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Abbreviations

AAAQO	Alberta Ambient Air Quality Objective
AEP	Alberta Environment and Parks
AESRD	Alberta Environment and Sustainable Resource Development
CAAQS	Canadian Ambient Air Quality Standards
CCME	Canadian Council of Ministers of the Environment
CEMA	Calgary Emergency Management Agency
CMAQ	Community Multi-scale Air Quality
COPC	contaminants of potential concern
Cs	soil concentration
CWS	Canada Wide Standards
DEP	diesel exhaust particulate
EBAM	environmental beta attenuation monitor
ECO Plan	Environmental Construction Operations Plan
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMS	Environmental Management System
EPP	environmental protection plan
ER	exposure ratio
ERC	Emergency Resource Centre
ERP	emergency response plan
GEOC	Government Emergency Operations Centre
HHRA	human health risk assessment
IFE	imminent flood emergencies
IR	information request
LAA	local assessment area
LOAEC	lowest-observed adverse effect concentration
MC1	McLean Creek

MEP	Municipal Emergency Plan
MOECC	Ontario Ministry of Environment and Climate Change
MPOI	maximum point of impingement
NAAQO	National Ambient Air Quality Objectives
NRCB	Natural Resources Conservation Board
PDA	Project development area
PM	particulate matter
PM_{10}	particulate matter less than 10 micrometers in diameter
$PM_{2.5}$	particulate matter less than 2.5 micrometers in diameter
Project	Springbank Off-stream Reservoir
RCMP	Royal Canadian Mounted Police
REOC	Regional Emergency Operations Centre
RfC	reference concentration
SCP	site command post
SR	special receptor
TAS	traffic accommodation strategy
TOR	terms of reference
TRV	toxicological reference value
TSP	total suspended particulate
US EPA	United States Environmental Protection Agency
VOC	volatile organic compound
WHO	World Health Organization

7 HEALTH

Question 436

Springbank Final Terms of Reference, 6.2 [A] a), c), d), e)

The Final Terms of Reference (fTOR) 6.2[A] states *[A] Describe aspects of the Project that may have implications for public safety. Specifically:*

a) ***describe the emergency response plan including public notification protocol and safety procedures to minimize adverse environmental effects, including emergency reporting procedures for spill containment and management;***

b) document any safety concerns raised by stakeholders during consultation on the Project;

c) describe how local residents will be contacted during an emergency and the type of information that will be communicated to them;

d) describe the existing agreements with area municipalities or industry groups such as safety cooperatives, emergency response associations, regional mutual aid programs and municipal emergency response agencies; and

e) describe the potential safety impacts resulting from higher regional traffic volumes.

Supporting information addressing all Public Safety in the fTOR were not provided for 6.2 [A] a), c), d), e) in the revised EIS.

a. Provide supporting information to address fTOR 6.2[A] a), c), d) and e).

Response 436

a,c,d. Details regarding emergency response are provided in Volume 3D, Section 1.3 and are summarized below.

CONSTRUCTION

Alberta Transportation has an Environmental Management System (EMS) that will be applied to the Project during construction. The EMS includes standard environmental practices and procedures and spill release reporting procedures. In addition to the EMS, Alberta Transportation requires an Environmental Construction Operations Plan (ECO Plan) to be developed by the selected construction contractor using Alberta Transportation's ECO Plan framework which is a joint document prepared by Alberta

Transportation, the City of Calgary, and the City of Edmonton (Alberta Government 2017). The ECO Plan will be a Project-specific plan that identifies and provides mitigation measures for the potential environmental effects of construction. The ECO Plan is required to specifically identify hazardous materials handling measures and emergency response procedures. The contractor will be responsible for developing and implementing the ECO Plan. The ECO plan framework is provided in Volume 4, Supporting Documentation, Document 4.

The ECO Plan will identify potential Project-related incidents that may affect the environment. These incidents could be the result of natural events, accidents, human error or improper work practices. Examples of potential incidents include:

- contaminant spills and releases to land, water and air from fuels, oils, lubricants and chemicals
- discovery of historical contamination
- erosion of land (e.g., water, wind), watercourses (e.g., bank erosion, flooding), berms and coffer dams

The ECO Plan will provide emergency procedures to prevent and respond to potential incidents that may affect the environment. The emergency response procedures will include:

- training provisions to make the contractor staff and sub-contractors aware of their responsibilities during emergency situations
- a list of equipment and materials available on site, including their specific location
- initial response to an emergency, describing the steps to be taken and equipment to be used
- immediate reporting of environmental incidents to appropriate authorities
- post-emergency review, follow up and improvement of procedures as needed

The contractor is responsible that each emergency response procedure reflects the current specific regulatory requirements. The ECO Plan will include contamination discovery and release reporting emergency response procedures. The immediate reporting of environmental releases and spills is a requirement of provincial and federal environmental legislation.

The ECO Plan will include a current emergency contact list and describe where it will be posted. The list must include names and contact details for key personnel and applicable regulatory agencies.

POST-CONSTRUCTION

Post-construction emergency response will be the responsibility of AEP Operations.

Section 6 of the provincial *Water Act* requires the operator of a project to prepare an emergency preparedness plan and emergency response plan (ERP) that is specific to the dam and its operation (Alberta Environment 2003). These documents will be prepared prior to operation of the Project and administered through the Project's lifecycle. As the operator of the Project, AEP Operations will develop the emergency preparedness plan and the ERP prior to the operation of the Project.

Emergency planning for a flood emergency related to dams relies on dam owners providing warnings of any imminent flood emergencies (IFE) and downstream local authorities initiating their own municipal emergency plans (MEP) in response to those warnings. The ERP will detail the actions to be taken, including warnings issued to emergency responders. The EPP will, in general terms, describe the actions expected of other responders. The EPP will contain inundation maps and flood arrival details that will allow responders to plan appropriately for these situations, when they occur.

The EPP lists the 'fan-out' notification procedures and has key contact numbers for other responding agencies. Local authorities, municipalities and other stakeholders will use the developed EPP to update their existing MEPs and it is the responsibility of those agencies to ensure their MEPs for a major flood or dam breach are current and functional.

The ERP is the response document that couples with the emergency preparedness plan and is enacted during an emergency at the Project site. The ERP will establish the site command post (SCP) and if required, activate the province's Regional Emergency Operations Centre (REOC). The ERP will direct staff to begin notification as per the 'fan-out' procedures described in the EPP. The SCP will notify the Government Emergency Operations Centre (GEOC) and advise them to begin the 'fan-out' procedures in the case of an imminent flood emergency (Alberta Environment 2003). The SCP staff will also begin to notify residents below the dam according to the downstream notifications table that will be provided within the ERP. Local authorities and municipalities and other stakeholders will be responsible for activating their MEPs following notifications and, if necessary, will send a representative to the REOC. The Royal Canadian Mounted Police (RCMP) may also be requested to send a representative to the REOC. If an Imminent flood emergency has been declared, AEP's Flow Forecasting Program will activate Alberta Environment's Emergency Resource Centre (ERC). The flow forecasting program can also initiate the province's emergency public warning system, which supplements the telephone-based notices initiated earlier in the process by the SCP.

The City of Calgary and Rocky View County will also have emergency response measures in place.

The Calgary Emergency Management Agency (CEMA) of the City of Calgary plans and coordinates emergency services and resources during major emergencies and disasters (City of Calgary 2017). CEMA works with other City departments, corporations, communities and non-profit agencies to increase Calgary's capacity to be prepared for and recover more quickly from a disaster.

CEMA was established under the Province of *Alberta's Emergency Management Act.* CEMA is responsible for maintaining and coordinating the MEP. The MEP is a guide for preparation and response to major emergencies and disasters affecting Calgary. The plan documents the roles and responsibilities of internal, external, and supporting agency representatives during all phases of an emergency. The MEP can be activated by the Chief of CEMA, who is the lead authority responsible for public safety and municipal response before, during and after local disasters.

The MEP is intended to provide for prompt coordination of the City's resources when consequences of an identified emergency, disaster, or catastrophe and subsequent recovery are outside the scope of normal operations. The only accident scenario related to the Project in which CEMA would be involved would be in the unlikely event of a failure of breach of the off-stream dam.

Rocky View County's Municipal Emergency Advisory Committee and Municipal Emergency Management Agency plans and coordinates emergency services and resources during major emergencies and disasters within the county and reviews the Municipal Emergency Management Plan. Rocky View County's MEP was established under Bylaw C-7396-2014 and is a guide for preparation and response to major emergencies and disasters affecting the county. The plan documents the roles and responsibilities of internal, external, and support agency representatives during all phases of an emergency.

b. Table IR436-1 provides the detail related to safety concerns raised by stakeholders during consultation on the Project. The information in this table is taken from Volume 1, Section 7, Table 7-3 to Table 7-12.

Table IR436-1 Concerns Raised by Stakeholders during Engagement

Stakeholder	Concerns
Stoney Nakoda Nations	• A lack of comprehensive emergency preparedness plans for the Project and how emergencies would be communicated to Stoney Nakoda Nations (specifically for pipelines and utility lines)
Tsuut'ina Nation	• Concerns about debris and contamination from the flood water and concerns about air quality from the debris left over after a flood. • Concerns about dam failure having catastrophic consequences for the nation. • Concerns that the dam and diversion will not act as intended – what if the inlet is blocked and floods? What if the dam fails? What assurances are there that the project will function as intended? • Concerns about safety and requested a communication plan to ensure that Nations and reserves receive warning about potential floods. • Adequate information is not available for a regulatory authority or an independent engineer to evaluate the feasibility of the concepts and the safety of the dam and other project components. • Adequate information was not provided to evaluate the technical, safety, and performance differences and risks between the MC1 and SR1 alternatives. • Potential failure modes for the dam and other facilities do not appear to have been identified and therefore, have not been addressed in development of the design concept. • The design includes a gated outlet that enables, or could result in, the dam storing waste water for prolonged periods of time. It does not appear that the design has adequately considered this condition, which could impact the safety of the dam. • Concerns that the emergency response plan would be developed after Project approvals, and Tsuut'ina Nation would not be able to assess the plan. • Tsuut'ina Nation would like to see disaster planning done for this project. • Emergency response process. Tsuut'ina Nation would like there to be an emergency response planning exercise. When a flood hits, both Alberta Transportation and Tsuut'ina Nation need to understand the process so people are prepared. • Sediment and dust after a flood. • Safety and security of Tsuut'ina Nation in terms of flood protection.
Métis Nation of Alberta Region 3	• The risks of the Project being operated remotely

Table IR436-1 Concerns Raised by Stakeholders during Engagement

Stakeholder	Concerns
Various stakeholders through several venues: • Project Open House • Emails • In-person meetings	• Long grass in the reservoir being a fire hazard • Saturation below the Project dam causing a potential failure • Airborne and waterborne sediments causing illness, stating there were increased incidents of cancer since the 2013 flood • The ability for people in the area to evacuate • The proposed diversion channel and diversion mechanisms ability to respond to a flood and their impact on wildlife corridors • The limited number of emergency exits for residents in West Bragg Creek and if alternative options for emergency exits would be provided to residents in West Bragg Creek • Visibility and a dust bowl effect • The risk assessment for the Project and its compliance to the Canadian Dam Association • Why the Project was not being designed to appropriate safety standards • The impacts of the Project with respect to pipeline integrity and safety • The operating capability and safety of the Project and the difference between a dry-dam and a reservoir • The safety and maintenance related to the design having a single drainage conduit • The level of residual risk that would exist even with the Project in place and how it could directly affect the City's downstream planning and required structural mitigation measures • The emergency services contingency plans would be implemented after the Project was built, due to the Stoney Trail Ring Road being partially blocked

e. Higher regional traffic volumes are expected during the construction phase of the Project, as workers travel to and from the site. Workers will be expected to adhere to posted speed limits and follow any traffic detours associated with Project construction. Flag persons will be present to direct traffic in areas with temporary higher volumes of construction traffic entering or leaving the Project. Stop signs will be placed at intersections of exit locations and access roads. These mitigation measures are expected to decrease the likelihood of vehicle collisions. Following the selection of the construction contractor, the details of construction traffic scenarios will be included as part of the traffic accommodation strategy (TAS) developed by the contractor and approved by Alberta Transportation.

REFERENCES

Alberta Environment. 2003. Emergency Preparedness for Flood Emergencies at Dams Guideline. Update June 1. 2016. https://open.alberta.ca/dataset/f3b55cd9-f01f-42c7-83e8-31738a627b60/resource/41d22390-c934-4acf-a26e-b70506ccbbb1/download/2897068-2003-emergency-preparedness-for-flood-emergencies-at-dams-guideline.pdf

Alberta Government. 2017. Environmental Construction Operations (ECO) Plan Framework 2017 edition. : https://open.alberta.ca/dataset/86e76cd8-f3fd-4724-b51b-7a81cc7120d7/resource/de95cbcb-527d-4529-b69b-1e205c36467d/download/2017ecoplanframework.pdf

City of Calgary. 2017. Calgary Emergency Management Agency (CEMA). Available online: http://www.calgary.ca/CSPS/cema/Pages/home.aspx

Question 437

<u>Volume 3A, Section 15.4.1.4, Table 15-10, Page 15.41</u>
<u>Volume 4, Appendix O, Section 4.2.1, Pages 4.5 and 4.6</u>

In Table 15-10, Alberta Transportation states the criteria health effects for $PM_{2.5}$ are *not specified*; whereas the toxicological discussion of $PM_{2.5}$ in Appendix O describes health effects associated with exposure to $PM_{2.5}$ as cardiovascular and respiratory morbidity and mortality. The potential adverse health effects associated with exposure to $PM_{2.5}$ is well described in the literature (Health Canada and WHO). Table 15-10 and Appendix O contradict each other.

a. Explain why Alberta Transportation states that the criteria health effects for $PM_{2.5}$ are not specified when there is data supporting health effects with $PM_{2.5}$ in Appendix O.

b. Update Table 15-10 as required so that the information is representative of the information in Appendix O.

Response 437

a-b. The information in Volume 4, Appendix O, Section 4, Table 4-1 and in Volume 3A, Section 15, Table 15-10 are identical and reflect that the identified reference does not explicitly state the critical health effects used to establish the exposure limit that is used as the toxicological reference value (TRV). The text in Volume 4, Appendix O, Section 4.2.1, pages 4.5 and 4.6 provides a summary of toxicological studies which have identified the health effects associated with exposure to fine particulate matter. Since it is reasonable to assume that the "health effects" referred to in the identified reference are protective of the health effects identified in the literature, Table IR437-1 (this revision only includes the portion of the tables requiring revision: the rows under the subheading for criteria air contaminants) for revisions to Volume 4, Appendix O, Section 4, Table 4-1 and Volume 3A, Section 15, Table 15-10.

Table IR437-1 Toxicological Reference Values (revision to Volume 3A, Section 15, Table 15-10 and Volume 4, Appendix O, Section 4, Table 4-1)

Chemical of Potential Concern	Exposure Period	Toxicological Reference Value	Critical Effect	Reference
Criteria Air Contaminants				
Nitrogen Dioxide	Acute (1-hour) [a]	114 $\mu g/m^3$	Respiratory effects	CAAQS (2017)
	Chronic (Annual)	32 $\mu g/m^3$	Respiratory effects	CAAQS (2017)
Sulphur Dioxide	Acute (1-hour) [a]	183 $\mu g/m^3$	Respiratory effects	CAAQS (2017)
	Chronic (Annual)	~~13 $\mu g/m^3$~~ n/a	~~Respiratory effects~~ n/a	~~CAAQS 2017~~ US EPA (2017)
Carbon Monoxide	Acute (1-hour)	15,000 $\mu g/m^3$	Oxygen carrying capacity of blood	Health Canada (1994)
	Acute (8-hour)	6,000 $\mu g/m^3$	Oxygen carrying capacity of blood	Health Canada (1994)
$PM_{2.5}$	Acute (1-hour)	80 $\mu g/m^3$	~~Health (not specified)~~ Respiratory and cardiovascular	AAAQO (2017)
	Acute (24-hour) [a]	28 $\mu g/m^3$	~~Health (not specified)~~ Respiratory and cardiovascular	CAAQS (2017)
	Chronic (Annual) [a]	10 $\mu g/m^3$	~~Health (not specified)~~ Respiratory and cardiovascular	CAAQS (2017)
DEP	Acute (2-hour) [b]	10 $\mu g/m^3$	Respiratory effects	Health Canada (2016b)
	Chronic (Annual)	5 $\mu g/m^3$	Respiratory effects	Health Canada (2016b)

REFERENCES

AAAQO (Alberta Ambient Air Quality Objectives and Guidelines). 2017. Published by Alberta Environmental and Parks (AEP). Available at: http://aep.alberta.ca/air/legislation-and-policy/ambient-air-quality-objectives/documents/AAQO-Summary-Jun29-2017.pdf

CAAQS (Canadian Ambient Air Quality Standards). 2017. Published by CCME (Canadian Council for Ministers of the Environment). Available at: https://www.ccme.ca/en/current_priorities/air/caaqs.html

Health Canada. 1994. National Ambient Air Quality Objectives for Carbon Monoxide: Executive Summary. Desirable, Acceptable and Tolerable Levels. Prepared by the CEPA /FPAC Working Group on Air Quality Objectives and Guidelines. Health Canada

Health Canada. 2016b. Human Health Risk Assessment for Diesel Exhaust. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

US EPA (United States Environmental Protection Agency). 2017. Integrated Science Assessment for Sulphur Oxides – Health Criteria. Available at: https://www.epa.gov/isa/integrated-science-assessment-isa-sulfur-oxides-health-criteria

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Question 438

<u>Volume 4, Appendix O, Section 4.2.1, Page 4.3</u>

Alberta Transportation states *As NO_2 has been classified as having non-threshold effects, the acute and chronic TRVs for NO_2 are based upon the CAAQS, as they are more conservative than the AAAQO and NAAQO*.

a. Provide a discussion of the health basis for the derivation of the NO_2 CAAQS and the complete source citation.

b. Provide a health-based discussion of the AAAQO and NAAQOs, the TRVs and the complete source citation for each.

Response 438

a. NO_2 emissions are limited to diesel exhaust during construction. The Canadian Council of Ministers of the Environment (CCME) announced new Canadian Ambient Air Quality Standards (CAAQS) for nitrogen dioxide (NO_2) on November 3, 2017 (CCME 2014a). The CCME noted emissions of NO_2 are linked to health effects such as decreased lung function, respiratory health problems, particularly for children and adults with asthma, and environmental impacts such as acid rain and smog. The 2020 CAAQS for NO_2 are as follows (CCME 2014b):

   - CAAQS for 1-hour NO_2 is 60 ppb (114 µg/m^3) and is based on the 3-year average of the annual 98th percentile of the NO_2 daily maximum 1-hour average concentrations.
   - CAAQS for annual NO_2 is 17 ppb (32 µg/m^3) and is based on the average over a single calendar year of all the 1-hour average NO_2 concentrations.

   Health Canada (2016) identifies the following issues related to NO_2 and for which the CAAQS concentrations are considered health protective:

   - There is strong evidence that ambient NO_2 concentrations cause both short-term and long-term respiratory effects and short-term mortality.
   - These (respiratory and mortality) effects have been observed in epidemiological studies at NO_2 concentrations that commonly occur in Canada.
   - The concentration-response curve for NO_2 is approximately linear, with no clear evidence of a threshold.
   - Evidence supports the establishment of both short-term and long-term standards to protect against the health effects associated with ambient NO_2.

   Therefore, CAAQS are used as the toxicological reference values (TRVs) for the HHRA.

b. The federal government sets National Ambient Air Quality Objectives (NAAQOs) based on recommendations from the Federal-Provincial Working Group on Air Quality Objectives and Guidelines (CCME 1999). The basis of the 1-hour NAAQO of 400 µg/m^3 is for odours (Government of Alberta 2011) and, therefore, is not suitable as a toxicological reference value (TRV). The basis of the 24-hour NAAQO of 200 µg/m^3 and the annual NAAQO of 60 µg/m^3 is unknown.

   The 1-hour average Alberta Ambient Air Quality Objective (AAAQO) for nitrogen dioxide is 300 µg/m^3, which is based on respiratory effects (Government of Alberta 2019). This AAAQO was last reviewed in 2009 (Government of Alberta 2019). For this reason, the lower CAAQS 1-hour exposure level of 114 µg/m^3 is used as the TRV for the HHRA. The annual average AAAQO for nitrogen dioxide (45 µg/m^3) is based on the protection of vegetation; so, it is not suitable as a TRV for the HHRA (Alberta Government 2019).

REFERENCES

CCME (Canadian Council for Ministers of the Environment). 1999. Canadian National Ambient Air Quality Objectives. Available at: http://ceqg-rcqe.ccme.ca/download/en/133/ . Accessed: December 2017.

CCME. 2014a. Canadian Ambient Air Quality Standards (CAAQS), Canadian Ambient Air Quality Standards for Nitrogen Dioxide. Available at: https://www.ccme.ca/en/whats_new/article.html?id=83

CCME. 2014b. Canadian Ambient Air Quality Standards (CAAQS), Current Priorities. Available at: https://www.ccme.ca/en/current_priorities/air/caaqs.html

Government of Alberta. 2011. Alberta Ambient Air Quality Objectives, Nitrogen Dioxide. Effective July 15, 2011.

Government of Alberta. 2019. Alberta Ambient Air Quality Objectives and Guidelines Summary. Updated January 2019.

Health Canada. 2016. Human Health Risk Assessment for Ambient Nitrogen Dioxide. Published May 2016.

Question 439

Volume 4, Appendix O, Section 4.2.1, Page 4.4

Alberta Transportation states *The CAAQS for SO_2 were developed in recognition of the respiratory health effects associated with acute inhalation exposures, and represent the most recent (and most conservative) of the AAAQO, NAAQO and CAAQS*.

a. Provide a discussion of the health basis for the derivation of the SO_2 CAAQS and the complete source citation.

b. Provide a health-based discussion of the AAAQO and NAAQOs, the TRVs and the complete source citation for each.

Response 439

a. The Canadian Council of Ministers of the Environment (CCME) announced new Canadian Ambient Air Quality Standards (CAAQS) for sulphur dioxide (SO_2) on October 3, 2016 (CCME 2014). The CCME noted emissions of SO_2 are linked to respiratory health problems, particularly for children and adults with asthma, and environmental impacts such as acid rain and smog. The new standards are as follows:

- CAAQS for 1-hour SO_2 is 183 µg/m^3 and is based on the 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations.
- CAAQS for Annual SO_2 is 13 µg/m^3 and is based on the average over a single calendar year of all the 1-hour average SO_2 concentrations.

According to the Ontario Ministry of Environment and Climate Change (MOECC 2016), the 1-hour CAAQS was informed by the Health Canada (2016) reference concentration (RfC) of 67 ppb (180 µg/m^3). Health Canada (2016) derived the RfC from controlled human exposure studies for respiratory effects. The CAAQS exposure limit was selected as the toxicological reference value (TRV) for short-term exposures to SO_2.

The CAAQS for annual SO_2 is protection of vegetation (Ontario MOECC 2016). Health Canada (2016) concluded that there is inadequate evidence to infer a causal relationship between long term exposures of SO_2 and health effects. Additional discussion of chronic exposures to SO_2 and human health are provided in the response to IR440.

b. The NAAQS and the Alberta Ambient Air Quality Objective (AAAQO) for SO_2 were not selected as TRVs.

The federal government set National Ambient Air Quality Objectives (NAAQOs) based on recommendations from the Federal-Provincial Working Group on Air Quality Objectives and Guidelines (CCME 1999). Health Canada (2006) provided guidance for the acute NAAQO for 1- and 24-hour averaging times of 450 µg/m^3 and 150 µg/m^3 and a chronic NAAQO (annual averaging time) of 30 µg/m^3, with the goal of providing protection of human health effects from SO_2. However, the basis of the derivation of these values is unknown.

The 1-hour average AAAQO for sulphur dioxide is 450 µg/m^3, which is based on pulmonary effects (Alberta Environment 2011; Alberta Government 2017). The 24-hour average AAAQO for sulphur dioxide (125 µg/m^3) and the annual average AAAQO for sulphur dioxide (20 µg/m^3) were adopted from the European Union. The European Union's 24-hour objective is based on protection of human health while its annual average objective is based on the protection of ecosystems.

REFERENCES

Alberta Environment. 2011. Alberta Ambient Air Quality Objectives, Sulphur Dioxide. Available at: https://open.alberta.ca/dataset/f7925f51-1395-4c95-9a2d-dc4a339dddd8/resource/657df534-14dd-424f-9d80-90daf715e8e3/download/2011-aaqo-sulphurdioxide-feb2011.pdf Accessed: October 2018

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Ontario MOECC (Ministry of Environment and Climate Change). 2016. Science Discussion Document on the Development of Air Standards for Sulphur Dioxide (SO_2). Standards Development Branch, Ministry of the Environment and Climate Change.

Question 440

Volume 4, Appendix O, Section 4.2.1, Pages 4.2 to 4.8
Volume 4, Appendix O, Section 4.2.6, Table 4-1, Page 4.22 to 4.25
Volume 3A, Section 15.4.1.4, Table 15-10, Page 15.40

Alberta Transportation states *the chronic, annual SO_2 TRV applies the lowest annual objective among the AAAQO, NAAQO and CAAQS, which is an ecosystem-based objective to protect vegetation.*

Health Canada (2016) did not derive a chronic TRV due to the lack of evidence of long term exposure resulting in adverse human health effects. It is incorrect to apply a vegetation based TRV to assess potential human health risk.

Tables 4-1 and 15-10 incorrectly describe the critical effect of chronic exposure to SO_2 as Respiratory effects.

a. Provide a scientific discussion supporting why the chronic assessment of SO_2 for human health should not be conducted.

Update Tables 4-1 and 15-10 without a chronic SO_2 TRV.

Health Canada. 2016. Human Health Risk Assessment for Sulphur Dioxide (CAS RN: 7446-09-5), Analysis of Ambient Exposure to and Health Effects of Sulphur Dioxide in the Canadian Population, Water and Air Quality Bureau, Safe Environment Directorate.

Response 440

a. As noted in Volume 4, Appendix O, Section 4.2.1, page 4.4, there is inadequate toxicological information to infer a causal relationship with long-term sulfur dioxide (SO_2) exposure. However, the HHRA applied the annual Canadian Ambient Air Quality Standard (CAAQS) as a toxicological reference value (TRV) despite acknowledging that this value is an ecosystem-based objective to protect vegetation. The annual CAAQS is not appropriate as a human health TRV.

   The CAAQS (CCME 2014) and the Alberta Ambient Air Quality Objective (AAAQO) (Alberta Government 2017) for annual SO_2 were developed as ecosystem-based objectives to protect vegetation. The United States Environmental Protection Agency (US EPA 2017) and Health Canada (2016b) concluded that there is inadequate evidence to infer a causal relationship between long-term SO_2 exposure and cardiovascular effects, reproductive and development effects, total mortality, or cancer. Similarly, the US EPA (2017) and Health Canada (2016b) concluded that evidence is suggestive of, but not sufficient to infer, a causal relationship between long-term SO_2 exposure and respiratory effects. In the absence of evidence of a causal relationship, a chronic assessment of SO_2 for human health has not been conducted. See Table IR440-1 (this revision only includes the portion of the tables requiring revision: the rows under the subheading for criteria air contaminants) for revisions to Volume 4, Appendix O, Section 4, Table 4-1 and Volume 3A, Section 15, Table 15-10.

Table IR440-1 Toxicological Reference Values (revision to Volume 3A, Section 15, Table 15-10 and Volume 4, Appendix O, Table 4-1)

Chemical of Potential Concern	Exposure Period	Toxicological Reference Value	Critical Effect	Reference
Criteria Air Contaminants				
Nitrogen Dioxide	Acute (1-hour) [a]	114 µg/m³	Respiratory effects	CAAQS (2017)
	Chronic (Annual)	32 µg/m³	Respiratory effects	CAAQS (2017)
Sulphur Dioxide	Acute (1-hour)[a]	183 µg/m³	Respiratory effects	CAAQS (2017)
	Chronic (Annual)	~~13 µg/m³~~ n/a	~~Respiratory effects~~ n/a	~~CAAQS 2017~~ US EPA (2017)
Carbon Monoxide	Acute (1-hour)	15,000 µg/m³	Oxygen carrying capacity of blood	Health Canada (1994)
	Acute (8-hour)	6,000 µg/m³	Oxygen carrying capacity of blood	Health Canada (1994)
$PM_{2.5}$	Acute (1-hour)	80 µg/m³	~~Health (not specified)~~ Respiratory and cardiovascular	AAAQO (2017)
	Acute (24-hour) [a]	28 µg/m³	~~Health (not specified)~~ Respiratory and cardiovascular	CAAQS (2017)
	Chronic (Annual) [a]	10 µg/m³	~~Health (not specified)~~ Respiratory and cardiovascular	CAAQS (2017)
DEP	Acute (2-hour) [b]	10 µg/m³	Respiratory effects	Health Canada (2016b)
	Chronic (Annual)	5 µg/m³	Respiratory effects	Health Canada (2016b)

References

AAAQO (Alberta Ambient Air Quality Objectives and Guidelines). 2017. Published by Alberta Environmental and Parks (AEP). Available at: http://aep.alberta.ca/air/legislation-and-policy/ambient-air-quality-objectives/documents/AAQO-Summary-Jun29-2017.pdf

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Question 441

Volume 4, Appendix O, Section 4.2.1, Pages 4.3 and 4.4

In their assessment of sulphur dioxide (SO_2), Health Canada (2016) and the World Health Organization (WHO 2005) provide a toxicological reference value (TRV) for 10-minute exposure to SO_2 as short-term exposures (5-10 minute) have the strongest evidence of causality compared to 1 hour, or 24 hours exposures.

a. **Provide an assessment of 10-minute SO_2 exposure using the TRV derived by Health Canada (2016).**

Health Canada. 2016. Human Health Risk Assessment for Sulphur Dioxide (CAS RN: 7446-09-5), Analysis of Ambient Exposure to and Health Effects of Sulphur Dioxide in the Canadian Population, Water and Air Quality Bureau, Safe Environment Directorate.

WHO (World Health Organization). 2005. Air Quality Guidelines, Global Update 2005. Particulate matter, ozone, nitrogen dioxide and sulfur dioxide.

Response 441

a. In its human health risk assessment for sulphur dioxide, Health Canada (2016) derived a 10-minute reference concentration of 174 µg/m^3 (67 ppb), based on the lowest-observed adverse effect concentration (LOAEC) of 400 ppb. This value was based on lung function decrements from controlled human exposure studies of asthmatics exposed to sulfur dioxide (SO_2) for 5-10 minutes and application of an uncertainty factor of 6. The factor of 6 accounts for uncertainties related to the potential impact of intermittent spikes of higher concentrations of SO_2 on other health endpoints.

   As requested, 10-minute SO_2 concentrations are predicted (see Table IR441-1) for each of the special receptor locations, as well as the maximum point of impingement (MPOI). These concentrations are compared to the 10-minute toxicological reference value (TRV) of 174 µg/m^3, consistent with the approach described in Section 15.4.1.1, page 15.39. The maximum exposure ratio (ER) of 0.12 occurs at the MPOI location and is below the threshold of 1.0. The ERs for the special receptor locations range from 0.031 to 0.049. These results are consistent with the assessment of acute effects based on 1-hour SO_2 concentrations provided in Appendix O, Section 6.2.1, which also found the ERs at the MPOI and the special receptors were less than 1.0. These results based in 10-minute exposures confirm that the risk to human health from short-term exposure to SO_2 is negligible.

Table IR441-1 Exposure Concentrations and Exposure Ratios for 10-minute SO_2 (Construction)

Human Receptor Location	10-minute SO_2 (TRV = 174 µg/m³)					
	Exposure Concentration (µg/m³)			Exposure Ratio (unitless)		
	Base Case	Project Alone	Application Case	Base Case	Project Alone	Application Case
MPOI	1.5E+01	7.6E+00	2.1E+01	8.8E-02	4.4E-02	1.2E-01
SR01	5.5E+00	2.8E+00	8.3E+00	3.2E-02	1.6E-02	4.7E-02
SR02	5.8E+00	1.8E+00	7.1E+00	3.3E-02	1.0E-02	4.1E-02
SR03	5.7E+00	1.2E+00	6.6E+00	3.3E-02	7.2E-03	3.8E-02
SR04	5.4E+00	8.0E-01	6.1E+00	3.1E-02	4.6E-03	3.5E-02
SR05	5.4E+00	9.2E-01	6.2E+00	3.1E-02	5.3E-03	3.6E-02
SR06	5.4E+00	5.0E-01	5.8E+00	3.1E-02	2.9E-03	3.3E-02
SR07	5.4E+00	4.4E-01	5.7E+00	3.1E-02	2.5E-03	3.3E-02
SR08	5.4E+00	4.1E-01	5.7E+00	3.1E-02	2.3E-03	3.3E-02
SR09	5.6E+00	3.1E+00	8.6E+00	3.2E-02	1.8E-02	4.9E-02
SR10	5.5E+00	1.3E+00	6.7E+00	3.2E-02	7.7E-03	3.9E-02
SR11	6.0E+00	1.5E+00	7.3E+00	3.5E-02	8.9E-03	4.2E-02
SR12	5.4E+00	1.4E+00	6.7E+00	3.1E-02	7.9E-03	3.8E-02
SR13	5.4E+00	1.3E+00	6.6E+00	3.1E-02	7.5E-03	3.8E-02
SR14	5.4E+00	1.7E+00	7.0E+00	3.1E-02	1.0E-02	4.0E-02
SR15	5.4E+00	1.4E+00	6.7E+00	3.1E-02	8.2E-03	3.9E-02
SR16	5.3E+00	1.2E+00	6.5E+00	3.1E-02	7.2E-03	3.7E-02
SR17	5.4E+00	4.4E-01	5.7E+00	3.1E-02	2.5E-03	3.3E-02
SR18	5.6E+00	1.6E+00	7.0E+00	3.2E-02	8.9E-03	4.0E-02
SR19	5.5E+00	2.2E+00	7.5E+00	3.2E-02	1.3E-02	4.3E-02
SR20	5.6E+00	1.3E+00	6.6E+00	3.2E-02	7.5E-03	3.8E-02
SR21	5.3E+00	5.0E-01	5.8E+00	3.1E-02	2.9E-03	3.3E-02
SR22	5.3E+00	5.2E-01	5.8E+00	3.1E-02	3.0E-03	3.3E-02
SR23	5.3E+00	4.5E-01	5.7E+00	3.0E-02	2.6E-03	3.3E-02
SR24	5.3E+00	3.9E-01	5.7E+00	3.0E-02	2.2E-03	3.2E-02
SR25	5.7E+00	1.7E+00	7.1E+00	3.3E-02	1.0E-02	4.1E-02
SR26	5.5E+00	6.3E-01	5.9E+00	3.2E-02	3.6E-03	3.4E-02
SR27	5.7E+00	5.3E-01	6.0E+00	3.3E-02	3.1E-03	3.5E-02
SR28	5.7E+00	5.3E-01	6.0E+00	3.3E-02	3.1E-03	3.5E-02
SR29	5.7E+00	5.1E-01	6.1E+00	3.3E-02	3.0E-03	3.5E-02

Table IR441-1 Exposure Concentrations and Exposure Ratios for 10-minute SO_2 (Construction)

Human Receptor Location	10-minute SO_2 (TRV = 174 µg/m³)					
	Exposure Concentration (µg/m³)			Exposure Ratio (unitless)		
	Base Case	Project Alone	Application Case	Base Case	Project Alone	Application Case
SR30	6.0E+00	5.7E-01	6.3E+00	3.5E-02	3.3E-03	3.6E-02
SR31	6.0E+00	5.7E-01	6.3E+00	3.5E-02	3.3E-03	3.6E-02
SR32	5.7E+00	5.0E-01	6.1E+00	3.3E-02	2.9E-03	3.5E-02
SR33	5.5E+00	5.3E-01	6.0E+00	3.2E-02	3.0E-03	3.4E-02
SR34	5.5E+00	5.2E-01	5.9E+00	3.1E-02	3.0E-03	3.4E-02
SR35	5.5E+00	5.2E-01	5.9E+00	3.1E-02	3.0E-03	3.4E-02
SR36	5.4E+00	1.2E+00	6.4E+00	3.1E-02	6.7E-03	3.7E-02
SR37	5.3E+00	4.5E-01	5.7E+00	3.0E-02	2.6E-03	3.3E-02
SR38	5.6E+00	8.0E-01	6.2E+00	3.2E-02	4.6E-03	3.6E-02
SR39	5.6E+00	6.7E-01	6.1E+00	3.2E-02	3.8E-03	3.5E-02
SR40	5.4E+00	1.5E+00	6.9E+00	3.1E-02	8.7E-03	3.9E-02
SR41	5.5E+00	2.8E+00	8.1E+00	3.1E-02	1.6E-02	4.6E-02
SR42	5.9E+00	9.5E-01	6.5E+00	3.4E-02	5.4E-03	3.7E-02
SR43	6.6E+00	1.1E+00	7.5E+00	3.8E-02	6.2E-03	4.3E-02
SR44	5.4E+00	2.1E-01	5.6E+00	3.1E-02	1.2E-03	3.2E-02
SR45	5.4E+00	1.5E-01	5.4E+00	3.1E-02	8.3E-04	3.1E-02
SR46	5.5E+00	1.2E-01	5.5E+00	3.2E-02	6.9E-04	3.2E-02
SR47	5.6E+00	1.3E-01	5.6E+00	3.2E-02	7.4E-04	3.2E-02
SR48	5.5E+00	9.4E-02	5.5E+00	3.2E-02	5.4E-04	3.2E-02
SR49	5.7E+00	8.9E-02	5.7E+00	3.3E-02	5.1E-04	3.3E-02
SR50	5.3E+00	7.9E-02	5.3E+00	3.0E-02	4.6E-04	3.1E-02
SR51	5.3E+00	2.5E-01	5.5E+00	3.0E-02	1.4E-03	3.2E-02
SR52	5.6E+00	2.6E-01	5.6E+00	3.2E-02	1.5E-03	3.2E-02
SR53	5.4E+00	9.2E-02	5.4E+00	3.1E-02	5.3E-04	3.1E-02
SR54	5.6E+00	1.3E-01	5.6E+00	3.2E-02	7.7E-04	3.2E-02
SR55	5.6E+00	8.8E-02	5.6E+00	3.2E-02	5.0E-04	3.2E-02
SR56	5.3E+00	7.7E-02	5.3E+00	3.0E-02	4.4E-04	3.1E-02
SR57	5.7E+00	5.5E-01	6.0E+00	3.3E-02	3.2E-03	3.5E-02
SR58	5.3E+00	4.2E-02	5.3E+00	3.0E-02	2.4E-04	3.1E-02

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Health Canada. 2016. Human Health Risk Assessment for Sulphur Dioxide, Analysis of Ambient Exposure to and Health Effects of Sulphur Dioxide in the Canadian Population, Water and Air Quality Bureau, Safe Environment Directorate.

Question 442

Volume 4, Appendix O, Section 4.2.1, Page 4.5

Alberta Transportation states *For the purposes of this HHRA, the AAAQO and NAAQO for acute and chronic exposures were used to characterize the health risk from $PM_{2.5}$.*

a. Provide a discussion of the health basis for the derivation of the TRVs and the complete source citation.

Response 442

a. The Alberta ambient air quality objectives and guidelines (AAAQO) (Alberta Government 2017) and Canadian ambient air quality standards (CAAQS) (CCME 2014) for acute and chronic exposures were used to characterize the health risk from particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$).

Predicted one-hour concentrations of $PM_{2.5}$ were compared to the AAAQO of 80 µg/m^3. The evidence for health impacts of $PM_{2.5}$ is typically based on exposure periods of 24 hours or longer. As noted by Alberta Environment (2007), the 1-hour guideline is statistically equivalent to the 24-hour guideline (which, in 2007, was 30 µg/m^3).

Predicted maximum 24-hour concentrations of $PM_{2.5}$ were compared to the CAAQS (CCME 2014) of 28 µg/m^3. While it is acknowledged that the 2020 CAAQS for $PM_{2.5}$ will be 27 µg/m^3, this would not affect the conclusions of the assessment since, as indicated in Volume 4, Appendix O, Attachment A, Table A-8, the predicted concentrations at the receptor locations are less than 27 µg/m^3.

The CAAQS for $PM_{2.5}$ is based on a 3-year average of annual 98th percentile daily 24-hour average concentrations measured in environments around Canada. It is not a threshold health-based limit. but is a level that is intended to protect human health (CCME 2005). This level (28 µg/m^3) is similar to the World Health Organization (WHO) air quality guideline of 25 µg/m^3 for the 99th percentile of 24-hour mean concentrations for a given year (WHO 2005, 2013), which was based on relationship between 24-hour and annual particulate matter (PM) levels. As noted by the WHO (2005), the annual average guidelines for PM take precedence over the 24-hour average because, at low levels, there is less concern about episodic excursions; however, meeting the guideline values for the 24-hour mean will protect against peaks of pollution that would otherwise lead to excess health effects.

Predicted annual average concentrations of $PM_{2.5}$ were compared to the CAAQS (CCME 2014) of 10 µg/m³. The CAAQS for $PM_{2.5}$ is based on a 3-year average of annual average concentrations. Like 24-hour $PM_{2.5}$, the annual $PM_{2.5}$ was set at a level that is intended to protect human health and is the same as the WHO air quality guideline of 10 µg/m³ (WHO 2005, 2013). Based on their review of the scientific literature, the WHO (2005) concluded that exposures to annual mean concentrations of $PM_{2.5}$ of 10 µg/m³ are below the mean for most likely effects.

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CCME. 2014. Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone. Available at: http://www.ccme.ca/en/resources/air/pm_ozone.html. Accessed: October 2018

WHO (World Health Organization). 2005. WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide, Global Update 2005. WHO/SDE/PHE/OEH/06.02

WHO. 2013. Health Effects of Particulate Matter, Policy Implications for Countries in Eastern Europe, Caucasus and Central Asia. ISBN 978 92 890 0001 7

Question 443

Volume 4, Appendix O, Section 3.1.1, Pages 3.1 to 3.4

Ozone (O_3) and PM_{10} were not included as COPC in the HHRA. $PM_{2.5}$ was identified as a COPC in the HHRA.

a. **Provide the rationale for the exclusion of O_3 and PM_{10} from the HHRA or include an assessment of potential risk of adverse human health effects associated with the exposure to O_3 and PM_{10}.**

b. **Confirm that the formation of secondary particulates was included in the predicted $PM_{2.5}$ ground level air concentrations or provide a rationale for exclusion of assessment of secondary particulates.**

Response 443

a. ***OZONE***

Ozone is not emitted directly by combustion sources. Rather, ozone can be formed in the troposphere when oxides of nitrogen (NO_X) and volatile organic compounds (VOC) react in the presence of sunlight. These substances are known as ozone precursors. Ozone formation is influenced by both local and distant upwind pollutant emission sources. The potential for the formation of ozone tends to peak during conditions of strong solar radiation, high temperatures, and low wind speeds.

Due to the nitric oxide (NO) to NO_2 conversion reaction, ozone concentrations near emission sources of NO (e.g., congested roadways, urban areas and industrial complexes) can be less than natural background values. Downwind of ozone precursor areas, the photochemically produced ozone concentration reaches its maximum a few hours past solar noon. At night, ozone reverts back to oxygen (O_2) in the presence of NO, which is oxidized to NO_2.

CONDITIONS WITHOUT THE PROJECT

The potential for the Project to contribute to the formation of ozone was examined through the review of regional photochemical model studies. It is important to recognize that the South Saskatchewan Planning Region includes both VOC-limited and NO_X-limited ozone formation regimes. The VOC-limited regime exists within the City of Calgary and likely extends to nearby suburban and rural communities (Environ 2013). In a VOC-limited regime, potential ozone formation associated with the addition of NO_X is limited by the lack of VOC. By contrast, ozone formation within rural areas is likely to be dominated by a NO_X-limited regime. In a NO_X limited regime, potential ozone formation associated with the addition of VOC is limited by the lack of available NO_X.

Environ (2013) conducted a photochemical modelling study using the community multi-scale air quality (CMAQ) model to improve the understanding of ozone and particulate matter formation in the South Saskatchewan Region. The study developed modelling inputs for the CMAQ modelling system for the 2006, 2007 and 2008 base years and two future year emissions (2020 and 2050). The CMAQ emission inventory database was used to conduct air quality simulations for the 2006-2008 base years and two future-year emissions to predict ozone and particulate matter concentrations. The CMAQ concentration estimates were compared against the Canada Wide Standards (CWS), the Canada National Ambient Air Quality Objectives (NAAQOs), and the Alberta Ambient Air Quality Objectives (AAAQOs). In addition, the CMAQ model was applied to estimate impact of local emissions to air quality.

Ozone trends of the 4th highest maximum 8-hour ozone measured at monitoring stations were analyzed using measured ozone concentrations from 1986 to 2009. The trend in ozone concentrations over the time at each monitoring station were evenly split between both stations with positive (increasing) and negative (decreasing) concentration trends. Negative (decreasing) trends were primarily observed at the monitoring stations with higher ozone concentrations. In all cases, the trend in ozone concentrations were small and none of the trends were statistically significant (Environ 2013).

The CMAQ 2006-2008 ozone model predictions were compared against the CWS, NAAQS, AAAQOs and to measured ozone concentrations over this same period. Both the model predictions and the ambient measurements indicate that the 4th highest maximum 8-hour ozone concentration averaged over three years do not to exceed the CWS of 65 ppb. The CMAQ model was also run for the 2020 and 2050 future emission. The predicted change in ozone concentrations for the 2020 and 2050 years as compared to the base case prediction are summarized in Table IR443-1.

Table IR443-1 Predicted Changes in Maximum and Minimum O_3 Concentrations (ppb)

Averaging Period	Maximum			Minimum		
	Base Case	2020	2050	Base Case	2020	2050
1-h	98	96	95	56	54	54
8-h (4th highest)	56	54	54	47	47	44
24-h	68	66	66	40	42	38
Annual	40	39	39	22	22	22

NOTE:
Model Predictions based upon CMAQ Model for South Saskatchewan Planning Region (Environ 2013, Table 2).

Similar to the findings of the trend analysis, the CMAQ model predictions for the future year emissions indicate only small changes to maximum and minimum ozone concentrations. In fact, maximum predicted ozone concentrations are predicted to decrease slightly in the 2020 and 2050 future year emissions (approximately 1 ppb to 2 ppb) at the locations of maximum predicted ozone concentration in the South Saskatchewan Region. The CMAQ model predictions also indicate that the minimum predicted ozone concentration will increase slightly (2 ppb to 4 ppb). The trend analysis of historic ozone measurements and the photochemical model predictions indicate that ozone concentration in the South Saskatchewan region has been relatively insensitive to historic and future changes in NO_X and VOC emissions.

CONDITIONS WITH THE PROJECT

Photochemical modelling was not undertaken specifically for the Project because regulatory dispersion models such as CALPUFF are not capable of realistically simulating the complicated atmospheric chemistry that leads to ozone formation.

The construction phase of the Project will increase NO_X and VOC precursor emissions. Table IR443-2 compares the Project NO_X and VOC emissions in comparison to the emissions in the South Saskatchewan Planning region from the CMAQ model study. The Project is anticipated to increase NO_X and VOC precursor emissions by 0.16% and 0.016%, respectively. Based upon the small increase in ozone precursors and the relatively small predicted changes in future year ozone concentrations from regional photochemical modelling studies, it is concluded that the Project will not likely result in a measurable difference in the magnitude of maximum ozone concentration.

Table IR443-2 Change in Ozone Precursor Emissions (tonne/day)

Assessment Case	NO_X Emissions (tonne/day)	VOC Emissions (tonne/day)
Project (Construction Phase)	1.1	0.093
South Saskatchewan Region	708	572
Percent Increase	0.16%	0.016%

NOTES:
[1] Project emissions are annual average values (see Volume 4, Appendix E, Attachment 3A, Table 3A-2).
[2] South Saskatchewan Planning Region Emissions for 2006 (Environ 2013, Table 1).

Because ozone is not emitted directly by Project activities and the Project is not anticipated to result in an increase in ozone formation, ozone was not selected as a COPC for the HHRA. The Project is not predicted to result in an adverse effect on human health associated with ozone formation

COARSE PARTICULATE MATTER (PM_{10})

Particles larger than about 10 µm in aerodynamic diameter are deposited almost exclusively in the nose, throat, and upper respiratory tract, and tend to be coughed out over a short period of time (Health Canada 2013).

Health Canada (2016) concluded that

"… it cannot be dismissed that there are health effects on the respiratory system resulting from short-term exposure to coarse particles" based on evidence of an association between PM_{10} and respiratory morbidity but acknowledged that the data on health effects of coarse particles are weaker than for fine particles and subject to large measurement errors. Further, the composition of the coarser particulate associated with construction is primarily dust from soil, which is an inert crustal material. Health Canada (2016) reviewed studies that indicated, "…only limited evidence that crustal coarse particulate matter from Asian dust storm events has an effect on mortality, in spite of the extremely high levels of PM_{10} from dust storms."

Consequently, PM_{10} was screened out as a COPC and the HHRA of particulate matter focused on $PM_{2.5}$.

Unlike PM_{10}, fine particles (less than 2.5 µm), are small enough to reach the alveoli (air spaces) deep in the lungs. Generally, the smaller the particle, the greater the potential to penetrate the deepest part of the lung structures. Fine particles ($PM_{2.5}$) also have a greater tendency than larger particles to carry bound chemical components into the deeper lung structures. When both PM_{10} and $PM_{2.5}$ data are available, the $PM_{2.5}$ data tends to carry more weight in determining the potential for health risks, due to the finer size of the particles. Hence, the human health risk assessment for PM, like the federal guidelines, focuses on $PM_{2.5}$.

b. The formation of secondary particulates is included in the $PM_{2.5}$ predicted ground level air concentrations and is considered in the HHRA. From Volume 4, Appendix E, Attachment 3C, Section 3C.3.9, page 3C.13:

"The CALPUFF model is used to predict secondary $PM_{2.5.}$ formation due to precursor SO_2 and NO_X emissions. The model predicts particulate nitrate NO_3^-, which can exist as an aerosol (i.e., dissolved in a water droplet) or as a particle (e.g., NH_4NO_3). Similarly, sulphate SO_4^{2-} can also exist as an aerosol or as a particle (e.g., ammonium sulphate [$(NH_4)_2SO_4$]). NO_3^- and SO_4^{2-} are assumed to react with ambient ammonia (NH_3) to produce ammonium nitrate and ammonium sulphate, respectively. The predicted sulphate and nitrate are multiplied by the factors indicated in Table 3C-4 to account for these transformations.

The $PM_{2.5}$ predictions derived from the CALPUFF model include the primary $PM_{2.5}$ contribution plus the secondary sulphate and nitrate contributions."

REFERENCES

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Health Canada. 2013. Canadian Smog Science Assessment, Volume 2: Health Effects. Published July 2013. Cat.: En88-5/2-2013E-PDF, ISBN: 978-1-100-22463-3, Pub.: 130107

Health Canada. 2016. Human Health Risk Assessment for Coarse Particulate Matter.

Question 444

Volume 4, Appendix O, Section 6.2.1, Table 6-1, Pages 6.2 and 6.3

Alberta Transportation identifies exposure ratios (ERs) greater than 1.0 for the maximum point of impingement (MPOI) receptor locations for NO_2, $PM_{2.5}$ and diesel emission particulate (DEP). The predicted concentrations for acute exposure to DEP were >10 times the exposure limit at the MPOI (ER = 18).

a. **Provide a figure illustrating the location of the MPOI for each COPC with a concentrations ratio greater than 1.0.**

b. **Provide a discussion of the MPOI locations with respect to receptor locations identified in the HHRA and the likelihood a person will be exposed to predicted air concentrations at the MPOI locations.**

c. **Provide a discussion of potential health effects associated with exposure to air concentrations predicted at the MPOI (10x higher than the TRV).**

Response 444

a. As indicated in Volume 4, Appendix O, Section 6.2.1, Table 6-1, concentrations ratios greater than 1.0 are predicted for NO_2 (1-hour and annual exposures), $PM_{2.5}$ (1-hour, 24-hour, and annual average exposures), and DEP (1-hour exposures). Figures illustrating the location of the maximum point of impingement (MPOI) for NO_2 and $PM_{2.5}$ are provided in Volume 3A, Section 3.4.5, specifically:

- Volume 3A, Section 3.4.5.2, Figure 3.9 - Predicted 9th Highest 1-hour Average NO_2 Concentration (Project Case), page 3.69
- Volume 3A, Section 3.4.5.2, Figure 3.10 - Predicted 9th Highest 1-hour Average NO_2 Concentration (Application Case), page 3.70

- Volume 3A, Section 3.4.5.2, Figure 3.11 – Maximum Predicted Annual Average NO_2 Concentration (Base Case), page 3.71
- Volume 3A, Section 3.4.5.2, Figure 3.13 – Maximum Predicted Annual Average NO_2 Concentration (Application Case), page 3.73
- Volume 3A, Section 3.4.5.3, Figure 3.15 - 9th Highest Predicted 1-hour Average $PM_{2.5}$ Concentration (Project Case), page 3.78
- Volume 3A, Section 3.4.5.3, Figure 3.16 - 9th Highest Predicted 1-hour Average $PM_{2.5}$ Concentration (Application Case), page 3.79
- Volume 3A, Section 3.4.5.3, Figure 3.25 – 8th Highest Predicted 24-hour Average $PM_{2.5}$ Concentration (Project Case), page 3.88
- Volume 3A, Section 3.4.5.3, Figure 3.27 – 8th Highest Predicted 24-hour Average $PM_{2.5}$ Concentration (Application Case), page 3.90
- Volume 3A, Section 3.4.5.3, Figure 3.30 – Predicted Annual Average $PM_{2.5}$ Concentration (Project Case), page 3.93
- Volume 3A, Section 3.4.5.3, Figure 3.31 –Predicted Annual Average $PM_{2.5}$ Concentration (Application Case), page 3.94

Figures for DEP were not included in the EIA, and so are provided as follows:

- Figure IR444-1, Maximum Predicted 1-hour Average Diesel Exhaust Particulate Concentrations (Base Case)
- Figure IR444-2, Maximum Predicted 1-hour Average Diesel Exhaust Particulate Concentrations (Project Case)
- Figure IR444-3, Maximum Predicted 1-hour Average Diesel Exhaust Particulate Concentrations (Application Case)

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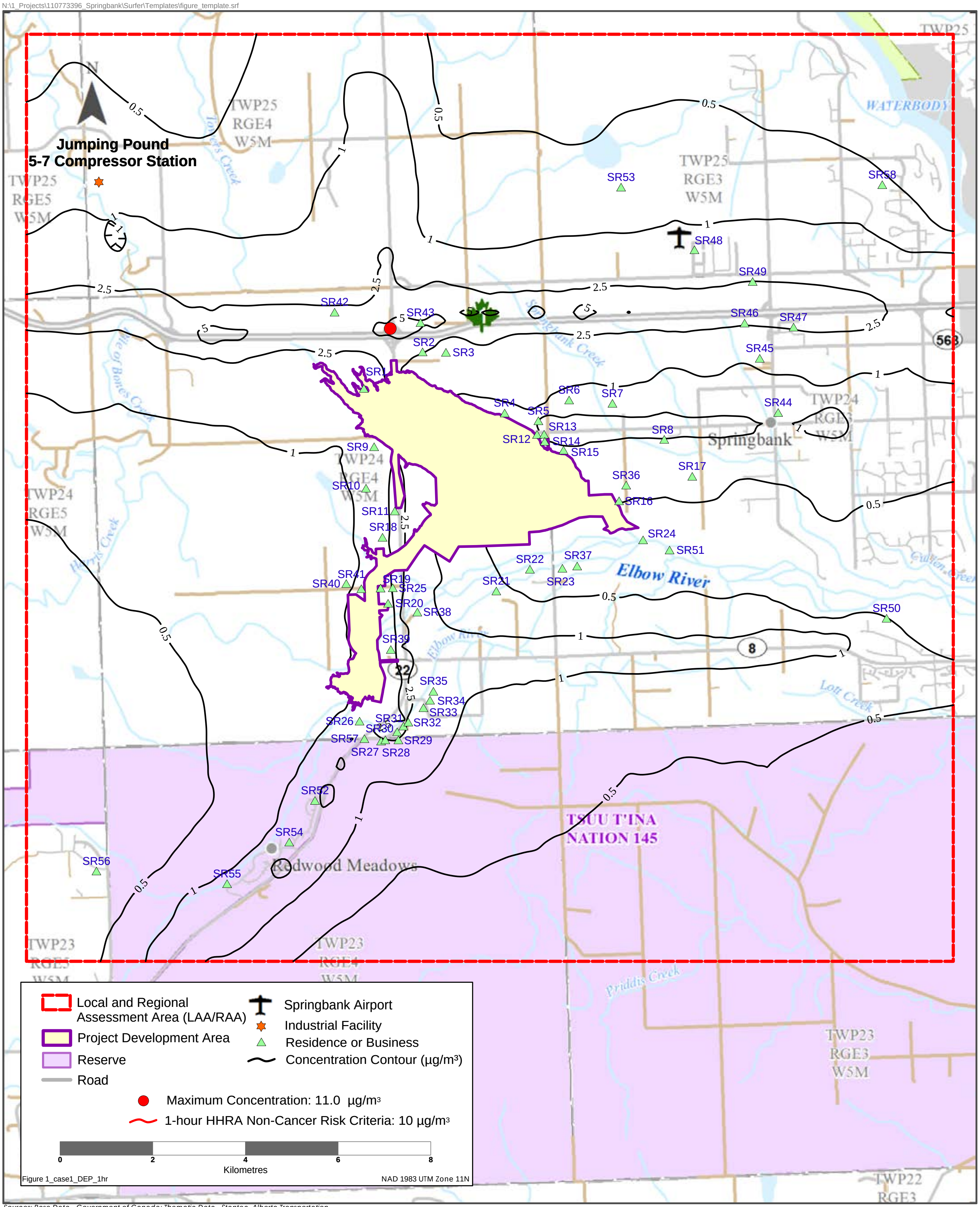


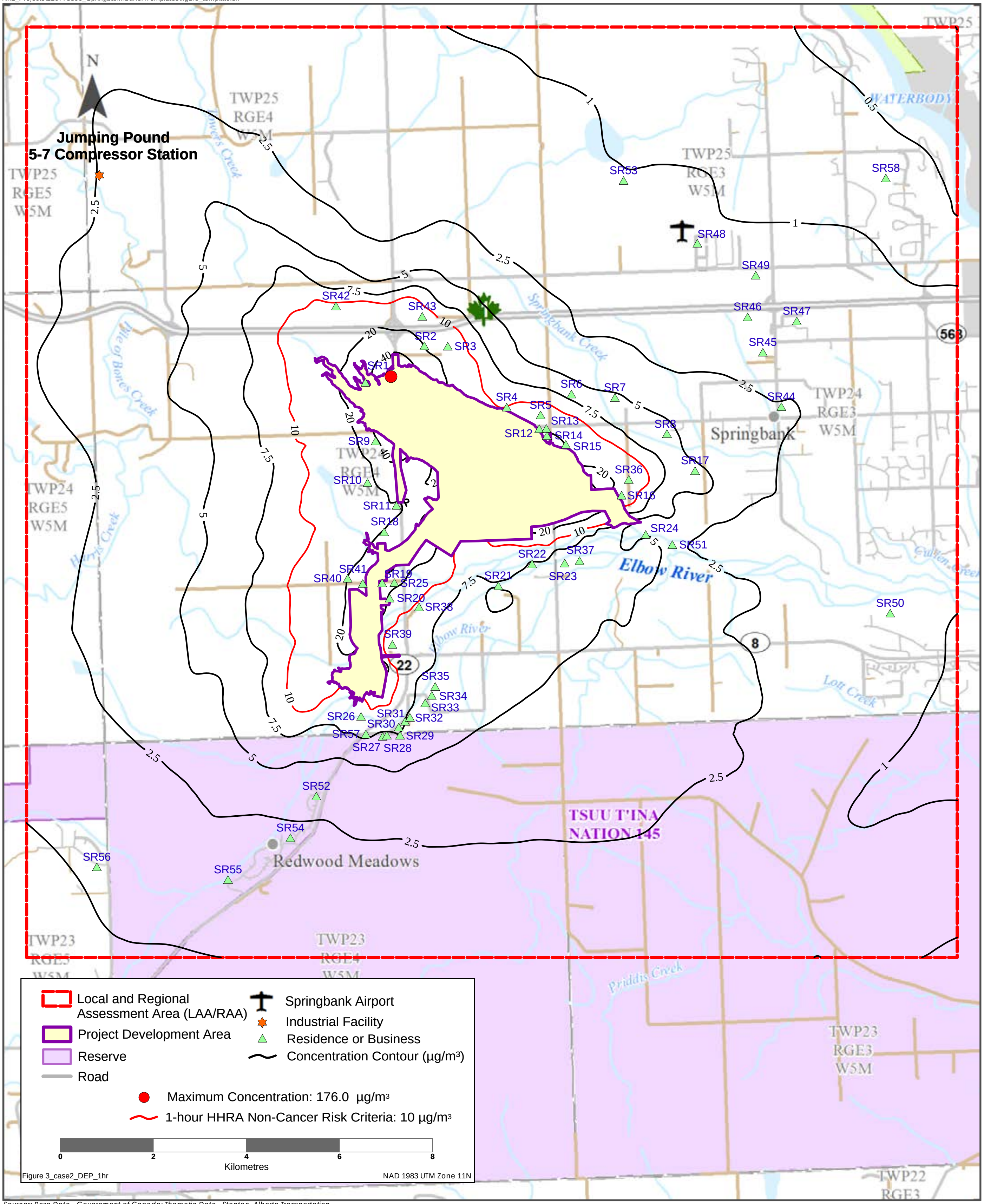
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 1-hour Average Diesel Exhaust Particulate Concentrations (Base Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure IR444-1



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 1-hour Average Diesel Exhaust Particulate Concentrations (Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure IR444-2

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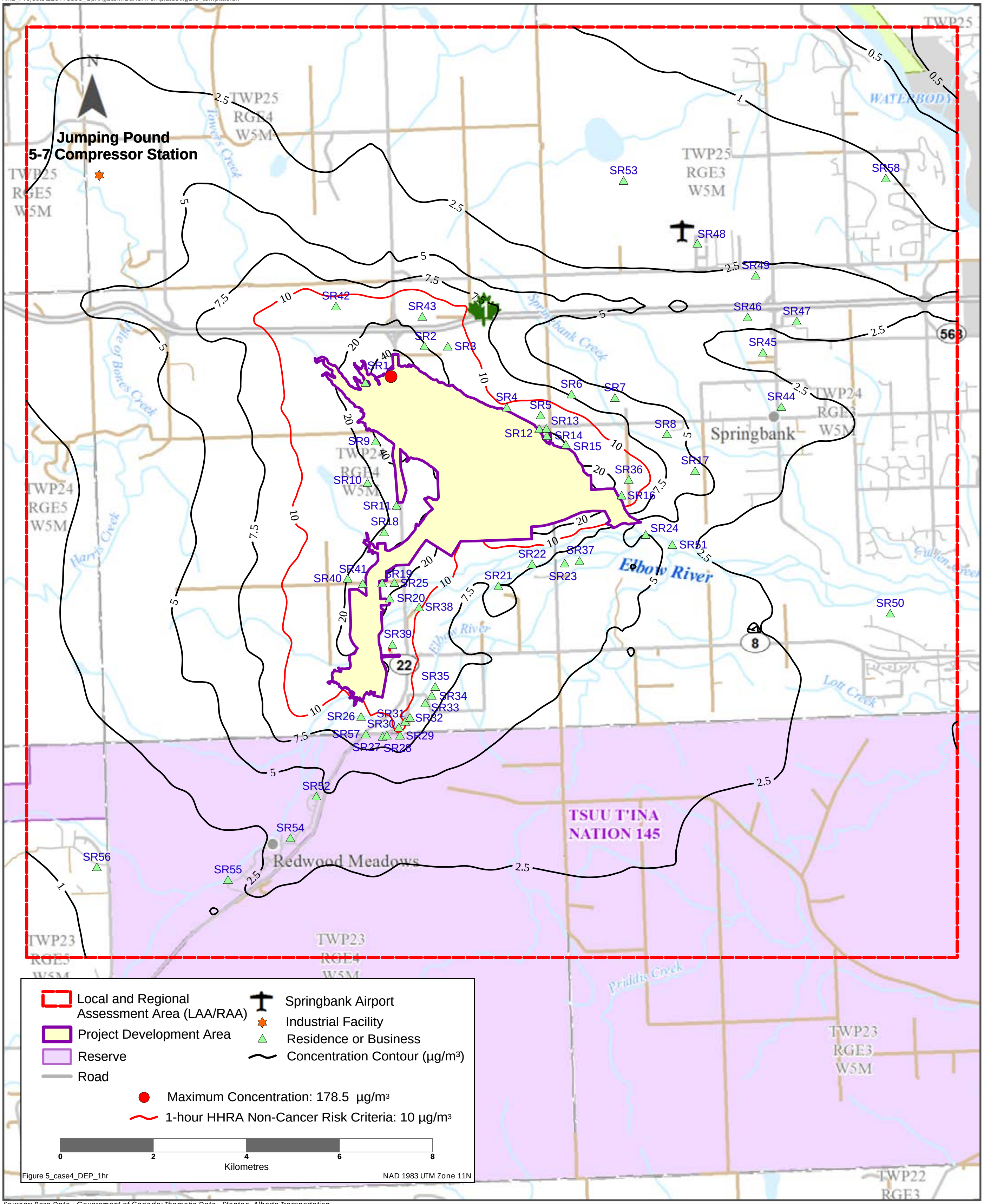

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 1-hour Average Diesel Exhaust Particulate Concentrations (Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure IR444-3

As indicated in Figure IR444-1, the maximum 1-hour concentration of DEP for the Base Case (11.0 µ/m^3) is higher than the 1-hour toxicological reference value (TRV) of 10 µ/m^3, which is equivalent to a concentration ratio of 1.1. The location of the maximum concentration is near the intersection of the TransCanada Highway (Highway 1) and Cowboy Trail (Highway 22). Contours of DEP illustrate that, for Base Case, the highest predicted concentrations are within 1 km of the highways.

The maximum predicted 1-hour concentrations of DEP during the 3-year construction phase are illustrated on Figure IR444-2 (Project Case). The maximum predicted 1-hour concentration (176 µ/m^3) is higher than the 1-hour TRV, and it occurs near a haul road at the boundary of the PDA. As illustrated by the 10 µg/m^3 (which is equivalent to a concentration ratio of 1.0), the maximum 1-hour concentrations of DEP are predicted to exceed the TRV at distances up to 2 km from the western boundary of the PDA, but less than 1 km along the northern, eastern, and southern boundaries. The maximum 1-hour concentrations of DEP for the Application Case (Figure IR444-3) are similar to those for the Project Case.

b. The source of the NO_2 and DEP emissions is diesel exhaust from construction equipment. Diesel emissions are a source of $PM_{2.5}$ (other source is dust from soil). The predicted concentrations for all diesel-related emissions, at the MPOI and throughout the HHRA LAA are expected to be an overestimate due to the conservative assumptions used for the diesel exhaust emission estimates (as described in Volume 3A, Section 3.4.3.3, pages 3.47 and 3.48). For example, emissions were estimated to represent older construction equipment (i.e., prior to Tier 4 emission standard implementation in 2012).

The following presents additional discussion of the MPOI locations with respect to receptor locations and the likelihood a person will be exposed to predicted air concentrations at the MPOI locations for NO_2, $PM_{2.5}$, and DEP.

1-HOUR NO_2 CONCENTRATIONS AT THE MPOI

The highest predicted 1-hour concentrations for the Project Case (359 µg/m^3 at MPOI, as shown in Volume 3A, Section 3.4.5.2, Figure 3.9) and the Application Case (373 µg/m^3 at MPOI, as shown in Volume 3A, Section 3.4.5.2, Figure 3.10) occur along the PDA boundary, 50 m from the north end of the haul road that is parallel to Highway 22 and 500 m from the nearest receptor (SR1).

Based on US EPA guidance (US EPA 2012) for modelling of haul roads as a line of volume sources, predicted concentrations might not be valid within the horizontal dimension of the volume sources referred to as “exclusion zone”. The dimension of the volume sources is the initial dispersion plume width. Volume sources with a horizontal dimension of 120 m (60 m from the centre of the road) are used to model haul roads in the PDA. The location of the maximum predicted 1-hour average NO_2 concentrations falls within the haul road exclusion zone of 60 m from the centre of the road and, therefore, the predicted concentration might be conservative (i.e., overstated).

Further, the location is approximately 500 m from the nearest receptor locations, and the land is undeveloped (i.e., while people may traverse the area, they would be unlikely to linger in the area of the MPOI for an appreciable length of time). While the Project is predominantly situated on private land that has been used for ranching and agriculture since the late 1800s, as stated in Volume 3A, Section 14.1.7, some landowners allow Indigenous groups access for traditional purposes. None of the Traditional Use Studies (TUS) completed by Indigenous groups for the Project have identified specific traditional land use sites at this location. Kanai First Nation has identified elk and white-tailed deer habitat at this location. Ermineskin Cree Nation has identified low to moderate subsistence harvesting within this area. Therefore, it is possible, but unlikely, that Indigenous harvesters could be in this area during construction. Opportunities for harvesting country foods during construction will not be permitted, due to safety. Therefore, it is unlikely that a person will be exposed to the predicted air concentrations at the MPOI location for a 1-h period.

ANNUAL AVERAGE NO_2 CONCENTRATIONS AT THE MPOI

The maximum predicted annual NO_2 concentrations of 42.1 µg/m³ (Base Case) and 42.7 µg/m³ (Application Case) occurs at the intersection of the TransCanada Highway and Highway 22 (Volume 3A, Section 3.4.5.2, Figure 3-11 and Figure 3-13). There are two receptor locations (SR2 and SR43) within 1 km of this MPOI. Because the MPOI is located in the centre of a major intersection, it is unlikely that a person will be exposed to the predicted air concentrations at this location for any appreciable length of time, and receptors would not be exposed to the annual average concentration.

1-HOUR $PM_{2.5}$ CONCENTRATIONS AT THE MPOI

The highest predicted 1-hour $PM_{2.5}$ concentrations for the Project Case (299 µg/m³) and the Application Case (314 µg/m³) occur along the northwest PDA boundary, approximately 50 m from the north end of the haul road that is parallel to Highway 22 and 500 m from the nearest receptor (SR1) (Volume 3A, Section 3.4.5.3, Figure 3-15 and Figure 3-16). Similar to the discussion of 1-hour NO_2 concentrations at the MPOI, the predicted concentrations may be conservative (as the MPOI is within the "exclusion zone" of the haul road volume source), and the location is approximately 500 m from the nearest receptor in an area where people are unlikely to linger for an appreciable length of time. Therefore, it is unlikely that a person will be exposed to the 1-h predicted air concentrations at the MPOI location.

24-HOUR $PM_{2.5}$ CONCENTRATIONS AT THE MPOI

The predicted 24-hour $PM_{2.5}$ concentration at the MPOI for the Project Case (59.7 µg/m³) and the Application Case (72.0 µg/m³) occurs along the northwest PDA boundary, approximately 50 m from the north end of the haul road parallel to Highway 22 and 500 m from the nearest receptor (SR1) (Volume 3A, Section 3.4.5.3, Figure 3-25 and Figure 3-27). Similar to the discussion of 1-hour NO_2 and 1-hour $PM_{2.5}$ concentrations at the MPOI, the predicted concentrations may be overstated (the MPOI is within the "exclusion zone" of the haul road volume source), and the location is approximately 500 m from the nearest receptor in an area where people are unlikely to linger for an appreciable length of time. Therefore, it is unlikely that a person will be exposed to the predicted 24-h air concentrations at the MPOI location.

ANNUAL AVERAGE $PM_{2.5}$ CONCENTRATIONS AT THE MPOI

The highest concentrations for the Project Case (12.1 µg/m³) and the Application Case (15.9 µg/m³) occur along the southeast PDA boundary, within 1 km of three receptors (SR18, SR19, and SR25) (Volume 3A, Section 3.4.5.3, Figure 3-30 and Figure 3-31). Because the nearest receptor is approximately 800 m from the MPOI, it is unlikely that a person would be exposed to predicted concentrations of 15.9 µg/m³ on an annual basis.

1-HOUR DEP AT THE MPOI

The predicted 1-hour DEP concentration at the MPOI of 11.0 µg/m³ for the Base Case occurs at the intersection of the TransCanada Highway and Highway 22 (Figure IR444-1). There are two receptor locations (SR2 and SR43) within 1 km of this MPOI. Because the MPOI is in the centre of a major intersection, it is unlikely that a person will be exposed to the predicted air concentrations at this location for any appreciable length of time.

The predicted 1-hour DEP concentration at the MPOI for the Project Case (176 µg/m³) and the Application Case (179 µg/m³) occurs along the northwest PDA boundary, approximately 50 m from the north end of the haul road parallel to Highway 22, and 500 m from the nearest receptor (SR1) (Figure IR444-2 and Figure IR444-3). Similar to the discussion of 1-hour NO_2 and 1-hour and 24-hour $PM_{2.5}$ concentrations at the MPOI, the predicted concentrations may be overstated (as the MPOI is within the "exclusion zone" of the haul road volume source), and the location is approximately 500 m from the nearest receptor in an area where people are unlikely to linger for an appreciable length of time. Therefore, it is unlikely that a person will be exposed to the predicted 1-hour maximum air concentrations at the MPOI location.

c. The MPOI locations for short-term (1-h and 24-h) exposures of NO_2, $PM_{2.5}$, and DEP are in the same general location—along the northwest PDA boundary near the north end of the haul road parallel to Highway 22. While the source of $PM_{2.5}$ includes both diesel exhaust and inert crustal material (i.e., dust from soil), the source of the NO_2 and DEP emissions is solely diesel exhaust from construction equipment. Hence, the focus of the discussion on potential health effects associated with exposure at the MPOI locations is on health effects associated with diesel exhaust emissions.

Diesel exhaust emissions represent a complex mixture of many gaseous and particulate compounds (including carbon monoxide, volatile organic compounds, nitrogen oxides, polycyclic aromatic hydrocarbons, and particulate matter). Researchers have considered surrogate markers of diesel exhaust exposure, including NO_2 and PM (Health Canada 2016b). These surrogates have been used to quantify exposure to the diesel exhaust mixture in controlled studies where human subjects have been exposed to dilute diesel exhaust. The findings of these controlled studies provide an indication of potential health effects associated with exposure to diesel exhaust emissions:

- In studies conducted with healthy subjects, mildly asthmatic subjects, and both health and mildly asthmatic subjects, increased measures of airway resistance were observed for a 2 h diluted diesel exhaust exposure, where measured concentrations of DEP (reported as PM_{10}) were 100 µg/m³ while concentrations of NO_2 in the studies ranged from 650 to 1300 µg/m³ (0.35 to 0.7 ppm) (Mudway et al. 2004; Riedl et al. 2012; Stenfors et al. 2004).
- In three studies, healthy subjects exposed to diluted diesel exhaust for 2 h reported respiratory inflammation (Behndig et al. 2006, 2011; Stenfors et al. 2004). Concentrations of DEP (reported as PM_{10}) in the studies were 100 µg/m³ while concentrations of NO_2 ranged from 750 to 1300 µg/m³ (0.4 to 0.7 ppm).
- Respiratory inflammation was not noted in asthmatic subjects exposed to diluted diesel exhaust for 2 h (Behndig et al. 2011; Stenfors et al. 2004). Concentrations of DEP (reported as PM_{10}) in the studies were 100 µg/m³ while concentrations of NO_2 ranged from 750 to 1300 µg/m³ (0.4 to 0.7 ppm).
- In studies where subjects were exposed to diluted diesel exhaust for a 1 h exposure period, increased airway resistance was observed in both healthy and asthmatic subjects; however, while an inflammatory response was observed in healthy subjects, respiratory inflammation was not observed in asthmatic subjects (Nordenhall et al. 2000, 2001; Salvi et al. 1999). Concentrations of DEP (reported as PM_{10}) in the studies was 300 µg/m³ while concentrations of NO_2 ranged from 2200 to 3000 µg/m³ (1.2 to 1.6 ppm).

These same key studies were used by Health Canada (2016) to derive a short-term exposure limit for diesel exhaust emissions using DEP as a surrogate for the mixture as a whole (i.e., 2-h exposure limit of 10 µg/m³ for DEP). There are uncertainties associated with this short-term exposure limit. Key uncertainties include relevancy of the diesel exhaust mixtures in the key studies relative to current engine technologies, the use of DEP as a surrogate, and the uncertainty in the study designs, as described below.

- Many of the key studies relied on diesel exhaust emissions produced using older engine technology (e.g., 1991 Volvo diesel engine was used for many of the studies). There have been major changes in diesel fuels, engines and after-treatment technologies that have occurred since 1991, which have implications for diesel exhaust emissions and the risk associated with them (HEI 2015). For example, there has been 99% reduction in particulate mass emissions from 2007 and 2010 heavy-duty diesel engines relative to 1998 emissions standards (HEI 2015). As a result, the diesel exhaust mixture that the test subjects were exposed to may not be representative of Project-related diesel exhaust exposures.

- As indicated previously, there is a high potential for co-exposure to other compounds in the diesel exhaust. Subjects in the key 2-h exposure studies were exposed to the full diesel exhaust mixture, including major documented concentrations of NO_2, ranging from 650 to 1300 µg/m³. Short-term exposures to these other compounds are also known to result in respiratory effects.
- The study designs also introduce uncertainty into the development of the short-term exposure limit. In the key studies, 2-h exposures were limited to one exposure concentration (i.e., DEP/PM_{10} of 100 µg/m³). This concentration was selected by Health Canada (2016a) as the lowest observed adverse effect level; however, in the absence of additional 2-h exposure studies at other concentrations, there is a large degree of uncertainty with respect to the shape of the exposure-response relationship for short-term exposures to diesel exhaust. Health Canada (2016) appears to acknowledge this uncertainty, noting that large-scale epidemiological studies examining the acute effects of diesel exhaust in the general population would likely provide a better understanding of the exposure–response relationships and characterization of population health risks associated with short-term diesel exhaust exposure.

As noted in b., the short-term concentrations of diesel exhaust at the MPOI are characterized by a predicted 1-h DEP concentration of 179 µg/m³ (ER=18), 1-h NO_2 concentration of 373 µg/m³ (ER=3.3), and 1-h concentration of $PM_{2.5}$ of 310 µg/m³ (ER=3.9). The predicted 1-hr maximum concentration of particulate matter (expressed as DEP) at the MPOI is similar to or lower than those observed in the key studies (i.e., 179 µg/m³ at the MPOI versus 100 to 300 µg/m³ for 2-h and 1-h exposure periods, respectively), but the 1-h concentration of NO_2 is considerably lower than those observed in the key studies (i.e., 373 µg/m³ at the MPOI versus 650 to 3,000 µg/m³). These results suggest that the diesel exhaust mixture associated with the Project differs from the diesel exhaust mixture used in the key studies relied upon by Health Canada (2016) to derive the DEP short-term exposure limit of 10 µg/m³ and highlights the considerable uncertainty associated with the calculated ER of 18 for DEP.

With respect to NO_2, controlled human exposure studies in healthy adults suggested that respiratory and cardiovascular systems were not adversely affected by inhalation of up to 1,880 µg/m³ for one to six hours, with or without exercise, although evidence of slight hematological, inflammatory, and immunological effects has been observed in some healthy adults with exposure to 1,100 µg/m³ NO_2 (Health Canada 2015). Evidence for the respiratory health effects for NO_2 exposures below concentrations of 500 µg/m³ is inconsistent (Health Canada 2015). While the predicted1-h concentration of NO_2 at the MPOI (373 µg/m³) is higher than the Canadian Ambient Air Quality Standard (CAAQS) of 113 µg/m³, it is less than the Alberta Ambient Air Quality Objective (AAAQO) of 300 µg/m³, established for the protection of respiratory effects and below the concentrations associated with effects identified in the controlled human studies.

Based on the studies of healthy and asthmatic subjects exposed to diesel exhaust, the predicted 1-h concentrations at the MPOI (DEP =179 µg/m³, NO_2 = 373 µg/m³) may cause increased airway resistance and inflammation. These effects are characterized as "mild and reversible" (Health Canada 2016). However, as in the response to b., it is considered unlikely that a person would be exposed to the predicted NO_2, $PM_{2.5}$, and DEP concentrations at the MPOI. The predicted model concentrations are conservative as the MPOI is within the "exclusion zone" of the haul road volume source (increasing model uncertainty and more likely to overestimate concentrations) and the emission estimates related to diesel exhaust are expected to overestimate predicted concentrations (as described in Volume 3A, Section 3.4.3.3, pages 3.47 and 3.48). Also, people are unlikely to be present at the MPOI for the exposure duration (i.e., one to two hours) since the location is approximately 500 m from the nearest receptor in an area where people are unlikely to linger for an appreciable length of time.

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Question 445

Volume 4, Appendix O, Attachment C, Page C.1

Alberta Transportation applied a formula for the calculation of soil concentrations.

a. Provide the complete source citation supporting the use of the formula used to predict C_S.

Response 445

a. The equation used to predict soil concentration (Cs) is provided in:

Drivas, P., T. Bowers, and R. Yamartino. 2011. Soil mixing depth after atmospheric deposition. I. Model development and validation. Atmospheric Environment, Vol. 45, pp. 4133-4140

Question 446

Volume 3A Section 3.4.4.1, Page 3.55
Volume 3C, Section 2.2, Pages 2.2 and 2.3
Volume 3A Section 15.1.2, Page 15.2
Volume 3A, Section 15.4.4.1, Page 15-46

Volume 3A, Section 3.4.4.1, Alberta Transportation states *Therefore, chemical dust suppression will be applied on an as-needed basis during high wind conditions or if PM concentrations are in exceedance of the Alberta Air Quality Objectives and if an increase of watering is determined ineffective or unfeasible at the time…. Additional mitigation measures can be implemented on an as-required basis.*

Volume 3C, Section 2.2, Alberta Transportation states *As maximum total suspended particulate (TSP) and $PM_{2.5}$ concentrations and dustfall deposition are predicted to be greater than the ambient air quality criteria outside the PDA during construction, an ambient air quality monitoring program will be used to determine TSP concentrations, $PM_{2.5}$ concentrations, and dustfall during construction. The air quality and climate follow-up program will be conducted to validate the success of particulate matter mitigation measures.*

Volume 3A, Section 15.1.2, Alberta Transportation states *Concerns were received following engagement with Indigenous groups, the public and regulators. Concerns were raised regarding air quality around the construction areas near residences because people could inhale emissions from vehicles and construction equipment.*

Volume 3A, Section 15.4.4.1, Alberta Transportation states *The results indicate that with partial mitigations to reduce $PM_{2.5}$ along the haul road and borrow material area, there could still be an unacceptable short-term risk to human health for residents and people adjacent to the PDA ... More intensive dust mitigation measures can be applied during the construction phase.*

Adequate discussion of additional mitigation strategies to be applied in the event of short term air quality exceedance and communication strategies with local communities were not provided.

a. **Provide additional details of the more intensive dust mitigation measures that can be applied. Include details of what will trigger implementation of the additional mitigation measures.**

b. **Describe how TSP and $PM_{2.5}$ exceedances identified in the air quality monitoring program will be communicated to residents in the LAA.**

c. **Provide a description of how Alberta Transportation will receive and respond to complaints regarding dust and air quality during the construction phase.**

d. **How will it be determined that PM concentrations would be exceeding the AAQO, thus requiring dust suppressant?**

e. **Describe the implementation plan for this mitigation measure.**

Response 446

a. During construction, adaptive management techniques will be used to help control the generation of airborne dust (see Volume 3A, Section 3.4.4.1, Volume 3C, Section 2.2 and the response to IR206); the management techniques will include ambient air monitoring in conjunction with dust emission mitigation. Ambient air monitoring will be combined with review of weather data (from an onsite meteorological station) to assess the need for more rigorous dust mitigation. Monitoring will include the installation and operation of an anemometer to measure wind speed and wind direction and an environmental beta attenuation monitor (EBAM) to measure $PM_{2.5}$ and total suspended particles (TSP) concentrations. Monitoring will be continuous over 24 hours and extended throughout the construction period.

   If the monitoring program indicates that ground-level $PM_{2.5}$ and TSP concentrations are greater than Alberta ambient air quality objectives (AEP 2019), additional mitigation to reduce dust emissions will be implemented. This mitigation could include increased watering of the roads, the spraying of surfactants, or the suspension of construction activity at the site.

An Environmental Construction Operations Plan (ECO Plan) will be developed by the selected construction contractor using Alberta Transportation's ECO Plan framework (Volume 4, Supporting Documentation, Document 4). The ECO Plan will identify the mitigation measures for the potential environmental effects of construction, including the ambient air monitoring program and adaptive management techniques to control the generation of airborne dust. The ECO Plan will include the mitigation measures identified in Volume 4, Appendix C, Table C-1, page C.3 to page C.4. Key points related to the ambient air monitoring program and dust mitigation are described in the response to IR206.

b. Prior to start of construction, Alberta Transportation will identify land owners in the air quality LAA and collect their contact information. The construction contractor, as per the *Construction Works Master Specifications Environmental Section 01391* (see Volume 4, Supporting Documentation, Document 11), will implement an ambient air monitoring program that will include 24-hour continuous monitoring of $PM_{2.5}$ and TSP. Monitoring will include the installation and operation of an anemometer to measure wind speed and wind direction, and an EBAM to measure ambient $PM_{2.5}$ and TSP concentrations. Monitoring will be continuous over 24 hours and extend throughout the construction period. Copies of the $PM_{2.5}$ and TSP monitoring results will be prepared in a daily summary format. If there are $PM_{2.5}$ and TSP exceedances, the construction contractor will notify the affected residents within 24 hours by their preferred method of communication. Should $PM_{2.5}$ and TSP exceedances be identified the construction contractor will take immediate actions to reduce fugitive dust as described in the ECO Plan.

c. Alberta Transportation will appoint a Community Liaison that will serve as point of contact with surrounding stakeholders; they will primarily communicate through the local representation for Indigenous groups, community associations, local businesses, government administration and local government officials. Complaints regarding dust and air quality during construction will be directed by the Community Liaison to the construction contractor. The construction contractor will describe the protocol for the receipt, response and documentation of complaints in their ECO Plan. The construction contractor will investigate the conditions and cause of the conditions that led to the complaint. The construction contractor will take necessary actions to reduce the generation of fugitive dust as outlined in the ECO Plan.

d. During construction, adaptive management will be used to help control the generation of airborne dust (see Volume 3A, Section 3.4.4.1, Volume 3C, Section 2.2). The adaptive management will include ambient air monitoring in conjunction with dust emission mitigation. If the monitoring program indicates that the ground-level $PM_{2.5}$ and TSP concentrations are greater than Alberta ambient air quality objectives (AEP 2019), additional mitigation to reduce dust emissions will be implemented.

e. Key points related to the ambient air monitoring program and dust mitigation are described in the response to IR206.

REFERENCES

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Question 447

Volume 3A, Section 15.7, Page 15.65
Volume 3A, Section 15.4.4.1, Tables 15-13, Pages 15.49 to 15.51
Volume 3A, Section 15.4.4.1 Table 15-14, Pages 15.52 and 15.53
Volume 4, Appendix O, Section 8.0, Page 8.1

Volume 3A, Section 15.7, Alberta Transportation states *The assessment of public health shows that the effects from air quality, water quality and country foods are not significant for the construction and dry operations phases*.

This statement is not supported by the technical data report (Volume 4, Appendix O) ER results tables and conclusions which report risk of potential health effects associated with acute inhalation exposures as follows in Volume 4 Appendix O:

- ***Acute concentrations of $PM_{2.5}$, for which both short-term (1-hour or 24-hour) and long-term (annual) ERs are greater than 1.0 at up to 18 of the 58 human receptor locations. Even with partial mitigations, model results indicate there could still be an unacceptable short-term risk to human health for residents and people adjacent to the PDA. Although concentrations of $PM_{2.5}$ are expected to be lower than the modelled predictions, more intensive dust mitigation measures may be considered during the construction phase, including dust suppressants or water on haul roads on an as-needed basis during dry periods with high wind conditions.***
- ***1-hour concentrations of DEP at some receptor locations may exceed the acute (2- hour) DEP exposure limit (maximum frequency of exceedances is less than 5%). Based on multiple studies on test subjects, Health Canada (2016b) concluded that at concentrations above the DEP exposure limit, healthy and/or mildly asthmatic participants may experience increased measures of airway resistance and/or respiratory inflammation. Additional mitigation that may be used to reduce $PM_{2.5}$ exposures (such as adjusting the construction schedule to reduce the number of vehicles operating in an area during dry periods with high wind conditions) would also mitigate acute DEP exposures.***

a. Discuss $PM_{2.5}$ and DEP risk results in the conclusion section of the Public Health report (Volume 3A, Section 15.7) or provide rationale for their exclusion.

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a. Although the exposure ratio (ER) is greater than 1 for short-term exposures to $PM_{2.5}$ and diesel exhaust particulate (DEP), exposures are unlikely to result in a substantive change in the health of an identified receptor. The following explains the reason for this conclusion.

   From Volume 3A, Section 15.1.6, Table 15-3, the significance criteria for human health where the measurable parameter is the ER is defined as:

   > "A significant adverse effect to human health may occur when hazard exposures exceed the objectives established by relevant regulatory organizations (i.e., an ER greater than 1.0), and are likely to result in a substantive change in the health of an identified receptor. This conclusion is based on a consideration of the measurable parameter and relevant contextual effects attributes."

   When the ER is less than the threshold of 1.0 for inhalation, it indicates a low or negligible health risk. However, an ER greater than 1.0 does not necessarily indicate that adverse health effects are expected to occur, or that the health risks are considered unacceptable (Government of Alberta 2011). When the ER is greater than one, the potential for significant adverse effects needs to consider:

   - the context of the Project alone predictions and various assessment assumptions
   - nature and likelihood of potential adverse human health effects (including typical environmental assessment criteria as frequency, magnitude, and reversibility of the effect)
   - the context of the assumptions made in the human health assessment

   Additional considerations related to short-term exposure of $PM_{2.5}$ and DEP are:

   - The source of $PM_{2.5}$ includes both diesel exhaust and inert crustal material (i.e., fugitive emissions of dust from soil). Fugitive dust emissions can be effectively mitigated using industry proven mitigation measures (such as more frequent road watering or more frequent application of a dust suppressant), and real-time $PM_{2.5}$ monitors will be deployed in the areas of concern to indicate when these more intensive dust mitigation measures may be needed. As stated in IR446, the construction contractor, as per the *Construction Works Master Specifications Environmental Section 01391* (see Volume 4, Supporting Documentation, Document 11), will implement an ambient air monitoring program that will include continuous monitoring of $PM_{2.5}$. Further, there is uncertainty with respect to the toxicity of the particulate matter associated with fugitive dust. Both Health Canada (2016a) and WHO (2006) noted a number of studies that suggest particulate from inert crustal material is less toxic than particulate associated with urban environments.

- Most of the sensitive receptor (SR) locations where the concentrations of $PM_{2.5}$ and DEP guidelines are predicted to exceed guidelines during construction are within 100 m of the boundary PDA and roadways (i.e., limited spatial extent relative to the HHRA LAA).
- Emission estimates related to diesel exhaust are conservative and are expected to overestimate predicted concentrations. As described in Volume 3A, Section 3.4.3.3, pages 3.47 and 3.48, these conservative assumptions include assuming only older off-road equipment to be used (for the purposes of estimating diesel exhaust emissions), and basing maximum short-term (i.e., hourly average) emission rates on a compressed construction schedule that would result in greater substance emission rates.
- There is considerable uncertainty with respect to the short-term exposure limit for DEP developed by Health Canada (2016b), including the relevancy of the diesel exhaust mixtures in the key studies relative to current engine technologies, the use of DEP as a surrogate, and the designs of the key studies, which limited exposure to only one concentration (see the response to IR444 for additional details).
- Even with the application of conservative emission rates for diesel exhaust and the uncertainties associated with the short-term exposure limits, 95% of the time concentrations would be below exposure limits (i.e., ER less than 1) at all receptor locations (i.e., limited frequency).
- The health effects associated with short-term exposure to diesel exhaust (increased airway resistance and inflammation) are characterized by Health Canada (2016b) as "mild and reversible" (i.e., magnitude and reversibility).

Ultimately, the air emissions associated with the Project construction are similar to other large construction projects and are limited to fugitive dust (which can be controlled using standard dust suppression methods) and diesel exhaust emissions (including $PM_{2.5}$ and DEP). Emissions estimates used in the modelling are conservative and overestimate the predicted concentrations. The exposure limits used are also conservative, and the potential health effects associated with these short-term exposures are characterized as mild and reversible. Even with the application of conservative emissions estimates and conservative exposure limits, the frequency of occurrence of ER greater than 1.0 is limited. Therefore, the Project is not expected to result in a substantive change in health and the adverse effect is considered not significant.

REFERENCES

Government of Alberta. 2011. Guidance on Human Health Risk Assessment for Environmental Impact Assessment in Alberta.

Health Canada. 2016a. Human Health Risk Assessment for Coarse Particulate Matter. Cat.: H144-30/2016E-PDF, ISBN: 978-0-660-04440-8, Pub.: 150213

Health Canada. 2016b. Human Health Risk Assessment for Diesel Exhaust. Cat.: H129-60/2016E-PDF. ISBN: 978-0-660-04555-9. Pub.: 150239

WHO (World Health Organization). 2006. Air Quality Guidelines, Global Update 2005, Particulate matter, ozone, nitrogen dioxide and sulfur dioxide.

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Volume 3A, Section 15.4.1.4, Page 15.39
Volume 3B, Section 15.4.1.4, Page 15.18
Volume 4, Appendix O

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.

a. In the event that new or additional air dispersion data is generated for selected COPC, compare the results to health-based Toxicity Reference Values (TRVs) and discuss the potential health impact or provide justification for not completing these steps.

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a. No additional air modelling for the air quality portions of the application were required and, therefore, no new data are generated to compare with health-based toxicological reference values (TRVs).