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Abbreviations

BMP	best management practice
LAA	local assessment area
PDA	project development area
$PM_{2.5}$	fine particles with an aerodynamic diameter of 2.5 µm or less
TSP	total suspended particulates with an aerodynamic diameter of 30 µm or less

3.0 ASSESSMENT OF POTENTIAL EFFECTS ON AIR QUALITY AND CLIMATE

The scope of the assessment and existing conditions for air quality and climate are presented in Volume 3A, Section 3. This section assesses the effects of the Project on air quality and climate during flood and post-flood operations due to:

- fugitive dust emissions from the surface of sediment that would be deposited in the off-stream reservoir after impounded flood water has been released back into the Elbow River (post-flood phase) and associated changes in ambient air quality
- odours that may be generated during flood and post-flood phases
- changes in the carbon sequestration capacity for flood and post-flood phases

Existing background conditions for the flood and post-flood phases are the same as those associated with the construction and dry operations. Fugitive dust emissions associated with wind erosion of the sediment surface are quantified and their effect on ambient air quality is assessed using standard dispersion modelling techniques. Changes in odours and carbon sequestration capacity are negligible compared to those during construction and dry operation. For these reasons, their effect on ambient air quality is assessed qualitatively rather than quantitatively.

3.1 PROJECT INTERACTIONS WITH AIR QUALITY

Table 3-1 identifies interactions of the Project during flood and post-flood operations with ambient air quality and climate. These interactions are discussed in more detail in Section 3.2 in the context of effects pathways, air emissions, standard and project-specific mitigation, and residual effects.

Table 3-1 Project-Environment Interactions with Air Quality and Climate during Flood and Post-flood Operations

Project Components and Physical Activities	Environmental Effects		
	Air Quality - Fugitive Dust	Air Quality - Odours	Change in Carbon Sequestration Capacity
Flood and Post-flood Operations			
Reservoir filling	-	-	-
Reservoir draining	-	-	-
Reservoir drainage maintenance	-	-	-
Drained reservoir	✓	✓	✓
Channel maintenance	-	-	-
Road and bridge maintenance	-	-	-
NOTES: ✓ = Potential interaction – = No interaction			

Due to the wet nature during reservoir filling and draining, no fugitive dust emissions are expected because dust emissions would be suppressed under these conditions. There may be fugitive dust emissions occurring during reservoir drainage maintenance and channel, road, and bridge maintenance; however, these emissions would be much smaller than the fugitive dust emissions associated with construction.

Odours are not expected and nor are changes in the carbon sequestration capacity during reservoir filling, reservoir draining, reservoir sediment partial cleanup, channel maintenance, and road and bridge maintenance. These activities are short term; longer periods of time are required to cause odours from rotting vegetation and to cause a measurable change in carbon sequestration capacity.

3.2 ASSESSMENT OF RESIDUAL ENVIRONMENTAL EFFECTS ON AIR QUALITY AND CLIMATE

3.2.1 Analytical Assessment Techniques

Preliminary (conceptual) hydrological modelling is presented in Volume 3B, Section 6 and Volume 4 Appendix J, Hydrology TDR. The hydrological model predicts that the 1:100 year flood and design flood [approximately, a 1: 200 year flood]) will result in measurable sediment deposition. The substances assessed are particulate matter with particle aerodynamic diameter less or equal to 2.5 µm ($PM_{2.5}$) and total suspended particulates (TSP) with particle aerodynamic diameter of less or equal to approximately 30 µm. The emission rates vary with wind speed, since wind speed affects wind erosion of the sediment. Emissions associated with existing emission sources in the LAA are discussed in Volume 3A, Section 3. More detailed information about the calculation methods for estimating fugitive dust emissions from wind erosion of the sediment are provided in Volume 4, Appendix E, Dispersion Modelling for Wind-eroded Sediment from the Off-stream Reservoir Technical Data Report.

The CALMET/CALPUFF model (Scire et al. 2000) is used to determine the effect of fugitive dust emissions from flood and post-flood operations on ambient air quality. This assessment approach is consistent with the approach used for Project construction and dry operation (Volume 3A, Section 3). The application of the model is conducted in accordance with the Alberta Air Quality Model Guideline (AQMG; (AEP 2013)). The CALMET model is used to provide hourly meteorological data required for the CALPUFF transport, dispersion, and deposition model.

The same receptor locations as used in the air quality assessment for construction and dry operations are used in the dispersion modelling study. Ground-level concentrations are predicted at 58 residence and business locations to provide input to the public health VC (Volume 3B, Section 15).

Details on the CALMET/CALPUFF model implementation are provided in Volume 4, Appendix E, Attachment 3B and Attachment 3C. A list of the gridded receptor points and the 58 residence and business locations of specific interest is provided in Volume 4, Appendix E, Attachment 3C.

The modelling is completed for a period of five months between June and October. This period corresponds to a summer period after a most probable flood occurrence (May to September). May is excluded to account for the residence time of water in the off-stream reservoir and the release time of water in the Elbow River. It is assumed that fugitive dust emissions from wind erosion of the sediment will be negligible in winter due to show cover and frozen ground. For fugitive dust emissions winter is considered five months (November to March).

Maximum predicted short-term ground-level concentrations along and outside the PDA (with the background contribution), are compared to the most stringent ambient air quality criteria, which are discussed in Volume 3A, Section 3. Concentrations inside the PDA are not compared to the ambient criteria because public access is restricted in this region.

Only 1-hour and 24-hour concentrations are evaluated since it is assumed that fugitive dust emissions from wind erosion of the sediment will be effectively mitigated in long term (greater than one year) by revegetation of the sediment surface after a flood.

3.2.2 Project Pathways

Floods, when full operation of the off-stream reservoir is needed, are expected to be infrequent. For example, the return period for the design flood is estimated to be in the order of 1:200 years. Based on the design flood, modelling results show the off-stream reservoir filling in approximately 4 days, water retained in the reservoir for approximately 20 days to allow natural water flows to decrease, and to drain back into the Elbow River in at least 38 days. Hence the total estimated duration for flooding and draining is at least 62 days for a design flood. Portions of the land in the reservoir is therefore expected to be under water for at least 62 days for an extreme flood.

Following the release of the flood waters, the wet sediment would have a high moisture content. Areas associated with thick sediment deposits would cover existing vegetation, resulting in bare soil cover that would be subject to a greater wind erosion potential when the surface moisture content has evaporated.

Sediment deposition modelling indicates that sediment depths greater than 10 cm could cover an approximate area of 82 ha in the reservoir for the 1:100 year flood, and an approximate area of 155 ha for a design flood. The total area in the reservoir that would be covered by a 1:100 year flood is 500 ha and by a design flood is 730 ha (see Volume 3B, Section 6 and Volume 4 Appendix J, Hydrology TDR).

For the 1:10 year flood, modelling results show the reservoir would take approximately 0.4 days to fill, be retained in the reservoir at least 43 days and take at least 30 days to discharge the impounded water back into the Elbow River for a total of at least 73 days for the flooded area being under water. Given the low suspended sediment concentrations and volumes associated with the 1:10 year flood, the hydrological model is not able to resolve sediment thicknesses beyond thin drapes and cannot define the extent of sediment cover.

3.2.2.1 Fugitive Dust

When the sediment deposits dry out, there is a potential for fugitive dust emissions from the sediment surface during high wind speed conditions. The amount of dust would depend on the effectiveness of natural and other mitigation measures to control these fugitive dust emissions.

3.2.2.2 Odours

There are two potential sources of odours during flood and post-flood operations. One relates to the possibility of upstream sewage being accidently released due to system failure, entrained into the floodwaters and being deposited in the reservoir. The other relates to submerged and decaying vegetation within the reservoir.

3.2.2.3 Carbon Sequestration Capacity

During the post-flood period, vegetation activity would be decreased prior to the reestablishment of new vegetation cover. This would potentially decrease the natural carbon uptake during the period prior to reestablishing the new vegetation cover.

3.2.3 Air Emission Rates

3.2.3.1 Assessment Cases

The air quality assessment addresses three cases: Base Case defined by existing emissions in the LAA, a Project Case that considers only Project emissions during flood and post-flood operation, and an Application Case that considers the combined effects of the Base Case and the Project Case. Background contributions (from emission sources outside the LAA) are considered for the Base Case and the Application Case. The Project Case includes the 1:100 year flood and the design flood, which are predicted to result in measurable sediment deposition in the off-stream reservoir. The Project Case provides an explicit indication of the Project's contribution.

3.2.3.2 Base Case – Air Emissions

Existing (Base Case) emissions in the LAA include traffic exhaust and road dust emissions on nearby roadways and a compressor station located in the northwest sector of the LAA. Base Case emissions are described in greater detail in Volume 3A, Section 3 and Volume 4, Appendix E, Attachment 3A.

3.2.3.3 Project Case – Air Emissions

Fugitive dust emissions from wind erosion of the sediment are estimated using methodology developed by ENVIRON and the Western Regional Air Partnership (WRAP) Regional Modeling Center (RMC) (Mansell et.al 2006). This method is referred to as ENVIRON/RMC method.

Fugitive dust emissions from wind erosion of the sediment are estimated from the area (m^2) subject to erosion and emission fluxes calculated following the ENVIRON/RMC method. Based on the ENVIRON/RMC method, wind erosion emissions are generated when the wind exceeds a threshold friction velocity that is defined based on the characteristics of the soil subject to erosion. The magnitude of the emission flux is estimated as a function of the hourly gust wind speed (i.e. fastest mile wind) based on empirical relationships derived from wind tunnel studies.

Variable emission rates are calculated for six wind speed categories. This approach allows wind erosion emissions to be modelled as variable emissions by wind speed in the CALPUFF dispersion model.

A summary of estimated Project emission rates for the 1:100 year flood and design flood is presented in Table 3.2-1. The probability of wind within each wind speed category is estimated from the CALMET 5-year time series at the approximate centre of the sediment area in the off-stream reservoir. Total emissions are calculated by multiplying the emission flux for each wind speed category with the probability of wind within that wind speed category.

The wind probabilities show that approximately 82% of the time hourly winds are below the threshold friction velocity that would trigger windblown emissions. For the 5-month summer period that is modelled (June to October), there are 446 hours on average in a year with wind speed greater than 4.5 m/s that have the potential to generate windblown emissions.

Emissions are presented without dust mitigation and with application of 84% dust control efficiency corresponding to application of chemical dust suppressant.

A detailed description of emission calculations is provided in Volume 4, Appendix E, Dispersion Modelling Technical Data Report.

3.2.3.4 Application Case – Air Emissions

The Application Case includes the combined emissions of the Base Case and Project Case. Table 3.2-2 presents the emission summary for the three cases. Project contribution to $PM_{2.5}$ emissions in the LAA is small, 14% to 24% (the Base Case contributes 76% to 86%). The Project contribution for TSP emissions is 26% to 40% (the Base Case contributes 60% to 74%).

Table 3.2-1 Project Emission Rates

Flood Scenario	Sediment Area [a]	Wind Speed Category	Lower Limit Wind Speed	Upper Limit Wind Speed	Mean Wind Speed [b]	Wind Probability [b]	Emission Rate without Dust Mitigation		Dust Control Efficiency [c]	Emission Rate with Applied Dust Mitigation	
							$PM_{2.5}$	TSP		$PM_{2.5}$	TSP
	(m²)	—	(m/s)	(m/s)	(m/s)	(%)	(kg/d)		(%)	(kg/d)	
1:100 year flood	820,578	1	0	4.5	2.44	81.6	0	0	84	0	0
		2	4.5	5.5	4.94	9.7	17	447		2.7	72
		3	5.5	6.5	5.93	4.8	14	362		2.2	58
		4	6.5	8.5	7.24	3.1	15	396		2.4	63
		5	8.5	11	9.39	0.73	6.9	184		1.1	29
		6	11	17	12.19	0.11	2.0	54		0.32	8.6
		Total Emissions:				**100**	**54**	**1,443**		**8.7**	**231**
Design flood	1,553,792	1	0	4.5	2.44	81.6	0	0	84	0	0
		2	4.5	5.5	4.94	9.7	32	847		5.1	136
		3	5.5	6.5	5.93	4.8	26	685		4.1	110
		4	6.5	8.5	7.24	3.1	28	751		4.5	120
		5	8.5	11	9.39	0.73	13	349		2.1	56
		6	11	17	12.19	0.11	3.8	102		0.61	16
		Total Emissions:				**100**	**102**	**2,733**		**16**	**437**

NOTES:

[a] Sediment area corresponding to sediment depth equal or greater than 0.10 m in the off-stream reservoir.

[b] Mean wind speed and probability of wind within each wind speed category calculated from CALMET 5-year time series at the approximate centre of the sediment area in the off-stream reservoir.

[c] Control efficiency corresponds to application of chemical dust suppressant.

Table 3.2-2 Comparison of Base Case, Project Case and Application Case Emission Rates

Assessment Case	Flood Scenario	Emission Source	Daily Emission Rate (kg/d)	
			$PM_{2.5}$	TSP
Base Case (Summer [a])	—	Road Traffic Combustion Emissions	21.3	31.7
		Road Traffic Fugitive Dust Emissions	29.8	624
		Compressor Station (Shell Jumping Pound 5-7)	—	—
		Emission Total	**51.1**	**656**
Project Case (Summer)	1:100 Year Flood	Fugitive dust emissions from wind erosion of post-flood sediment [b]	8.7	231
		Emission Total	**8.7**	**231**
	Design Flood	Fugitive dust emissions from wind erosion of post-flood sediment [b]	16.4	437
		Emission Total	**16.4**	**437**
Application Case	1:100 Year Flood	Base Case Emissions	51.1	656
		Project Case Emissions	8.7	231
		Emission Total	**59.8**	**887**
	Design Flood	Base Case Emissions	51.1	656
		Project Case Emissions	16.4	437
		Emission Total	**67.5**	**1,093**
Project Contribution (%) to Application Case Emissions 1:100 Year Flood:			**14%**	**26%**
Project Contribution (%) to Application Case Emissions Design Flood:			**24%**	**40%**

NOTES:

[a] For traffic combustion emissions, summer is defined as the 6-month period April to September. For road dust emissions, summer is defined as the 8-month period March to October.

[b] Fugitive dust emission rates for wind erosion of post-flood sediment represent emissions during summer with applied dust control efficiency (84%) corresponding to application of chemical dust suppressant. Wind erosion emissions are estimated for the 5-month summer period June to October.

3.2.4 Mitigation

3.2.4.1 Fugitive Dust

To some extent, natural mitigation with respect to future potential fugitive dust emissions has already occurred. The 2013 flood removed an appreciable portion of fine sediment (e.g., clay and fine silt) from the upstream Elbow River drainage basin. The remaining surficial materials in the stream bed and on the banks of the Elbow River and its tributaries that may be prone to mobilization during a future flood would comprise mostly larger material (e.g., sand). Hence, most of the sediment deposited in the reservoir during future floods would be dominated by sand, not fine silt. The sand is less prone to result in fugitive dust during dry windy meteorological conditions.

A primary mitigation for wind erosion in the reservoir would be the re-establishment of vegetation cover (e.g., native grasses) after reservoir draining. Natural revegetation success, however, is not assured, given initial high moisture contents and reduced energy input in the autumn. Should wind erosion occur and natural revegetation prove to be ineffective, a tackifier would be applied where required. Tackifiers are a sprayable erosion control product that bonds with the soil surface and creates a porous and absorbent erosion resistant blanket that can last for up to 12 months.

Reapplication of the chemical stabilizer (tackifier) at defined periods is necessary to maintain high control efficiency. The dilution ratio, chemical application rate and time between reapplications of a chemical stabilizer can be adjusted to achieve and maintain high levels of fugitive dust control. Frequent reapplication of a chemical stabilizer can maintain a control efficiency of 90%. The U.S. Bureau of Mines (Olson and Veith 1987) measured the effectiveness and durability of dust suppressants on tailings for a range of different chemical stabilizers. The study calculated that a 90% level of control can be maintained over a three-month summer period with one initial application and one reapplication of typical latex-based chemical stabilizers.

A dust control efficiency of 84% is applied to fugitive dust emissions as per the WRAP Fugitive Dust Handbook (WRAP 2006) corresponding to application of a chemical dust suppressant.

3.2.4.2 Odours

No sewage is expected to be deposited in the off-stream reservoir. The upstream flood catchment area, which includes Bragg Creek and Redwood Meadows, does not have large septic fields near the banks of the Elbow River that could potentially be damaged by flooding. Hence, the potential for odours emanating from the drained reservoir due to sewage is negligible.

For the design flood, 67 days for the presence of water in the reservoir is short-term with respect to the time required for submerged vegetation to decay and generate odours. There are no Project specific mitigation measures for odours.

3.2.4.3 Carbon Sequestration Capacity

Re-establishment of the vegetation cover on the deposited sediment would mitigate the temporary loss of carbon sequestration capacity. For the design flood, 67 days for the presence of water in the reservoir is short-term with respect to the time required for a substantial change to occur in the carbon sequestration capacity.

Following the release of the impounded water, there would be sufficient growing season to allow vegetation to naturally reestablish in regions where the deposited sediment is less than 10 cm deep. The 2013 flood occurred during the third week of June. For a future flood of similar timing and magnitude, the draining of the reservoir would be completed approximately by the third week of August. The climate 30-year normals for the Springbank Airport (ECCC 2016) indicates that there is a 90% probability that the frost-free period extends into the second week of September. Hence, there are approximately three weeks of remaining growing season for moderately affected vegetation to recover.

For areas covered with large sediment thicknesses, the revegetation (e.g., planting of native grasses) would require another season to restore the ability of the reservoir to fix carbon sequestration capacity.

Between floods, the natural regeneration of the grassland areas would occur in areas where the sediment is less than 10 cm thick. It is highly likely that the natural grasses would be able to grow up through a 10 cm layer of sediment.

3.2.5 Change in Ambient Air Quality

3.2.5.1 Overview

Summaries of maximum predicted ground-level concentrations for $PM_{2.5}$ and TSP for the 1:100 year flood and the design flood are presented in Table 3.2-3 and Table 3.2-4, respectively. The tables include predicted results for the existing emission sources in the LAA (Base Case), the flood and post-flood operations (Project Case) and the combined results for the Project and existing regional emissions sources (Application Case). The maximum predicted values are based on areas along and outside the PDA where public access is not restricted. The presented results for the Base Case and Application Case include background concentrations which account for other emission sources (natural and anthropogenic) that have not been included directly in the dispersion model. The maximum values for the Project Case do not include background contribution because the purpose of the Project Case is to quantify the relative contribution of the Project to the Application Case. Maximum predicted ground-level concentrations along and outside the PDA are compared to the relevant ambient air quality criteria.

The model results for the 1:100 year flood indicate that:

- The maximum predicted $PM_{2.5}$ concentrations are less than the AAAQG, AAAQO and the CAAQS for the Base Case, Project Case and Application Case.
- The maximum predicted TSP concentrations are greater than the AAAQO for the Base Case, Project Case and Application Case. The TSP concentrations are predicted to be above the AAAQO for 2 days per year following a 1:100 year flood, equivalent to a probability of 1 day every 50 years.
- The Project contributes up to 25% of maximum predicted $PM_{2.5}$ concentrations and up to 65% for maximum predicted TSP concentrations.

The model results for the design flood indicate that:

- The maximum predicted $PM_{2.5}$ concentrations are less than the AAAQG, AAAQO and the CAAQS for the Base Case, Project Case and Application Case.
- The maximum predicted TSP concentrations are greater than the AAAQO for the Base Case, Project Case and Application Case. The TSP concentrations are predicted to be above the AAAQO for 10 days per year following a design flood, equivalent to a probability of 1 day every 20 years.
- The Project contributes up to 55% of maximum predicted $PM_{2.5}$ concentrations and up to 81% for maximum predicted TSP concentrations.

Concentration isopleth maps showing predicted ground-level concentrations for the Base Case are presented in Volume 3A, Section 3. Concentration isopleth maps showing predicted ground-level concentrations (Application Case) for the 1:100 year and design floods are presented in Volume 4, Appendix E, Dispersion Modelling Technical Data Report.

3.2.5.2 Results for the 1:100 Year Flood

The predicted maximum ambient concentrations of $PM_{2.5}$ and TSP for the 1:100 year flood are summarized in Table 3.2-3.

Maximum $PM_{2.5}$ Concentrations

The following summarizes modelling results for $PM_{2.5}$ concentrations:

- Base Case—The highest 1-hour and 24-hour average concentrations for the Base Case occur on and near highways. The maximum predicted 1-hour, 24-hour and 8th highest 24-hour $PM_{2.5}$ concentrations of 27.3 µg/m^3, 21.8 µg/m^3 and 18.5 µg/m^3, respectively occur at the intersection of the TransCanada Highway and Highway 22. The maximum predicted $PM_{2.5}$ concentrations are less than the applicable AAAQG, AAAQO and CAAQS.
- Project Case—The highest 1-hour and 24-hour average concentrations for the Project Case occur along the PDA boundary. The maximum predicted 1-hour, 24-hour and 8th highest 24-hour $PM_{2.5}$ concentrations of 6.88 µg/m^3, 4.14 µg/m^3 and 0.641 µg/m^3 occur along the east PDA boundary.
- Application Case—The highest 1-hour and 24-hour average concentrations for the Application Case occur on and near highways. The maximum predicted 1 hour, 24-hour and 8th highest 24-hour $PM_{2.5}$ concentrations of 27.3 µg/m^3, 21.8 µg/m^3 and 18.5 µg/m^3, respectively occur at the intersection of the TransCanada Highway and Highway 22.

The maximum predicted $PM_{2.5}$ concentrations are less than the AAAQG, AAAQO and the CAAQS for the Base Case, Project Case and Application Case. The Project contribution to maximum predicted $PM_{2.5}$ concentrations for the Application Case is small, ranging from 3% to 25%.

Maximum TSP Concentrations

The following summarizes the modelling results for TSP concentrations:

- Base Case—The highest 24-hour average concentrations for the Base Case occur on and near highways. The maximum predicted 24-hour TSP concentration of 163 µg/m^3 occurs at the intersection of the TransCanada Highway and Highway 22. Predicted TSP concentrations greater than the 24-hour AAAQO of 100 µg/m^3 occur for up to 131 days per year near the intersection of the TransCanada Highway and Highway 22.

- Project Case—The highest 24-hour average concentrations for the Project Case occur along the PDA boundary. The maximum predicted 24-hour TSP concentration of 107 µg/m³ occurs along the east PDA boundary. Predicted TSP concentrations greater than the 24-hour AAAQO of 100 µg/m³ occur for up to one day per year along the east PDA boundary.
- Application Case—The highest 24-hour average concentrations for the Application Case occur along the PDA boundary and near highways. The maximum predicted 24-hour TSP concentration of 165 µg/m³ occurs along the east PDA boundary. Predicted TSP concentrations greater than the 24-hour AAAQO of 100 µg/m³ occur for up to 131 days per year near the intersection of the TransCanada Highway and Highway 22 and up to two days per year along the east PDA boundary.

The model predicts maximum 24-hour TSP concentrations greater than the AAAQO to occur approximately 150 m from the east PDA and near the intersection of the TransCanada Highway and Highway 22. Along the east PDA boundary, values greater than the AAAQO are predicted for 2 days in a year, reducing to one day per year with increasing distance.

The 24-hour TSP concentrations are predicted to be greater than the AAAQO at two residence receptor locations near the east PDA boundary for up to one day per year.

The Project contribution to maximum predicted TSP concentrations for the Application Case is approximately 65%.

Table 3.2-3 Maximum Predicted Ground-Level Concentrations for the 1:100 Year Flood

Substance	Averaging Period	Background Concentration	Ambient Criteria [a]	Base Case (includes Background Concentrations)			Project Only			Application Case (includes Background Concentrations)			Percent Contribution of Project to Application Case
				Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Criteria [e]	
		(µg/m³)	(µg/m³)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	%
$PM_{2.5}$	1-hour [c]	11.0	80	27.3	34	0	6.88	9	0	27.3	34	0	25
	24-hour	11.0	30	21.8	73	0	4.15	14	0	21.8	73	0	19
	24-hour [d]	11.0	28 [b]	18.5	66	0	0.641	2	0	18.5	66	0	3
TSP	24-hour	51.0	100	163	**163**	131 d/a	107	**107**	1 d/a	165	**165**	2 d/a (131 d/a)	65

NOTES:

[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2017)

[b] CAAQS: Canadian Ambient Air Quality Standards (ECCC 2013 and CCME 2014)

[c] Concentration represents the 9th highest 1-hour concentration

[d] Concentration represents the 3-year average of the annual 8th highest 24-hour average concentrations

[e] The first value represents maximum frequency above ambient criteria near the east PDA boundary; the value in brackets represents maximum frequency near the intersection of the TransCanada Highway and Highway 22.

Percent values greater than 100% are in **bold** text.

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3.2.5.3 Results for the Design Flood

The predicted maximum ambient concentrations of $PM_{2.5}$ and TSP for the design flood are summarized in Table 3.2-4.

Maximum $PM_{2.5}$ Concentrations

The following summarizes modelling results for $PM_{2.5}$ concentrations:

- Base Case—The highest 1-hour and 24-hour average concentrations for the Base Case occur on and near highways. The maximum predicted 1-hour, 24-hour and 8th highest 24-hour $PM_{2.5}$ concentrations of 27.3 µg/m³, 21.8 µg/m³ and 18.5 µg/m³, respectively occur at the intersection of the TransCanada Highway and Highway 22. The maximum predicted $PM_{2.5}$ concentrations are less than the applicable AAAQG, AAAQO and CAAQS.
- Project Case—The highest 1-hour and 24-hour average concentrations for the Project Case occur near highways and along the PDA boundary. The maximum predicted 1 hour, 24-hour and 8th highest 24-hour $PM_{2.5}$ concentrations of 15.2 µg/m³, 9.59 µg/m³ and 1.62 µg/m³, respectively occur along the east PDA boundary.
- Application Case—The highest 1-hour and 24-hour average concentrations for the Application Case occur near highways and long the PDA boundary. The maximum predicted 1-hour $PM_{2.5}$ concentration of 27.6 µg/m³ occurs along the east PDA boundary. The maximum predicted 24-hour and 8th highest 24-hour $PM_{2.5}$ concentrations of 21.8 µg/m³ and 18.5 µg/m³ occur at the intersection of the TransCanada Highway and Highway 22.

The maximum predicted $PM_{2.5}$ concentrations are less than the AAAQG, AAAQO and the CAAQS for the Base Case, Project Case and Application Case. The Project contribution to maximum predicted $PM_{2.5}$ concentrations for the Application Case is less than approximately 50%.

Maximum TSP Concentrations

The following summarizes the modelling results for TSP concentrations:

- Base Case—The highest 24-hour average concentrations for the Base Case occur on and near highways. The maximum predicted 24-hour TSP concentration of 163 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22. Predicted TSP concentrations greater than the 24-hour AAAQO of 100 µg/m³ occur for up to 131 days per year near the intersection of the TransCanada Highway and Highway 22.

- Project Case—The highest 24-hour average concentrations for the Project Case occur along the PDA boundary. The maximum predicted 24-hour TSP concentration of 245 µg/m³ occurs along the east PDA boundary. Predicted TSP concentrations greater than the 24-hour AAAQO of 100 µg/m³ occur for up to four days per year along the east PDA boundary.
- Application Case—The highest 24-hour average concentrations for the Application Case occur near highways and along the PDA boundary. The maximum predicted 24-hour TSP concentration of 303 µg/m³ occurs along the east PDA boundary. Predicted TSP concentrations greater than the 24-hour AAAQO of 100 µg/m³ occur for up to 131 days per year near the intersection of the TransCanada Highway and Highway 22 and up to 10 days per year along the east PDA boundary.

The model predicts maximum 24-hour TSP concentrations greater than the AAAQO to occur approximately 550 m from the east PDA and near the intersection of the TransCanada Highway and Highway 22. Along the east PDA boundary, values greater than the AAAQO are predicted for 10 days in a year, reducing to one day per year with increasing distance.

The 24-hour TSP concentrations are predicted to be greater than the AAAQO at 6 residence receptor locations near the east PDA boundary for up to seven days per year.

The Project contribution to maximum predicted TSP concentrations for the Application Case is approximately 81%.

Table 3.2-4 Maximum Predicted Ground-Level Concentrations for the Design Flood

Substance	Averaging Period	Background Concentration	Ambient Criteria [a]	Base Case (includes Background Concentrations)			Project Only			Application Case (includes Background Concentrations)			Percent Contribution of Project to Application Case
				Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Criteria [e]	
		(µg/m³)	(µg/m³)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	%
$PM_{2.5}$	1-hour [c]	11.0	80	27.3	34	0	15.2	19	0	27.6	34	0	55
	24-hour	11.0	30	21.8	73	0	9.59	32	0	21.8	73	0	44
	24-hour [d]	11.0	28 [b]	18.5	66	0	1.62	6	0	18.5	66	0	9
TSP	24-hour	51.0	100	163	**163**	131 d/a	245	**245**	4 d/a	303	**303**	10 d/a (131 d/a)	81

NOTES:

[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2017)

[b] CAAQS: Canadian Ambient Air Quality Standards (ECCC 2013 and CCME 2014)

[e] The first value represents maximum frequency above ambient criteria near the east PDA boundary; the value in brackets represents maximum frequency near the intersection of the TransCanada Highway and Highway 22.

Percent values greater than 100% are in **bold** text.

3.2.6 Change in Odours

Unpleasant odours are not expected from the reservoir during the flood and post-flood operations. The estimated time duration between filling and draining the reservoir (67 days assuming the design flood) is not considered sufficient to cause the submerged vegetation to decay and generate odours. Sewage would not be washed into the reservoir because there are no septic fields close to the banks of the Elbow River through Bragg Creek and Redwood Meadows that could be damaged by a future flood that is equal to or less than the magnitude of the design flood.

If there are local pockets of decaying vegetation with the potential to produce odorous emissions, the perception of odour is likely to be limited to the reservoir basin. This is because the height of the dam at the maximum height location is 24 m; this would be a barrier to offsite air transport during conditions associated with poor dispersion. Poor dispersion conditions are typically associated with low wind speed and stable atmospheric conditions that occur at night. Under these conditions, there is a tendency for downslope flows that would cause any odourant emissions to pool in the reservoir basin.

3.2.7 Change in Carbon Sequestration Capacity

The changes to the carbon sequestration capacity of the project development area (PDA) are expected to be minimal for a variety of reasons.

Floods are expected to be infrequent. The return period for the design flood is estimated to be in the order of 1:200 years; the estimated period when the vegetation is submerged is 62 days; and the extent of sedimentation deposit greater than 10 cm is 155 ha. While smaller floods are more frequent, the length of time when vegetation is submerged and the sediment thicknesses are much less. For a 1:10 year flood, the estimated length of time when vegetation is submerged is 73 days. This duration is short-term compared with the time needed for a measurable change to occur in carbon sequestration.

Soils would likely become anoxic during the period of inundation (e.g., estimated 62 days for the design flood and 73 days for a 1:10 year flood), and would remain anoxic until soil drainage is able to restore aeration. Over these time periods, soil anoxia would be relatively infrequent, and anaerobic loss of carbon is expected to be much less than rates of accumulation. Soils in this zone are naturally high in organic carbon, and providing vegetation patterns remain similar over time, are expected to continue to function in this way (Landi et al. 2003).

3.2.8 Summary of Project Residual Effects

Table 3-2 summarizes the residual environmental effects on air quality and climate during flood and post-flood operations. The rationale for the characterizations are indicated as follows.

3.2.8.1 Change in Ambient Air Quality

Project residual effects specific to change in air quality:

- direction—the direction is positive (P) during flood because dust emissions would be suppressed, and adverse (A) during post-flood because the Project results in a predicted increase of ambient concentrations of particulate matter compared to the Base Case.
- magnitude—the magnitude a during flood is negligible (N) because no fugitive dust emissions are expected due to the wet nature during reservoir filling and draining. The magnitude during post-flood is rated moderate to high (M/H) because the Project results in predicted ambient concentrations that are greater than 50% of the ambient criteria (M) or greater than the ambient criteria (H) for different substances of interest.
- geographic extent—the geographic extent during flood is expected to be limited to the off-stream reservoir in the PDA. The geographic extent during post-flood is limited to the LAA because the areas where the Project results in predicted ambient concentrations greater than the Base Case is limited to the extent of the LAA.
- duration—the duration during flood is short-term (ST) because of limited residence time of water in the off-stream reservoir and the release time of water in the Elbow River. the duration during post-flood is short-term (ST) because exposed sediments are expected to be revegetated within a one-year period. Vegetation is expected to mitigate dust emissions from exposed sediments during the first season in areas where the sediment thickness is less than 10 cm. In areas where the sediment thickness is greater than 10 cm, revegetation in the second season is expected to produce more efficient dust control. Snow cover and frozen ground would also reduce the duration of potential dust emissions during the intermediate winter period.
- frequency—the frequency is irregular (IR) because potential dust emissions would only occur during a flood that exceeds a 1:10 year return period when water and associated sediments are diverted to the reservoir. Furthermore, when the reservoir is used, dust emissions only occur after the sediments have dried, and under high wind speed conditions.
- reversibility—the reversibility is reversible (R) because revegetation of the sediment covered surfaces would return to pre-flood conditions between floods and control dust emissions.

Timing — time of day and seasonality are inputs into the models and the algorithms used to represent atmospheric physics and chemistry processes.

The reservoir is rated as disturbed (D) because there are existing sources of fugitive dust not associated with the Project. Agricultural activity, unpaved roads, and paved roads within the local assessment area (LAA) are sources of fugitive dust.

3.2.8.2 Change in Odours

The direction with respect to odour occurrences is expected to be neutral (N) because odours are not expected from the reservoir during the flood and post-flood operations. On this basis, the magnitude, geographic extent, duration, frequency and reversibility characterizations are not applicable. Timing is seasonal and time of day. The reservoir basin is rated as disturbed (D) with respect to odours because there are existing sources of odours not associated with flood and post-flood operations. Agricultural activity and traffic on roads within the LAA can be sources of odourant emissions.

3.2.8.3 Change in Carbon Sequestration Capacity

The direction with respect to carbon sequestration capacity is expected to be neutral (N) because of minimal disruption of the reservoir surface due to flood and post-flood operations. On this basis, the timing, magnitude, geographic extent, duration, frequency, and reversibility characterizations are not applicable. The reservoir basin is rated as disturbed (D) because agricultural activities (e.g., tillage and grazing) in the LAA can cause changes in carbon sequestration capacity.

Table 3-2 Project Residual Effects on Air Quality during Flood and Post-flood Operations

Residual Effects	Residual Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Air Quality	F	T/S	P	N	PDA	ST	IR	R	D
	PF	T/S	A	M/H	LAA	ST	IR	R	D
Change in Odours	F	T/S	N	N/A	N/A	N/A	N/A	N/A	D
	PF	T/S	N	N/A	N/A	N/A	N/A	N/A	D
Change in Carbon Sequestration Capacity	F	N/A	N	N/A	N/A	N/A	N/A	N/A	D
	PF	N/A	N	N/A	N/A	N/A	N/A	N/A	D

KEY

See Table 3-23 in Volume 3A for detailed definitions

Project Phase
F: Flood
PF: Post flood
D: Decommissioning

Timing Consideration
S: Seasonality
T: Time of day
R: Regulatory

Direction:
P: Positive
A: Adverse
N: Neutral

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PDA: Project Development Area
LAA: Local Assessment Area
RAA: Regional Assessment Area

Duration:
ST: Short-term;
MT: Medium-term
LT: Long-term

N/A: Not applicable

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological/Socio-Economic Context:
D: Disturbed
U: Undisturbed

3.3 DETERMINATION OF SIGNIFICANCE

A change in ambient air quality is rated as not significant in consideration of:

- the small areas, short duration and short frequency predicted for concentrations of TSP to be greater than the ambient air quality objectives,
- concentrations of TSP greater than the ambient air quality objectives at residence locations near the east PDA boundary predicted to occur infrequently (one day per year following a 1:100 year flood and up to seven days per year following a design flood), and
- the planned short-term (i.e. application of tackifier) and long-term (i.e. revegetation) mitigation measures to further control fugitive dust emissions from wind erosion of the sediment.

With implementation of the mitigation measures, the change in ambient air quality due to fugitive dust from the post-flood sediment is expected to be minimal. The adaptive management nature of the fugitive dust mitigations is expected to be adequate to control fugitive dust to low levels that do not have appreciable adverse environmental effects.

A change in odour occurrences is rated as not significant since the duration of the submerged vegetation is not considered sufficient to generate unpleasant odours. Because no sewage would be washed into the reservoir, there is negligible potential for sewage type odours to occur.

A change in carbon sequestration capacity is rated as not significant since there would be ample time between extreme floods for revegetation to occur in the reservoir. This conclusion is based on experience and information found in the literature on studies related to river flooding (Khan et al. 2013). It also made without the benefit of having a full study on the carbon cycle for this geography, the watershed, the river, the Project activities, and the design flood. Nevertheless, for the reasons stated above, the change in carbon sequestration capacity is expected to be not significant.

3.4 PREDICTION CONFIDENCE

The prediction confidence for potential effects related to changes in ambient air quality, odours and change in carbon sequestration capacity is medium because the mechanisms causing these potential changes are well understood and there are industry proven BMPs to mitigate potential effects.

3.5 CONCLUSIONS

3.5.1 Change in Ambient Air Quality

The only potential source of fugitive dust during post-flood operations is wind erosion of deposited sediments in the reservoir after they dry out, and when strong wind conditions occur. Because these emissions are ground based, the greatest air quality changes due to these emissions occur inside and near the PDA, decreasing to Base Case levels with increasing distance from the PDA. The main finding of the modeling is the potential for TSP concentrations to be greater than the regulatory criteria outside the PDA. However, given the low recurrence of the floods that result in sediment deposition (i.e. 100 years and design flood [200 years]) and the proposed mitigation measures, it is expected that fugitive dust emissions would not have significant adverse effects on ambient air quality.

3.5.2 Change in Odours

Unpleasant odours are not expected because there would be no sewage washed into the off-stream reservoir and the short duration that vegetation would be submerged is not considered sufficient to allow decay and appreciable decomposition to occur.

3.5.3 Change in Carbon Sequestration Capacity

Given the short duration of a flood, its infrequent occurrence, and the small area flooded, the change in carbon sequestration capacity is expected to be low.

3.6 REFERENCES

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