

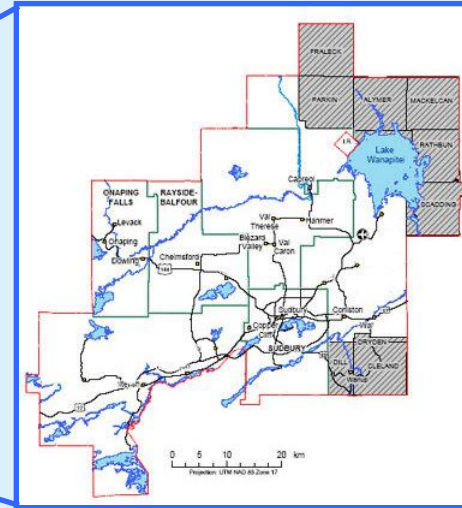


The Potential Effects of Climate Change on the Vulnerability of Roads and Associated Structures, Greater Sudbury, Ontario

H. Arisz, M. Therrien, B.C. Burrell, M. M. LeBlanc

R.V. Anderson Associates Limited

Project Definition – Greater Sudbury, Ont.



- 425 km west of Ottawa
- population ~160 000
- on Canadian Shield
- 3627 km²
- 330 Lakes within city boundaries
- main industry is mining (nickel/copper ore)

Project Definition – Infrastructure of Interest

- Surface – Gravel
- Surface – LCB
- Surface – Asphalt
- Curb
- Sidewalk
- Traffic Signals
- Street Lighting
- Utility Poles
- Boulevards & Shoulders
- Ditches
- Interlock Pavers
- Catch Basins
- Culverts
- Maintenance Holes
- Bikepaths
- Embankments/Cuts
- Bridge/Structures
- Municipal Signage
- Road Sub-Base
- Storm Sewer Systems
- Collection Systems
- Underground Utilities
- Administration/Personnel
- Maintenance (Markings, Crack Sealing)
- Winter Maintenance
- Record Keeping

Project Definition – Team and Timeframe


Study Team:

- City of Greater Sudbury
- Dennis Consultants (RVA Sudbury)
- Hydro-Com Technologies (RVA Fredericton)
- Lifecycle of pavement to be 30 years
- Lifecycle of “buried structures” 50 - 100 years
- Three tri-decadal horizons:
 - 2011-2040 (2020)
 - 2041-2070 (2050)
 - 2071-2100 (2080)

Deviations from PIEVC Protocol

- Evaluation performed before complete data received.
- Potential cumulative effects not evaluated.
- 9,000 potential vulnerability calculations – whittled to 18 when:
 - Data was not available
 - Positive or no climate trend identified
 - Not infrastructure
- Evaluated interactions qualitatively.

Climate Analysis

Rainfall: 
“more rainfall with more frequent and more intense storms”

- ↑ 6 hour freq for 5, 10 and 20 mm events
- ↑ 1 day freq for 5, 10 and 20 mm events
- ↑ Avg. max for 1, 2, and 5 day periods
- ↑ Avg. total annual
- ↑ Daily intensity

Snowfall: 
“less snow with less small storms but more big storms”

- ↑ 1 day freq events ≥ 20 mm SWE
- ↓ 1 day freq events ≥ 5 mm and ≥ 10 mm SWE
- ↓ Avg. total annual
- ↑ Daily intensity
- ↑ Rain on snow events

Climate Analysis

Temperatures:



“rising temperatures”

- ↑ Monthly average maximum
- ↑ Monthly average minimum
- ↑ Annual maximum
- ↑ Annual minimum

Wind:

no trends identified

Freeze-Thaw:

decreasing frequency

Ice Accretion:

no data available

Groundwater table:

no data available

Infrastructure Data

- No drainage infrastructure or culvert data.
- Insufficient infrastructure age info.
- Good information on road types and lengths.
- Some information on road maintenance costs.

Conclusions

- Increased frequency of high intensity rain events **will** affect:
 - Washouts and damage of gravel road surfaces.
 - Surcharging/flooding of drainage systems.
- Rising temperatures **may** affect softening/rutting of asphalt road surfaces.
- Ice accretion **could** affect all infrastructure of interest (functionality and O&M).

Conclusions

- **Probable *major* vulnerabilities exist for:**
 - Drainage infrastructure
 - Rainfall (surcharging and/or flooding)
 - All performance responses
 - *Retrofit and change design standards*
 - Gravel surfaced roads
 - Rainfall (washouts and damage)
 - Functionality, O&M and environmental
 - *Retrofit and change construction standards*

Conclusions

- *Minor vulnerabilities exist for:*
 - Asphalt surfaced roads
 - Higher max. temperatures (softening & rutting)
 - Durability and O&M
 - *Modify mix design for new roads*
 - Embankments/cuts
 - Higher groundwater tables (slope stability)
 - Structural integrity
 - *Perform sensitivity analyses*

Conclusions

- **Possible** vulnerabilities exist for:
 - All infrastructure of interest
 - More ice, more often ????
 - All performance responses but especially functionality and O&M
- Additional study of changes in climate
- Risk & criticality assessment
- Changes in winter maintenance of roads and sidewalks

Recommendations

- Develop hydraulic inventory database.
- Develop stormwater management plan.
- Assess impacts of environmental and functionality effects on gravel surfaced roads .
- Perform infrastructure risk assessment for ice accretion/ice storms.
- Change asphalt mix to accommodate higher temperatures.
- Evaluate slope stability of large and “high risk” embankments/cuts.

Cross-Cutting Issues

- Major vulnerabilities due to:
 - Increase in frequency of high intensity rain events (drainage and flooding).
 - Potentially increased incidence and intensity of ice accretion/ice storms (structural stability, functionality and O&M).
- Minor vulnerabilities due to:
 - Increased max. temperatures (material durability).
 - Rise in groundwater (slope stability).

Questions ?



Post-conference, please contact:
H. Arisz or B.C. Burrell
R.V. Anderson Associates Limited
455 Urquhart Crescent
Fredericton, NB E3B 8K4

