



CONSULTING ENGINEERS
& SCIENTISTS

Submitted To: Crofton Airshed Citizens Group and
Reach for Unbleached!

By Email.

FINAL PEER REVIEW

Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division

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EXECUTIVE SUMMARY

RWDI AIR Inc. (RWDI) and PIONEER Technologies Corporation (PIONEER) were retained by the Crofton Airshed Citizens Group and Reach for Unbleached to review the report by Jacques Whitford (JW) entitled, “Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division” dated October, 2004. RWDI was responsible for reviewing Volume I: Air Quality Modelling and PIONEER was responsible for reviewing Volume II: Human Health Risk Assessment. The review of Volume I consisted of reviewing the Volume I report and other documents and electronic files provided under the non-disclosure agreement including CALMET and CALPUFF model input and output files and the emission inventory spreadsheet.

The following five main components of the air quality and human health risk assessment were reviewed:

- Emission inventory,
- CALMET and CALPUFF modelling methodology,
- Ambient air quality data analysis,
- Dispersion model results, and
- Human health risk assessment.

Significant deficiencies have been noted in the Baseline Air Quality Modelling and Human Health Risk Assessment prepared by Jacques Whitford to the degree that we believe substantial re-work is required. This report identifies and discusses all deficiencies that were found in the report from typographical errors to major flaws and weaknesses. The deficiencies were ranked from minor (deficiency ranking 1) to major (deficiency ranking 5). The deficiencies of greatest concern relate to the emission inventory, dispersion modelling methodology and human health risk assessment. These are summarized below.

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Emission Inventory

- Average annual emission rates were used in the Crofton Mill Emission Inventory. Peak 1-hour emission rates should have been used to determine maximum short-term (24-hour or less) ground-level concentrations and resulting acute health impacts.
- Emissions during start up, shut down or during low efficiency operation were not considered. As a result, emissions and associated risk may have been significantly underestimated.
- Emission rates were based on 2003 production information only. Several years of production data should have been analyzed.
- Zero emission rates were assumed for non-detects, rather than ½ of detection limit, as recommended by the National Association for Air and Stream Improvement (NCASI). As a result, a number of contaminants were eliminated from the risk assessment.
- A number of contaminants were not included even though NCASI emission factors are available for at least some of the processes. No explanation is provided for not including these contaminants. This may have resulted in an underestimation of emissions and associated risk.
- The Crofton emission inventory does not include criteria air contaminant emissions for the operation of the power boilers using bunker C oil and natural gas.
- Idling and off-site emissions from trucks, rail and marine traffic were not included.

CALMET and CALPUFF Modelling Methodology

RWDI agrees with the overall approach used in the modelling that Jacques Whitford adopted for the Crofton assessment. However, RWDI believes there are significant deficiencies in the input files used and in the model options chosen and that these deficiencies could in turn have a significant effect on the resulting predictions of pollutant concentration. These deficiencies include:

- Omission of surface observation from the Crofton Mill site;
- Option to extrapolate surface observation to higher levels was not chosen;

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- Land use in the study domain, particularly in the region immediately surrounding the Crofton Mill was improperly characterized;
- Receptor spacing immediately beyond the fenceline is too sparse; and
- Background sources should have been included in modelling or predicted model concentrations should have included some estimate of background contributions.

Ambient Monitoring Recommendations

- The suitability of current ambient monitoring station locations should be reviewed. Ideally a new study using site-specific meteorological data and all other recommended changes to the CALMET/CALPUFF model should be conducted to determine optimal ambient air monitoring locations in the Crofton area.

Human Health Risk Assessment

PIONEER disagrees with the overall approach that Jacques Whitford adopted for the Crofton risk assessment. There are significant deficiencies in the approach, which results in an underestimation of the human health risks associated with exposure to emissions from the Crofton Mill. These deficiencies include:

- The JW Report does not constitute a Baseline Human Health Risk Assessment because it does not evaluate all complete exposure pathways and sensitive subpopulations. The JW Report only evaluates the inhalation pathway for adults. Indirect exposure pathways (e.g., ingestion, dermal) and sensitive sub-populations should have been evaluated in the JW Report.
- The JW Report only considers/calculates the risks/hazards associated with individual substances. Cumulative risks/hazards should have been calculated and presented. Risk is therefore greatly underestimated.

Please note that PIONEER performed a Screening Level Risk Evaluation (SLRE) of the airborne concentrations presented in Tables 5-4 through 5-13 in the Report using the most current toxicity information available from the USEPA. Each of the airborne concentrations presented in Tables 5-4 through 5-13 in the Report were used “as-is” to calculate Hazard Quotients (HQs) and Cancer Risks (CRs) for an adult

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resident exposed via inhalation of air only. The individual HQs and CRs were summed to calculate the cumulative Hazard Index (HI) and cumulative CRs for each receptor (i.e., fence-line, gridded, and special receptor). The SLRE is presented in Appendix A.

- The JW Report is not transparent and does not follow generally accepted risk assessment principals and guidelines. For example, the Health Risk Assessment did not follow United States Environmental Protection Agency (USEPA) guidance in regards to pathways, cumulative noncancer and cancer risks.
- All substances in emission inventory should be identified as substances of potential concern (SoPCs) and carried through the risk assessment.
- Conceptual Site Model does not include all complete exposure and ingestion pathways.
- The Exposure Assessment is inadequate. Only one page and a figure were devoted to this topic. Typically, the Exposure Assessment is one of the most involved and well-documented chapters in a risk assessment. This section should be revised to identify and discuss potentially exposed populations and exposure pathways that are (and are not) being evaluated in the risk assessment and should provide rationale for the decisions that were made. The section should also include a presentation of the exposure parameters that were used to estimate the exposure for each receptor and exposure pathway. If exposure assumptions are embedded in the ambient air quality criteria or toxicological criteria, then they should be extracted and explained to the reader. Media concentrations should be calculated using equations and associated parameters for each exposure scenario presented in this chapter.
- The Toxicity Assessment should explicitly identify and summarize toxicological criteria for each substance. All toxicity values used should be presented in this section, and not fragmented between Section 4, Appendix A, and Appendix B, which makes it confusing for a reader evaluating which values were used for each exposure scenario. The decision rules used to select toxicity information should be explicitly stated and justified in the text. In addition, it is important to consider whether or not the criterion have been updated to reflect more recent scientific information. For example the British Columbia ambient air quality objectives were developed in the

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1980s and it is not clear if they have ever been updated and if not, is there new science that should be considered when applying the values.

- The Exposure Assessment and Risk Characterization should be presented separately.
- Toxicity Reference Values should be compared to all modeled concentrations and not just concentrations for SoPCs that did not have Ontario Ministry of the Environment or World Health Organization criteria.

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1.0 INTRODUCTION

RWDI AIR Inc. (RWDI) and PIONEER Technologies Corporation (PIONEER) were retained by the Crofton Airshed Citizens Group (CACG) and Reach for Unbleached (RFU) to review the report by Jacques Whitford (JW) entitled, “Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division” dated October, 2004. RWDI was responsible for reviewing Volume I: Air Quality Modelling and PIONEER was responsible for reviewing Volume II: Human Health Risk Assessment. Since the Human Health Risk Assessment utilizes information presented in Volume I, PIONEER also reviewed portions of that Volume. Specifically, PIONEER assisted RWDI in their review of Volume I: Chapter 5 – Emissions Inventory.

There are five main components of the air quality and human health risk assessment that were reviewed. These are the:

- meteorological fields developed for the dispersion modelling,
- ambient air quality data analysis,
- emission inventory,
- dispersion modelling, and
- human health risk assessment.

This review was conducted under a non-disclosure agreement with NorskeCanada. This enabled RWDI and PIONEER to review confidential information, such as spreadsheets and model input and output files, in addition to the publicly released report by Jacques Whitford.

Our review methodology consisted of the following steps:

1. Carefully reading the report prepared by Jacques Whitford and compiling a list of additional information required to thoroughly assess the Jacques Whitford study.
2. Receiving and reviewing all of the additional information and electronic files that we request.

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3. Evaluating the assumptions used in the Jacques Whitford study, including emission factors, model input parameters, and the exposure, toxicity and risk characterization data. As part of this evaluation step we conducted sensitivity studies using the meteorological, dispersion or health risk models.
4. Documenting our findings.

To assist the reader in interpreting our findings, we have used a scale from 1 to 5 to characterize the magnitude of deficiencies that we found in the study with 1 representing a minor deficiency and 5 representing a major deficiency.

This report consists of five main sections. Section 2 reviews Volume I of the JW report, including the meteorological fields, ambient air quality data analysis, dispersion modelling methodology, the emission inventory, and the dispersion model results. Section 3 reviews Volume II of the JW report, including study background, problem formulation, toxicity assessment, exposure assessment, risk characterization, and uncertainty analysis. Section 4 summarizes major deficiencies in tabular format. Section 5 presents recommendations for future work.

General and specific comments are provided. The general comments focus on the entire JW report and the specific comments focus on specific sections and Pages within the JW report.

2.0 REVIEW OF VOLUME I: AIR QUALITY MODELLING

2.1 INTRODUCTION

The review of Volume I consisted of reviewing the Volume I report and other documents and electronic files provided under the non-disclosure agreement including CALMET and CALPUFF model input and output files and the emission inventory spreadsheet. Since more information than just the JW report was reviewed, this section is structured somewhat differently from Volume I of the report. First we review the emission inventory, then we review the modelling methodology and meteorology, and finally we review the ambient air quality data and monitoring recommendations. We have attempted to provide the reader with sufficient background information such that they can understand the deficiencies that are discussed.

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2.2 EMISSION INVENTORY

2.2.1 General Comments

- G.1 Volume I lacks specific detail on how the emissions inventory (EI) was prepared. Even when taking into consideration NorskeCanada's need for protecting their business interests by invoking the non disclosure agreement, the report could have done more to justify assumptions used in preparation of the emissions inventory. The EI is a critical element used in the dispersion analysis and risk assessment. Therefore more information regarding the underlying assumptions and the results of the EI should have been provided in the report. **(Deficiency Ranking: 3)**
- G.2 Average annual emission rates were used in the Crofton Mill Emission Inventory. Annual average emission rates are not acceptable for determining 1-hour ground level maximum concentrations and determining acute health impacts. **(Deficiency Ranking: 5)**
- G.3 A more detailed analysis of the mill's process and production rates over several years is needed. In addition, short-term peak emission rates from the recovery and power boilers should be estimated to determine if they would significantly affect short-term averages. **(Deficiency Ranking: 4)**
- G.4 On-site and off-site emissions, including idling and auxiliary power from trucks, rail and marine traffic should be included in the Crofton Mill EI. **(Deficiency Ranking: 3)**
- G.5 All NCASI emission factors used in the Crofton Mill EI assumed that the non-detects from the source test data were zero as opposed to the ½ of the detection limit for the contaminant, as recommended by NCASI. As a result, for a number of contaminants where the NCASI test data were less than the detection limits, the Crofton Mill EI uses an emission factor of zero. This is not a conservative approach, and typically for risk assessments the ½ detection limit value would be used rather than reporting zero emissions. **(Deficiency Ranking: 4)**

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G.6 A number of contaminants were not included in the Crofton EI even though NCASI emission factors are available for at least some of the processes. No explanation is provided for not including these contaminants. **(Deficiency Ranking: 4)**

G.7 The Crofton EI does not calculate Criteria Air Contaminant emissions for the operation of the power boilers using bunker C Oil and natural gas. **(Deficiency Ranking: 4)**

2.2.2 Specific Comments

The Jacques Whitford Baseline Air Quality Modelling Assessment uses the Emission Inventory that was prepared for reporting to the National Pollutant Release Inventory (NPRI) for the 2003 reporting year. Total annual emissions were calculated using mill production data from 2003, emission factors primarily from the National Council for Air and Stream Improvement (NCASI), and some site-specific testing of 26 sources at the Crofton Mill in 2002. The JW report does not review the emission inventory in detail, and essentially apportions the emissions reported in 2003 between stack and volume sources and models these sources. This methodology is too simplistic – a more detailed emission inventory should be prepared.

2.2.2.1 Emission Inventory Information Sources

The Crofton Mill EI was supplemented with site-specific stack testing data from an emission survey conducted in 2002 as part of a national survey under the Forest Products Association of Canada (FPAC). The emission survey investigated emissions from a number of sources at the Crofton Mill including the recovery and power boilers. The goal of the survey was to measure emissions at approximately 90 percentile loads. Three tests were typically conducted during the same day and under similar load conditions. The average emission rates from the three separate tests were used in the emission inventory to calculate NO_x, SO₂ and particulate matter emissions from the recovery and power boilers. No discussion is provided in the report to justify the selection of these emission rates rather than rates based on NCASI or other emission factors. Also, because only one load condition is considered, these emission rates may not represent peak emission values. **(Deficiency Ranking: 3)**

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2.2.2.2 Mill Production 2003

Modelled emission rates are based on annual average emission rates (total annual emissions divided by the number of production days in 2003). Emission rates during peak production or upset conditions are not considered. Although some discussion is provided that short-term production rates may vary by 12 to 31% from the annual production rates, this does not necessarily mean that emission rates will vary in the same range for all emission sources.

It is unclear why the report used average emission rates, especially when determining maximum one-hour ground-level concentrations. This is fundamentally important for determining acute noncancer health effects. Annual averages are not acceptable for determining acute health impacts. The report goes on to say that the “effect of a marginally higher maximum predicted 1-hour value has little effect on the study conclusions.” This is misleading and inappropriate, especially since no data are presented to justify this conclusion. It is also not appropriate to suggest that 24-hour exposures are associated with chronic impacts. The report already demonstrates that there are significant differences in values for median and maximum daily emission rates (Table 5-4). **(Deficiency Ranking: 5)**

It is unclear why maximum production rates were compared to median rates rather than average rates on page 5-10 given that average – not median – emission rates were used in the study. The effect of comparing to median values is to understate the potential for underestimating impacts by using an average emission rate. If the comparison had been made of maximum and average process rates, one would conclude from Table 5-4 that the maximum production rate can be as much as 1.68 times greater than the average production rate (for #3 Rec Solids Fired). **(Deficiency Ranking: 4)**

Combustion emission sources such as the boilers may have much greater emissions during start-up, shut-down or when operated at low efficiency. Emission rates for various loads and operating conditions of the recovery and power boilers should be estimated to determine if they would significantly affect short-term (1-hr, 8-hr and 24-hr) averages. **(Deficiency Ranking: 4)**

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It is especially important that an emission inventory be accurate and representative of typical long-term operations at the mill. Not enough information is provided to conclude whether 2003 annual production rates represent typical long-term operations at the mill and whether these rates are conservative or appropriate. 2003 may have been an “off” year due to process limitations or restrictions. Conversely, it could have been a banner year with respect to production and process rates. A more detailed analysis of the mill’s process and production rates over several years is needed. **(Deficiency Ranking: 4)**

2.2.2.3 Other Emission Sources

The JW report briefly overviews other emission sources that are not included in the NPRI emission inventory including emissions from truck, rail and marine traffic. A brief analysis of emissions due to on-site movements from truck, rail, and marine traffic concludes that these emissions are small compared to the Crofton Mill stack emissions and therefore they were excluded. This conclusion may be inaccurate for two reasons.

1. The calculations do not consider emissions from ships hotelling (using auxiliary power) in berth, and trains and trucks idling. Idling and auxiliary power emissions can be significant and are often greater than the emissions from on-site movements.
2. The JW report also does not consider emissions from truck, rail and marine traffic that occur off-site within the 55 km by 45 km study boundary. Trucks, trains and ships would travel at least 20 to 40 km within the study area and emissions from this traffic, although dispersed over a much greater area, would be much higher than the on-site emissions considered. Furthermore, these are sources associated with the mill that can be located close to residences. Previous studies have shown that the largest impact from a facility can be due to related transportation within the study area.

Idling and off-site emissions from trucks, rail and marine traffic should be included in the Crofton Mill EI. Also, there is no listing for non-road diesel emission sources such as front-end loaders and fork lifts. **(Deficiency Ranking: 4)**

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2.2.2.4 Review of Crofton Mill EI Spreadsheet

The Crofton Mill emission inventory was provided to RWDI in a spreadsheet format. This spreadsheet calculates emissions for the 26 individual processes identified in the JW report. For each process, the annual production rate used to calculate total annual emissions and emission factors for the 106 contaminants is provided. The mill production rates are based on total production in 2003 and the number of operating days for the mill in 2003 (344 days).

The resources are not available to check every single emission factor for 106 contaminants and all the individual processes in the emission inventory. Spot checks were made for all processes, but it was necessary to limit a detailed review to a small number of processes. Specifically the following processes were reviewed in detail and these processes represent the vast majority of emissions for most contaminants.

- Lime Kiln
- Slaker Cauticizer
- Power Boilers
- Recovery Boilers
- 100% Bleached Dryer
- WBL and SBL Tanks

Based on this review of the Crofton EI the following specific comments are provided on the NCASI emission factors and on some of the Crofton Mill processes.

NCASI Emission Factors

NCASI has compiled comprehensive air toxic emissions data from extensive testing conducted at 26 chemical wood pulp mills prior to 1995. This database has been expanded significantly since that time. For each process and specific contaminant, the number of tests and data range of test measurements are provided. The limitations of NCASI emission factors (data gaps) should be clearly documented in the JW report.

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Emission factors are based on a unit production capacity such as kg/tonne of CaO, or kg/GJ. For many of the NCASI measurements, the contaminant measured was below the detection limit. These measurements are reported as non-detects. If for any process and specific contaminant less than half the measurements were non-detects, NCASI reported an average emission factor of the detected emissions. If more than 50% of the measurements were non-detects, two emission factors were provided: (1) the median value assuming that the non-detects were equal to zero and (2) the median value assuming that the non-detects were equal to ½ the detection limit. For a process and specific contaminant where no concentrations greater than the detection limit were measured, the reported emission factor is equal to ½ the detection limit.

The 2003 Crofton Mill EI emission factors typically matched the average or median emission factors reported by NCASI. However, all emission factors used assumed that the non-detects were zero as opposed to the ½ of the detection limit for the contaminant, i.e., the lower emission factor was selected. In addition, for a number of contaminants where the NCASI test data measured only non-detects, the Crofton Mill EI used an emission factor of zero rather than ½ the detection limit. This is not a conservative approach. Typically for risk assessments, the ½ detection limit value would be used rather than reporting zero emissions. **(Deficiency Ranking: 4)**

The Crofton Mill EI uses the reported NCASI emission factors that are the average or median of measurement tests at different pulp mills. The individual test results were not reviewed by JW to determine if a particular mill process might best represent the processes at the Crofton Mill. **(Deficiency Ranking: 2)**

A small number of emission factors from the Crofton Mill EI were not verifiable. They did not appear to match 2003 NCASI emission factors available to RWDI (NCASI, Technical Bulletin No. 858 February 2003). It is possible that these are transcription errors, that they are derived from an unspecified source, or that they were inadvertently not entered. **(Deficiency Ranking: 2)**

A number of contaminants for which NCASI emission factors are provided for at least some of the processes were not included in the Crofton EI. A partial list of these contaminants appears below. No explanation is provided as to why these contaminants were not included. **(Deficiency Ranking: 4)**

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Acetophenone	Hexachlorobenzene	Tetrachlorethene
Benzaldehyde	Hexachlorobiphenyl	Trichlorobiphenyl
Benzoic Acid	Hexachlorocyclopentadiene	Tricchlorofluoromethane
Bromodichloromethane	Hexachloroethane	2,4,6 Trichlorophenol
Bromomethane	Hexaldehyde	Valeradehyde
Carbonyl Sulfide	Methylene Chloride	Vinyl Acetate
Crotonaldehyde	Nitrophenol	Vinyl Chloride
Ethanol	Tetrachlorobiphenyl	

FPAC Survey Crofton Mill 2002

Site-specific emission factors based on Crofton Mill stack testing data (2002) collected as part of a study by the Forest Products Association of Canada (FPAC) were also used in the Crofton Mill EI. In general the document is hard to follow and poorly organized. Emission factor derivations from these data should be clearly demonstrated where appropriate. **(Deficiency Ranking: 3)**

Lime Kiln

The Crofton EI indicates that the Lime Kiln used 2004 NCASI emission factors to estimate PAHs. RWDI was unable to verify the source of data, and noted that the sum of individual PAH emission factors is more than the total emission factor used. **(Deficiency Ranking: 2)**

Recovery Boilers

The PAH emission factors for the recovery boilers were taken from Powell River 1999 stack test data adjusted for Crofton stack flow rates. Emission factors are only available for a few of the PAH compounds and the total PAH emissions may be underestimated. In addition, SO₂ emission factors appear to be based on FPAC 2002 stack tests at Crofton. However, the emission rates used in the EI spreadsheet don't match the test data presented in the report. **(Deficiency Ranking: 3)**

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Power Boilers

The proposed alternative fuels trial will involve the #4 power boiler and therefore the emissions inventory for this unit was examined in greater detail. The #4 power boiler at Crofton is a Foster Wheeler large traveling grate unit that has been in service since 1978. The boiler burns approximately 735 volumetric units of hog fuel per day and uses natural gas or #6 fuel oil as auxiliary fuel. In 2002, the boiler generated an average 323,000 lbs/hr of steam with 73.9% (246,000 lbs/hr) generated by burning hog fuel and sludges. The maximum total firing rate in this period was 473,800 lbs/hr and the 90th percentile total firing rate was 415,000 lbs/hr.

The new precipitator on the #4 power boiler has reduced historical emissions and the current particulate emissions have averaged 53 mg/m³ (12% CO₂) since commissioning in May 2001.

Emission rates were calculated using an average not maximum flow rate

Criteria air contaminant, PAH, dioxin, furan and HCB emissions for the #4 Power Boiler presented in the NorskeCanada 2003 NPRI emission inventory were calculated based on an average exhaust flow rate of 5054 Nm³/min and the 2003 operating period of the power boiler, which was 344 days. However, all boilers have operational variations, and for short-term periods will have exhaust flow rates that exceed the average. This is apparent from the monthly stack testing data for 2003. Each month three individual 1-hour tests are conducted to estimate particulate concentrations. The annual average flow rate of the monthly tests from the #4 Power Boiler is 5,054 Nm³/min and matches the average flow rate used in the Emission Inventory. The maximum flow rate measured in the monthly tests (average of three tests) was 5,697 Nm³/min and the minimum was 4,187 Nm³/min. Furthermore, an emission survey conducted in 2002 indicated an exhaust flow rate for the #4 power boiler of 6,020 Nm³/min. (It is of note that this flowrate was used by Jacques Whitford to determine the exit velocity used in the modelling, which is inconsistent with the lower flow rate used to estimate emissions.)

Thus, monthly testing in 2003 shows a variation in flow rate as high as 13% above the average. Furthermore, the 2002 FPAC emission survey measured exhaust flow rates as much as 20% above the average, which likely represents the peak load of the power boiler.

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In conclusion, we can anticipate that the maximum short-term emissions of criteria air contaminants, PAHs, dioxins, furans and HCBs will be as much as 20% greater than the emission rates applied by Jacques Whitford. Without conducting additional modelling one cannot accurately determine the associated increase in maximum ground-level concentrations but they could potentially be as much as 20% greater than the values presented in the Jacques Whitford report. **(Deficiency Ranking: 4)**

Emission rates were calculated using annual average steam generation capacity

A large number of compounds rely on the NCASI emission factors that are based on the fuel energy consumed by the boiler (i.e., kg of compound produce per GJ of energy consumed by the boiler). Average annual fuel energy for 2003 was used to estimate emissions for these compounds. The total generating capacity estimated in 2003 was 3,540,000 GJ/yr. This method of emission estimation is appropriate for assessing ground-level concentrations for long averaging periods, such as annual averages, but is inappropriate for short-term averaging periods such as 1-hr and 24-hr. Monthly stack testing of the #4 power boiler in 2003 indicates that the total pounds of steam generated from hog fuel varies by as much as 18% from the average value.

In conclusion, we can anticipate that compounds that rely on the NCASI emission factors (total of 38 compounds) could have maximum short-term emission rates that are as much as 18% above the levels modeled. Thus, the maximum predicted ground-level concentrations for these compounds could be underestimated by as much as 18%. **(Deficiency Ranking: 4)**

Particulate concentrations rely on average stack test measurements and don't account for measured variations

The total particulate measured in monthly tests in 2003 varies from 15 ug/m³ to 119 ug/m³. The emission inventory used 53 ug/m³ (based on 322 days of hog fuel use). This value matches the annual average of 53 ug/m³ from stack testing in 2003. The maximum measured particulate concentration measured in 2003 was 119 ug/m³, which is 125% greater than the value that was used. Since 2001, when the electric precipitator was installed, the maximum monthly test result was 126 ug/m³ in May of 2002. Furthermore, the maximum values of 119 and 126 ug/m³ represent snapshots in time, when stack

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testing was conducted, and are unlikely to represent the true maximum particulate emission rate.

In conclusion we can anticipate that particulate emissions could more than double the emission rates that were modelled. **(Deficiency Ranking: 5)**

Startup Emissions are likely higher than Normal Operation Emissions

The #4 Power Boiler would require a cold startup infrequently as the boiler is operating 344 days per year. During the startup of boilers the electrostatic precipitator (ESP) that is used to control particulate emissions does not operate at high efficiency until a minimum operating temperature is reached. Thus, until the boiler reaches optimal operating temperatures emissions of PM and other compounds such as dioxins and furans can be elevated above normal levels. Emissions during startup should have been quantified and modelled to assess maximum ground-level concentrations for short averaging periods. **(Deficiency Ranking: 4)**

Criteria air contaminant emissions not assessed when power boilers burn Bunker C fuel oil or natural gas

The primary fuel for the #4 Power Boiler is hog fuel and approximately 10% of the time Bunker C fuel oil is used. The #5 Power Boiler uses Bunker C oil and natural gas. Annual fuel consumption estimates are provided for Bunker C fuel oil and natural gas but the emissions are not calculated. RWDI has estimated these emissions based on the natural gas and fuel oil consumption reported in the emission inventory and standard AP-42 emission factors for natural gas and fuel oil combustion boilers. The calculations considered that the #5 Power Boiler used approximately 80% of the Bunker C Oil consumed and 70% of the natural gas in 2003 as stated in the Jacques Whitford report.

The addition of #5 Power Boiler criteria air contaminant emissions to the emission inventory results in an increase of approximately 4% for particulate, 12% for NO_x, 5% for CO and 8% for SO₂. **(Deficiency Ranking: 4)**

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2.3 MODELLING METHODOLOGY AND METEOROLOGY (THE CALPUFF MODELLING SYSTEM AND MC2)

The CALPUFF modelling system is a generalized non-steady state air quality modelling system for regulatory use (Scire et al., 2000). It is non-steady state because model calculations carry over from hour to hour, as opposed to steady state models that make an independent calculation for each hour.

The model was developed to meet the following specifications:

1. capability to treat time-varying point and area sources,
2. suitability for modeling domains from tens of meters to hundreds of kilometers from a source,
3. predictions for averaging times ranging from one-hour up to one year,
4. applicability to inert pollutants and those subject to linear removal (deposition) and chemical conversion mechanisms, and
5. applicability for rough or complex terrain situations.

The CALPUFF system developed to meet these objectives consists of three main components:

1. CALMET - a diagnostic meteorological model wind field generator;
2. CALPUFF - a Gaussian puff dispersion model with chemical removal, wet and dry deposition, complex terrain algorithms, building downwash, plume fumigation, and other effects; and
3. CALPOST - a utility for post processing model results.

CALMET is a meteorological model that develops 3-dimensional hourly wind and temperature fields from observations of surface and upper air meteorological data and from geophysical characteristics, such as terrain elevation and land use category, over the model domain. CALPUFF is a transport and dispersion model that transports ‘puffs’ of pollutants emitted from model sources, simulating dispersion, deposition and transformation processes along the way. In so doing it typically makes use of the fields generated by CALMET.

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CALPUFF is on the short list of USEPA supported and recommended models. It is has also been accepted for use in Environmental Impact Assessments by the BC Ministry of Water Land and Air Protection.

The Mesoscale Compressible Community [MC2] model is a state-of-the-art atmospheric model widely used by Environment Canada, Canadian Universities, and others worldwide, for mesoscale and microscale atmospheric research. It was developed by Recherche en Prevision Numerique in Dorval, Quebec. MC2 can be used both to forecast weather and to provide estimates of three-dimensional wind patterns for air quality studies.

MC2 is fully prognostic, meaning that it integrates the equations of motion and state throughout the length of the model run and the results of one hour serve as inputs for the next. MC2 can simulate, with the same program code, meteorological events ranging in scale from cyclones and squall lines to tornadoes and turbulent plumes. However, because it is fully prognostic, MC2 does not have the capability to adjust, or ‘nudge’ model predictions with observed data, unlike some other mesoscale models, most notably MM5.

In BC, MC2 is run operationally by UBC to perform ongoing weather forecasts for an area covering southwestern BC, northern Washington state and Vancouver Island.

2.3.1 General Comments

G.8 Overall Modelling Approach: RWDI agrees with the overall approach used in the modelling that Jacques Whitford adopted for the Crofton assessment. Specifically, we agree that the CALMET/CALPUFF modelling system is the most appropriate tool to employ, and we further agree that, in areas of complex terrain such as that surrounding the Crofton mill, the use of prognostic meteorological model outputs (i.e., MC2) to initialize CALMET is appropriate. However, RWDI believes there are significant deficiencies in the input files used and in the model options chosen and that these deficiencies could in turn have a significant effect on the resulting predictions of pollutant concentration. These deficiencies include the omission of surface observation from the Crofton Mill site, the option not to extrapolate surface

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observations to higher model levels, the lack of accuracy in the land use file supplied to the model and errors in the options pertaining to terrain adjustments done by the CALMET model. Each of these deficiencies is ranked under the Specific Comments section.

G.9 Description of CALMET: In more than one instance, the calculations performed by the CALMET model are incorrectly described. **(Deficiency Ranking: 2)**

G.10 MC2 Model Output as ‘Data’: Throughout the modelling section, the MC2 prognostic meteorological model fields are referred to as ‘data’. They are not. They are model output. They are not same as in situ measurements of ambient meteorology. They are model predictions of ambient meteorology. Though seemingly trivial, the implicit result of referring to MC2 as ‘data’ is to grant model results the same level of veracity as actual observations. This is effectively a statement that model predictions are equally representative of reality as observations, without any model evaluation offered to support this claim. It is this error that permits the assertion that MC2 model estimates are of the same value as actual measurements from Crofton, and, by extension, that the omission of surface data from Crofton in the CALMET calculation is acceptable. **(Deficiency Ranking: 3)**

G.11 Cumulative Effect of Model Errors: Taken on their own, the effect of each of the issues outlined in this section on model predictions may be rationalized as insufficient to significantly affect the project assessment. However, taken as a whole, the sum total of these deficiencies severely undermines the confidence of the model predictions. Therefore we recommend remodeling using site-specific meteorology and more representative model options. **(Deficiency Ranking: 5)**

2.3.2 Specific Comments

The following subsections outline the issues of concern that RWDI has identified within the modelling. The first section deals with errors in the description of the CALMET/CALPUFF system present in the JW report. These do not directly affect model

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results, but they do mislead the reader as to how the model actually works. The subsequent subsections describe RWDI's concerns with more technical aspects of the actual model application. Each of the issues addressed is ranked according to the scale described previously.

2.3.2.1 Description of CALMET Algorithm

The report contains misleading statements in the description of the CALMET algorithms. On page 2-1, the report states:

“..CALMET derives meteorological data from the nearest station but will fill in the data with the next nearest station if any particular datum point is flagged as missing”

This is incorrect. Wind data are incorporated into CALMET based on user-weighted inverse distance averages as defined by equation 2-18 of the CALMET manual. Temperature fields may be interpolated from prognostic model outputs or from surface and upper air stations. If prognostic outputs are not used, then the model can be made to use a single station to define surface temperature. However, even without using prognostic model outputs, 3-D temperature is usually interpolated from all available surface and upper air information as described in section 2.3.2. Overall CALMET does not take data from the closest station; rather it uses all available data according to the options selected by the user.

In reference to incorporation of observations from offshore stations, on page 2-4 the report states:

“CALMET will preferentially use observed winds in close proximity, but will use other data if data from the nearest buoy are missing”

Again, this is not correct. As stated above, CALMET performs user-weighted averages of all available data. The user weights are set as radii of influence from the type of station in question. The closer to a station, the more influence it has on the wind calculation. Similarly, the smaller the radius of influence, the less that station affects points further away. These weights can be set differently for surface, upper air and over-water stations, and can be chosen such that the influence of a station does not extend beyond what is

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physically reasonable. For example, so that measurements from an offshore buoy have less effect over land. If a value at a particular station is missing, then the user weighted averaging is performed without that station. If wind data from a buoy is missing, CALMET does not replace that data with data from another buoy, it merely performs the user-weighted averaging of equation 2-18 without data from that buoy.

Only if there are no stations located within the maximum radius of influence selected by the user will CALMET preferentially select the closest station.

However, temperature can be set using over-water stations for cells defined as water. This is described in section 2.3.2.1 of the CALMET manual. **(Deficiency Ranking: 2)**

2.3.2.2 Use of Prognostic Model Output (MC2) with CALMET

Overview of Prognostic Models and CALMET

Prognostic models are detailed mathematical expressions of the dynamic and thermal properties of the atmosphere. These models solve the equations of motion (winds) and of state (temperature and precipitation) and advance them through time. MC2 is one such model. There are many others.

The primary scientific use of prognostic models is for numerical weather forecasting. There are numerous institutions and agencies worldwide that use the outputs of many such models to predict weather over scales ranging from the entire globe to the southwestern portion of BC.

However, prognostic models are also used to provide three-dimensional wind and temperature fields for other scientific endeavors, most notably air quality dispersion modelling. In such cases, prognostic models are used to estimate the spatial and temporal variation of the motion and state of the atmosphere in areas and at resolutions that are not sufficiently defined by surface or upper air observations. As these types of studies are not forecasts (i.e. they are run for some period in the past), typically observations of surface or upper air meteorology are available and the model predictions are adjusted, or ‘nudged’, to better agree with observations.

It is important to note that the output of such models is not ‘data’ in the classical sense, in that it is not a measurement of reality, but rather is a very complex estimation of reality.

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Referring to such model outputs as data is misleading in that it tends to suggest a level of accuracy that may not be present. It is also confusing in that it does not differentiate between such information and surface or upper air observations, which are data in the classical sense.

CALMET is not a prognostic model. It does not solve the equations of motion and state and advance them in time. Rather, at each hour it takes the information provided (surface and upper air observations, prognostic model fields, land use and terrain elevation) and performs a series of user-weighted averages and terrain based adjustments to calculate a three dimensional estimate of winds and temperatures for the model domain at that time.

The application of a prognostic model typically requires many orders of magnitude more effort than the application of CALMET and as a result prognostic models are typically run at a much coarser resolution than is required for the CALMET application. Therefore, prognostic models run at a coarse resolution are useful as inputs to CALMET, but generally not as a replacement to CALMET, except for shorter time scales, or episodes, as are examined in more detailed studies such as photochemical regional airshed modelling.

CALMET in No-Obs Mode

The most recent version of CALMET can be run in so called ‘No-Obs’ mode using only prognostic meteorological fields without any surface or upper air observations. In this mode, CALMET takes the prognostic fields and adjusts them to a finer resolution based on local terrain and land use. The ‘No-Obs’ option can be used to exclude either upper air profiles or surface measurements, or both. *JW used the ‘No-Obs’ option and excluded upper air measurements during any period for which MC2 fields were available. RWDI does not agree with this approach.*

The main purpose of utilizing prognostic fields in CALMET is to provide a ‘head start’ to make it more likely that the CALMET diagnostic analysis of surface and upper air observations is able to converge to a representative wind field. It is not intended that prognostic model outputs supercede surface and upper air observations. Further it is RWDI’s opinion that the ‘No-Obs’ CALMET option is not intended to allow the modeler to avoid using appropriate surface and upper air measurements. It is intended to allow CALMET to be run in forecast mode, i.e., when surface and upper air observations are

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not available because they do not yet exist. Given the nature of the CALMET algorithm, (i.e., it performs weighted averages of all available data) there is no compelling reason to exclude the upper air measurements altogether. However, as the MC2 fields will likely not be very different from the upper air profiles and will probably have used the observed upper air profiles to adjust the model predictions, the effect of this error will be limited. The main deficiency is the underlying assumption that the MC2 fields are superior to actual measurements. (**Deficiency Ranking: 2**)

2.3.2.3 Surface Data in CALMET

Exclusion of Crofton Data

The JW CALMET run used surface observations from six stations on Vancouver Island, as listed in Tables 2-1 and 2-2 of the JW report. However, they specifically excluded data from the Crofton Mill. This site was deemed not reliable due to instrument malfunction. As a result, the CALMET fields in the region immediately surrounding the Crofton Mill, where the predicted pollutant concentrations are likely to be greatest, are based almost exclusively on the MC2 model results and not on observations.

Surface meteorology at Crofton is available from WLAP for the period from 1992 through to the present. Wind roses of the wind speed and direction as measured at this site are shown in Figure 2-1 through Figure 2-10 for each year from 1995-2003 as well as for the combined 5 year period from 1995-1999.

The wind roses for 2000 and 2001 (Figure 2-7 and Figure 2-8) are very different from all other years and do in fact suggest that there was a problem with the wind sensor during these times. The wind roses for 2002 and 2003 (Figure 2-9 and Figure 2-10) are also slightly different from those previous to 2000 and also lend some credence to the assertion that the sonic anemometer in place may have been affected by noise from the plant or from improper siting.

The wind roses from 1995-1999 (Figure 2-1 through Figure 2-5) are quite consistent with each other and therefore this time frame represents the best five year data set from which to characterize winds in the region.

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Figure 2-6 shows the wind rose for the five year period from 1995-1999. This is the five-year span directly preceding the 2000-2001 MC2 model period. This figure is very different from the output of the CALMET model that is shown for the Crofton Mill in Figure 2-3 of the JW report. This is strong evidence that either CALMET with MC2 is not able to replicate local winds or the 2000-2001 model period is atypical for the study area. In either case *RWDI does not agree with the practice of using MC2 model output to the exclusion of local surface observations.*

If the MC2 fields were commissioned for this study, it makes no sense to have chosen a period for which data from the most representative station, the Crofton mill, were unavailable. Similarly, as the CALMET simulation in the area of the mill is based almost entirely on the MC2 model fields it is difficult to conclude that the CALMET modelling has accurately represented wind speed and direction in the area of the Crofton Mill.

Even relatively minor differences in wind patterns between the MC2 derived and the observed winds at Crofton might result in large differences in predicted concentrations. For example, the highest concentrations close to an elevated point source are often due to unstable atmospheric conditions. These conditions correspond to a Pasquill-Gifford stability classification of 1, which is defined roughly as strong solar insolation, clear skies and very low synoptic winds. Under these conditions, elevated plumes will undergo 'looping' behaviour. This means they are very quickly mixed to ground by well developed thermal circulation that results from the strong solar forcing and is undisturbed by low synoptic winds. At latitudes such as Crofton, these episodes are relatively infrequent, occurring only on the warmest and calmest summer days, and typically comprising only a few percent of the total hours of the year. Misrepresenting these conditions may not have a large influence on a wind rose containing all the hours of the year, but could have a large impact on the maximum predictions, particularly if they display some directional dependency.

Figure 2-11 shows the wind rose for winds at Crofton for 1999 for PG stability class 1 (very unstable). The wind rose shows virtually all winds are from the northeast sector. As stated above, PG class 1 requires strong solar forcing and very low winds. In coastal environments, these conditions usually lead to well developed sea-breezes. Recalling the position of the Crofton mill, the wind rose shows that PG class 1 and thus looping plumes at the Crofton Mill are very strongly linked to winds with an onshore component.

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By extension, this means that wind patterns at Crofton are distinctly site dependent, and may not be properly resolved by anything other than direct measurement.

It is not clear from the wind roses shown in the JW report whether the MC2 derived winds for Crofton reflect the observed wind pattern for very unstable conditions as illustrated in Figure 11.

(Deficiency Ranking: 5)

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Figure 2-1: Wind Rose from Crofton Mill for 1995

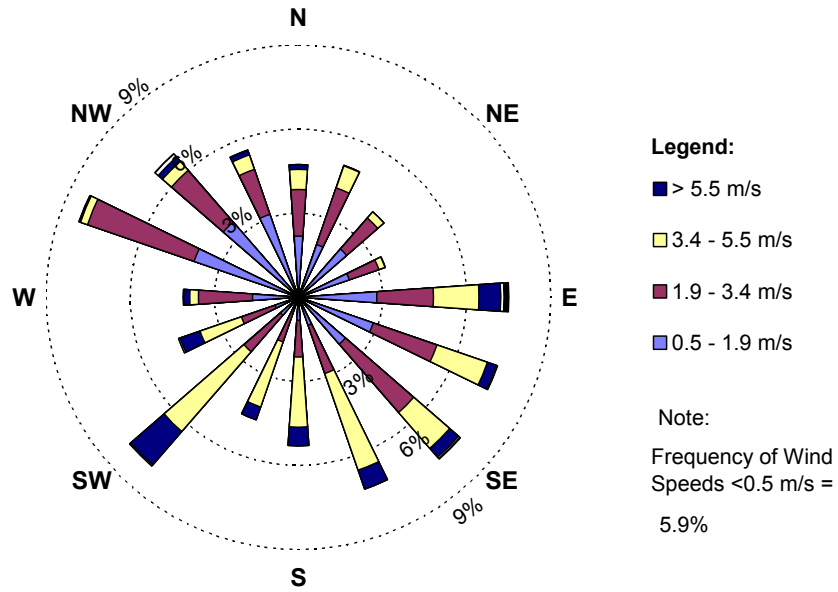
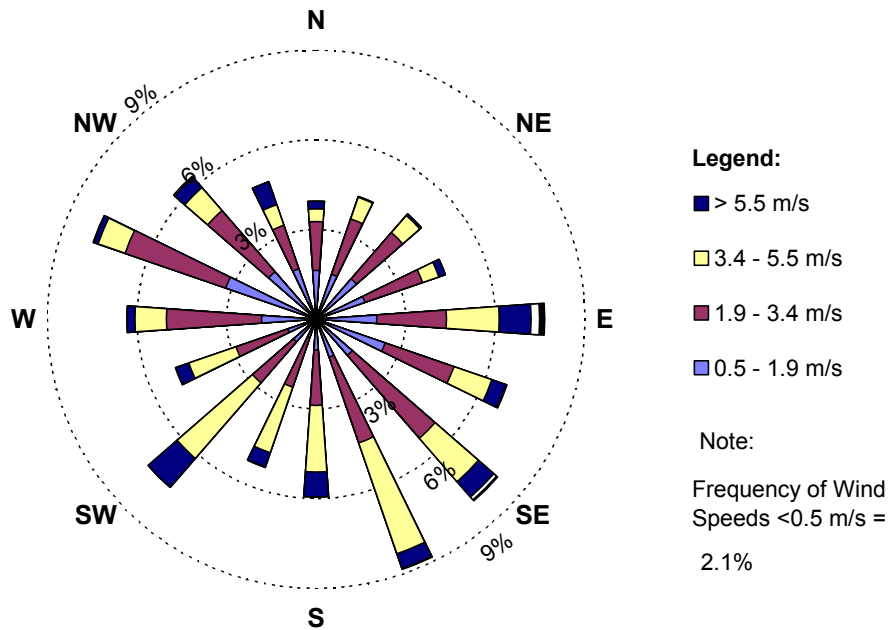


Figure 2-2: Wind Rose from Crofton Mill for 1996



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Figure 2-3: Wind Rose from Crofton Mill for 1997

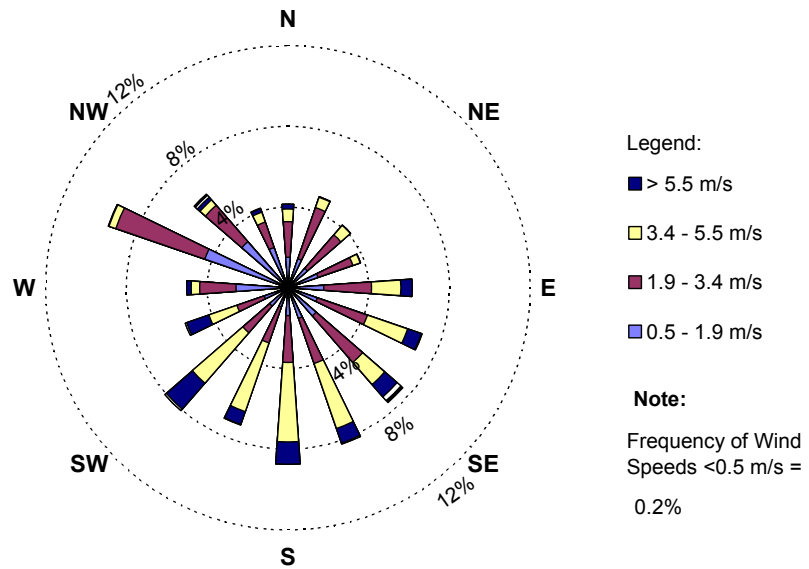
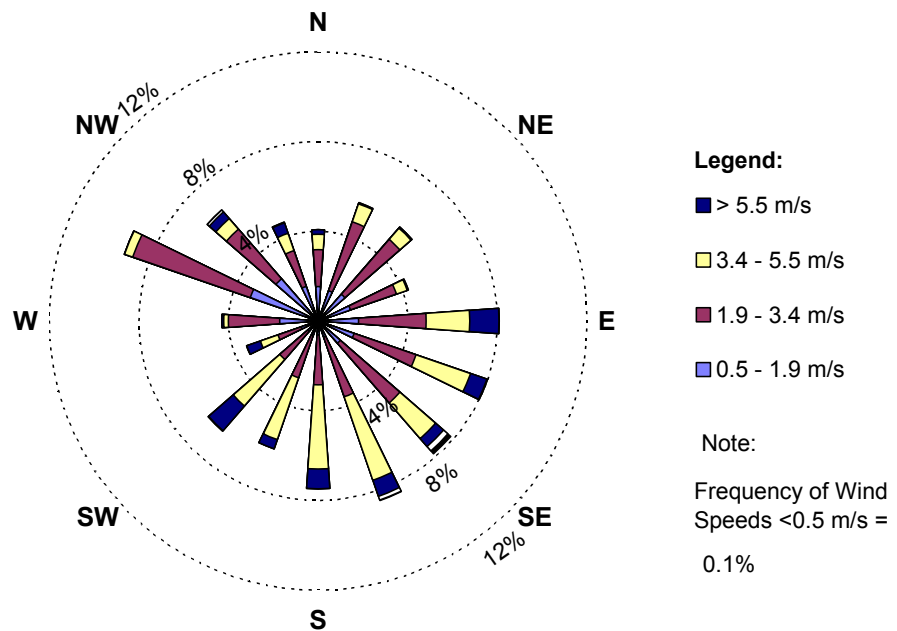


Figure 2-4: Wind Rose from Crofton Mill for 1998



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Figure 2-5: Wind Rose from Crofton Mill for 1999

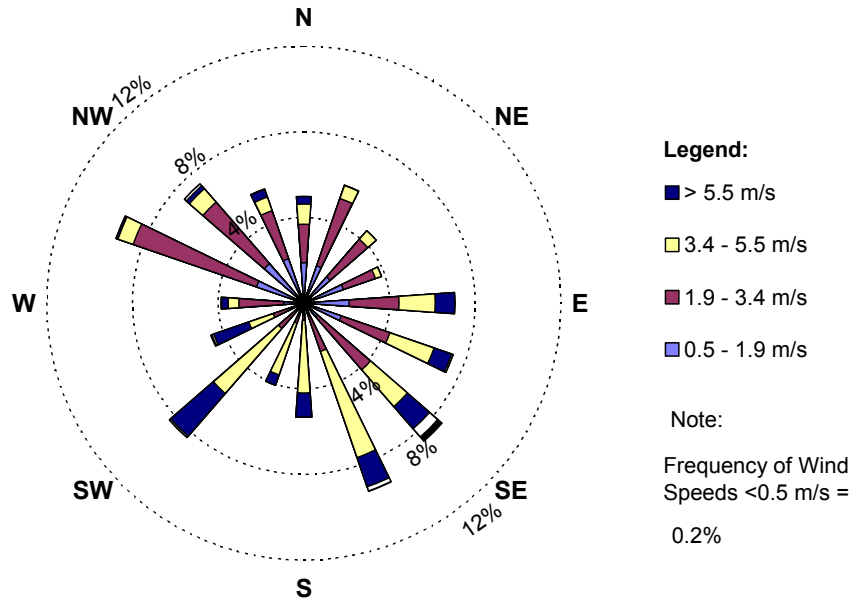
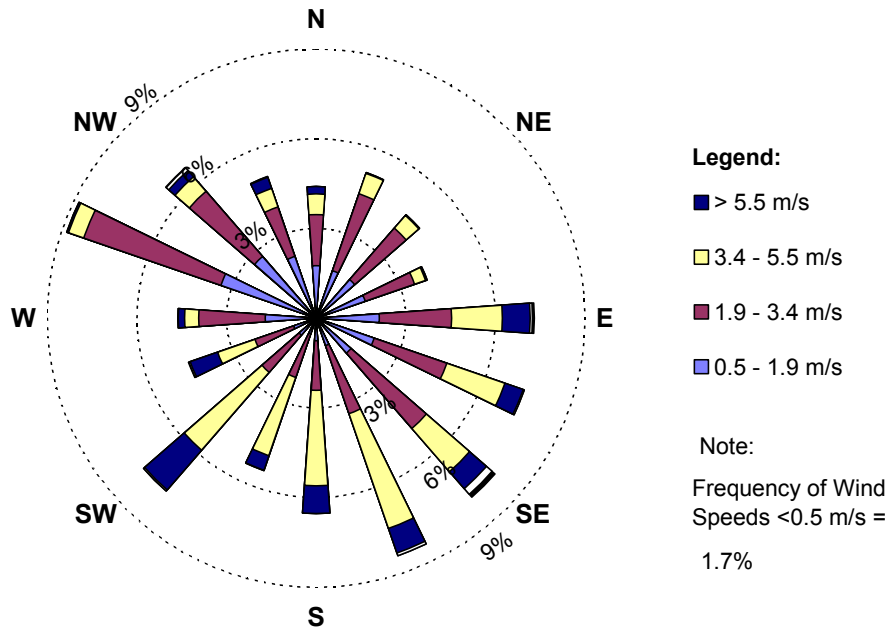


Figure 2-6: Wind Rose for Five Year Period from 1995-1999



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Figure 2-7: Wind Rose from Crofton Mill for 2000

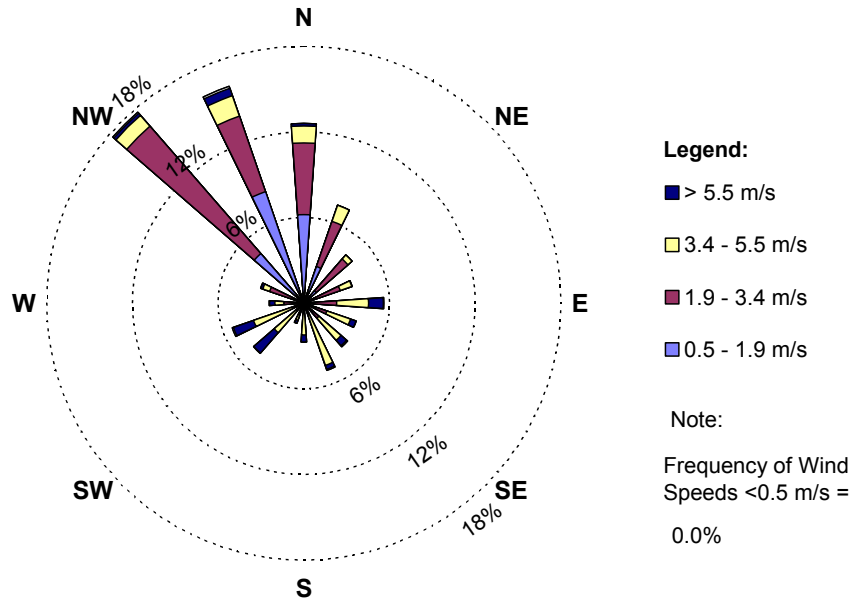
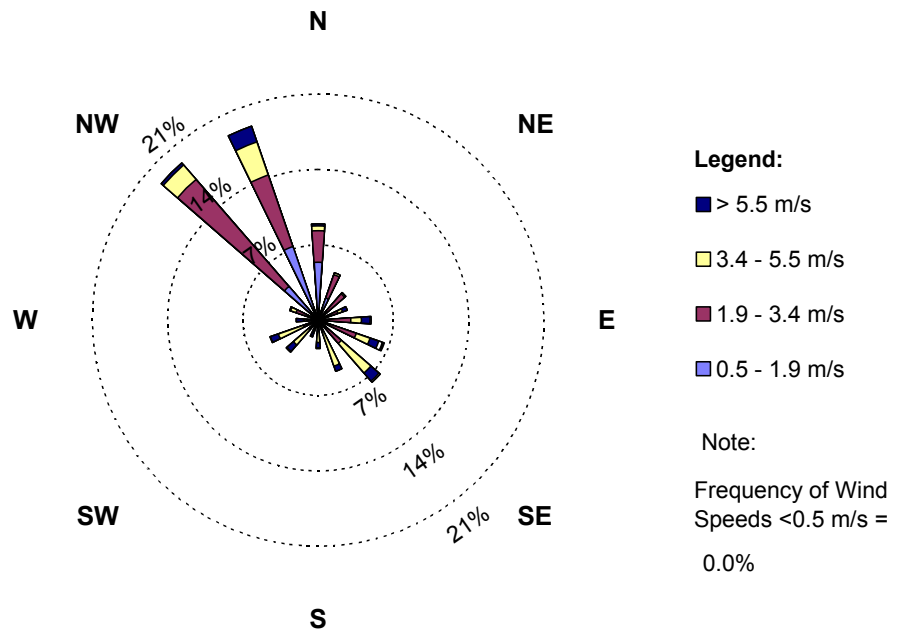


Figure 2-8: Wind Rose from Crofton Mill for 2001



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Figure 2-9: Wind Rose from Crofton Mill for 2002

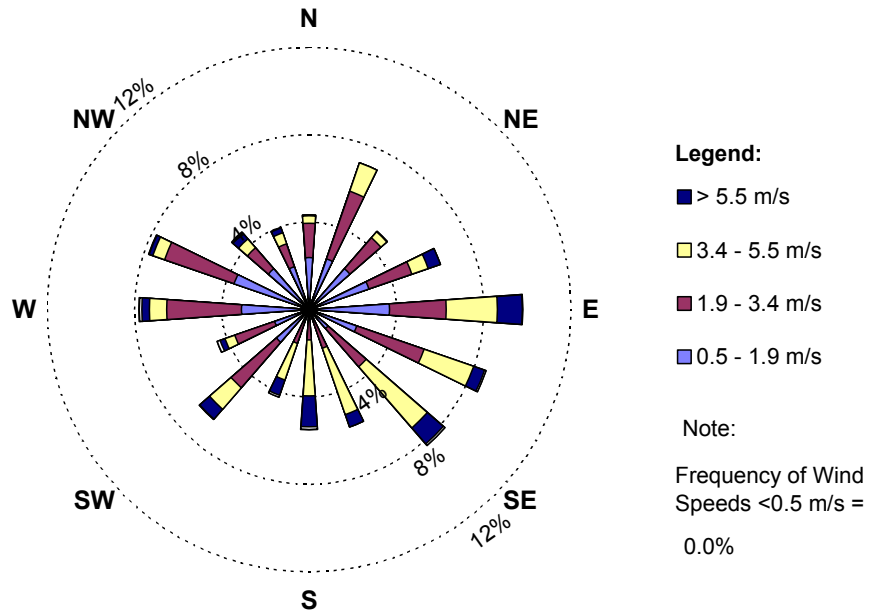
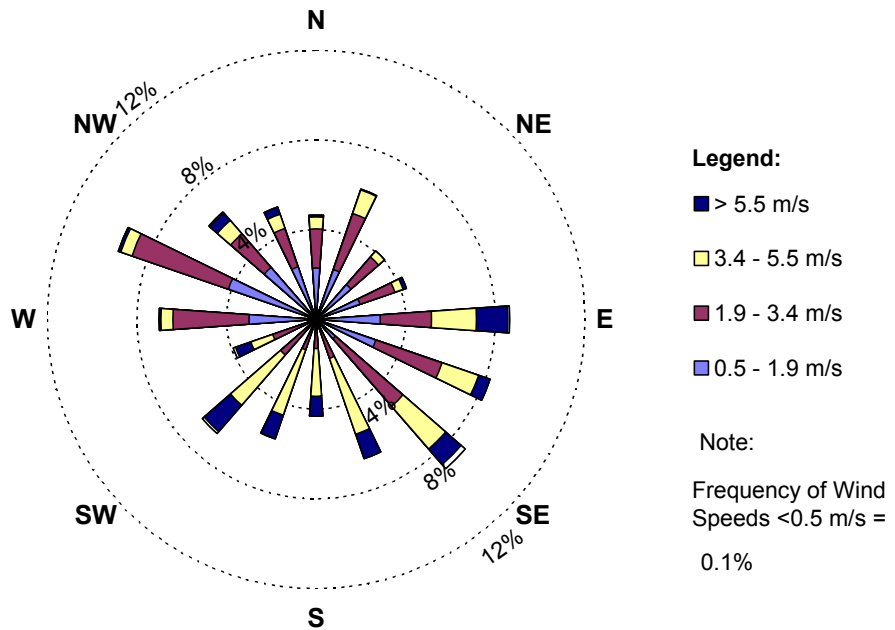
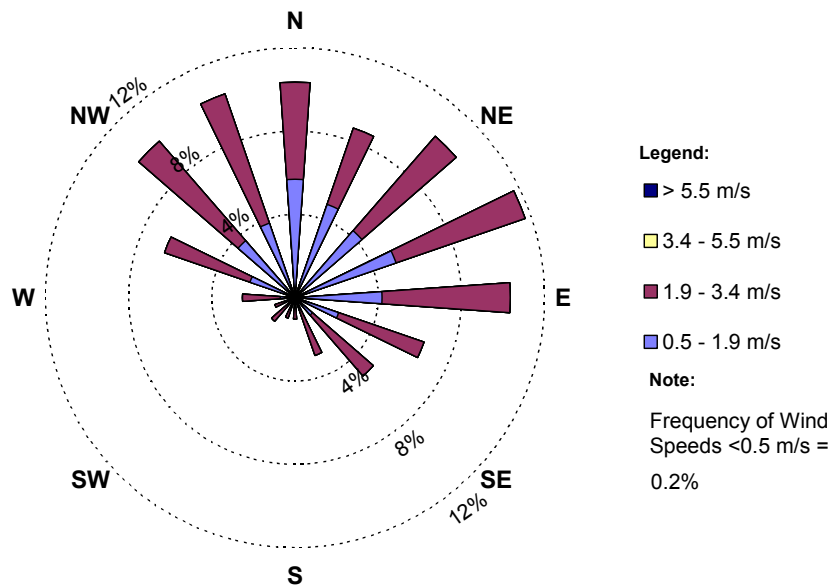


Figure 2-10: Wind Rose from Crofton Mill for 2003



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Figure 2-11: Wind Rose From Crofton Mill for 1999 Showing Only PG Class 1 (Very Unstable) Hours.



No Extrapolation of Surface Winds

When CALMET is initialized with prognostic model output, surface data is incorporated during the ‘step 2’ analysis. One of the options at this time is to extrapolate surface observation upward to levels above the surface. This option is included because in areas of complex terrain, such as within a valley, winds at lower levels will be more affected by valley geometry and will thus be more accurately represented by the surface station within the valley than by either an upper air station some distance away or by prognostic outputs that may not fully resolve valley effects.

The extrapolation of surface wind may be included regardless of how CALMET is initialized. The use of prognostic MC2 to initialize CALMET does not preclude the vertical extrapolation of surface winds observations during the ‘step 2’ calculation.

For the CALMET simulation, JW used 10 vertical levels. The tops of each cell were set at 20, 50, 100, 250, 500, 1000, 2000 and 3000 m above ground level. *The option to extrapolate surface winds upward was not exercised in the JW CALMET modelling.* As

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such, the CALMET derived wind field is influenced by surface observations for the bottom-most layer, i.e. below 20 m above ground, only. CALMET wind fields from Levels 2 through 10 are determined solely by MC2. *RWDI believes this approach is incorrect.*

There are three different options for how the extrapolate surface winds to upper levels. The simplest is to use the power law

$$u_z = u_m * (z/z_m)^P .$$

where u_m and z_m are the measured surface wind speed and height of measurement and u_z and z are the height to which the surface wind is extrapolated. The exponent P has one value over water and another over land. Note that the specific type of land use (other than water or land) has no effect and the wind direction is not changed.

The user may also supply specific weighting factors to scale the surface wind for each layer above ground. This requires sufficient empirical data to define the scaling factors for the model location.

The default option given in CALMET is to extrapolate using Monin-Obukhov similarity theory (MOST). MOST defines a ‘scale length’ that describes the turbulent state of the atmosphere based on the temperature, wind speed and surface energy flux (as determined from land use) in the lower atmosphere. The equations are somewhat involved and are described in sections 2.2 and 2.3 of the CALMET manual. Of the three options, the MOST method takes into account the greatest amount of variability of the land surface and adjusts both wind speed and direction as height increases.

If the option to extrapolate using Monin-Obukhov similarity theory is chosen, the surface wind influence will be included up to 200 m above ground or the height of the model determined mixing layer, whichever is greater. Given that the maximum mixing height tends to be on the order of 600-1000 m, the surface influence would extend to at least Level 4 of the CALMET grid utilized by JW and, under some conditions, as high as Level 7.

The effect of not extrapolating surface winds is clearly demonstrated by the figures supplied in the JW report. CALMET derived wind rose for heights of 10 m and 30 m are

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given in Figure 2-3 and 2-4, respectively. For the Crofton Mill there is very little difference between the wind roses for the two heights. This is because winds at both heights are determined mostly by MC2, as discussed in the previous section.

However, at Duncan there is very little similarity between the winds at the two heights. The wind at 10 m is determined by the surface observations from this site, while the wind only 20 m above is determined by the MC2. Physically, one would expect that winds at 30 m should closely resemble winds at 10m, but this is clearly not the case. There are instances, such as drainage winds in a nighttime stable layer, where discontinuities in winds between these two heights could exist in the short term, but over the course of an entire year, the two patterns should be more similar.

These figures indicate that *model winds above the surface in the lower layers of the JW CALMET simulation are suspect*. Combined with the decision to use a model year for which no data from Crofton is available means that *the CALMET wind fields in the region of the Crofton mill are suspect, not only in the bottom-most layer, but through much of the vertical model extent*. Specifically, it is difficult to conclude that pollutant transport in the mixed layer will be adequately represented.

This problem is exacerbated by the fact that the heights of many of the emission sources are such that they will emit above the bottom layer. As a result, the emissions are transported by winds determined solely by MC2 model outputs when they should be transported by winds that are representative of surface measurements. **(Deficiency Ranking: 5)**

2.3.2.4 Upper Air Data in CALMET

As per the above discussion, *upper air data should be included not just when MC2 is missing, but for all periods when upper air data are available*. All available data should be included in the CALMET calculation unless there is a compelling reason not to do so. Although upper air profiles are available from Quillayute in Washington State, the JW report claims that these were deemed not representative of the Crofton region. No further explanation is given. However, for the EIA of the BC Hydro VIGP at Duke Point in Nanaimo, profiles from Quillayute were used. Furthermore, the Quillayute station is actually much closer to the model domain than is Port Hardy. *RWDI does not agree with*

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the exclusion of upper air data from Quillayute in Washington State. (Deficiency Ranking: 2)

2.3.2.5 MC2 Gaps, Initialization with Surface and Upper Air Observations

There are 16 days in the 2000-2001 period for which the MC2 fields are missing. When MC2 model output is not used to initialize CALMET, the first guess wind field is obtained as a distance weighted average of surface and upper air observation. CALMET includes options for specifying how the weight surface and upper air data in the first guess field. One of the options is to extrapolate surface winds to upper layers and to choose how much to weight surface and upper air observation in each layer. Note that this is different from the inclusion of surface data in the step 2 calculation. This calculation is done in place of reading the MC2 model fields, and the distance weighted inclusion of surface data is still performed at a later stage as described above. From the CALMET manual page 2-3:

“When the sounding is taken from a distant upper air station outside the valley, this may produce a poor initial guess field. In many cases, the surface observations, extended with the similarity profile, will produce a superior initial guess field and final wind field.”

This was not done by JW. The extrapolation and weighting is controlled by the BIAS parameter as explained on page 2-4 of the CALMET manual. JW chose a BIAS of 0 for all layers. This sets the initial guess based on surface stations alone in the lowest layer and based on upper air alone for all layers above the surface.

For the JW CALMET configuration this means that the first guess wind at 10 m above ground will be determined predominantly from the nearest surface station, while the wind at 30 m above ground will be determined by the sounding from Port Hardy, some 300 km distant. The BIAS could have been chosen to give local surface data more weight in the lower layers than the distant upper air sounding.

The effect of this error is mitigated by the fact that the gaps in MC2 represent a small portion of the model period, but the error is probably quite significant on the days in question. **(Deficiency Ranking: 3)**

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2.3.2.6 Terrain and Land Use in CALMET and CALPUFF

Terrain elevation and land use category are input to CALMET through the GEO.DAT file. CALMET uses terrain elevation to calculate the effect of topography on local wind patterns. The land use category determines the characteristics of the surface for the CALMET micrometeorological module. This module calculates parameters such as mixing height and stability class that are required by CALPUFF. CALMET land use definition, the parameters derived from each land use category and the default value of each parameter for each of the land use types are given in Table 2-1.

Land Use Definition in the JW Modelling

Figure 12 shows the cell by cell CALMET defined domain land use characterization used by JW. All cells in the CALMET domain were set either to 'Urban (10)', 'Water (55)' or 'Forest (40)'. The use of 'Forest' for all non-urban land is stated on page 2-4 to be "more representative of the actual boundary layer parameters in the region" though no further reference or rationale for this statement is given. RWDI does not agree. One of the features of CALMET is the model's ability to incorporate spatial land use variation. If this ability is bypassed by specifying a uniform land use description, then the reasoning should be explicitly provided.

Figure 2-13 shows the cell by cell land use for the same region as Figure 12 as determined from 1:250000 Baseline Thematic Maps obtained from Land Data BC. Land use in this figure is much different from that used by JW. There is much more variation, not just in the 'Urban' or 'Forest', but across all the CALMET land use categories. In particular, the JW land use greatly underestimates the amount of 'Urban' land use. In addition, there are several prominent terrain features missing completely from the JW data. These include the omission of inland lakes near Duncan and the complete omission of Kuper Island, directly south of Thetis Island. *Most importantly, land use at the Crofton Mill site and in the surrounding area was classified as 'Forest'. Several photos given in the JW report, including the cover, and the land use of Figure 2-13 clearly show that this is in error.*

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Table 2-1: CALMET Land Use and Associated Geophysical Parameters (From Table 4-45, Scire et al, 2000)

CALMET Land Use Category	CALMET Land Use Code	Surface Roughness (m)	Albedo	Bowen Ratio	Soil Heat Flux Parameter	Anthropogenic Heat Flux (W/m ²)	Leaf Area Index
Urban	10	1.0	0.18	1.5	0.25	0.0	0.2
Agricultural	20	0.25	0.15	1.0	0.15	0.0	3.0
Rangeland	30	0.05	0.15	1.0	0.15	0.0	0.5
Forest Land	40	1.0	0.25	1.0	0.15	0.0	7.0
Water (Bays, Estuaries, Ocean, Rivers and Lakes)	50-55	.0001	0.10	0.0	1.0	0.0	0.0
Wetlands	60	1.0	0.10	0.5	0.25	0.0	2.0
Barren Land	70	0.05	0.30	1.0	0.15	0.0	0.05
Tundra	80	0.20	0.30	0.5	0.15	0.0	0.0
Perennial Snow and Ice	90	0.20	0.70	0.5	0.15	0.0	0.0

One of the more important features of CALMET, through the micrometeorological module, is the model’s ability to estimate spatial variation of mixing height. This is done by the CALMET micrometeorological model (section 2.3 of the manual) which depends on land-use distribution to estimate surface heat fluxes. If the land use is not resolved (not just as forest vs. agricultural, but for all CALMET land use categories) to the same resolution as the CALMET grid domain, then much of this ability will be lost.

In the SENES review of VIGP, the 1 km resolution used by Levelton Consultants was severely criticized because it did not allow proper resolution of terrain and land use influences. Setting all land based cells equal to either forest or urban, and then greatly underestimating the amount of urban land use is analogous to using a coarser grid resolution in that it too leaves much of the land use variability un-accounted for. In the case of VIGP, SENES concluded that the result of the coarse resolution was “a significant underestimation of ground-level concentrations in some locations (page 20)”.

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Of the greatest concern, however, is the error in the classification of land use in the vicinity of the Crofton Mill. From equations 2-42 through 2-49 of the CALMET manual, land use determines Bowen-Ratio, which in turn determines sensible heat flux, which in turn determines the Monin-Obukhov length. Because the option to calculate plume dispersion sigmas based on Monin-Obukhov length was chosen, the use of 'Forest' for land use surrounding the Crofton Mill means that both the mixing height and the plume coefficients are incorrectly estimated in the areas closest to the site, i.e. where the highest concentrations are predicted.

Land Use classification is also important in the calculation of mixing height. Mixing height is not directly obtained from any of the CALMET input files. It is calculated by the CALMET micrometeorological module, as described on pages 2-23 to 2-29 of the CALMET manual. It is calculated using the 'Energy Budget Method'. The quantities required for this method are estimated from the surface properties of the CALMET grid cell where the mixing height is being calculated. This information is obtained from the CALMET GEO.DAT file. The atmospheric lapse rate is also required, and in no-obs mode, this will be provided by MC2. The MC2 lapse rates used in the Jacques Whitford study are probably reasonable, but the surface properties will be subject to the errors outlined above, specifically the misrepresentation of land use in the Crofton area.

The mixing height determines how plumes are dispersed. For example, whether plumes are lofted above the mixing height or trapped below it, or whether pollutants are fumigated to ground level by the mixing height intersecting an elevated plume. If the inputs, such as land use, on which the mixing calculation depends are not representative, then the mixing height calculations will not be accurate and in turn the behavior of dispersing plumes will not be correctly simulated.

Consider, for example, the case of 'lofting' plumes. This term refers to plumes that are either emitted above the mixed layer or have sufficient vertical momentum to penetrate above the mixed layer. Such plumes may travel long distances without intersecting the surface and as such have very little impact on ground level concentrations. Whether or not a plume is 'lofted' will depend very strongly on the height of the mixed layer. If the predicted mixing height is too low, the model plumes will be more likely to escape the mixed layer and thus not impact the surface, leading to an under-representation of surface concentrations.

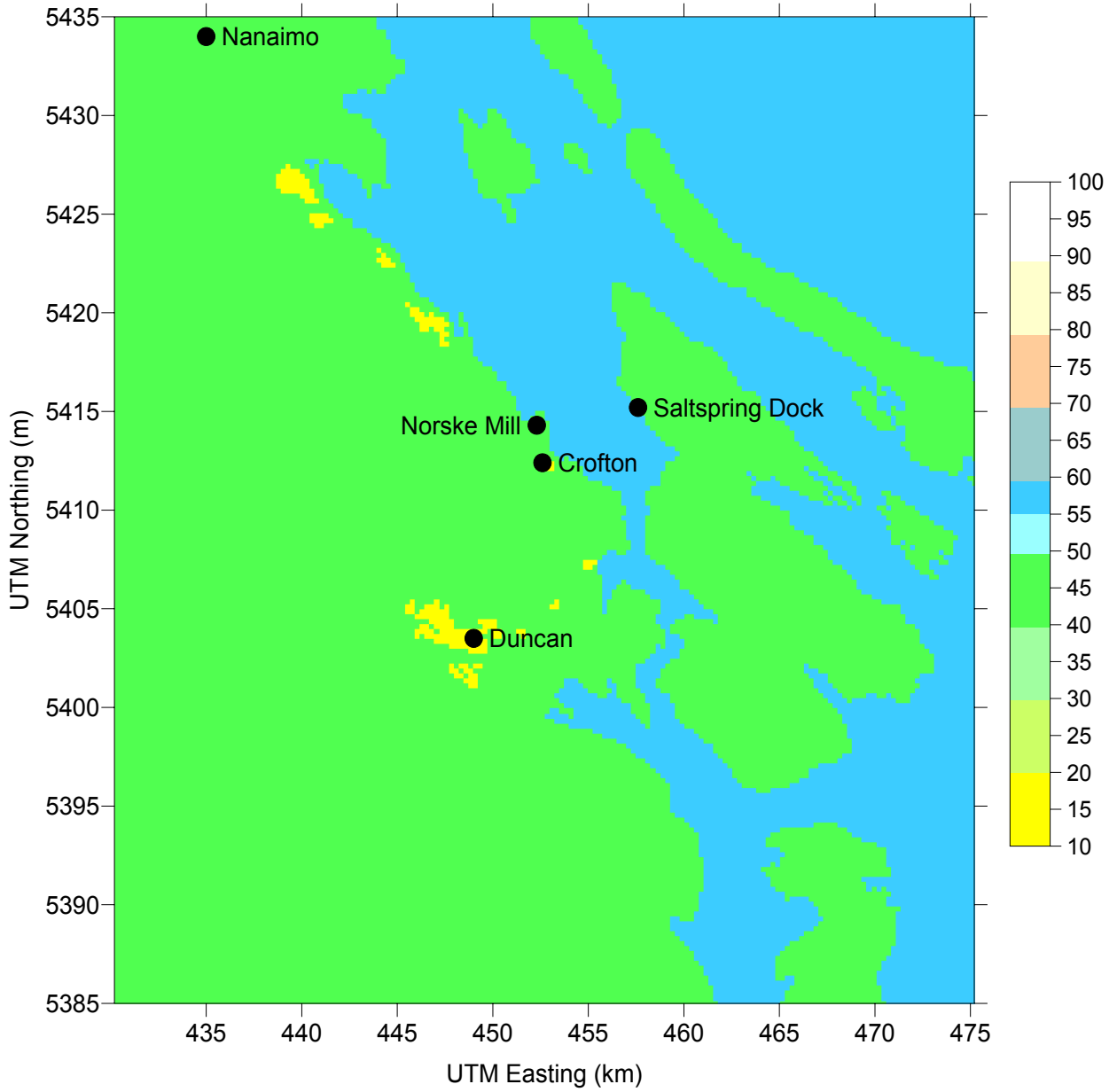
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A further example would be ‘fumigating’ plumes. This term refers to the case where an increasing mixing layer intersects with an elevated plume that was previously trapped above the inversion height. This case is common during the morning when the mixing height increases as the sun rises and in coastal locations where the mixed layer increases as the atmosphere reacts to stronger surface heating and increased roughness as it passes from over the boundary from water to land. In such cases, plumes can be rapidly mixed to ground and may greatly affect ground-level concentrations. Obviously, proper modelling of this occurrence requires an accurate prediction of the mixing height growth to determine whether or not the overhead plume is intersected.

The position of Crofton near the coast means that it is in an area where the mixing height displays a large degree of spatial variation, particularly as the lower atmosphere transitions from being influenced by the ocean surface to being influenced by the land surface. This variation means that for a given elevated source, either of the conditions described above may be possible depending on the ambient conditions present for any given hour. As such the predicted height of the mixed layer is crucial in determining exactly what type of dispersion will occur. If the inputs, such as land use, that determine the properties of the mixed layer are not properly resolved, then it is possible that plume dispersion will not be accurately simulated. **(Deficiency Ranking: 4)**

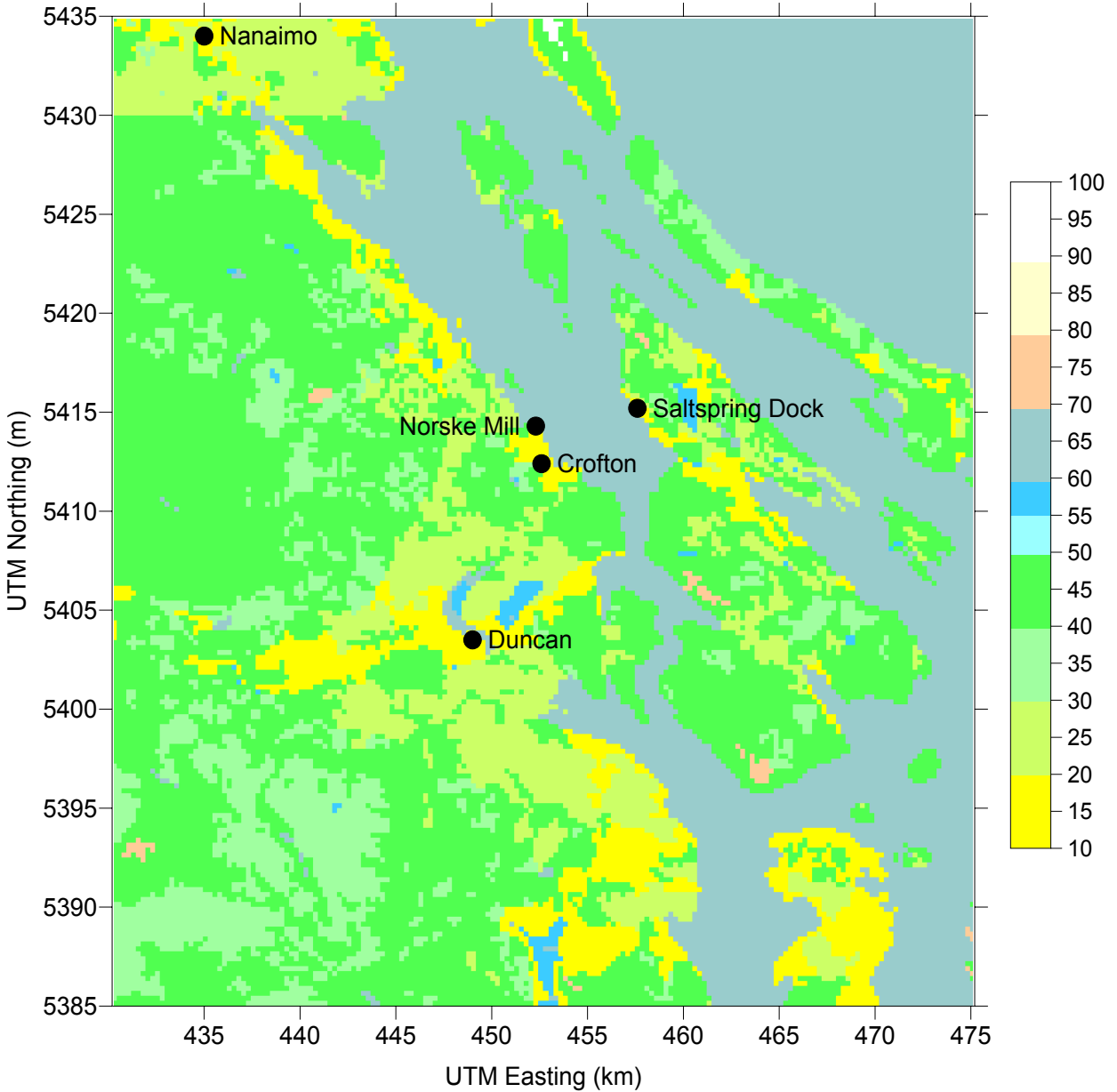
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Figure 2-12: Domain Land Use as Defined in the Jacques Whitford CALMET Modelling



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Figure 2-13: Domain Land Use as Obtained from Land Data BC Baseline Thematic Maps (BTM)



Sub-grid Scale Coastal Boundary Data File

The state of the lowest part of the atmosphere is largely determined by the properties of the earth’s surface. When the atmosphere passes over a drastic change in the earth surface, such as from a large body of water to land, there often develops a very distinct

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boundary, in terms of temperature, water vapor, turbulent kinetic energy and mixing depth, between the air that is adjusted to the water surface and the air that is adjusted to the land surface. The boundary between the two masses is referred to as a Thermal Internal Boundary, and the layer that is adjusting to the new surface below is called the Thermal Internal Boundary Layer or TIBL.

CALPUFF includes algorithms to model the development of the TIBL. Ordinarily, the TIBL algorithm reads land use from the GEO.DAT as is contained in the CALMET files to determine water/land boundaries. CALPUFF also includes the option to define the position of the water/land boundary in a COASTLN.DAT file.

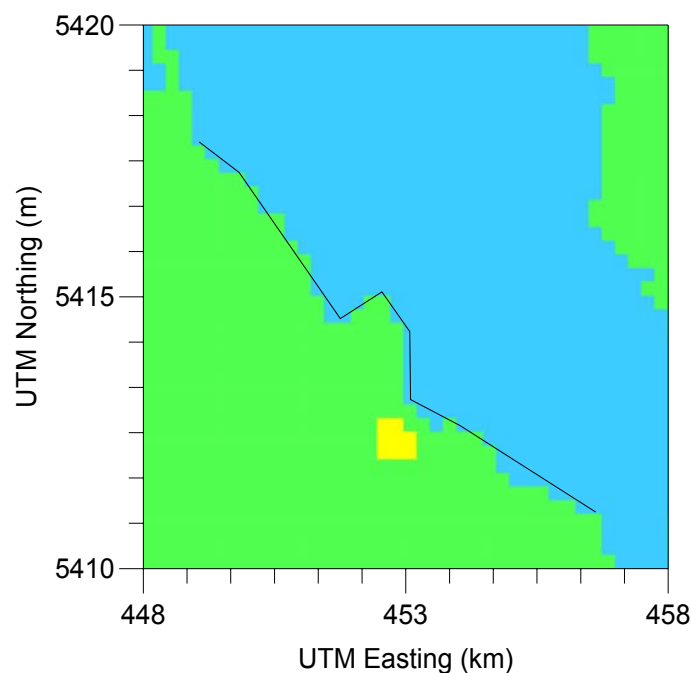
The purpose of the COASTLN.DAT file is to resolve the coastline at a finer resolution, or sub-grid scale, than is present in the GEO.DAT so that the CALMET TIBL algorithm can properly simulate growth of a thermal internal boundary layer in coastal regions. For example, if the CALMET grid spacing and land use was set at 5 km, but one knew that the coast ran through the middle of the cell, then the COASTLN.DAT file could be used to define a coastline through the middle of the 5 km cell, i.e. at a *sub-grid scale*.

This option was invoked by JW, but the COASTLN.DAT file used by JW was resolved on a scale slightly *larger* than that already given in the GEO.DAT file. Figure 2-14 shows the land use in the area of the Crofton Mill with the coastline defined in the JW CLN.DAT (listed in Appendix C4) superimposed. The figure shows that the boundary between water and land in the land use file actually is defined at a higher resolution than the coastline defined by the CLN.DAT file.

The effect of this is unclear. The effect may not be great, but if the model used the COASTLN.DAT instead of the water/land boundary as defined by land use category in the GEO.DAT, then the effect of using this option could be to actually *decrease* the accuracy with which CALPUFF defines the boundary layer near the mill. The overall effect is likely small, but it is further evidence of errors in the modelling approach.
(Deficiency Ranking: 1)

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Figure 2-14: Water Land Definition in Vicinity of Crofton Mill and Coastline used for Sub-Grid Scale TIBL option.



Note: Land use definitions are the same as for Figure 2-12 and Figure 2-13 above. Coastline used for TIBL algorithm is shown as solid line.

Gridded Receptor Heights From the GEO.DAT Terrain Elevations

When the option to use gridded receptors is chosen, receptors locations and elevations are obtained from the gridded terrain points given in the GEO.DAT file. This option places a receptor at the middle of each CALMET grid.

As stated in the JW report, the CALMET terrain heights were calculated using the TERREL preprocessor. This is correct as pertains to inputs for CALMET. However, the TERREL preprocessor calculates the *average* terrain height over each cell and assigns that height to the location defined by the center of the cell. Conversely, standard protocol for receptor sampling is to take either the best estimate of the *actual* terrain height at the receptor location or the *highest* point within the grid cell. In complex terrain, either of these may be significantly different than the average value calculated by TERREL.

Receptors elevations should have been set to either the actual height at the receptor location or the maximum height in the grid cell and using the discrete receptor option.

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Use of the average terrain height may result in an underestimation of ground-level concentrations. (**Deficiency Ranking: 2**)

Gridded Receptor Spacing

The use by JW of the gridded receptors option means that beyond the fence line, receptor spacing jumps immediately to 250 m. Generally, receptors are spaced more closely near to sources and the receptors spacing is increased as distance from sources increases. This is particularly important when maximum concentrations are predicted close to the emission source.

In BC and Alberta, standard practice is to use the nested receptor grids similar to the following:

- 20 m receptor spacing along the plant boundary.
- 50 m spacing within 500 m of the source of interest.
- 250 m spacing within 2 km of the source of interest.
- 500 m spacing within 5 km of the source of interest.
- 1000 m spacing beyond 5 km of the source of interest.

Some of the sources at the Crofton Mill are within 500 m from the fenceline (see Figure 6-4). *It would be more prudent to have placed receptors at spacing of 50 m or 100 m for some distance immediately outside the fenceline, before increasing to 250 m spacing, particularly as the maximum concentrations are often predicted at the fenceline.* (**Deficiency Ranking: 4**)

2.3.2.7 Terrain Based Model Options

The modeller must decide how terrain information will be used by the model. This is done through the selection of model options that pertain to terrain and land use effects. These options are of particular importance because, due to the fact that upper air profiles from Port Hardy and surface observation from Crofton were excluded, the CALMET calculation in the vicinity of the Crofton Mill consists mostly of a CALMET terrain-based adjustment of the MC2 model outputs.

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Inclusion of Kinematic Effects

This refers to the calculation of terrain forced vertical and horizontal wind in the CALMET module. This is described starting on page 2-4 of the CALMET manual. On page 2-6 of the report JW states:

“..it was decided that prognostic data (read MC2) should be adjusted by CALMET for *kinematic* and terrain effects and therefore be introduced as an initial guess field”

RWDI agrees this would be the best approach. However, Table 2-5 of the JW report states that as per the USEPA default guidance, the option to calculate kinematic effects was *not* selected.

Table 2-2 below shows the section of the CALMET input file given in Appendix C-2 of the JW report where the wind field options are selected. It shows that the IKINE option is set to ‘0’ which again means that kinematic effects were not included.

According to the sample input file included in the report, kinematic effects were not included. RWDI recommends that they should be included. (Deficiency Ranking: 3)

Table 2-2: Wind Field Options from JW CALMET Input Files

```
INPUT GROUP: 5 -- Wind Field Options and Parameters
-----
WIND FIELD MODEL OPTIONS
  Model selection variable (IWFCOD)      Default: 1      ! IWFCOD = 1 !
    0 = Objective analysis only
    1 = Diagnostic wind module
  Compute Froude number adjustment
  effects ? (IFRADJ)                    Default: 1      ! IFRADJ = 1 !
  (0 = NO, 1 = YES)
  Compute kinematic effects ? (IKINE)    Default: 0      ! IKINE = 0 !
  (0 = NO, 1 = YES)
  Use O'Brien procedure for adjustment
  of the vertical velocity ? (IOBR)      Default: 0      ! IOBR = 0 !
  (0 = NO, 1 = YES)
  Compute slope flow effects ? (ISLOPE) Default: 1      ! ISLOPE = 1 !
  (0 = NO, 1 = YES)
```

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The TERRAD Parameter

The CALMET user can also adjust the influence of terrain effects through the TERRAD parameter. This parameter defines the maximum distance away from a point that CALMET will search to find the maximum elevation for calculating terrain effects. It should be slightly larger than the peak to valley distance of the dominant terrain features in the model domain. If TERRAD is chosen too large, then the model may select heights beyond the top of the nearest major ridge or peak. If it is too small, then the model will not look far enough away and will underestimate terrain effects.

The value of TERRAD used in the JW modelling is 3 km. Based on Figure 2-1 of the JW report, the distance from the coastline near the Crofton Mill to the first major inland ridge is on the order of 10 km and therefore this value should have been used. The value of TERRAD used by JW will minimize terrain effects in the immediate vicinity of the Crofton Mill. Again, this error is made more significant by the fact that terrain adjustment of MC2 is essentially the only calculation done by CALMET in the vicinity of the Crofton Mill. (Deficiency Ranking: 3)

2.3.2.8 Interaction of Emissions from Local Sources with Crofton Mill Emissions

To be conservative, other sources of air pollutants in the study area that were identified in Section 3.4 should have been included in the modelling rather than assuming that their influence would not be significant. Especially since exceedances of objectives for some contaminants were predicted. In particular, the total emissions of PM (412 tonnes per annum) in the study area is large and the cautionary principle would indicate that these emissions should have been included in the modelling to assess the influence of background industrial sources. (Deficiency Ranking: 4)

RWDI disagrees that Jacques Whitford has demonstrated (on page 3-10) that there are no sources of CACs that have the potential to interact in a significant way with those of the Crofton mill as their analysis did not account for source location, stack height and other parameters. Also, they have not defined what would be a significant interaction. A more convincing way to demonstrate this assertion would be to model the background sources, a step that is commonly performed in air quality assessments. Otherwise, an observed background value should be added. As it stands, the JW assessment does not account for

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the influence of background sources. The scenario that was modelled – the Crofton mill alone with all other sources switched off – is unrealistic. **(Deficiency Ranking: 4)**

2.4 AMBIENT AIR QUALITY

2.4.1 General Comments

G.12 Overall, the data presented in Section 3.0 of the Report do not seem to be referred to anywhere else in the report. The dispersion modelling output should be discussed in the context of the background ambient air quality in the area. **(Deficiency Ranking: 3)**

G.13 Customarily, a minimum of five full years of observational data are used to summarize background ambient air quality. In the Report, less than five years of data were used (July 2000 to April 2004). **(Deficiency Ranking: 2)**

G.14 Only PM₁₀, TRS and O₃ were considered in Section 3.0 of the Report. In addition, ambient background levels of SO₂, NO₂ and NO were addressed in Section 7.6 of the Report. From a reader's standpoint, it would have been preferable to gather all of the ambient air quality data analysis in one chapter of the Report. **(Deficiency Ranking: 1)**

G.15 It appears that the ambient air quality summary did not take into account all of the pollutants that have been monitored in the Crofton area since the year 2000. For instance, the Duncan Mobile Transfer Station monitored CO, TRS, NO₂, NO, O₃, PM₁₀ and PM_{2.5} from July 2000 to May 2001. Only the NO₂ and NO observations from this station were summarized in the Report. **(Deficiency Ranking: 4)**

G.16 Section 3.4, "Local Sources of Air Contaminants Potentially Interacting with Crofton Emissions", belongs in Section 5.0 "Emission Inventory". **(Deficiency Ranking: 1)**

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2.4.2 Specific Comments

2.4.2.1 Section 3.0 Existing Air Quality in the Region

- 3.1 Page 3-3: The Report states that both the Crofton Substation and the Crofton South monitoring sites collect 24-hour PM₁₀ samples using a standard high volume sampler on the NAPS schedule (every six days). However, these data are not presented in the Report. The Hi-Vol PM₁₀ data from Crofton Substation and Crofton South should have been included in Table 3-2. **(Deficiency Ranking: 3)**
- 3.2 Page 3-4: The Crofton West monitoring site was decommissioned in 1998 and should not be included in Figure 3-1. **(Deficiency Ranking: 1)**
- 3.3 Page 3-5: It would appear from Figure 3-3 and Figure 3-4 that the stations are located in too close proximity to trees. **(Deficiency Ranking: 3)**
- 3.4 Page 3-7: In the text, it states that the one-hour Level B guideline was exceeded 0.034% of the time at Crofton Substation – this does not match the 0.8% frequency listed in Table 3-3. **(Deficiency Ranking: 3)**
- 3.5 Page 3-7: In the discussion of frequencies of exceeding the TRS air quality guidelines, only the one-hour guidelines were mentioned. The fact the Level A 24-hour guideline was exceeded 20.0% of the time at the Crofton Substation site in 2003 was omitted from the text. **(Deficiency Ranking: 3)**
- 3.6 Page 3-9: Frequencies of exceedance were only presented for the year 2003 in Table 3-3. They should have been presented for the same period as the ambient air quality data in Table 3 2 (July 2000 – April 2004). Table 3-3 is reproduced below with the frequencies of exceedance for the period from July 2000 to April 2004. **(Deficiency Ranking: 3)**

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Revised Table 3-3 Summary of Frequencies of Exceeding BC TRS Ambient Guidelines (July 2000-April 2004)

Station	Contaminant	Frequency (%) of Exceeding TRS Level A		Frequency (%) of Exceeding TRS Level B	
		Hourly (7 µg/m ³)	24-Hour (3 µg/m ³)	Hourly (28 µg/m ³)	24-Hour (6 µg/m ³)
Crofton South	TRS	1.6%	4.2%	0.02%	0.6%
Crofton Substation	TRS	7.2%	17.8%	0.6%	4.6%
Duncan Deykin	TRS	0.6%	1.0%	0.0%	0.1%

3.7 Page 3-11: In addition to the Duncan Koksilah ozone-monitoring site, ambient ozone measurements were also taken at the Duncan Mobile Transfer Station. For completeness, the latter should have been included in the Report. **(Deficiency Ranking: 2)**

3.8 Page 3-11: The Report erroneously defines the Canada-wide Standards for ozone as 160 µg/m³ (one-hour averaging period), 50 µg/m³ (24-hour averaging period), and 30 µg/m³ (annual averaging period). These are the national maximum acceptable objectives for ozone. The Canada-wide Standard for ozone is 65 ppb for an eight-hour averaging period, based on the fourth highest measurement annually, averaged over three consecutive years. **(Deficiency Ranking: 3)**

3.9 Page 3-14: The Report states that the closest long-term continuously operating ozone-monitoring site to Crofton is Victoria (about 35 km SSE). The station in question, Victoria PAPS, was in fact located approximately 50 km SSE of Crofton (it was decommissioned in 1997). However, there is another long-term ozone-monitoring site located closer to Crofton on Saturna Island (about 35 km E of Crofton), operating as part of the Canadian Air and Precipitation Monitoring Network (CAPMoN). This station is considered by CAPMoN to be representative of the regional background ambient ozone concentration in an area covering several hundred kilometres. The Saturna Island station would have been a better choice for looking at long-term ozone background levels representative of the Crofton area. **(Deficiency Ranking: 4)**

3.10 Page 3-14: Ambient ozone concentrations should have been compared to the Canada-wide Standard. The Duncan Koksilah monitoring station does not have

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enough data for comparison to the Canada-wide standard; however, the Saturna Island ozone-monitoring site has a long enough data record. **(Deficiency Ranking: 4)**

3.11 Page 3-14: In addition to Table 3-5 “Summary of Ground Level Ozone Measurements in Duncan”, a table of frequencies of exceeding the guideline ozone levels should have been included in the Report. **(Deficiency Ranking: 3)**

2.5 DISPERSION MODEL RESULTS AND MONITORING RECOMMENDATIONS

2.5.1 General Comments

G.17 Pages 7-1 to 7-14. The discussion of results in Section 7 is very limited. No indication is provided regarding why some maxima occur on the fenceline and others further away nor how far away they occur. It is therefore difficult to be able to pinpoint which sources are the major contributors to the maximum concentrations. This type of analysis is required in order to assess whether additional emission controls are feasible. **(Deficiency Ranking: 4)**

G.18 The figures provided in Appendix E do not clearly indicate where the maximum concentrations occur. They should be revised to indicate locations of maximum predicted concentrations. **(Deficiency Ranking: 3)**

2.5.2 Specific Comments

2.5.2.1 Section 7.0 Results of Calpuff Analysis

7.1 Page 7-1: It is unclear how contaminants were selected for the full meteorological domain. However, it appears from Table 7-2 that for most of the 10 contaminants selected for the larger study area the maximum concentrations occurred on the fenceline. By contrast, the results presented in Table 7-1 indicate that the majority of the maximum predicted concentrations occurred at gridded receptors and not on the fence line. If the only difference between the screening and refined runs is the size of the model domain, it would be more logical to select contaminants for which the maximum predicted concentrations occur beyond the fenceline rather than on the fenceline. **(Deficiency Ranking: 3)**

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- 7.2 Page 7-1: Odour thresholds as low as 0.5 ppb or 0.7 µg/m³ have been reported in the literature. Thus, the potential extent of odours downwind of the pulp mill is even greater than presented in the report. **(Deficiency Ranking: 3)**
- 7.3 Page 7-1: The discussion of H₂S results understates the magnitude of the predictions. Based on Figures E-13 and E-14, exceedances of the hourly and daily H₂S objectives are predicted to occur at Crofton and on Saltspring Island but this is not mentioned in the text. Also, the isopleth intervals selected for H₂S do not match the BC H₂S objectives, which makes it difficult to determine the area of exceedance. **(Deficiency Ranking: 4)**
- 7.4 Pages 7-2 to 7-7: Table 7-1 would be improved if the distance and direction were included for the maximum concentrations predicted at gridded receptors, especially for those contaminants for which no isopleth maps are provided. **(Deficiency Ranking: 2)**
- 7.5 Page 7-10: It is unclear why seasonally adjustable SO₂ threshold concentrations for potential acute foliar injury were calculated given that an ecological risk assessment was not performed. **(Deficiency Ranking: 1)**
- 7.6 Page 7-11: Table 7-4 provides the frequency of exceedance of SO₂ objectives but nowhere in the report is an indication provided of the area of exceedance of the hourly and daily objectives. **(Deficiency Ranking: 3)**
- 7.7 Page 7-11: The frequency and areas of exceedances of hourly and daily H₂S objectives should be presented in a table. **(Deficiency Ranking: 3)**
- 7.8 Page 7-12: The text indicates that “Background is accounted for in a dispersion modelling exercise by adding the background value to the predicted concentration.” This is one way to account for background sources of emissions. Another way is to include them in the modelling. The fact that neither method was used is a deficiency of the assessment. **(Deficiency Ranking: 4)**

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- 7.9 Page 7-13: It is stated that ambient concentrations observed at Victoria Topaz are not representative of a pristine environment and this is used as justification for not adding the value to predicted concentrations. However, there is no reason to believe that the background air quality at Crofton is pristine. **(Deficiency Ranking: 2)**
- 7.10 Page 7-13: We disagree with the conclusion that adding a background concentration would not alter the potential frequency with which objectives may or may not be exceeded. It is most likely that by adding a background value the frequency of exceedances would be increased. **(Deficiency Ranking: 4)**
- 7.11 Page 7-13: Notwithstanding whether background sources should have been included in the modelling, emissions from ships and trucks that service the mill should have been included in the modelling as they are part of the mill's operations. These emissions should have been included along roads and shipping lanes throughout the study area. This is of particular importance for SO₂ emissions as exceedances were predicted due to stationary mill sources alone. By not including mill-related transportation sources of SO₂ the area and frequency of exceedances is likely underestimated. **(Deficiency Ranking: 4)**
- 7.12 Page 7-13: On Page 7-13 of the report it is stated that: "Unlike SO₂, natural sources comprise 92% of global NO_x emissions (Wayne, 1991)." This number seems high – another reference states that anthropogenic NO_x emissions account for 50% of global NO_x emissions (Calvert, Jack G., 1994, The Chemistry of the Atmosphere: Its Impact on Global Change, p. 349). **(Deficiency Ranking: 2)**

2.5.2.2 Section 8.0 Monitoring Station Comparisons

- 8.1 Section 8: No reference is made in the text to the fact that maximum predicted PM₁₀ concentrations are an order of magnitude less than measured concentrations. PM₁₀ is a better parameter for comparison of predicted and observed concentrations than TRS because the latter consists of H₂S and other reduced sulphur compounds, which were not included in the modelling. **(Deficiency Ranking: 3)**

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8.2 Page 8-1: It is unclear why model predictions based on 2003 emissions were compared to 2000-2001 ambient data. Why not re-run those select points with 2000-2001 emission data? Or alternatively, compare to 2003 ambient data given that the meteorological data isn't site-specific. **(Deficiency Ranking: 2)**

8.3 Page 8-2: Based on Table 8-1 all maximum predicted concentrations were less than measured concentrations. Indicating that the model underpredicts observed concentrations at all stations. This is not mentioned in the text. **(Deficiency Ranking: 3)**

3.0 REVIEW OF VOLUME II: HUMAN HEALTH RISK ASSESSMENT

3.1 INTRODUCTION

The purpose of this section is to provide comments on *Volume II: Human Health Risk Assessment of the Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division* report prepared by Jacques Whitford in October 2004 (herein referred to as the Report). Since the Human Health Risk Assessment utilizes information presented in Volume I, PIONEER also reviewed portions of that Volume. Specifically, PIONEER assisted RWDI in their review of Volume I: Chapter 5 – Emissions Inventory. Please note that this review focused on whether or not the Report was developed following generally accepted risk assessment principles. PIONEER assumed that the calculations presented in the Report were performed correctly (i.e., we did not verify the accuracy of the calculations).

The following sections reflect the structure of the Volume II report.

The primary websites and guidance documents that provide the technical basis for many of the review comments in this memo include:

1. British Columbia, Canada. 2004. Environmental Management Act Contaminated Sites Regulation. BC Reg. 375/96. OC 1480/96. Website:
http://www.qp.gov.bc.ca/statreg/reg/E/EnvMgmt/EnvMgmt375_96/375_96.htm.

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2. British Columbia, Canada. 2004. Ministry of Water, Land, and Air Protection – Contaminated Sites Website:
http://wlapwww.gov.bc.ca/epd/epdpa/contam_sites/index.html.
3. Health Canada. 2004. Human Health Risk Assessment Website: http://www.hc-sc.gc.ca/hecs-sesc/ehas/sites_human_health_risk.htm.
4. USEPA 1989. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual Part A. Interim Final. Office of Emergency and Remedial Response. Washington, D.C. 9285.701A. EPA/540/1-89/002.
5. USEPA. 1998. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. Office of Solid Waste and Emergency Response, EPA 530-D-98-001A.
6. USEPA. 1995. Memo from Carol Browner (former USEPA Administrator) Regarding the Importance of Transparency and Clarity in the USEPA's Risk Characterization Program. <http://epa.gov/osa/spc/htm/rccover.htm>.

3.2 GENERAL COMMENTS

G.19 The Report does not constitute a Baseline Human Health Risk Assessment because it does not evaluate all complete exposure pathways and sensitive subpopulations. The Report only evaluates the inhalation pathway for adults. Indirect exposure pathways and sensitive sub-populations should have been evaluated in the Report. **(Deficiency Ranking: 5)**

G.20 The Report only considers/calculates the risks/hazards associated with individual substances. Cumulative risks/hazards should have been calculated and presented in the Report. **(Deficiency Ranking: 5)**

Please note that PIONEER performed a Screening Level Risk Evaluation (SLRE) of the airborne concentrations presented in Tables 5-4 through 5-13 in the Report using the most current toxicity information available from the USEPA. Each of the

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airborne concentrations presented in Tables 5-4 through 5-13 in the Report were used “as-is” to calculate Hazard Quotients (HQs) and Cancer Risks (CRs) for an adult resident exposed via inhalation of air only. The individual HQs and CRs were summed to calculate the cumulative Hazard Index (HI) and cumulative CRs for each receptor (i.e., fenceline, gridded, and special receptor). The SLRE is presented in Appendix A.

G.21 A cancer risk goal of 1E-05 (i.e., an individual could have 1 in 100,000 chance of developing cancer over a 70-year lifetime under the evaluated exposure conditions) was used to derive “acceptable” screening levels for individual substances. No justification or rationale was presented in the Report for why this cancer risk goal was used. The USEPA typically uses a cancer risk goal of 1E-06 (i.e., an individual could have 1 in 1,000,000 chance of developing cancer over a 70-year lifetime under the evaluated exposure conditions) to derive “acceptable” screening levels for individual substances. The decision to use a cancer risk goal of 1E-05 to derive acceptable screening levels for individual substances is unusual given the fact that the Report did not consider cumulative cancer risks or hazards. **(Deficiency Ranking: 3)**

G.22 The Report does not follow generally accepted risk assessment principals and guidelines. One of the key “goals” of a risk assessment is “transparency.” That is, all inputs, assumptions, and uncertainties associated with the risk assessment process should be clearly documented and presented in the assessment. This allows stakeholders and risk managers to have a full and frank discussion about the relative strengths and weaknesses of the risk assessment so that informed decisions (regarding risks and uncertainties) can be made by the parties involved. This document is not transparent. For example, very little supporting information is presented regarding how the emission rates were developed and how “representative” these emission rates are for the Crofton Mill. Some of the emission rates were obtained from site-specific stack test data and others were obtained from the National Council for Air and Stream Improvement, Inc. (NCASI) data. However, the document does not identify which emission rates were from which source or discuss/evaluate whether or not the emission rates are representative of long-term emissions from the Crofton Mill. Another example of

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the lack of transparency is evident in Sections 3.5, 3.6, and 3.7 of the Report where exposure pathways, receptor characteristics, and the conceptual model are discussed. The discussion of these topics fits on one page of the Report and includes one figure. This is inadequate. Typically, the Exposure Assessment is one of the most involved and well-documented chapters in a risk assessment. This section should be revised to identify and discuss potentially exposed populations and exposure pathways that are (and are not) being evaluated in the risk assessment and should provide rationale for the decisions that were made. The section should also include a presentation of the exposure parameters that were used to estimate the exposure for each receptor and exposure pathway. If exposure assumptions are embedded (i.e., the criteria was derived assuming a certain set of exposure assumptions) in the Ambient Air Quality Criteria (AAQC) or toxicological criteria, then they should be extracted and explained to the reader. Finally, the equations and associated parameters for each exposure scenario presented in this chapter should be used to calculate the resulting media concentrations. This Report requires significant revisions in all chapters/sections to meet the transparency goal. Please see <http://epa.gov/osa/spc/htm/rcover.htm> for USEPA policy and guidance on the importance of transparency and clarity in risk assessments. **(Deficiency Ranking: 5)**

G.23 The following are key omissions from the Report:

- An evaluation of the potential human health impacts due to potential accidents and upsets.
- An evaluation of the risks associated with fugitive emissions from the mill.
- The particle size distribution used for the modelling.
- A figure that presents the Facility and identifies emission sources presented in Volume I: Chapter 5 – Emissions Inventory. This figure should identify each emission source and correspond with Table 5-3. It should be something similar to the figure in the Permit for the Facility or Figure 3 from the Optimal Selection of Ambient Air Monitoring Sites for the Crofton Pulp and Paper Mill (Colin Felton Air Quality Group, 1992).
- Ecological Risk Evaluation. **(Deficiency Ranking: 3)**

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3.3 SPECIFIC COMMENTS

3.3.1 Executive Summary

E.1 We have chosen not to comment on the executive summary because it summarizes the information presented in the main body of the Report. However, we did comment on specific sections of the Report and note that the executive summary should be revised/rewritten based on the changes to those sections.

3.3.2 Chapter 1.0 – Introduction

1.1 Page 1-1 of the Report states, “One of the Key Findings of this process was a community interest in having a baseline air quality study and accompanying human health risk assessment conducted on current day aerial emissions from the Crofton Mill. The human health risk assessment provided in this report is meant to inform on the potential human inhalation health impacts from current day mill operations on health of the local community.” The Report continues to identify three tasks in the scope of work (SOW):

1. Review of ambient air quality monitoring results from the three existing monitoring stations in the Crofton Air shed to detect temporal trends and evaluate potential risk to human health from measured airborne levels of substances of potential concern (SoPC) (Vol. II).
2. Modelling of ground-level concentrations of SoPC in ambient air from current day emissions from the Crofton Mill (Vol. I).
3. Determining whether or not modeled concentrations of SoPCs in ambient air pose a potential risk to the health of the residents of the Crofton Air shed (Vol. II).

Comments:

SOW Task 1: The evaluation of air quality monitoring results from the three existing monitoring stations presented in Section 5.2 considered Total Reduced Sulfur (TRS) (as H₂S) and particulate matter. The study concluded the following for TRS, “...although residents in the local air shed may be able to detect the odour coming from the mill, it

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does not pose an acute, sub-chronic, or chronic health threat to local residents occupying the area year round.” This sentence (on page 5-5) should be removed from the Report or significantly revised. There were exceedances of the acute Toxicity Reference Value (TRV) and the subchronic TRV (although very infrequent) at the Crofton Substation, so it is possible that there may be some adverse health effects for people near the fenceline of the facility. The annual average TRS concentration at the Crofton Substation was 1.9 ug/m³, which is very close to the chronic TRV of 2 ug/m³ and may indicate potential health concerns, especially for individuals with compromised respiratory systems (e.g., asthmatics). When evaluating/comparing emission data from the mill over time it is important to normalize the data to emissions per tonne of throughput or other metric to ensure that the comparisons make sense. Simply comparing emission rates from 1994 to 2004 is not informative unless the throughput and other process variables are presented in the text so that the reader can evaluate the data in the context of changes at the mill. **(Deficiency Ranking: 5)**

SOW Task 2: The modelling did predict ground-level concentrations of SoPCs in ambient air from current day emissions from the Crofton Mill. However, the modelling results presented in Volume II did not include wet and dry deposition that occurs as particulates that are emitted from the combustion sources are deposited onto land. The omission of wet and dry deposition from the modelling is a serious data gap because it is used in the human health risk assessment to evaluate “indirect” exposure pathways (i.e., non-inhalation exposure pathways) such as incidental soil ingestion, ingestion of homegrown beef, ingestion of homegrown dairy products, et cetera). Wet and dry deposition should be included in the modelling effort. **(Deficiency Ranking: 5)**

SOW Task 3: The risk assessment does not constitute a “baseline air quality study and human health risk assessment” as was requested by the community because it focuses solely on the risks associated with inhalation. The Report does not consider, or even discuss, other exposure pathways (e.g., incidental soil ingestion, dermal contact with soil, ingestion of homegrown beef, ingestion of homegrown dairy, ingestion of fish, et cetera) that typically have a significant impact on the results of a baseline risk assessment of combustion sources (see the USEPA Region VI Protocol). The risk assessment should have included an evaluation of all complete exposure pathways and potentially exposed populations. **(Deficiency Ranking: 5)**

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- 1.2 Page 1-4, Figure 1-4. The Toxicity Assessment box should include short-term or subchronic toxicity values. **(Deficiency Ranking: 2)**
- 1.3 Page 1-4, Figure 1-4. The Risk Characterization box should include an assessment of short-term or subchronic health risks. **(Deficiency Ranking: 2)**
- 1.4 Page 1-5, fourth bullet. The first sentence states, “All identified environmental release data and predicted human exposure (i.e. ground-level air concentration) data, as applicable, will be combined to conduct the risk characterization part of the study...” This sentence is misleading because “predicted human exposure data” would include exposure via a variety of exposure routes, which were not considered in the evaluation. **(Deficiency Ranking: 5)**
- 1.5 Page 1-5, fifth bullet. The paragraphs states, “the risk assessment will use scientifically accepted risk characterization and risk assessment techniques” including guidance documents from USEPA among others. This statement is inaccurate in that the evaluation did not follow USEPA protocols (e.g., USEPA Region VI Protocol, USEPA Risk Assessment Guidance for Superfund) in regards to evaluating all potential exposure pathways, evaluating cumulative noncancer hazards, and evaluating cumulative cancer risks. **(Deficiency Ranking: 5)**

3.3.3 Chapter 2.0 – Study Background

- 2.1 Page 2-3, Section 2.2 should include figure(s) of the geographical features of interest (e.g., towns, rivers, lakes, streams, highways, et cetera) in the region of the Crofton Mill. Figure 1-1, which is presented in Section 1, is blank. In addition, figures identifying current land use within the area, from Parcel Maps, should be presented along with a break down (e.g., a Pie Chart) of the percentage of land use in each category (e.g., forestry, agricultural, residential, commercial, industrial, open space, vacant, et cetera). This information is important and should be used to establish the Conceptual Site Model that is used to identify exposure pathways and receptors evaluated in the risk assessment. **(Deficiency Ranking: 3)**

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3.3.4 Chapter – 3.0 Problem Formulation

3.1 Page 3-1, Section 3.1 discusses the facility emission data. The emission rates should be presented as a table in this section with units of mass per unit time (e.g., grams/sec). Stack monitoring information should be provided, including the concentrations of the substances (e.g., ng/dscm), the actual velocity of stack gas release (m/s), and stack gas temperature (K). In addition, based on the characteristics and heat value of the waste feed, the temperature of combustion, stoichiometric conditions, and the volume of flue gases evolved per unit of time, should be estimated (in metric units of dry standard cubic meters per minute [dscm] at 12% CO₂ or 7% O₂). To calculate a mass emission rate of the substance, it is necessary to multiply the estimated dry flue gas volume (m³) per minute associated with combustion by the measured in-stack concentration of the contaminant in units of g/dscm. This information is important because it allows the reviewer to determine if the emission rates used in the modelling are representative of typical facility operations. **(Deficiency Ranking: 4)**

3.2 Page 3-1, Section 3.1 discusses the facility emissions data. This section is a summary of the information presented in Volume I: Chapter 5 – Emissions Inventory of this report and states that emission estimates were based on NCASI estimates, supplemented by mill stack testing data collected in 2002 as part of a study by the Forest Products Association of Canada (FPAC). One of the goals of the risk assessment is to evaluate the potential long-term health effects associated with exposure to emissions from the facility. In order to do so, emission rates that are representative of long-term exposure must be established. The Report does not provide enough detail so that the reviewers can assess the representativeness of these data. The Report does not identify which SoPC's emission factors are based on site-specific stack testing data and which emission factors are based on NCASI data. This is important because it assists in determining the confidence in the emission rates (i.e., was mill production in 2002 consistent with previous years). The Report also does not comment on the representativeness of the 2002 stack test data versus long-term emission rates. How were nondetected results considered when calculating emission rates that had more than one measurement? More information should be provided in the Report on the appropriateness of using the

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NCASI data to estimate emissions from the Crofton Mill. For example, were these data reviewed to ensure that the NCASI emissions were based on facilities that were similar to the Crofton Mill in type and production rates? Stack test data and NCASI data should be presented and discussed as appropriate for each of the 106 substances. This is consistent with the USEPA Region VI Protocol that states, “Developing defensible estimates of compound emission rates is one of the most important elements of the risk assessment.” **(Deficiency Ranking: 4)**

3.3 Page 3-1, Section 3.1 states that SoPCs that were estimated to have zero emissions from the mill were not carried forward in the risk assessment. Where are the data to support this statement? There is no discussion of whether or not the detection limits used to analyze the stack samples were sensitive enough to ensure protection of human health. In addition, because there is only one set of site-specific stack test data available, it would have been more appropriate to evaluate the impact of eliminating these non-detected data on the risk assessment in a quantitative uncertainty analysis. That is, the risks should also have been calculated using all of the emission factors whether or not they were detected. Non-detected data should be evaluated assuming that the SoPC is present at the one-half detection limit. By doing so, the impact of this assumption could be quantitatively evaluated and discussed in the Report. **(Deficiency Ranking: 3)**

3.4 Page 3-2, Table 3-1 identifies 12 carcinogenic polycyclic aromatic hydrocarbons (PAHs) – which the report later states (see Page 4-10, Section 4.7) are based on information from the USEPA. However, the USEPA only identifies seven carcinogenic PAHs: benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoroanthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. **(Deficiency Ranking: 1)**

3.5 Page 3-3, Section 3.2.1. This section states that “ground-level substance concentrations were calculated over the uniform receptor grid...” While this is correct, wet and dry deposition of SoPCs should also have been calculated over the receptor grid so that all exposure pathways could have been evaluated in the baseline risk assessment. **(Deficiency Ranking: 3)**

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- 3.6 Page 3-3, Section 3.2.1, Receptor Grid Used for Modelling Study. This receptor grid and Special Receptor Locations identified in Table 3-2 are helpful. However, the Special Receptor locations should be labeled on Figure 3-1. (**Deficiency Ranking: 2**)
- 3.7 Page 3-4, Figure 3-1. The air modelling receptor grid should be superimposed on Figure 3-1 or presented on a separate figure so that the reader can see the full extent of the modelling with respect to the geographical features presented on the figure. The X axis and Y axis on the figure should be labeled. In addition, the USEPA Region VI Protocol recommends that the receptor grid “should consist of a Cartesian grid with grid nodes spaced 100 meters apart extending from the centroid of the emission sources out to 3 kilometers from the centroid.” The current grid spacing of 250 meters should be adjusted downward to 100 meters or less in the vicinity of the Crofton facility. The rationale for using a tighter receptor grid in the vicinity of the facility is supported by the presence of actual residences within 100 meters of the facility fenceline. (**Deficiency Ranking: 4**)
- 3.8 Page 3-5, Section 3.4. This section presents the approach for selecting SoPCs. A total of 106 substances were identified as substances that may be emitted from the facility. Thirty-six were eliminated because their emission rates were zero, leaving 70 substances with non-zero emission rates. These substances were included in the air dispersion modelling, and ambient air concentrations were predicted at each of the receptor points. The next step performed in the HHRA was to screen the concentrations at the receptor points versus AAQC or toxicological data to determine if any of these substances are present at receptor locations above concentrations that may be of concern to human health. If the maximum-modeled concentration was less than the AAQC or toxicological criteria, then the substance was not identified as a SoPC and was not discussed further in the risk assessment. This approach is not consistent with the intent of a Baseline Risk Assessment of a combustion source (see the USEPA Region VI Protocol). In a Baseline Risk Assessment of a combustion source the SoPCs should be all of the substances identified in the Emissions Inventory. None of the substances identified in the site-specific Emissions Inventory should be screened out of the process because the purpose of the Baseline Risk Assessment is to evaluate the hazards and risks

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associated with exposure to SoPCs being emitted from the facility for all exposure pathways of concern. In addition, both individual substance hazards and risks and cumulative hazards and risks (i.e., the hazards and risks totaled for each receptor for all substances and exposure pathways) should be calculated. As presented in our comments on Chapter 5, only the hazards and risks associated with individual substances for the inhalation pathway were evaluated and presented in this report. Section 3.4 should be omitted from the Report and all substances in the Emissions Inventory for the Facility should be identified as SoPCs and carried through the risk assessment. **(Deficiency Ranking: 5)**

3.9 Page 3-7, Section 3.7 Conceptual Site Model. The conceptual site model is incomplete in that it only includes the inhalation exposure pathway. In addition, Figure 3-3 depicts exposure via indoor vapors/dust. This figure is inaccurate because the primary exposure route to indoor dust is incidental soil ingestion and this pathway was not evaluated in the study. **(Deficiency Ranking: 5)**

3.10 Page 3-7, Exposure Assessment. There is no discussion of potential impacts to ecological receptors. The justification and rationale for not evaluating the potential impacts to ecological receptors should be included in the document. The USEPA Region VI Protocol includes guidance for performing an ecological risk assessment (i.e., Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities). **(Deficiency Ranking: 2)**

3.11 Page 3-7, Sections 3.5, 3.6, and 3.7 present a discussion of the Exposure Pathways, Receptor Characteristics, and Conceptual Model evaluated in the risk assessment. The discussion of these topics fits on one page of the Report and includes one figure. This is inadequate. Typically, the Exposure Assessment is one of the most involved and well-documented chapters in a risk assessment. This section should be revised to identify and discuss potentially exposed populations and exposure pathways that are (and are not) being evaluated in the risk assessment and should provide rationale for the decisions that were made. The section should also include a presentation of the exposure parameters that were used to estimate the exposure for each receptor and exposure pathway. If exposure assumptions are embedded in the AAQC or toxicological criteria, then they should be extracted and explained to

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the reader. Media concentrations should be calculated using equations and associated parameters for each exposure scenario presented in this chapter. Examples of media that should be evaluated in the assessment include:

- Air
- Soil
- Produce
- Animal feed (forage, grain, silage)
- Beef
- Milk
- Pork
- Chicken
- Eggs
- Fish

Examples of receptors that should be evaluated in the risk assessment include:

- Subsistence farmer (Adult, Child, and Infant)
- Resident (Adult, Child, and Infant)
- Subsistence fishermen (Adult, Child, and Infant)
- Recreational fisherman (Adult, Child, and Infant)
- First Nations (Adult, Child, and Infant)

Daily intakes for each SoPC, exposure pathway, and receptor should be calculated using equations and associated parameters for each exposure scenario presented in this chapter. Examples of exposure pathways that should be evaluated in the risk assessment include:

- Direct inhalation of vapors and particles
- Incidental ingestion of soil
- Ingestion of homegrown produce
- Ingestion of homegrown beef
- Ingestion of milk from homegrown cows
- Ingestion of homegrown chicken
- Ingestion of eggs from homegrown chickens
- Ingestion of homegrown pork

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- Ingestion of breast milk (infants)
- Ingestion of fish

The Conceptual Site Model should be revised to reflect the recommendations presented above. Also, when evaluating the subsistence and recreational fishermen it is important that the text present the rationale for the waterbody that was selected for the watershed modelling required to estimate concentrations of SoPCs in fish. **(Deficiency Ranking: 5)**

3.3.5 Chapter – 4.0 Toxicity Assessment

4.1 This section would be clearer if it presented an overall hierarchy of sources used for identifying toxicity values, separated by those used to assess acute effects, those used to assess chronic effects, and those used to assess subchronic effects. The separation of Canadian Ambient Air Quality Objectives from Health Based Guidelines implies that the AAQOs are not health-based, which is not supported by the paragraphs that describe these values. All toxicity values used should be presented in this section, and not fragmented between Section 4, Appendix A, and Appendix B, which makes it confusing for a reader evaluating which values were used for each exposure scenario. **(Deficiency Ranking: 4)**

4.2 Section 4.1.1, p. 4-1. The Toxicity Assessment should explicitly identify and summarize toxicological criteria for each substance. The decision rules used to select toxicity information should be explicitly stated and justified in the text. In addition, it is important to consider whether or not the criterion have been updated to reflect more recent scientific information. For example the B.C. AQOs were developed in the 1980s and it is not clear if they have ever been updated and if not, is there new science that should be considered when applying the values. **(Deficiency Ranking: 4)**

4.3 Page 4-1 Toxicity Assessment. When evaluating combustion sources that emit potentially bioaccumulative substances, such as the Crofton Mill, it is not appropriate to screen out substances using criteria that do not take into account potential cumulative cancer and noncancer health effects. **(Deficiency Ranking: 4)**

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4.4 Page 4-1, Last Paragraph. The last sentence states, “Generally, the B.C. AQO do not account for chronic, long-term or acute effects of pollutants.” If this is the case, it is unclear why they are relevant to consider in a health risk assessment. **(Deficiency Ranking: 2)**

4.5 Page 4-1 Toxicity Assessment. The use of regulatory or policy based criteria such as B.C. AQOs or Canadian National Ambient Air Quality Objectives (NAAQOs), without a critical evaluation of their basis, in a baseline risk assessment is inappropriate because:

- Criteria may be old and may not incorporate new science.
- Criteria may take into account factors other than public health.
- Criteria may incorporate other policy decisions, such as what is an acceptable risk level.
- Criteria do not take into account concurrent exposure to other substances, concurrent exposure via other exposure pathways, and the potential cumulative effects.

(Deficiency Ranking: 3)

4.6 Page 4-4, Section 4.2. A table of the Ontario Ministry of the Environment (OMOE) and World Health Organization (WHO) values used in the assessment should be provided in this section. **(Deficiency Ranking: 3)**

4.7 Page 4-4, Last paragraph before Section 4.3. This paragraph states that if the concentration of a SoPC exceeded health criteria then a Toxicity Reference Value (TRV) was sought. It is unclear why this step was done. If a health-based criterion was exceeded, what additional information was sought by looking for a TRV? **(Deficiency Ranking: 2)**

4.8 Page 4-5, Section 4.4.1. If scaling factors are recommended by OMOE and USEPA and scientifically justified, then they should be applied to all data consistently, including the WHO data. **(Deficiency Ranking: 2)**

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- 4.9 Page 4-6, Section 4.4.2. The text states, “Chronic exposure values are founded on human health effects based on annual average air quality objectives.” It is not clear what this sentence means in the context of the toxicity assessment. It is not true that regulatory criteria are always based only on human health considerations. Often, other policy considerations are incorporated into the development of the criteria. **(Deficiency Ranking: 2)**
- 4.10 Page 4-6, 4th paragraph. It is not necessarily true that a comparison of an annual average air concentration to a Reference Concentration (RfC) is a conservative comparison. An RfC is a safe daily dose by definition. There most certainly will be days where the 24-hour concentration could exceed the RfC and an annual average concentration dilutes out these extremes where acute health effects could possibly occur. **(Deficiency Ranking: 4)**
- 4.11 Page 4-6, Section 4.4.2, third paragraph. The text states “By comparing annual average air concentrations of SoPCs to lifetime TCs [Health Canada’s Tolerable Concentration values] and RfCs, risk to human health will be overestimated.” This statement is misleading in that it suggests that the “risks” calculated in this study will be overestimated. If the study evaluated all potentially exposed populations and exposure pathways and did not inappropriately screen out SoPCs then this statement could be considered by some to be accurate. Because people live in the vicinity of the property boundary, it is reasonable to assume that they could be exposed for a lifetime to the substances emitted from the Crofton facility. **(Deficiency Ranking: 4)**
- 4.12 Page 4-6, Section 4.5. An acceptable cancer risk of one in one hundred thousand was used to develop acceptable substance concentrations in air. This is a key assumption for which the regulatory and/or policy basis should be justified and well documented. **(Deficiency Ranking: 3)**
- 4.13 Page 4-7, First paragraph states “...UR and TC₀₅ concentrations were converted to their exposure values representing the airborne concentration that would result in a one in one hundred thousand cancer risk...” What is the regulatory basis for this conversion? This is an especially high cancer risk goal given the fact that only the

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risks for individual SoPCs are presented in the Report. This is a key assumption for which the regulatory and/or policy basis should be justified and well documented. **(Deficiency Ranking: 3)**

4.14 Page 4-8, Table 4-2. Toxicity values are not presented for dioxins/furans. **(Deficiency Ranking: 3)**

4.15 Page 4-9, Section 4.7. The Toxic Equivalency Factors (TEFs) for individual dioxins/furans and for carcinogenic PAHs should be presented in this section. The TRV for 2,3,7,8-TCDD should be presented in Table 4-2. **(Deficiency Ranking: 2)**

4.16 Page 4-10, Section 4.7. The text states, “The USEPA Toxic Equivalency Factors (TEFs) were used to generate the TEQ concentrations of individual PAH compounds.” However, Page 3-2, Table 3-1 identifies 12 Carcinogenic PAHs. The USEPA identifies only seven carcinogenic PAHs: benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoroanthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. **(Deficiency Ranking: 1)**

4.17 Page 4-10, Section 4.7. The text states, “...all dioxins/furans are represented by 2,3,7,8-TCDD equivalents.” The text should state which 2,3,7,8-TCDD TEF weighting scheme was applied, present the TEFs for each isomer and congener used to calculate the 2,3,7,8-TCDD toxic equivalent (TEQ) concentrations, and document how the non-detected congeners were treated in the TEQ calculations. **(Deficiency Ranking: 2)**

3.3.6 Chapter – 5.0 Exposure Assessment and Risk Characterization

5.1 Page 5-1. The Exposure Assessment and Risk Characterization should be separated in the text as two independent sections. It is confusing to discuss both simultaneously. **(Deficiency Ranking: 4)**

5.2 Pages 5-3 – 5-10 present an evaluation of measured H₂S and PM₁₀ results. The potential impact of the 1997 strike at the mill and upgrade of the stack of the #4 Power Boiler are considered in the Report (assuming that the figures labeled “Post

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Scrubber” are associated with upgrades to the stack of the #4 Power Boiler). However, the text does not provide enough background information so that the reader can consider the context of the evaluation. Specifically, the text presents measured concentrations but does not explicitly discuss their relationship to production rates at the Crofton Mill and/or modifications of production processes (e.g., changes in feedstock used in the boilers). Obviously, H₂S and PM₁₀ emissions are directly related to production. One would expect emissions of H₂S and PM₁₀ to increase as production increases (assuming no change in production or installation of pollution control equipment) or emissions to decrease as production decreases. When evaluating emissions on a temporal basis it would make more sense to normalize the emission data prior to the analysis so that the emission data are being compared using the same metric. For example, a possible explanation for the H₂S emission remaining the same (see Figure 5-3) after the scrubber was installed is that the production rate at the mill has increased and thus off-set the reduction in H₂S emitted from the facility. However, not enough data were presented in this section to determine if this is the case or not. It is important that the reader be able to evaluate the potential risks in the proper perspective, which the current text does not do. **(Deficiency Ranking: 3)**

- 5.3 Pages 5-3 – 5-5. How do the measured results compare with the modeled results for H₂S? These results were presented for PM₁₀ but not for H₂S. **(Deficiency Ranking: 2)**
- 5.4 Pages 5-3 – 5-5. One of the key factors missing in this section is a discussion of any real temporal trends in the data set. For example, Table 5-1 indicates that 17% of the TRS measurements at the Substation exceeded the B.C. AQO. However, the text does not discuss whether or not these exceedances were related (temporally). If the exceedances were grouped or correlated with some event, rather than being random, there may be more cause for concern. **(Deficiency Ranking: 3)**
- 5.5 Page 5-3 states, “There are actually five monitoring stations...” If this is correct, then the results for the five monitoring stations should be presented in Table 5-1. **(Deficiency Ranking: 2)**

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- 5.6 Page 5-3, Section 5.2.1. The text states “...there are no H₂S health effects associated with the smell of the pulp and paper mill.” This is an overly broad statement and should be removed from the document because it only considers exposures at the low-end of the concentration range for H₂S. Adverse health effects are a function of the dose and toxicity of the substance being evaluated. A person could be exposed to relatively high concentrations (concentrations that they could certainly smell) of H₂S from the mill for short time-periods and exhibit adverse health effects. In addition, if the odor threshold for TRS compounds is 2 ug/m³ and the chronic TRV for H₂S is 2 ug/m³, then if one could smell TRS, it may be indicative of levels that could cause health problems. **(Deficiency Ranking: 2)**
- 5.7 Page 5-4. Table 5-1 should present more detailed information on the number of samples collected, sampling frequency (24-hour versus, 15-minute, et cetera), range of detections, range of detection limits, and general descriptive statistics. **(Deficiency Ranking: 3)**
- 5.8 Page 5-4. Table 5-1 should present the percentage exceedances of the chronic H₂S TRV of 2 ug/m³. **(Deficiency Ranking: 2)**
- 5.9 Page 5-5 states, “...there was a significant drop in TRS concentrations after the strike...” A drop in TRS from approximately 2.3 ug/m³ to approximately 2 ug/m³ (see Figure 5-3) does not constitute a significant drop. **(Deficiency Ranking: 1)**
- 5.10 Page 5-5 states, “Therefore, although residents in the local air shed may be able to detect the odour coming from the mill, it does not pose an acute, sub-chronic, or chronic health threat to local residents occupying the area year round.” This sentence should be removed from the Report or significantly revised. There were exceedances of the acute TRV and subchronic TRV (although very infrequent) at the Crofton Substation, so it is possible that there may be some adverse health effects near the fenceline of the facility. The annual average TRS concentration at the Crofton Substation was 1.9 ug/m³, which is very close to the chronic TRV of 2 ug/m³ and may indicate potential health concerns, especially for individuals with compromised respiratory systems (e.g., asthmatics). **(Deficiency Ranking: 3)**

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- 5.11 Page 5-6, Table 5-2 should present more detailed information on the number of samples collected, sampling frequency (24-hour versus, 15-minute, et cetera), range of detections, and range of detection limits. **(Deficiency Ranking: 2)**
- 5.12 Page 5-6 states, “Given that there are multiple sources of PM₁₀ that could be contributing to PM₁₀ levels in the area, including automobiles and wood fired stoves, the results of the modeled data appear to be a reasonable correlation with that found in the environment.” The modeled results for PM₁₀ presented in Tables 5-4, 5-5, and 5-6 are approximately an order of magnitude lower than the average measured values presented in Table 5-2. However, not enough information is presented to assess whether or not the measured versus modeled results are really similar. For example, do measured PM₁₀ concentrations significantly decrease in the spring and summer when the vast majority of wood stoves are not being used? **(Deficiency Ranking: 2)**
- 5.13 Page 5-6 states, “...it is conservatively assumed that all of the measured PM₁₀ was in fact PM_{2.5} (actual ratio is closer to 0.7)...” The 0.7 ratio should be supported by site-specific information or a reference from testing of a similar facility/configuration. **(Deficiency Ranking: 1)**
- 5.14 Page 5-7, Figure 5-4. The units on the Y-axis of the figures are mg/m³ and the units for the PM₁₀ Guidelines are in ug/m³. Are the units on the Y-axis correct? Should they be ug/m³ instead of mg/m³? **(Deficiency Ranking: 2)**
- 5.15 Page 5-11, Section 5.3 Results of Air Modelling of Concentrations of SoPCs. Figure(s) should be added that show the location of the maximum fence line, special receptor, and gridded receptor locations relative to the Crofton Mill and prominent geographical features. **(Deficiency Ranking: 2)**
- 5.16 Pages 5-11 – 5-21. These pages describe the results of comparing the modelling of ambient air concentrations with AAQCs and toxicological criteria at each of the maximum receptor locations presented on page 5-11, and are consistent with a screening level evaluation of individual substances in ambient air. However, as

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described in comment 3.11 (see above) this approach is not appropriate for a baseline risk assessment. Indirect exposure pathways often drive combustor risk assessments because many of the contaminants emitted from the source bioaccumulate in the food chain (USEPA Region VI Protocol). This section should be augmented by including the revisions to the Exposure Assessment and Conceptual Site Model that were recommended in the comments provided on Chapter 3. In addition, it is important that both the individual substance hazards and risks, and the cumulative hazards and risks (i.e., the hazards and risks totaled for each receptor for all substances and exposure pathways), be presented and discussed. Then, the hazards and risks for the exposure pathways and SoPCs responsible for the majority of the risks should be identified. **(Deficiency Ranking: 5)**

- 5.17 Pages 5-11 – 5-16, Tables 5-4 – 5-9. These tables present the results of comparing modeled concentrations with OMOE Criteria and WHO Criteria. The column entitled “Carried Forward in Risk Assessment” should be changed to “Concentration(s) Exceeding Screening Criteria.” The carcinogenic risk goals and/or hazard quotient goals used to derive the OMOE and WHO Criteria should be presented in the footnotes of these tables. Also, the text needs to be revised to demonstrate that the Screening Criteria are protective of all potentially exposed populations. For example, if the screening criteria are based on an adult resident, are they also protective of a subsistence farmer or child, or other receptors evaluated in the risk assessment? In other words, the Screening Criteria should be based on the maximum exposed individual and then the comparisons to ambient air concentrations should be made. This is especially important for children and other sensitive subpopulations that are susceptible to respiratory problems. In addition, any risk-based screening should always take into account potential cumulative cancer risks or noncancer hazards. A number of substances with the same toxicological endpoint could be present at concentrations just below the screening criteria. If they are evaluated from a cumulative point of view they could collectively be present at levels that could result in unacceptable risks or hazards. **(Deficiency Ranking: 5)**

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- 5.18 Pages 5-17 and 5-18, Tables 5-10, 5-11, and 5-12. The Toxicity Reference Values should be compared to all modeled concentrations and not just concentrations for SoPCs that did not have OMOE or WHO Criteria. In addition, the titles of these tables are misleading and should be revised. They all contain "...Non Health Based Criteria (exceedances – bold)" when in fact these tables present a comparison of modeled SoPC concentrations with Toxicity Reference Values which are health based. **(Deficiency Ranking: 5)**
- 5.19 Page 5-21, Section 5.3.3. This section discusses the results of the evaluation of carcinogenic PAHs, which Section 4.7 (see Page 4-10) states were identified based on information from the USEPA. It should be noted that the USEPA only identifies seven carcinogenic PAHs: benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. **(Deficiency Ranking: 1)**
- 5.20 Page 5-21, Section 5.3.3, Second paragraph. The text states "Table 5-13 presents the results of the PAH screening for the maximum concentrations of PAHs detected, which was at the Gridded Receptor." A small point but the text should state, "...maximum concentrations of PAHs modelled, which was at the Gridded Receptor." Also, it is very difficult to determine where this point is located. The exposure assessment results and the risk characterization results should be presented in a combination of figures and tables so it is transparent what the substance concentrations are at the different receptor locations. A combination of figures such as substance concentration isopleth maps and tables should be included to communicate this information. **(Deficiency Ranking: 2)**
- 5.21 Page 5-21, Section 5.3.3, Second paragraph states "...there was no increased cancer risk above a benchmark of one person in one hundred thousand." The basis for this benchmark should be documented in the text. The cumulative cancer risk benchmark should also be identified. **(Deficiency Ranking: 3)**
- 5.22 Page 5-21, Table 5-13. Chrysene (benzo(a)pyrene TEF = 0.001) should be included on this table. **(Deficiency Ranking: 2)**

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5.23 Page 5-21, Section 5.3.4. There was no discussion of the use of a surrogate toxicity value to evaluate propionaldehyde. **(Deficiency Ranking: 1)**

3.3.7 Chapter – 6.0 Further Risk Evaluation of Selected SOPCs

6.1 Page 6-5, Section 6.4, third paragraph. The Report states, "...Jacques Whitford believes that the air model is likely overestimating the H₂S concentrations in the near field area of the Crofton mill (Vol. 1)." This is inconsistent with the statement in Section 3.3, p. 3-5 where it states "The agreement is quite good at the maximum (and the model generally over-predicts otherwise) for the Crofton Sub-Station monitor. The model is somewhat under-predicting the Crofton South and Duncan measurements, but most predictions fall within the factor of two range; considered as good model performance." The measured annual H₂S concentration at the Crofton Substation is 1.9 ug/m³ (p. 5-5) and the equivalent modeled concentration is 4.98 ug/m³ (p. 6-6, table 6-4). The modeled concentration is a factor of 2.6 higher than the monitored, which suggests that there is agreement between the monitored and modeled results. **(Deficiency Ranking: 2)**

3.3.8 Chapter – 7.0 Uncertainty Analysis

7.1 Page 7-1, First paragraph. The text states, "Risk estimates normally include an element of uncertainty, and generally these uncertainties are addressed by incorporating conservative assumptions in the analysis. As a result, risk assessments tend to overstate the actual risk." This introduction is misleading because it is telling the reader that the results of this risk assessment should be interpreted as conservative (i.e., an overestimate of the actual risks). This is clearly not true for this study where it incorrectly screened out substances from the evaluation, did not take into account cumulative risks and hazards, and did not evaluate the majority of the potential exposure pathways. **(Deficiency Ranking: 4)**

7.2 Page 7-1, Second paragraph. The text states, "A risk assessment containing a high degree of confidence will be based on: Conditions where the problem is defined with a high level of certainty based on data and physical observations." This statement underlines the fact that this risk assessment does not contain a high

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degree of confidence because the problem was incorrectly defined to only be exposure via inhalation. **(Deficiency Ranking: 3)**

7.3 Page 7-1, Second set of bullets. The text states, “The exposure assessment performed as part of this study was based on: Well-understood and generally accepted methods for risk prediction.” This statement is inaccurate in that the Report did not follow USEPA or other guidelines for performing an exposure assessment associated with combustor emissions. **(Deficiency Ranking: 5)**

7.4 Page 7-1, Section 7.1.1. The text states, “These estimations require that a number of assumptions be made: Short-term exposures used in animal studies can be extrapolated to chronic or long-term exposures in humans.” In many cases this statement is not correct. Often long term animal studies (i.e., 2 years or the life-time of a rodent) are used as the basis for developing chronic human health criteria. **(Deficiency Ranking: 1)**

7.5 Page 7-2. The text states, “Because risk assessments that use these toxicity reference values incorporate the conservatism used in the development of the toxicological information, the results can generally be viewed as being conservative.” This statement is very misleading. It asserts that risk assessments, including this risk assessment, are conservative simply if they incorporate conservative assumptions into the development/selection of toxicity values. However, risk and hazards are a function of both the dose (calculated in the exposure assessment) and the toxicity of the substance. The use of toxicity criteria in this study does not make the results conservative because the exposure assessment significantly under-predicts the dose of each substance to which people are exposed because it does not include all complete exposure pathways. **(Deficiency Ranking: 5)**

7.6 Page 7-4, First paragraph. This is the first point in the document where cumulative noncancer hazards are discussed. Why is the concept raised here but not incorporated into the Report? **(Deficiency Ranking: 5)**

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7.7 Page 7-4, Section 7.3.2, first paragraph. The text states that “Specifically, an uncertainty factor of 10 has typically been applied to account for intraspecies variations (i.e., susceptible populations).” This is incorrect in that intraspecies variations are not equivalent to susceptible populations. USEPA incorporates a safety factor of 10 to account for intraspecies variations and another safety factor of 10 to account for variation in susceptibility among individuals in the human population. In addition, a safety factor of 10 is added for substances with databases that are less complete (for example, those for which only the results of subchronic studies are available) <http://www.epa.gov/iris/rfd.htm>. (**Deficiency Ranking: 3**)

3.3.9 Chapter – 8.0 Summary and Recommendations

8.1 Page 8-2, Section 8.2, point number three. It is not clear what the last sentence is recommending. (**Deficiency Ranking: 1**)

8.2 Page 8-2, Section 8.2, point number three. The Report states that based on a comparison between air modelling results and ambient measured concentrations, the current locations of the ambient air monitoring stations are suitable. A review of the plots of dispersion modelling results in Volume I: Appendix E suggests that another monitoring location, near Saltspring Dock, may be necessary. The locations of the current monitoring stations are based on dispersion modelling analysis in a 1992 report “Optimal Selection of Ambient Air Monitoring Sites for the Crofton Pulp and Paper Mill” (BC Research Corporation, 1992). This analysis was based on limited meteorological data from Crofton and the dispersion models that were used have since been phased out and replaced by other models. RWDI recommends that a new study be conducted using site-specific meteorological data and all other recommended changes to the CALMET/CALPUFF model to determine optimal ambient air monitoring locations in the Crofton area. (**Deficiency Ranking: 4**)

3.3.10 Chapter – 9.0 References

9.1 No comments.

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3.3.11 Appendix A

A.1 This appendix should also present sample calculations for TEQ calculations for carcinogenic PAHs. **(Deficiency Ranking: 1)**

3.3.12 Appendix B

B.1 This appendix should contain information on the TRV for 2,3,7,8-TCDD. **(Deficiency Ranking: 3)**

B.2 Page B-11, fourth paragraph. It is unclear why a toddler receptor was considered for this substance and for no other substance. Explain why this was a consideration for only 1-1 biphenyl. **(Deficiency Ranking: 1)**

B.3 Page B-20, Table 7-1. Explain why a noncancer value was not included for hexachlorobenzene. There is a chronic RfD of 0.0008 in IRIS, which could have been converted into an RfC. **(Deficiency Ranking: 1)**

B.4 Page B-41, Table 14-1. The values in this table should be included in Section 4, Table 4-2. **(Deficiency Ranking: 4)**

B.5 Page B-43. Explain why a noncancer TRV was not obtained for PAHs. **(Deficiency Ranking: 2)**

B.6 Page B-48, Table 16-1. The values in this table should be presented in Section 4, Table 4-2. **(Deficiency Ranking: 4)**

B.7 Page B-57, Table 19-1. Explain why a noncancer value was not included for 1,1,2-Trichloroethane. There is a chronic RfD of 0.004 in IRIS, which could have been converted into an RfC. **(Deficiency Ranking: 1)**

B.8 Page B-63, Section 21.4.1. The values in this section should be included in Section 4, Table 4-2. **(Deficiency Ranking: 4)**

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4.0 SUMMARY

This section summarizes the major deficiencies noted in the review of the Baseline Air Quality Modelling and Human Health Risk Assessment prepared by Jacques Whitford. Table 4.1 summarizes the deficiencies that have been given the highest ranking (5). Table 4.2 summarizes the deficiencies that have been given the second highest ranking (4). Noted deficiencies in this report have been ranked on a scale from 1 to 5 to characterize the magnitude of deficiencies that we have found in the study with 1 representing a minor deficiency and 5 representing a major deficiency. The deficiencies in the tables are ordered by the main components of the assessment:

- Emission Inventory,
- CALMET AND CALPUFF Modelling Methodology,
- Ambient Air Quality Data Analysis,
- Dispersion Modelling, and
- Human Health Risk Assessment.

The order that the deficiencies are listed in each of the tables does not imply their relative importance.

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**Table 4-1: Major Deficiencies Identified in Review of Jacques Whitford Report
(Rank 5)**

Rank 5 Deficiencies	
Comment	Section
Only annual average emission rates are used for modelling	Emission Inventory
Cumulative effect of several modelling errors severely undermines confidence in model predictions	CALMET and CALPUFF Modelling Methodology
Lack of surface observations from the Crofton Mill	CALMET and CALPUFF Modelling Methodology
Option to extrapolate surface observation to higher levels was not chosen	CALMET and CALPUFF Modelling Methodology
Report does not evaluate all complete exposure pathways and sensitive subpopulations	Human Health Risk Assessment
Report only considers risks/hazards from single pollutants. Cumulative risks not included.	Human Health Risk Assessment
In general, Human Health Risk Assessment is not transparent	Human Health Risk Assessment
Health Risk from TRS underestimated	Human Health Risk Assessment
Wet and dry deposition of pollutants not considered in Health Risk Assessment	Human Health Risk Assessment
Though implied in the report, the Health Risk Assessment did not follow USEPA guidance in regards to pathways, cumulative noncancer and cancer risks	Human Health Risk Assessment
All substances in EI should be identified as SoPCs and carried through the risk assessment	Human Health Risk Assessment
Conceptual Site Model does not include all exposure and ingestion pathways	Human Health Risk Assessment
Toxicity Reference Values should be compared to all modeled concentrations and not just concentrations for SoPCs that did not have OMOE or WHO criteria	Human Health Risk Assessment

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**Table 4-2: Major Deficiencies Identified in Review of Jacques Whitford Report
(Rank 4)**

Rank 4 Deficiencies	
Comment	Section
For non-detects, zero emission rate is used rather than ½ of detection limit as recommended by NCASI	Emission Inventory
EI does not included CAC emissions for operation of boilers using bunker C oil or natural gas	Emission Inventory
Maximum production rates are compared to median rates rather than average rates	Emission Inventory
Emissions during start-up, shut down or during low efficiency operation were not considered	Emission Inventory
Emission rates based on 2003 only. Analysis of mill emissions over several years is required.	Emission Inventory
Idling and off site emissions from trucks, rail and marine traffic were not included	Emission Inventory
Some contaminants for which NCASI emissions factors are provided were not included	Emission Inventory
Land use in the study domain, particularly in the region immediately surrounding the Norske Mill was improperly characterized	CALMET and CALPUFF Modelling Methodology
Receptor spacing immediately beyond the fenceline is too sparse	CALMET and CALPUFF Modelling Methodology
Background sources should have been included in modelling	CALMET and CALPUFF Modelling Methodology
Predicted model concentrations should include some estimate of background contributions	CALMET and CALPUFF Modelling Methodology
Ambient air quality summary did not include all pollutants that have been monitored since 2000.	Ambient Air Quality
Current locations of the ambient air monitoring stations may not be suitable	Ambient Air Quality
Saturna Island a better choice for long-term ozone background levels representative of the Crofton area	Ambient Air Quality
No analysis of locations of predicted maximums is given	Dispersion Model Results and Monitoring Recommendations
Discussion of H ₂ S results understates the magnitude of predictions	Dispersion Model Results and Monitoring Recommendations
Report claims that adding background component to pollutant predictions would not affect frequency of exceedences	Dispersion Model Results and Monitoring Recommendations
Confusing presentation of sources and criteria for toxicity values	Human Health Risk Assessment
Annual average concentrations are used to compare with RfC	Human Health Risk Assessment
Exposure Assessment and Risk Characterization should be presented separately	Human Health Risk Assessment

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5.0 RECOMMENDATIONS FOR FUTURE WORK

Significant deficiencies have been noted in the Baseline Air Quality Modelling and Human Health Risk Assessment prepared by Jacques Whitford. All deficiencies are reviewed and ranked in Sections 2 and 3 of this report. In addition, major deficiencies are summarized in Section 4.

Each major aspect of the study: the emission inventory, dispersion modelling of the contaminants, and the health risk assessment were found to be deficient to the degree that we believe they would have to be substantially re-worked to satisfy the interests of the Crofton Airshed Citizen's Group and Reach for Unbleached. However, re-working much of the assessment would require considerable resources, on the order of \$150,000, and permission from NorskeCanada to use confidential mill process and production information.

The foundation of the assessment is the Crofton Mill emission inventory. The emission inventory is based on the annual emissions reported to NPRI in the year 2003. It is unclear from the Jacques Whitford report why this year was selected for the baseline and what annual variations might be expected. The emission inventory does not consider maximum short-term emission rates that may be caused by start-up or upset conditions from the Power and Recovery Boilers. In addition, all emissions from the use of fuel oil and natural gas from the Power boilers may not have been considered. These important deficiencies could be addressed with a modest level of effort, without re-doing the entire emission inventory. We strongly recommend that these deficiencies be addressed first.

Deficiencies exist with the air dispersion modelling, specifically in regards to the absence of site-specific meteorology to generate wind fields. As a result the modelling work performed by Jacques Whitford may not provide the most realistic assessment of maximum concentrations and their locations; however, it is unclear whether correcting these problems would result in significantly different results. In terms of immediate value to the Crofton Airshed Citizen's Group we would place addressing these deficiencies as a secondary priority.

The Baseline Health Risk Assessment does not evaluate indirect exposure pathways and sensitive sub-populations. Furthermore, cumulative risks and hazards were not calculated. The assessment also relies on the emission inventory and modelling, so ultimately any changes to these will impact the Health Risk Assessment. If the goal of the CACG is to have a Baseline Human Health Risk Assessment of emissions from the Crofton Mill, then a total reassessment / recalculation of the emissions inventory, modeling, and human health risks (including indirect exposure pathways) would be required. This is the most expensive option but would provide the most accurate estimate of potential health impacts associated with emissions from the mill. A less

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costly option would be to perform a Screening Level Risk Evaluation (SLRE), based only on the inhalation pathway, using the most current toxicity information for each contaminant in the emissions inventory. This would entail reassessing risks using the most current USEPA toxicity values and a Cancer Risk Goal of 1E-06 (i.e., an individual could have 1 in 1,000,000 chance of developing cancer over a 70-year lifetime under the evaluated exposure conditions) and the modeled air concentrations presented in Tables 5 – 4 – 5-12. Please note that this option could be combined with other tasks, such as revision of the modeling and/or potential modifications to the emissions inventory. This option would provide a more accurate estimate of potential health impacts associated with inhalation of emissions from the mill (than those that were presented in Jacques Whitford's Report) but would not provide an estimate of the baseline risks.

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Table 5-1: Potential Future Work Options

	Option	Crofton Mill Assessment Deficiency	Required First Steps	Value (Benefit vs. Cost)	Estimated Time
<i>Improvements to Emission Inventory</i>					
1	a) Estimate power and recovery boiler emissions that consider maximum short-term emission rates	Emissions for power and recovery boilers do not consider maximum short-term emission rates and may be underestimated for fuel oil and natural gas combustion.	-	High	2 weeks
	b) Add ½ the detection limit emission factors where appropriate.	NCASI emission factors assume that the non-detects from the source test data are zero as opposed to the ½ of the detection limit for the contaminant.	-	Medium	2 weeks
	c) Estimate on-site and off-site emissions from truck, rail and marine traffic and add to EI	On-site and off-site emissions, including idling and auxiliary power from trucks, rail and marine traffic are not included in EI	-	Medium	2 weeks
<i>Improvements to CALMET and CALPUFF modelling</i>					
2	Re-run CALMET field for site-specific meteorology.	The CALMET simulation contains a number of possible errors. The most important is the fact that it does not use site-specific meteorology. It is unclear what the cumulative impact of these errors is.	-	Medium	3 weeks
3	Remodel contaminants using updated emission factors or emission rates	To recalculate risks using the updated emission factors or emission rates, ground-level concentrations of affected contaminants need to be remodelled	1 2 (optional)	High to Medium	2 weeks

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	Option	Crofton Mill Assessment Deficiency	Required First Steps	Value (Benefit vs. Cost)	Estimated Time
<i>Improvements to Ambient Data</i>					
4	Re-run the CALPUFF model to determine the most appropriate locations for monitoring	The JW report recommends additional monitoring but the current monitoring station locations are likely not optimal	2	Medium	2-3 days (depending on run-time)
<i>Improvement to Health Risk Assessment</i>					
5	Without re-modelling, reassess risks using the most current USEPA toxicity values and a Cancer Risk Goal of 1E-06 and the modeled air concentrations presented in Tables 5.4 – 5.12. Note: We would only change the toxicity values/standards presented in the tables and not the airborne concentrations predicted by JW.	The JW risk assessment does not use the most conservative/appropriate toxicity values to evaluate the inhalation pathway.	-	High	2 – 3 weeks
6	Reassess the risks using the most current emission factors or emission rates. This evaluation would also include the most current USEPA toxicity values and a Cancer Risk Goal of 1E-06.	After the emission factors or emission rates have been updated, the risks will need to be recalculated to reflect the additional contaminants.	1 2 (optional) 3 (optional)	High to Medium	3 – 4 weeks

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	Option	Crofton Mill Assessment Deficiency	Required First Steps	Value (Benefit vs. Cost)	Estimated Time
6a	<p>Reassess the risks using the most current emission factors or emission rates. This evaluation would also include the most current USEPA toxicity values and a Cancer Risk Goal of 1E-06.</p> <p>Please note: This option is identical to option 6 except these calculations would only be performed for 3 – 5 contaminants.</p>	After the emission factors or emission rates have been updated, the risks will need to be recalculated for 3 – 5 contaminants.	<p>1</p> <p>2 (optional)</p> <p>3 (optional)</p>	Low	3 – 4 weeks
<i>New Work</i>					
7	Create new receptor field	The JW risk assessment does not include risks to workers inside the plant fence line	1 (optional)	Low	1 day
	Re-run CALPUFF for receptors inside fenceline for all 100 pollutants		2 (optional)		2-3 weeks
	Re-run CALPUFF for receptors inside fenceline for all 100 pollutants				1-1.5 months
8	Total reassessment of the risks using the methodology presented in the USEPA Region VI Hazardous Waste Combustor Protocol. This includes modeling, and risk assessment	We would use JW's emissions inventory data but would need to re-run the air model to develop wet, dry, and total deposition information for the risk assessment. All of modelling parameters would be identical to JW's only the wet, dry, and total deposition would be calculated. The risk assessment would be totally redone based on the new modeling data.		Medium to High	3 – 5 months

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	Option	Crofton Mill Assessment Deficiency	Required First Steps	Value (Benefit vs. Cost)	Estimated Time
8a	<p>Total reassessment of the risks using the methodology presented in the USEPA Region VI Hazardous Waste Combustor Protocol. This includes modeling, and risk assessment</p> <p>Please note: This option is identical to option 8 except these calculations would only be performed for 3 – 5 contaminants. However, we would still need to develop a thorough risk assessment report that clearly documents the approach, assumptions, limitations, uncertainty, and results.</p>	<p>We would use JW’s emissions inventory data but would need to re-run the air model to develop wet, dry, and total deposition information for the risk assessment. All of modelling parameters would be identical to JW’s only the wet, dry, and total deposition would be calculated. The risk assessment would be totally redone based on the new modeling data.</p>		Low to Medium	2 – 3 months
9	<p>Total reassessment of the risks using the methodology presented in the USEPA Region VI Hazardous Waste Combustor Protocol. This includes a reassessment / recalculation of the emissions inventory, modeling, and risk assessment. Please note that the difference between this step and step 8 is that every step (i.e., emissions inventory, meteorology, modelling, and risk assessment) would be redone based on RWDI’s and PIONEER’s professional judgement.</p>		We could not conduct a total reassessment without Norske approval	Medium	4 – 6 months

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	Option	Crofton Mill Assessment Deficiency	Required First Steps	Value (Benefit vs. Cost)	Estimated Time
9a	<p>Total reassessment of the risks using the methodology presented in the USEPA Region VI Hazardous Waste Combustor Protocol. This includes a reassessment / recalculation of the emissions inventory, modeling, and risk assessment. Please note that the difference between this step and step 8 is that every step (i.e., emissions inventory, meteorology, modelling, and risk assessment) would be redone based on RWDI's and PIONEER's professional judgement.</p> <p>Please note: This option is identical to option 9 except these calculations would only be performed for 3 – 5 contaminants. However, we would still need to develop a thorough risk assessment report that clearly documents the approach, assumptions, limitations, uncertainty, and results.</p>		We could not conduct a total reassessment without Norske approval	Low to Medium	3 – 5 months

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APPENDIX A

**SCREENING LEVEL RISK EVALUATION OF AIRBORNE EMISSIONS
FROM NORSKECANADA'S CROFTON MILL**

Screening Level Risk Evaluation of Airborne Emissions From NorskeCanada's Crofton Mill

The purpose of this appendix is to present the results of a Screening Level Risk Evaluation (SLRE) of the airborne concentrations presented in Tables 5-4 through 5-13 in *Volume II: Human Health Risk Assessment of the Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division* report prepared by Jacques Whitford in October 2004 (herein referred to as the Report).

Background Information on Risk Assessment

Risk assessment is an established approach to evaluate the potential for adverse health effects associated with exposures to toxic chemicals. Risk assessment is a management decision tool and does not provide absolute statements about possible human health effects. Risk assessments typically focus on chemicals and exposure pathways directly related to a site (e.g., the incremental risks due to inhalation of air pollutants emitted from the Crofton Mill). These assessments do not address risks from other sources of exposure (e.g., inhalation of air pollutants from automobile exhaust) or risks from other chemicals that are not associated with the site under evaluation. The general approach used in preparing this SLRE is presented in the USEPA's Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (EPA, 1989).

Methodology for Calculating Cancer Risks

The cancer risk (CR) associated with exposure to an analyte is described in terms of the probability that an exposed individual will develop cancer during a lifetime from that exposure. CR is calculated by multiplying the lifetime average daily dose (LADD) of a particular analyte by the carcinogenic slope factor (CSF). The CRs for individual analytes are summed to calculate the total CR.

- $CR = LADD \times CSF$

- $Total\ CR = CR_1 + CR_2 + CR_3 \dots CR_n$

where,

Parameter	Definition
CR	Lifetime probability of developing cancer due to exposure to the analyte
LADD	Lifetime average daily dose of the analyte (mg/kg-day)
CSF	Carcinogenic slope factor for the analyte (mg/kg-day) ⁻¹

Methodology for Calculating Noncancer Hazard Quotients and Hazard Indices

The potential for adverse noncancer health effects is quantitatively expressed as a hazard quotient (HQ) and/or a hazard index (HI). The HQ is the ratio of the average daily dose (ADD) of a particular analyte to the reference dose (RfD) for that analyte. The HI is the sum of HQs for each analyte.

- $HQ = ADD / RfD$

- $HI = HQ_1 + HQ_2 + HQ_3...HQ_n$

where,

Parameter	Definition
HQ	Hazard Quotient – The ratio of the ADD to the RfD
HI	Hazard Index – The sum of HQs for each analyte
ADD	Average daily dose of an analyte (mg/kg-day)
RfD	Reference dose for an analyte (mg/kg-day). An RfD is the threshold dose for a particular analyte below which it is unlikely that even sensitive subpopulations would experience adverse noncancer health effects.

Risks Associated with Airborne Emissions From NorskeCanada's Crofton Mill

PIONEER performed a SLRE of the airborne concentrations presented in Tables 5-4 through 5-13 in the Report using the most current toxicity information available from the USEPA. Each of the airborne concentrations presented in Tables 5-4 through 5-13 in the Report were used “as-is” to calculate CRs and HQs for an adult resident exposed via inhalation of air only. The individual CRs and HQs were summed to calculate the cumulative CRs and HIs for each receptor (i.e., fenceline, gridded, and special receptor). The equations, exposure parameters, and toxicity values used to calculate the risks are presented in Tables A-1 and A-2, respectively. The results of the risk calculations are summarized in Table A-3 and detailed results of the risk calculations are presented in Tables A-4 through A-6.

The cumulative CRs are:

- Fenceline Receptor: 3.8E-06
- Gridded Receptor: 1.4E-05
- Special Receptor: 2.2E-06

Acetaldehyde, arsenic, carbon tetrachloride, chloroform, chromium VI, dioxin/furans, formaldehyde, tetrachloroethylene, and trichloroethylene were responsible for the majority of the carcinogenic risks. The percentage that each analyte contributed to the total CR varied at each of the receptor locations. See Table A-4 for detailed information on the risks and percent contribution to the total risk for each analyte and receptor location.

The CRs presented above range from 2.2E-06 to 1.4E-05 (a 1E-06 CR means that the modelling indicates that an individual would have a 1 in 1,000,000 chance of developing cancer due to emissions from the Crofton Mill if they were exposed per the parameters presented in Table A-1). These CRs fall within the 1E-06 to 1E-04 (1 in 1,000,000 to 1 in 10,000) CR range established by the USEPA to evaluate CRs at most sites. The USEPA's approach “emphasizes the use of 1 chance in one million (i.e., 1E-06) as the point of departure while allowing site or remedy-specific factors, including potential future uses, to enter into the evaluation of what is appropriate at a given site.” As risks

increase above 1 chance in 1,000,000, they become less desirable. The risk to individuals generally should not exceed 1 in 10,000 (i.e., 1E-04) (40 CFR 300.430[e][2]).

The chronic (i.e., long-term) HIs are:

- Fenceline Receptor: 5.3
- Gridded Receptor: 10.7
- Special Receptor: 2.8

Acetaldehyde, acrolein, chlorine, chlorine dioxide, hydrochloric acid, hydrogen sulphide, oxides of nitrogen, PM10, and sulphur dioxide were responsible for the majority of the chronic HIs. The percentage that each analyte contributed to the chronic HIs varied at each of the receptor locations. See Table A-5 for detailed information on the chronic HQs and percent contribution to the chronic HIs for each analyte and receptor location.

The subchronic (i.e., short-term) HIs are:

- Fenceline Receptor: 2.8
- Gridded Receptor: 4.6
- Special Receptor: 1.8

Ammonia and hydrogen sulphide were responsible for the majority of the subchronic HIs. The percentage that each analyte contributed to the subchronic HIs varied at each of the receptor locations. See Table A-6 for detailed information on the subchronic HQs and percent contribution to the subchronic HI for each analyte and receptor location.

The chronic HIs presented above range from 2.8 to 10.7. The subchronic HIs presented above range from 1.8 to 4.6. A total HI less than 1 indicates that adverse noncancer health effects are unlikely. A total HI greater than 1, indicates that adverse noncancer health effects are possible. However, the HI does not represent a probability of occurrence or a quantification of the magnitude of noncancer health effects.

All of the chronic and subchronic HIs exceed 1, which indicates that noncancer health effects may be manifested. In practice, many risk managers consider a HI of less than 1 as "acceptable" and a HI of greater than 1 as "unacceptable." This strict demarcation between what is "acceptable" and what is "unacceptable" is contrary to the views of most toxicologists, who typically view a HI as a "soft" estimate, whose bounds of uncertainty

can span an order of magnitude or more (i.e., ± 10 times or more). That is, within reasonable limits, while exposures that result in HIs greater than 1 may indeed result in adverse noncancer health effects, it is not a certainty that adverse noncancer health effects will occur. Similarly, while exposures that result in hazard indices less than 1 are not expected to result in adverse noncancer health effects, the absence of all adverse noncancer health effects to all people cannot be assured at this level.

Uncertainties

The results presented in this appendix depend on a number of factors, including the availability of pertinent scientific information, policy decisions made by regulatory agencies, standard risk assessment practices, and exposure and toxicity assumptions used in the modelling. Each step of the risk assessment process has its own set of uncertainties. The purpose of this section is to identify the key uncertainties in the risk calculations:

1. The risks presented in this appendix were calculated assuming that the airborne concentrations presented in JW's Report are representative of long-term emissions from the Crofton Mill. This is a key uncertainty in the evaluation because the emissions data presented in JW's Report are based on a combination of site-specific stack test information and information from the National Council for Air and Stream Improvement, Inc. (NCASI). However, JW's Report does not identify which emissions rates were from which source or discuss the applicability of the NCASI emission rates to the Crofton Mill. For example, JW's Report does not mention if the NCASI emission rates were based on information from the same type of mill or if the emission rates were normalized to reflect long-term production rates at the Crofton Mill. As such, the risks presented in this appendix could be an underestimate or overestimate of the actual risks associated with exposure to airborne emissions from the Crofton Mill.
2. The risks presented in this appendix were calculated assuming that an adult was exposed 24-hours per day, 350 days per year, for 30 years to the airborne concentrations presented in JW's Report. These exposure conditions are conservative and are intended to provide an estimate of the reasonable maximum exposure (RME). Please note that while this may reflect the RME for inhalation, it does not reflect RME for all plausible exposure pathways (see PIONEER's comment 3.11 on JW's Report). As such, the risks presented in this appendix are lower than the risks that would be calculated if all plausible exposure pathways were evaluated.

3. The cancer risks for Dioxins and Furans (Dioxin) presented in this appendix were calculated using a USEPA CSF of 150,000 (mg/kg-day)⁻¹. The USEPA is re-evaluating the carcinogenicity of Dioxin (generically referred to as the 2003 Dioxin Reassessment) and is currently proposing to change the cancer slope factor to 1,000,000 (mg/kg-day)⁻¹ (please see <http://www.epa.gov/ncea/pdfs/dioxin/nas-review/> for more information on the USEPA's Dioxin Reassessment). The 2003 Dioxin Reassessment is still in draft form and is subject to changes/modification due to comments from the U.S. National Academy of Sciences and other interested parties. However, if the CSF for Dioxins is increased to 1,000,000 (mg/kg-day)⁻¹, then the CRs presented in this appendix are underestimated.
4. The HQs/HIs presented in this appendix do not include contribution from Dioxin. An RfD is required to calculate an HQ, and currently, there is no RfD (i.e., a noncancer toxicity value) available from the USEPA for Dioxin. According to the USEPA:

Any RfD that the Agency would recommend under the traditional approach for setting an RfD is likely to be 2 to 3 orders of magnitude (100 to 1,000) below current background intakes and body burdens. Because exceeding the RfD is not a statement of risk, discussion of an RfD for an incremental exposure when the RfD has already been exceeded by average background exposures is meaningless.

As such, the HQs/HIs presented in this appendix are underestimated.

Tables Documenting the Results of the Screening Level Risk Evaluation

Table A-1

Exposure Parameters Used to Calculate Risks for an Adult Resident Based on Inhalation of Air

Equations:

Cancer Risk = (CA / CF) * IR * ET * EF * ED / (BW * ATcar)
Hazard Quotient = (CA / CF) * IR * ET * EF * ED / (BW * ATnc)

Exposure Parameter		Value	Units	Source
CA	Airborne Concentration	Analyte Specific	ug/m ³	Jaques Whitford's October 22, 2004 NorskeCanada Crofton Report
CF	Conversion Factor	1000	ug per mg	None
IR	Inhalation Rate	0.833	m ³ /hour	USEPA, 1991 OSWER Directive 9285.6-03
ET	Exposure Time	24	hours/day	USEPA, 1991 OSWER Directive 9285.6-03
EF	Exposure Frequency	350	days/year	USEPA, 1991 OSWER Directive 9285.6-03
ED	Exposure Duration	30	years	USEPA, 1991 OSWER Directive 9285.6-03
BW	Body Weight	70	kg	USEPA, 1991 OSWER Directive 9285.6-03
ATcar	Averaging Time (cancer)	25550	days	USEPA, 1991 OSWER Directive 9285.6-03
ATnc	Averaging Time (noncancer)	10950	days	USEPA, 1991 OSWER Directive 9285.6-03

Table A-2
Toxicity Values Used to Calculate Risks for an Adult Resident Based on Inhalation of Air

Cas No	Analyte	Inhalation Slope Factor (mg/kg-day) ⁻¹	Inhalation Slope Factor Source	Inhalation Reference Dose (mg/kd-day)	Inhalation RfD Source
95-63-6	1,2,4-Trimethylbenzene	--	--	1.70E-03	NCEA
75-07-0	Acetaldehyde	7.70E-03	IRIS (4th Quarter), 2004	2.57E-03	IRIS (4th Quarter), 2004
67-64-1	Acetone	--	--	--	--
107-02-8	Acrolein	--	--	5.71E-06	IRIS (4th Quarter), 2004
7664-41-7	Ammonia	--	--	2.86E-02	IRIS (4th Quarter), 2004
7440-36-0	Antimony (metallic)	--	--	--	--
7440-38-2	Arsenic (inorganic)	1.51E+01	IRIS (4th Quarter), 2004	--	--
71-43-2	Benzene	2.73E-02	IRIS (4th Quarter), 2004	8.57E-03	IRIS (4th Quarter), 2004
56-55-3	Benzo(a)anthracene	3.10E-01	NCEA Value from EPA Reg IX PRG Table	--	--
50-32-8	Benzo(a)pyrene	3.10E+00	NCEA Value from EPA Reg IX PRG Table	--	--
205-99-2	Benzo(b)fluoranthene	3.10E-01	NCEA Value from EPA Reg IX PRG Table	--	--
207-08-9	Benzo(k)fluoranthene	3.10E-02	NCEA Value from EPA Reg IX PRG Table	--	--
92-52-4	Biphenyl	--	--	--	--
630-08-0	CO	--	--	--	--
7440-43-9F	Cadmium	6.30E+00	IRIS (4th Quarter), 2004	--	--
75-15-0	Carbon Disulfide	--	--	2.00E-01	IRIS (4th Quarter), 2004
56-23-5	Carbon Tetrachloride	5.25E-02	IRIS (4th Quarter), 2004	--	--
7782-50-5	Chlorine	--	--	5.70E-05	NCEA
10049-04-4	Chlorine Dioxide	--	--	5.71E-05	IRIS (4th Quarter), 2004
67-66-3	Chloroform	8.05E-02	IRIS (4th Quarter), 2004	8.60E-04	NCEA
74-87-3	Chloromethane	6.30E-03	HEAST1 (Tables 1 & 3), 1997	2.57E-02	IRIS (4th Quarter), 2004
16065-83-1	Chromium	--	--	--	--
18540-29-9V	Chromium VI	4.20E+01	IRIS (4th Quarter), 2004	2.29E-06	IRIS (4th Quarter), 2004
218-01-9	Chrysene	3.10E-03	NCEA Value from EPA Reg IX PRG Table	--	--
7440-48-4	Cobalt	--	--	--	--
7440-50-8	Copper	--	--	--	--
1319-77-3	Cresol	--	--	--	--
98-82-8	Cumene	--	--	1.14E-01	IRIS (4th Quarter), 2004
53-70-3	Dibenz(a,h)anthracene	3.10E+00	NCEA Value from EPA Reg IX PRG Table	--	--
75-09-2	Dichloromethane	1.65E-03	IRIS (4th Quarter), 2004	8.57E-01	HEAST1 (Tables 1 & 3), 1997
1746-01-6	Dioxins & Furans (surr: 2,3,7,8-TCDD)	1.50E+05	HEAST1 (Tables 1 & 3), 1997	--	--
50-00-0	Formaldehyde	4.55E-02	IRIS (4th Quarter), 2004	--	--
118-74-1	Hexachlorobenzene	1.61E+00	IRIS (4th Quarter), 2004	--	--
7647-01-0	Hydrochloric Acid	--	--	5.71E-03	IRIS (4th Quarter), 2004
73602-61-6	Hydrogen Fluoride	--	--	--	--

Table A-2
Toxicity Values Used to Calculate Risks for an Adult Resident Based on Inhalation of Air

Cas No	Analyte	Inhalation Slope Factor (mg/kg-day) ⁻¹	Inhalation Slope Factor Source	Inhalation Reference Dose (mg/kd-day)	Inhalation RfD Source
2148-87-8	Hydrogen Sulphide	--	--	5.71E-04	IRIS (4th Quarter), 2004
193-39-5	Indeno(1,2,3-cd)pyrene	3.10E-01	NCEA Value from EPA Reg IX PRG Table	--	--
67-63-0	Isopropyl Alcohol	--	--	--	--
7439-92-1	Lead (and compounds) (inorganic)	--	--	--	--
7439-96-5F	Manganese	--	--	1.43E-05	IRIS (4th Quarter), 2004
7439-97-6	Mercury (inorganic)	--	--	8.57E-05	IRIS (4th Quarter), 2004
67-56-1	Methanol	--	--	--	--
78-93-3	Methyl Ethyl Ketone	--	--	1.43E+00	IRIS (4th Quarter), 2004
108-10-1	Methyl Isobutyl Ketone	--	--	8.57E-01	IRIS (4th Quarter), 2004
NOX	NOx	--	--	2.90E-02	NAAQS in HEAST
91-20-3	Naphthalene	--	--	8.57E-04	IRIS (4th Quarter), 2004
7440-02-0	Nickel (soluble salts)	--	--	--	--
PM10	PM10	--	--	1.40E-02	NAAQS in HEAST
PM25	PM2.5	--	--	--	--
108-95-2	Phenol	--	--	--	--
123-38-6	Propionaldehyde	--	--	--	--
7446-09-5	SO2	--	--	2.30E-02	NAAQS in HEAST
7782-49-2	Selenium (and compounds)	--	--	--	--
7440-22-4	Silver	--	--	--	--
100-42-5	Styrene	--	--	2.86E-01	IRIS (4th Quarter), 2004
65-85-0	Sulfuric Acid	--	--	--	--
TPM	TPM	--	--	--	--
127-18-4	Tetrachloroethylene	2.10E-02	NCEA	1.70E-01	NCEA
108-88-3	Toluene	--	--	1.14E-01	IRIS (4th Quarter), 2004
120-82-1	Trichlorobenzene, 1,2,4-	--	--	5.71E-02	HEAST1 (Tables 1 & 3), 1997
79-00-5	Trichloroethane, 1,1,2-	5.60E-02	IRIS (4th Quarter), 2004	--	--
79-01-6	Trichloroethylene	4.00E-01	NCEA	1.00E-02	NCEA
1330-20-7	Xylenes	--	--	2.86E-02	IRIS (4th Quarter), 2004
7440-66-6	Zinc and Compounds	--	--	--	--

Notes:

-- = No toxicity value on IRIS, HEAST 1997 or NCEA.

IRIS = U.S. EPA's Integrated Risk Information System (4th Quarter 2004).

HEASTS = U.S. EPA's Health Effects Assessment Summary Tables (1997)

NCEA = U.S. EPA's National Center for Environmental Assessment.

EPA Region IX PRG Table = U.S. EPA Region IX's Preliminary Remediation Goals Excel Table.

Table A-2
Toxicity Values Used to Calculate Risks for an Adult Res

Cas No	Analyte	SubChronic Inhalation Reference Dose (mg/kd-day)	SubChronic Inhalation RfD Source
95-63-6	1,2,4-Trimethylbenzene	--	
75-07-0	Acetaldehyde	--	--
67-64-1	Acetone	--	--
107-02-8	Acrolein	--	--
7664-41-7	Ammonia	2.86E-02	HEAST1 (Tables 1 & 3), 1997
7440-36-0	Antimony (metallic)	--	--
7440-38-2	Arsenic (inorganic)	--	--
71-43-2	Benzene	--	--
56-55-3	Benzo(a)anthracene	--	--
50-32-8	Benzo(a)pyrene	--	--
205-99-2	Benzo(b)fluoranthene	--	--
207-08-9	Benzo(k)fluoranthene	--	--
92-52-4	Biphenyl	--	--
630-08-0	CO	--	
7440-43-9F	Cadmium	--	--
75-15-0	Carbon Disulfide	2.00E-01	HEAST1 (Tables 1 & 3), 1997
56-23-5	Carbon Tetrachloride	--	--
7782-50-5	Chlorine	--	--
10049-04-4	Chlorine Dioxide	--	--
67-66-3	Chloroform	--	--
74-87-3	Chloromethane	--	--
16065-83-1	Chromium	--	--
18540-29-9V	Chromium VI	--	--
218-01-9	Chrysene	--	--
7440-48-4	Cobalt	--	--
7440-50-8	Copper	--	--
1319-77-3	Cresol	--	--
98-82-8	Cumene	2.57E-02	HEAST1 (Tables 1 & 3), 1997
53-70-3	Dibenz(a,h)anthracene	--	--
75-09-2	Dichloromethane	8.57E-01	HEAST1 (Tables 1 & 3), 1997
1746-01-6	Dioxins & Furans (surr: 2,3,7,8-TCDD)	--	--
50-00-0	Formaldehyde	--	--
118-74-1	Hexachlorobenzene	--	--
7647-01-0	Hydrochloric Acid	--	--
73602-61-6	Hydrogen Fluoride	--	

Table A-2
Toxicity Values Used to Calculate Risks for an Adult Res

Cas No	Analyte	SubChronic Inhalation Reference Dose (mg/kd-day)	SubChronic Inhalation RfD Source
2148-87-8	Hydrogen Sulphide	2.86E-03	HEAST1 (Tables 1 & 3), 1997
193-39-5	Indeno(1,2,3-cd)pyrene	--	--
67-63-0	Isopropyl Alcohol	--	--
7439-92-1	Lead (and compounds) (inorganic)	--	--
7439-96-5F	Manganese	--	--
7439-97-6	Mercury (inorganic)	8.57E-05	HEAST1 (Tables 1 & 3), 1997
67-56-1	Methanol	--	--
78-93-3	Methyl Ethyl Ketone	2.86E-01	HEAST1 (Tables 1 & 3), 1997
108-10-1	Methyl Isobutyl Ketone	2.29E-01	HEAST2 (Table 2), 1997
NOX	NOx	--	
91-20-3	Naphthalene	--	--
7440-02-0	Nickel (soluble salts)	--	--
PM10	PM10	--	
PM25	PM2.5	--	
108-95-2	Phenol	--	--
123-38-6	Propionaldehyde	--	
7446-09-5	SO2	--	
7782-49-2	Selenium (and compounds)	--	--
7440-22-4	Silver	--	--
100-42-5	Styrene	8.57E-01	HEAST1 (Tables 1 & 3), 1997
65-85-0	Sulfuric Acid	--	--
TPM	TPM	--	
127-18-4	Tetrachloroethylene	--	--
108-88-3	Toluene	--	--
120-82-1	Trichlorobenzene, 1,2,4-	5.71E-01	HEAST1 (Tables 1 & 3), 1997
79-00-5	Trichloroethane, 1,1,2-	--	--
79-01-6	Trichloroethylene	--	--
1330-20-7	Xylenes	--	--
7440-66-6	Zinc and Compounds	--	--

Notes:

-- = No toxicity value on IRIS, HEAST 1997 or NCEA.

IRIS = U.S. EPA's Integrated Risk Information System (4th Quarter 200

HEASTS = U.S. EPA's Health Effects Assessment Summary Tables (1

NCEA = U.S. EPA's National Center for Environmental Assessment.

EPA Region IX PRG Table = U.S. EPA Region IX's Preliminary Reme

Table A-3
Risk Summary for an Adult Resident Based on Inhalation of Air
Impacted by Emissions from NorskeCanada's Crofton Mill

Risk Model	Fenceline Receptor		Gridded Receptor		Special Receptor	
	Annual	24-Hour	Annual	24-Hour	Annual	24-Hour
Cancer	3.8E-06	na	1.4E-05	na	2.2E-06	na
Hazard Index	5.3	2.8	10.7	4.6	2.8	1.8

Notes:

na = not applicable.

The airborne concentrations used to calculate the risks presented in this table were obtained from Tables 5-4 through 5-13 in Volume II of Jacques Whitford's October 22, 2004 Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division.

The risks presented in this table underestimate the actual risks because they are based solely on Inhalation of Air and do not include the risks associated with indirect exposure pathways or consider sensitive subpopulations.

Table A-4
Cancer Risk Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Fenceline Receptor Cancer Risks			
		Annual Average Concentration in Air ¹ (ug/m ³)	Lifetime Average Daily Intake (mg/kg-day)	Cancer Risk	% of Total Cancer Risk
79-00-5	1,1,2-Trichloroethane	0.0022	2.58E-07	1.45E-08	0.38
120-82-1	1,2,4-Trichlorobenzene	0.072	8.45E-06		
95-63-6	1,2,4-Trimethylbenzene	0.000084	9.86E-09		
75-07-0	Acetaldehyde	0.59	6.92E-05	5.33E-07	13.88
67-64-1	Acetone	1.05	1.23E-04		
107-02-8	Acrolein	0.0091	1.07E-06		
7664-41-7	Ammonia	1.69	1.98E-04		
7440-36-0	Antimony (metallic)	0.00017	2.00E-08		
7440-38-2	Arsenic (inorganic)	0.000048	5.63E-09	8.48E-08	2.21
71-43-2	Benzene	0.0066	7.75E-07	2.11E-08	0.55
56-55-3	Benzo(a)anthracene	0.0000183	2.15E-09	6.66E-10	0.02
50-32-8	Benzo(a)pyrene	0.0000182	2.14E-09	6.62E-09	0.17
205-99-2	Benzo(b)fluoranthene	0.0000181	2.12E-09	6.59E-10	0.02
207-08-9	Benzo(k)fluoranthene	0.0000181	2.12E-09	6.59E-11	<0.01
92-52-4	Biphenyl	0.095	1.12E-05		
7440-43-9F	Cadmium	0.000069	8.10E-09	5.10E-08	1.33
75-15-0	Carbon Disulfide	0.026	3.05E-06		
56-23-5	Carbon Tetrachloride	0.02	2.35E-06	1.23E-07	3.21
7782-50-5	Chlorine	0.16	1.88E-05		
10049-04-4	Chlorine Dioxide	0.18	2.11E-05		
67-66-3	Chloroform	0.051	5.99E-06	4.82E-07	12.55
74-87-3	Chloromethane	0.0037	4.34E-07	2.74E-09	0.07
16065-83-1	Chromium	0.000066	7.75E-09		
18540-29-9V	Chromium VI	0.00015	1.76E-08	7.39E-07	19.25
630-08-0	CO	10.4	1.22E-03		
7440-48-4	Cobalt	0.00019	2.23E-08		
7440-50-8	Copper	0.00036	4.23E-08		
1319-77-3	Cresol	0.43	5.05E-05		
98-82-8	Cumene	0.0037	4.34E-07		
53-70-3	Dibenz(a,h)anthracene	0.000018	2.11E-09	6.55E-09	0.17
75-09-2	Dichloromethane	0.0082	9.62E-07	1.58E-09	0.04
1746-01-6	Dioxins & Furans (surr: 2,3,7,8-TCDD)	6.6E-09	7.75E-13	1.16E-07	3.03
50-00-0	Formaldehyde	0.124	1.46E-05	6.62E-07	17.24
118-74-1	Hexachlorobenzene	0.0000048	5.63E-11	9.07E-11	<0.01
7647-01-0	Hydrochloric Acid	2.88	3.38E-04		
73602-61-6	Hydrogen Fluoride	0.00097	1.14E-07		
7783-06-4	Hydrogen Sulphide	5.63	6.61E-04		
193-39-5	Indeno(1,2,3-cd)pyrene	0.0000181	2.12E-09	6.59E-10	0.02
67-63-0	Isopropyl Alcohol	0.047	5.52E-06		
7439-92-1	Lead (and compounds) (inorganic)	0.00019	2.23E-08		
7439-96-5F	Manganese	0.0012	1.41E-07		
7439-97-6	Mercury (inorganic)	0.00002	2.35E-09		
67-56-1	Methanol	18.9	2.22E-03		
78-93-3	Methyl Ethyl Ketone	0.14	1.64E-05		
108-10-1	Methyl Isobutyl Ketone	0.015	1.76E-06		
91-20-3	Naphthalene	0.029	3.40E-06		
7440-02-0	Nickel (soluble salts)	0.0039	4.58E-07		
NOX	NOx	6.77	7.95E-04		

**Table A-4
Cancer Risk Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident**

Cas No	Analyte	Fenceline Receptor Cancer Risks			
		Annual Average Concentration in Air ¹ (ug/m ³)	Lifetime Average Daily Intake (mg/kg-day)	Cancer Risk	% of Total Cancer Risk
108-95-2	Phenol	0.206	2.42E-05		
PM10	PM10	2.89	3.39E-04		
PM25	PM2.5	2.09	2.45E-04		
123-38-6	Propionaldehyde	0.062	7.28E-06		
7782-49-2	Selenium (and compounds)	0.000058	6.81E-09		
7440-22-4	Silver	0.000039	4.58E-09		
7446-09-5	SO2	14.1	1.65E-03		
100-42-5	Styrene	0.024	2.82E-06		
65-85-0	Sulfuric Acid	0.144	1.69E-05		
127-18-4	Tetrachloroethylene	0.041	4.81E-06	1.01E-07	2.63
108-88-3	Toluene	0.0068	7.98E-07		
TPM	TPM	3.32	3.90E-04		
79-01-6	Trichloroethylene	0.019	2.23E-06	8.92E-07	23.23
1330-20-7	Xylenes	0.015	1.76E-06		
7440-66-6	Zinc and Compounds	0.019	2.23E-06		
			Total CR	3.84E-06	

Notes:

¹ The airborne concentrations used to calculate the risks presented in this table were obtained from Tables 5-4 through 5-13 in Volume II of Jacques Whitford's October 22, 2004 Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division.

The risks presented in this table underestimate the actual risks because they are based solely on Inhalation of Air and do not include the risks associated with indirect exposure pathways or consider sensitive subpopulations.

Table A-4
Cancer Risk Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Gridded Receptor Cancer Risks			
		Annual Average Concentration in Air ¹ (ug/m ³)	Lifetime Average Daily Intake (mg/kg-day)	Cancer Risk	% of Total Cancer Risk
79-00-5	1,1,2-Trichloroethane	0.0088	1.03E-06	5.78E-08	0.41
120-82-1	1,2,4-Trichlorobenzene	0.275	3.23E-05		
95-63-6	1,2,4-Trimethylbenzene	0.00013	1.53E-08		
75-07-0	Acetaldehyde	6.27	7.36E-04	5.67E-06	40.17
67-64-1	Acetone	2.88	3.38E-04		
107-02-8	Acrolein	0.03	3.52E-06		
7664-41-7	Ammonia	1.06	1.24E-04		
7440-36-0	Antimony (metallic)	0.00022	2.58E-08		
7440-38-2	Arsenic (inorganic)	0.000061	7.16E-09	1.08E-07	0.76
71-43-2	Benzene	0.0084	9.86E-07	2.69E-08	0.19
56-55-3	Benzo(a)anthracene	0.0000183	2.15E-09	6.66E-10	<0.01
50-32-8	Benzo(a)pyrene	0.0000182	2.14E-09	6.62E-09	0.05
205-99-2	Benzo(b)fluoranthene	0.0000181	2.12E-09	6.59E-10	<0.01
207-08-9	Benzo(k)fluoranthene	0.0000181	2.12E-09	6.59E-11	<0.01
92-52-4	Biphenyl	0.39	4.58E-05		
7440-43-9F	Cadmium	0.00009	1.06E-08	6.65E-08	0.47
75-15-0	Carbon Disulfide	1.04	1.22E-04		
56-23-5	Carbon Tetrachloride	0.02	2.35E-06	1.23E-07	0.87
7782-50-5	Chlorine	0.25	2.93E-05		
10049-04-4	Chlorine Dioxide	0.48	5.63E-05		
67-66-3	Chloroform	0.05	5.87E-06	4.72E-07	3.35
74-87-3	Chloromethane	0.0069	8.10E-07	5.10E-09	0.04
16065-83-1	Chromium	0.000084	9.86E-09		
18540-29-9V	Chromium VI	0.00017	2.00E-08	8.38E-07	5.94
630-08-0	CO	12.2	1.43E-03		
7440-48-4	Cobalt	0.00026	3.05E-08		
7440-50-8	Copper	0.00047	5.52E-08		
1319-77-3	Cresol	2.2	2.58E-04		
98-82-8	Cumene	0.014	1.64E-06		
53-70-3	Dibenz(a,h)anthracene	0.000018	2.11E-09	6.55E-09	0.05
75-09-2	Dichloromethane	0.016	1.88E-06	3.09E-09	0.02
1746-01-6	Dioxins & Furans (surr: 2,3,7,8-TCDD)	7.4E-09	8.69E-13	1.30E-07	0.92
50-00-0	Formaldehyde	0.197	2.31E-05	1.05E-06	7.46
118-74-1	Hexachlorobenzene	0.0000053	6.22E-11	1.00E-10	<0.01
7647-01-0	Hydrochloric Acid	3.24	3.80E-04		
73602-61-6	Hydrogen Fluoride	0.0013	1.53E-07		
7783-06-4	Hydrogen Sulphide	9.5	1.12E-03		
193-39-5	Indeno(1,2,3-cd)pyrene	0.0000181	2.12E-09	6.59E-10	<0.01
67-63-0	Isopropyl Alcohol	0.197	2.31E-05		
7439-92-1	Lead (and compounds) (inorganic)	0.00023	2.70E-08		
7439-96-5F	Manganese	0.0014	1.64E-07		
7439-97-6	Mercury (inorganic)	0.000022	2.58E-09		
67-56-1	Methanol	20.2	2.37E-03		
78-93-3	Methyl Ethyl Ketone	0.576	6.76E-05		
108-10-1	Methyl Isobutyl Ketone	0.26	3.05E-05		
91-20-3	Naphthalene	0.069	8.10E-06		
7440-02-0	Nickel (soluble salts)	0.0051	5.99E-07		
NOX	NOx	6.4	7.51E-04		

**Table A-4
Cancer Risk Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident**

Cas No	Analyte	Gridded Receptor Cancer Risks			
		Annual Average Concentration in Air ¹ (ug/m ³)	Lifetime Average Daily Intake (mg/kg-day)	Cancer Risk	% of Total Cancer Risk
108-95-2	Phenol	1.12	1.31E-04		
PM10	PM10	3.35	3.93E-04		
PM25	PM2.5	2.46	2.89E-04		
123-38-6	Propionaldehyde	0.07	8.22E-06		
7782-49-2	Selenium (and compounds)	0.000068	7.98E-09		
7440-22-4	Silver	0.000051	5.99E-09		
7446-09-5	SO2	16.3	1.91E-03		
100-42-5	Styrene	0.08	9.39E-06		
65-85-0	Sulfuric Acid	0.18	2.11E-05		
127-18-4	Tetrachloroethylene	0.172	2.02E-05	4.24E-07	3.01
108-88-3	Toluene	0.037	4.34E-06		
TPM	TPM	2.9	3.40E-04		
79-01-6	Trichloroethylene	0.109	1.28E-05	5.12E-06	36.28
1330-20-7	Xylenes	0.054	6.34E-06		
7440-66-6	Zinc and Compounds	0.02	2.35E-06		
			Total CR	1.41E-05	

Notes:

¹ The airborne concentrations used to calculate the risks presented in this table were obtained from Tables 5-4 through 5-13 in Volume II of Jacques Whitford's October 22, 2004 Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division.

The risks presented in this table underestimate the actual risks because they are based solely on Inhalation of Air and do not include the risks associated with indirect exposure pathways or consider sensitive subpopulations.

**Table A-4
Cancer Risk Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident**

Cas No	Analyte	Special Receptor Cancer Risks			
		Annual Average Concentration in Air ¹ (ug/m ³)	Lifetime Average Daily Intake (mg/kg-day)	Cancer Risk	% of Total Cancer Risk
79-00-5	1,1,2-Trichloroethane	0.0015	1.76E-07	9.86E-09	0.45
120-82-1	1,2,4-Trichlorobenzene	0.044	5.16E-06		
95-63-6	1,2,4-Trimethylbenzene	0.000042	4.93E-09		
75-07-0	Acetaldehyde	0.37	4.34E-05	3.34E-07	15.16
67-64-1	Acetone	0.558	6.55E-05		
107-02-8	Acrolein	0.0063	7.39E-07		
7664-41-7	Ammonia	0.92	1.08E-04		
7440-36-0	Antimony (metallic)	0.00014	1.64E-08		
7440-38-2	Arsenic (inorganic)	0.00004	4.69E-09	7.07E-08	3.20
71-43-2	Benzene	0.0058	6.81E-07	1.86E-08	0.84
56-55-3	Benzo(a)anthracene	0.0000183	2.15E-09	6.66E-10	0.03
50-32-8	Benzo(a)pyrene	0.0000182	2.14E-09	6.62E-09	0.30
205-99-2	Benzo(b)fluoranthene	0.0000181	2.12E-09	6.59E-10	0.03
207-08-9	Benzo(k)fluoranthene	0.0000181	2.12E-09	6.59E-11	<0.01
92-52-4	Biphenyl	0.084	9.86E-06		
7440-43-9F	Cadmium	0.00006	7.04E-09	4.44E-08	2.01
75-15-0	Carbon Disulfide	0.017	2.00E-06		
56-23-5	Carbon Tetrachloride	0.0061	7.16E-07	3.76E-08	1.70
7782-50-5	Chlorine	0.078	9.15E-06		
10049-04-4	Chlorine Dioxide	0.091	1.07E-05		
67-66-3	Chloroform	0.019	2.23E-06	1.80E-07	8.14
74-87-3	Chloromethane	0.0022	2.58E-07	1.63E-09	0.07
16065-83-1	Chromium	0.000058	6.81E-09		
18540-29-9V	Chromium VI	0.00012	1.41E-08	5.92E-07	26.81
630-08-0	CO	7.51	8.81E-04		
7440-48-4	Cobalt	0.00016	1.88E-08		
7440-50-8	Copper	0.00028	3.29E-08		
1319-77-3	Cresol	0.169	1.98E-05		
98-82-8	Cumene	0.0032	3.76E-07		
53-70-3	Dibenz(a,h)anthracene	0.000018	2.11E-09	6.55E-09	0.30
75-09-2	Dichloromethane	0.01	1.17E-06	1.93E-09	0.09
1746-01-6	Dioxins & Furans (surr: 2,3,7,8-TCDD)	5.8E-09	6.81E-13	1.02E-07	4.63
50-00-0	Formaldehyde	0.081	9.51E-06	4.33E-07	19.61
118-74-1	Hexachlorobenzene	0.0000042	4.93E-11	7.94E-11	<0.01
7647-01-0	Hydrochloric Acid	2.51	2.95E-04		
73602-61-6	Hydrogen Fluoride	0.00081	9.51E-08		
7783-06-4	Hydrogen Sulphide	2.57	3.02E-04		
193-39-5	Indeno(1,2,3-cd)pyrene	0.0000181	2.12E-09	6.59E-10	0.03
67-63-0	Isopropyl Alcohol	0.034	3.99E-06		
7439-92-1	Lead (and compounds) (inorganic)	0.00016	1.88E-08		
7439-96-5F	Manganese	0.001	1.17E-07		
7439-97-6	Mercury (inorganic)	0.000017	2.00E-09		
67-56-1	Methanol	8.24	9.67E-04		
78-93-3	Methyl Ethyl Ketone	0.065	7.63E-06		
108-10-1	Methyl Isobutyl Ketone	0.0099	1.16E-06		
91-20-3	Naphthalene	0.023	2.70E-06		
7440-02-0	Nickel (soluble salts)	0.0033	3.87E-07		
NOX	NOx	5.91	6.94E-04		

**Table A-4
Cancer Risk Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident**

Cas No	Analyte	Special Receptor Cancer Risks			
		Annual Average Concentration in Air ¹ (ug/m ³)	Lifetime Average Daily Intake (mg/kg-day)	Cancer Risk	% of Total Cancer Risk
108-95-2	Phenol	0.084	9.86E-06		
PM10	PM10	2.3	2.70E-04		
PM25	PM2.5	1.61	1.89E-04		
123-38-6	Propionaldehyde	0.041	4.81E-06		
7782-49-2	Selenium (and compounds)	0.00005	5.87E-09		
7440-22-4	Silver	0.000025	2.93E-09		
7446-09-5	SO2	12.2	1.43E-03		
100-42-5	Styrene	0.013	1.53E-06		
65-85-0	Sulfuric Acid	0.125	1.47E-05		
127-18-4	Tetrachloroethylene	0.021	2.46E-06	5.18E-08	2.35
108-88-3	Toluene	0.0032	3.76E-07		
TPM	TPM	2.65	3.11E-04		
79-01-6	Trichloroethylene	0.0067	7.86E-07	3.15E-07	14.26
1330-20-7	Xylenes	0.0088	1.03E-06		
7440-66-6	Zinc and Compounds	0.016	1.88E-06		
			Total CR	2.20E-06	

Notes:

¹ The airborne concentrations used to calculate the risks presented in this table were obtained from Tables 5-4 through 5-13 in Volume II of Jacques Whitford's October 22, 2004 Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division.

The risks presented in this table underestimate the actual risks because they are based solely on Inhalation of Air and do not include the risks associated with indirect exposure pathways or consider sensitive subpopulations.

Table A-5
Chronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Fenceline Receptor Chronic Hazard Quotients			
		Annual Average Concentration in Air ¹ (ug/m ³)	Average Daily Intake (mg/kg-day)	Hazard Quotient	% of Total Hazard Index
79-00-5	1,1,2-Trichloroethane	0.0022	6.02E-07		
120-82-1	1,2,4-Trichlorobenzene	0.072	1.97E-05	3.45E-04	0.01
95-63-6	1,2,4-Trimethylbenzene	0.000084	2.30E-08	1.35E-05	<0.01
75-07-0	Acetaldehyde	0.59	1.62E-04	6.28E-02	1.18
67-64-1	Acetone	1.05	2.88E-04		
107-02-8	Acrolein	0.0091	2.49E-06	4.36E-01	8.17
7664-41-7	Ammonia	1.69	4.63E-04	1.62E-02	0.30
7440-36-0	Antimony (metallic)	0.00017	4.66E-08		
7440-38-2	Arsenic (inorganic)	0.000048	1.31E-08		
71-43-2	Benzene	0.0066	1.81E-06	2.11E-04	<0.01
56-55-3	Benzo(a)anthracene	0.0000183	5.01E-09		
50-32-8	Benzo(a)pyrene	0.0000182	4.98E-09		
205-99-2	Benzo(b)fluoranthene	0.0000181	4.96E-09		
207-08-9	Benzo(k)fluoranthene	0.0000181	4.96E-09		
92-52-4	Biphenyl	0.095	2.60E-05		
7440-43-9F	Cadmium	0.000069	1.89E-08		
75-15-0	Carbon Disulfide	0.026	7.12E-06	3.56E-05	<0.01
56-23-5	Carbon Tetrachloride	0.02	5.48E-06		
7782-50-5	Chlorine	0.16	4.38E-05	7.69E-01	14.40
10049-04-4	Chlorine Dioxide	0.18	4.93E-05	8.63E-01	16.16
67-66-3	Chloroform	0.051	1.40E-05	1.62E-02	0.30
74-87-3	Chloromethane	0.0037	1.01E-06	3.94E-05	<0.01
16065-83-1	Chromium	0.000066	1.81E-08		
18540-29-9V	Chromium VI	0.00015	4.11E-08	1.80E-02	0.34
630-08-0	CO	10.4	2.85E-03		
7440-48-4	Cobalt	0.00019	5.20E-08		
7440-50-8	Copper	0.00036	9.86E-08		
1319-77-3	Cresol	0.43	1.18E-04		
98-82-8	Cumene	0.0037	1.01E-06	8.87E-06	<0.01
53-70-3	Dibenz(a,h)anthracene	0.000018	4.93E-09		
75-09-2	Dichloromethane	0.0082	2.25E-06	2.62E-06	<0.01
1746-01-6	Dioxins & Furans (surr: 2,3,7,8-TCDD)	6.6E-09	1.81E-12		
50-00-0	Formaldehyde	0.124	3.40E-05		
118-74-1	Hexachlorobenzene	0.0000048	1.31E-10		
7647-01-0	Hydrochloric Acid	2.88	7.89E-04	1.38E-01	2.59
73602-61-6	Hydrogen Fluoride	0.00097	2.66E-07		
7783-06-4	Hydrogen Sulphide	5.63	1.54E-03	2.70E+00	50.54
193-39-5	Indeno(1,2,3-cd)pyrene	0.0000181	4.96E-09		
67-63-0	Isopropyl Alcohol	0.047	1.29E-05		
7439-92-1	Lead (and compounds) (inorganic)	0.00019	5.20E-08		
7439-96-5F	Manganese	0.0012	3.29E-07	2.30E-02	0.43
7439-97-6	Mercury (inorganic)	0.00002	5.48E-09	6.39E-05	<0.01
67-56-1	Methanol	18.9	5.18E-03		
78-93-3	Methyl Ethyl Ketone	0.14	3.83E-05	2.68E-05	<0.01
108-10-1	Methyl Isobutyl Ketone	0.015	4.11E-06	4.79E-06	<0.01
91-20-3	Naphthalene	0.029	7.94E-06	9.27E-03	0.17
7440-02-0	Nickel (soluble salts)	0.0039	1.07E-06		
NOX	NOx	6.77	1.85E-03	6.39E-02	1.20

**Table A-5
Chronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident**

Cas No	Analyte	Fenceline Receptor Chronic Hazard Quotients			
		Annual Average Concentration in Air ¹ (ug/m ³)	Average Daily Intake (mg/kg-day)	Hazard Quotient	% of Total Hazard Index
108-95-2	Phenol	0.206	5.64E-05		
PM10	PM10	2.89	7.91E-04	5.65E-02	1.06
PM25	PM2.5	2.09	5.72E-04		
123-38-6	Propionaldehyde	0.062	1.70E-05		
7782-49-2	Selenium (and compounds)	0.000058	1.59E-08		
7440-22-4	Silver	0.000039	1.07E-08		
7446-09-5	SO2	14.1	3.86E-03	1.68E-01	3.14
100-42-5	Styrene	0.024	6.57E-06	2.30E-05	<0.01
65-85-0	Sulfuric Acid	0.144	3.94E-05		
127-18-4	Tetrachloroethylene	0.041	1.12E-05	6.60E-05	<0.01
108-88-3	Toluene	0.0068	1.86E-06	1.63E-05	<0.01
TPM	TPM	3.32	9.09E-04		
79-01-6	Trichloroethylene	0.019	5.20E-06	5.20E-04	0.01
1330-20-7	Xylenes	0.015	4.11E-06	1.44E-04	<0.01
7440-66-6	Zinc and Compounds	0.019	5.20E-06		
			Total HI	5.3	

Notes:

¹ The airborne concentrations used to calculate the risks presented in this table were obtained from Tables 5-4 through 5-13 in Volume II of Jacques Whitford's October 22, 2004 Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division.

The risks presented in this table underestimate the actual risks because they are based solely on Inhalation of Air and do not include the risks associated with indirect exposure pathways or consider sensitive subpopulations.

Table A-5
Chronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Gridded Receptor Chronic Hazard Quotients			
		Annual Average Concentration in Air ¹ (ug/m ³)	Intake	Hazard Quotient	% of Total Hazard Index
79-00-5	1,1,2-Trichloroethane	0.0088	2.41E-06		
120-82-1	1,2,4-Trichlorobenzene	0.275	7.53E-05	1.32E-03	0.01
95-63-6	1,2,4-Trimethylbenzene	0.00013	3.56E-08	2.09E-05	<0.01
75-07-0	Acetaldehyde	6.27	1.72E-03	6.68E-01	6.22
67-64-1	Acetone	2.88	7.89E-04		
107-02-8	Acrolein	0.03	8.22E-06	1.44E+00	13.39
7664-41-7	Ammonia	1.06	2.90E-04	1.02E-02	0.09
7440-36-0	Antimony (metallic)	0.00022	6.02E-08		
7440-38-2	Arsenic (inorganic)	0.000061	1.67E-08		
71-43-2	Benzene	0.0084	2.30E-06	2.68E-04	<0.01
56-55-3	Benzo(a)anthracene	0.0000183	5.01E-09		
50-32-8	Benzo(a)pyrene	0.0000182	4.98E-09		
205-99-2	Benzo(b)fluoranthene	0.0000181	4.96E-09		
207-08-9	Benzo(k)fluoranthene	0.0000181	4.96E-09		
92-52-4	Biphenyl	0.39	1.07E-04		
7440-43-9F	Cadmium	0.00009	2.46E-08		
75-15-0	Carbon Disulfide	1.04	2.85E-04	1.42E-03	0.01
56-23-5	Carbon Tetrachloride	0.02	5.48E-06		
7782-50-5	Chlorine	0.25	6.85E-05	1.20E+00	11.19
10049-04-4	Chlorine Dioxide	0.48	1.31E-04	2.30E+00	21.42
67-66-3	Chloroform	0.05	1.37E-05	1.59E-02	0.15
74-87-3	Chloromethane	0.0069	1.89E-06	7.35E-05	<0.01
16065-83-1	Chromium	0.000084	2.30E-08		
18540-29-9V	Chromium VI	0.00017	4.66E-08	2.04E-02	0.19
630-08-0	CO	12.2	3.34E-03		
7440-48-4	Cobalt	0.00026	7.12E-08		
7440-50-8	Copper	0.00047	1.29E-07		
1319-77-3	Cresol	2.2	6.02E-04		
98-82-8	Cumene	0.014	3.83E-06	3.35E-05	<0.01
53-70-3	Dibenz(a,h)anthracene	0.000018	4.93E-09		
75-09-2	Dichloromethane	0.016	4.38E-06	5.11E-06	<0.01
1746-01-6	Dioxins & Furans (surr: 2,3,7,8-TCDD)	7.4E-09	2.03E-12		
50-00-0	Formaldehyde	0.197	5.40E-05		
118-74-1	Hexachlorobenzene	0.0000053	1.45E-10		
7647-01-0	Hydrochloric Acid	3.24	8.87E-04	1.55E-01	1.45
73602-61-6	Hydrogen Fluoride	0.0013	3.56E-07		
7783-06-4	Hydrogen Sulphide	9.5	2.60E-03	4.55E+00	42.40
193-39-5	Indeno(1,2,3-cd)pyrene	0.0000181	4.96E-09		
67-63-0	Isopropyl Alcohol	0.197	5.40E-05		
7439-92-1	Lead (and compounds) (inorganic)	0.00023	6.30E-08		
7439-96-5F	Manganese	0.0014	3.83E-07	2.68E-02	0.25
7439-97-6	Mercury (inorganic)	0.000022	6.02E-09	7.03E-05	<0.01
67-56-1	Methanol	20.2	5.53E-03		
78-93-3	Methyl Ethyl Ketone	0.576	1.58E-04	1.10E-04	<0.01
108-10-1	Methyl Isobutyl Ketone	0.26	7.12E-05	8.31E-05	<0.01
91-20-3	Naphthalene	0.069	1.89E-05	2.20E-02	0.21
7440-02-0	Nickel (soluble salts)	0.0051	1.40E-06		
NOX	NOx	6.4	1.75E-03	6.04E-02	0.56

**Table A-5
Chronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident**

Cas No	Analyte	Gridded Receptor Chronic Hazard Quotients			
		Annual Average Concentration in Air ¹ (ug/m ³)	Intake	Hazard Quotient	% of Total Hazard Index
108-95-2	Phenol	1.12	3.07E-04		
PM10	PM10	3.35	9.17E-04	6.55E-02	0.61
PM25	PM2.5	2.46	6.74E-04		
123-38-6	Propionaldehyde	0.07	1.92E-05		
7782-49-2	Selenium (and compounds)	0.000068	1.86E-08		
7440-22-4	Silver	0.000051	1.40E-08		
7446-09-5	SO2	16.3	4.46E-03	1.94E-01	1.81
100-42-5	Styrene	0.08	2.19E-05	7.67E-05	<0.01
65-85-0	Sulfuric Acid	0.18	4.93E-05		
127-18-4	Tetrachloroethylene	0.172	4.71E-05	2.77E-04	<0.01
108-88-3	Toluene	0.037	1.01E-05	8.87E-05	<0.01
TPM	TPM	2.9	7.94E-04		
79-01-6	Trichloroethylene	0.109	2.99E-05	2.99E-03	0.03
1330-20-7	Xylenes	0.054	1.48E-05	5.18E-04	<0.01
7440-66-6	Zinc and Compounds	0.02	5.48E-06		
			Total HI	10.7	

Notes:

¹ The airborne concentrations used to calculate the risks presented in this table were obtained from Tables 5-4 through 5-13 in Volume II of Jacques Whitford's October 22, 2004 Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division.

The risks presented in this table underestimate the actual risks because they are based solely on Inhalation of Air and do not include the risks associated with indirect exposure pathways or consider sensitive subpopulations.

Table A-5
Chronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Special Receptor Chronic Hazard Quotients			
		Annual Average Concentration in Air ¹ (ug/m ³)	Average Daily Intake (mg/kg-day)	Hazard Quotient	% of Total Hazard Index
79-00-5	1,1,2-Trichloroethane	0.0015	4.11E-07		
120-82-1	1,2,4-Trichlorobenzene	0.044	1.20E-05	2.11E-04	0.01
95-63-6	1,2,4-Trimethylbenzene	0.000042	1.15E-08	6.77E-06	<0.01
75-07-0	Acetaldehyde	0.37	1.01E-04	3.94E-02	1.40
67-64-1	Acetone	0.558	1.53E-04		
107-02-8	Acrolein	0.0063	1.73E-06	3.02E-01	10.76
7664-41-7	Ammonia	0.92	2.52E-04	8.82E-03	0.31
7440-36-0	Antimony (metallic)	0.00014	3.83E-08		
7440-38-2	Arsenic (inorganic)	0.00004	1.10E-08		
71-43-2	Benzene	0.0058	1.59E-06	1.85E-04	0.01
56-55-3	Benzo(a)anthracene	0.0000183	5.01E-09		
50-32-8	Benzo(a)pyrene	0.0000182	4.98E-09		
205-99-2	Benzo(b)fluoranthene	0.0000181	4.96E-09		
207-08-9	Benzo(k)fluoranthene	0.0000181	4.96E-09		
92-52-4	Biphenyl	0.084	2.30E-05		
7440-43-9F	Cadmium	0.00006	1.64E-08		
75-15-0	Carbon Disulfide	0.017	4.66E-06	2.33E-05	<0.01
56-23-5	Carbon Tetrachloride	0.0061	1.67E-06		
7782-50-5	Chlorine	0.078	2.14E-05	3.75E-01	13.35
10049-04-4	Chlorine Dioxide	0.091	2.49E-05	4.36E-01	15.54
67-66-3	Chloroform	0.019	5.20E-06	6.05E-03	0.22
74-87-3	Chloromethane	0.0022	6.02E-07	2.34E-05	<0.01
16065-83-1	Chromium	0.000058	1.59E-08		
18540-29-9V	Chromium VI	0.00012	3.29E-08	1.44E-02	0.51
630-08-0	CO	7.51	2.06E-03		
7440-48-4	Cobalt	0.00016	4.38E-08		
7440-50-8	Copper	0.00028	7.67E-08		
1319-77-3	Cresol	0.169	4.63E-05		
98-82-8	Cumene	0.0032	8.76E-07	7.67E-06	<0.01
53-70-3	Dibenz(a,h)anthracene	0.000018	4.93E-09		
75-09-2	Dichloromethane	0.01	2.74E-06	3.20E-06	<0.01
1746-01-6	Dioxins & Furans (surr: 2,3,7,8-TCDD)	5.8E-09	1.59E-12		
50-00-0	Formaldehyde	0.081	2.22E-05		
118-74-1	Hexachlorobenzene	0.0000042	1.15E-10		
7647-01-0	Hydrochloric Acid	2.51	6.87E-04	1.20E-01	4.29
73602-61-6	Hydrogen Fluoride	0.00081	2.22E-07		
7783-06-4	Hydrogen Sulphide	2.57	7.04E-04	1.23E+00	43.88
193-39-5	Indeno(1,2,3-cd)pyrene	0.0000181	4.96E-09		
67-63-0	Isopropyl Alcohol	0.034	9.31E-06		
7439-92-1	Lead (and compounds) (inorganic)	0.00016	4.38E-08		
7439-96-5F	Manganese	0.001	2.74E-07	1.92E-02	0.68
7439-97-6	Mercury (inorganic)	0.000017	4.66E-09	5.43E-05	<0.01
67-56-1	Methanol	8.24	2.26E-03		
78-93-3	Methyl Ethyl Ketone	0.065	1.78E-05	1.25E-05	<0.01
108-10-1	Methyl Isobutyl Ketone	0.0099	2.71E-06	3.16E-06	<0.01
91-20-3	Naphthalene	0.023	6.30E-06	7.35E-03	0.26
7440-02-0	Nickel (soluble salts)	0.0033	9.04E-07		
NOX	NOx	5.91	1.62E-03	5.58E-02	1.99

Table A-5
Chronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Special Receptor Chronic Hazard Quotients			
		Annual Average Concentration in Air ¹ (ug/m ³)	Average Daily Intake (mg/kg-day)	Hazard Quotient	% of Total Hazard Index
108-95-2	Phenol	0.084	2.30E-05		
PM10	PM10	2.3	6.30E-04	4.50E-02	1.60
PM25	PM2.5	1.61	4.41E-04		
123-38-6	Propionaldehyde	0.041	1.12E-05		
7782-49-2	Selenium (and compounds)	0.00005	1.37E-08		
7440-22-4	Silver	0.000025	6.85E-09		
7446-09-5	SO2	12.2	3.34E-03	1.45E-01	5.18
100-42-5	Styrene	0.013	3.56E-06	1.25E-05	<0.01
65-85-0	Sulfuric Acid	0.125	3.42E-05		
127-18-4	Tetrachloroethylene	0.021	5.75E-06	3.38E-05	<0.01
108-88-3	Toluene	0.0032	8.76E-07	7.67E-06	<0.01
TPM	TPM	2.65	7.26E-04		
79-01-6	Trichloroethylene	0.0067	1.83E-06	1.83E-04	0.01
1330-20-7	Xylenes	0.0088	2.41E-06	8.43E-05	<0.01
7440-66-6	Zinc and Compounds	0.016	4.38E-06		
			Total HI	2.8	

Notes:

¹ The airborne concentrations used to calculate the risks presented in this table were obtained from Tables 5-4 through 5-13 in Volume II of Jacques Whitford's October 22, 2004 Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division.

The risks presented in this table underestimate the actual risks because they are based solely on Inhalation of Air and do not include the risks associated with indirect exposure pathways or consider sensitive subpopulations.

Table A-6
SubChronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Fenceline Receptor SubChronic Hazard Quotients			
		24-Hour Concentration in Air ¹ (ug/m ³)	Average Daily Intake (mg/kg-day)	Hazard Quotient	% of Total Hazard Index
79-00-5	1,1,2-Trichloroethane	0.028	7.67E-06		
120-82-1	1,2,4-Trichlorobenzene	0.385	1.05E-04	1.85E-04	0.01
95-63-6	1,2,4-Trimethylbenzene	0.00054	1.48E-07		
75-07-0	Acetaldehyde	2.53	6.93E-04		
67-64-1	Acetone	6.09	1.67E-03		
107-02-8	Acrolein	0.056	1.53E-05		
7664-41-7	Ammonia	10.6	2.90E-03	1.02E-01	3.60
7440-36-0	Antimony (metallic)	0.0013	3.56E-07		
7440-38-2	Arsenic (inorganic)	0.00035	9.59E-08		
71-43-2	Benzene	0.071	1.94E-05		
56-55-3	Benzo(a)anthracene	0.0000183	5.01E-09		
50-32-8	Benzo(a)pyrene	0.0000182	4.98E-09		
205-99-2	Benzo(b)fluoranthene	0.0000181	4.96E-09		
207-08-9	Benzo(k)fluoranthene	0.0000181	4.96E-09		
92-52-4	Biphenyl	0.967	2.65E-04		
7440-43-9F	Cadmium	0.00047	1.29E-07		
75-15-0	Carbon Disulfide	0.2	5.48E-05	2.74E-04	0.01
56-23-5	Carbon Tetrachloride	0.14	3.83E-05		
7782-50-5	Chlorine	1.03	2.82E-04		
10049-04-4	Chlorine Dioxide	1.2	3.29E-04		
67-66-3	Chloroform	0.38	1.04E-04		
74-87-3	Chloromethane	0.021	5.75E-06		
16065-83-1	Chromium	0.00041	1.12E-07		
18540-29-9V	Chromium VI	0.0015	4.11E-07		
630-08-0	CO	102	2.79E-02		
7440-48-4	Cobalt	0.0015	4.11E-07		
7440-50-8	Copper	0.0024	6.57E-07		
1319-77-3	Cresol	3.22	8.82E-04		
98-82-8	Cumene	0.028	7.67E-06	2.98E-04	0.01
53-70-3	Dibenz(a,h)anthracene	0.000018	4.93E-09		
75-09-2	Dichloromethane	0.091	2.49E-05	2.91E-05	<0.01
1746-01-6	Dioxins & Furans (surr: 2,3,7,8-TCDD)	0.00000013	3.56E-11		
50-00-0	Formaldehyde	0.704	1.93E-04		
118-74-1	Hexachlorobenzene	0.0000093	2.55E-09		
7647-01-0	Hydrochloric Acid	53.1	1.45E-02		
73602-61-6	Hydrogen Fluoride	0.0077	2.11E-06		
7783-06-4	Hydrogen Sulphide	28.4	7.78E-03	2.72E+00	96.32
193-39-5	Indeno(1,2,3-cd)pyrene	0.0000181	4.96E-09		
67-63-0	Isopropyl Alcohol	0.636	1.74E-04		
7439-92-1	Lead (and compounds) (inorganic)	0.0021	5.75E-07		
7439-96-5F	Manganese	0.017	4.66E-06		
7439-97-6	Mercury (inorganic)	0.00019	5.20E-08	6.07E-04	0.02
67-56-1	Methanol	115	3.15E-02		
78-93-3	Methyl Ethyl Ketone	0.92	2.52E-04	8.82E-04	0.03
108-10-1	Methyl Isobutyl Ketone	0.073	2.00E-05	8.75E-05	<0.01
91-20-3	Naphthalene	0.181	4.96E-05		
7440-02-0	Nickel (soluble salts)	0.03	8.22E-06		
NOX	NOx	73.9	2.02E-02		

Table A-6
SubChronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Fenceline Receptor SubChronic Hazard Quotients			
		24-Hour Concentration in Air ¹ (ug/m ³)	Average Daily Intake (mg/kg-day)	Hazard Quotient	% of Total Hazard Index
108-95-2	Phenol	1.52	4.16E-04		
PM10	PM10	24	6.57E-03		
PM25	PM2.5	17.1	4.68E-03		
123-38-6	Propionaldehyde	0.366	1.00E-04		
7782-49-2	Selenium (and compounds)	0.00077	2.11E-07		
7440-22-4	Silver	0.00024	6.57E-08		
7446-09-5	SO2	105	2.88E-02		
100-42-5	Styrene	0.13	3.56E-05	4.15E-05	<0.01
65-85-0	Sulfuric Acid	0.926	2.54E-04		
127-18-4	Tetrachloroethylene	0.255	6.98E-05		
108-88-3	Toluene	0.047	1.29E-05		
TPM	TPM	27.4	7.50E-03		
79-01-6	Trichloroethylene	0.143	3.92E-05		
1330-20-7	Xylenes	0.073	2.00E-05		
7440-66-6	Zinc and Compounds	0.142	3.89E-05		
			Total HI	2.8	

Notes:

¹ The airborne concentrations used to calculate the risks presented in this table were obtained from Tables 5-4 through 5-13 in Volume II of Jacques Whitford's October 22, 2004 Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division.

The risks presented in this table underestimate the actual risks because they are based solely on Inhalation of Air and do not include the risks associated with indirect exposure pathways or consider sensitive subpopulations.

Table A-6
SubChronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Gridded Receptor SubChronic Hazard Quotients			
		24-Hour Concentration in Air ¹ (ug/m ³)	Average Daily Intake (mg/kg-day)	Hazard Quotient	% of Total Hazard Index
79-00-5	1,1,2-Trichloroethane	0.033	9.04E-06		
120-82-1	1,2,4-Trichlorobenzene	0.864	2.37E-04	4.14E-04	0.01
95-63-6	1,2,4-Trimethylbenzene	0.0012	3.29E-07		
75-07-0	Acetaldehyde	25.2	6.90E-03		
67-64-1	Acetone	11.6	3.18E-03		
107-02-8	Acrolein	0.11	3.01E-05		
7664-41-7	Ammonia	16.9	4.63E-03	1.62E-01	3.49
7440-36-0	Antimony (metallic)	0.0016	4.38E-07		
7440-38-2	Arsenic (inorganic)	0.00044	1.20E-07		
71-43-2	Benzene	0.05	1.37E-05		
56-55-3	Benzo(a)anthracene	0.0000183	5.01E-09		
50-32-8	Benzo(a)pyrene	0.0000182	4.98E-09		
205-99-2	Benzo(b)fluoranthene	0.0000181	4.96E-09		
207-08-9	Benzo(k)fluoranthene	0.0000181	4.96E-09		
92-52-4	Biphenyl	2.48	6.79E-04		
7440-43-9F	Cadmium	0.00055	1.51E-07		
75-15-0	Carbon Disulfide	4.22	1.16E-03	5.78E-03	0.12
56-23-5	Carbon Tetrachloride	0.11	3.01E-05		
7782-50-5	Chlorine	2.32	6.35E-04		
10049-04-4	Chlorine Dioxide	3.62	9.91E-04		
67-66-3	Chloroform	0.3	8.22E-05		
74-87-3	Chloromethane	0.04	1.10E-05		
16065-83-1	Chromium	0.00082	2.25E-07		
18540-29-9V	Chromium VI	0.0011	3.01E-07		
630-08-0	CO	94.5	2.59E-02		
7440-48-4	Cobalt	0.0019	5.20E-07		
7440-50-8	Copper	0.0036	9.86E-07		
1319-77-3	Cresol	8.47	2.32E-03		
98-82-8	Cumene	0.097	2.66E-05	1.03E-03	0.02
53-70-3	Dibenz(a,h)anthracene	0.000018	4.93E-09		
75-09-2	Dichloromethane	0.07	1.92E-05	2.24E-05	<0.01
1746-01-6	Dioxins & Furans (surr: 2,3,7,8-TCDD)	0.000000073	2.00E-11		
50-00-0	Formaldehyde	0.821	2.25E-04		
118-74-1	Hexachlorobenzene	0.0000053	1.45E-09		
7647-01-0	Hydrochloric Acid	30.7	8.41E-03		
73602-61-6	Hydrogen Fluoride	0.0095	2.60E-06		
7783-06-4	Hydrogen Sulphide	46.6	1.28E-02	4.47E+00	96.30
193-39-5	Indeno(1,2,3-cd)pyrene	0.0000181	4.96E-09		
67-63-0	Isopropyl Alcohol	0.751	2.06E-04		
7439-92-1	Lead (and compounds) (inorganic)	0.0014	3.83E-07		
7439-96-5F	Manganese	0.01	2.74E-06		
7439-97-6	Mercury (inorganic)	0.00015	4.11E-08	4.79E-04	0.01
67-56-1	Methanol	152	4.16E-02		
78-93-3	Methyl Ethyl Ketone	1.99	5.45E-04	1.91E-03	0.04
108-10-1	Methyl Isobutyl Ketone	1.04	2.85E-04	1.25E-03	0.03
91-20-3	Naphthalene	0.384	1.05E-04		
7440-02-0	Nickel (soluble salts)	0.037	1.01E-05		
NOX	NOx	59.1	1.62E-02		

Table A-6
SubChronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Gridded Receptor SubChronic Hazard Quotients			
		24-Hour Concentration in Air ¹ (ug/m ³)	Average Daily Intake (mg/kg-day)	Hazard Quotient	% of Total Hazard Index
108-95-2	Phenol	4.12	1.13E-03		
PM10	PM10	21.5	5.89E-03		
PM25	PM2.5	15.3	4.19E-03		
123-38-6	Propionaldehyde	0.44	1.20E-04		
7782-49-2	Selenium (and compounds)	0.00049	1.34E-07		
7440-22-4	Silver	0.00029	7.94E-08		
7446-09-5	SO2	205	5.61E-02		
100-42-5	Styrene	0.24	6.57E-05	7.67E-05	<0.01
65-85-0	Sulfuric Acid	1.2	3.29E-04		
127-18-4	Tetrachloroethylene	0.604	1.65E-04		
108-88-3	Toluene	0.11	3.01E-05		
TPM	TPM	23.1	6.33E-03		
79-01-6	Trichloroethylene	0.425	1.16E-04		
1330-20-7	Xylenes	0.149	4.08E-05		
7440-66-6	Zinc and Compounds	0.18	4.93E-05		
			Total HI	4.6	

Notes:

¹ The airborne concentrations used to calculate the risks presented in this table were obtained from Tables 5-4 through 5-13 in Volume II of Jacques Whitford's October 22, 2004 Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division.

The risks presented in this table underestimate the actual risks because they are based solely on Inhalation of Air and do not include the risks associated with indirect exposure pathways or consider sensitive subpopulations.

Table A-6
SubChronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Special Receptor SubChronic Hazard Quotients			
		24-Hour Concentration in Air ¹ (ug/m ³)	Average Daily Intake (mg/kg-day)	Hazard Quotient	% of Total Hazard Index
79-00-5	1,1,2-Trichloroethane	0.011	3.01E-06		
120-82-1	1,2,4-Trichlorobenzene	0.516	1.41E-04	2.47E-04	0.01
95-63-6	1,2,4-Trimethylbenzene	0.00045	1.23E-07		
75-07-0	Acetaldehyde	2.36	6.46E-04		
67-64-1	Acetone	3.29	9.01E-04		
107-02-8	Acrolein	0.071	1.94E-05		
7664-41-7	Ammonia	6.19	1.70E-03	5.93E-02	3.34
7440-36-0	Antimony (metallic)	0.00082	2.25E-07		
7440-38-2	Arsenic (inorganic)	0.00023	6.30E-08		
71-43-2	Benzene	0.035	9.59E-06		
56-55-3	Benzo(a)anthracene	0.0000183	5.01E-09		
50-32-8	Benzo(a)pyrene	0.0000182	4.98E-09		
205-99-2	Benzo(b)fluoranthene	0.0000181	4.96E-09		
207-08-9	Benzo(k)fluoranthene	0.0000181	4.96E-09		
92-52-4	Biphenyl	0.8089	2.22E-04		
7440-43-9F	Cadmium	0.00032	8.76E-08		
75-15-0	Carbon Disulfide	0.152	4.16E-05	2.08E-04	0.01
56-23-5	Carbon Tetrachloride	0.035	9.59E-06		
7782-50-5	Chlorine	0.846	2.32E-04		
10049-04-4	Chlorine Dioxide	0.989	2.71E-04		
67-66-3	Chloroform	0.103	2.82E-05		
74-87-3	Chloromethane	0.012	3.29E-06		
16065-83-1	Chromium	0.00029	7.94E-08		
18540-29-9V	Chromium VI	0.00072	1.97E-07		
630-08-0	CO	54.7	1.50E-02		
7440-48-4	Cobalt	0.00094	2.57E-07		
7440-50-8	Copper	0.0016	4.38E-07		
1319-77-3	Cresol	0.9	2.46E-04		
98-82-8	Cumene	0.022	6.02E-06	2.34E-04	0.01
53-70-3	Dibenz(a,h)anthracene	0.000018	4.93E-09		
75-09-2	Dichloromethane	0.04	1.10E-05	1.28E-05	<0.01
1746-01-6	Dioxins & Furans (surr: 2,3,7,8-TCDD)	0.000000057	1.56E-11		
50-00-0	Formaldehyde	0.496	1.36E-04		
118-74-1	Hexachlorobenzene	0.0000042	1.15E-09		
7647-01-0	Hydrochloric Acid	23.9	6.55E-03		
73602-61-6	Hydrogen Fluoride	0.0048	1.31E-06		
7783-06-4	Hydrogen Sulphide	17.9	4.90E-03	1.72E+00	96.58
193-39-5	Indeno(1,2,3-cd)pyrene	0.0000181	4.96E-09		
67-63-0	Isopropyl Alcohol	0.259	7.09E-05		
7439-92-1	Lead (and compounds) (inorganic)	0.00098	2.68E-07		
7439-96-5F	Manganese	0.0081	2.22E-06		
7439-97-6	Mercury (inorganic)	0.000094	2.57E-08	3.00E-04	0.02
67-56-1	Methanol	43	1.18E-02		
78-93-3	Methyl Ethyl Ketone	0.32	8.76E-05	3.07E-04	0.02
108-10-1	Methyl Isobutyl Ketone	0.096	2.63E-05	1.15E-04	0.01
91-20-3	Naphthalene	0.168	4.60E-05		
7440-02-0	Nickel (soluble salts)	0.019	5.20E-06		
NOX	NOx	39.1	1.07E-02		

Table A-6
SubChronic Hazard Quotient Detail
Inhalation of Air Impacted by Emissions from
NorskeCanada's Crofton Mill by an Adult Resident

Cas No	Analyte	Special Receptor SubChronic Hazard Quotients			
		24-Hour Concentration in Air ¹ (ug/m ³)	Average Daily Intake (mg/kg-day)	Hazard Quotient	% of Total Hazard Index
108-95-2	Phenol	0.461	1.26E-04		
PM10	PM10	12.5	3.42E-03		
PM25	PM2.5	8.77	2.40E-03		
123-38-6	Propionaldehyde	0.281	7.70E-05		
7782-49-2	Selenium (and compounds)	0.00036	9.86E-08		
7440-22-4	Silver	0.00017	4.66E-08		
7446-09-5	SO2	65.7	1.80E-02		
100-42-5	Styrene	0.125	3.42E-05	3.99E-05	<0.01
65-85-0	Sulfuric Acid	0.685	1.88E-04		
127-18-4	Tetrachloroethylene	0.19	5.20E-05		
108-88-3	Toluene	0.01503	4.12E-06		
TPM	TPM	14.4	3.94E-03		
79-01-6	Trichloroethylene	0.036	9.86E-06		
1330-20-7	Xylenes	0.091275	2.50E-05		
7440-66-6	Zinc and Compounds	0.091	2.49E-05		
			Total HI	1.8	

Notes:

¹ The airborne concentrations used to calculate the risks presented in this table were obtained from Tables 5-4 through 5-13 in Volume II of Jacques Whitford's October 22, 2004 Baseline Air Quality Modelling and Human Health Risk Assessment of Current Day Emissions from NorskeCanada Crofton Division.

The risks presented in this table underestimate the actual risks because they are based solely on Inhalation of Air and do not include the risks associated with indirect exposure pathways or consider sensitive subpopulations.