detector might be damaged." Thermo has come up with a leak test adapter that is installed on the sample inlet. It causes a flow restriction, but not enough to damage the detector. The procedure is to measure the flow first, then install the adapter and measure the flow again. Any significant drop in flow indicates a leak. Thermo has provided an example of an improper cleaning procedure that might cause a leak. Manufacturer will provide an official firmware release that will address the heater control and correction factor calculation. We are also looking forward to the final version of the temperature correction factor calculation procedure. They will also be providing a 	

Appendix II (continued): Monitoring Instrumentation Considerations

Instrument	Pros	Cons	Cost
		<p>shorter, low-temperature heater and a leak test adapter. Once everything is in place, we will have a much improved Sharp.</p> <ul style="list-style-type: none"> The Sharp's currently being supplied are manufactured & assembled in Germany & shipped to Thermo in the United States. Within a year the components will be shipped to the States from Germany to be assembled & distributed by Thermo. Dave Pengilly's (G.V.R.D.) work & field observations have gone a long way in assisting Thermo at addressing problems noted in the Canadian monitoring environment. A few years ago I would not have suggested these units as an upgrade to the Quesnel monitoring network. Thanks to Dave's hard work & Thermo's dedication to QC & transparency, the Sharp may be a viable replacement option in the future once Thermo has completed upgrades addressing issues mentioned above. 	
<p>FDMS 1405-F & 1405-DF (Dichot Version) TEOM</p>	<p>Principle of operation: 1405-F & 1405-DF TEOM – Tapered Element Oscillating Microbalance</p> <ul style="list-style-type: none"> Tapered element oscillates at its natural frequency Particulate matter collects on filter continuously Frequency decreases with accumulation of mass <i>Direct</i> relationship between mass and frequency change <p>FDMS – Filter Dynamics Measurement System</p> <ul style="list-style-type: none"> Every 6 minutes the system performs a self 	<ul style="list-style-type: none"> The 1405-F had a lot of problems upon release to the Canadian sampling market, as a result most agencies in BC have sent back or discontinued their use for a variety of reasons. Display LCD screens on the instruments had a tendency for total failure. This failure was attributed to the LCD screen component itself, not the overall instrument. Aliasing issues were noted on the 1405 FDMS instruments. This was specific to the sensor unit itself which was causing the TE energy to attenuate actually following the shelter temperature changes. Shelter temperature was collected to compare rapid changes to the data spikes. It was noted that the temperature 	<p>1405-DF TEOM: \$34,855.00 1405- FDMS TEOM: \$30,150.00</p> <p>Consumables: TEOM sample filters: \$435.00 per box of 20. Large in-line filters: \$100.00 ea</p>

Appendix II (continued): Monitoring Instrumentation Considerations

Instrument	Pros	Cons	Cost
	<p>reference measurement</p> <ul style="list-style-type: none"> • The PM mass concentration is then corrected for mass change during the self referencing period • Self referencing provides an indication of volatile fraction <ul style="list-style-type: none"> • 1405-DF TEOM: The difference between the TEOM 1405 FDMS & the 1405-DF is the DF has 2 mass transducers as opposed to 1. The sample head configuration is different as well. Usually the PM10 cyclonic sample head would be positioned on top of the SCC cyclonic PM2.5 head with PM2.5 particulates allowed onto the actual oscillating sample filter. The 1405 separates the sample heads so that PM2.5 is allowed to travel to 1 mass transducer for analysis & PM10 particulate is allowed to travel to the second mass transducer for PM10 analysis. The instrument calculates the combination of PM2.5 & PM10 to display a coarse fraction that should not be considered as TSP. Although more expensive the 1405-DF FDMS does provide PM10, PM2.5 & coarse fraction values. • The 1405-DF is an acceptable FEM for both NAPS & USEPA programs. 	<p>would change rapidly @ ~ 12 to 13 minute intervals and the response from the TEOM would be an oscillation in the mass trace of roughly one to two hours. A similar response to a rapid change in shelter temperature was noted and once the shelter temperature settled out so would the instrument. Some of the issues noted were related to the Thermo "Flat Dryer" which was used in the 1405 & 8500 series FDMS. Thermo has since completed a lot of improvements & Quality Control to prevent these previous "Dryer" problems from re-surfacing. Although the regular 1405 FDMS TEOM is not on the NAPS list of accepted FEM's it is expected to be added soon as it is basically the same technology utilized by the 1405-DF FDMS TEOM.</p>	
<p>Met-One Bam 1020 - FEM</p>	<ul style="list-style-type: none"> • Principle of Operation: Mass density is determined using beta attenuation. <ul style="list-style-type: none"> – A small 14C beta source (60uCi) is coupled to a detector that counts the emitted beta particles. 	<ul style="list-style-type: none"> • Launched in 1998, last major upgrade 2008 for PM2.5 approval. • I have tended to stay away from this instrument because the user only gets about 42 minutes of actual sample data per hour. Following that 42 minutes an 8 	<p>Bam 1020: \$21,845</p> <p>Consumables: 1 roll filter tape last 2 months (21 meter roll length), use ~6 rolls/year @ \$390/roll US list price</p>

Appendix II (continued): Monitoring Instrumentation Considerations

Instrument	Pros	Cons	Cost
	<ul style="list-style-type: none"> - Filter tape is placed between beta source & detector. As mass deposited on filter tape increases, the measured beta particle count is reduced according to a known equation. • Considered an acceptable FEM by NAPS & USEPA. 	<p>minute count time is performed followed by an internal calibration with a duration of 10 minutes. With other sampling technologies in a network this can cause discrepancies in terms of comparatives. Average concentration value for that hour is computed & outputted for an hour until following hour has been completed.</p> <ul style="list-style-type: none"> • Sample nozzle assembly must be replaced yearly. • Possibility of mechanical problems with filter roll advance. • Possible build up of tape material on sample nozzle surface causing potential leak • One comparative study showed: <ul style="list-style-type: none"> • BAM 1020 arrived with Background Coef. -5.4 ug/m³ • BAM Zeroed on-site new Background Cf -3.1 ug/m³ • BAM Zero check 2 Months later without reset 1.9 ug/m³ • BAM Zero deviation may be related to background radiation at site (Radon), instrument conditions, seasonal affects: temperature and humidity. (NYS Department of environmental Conservation) 	<p>= \$2,340 annual consumable cost (source: Metone BAM1020 datasheet)</p>
<p>1400ab TEOM with 8500C FDMS</p>	<ul style="list-style-type: none"> • This option adds the 8500C FDMS to existing 1400ab TEOM's being utilized in the Quesnel Air Shed. • The 8500C FDMS attempts to account for both the volatile & non-volatile components of particulate matter and reporting the combination as a mass concentration. • Measurement Range: 0 to 5,000,000 µg/m³ (5 g/m³). • Resolution: 0.1 µg/m³. • Precision: ±2.5 µg/m³ (1-hour ave), ±0.8 µg/m³ 	<ul style="list-style-type: none"> • On installation of these units it has been noted that some of the older sensor units are too sensitive & can cause a rolling negative to positive trace. In this case an exchange mass transducer is purchased & installed into sensitive sensor unit which corrects the problem. • Some of the older TEOM's in Quesnel may need a new exchange control unit mother board as well if they have problems accepting the new software that would be loaded to facilitate 8500C FDMS config. (ver 3.019) • Sample tube mast assemblies being utilized by current AB TEOM's in Quesnel would have to be shortened by 	<p>8500C FDMS: \$12,110 (This includes adapter kit to re-plumb control unit) TEOM AB Control unit Mother Board Replacement (if required): \$1,625.00 Sensor Unit Mass Transducer Exchange Replacement (if required): \$2,150.00 Worst Case Scenario per existing AB TEOM's: \$15,925.00 Consumables: Sample filters \$435.00 / box of 20.</p>

Appendix II (continued): Monitoring Instrumentation Considerations

Instrument	Pros	Cons	Cost
	<p>(24-hour ave).</p> <ul style="list-style-type: none"> • Minimum Detectable Limit for Mass Measurement: 10 nanograms, 0.06 µg/m³ (1-hour ave). • Accuracy for Mass Measurement: ±0.75%. • Hourly Mass Concentration Average Updated Every Six Minutes. Data output can be set up to display 6 minute updates as they occur as opposed to hourly output. • Scientifically Validated – Total Mass of Aerosol Chemical Species • Purge filter: 47 mm diameter filter housed in an FRM-style molded filter cassette, maintained at 4 °C. Suitable for collecting and archiving time integrated particulate matter samples for subsequent laboratory analysis. • Considered an acceptable FEM by NAPS & USEPA. 	<p>about 2.5 feet on the inside or room end to facilitate 8500C addition directly above current sensor unit.</p> <ul style="list-style-type: none"> • System height: sensor unit only is 99 cm (39”) in height, total system including sensor unit and FDMS kit is 160 cm (63”) in height. • Local ambient dew point will need to be considered to run these units properly. It may be necessary to set the chiller to 10C when ambient dew points are about 20C and higher to alleviate the stress and strain of the system to maintain sample dew points below 2C. With the chiller set to 10C the warning should be coming at sample dew points of 8C and higher. • Some negative values may still occasionally occur during some atmospheric events, especially if cooler/chiller temp settings are not synced to local conditions in terms of ambient dew point. When maintained well it would provide comparable data with a better representation of volatiles within the air shed. 	<p>Large in-line filters \$100.00 ea.</p>
<p>Grimm EDM 180 PM2.5</p> <p>The Grimm’s designation is now listed in the US EPA’s List of Designated Reference & Equivalent Methods. (version 4/1/11). As the current list of approved</p>	<ul style="list-style-type: none"> • The Grimm can run unattended & monitored remotely. There are no consumables & maintenance/cleaning is only required periodically. • Calibrations are performed using a Grimm Calibration Tower. The computer-controlled process itself is completely automated. Dolomite dust is used for a calibration aerosol. • Dolomite dust is anoxic, not hygroscopic, polydisperse and very stable during storage. In addition, Dolomite dust covers the entire sizing range for all Grimm spectrometer from approx. 0.2 m to >30 m. Due to the fact that both the reference unit and the candidate were 	<ul style="list-style-type: none"> • Requires calibration tower unique to the Grimm. • The Grimm had problems with moisture in the past. To address this issue Grimm uses an Autom. nafion dryer system. • Sample flow works out to be 72 l/h. Some agencies feel that this lower flow can cause issues relating to the sample inlet tubing wherein it can act as a scrubber removing some of the fine particulates before detection. It is suggested that a cleaning maintenance schedule should be used that takes particulate loading unique to that location into consideration. • Total length of sample mast assembly is 3 meters – this will cause some installation considerations where current mast assemblies are a lot longer. 	<p>Calibration Tower: approximately \$10,000.00 Model 180 basic system total: \$29,995.00 This includes:</p> <ul style="list-style-type: none"> – 181 – 19” support for sample tube assembly. – 182 – 1,5m Sampling Pipe with nafion dryer and sensors for temperature and relative humidity. – 183 - 1,5m extension Sampling Pipe (can only be used with #182) \$1,425 – 177 - Software Licence \$495 – 1141 - USB to RS-232 Converter

Appendix II (continued): Monitoring Instrumentation Considerations

Instrument	Pros	Cons	Cost
<p>FEM's provided by NAPS was the same as the US EPA's list it is assumed that the Grimm could be added soon with designation for PM2.5 EDM 180 can be delivered with one PM value determination only and subsequently be upgraded to deliver up to 3 PM values and the total count; in addition, the complete particle count information from 0.25 µm to 32 µm can be made available in 31 particle sizes.</p>	<p>manufactured identically, the Dolomite dust has to produce identical results in both spectrometers. The dust is injected at the top of the cylindrical calibration tower by particle-free compressed air and homogeneously dispersed within the entire tower. Up to three calibration candidates and one reference unit are attached to the bottom of the tower via identical aerosol inlets. A reverse flow of particle-free compressed air from the bottom to the top of the cylindrical tower guarantees a well defined and reproducible aerosol particle distribution during the whole calibration process.</p>		<p>with 1 m cable and driver. \$125 – 1142.A2 - Data storage card 1MB. \$195</p> <p>Additional Options: 180-DU - Option to upgrade the 180 Spectrometer to four (4) different values -> PM10, PM2.5, TSP and TC. \$3,500 180-DF - Sample Pipe Heater for extreme cold area (≤ 20°C) \$1,195 186 - Test Kit for Grimm Environmental Monitors including sampling Head Adaptor, Flowmeter, Zero Filter and plastic carrying case. \$1,495 189 - Roof Mount Flange \$675 1143E - Connecting cable RS-232 \$125 X180160 - Sensor Simulator for testing Grimm 180 \$275 160 - Analog Output Adapter for PM-10, PM-2.5 and PM-1 \$995 1155A - External memo Card reader \$795 158 - Wind-direction and air velocity sensor \$1,250 180-EU - Update Package to get Particle Count/Liter in 31 size channels between 0.25 and > 32 µm and reversable to PM values. \$3,995</p>

Note: Footnotes to table on following page.

Footnotes to Appendix II:

1. NAPS: The goal of the National Air Pollution Surveillance (NAPS) program is to provide accurate and long-term air quality data of a uniform standard across Canada. NAPS was established in 1969 to monitor and assess the quality of ambient (outdoor) air in the populated regions of Canada. NAPS is managed using a cooperative agreement among the provinces, territories and some municipal governments. In 1969, eight provinces -- Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan Alberta and British Columbia -- joined the program. In the first annual data report 36 monitoring sites reported to the Canada-wide database. Today there are 286 sites in 203 communities located in every province.

2. FEM: The Federal Equivalent Method or FEM, are standards for semi-continuous and continuous monitors considered acceptable by the USEPA and NAPS. The FRM or Federal Reference Method is equivalent to the FRM but is applied to filter based methods such as particals.