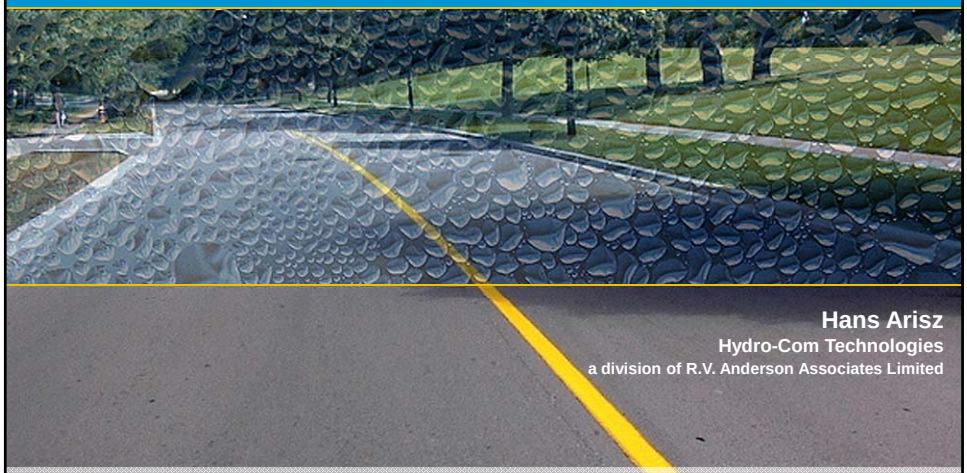
SUDBURY ROADS AND ASSOCIATED STRUCTURES VULNERABILITY ASSESSEMENT

PHASE II – PILOT STUDY



Hans Arisz
Hydro-Com Technologies
a division of R.V. Anderson Associates Limited

PROJECT DEFINITION-OBJECTIVE

- Identify the vulnerability of road-related infrastructure in the city of Greater Sudbury to climate change.

- Present changes to the design, construction, operation and maintenance practices of road-related infrastructure to adapt to the predicted effects of climate change.

PROJECT DEFINITION-METHODOLOGY

- Identify infrastructure of interest
- Identify climate factors of interest
- Predict effects of climate change

- Evaluate climate change impacts on infrastructure (9,000 interactions)
- Identify adaptive measures

PROJECT DEFINITION-GREATER SUDBURY,ON

- 340 km NW of Toronto, 425 km west of Ottawa
- population ~160 000
- main industry is mining (nickel/copper ore)
- area 3,627 km^2
- 330 lakes within city boundaries
- > 3,000 lane/km paved roads
- > 600 lane/km unpaved roads

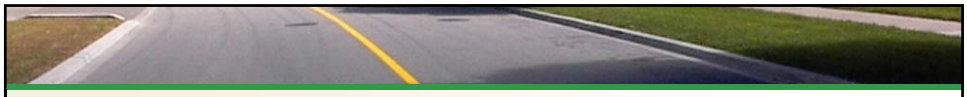
PROJECT DEFINITION - TEAM

Study Team

- City of Greater Sudbury
- Dennis Consultants (RVA Sudbury, ON)
- Hydro-Com Technologies (RVA Fredericton, NB)
- Ouranos (climate change research consortium)

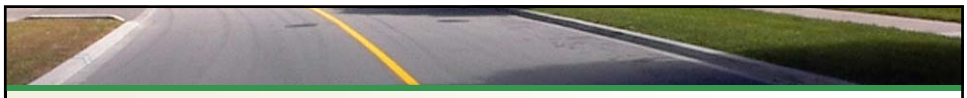
PROJECT DEFINITION-TIMEFRAME

- 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)



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 -CLIMATE FACTORS OF INTEREST

Climate Elements

- Temperature
- Precipitation as Rain
- Precipitation as Snow
- Wind Speed
- Ice
- Hail
- Frost
- Ice Accretion

Potential Change Factors

- rate of change
- mean values
- Extremes
- Frequency
- annual/seasonal totals Intensity
- portion as rain/snow freeze/thaw cycles
- change in timing/duration season

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

Sudbury Greater Grand | PIEVC CVIIP | 60 Years | Hydro-Com Technologies

CLIMATE ANALYSIS

Temperatures

- "rising temperatures"
  - ↑ Monthly average maximum
  - ↑ Monthly average minimum
  - ↑ Annual maximum
  - ↑ Annual minimum

Wind

- no trends identified

Freeze-Thaw

- decreasing frequency of days with: $t_{max} > 0°C < t_{min}$

Ice Accretion

- no data available

Groundwater table

- no data available

Sudbury Greater Grand | PIEVC CVIIP | 60 Years | Hydro-Com Technologies

CLIMATE ANAYSIS - CONCLUSIONS

- Increased frequency of high intensity rain events (10% to 20%) ***will*** affect:
  - Washouts and damage of gravel road surfaces.
  - Surcharging/flooding of drainage systems.
- Rising temperatures (t_{max} 32.0°C to 37.6°C) ***may*** affect softening/rutting of asphalt road surfaces.
- Ice accretion ***could*** affect all infrastructure of interest (no data).

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

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

CONCLUSIONS

➔ Develop hydraulic inventory database.

➔ Develop stormwater management plans.

➔ Assess impacts of environmental and functionality effects on gravel surfaced roads .

➔ Perform infrastructure risk assessment for ice accretion/ice storms (no data).

➔ Change asphalt mix to accommodate higher temperatures.

➔ Review winter maintenance of roads and sidewalks.

➔ 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?

Hans Arisz, Senior Associate
Tel: 506-455-2888 Fax: 506-455-0193
harisz@rvanderson.com