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Abbreviations

CAC	criteria air contaminant
CALMET	A meteorological preprocessor for the CALPUFF model
CALPUFF	(California PUFF) air quality transport and dispersion model
CEA Agency	Canadian Environmental Assessment Agency
CEAA	Canadian *Environmental Assessment Act*
EIA	environmental impact assessment
ECCC	Environment and Climate Change Canada
GHG	greenhouse gas
LAA	local assessment area
PAH	polycyclic aromatic hydrocarbon
PDA	project development area
PM	particulate matter
RAA	regional assessment area
TSP	total suspended particulate
VC	valued component
VOC	volatile organic compound

3.0 ASSESSMENT OF POTENTIAL EFFECTS ON AIR QUALITY AND CLIMATE

The Springbank Off-stream Reservoir Project (the Project) will be a source of air emissions (including odours), light, greenhouse gases (GHG), and the Project components and activities could potentially cause a change to the carbon sequestration capacity of the project area. The air quality and climate assessment addresses four related components to meet the requirements specified in the February 2015 AESRD Terms of Reference (AESRD 2015) and the August 2016 CEA Agency Final Guidelines (CEAA 2016):

- air quality changes (including odour) due to air emissions resulting from Project activities
- light changes due to Project activities
- greenhouse gas (GHG) emissions due to Project activities
- changes to the carbon sequestration capacity associated with project components or activities

3.1 SCOPE OF THE ASSESSMENT

3.1.1 Regulatory and Policy Setting

3.1.1.1 Air Quality

Ambient Regulatory Criteria

Criteria air contaminants (CACs) are common air pollutants that can potentially cause harm to health and the environment, and cause property damage. These pollutants are particulate matter (PM), carbon monoxide (CO), sulphur oxides (SO_x), nitrogen oxides (NO_x) and volatile organic compounds (VOCs). These contaminants are called “criteria” because the Alberta Government and Environment and Climate Change Canada have set ambient air quality objectives, guidelines or standards for them. The term “criteria” refers to the latest scientific information related to these pollutants’ effects on health and welfare.

Ambient air quality changes are compared to ambient air quality criteria that are established by provincial and national regulatory agencies. Relevant ambient air quality criteria include the Alberta Ambient Air Quality Objectives and Guidelines (AAAQO and AAAQG), the National Ambient Air Quality Objectives, and the Canada Ambient Air Quality Standards (CAAQS). Table 3-1 identifies the AAAQOs, AAAQGs, and CAAQSs for relevant substances and associated averaging periods.

Canadian Ambient Air Quality Standards (CAAQS) are health-based standards for concentrations in outdoor air. Currently CAASs have been developed and are in place for $PM_{2.5}$. The CAAQS are developed for managing regional air quality in each Air Zone (referred to as Land Use Planning Region in Alberta) based on concentrations measured at local monitoring stations. These standards are not intended for evaluating near-field impacts at a project boundary. CAAQSs have also been developed for SO_2 to be implemented in 2020. As the construction period is expected to be essentially completed by this time, the air quality assessment uses the AAAQO for SO_2.

To be conservative, the most stringent criteria are compared to the maximum predicted ambient concentrations associated with construction. Prior to comparison, however, a background level is added to the predicted values to include the contribution from other emission sources.

Table 3-1 Provincial (Alberta) and National Ambient Air Quality Criteria

Substance	Averaging Period	Provincial	National	
		AAAQO[a] (µg/m³)	NAAQO[b] (µg/m³)	CAAQS[c] (µg/m³)
CAC gases				
NO_2	1-hour	300	400	–
	24-hour	–	200	–
	Annual	45	60	–
SO_2	1-hour	450	450	183 (or 70 ppb)[e]
	24-hour	125	150	–
	30 day	30	–	–
	Annual	20	30	13 (or 5.0 ppb)[f]
CO	1-hour	15,000	15,000	–
	8-hour	6,000	6,000	–
Particles				
$PM_{2.5}$	1-hour	80a	–	–
	24-hour	30	–	28[c]
	Annual	–	–	10[d]
	Annual	60	60	–
TSP	24-hour	100	120	–
	Annual	60	60	–

Table 3-1 Provincial (Alberta) and National Ambient Air Quality Criteria

Substance	Averaging Period	Provincial	National	
		AAAQO[a] (µg/m³)	NAAQO[b] (µg/m³)	CAAQS[c] (µg/m³)
Dustfall	30 days (residential/recreation areas)	53 mg/ 100 cm²	–	–
	30 days (commercial/industrial areas)	158 mg/100 cm²	–	–
VOCs				
Acetaldehyde	1-hour	90	–	–
Acrolein	1-hour	4.5	–	–
	24-hour	0.40	–	–
Benzene	1-hour	30	–	–
	24-hour	3	–	–
Ethylbenzene	1-hour	2,000	–	–
Formaldehyde	1-hour	65	–	–
Toluene	1-hour	1,880	–	–
	24-hour	400	–	–
Xylenes	1-hour	2,300	–	–
	24-hour	700	–	–
PAHs				
Benzo(a)pyrene	Annual	0.0003	–	–
Naphthalene	Annual	3	–	–
Metals				
Arsenic	1-hour	0.1	–	–
	Annual	0.01	–	–
Chromium	1-hour	1	–	–
Manganese	1-hour	2	–	–
	Annual	0.2	–	–
Nickel	1-hour	6	–	–
	Annual	0.05	–	–

Table 3-1 Provincial (Alberta) and National Ambient Air Quality Criteria

NOTES:

[a] Alberta Ambient Air Quality Objective and Guidelines (AEP 2016)

[b] National Ambient Air Quality Objective (NAAQO) (CCME 1999)

[c] The Canadian Ambient Air Quality Standard (CAAQS) for 24-hour $PM_{2.5}$ is referenced to the annual 98th percentile of daily 24-hour average concentrations, averaged over three years (ECCC 2013, CCME 2014).

[d] The CAAQS for annual $PM_{2.5}$ is referenced to the three-year mean of annual average concentrations (ECCC 2013, CCME 2014).

[e] The 1-h CAAQS for SO_2 is referenced to the three-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations (effective 2020). This standard is not used for this assessment since construction is expected to be completed by this date.

[f] The annual CAAQS for SO_2 is referenced to the arithmetic average over a single calendar year of all 1-hour average SO_2 concentrations (effective 2020). This standard is not used for this assessment since construction is expected to be completed by this date.

– No applicable objective or standard in this jurisdiction.

$\mu g/m^3$ = micrograms per cubic metre

Odour Thresholds

While some regulatory criteria consider odours, the criteria can be limited with respect to addressing odour issues. This is because criteria are not defined for all potential odourants, do not recognize varying individual sensitivities, and do not address multiple odourants. For this reason, odour criteria have been selected based on a review of relevant literature.

Odour thresholds for a substance often span a wide range of concentrations that can depend on the approach used to define and determine the thresholds. The following are typical odour thresholds:

- The minimum perceptible threshold is the lowest concentration at which an odour is noticed by a sensitive member of the population.
- The detection threshold is the lowest concentration at which an odour is noticed by a specified percentage of the population.
- The recognition threshold is the lowest concentration at which the specific character of an odour can be identified by a specified percentage of the population. Recognition thresholds can typically be 2 to 10 times greater than the detection thresholds (U.S. EPA 1992).

Table 3-2 identifies detection and recognition thresholds adopted for this odour assessment.

An ambient concentration divided by an odour threshold is defined as a dimensionless odour unit concentration. A dimensionless concentration of one odour unit (1 OU) is, therefore, used for either the detection or recognition threshold. Regulatory agencies have adopted OU guidelines that range from 0.5 OU to 10 OU, with compliance frequencies that range from 98.0% to 99.9% (Nicell 2009). The selected limits or guidelines depend on factors such as the nature of the exposed region (e.g., residential or industrial), the averaging time over which the odour is measured (e.g., 5 seconds to 1 hour), and the nature of the source (e.g., wastewater treatment plant or bakery). This assessment provides concentration contours that correspond to 1 OU and 99.5% compliance (44 hours per year) for indicating where odours could potentially occur. This odour concentration threshold and compliance frequency are within the adopted guidelines (Nicell 2009).

Odour events can be associated with periods less than 1-hour in duration. A scaling factor of 2.7, based on a formula converting 1-hour average concentrations to 3-minute average from Alberta AQMG (AEP 2013), is used to adjust the one-hour predictions in the model for peak concentrations that can occur over shorter periods.

Table 3-2 Ambient Concentration Odour Thresholds

Odourant	Detection Threshold			Recognition Threshold	
	Nagata 2003		Odour Assessment	Odour Assessment	
	(ppb)	(μg/m³)	(μg/m³)	(μg/m³)	Information Source
NO_2	120	226	226	734	Amoore and Hautala (1983); van Gemert (2011); European Commission (2014)
Acetaldehyde	1.5	2.7	2.7	15	TCEQ (2014)
Acrolein	3.6	8.3	8.3	367	AENV (2011); Amoore and Hautala (1983); van Gemert (2011)
Naphthalene	-	-	199	440	Amoore and Hautala (1983); van Gemert (2011)

NOTES:
Odour thresholds from Amoore and Hautala (1982) are geometric means of collected literature data, primarily from van Gemert compilation of odour thresholds (1977, 1980). The latest edition of van Gemert compilation of odour thresholds is provided for reference (van Gemert 2011).

Metric for the Ambient Regulatory Criteria

The ambient air quality criteria are developed for a time-averaging period (e.g. 1-hour, 24-hour) and have a specific statistical form referred to as a "metric" (e.g. 98th percentile, 99.9th percentile).

Alberta Air Quality Modelling Guideline (AQMG; (AEP 2013)) recognizes that extreme, rare, and transient meteorological conditions can affect predicted 1-hour average ambient air concentrations. To address this issue, AEP recommends "the highest eight 1-hour predicted average concentrations for each receptor in each single year should be disregarded". Therefore, for the assessment of 1-hour average concentrations, the 9th highest hourly values (equal to the 99.9th percentile) for each year at a given location are used to determine compliance with the 1-hour AAAQO.

For averaging periods greater than 1 hour (e.g. 24-hour, annual), no predicted values greater than the AAAQO are viewed as being acceptable (AEP 2013). Therefore, the maximum 24-hour and annual predicted concentrations are compared to the AAAQO.

The 24-hour CAAQS for $PM_{2.5}$ is based on the three-year average of the annual 98th percentile of the daily 24-hour average concentrations. For this assessment, the 8th highest predicted 24-hour average $PM_{2.5}$ concentration in each year is used to represent the 98th percentile of daily 24-hour average concentrations. The 8th highest predicted 24-hour average $PM_{2.5}$ concentrations for each year are averaged over three years and the maximum of the three-year averages is compared to the 24-hour CAAQS.

The annual CAAQS for $PM_{2.5}$ is based on the three-year average of the annual average concentrations. Therefore, the arithmetic averages of 1-hour average $PM_{2.5}$ concentrations over a single calendar year are averaged over three years and the maximum of the three-year averages is compared to the annual CAAQS.

3.1.1.2 Ambient Light

Most guidelines and regulations for lighting have been directed toward providing suitable lighting to promote safe and efficient activities. For example, street lighting, indoor lighting, and lighting around industrial plants are all subject to various guidelines to facilitate a safe work environment. Currently, there are no regulations in Alberta to regulate obtrusive light during construction or operation of industrial facilities.

Guidelines to avoid obtrusive lighting have been developed and are often used for the design of new projects. These include guidelines from the International Dark Sky Association (IDA) and from the Commission Internationale de L'Éclairage (CIE), also known as the International Commission on Illumination. These organizations have developed guidelines and recommendations to limit light pollution and associated effects on humans and wildlife. Many lighting design elements adhere to these guidelines through design standards developed by the Illuminating Engineering Society (IES), who have adopted IDA and CIE guidelines and recommendations for use in developing new outdoor lighting guidance and standards.

CIE has established guidelines for light trespass and glare for various levels of urbanization. The values represented in the guidelines are based on environmental zones and time of day. Four environmental zones have been established by the CIE for outdoor lighting (CIE 2003). The four zones are listed in Table 3-3. The maximum values recommended by CIE for light trespass (illuminance) on properties by environmental zone and time of day are presented in Table 3-4. The maximum values recommended by CIE for glare (intensity of luminaires) in designated directions by environmental zone and time of day are presented in Table 3-5.

Reference levels of sky glow are presented in Table 3-6. Larger numbers are associated with darker conditions, while smaller numbers are associated with brighter night time conditions with more contributions from exterior lighting.

Table 3-3 Ambient Light Environmental Zones

Zone	Surrounding	Lighting Environment
E1 (natural)	Natural	Intrinsically dark
E2 (rural)	Rural	Low distinct brightness
E3 (suburban)	Suburban	Medium distinct brightness
E4 (urban)	Urban	High distinct brightness
SOURCE: CIE 2003		

Table 3-4 Recommended Maximum Values of Light Trespass (Illumination) per Environmental Zones

Time of Day	Environmental Zones			
	E1 (natural)	E2 (rural)	E3 (suburban)	E4 (urban)
Pre-curfew (19:00–23:00)	2 lux	5 lux	10 lux	25 lux
Post-curfew (23:00–6:00)	0 lux	1 lux	2 lux	5 lux
SOURCE: CIE 2003				

Table 3-5 Recommended Maximum Values for Glare (Intensity of Luminaires) in Designated Directions

Time of Day	Environmental Zones			
	E1 (natural)	E2 (rural)	E3 (suburban)	E4 (urban)
Pre-curfew (19:00–23:00)	2,500 cd	7,500 cd	10,000 cd	25,000 cd
Post-curfew (23:00–6:00)	0 [1] cd	500 cd	1,000 cd	2,500 cd
NOTE: [1] If for public lighting value may be up to 500 cd				
SOURCE: CIE 2003				

Table 3-6 Reference Levels of Sky Glow

Sky Glow (mag/arcsec^2)	Corresponding Appearance of the Sky
21.7 (Rural)	The sky is covered with stars that appear large and close. In the absence of haze, the Milky Way can be seen to the horizon. The clouds appear as black silhouettes against the sky.
21.6	Glow in the direction of one or more cities is seen on the horizon. Clouds are bright near the city glow.
21.1	The Milky Way is brilliant overhead but cannot be seen near the horizon. Clouds have a greyish glow at the zenith and appear bright in the direction of one or more prominent city glows.
20.4	The contrast to the Milky Way is reduced and detail is lost. Clouds are bright against the zenith sky. Stars no longer appear large and near.
19.5	Milky Way is marginally visible and only near the zenith. The sky is bright and discoloured near the horizon in the direction of cities. The sky looks dull grey.
(18.5 Urban)	Stars are weak and washed out and reduced to a few hundred. The sky is bright and discoloured everywhere.
SOURCE: Berry 1976	

3.1.1.3 Greenhouse Gases

The management of GHG emissions takes place on provincial, national, and international scales. However, none of the existing acts and accords apply to the Project because GHG emissions are less than the various thresholds stipulated:

- The Alberta Climate Change and Emissions Management Act (CCEMA) – Specified Gas Reporting Regulation (SGRR) does not apply to project construction and only applies to project operations if emissions are greater than 50,000 tonnes of CO_2e/year.
- The Alberta Climate Leadership Implementation Act stipulates a tax on GHG emissions, including emissions during construction. This increases cost of construction and operation but does not apply or put a limit on construction emissions.
- The national GHG Emission Reporting Program under the authority of the Canadian Environmental Protection Act (ECCC 2015) applies to operations emissions of greater than 50,000 tonnes of CO_2e/year.
- Under the 2009 Copenhagen Accord, Canada committed to a 17% reduction in national GHG emissions below the 2005 level by 2020 (UNFCCC 2009). Under the 2015 Paris Agreement, Canada committed to a 30% reduction in national GHG emissions below the 2005 level by 2030 (UNFCCC 2015).

3.1.2 Engagement and Key Concerns

Engagement has been ongoing and will continue with agencies, public stakeholders and Indigenous groups through the life of the Project.

The public concerns related to air quality were related to construction dust and air pollution. There was also a public concern related to air quality and dust from the silt left in the reservoir after a flood. This concern is addressed in Volume 3B.

Concerns raised by indigenous groups related to dust during construction and operations, air quality and visual impact. In a letter submitted to the Canadian Environmental Assessment Agency, the Tsuut'ina Nation outlined Project-specific concerns related to dust and air pollution during construction activities, the visibility of the diversion structure and off-stream dam from the Tsuut'ina Nation 145 Reserve, and the potential for contaminated dry dust given Tsuut'ina Nation's proximity to the Project area.

The Piikani Nation is concerned about potential air quality effects from flood residue spread by the wind, deposition of silt in the reservoir, and wind-blown dust from the reservoir.

In secondary sources reviewed for the Project, Samson Cree Nation expressed concerns about air quality and GHG emissions as they relate to industrial development. Foothills Ojibwa First Nation previously expressed concern about project effects on air quality from the destruction (i.e. harvesting) of trees.

Traditional Land and Resource Use (TLRU) information was considered during the preparation of all aspects of the EIS, including both methodology and analysis, as stipulated by the CEA Agency project guidelines. TLRU information contributed to the understanding of the existing conditions and informed the assessment of potential Project effects. While this information did not directly affect the significance definition it has been incorporated into the analysis of effects on which the significance determination was based. As of January 1, 2018, no project-specific intangible concerns were identified with respect to air quality and GHG emissions.

3.1.3 Potential Effects, Pathways, and Measurable Parameters

Table 3-7 presents potential effects, pathways and measurable parameters for air quality (including odour), ambient light, and GHG components.

Table 3-7 Potential Effects, Effects Pathways and Measurable Parameters for Air Quality, Ambient light, and Greenhouse Gases

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Air Quality Changes in ambient air quality, expressed collectively or singly, by change in the following: • ambient concentration of criteria air contaminants (CACs) including nitrogen dioxide (NO_2,), sulphur dioxide (SO_2), carbon monoxide (CO), fine particulate matter of 2.5 microns (µm) in diameter or less ($PM_{2.5}$), total suspended particulate (TSP) • dustfall • ambient concentration of volatile organic compounds (VOCs), PAHs, and metals. • odour from construction activities	The release of air contaminants to the atmosphere due to Project activities may adversely affect the quality of the ambient air.	Change in ambient concentration measured outside the PDA boundary in micrograms per cubic metre (µg/m³) for NO_2, SO_2, CO, $PM_{2.5}$, TSP. The predicted ambient concentrations are compared to ambient criteria for the relevant averaging periods. Dustfall measured outside the PDA boundary in mg/100 cm²/30 days. Change in the ambient concentration measured outside the PDA boundary in µg/m³ for VOCs, PAHs, and metals. The predicted ambient concentrations are compared to ambient criteria for the relevant averaging periods. Odourant concentration (µg/m³) compared to odour thresholds.

Table 3-7 Potential Effects, Effects Pathways and Measurable Parameters for Air Quality, Ambient light, and Greenhouse Gases

Potential Environmental Effect	Effect Pathway	Measurable Parameter(s) and Units of Measurement
Ambient light	Project lighting can have adverse effects through changes in night time lighting. Light Trespass – Light output from the project perimeter on vertical surface of receptors Glare – Horizontal contrast between project lighting and background lighting Sky Glow – Ratio of upward directed lighting to total lighting	Change in light trespass in units of lux. Changes in glare in units of candela (cd). Changes in sky glow in units of magnitude/arcsec^2.
Greenhouse Gases	Construction phase would release GHGs, including: • carbon dioxide (CO_2) • methane (CH_4) • nitrous oxide (N_2O)	CO_2, CH_4 and N_2O are the primary GHGs that would be released from the Project.

3.1.4 Boundaries

3.1.4.1 Spatial Boundaries

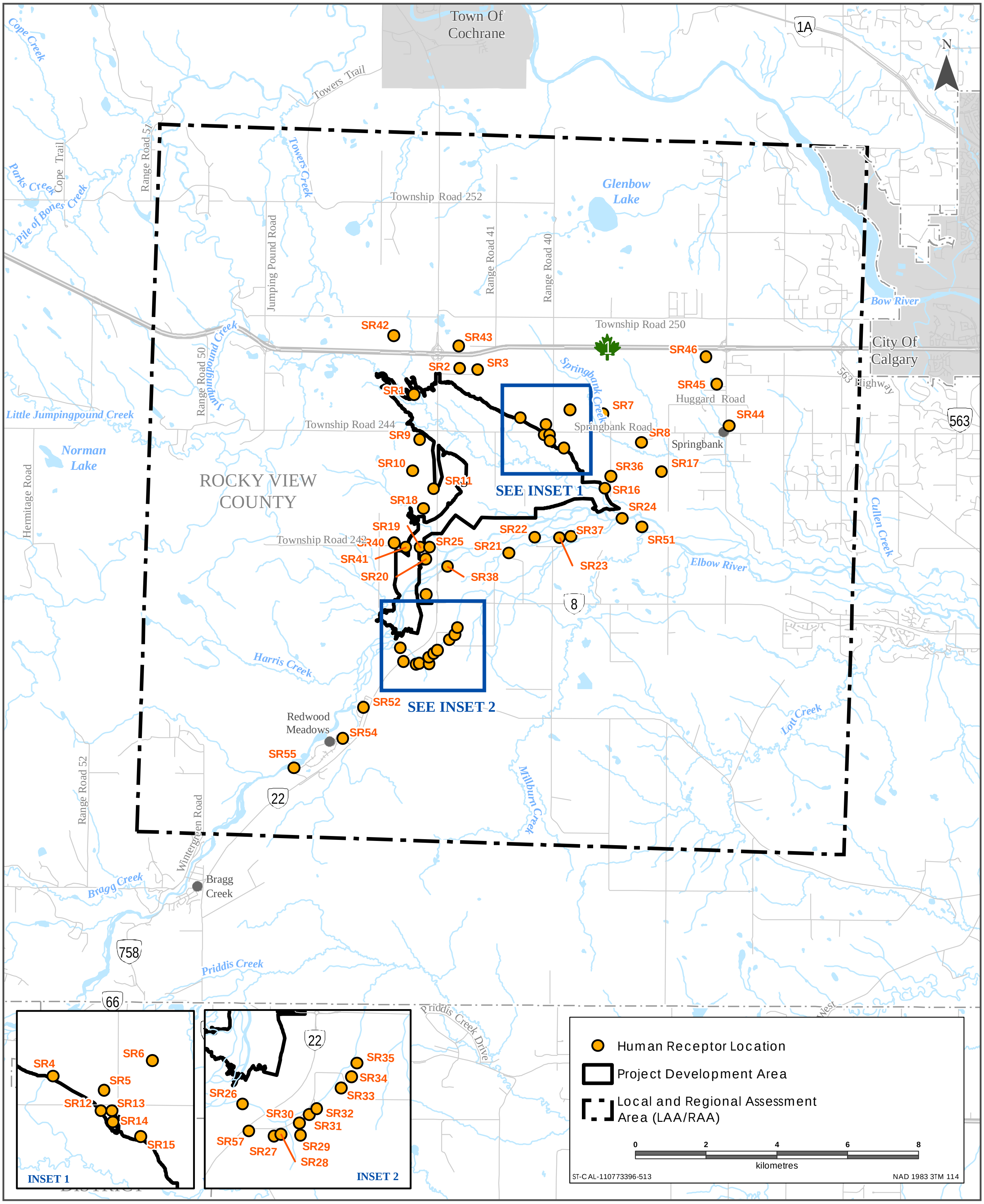
The air quality assessment focuses on areas outside the PDA, where the public might be affected. The Alberta Ambient Air Quality Objectives (AEP 2016) are only applied to areas where there is public access (i.e., on and outside the PDA). Similarly, the Canadian Ambient Air Quality Standards (CAAQS) for fine particulate matter ($PM_{2.5}$) (ECCC 2013, CCME 2014) are only applied to areas where there is public access.

One spatial area is used to assess project effects and cumulative effects on the atmospheric environment. This area, both the local assessment area (LAA) and the regional assessment area (RAA), is a 20 km × 20 km region centred on the PDA and extending approximately 6 km (Figure 3-1). One spatial boundary (LAA/RAA) is sufficient to comply with the recommendation of the Alberta air quality modelling guideline (AQMG) (AEP 2013). The AQMG states that the modelled area should include predicted ground level concentrations from the Project, at or above 10% of the ambient air quality objective or background concentration, whichever is higher. The LAA meets this requirement. The air quality LAA is also adopted for the ambient light assessment.

No local or regional spatial boundaries are used for the GHG assessment because the environmental effect associated with GHG emissions is on a global scale. This is because GHGs mix well in the atmosphere and disperse from their emission sources (IPCC 2013). However, as a reference point, this assessment determines the effect of the release of GHGs during Project construction on provincial and federal GHG inventories.

3.1.4.2 Temporal Boundaries

Project construction would take place over a 36-month period. Assuming regulatory approval by Q4 2018, construction would commence in Q1 2019. By Q4 2020, the Project would be able to accommodate a 1:100 year flood. Construction would be complete by Q1 2022 at which time the Project would be able to accommodate water volumes equal to the 2013 flood. Dry operations of the Project will occur indefinitely (i.e., permanent installation) after construction, with periods of dry operations alternating with flood and post-flood phases.



Sources: Base Data - ESRI, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Human Receptor Locations

Stantec

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Figure 3-1

3.1.5 Residual Effects Characterization

Table 3-8 presents definitions for residual environmental effects on air quality (including odour), ambient light, GHG, and climate. No definitions are provided for residual environmental effects related to a potential change in carbon sequestration because there are no widely recognized regulatory or policy instruments. The potential change in carbon sequestration capacity is assessed in a qualitative manner.

Ambient air quality changes vary considerably with time and location. The maximum predicted ambient air quality effects (CAC and dustfall) are compared to the ambient criteria identified in the previous section. For consistency with other sections of the environmental assessment the predicted changes are also examined in context with the characterization criteria that are provided in Table 3-8. The characterization criteria are discussed in the context of the emissions and in the context of the air quality changes. While the comparisons of ambient air quality changes to ambient criteria are objective, the definition and application of the characterization criteria have elements of subjectivity.

The characterization parameters in Table 3-8 refer specifically to air quality changes and not to the potential responses of receptors exposed to these changes. Other valued components (VC) address the receptor responses to the predicted air quality changes (e.g., public health and safety in Section 15).

Table 3-8 Characterization of Residual Effects on Air Quality, Ambient light, and Greenhouse Gases

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Direction	The long-term trend of the residual effect	**For Air Quality, Ambient Light and GHG:** Positive – a residual effect that changes measurable parameters in a direction beneficial relative to the Base Case. Adverse – a residual effect that changes measurable parameters in a direction detrimental relative to the Base Case. Neutral – no net change in measurable parameters relative to the Base Case.

Table 3-8 Characterization of Residual Effects on Air Quality, Ambient light, and Greenhouse Gases

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Magnitude	The amount of change in measurable parameters or the VC relative to the Base Case	**For Air Quality:** Negligible – predicted ambient air quality levels are less than 1% of the Base Case and do not result in exceedances of the most stringent criteria. Low - predicted ambient air quality levels are greater than 1% of the Base Case, but less than 50% of the most stringent criteria Moderate – predicted ambient air quality levels are greater than 50% of the most stringent criteria, but the maximum air quality levels are less than the most stringent criteria High – predicted ambient air quality levels are greater than the most stringent criteria
		For Ambient Light: Negligible – no measurable change from the Base Case Low – effect is detectable but is limited through design mitigation Moderate – facility lighting is effectively controlled, but navigation, security and other required lighting have a measurable effect High – the design is without regard to lighting design criteria
		For Greenhouse Gases: Negligible – no measurable change in GHG emissions from the Base Case Low – although a change from the Base Case is measurable, based on CEA Agency guidance (CEAA 2003) and professional judgment, relatively small changes are expected in provincial and national GHG emissions Moderate – based on CEA Agency guidance (CEAA 2003) and professional judgment, notable changes are expected in provincial and national GHG emissions High – based on CEA Agency guidance (CEAA2003) and professional judgment material changes are expected in provincial and national GHG emissions

Table 3-8 Characterization of Residual Effects on Air Quality, Ambient light, and Greenhouse Gases

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Geographic Extent	The geographic area in which a residual effect occurs	**For Air Quality and Ambient Light:** PDA – residual effects are restricted to the PDA LAA – residual effects extend into the LAA
		For Greenhouse Gases: Provincial – residual effects are restricted to the provincial extent National — residual effects are restricted to the national extent Global – residual effects extend into the global extent
Frequency	Identifies how often the residual effect occurs and how often during the Project or in a specific phase	**For Air Quality:** Single event - a single occurrence of air emissions during Project construction or dry operations Multiple irregular event (no set schedule) – short term upset emission events, or infrequent release of air emissions that occur sporadically or at irregular intervals Multiple regular event – release of air emissions during Project construction or dry operations that occurs multiple times and on a repetitive schedule Continuous – the release of air emissions occurs continuously during Project construction and dry operations
		For Ambient Light: Single event – a single occurrence of light emissions during Project construction or dry operations Multiple irregular event (no set schedule) – short term upset light emission events, or infrequent release of light emissions that occur sporadically or at irregular intervals Multiple regular event – a release of light emissions during Project construction or dry operations that occurs multiple times and on a repetitive schedule Continuous – the release of light emissions occurs continuously during Project construction and dry operations

Table 3-8 Characterization of Residual Effects on Air Quality, Ambient light, and Greenhouse Gases

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Frequency (cont'd)		**For GHG:** Single event – a single occurrence of GHG emissions during Project construction or dry operations Multiple irregular event (no set schedule) – the release of GHG emissions occurs more than once but at an unpredictable interval of time Multiple regular event – a release of GHG emissions during Project construction or dry operations occurs at regular intervals Continuous – the release of GHG emissions occurs continuously during Project construction and dry operations
Duration	The period of time required for the measurable parameter to return to its Base Case condition, or the residual effect can no longer be measured or otherwise perceived	**For Air Quality, Ambient Light and GHG:** Short-term – residual effect restricted to less than the duration of the construction phase (27 months) Medium-term – residual effect extends through the construction phase into the dry operations phase Long-term – residual effect extends through the construction and dry operations phase of the project
Reversibility	Pertains to whether a measurable parameter or the VC can return to its Base Case condition after the project activity ceases	**For Air Quality, Ambient Light and GHG:** Reversible – the residual effect is likely to be reversed after activity completion and reclamation Irreversible – the residual effect is unlikely to be reversed
Ecological and Socio-economic Context	Base Case condition and trends in the area where residual effects occur	**For Air Quality, Ambient Light and GHG:** Undisturbed – Atmosphere relatively unaffected, or not affected, by human activity (anthropogenic sources) Disturbed – Atmosphere has been previously disturbed by human activity (anthropogenic sources)
Timing	Periods of time where residual effects from Project activities could affect the VC	**For Air Quality, Ambient Light and GHG:** Seasonality – residual effect is greater in one season than another (e.g., spring/summer vs. fall/winter) Time of day – residual effect is greater during daytime or nighttime Regulatory – provincial or federal restricted activity periods or timing windows (e.g., migration, breeding, spawning) related to the VC Not applicable - the residual effect of Project activities will have the same effect on the VC, regardless of timing

3.1.6 Significance Definition

3.1.6.1 Ambient Air Quality

A residual effect is rated as significant if ambient concentrations of the CAC (or odour) are predicted to be above the applicable regulatory objectives (i.e., are high in magnitude) and are of concern because of their geographic extent and frequency of occurrence, and the presence of potentially sensitive receptors (e.g., human, wildlife, vegetation, soils, or waterbodies).

Predicted concentrations that are greater than the applicable air quality and odour objectives do not imply that the effect on air quality and odour is significant. Dispersion models often produce results that are highly conservative (i.e., they overpredict concentrations). Professional judgment and the consideration of aspects such as geographic extent, frequency and reversibility are important considerations in determining significance.

3.1.6.2 Ambient Light

A significant environmental effect on lighting is defined as an increase in project-related light emissions such that the CIE guidelines for light trespass and glare in a rural environment (E2) are exceeded, and the resulting conditions related to sky glow would be altered toward those of a suburban environment.

3.1.6.3 Greenhouse Gases

Provincial and federal governments have indicated a desire to reduce their total GHG emissions and have announced GHG reduction targets. These targets have been established to identify Alberta's and Canada's contribution in reducing global GHG concentrations. Jurisdictional targets are affected by numerous factors outside the scope of this Project.

Therefore, significance related to the release of GHG emission is focused on the effect project emissions would have on the provincial and national emission totals. In the absence of provincial and federal policy and legislation related to a quantitative significance threshold, this Project uses CEA Agency guidance (CEAA 2003), professional judgment, and the characterization of the effect to arrive at a qualitative determination of significance.

3.1.6.4 Carbon Sequestration

No significance determination is be provided for a potential change in carbon sequestration because there are no widely recognized regulatory or policy instruments. Due to the absence of regulatory benchmarks, the potential change in carbon sequestration capacity is assessed in a qualitative manner.

3.2 EXISTING CONDITIONS FOR AIR QUALITY AND CLIMATE

3.2.1 Methods

Four subcomponents characterize the existing atmospheric environment: climate and meteorology, existing ambient air quality (including odour), existing light, and GHG emissions.

3.2.1.1 Climate and Meteorology

Climate is described in terms of average and extreme weather conditions that occur over a 30-year period; these values being referred to as climate normals. Meteorological observations are recorded at the Springbank Airport, which is 7 km to the northeast of the PDA. Springbank climate normals were therefore obtained from Environment and Climate Change (http://climate.weather.gc.ca/climate_normals/index_e.html) for the most recent climate normal period, 1981 to 2010. Additional hourly wind data were obtained for 2016 to provide a more refined understanding of local winds. Given the proximity of the airport to the PDA, the airport meteorological conditions are expected to be representative of the LAA for air quality.

3.2.1.2 Ambient Air Quality

Local Measurements

Ambient $PM_{2.5}$, TSP, and dustfall measurements were conducted at two locations near the PDA (Figure 3-2). Site A is 380 m south of the TransCanada Highway near the intersection of the TransCanada Highway and Highway 22, and Site B is near the eastern perimeter of the PDA near the Elbow River.

$PM_{2.5}$ measurements were collected as 24 hour averages for the August 15 to September 16, 2016 period; and TSP measurements were collected as 24-hour averages over the September 16 to October 13, 2016 period. Dustfall was also measured at these two sites. The dustfall samples were analyzed to determine metal composition that were used by disciplines investigating the cumulative effects of metals deposition on terrain/soils and vegetation/wetlands (Volume 3A, Sections 9 and 10, respectively).

Other Measurements

Local monitoring was complemented with ambient air quality data from other monitoring programs that were selected to be representative of the LAA. Multiple information sources were used as ambient monitoring sites do not measure all the substances of interest listed in the AEP terms of reference and CEA Agency guidelines. Further details regarding the selected sites for background data from these information sources are provided in Volume 4, Appendix E.

3.2.1.3 Ambient Light

Light monitoring was conducted during the night of January 6 and 7, 2017 (ground was snow covered) at four sites (Figure 3-2) either adjacent to or with unobstructed views of the PDA:

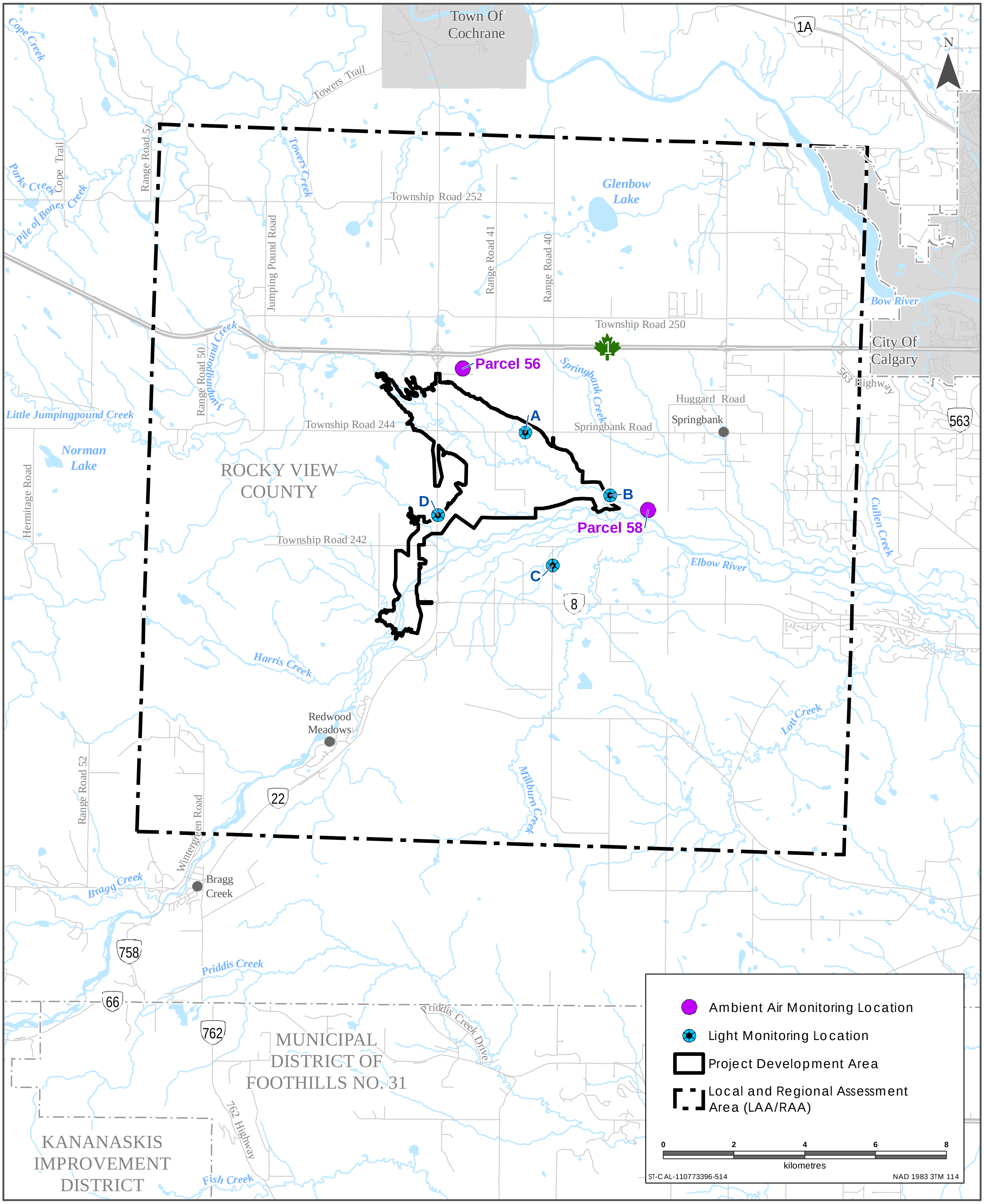
- Site A—south of Springbank Road, inside the northern boundary of the PDA
- Site B—near the eastern limit of the PDA, north of Elbow River
- Site C—south of Elbow River along Range Road 40
- Site D—north of Elbow River along Highway 22

The monitoring sites did not have any visual obstructions to the PDA either by topography or vegetation.

Monitoring at each viewpoint included measurements of illuminance (lux) and sky glow. Illuminance was measured using a conventional, integrating hemispherical light meter (Extech EA33) with a resolution of 0.01 lux. Sky glow was measured using a Unihedron Sky Quality Meter with lens (SQM-L). In addition to the light measurements, panoramic photographs were taken at each location to document the view during the day and during the night using a high quality (Canon 60D) digital camera. The panoramic photographs are provided in Volume 4, Appendix E, Attachment 3G.

3.2.1.4 Greenhouse Gases

Existing GHG emissions are characterized by summarizing provincial and national inventory totals. The 2014 data (most recently available) for the province and Canada were used (ECCC 2016a).



Sources: Base Data - ESRI, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Ambient Air Quality and Light Monitoring Locations

Stantec

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Figure 3-2

3.2.2 Overview

3.2.2.1 Climate and Meteorology

Table 3-9 provides a summary of the 1981 to 2010 meteorological observations from Springbank Airport:

- Temperature—While the average monthly maximum temperature is 22.2°C, the extreme maximum is 33.8°C; both being observed in July. While the average monthly minimum temperature is -14.2°C, the extreme minimum is -42.8°C; both being observed in January. Freezing conditions (temperatures less than 0°C) can occur more than 75% of the days during the October to April period.
- Precipitation—Most precipitation tends to occur in the May to September period, with the high value occurring in June. The greatest recorded extreme daily rainfall event was 128.4 mm and occurred in June, this value was greater than the average rainfall amount of 106.7 mm for that month. The highest extreme daily snowfall event, 30.0 cm, occurred in March. Rainfall can occur more than 25% of the days during the May to August period.
- Snow depth—The ground is snow-covered in the November to March period with average depths of 4 to 8 cm. Extreme snow depths for this period have ranged from 22 to 60 cm. Eight or more days with 10 cm or more of snow depth occur in the December to March period.
- Winds—The maximum hourly wind speeds range from 61 km/h to 76 km/h, and these events occur most frequently from the west. The maximum recorded wind gust speed is 120 km/h (occurring January 1997).

Table 3-9 Canadian Climate Normals based on Springbank Airport Observations (1981 to 2010)

Parameter	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature:												
Daily average (°C)	-8.2	-6.7	-2.7	3.4	8.1	12.1	14.8	13.7	9.5	3.9	-3.8	-7
Standard deviation	4.2	3.5	3.7	1.5	1.5	1.0	1.6	1.4	1.5	1.6	3.7	4
Daily maximum (°C)	-1.8	0	3.9	10.5	15.3	18.8	22.2	21.2	17	11	2.3	-0.6
Daily minimum (°C)	-14.5	-13.4	-9.2	-3.8	0.9	5.4	7.4	6.2	1.9	-3.3	-9.9	-13.3
Seasonal Average:												
Extreme maximum (°C)	16.5	22.1	23.8	26.5	33	31	33.8	32.1	30.6	27.1	20.4	17.9
Date (yyyy/dd of month)	2003/ 07	1992/ 27	2004/ 30	1987/ 28	1986/ 30	1986/ 01	2002/ 13	2003/ 01	1998/ 07	1991/ 11	1999/ 07	1988/ 01
Extreme minimum (°C)	-42.8	-41.6	-36.3	-21.7	-14.1	-6.1	-0.1	-5.9	-9.8	-29.1	-36.5	-41.6
Date (yyyy/dd of month)	1997/ 25	1989/ 03	1989/ 01	2002/ 02	2002/ 08	2000/ 19	2002/ 02	1992/ 25	2000/ 23	1991/ 28	1996/ 21	1996/ 29
Precipitation:												
Rainfall (mm)	0.2	0	0.4	9.3	49.5	106.7	66.9	78	45.5	7	2.4	0.3
Snowfall (cm)	12.7	14.7	21.7	19	12.4	0	0.1	0	5.3	11.6	17.4	12.4
Precipitation (mm)	9.9	11.5	17.6	25.4	61.1	106.7	66.9	78	50.3	16.3	16.3	9.8
Average snow depth (cm)	8	7	6	1	0	0	0	0	0	0	4	6
Median snow depth (cm)	7	7	4	0	0	0	0	0	0	0	3	6
Snow depth at month-end (cm)	7	7	2	1	0	0	0	0	0	2	7	7
Extreme daily rainfall (mm)	1.2	0.4	4.4	36.2	42.6	128.4	48.2	62.8	64	11.6	10	2

Table 3-9 Canadian Climate Normals based on Springbank Airport Observations (1981 to 2010)

Parameter	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Date (yyyy/dd of month)	2003/ 04	1991/ 16	1991/ 22	1999/ 20	1990/ 24	2005/ 17	1987/ 18	1988/ 01	1985/ 11	2004/ 14	1986/ 05	1987/ 22
Extreme daily snowfall (cm)	19.1	14.2	30	18	27	0	0.8	0.4	14	13	25.2	20
Date (yyyy/dd od month)	1989/ 05	2000/ 09	1998/ 16	2001/ 02	1997/ 20	1985/ 01	1994/ 07	1992/ 23	1985/ 06	1997/ 07	1996/ 14	1985/ 12
Extreme daily precipitation (mm)	19.1	11.3	20.2	42.4	42.6	128.4	48.2	62.8	64	11.6	19.4	20
Date (yyyy/dd of month)	1989/ 05	2000/ 09	1998/ 16	1999/ 20	1990/ 24	2005/ 17	1987/ 18	1988/ 01	1985/ 11	2003/ 28	1996/ 14	1985/ 12
Extreme snow depth (cm)	60	22	41	24	32	0	0	0	22	17	33	33
Date (yyyy/dd of month)	1998/ 02	1996/ 01	1998/ 18	2001/ 03	2002/ 07	1985/ 01	1985/ 01	1985/ 01	1988/ 24	1991/ 27	1996/ 20	1996/ 30
Days with Maximum Temperature:												
≤ 0 °C	14.5	12.3	8.5	2.2	0.33	0	0	0	0.05	1.9	9.8	14.4
> 0 °C	16.5	15.9	22.6	27.8	30.7	30	31	31	30	29.1	20.2	16.6
> 10 °C	1.6	2.9	7.2	16.8	25.7	29.1	30.9	30	25.6	17.9	4.5	1.9
> 20 °C	0	0.09	0.09	1.6	7	12	21.2	19	10.5	3	0.04	0
> 30 °C	0	0	0	0	0	0.09	1.2	0.7	0.05	0	0	0
> 35 °C	0	0	0	0	0	0	0	0	0	0	0	0

Table 3-9 Canadian Climate Normals based on Springbank Airport Observations (1981 to 2010)

Parameter	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days with Minimum Temperature:												
> 0 °C	0.68	0.73	1.1	4.7	17.5	28.5	30.9	30	21.2	7.1	1.4	0.48
≤ 2 °C	30.8	27.8	30.6	28.2	19.3	4.9	1.1	3	15.1	27.7	29.4	31
≤ 0 °C	30.3	27.5	29.9	25.3	13.5	1.6	0.09	1.1	8.8	23.9	28.7	30.5
< -2 °C	29.4	26.3	27.1	19.5	7	0.23	0	0.2	4.2	18.1	26.6	29.5
< -10 °C	20	17.4	11.1	2.3	0.05	0	0	0	0	2.4	12.9	18.6
< -20 °C	8.2	6	2.9	0.1	0	0	0	0	0	0.27	2.7	6.1
< - 30 °C	2.2	1.3	0.73	0	0	0	0	0	0	0	0.48	1.5
Days with Rainfall:												
≥ 0.2 mm	0.17	0.04	0.48	3.5	9.7	14.5	12.8	12.3	8.8	4.3	0.91	0.23
≥ 5 mm	0	0	0	0.57	3	6	4.6	5	2.4	0.22	0.13	0
≥ 10 mm	0	0	0	0.17	1.6	3.5	2.1	2.8	1.1	0.04	0.04	0
≥ 25 mm	0	0	0	0.04	0.27	0.87	0.18	0.35	0.36	0	0	0
Days with Snowfall:												
≥ 0.2 cm	6	5.9	7.6	5.8	3	0	0.09	0.05	1.4	3.9	5.9	5.4
≥ 5 cm	0.57	0.83	1.4	1.1	0.86	0	0	0	0.36	0.68	1.1	0.68
≥ 10 cm	0.17	0.13	0.39	0.35	0.36	0	0	0	0.05	0.09	0.26	0.09
≥25 cm	0	0	0.04	0	0.05	0	0	0	0	0	0.04	0

Table 3-9 Canadian Climate Normals based on Springbank Airport Observations (1981 to 2010)

Parameter	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days with Precipitation:												
≥ 0.2 mm	5.8	5.7	7.5	8.1	11.6	14.5	12.8	12.4	9.4	7.2	6	5.3
≥ 5 mm	0.35	0.57	1	1.5	3.9	6	4.6	5	2.9	0.77	0.95	0.45
≥ 10 mm	0.09	0.09	0.17	0.48	1.9	3.5	2.1	2.8	1.2	0.14	0.23	0.05
≥ 25 mm	0	0	0	0.04	0.32	0.87	0.18	0.35	0.36	0	0	0
Days with Snow Depth:												
≥ 1 cm	23.8	21.8	17.1	4.7	1.7	0	0	0	0.43	3.3	13.2	20
≥ 5 cm	13.8	16.1	13	2.3	0.68	0	0	0	0.05	0.83	7.2	12.7
≥ 10 cm	10.1	8.5	8.1	1.2	0.32	0	0	0	0.05	0.44	3.8	8.2
≥ 20 cm	3.8	1.6	1.4	0.06	0.05	0	0	0	0.05	0	1.7	3
Wind:												
Maximum hourly speed (km/h)	74	69	74	70	65	69	61	61	61	72	76	74
Date (yyyy/dd)	1986/08	1991/07	1986/27	2002/14	1985/04	1985/24	2007/09	1985/30	2009/08	2008/07	1993/20	1989/03
Direction of maximum hourly speed	W	W	SW	W	W	NW	N	W	W	W	W	SW
Maximum gust speed (km/h)	120	89	93	102	78	91	111	115	78	102	96	111
Date (yyyy/dd)	1997/01	1991/07	1994/27	2001/17	2000/04	1990/11	1998/08	1988/29	2001/08	1989/10	1988/23	1989/03
Direction of maximum gust	W	W	N	W	W	W	W	W	N	N	W	SW

Table 3-9 Canadian Climate Normals based on Springbank Airport Observations (1981 to 2010)

Parameter	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Degree Days:												
Above 24 °C	0	0	0	0	0	0	0	0	0	0	0	0
Above 18 °C	0	0	0	0	0	0.9	7.8	2.6	0	0	0	0
Above 15 °C	0	0	0	0	1.7	9.1	34.9	22.8	3.1	0.4	0	0
Above 10 °C	0	0.1	0.2	2.9	25.7	75	151.1	121.5	41.9	7	0	0
Above 5 °C	0.8	2.8	6.6	31.4	112.6	212.8	303.9	268.7	142.4	46.9	5.3	1
Above 0 °C	13	18.3	47.6	119.6	251	362.8	458.8	423.1	284	145	33	14.5
Below 0 °C	274.4	213.1	125.5	23.5	2.4	0	0	0	0.4	24.3	147.6	235.8
Below 5 °C	417.1	338.6	239.4	85.3	19	0	0.1	0.6	8.8	81.2	269.9	377.3
Below 10 °C	571.3	477.1	388.1	206.9	87.1	12.2	2.3	8.4	58.3	196.3	414.6	531.3
Below 15 °C	726.3	618.2	542.9	354	218.1	96.3	41.1	64.7	169.5	344.7	564.6	686.3
Below 18 °C	819.3	702.8	635.9	444	309.4	178.1	106.9	137.4	256.4	437.3	654.6	779.3
Humidity:												
Average vapour pressure (kPa)												
Average relative humidity - 0600LST (%)	69.2	70.3	71.3	75.1	78.5	83.1	85.6	87.9	83.8	75.1	72.4	69.7
Average relative humidity - 1500LST (%)	58.6	56	50.3	43.3	45.7	50.8	48.2	49.2	47.8	46.5	57.1	60.4
SOURCE: ECCC 2016b.												

Wind speed and direction are the most important meteorological parameters that determine the dispersion of air emissions. Figure 3-3 shows the joint frequency distribution of wind direction and wind speed bases on 2016 observations. The distribution is plotted in polar coordinates and is referred to a wind rose. The direction of the bar indicates the direction the wind is blowing from, and the 16 bars represent the compass points (i.e., N, NNW, NE, ENE, E etc.). The length of the bars represents the frequency of differing wind speed classes occurring. The wind rose indicates the most frequent winds from the northwest (NW) and west (W) sectors. The least frequent winds are from the northeast (NE) and east-northeast (ENE) sectors.

Figure 3-3 also shows the wind speed frequency distribution. Most of the winds are in the 2 to 4 m/s (i.e., 7.2 to 14.4 km/h) range. Winds greater than 10 m/s (36 km/h) occur 2.9% of the time. As indicated in the wind rose, these strong winds tend to be from the west.

3.2.2.2 Ambient Air Quality

Local Measurements

Due to proximity of farms and/or ranch yards, a particulate matter (PM) monitoring program was conducted for $PM_{2.5}$, TSP and dustfall. The monitoring program was conducted during dry summer months to coincide with the worst-case conditions for PM generation from activities that are common for a rural farm location. Details of the local monitoring program are provided in Volume 4, Appendix E. The following discussion provides an overview of the findings from that report.

$PM_{2.5}$ Concentration

Figure 3-4 shows the 24-hour $PM_{2.5}$ measurements from Parcels 56 and 58. There are 26 complete days of $PM_{2.5}$ measurements (i.e., more than 18 hours in each 24-hour period) at Parcel 56; the average and maximum $PM_{2.5}$ concentrations for these 26 days are 1.51 and 3.6 µg/m^3, respectively. There are 31 complete days of $PM_{2.5}$ measurements at Parcel 58; the average and maximum $PM_{2.5}$ concentrations for these 31 days are 4.62 and 11.22 µg/m^3, respectively.

The results indicate, for the period measured, that average $PM_{2.5}$ concentrations tend to be in the 2 to 5 µg/m^3 range. The maximum measured values are less than the AAAQO of 30 µg/m^3.

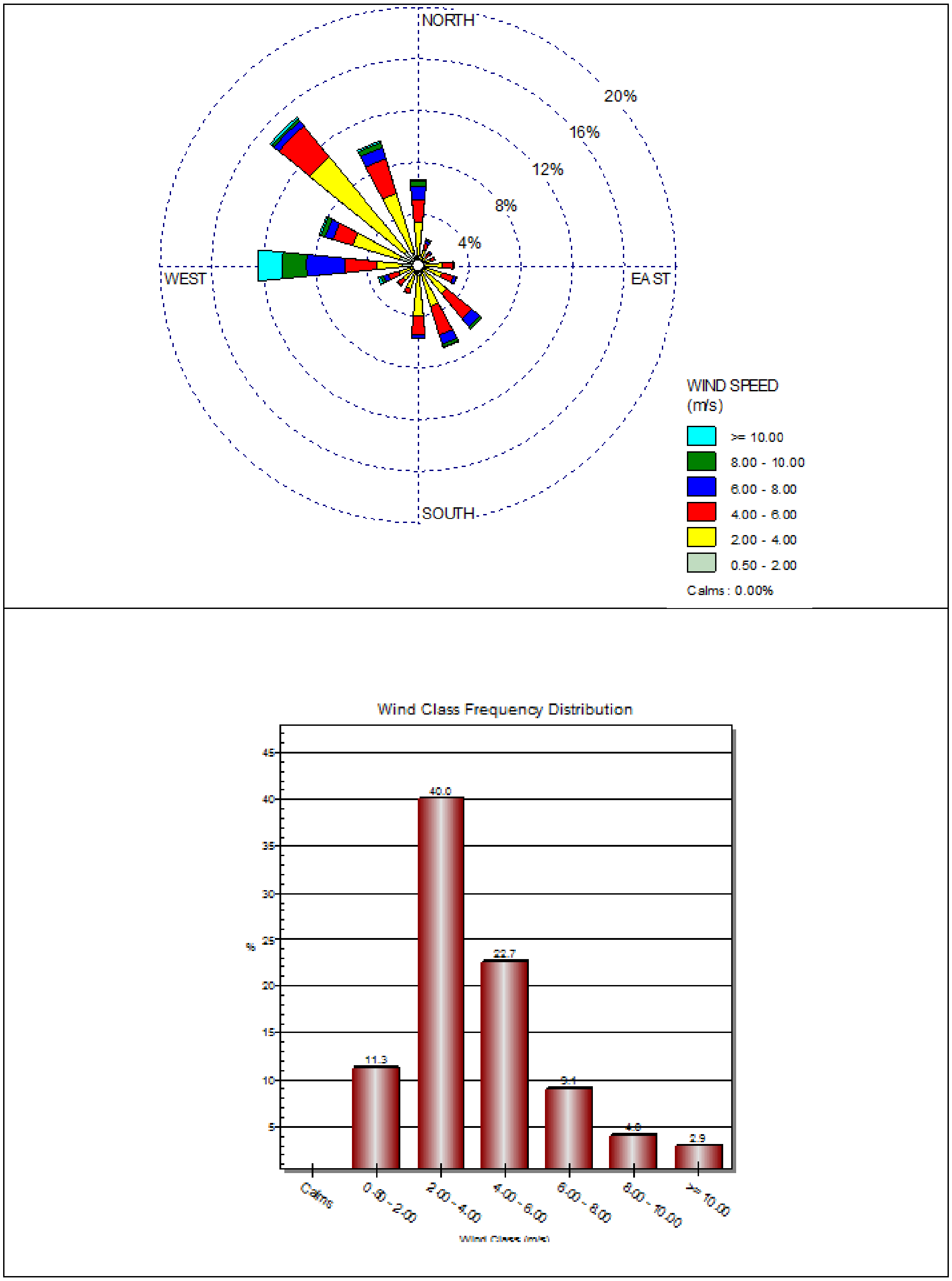


Figure 3-3 Wind Rose and Wind Speed Frequency Distribution Based on Springbank Airport Observations (January 1 to December 31, 2016)

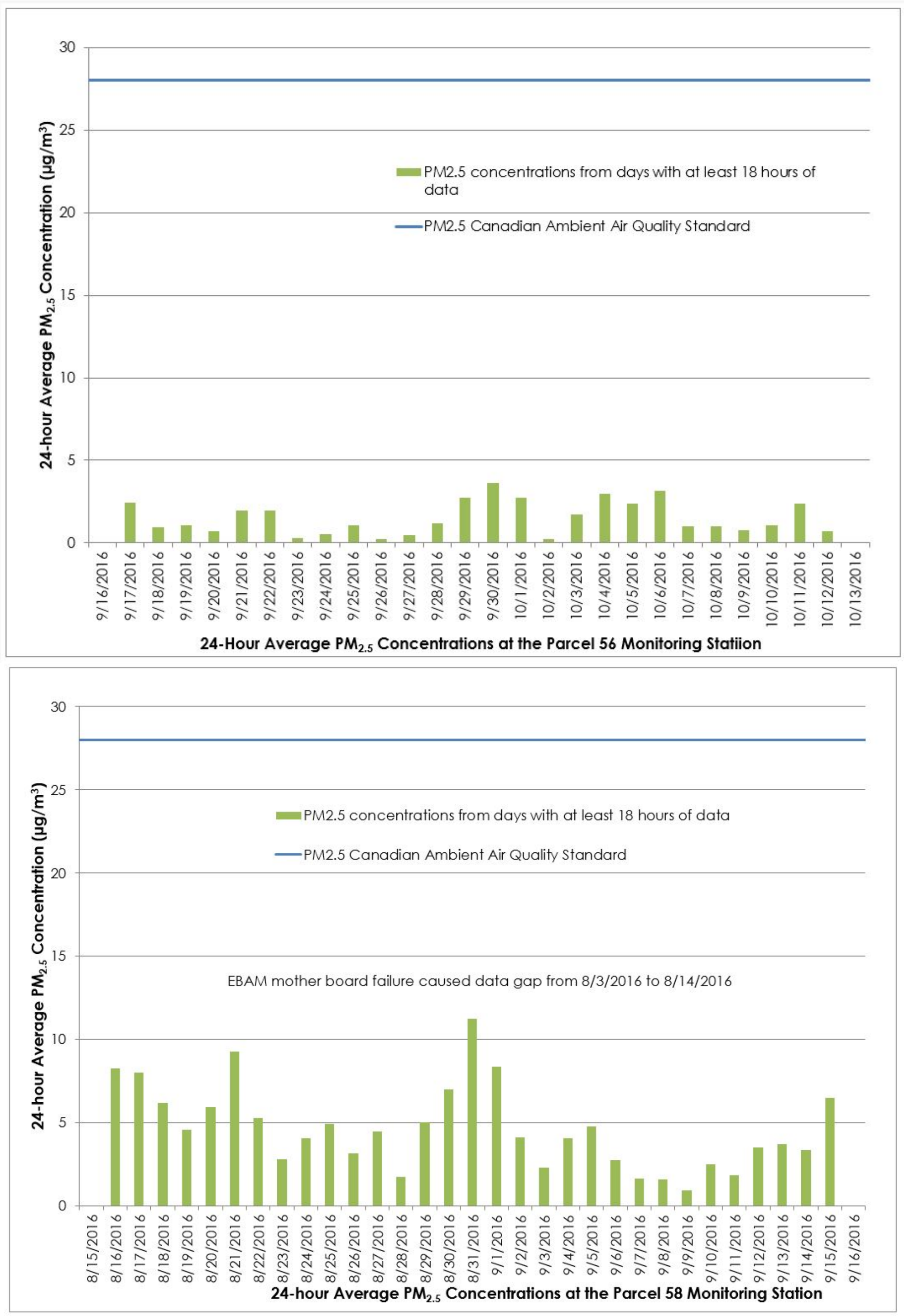


Figure 3-4 Local $PM_{2.5}$ Measurements (August to October 2016)

TSP Concentration

Figure 3-5 shows the 24-hour TSP measurements from Parcels 56 and 58. There are 13 complete days of TSP measurements (i.e., days more than 18 hours in each 24-hour period) at Parcel 56; the average and maximum TSP concentrations for these 13 days are 5.58 and 8.98 µg/m^3, respectively. There are 26 complete days of TSP measurements at Parcel 58; the average and maximum TSP concentrations for these 26 days are 10.97 and 48.47 µg/m^3, respectively. Instrumentation problems (failure of air sampler mother board) reduced the number of measurements at Parcel 56.

The results indicate, for the period measured, that average TSP concentrations tend to be in the 6 to 11 µg/m^3 range. The maximum measured values are less than the AAAQO of 100 µg/m^3.

Dust

Two dustfall measurements were collected at each site; the first measurement for the period August 2 to August 26, 2016, and the second measurement for the period August 26, 2016 to October 13, 2016. The two dustfall measurements at Parcel 56 were identical, being 22.6 mg/100 cm^2/30 day. For Parcel 58, the two measurements are 13.6 mg/100 cm^2/30 day and 12.0 mg/100 cm^2/30 day, for an average value of 12.8 mg/100 cm^2/30 day.

Based on both sites and both periods, the average dustfall is 17.7 mg/100 cm^2/30 day. The overall average and the individual measurements are less than the AAAQO of 53 mg/100 cm^2/30 day for residential and recreational areas.

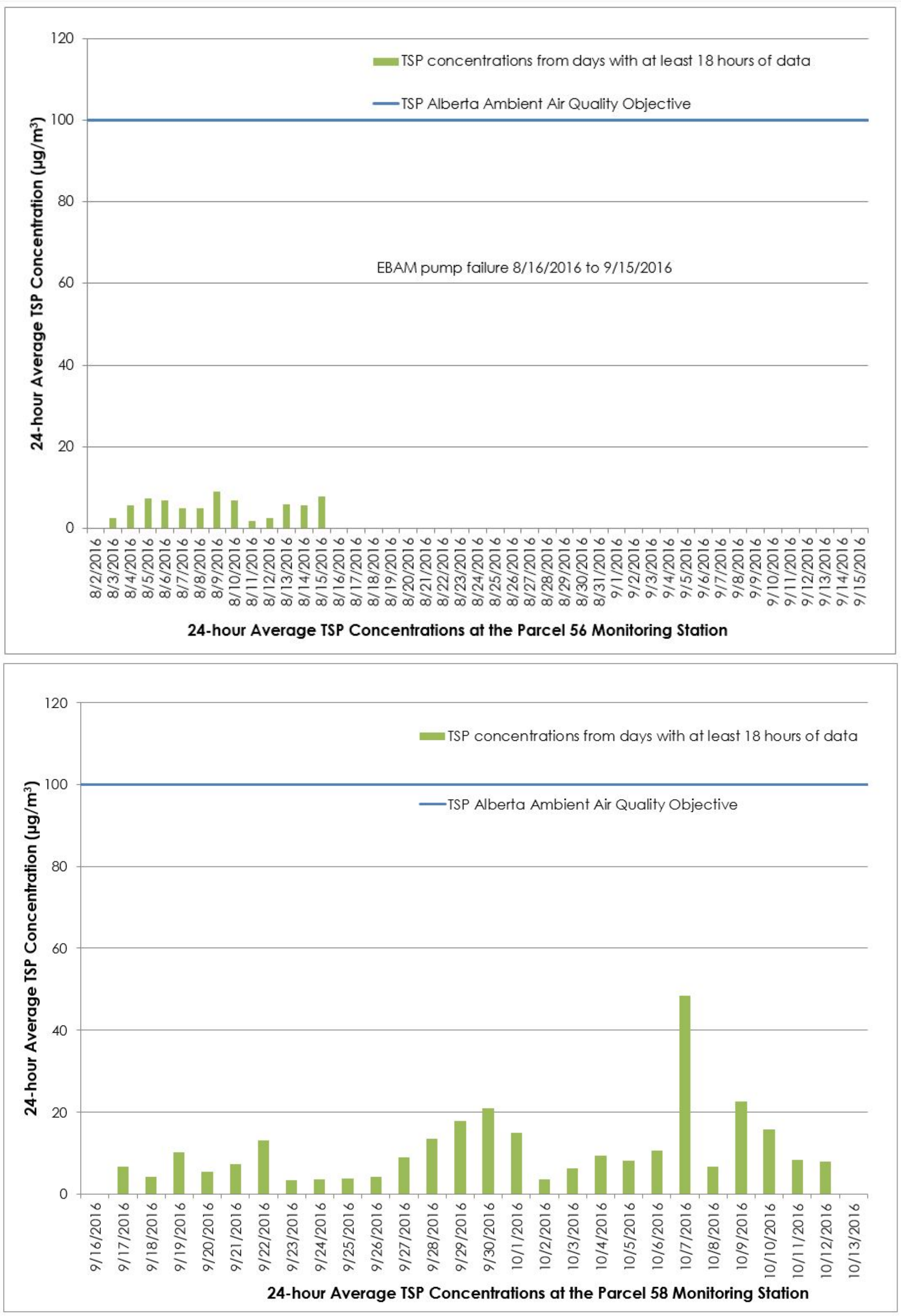


Figure 3-5 Local TSP Measurements (August to October 2016)

Other Measurements

To provide a more robust definition of the background ambient air quality conditions the results from the 10-week local PM monitoring program were combined with published ambient air quality data from regional (more distant) air quality monitoring stations with longer records. The consideration of ambient air quality data from regional monitoring stations with longer records incorporated the effects of seasonality in the data set. Background concentrations for the substances of interest based on more distant measurements are shown in Table 3-10. The table identifies the values and compares them to regulatory criteria. The selected background concentrations range from 0.005 to 51 percent of the regulatory criteria. Out of the 35 substance/averaging period combinations, ten background values are more than 10% of the criteria, and five are more than 25% of the criteria. The occurrence of these latter values is likely associated with selecting an overly conservative value rather than suggesting existing air quality is compromised in the Springbank region.

The high percent values are associated with particles, specifically with ambient $PM_{2.5}$ and TSP concentrations, and with dustfall. The background 24-hour $PM_{2.5}$ value of 11 µg/m³ is similar to the greatest value measured locally (i.e., 11.22 µg/m³). The background 24-hour TSP value of 51 µg/m³ is similar to the greatest value measured locally (i.e., 48.47 µg/m³).

The identification of the monitoring stations and information sources for the background measurements in Table 3-10 are provided in Volume 4, Appendix E, Attachment 3D.

Table 3-10 Background Air Quality

Substance	Averaging Period[a]	Background Concentrations (µg/m³)	AAAQO/AAAQG (µg/m³)	Comparison of Background to AAAQO/AAAQG (%)
CAC Gases				
NO_2	1-hour	9.59	300	3.2
	Annual	3.77	45	8.4
SO_2	1-hour	5.24	450	1.2
	24 hour	4.95	125	4.0
	30 day	3.08	30	10.3
	Annual	2.49	20	12.5
CO	1-hour	344	15,000	2.3
	8-hour	344	6,000	5.7

Table 3-10 Background Air Quality

Substance	Averaging Period[a]	Background Concentrations (µg/m³)	AAAQO/AAAQG (µg/m³)	Comparison of Background to AAAQO/AAAQG (%)
Particles				
$PM_{2.5}$	1-hour	11.0	80	13.8
	24-hour	11.0	28 [h]	39.3
	Annual	3.50	10 [h]	35.0
TSP	24-hour	51.0	100	51.0
	Annual	16.2	60	27.0
Dustfall	30-day	17.7	53	33.4
VOCs				
Acetaldehyde	1-hour	3.38	90	3.8
Acrolein	1-hour	0.29	4.5	6.4
	24-hour	0.048	0.40	12.0
Benzene[j]	1-hour	0.81	30	2.7
	Annual	0.32	3	10.7
Ethyl Benzene	1-hour	0.19	2000	0.01
Formaldehyde	1-hour	9.9	65	15
Toluene	1-hour	1.0	1880	0.053
	24-hour	1.0	400	0.25
Xylenes	1-hour	0.22	2300	0.010
	24-hour	0.22	700	0.031
Styrene	1-hour	0.011	215	0.0051
PAHs				
Benzo(a)pyrene	Annual	0.000022	0.0003	7.3
Naphthalene	Annual	0.052	3	1.7
Metals				
Arsenic	1-hour	0.00050	0.1	0.50
	Annual	0.00016	0.01	1.60
Chromium	1-hour	0.00060	1	0.060
Manganese	1-hour	0.0045	2	0.23
	Annual	0.002	0.2	1.0

Table 3-10 Background Air Quality

Substance	Averaging Period[a]	Background Concentrations (µg/m³)	AAAQO/AAAQG (µg/m³)	Comparison of Background to AAAQO/AAAQG (%)
Nickel	1-hour	0.00036	6	0.0060
	Annual	0.00017	0.05	0.34

NOTES:
See Attachment 3D of Volume 4, Appendix E for details regarding the selection of the indicated background values.
'-' No data available

3.2.2.3 Ambient Light

Results of the existing light monitoring are shown in Table 3-11. Measurements of incident light were less than 1 Lux at each monitoring location. Based on the ambient light levels (both sky glow and light trespass), the LAA is considered a rural environmental zone, Category E2 (see Table 3-3): light trespass measurements were consistently less than 1 Lux, well within the CIE guidelines for light trespass in rural/suburban/urban areas (see Table 3-4). However, sky glow measurements are consistent for an urban environment due to combined light emissions from nearby urban areas (see Table 3-6).

Panoramic photographs taken from the four monitoring locations are included in Volume 4, Appendix E, Attachment 3G. The panoramic photographs are intended to portray the existing environment to better understand visual perception associated with existing conditions.

Table 3-11 Measured Sky Glow and Light Trespass Readings

Site	Average Sky Brightness (mag/arcsec 2)	Light Trespass 1 (Lux)	CIE Environmental Zone	Date
A	17.2	< 0.01	E2	January 6 -7, 2017
B	17.2	< 0.01	E2	January 6 -7, 2017
C	17.5	< 0.01	E2	January 6 -7, 2017
D	17.3	< 0.01	E2	January 6 -7, 2017

NOTE:
[1] Lux levels were below instrument detection limit

3.2.2.4 Greenhouse Gases

According to CEAA 2012 guidance, project GHG emissions should be compared to local, provincial, and federal GHG inventories. There are no local GHG emission inventories for the Springbank area; therefore, project GHG emissions cannot be compared to local emissions.

The provincial and national GHG emissions (ECCC 2016a) are presented in Table 3-12. The emissions presented are for the latest year for which data has been published (2014). Alberta GHG emissions accounted for 37.4% of the national GHG emissions.

Table 3-12 2014 Provincial and National GHG Emissions

Parameter	CO_2	CH_4	N_2O	Other GHGs [a] (expressed as CO_2e)	Total (expressed as CO_2e)
Alberta (kilotonnes)	217,000	1,800	35	1,404.5	274,000
National (kilotonnes)	574,000	4,300	130	10,460.2	732,000
Alberta contribution to national	37.8 %	41.9%	26.9%	13.4%	37.4%

NOTE:
[a] Other GHGs include sulphur hexafluoride, hydrofluorocarbons, perfluorocarbons, and nitrogen trifluoride.

SOURCE: ECCC NIR (ECCC 2016a)

3.3 PROJECT INTERACTIONS WITH AIR QUALITY AND CLIMATE

Table 3-13 identifies interactions of the Project with the various air quality components. The changes due to these interactions are discussed in detail in Section 3.4 in the context of effects pathways, criteria, project-specific mitigation, and residual effects.

Table 3-13 Project-Environment Interactions with Air Quality during Construction and Dry Operations

Project Components and Physical Activities	Environmental Effects		
	Change in Air Quality (including Odour)	Change in Ambient Light	GHG Emissions
Construction Phase			
Clearing	✓	✓	✓
Channel excavation	✓	✓	✓
Water diversion construction	✓	✓	✓
Dam and berm construction	✓	✓	✓
Low-level outlet works construction	✓	✓	✓
Road construction	✓	✓	✓
Bridge construction	✓	✓	✓
Lay down areas	–	✓	–
Borrow extraction	✓	✓	✓
Reclamation	–	✓	–
Dry Operations Phase			
Maintenance	–	-	–

NOTES:
✓ = Potential interaction, – = No interaction

3.3.1 Construction Phase

Atmospheric emissions during the construction phase result from construction vehicle exhausts and from fugitive dust associated with the construction activities. The magnitude of these emissions is directly related to the construction activity intensity. The off-stream dam construction activity (identified as dam and berm construction in Table 3-13), and the raising of Highway 22 (identified as road construction in Table 3-13) involve the movement of the most material, and hence these two activities are associated with the largest emissions during the construction phase. Smaller emissions are associated with other activities such as clearing, channel excavation, water diversion construction, low-level outlet construction, and bridge construction.

While lay down areas and reclamation are indicated to have no interaction with air quality or climate (GHG emissions), they are very minor sources of emissions. Lay down areas are designated areas for the receipt and storage of project equipment and materials required for construction. These laydown areas would be prepared prior to the main construction activity period. Construction reclamation activities include reclaiming the laydown areas, temporary construction roads, and the borrow pit. These reclamation activities would occur after the main construction activity period. Since these activities do not overlap with the main construction period and since they are also very small compared to other activities, they are not included explicitly in the assessment. In addition, emissions associated with on-highway vehicles transporting equipment and materials to the project site are not included in the assessment as the associated emissions occur off the project site.

Utility realignments are related to pipeline and electricity line installation. Emissions associated with excavation works for the installation of these pipelines and power lines are outside the scope of the assessment and not included.

3.3.2 Dry Operations

During the dry operations phase, associated activities would be limited to periodic inspections and routine maintenance. There are no interactions of the Project with air quality, light, or climate (GHG emissions).

The release of GHGs and other substances would be limited to small quantities of fuel combusted for these periodic maintenance activities. Approximately six lighting fixtures will be in operation at night to provide illumination at the diversion structure and off-stream dam outflow components. Annual electricity use from these fixtures is considered negligible in the context of GHG emissions. The dry operations phase is not assessed for the ambient air quality and light components because there are no continuous emissions and lighting requirements are minimal.

After the construction phase is completed, surfaces of the off-stream dam, banks of the diversion channel, and the floodplain berm will be covered with a layer of topsoil and revegetated. These areas would undergo a short-term land-use change because they can fix carbon when re-vegetated. The area that would undergo a permanent land use change is the diversion structure itself, an estimated 0.3 hectares. Considering the small area that would be affected by the Project, the magnitude of the change in carbon sequestration is expected to be low. For these reasons, GHGs are not assessed for the dry operations phase.

3.4 ASSESSMENT OF RESIDUAL ENVIRONMENTAL EFFECTS ON AIR QUALITY AND CLIMATE

3.4.1 Analytical Assessment Techniques

3.4.1.1 Ambient Air Quality

It is important to understand potential ambient air quality changes associated with Project activities so appropriate mitigation measures can be applied to reduce emissions, especially fugitive particulate emissions that can increase during adverse meteorological conditions (i.e., dry windy conditions). This air quality assessment considers substances for which there are ambient air quality criteria (i.e., objectives, guidelines, or standards) adopted by either provincial (Alberta) or national regulatory agencies. The predicted concentrations and dustfall due to emissions, in combination with current emissions for other non-project sources are compared to these criteria. Ambient concentrations are expressed in units of $\mu g/m^3$), and dustfall is expressed as a deposition rate in $mg/100\ cm^2/30$ days.

The first stage of the ambient air quality assessment estimates emission rates and associated source parameters due to project construction activities. The construction activities include combustion exhaust and fugitive dust sources. In addition, associated emission rates and parameters are required for existing sources operating in the LAA. Collectively, the systematic identification of emission sources and associated parameters is referred to as an emission inventory. The preparation of the emission inventory for the Project and existing sources in the LAA is discussed in Volume 4, Appendix E, Attachment 3A.

An air quality transport, dispersion, and deposition computational model provides the link between these emissions and ambient concentration and deposition changes in the LAA. For this assessment, the CALMET/CALPUFF model system (Scire et al. 2000) is used to determine the effect of project construction emissions on ambient air quality. The application of the model system 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 CALMET model domain of 40 km by 40 km contains the LAA (20 km by 20 km) with a buffer of 10 km on each side to minimize potential computational boundary effects near the perimeter of the LAA. Specifically, the larger CALMET domain allows air emissions to exit and re-enter the LAA if the wind directions are shifting. For this assessment, the CALPUFF domain coincides with the LAA, centred on the PDA. The CALPUFF domain is sized to capture the overall predicted maximum concentrations.

Maximum predicted ground-level concentrations along and outside the PDA (with the background contribution), are compared to the most stringent ambient air quality criteria (Tables 3-1). Concentrations and deposition inside the PDA are not compared to the ambient criteria because public access is restricted in this region.

Maximum predicted short-term peak ground-level concentrations for odour causing substances (i.e., odourants) at residence and business receptor locations (with the background contribution) are compared to the detection and recognition thresholds identified in Table 3-2. Additionally, the potential areas where odour could occur are identified by considering the collective effect of all odourants. The predicted odourant concentrations for the individual odourants are combined in the form of odour unit (OU) concentration based on the detection and recognition thresholds of each odourant (without considering the background contribution). The combined OU concentration is compared to a threshold of 1 OU to provide estimates where there could be potential odour events in the LAA.

Details on the CALMET/CALPUFF model implementation are provided in Volume 4, Appendix E, Attachment 3B and Attachment 3C.

3.4.1.2 Ambient Light

Lighting can become obtrusive if the light criteria in Table 3-4 and Table 3-5 are not met. The effects of Project lighting on nearby residential locations is assessed by comparing the predicted light changes to these light criteria.

The assessment of a change in ambient light from the construction phase focuses on the potential effects that exterior lighting could have on light trespass, glare, and sky glow at the nearest receptor locations.

The quantitative assessment for light trespass and glare involves:

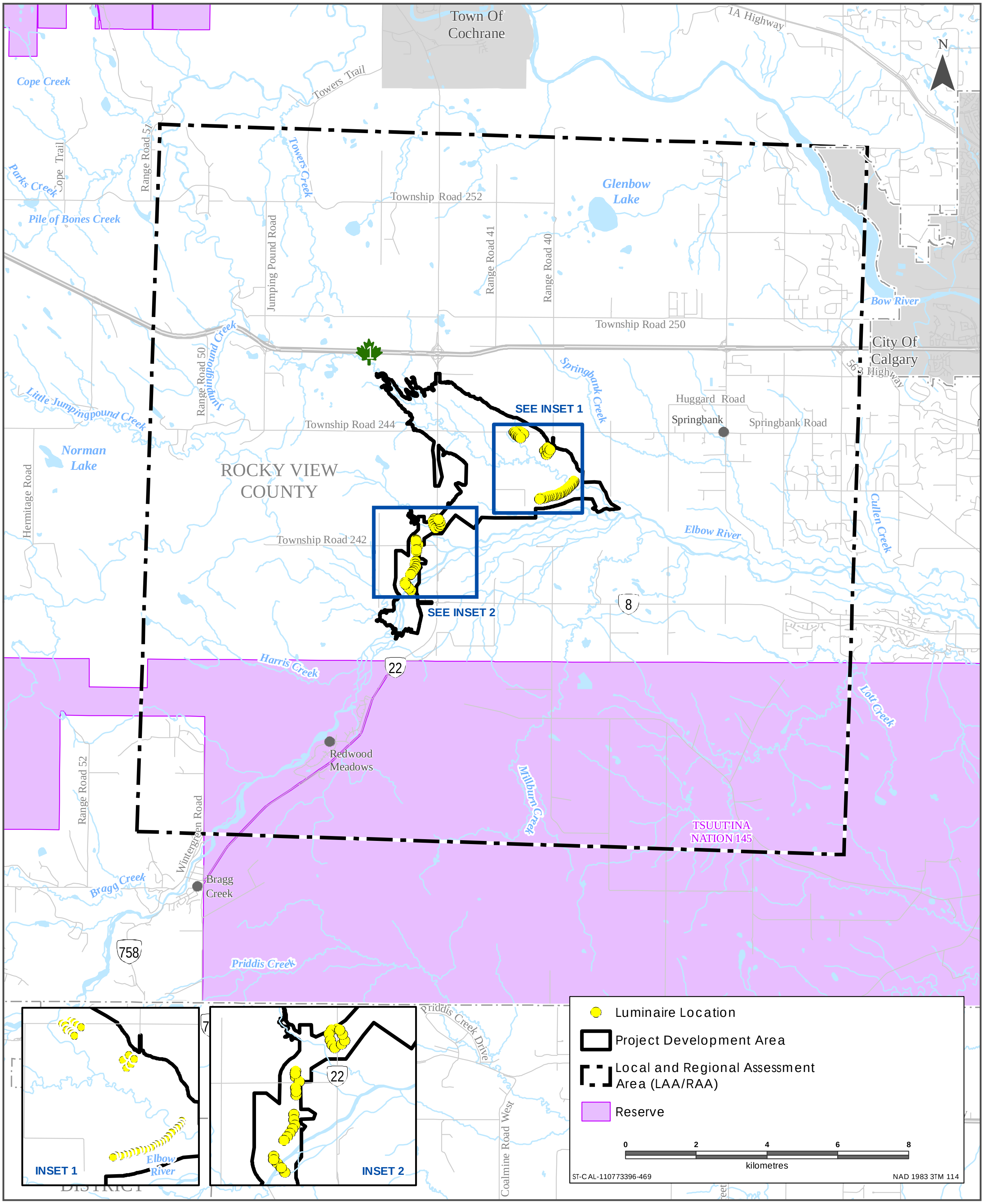
- gathering information on the current lighting conditions in and surrounding the assessment area (refer to Section 3.2.1)
- building a model that incorporates project-specific information pertaining to exterior Project lighting
- identifying the locations of the nearest residence and business receptors
- predicting levels of light trespass and glare from construction activities at the nearest receptor locations
- determining if the predictions are below or above CIE criteria for a rural environment (E2)

To predict the potential effects that construction lighting from mobile flood lighting could have on the nearest residential receptors, light trespass and glare are modelled at individual receptor locations using the AGi32 photometric analysis software. AGi32 is an industry standard software package used for industrial lighting design.

Figure 3-1 shows the locations of residences and businesses in the LAA. A detailed list of residence and business receptors is provided in Volume 4, Appendix E, Attachment 3C. However, for assessing potential effects of lighting during construction, only the nearest receptors to the PDA are included in the light assessment.

The lighting model is set up by placing the lights at approximately 30 m increments near locations where earth works will take place and near roadway intersections. It is estimated that up to 69 lighting units could be in operation at any one time, scattered throughout the PDA and at major roadway intersections. The lighting, to safely and efficiently carry out construction activities during nighttime hours, will use mobile flood lighting. Each mobile lighting unit is assumed to be comprised of four, 1,000 W metal halide luminaires capable of independent orientation. Luminaires are set at a 10° tilt from horizontal. Terrain elevation is estimated at each light source and at residence and business locations using the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model Version 2, with a resolution of 1 arc second. Figure 3-6 shows the locations of the light sources used in the light model.

To assess the effect of lighting during construction on nearby residences and businesses, the predicted levels of light trespass and glare are compared to the applicable light criteria. For the qualitative assessment of sky glow, conclusions are based on the existing ambient light data and the predicted results for light trespass and glare.



Sources: Base Data - ESRI, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Construction Luminaire (Light) Locations

Stantec

Figure 3-6

3.4.1.3 Greenhouse Gases

The Canadian Environmental Assessment Agency (CEA Agency) guidance document (CEAA 2003) outlines how to incorporate GHG considerations in environmental assessments (EAs). This assessment aligns with the guidance document by comparing Project GHG emissions to provincial and national GHG inventories. As stated in the CEA Agency (CEAA 2003) document, GHG assessments cannot address the significance of a single project's potential effect on climate change, as the small effect of one project on climate change cannot be accurately quantified or measured. Although it is understood that there is a relationship between GHG emissions from anthropogenic sources over the past 100+ years and a changing climate as an effect thereof, effects on climate change cannot be addressed in this GHG assessment. The science of climate change has not advanced to the point where a clear cause and effect relationship can be established between individual project releases and measurable changes to global climate.

GHG emissions associated with construction activities are estimated and compared to provincial and national totals. The methods used to estimate GHG emissions from the Project are guided by the principles of the GHG Protocol (WRI 2013). The GHG Protocol is an internationally accepted accounting standard and provides guidance on preparing a GHG emissions inventory. Relevance, completeness, consistency, transparency, and accuracy are the five principles that should build the base of any GHG accounting and, therefore, guide this assessment.

Input data such as the engine type, number of units, power rating, utilization factors and total operating hours of all the equipment were estimated. With the use of the US EPA NONROAD model (U.S. EPA 2010), the fuel consumption rate of construction equipment was calculated. Diesel consumption emission factors from the ECCC National Inventory Report (ECCC 2016a) were used to estimate emissions from the list of representative construction equipment and fuel consumption rates.

Emissions from land clearing activities (i.e. tree removal) would be expected to be negligible because disturbed areas are primarily farmland or cultivated crops. Limited tree coverage will be cleared.

The quantification method used, including emission factors, are provided in Volume 4, Appendix E, Attachment 3G. The emission inventory is an estimate based on best available information at the time of Application submission.

3.4.2 Project Pathways

3.4.2.1 Ambient Air Quality

During construction, there are two types of air emissions:

Exhaust emissions from construction equipment that include but are not limited to bulldozers, scrapers, graders, and haul trucks. These vehicles consume diesel fuel and the products of combustion are vented the atmosphere. The exhaust emissions primarily comprise nitrogen (N_2), carbon dioxide (CO_2), and water vapour (H_2O); with trace amounts of substances such as oxides of nitrogen (NO_X), sulphur dioxide (SO_2), carbon monoxide (CO), hydrocarbons (HC), particulate matter (PM), polycyclic aromatic hydrocarbons (PAHs), and metals. These gases and particles are common by-products of fossil fuel combustion.

Fugitive dust emissions from surface disturbance activities result in particle emissions of various size ranges (e.g., $PM_{2.5}$ and TSP) that can also be deposited to off-site ground surfaces (i.e., dustfall). $PM_{2.5}$ refers to respirable particulate matter that has an aerodynamic diameter less than 2.5 µm, and total suspended particulate (TSP) includes larger particles, nominally up to 30 µm in diameter. The larger dust particles are removed near the disturbance area by gravitational settling and is the main contributor to dustfall. TSP and $PM_{2.5}$ emissions are carried off-site by the wind; the smaller $PM_{2.5}$ fraction tends to be transported further downwind than the TSP.

Traffic flow along nearby highways and roadways is the main source of current emissions in the Springbank area. Traffic sources produce combustion product emissions and fugitive dust emissions.

Predicted ambient concentrations due to project activities, when combined with similar contributions from other sources, are compared to relevant ambient air quality criteria.

3.4.2.2 Ambient Light

Because construction is planned to occur 24 hours per day, portable lighting units will be used at night to meet visibility and worker safety needs. Three attributes are used to describe light:

- Light trespass refers to the transmission of light from fixtures within a facility to the environment and receptors outside the facility. The unit of measure for light incidence either in or outside the facility is a lux. A lux is equal to one lumen/m^2. Light trespass reaches problematic levels, for example, when lights located on the outside of an industrial facility shine in through the windows of nearby residential homes at levels that could disrupt sleep, or distract from normal levels.

- Glare refers to intense, harsh, or contrasting lighting conditions that reduce humans, birds, and other organisms' ability to see. The most common example of glare is oncoming high-beam headlights that provide ample light but result in poor visibility, potentially reaching hazardous conditions. The unit of measure is luminance, which is equal to lumens per steradian: this is the unit candela (cd).
- Sky glow refers to the illumination of the clouds by light sources on the surface of the earth such as street lighting, and haze in the atmosphere that replaces the natural nighttime sky with a translucent to opaque lighted dome. The sky appears washed out, or brownish-purple and may be devoid of visible stars in the extreme. Sky glow is the cumulative effect of all the lights at the surface either emitting upward, or being reflected upward by the surface plus the emission from photochemical activity in the atmosphere. The unit of measure for the brightness of the sky, including sky glow, is magnitudes per square arcsecond ($mag/arcsec^2$).

3.4.2.3 Greenhouse Gases

Construction vehicle exhausts are a source of greenhouse (GHG) emissions. These GHG emissions are primarily carbon dioxide (CO_2), with smaller amounts of methane (CH_4) and nitrous oxide (N_2O). Per the GHG Protocol (WRI 2013), The GHG emissions include all direct emissions from the Project.

Upstream GHG emissions can originate from construction material extraction, processing, fabrication, and shipping to the project site; and electricity use in construction offices and lighting. Accurately quantifying construction material upstream emissions is difficult, given the wide range of material sources, fabrication methods, and shipping options. Due to the preliminary nature of the engineering design of the project, estimates of construction materials were not available and are not considered further in this assessment.

3.4.2.4 Carbon Sequestration

Carbon sequestration is the removal and storage of carbon from the atmosphere in carbon sinks such as oceans, forests and soils through physical or biological processes. Natural carbon sequestration is the ability of the ecosystem to fix carbon into biogenic material. An example of this is the process of photosynthesis, which removes carbon dioxide from the atmosphere and fixes the carbon in plants.

This assessment provides a qualitative assessment of potential changes, associated with the reservoir construction and dry operations components or activities, to the carbon sequestration capacity of the area within the PDA.

3.4.2.5 Climate Effects

Extreme weather events can adversely affect the construction budget and schedule, and influence ambient air quality. The best indicator of the occurrence and likelihood of adverse weather event occurring is the review of historical climate data. Because construction is proposed to nominally occur in the 2019 to 2021 period, the influence of future climate change on the historical data is not warranted. The potential effects of climate on the Project are presented in Volume 3D, Section 3.

3.4.3 Air Emission Rates

3.4.3.1 Assessment Cases

The ambient air quality assessment addresses three cases: Base Case defined by existing emissions in the LAA, a Project Case that considers only project emissions, 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 provides an explicit indication of the Project's contribution.

3.4.3.2 Base Case – Air Emissions

Existing 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. Traffic emission rates were determined for the TransCanada Highway (Highway 1), Highway 22, Highway 8, and the Springbank Road based on traffic counts and on the application of the U.S. EPA Motor Vehicle Emission Simulator (MOVES) traffic emission model version 2014a (U.S. EPA, 2015). Road dust emissions were estimated using U.S. EPA AP-42 emission factors from Chapter 13.2.1 Paved Roads (U.S. EPA, 2011).

Emission speciation profiles for VOCs, PAHs, and metals for on-road vehicles are derived using MOVES2014a (U.S. EPA, 2015). Emission speciation profiles for metals in road fugitive dust are based on laboratory analysis of five soil samples collected near the PDA.

Traffic and road dust emissions on regional roads are estimated for winter and summer periods based on winter and summer-specific emission factors. Traffic counts are provided by Alberta Transportation for the average annual daily traffic (AADT) count and an average summer daily traffic (ASDT) count. The summer traffic counts for all regional roads are higher than the average annual traffic counts which indicates that traffic volume in summer is higher than traffic in winter. Therefore, the AADT count is applied to winter emissions and the ASDT count is applied to summer emissions. For traffic combustion emissions, winter is defined as the six-month period October to March. For fugitive road dust emissions, winter is defined as the four-month period November to February.

A summary of Base Case emission rates is provided in Table 3-14. NO_X, SO_2, CO and VOC emissions are associated with combustion sources only. $PM_{2.5}$ emission rates associated with combustion and fugitive dust sources are similar in magnitude. TSP emission rates associated with fugitive dust sources are much greater than those associated with combustion emissions. The Base Case emission rates in Table 3-15 do not include combustions emission associated with residential heating or fugitive dust associated with agricultural operations. The background values that are added to the model predictions indirectly account for these sources. Further details are provided in Volume 4, Appendix E, Attachment 3A.

3.4.3.3 Project Case – Air Emissions

Project emissions during construction are associated with the operation of the off-road construction equipment and earth moving activities for the construction of the major components of the Project. The following emission sources due to construction activities are estimated:

- Diesel combustion exhaust emissions from off-road construction equipment and haul trucks
- Fugitive dust emissions from scraping, bulldozing and grading of top soil and overburden
- Mechanically generated dust by off-road equipment in transition
- Fugitive dust emissions from truck loading and unloading
- Mechanically generated dust by truck traffic along haul roads
- Fugitive dust emissions from wind erosion on top soil and overburden stockpile

Exhaust emissions from off-road diesel equipment are based on the Canadian off-road compression-ignition engine emission standards (ECCC 2005). Emission speciation profiles for VOCs, PAHs and metals for off-road diesel equipment are derived using the U.S. EPA Motor Vehicle Emission Simulator model version 2014a (MOVES2014a) (U.S. EPA, 2015) and the integrated NONROAD2008 model. The MOVES2014a-NONROAD model uses a compilation of equipment of different ages up to the year that is modelled. Emissions are conservatively estimated for the year 2012 to represent construction equipment prior to Tier 4 emission standard implementation. Tier 4 standard for off-road engines comes into effect in 2014 with a transitional period for some engine categories starting in 2012. Year 2012 is selected to allow only older off-road equipment (Tier 1, Tier 2 and Tier 3) to be used for estimating emissions. The estimated emissions are therefore conservative. If a newer, Tier 4 off-road diesel equipment is used during construction the exhaust emissions from the construction equipment would be less.

Fugitive dust emissions from construction equipment activities and wind erosion are estimated using emission factors from various chapters of the U.S. EPA AP-42 Fifth Edition Compilation of Air Pollutant Emission Factors emission factors (U.S. EPA 1995). Emission speciation profiles for metals in fugitive dust are based on laboratory analysis of five soil samples collected near the PDA.

Construction activities and the associated intensity levels would vary with individual construction components, the individual component construction phase, and weather conditions during the construction period. Multiple simultaneous construction activities at high intensity levels would result in large substance emission rates, and these periods are expected to be biased to day-time, non-winter periods. Reduced activities associated with winter conditions when the ground is frozen are expected result in low substance emission rates.

While construction could occur over a nominal two to three-year period, the air substance emission rates would not be constant and vary greatly during this period. To assess air quality changes associated with construction activities, maximum short-term (i.e., hourly average) emission rates are based on a compressed construction schedule that would result in greater substance emission rates. This approach is made to be conservative and overstate potential emission rates and hence associated ambient concentrations. To better represent annual average concentration exposures, equivalent annual average emission rates that are less than the maximum short-term emission rates are used. Assumptions used to estimate the maximum short-term and annual average emission rates are provided in Volume 4, Attachment 3A.

Figure 3-7 shows the location of the emission sources within the PDA boundary. A summary of project emissions is provided in Table 3-15. NO_X, SO_2, CO and VOC emissions are associated with combustion sources only. Most of the $PM_{2.5}$ and TSP emissions are associated with the fugitive haul road dust emissions. The annual equivalent emissions rates are about 74% the maximum daily emission rate.

A detailed description of emission calculations is provided in Volume 4, Appendix E, Attachment 3A.

Table 3-14 Base Case Emission Rates

Emission Source	Length (km)	AADT [a] (vehicle/ day)	ASDT [b] (vehicle/ day)	Winter Emission Rates [c] (kg/d)						Summer Emission Rates (kg/d)					
				NO_x	SO_2	CO	$PM_{2.5}$	TSP	VOC	NO_x	SO_2	CO	$PM_{2.5}$	TSP	VOC
Road Traffic - Combustion Emissions															
Highway 1	20.3	23,330	27,630	348	2.09	964	13.3	18.4	44.6	366	1.25	1,247	11.7	17.2	43.8
Highway 22	22.4	12,800	13,760	207	1.25	564	7.96	11	26.5	197	0.673	667	6.4	9.4	23.3
Highway 8	12.1	7,130	8,380	70.3	0.378	153	2.61	3.6	7.84	74.5	0.244	201	2.43	3.51	6.81
Springbank Road	8.8	5,260	6,150	18.8	0.198	77.6	0.939	1.72	4.13	18.8	0.096	101	0.767	1.63	4.47
Total Emissions				**644**	**3.92**	**1,759**	**24.8**	**34.7**	**83.1**	**657**	**2.26**	**2,217**	**21.3**	**31.7**	**78.4**
Road Traffic - Fugitive Dust Emissions															
Highway 1	20.3	23,330	27,630	—	—	—	12.9	270	—	—	—	—	14.6	306	—
Highway 22	22.4	12,800	13,760	—	—	—	7.5	157	—	—	—	—	7.72	162	—
Highway 8	12.1	7,130	8,380	—	—	—	9.31	195	—	—	—	—	5.58	117	—
Springbank Road	8,.8	5,260	6,150	—	—	—	3.18	66.7	—	—	—	—	1.9	39.7	—
Total Emissions				**—**	**—**	**—**	**32.9**	**689**	**—**	**—**	**—**	**—**	**29.8**	**624**	**—**
Point Source Emissions															
Compressor Station (Shell Jumping Pound 5-7)	—	—	—	68.2	—	—	—	—	—	68.2	—	—	—	—	—
TOTAL EMISSIONS				**712**	**3.92**	**1,759**	**57.7**	**723**	**83.1**	**725**	**2.26**	**2,217**	**51.1**	**656**	**78.4**

NOTES:

AADT - Average Annual Daily Traffic (vehicle/day). Two-way traffic for period January 1 to December 31 (365 days)

ASDT - Average Summer Daily Traffic (vehicle/day). Two-way traffic for period of May 1 to September 30 (153 days)

[a] AADT used in calculation of winter emissions

[b] ASDT used in calculation of summer emissions

[c] For traffic combustion emissions winter is defined as the 6-month period October to March. For road dust emissions winter is defined as the 4-month period November to February.

Table 3-15 Project Case Emission Rates

Emission Source	Daily Emission Rates [a] (kg/d)						Annual Emission Rates [b] (kg/d)					
	NO_x	SO_2	CO	$PM_{2.5}$	TSP	VOC	NO_x	SO_2	CO	$PM_{2.5}$	TSP	VOC
Diesel Exhaust Emissions from Off-Road Equipment	1,524	3.9	1,450	83.8	86.4	124	1,134	2.8	1,074	62.6	64.5	93.0
Fugitive Dust Emissions from Bulldozing and Grading	—	—	—	36.9	351	—	—	—	—	20.3	193	—
Fugitive Dust Emissions from Off-Road Equipment in Transition	—	—	—	4.4	154	—	—	—	—	1.9	67.6	—
Fugitive Dust Emissions from Material Loading and Unloading	—	—	—	5.8	80.9	—	—	—	—	5.2	71.9	—
Fugitive Dust Emissions from Truck Traffic on Haul Roads	—	—	—	368 [c]	12,875[c]	—	—	—	—	356 [c]	12,476[c]	—
Fugitive Dust Emissions from Wind Erosion [d]	—	—	—	0.728[e]	6.1 [e]	—	—	—	—	0.728 [e]	6.1[e]	—
TOTAL EMISSIONS	**1,524**	**3.9**	**1,450**	**499**	**13,554**	**124**	**1,134**	**2.8**	**1,074**	**447**	**12,879**	**93.0**

NOTES:

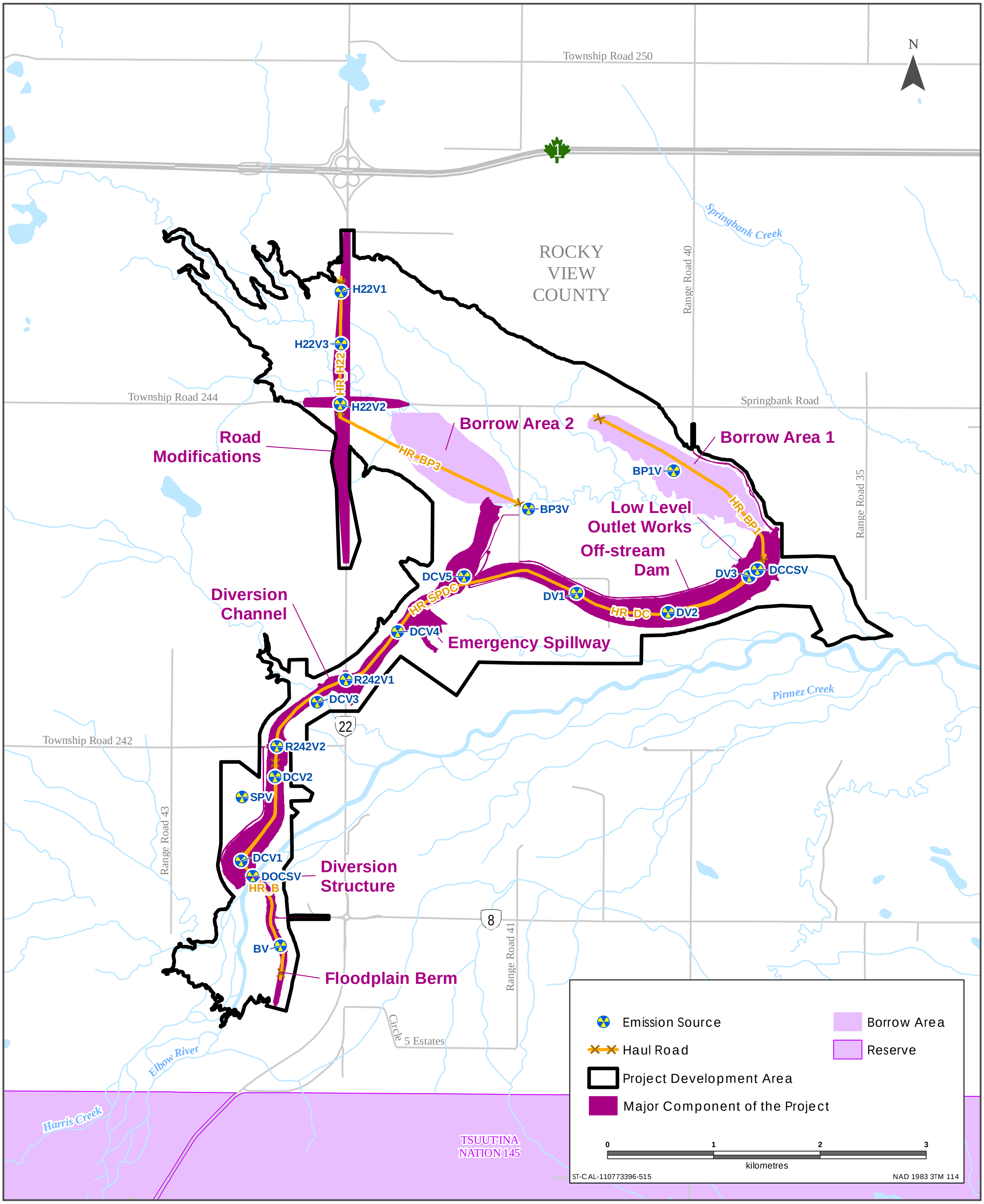
[a] Daily emission rates are based on maximum hourly emission rates and the work hours per day for each activity

[b] Annual emission rates are based on scaled (reduced) hourly emission rates and the work hours per day for each activity

[c] Daily emission rates for haul roads represent emissions during summer with applied dust control efficiency (75%) corresponding to water application twice daily

[d] Wind erosion emissions represent emissions at hourly average wind speed greater than 10.8 m/s. At wind speeds less than 10.8 m/s, no wind erosion emissions are generated.

[e] Annual emission rate estimated based on 0.37% probability of hourly average wind speed greater than 10 m/s, extracted from CALMET for the location of the temporary top soil and overburden stockpile.



Sources: Base Data - ESRI, Natural Earth, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Location of the Project Air Emission Sources

Comparison to other Projects

The Project emission sources are typical for a construction site that involves surface disturbances and associated earth moving activities. The disturbance area for the Project is compared to disturbance areas associated other similar projects in the Springbank and Calgary areas. A comparison of construction emission rates cannot be done since emission rates have not been estimated for these other construction projects. The construction phase would result in a surface disturbance area of approximately1,300 ha. In comparison, residential community developments include the Harmony development near Springbank Airport is 708 ha (or 1,750 acres), the Walden/Legacy subdivision development in southeast Calgary is 696 ha (or 1,720 acres), and the Cross Iron Mill commercial area is 24 ha (or 59 acres).

As previously indicated Project construction could occur over a nominal three-year period. Calgary road construction projects include the construction of the Trinity Hills and the TransCanada Highway/Sarcee Trail interchange projects (2 years duration) and the Calgary Ring Road (101 km and 5 years duration) projects.

The PDA is similar to the community development areas. The community developments are planned for construction in phases with total duration span of 10-15 years. However, the nature of the surface disturbance areas at any given time would be similar to the Project. The haul truck traffic for the Project is more intense (the highest truck traffic is estimated to 33 loaded trucks per hour) than typical truck traffic for community development. The project haul truck traffic is more comparable to the construction of major roadways such as the Calgary Ring Road. However, the Project construction and associated emissions would have shorter duration compared to the construction of Calgary Ring Road.

3.4.3.4 Application Case – Air Emissions

The Application Case emission rates are the sum of the Base Case and Project Case emission rates. Table 3-16 shows the emission rates for the three cases. The project contribution is 91% to 95% (i.e., the Base Case contributes 5% to 9%) for particulate emissions and 40% to 68% (i.e., the Base Case contributes 32% to 60%) for gaseous emissions. These comparisons are based on the larger daily emission rates. On an annual basis, the project contribution ranges from 90% to 95% for particulate emissions and 33% to 61% for gaseous emissions.

Table 3-16 Comparison of Base Case, Project Case, and Application Case Emission Rates

Assessment Case	Emission Source	Daily Emission Rate (kg/d)					
		NO_X	SO_2	CO	$PM_{2.5}$	TSP	VOC
Base Case (Summer [a])	Road Traffic Combustion Emissions	657	2.26	2,217	21.3	31.7	78.4
	Road Traffic Fugitive Dust Emissions	—	—	—	29.8	624	—
	Compressor Station (Shell Jumping Pound 5-7)	68.2	—	—	—	—	—
	Emission Total	**725**	**2.26**	**2,217**	**51.1**	**656**	**78.4**
Project Case (Daily)	Diesel Exhaust Emissions from Off-Road Equipment	1,524	3.9	1,450	83.8	86.4	124
	Fugitive Dust Emissions from Bulldozing and Grading	—	—	—	36.9	351	—
	Fugitive Dust Emissions from Off-Road Equipment in Transition	—	—	—	4.4	154	—
	Fugitive Dust Emissions from Truck Traffic on Haul Roads [b]	—	—	—	368	12,875	—
	Fugitive Dust Emissions from Material Loading/Unloading	—	—	—	5.8	80.9	—
	Fugitive Dust Emissions from Wind Erosion	—	—	—	0.728	6.1	—
	Emission Total	**1,524**	**3.9**	**1,450**	**499**	**13,554**	**124**
Application Case	Base Case Emissions	725	2.26	2,217	51.1	656	78.4
	Project Case Emissions	1,524	3.9	1,450	499	13,554	124
	Emission Total	**2,249**	**6.16**	**3,667**	**551**	**14,210**	**202**
Project Contribution (%) to Application Case Emissions:		**68%**	**63%**	**40%**	**91%**	**95%**	**61%**

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] Daily emission rates for haul roads represent emissions during summer with applied dust control efficiency (75%) corresponding to water application twice daily. For haul road dust emissions, summer is defined as the 8-month period March to October.

3.4.4 Project Mitigation Measures

3.4.4.1 Ambient Air Quality

Mitigation measures would be implemented to manage and reduce emissions during the construction phase. Monitoring would be implemented in conjunction with emissions mitigation to provide understanding of meteorological conditions and off-site concentrations, and determine the need for more rigorous mitigation. Monitoring systems include the installation and operation of a meteorological tower and PM monitoring equipment. Based on the current wind conditions and measured concentration levels, the most appropriate and effective mitigation options would be implemented to reduce emissions. This emissions mitigation management is referred to as “adaptive management”.

The following mitigation options would be planned for the management of combustion emissions (i.e., construction vehicles) during the construction phase:

- One-way traffic flows on Highway 22 and Springbank Road, to accommodate construction activities, that may result in traffic line-ups and idling will be limited to the extent possible.
- Prevent the discharge of atmospheric contaminants from construction operations in accordance with Regulatory Requirements.
- Project construction vehicles will be required to meet current emission control standards.
- Engines and exhaust systems will be properly maintained. Do not operate equipment, including construction equipment, that shows excessive emissions of exhaust gases until corrective repairs or adjustments are made.
- The concentration of sulphur in diesel fuel shall not exceed15 mg/kg.
- Construction vehicle idling times will be reduced to the extent possible in order to reduce emissions, as a best management practice.
- Cold starts will be limited to the extent possible to reduce emissions, as a best management practice.

The following mitigation measures would be planned for the management of fugitive dust emissions during the construction phase:

- Suspend dust generating construction activities during periods of excessive winds whereby dust suppression measures are not working adequately.
- During dry periods, water will be applied to haul roads and/or disturbed areas to mitigate dust emissions. The application of water will be limited to non-freezing temperatures to prevent icing that can present a safety hazard. Watering is most effective immediately after application, and repeated watering several times a day may be required, depending on surface and meteorological conditions.

- Chemical dust suppressants will be applied to haul roads as an alternative option to watering. While chemical dust suppressants can be more effective at controlling fugitive dust than watering; they are also more expensive. 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. Examples of suppressants include chlorides, petroleum products, liquid polymer emulsions, and agglomerating chemicals. These suppressants, if required, will be applied, as per the manufacturer's recommendations, to preclude unintended environmental effects.
- In the event of trackout and carryout of soils occurs, conduct road cleaning by manually picking up and sweeping material or by using rotary or vacuum street cleaning vehicles.
- Disturbed surfaces will be revegetated promptly following construction to prevent wind erosion and to control dust.
- Surfaces of temporary soil and overburden stockpiles will be stabilized during extended periods between usage, by means of vegetating or covering the exposed surfaces.
- Use silt fences and other erosion control methods such as mulching and application of tackifiers to prevent soil loss from soil stockpiles due to wind erosion.

These mitigation measures are based on a best practices document prepared for and Environment Canada (Cheminfo 2005) and on Alberta Transportation's ECO Plan Framework (Volume 4, Supporting Documentation, Document 4).

The following were explicitly quantified in the emission inventory for project construction:

- The concentration of sulphur in diesel fuel shall not exceed15 mg/kg.
- 75% control efficiency applied to particulate emissions from haul roads corresponding to watering twice daily (U.S. EPA, 2006)
- Stabilized surfaces of temporary soil and overburden stockpiles during extended periods between usage, resulting in no fugitive dust emissions during these periods.

Additional mitigation measures can be implemented on an as-required basis.

3.4.4.2 Ambient Light

Mobile lighting is required to provide a secure and safe working environment. To limit potential effects from the use of the mobile lighting on light trespass, glare, and sky glow, the following mitigation measures would be employed:

- Lights will be positioned so that the luminaires can be pointed downward with no more than a 10º tilt from the horizontal, so that only the working area is illuminated.

- As much as is possible, lighting will be located such that unavoidable light spill off the working area is not directed toward receptors outside the PDA.
- Lighting will be located so that the lights are not directed toward oncoming traffic on nearby roads on or off-site because of the objectionable nuisance and safety hazard this may present.
- Lights will be designed to avoid excessive use of the mobile flood lighting units and reduce potential effects by turning off lighting when they are not required; this would also conserve fuel.
- Adherence to lighting design guidelines, such as the CIE, IDA, IES, and the lighting requirements for workspaces as enforced by Labour Canada.
- Comply with Occupational Health and Safety Part 12 General Safety Precautions - Lighting.

3.4.4.3 Greenhouse Gases

The mitigation measures associated with ambient air quality to reduce combustion emissions are also applicable to the mitigation of GHG emissions because combustion sources account for virtually all the GHG emissions associated with the construction phase.

3.4.5 Change in Ambient Air Quality

A tiered approach has been adopted to present the ambient air quality predictions. The first tier provides summary tables showing the maximum predicted concentrations at or outside the PDA boundary. These values are compared to the ambient air quality criteria. If the values are greater than the ambient criteria, then the second tier provides concentration or deposition plots to show the spatial variation in the LAA, and the predicted frequencies that potential values greater than regulatory criteria could occur.

Additional concentration and deposition plots are provided in Volume 4, Appendix E, Attachment 3E. The contours on plots may be distorted within 2 km of the edge of the LAA boundary area. This distortion is due to three contributing factors: only emissions sources within the LAA are explicitly simulated; highway emissions are represented as discrete segments with a lower resolution near the edges of the LAA boundary; and the model receptor grid has a lower resolution near the edge of the LAA.

The focus of the assessment is to provide greater detail near the PDA boundary where the greatest contribution from project activities would occur. Furthermore, predicted concentrations within 60 m of the roadways may also be distorted due to the way the roads sources are represented in the model.

3.4.5.1 Air Quality Assessment – Overview

Tables 3-17, 3-18, and 3-19 list the maximum predicted concentrations and dustfall for the Base Case, Project Case, and Application Cases. The results indicate:

- Base Case—the maximum ambient TSP and benzo(a)pyrene values are greater than the criteria.
- Project Case—the maximum ambient NO_2, $PM_{2.5}$, TSP, dustfall, and acrolein values are greater than the criteria.
- Application Case—the maximum ambient NO_2, $PM_{2.5}$, TSP, dustfall, acrolein, formaldehyde and benzo(a)pyrene values are greater than the criteria.

For the other CAC gases, VOCs, PAHs and metals, the maximum predicted values are all less than the ambient criteria.

While the model predicts acrolein concentrations that are greater than the criteria outside the PDA boundary, values greater than the 1-hour AAAQO are limited to a small area near the north end of the haul road that is parallel to Highway 22. Values greater than the 24-hour AAAQO are predicted to occur less than 350 m from the PDA.

The model predicts 1-hour average formaldehyde concentrations that are greater than the AAAQO; however, these values are limited to a small area near the north end of the haul road that is parallel to Highway 22.

The model predicts annual average benzo(a)pyrene concentrations greater than the AAAQO; however, these values are limited to only a small area near the intersection of the TransCanada Highway and Highway 22. There are no predicted benzo(a)pyrene concentrations that are greater than the criteria along the PDA boundary, and the Project contributes less than 3% (i.e., the Base Case contributes 97%) to the maximum predicted concentrations for the Application Case.

Therefore, spatial concentration plots for ambient acrolein, formaldehyde and benzo(a)pyrene are not provided in this section. Detailed plots for these substances are in Volume 4, Appendix E, Attachment 3E.

The following sections provide spatial concentration plots for only NO_2, $PM_{2.5}$, TSP and dustfall.

Table 3-17 Base Case Maximum Ground-Level Concentrations

Substance	Averaging Period	Base Case Maximum Predicted Concentration (µg/m³)	Background Concentration (µg/m³)	Base Case Maximum Predicted Concentration with Background (µg/m³)	Ambient Criteria [a] (µg/m³)	Base Case, Percent of Ambient Criteria (%)
CAC Gases						
NO_X	1-hour [d]	208	9.59	217	-	-
	Annual	50.0	3.77	53.8	-	-
NO_2	1-hour [d]	92.8	9.59	102	300	34.1
	Annual	38.4	3.77	42.1	45	93.6
SO_2	1-hour [d]	1.24	5.24	6.48	450	1.4
	24-hour	0.842	4.95	5.79	125	4.6
	30-day	0.410	3.08	3.49	30	11.6
	Annual	0.244	2.49	2.74	20	13.7
CO	1-hour [d]	684	344	1,028	15,000	6.9
	8-hour	511	344	855	6,000	14.2
Particles						
$PM_{2.5}$	1-hour [d]	16.3	11.0	27.3	80	34.1
	24-hour	10.8	11.0	21.8	30	72.7
	24-hour [e]	7.47	11.0	18.5	28 [b]	66.0
	Annual [f]	3.73	3.50	7.23	10 [b]	72.3

Table 3-17 Base Case Maximum Ground-Level Concentrations

Substance	Averaging Period	Base Case Maximum Predicted Concentration (µg/m³)	Background Concentration (µg/m³)	Base Case Maximum Predicted Concentration with Background (µg/m³)	Ambient Criteria [a] (µg/m³)	Base Case, Percent of Ambient Criteria (%)
TSP	24-hour	112	51.0	163	100	**163**
	Annual	43.6	16.2	59.8	60	99.6
Dustfall	30-day	24.5	17.7	42.2	53 [c]	79.5
VOCs						
Acetaldehyde	1-hour [d]	0.307	3.38	3.68	90	4.1
Acrolein	1-hour [d]	0.0523	0.290	0.342	4.5	7.6
	24-hour	0.0357	0.048	0.0837	0.40	20.9
Benzene	1-hour [d]	0.726	0.810	1.54	30	5.1
	Annual	0.170	0.320	0.490	3	16.3
Ethyl Benzene	1-hour [d]	0.472	0.190	0.662	2,000	0.03
Formaldehyde	1-hour [d]	0.733	9.90	10.6	65	16
Toluene	1-hour [d]	3.08	1.00	4.08	1,880	0.2
	24-hour	2.04	1.00	3.04	400	0.8
Xylenes	1-hour [d]	1.74	0.220	1.96	2,300	0.1
	24-hour	1.19	0.220	1.41	700	0.2
PAH						
Benzo(a)pyrene	Annual	0.000418	0.000022	0.000440	0.0003	**147**
Naphthalene	Annual	0.0203	0.0520	0.0723	3	2.4

Table 3-17 Base Case Maximum Ground-Level Concentrations

Substance	Averaging Period	Base Case Maximum Predicted Concentration (µg/m³)	Background Concentration (µg/m³)	Base Case Maximum Predicted Concentration with Background (µg/m³)	Ambient Criteria [a] (µg/m³)	Base Case, Percent of Ambient Criteria (%)
Metals						
Arsenic	1-hour [d]	0.00166	0.0005	0.00216	0.1	2.2
	Annual	0.000401	0.00016	0.000561	0.01	5.6
Chromium	1-hour [d]	0.00446	0.0006	0.00506	1	0.5
Manganese	1-hour [d]	0.000343	0.0045	0.00484	2	0.2
	Annual	0.0000787	0.002	0.00208	0.2	1.0
Nickel	1-hour e [d]	0.00458	0.00036	0.00494	6	0.1
	Annual	0.00111	0.00017	0.00128	0.05	2.6

NOTES:
[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2016)
[b] CAAQS: Canadian Ambient Air Quality Standards (ECCC 2013 and CCME 2014)
[c] Dustfall objective (mg/100 cm²) in residential and recreational areas
[d] Concentration represents the 9th highest 1-hour concentration
[e] Concentration represents the 3-year average of the annual 8th highest 24-hour average concentrations
[f] Concentration represents the 3-year average of the annual average concentrations
Percent values greater than 100% are in **boldface text**.

Table 3-18 Project Case Maximum Ground-Level Concentrations

Substance	Averaging Period	Project Case Maximum Predicted Concentration (µg/m³)	Ambient Criteria[a] (µg/m³)	Project Case, Percent of Ambient Criteria (%)
CAC Gases				
NO_X	1-hour [d]	3,132	-	-
	Annual	63.7	-	-
NO_2	1-hour [d]	359	300	**120**
	Annual	21.9	45	48.7
SO_2	1-hour [d]	8.12	450	1.8
	24-hour	2.81	125	2.2
	30-day	0.674	30	2.2
	Annual	0.162	20	0.8
CO	1-hour [d]	3,037	15,000	20.2
	8-hour	2,064	6,000	34.4
Particles				
$PM_{2.5}$	1-hour [d]	299	80	**374**
	24-hour	136	30	**454**
	24-hour [e]	59.7	28 [b]	**213**
	Annual [f]	12.1	10 [b]	**121**
TSP	24-hour	2,851	100	**2,851**
	Annual	313	60	**521**
Dustfall	30-day	220	53 [c]	**415**
VOCs				
Acetaldehyde	1-hour [d]	21.6	90	24.0
Acrolein	1-hour [d]	5.20	4.5	**115**
	24-hour	1.79	0.40	**448**
Benzene	1-hour [d]	8.29	30	27.6
	Annual	0.170	3	5.7
Ethyl Benzene	1-hour [d]	1.47	2,000	0.1
Formaldehyde	1-hour [d]	61.0	65	93.9

Table 3-18 Project Case Maximum Ground-Level Concentrations

Substance	Averaging Period	Project Case Maximum Predicted Concentration (µg/m³)	Ambient Criteria[a] (µg/m³)	Project Case, Percent of Ambient Criteria (%)
Toluene	1-hour [d]	6.41	1,880	0.3
	24-hour	2.21	400	0.6
Xylenes	1-hour [d]	4.46	2,300	0.2
	24-hour	1.54	700	0.2
PAHs				
Benzo(a)pyrene	Annual	0.0000146	0.0003	4.9
Naphthalene	Annual	0.0234	3	0.8
Metals				
Arsenic	1-hour [d]	0.03984	0.1	39.8
	Annual	0.00216	0.01	21.6
Chromium	1-hour [d]	0.150	1	15.0
Manganese	1-hour [d]	0.000862	2	0.04
	Annual	0.0000176	0.2	0.01
Nickel	1-hour [d]	0.141	6	2.3
	Annual	0.00763	0.05	15.3

NOTES:

[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2016)

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

[c] Dustfall objective (mg/100 cm²) in residential and recreational areas

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

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

[f] Concentration represents the 3-year average of the annual average concentrations

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

Table 3-19 Application Case Maximum Ground-Level Concentrations

Substance	Averaging Period	Application Case Maximum Predicted Concentration	Background Concentration	Application Case Maximum Predicted Concentration with Background	Ambient Criteria [a]	Application Case, Percent of Ambient Criteria
		(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)	(%)
CAC Gases						
NO_X	1-hour [d]	3,177	9.59	3,187	-	-
	Annual	69.1	3.77	72.9	-	-
NO_2	1-hour [d]	364	9.59	373	300	**124**
	Annual	38.9	3.77	42.7	45	94.8
SO_2	1-hour [d]	8.40	5.24	13.6	450	3.0
	24-hour	2.91	4.95	7.86	125	6.3
	30-day	0.726	3.08	3.81	30	12.7
	Annual	0.250	2.49	2.74	20	13.7
CO	1-hour [d]	3,168	344	3,512	15,000	23.4
	8-hour	2,143	344	2,486	6,000	41.4
Particles						
$PM_{2.5}$	1-hour [d]	303	11.0	314	80	**392**
	24-hour	136	11.0	147	30	**492**
	24-hour [e]	61.0	11.0	72.0	28 [b]	**257**
	Annual [f]	12.4	3.50	15.9	10 [b]	**159**

Table 3-19 Application Case Maximum Ground-Level Concentrations

Substance	Averaging Period	Application Case Maximum Predicted Concentration (µg/m³)	Background Concentration (µg/m³)	Application Case Maximum Predicted Concentration with Background (µg/m³)	Ambient Criteria [a] (µg/m³)	Application Case, Percent of Ambient Criteria (%)
TSP	24-hour	2,852	51.0	2,903	100	**2,903**
	Annual	314	16.2	330	60	**551**
Dustfall	30-day	220	17.7	238	53 [c]	**449**
VOCs						
Acetaldehyde	1-hour [d]	21.7	3.38	25.0	90	27.8
Acrolein	1-hour [d]	5.21	0.29	5.50	4.5	**122**
	24-hour	1.80	0.048	1.85	0.40	**461**
Benzene	1-hour [d]	8.46	0.81	9.27	30	30.9
	Annual	0.189	0.320	0.509	3	17.0
Ethyl Benzene	1-hour [d]	1.58	0.190	1.77	2,000	0.1
Formaldehyde	1-hour [d]	61.2	9.9	71.1	65	**109**
Toluene	1-hour [d]	7.12	1.00	8.12	1,880	0.4
	24-hour	2.50	1.00	3.50	400	0.9
Xylenes	1-hour [d]	4.87	0.22	5.09	2,300	0.2
	24-hour	1.69	0.220	1.91	700	0.3
PAHs						
Benzo(a)pyrene	Annual	0.000419	0.000022	0.000441	0.0003	**147**
Naphthalene	Annual	0.0256	0.052	0.0776	3	2.6

Table 3-19 Application Case Maximum Ground-Level Concentrations

Substance	Averaging Period	Application Case Maximum Predicted Concentration (µg/m³)	Background Concentration (µg/m³)	Application Case Maximum Predicted Concentration with Background (µg/m³)	Ambient Criteria [a] (µg/m³)	Application Case, Percent of Ambient Criteria (%)
Metals						
Arsenic	1-hour [d]	0.0399	0.0005	0.0404	0.1	40.4
	Annual	0.00218	0.00016	0.00234	0.01	23.4
Chromium	1-hour [d]	0.150	0.0006	0.150	1	15.0
Manganese	1-hour [d]	0.000940	0.0045	0.00544	2	0.3
	Annual	0.0000794	0.002	0.00208	0.2	1.0
Nickel	1-hour [d]	0.141	0.00036	0.141	6	2.4
	Annual	0.00768	0.00017	0.00785	0.05	15.7

NOTES:
[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2016)
[b] CAAQS: Canadian Ambient Air Quality Standards (ECCC 2013 and CCME 2014)
[c] Dustfall objective (mg/100 cm²) in residential and recreational areas
[d] Concentration represents the 9th highest 1-hour concentration
[e] Concentration represents the 3-year average of the annual 8th highest 24-hour average concentrations
[f] Concentration represents the 3-year average of the annual average concentrations
Percent values greater than 100% are in **boldface text**.

3.4.5.2 Maximum NO_2 Concentrations

1-hour Average NO_2 (9th Highest)

Figures 3-8 to 3-10 show the 9th highest predicted 1-hour average NO_2 concentrations for the Base, Project and Application cases:

- Base Case—The highest concentrations for the Base Case occur on and near highways. The maximum predicted 1-hour NO_2 concentration of 102 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22 (Figure 3-8). The maximum predicted NO_2 concentration is less than the 1-hour AAAQO of 300 µg/m³.
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The maximum predicted 1-hour NO_2 concentration of 359 µg/m³ occurs on the northwest PDA boundary near the north end of the haul road that is parallel to Highway 22 (Figure 3-9). There are no sensitive receptors on or near the boundary at this location. Predicted NO_2 concentrations greater than the 1-hour AAAQO of 300 µg/m³ only occur for 29 hours per year.
- Application Case—The highest concentrations for the Application Case occur along the PDA boundary. The maximum predicted 1-hour NO_2 concentration of 373 µg/m³ occurs on the northwest boundary near the north end of the haul road that is parallel to Highway 22 (Figure 3-10). There are no sensitive receptors on or near the boundary at this location. Predicted NO_2 concentrations greater than the 1-hour AAAQO of 300 µg/m³ only occur for 46 hours per year.

Annual Average NO_2

The following summarizes the modelling results for NO_2 concentrations:

- Base Case—The highest concentrations for the Base Case occur on and near highways. The maximum predicted annual NO_2 concentration of 42.1 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22 (Figure 3-11). The maximum predicted NO_2 concentration is 94% of the annual AAAQO of 45 µg/m³.
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The maximum predicted annual NO_2 concentration of 21.9 µg/m³ occurs along the southeast PDA boundary near the diversion channel haul road (Figure 3-12). The maximum predicted NO_2 concentration is less than the annual AAAQO of 45 µg/m³.
- Application Case—The highest concentrations for the Application Case occur along the PDA boundary and along highways. The maximum predicted annual NO_2 concentration of 42.7 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22 (Figure 3-13). The maximum predicted NO_2 concentration is 95% of the annual AAAQO of 45 µg/m³.

NO_2 Comments

While the model predicts 9th highest 1-hour NO_2 concentrations that are greater than the AAAQO, these values are limited to the PDA boundary near the north end of the haul road that is parallel to Highway 22. There are no sensitive receptors on or near the boundary at this location. This PDA boundary location is 50 m from the north end of the haul road. Based on U.S. EPA guidance (U.S. 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 represents the initial dispersion plume width. Volume sources with a horizontal dimension of 120 m (60 m from the centre of the road) were used to model haul roads in the PDA. The location of the maximum predicted 1-hour average NO_2 concentration falls within the haul road exclusion zone of 60 m from the centre of the road and therefore the predicted concentration might be overstated. One-hour predicted NO_2 values greater than the AAAQO are limited to 46 hours per year.

The maximum predicted annual NO_2 concentrations for all cases are less than the annual AAAQO of 45 $\mu g/m^3$.

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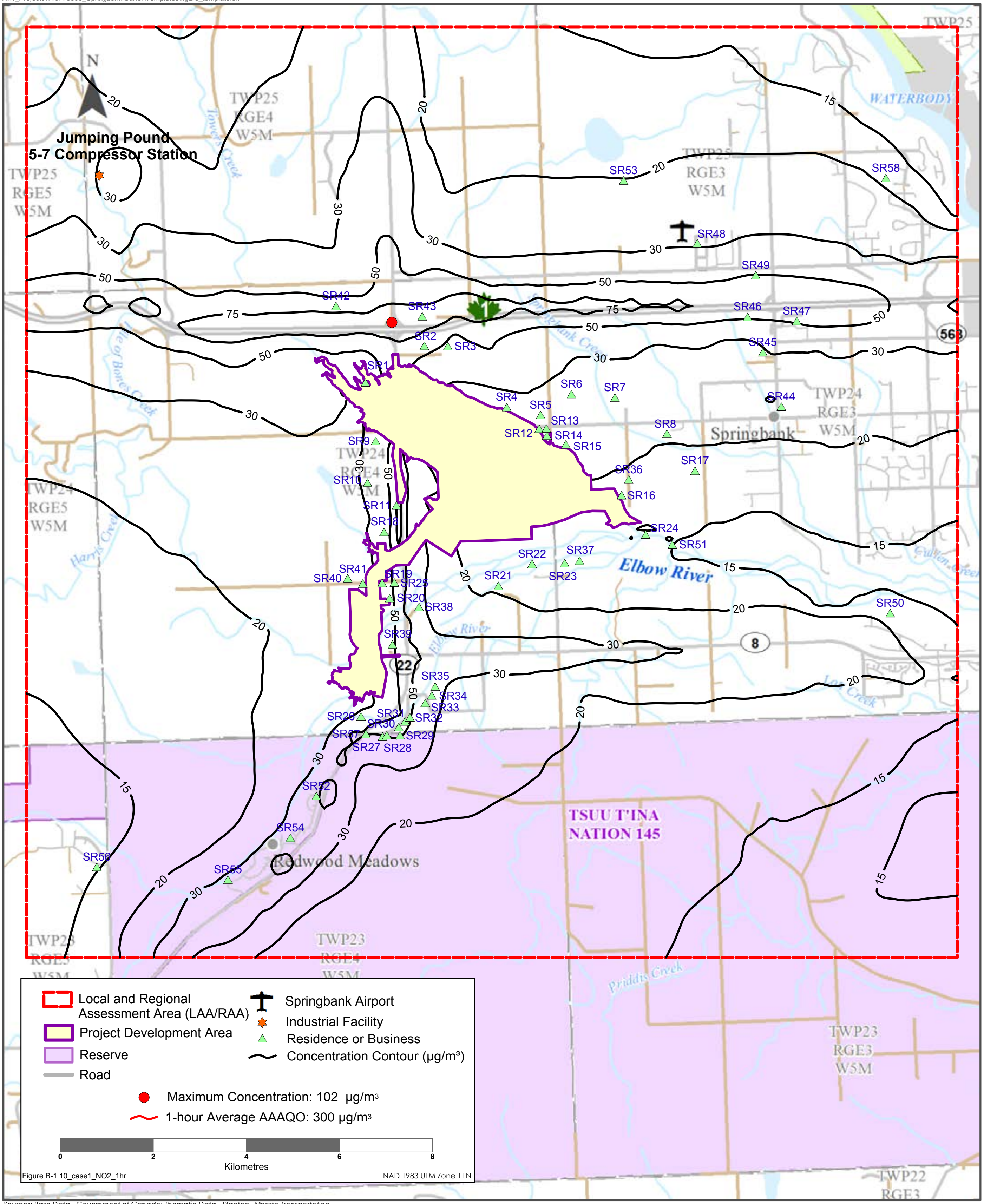

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average NO_2 Concentration (Base Case)

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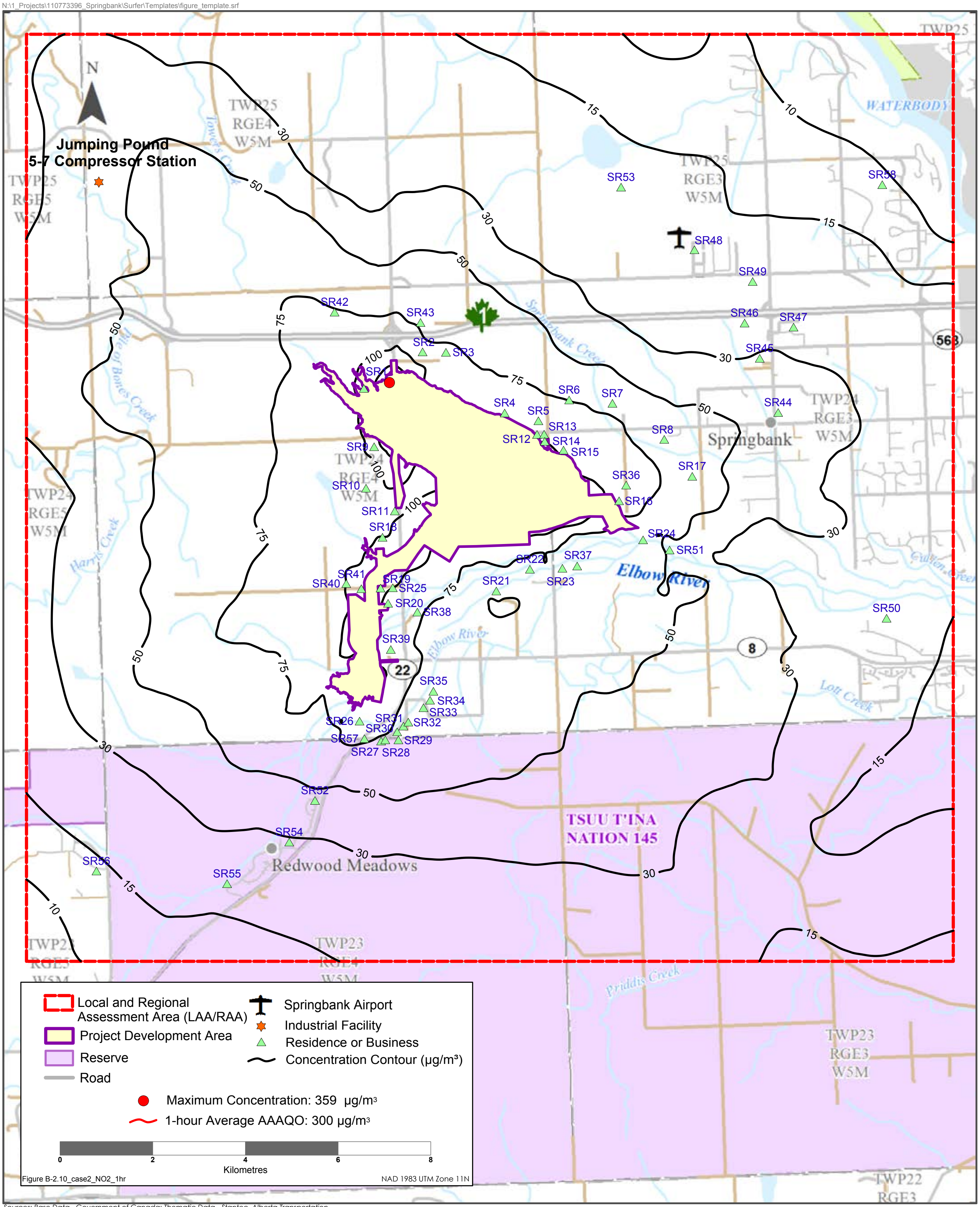

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average NO_2 Concentration (Project Case)

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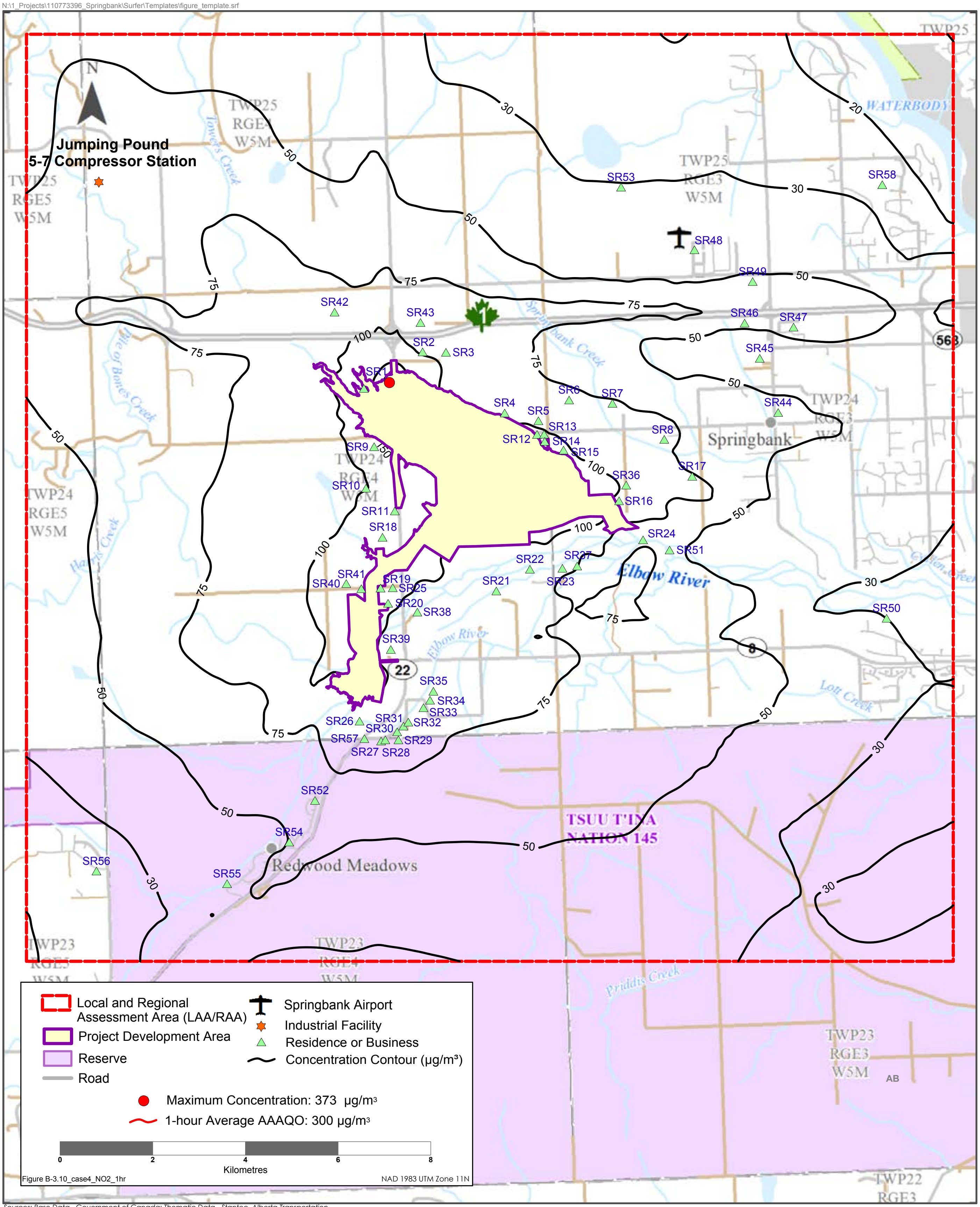
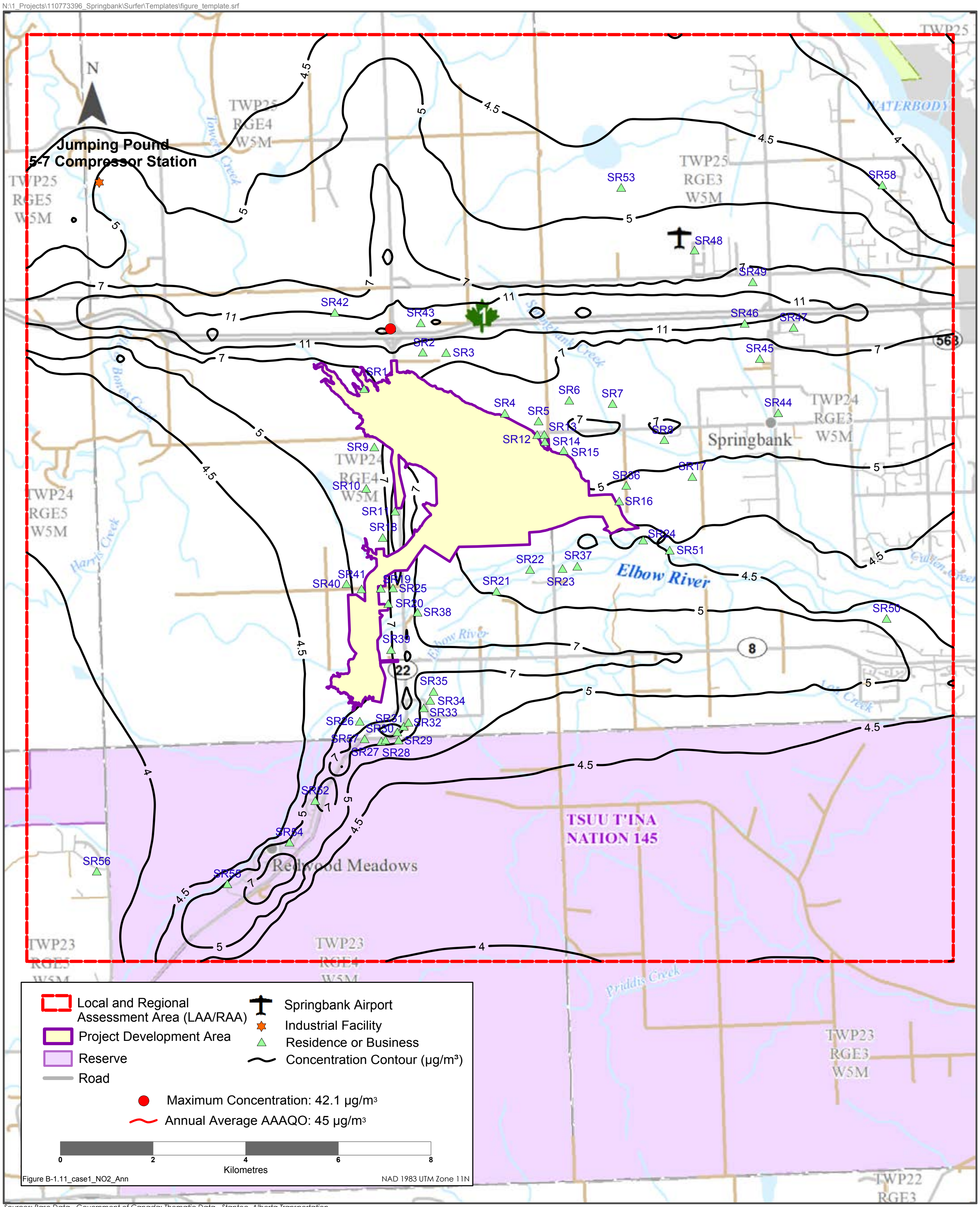


Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average NO_2 Concentration (Application Case)

Figure 3-10



Maximum Predicted Annual average NO_2 Concentration (Base Case)

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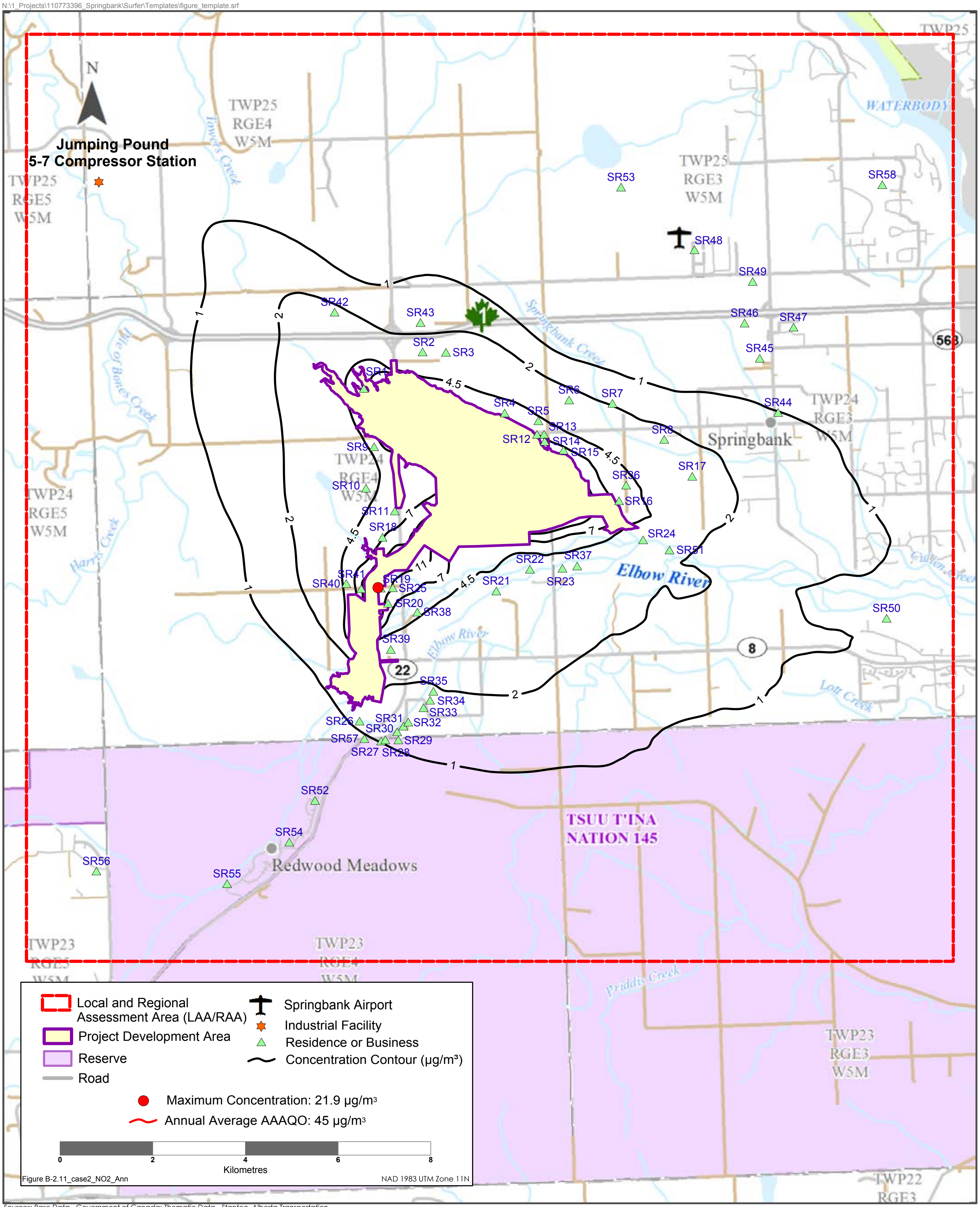
Figure 3-11



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

Maximum Predicted Annual average NO_2 Concentration (Project Case)

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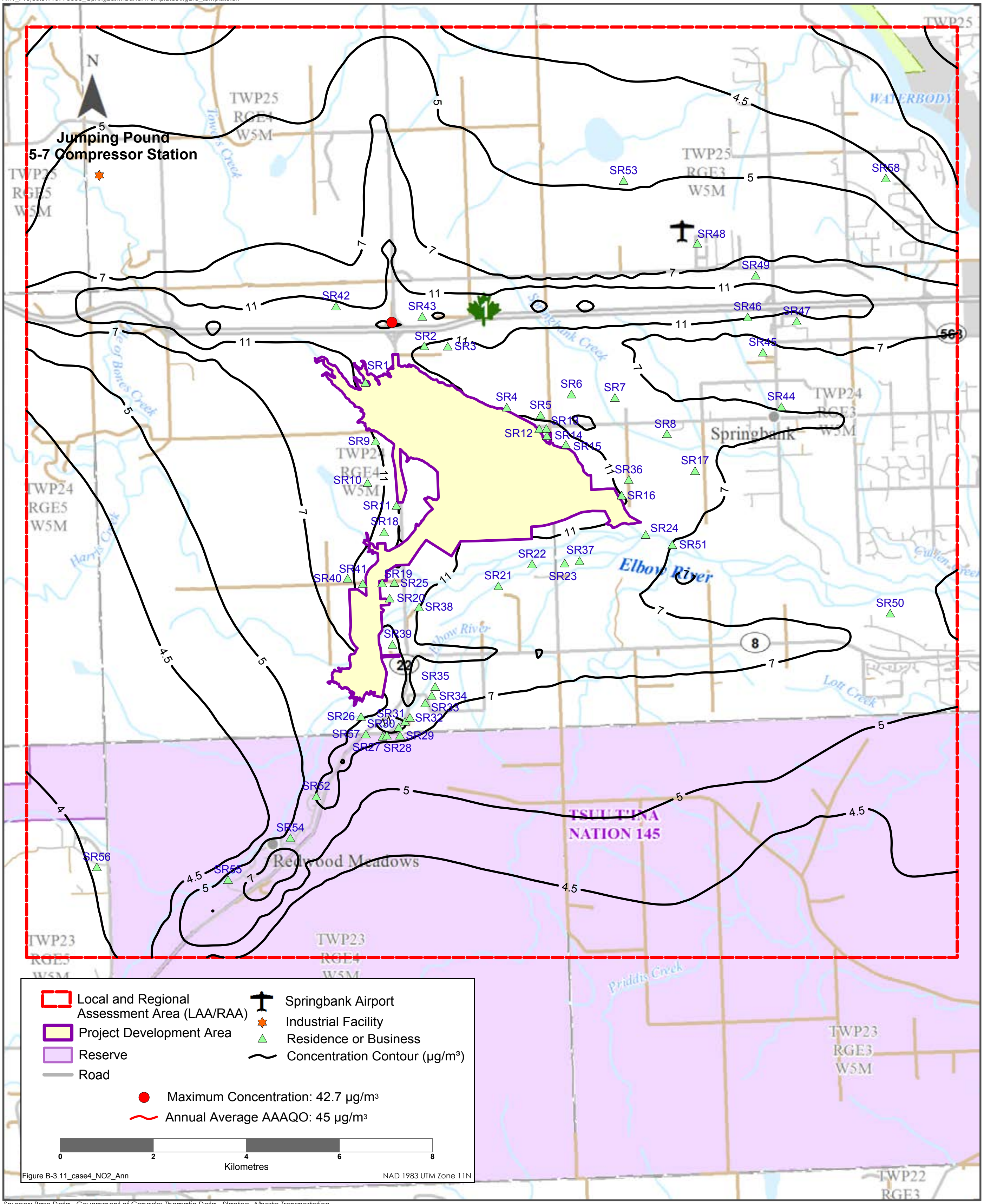

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted Annual average NO_2 Concentration (Application Case)

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Figure 3-13

3.4.5.3 Maximum $PM_{2.5}$ Concentrations

1-hour Average $PM_{2.5}$ (9th Highest)

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

- Base Case—The highest concentrations for the Base Case occur on and near highways. The maximum predicted 1-hour $PM_{2.5}$ concentration of 27.3 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22 (Figure 3-14). The maximum predicted $PM_{2.5}$ concentration is less than the 1-hour AAAQG of 80 µg/m³.
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The maximum predicted 1-hour $PM_{2.5}$ concentration of 299 µg/m³ occurs along the northwest PDA boundary near the north end of the haul road that is parallel to Highway 22 (Figure 3-15). Predicted $PM_{2.5}$ concentrations greater than the 1-hour AAAQG of 80 µg/m³ occur for up to 410 hours per year near the diversion channel haul road (Figure 3-16).
- Application Case—The highest concentrations for the Application Case occur along the PDA boundary. The maximum predicted 1-hour $PM_{2.5}$ concentration of 314 µg/m³ occurs along the northwest PDA boundary near the north end of the haul road that is parallel to Highway 22 (Figure 3-17). Predicted $PM_{2.5}$ concentrations greater than the 1-hour AAAQG of 80 µg/m³ occur for up to 532 hours per year near the diversion channel haul road (Figure 3-18).

24-hour Average $PM_{2.5}$ (Maximum)

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

- Base Case—The highest concentrations for the Base Case occur on and near highways. The maximum predicted 24-hour $PM_{2.5}$ concentration of 21.8 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22 (Figure 3-19). The maximum predicted $PM_{2.5}$ concentration is less than the 24-hour AAAQO of 30 µg/m³.
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The maximum predicted 24-hour $PM_{2.5}$ concentration of 136 µg/m³ occurs along the eastern PDA boundary near the east end of the diversion channel haul road (Figure 3-20). Predicted $PM_{2.5}$ concentrations greater than the 24-hour AAAQO of 30 µg/m³ occur for up to 50 days per year near the diversion channel haul road (Figure 3-21).
- Application Case—The highest concentrations for the Application Case occur along the PDA boundary. The maximum predicted 24-hour $PM_{2.5}$ concentration of 147 µg/m³ occurs along the northwest PDA boundary near the east end of the diversion channel haul road (Figure 3-22). Predicted $PM_{2.5}$ concentrations greater than the 24-hour AAAQO of 30 µg/m³ occur for up to 117 days per year near the diversion channel haul road (Figure 3-23).

24-hour Average $PM_{2.5}$ (8th Highest)

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

- Base Case—The highest concentrations for the Base Case occur on and near highways. The 8th highest predicted 24-hour $PM_{2.5}$ concentration of 18.5 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22 (Figure 3-24). The maximum predicted $PM_{2.5}$ concentration is less than the 24-hour CAAQS of 28 µg/m³.
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The 8th highest predicted 24-hour $PM_{2.5}$ concentration of 59.7 µg/m³ occurs along the northwest PDA boundary near the north end of the haul road that is parallel to Highway 22 (Figure 3-25). Predicted $PM_{2.5}$ concentrations greater than the 24-hour CAAQS of 28 µg/m³ occur for up to 45 days per year near the east end of the diversion channel haul road (Figure 3-26).
- Application Case—The highest concentrations for the Application Case occur along the PDA boundary. The 8th highest predicted 24-hour $PM_{2.5}$ concentration of 72.0 µg/m³ occurs along the northwest PDA boundary near the north end of the haul road parallel to Highway 22 (Figure 3-27). Predicted $PM_{2.5}$ concentrations greater than the 24-hour CAAQS of 28 µg/m³ occur for up to 115 days per year along the southeast PDA boundary near the diversion channel haul road (Figure 3-28).

Annual Average $PM_{2.5}$

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

- Base Case—The highest concentrations for the Base Case occur on and near highways. The maximum predicted annual $PM_{2.5}$ concentration of 7.23 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22 (Figure 3-29). The maximum predicted annual $PM_{2.5}$ concentration is less than the annual CAAQS of 10 µg/m³.
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The maximum predicted annual $PM_{2.5}$ concentration of 12.1 µg/m³ occurs along the southeast PDA boundary near the diversion channel haul road (Figure 3-30). Values that are greater than the annual CAAQS only occur along the PDA boundary.
- Application Case—The highest concentrations for the Application Case occur along the PDA boundary. The maximum predicted annual $PM_{2.5}$ concentration of 15.9 µg/m³ also occurs along the southeast boundary near the diversion channel haul road (Figure 3-31). Values that are greater than the annual CAAQS occur within 300 m of limited areas along the PDA boundary.

$PM_{2.5}$ Comments

While the model predicts 9th highest 1-hour $PM_{2.5}$ concentrations that are greater than the AAAQG outside the PDA, these predicted values are within 2 km from the PDA. Along the PDA boundary, values greater than the AAAQG are predicted more than 500 hours in a year, reducing to one hour per year with increasing distance.

While the model predicts maximum 24-hour $PM_{2.5}$ concentrations that are greater than the AAAQO outside the PDA, these predicted values are within 2.5 km from the PDA. Along the PDA boundary, values greater than the AAAQO are predicted for more than 100 days in a year, reducing to one hour per year with increasing distance.

While the model predicts 8th highest 24-hour $PM_{2.5}$ concentrations that are greater than the CAAQS outside the PDA, these predicted values are within 1 km from the PDA. Along the PDA boundary, values greater than the CAAQS are predicted for more than 100 days in a year, reducing to one hour per year with increasing distance.

While the model predicts annual average $PM_{2.5}$ concentrations that are greater than the CAAQS outside the PDA, these values are predicted to occur within 300 m from the PDA boundary.

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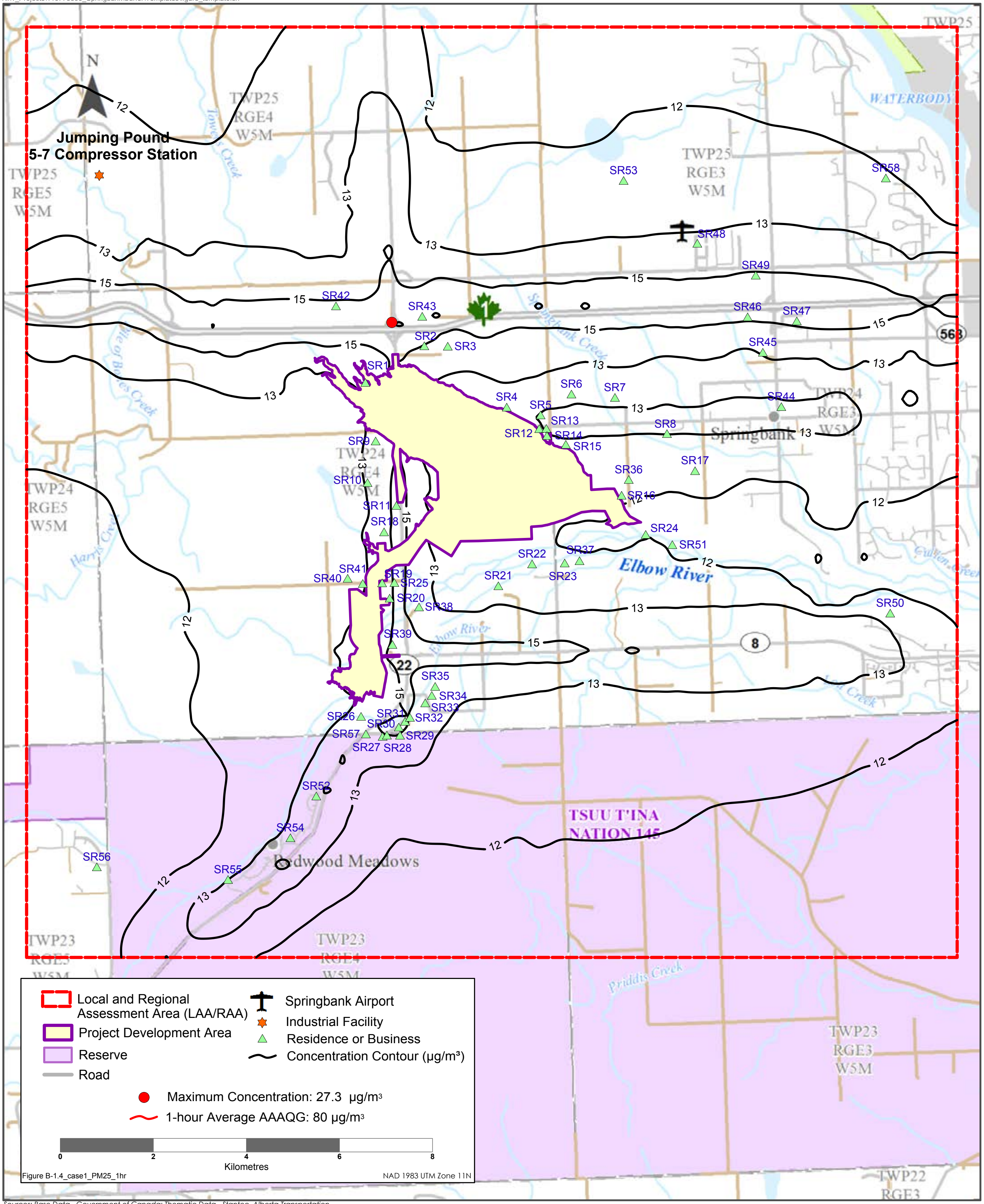

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

9th Highest Predicted 1-hour average $PM_{2.5}$ Concentration (Base Case)

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Figure 3-14

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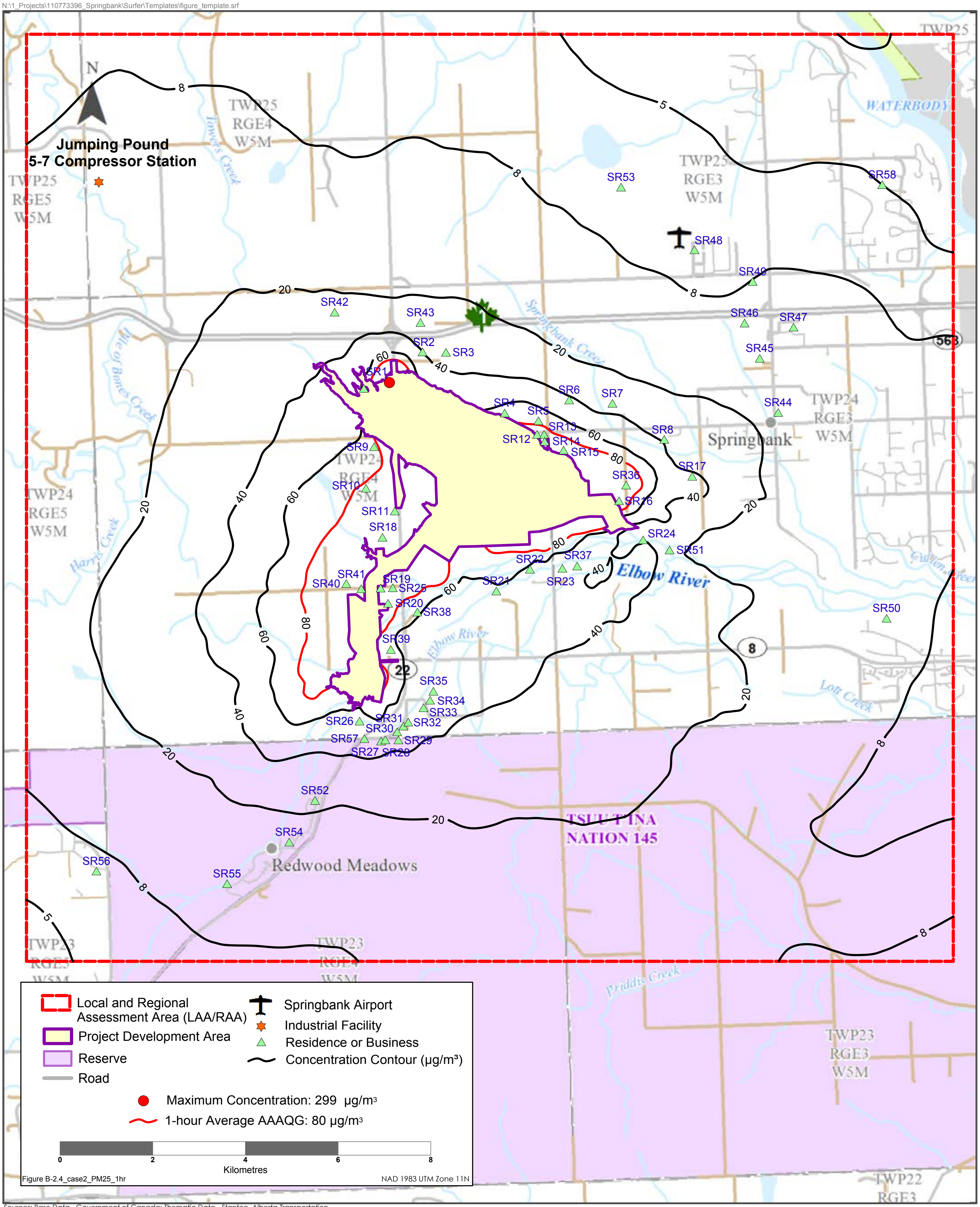

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

9th Highest Predicted 1-hour average $PM_{2.5}$ Concentration (Project Case)

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Figure 3-15

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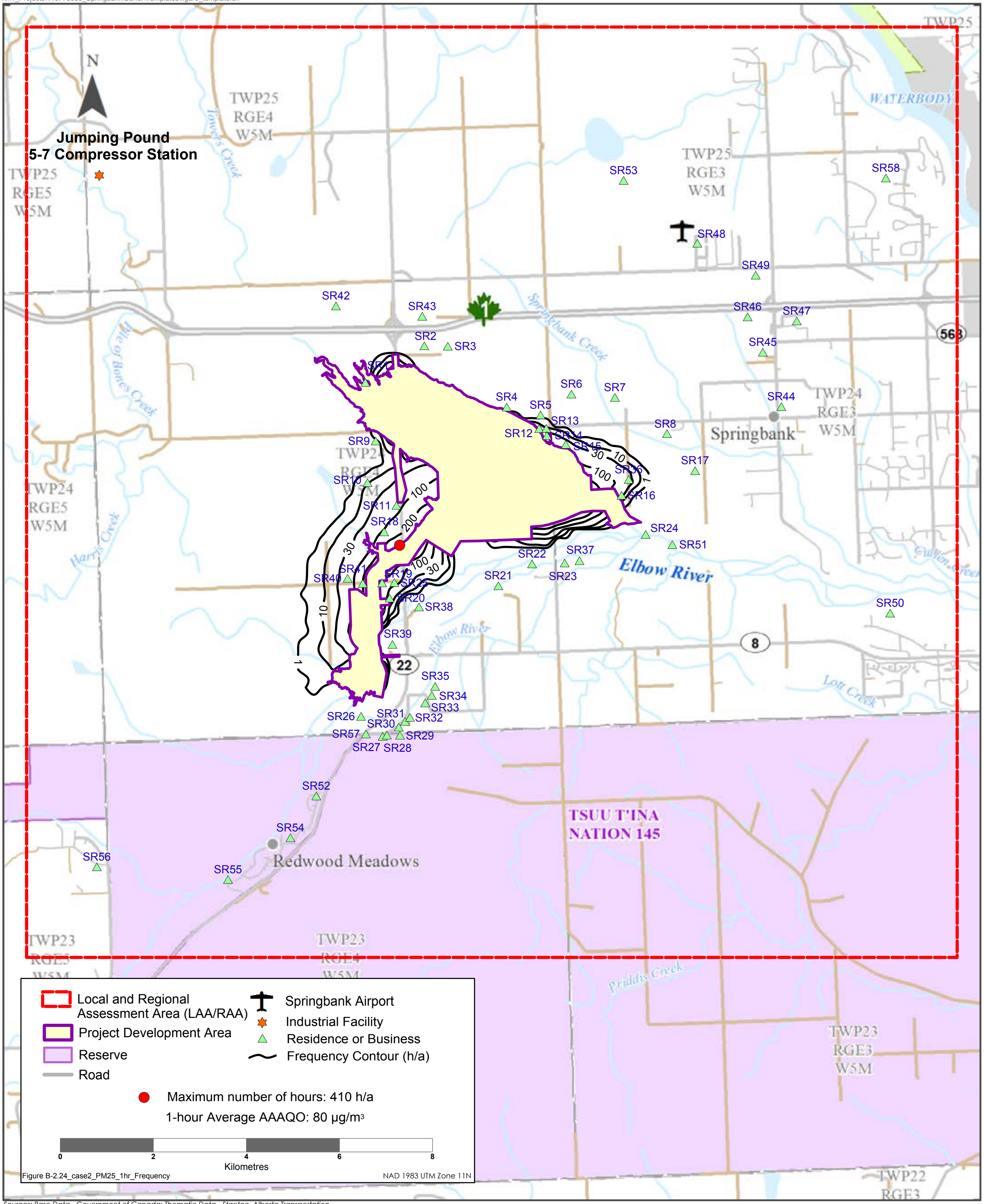

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Frequency of Predicted 1-hour average $PM_{2.5}$ Concentration greater than the AAAQG (Project Case)

Stantec

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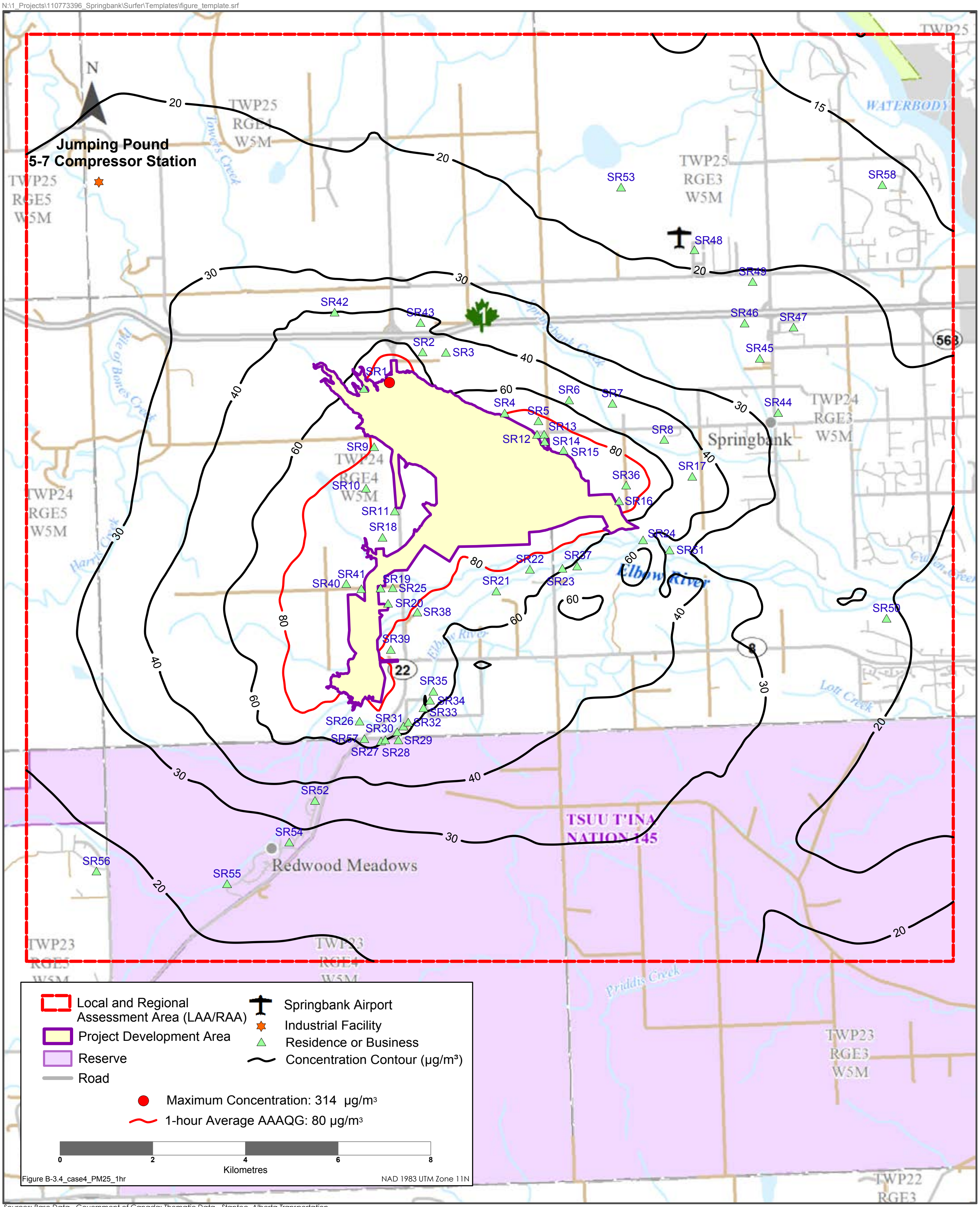
Figure 3-16



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

9th Highest Predicted 1-hour average $PM_{2.5}$ Concentration (Application Case)

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Figure 3-17

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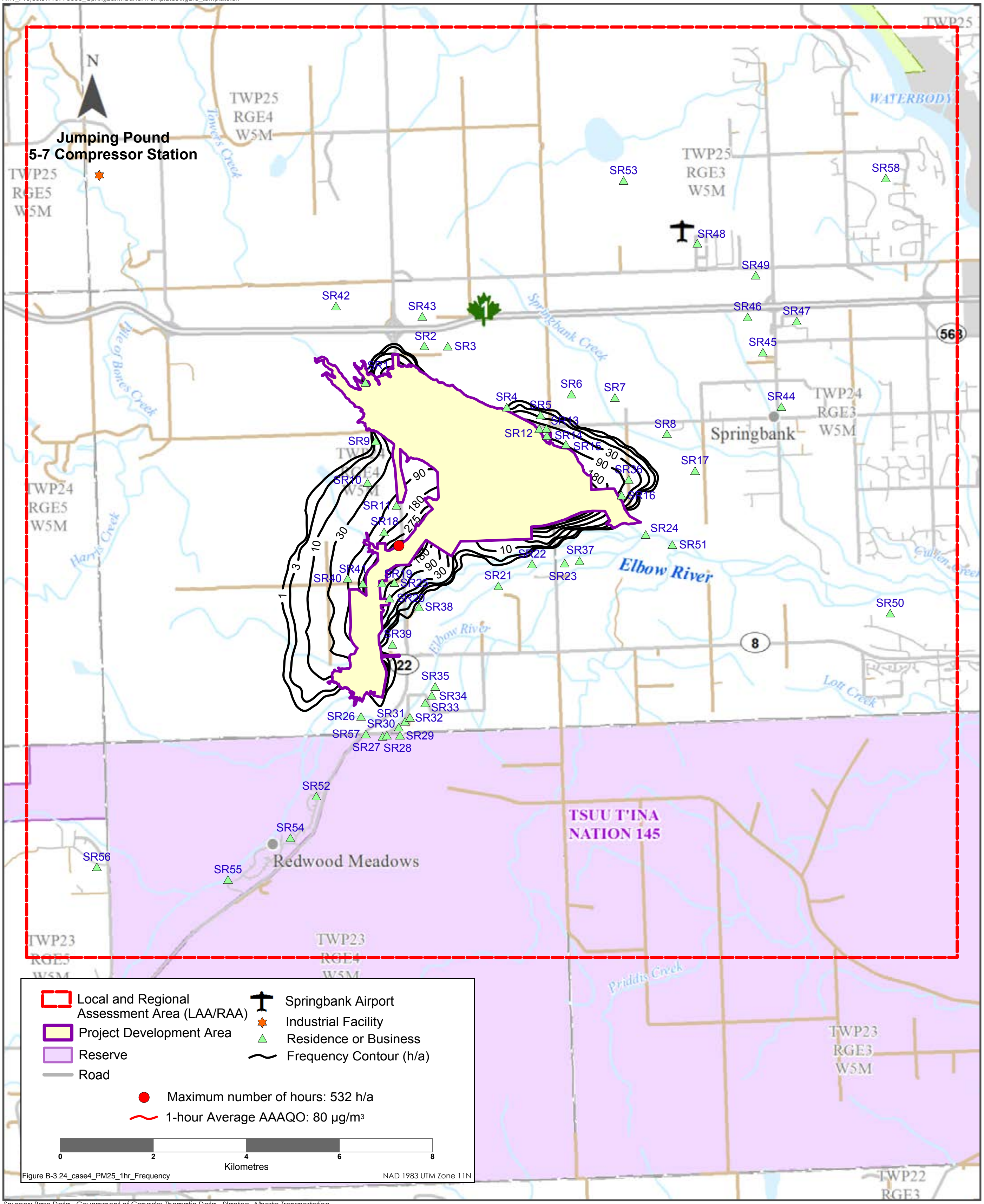

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Frequency of Predicted 1-hour average $PM_{2.5}$ Concentration greater than the AAAQG (Application Case)

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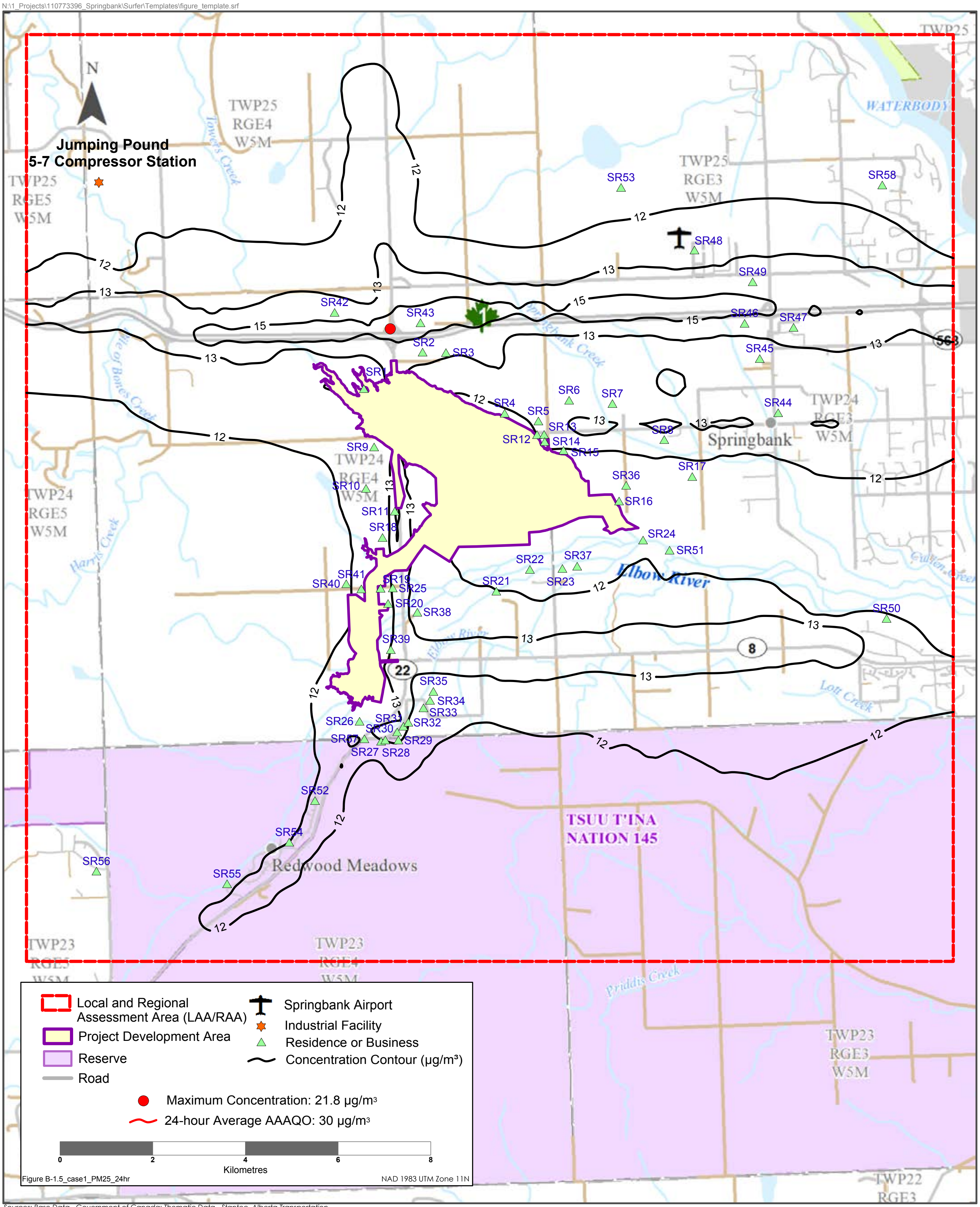
Figure 3-18



Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Base Case)

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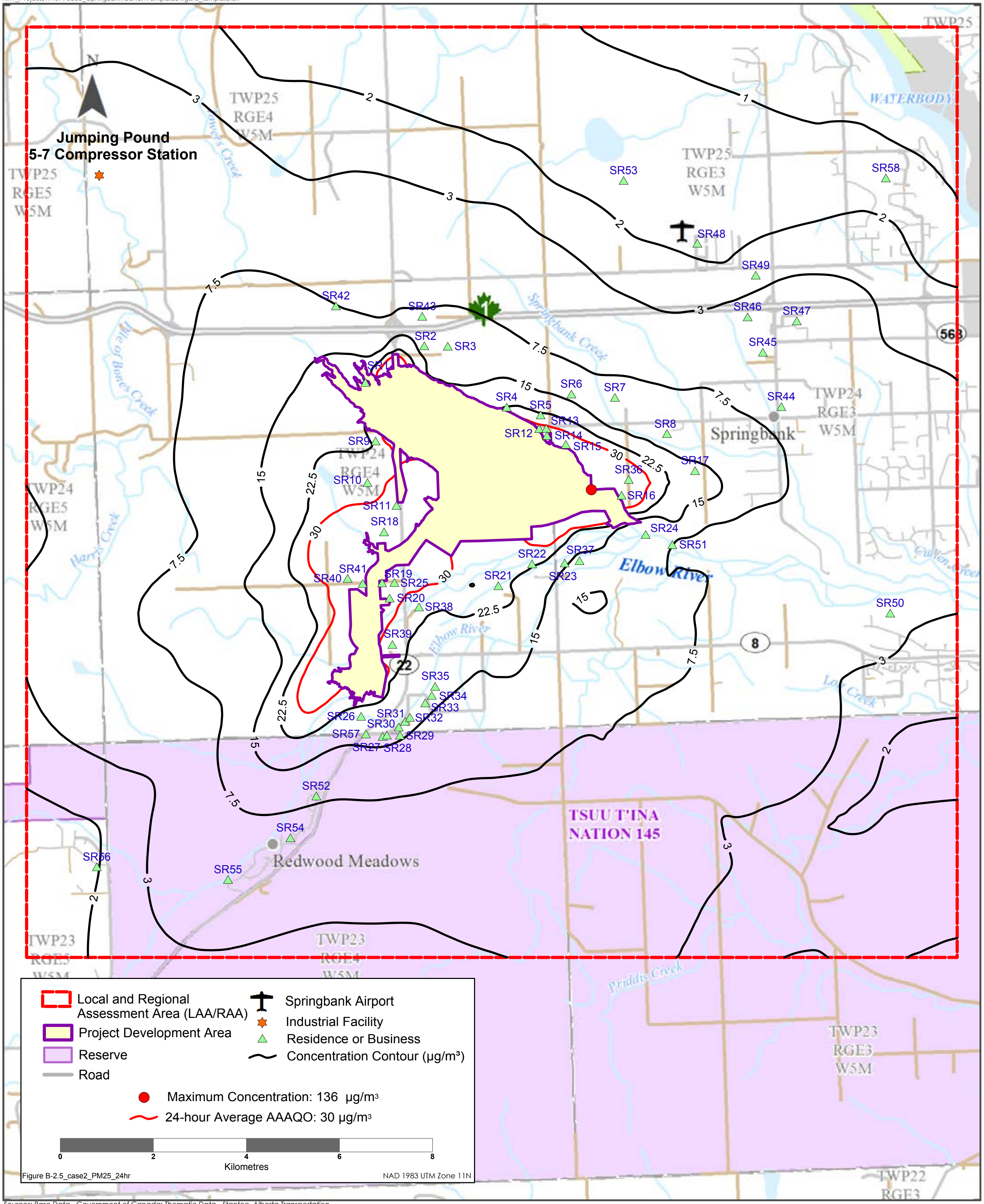
Figure 3-19



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

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Project Case)

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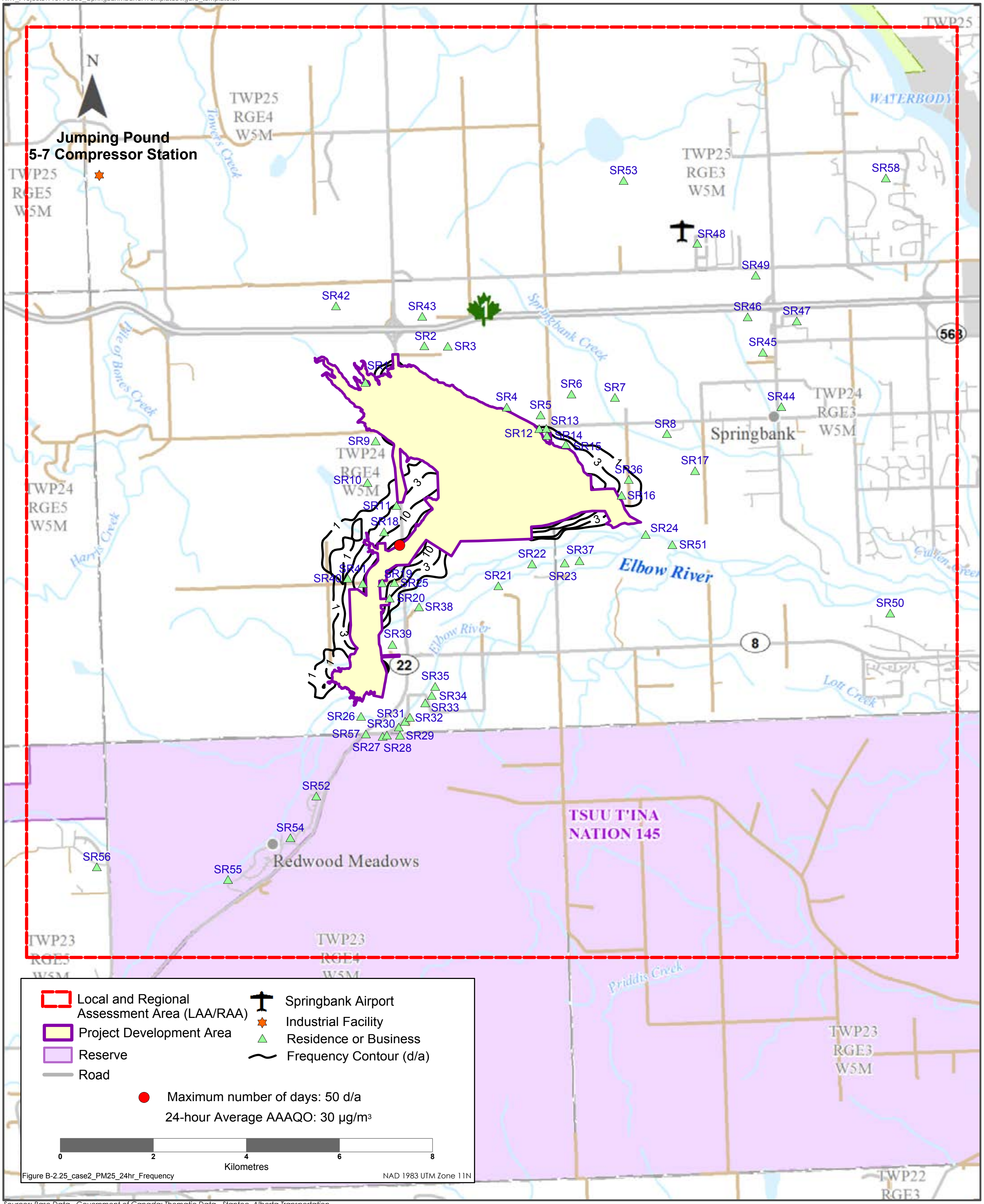

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Frequency of Predicted 24-hour average $PM_{2.5}$ Concentration greater than the AAAQO (Project Case)

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Figure 3-21

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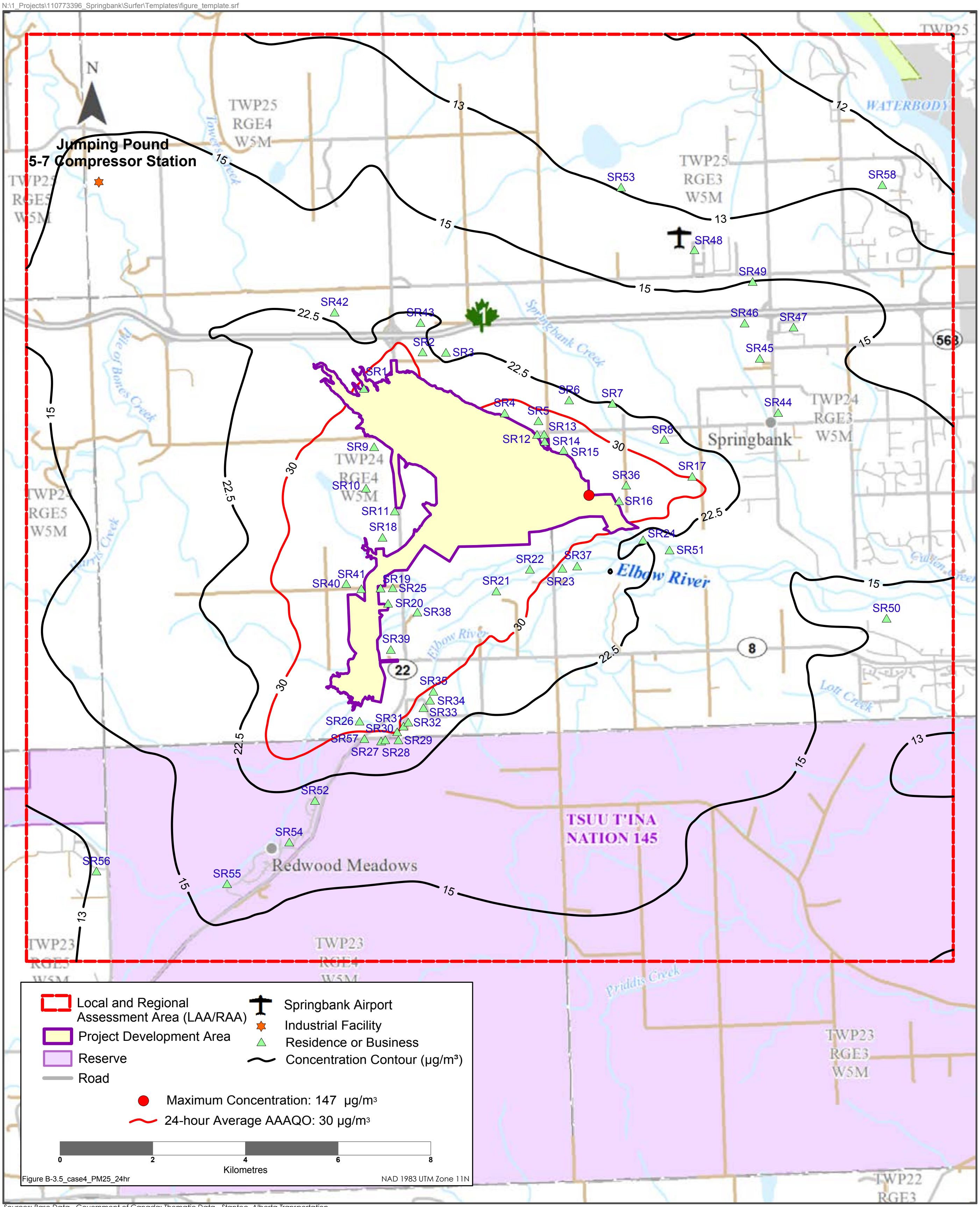

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Application Case)

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Figure 3-22

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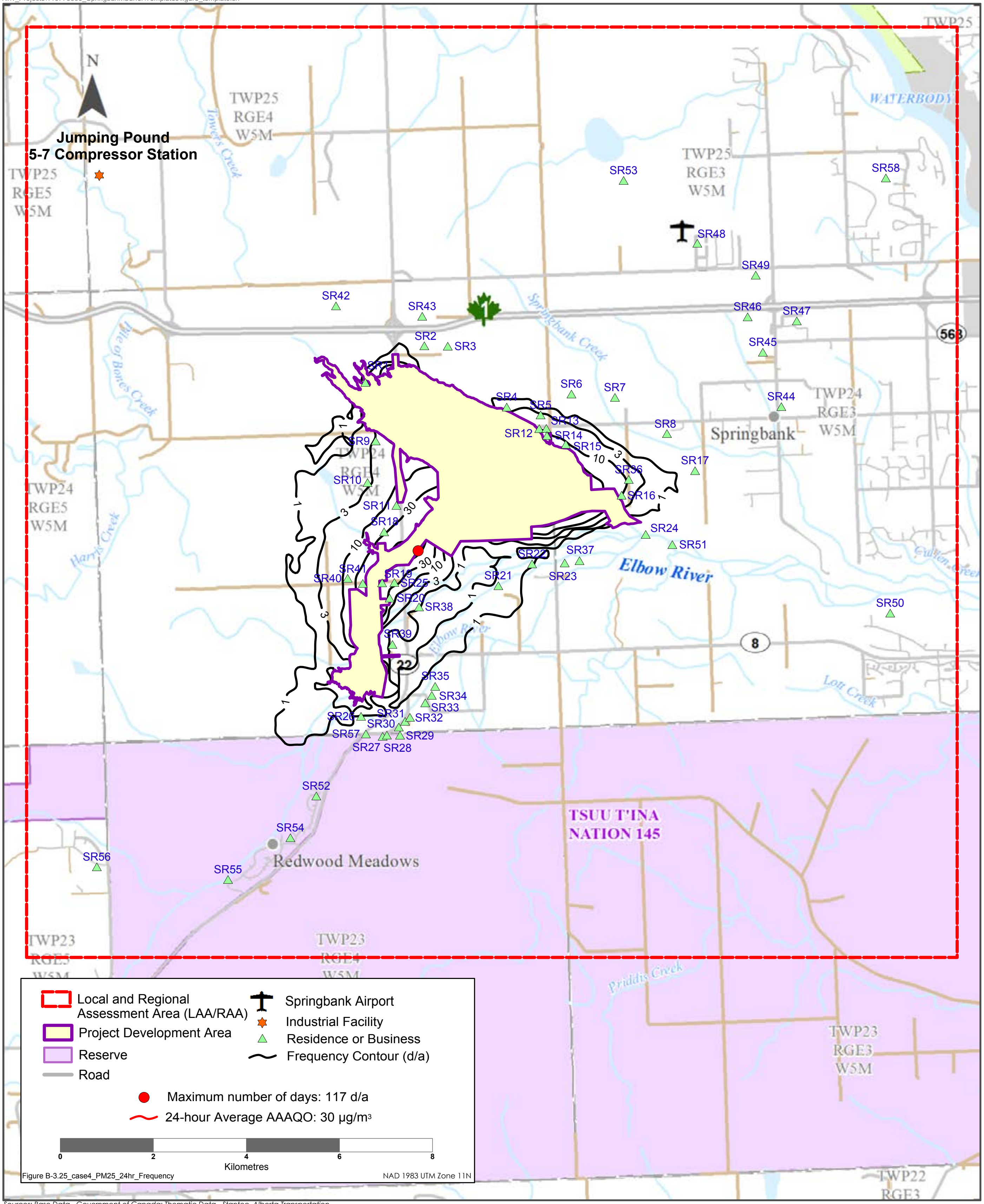
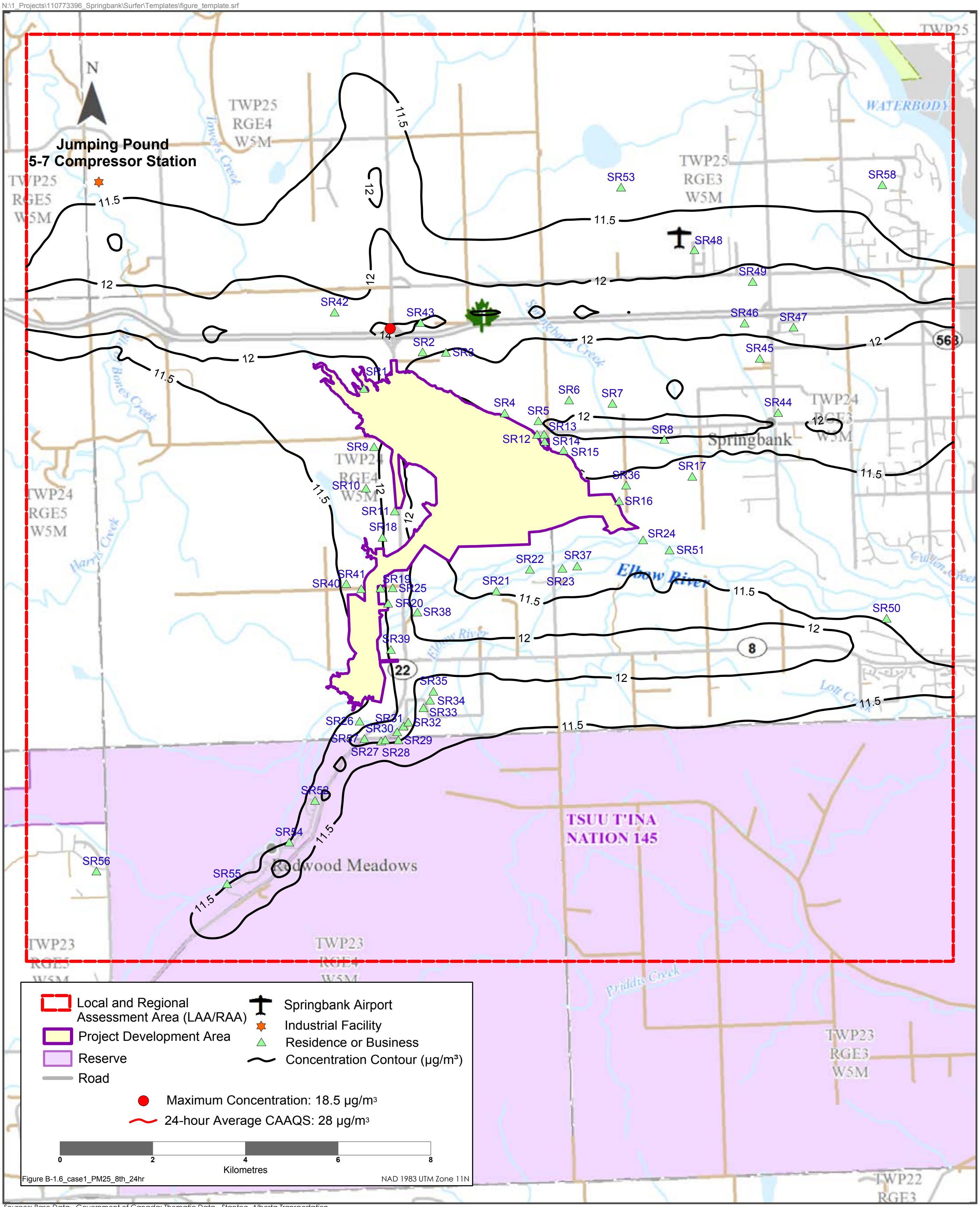


Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Frequency of Predicted 24-hour average $PM_{2.5}$ Concentration greater than the AAAQO (Application Case)



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

8th Highest Predicted 24-hour average $PM_{2.5}$ Concentration (Base Case)

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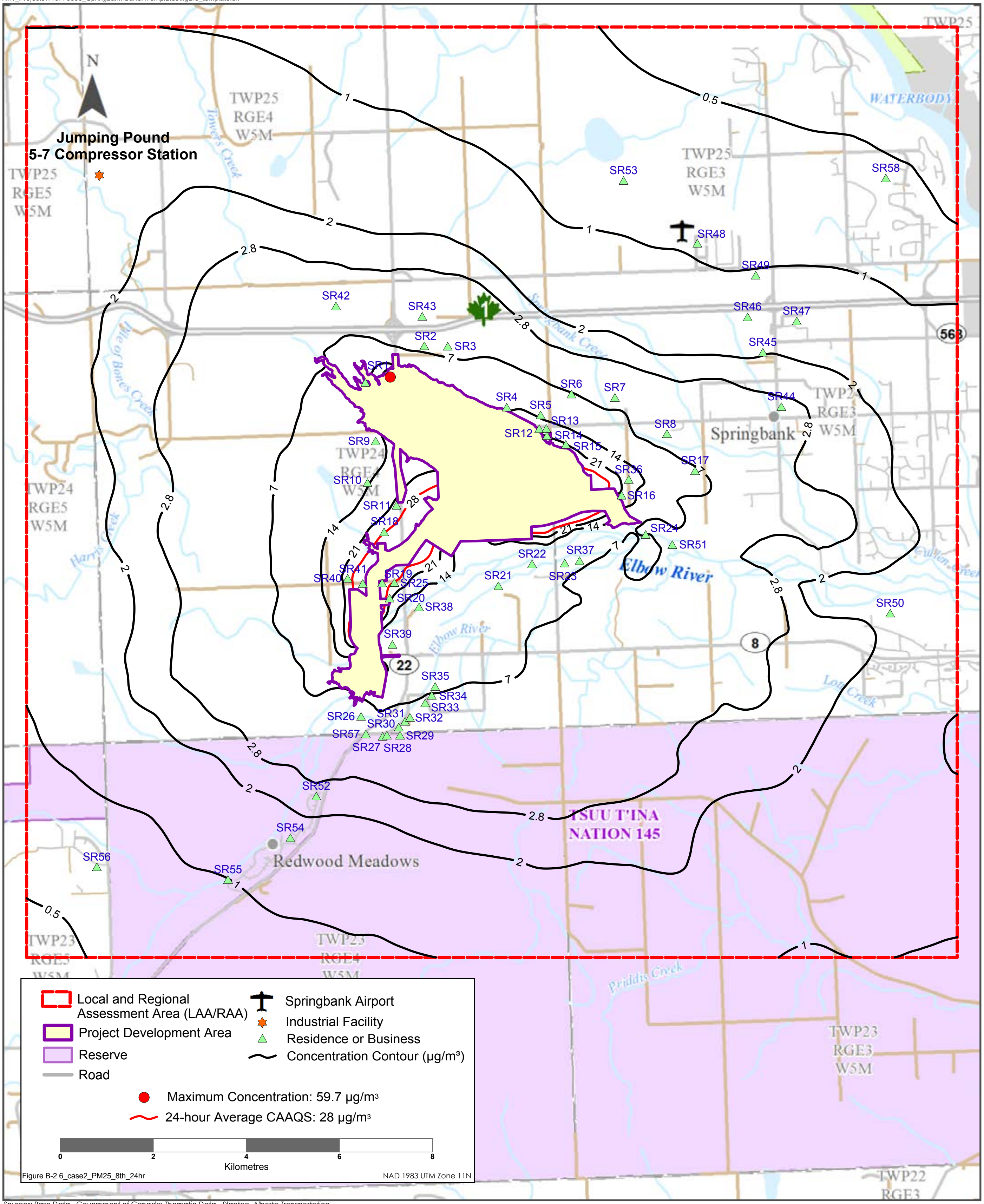
Figure 3-24



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

8th Highest Predicted 24-hour average $PM_{2.5}$ Concentration (Project Case)

Figure 3-25

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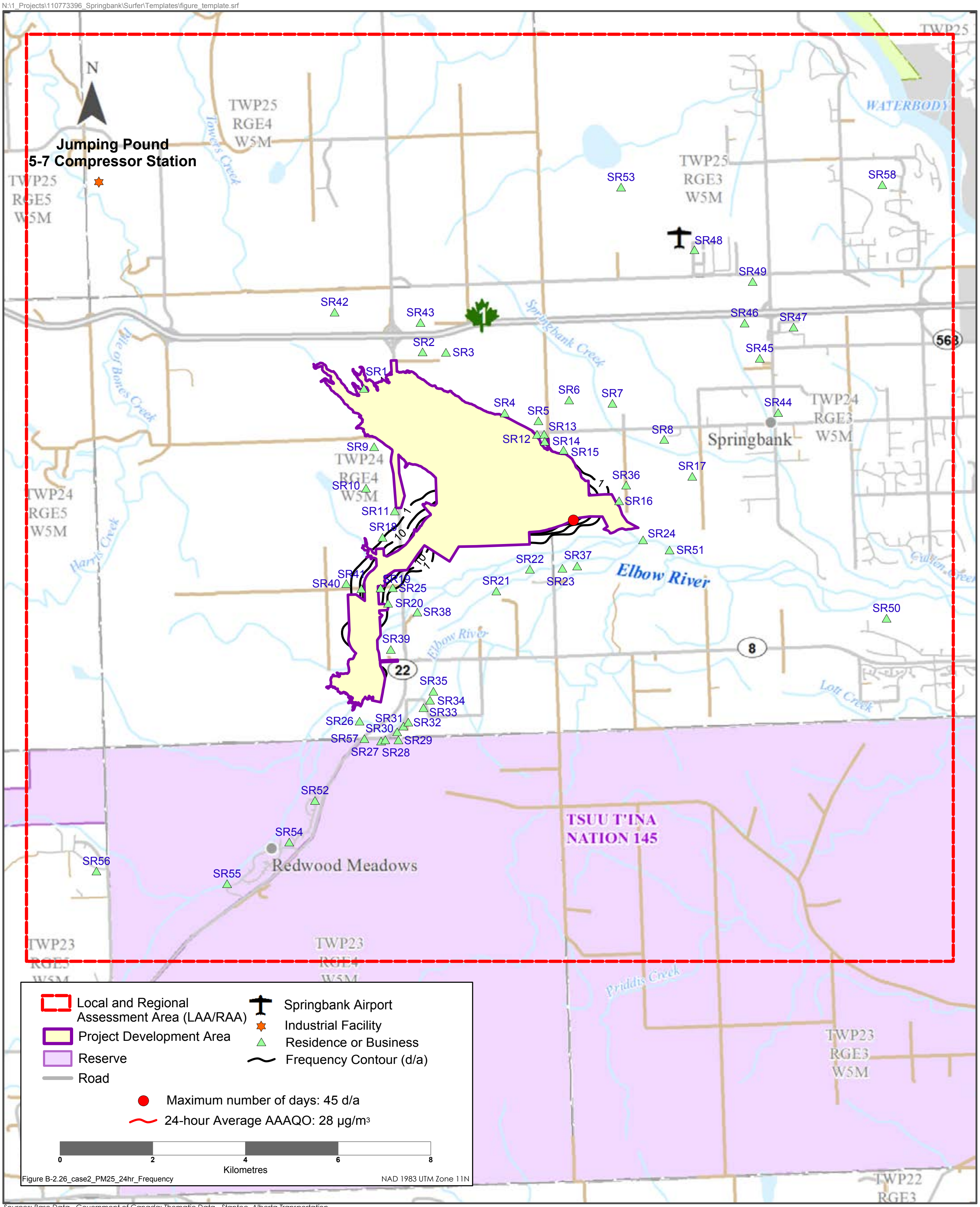

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Frequency of Predicted 24-hour average $PM_{2.5}$ Concentration greater than the CAAQS (Project Case)

Figure 3-26

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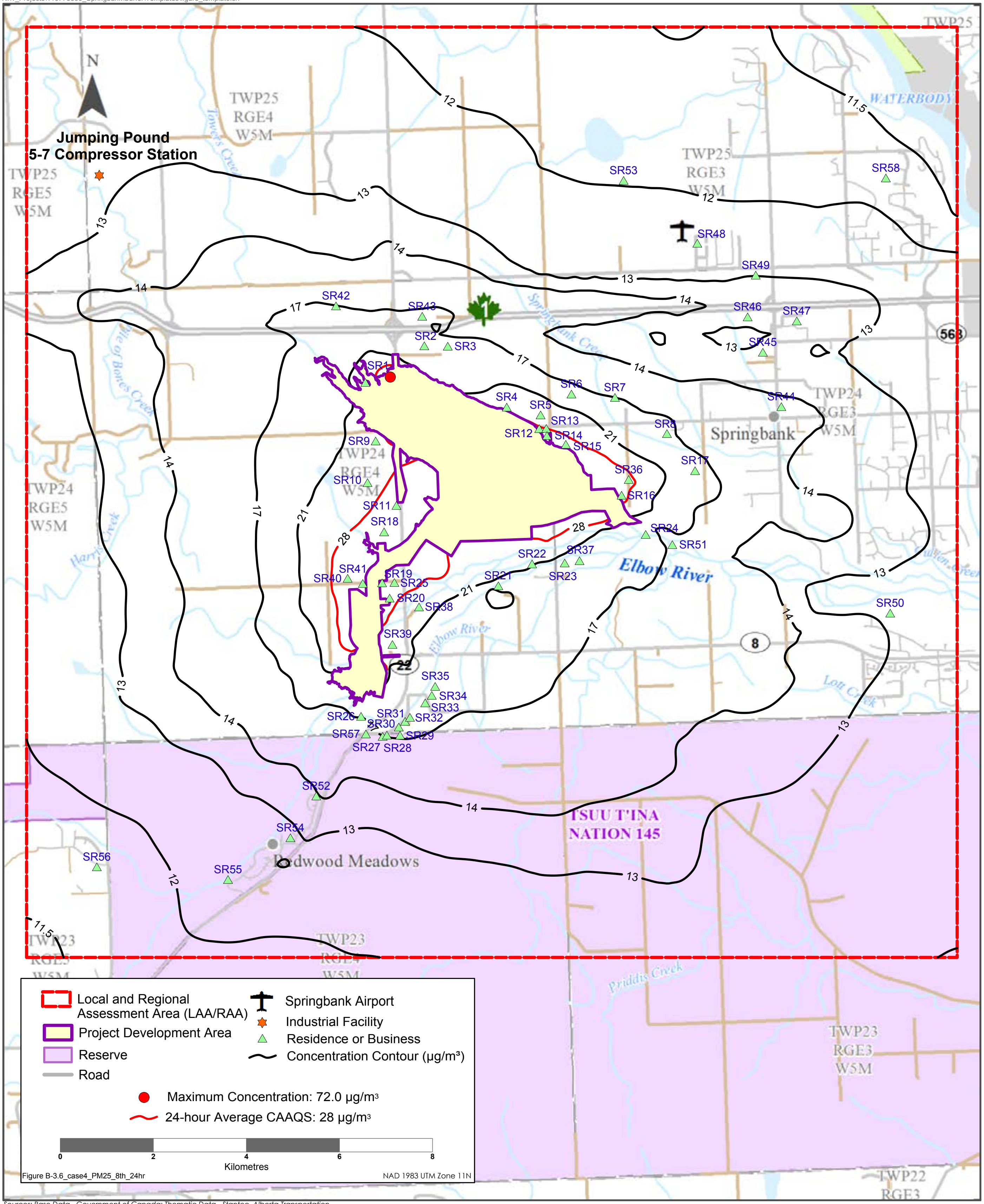
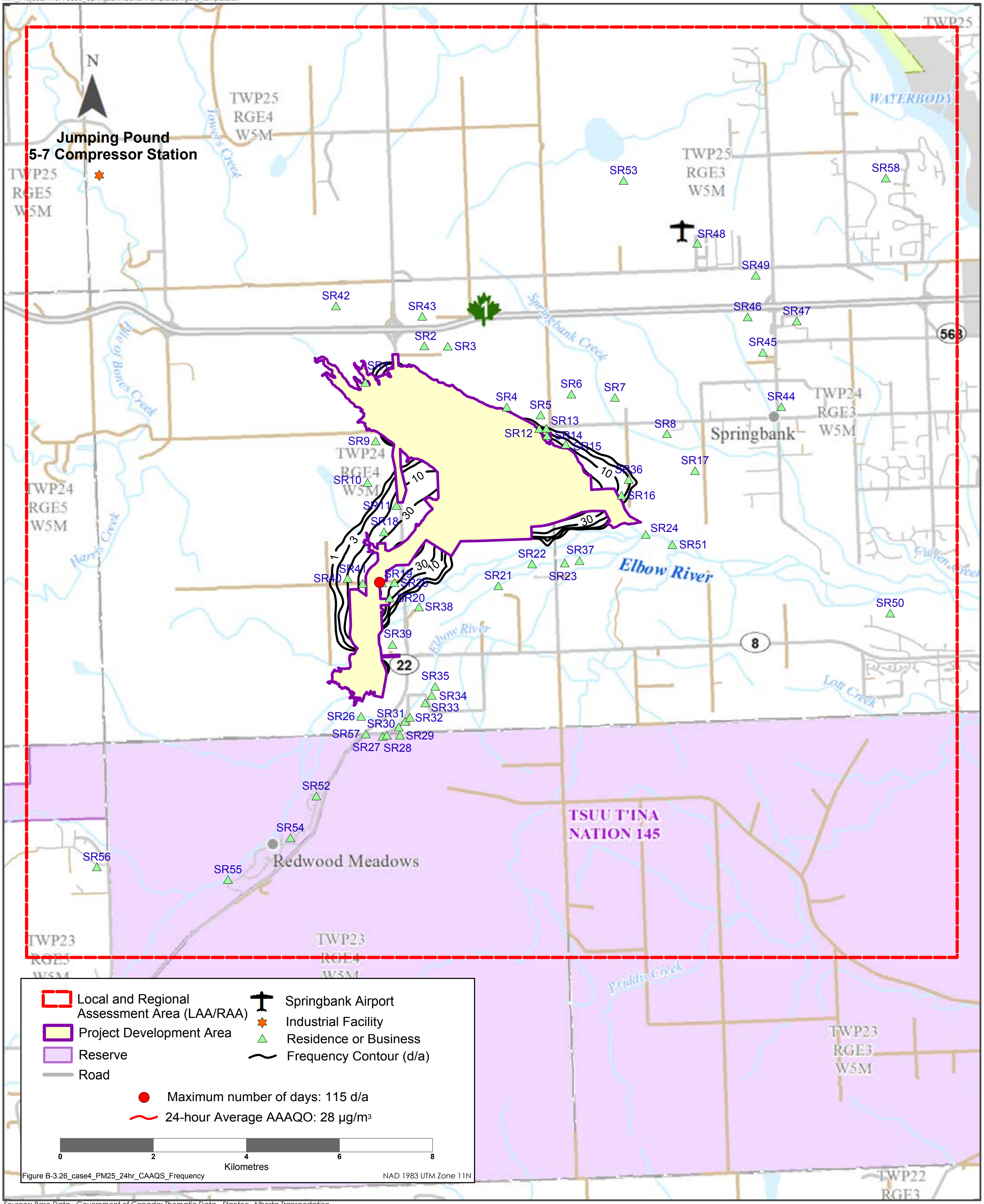


Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

8th Highest Predicted 24-hour average $PM_{2.5}$ Concentration (Application Case)

Stantec



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

Frequency of Predicted 24-hour average $PM_{2.5}$ Concentration greater than the CAAQS (Application Case)

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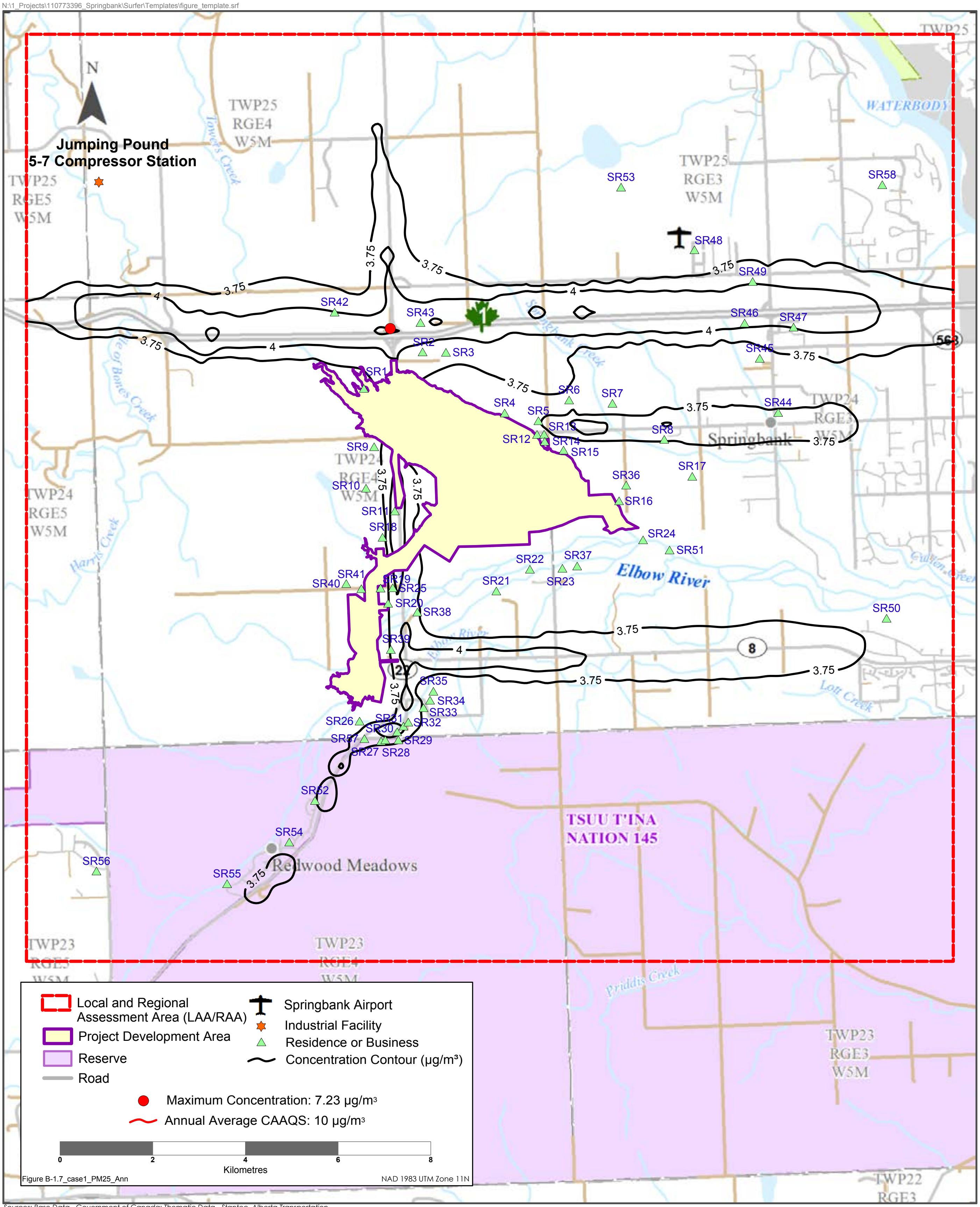

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted Annual average $PM_{2.5}$ Concentration (Base Case)

Stantec

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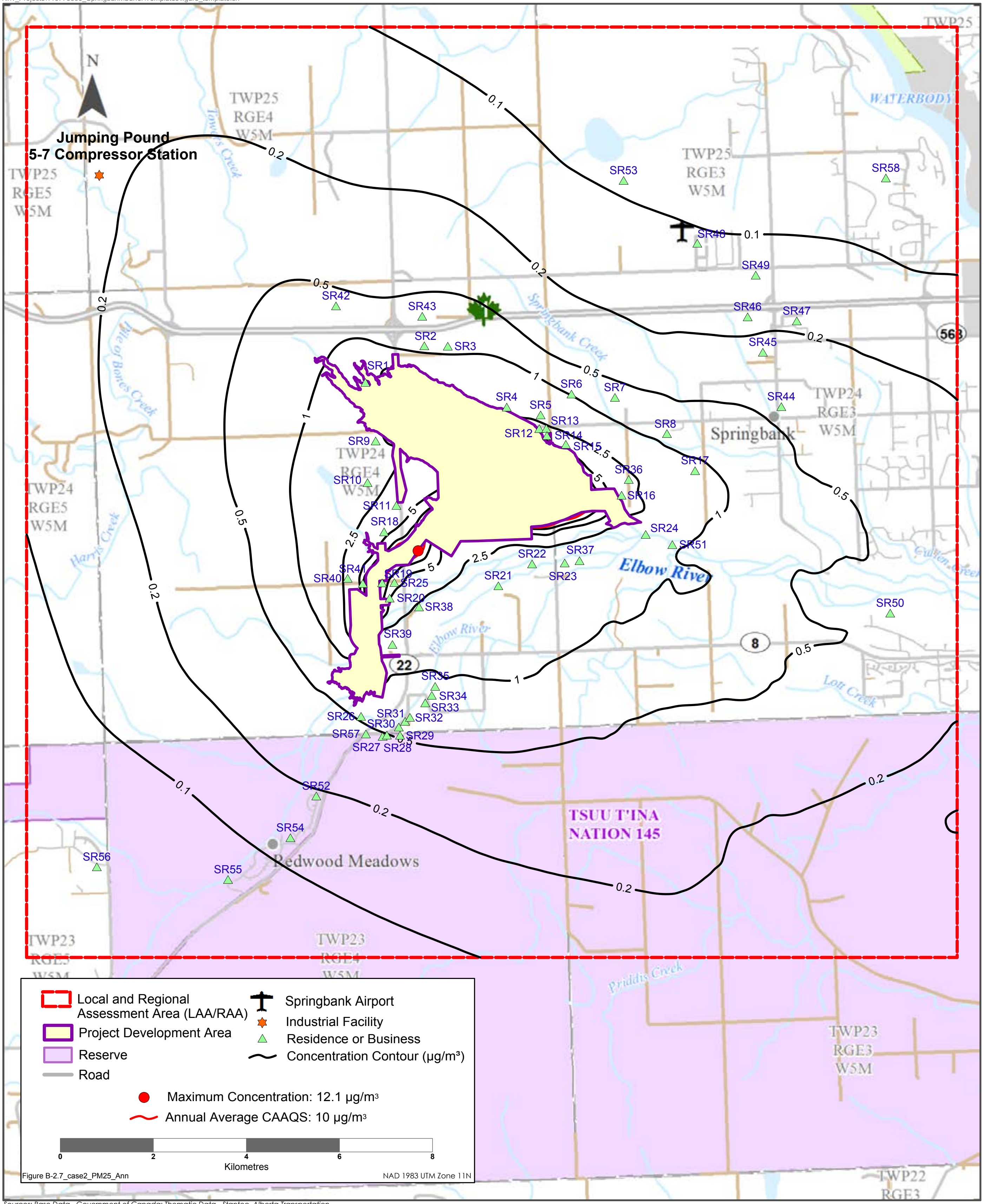
Figure 3-29



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

Maximum Predicted Annual average $PM_{2.5}$ Concentration (Project Case)

Stantec

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Figure 3-30

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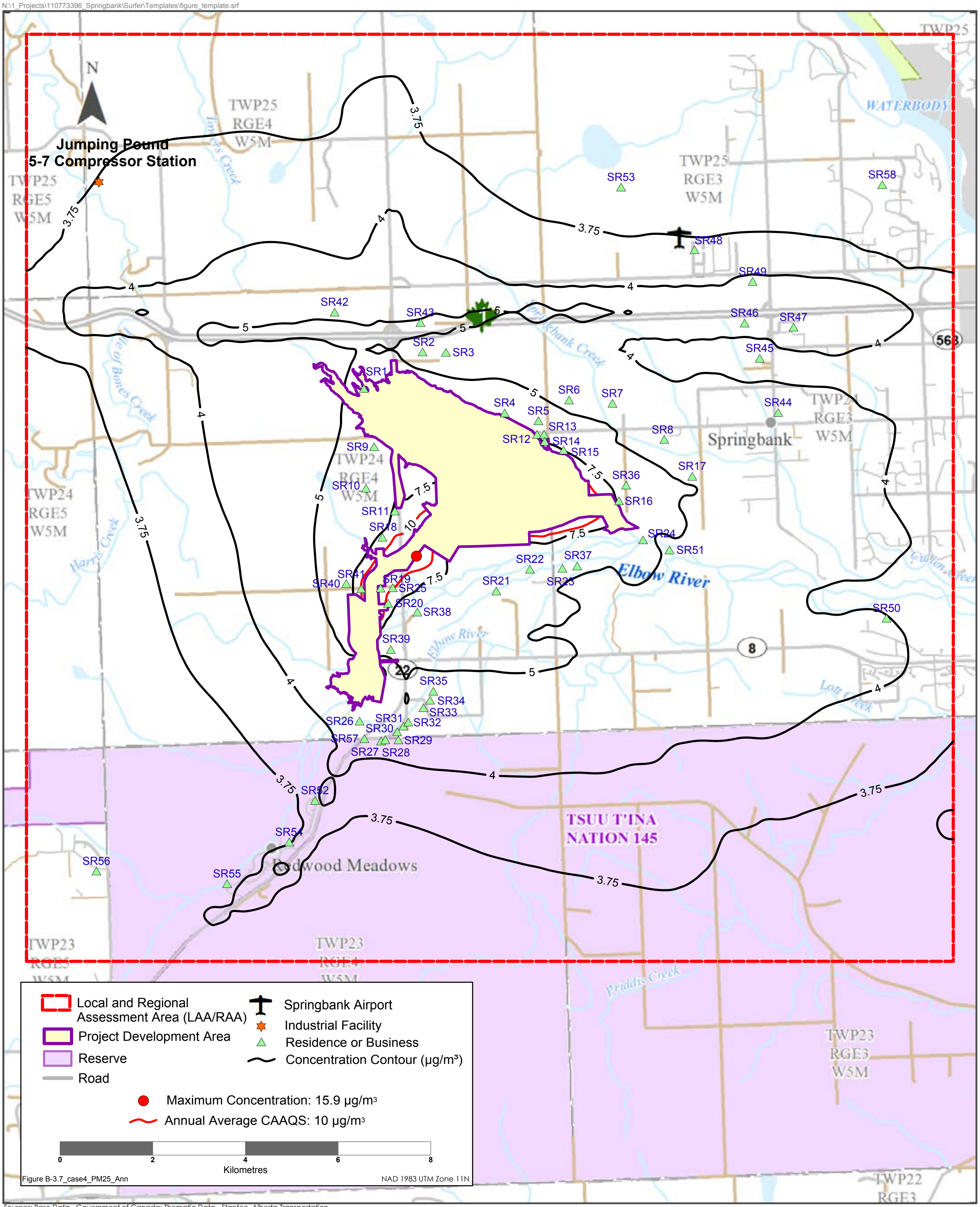

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted Annual average $PM_{2.5}$ Concentration (Application Case)

Stantec

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Figure 3-31

3.4.5.4 Maximum TSP Concentrations

24-hour Average TSP (Maximum)

The following are modelling results for TSP concentrations:

- Base Case—The highest 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 (Figure 3-32). 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 (Figure 3-33).
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The maximum predicted 24-hour TSP concentration of 2,851 µg/m³ occurs along the eastern PDA boundary near the east end of the diversion channel haul road (Figure 3-34). Predicted TSP concentrations greater than the 24-hour AAAQO of 100 µg/m³ occur for up to 241 days per year along the southeast PDA boundary near the diversion channel haul road (Figure 3-35).
- Application Case—The highest concentrations for the Application Case occur along the PDA boundary. The maximum predicted 24-hour TSP concentration of 2,903 µg/m³ also occurs along the eastern PDA boundary near the east end of the diversion channel haul road (Figure 3-36). Predicted TSP concentrations greater than the 24-hour AAAQO of 100 µg/m³ occur for up to 297 days per year along the southeast PDA boundary near the diversion channel haul road (Figure 3-37).

Annual Average TSP

The following summarizes modelling results for TSP concentrations:

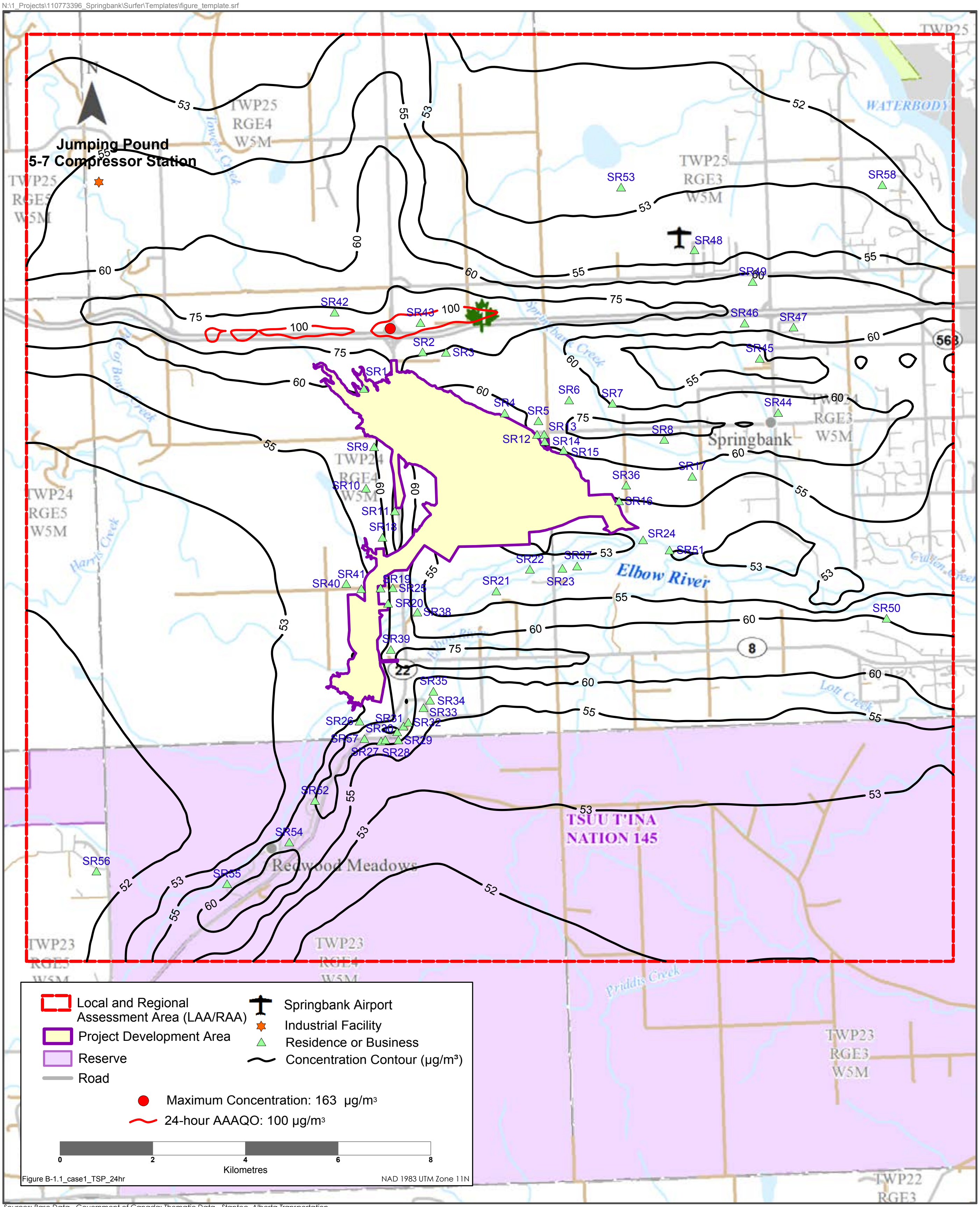
- Base Case—The highest concentrations for the Base Case occur on and near highways. The maximum predicted annual TSP concentration of 59.8 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22 (Figure 3-38). The maximum predicted annual TSP concentration is at the annual AAAQO of 60 µg/m³.
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The maximum predicted annual TSP concentration of 313 µg/m³ occurs along the southeast PDA boundary near the diversion channel haul road (Figure 3-39). Values that are greater than the annual AAAQO occur within 900 m of limited areas along the PDA boundary.

- Application Case—The highest concentrations for the Application Case occur along the PDA boundary. The maximum predicted annual TSP concentration of 330 µg/m³ occurs along the southeast PDA boundary near the diversion channel haul road (Figure 3-40). Values that are greater than the annual AAAQO occur within 1.2 km of limited areas along the PDA boundary.

TSP Comments

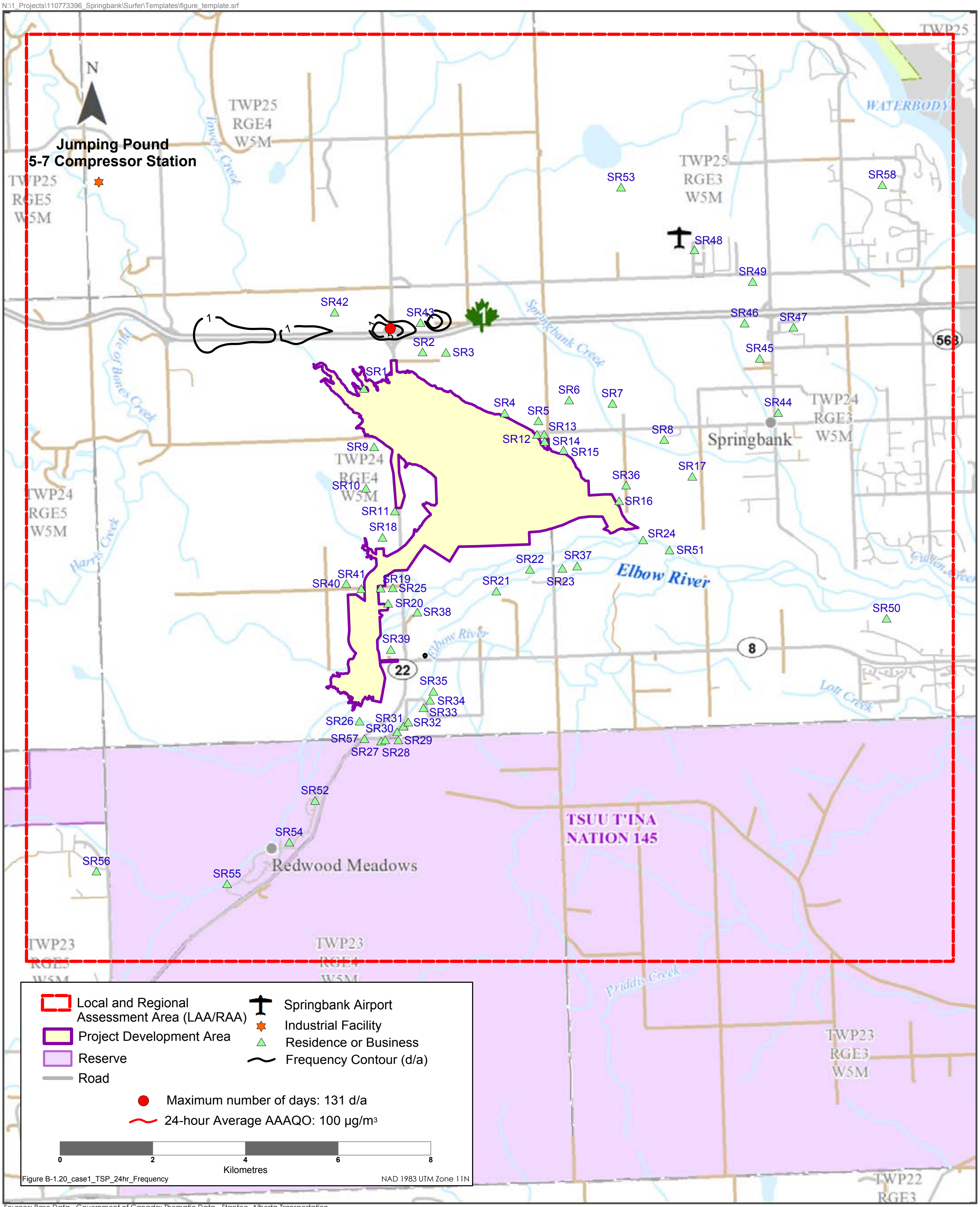
The model predicts maximum 24-hour TSP concentrations greater than the AAAQO to occur approximately 6 km from the PDA. Along the PDA boundary, values greater than the AAAQO are predicted for more than 200 days in a year, reducing to one hour per year with increasing distance.

While the model predicts annual average TSP concentrations that are greater than the AAAQO outside the PDA, these values are predicted to occur within 1.2 km of limited areas along the PDA boundary.



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

Maximum Predicted 24-hour average TSP Concentration (Base Case)



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

Frequency of Predicted 24-hour Average TSP Concentration greater than the AAAQO (Base Case)

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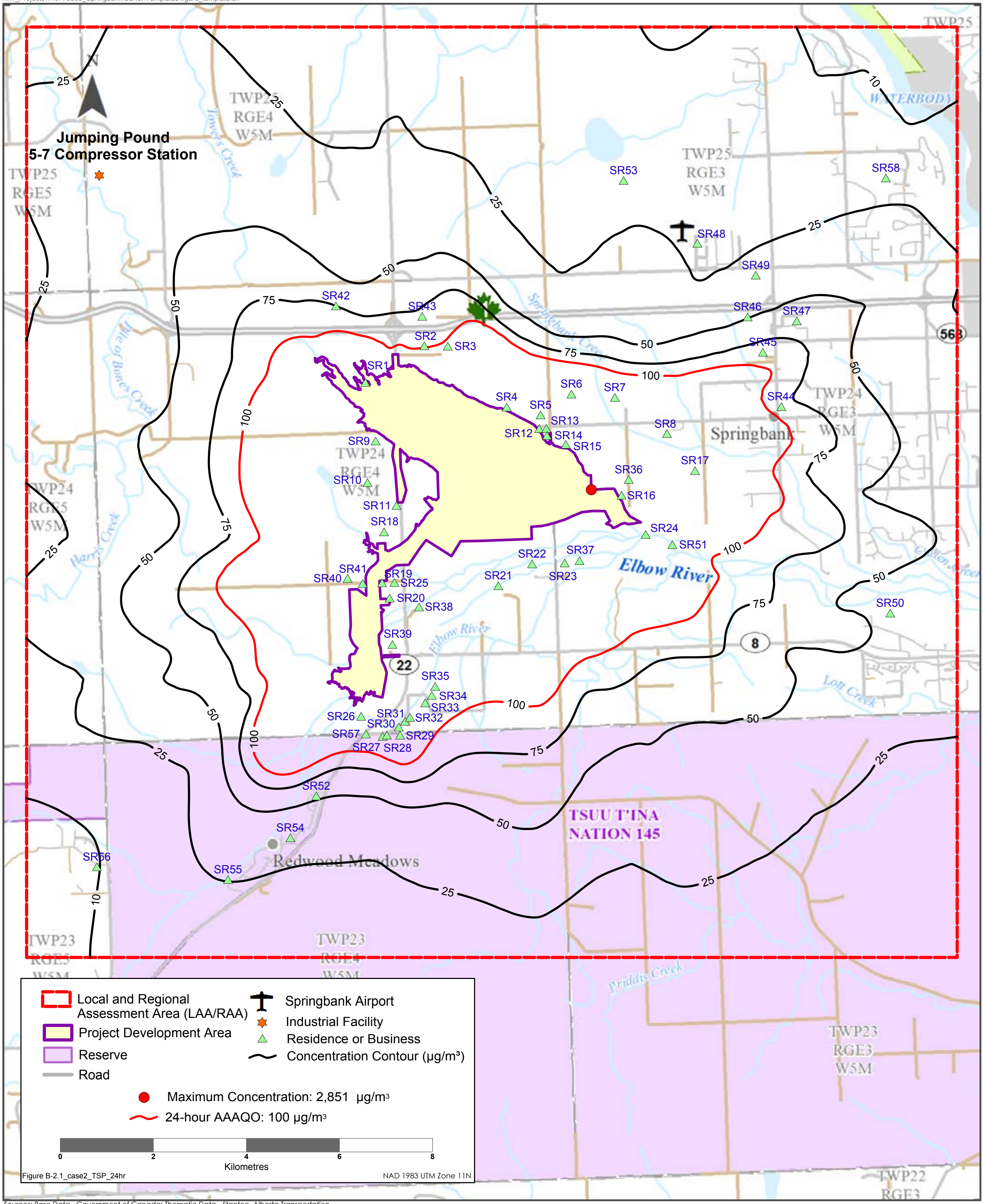


Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

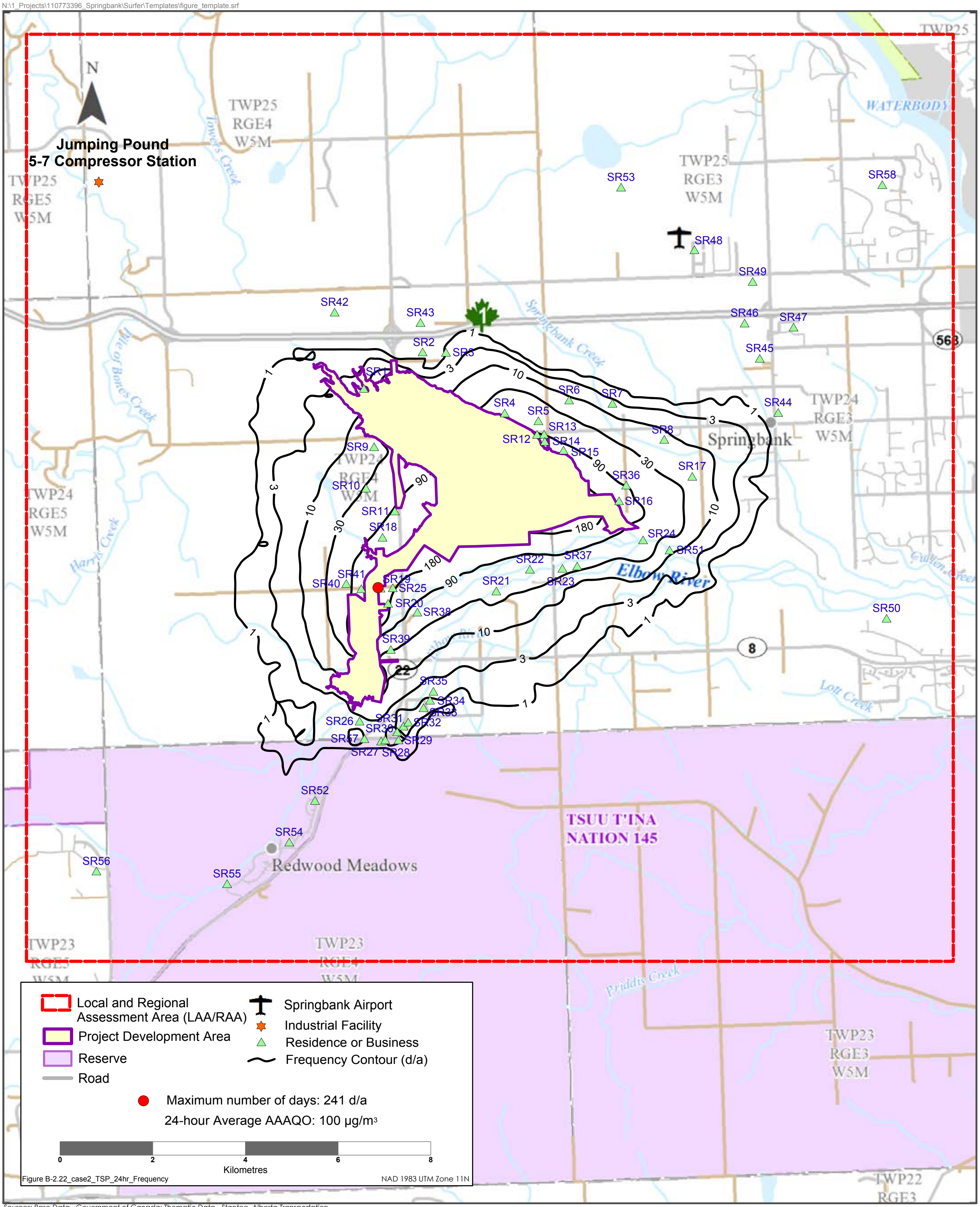
Maximum Predicted 24-hour average TSP Concentration (Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure 3-34

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



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

Frequency of Predicted 24-hour Average TSP Concentration greater than the AAAQO (Project Case)

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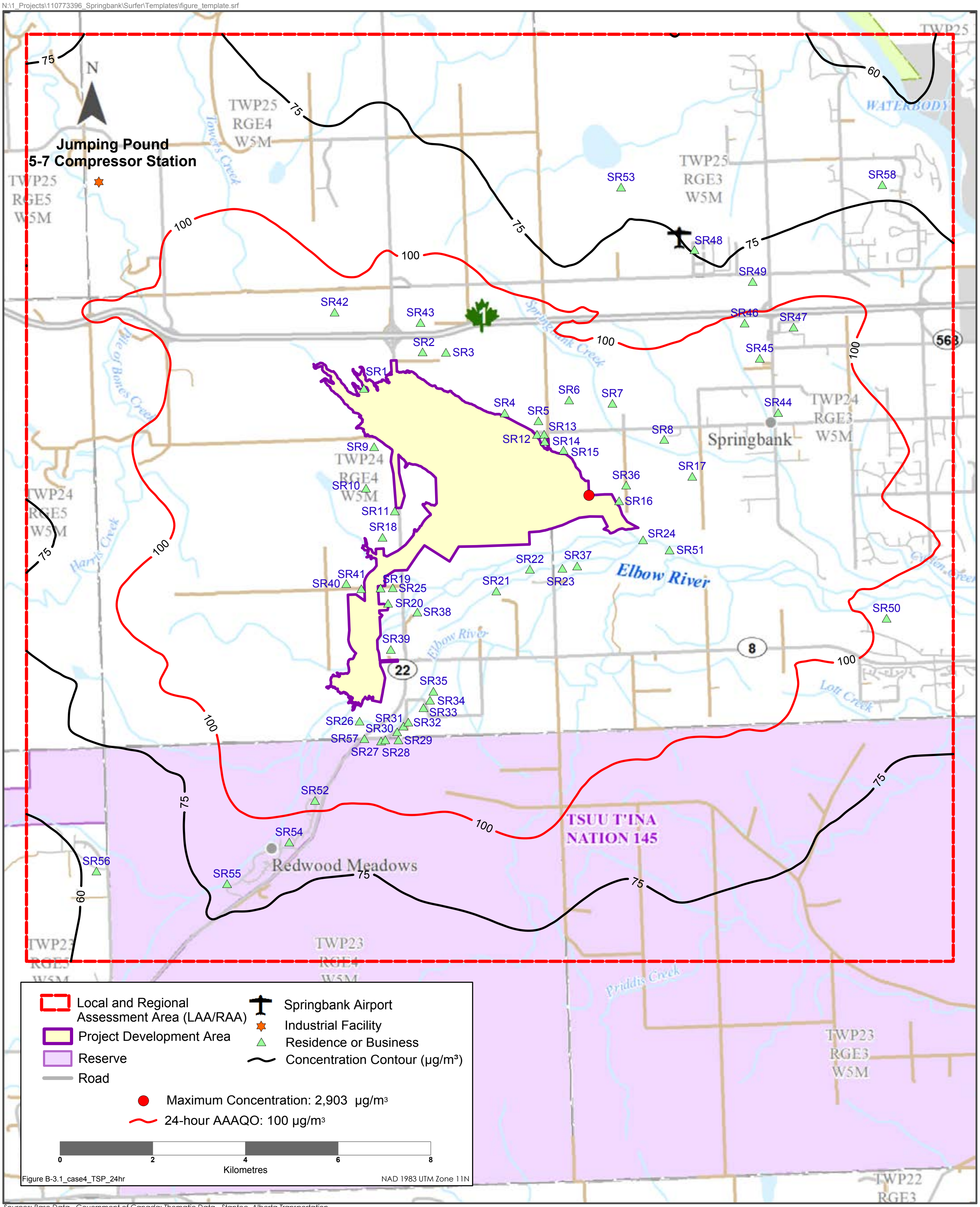


Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

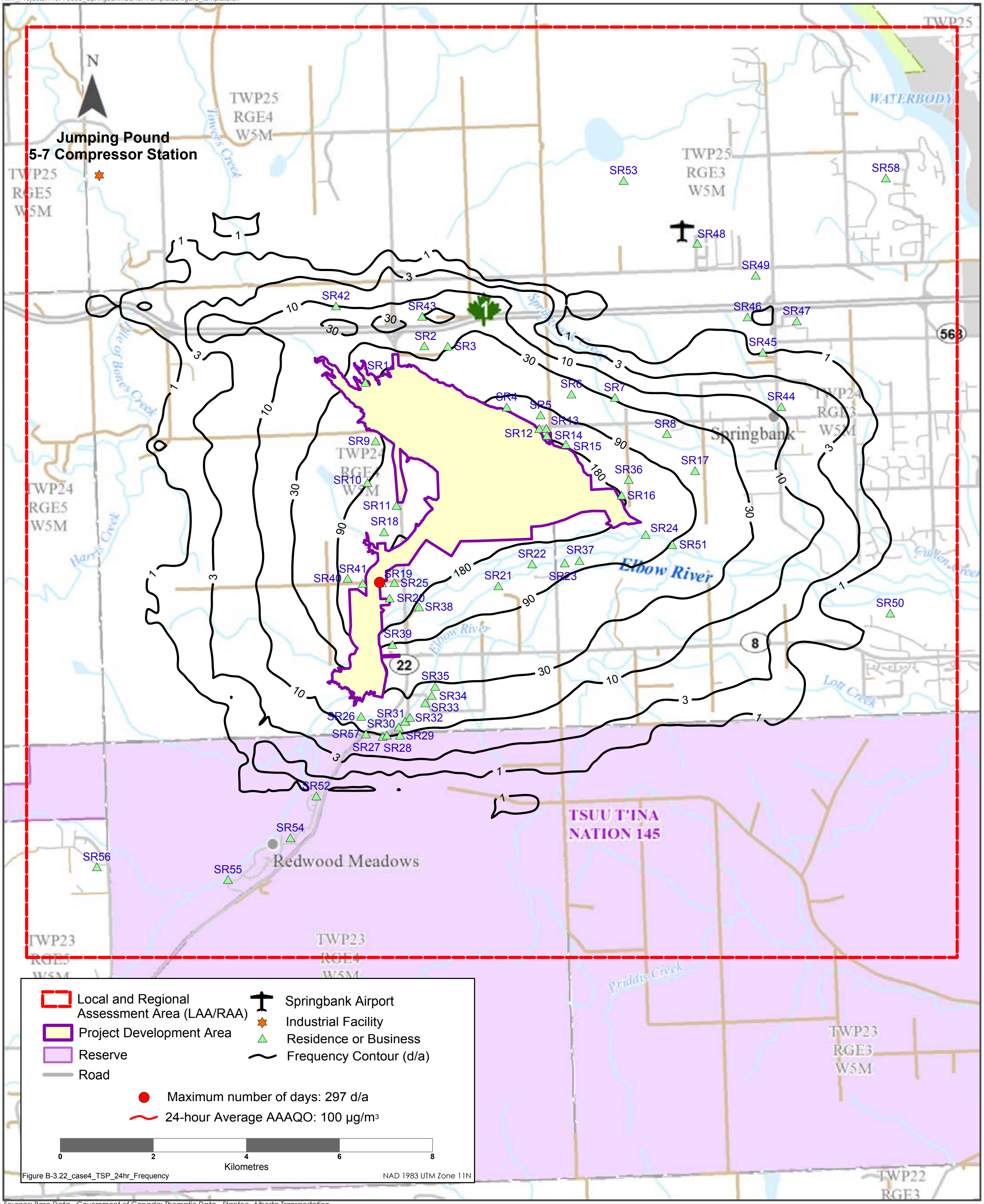
Maximum Predicted 24-hour average TSP Concentration (Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

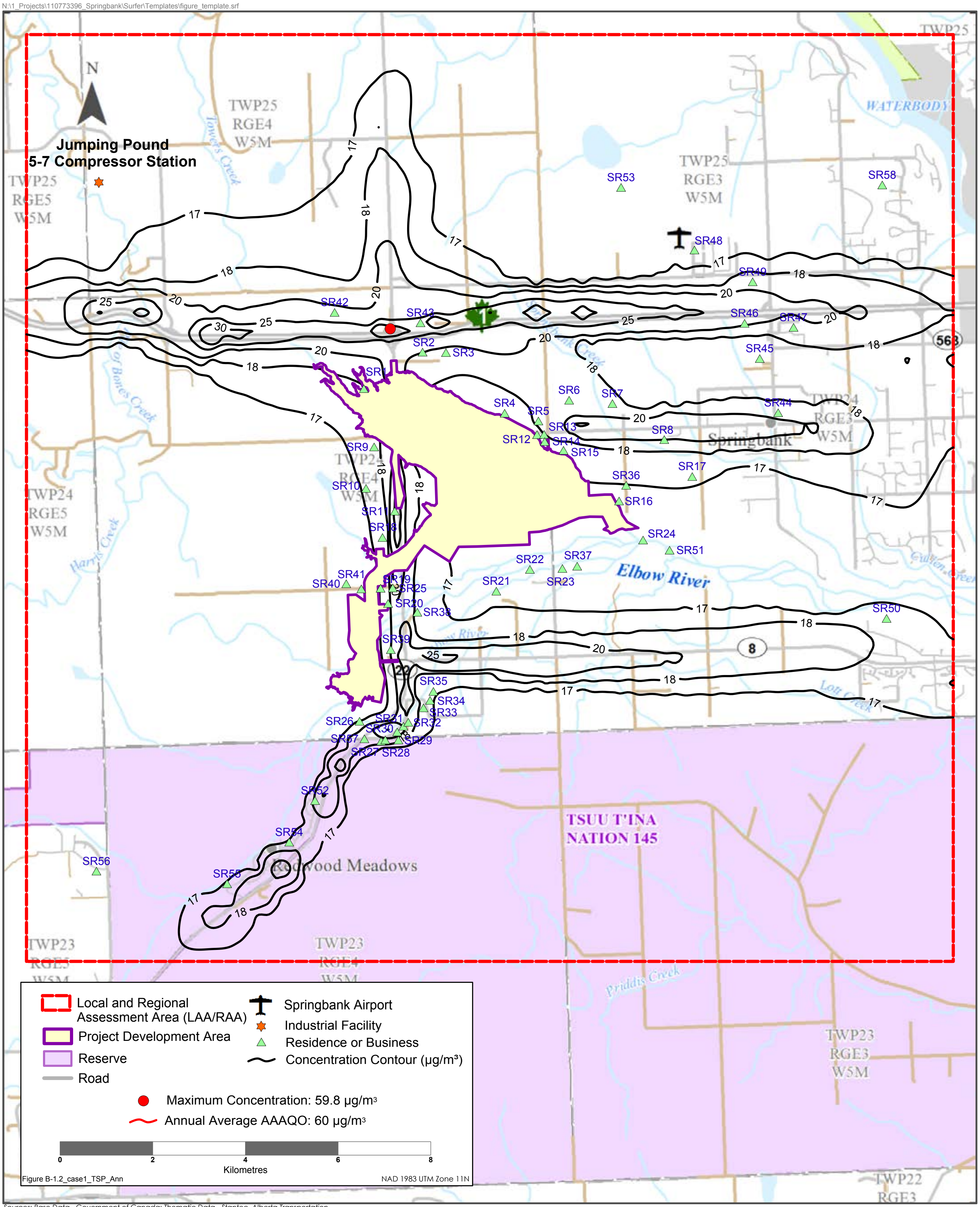
Figure 3-36

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



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

Frequency of Predicted 24-hour Average TSP Concentration greater than the AAAQO (Application Case)

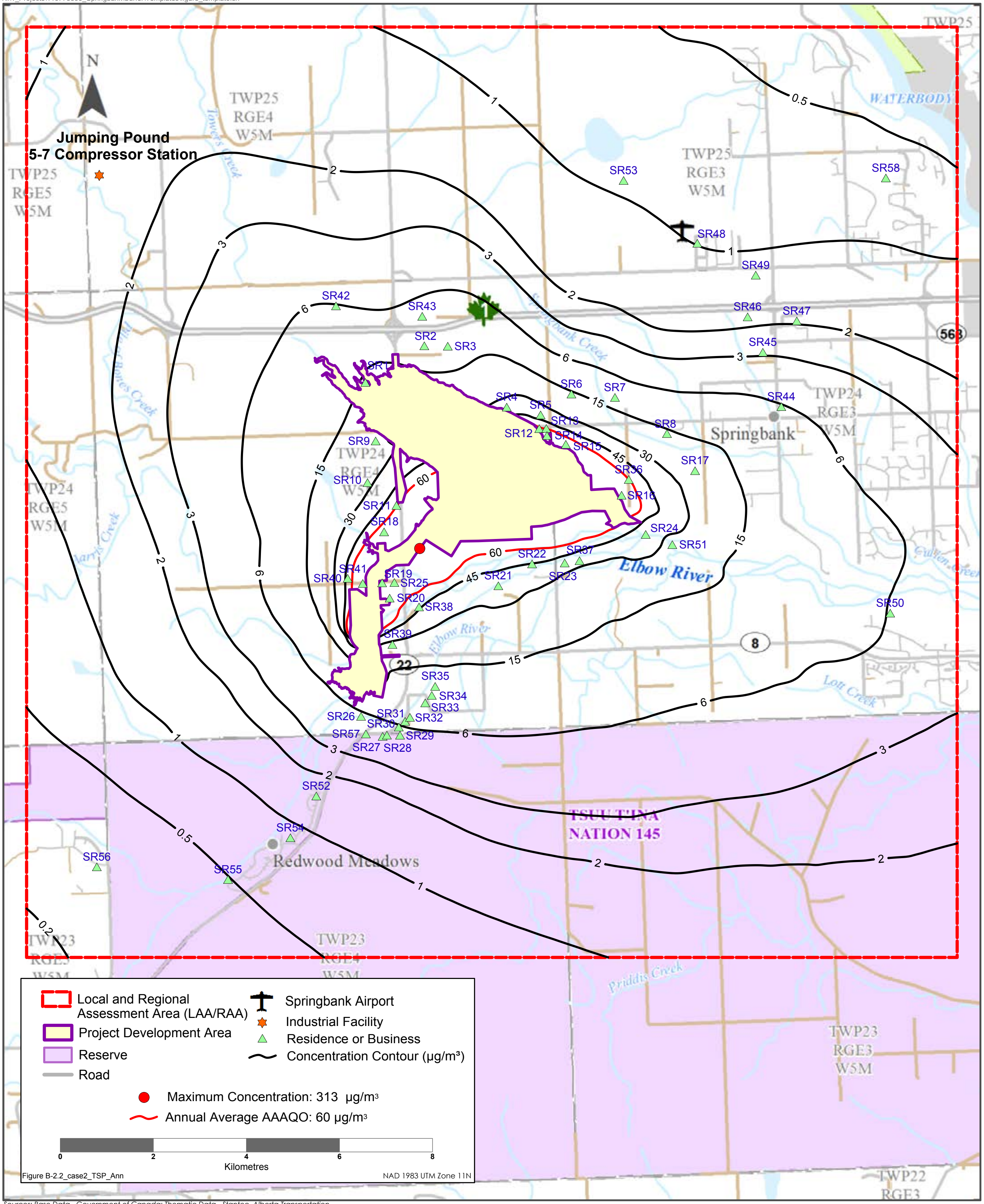


Maximum Predicted Annual average TSP Concentration (Base Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure 3-38



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

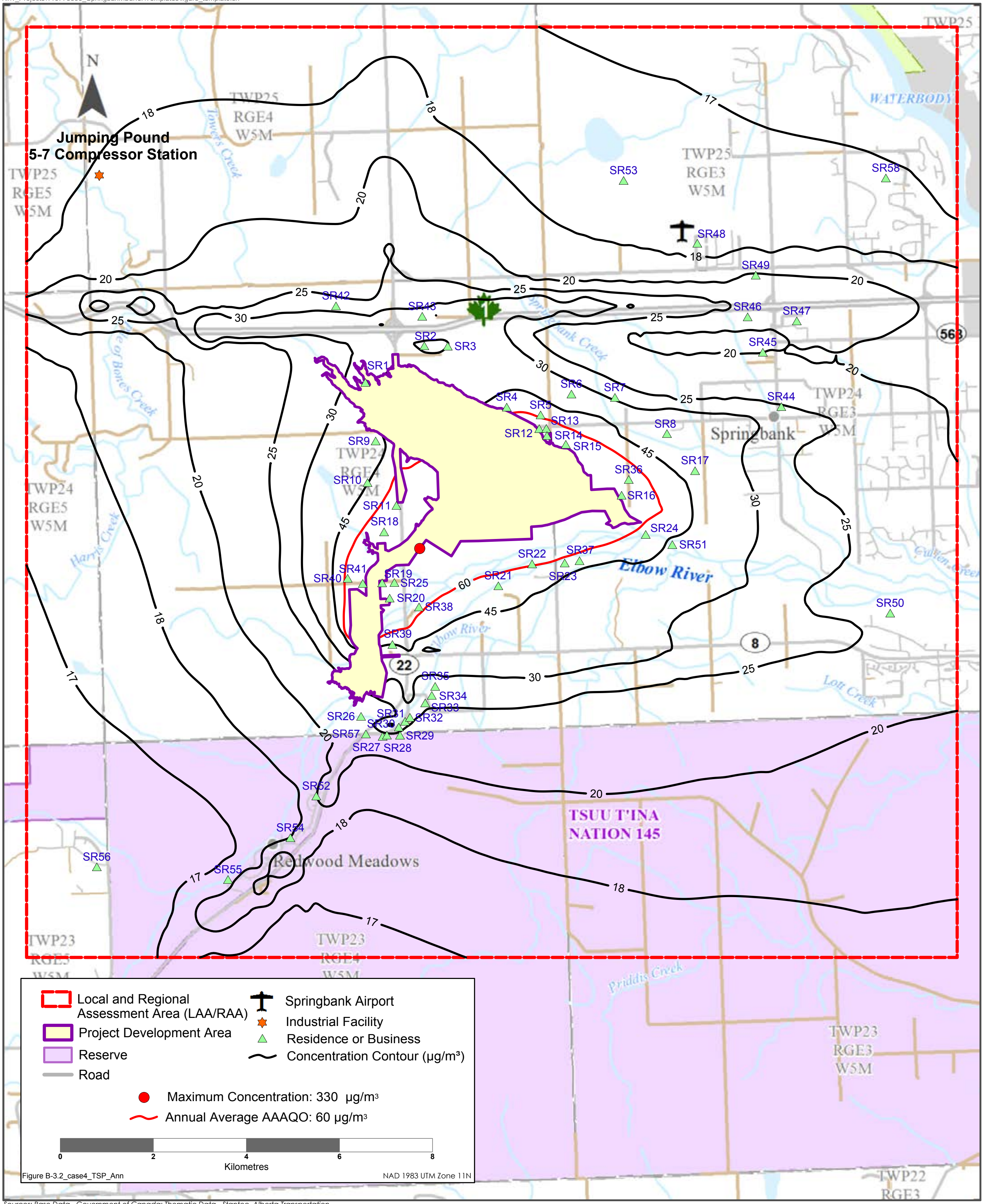
Maximum Predicted Annual average TSP Concentration (Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure 3-39

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



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

Maximum Predicted Annual average TSP Concentration (Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure 3-40

3.4.5.5 Maximum Dustfall Deposition

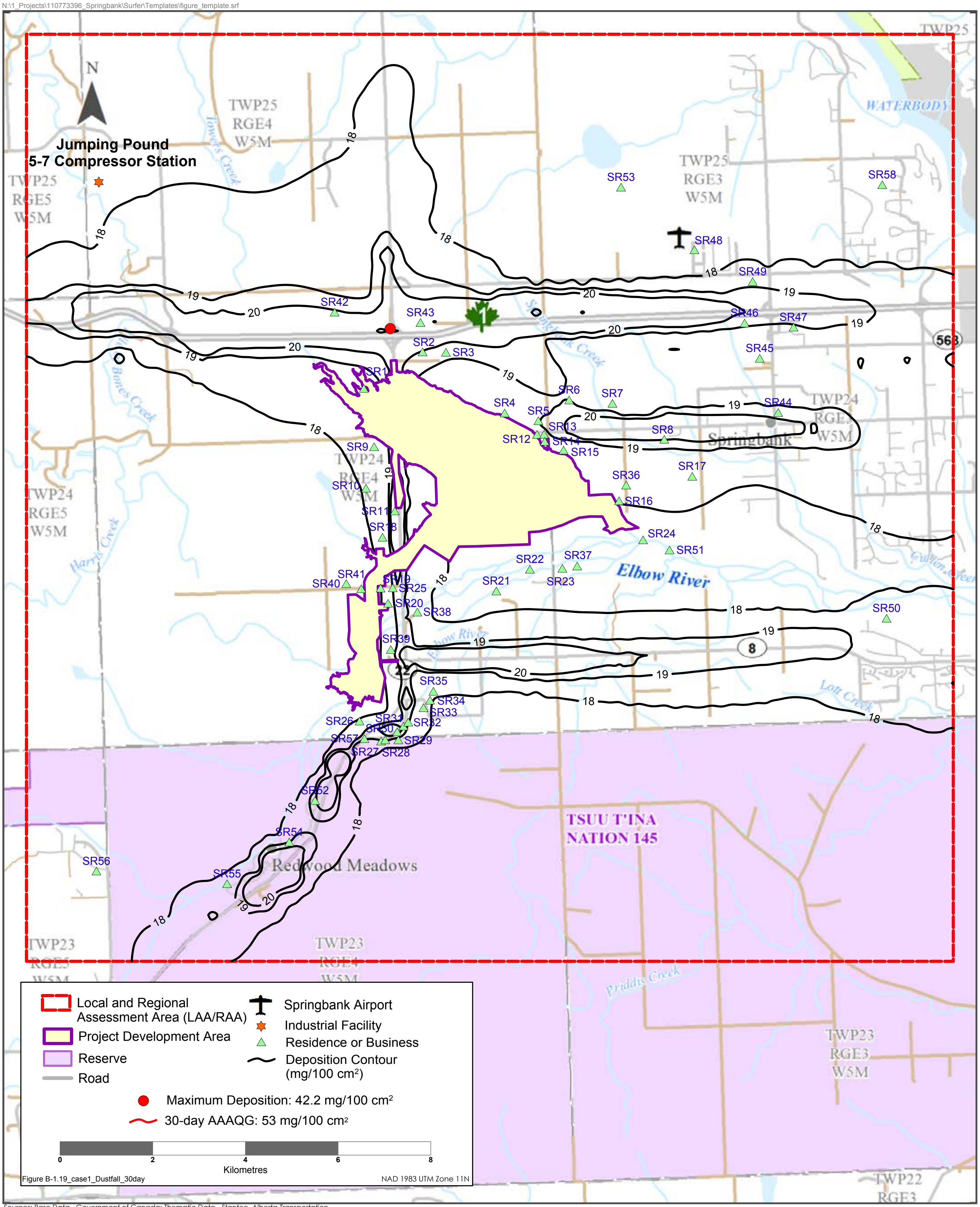
30-day Average Dustfall (Maximum)

The following summarizes modelling results for dustfall:

- Base Case—The highest dustfall for the Base Case occurs on and near highways. The maximum predicted 30-day dustfall of 42.2 mg/100 cm^2 occurs at the intersection of the TransCanada Highway and Highway 22 (Figure 3-41). The maximum predicted dustfall is less than the 30-day AAAQG of 53 mg/100 cm^2.
- Project Case—The highest dustfall for the Project Case occurs along the PDA boundary. The maximum predicted 30-day dustfall of 220 mg/100 cm^2 occurs along the eastern PDA boundary near the east end of the diversion channel haul road (Figure 3-42). Predicted dustfall greater than the 30-day AAAQG of 53 mg/100 cm^2 occur for up to 8 months per year near the east end of the diversion channel haul road (Figure 3-43).
- Application Case—The highest dustfall for the Application Case occurs along the PDA boundary. The maximum predicted 30-day dustfall of 238 mg/100 cm^2 occurs along the eastern PDA boundary near the east end of the diversion channel haul road (Figure 3-44). Predicted dustfall greater than the 30-day AAAQG of 53 mg/100 cm^2 occur for up to 8 months per year near the east end of the diversion channel haul road (Figure 3-45).

Dustfall Comments

While the model predicts maximum 30-day dustfall depositions that are greater than the AAAQG outside the PDA, these values are predicted to occur less than 1.1 km from the PDA. Along the PDA boundary, values greater than the AAAOQ are predicted for more than 7 months in a year, reducing to one month per year with increasing distance.



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

Maximum Predicted 30-day Average Dustfall (Base Case)

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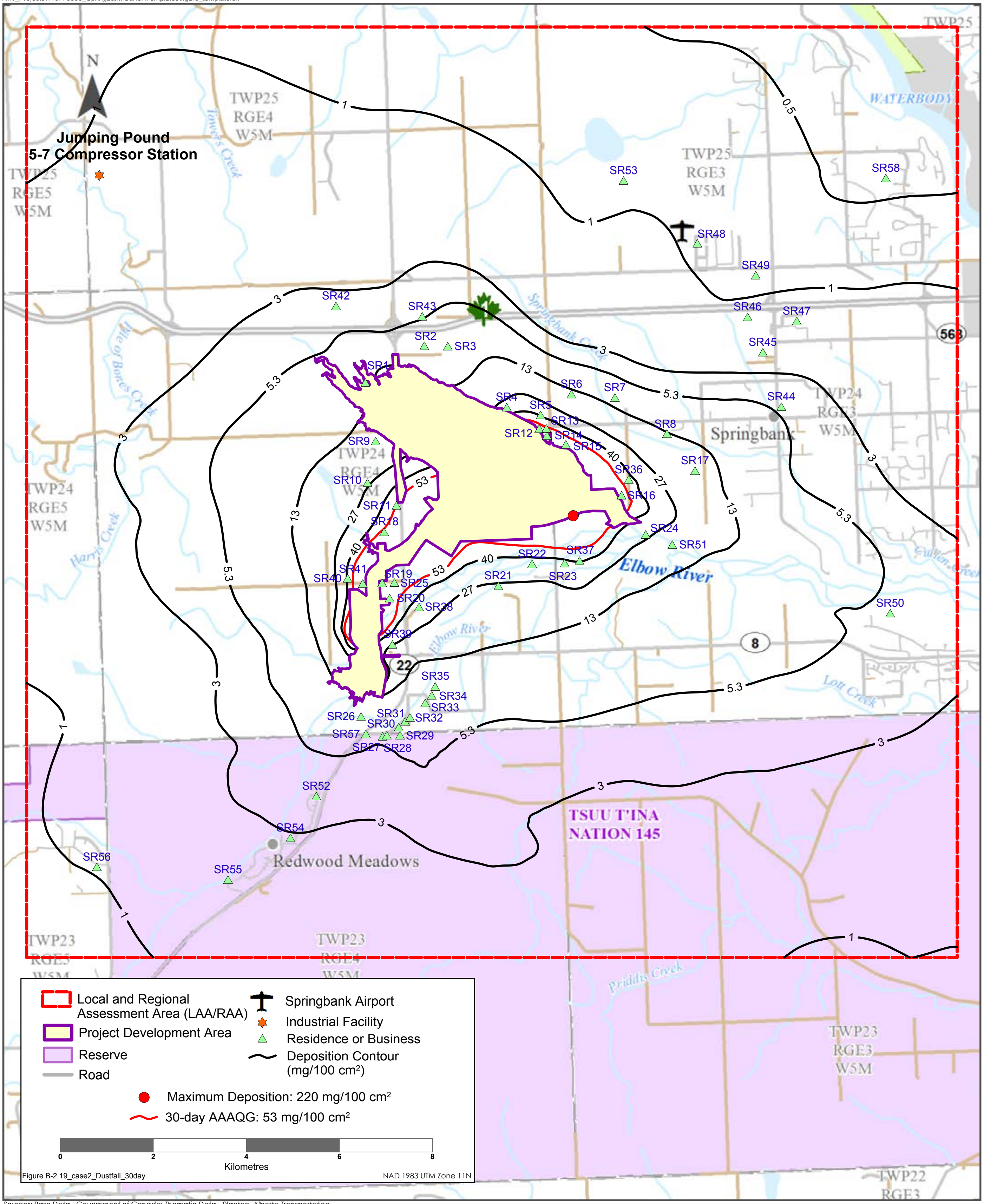
SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure 3-41

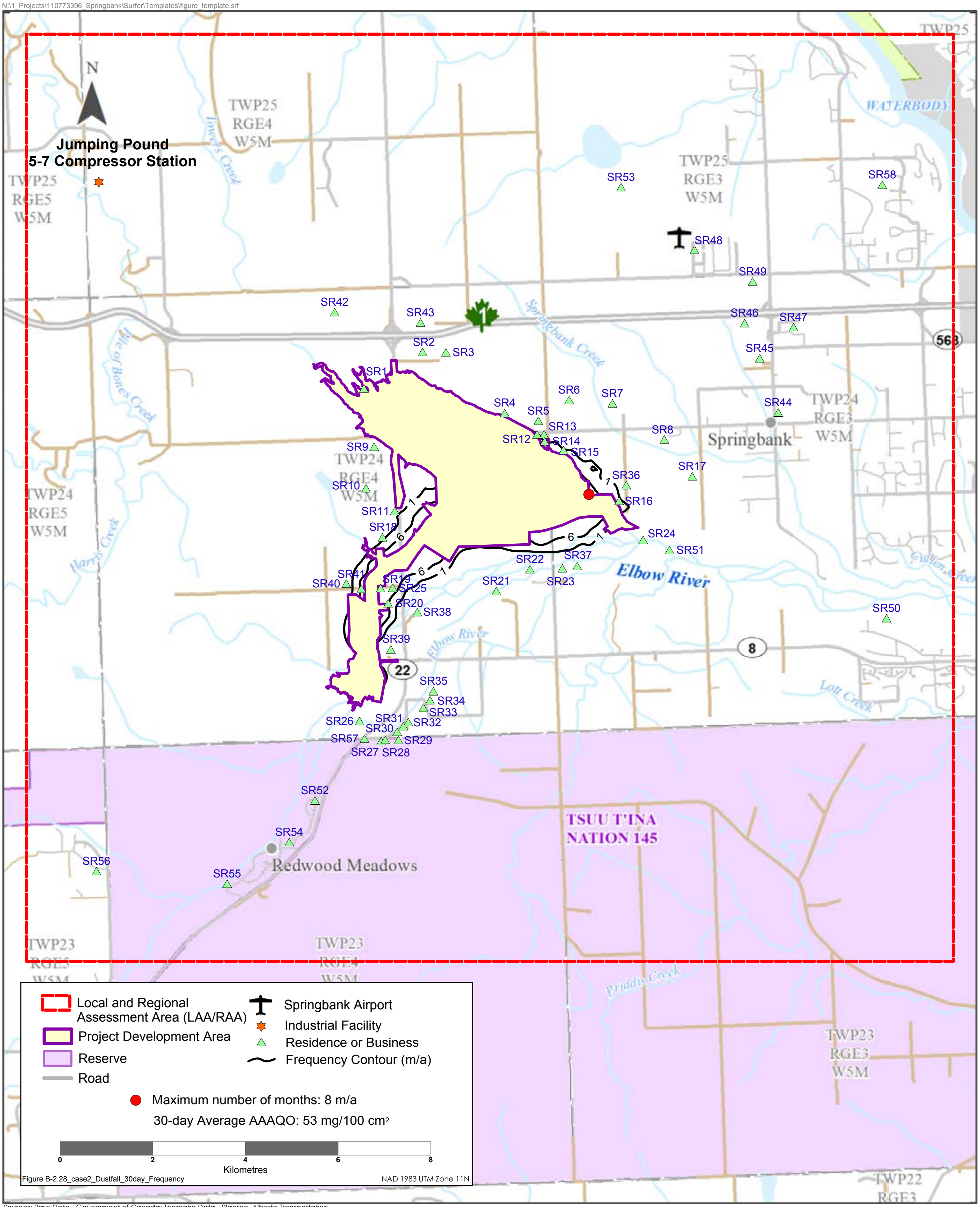
N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



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

Maximum Predicted 30-day Average Dustfall (Project Case)

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



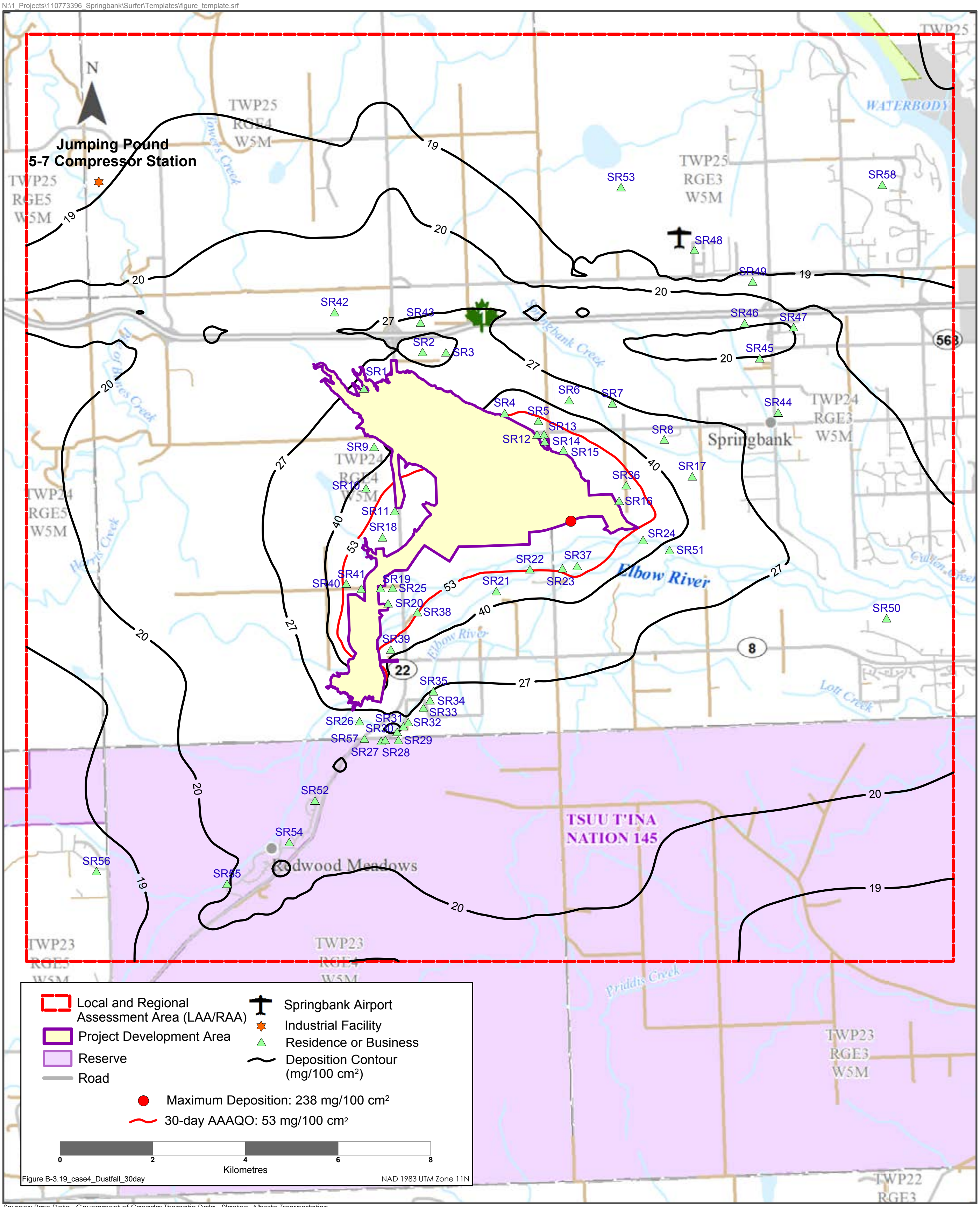
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Frequency of Predicted 30-day Average Dustfall greater than the AAAQG (Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure 3-43



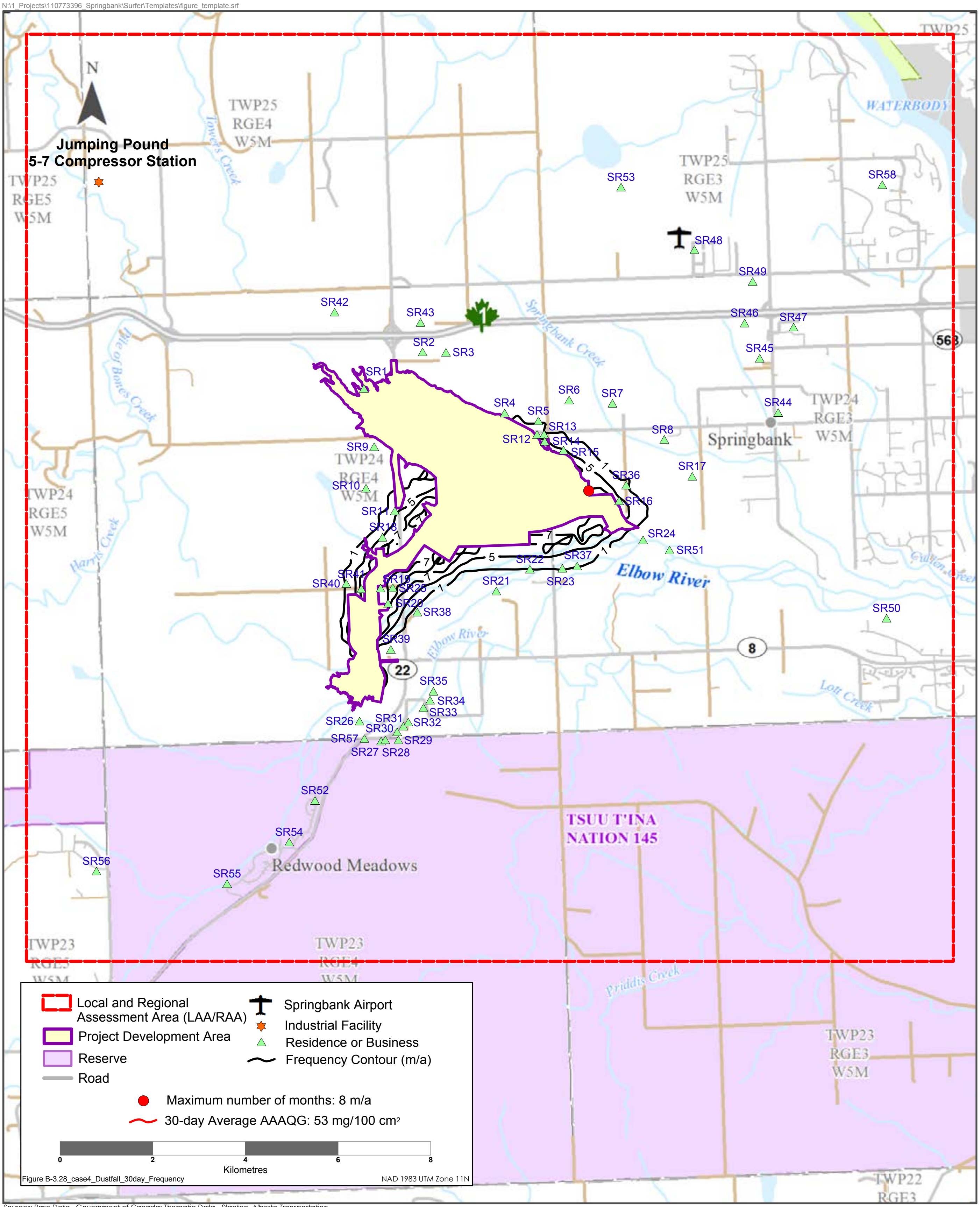
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 30-day Average Dustfall (Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure 3-44



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

Frequency of 30-day Dustfall Exceeding the AAAQO (Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure 3-45

3.4.5.6 Maximum Acrolein Concentrations

1-hour Average Acrolein (9th Highest)

The following summaries modelling results for acrolein concentrations (from Volume 4, Appendix E, Attachment 3E):

- Base Case—The highest concentrations for the Base Case occur on and near highways. The maximum predicted 1-hour acrolein concentration of 0.342 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22. The maximum predicted acrolein concentration is less than the 1-hour AAAQO of 4.5 µg/m³.
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The maximum predicted 1-hour acrolein concentration of 5.20 µg/m³ occurs on the northwest PDA boundary near the north end of the haul road that is parallel to Highway 22. There are no sensitive receptors on or near the boundary at this location. Along the PDA boundary, predicted acrolein concentrations greater than the 1-hour AAAQO of 4.5 µg/m³ occur for up to 18 hours per year near the north end of the haul road that is parallel to Highway 22.
- Application Case—The highest concentrations for the Application Case occur along the PDA boundary. The maximum predicted 1-hour acrolein concentration of 5.50 µg/m³ occurs on the northwest PDA boundary near the north end of the haul road that is parallel to Highway 22. There are no sensitive receptors on or near the boundary at this location. Along the PDA boundary, predicted acrolein concentrations greater than the 1-hour AAAQO of 4.5 µg/m³ occur for up to 28 hours per year near the north end of the haul road that is parallel to Highway 22.

24-hour Average Acrolein (Maximum)

The following summarizes modelling results for acrolein (from Volume 4, Appendix E, Attachment 3E):

- Base Case—The highest concentrations for the Base Case occur on and near highways. The maximum predicted 24-hour acrolein concentration of 0.084 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22. The maximum predicted acrolein concentration is less than the 24-hour AAAQO of 0.40 µg/m³.
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The maximum predicted 24-hour acrolein concentration of 1.79 µg/m³ occurs on the northwest PDA boundary near the north end of the haul road that is parallel to Highway 22. Predicted acrolein concentrations greater than the 24-hour AAAQO of 0.40 µg/m³ occur for up to 47 days per year near the north end of the haul road that is parallel to Highway 22.

- Application Case—The highest concentrations for the Application Case occur along the PDA boundary. The maximum predicted 24-hour acrolein concentration of 1.85 µg/m³ occurs on the northwest PDA boundary near the north end of the haul road that is parallel to Highway 22. Predicted maximum 24-hour acrolein concentrations that are greater than the AAAQO occur along and within 350 m of the PDA boundary. Along the PDA boundary, values greater than the AAAQO are predicted to occur for up to 31 to 57 days during the year (the frequency depending on the simulation year). Outside the PDA, there is one residence near the western PDA boundary where the maximum predicted concentration is 0.407 µg/m³, which is marginally greater than the 0.4 µg/m³ 24-hour AAAQO. Values greater than the AAAQO are predicted to occur 0 to 1 day during the year (the frequency depends on the simulation year). Beyond 350 m from the PDA, there are no days when the predicted maximum 24-hour acrolein concentrations are greater than the AAAQO.

Acrolein Comments

While the model predicts 9th highest 1-hour acrolein concentrations that are greater than the AAAQO, these values are limited to the PDA boundary near the north end of the haul road along Highway 22. There are no sensitive receptors on or near the boundary at this location. This PDA boundary location is 50 m from the north end of the haul road. Similar to the maximum predicted 1-hour average NO_2 concentration (Section 3.4.4.2, Maximum NO_2 Concentrations), the location of the maximum predicted 1-hour average acrolein concentration falls within the haul road "exclusion zone" of 60 m from the centre of the road and therefore the predicted concentration might be overstated. The "exclusion zone" is defined as the horizontal dimension of the volume sources used to model haul roads. Based on U.S. EPA guidance (U.S. EPA 2012) for modelling of haul roads as a line of volume sources, predicted concentrations might not be valid within the haul road "exclusion zone". One-hour predicted acrolein values greater than the AAAQO are limited to 28 hours per year.

While the model predicts maximum 24-hour acrolein concentrations that are greater than the AAAQO outside the PDA, these values are predicted to be infrequent, occur near the PDA boundary, and are marginally greater than the AAAQO at one residence receptor.

3.4.5.7 Maximum Formaldehyde Concentrations

1-hour Average Formaldehyde (9th Highest)

The following summarizes modelling results for formaldehyde (from Volume 4, Appendix E, Attachment 3E):

- Base Case—The highest concentrations for the Base Case occur on and near highways. The maximum predicted 1-hour formaldehyde concentration of 10.6 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22. The maximum predicted formaldehyde concentration is less than the 1-hour AAAQO of 65 µg/m³.
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The maximum predicted 1-hour formaldehyde concentration of 61.0 µg/m³ occurs on the northwest PDA boundary near the north end of the haul road that is parallel to Highway 22. The maximum predicted formaldehyde concentration is less than the 1-hour AAAQO of 65 µg/m³.
- Application Case—The highest concentrations for the Application Case occur along the PDA boundary. The maximum predicted 1-hour formaldehyde concentration of 71.1 µg/m³ occurs on the northwest PDA boundary near the north end of the haul road that is parallel to Highway 22. There are no sensitive receptors on or near the boundary at this location. Along the PDA boundary, predicted formaldehyde concentrations greater than the 1-hour AAAQO of 65 µg/m³ occur for up to 11 hours per year.

Formaldehyde Comments

While the model predicts 9th highest 1-hour formaldehyde concentrations that are greater than the AAAQO, these values are limited to the PDA boundary near the north end of the haul road along Highway 22. There are no sensitive receptors on or near the boundary at this location. This PDA boundary location is 50 m from the north end of the haul road. Similar to the maximum predicted 1-hour average NO_2 concentration (Section 3.4.4.2), the location of the maximum predicted 1-hour average formaldehyde concentration falls within the haul road "exclusion zone" of 60 m from the centre of the road. Therefore, the predicted concentration might be overstated. The "exclusion zone" is defined as the horizontal dimension of the volume sources used to model haul roads. Based on U.S. EPA guidance (U.S. EPA 2012) for modelling of haul roads as a line of volume sources, predicted concentrations might not be valid within the haul road "exclusion zone". Along the PDA boundary, 1-hour predicted formaldehyde values greater than the AAAQO are limited to 11 hours per year.

3.4.5.8 Maximum Benzo(a)pyrene Concentrations

Annual Average Benzo(a)pyrene

The following summarizes modelling results for benzo(a)pyrene (from Volume 4, Appendix E, Attachment 3E):

- Base Case—The highest concentrations for the Base Case occur on and near highways. The maximum predicted annual benzo(a)pyrene concentration of 0.00044 µg/m³ occurs at the intersection of the TransCanada Highway and Highway 22. Values that are greater than the annual AAAQO of 0.0003 µg/m³ only occur near the intersection of the TransCanada Highway and Highway 22.
- Project Case—The highest concentrations for the Project Case occur along the PDA boundary. The maximum predicted annual benzo(a)pyrene concentration of 0.0000146 µg/m³ occurs along the northwest boundary near the north end of the haul road that is parallel to Highway 22. The maximum predicted benzo(a)pyrene concentration is less than the annual AAAQO of 0.0003 µg/m³.
- Application Case—The highest concentrations for the Application Case occur along highways. The maximum predicted annual benzo(a)pyrene concentration of 0.00044 µg/m³ also occurs at the intersection of the TransCanada Highway and Highway 22. Values that are greater than the annual AAAQO of 0.0003 µg/m³ only occur near the intersection of the TransCanada Highway and Highway 22.

Benzo(a)pyrene Comments

While the model predicts annual average benzo(a)pyrene concentrations that are greater than the AAAQO outside the PDA, these values are predicted to occur only near the intersection of the TransCanada Highway and Highway 22. The maximum predicted annual benzo(a)pyrene concentrations for the Project Case are much less (less than 5%) than the annual AAAQO of 0.0003 µg/m³. The Project contributes less than 3% (i.e., the Base Case contributes 97%) to maximum predicted concentrations for the Application Case.

3.4.5.9 Odours

Odourant Concentrations at Residence and Business Receptors

Table 3-20 compares the predicted peak odourant concentrations at residence and business receptors to the odour detection and odour recognition thresholds. Receptors identified as Indigenous receptors in Table 3-20 correspond with receptors located on the Tsuut'ina Nation reserve.

The predicted peak concentrations for all odourants are less than the applicable odour recognition thresholds. The predicted peak NO_2 and acetaldehyde concentrations are greater than the associated odour detection thresholds at some of the residence and business receptors. The predicted peak acetaldehyde concentrations are greater than the odour detection threshold at all residence and business receptors; this is due to the background contribution for acetaldehyde (3.38 $\mu g/m^3$) being greater than the odour detection threshold (2.7 $\mu g/m^3$). The Project maximum contribution to peak NO_2 and acetaldehyde concentrations at residence and business receptors for the Application Case is 96% and 78%, respectively.

The frequencies of peak NO_2 concentrations greater than the odour detection threshold (226 $\mu g/m^3$) were examined at the residence and business receptors for the Base, Project and Application cases. The frequencies of peak acetaldehyde concentrations greater than the odour detection threshold of 2.7 $\mu g/m^3$ were examined at the residence and business receptors for the Project Case only since the Project Case does not include the background contribution:

- Base Case—predicted peak NO_2 concentrations are greater than the odour detection threshold at one receptor for maximum of 4 hours per year.
- Project Case—the number of predicted peak NO_2 concentrations greater than the odour detection threshold at residence and business receptors, without including the background contribution, varies from 1 hour per year to 135 hours per year, for an average of 29 hours per year. The number of peak acetaldehyde concentrations greater than the odour detection threshold varies from 1 hour per year to 345 hours per year, for an average of 107 hours per year.
- Application Case—the number of predicted peak NO_2 concentrations greater than the odour detection threshold at residence and business receptors varies from 1 hour per year to 175 hours per year, for an average of 32 hours per year.

Table 3-20 Predicted Peak Odourant Concentrations at Residence and Business Receptors

Peak Odourant Concentrations ($\mu g/m^3$)														
Compound:			NO_2			Acetaldehyde			Acrolein			Naphthalene		
Background:			9.59			3.38			0.29			0.12		
ID	Receptor Description	Indigenous Receptor	Base Case	Project Case	Application Case	Base Case	Project Case	Application Case	Base Case	Project Case	Application Case	Base Case	Project Case	Application Case
1	Residence	-	79.2	**295**	**307**	**3.49**	**10.9**	**14.4**	0.309	2.63	2.93	0.152	0.577	0.714
2	Residence	-	136	**234**	**248**	**3.56**	**6.71**	**10.1**	0.322	1.61	1.91	0.174	0.354	0.494
3	Residence	-	111	220	**233**	**3.53**	**4.73**	**8.15**	0.316	1.14	1.44	0.163	0.250	0.382
4	Residence	-	49.6	**228**	**239**	**3.44**	**3.57**	**6.97**	0.302	0.86	1.15	0.140	0.188	0.317
5	Residence	-	54.3	**238**	**248**	**3.46**	**4.40**	**7.80**	0.305	1.06	1.35	0.145	0.232	0.361
6	Residence	-	51.7	207	219	**3.45**	2.38	**5.81**	0.303	0.574	0.873	0.142	0.126	0.257
7	Residence	-	49.7	184	205	**3.45**	1.96	**5.36**	0.303	0.473	0.767	0.142	0.104	0.231
8	Residence	-	41.2	189	202	**3.45**	1.86	**5.28**	0.303	0.449	0.747	0.142	0.098	0.232
9	Residence	-	89.1	**315**	**329**	**3.51**	**12.1**	**15.5**	0.312	2.91	3.21	0.157	0.637	0.777
10	Residence	-	71.3	**240**	**252**	**3.48**	**5.41**	**8.84**	0.308	1.30	1.60	0.149	0.286	0.420
11	Residence	-	186	**264**	**282**	**3.67**	**6.56**	**10.1**	0.340	1.58	1.89	0.202	0.346	0.524
12	Residence	-	47.1	**255**	**266**	**3.45**	**6.68**	**10.1**	0.302	1.61	1.90	0.140	0.353	0.479
13	Residence	-	52.8	**250**	**260**	**3.46**	**6.24**	**9.64**	0.304	1.50	1.80	0.144	0.329	0.456
14	Residence	-	49.1	**269**	**279**	**3.45**	**8.36**	**11.8**	0.303	2.01	2.31	0.142	0.441	0.570
15	Residence	-	48.2	**254**	**265**	**3.45**	**6.68**	**10.1**	0.303	1.61	1.90	0.142	0.353	0.482
16	Residence	-	29.9	**234**	**244**	**3.42**	**4.97**	**8.37**	0.298	1.20	1.49	0.133	0.262	0.391
17	Residence	-	35.4	184	195	**3.43**	1.96	**5.34**	0.299	0.47	0.763	0.135	0.104	0.226
18	Residence	-	103	**273**	**286**	**3.53**	**7.56**	**11.0**	0.317	1.82	2.12	0.165	0.399	0.546
19	Residence	-	76.2	**280**	**294**	**3.50**	**9.19**	**12.6**	0.312	2.21	2.51	0.156	0.485	0.622

Table 3-20 Predicted Peak Odourant Concentrations at Residence and Business Receptors

Peak Odourant Concentrations ($\mu g/m^3$)														
Compound:			**NO_2**			**Acetaldehyde**			**Acrolein**			**Naphthalene**		
Background:			**9.59**			**3.38**			**0.29**			**0.12**		
ID	**Receptor Description**	**Indigenous Receptor**	**Base Case**	**Project Case**	**Application Case**	**Base Case**	**Project Case**	**Application Case**	**Base Case**	**Project Case**	**Application Case**	**Base Case**	**Project Case**	**Application Case**
20	Residence	-	96.5	**256**	**267**	**3.54**	**6.68**	**10.1**	0.317	1.61	1.90	0.165	0.353	0.482
21	Residence	-	32.4	188	203	**3.42**	2.49	**5.9**	0.298	0.600	0.893	0.134	0.131	0.258
22	Residence	-	26.8	195	205	**3.41**	2.57	**6.0**	0.296	0.617	0.912	0.130	0.135	0.260
23	Residence	-	25.6	181	194	**3.41**	2.21	**5.6**	0.296	0.532	0.823	0.130	0.117	0.243
24	Residence	-	25.3	156	168	**3.41**	1.71	**5.1**	0.296	0.411	0.703	0.129	0.090	0.215
25	Commercial	-	114	**270**	**284**	**3.57**	**8.57**	**12.0**	0.323	2.06	2.365	0.174	0.452	0.592
26	Residence	-	80.1	218	**241**	**3.52**	**3.05**	**6.47**	0.314	0.734	1.032	0.160	0.161	0.294
27	Residence	✓	111	190	**235**	**3.55**	2.45	**5.91**	0.321	0.590	0.894	0.171	0.129	0.278
28	Entheos Conference and Retreat Centre	✓	111	190	**235**	**3.55**	2.45	**5.91**	0.321	0.590	0.894	0.171	0.129	0.278
29	Residence	✓	122	189	**240**	**3.56**	2.57	**6.11**	0.322	0.618	0.936	0.173	0.136	0.300
30	Residence	-	163	191	**244**	**3.66**	**2.82**	**6.46**	0.339	0.678	1.014	0.202	0.149	0.335
31	Residence	-	163	191	**244**	**3.66**	**2.82**	**6.46**	0.339	0.678	1.014	0.202	0.149	0.335
32	Residence	-	126	186	**242**	**3.57**	2.61	**6.16**	0.323	0.627	0.946	0.175	0.138	0.301
33	Residence	-	80.5	182	222	**3.51**	2.51	**5.93**	0.313	0.604	0.901	0.158	0.132	0.277
34	Residence	-	70.5	184	225	**3.48**	2.51	**5.97**	0.308	0.605	0.909	0.150	0.133	0.277
35	Residence	-	70.5	184	225	**3.48**	2.51	**5.97**	0.308	0.605	0.909	0.150	0.133	0.277
36	Residence	-	34.7	**238**	**249**	**3.43**	**4.96**	**8.36**	0.299	1.19	1.488	0.135	0.262	0.391

Table 3-20 Predicted Peak Odourant Concentrations at Residence and Business Receptors

Peak Odourant Concentrations ($\mu g/m^3$)														
Compound:			**NO_2**			**Acetaldehyde**			**Acrolein**			**Naphthalene**		
Background:			**9.59**			**3.38**			**0.29**			**0.12**		
ID	**Receptor Description**	**Indigenous Receptor**	**Base Case**	**Project Case**	**Application Case**	**Base Case**	**Project Case**	**Application Case**	**Base Case**	**Project Case**	**Application Case**	**Base Case**	**Project Case**	**Application Case**
37	Residence	-	25.4	179	198	**3.41**	2.25	**5.64**	0.296	0.541	0.834	0.130	0.119	0.243
38	Camping Ground	-	94.4	**229**	**245**	**3.54**	**3.56**	**7.07**	0.318	0.856	1.170	0.167	0.188	0.332
39	Camping Ground	-	105	**226**	**241**	**3.55**	**3.45**	**6.93**	0.320	0.830	1.134	0.169	0.182	0.327
40	Residence	-	55.1	**270**	**282**	**3.45**	**6.96**	**10.4**	0.304	1.68	1.970	0.142	0.367	0.497
41	Residence	-	62.2	**316**	**329**	**3.47**	**11.7**	**15.2**	0.305	2.82	3.122	0.146	0.619	0.753
42	Residence	-	157	204	**227**	**3.62**	**3.59**	**7.07**	0.333	0.865	1.172	0.191	0.190	0.342
43	Residence	-	**233**	196	**244**	**3.86**	**4.29**	**7.85**	0.373	1.03	1.354	0.257	0.227	0.465
44	School	-	43.0	106	129	**3.46**	0.912	**4.32**	0.304	0.220	0.516	0.144	0.048	0.181
45	School	-	52.5	80.9	95.9	**3.47**	0.650	**4.03**	0.306	0.156	0.448	0.146	0.034	0.163
46	Park	-	78.1	66.7	95.8	**3.52**	0.550	**3.98**	0.315	0.132	0.431	0.161	0.029	0.172
47	Commercial	-	87.2	73.1	104	**3.54**	0.611	**4.00**	0.318	0.147	0.440	0.166	0.032	0.175
48	Airport	-	74.8	54.2	98.2	**3.51**	0.439	**3.88**	0.312	0.106	0.407	0.157	0.023	0.169
49	School	-	122	50.2	137	**3.60**	0.430	**3.92**	0.329	0.103	0.412	0.185	0.023	0.195
50	Golf Club	-	21.2	46.7	59.7	**3.40**	0.392	**3.77**	0.294	0.094	0.385	0.127	0.021	0.145
51	Golf Club	-	23.9	131	142	**3.41**	1.11	**4.50**	0.295	0.268	0.560	0.129	0.059	0.183
52	Residence	-	91.4	138	158	**3.53**	1.38	**4.82**	0.316	0.333	0.635	0.163	0.073	0.212
53	Residence	-	48.3	51.1	76.1	**3.46**	0.444	**3.86**	0.304	0.107	0.403	0.143	0.023	0.156
54	Park	-	83.4	73.7	107	**3.49**	0.818	**4.21**	0.310	0.197	0.489	0.154	0.043	0.173

Table 3-20 Predicted Peak Odourant Concentrations at Residence and Business Receptors

Peak Odourant Concentrations ($\mu g/m^3$)															
Compound:			**NO_2**			**Acetaldehyde**			**Acrolein**			**Naphthalene**			
Background:			**9.59**			**3.38**			**0.29**			**0.12**			
ID	**Receptor Description**	**Indigenous Receptor**	**Base Case**	**Project Case**	**Application Case**	**Base Case**	**Project Case**	**Application Case**	**Base Case**	**Project Case**	**Application Case**	**Base Case**	**Project Case**	**Application Case**
55	Golf Club	-	92.5	47.9	102	**3.51**	0.566	**3.98**	0.313	0.136	0.433	0.157	0.030	0.169
56	Golf Club	-	25.6	41.8	57.8	**3.41**	0.438	**3.83**	0.296	0.105	0.399	0.129	0.023	0.149
57	Park	✓	123	210	**244**	**3.57**	2.68	**6.16**	0.323	0.646	0.954	0.174	0.142	0.287
58	Golf Club	-	24.1	23.0	39.8	**3.41**	0.223	**3.61**	0.295	0.054	0.346	0.129	0.012	0.137
Detection Threshold			226			2.7			8.3			199		
Recognition Threshold			734			15			367			440		

NOTES:

Peak concentrations are calculated as 2.7 times the predicted 1-hour (9th highest) concentrations.

Background concentration is added to Base Case and Application Case predictions.

Bold indicates concentration greater than detection threshold.

✓ indicates that the receptor is identified as indigenous.
- Indicates that the receptor is not identified as indigenous

Odours in the LAA

The figures for odours show areas with 99.5% compliance of the odour detection. Odour recognition thresholds also are shown. The 99.5% thresholds correspond to odour events occurring 44 hours per year. Odour unit (OU) concentrations do not account for a potential contribution of a background odour concentration.

The following summarizes modelling results for odours:

- Base Case—the predicted OU concentrations for the Base Case are less than the odour recognition threshold (i.e., threshold at which most of the population could detect an odour) (Figure 3-46). The area where OU concentrations are greater than the odour detection threshold (i.e. areas the most sensitive population members might detect an odour) is limited to the intersection of the TransCanada Highway and Highway 22. The area enclosed by the odour detection threshold is less than 0.001 km².
- Project Case—areas where OU concentrations are greater than the odour recognition threshold (i.e. areas where most of the population could detect an odour) are confined to the PDA (Figure 3-47). The combined area enclosed by the odour recognition threshold is 0.90 km². In contrast, areas where the OU concentrations are greater than the odour detection threshold (i.e. areas the most sensitive population members might detect an odour) extend up to 2 km from the PDA boundary. The area enclosed by the odour detection threshold is 26.0 km².
- Application Case—areas where OU concentrations are greater than the odour recognition threshold (i.e. areas where most of the population could detect an odour) are confined to the PDA (Figure 3-48). The combined area enclosed by the odour recognition threshold is 0.90 km². In contrast, areas where the OU concentrations are greater than the odour detection threshold (i.e. areas the most sensitive population members might detect an odour) extend up to 2 km from the PDA boundary. The area enclosed by the odour detection threshold is 26.0 km².

Odour Comment

The odour assessment indicates two odourants of potential concern: NO_2 and acetaldehyde. Both odourants are associated with diesel combustion emissions from the construction equipment. The Project maximum contribution to predicted peak NO_2 and acetaldehyde concentrations at residence and business receptors is 96% and 78%, respectively.

Predicted peak NO_2 and acetaldehyde concentrations at all residence and business receptors are less than their odour recognition thresholds (i.e. threshold at which most of the population could detect an odour). At residence and business receptors, the peak NO_2 concentrations are predicted to be greater than the odour detection threshold (i.e. threshold at which the most sensitive members of the population might detect an odour) for 32 hours per year on average. The background acetaldehyde concentration (3.38 $\mu g/m^3$) is greater than the odour detection threshold (2.7 $\mu g/m^3$) which results in predicted peak acetaldehyde concentrations greater than the odour detection threshold at all residence and business receptors. The Project alone results in predicted peak acetaldehyde concentrations at residence and business receptors greater than the odour detection threshold for 107 hours per year on average.

The model does not predict potential odour events for the Base Case. While the model predicts potential odours associated with the Project, the predicted areas where most of the population could detect odour (i.e. areas where values are greater than the odour recognition threshold) are confined to the PDA. The predicted areas where the most sensitive members of the population might detect an odour (i.e., areas where values are greater than the odour detection threshold) extend up to 2 km from the PDA boundary.

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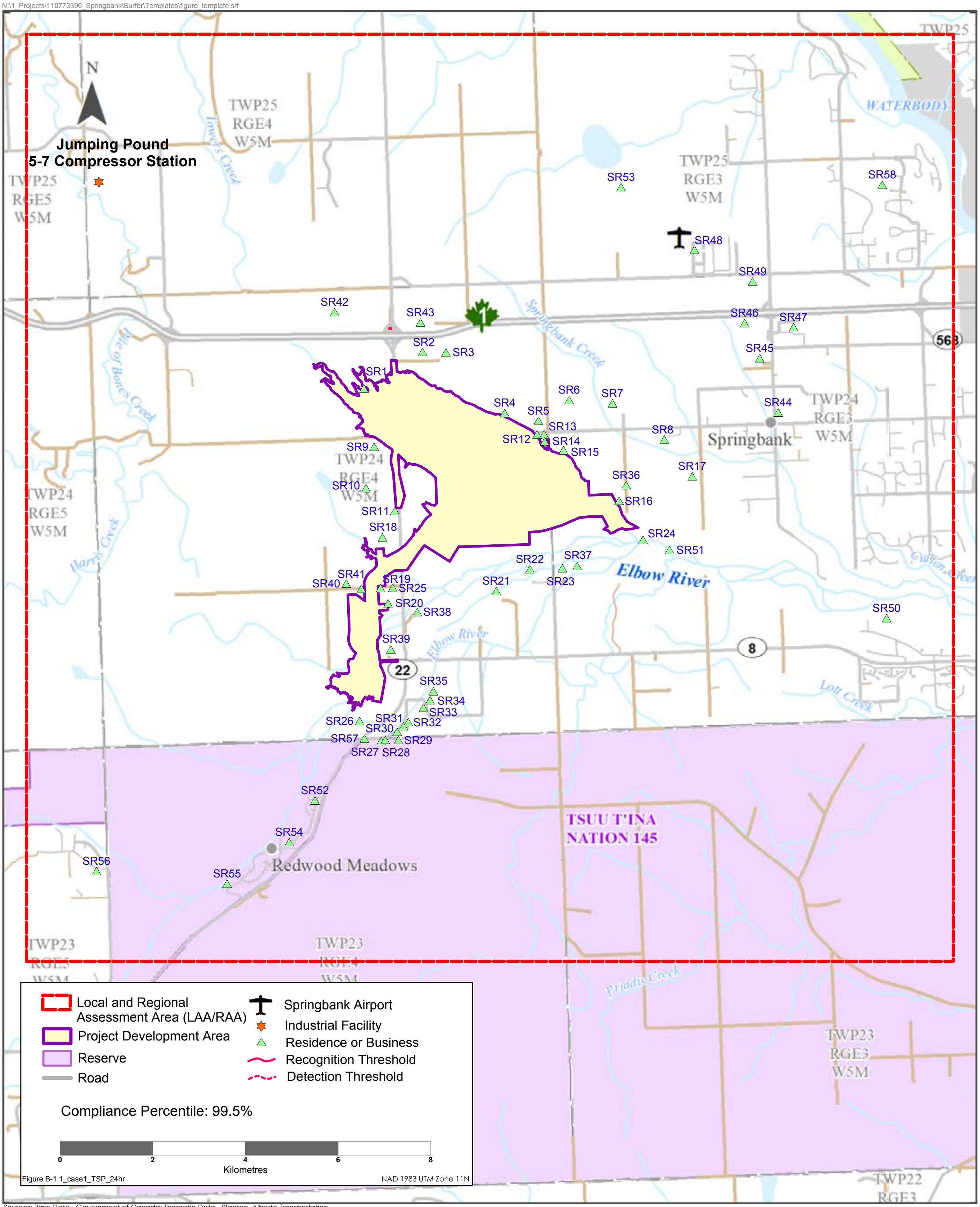

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Area Associated with Odours due to all Odourants (Base Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure 3-46

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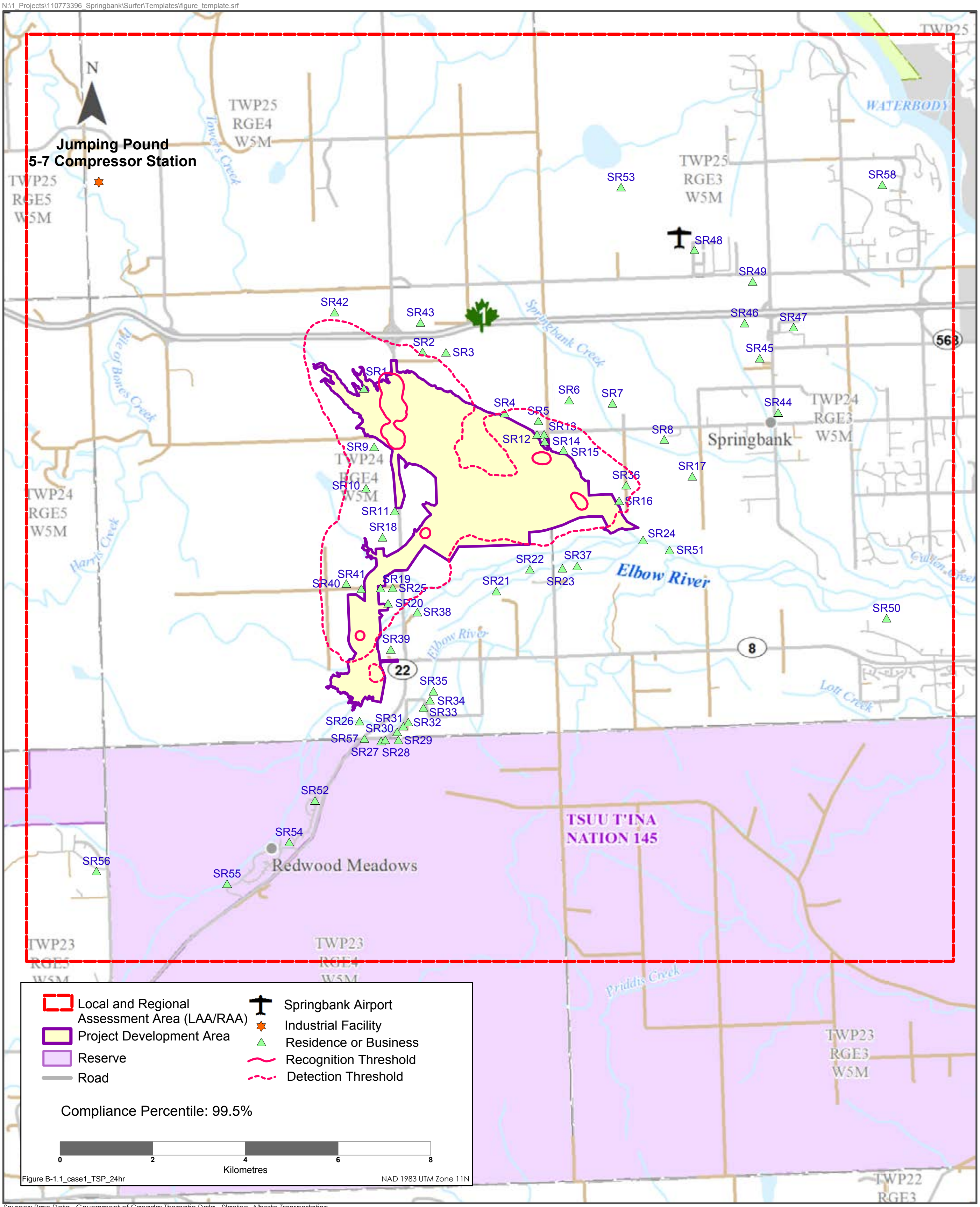


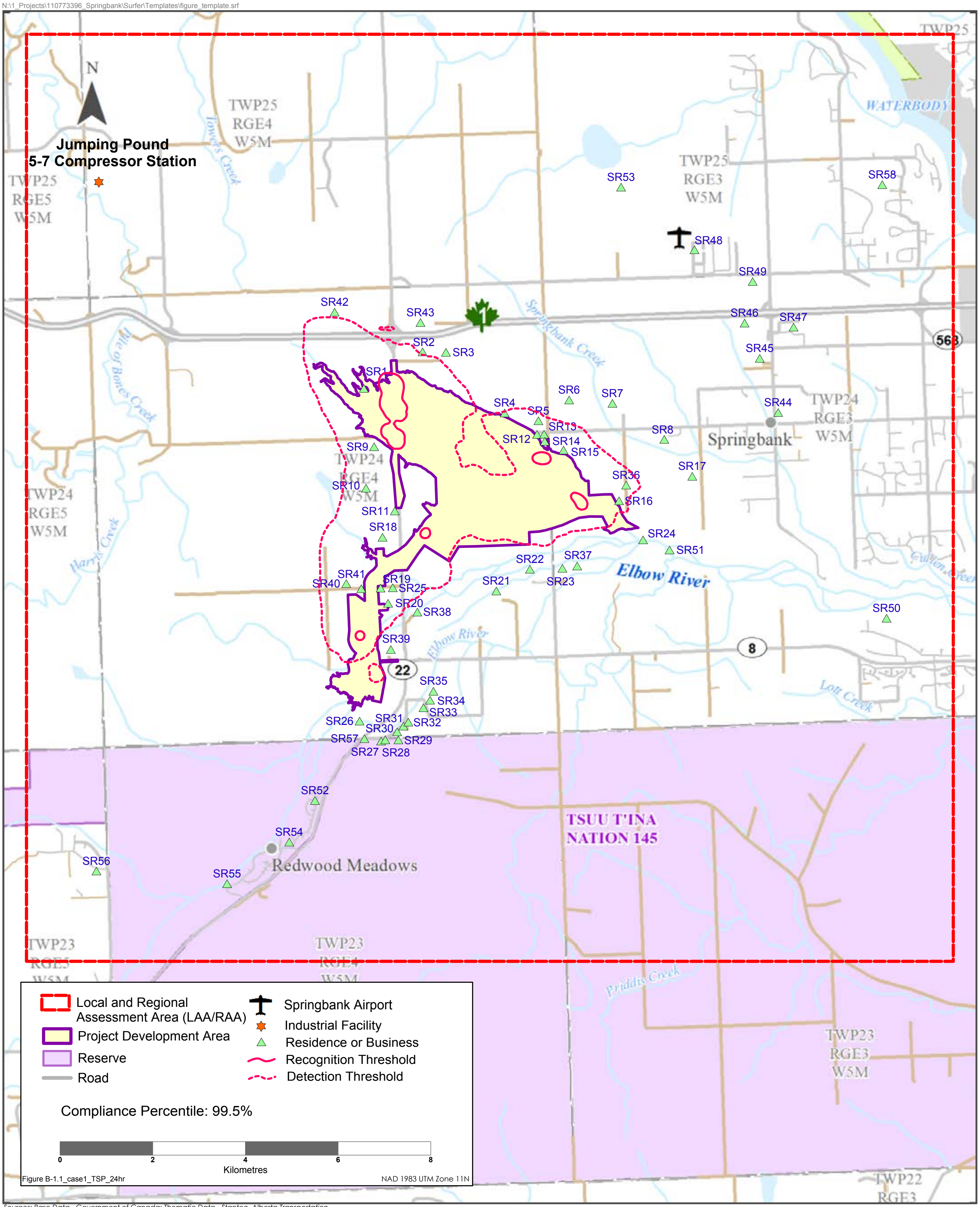
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Area Associated with Odours due to all Odourants (Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure 3-47



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

Area Associated with Odours due to all Odourants (Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure 3-48

3.4.6 Change in Ambient Light

Construction

The maximum predicted levels of light trespass and glare at the nearest residence and business receptor locations during construction are presented in Table 3-21.

The maximum predicted levels of light trespass and glare are expected to be less than CIE guidelines for a rural environment (i.e. environmental zone 2, E2) at each receptor during the nighttime. The mitigation incorporated into the assessment is designed to specifically limit illuminance off-site and reduce incidence of light trespass.

Considering the mitigation measures incorporated into the above assessment, and the use of mobile flood lighting units, the construction phase is not expected to have a substantial contribution to the existing sky glow.

Table 3-21 Predicted Levels of Light Trespass and Glare from Project Construction

Receptor Number	Receptor Description	Indigenous Receptor	Light Trespass (Lux)		Glare (cd)	
			Maximum Predicted	CIE Guideline Threshold for E2 (Post-curfew)	Maximum Predicted	CIE Guideline Threshold for E2 (Post-curfew)
10	Residence	-	0.003	1	348	500
11	Residence	-	0.006	1	377	500
12	Residence	-	0.036	1	363	500
14	Residence	-	0.029	1	363	500
15	Residence	-	0.022	1	387	500
16	Residence	-	0.020	1	377	500
18	Residence	-	0.021	1	340	500
19	Residence	-	0.227	1	214	500
20	Residence	-	0.007	1	0	500
21	Residence	-	0.004	1	344	500
22	Residence	-	0.011	1	365	500
23	Residence	-	0.017	1	375	500
24	Residence	-	0.009	1	362	500

NOTES:
- Indicates that the receptor is not identified as indigenous

3.4.7 Change in Greenhouse Gases

Emissions of GHGs from heavy mobile equipment and stationary generators during construction are presented in Table 3-22. Approximately 84,970 t CO_2e are estimated to be released over the construction period. Conservatively assuming that the majority of the large fuel consuming equipment would operate over a timeframe of less than 1 year, it is assumed that the entire 84,970 t CO_2e would be emitted in 1 year.

The GHG emissions associated with construction of the Project are also offset by reducing or eliminating future GHG emissions that would have occurred as a result of flood associated activities such as flood emergency management, flood debris cleanup, and during reconstruction of damaged areas.

Table 3-22 Estimated GHG Emissions from Construction

Parameter	CO_2	CH_4	N_2O	Tonnes CO_2e
Construction (tonnes)	76,400	4.3	28.4	84,970
NOTE: Aggregated totals may not equal disaggregated values in this table due to rounding				

3.4.8 Summary of Project Residual Effects

Table 3-23 summarizes the residual environmental effects on air quality, ambient light and GHG during construction and dry operations.

Construction

The direction for change in air quality, ambient light and greenhouse gases during construction is rated adverse (A) because the Project results in a predicted increase of ambient concentrations and dustfall, light trespass and glare, and greenhouse gas emissions compared to the Base Case. Time of day and seasonality are represented as inputs into the dispersion models and the algorithms used to represent atmospheric physics and chemistry processes. Time of day is relevant for evaluating the ambient light. The magnitude for change in air quality during construction 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. The magnitude for change in ambient light during construction is rated low (L) because the Project results in predicted light trespass and glare that is detectable but is limited through design mitigation. The magnitude for change in greenhouse gases during construction is rated low (L) because the Project results in a relatively small change of GHG emissions compared to provincial and national totals.

The geographic extent for change in air quality, ambient light and greenhouse gases during construction is limited to the LAA because the areas where the Project results in predicted ambient concentrations and dustfall, light trespass and glare, and estimated greenhouse gas emissions greater than the Base Case is limited to the extent of the LAA.

The duration for change in air quality, ambient light and greenhouse gases during construction is short-term (ST) because the predicted increase in ambient concentrations and dustfall, light trespass and glare, and greenhouse gas emissions due to the Project is restricted to the duration of the construction phase (36 months).

The frequency for change in air quality during construction is rated irregular event (IR) because the predicted ambient concentrations at a given location are variable in time depending on the current meteorological conditions, although emissions could be continuous. The frequency for change in ambient light during construction is rated regular event (R) because the predicted increase in light trespass and glare occurs regularly at nighttime. The frequency for change in greenhouse gases during construction is rated continuous (C) because GHG emissions occur continuously during the construction phase.

The reversibility for change in air quality, ambient light and greenhouse gases during construction is rated reversible (R) because the predicted increase in ambient concentrations and dustfall, light trespass and glare, and greenhouse gas emissions due to the Project would return to Base Case conditions after the end of the construction phase.

The LAA where the changes in air quality, ambient light and greenhouse gases are assessed, is rated as disturbed (D) because there are existing emission and light sources within the LAA prior to the project construction.

Dry Operation

The direction and magnitude for change in air quality, ambient light and greenhouse gases during dry operation are rated neutral (N) and negligible (N), respectively. During the dry operations phase, associated activities will be limited to periodic inspections and routine maintenance and there are no interactions of the Project with air quality, light, or GHG emissions as discussed in Section 3.3.2. Therefore, all remaining residual effects criteria (timing, geographic extent, duration, frequency, reversibility, and ecological and socio-economic context) are not applicable (N/A).

Table 3-23 Project Residual Effects on Air Quality and Climate during Construction and Dry Operation phases

Residual Effect	Residual Effects Characterization								
	Project Phase	Timing	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Construction									
Change in Air Quality	C	S/T	A	M/H	LAA	ST	IR	R	D
Change in Ambient Light	C	T	A	L	LAA	ST	R	R	D
Change in Greenhouse Gases	C	S/T	A	L	LAA	ST	C	R	D
Dry Operation									
Change in Air Quality	DO	N/A	N	N	N/A	N/A	N/A	N/A	N/A
Change in Ambient Light	DO	N/A	N	N	N/A	N/A	N/A	N/A	N/A
Change in Greenhouse Gases	DO	N/A	N	N	N/A	N/A	N/A	N/A	N/A

KEY

See Table 3-8 for detailed definitions

Project Phase
C: Construction
DO: Dry Operation

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

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

3.5 DETERMINATION OF SIGNIFICANCE

3.5.1 Ambient Air Quality

As defined in Section 3.1.6, a significant effect on air quality is one that results in predicted values that are greater than provincial, national, or local ambient air quality criteria (e.g., high in magnitude) and are of concern relative to one or more of geographic extent, frequency of occurrence, and the presence of potentially sensitive receptors (e.g., human, wildlife, vegetation, soils or waterbodies).

Predicted concentrations that are greater than the applicable ambient air quality criteria, in themselves, do not imply that the effect on ambient air quality is significant. Dispersion models often produce results that are conservative (i.e., they overpredict concentrations). The determination of significance is discussed on a substance group basis.

3.5.1.1 CAC Gases

Maximum predicted SO_2 and CO concentrations along and outside of the PDA are less than the applicable Alberta ambient air quality objectives (AAAQO). While corresponding maximum annual NO_2 concentrations are less than the AAAQO, the maximum 1-hour NO_2 concentration is predicted to be greater than the 1-hour AAAQO.

This maximum value is 24% greater than the AAAQO and is predicted on the PDA boundary near the north end of the haul road that is parallel to Highway 22. There are no sensitive receptors on or near the boundary at this location. Although the predicted maximum value is greater than the AAAQO, this occurrence is rated as not significant since it is only predicted to occur on the PDA boundary, and is not near any sensitive receptors.

3.5.1.2 Particles

As maximum TSP and $PM_{2.5}$ concentrations and dustfall deposition are predicted to be greater than the ambient air quality criteria outside of the PDA, an ambient air quality monitoring program would be used to determine TSP and $PM_{2.5}$ concentrations, and dustfall during the construction period. The monitoring program would determine whether additional mitigation measures are needed to further reduce fugitive PM emissions.

For example, if the monitoring program indicates that the ground-level TSP concentrations are greater than an ambient air quality objective, then additional mitigations to reduce TSP emissions would be implemented. Given that dust from the haul roads is the largest source of TSP emissions, more frequent road watering or more frequent application of a dust suppressant could be implemented. There are a wide range of industry proven mitigation measures that can further reduce construction PM emissions.

Although the predicted maximum values are greater than the AAAQO, these occurrences are rated as not significant because a monitoring program would be used to implement additional mitigation measures to appropriately reduce fugitive dust emissions. The details of the monitoring program and the results would be made available to nearby residents to help address local concerns.

3.5.1.3 VOCs

The assessment considers seven VOC substances. Maximum predicted concentrations for five of these substances along and outside of the PDA are less than the applicable AAAQO. Maximum acrolein and formaldehyde concentrations are predicted to be greater than the respective AAAQO.

Predicted maximum acrolein and formaldehyde concentrations greater than the 1-hour AAAQO occur on the PDA boundary near the north end of the haul road that is parallel to Highway 22. There are no sensitive receptors on or near the boundary at this location.

Predicted maximum 24-hour acrolein concentrations that are greater than the AAAQO occur along and within 350 m of the PDA boundary. Along the PDA boundary, values greater than the AAAQO are predicted to occur for up to 31 to 57 days during the year (the frequency depending on the simulation year). Outside the PDA, there is one residence near the western PDA boundary where the maximum predicted concentration is 0.407 $\mu g/m^3$, which is marginally greater than the 0.4 $\mu g/m^3$ 24-hour AAAQO. Values greater than the AAAQO are predicted to occur 0 to 1 day during the year (the frequency depends on the simulation year). Beyond 350 m from the PDA, there are no days when the predicted maximum 24-hour acrolein concentrations are greater than the AAAQO.

Although the predicted maximum acrolein and formaldehyde values are greater than the AAAQO, the occurrences are rated as not significant since they are predicted to be infrequent, occur near the PDA boundary, and are marginally greater than the AAAQO at one residence receptors.

3.5.1.4 PAHs

The assessment considers two PAH substances. Only ambient benzo(a)pyrene concentrations greater than the AAAQO are predicted, these occur near the intersection of the TransCanada Highway and Highway 22 for the Base Case. For the Application Case, the maximum benzo(a)pyrene values are still predicted to occur near this intersection and there are no predicted values greater than the AAAQO along the PDA boundary. The Project contribution near the intersection is than 3% to the maximum predicted benzo(a)pyrene concentration.

Although the predicted maximum value is greater than the AAAQO, this occurrence is rated as not significant because the maximum value is dominated by Base Case traffic emissions.

3.5.1.5 Metals

The assessment considers four metals. Maximum predicted concentrations the four metals along and outside of the PDA are less than the applicable AAAQO. Ambient metal concentrations due to the Project are rated as not significant since the maximum predicted concentrations are less than the applicable AAAQO.

3.5.1.6 Odours

The odour assessment considers four odourants and indicates two odourants of potential concern: NO_2 and acetaldehyde. The predicted areas where most of the population could detect an odour tend to be confined to the PDA. The predicted areas where the most sensitive population members might detect an odour extend up to 2 km from the PDA boundary.

To complement the ambient PM monitoring program, local residents can contact Alberta Transportation through the odour monitoring program. This program would result in documentation that can be used to identify the component of the Project that is the source of the odours and allow appropriate mitigation measured to be implemented. Given the appropriate community communication and the feedback, odour related to the Project is rated as not significant.

3.5.1.7 Overall Air Quality Significance

The overall residual effect for air quality is not significant in consideration of;

- the small areas and short duration predicted for concentrations of NO_2, acrolein, benzo(a)pyrene and odourants to be greater than the ambient air quality objectives or odour thresholds,
- the planned construction TSP, $PM_{2.5}$ and dustfall monitoring program and adaptive mitigation measures to further control construction PM emission, and
- the planned odour complaint and management process.

3.5.2 Ambient Light

As defined in Section 3.1.10.1, a significant environmental effect on lighting is defined as an increase in Project related light emissions that are greater than the CIE guidelines (Section 3.1.5.1) for light trespass and glare in a rural environment (E2) and the resulting conditions related to sky glow would be altered toward those of an urban environment.

With the proposed mitigation (Section 3.4.3.2), an increase in Project-related light emissions (light trespass and glare) such that the guidelines in Section 3.1.5.1 for a rural environment are exceeded is not likely. Based on this light assessment, Base Case sky glow levels in and surrounding the Project site are currently typical of an urban environment, being close to metropolitan areas, and they are not anticipated to increase due to the Project. Therefore, residual effects would be not significant.

3.5.3 Greenhouse Gases

As defined in Section 3.1.10.2, a significant effect on greenhouse gases cannot be determined quantitatively. Emissions from the Project are compared to provincial and national inventories to establish a context for the magnitude of emissions.

The Project releases represent a small contribution to Alberta and national GHG emissions (0.03% and 0.01%, respectively). Based on these results and the characterization of residual effects in Section 3.4.3.3, the residual environmental effects of the Project, in relation with CEA Agency guidance (CEAA 2003), on GHG emissions would be not significant.

3.6 PREDICTION CONFIDENCE

The air quality assessment depends on air quality simulation models to link emissions to air quality changes, and the model predictions depend on the representativeness of the source and emission inventory, the meteorological conditions used in the model, and the algorithms used to represent atmospheric physics and chemistry processes in the models.

Emission Uncertainty

The Base Case and Project Case vehicle exhaust emissions are based on local traffic data and accepted industry emission factors. The level of confidence associated with the estimation of CAC emissions (e.g., NO_X, SO_2, CO) from these sources is greater than that for the estimation of TSP, $PM_{2.5}$, VOC, PAH and metal emission rates.

Fugitive TSP (and associated $PM_{2.5}$) emission rates depend on the properties of the surface material, the occurrence and history of surface disturbances, and meteorological conditions. While the air quality assessment uses emission algorithms developed by the US EPA, there is uncertainty associated with estimating these emissions. This would result in uncertainties in the associated ambient TSP and $PM_{2.5}$ concentrations and dustfall deposition predictions. In response to the difficulty in estimating fugitive road dust emissions, the New York State Department of Environmental Conservation rates fugitive dust estimates using the US EPA approach as “indeterminate” (NYSDOEC 2013). They find that the approach has many shortcomings and the estimates do not correlate with ambient monitoring.

Nonetheless, fugitive dust emissions using US EPA approach were estimated for the Base Case and Project sources and used in the assessment to obtain a first order understanding of potential magnitude, geographic extent, and frequency of the maximum concentrations in the LAA due to Project construction.

Meteorology Uncertainty

The application of five years of hourly meteorological data includes a wide range of conditions which reduces the level of uncertainty related to meteorology. The use of five years of meteorology data is consistent with the recommendations provided in the Air Quality Model Guideline (AEP 2013). The CALMET model domain for this assessment is relatively flat and relatively small so large variations across the domain are not expected. The level of confidence related to the meteorological data is rated as moderate to high.

Model Uncertainty

In terms of the air quality model algorithms, the U.S. Environmental Protection Agency (U.S. EPA) (2005) states:

> *Models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of ±10 to ±40% are found to be typical, i.e., certainly well within the often quoted factor-of-two accuracy that has long been recognized for these models.*

In addition, they also state, "*it is desirable to quantify the accuracy or uncertainty associated with concentration estimates used in decision-making. Communications between modelers and decision-makers must be fostered and further developed*." This comparison, however, cannot be done as there are no ambient monitoring stations in the region.

The U.S. EPA (2005) indicates that the application of regulatory dispersion models is viewed as a best estimate approach and that this approach should be viewed as acceptable to the decision maker. AEP (2013) has issued air quality model guideline recognizing that the modelling is a best estimate approach and to ensure consistency with respect to the application of models to assess projects in Alberta. The model approach that was used for this assessment is viewed as being a best-practice approach. The level of confidence related to the air dispersion model is rated as moderate to high.

Overall Air Quality

- The level of confidence is high for the estimated combustion emissions, the representativeness of the meteorological data, the selected model approach, and the overall effectiveness of the proposed mitigation measures. A higher level of uncertainty is associated with the estimation of fugitive dust emissions. For this reason, an ambient monitoring program would be conducted during the construction period to determine the effectiveness of mitigation.

Ambient Light

The confidence level for the predictions made for a change in ambient light is medium because the predictions assume that 69 mobile flood lighting units would be in operation, simultaneously, during the construction phase. The exact number of mobile flood lighting plants required to safely and efficiently carry out construction activities, with associated proposed mitigation measures, is currently unknown and the assumption was based on professional judgement and previous experience with construction projects.

Illuminance and glare would be expected to be less than CIE guidelines at the residence and business receptors.

Greenhouse Gases

The estimation of GHG emissions associated with the construction phase depends on the engineering design and on the estimated fuel consumption. The prediction confidence for GHG emissions is rated as high because published GHG emission factors and manufacturer specifications were used. The confidence in the effectiveness of the GHG mitigation measures is also high because most the measures are known to effectively reduce the source of GHG emissions (e.g., lower fuel consumption is directly proportional to lower GHG emissions).

3.7 CONCLUSIONS

Change in Air Quality

The main sources of air emissions due to the Project are vehicle exhaust and fugitive. As these emissions result from ground based sources, 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 is the potential for TSP and $PM_{2.5}$ concentrations to be greater than the regulatory criteria outside the PDA. Since estimated dust (e.g., TSP and $PM_{2.5}$) emissions are rated “indeterminate”, the assessment indicates a need for ambient monitoring during construction to confirm if the adopted dust control mitigation is adequate. On this basis, Alberta Transportation plans to implement an air quality monitoring and record keeping program to provide appropriate mitigation. The plan would also address potential odour occurrences and light trespass through communication with nearby residents.

Change in Ambient Light

The light monitoring shows that the Base Case nighttime light levels surrounding the Project site are characteristic of a rural area, with slightly higher sky glow values due to the influence from nearby highly populated areas (i.e. City of Calgary). Nighttime light levels (light trespass and glare) due to Project construction would remain below CIE guidelines for a rural area (i.e. E2 environment) and sky glow levels would not be expected to increase.

Change in Greenhouse Gases

The key findings of the assessment include:

- Construction GHG emissions are conservatively estimated to be 84,970 tonnes CO_2e over the entire construction period.
- If all Project construction emissions were assumed to be emitted over one year, the magnitude of emissions represent 0.03% of 2014 provincial emissions and 0.01% of 2014 national emissions. 2014 is the latest year for which data has been published.
- Project GHG emissions during constructions were considered to have a low magnitude.
- As per CEAA Agency guidance (2003) GHG emissions from construction were determined to be not significant.

Change in Carbon Sequestration Capacity

The bottom and slopes of the diversion channel would be re-vegetated, thereby restoring the carbon sequestration capacity to a level that would be comparable to the pre-construction condition. During construction and dry operations, the area that is expected to undergo a permanent land use change is the concrete diversion structure and its area is estimated to be 0.36 hectares. This area is relatively small compared to the size of the diversion channel (64.23 hectares) and the overall Project footprint (1,438 hectares including the anticipated area of physical disturbance associated with construction and operation including the maximum possible backflooding area). Given the small area that is to undergo a permanent land use change during construction and dry operations, the change in carbon sequestration capacity in the PDA is expected to be very small.

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3.9 GLOSSARY

activity level	The measure of some activity related to the release of air contaminants. Examples for this Project include the tonnes of coal mined and hours of operation.
criteria air contaminant (CAC)	A group of five common air contaminants released into the air from various processes, including industrial production and fuel combustion. In this assessment, they include particulate matter less than 10 microns in diameter (coarse PM or PM_{10}), particulate matter less than 2.5 microns in diameter (fine PM or $PM_{2.5}$), sulphur dioxide (SO_2), nitrogen oxides (NO_X, expressed as NO_2), and carbon monoxide (CO). Abbreviated in this document as CAC.
dispersion model	A model that simulates the dispersion of air contaminants from various air contaminant sources to various receptors. The output of the air dispersion model is ground-level maximum 1-hour average, maximum 24-hour average, and maximum annual average concentrations at the various receptors.

easting	A term used to describe a location within a Universal Transverse Mercator (UTM) zone. The midline of each zone is given an easting value of 500,000 m. A point to the west of the midline has an easting value less than 500,000 m, and a point to the east of the midline has an easting value greater than 500,000 m.
emission factor	A representative value that relates the quantity of contaminant released to the atmosphere with an activity or input associated with the release of that pollutant.
fugitive emission	Air emissions which could not reasonably pass through a stack, chimney, vent or other functionally-equivalent opening. An example would be dust emissions from traffic along an upaved road.
luminaire	A complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.
meteorology	The science of weather and weather forecasting.
National Pollutant Release Inventory (NPRI)	The reporting program for specific contaminants operated by the federal government (Environment Canada). Facilities that exceed certain criteria, including contaminant release thresholds, are required to report facility information and release information to the government each year. Data collected through the program are publicly available on-line.
northing	A term used to describe a location within a UTM zone. Northing values are measured in metres relative to the equator.
receptor	The person, plant, or wildlife species that may be affected due to exposure to an air contaminant.
trackout	The soil and sediment that adheres to the tires or tracks of mobile equipment that gets deposited on public roads when the equipment exits the PDA.