Stantec

Alberta Transportation Springbank Off-stream Reservoir Project

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Summary

Overview of Windblown Dust Assessment

- Fundamentals of Dust Emissions
- Key Assumptions
- Prediction Bias
- Results
- Monitoring and Mitigation
- Conclusions

Fugitive Dust Emission Generation

- A complex physical process controlled by wind speed, soil characteristics (moisture, soil texture and structure), surface roughness, vegetation, frequency of disturbance of the soil.
- Soil texture and structure describe the proportions of different-sized mineral particles and how they combine or adhere into aggregates.
- Soil moisture increases soil cohesion and resistance to wind erosion.
- Fugitive dust occurs when there is a strong enough wind, a susceptible surface soil, and lack of surface protection by vegetation or other roughness elements.

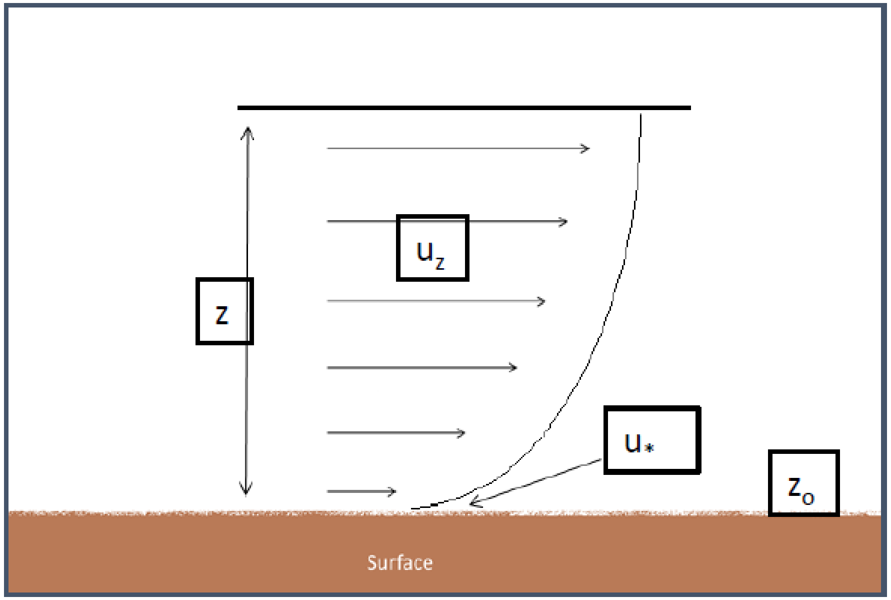
Soil Texture

- Sandy soils tend to be most susceptible to wind erosion as the coarse-textured soils dry out quickly and have poor structure (inter particle cohesion).
- Finer textured soils have both higher moisture retention and are better-structured (soil particles stick together) and hence more resistant.
- Soils with a greater amount of fine grain sizes, while they have a greater reservoir of finer particles that are a potential source of fugitive dust, are in fact more resistant to wind erosion.

Wind Profile and Surface Roughness

- Wind provides the driving force for particle movement
- This wind-surface interaction results in a logarithmic wind profile where wind speeds decrease near the surface of the ground.
- The stress force exerted by wind on a soil surface is represented by the parameter "friction velocity u*".

$$u(z) = \frac{u^*}{k} ln\left(\frac{z}{z_0}\right)$$



Surface Roughness – Wind Erosion Risk

- Low roughness surfaces allow faster near surface winds which increases surface wind erosion.
- Vegetation or a rough surfaces protect soil from wind erosion by reducing the wind speed at the soil surface.
- Practical examples: common agricultural practice to use cover crops or standing stubble to increase surface roughness and reduce wind erosion of topsoil.

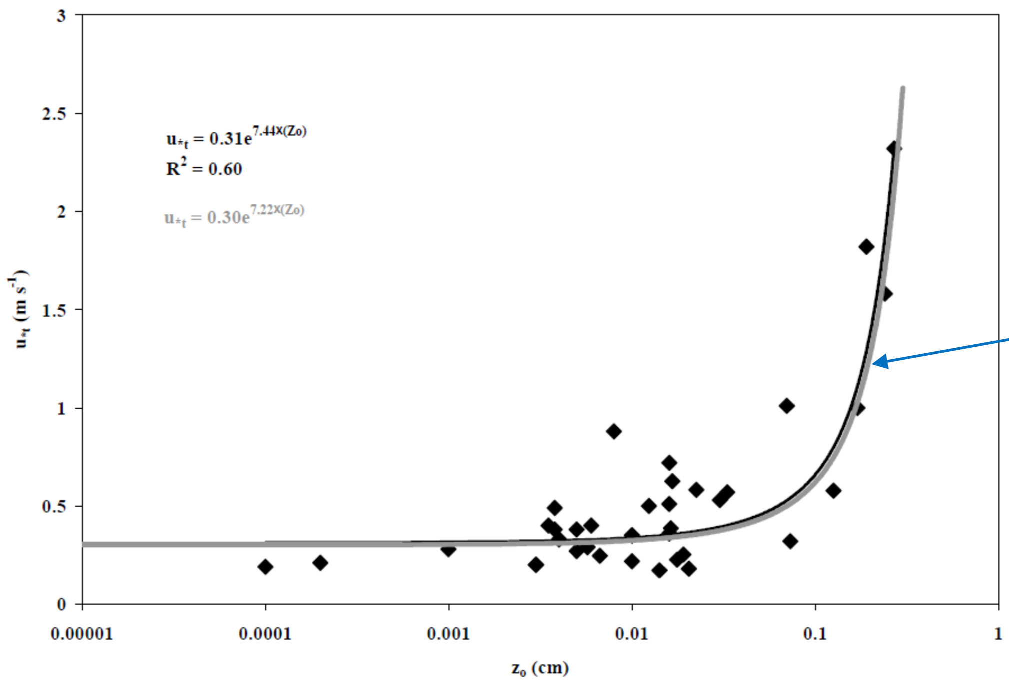


Figure 3-1, Exhibit 67, pdf page 376

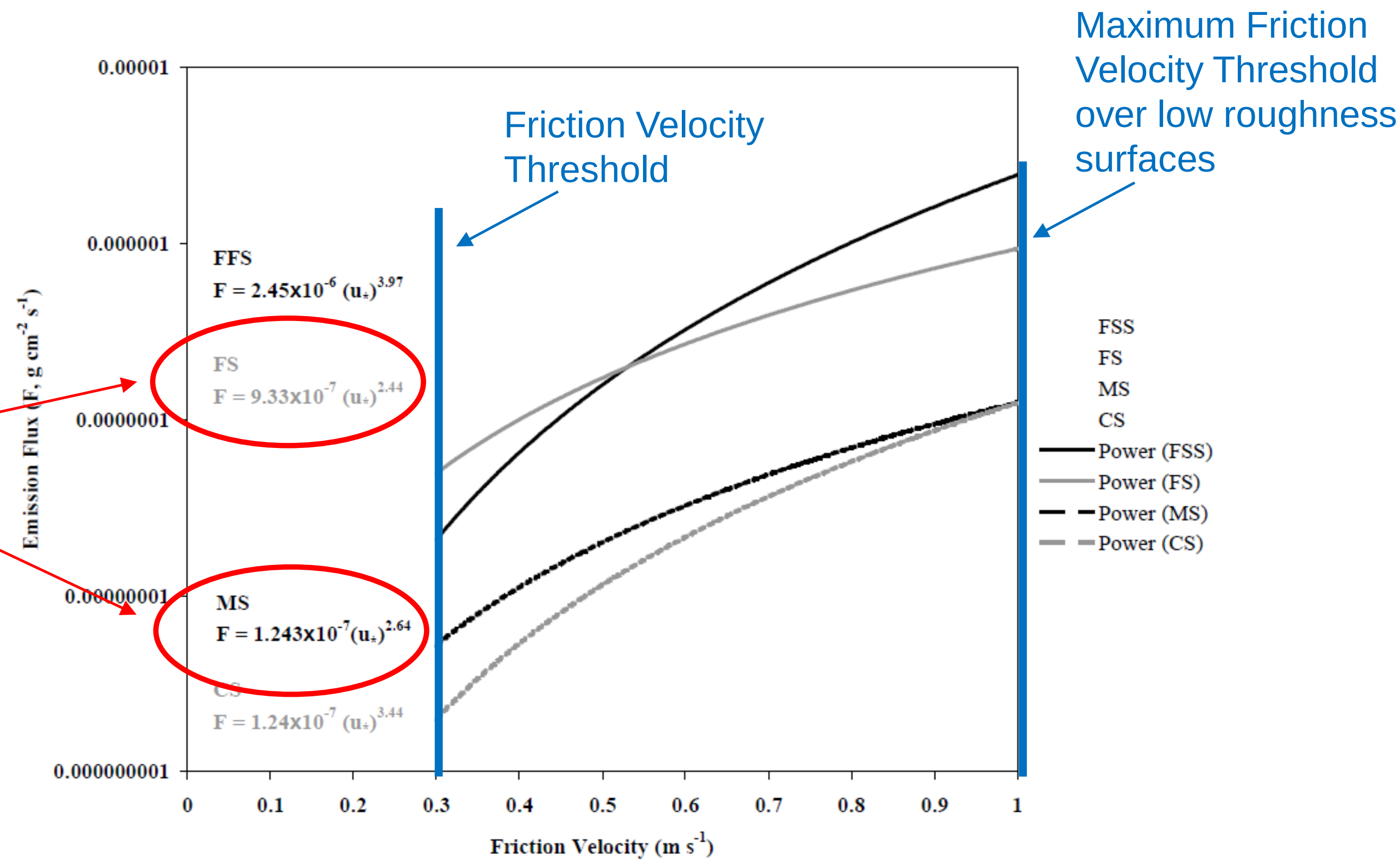
Rough Surfaces Require Very High Friction Velocities (Wind Speed) to Initiate Dust Emissions.

SCLG's Air Expert has adopted unrealistically high surface roughness

Fugitive Dust Emission Calculation

- ENVIRON/RMC Method
- Based upon wind tunnel measurements*
  - Wind speed, soil surface roughness (not macro-scale roughness) and emission flux are measured

Figure 3-2, Exhibit 67, pdf page 378



* Alfaro and Gomes 2001, Alfaro et al. 2003, Nickling and Gillies 1989

Key Assumption – $PM_{2.5}$ Fraction

- Alberta Transportation Adopted a $PM_{2.5}$ to TSP mass ratio of 0.075 based upon U.S.EPA Guidance (AP-42, Section 13.2.5).
- SCLG states that this U.S.EPA value is only "representative of an industrial work site". This is not correct.
- The U.S.EPA value of 0.075 is based upon a report (Cowherd 2006)* that clearly indicates that the value is representative of open area wind erosion of a variety of disturbed soils and also dust concentrations on dry lake beds.
- Alberta Transportation has followed an acceptable approach.

* C. Cowherd, Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors. Prepared by Midwest Research Institute for Western Governors Association, Western Regional Air Partnership, Denver, CO, February 1, 2006.

Key Assumption – Sediment Area and Roughness

- Smooth surfaces have higher potential for wind erosion. Rough and vegetated surfaces have low risk. Emissions from sediment area with > 10 cm depth. Realistic assumption.
- ENVIRON/RMC Method – surface roughness values are consistent with ENVIRON/RMC guidance, U.S.EPA emission estimation guidance, and consistent with wind tunnel origin of the ENVIRON/RMC flux equation – Z0 = 0.005 m. Realistic assumption.

SCLG Overprediction Bias

- Example – TSP and $PM_{2.5}$ Emission at Wind Speed of 40 km/h.

Standard Methodology and Guidance

Unconventional non-guideline assumptions

Parameter	Alberta Transportation Sediment	SCLG Deep Sediment	Percent Increase %
Surface Roughness (Z0)	0.005	0.05	-
Wind Speed km/h (m/s)	40 km/h (11.1 m/s)		-
Friction velocity u* (m/s)	0.74	1.06	43
Emission TSP Flux (Silty Sand - MS) (mg/m2/s)	0.55	1.44	159
Emission TSP Flux (Sandy Silt - FS) (mg/m2/s)	4.4	10.7	141
Assumed $PM_{2.5}$: TSP Ratio	0.075	0.23	207
Emission $PM_{2.5}$ Flux (Silty Sand - MS) (mg/m2/s)	0.04	0.33	695
Emission $PM_{2.5}$ Flux (Sandy Silt - FS) (mg/m2/s)	0.33	2.5	640

SCLG overestimates TSP Flux by 140+ %

SCLG overestimates $PM_{2.5}$ Flux by 640+ %

Key
Assumptions

AT – Conservative Assumptions

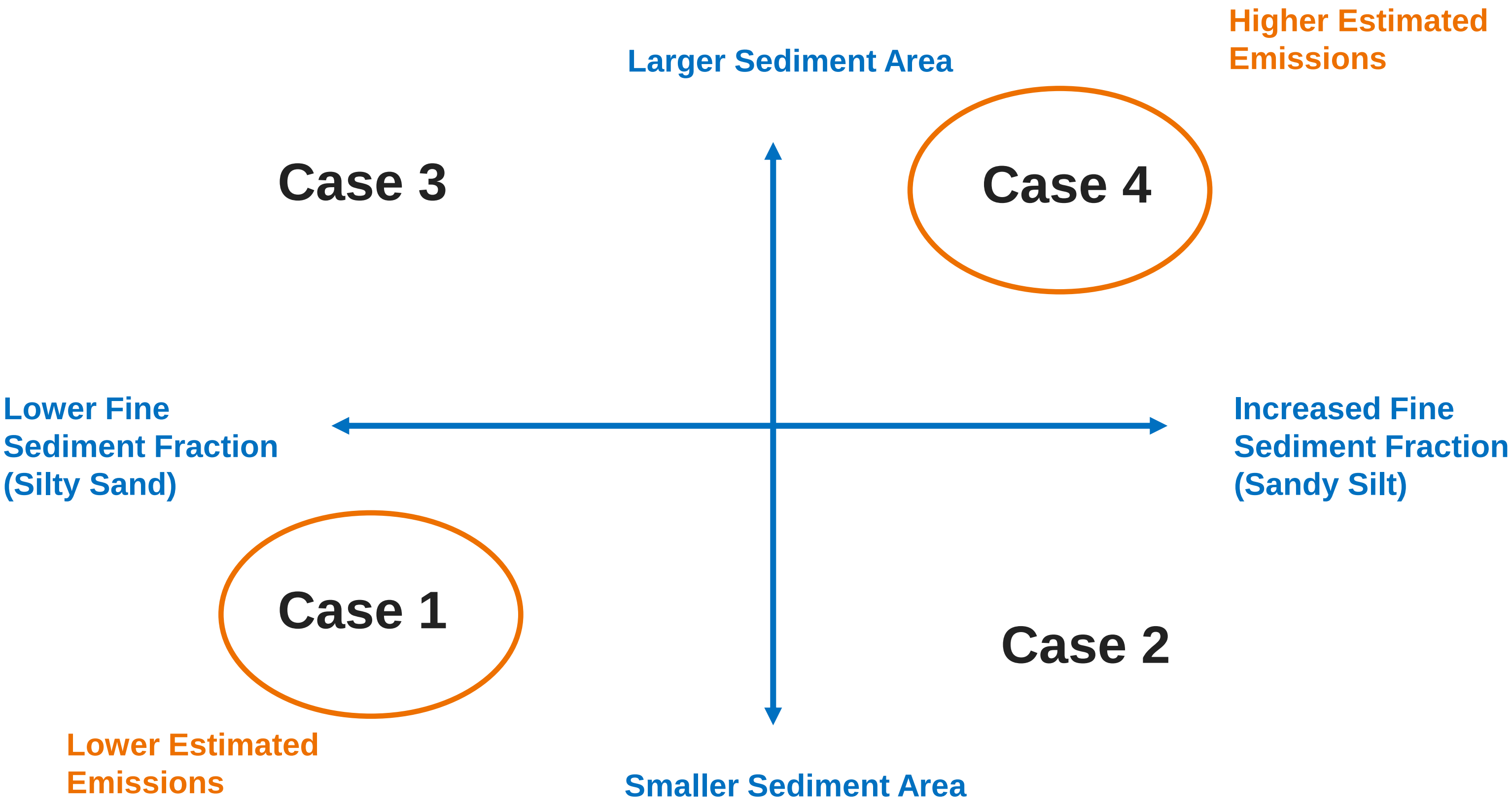
AT Post-flood Assessment:

- Assessed High Magnitude, Low-Recurrence Scenarios (Design, 1:100).
- Late Release Scenarios (increases sediment area).
- Did not account for mitigation associated with rainfall.
- Used a threshold friction velocity representing disturbed rather than crusted sediment.
- Did not account for particulate removal associated with 24 m tall dam structure which sits between the sediment and nearest receptors in the model.

Results

Post-Flood Results

Sensitivity Analysis – 4 Emission Scenarios Evaluated



Uncertainty – Sediment Area, Texture and Emission Quantification Methods

Scenarios presented in Exhibit 327, pdf page 79

Post-Flood Results

Design Flood

Application Case – Maximum 1-hour (99.9th) $PM_{2.5}$

Case 1

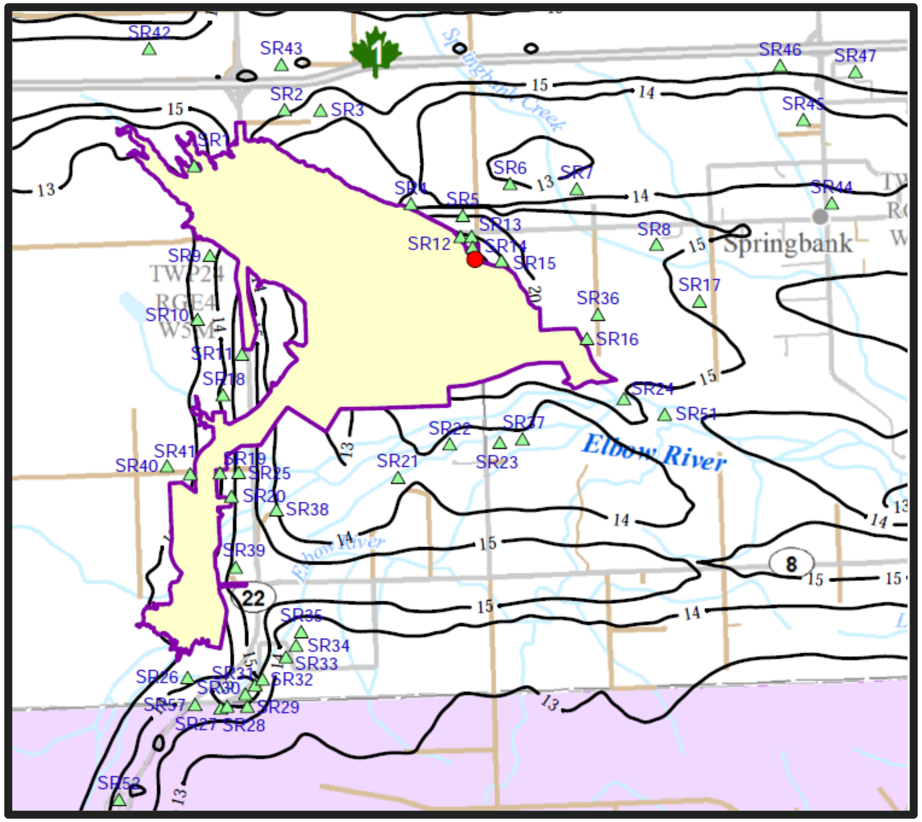


Figure A.1-12, Exhibit 327, pdf page 110

Case 4

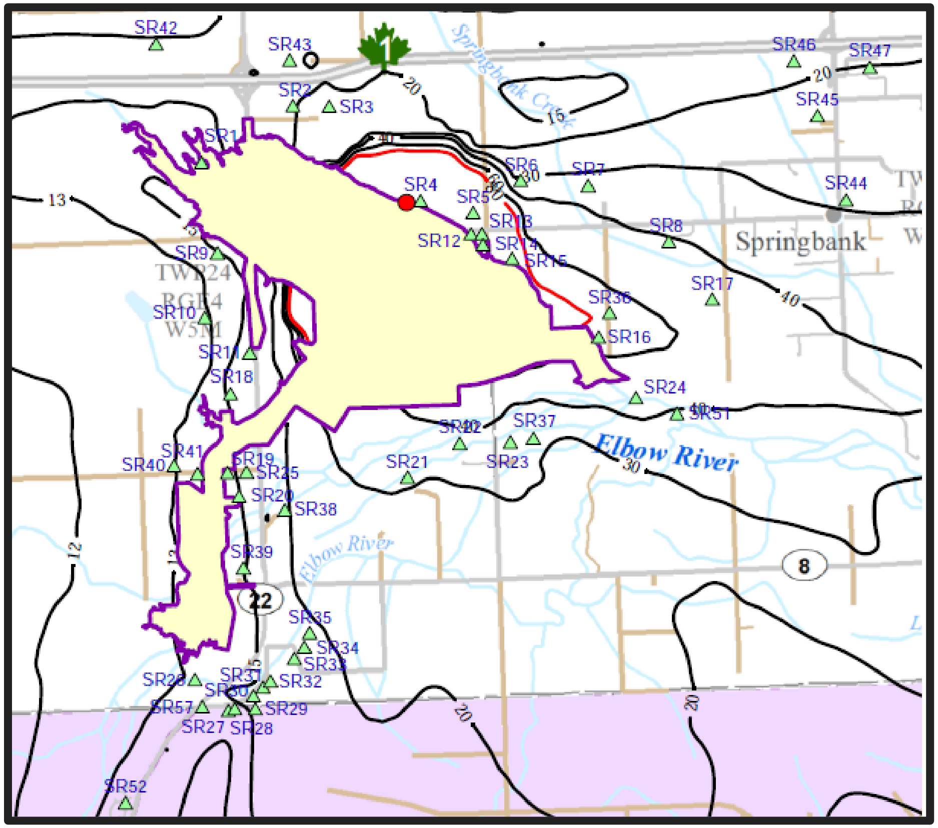


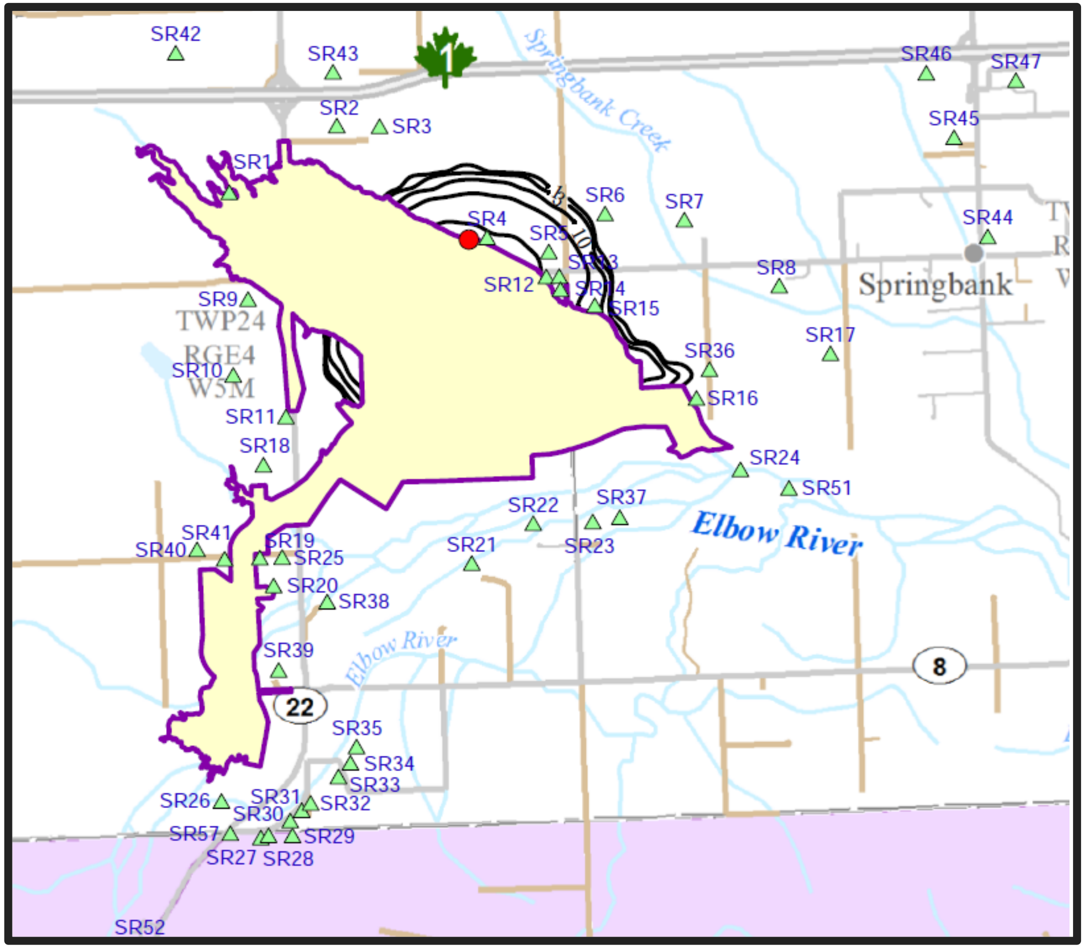
Figure A.4-12, Exhibit 327, pdf page 170

Typical control efficiency assumed

Post-Flood Results

Design Flood

Application Case – 1-hour (99.9th) $PM_{2.5}$



Frequency values for Figure A.4-12, Exhibit 327, pdf page 170

Case 4

Hours per Year Greater than AAAQG of 80 ug/m³.

Post-Flood Results

Design Flood

Application Case – Maximum 24-hour $PM_{2.5}$

Case 1

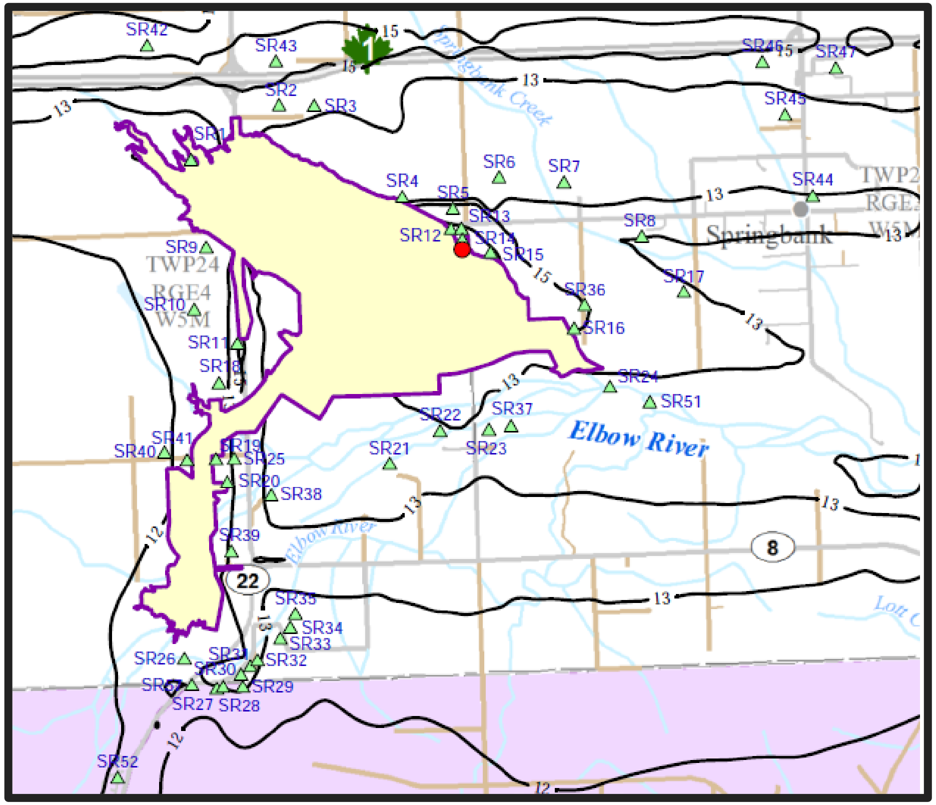


Figure A.1-14, Exhibit 327, pdf page 112

Case 4

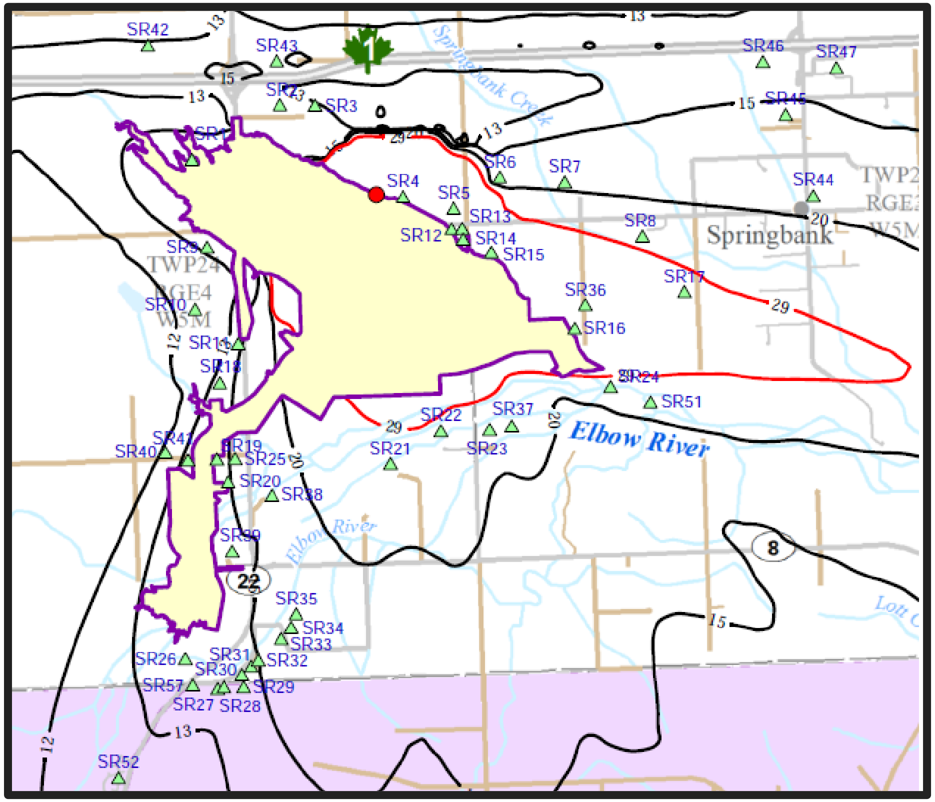


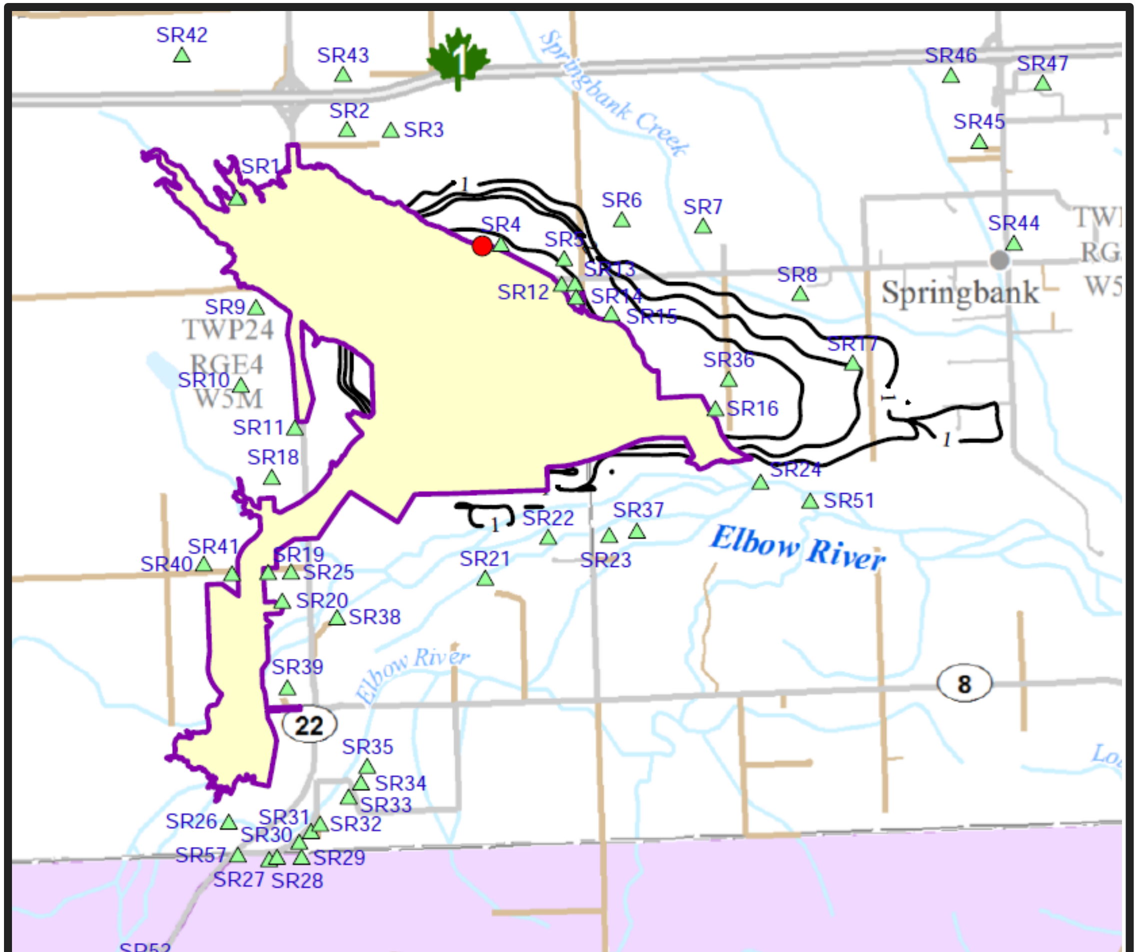
Figure A.4-14, Exhibit 327, pdf page 172

Typical control efficiency assumed

Post-Flood Results

Design Flood

Application Case – Maximum 24-hour $PM_{2.5}$



Case 4

Days per Year Greater than AAAQO of 29 ug/m³.

Frequency values for Figure A.4-14, Exhibit 327, pdf page 172

Monitoring and Mitigation

- Commitment to implement mitigation to achieve revegetation and control dust. Options include seeding, cover crops, tackifiers, soil covers, soil amendments, soil ripping to increase roughness, and/or shelter belts. These are proven and effective dust control methods to control dust and achieve revegetation.
- Commitment to monitor for TSP and $PM_{2.5}$ at a location near the east PDA boundary for 16 months after a flood event (i.e., from the flood event to the end fall the following year)
- Monitoring allows for adaptive management and the application of additional or modified mitigation if excessive TSP or $PM_{2.5}$ levels are measured.

Conclusion

- Low recurrence of the significant floods.
- Infrequent and localized risk of elevated particulate matter concentrations.
- Mitigation to achieve revegetation and control dust.
- Air quality monitoring and adaptive management.
- Overall conclusion – post-flood fugitive dust emissions are not anticipated to have significant adverse effects on ambient air quality.