



The Importance of Permafrost, Ice and Seasonally Frozen Ground to Road Transport Systems in Canada

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Presentation Overview

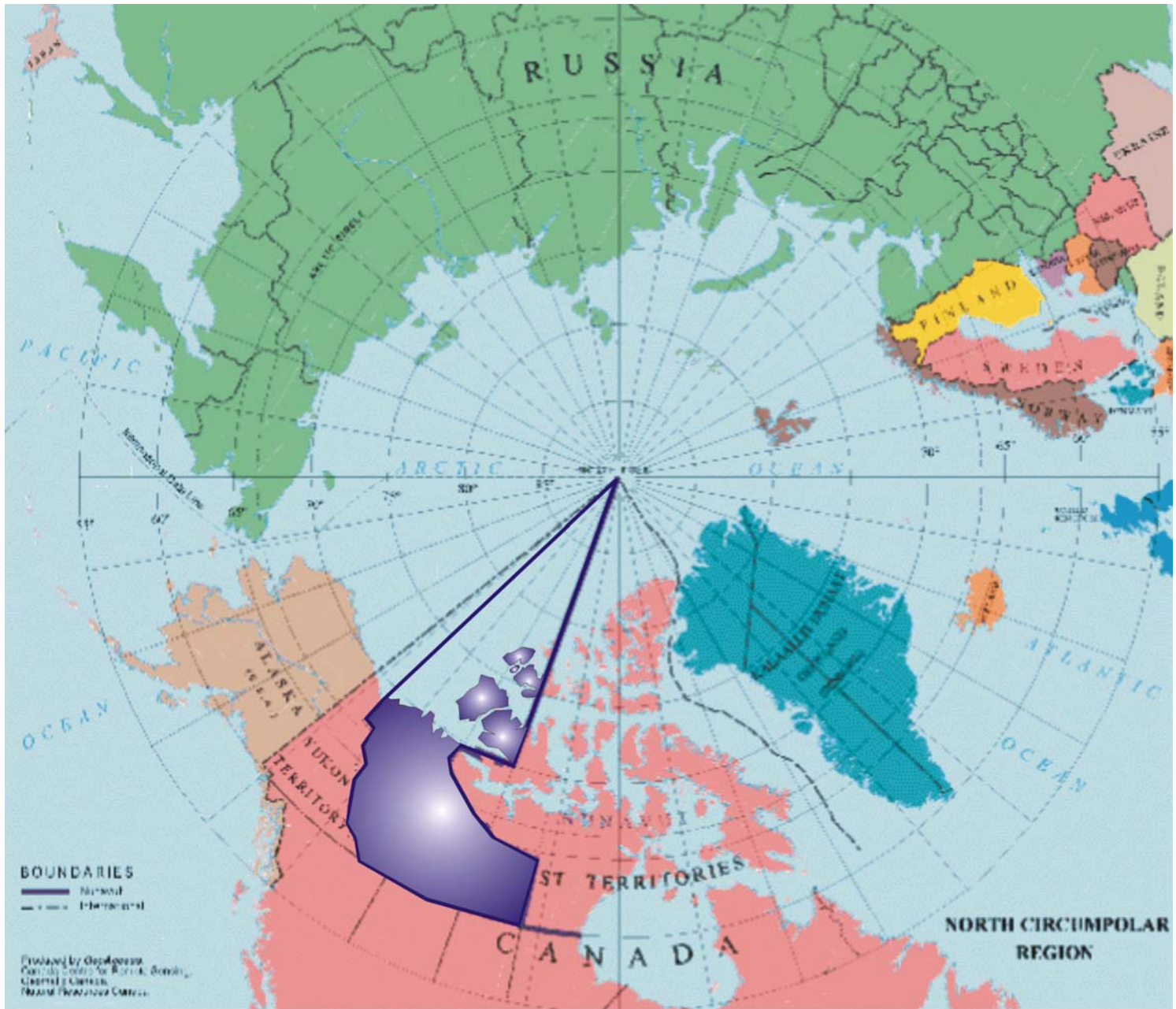
Introduction

- Northern Canada and the Northwest Territories
- Impacts of climate change on the Northern roads
- Video clip
- Permafrost

Case Studies

- Dempster and Yellowknife Highways
- Tibbett to Contwoyto Winter Road
- Mackenzie Valley Winter Road
- Mackenzie River Crossing near Fort Providence





The Northwest Territories



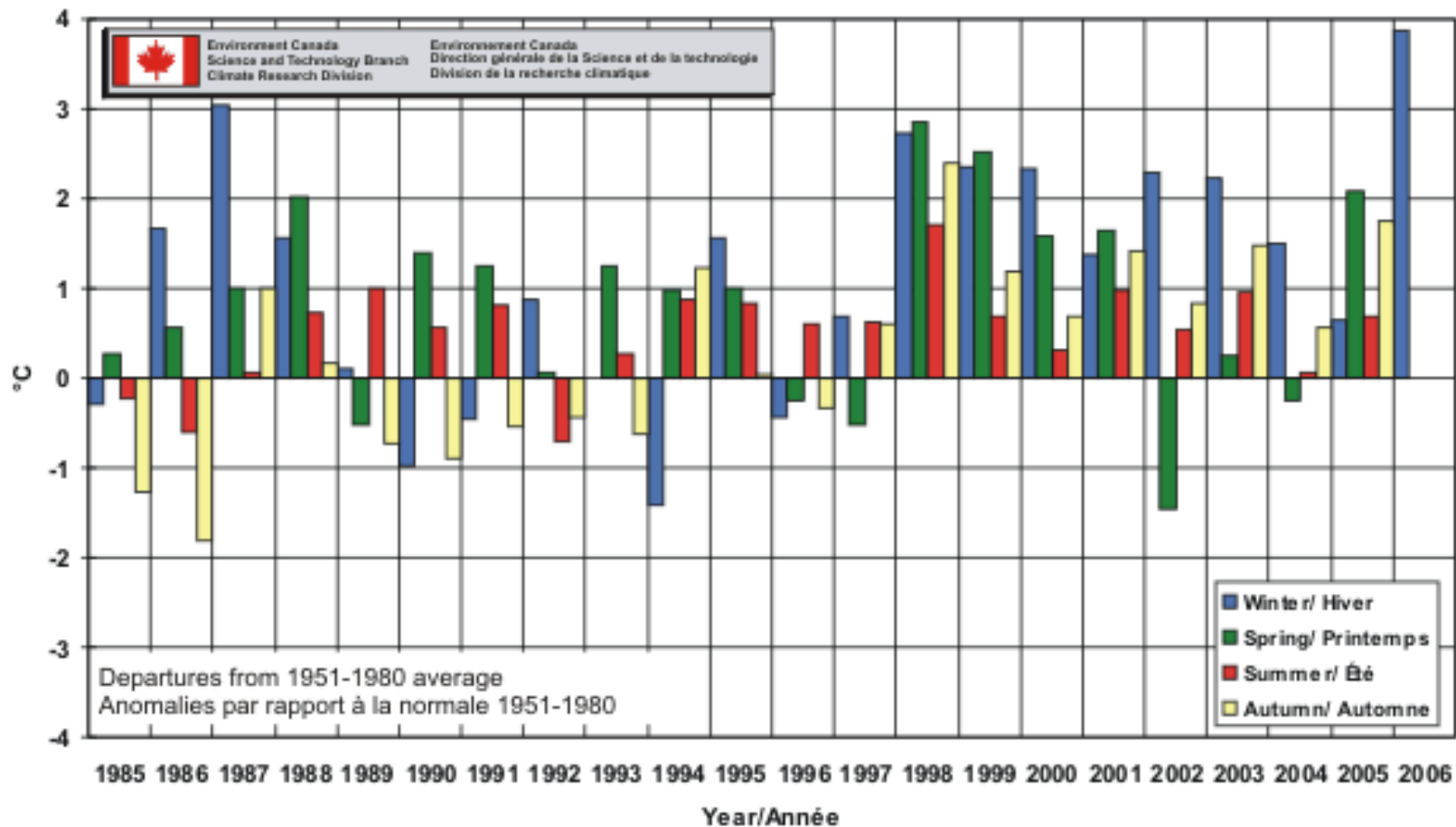
Romantic View of the North



The Reality



Consecutive seasons, national temperature departures, 1985-2006
 Anomalies de la température nationale (saisons consécutives), 1985-2006



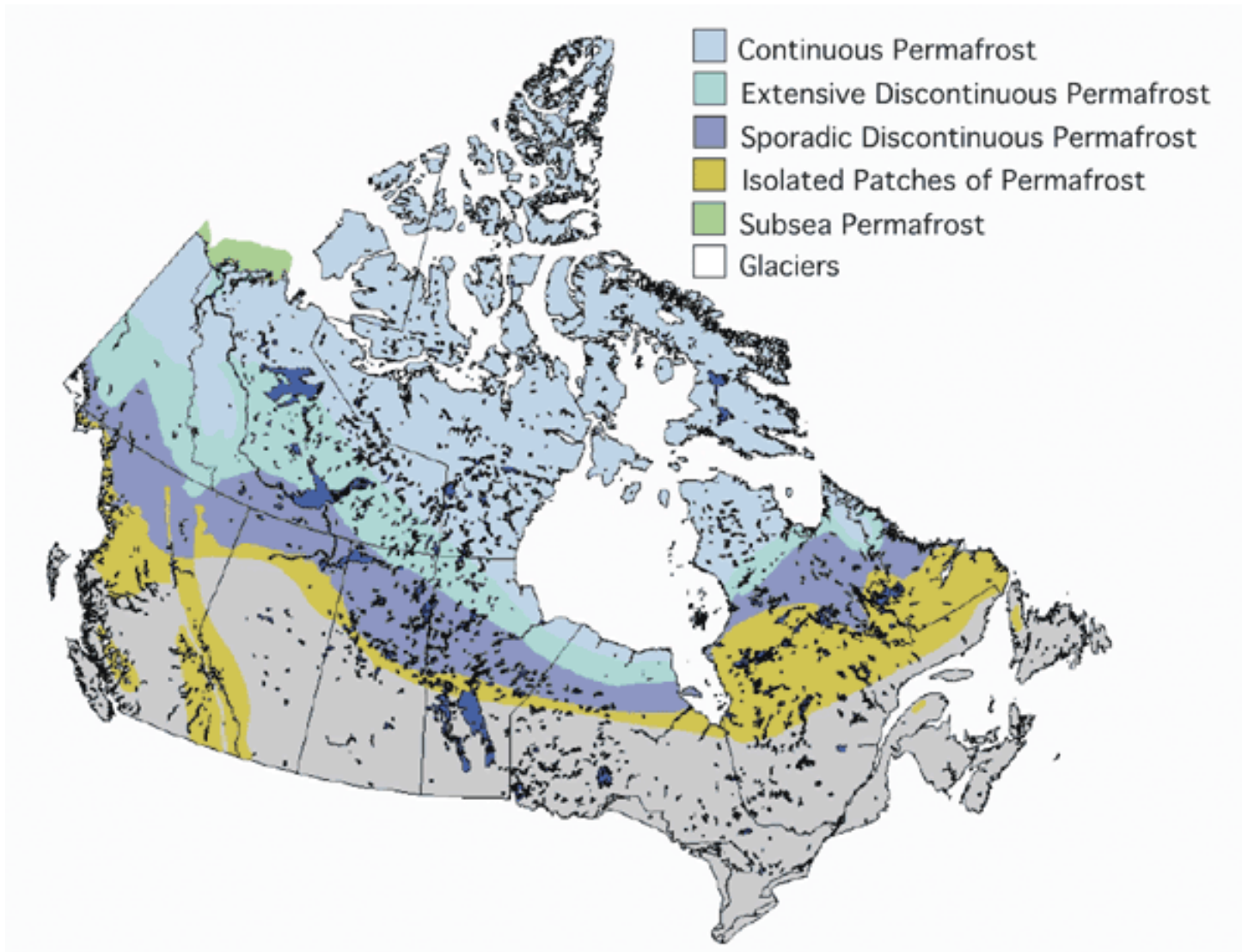
What is Predicted?



What is permafrost?

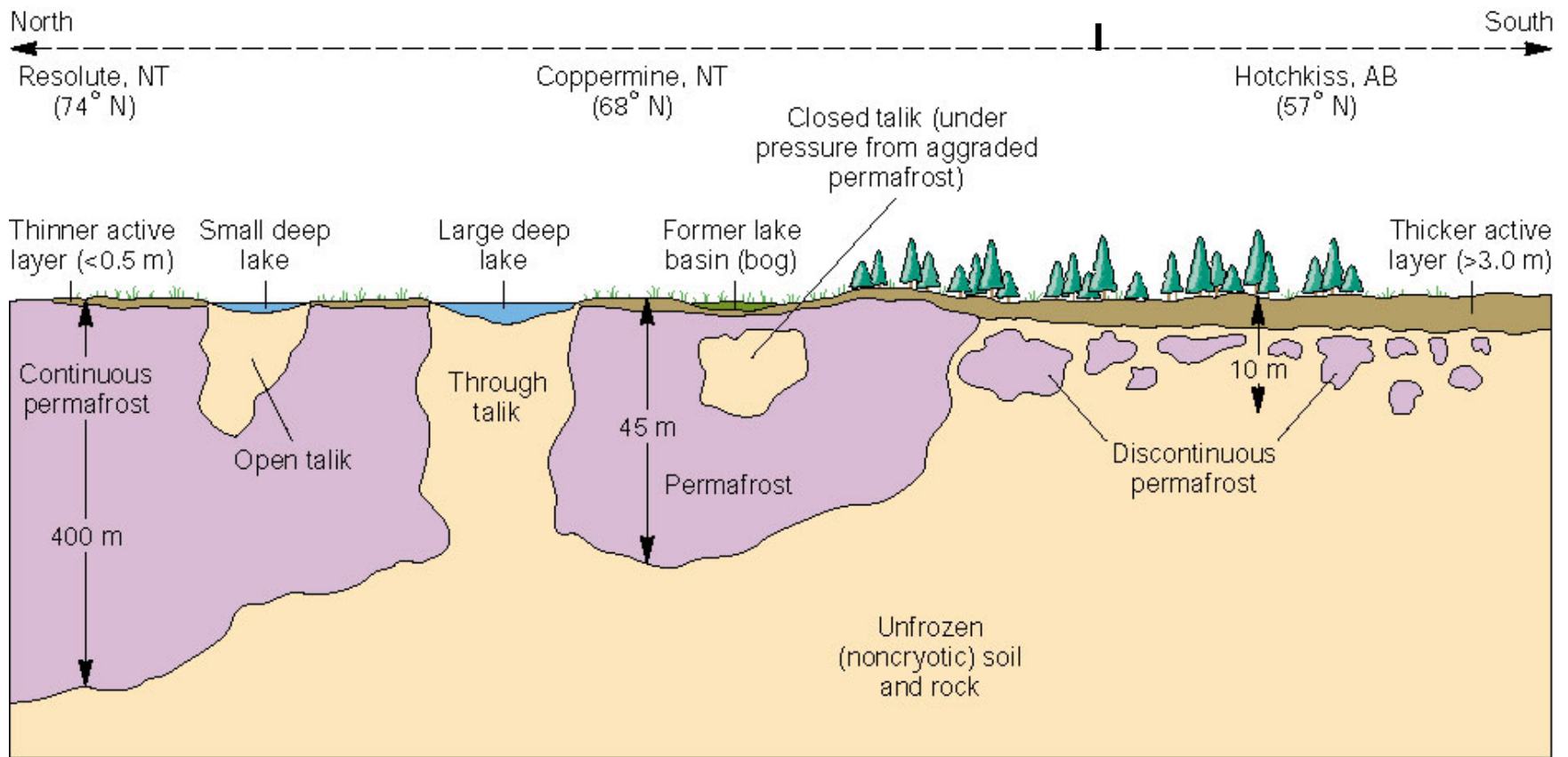
Any soil that remains frozen for a minimum period of two years is considered permafrost.





Permafrost

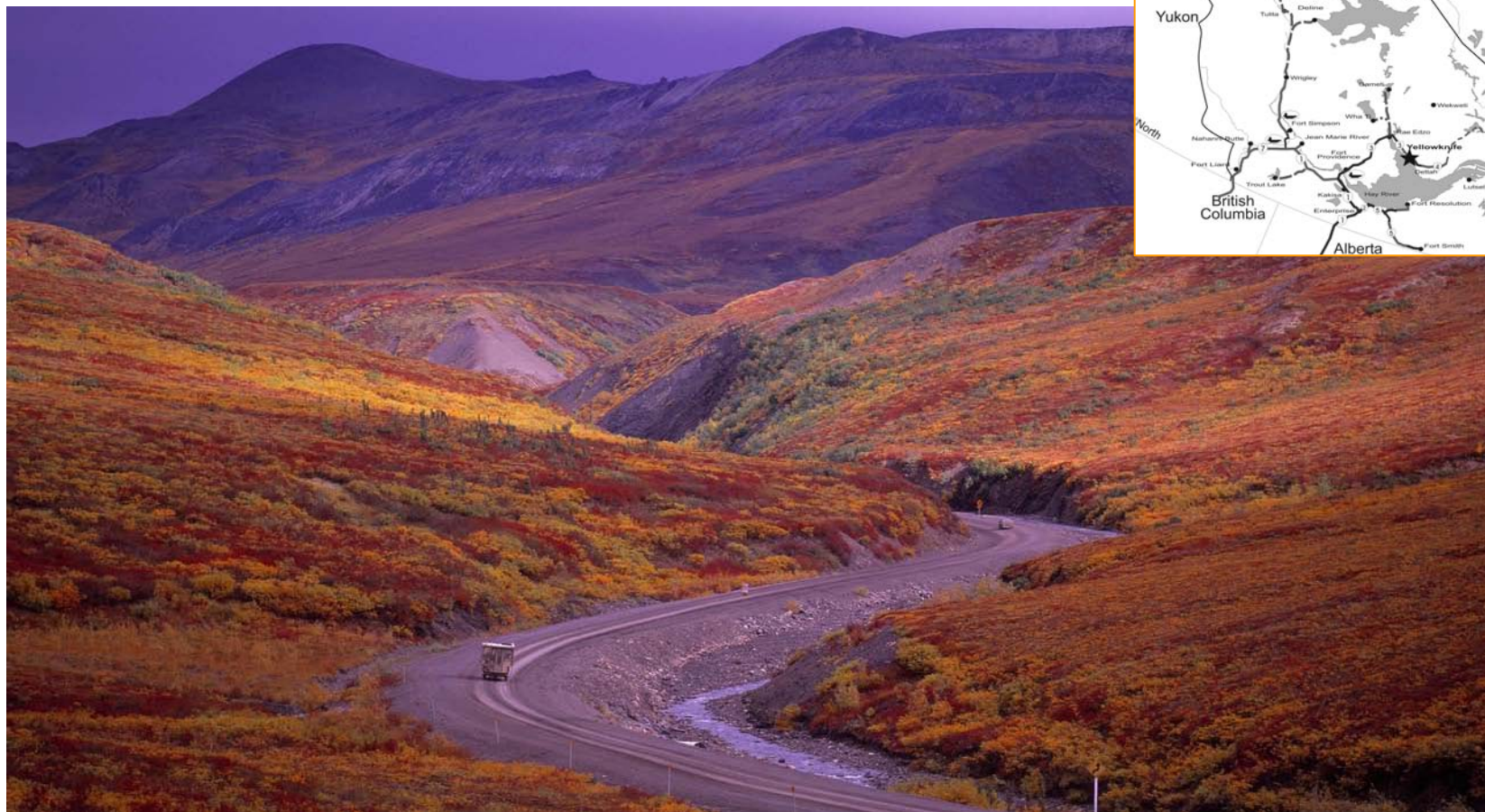
Yellowknife NT



Permafrost Degradation



Dempster Highway



Dempster Highway

Construction of road embankment over permafrost terrain impacts thaw-sensitive foundation soils

Roadbed failure due to subgrade warming may occur more frequently in periods of climate warming

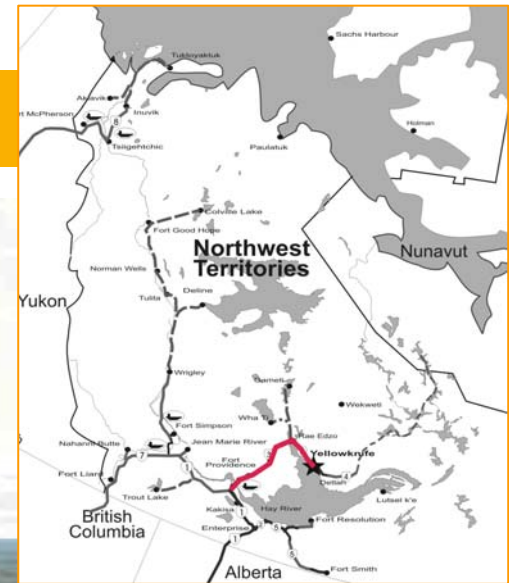


Dempster Highway



Photo by Pierre Castonguay

Yellowknife Highway Upgrade



- 100 km upgrade south of Yellowknife
- Near the southern fringe of the permafrost zone
- Crossings of poorly drained lowlands & permafrost soils
- Local warming trends – risk mitigation design approach

Yellowknife Highway Upgrade

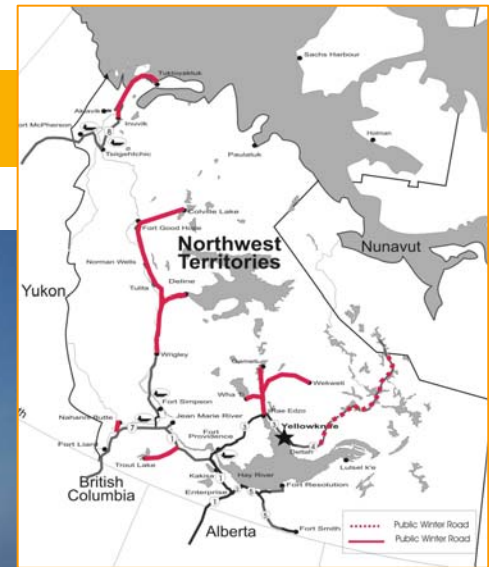


Climate Change Adaptation Strategies – Roads on Permafrost

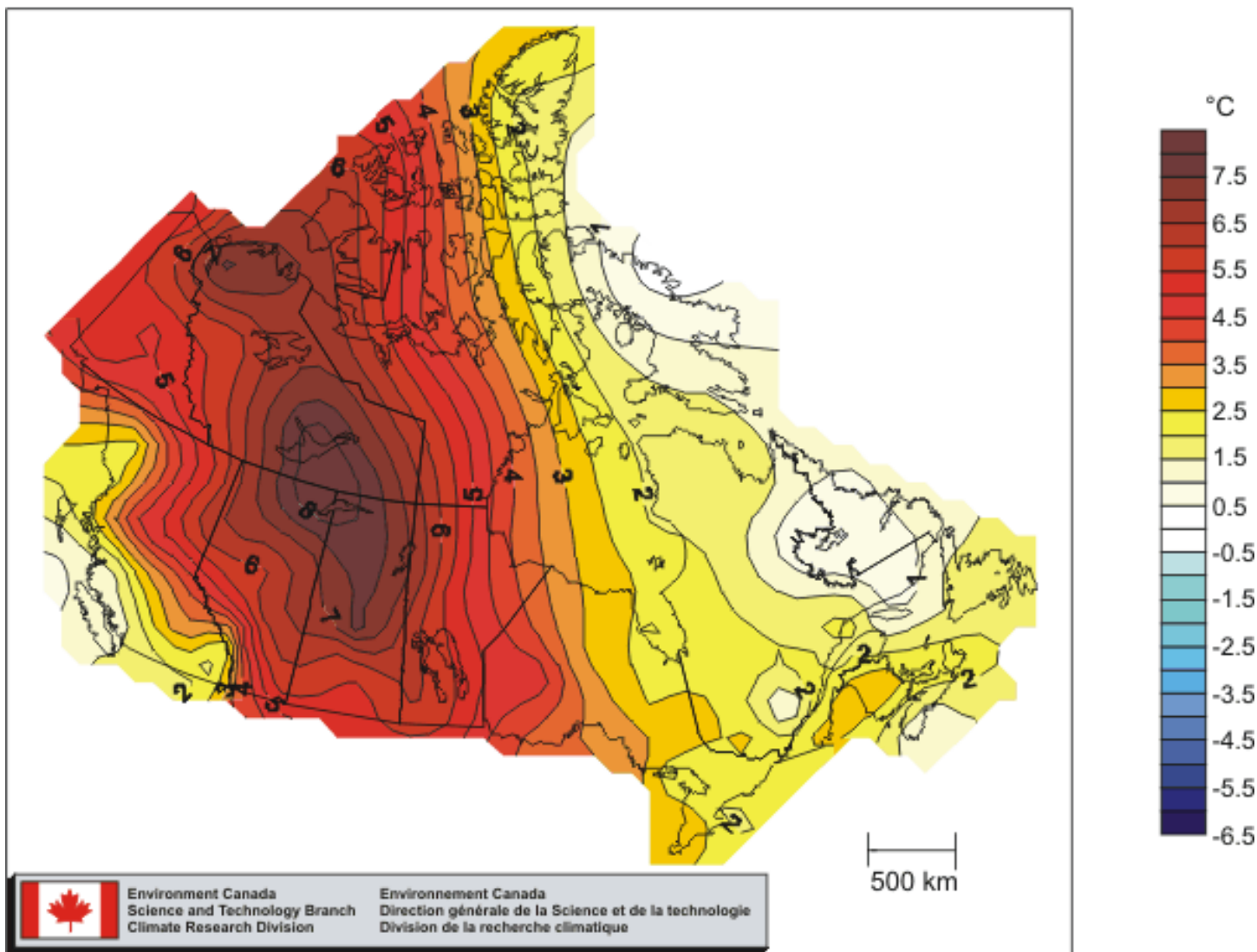


- Manage predicted settlements using common design principles
- Enhance winter heat extraction from the ground using thermosyphons
- Open-graded rock embankment materials
- Selective use of insulation within the embankment
- Reflective surface treatments

Winter Roads over Land and Ice



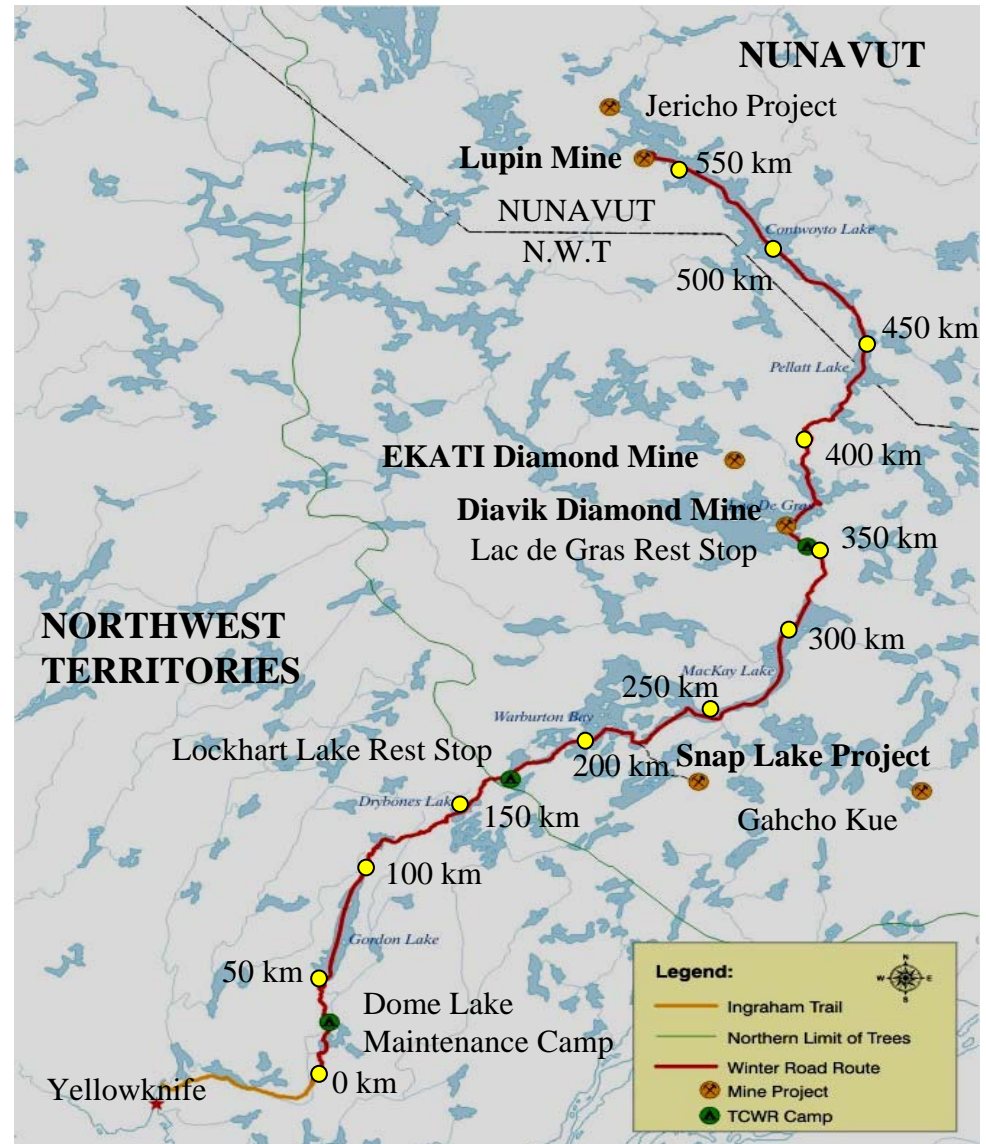
TEMPERATURE DEPARTURES FROM NORMAL
Winter (Dec, Jan, Feb) 2005/2006
ANOMALIES DE LA TEMPERATURE PAR RAPPORT A LA NORMALE
Hiver (dec, jan, fev) 2005/2006



Tibbett to Contwoyto Winter ROAD

600 km construction and
resupply corridor for
Canada's Diamond Mining
Industry

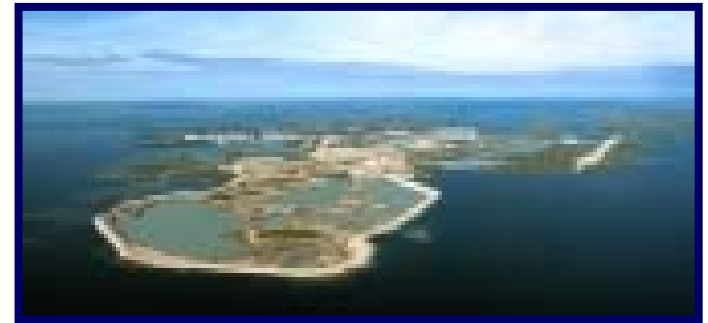
Traffic volumes increasing
and predicted decline in
available safe operating
period due to mean annual
air temperature warming



Diamond Mines



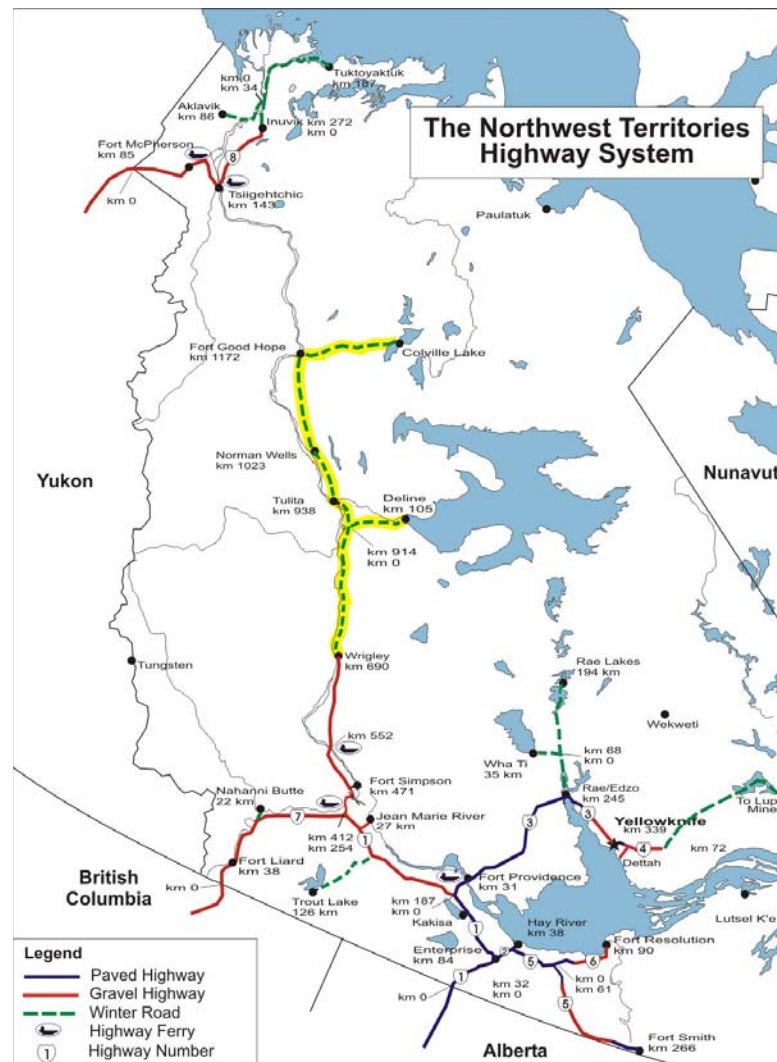
Ekati Mine Site



Diavik Mine Site



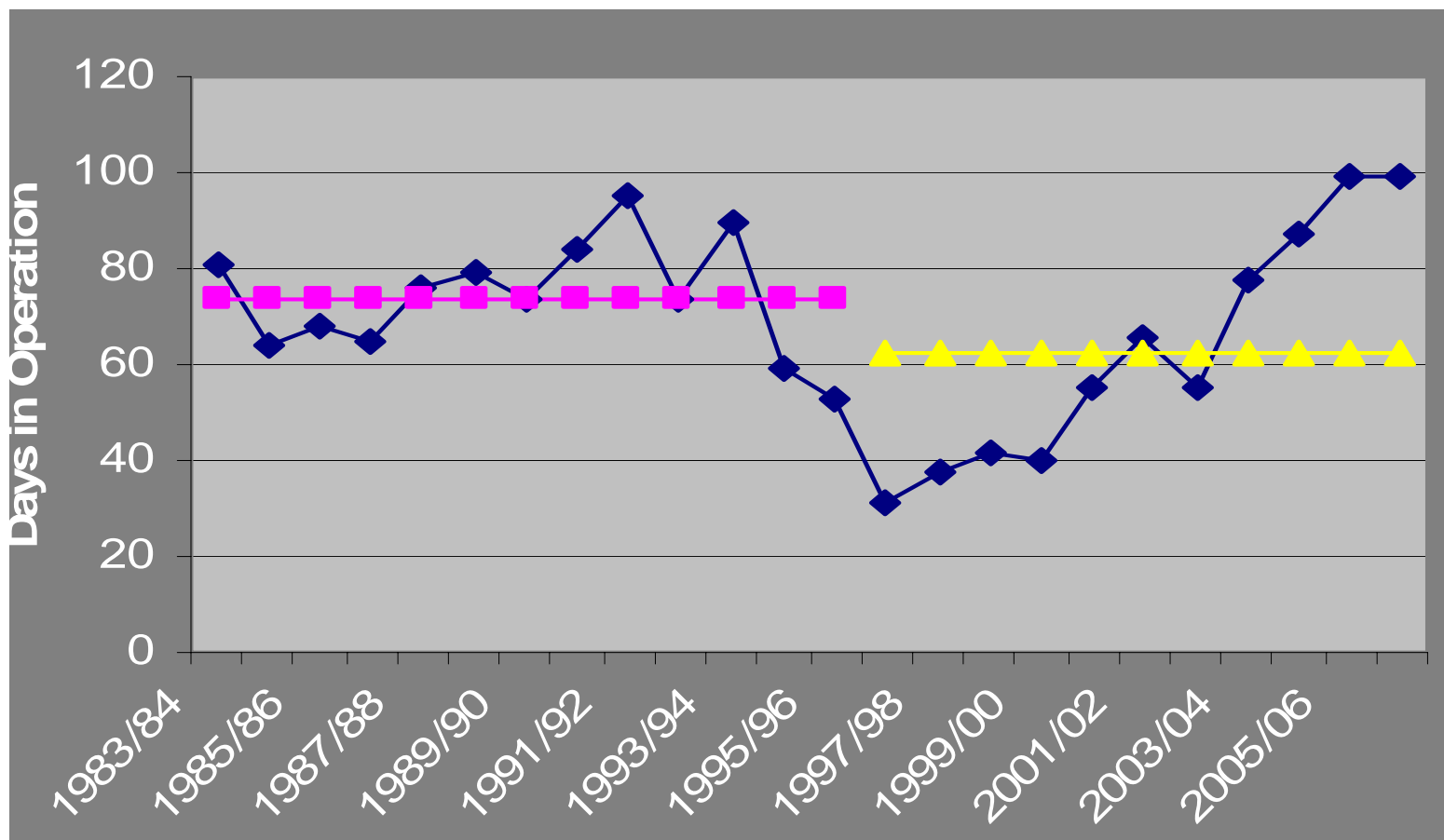
Mackenzie Valley Winter Road



Mackenzie Valley Winter Road

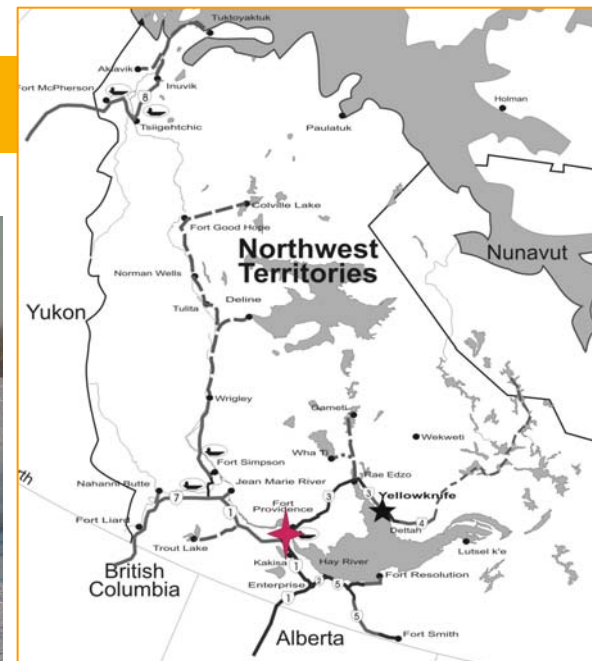


Winter Road Operating Season

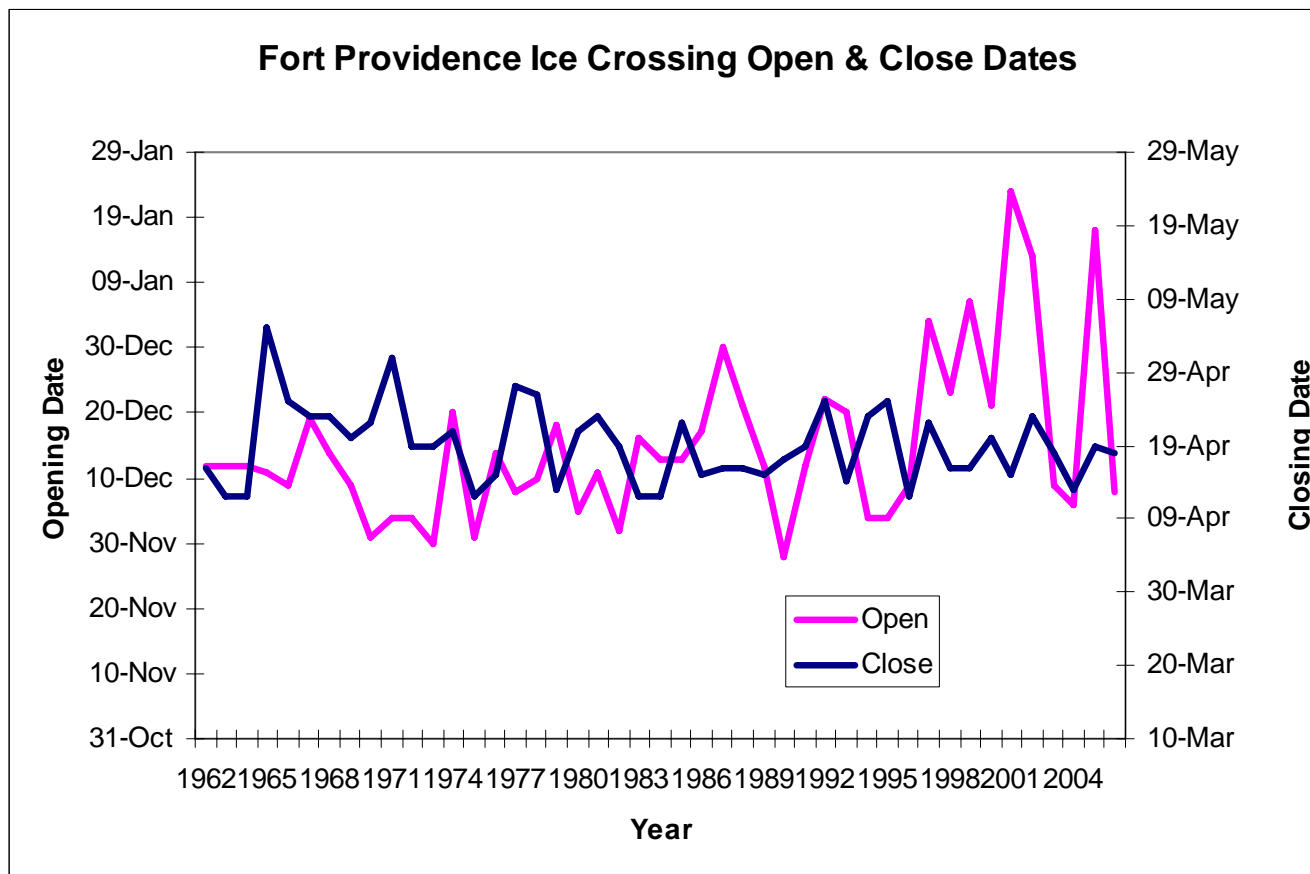


Mackenzie Valley Winter Road

Mackenzie River Crossing



Ice Bridge Opening

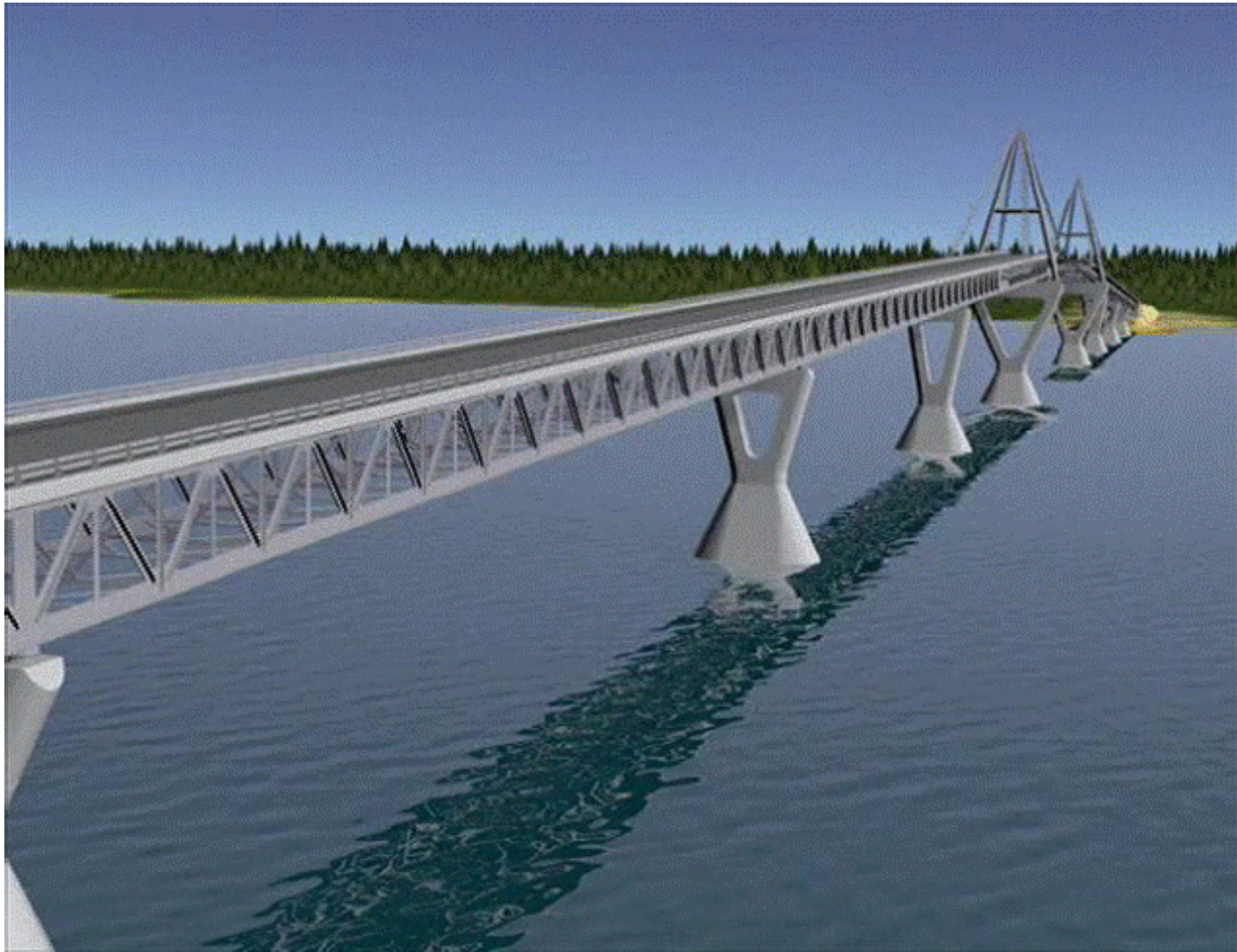


Mackenzie River Ice Crossing

Mackenzie River Crossing



Deh Cho Bridge



Thank you

