

# Recent Effects of Climate Change on Permafrost and Road Stability, Dempster Highway, NWT/YT

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# Outline of Presentation

- Purpose of the current study
- Photos and discussion of present and future maintenance issues – YT and NT
- Summary and Next Steps

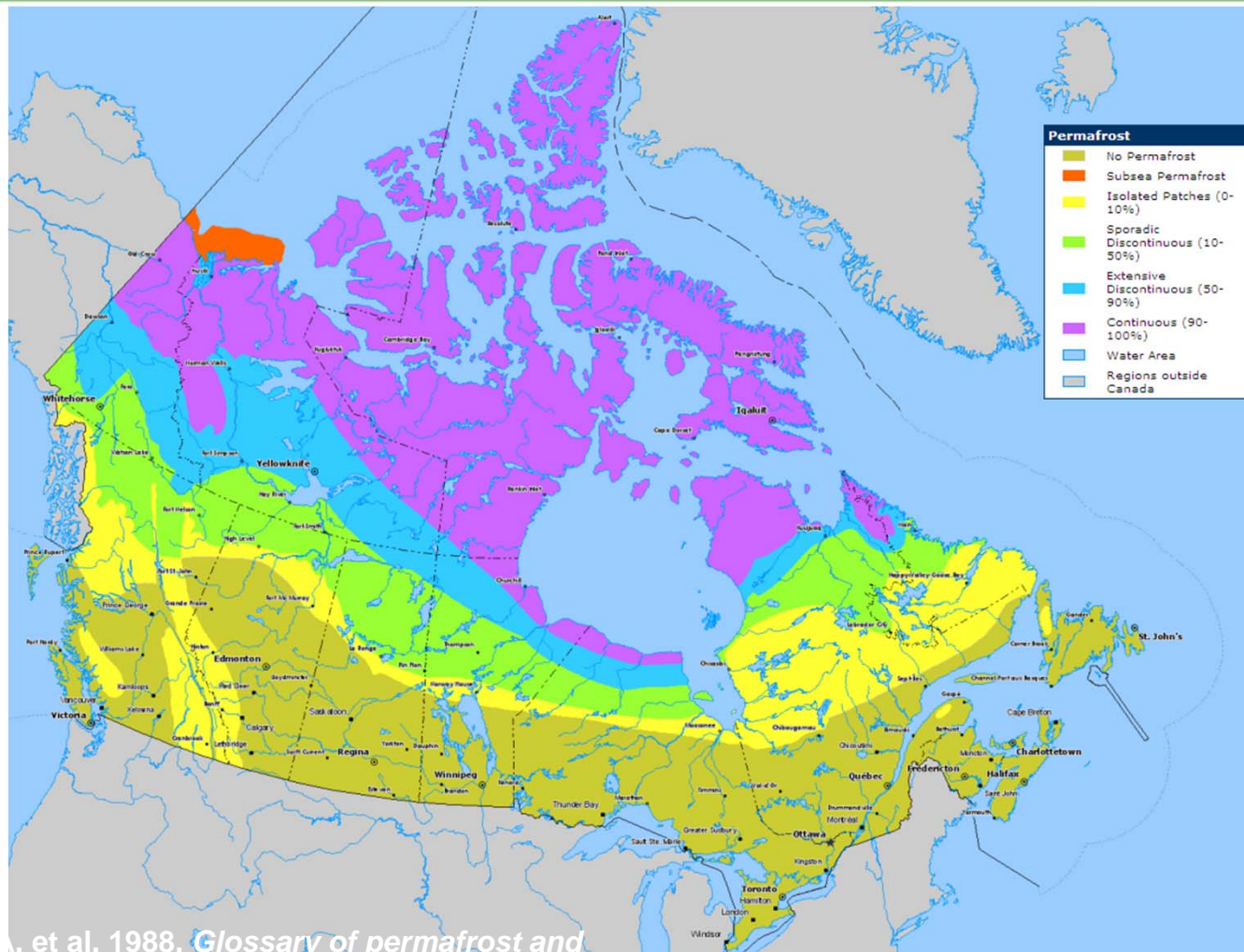
# Purpose of Study

- This project is jointly funded by the Governments of NT and YT
- First phase of a project to assess vulnerability of Dempster Highway to the impacts of climate change
- Climate change is just one factor that affects road maintenance, and it is sometimes difficult to specifically attribute an issue directly to climate change

# Observations

- A driving trip of the Dempster was completed over four days in late August 2013 to visually examine the road, meet with local maintenance personnel to discuss their sections of the highway, and document both existing and potential maintenance issues (from three sources)
- Driving trip was completed by representatives of EBA Engineering, Gov't of NT Highways, Gov't of YT Highways, and Carlton University.
- Primarily looking for the climate change effects of:
  - warming ground temperature (related to warming air T) causing embankment settlement and slope instability
  - increased surface runoff and creek/river flows
  - extreme events

# Permafrost in Canada



# Warm Permafrost

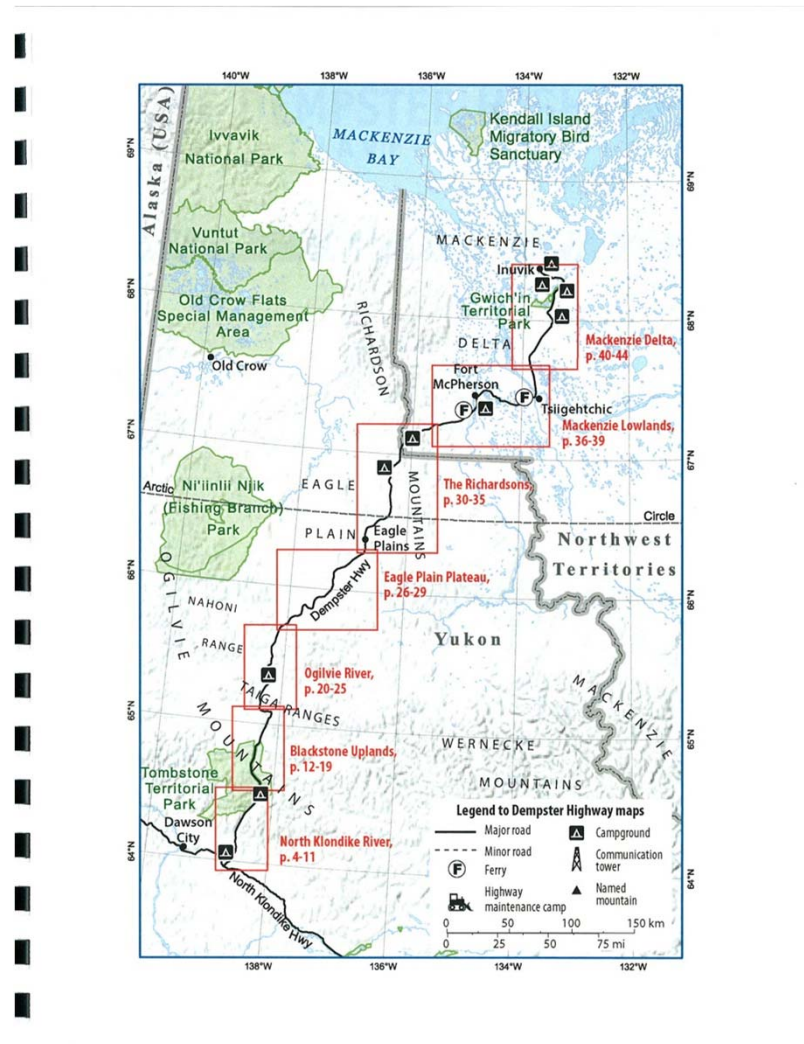
The Dempster Highway traverses primarily warm permafrost, especially susceptible to minor changes in Air T (and ground T)

Warm Permafrost ( $T > -2^{\circ}\text{C}$ )

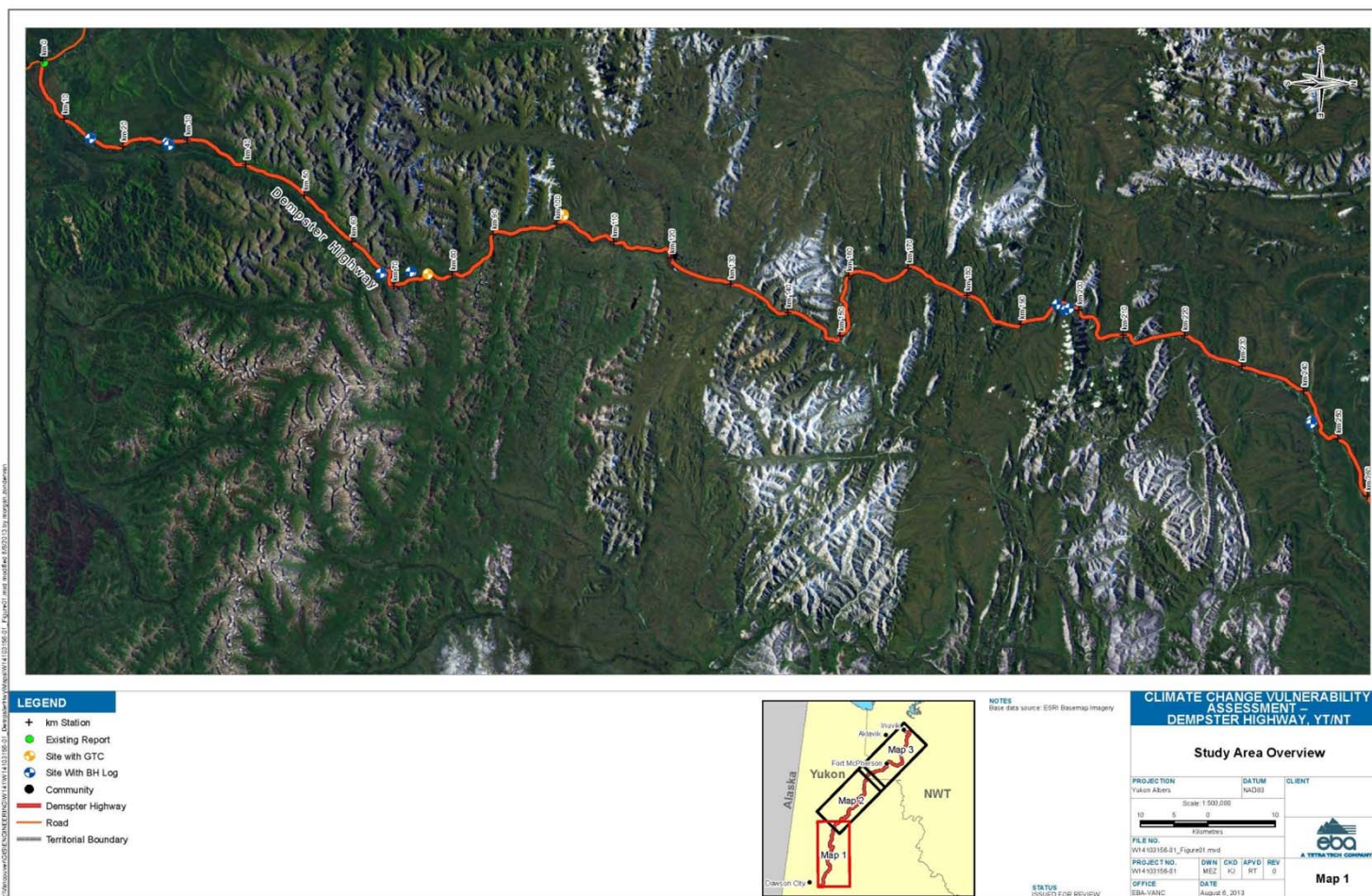
# Dempster Highway Ecoregions

- km 0 - 73 North Klondike River
- km 73 - 160 Blackstone Uplands
- km 160 – 246 Ogilvie River
- km 246 – 390 Eagle Plain Plateau
- km 390 – 42 (NT) Richardson Mountains
- km 42 – 142 Peel Plateau
- km 142 – 272 Mackenzie Delta

# Ecoregions along the Dempster Highway



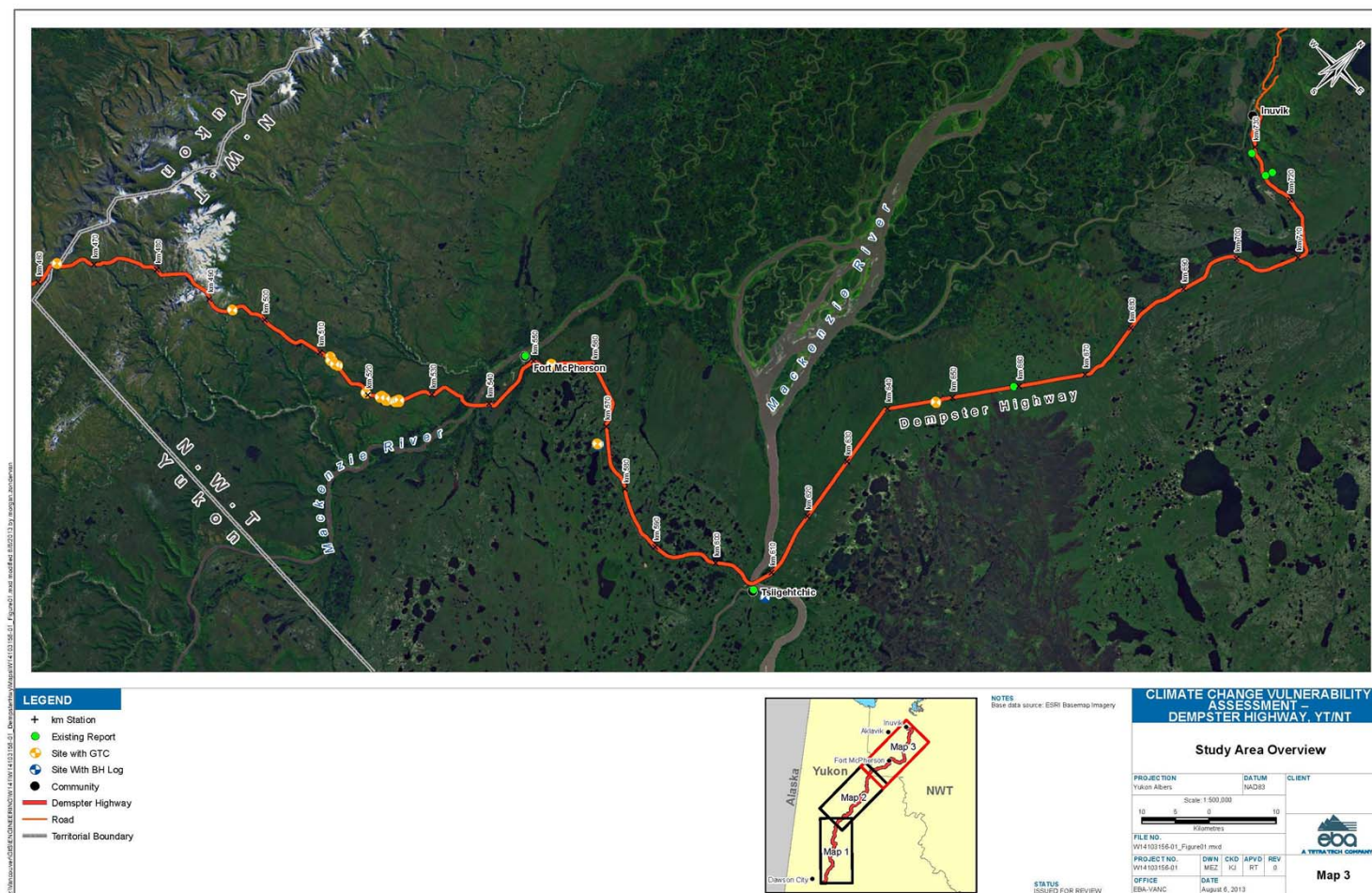
# Klondike Highway to km 250



# km 250 to YT/NT Border



# YT/NT Border to Inuvik



# Blackstone Uplands km 96 – collapsing ice wedges



# Blackstone Uplands km 96 – collapsing ice wedges



# Blackstone Uplands km 96 – collapsing ice lenses



# Blackstone Uplands km 103 – Two Moose Lake



# Blackstone Uplands km 109 – slide in moraine



# Blackstone Uplands/Chapman Lake – km 122 highway realignment



# Blackstone Uplands/Chapman Lake – km 122 km 122 highway realignment



# Blackstone Uplands/Chapman Lake – km 122 highway realignment



# Blackstone Uplands/Chapman Lake – highway realignment



# Blackstone Uplands – Chapman Lake Area – patterned ground at km 124



# Ogilvie River – Engineer Creek Culverts km 161



# Ogilvie River – erosion/slide repair km 177



# Ogilvie River – shale embankment km 192



# Ogilvie River Section – Engineer Creek bridge erosion km 195



# Ogilvie River – Engineer Creek bridge erosion km 195



# Ogilvie River – km 244 debris flow



# Ogilvie River – riprap protection at km 245 due to extreme event



# Richard Mountains – Flow next to (now undersized?) Culvert – km 415



# NWT section - Richardson Mountains – km 8.5 Accident Site



# Richardson Mountains – km 8.5 Accident Site



# Richardson Mountains – km 8.5 Accident Site



# Richardson Mountains – km 8.5 Accident Site



# Richardson Mountains – km 8.5 Accident Site



# Richardson Mountains – slope instability km 27



# Richardson Mountains – slope instability

## km 27



# Richardson Mountains – tension cracks in thick fill – km 30



# Richardson Mountains – tension cracks in thick fill – km 30



# Peel Plateau – slope failures away from highway – km 53



# Peel Plateau – slope failures away from highway – km 53



# Peel Plateau – tension cracks - km 59



# Peel Plateau – tension cracks and poor drainage - km 59



# Tourist at Midway Lake pit



# Peel Plateau – ponded water and culvert distress at km 90



# Mackenzie Lowlands – Communication Tower pad settlement – km 107



# Mackenzie Delta – pad settlement at km 182



# Mackenzie Delta – pad settlement at km 182



# Mackenzie Delta – massive ground ice and sinkhole in cut area – km 227



## Next Steps

- There is evidence that climate change is contributing to Dempster Highway maintenance requirements
- It is difficult to separate climate change effects from normal maintenance, although the maintenance personnel we've spoken to seem to agree maintenance requirements are increasing, and have also noted that random "sinkholes" are appearing more frequently than normal
- The data will be analyzed and then presented at a workshop to be attended by both NT and YT maintenance "foremen/forewomen" to determine if maintenance practices need to be revised to include the effects of climate change
- The available data that we're aware of has been collected – is there enough to complete a formal Vulnerability Assessment?

# Participants



Richard Trimble – EBA

Don Hayley – Hayley Arctic Geoconsulting (and photographer)

Greg Cousineau – NT Highways

Steve Kokelj NT Gov't (to YT/NT border)

Gurdev and Arvind – NT Highways Maintenance (to YT/NT border)

Chris Burn – Carleton University

Sandra Orban – YT Highways (from Eagle Plains)

-other highways maintenance foremen/women

Thank You