APPLICATION FOR APPROVAL OF THE CANADIAN NATURAL RESOURCES LIMITED PIKE 2 PROJECT

VOLUME 4a: CLARIFICATION OF SUPPLEMENTAL INFORMATION REQUEST 1

Submitted to:

Alberta Energy Regulator

Submitted by:

Canadian Natural Resources Limited
Calgary, Alberta

July 2019

Canadian Natural

July 30, 2019

Alberta Energy Regulator
Authorizations, In Situ South
Suite 1000, 250 – 5 Street SW
Calgary, Alberta, T2P 0R4

Attention Mr. Shay Dodds
Manager, In Situ South – Authorizations

RE: Clarification of Supplementation Information Request Responses for the Canadian Natural Resources Limited Pike 2 Project
AER Application No. 1917507

In support of the integrated *Oil Sands Conservation Act* and *Environmental Protection and Enhancement Act* application filed with the Alberta Energy Regulator (AER) on December 18, 2018 and the Supplemental Information Request 1 responses filed with the AER on May 6, 2019, Volume 4a – Clarification of Supplemental Information Request 1 is hereby submitted to address the request for clarification letter dated July 10, 2019.

Communication related to the application should be directed to Erin Sumner at 403.386.6413 or erin.sumner@cnrl.com.

Sincerely,

CANADIAN NATURAL RESOURCES LIMITED

Maude Ramsay, P.Eng.
Regulatory Manager - Thermal Operations
Office: 403.386.8949
Email: maude.ramsay@cnrl.com

Enclosure: Supplemental Information Request 1 Clarification

Cc: Wayne Bell, Alberta Energy Regulator
Jennifer Graydon, Alberta Health
Magdalena Greenough, Aboriginal Consultation Office

Preamble

This document, identified as *Volume 4a – Clarification of Supplemental Information Request 1*, forms part of the application submitted by Canadian Natural Resources Limited (Canadian Natural) to the Alberta Energy Regulator (AER) (*Oil Sands Conservation Act (OSCA)* and *Environmental Protection and Enhancement Act* (*EPEA*) Application No. 1917507) for approval of the Pike 2 Project (the Project).

The AER completed a review of the Project Application and on 10 July 2019 issued a Clarification of Supplemental Information Request 1 (CSIR1). CSIR1 contains requests for clarification from the AER.

Volume 4a (CSIR1) is organized as follows:

- Canadian Natural's responses to the nine information requests; information is provided in the same numerical sequence as the questions posed in the CSIR1; and
- appendices providing additional information to support specific CSIR1 responses.

It is requested that all reviewers understand that references to Devon Canada Corporation (Devon) should be assumed to refer to Canadian Natural Resources Limited (Canadian Natural). Canadian Natural acquired substantially all of the assets of Devon on 27 June 2019. Prior to 27 June 2019, the activities related to the Project were carried out under Devon.

Acronyms and Abbreviations

µg/m^3	micrograms per cubic metre
AMS	air monitoring station
BLMS	Buffalo Lake Métis Settlement
CAAQS	Canadian Ambient Air Quality Standard
CARB	California Air Resources Board
CCME	Canadian Council of Ministers of the Environment
CPF	central processing facility
EPEA	*Environmental Protection and Enhancement Act*
ESL	Effects Screening Level
H_2S	hydrogen sulphide
HHRA	human health risk assessment
KMS	Kikino Métis Settlement
LSA	local study area
MA DEP	Massachusetts Department of Environmental Protection
MPOI	maximum point of impingement
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
O_3	ozone
ppb	parts per billion
$PM_{2.5}$	particulate matter 2.5 microns
RfC	Reference Concentration
RIVM	Netherlands National Institute of Public Health and the Environment
RQ	risk quotient
RSA	regional study area
SO_2	sulphur dioxide
t/d	tonnes per day
TCEQ	Texas Commission on Environmental Quality
TLU	traditional land use
TPHCWG	Total Petroleum Hydrocarbon Criteria Working Group
WBEA	Wood Buffalo Environmental Association

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Canadian Natural

AER Responses
AER Application No. 1917507

ENVIRONMENTAL IMPACT ASSESSMENT REPORT AND *ENVIRONMENTAL PROTECTION AND ENHANCEMENT ACT*

AIR QUALITY

1. Volume 4, SIR1 10, Page 34-35. Figure 2.6-2 Material Balance Block Flow Diagram 70,000 BPSD SAGD Facility. Volume 4, SIR1 12, Page 70-71, Figure SIR1 12-1 and Central Processing Facility PFD-Vapour Recovery System Area 3000

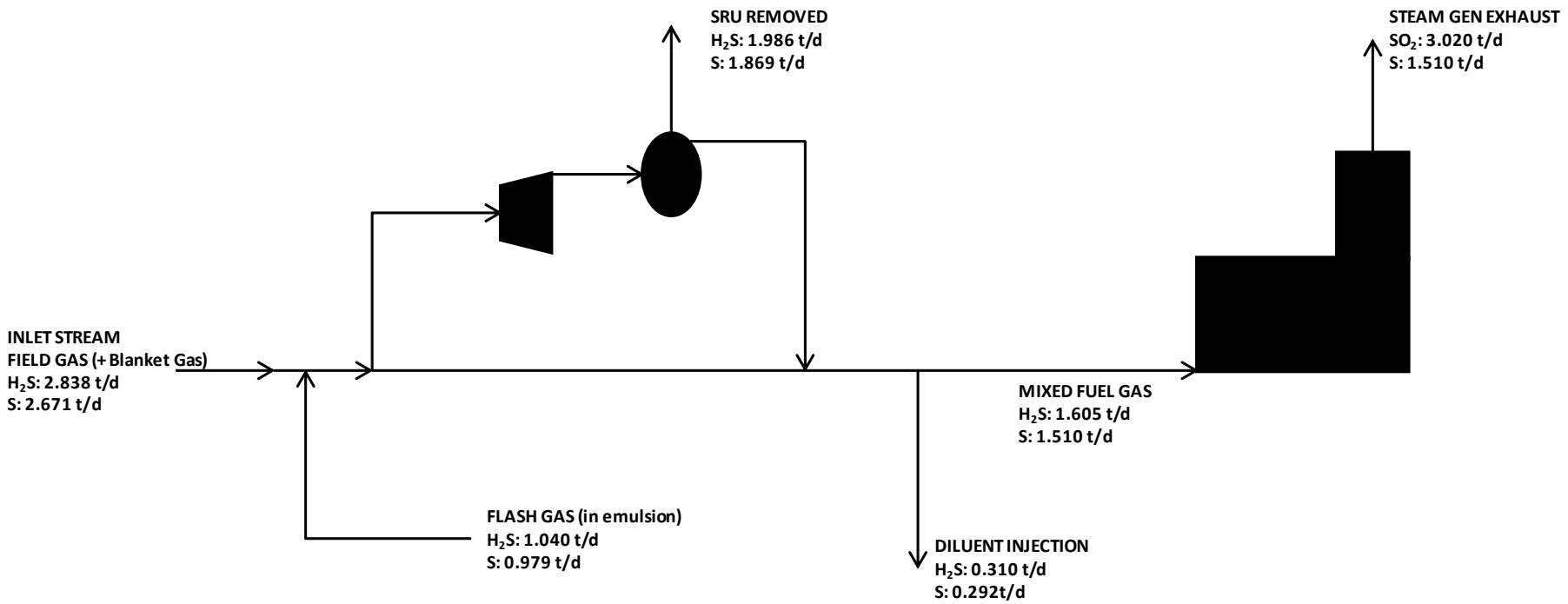
Devon states "It is expected that 0.979 t/d of sulphur will evolve from production during the treating process which is sent to the VRU". Figure 2.6-2 (Rev) indicates that the flash gas contains 1.04 t/d H_2S. Figure 12-1 indicates that the flash gas is being sent to the VRU and is subsequently sent to the SRU. It appears that the gas produced through the inlet treating process is routed through the SRU, however when calculating the SO_2 emission rate it seems Devon has not accounted for removal of 70% of the sulphur component of that produced gas.

1. Discuss why Devon has not accounted for removal of any sulphur from the flash gas produced in the inlet treating process when determining the SO_2 emission rate for the project.

Refer to Figure CSIR1 1-1 for a simplified process flow diagram showing the sulphur balance for the Pike 2 Project (the Project). The 'Inlet Stream Field Gas (+Blanket Gas)' represents the sulphur inlet rate for the central processing facility (CPF). The sulphur from the 'Flash Gas (in emulsion)' accounts for the sulphur that has degassed from oil emulsion treating. The sulphur from the 'Flash Gas (in emulsion)' stream is not considered as part of the total sulphur inlet rate. However, the Project will recover sulphur in such a manner that the anticipated *Environmental Protection and Enhancement Act (EPEA)*-approved sulphur dioxide (SO_2) emission rate will not be exceeded. Canadian Natural Resources Limited (Canadian Natural) has the ability to remove sulphur from the flash gas stream as necessary to ensure that the emission limit is not exceeded. Additional treating capacity is available, and the Project can recover additional sulphur to allow for 70% sulphur removal from the 'Flash Gas (in emulsion)' stream in addition to the 'Inlet Stream Field Gas (+Blanket Gas).'

2. Provide a comprehensive calculation to justify the requested SO_2 emission limit of 3.02 t/d for the project.

Refer to Figure CSIR1 1-1 for a simplified process flow diagram showing the sulphur balance for the Project. Hydrogen sulphide (H_2S) in the mixed fuel gas stream will be combusted during the steam generation process to form SO_2 ($2H_2S + 3O_2 \rightarrow 2H_2O + 2SO_2$). Any minor deviations in H_2S content in the sulphur balance are due to tolerances used in the simulation.



DILBIT (in emulsion)
H_2S: 0.292 t/d
S: 0.275 t/d

→

SALES OIL
H_2S: 0.292 t/d
S: 0.275 t/d

PRODUCED WATER
H_2S: 0.001 t/d
S: 0.001 t/d

→

PRODUCED WATER
H_2S: 0.001 t/d
S: 0.001 t/d

Pike 2 Project SIR1 Clarification Request

Sulphur Balance

July 30, 2019	Fig CSIR1 01-01 Sulphur.mxd
Canadian Natural	PROVIDED BY: Canadian Natural Resouces FINAL MAPPING BY: Wood

Figure CSIR1 1-1

Map Path: S:\Gis\Projects\CE\Devon\04808_Pike_2_EIA\SIR\ArcGIS\Fig CSIR1 01-01 Sulphur.mxd Analyst - trevor.robertson

TRADITIONAL ECOLOGICAL KNOWLEDGE AND LAND USE

2. Volume 2, Section 15.6.2.15, Traditional Ecological Knowledge and Land Use, Page 15-34

Devon discusses available TLU and TK information for the TURSA and the TLSA for the following communities: Beaver Lake Cree Nation, Fort McMurray First Nation #468, Chipewyan Prairie Dené First Nation, Heart Lake First Nation, Cold Lake First Nation and Saddle Lake Cree Nation. Métis groups have been grouped together; however, the ACO also triggered consultation with Buffalo Lake Metis Settlement and Kikino Metis Settlement. Devon states, "Devon is not aware of any publicly available information and is working with the community to obtain TLU data".

1. It is noted due to Devon's confidentiality agreements TLU information cannot be shared, provide updates/information specific to Buffalo Lake Métis Settlement and Kikino Métis Settlement in the EIA individually for each community, to demonstrate how Devon has been consulting with each community, instead of grouping Métis together as one group.

Buffalo Lake Métis Settlement

Canadian Natural began consultation for the Project with Buffalo Lake Métis Settlement (BLMS) on 29 May 2018. Both the consultation and traditional land use (TLU) work plans were agreed to and initiated on 09 July 2018, which included a target date for completion of the TLU study. Site visits with BLMS occurred 25 to 27 September 2018 and 22 October 2018. Canadian Natural was provided with the BLMS TLU study on 13 March 2019. Spring site visits occurred 16 to 17 April 2019 to close out the consultation effort. It was agreed that the TLU information would remain confidential per the work plan and confidentiality agreement.

Kikino Métis Settlement

Canadian Natural began consultation for the Project with Kikino Métis Settlement (KMS) on 24 May 2018. Both the consultation and TLU work plans were agreed to and initiated on 04 July 2018, which included a target date for completion of the TLU study. A site visit with KMS took place 06 to 07 November 2018. Canadian Natural was provided with the KMS TLU study on 02 April 2019. Canadian Natural emailed KMS the Confirmation of Confidentiality letter for the Project on 06 May 2019. It was agreed that the TLU information would remain confidential per the work plan and confidentiality agreement.

HUMAN HEALTH

3. Volume 4, SIR1 39, Table SIR1 39-1: Predicted Maximum Ground-Level Concentrations of Odorous Compounds in the Application Case, Pages 127 and 128.

Devon States "Table SIR1 39-1 shows the maximum predicted ground-level concentrations of odorous emissions for the Baseline Case and Application Case. Although some predicted concentrations are above the published odor thresholds, the increases in the Application Case relative to the Baseline Case are <1% for all odorous species and averaging periods, indicating that the Project has a low contribution to the maxima."

1. Provide the criteria for inclusion of odorous chemicals in Table SIR1 39-1. Justify exclusion of other odorous chemicals emitted from the project (e.g., mercaptans) or include these other odorous chemicals in the assessment.

In addition to the chemicals presented in Volume 4, Table SIR1 39-1, odour thresholds also exist for SO_2 and mercaptans. The mercaptans group includes methyl mercaptan, ethyl mercaptan, n-propyl mercaptan, n-butyl mercaptan, n-amyl mercaptan, and n-hexyl mercaptan, among others. For the purposes of the assessment, the total mercaptans group is considered as methyl mercaptan for comparison with the odour threshold.

Table SIR1 39-1 (Rev) is updated to include these chemicals and to present the absolute maximum instead of the 99.9th percentile predicted ground-level concentrations. As described in the response to Volume 4, SIR1 39, some predicted concentrations are above the published odour thresholds in the Baseline Case; however, the increases in the Application Case relative to the Baseline Case are <1% for most odourous species and averaging periods, except 30-day SO_2 (15%) and 1-hour formaldehyde (11%), indicating that the Project has a low contribution to the maxima. For the 30-day SO_2 and 1-hour formaldehyde, the predicted concentrations are well below the odour thresholds in all assessment cases. These results are consistent with the results presented in the Volume 2, Section 4.0 and in the response to Volume 4, SIR1 39. Therefore, there are no changes to the conclusions of the assessment.

Table SIR1 39-1 (Rev): Predicted Maximum Ground-level Concentrations of Odourous Compounds in the Application Case

Odourous Emissions	Maximum (ppm)[1]		Odour Threshold (ppm)[2]	AAAQO (ppm)	Increase from Baseline
	Baseline	Application			
1,3-Butadiene					
1-h	4.42E-05	4.42E-05	2.30E-01	–	<1%
Acetaldehyde					
1-h	4.61E-04	4.61E-04	1.50E-02	5.00E-02	<1%
Acrolein					
1-h	2.25E-04	2.25E-04	3.70E-04	1.90E-03	<1%
Benzaldehyde					
1-h	2.61E-05	2.61E-05	5.00E-03	–	<1%

Odourous Emissions	Maximum (ppm)[1]		Odour Threshold (ppm)[2]	AAAQO (ppm)	Increase from Baseline
	Baseline	Application			
Benzene					
1-h	1.22E-02	1.22E-02	2.70E+00	9.00E-03	<1%
Annual	1.40E-03	1.40E-03		9.00E-04	<1%
Carbon Disulphide					
1-h	1.07E-02	1.07E-02	2.10E-01	1.00E-02	<1%
Ethylbenzene					
1-h	5.40E-04	5.40E-04	1.70E-01	4.60E-01	<1%
Formaldehyde					
1-h	3.19E-03	3.56E-03	5.00E-01	5.30E-02	11.8%
Hydrogen Sulphide					
1-h	**1.970E-03**	**1.970E-03**	4.10E-04	1.00E-02	<1%
24-h	**5.396E-04**	**5.396E-04**		3.00E-03	<1%
Mercaptans as Methyl Mercaptan					
1-h	**1.75E-02**	**1.75E-02**	7.00E-05	–	<1%
n-Hexane					
1-h	9.12E-03	9.12E-03	1.50E+01	5.96E+00	<1%
24-h	3.77E-03	3.77E-03		1.99E+00	<1%
Naphthalene					
1-h	3.28E-04	3.28E-04	3.80E-02	–	<1%
Annual	7.84E-06	7.84E-06		5.72E-04	<1%
Sulphur Dioxide					
1-h	1.86E-01	1.86E-01	8.70E-01	1.72E-01	<1%
24-h	3.37E-02	3.37E-02		4.80E-02	<1%
30-day	5.11E-03	5.89E-03		1.10E-02	15.4%
Annual	2.46E-03	2.46E-03		8.00E-03	<1%
Thiophenes					
1-h	**1.33E-02**	**1.33E-02**	5.60E-04	–	<1%
Toluene					
1-h	4.63E-03	4.63E-03	3.30E-01	4.99E-01	<1%
24-h	1.92E-03	1.92E-03		1.06E-01	<1%
Xylenes					
1-h	2.35E-03	2.35E-03	3.80E-01	5.30E-01	<1%
24-h	9.73E-04	9.73E-04	3.80E-01	5.30E-01	<1%

Notes:

[1] The AAAQO should be compared to the 99.9th percentile predictions. Concentrations in **boldface** exceed the thresholds.

[2] Odour thresholds from Nagata (2003).

– = Not applicable.

Reference:

Nagata, Y. 2003. *Measurement of Odor Threshold by Triangle Odor Bag Method*. Odor Measurement Review, Japan Ministry of the Environment. pp. 118-127.

4. Volume 4, SIR1 40, Pages 129 and 130.

SIR1 40 asked "Assess the potential impact of O_3 on human health due to project activities". The response provided an estimate of O_3 as a result of secondary formation based on regional modeling results; however, a discussion of potential health effects as they may relate to the predicted O_3 concentrations was not provided.

1. Provide a discussion of the nature and likelihood of potential adverse effects associated with the predicted O_3 concentrations arising from secondary formation. Alternatively, clarify where the discussion has been provided.

In its summary of the Canadian Ambient Air Quality Standard (CAAQS) for ozone, the Canadian Council of Ministers of the Environment (CCME 2019) describes the potential health effects of ozone as follows:

> "*Exposure to ozone (O_3) can cause respiratory symptoms such as throat irritation, coughing, shortness of breath, and reduced lung function. Ozone exposure can also aggravate existing conditions like asthma or other chronic lung diseases. Sensitive populations such as children, and people suffering from respiratory or cardiovascular conditions are at higher risk, especially during summer months when ozone levels increase.*"

Based on the "no-threshold of effect" concept for ozone, Volume 4, SIR1 40 acknowledged that any increase in regional ozone concentrations could result in the type of health effects described by CCME. However, in 2017, ozone concentrations measured at the air monitoring station (AMS) nearest to the Project (i.e., 108 µg/m^3 [55 ppb] at Stony Mountain [AMS 18]) were less than the 2025 CAAQS of 118 µg/m^3 (60 ppb). It is significant to note that the Project's contribution to precursor emissions is not expected to result in new exceedances of the CAAQS.

In 2005, the California Air Resources Board (CARB) reviewed the available controlled human exposure studies prior to setting its air quality standard for ozone. According to CARB (2005), the "principal advantage of controlled human exposure studies over epidemiological studies is that exposures to the pollutant(s) of interest can be precisely measured and; therefore, exposure-response relationships can be determined with some degree of accuracy." In addition to the controlled human exposure studies, CARB reviewed available animal toxicological studies and epidemiological studies. Based on their review, CARB suggested that a 1-hour air quality standard of 180 µg/m^3 (90 ppb) was "protective of public health with an adequate margin of safety" (CARB 2005). As described in Volume 4, SIR1 40, the maximum 1-hour ozone concentration measured at AMS 18 was 151 µg/m^3, which is below the air quality standard set by CARB.

Project design features and mitigation measures that will reduce the effect of Project emissions on regional ozone concentrations include the use of low NO_x burners on steam generators and the collection of vent gas, rather than it being emitted to the atmosphere (Volume 2, Table 4.10-5). The Project NO_x emissions will have a low effect on photochemical production of ozone due to low regional precursor emissions. Combined with the ongoing regional monitoring program for ozone, Canadian Natural's emissions management plan will mitigate the potential formation of ozone and any related risks to health.

In the SIR1 40 response Devon States "The Project is located within the Wood Buffalo Environmental Association (WBEA) airshed, which operates a network of meteorological and ambient monitoring stations. Ambient O_3 is monitored at five stations: Athabasca Valley, Wapasu, Conklin, Stony Mountain (west of Conklin), and Janvier." However, 2017 data are presented for the Stony Mountain and Conklin stations only.

2. Provide rationale for providing summary ambient data for only the Conklin and Stony Mountain stations and not discussing results for the other three stations where O_3 data are monitored (i.e., Athabasca Valley, Wapasu and Janvier). Alternatively, provide and discuss the summary data for these stations.

There are a total of 25 active continuous air monitoring stations located within the Wood Buffalo area, operated by the Wood Buffalo Environmental Association (WBEA). Ambient ozone (O_3) is monitored at 10 stations: Anzac, Bertha Ganter – Fort McKay, Fort Chipewyan (WBEA), Fort McKay South, Fort McMurray-Athabasca Valley, Fort McMurray-Patricia McInnes, Wapasu, Stony Mountain, Conklin, Janvier. As shown in Figure CSIR1 4-1, only two of these monitoring stations, Stony Mountain and Conklin, are located in the regional study area (RSA) of the Project. The Christina Lake monitoring station shown is a portable station, which only provides short-term monitoring and does not have a complete record. Therefore, it has not been included in the summary data.

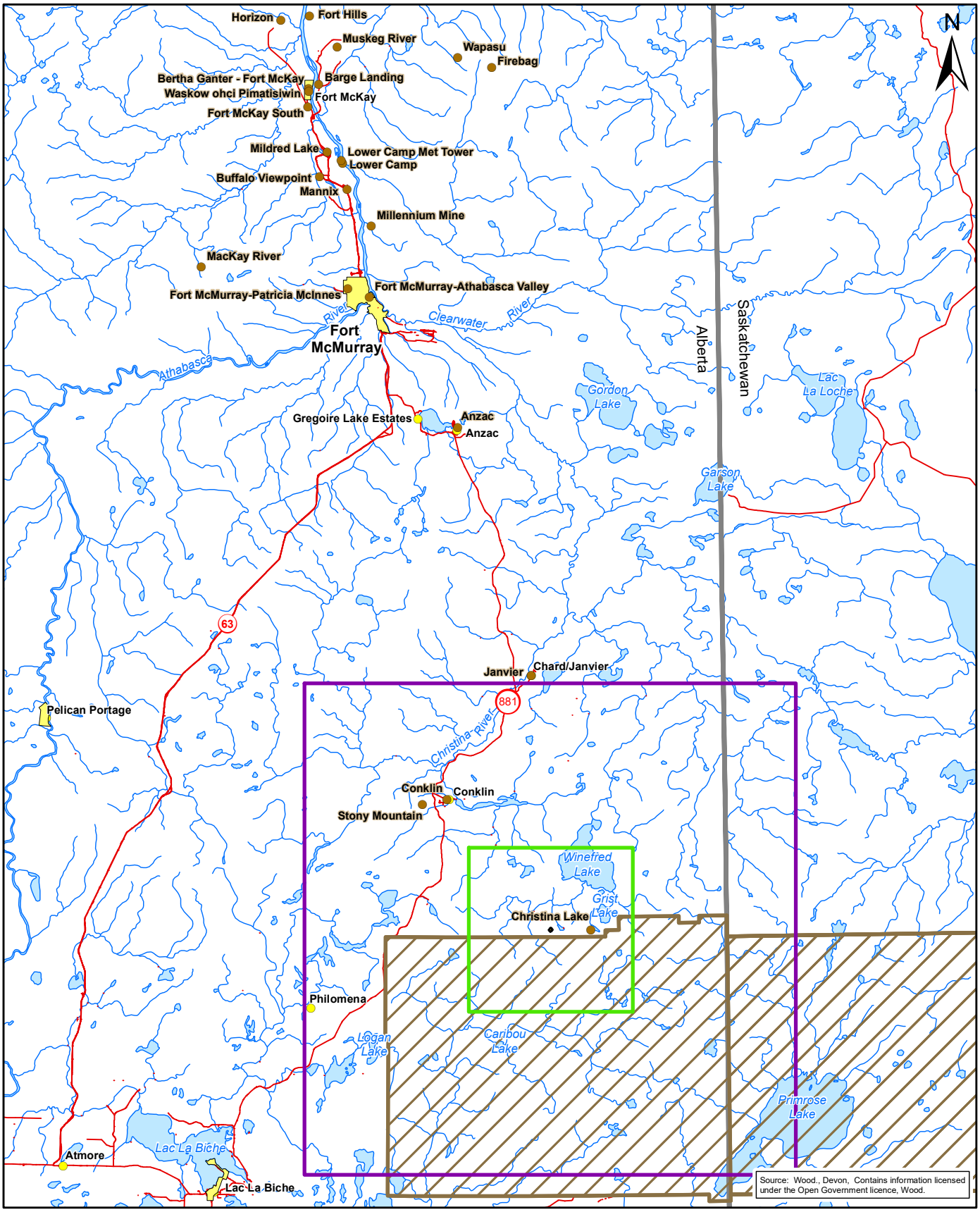
In the SIR1 40 response Devon states "While naturally high O_3 concentrations occur in the area, the residual O_3 impact for the Project is predicted to be low given the relatively low level of precursor in the region."

3. Provide discussion about the regional precursor emission rates (i.e., AQRSA NO_x , Baseline NO_x emissions of 116 t/d) and why these are considered low.

The incremental NO_x emissions attributable to the Project are 1.08 t/d. Using Volume 2, Figure 4.7-14, the incremental formation of O_3 due to the Project (the vertical axis of the figure) at the rate corresponding to the Baseline Case of 116 t/d emissions (horizontal axis) is approximately 0.6 ppb (0.2%), and is, therefore, of low magnitude.

The formation of O_3 is a photochemical process influenced by sunlight intensity, location in the atmosphere, temperature, and other factors. Tropospheric, or ground level O_3, is not emitted directly into the air, but is created by chemical reactions between NO_x and volatile organic compounds. This happens when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react with O_3 in the presence of sunlight. Higher emissions of precursors favour O_3 formation, but the process becomes more complex when the role of O_3 sinks is considered. A key O_3 sink is the conversion of nitrogen oxide or NO, which are also emitted by industrial and urban emissions, into nitrogen dioxide (NO_2).

To illustrate the role of industrial emissions in O_3 formation, 2017 O_3 concentrations in the non-industrial area (Steeper) and industrial area (Athabasca Valley) are compared. From Figure CSIR 4-2, hourly average O_3 concentrations at Steeper are slightly higher than those at the Athabasca Valley station. Except for May, monthly average concentrations at the Athabasca Valley station are lower than at Steeper. The difference is most pronounced in winter months (December to February). This is consistent with findings of Rudolph et al. (2003, 2004) that measurements in the oil sands region have not found an increase in O_3 formation from anthropogenic emissions.



Legend

- Air Quality Local Study Area
- Air Quality Regional Study Area
- Pike 2 CPF
- Cold Lake Air Weapons Range
- Open Water
- Watercourse
- Road
- Monitoring Station

Note: Additional monitoring station located at Fort Chipewyan (WBEA)

10 5 0 10 20
Kilometres
1:1,300,000

Pike 2 Project SIR1 Clarification Request

Wood Buffalo Environmental Association Monitoring Stations

July 18, 2019 | Fig CSIR 4-01 WBEA Monitoring.mxd

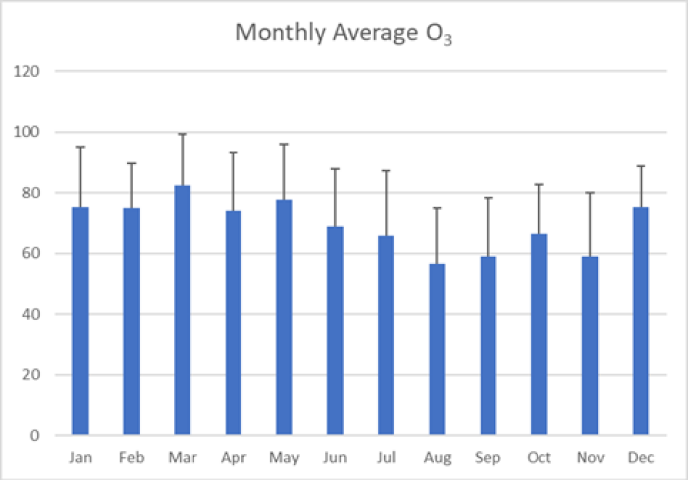
Canadian Natural

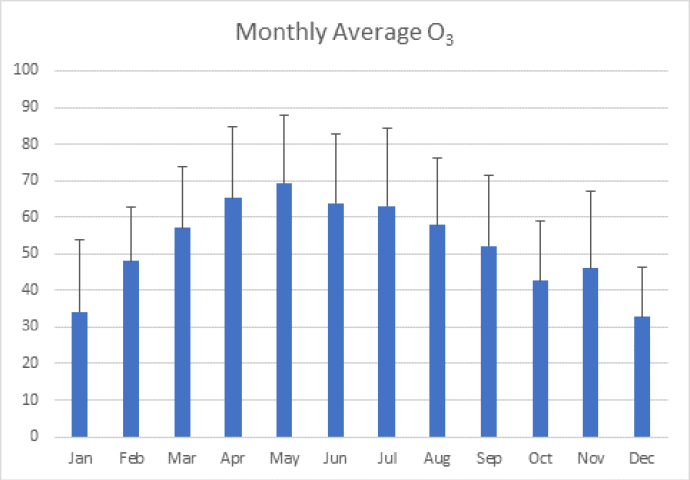
PROVIDED BY: Wood

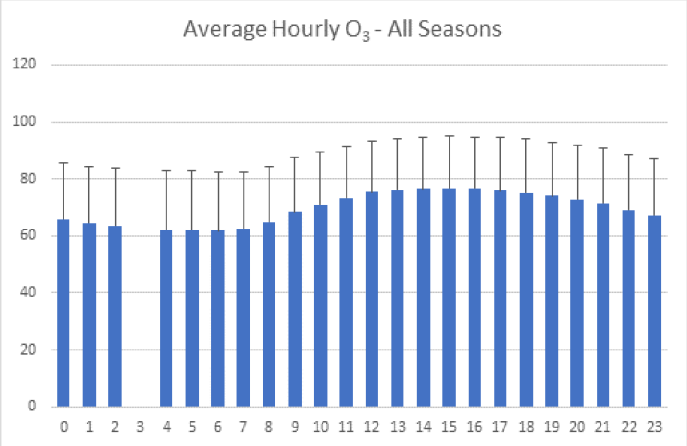
FINAL MAPPING BY: Wood

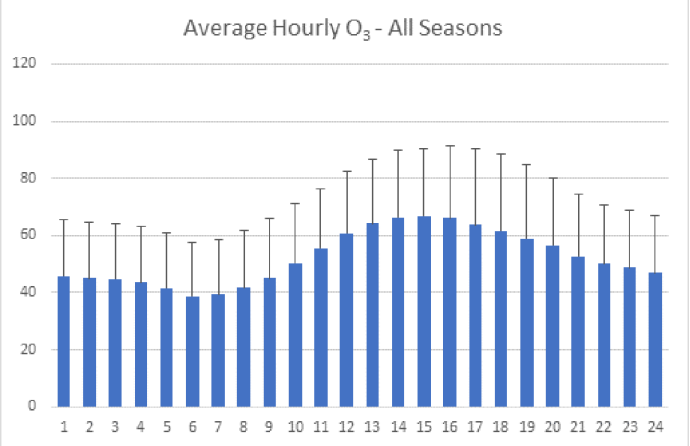
Figure CSIR1 4-1

Map Path: S:\Gis\Projects\CE\Devon\04808_Pike_2_EIA\SIR\ArcGIS\Fig SIRCL 10-01 WBEA Monitoring.mxd Analyst - Jay Boutin









Steeper (2017)

Fort McMurray-Athabasca Valley (2017)

Pike 2 Project SIR1 Clarification Request

2017 Average O_3 Concentrations (ug/m³)

July 24, 2019	Fig CSIR1 04-02 SO2.mxd
Canadian Natural	PROVIDED BY: Wood
	FINAL MAPPING BY: Wood
	Figure CSIR1 4-2

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References:

California Air Resources Board (CARB). 2005. *Review of the California Ambient Air Quality Standard for Ozone.* October 2005 Revision. Volume III of IV. Chapters 9-11. Staff Report, October 27, 2005.

Canadian Council of Ministers of the Environment (CCME) 2019. *Ozone: Effects on Human Health and the Environment*. Accessed at: http://airquality-qualitedelair.ccme.ca/en/.

Rudolph, R., M. Shauck, G. Zanin, S. Alvarez, E. Owen, and M. Buhr. 2003. *Analysis of 2001-2002 Airborne Ozone and Ozone Precursor Measurements in the Oil Sands*. Prepared by AMEC Earth & Environmental Limited for the Cumulative Effects Management Association. Fort McMurray, AB.

Rudolph, R., M. Shauck, G. Zanin, S. Alvarez, E. Owen, and M. Buhr. 2004. *Analysis of 2001-2002 Airborne Ozone and Ozone Precursor Measurements in the Oil Sands, Summer 2001 and 2002*. Prepared by AMEC Earth & Environmental, Baylor University and Sonoma Technologies for the Cumulative Effects Management Association. Fort McMurray, AB.

5. Volume 4, SIR1 42, Pages 132 to 160. Table SIR1 42-1. Discrete Locations Assumed to Represent Aboriginal Peoples, Workers and Area Users in the Regional Study Area, Page 133.

Devon states "Steam generation will be accomplished using a heat recovery steam generator (HRSG) utilizing turbine exhaust gases and duct firing. The cogeneration unit will be capable of approximately 38 MW of electric power generation and 65 MW of steam generation at 78% steam quality."

1. Provide a map including the Regional Study Area boundaries and receptor locations presented in Table SIR1 42-1, Page 133.

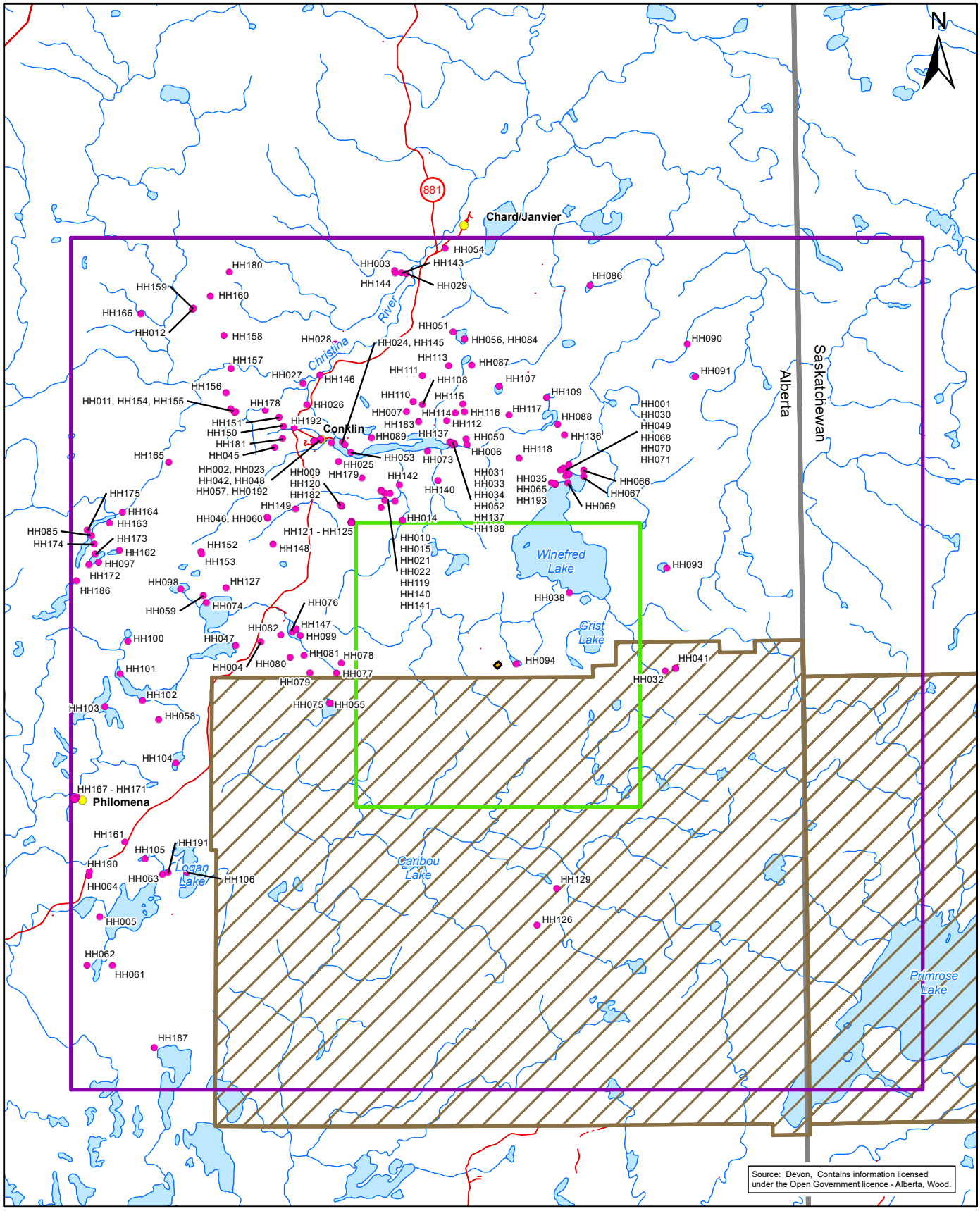
A map of the discrete receptor locations identified in the local study area (LSA) and RSA was provided as Volume 2, Figure 4.4-1. For ease of review, the discrete receptor locations listed in Volume 4, Table SIR1 42-1 for the RSA are shown in relation to the Project in Figure CSIR1 5-1, along with their corresponding location IDs.

As per the Alberta Health 2011 guidance document "A CR or ER exceeding one should be discussed further both in the context of the project alone and various assessment scenarios. The nature and likelihood of potential adverse human health effects should be described as well as the overall conclusions of the HHRA. As well, the significance of the estimated risks should be assessed in the context of the assumptions made in the HHRA including a description of the overall strengths and limitations (including uncertainties) of the assessment and their impact to the level of estimated risk (pg. 33-34)".

2. Provide discussion for the RQ values >1 in Table SIR1 42-13, or provide clarification on where it is discussed.

Volume 4, Table SIR1 42-13 presented the predicted maximum annual average air concentration (233 µg/m^3) for the aliphatic C_9-C_{16} group at the maximum point of impingement (MPOI) for the RSA alongside the corresponding chronic inhalation risk quotient (RQ) value (1.2) under each of the assessment cases (i.e., Baseline Case, Application Case and Planned Development Case). As discussed in the response to Volume 4, SIR1 42, the chronic inhalation RQ values for the aliphatic C_9-C_{16} group were predicted to be less than 1.0 for each of the discrete locations within the RSA where people are known or anticipated to spend time, and the chronic inhalation RQ values for the aliphatic C_9-C_{16} group at the RSA MPOI were not predicted to change between the Baseline Case and Application Case. Together, this suggests that the likelihood of a person being exposed to the predicted maximum annual average air concentration of 233 µg/m^3 on a long-term or chronic basis (i.e., repeated exposure over the course of several weeks or months or longer) is low and that the Project will have no effect on the Baseline Case health risks for long-term exposure to the aliphatic C_9-C_{16} group in the RSA.

For the purposes of the current response, the interpretation of the exceedance for the aliphatic C_9-C_{16} group was expanded to consider the spatial extent of the predicted exceedances and the conservatism incorporated in the chronic inhalation exposure limit used in the calculation of the chronic inhalation RQ values for the aliphatic C_9-C_{16} group.



Source: Devon, Contains information licensed under the Open Government licence - Alberta, Wood.

Legend

- Air Quality Local Study Area
- Air Quality Regional Study Area
- Pike 2 CPF
- Cold Lake Air Weapons Range
- Open Water
- Watercourse
- Road
- Discrete Receptor

5 0 5 10
Kilometres
1:750,000

Pike 2 Project SIR1 Clarification Request

Discrete Receptors
within
Regional Study Area

July 18, 2019	Fig CSIR 5-01 Receptors.mxd
Canadian Natural	PROVIDED BY: Wood
	FINAL MAPPING BY: Wood

Figure CSIR1 5-1

Map Path: S:\Gis\Projects\CE\Devon\04808_Pike_2_EIA\SIR\ArcGIS\Fig SIRCL 11-01 Receptors.mxd Analyst - Jay Boutin

The air quality assessment is based on grid spacing of 50 m to 10 km over the modelling domain, with the grid spacing progressively increasing with increased distance from the Project. However, in areas distant from the Project, but near identified emission sources in the region, a denser 2 km grid was used to enhance definition. The RSA MPOI refers to the location in the RSA at which the highest annual average air concentration of the aliphatic C_9-C_{16} group would be expected to occur (and, therefore, the location for which exposure would be greatest). The RSA MPOI for the predicted maximum annual average air concentration of the aliphatic C_9-C_{16} group is located approximately 37 km west-northwest of the Project in close proximity to another industrial project in the RSA, but outside the LSA. Annual average air concentrations of the aliphatic C_9-C_{16} group were only predicted to exceed the chronic exposure limit (i.e., RQ >1.0) for the one grid point in the 120 km by 120 km RSA that corresponds to the MPOI. Thus, the predicted exceedance is restricted to an area of less than 4 km by 4 km in close proximity to another industrial project. The location of the RSA MPOI under the Baseline Case is not predicted to change with the addition of the Project or any other planned developments in the RSA. There are no discrete receptor locations where people are known or anticipated to spend time in this area, and it is highly unlikely that a permanent residence would be constructed in this area in the future, particularly when the industrial project is in operation. For this reason, the likelihood of a person being exposed to the predicted maximum annual average air concentration of 233 µg/m^3 on a long-term or chronic basis (i.e., repeated exposure over the course of several weeks or months or longer) is very low.

The chronic inhalation RQ values for the aliphatic C_9-C_{16} group were calculated using the chronic Reference Concentration (RfC) of 200 µg/m^3 established by the Massachusetts Department of Environmental Protection (MA DEP 2003). The MA DEP RfC is based on neurological effects observed in a subchronic rodent study. The MA DEP RfC was selected as the chronic inhalation assessment of the aliphatic C_9-C_{16} group because it was the lowest (i.e., most conservative), defensible exposure limit available. However, the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) also has established a chronic RfC of 1,000 µg/m^3 for the aliphatic C_9-C_{16} group that is defensible and was adopted by the Canadian Council of Ministers of the Environment (CCME) and the Netherlands National Institute of Public Health and the Environment (RIVM) (TPHCWG 1997; RIVM 2001; CCME 2008). Use of the TPHCWG RfC in the calculation of the chronic RQ values for the aliphatic C_9-C_{16} group results in chronic inhalation RQ values below 1.0 at the RSA MPOI under each of the assessment cases (i.e., Baseline Case, Application Case and Planned Development Case).

Based on the above, adverse health effects as a result of long-term inhalation exposure to the aliphatic C_9-C_{16} group in the RSA are not expected.

References:

Canadian Council of Ministers of the Environment (CCME). 2008. *Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale*. Supporting Technical Document. January 2008. ISBN 978 1 896997 77 3.MA DEP.

Massachusetts Department of Environmental Protection (MA DEP). 2003. *Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/APH Methodology Final*. Boston, MA: Massachusetts Department of Environmental Protection.

Netherlands National Institute of Public Health and the Environment (RIVM). 2001. *Re-evaluation of Human Toxicological Maximum Permissible Risk Levels*. RIVM Report 711701 025. March 2001.

Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG). 1997. *Vol.4. Development of Fraction Specific Reference Doses (RfDs) and Reference Specific Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH).* Amherst Scientific Publishers. Amherst, Massachusetts.

6. Volume 4, SIR1 45, Page 175-176.

SIR1 45 stated "Explain the discrepancy between the results from these two tables." Although Devon provided the evidences of why these two tables have different results due to different time averaging metrics, Devon did not specifically address the potential impact of the linear relationship of $PM_{2.5}$ in relation to the values approaching the WHO AQG.

1. Provide a discussion as to what the mitigation and monitoring plans are for $PM_{2.5}$ to ensure health protection.

Consistent with Volume 4, SIR1 45, the response below focuses on the 24-hour particulate matter ($PM_{2.5}$) air concentrations for the construction phase of the Project.

Volume 2, Table 4.6-5 for the air quality assessment presents a maximum (1st highest) predicted 24-hour air concentration for fine $PM_{2.5}$ associated with the Project's construction activities alone (i.e., Project-Alone) of 28.8 µg/m³, which is less than Alberta's Ambient Air Quality Objective of 29 µg/m³ (AEP 2019).

As described in the human health risk assessment (HHRA; Volume 2, Section 17.7.1.1), concentration-response functions for $PM_{2.5}$ based on daily time-series data from multiple large urban centres with typical populations well in excess of 1 million people (i.e., significantly larger than the population that surrounds the Project) are near linear, with no obvious evidence of safe threshold levels (Pope and Dockery 2006). However, epidemiological studies that explore the relationship between short-term $PM_{2.5}$ exposure and health effects tend to tie the estimated changes in the rate of disease (e.g., incidence of cardiovascular and/or respiratory effects) to a sizable increase in ambient $PM_{2.5}$ levels (e.g., 10 µg/m³) (Krewski et al. 2009; Pope et al. 2009).

Although the maximum predicted 24-hour concentration for $PM_{2.5}$ of 28.8 µg/m³ for the Project-Alone during construction exceeds the incremental increase of 10 µg/m³ at the MPOI for the LSA, the $PM_{2.5}$ emissions and subsequent air dispersion modelling results (i.e., predicted ground-level air concentrations) presented in the Application for the Project's construction phase are conservative (Volume 2, Section 4.6.6.1). The air dispersion model assumed that the peak equipment counts are operating simultaneously throughout the year, which will not be the case. As well, the maximum predicted 24-hour concentration for $PM_{2.5}$ is predicted to occur within 50 m of the CPF boundary, where the air dispersion model is most likely to overpredict emissions from area sources. Consequently, actual ground-level air concentrations of $PM_{2.5}$ are expected to be much lower than those predicted as part of the air quality assessment (Volume 2, Section 4.0) and evaluated in the HHRA (Volume 2, Section 17.0). Moreover, the likelihood that someone would be present at the LSA MPOI along the CPF boundary to be exposed to the maximum predicted 24-hour concentration for $PM_{2.5}$, particularly during construction, would be low.

At the discrete locations, where people are known to or anticipated to spend time within the LSA, the maximum predicted 24-hour $PM_{2.5}$ concentrations for the Project-Alone during construction are generally low, 0.083 µg/m³ to 0.21 µg/m³ at the Aboriginal peoples locations, 0.062 µg/m³ to 0.36 µg/m³ at the worker locations and 0.086 µg/m³ to 4.1 µg/m³ at area user locations (Volume 3, Table B5-4; note that

Table B5-4 presents the maximum predicted $PM_{2.5}$ air concentrations for the discrete locations that correspond to the Aboriginal peoples and worker locations within the LSA, but not the waterbodies that correspond to the area user locations).

The Project construction will have little effect on the Baseline Case health risks for the short-term exposure to $PM_{2.5}$ in the LSA. Nevertheless, Canadian Natural recognizes that concentrations of $PM_{2.5}$ should be reduced in the ambient environment to the greatest extent possible. Therefore, Canadian Natural will implement low impact construction techniques, including:

- minimizing the size of facilities and access;
- using existing clearings, where possible;
- drilling multiple wells from surface locations; and
- utilizing frozen ground conditions to reduce soil disturbance.

In addition, Canadian Natural will apply appropriate dust suppression methods to limit dust, including $PM_{2.5,}$ during construction activities. Progressive reclamation of disturbed land base also will be undertaken, which will assist in minimizing potential impacts from dust.

Relevant Project mitigation for primary $PM_{2.5}$ emissions was further described in Volume 2, Section 4.8. Canadian Natural plans to manage $PM_{2.5}$ emissions from the Project's combustion and fugitive operational sources by:

- using produced gas in steam generators to replace natural gas to permit more complete combustion of produced gas that would be possible in a flare;
- optimizing combustion efficiencies to reduce $PM_{2.5}$; and
- adopting operational improvements to reduce shut-downs and associated flaring.

Operational air management for the Project was further described in Volume 2, Section 2.5.1. Emission controls that are relevant to mitigating the secondary formation of $PM_{2.5}$ include:

- installing low oxides of nitrogen (NO_x) burners on the steam generators; and
- installing and operating a sulphur removal unit to reduce SO_2 emissions.

Canadian Natural's air monitoring was described in Volume 2, Section 4.9. Once approved, Canadian Natural will incorporate the Project into existing Canadian Natural monitoring programs in accordance with regulatory approval conditions and internal reporting and performance evaluation requirements. Ambient monitoring programs in the area are currently being coordinated through the provincial Oil Sands Monitoring Program and the WBEA. Canadian Natural will participate in these programs as required under the anticipated *EPEA* Approval. Canadian Natural will continue to support the regional monitoring program for the Wood Buffalo area.

Combined, Canadian Natural's mitigation measures and air monitoring program for $PM_{2.5}$ will ensure the protection of public health.

References:

Alberta Environment and Parks (AEP). 2019. *Alberta Ambient Air Quality Objectives and Guidelines Summary*. AEP, Air Policy, 2016, No. 2. January 2019.

Krewski, D., M. Jerrett, R.T. Burnett, R. Ma, E. Hughes, Y. Shi, M.C. Turner, C.A. Pope III, G. Thurston, E.E. Calle, and M.J. Thun. 2009. *Extended Follow-up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality*. HEI Research Report 140. Health Effects Institute, Boston, MA.

Pope, C.A. III and D.W. Dockery. 2006. *Health Effects of Fine Particulate Air Pollution: Lines that Connect*. J. Air & Waste Manage. Assoc. 56:709-742.

Pope, C.A. III, M. Ezzati and D.W. Dockery. 2009. *Fine-particulate Air Pollution and Life Expectancy in the United States*. N. Eng. J. Med. 360:376-386.

7. Volume 4, Human Health.

The conclusions of the HHRA are dependent on the predicted air dispersion modelling results. Through the SIR process, additional air modelling may be required for the air quality portions of the application thus generating new predicted air concentration data.

1. If new or additional air dispersion data is generated for selected COPC, compare the results to health-based TRVs and discuss the potential health impact or provide justification for not completing these steps.

No new or additional air dispersion modelling results were prepared in responding to these clarification questions. Consequently, no new assessment is required.

8. Volume 4, SIR1 46, Page 177-191.

1. Please clarify if the new SO_2 data generated were applied in the response to SIR1 42.

The new air dispersion modelling results (i.e., predicted ground-level air concentrations) for SO_2 based on the higher SO_2 emission rate for the Project were not applied in the response to Volume 4, SIR1 42; however, the higher SO_2 emission rate for the Project does not influence the predicted ground-level air concentrations for SO_2 at the discrete receptor locations in the RSA. For this reason, there is no change in the acute inhalation RQ values presented for SO_2 and the respiratory irritants mixture in response to Volume 4, SIR1 42 for Aboriginal peoples, workers and area users. Only the MPOI for the RSA, which includes the LSA, is influenced by the new SO_2 results.

In the response to Volume 4, SIR1 42, the RSA MPOI based on the original SO_2 results was predicted to occur in close proximity to another industrial project in the RSA under each of the assessment cases (i.e., Baseline Case, Application Case and Planned Development Case); however, with the higher SO_2 emission rate for the Project, the RSA MPOI for the new peak (1st highest) predicted 10-minute SO_2 concentration under the Application Case and Planned Development Case is predicted to occur within the LSA along the CPF boundary for the Project. As a result, the new acute inhalation RQ values for SO_2 and the respiratory irritants mixture at the RSA MPOI under the Application Case and Planned Development Case are consistent with those presented and discussed in the response to Volume 4, SIR1 46 for the LSA MPOI.

Table CSIR1 8-1 presents the new maximum acute inhalation RQ values for the Application Case and Planned Development Case in the RSA together with the RQ values presented for SO_2 and the respiratory irritants mixture in the response to Volume 4, SIR1 42(1).

Table CSIR1 8-1: Acute Inhalation Risk Quotients for 10-Minute Sulphur Dioxide and the Respiratory Irritants Mixture in the Regional Study Area

Receptor Group	Chemical of Potential Concern/ Mixture	Volume 4, SIR1 42(1) Risk Quotient[1,2]			New Risk Quotient[1,2]	
		Baseline Case	Application Case	Planned Development Case	Application Case	Planned Development Case
RSA MPOI	SO_2	4.6	4.6	4.6	5.4[4]	5.4[4]
	Respiratory irritants[3]	7.3	7.3	7.3	8.1[4]	8.1[4]
Aboriginal peoples	SO_2	2.2	2.2	2.2	2.2	2.2
	Respiratory irritants[3]	2.7	2.7	2.7	2.7	2.7
Workers	SO_2	2.0	2.0	2.1	2.0	2.1
	Respiratory irritants[3]	2.5	2.5	2.6	2.5	2.6
Area users	SO_2	2.1	2.1	2.1	2.1	2.1
	Respiratory irritants[3]	2.6	2.6	2.6	2.6	2.6

Notes:

1 An RQ equal to or less than 1.0 signifies that predicted exposure was equal to or less than the exposure limit; whereas, an RQ greater than 1.0 indicates that the exposure estimate exceeded the exposure limit.
2 Based on the peak (1st highest) predicted 10-minute air concentration.
3 Individual constituents of the respiratory irritants mixture are acetaldehyde, acrolein, cadmium, chromium, H_2S, manganese, nickel, NO_2, SO_2, vanadium and xylenes.
4 Refer to Volume 4, SIR1 46 for a discussion of these results.

ERRATA

9. Volume 4, SIR1 43, Page 163. Table SIR1 43-2: Comparison of the Maximum Predicted Annual Air Concentrations at the Air Quality Local Study Area Maximum Point of Impingement Against Chronic Benchmarks, Page 163.

Some of the Chronic Benchmark guideline values appear to have been rounded (e.g., the value provided for Mercaptans by TCEQ is 1.8 µg/m³, not 2 µg/m³).

1. Provide all the Chronic Benchmark guideline values in Table SIR1 43-2 as they appear in the source cited (i.e., TCEQ 2018).

The chronic Effects Screening Level (ESL) for mercaptans of 1.8 µg/m³ (as presented by Texas Commission on Environmental Quality [TCEQ] 2018) was rounded to 2 µg/m³ in Volume 4, Table SIR1 43-2. All other acute and chronic benchmarks presented in Volume 4, Table SIR1 43-1 and Table SIR1 43-2, respectively, were presented correctly (i.e., without rounding).

Comparison of the chronic ESL of 1.8 µg/m³, instead of the rounded chronic ESL of 2 µg/m³, against the predicted annual average air concentrations of mercaptans for the LSA MPOI does not change the conclusions of the response to Volume 4, SIR1 43 because the maximum predicted annual average air concentration for mercaptans of 0.67 µg/m³ under all assessment cases (i.e., Baseline Case, Application Case and Planned Development Case) is still less than half of the chronic ESL of 1.8 µg/m³.

Reference:

Texas Commission on Environmental Quality (TCEQ). 2018. Texas Air Monitoring Information System (TAMIS) Web Interface. Tox ESL-Summary Report, Effective Date: 09/04/2018.

Canadian Natural

Appendix CSIR1 A

Final Clarification of Supplemental Information Request 1

Alberta Energy Regulator

Calgary Head Office
Suite 1000, 250 – 5 Street SW
Calgary, Alberta T2P 0R4
Canada

www.aer.ca

OSCA Application No. 1917507 and EPEA Application No. 001-00426706

July 10, 2019

By e-mail only

Erin Sumner, Sr. Environment and Regulatory Specialist
Canadian Natural Resources Limited
100, 400 – 3rd Avenue SW
Calgary, AB T2P 4H2

E-mail: Erin.Sumner@cnrl.com

Integrated OSCA and EPEA Application
Clarification of Supplemental Information Request Responses
Athabasca Oil Sands Area
Pike 2 Project

Dear Ms. Sumner:

In support of the Oil Sands Conservation Act (OSCA) Application No. 1917507 and Environmental Protection and Enhancement Act (EPEA) Application No. 001-00426706, the Alberta Energy Regulator (AER) and associated government agencies have reviewed the supplemental information request (SIR) response received on May 7, 2019.

To continue the review of the EIA report and associated applications, further clarification of the SIR responses provided is required. Review of the EIA report and processing of the applications will resume upon receipt of the requested information. The response should be submitted in one electronic copy to a maximum of 100 MB and in an Adobe PDF format file that is unlocked, text searchable and includes hyperlinks as required. A written response is expected on or before July 30, 2019.

Questions regarding this request can be directed to Wayne Bell at 403-297-7042 or by e-mail at wayne.bell@aer.ca.

Regards,

Shay Dodds, P. Eng.
Manager, In Situ South - Authorizations

inquiries 1-855-297-8311
24-hour emergency 1-800-222-6514

SD/wb

Enclosure (1): Clarification of Supplemental Information Request responses Canadian Natural Resources Limited Pike 2 Project

cc: Wayne Bell, Lead Coordinator, OSCA Enactment Lead, AER
Shirin Modami, EPEA Enactment Lead, AER
Camille Almeida, Environmental Assessment Coordinator, AER
Raegan Lewis, Environmental Assessment Coordinator, AER

Alberta Energy Regulator

Clarification of Supplemental Information Request Responses

Canadian Natural Resources Limited
Pike 2 Project

July 10, 2019

OSCA Application No. 1917507 and EPEA Application No. 001-00426706

Table of Contents

List of Acronyms

The following acronyms are used in this Supplemental Information Request

ACO	Aboriginal Consultation Office
AER	Alberta Energy Regulator
AQRSA	Air Quality Regional Study Area
COPC	Chemicals of Potential Concern
CR	Concentration Ratio
EIA	Environmental Impact Assessment
EPEA	*Environmental Protection and Enhancement Act*
ER	Exposure Ratio
HHRA	Human Health Risk Assessment
NOx	Nitrogen Oxides
OSCA	*Oil Sands Conservation Act*
$PM_{2.5}$	Particulate matter with a diameter less than or equal to 2.5 micrometre
RQ	Risk Quotient
SIR	Supplemental Information Request
TCEQ	Texas Commission on Environmental Quality
t/d	tonne per day
TK	Traditional Knowledge
TLSA	Terrestrial Local Study Area
TLU	Traditional Land Use
TURSA	Traditional Use Regional Study Area
TRV	Toxicological Reference Values
$\mu g/m^3$	micrograms per cubic meter
WBEA	Wood Buffalo Environmental Association

WHO AQG World Health Organization Air Quality Guidelines

1 Alberta Energy Regulator

This clarification request is issued in response to a technical review of the Integrated Application for the Pike 2 Project and SIR responses submitted to the Alberta Energy Regulator (AER) by Devon Canada Corporation (Devon), now Canadian Natural resources Limited (CNRL). Clarification of the SIRs will assist the AER in making a determination on the completeness of the EIA report and a decision on the related applications.

2 Environmental Impact Assessment Report and *Environmental Protection and Enhancement Act*

2.1 Air Quality

1. Volume 4, SIR1 10, Page 34-35. Figure 2.6-2 Material Balance Block Flow Diagram 70,000 BPSD SAGD Facility.
Volume 4, SIR1 12, Page 70-71, Figure SIR1 12-1 and Central Processing Facility PFD-Vapour Recovery System Area 3000

Devon states "It is expected that 0.979 t/d of sulphur will evolve from production during the treating process which is sent to the VRU". Figure 2.6-2 (Rev) indicates that the flash gas contains 1.04 t/d H2S. Figure 12-1 indicates that the flash gas is being sent to the VRU and is subsequently sent to the SRU. It appears that the gas produced through the inlet treating process is routed through the SRU, however when calculating the SO_2 emission rate it seems Devon has not accounted for removal of 70% of the sulphur component of that produced gas.

1. Discuss why Devon has not accounted for removal of any sulphur from the flash gas produced in the inlet treating process when determining the SO_2 emission rate for the project.

2. Provide a comprehensive calculation to justify the requested SO_2 emission limit of 3.02 t/d for the project.

2.2 Traditional Ecological Knowledge and Land Use

2. Volume 2, Section 15.6.2.15, Traditional Ecological Knowledge and Land Use, Page 15-34

Devon discusses available TLU and TK information for the TURSA and the TLSA for the following communities: Beaver Lake Cree Nation, Fort McMurray First Nation #468, Chipewyan Prairie Dené First Nation, Heart Lake First Nation, Cold Lake First Nation and Saddle Lake Cree Nation. Métis groups have been grouped together; however, the ACO also triggered consultation with Buffalo Lake Metis Settlement and Kikino Metis Settlement. Devon states, "Devon is not aware of any publicly available information and is working with the community to obtain TLU data".

3. It is noted due to Devon's confidentiality agreements TLU information cannot be shared, provide updates/information specific to Buffalo Lake Metis Settlement and Kikino Metis Settlement in the EIA individually for each community, to demonstrate

how Devon has been consulting with each community, instead of grouping Métis together as one group.

2.3 Human Health

3. Volume 4, SIR1 39, Table SIR1 39-1: Predicted Maximum Ground-Level Concentrations of Odorous Compounds in the Application Case, Pages 127 and 128.

Devon States "Table SIR1 39-1 shows the maximum predicted ground-level concentrations of odorous emissions for the Baseline Case and Application Case. Although some predicted concentrations are above the published odor thresholds, the increases in the Application Case relative to the Baseline Case are <1% for all odorous species and averaging periods, indicating that the Project has a low contribution to the maxima."

1. Provide the criteria for inclusion of odorous chemicals in Table SIR1 39-1. Justify exclusion of other odorous chemicals emitted from the project (e.g., mercaptans) or include these other odorous chemicals in the assessment.

4. Volume 4, SIR1 40, Pages 129 and 130.

SIR1 40 asked "Assess the potential impact of O_3 on human health due to project activities". The response provided an estimate of O_3 as a result of secondary formation based on regional modeling results; however, a discussion of potential health effects as they may relate to the predicted O_3 concentrations was not provided.

1. Provide a discussion of the nature and likelihood of potential adverse effects associated with the predicted O_3 concentrations arising from secondary formation. Alternatively, clarify where the discussion has been provided.

In the SIR1 40 response Devon States "The Project is located within the Wood Buffalo Environmental Association (WBEA) airshed, which operates a network of meteorological and ambient monitoring stations. Ambient O_3 is monitored at five stations: Athabasca Valley, Wapasu, Conklin, Stony Mountain (west of Conklin), and Janvier." However, 2017 data are presented for the Stony Mountain and Conklin stations only.

2. Provide rationale for providing summary ambient data for only the Conklin and Stony Mountain stations and not discussing results for the other three stations where O_3 data are monitored (i.e., Athabasca Valley, Wapasu and Janvier). Alternatively, provide and discuss the summary data for these stations.

In the SIR1 40 response Devon states "While naturally high O_3 concentrations occur in the area, the residual O_3 impact for the Project is predicted to be low given the relatively low level of precursor in the region."

3. Provide discussion about the regional precursor emission rates (i.e., AQRSA NOx , Baseline NOx emissions of 116 t/d) and why these are considered low.

5. Volume 4, SIR1 42, Pages 132 to 160. Table SIR1 42-1. Discrete Locations Assumed to Represent Aboriginal Peoples, Workers and Area Users in the Regional Study Area, Page 133.

1. Provide a map including the Regional Study Area boundaries and receptor locations presented in Table SIR1 42-1, Page 133.

As per the Alberta Health 2011 guidance document "A CR or ER exceeding one should be discussed further both in the context of the project alone and various assessment scenarios. The nature and likelihood of potential adverse human health effects should be described as well as the overall conclusions of the HHRA. As well, the significance of the estimated risks should be assessed in the context of the assumptions made in the HHRA including a description of the overall strengths and limitations (including uncertainties) of the assessment and their impact to the level of estimated risk (pg. 33-34)".

2. Provide discussion for the RQ values > 1 in Table SIR1 42-13, or provide clarification on where it is discussed.

6. Volume 4, SIR1 45, Page 175-176.

SIR1 45 stated "Explain the discrepancy between the results from these two tables." Although Devon provided the evidences of why these two tables have different results due to different time averaging metrics, Devon did not specifically address the potential impact of the linear relationship of $PM_{2.5}$ in relation to the values approaching the WHO AQG.

1. Provide a discussion as to what the mitigation and monitoring plans are for $PM_{2.5}$ to ensure health protection.

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The conclusions of the HHRA are dependent on the predicted air dispersion modelling results. Through the SIR process, additional air modelling may be required for the air quality portions of the application thus generating new predicted air concentration data.

1. If new or additional air dispersion data is generated for selected COPC, compare the results to health-based TRVs and discuss the potential health impact or provide justification for not completing these steps.

8. Volume 4, SIR1 46, Page 177-191.

1. Please clarify if the new SO2 data generated were applied in the response to SIR1 42.

2.4 Errata

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Some of the Chronic Benchmark guideline values appear to have been rounded (e.g., the value provided for Mercaptans by TCEQ is 1.8 µg/m^3, not 2 µg/m^3).

1. Provide all the Chronic Benchmark guideline values in Table SIR1 43-2 as they appear in the source cited (i.e., TCEQ 2018).