Fate and Transport of Wheat in the Athabasca River: R&D in the context of a grain derailment response strategy

Karla Graf
Loni Waldner, P.Eng.

Objectives

- Provide sustainable remediation by minimizing the environmental impacts to the aquatic environment through understanding the risks
- Decision-making by integrating the triple bottom line (environment, society, economy)
- Understanding the importance of Research and Development (R&D) as consultants and the benefits to our Clients
- Present a case where the opportunity for R&D was recognized during an emergency response

What you need:

- Scientific or Technological Uncertainty
- Scientific or Technological Advancement
- Record of Hypothesis and Results

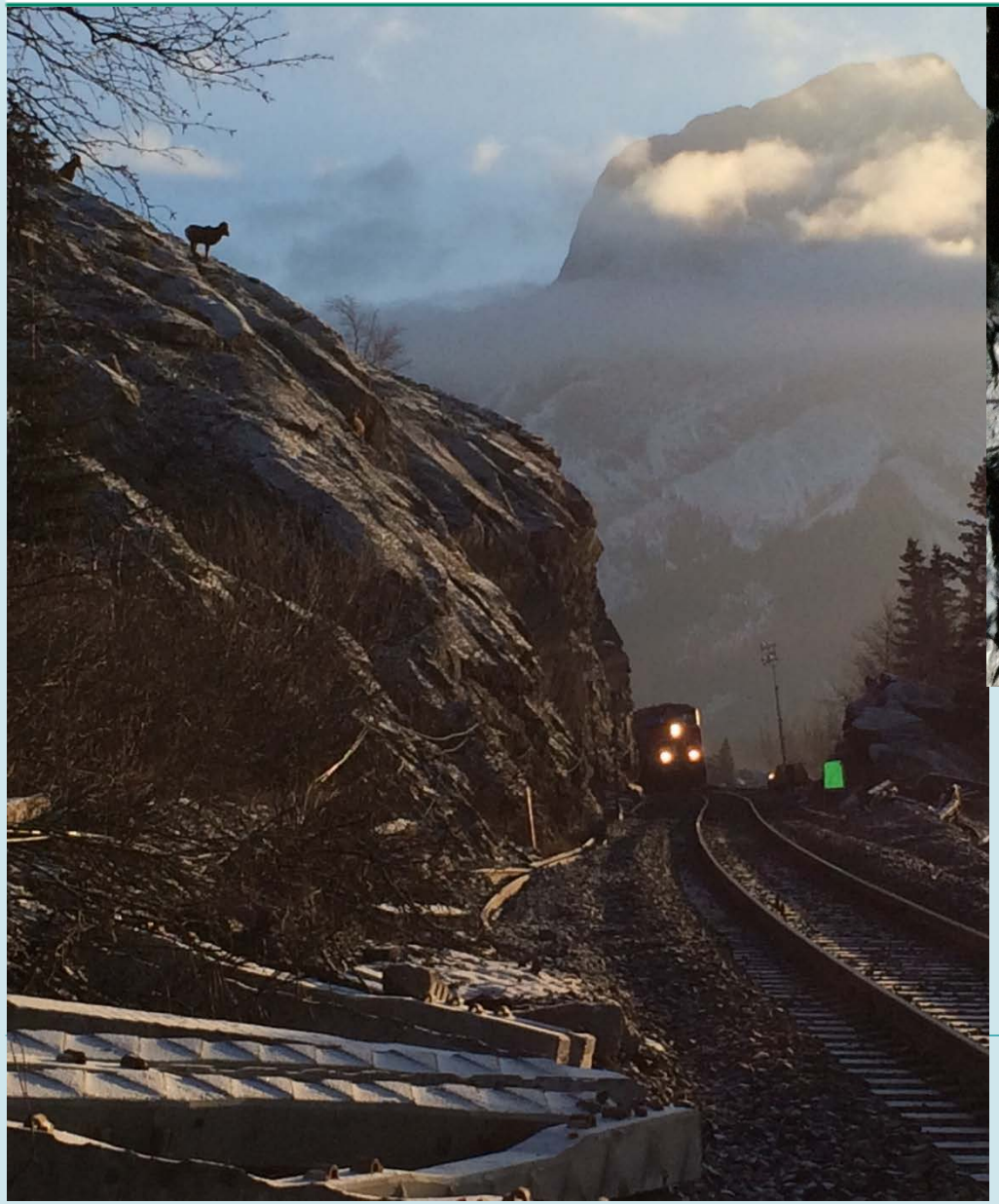
Site Location and Setting

Derailment Top View

Fate and Transport of Wheat in the Athabasca River

- Regulatory authorities felt that there was a potential risk
- Grain spills have occurred previously in aqueous environments --- but have not been investigated as a potential environmental risk
- No relevant scientific documentation of physical and chemical behaviour of wheat kernels in aqueous systems
- Golder performed a quantitative evaluation of the fate and transport of wheat in the Athabasca River

Challenges at the Site



Protection of Wildlife

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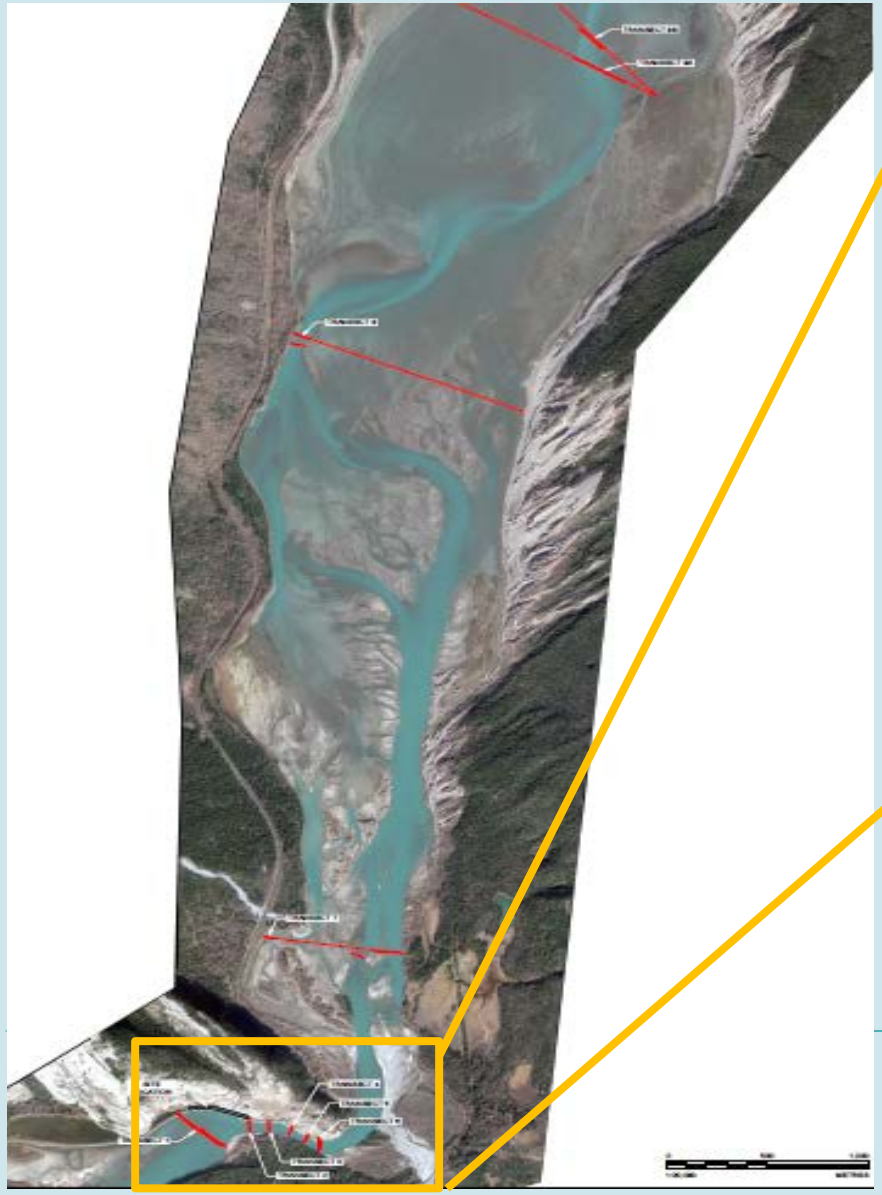
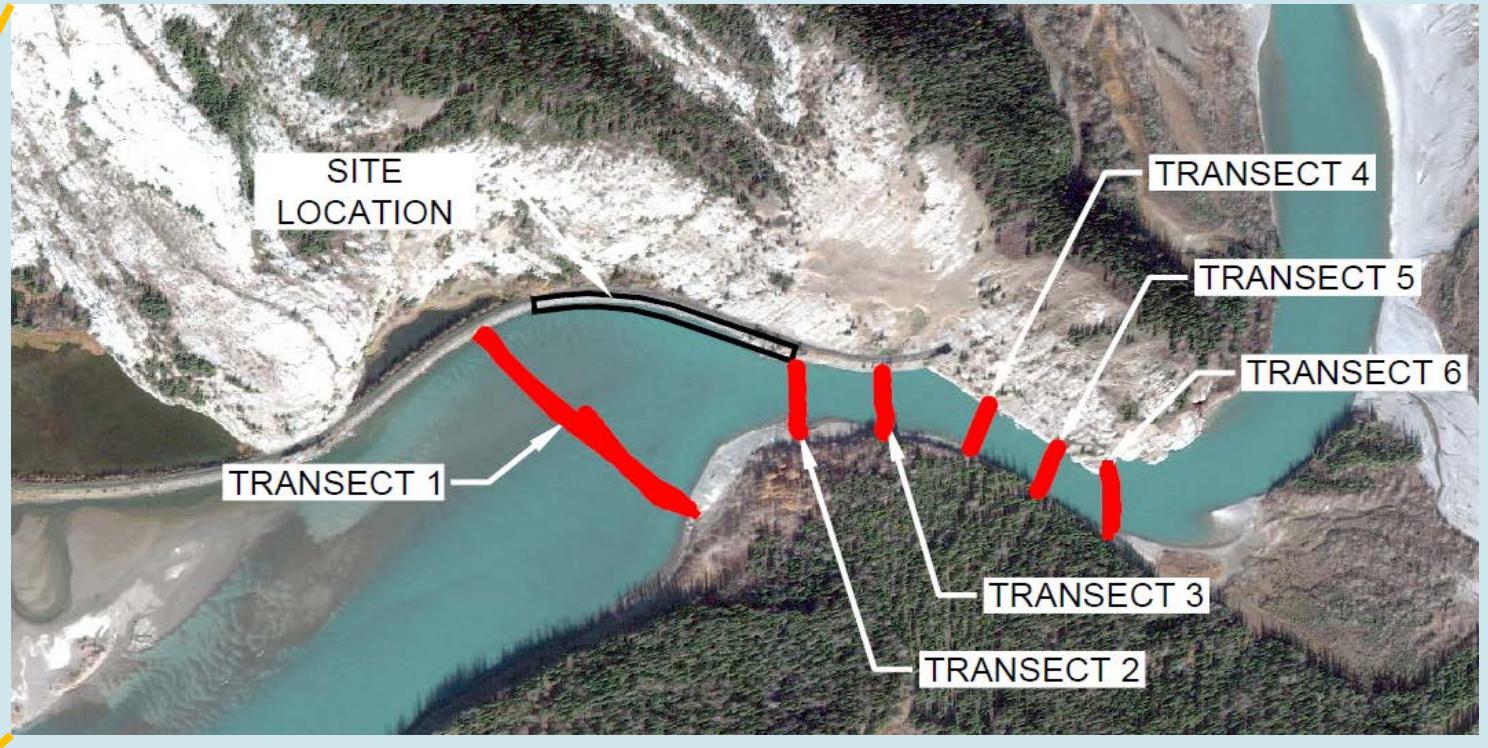
Site Background and Context





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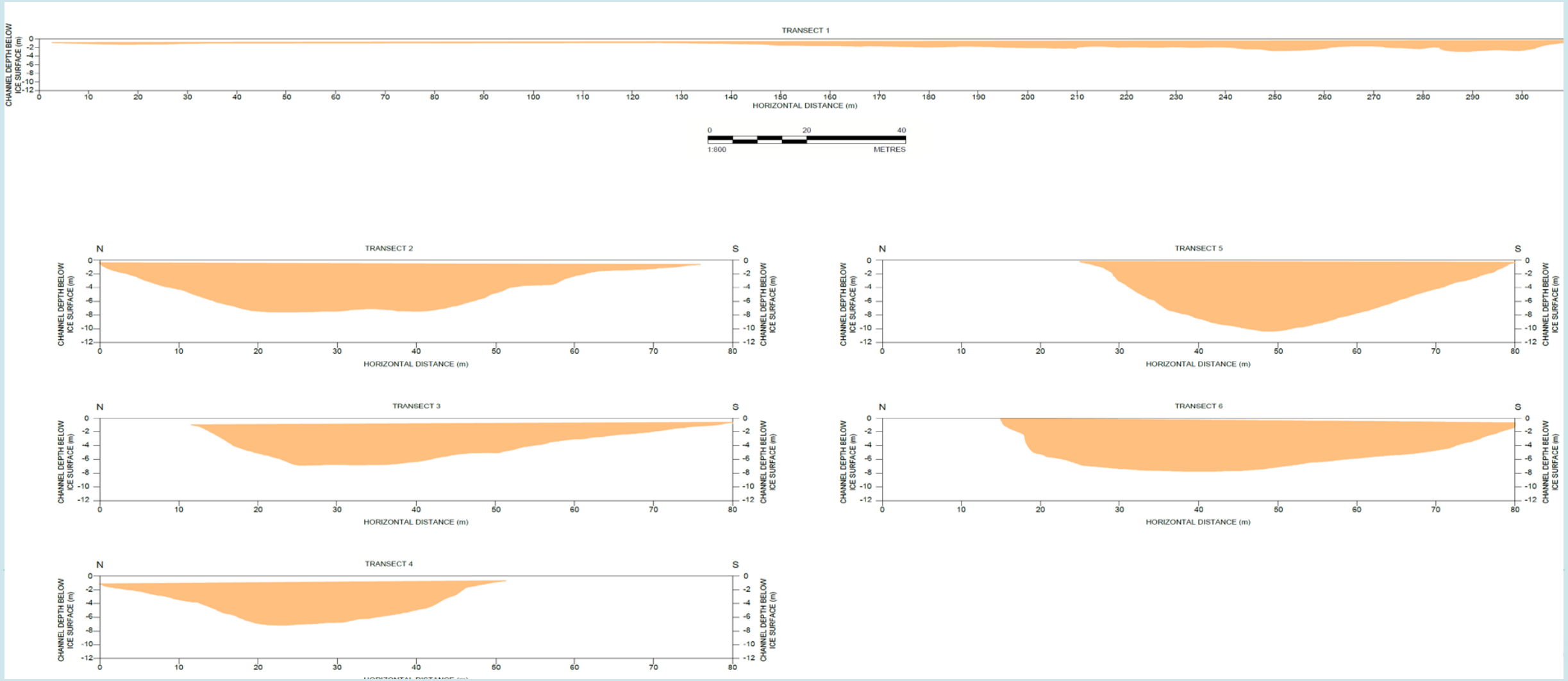
Data Gap Analysis

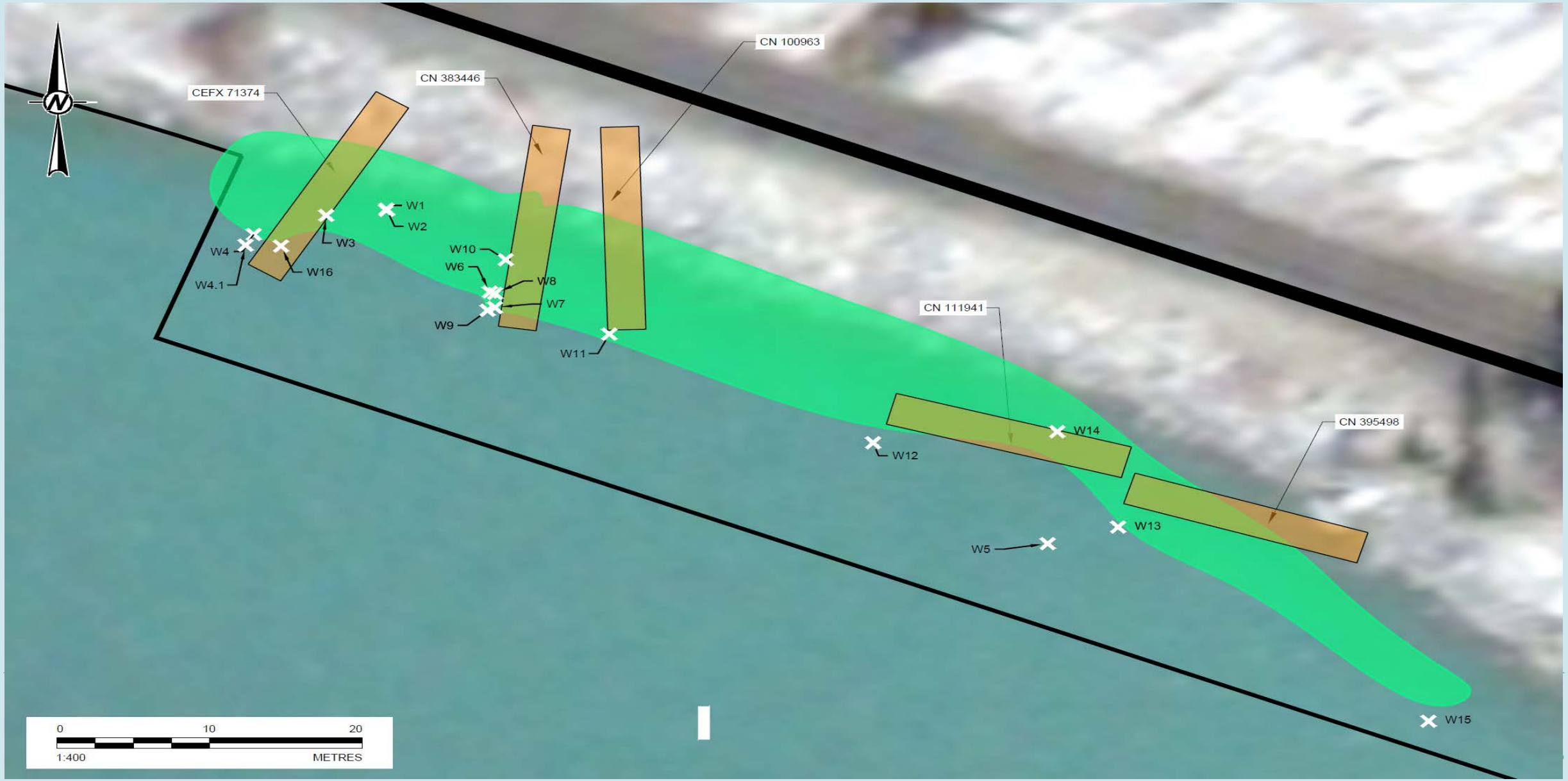
Data Gap	How the Data Gaps were Addressed
Channel geometry in vicinity of the Site	On-ice Ground penetrating radar (GPR) survey Satellite imagery
Characteristics of the bed and bank of the river in vicinity of the Site	Visual observations Satellite imagery
Discharge of the river (volume of flow per unit time)	Data from existing hydrometric stations (one upstream and one downstream) used to estimate discharge at Site
Hydraulic behaviour of wheat kernels	Laboratory tests with wheat obtained from the Site
Impact of submerged wheat on water quality	High-frequency water quality monitoring and sampling Literature review

Channel Geometry and Bathymetry

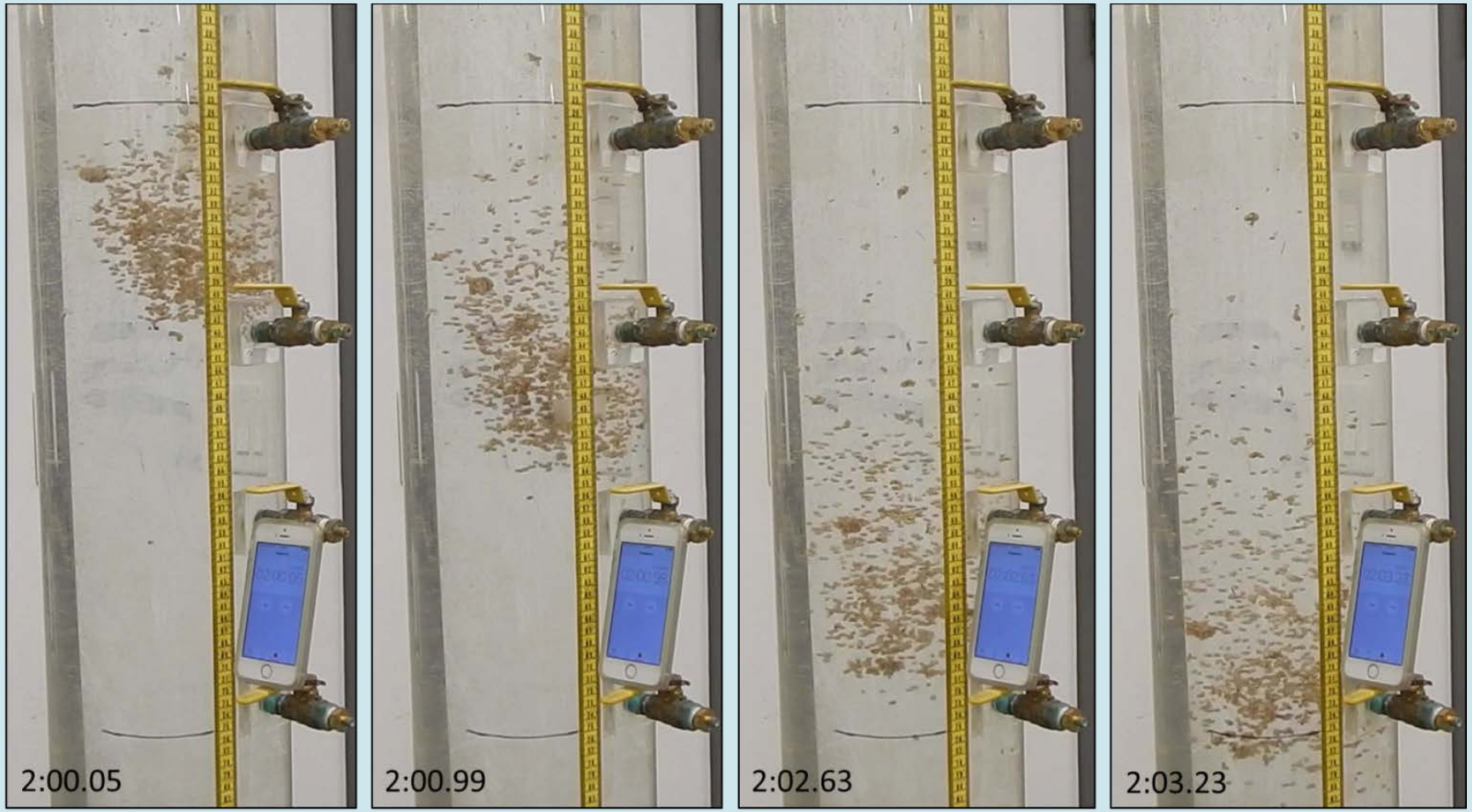
- GPR was used at the transects of the Athabasca River starting approximately 90 m upstream to approximately 450 downstream of the derailment as input to the hydraulic analysis



Wheat Distribution Below The Ice

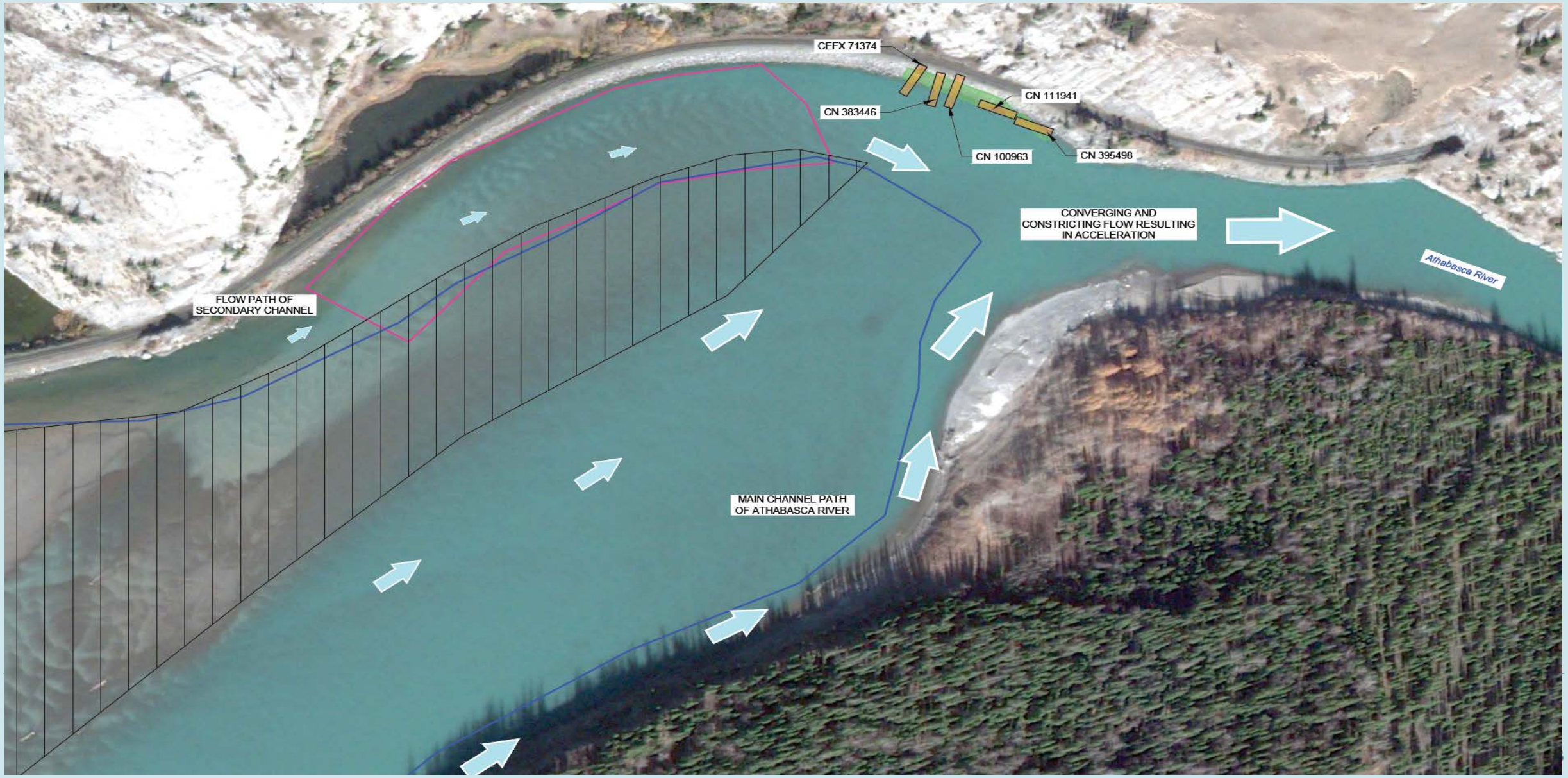


Wheat Settling Velocity

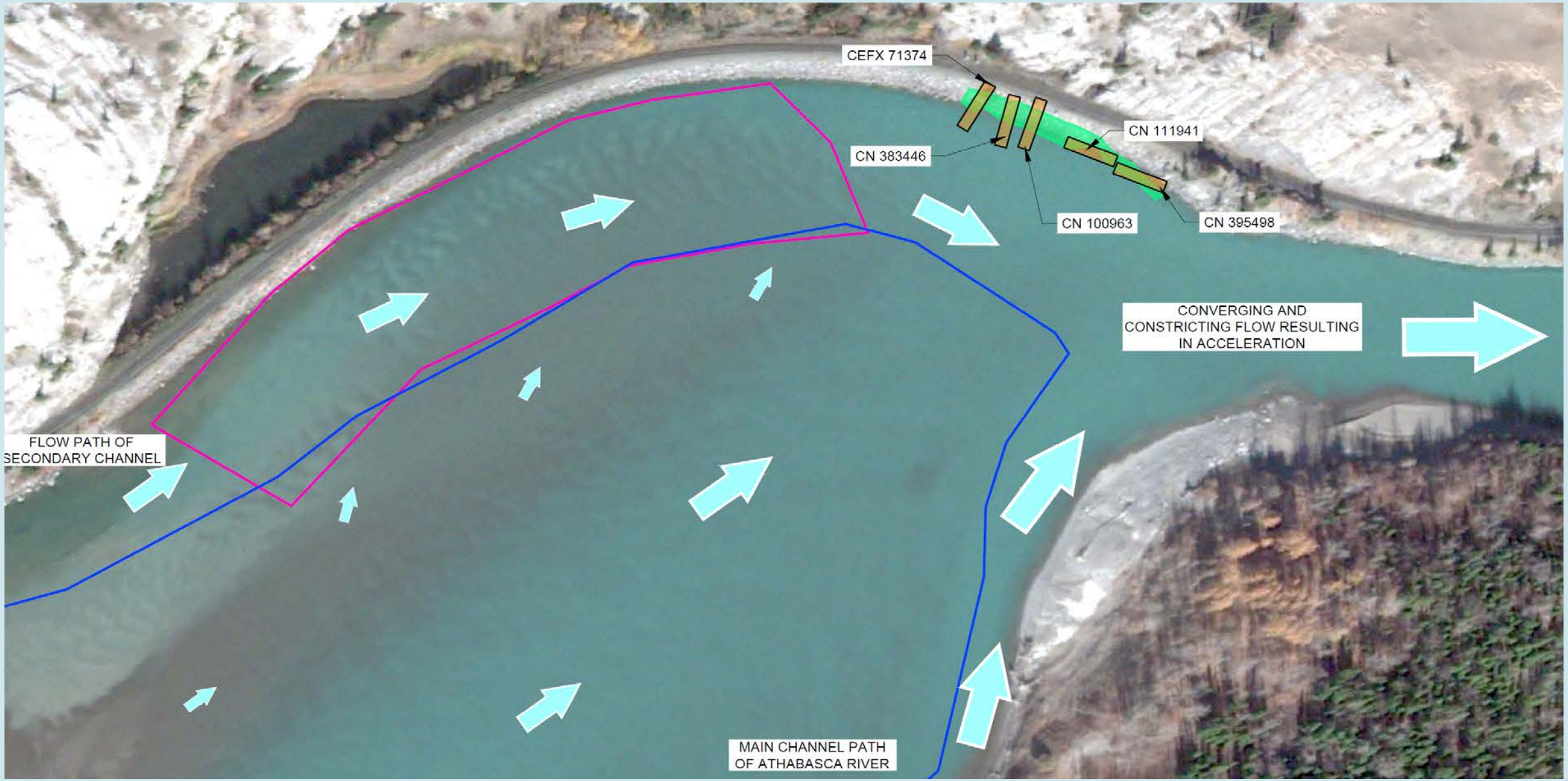


Photograph 1: Images from the video recording of a dry group settling test. The time on the stop clock is shown in the bottom left of each frame.

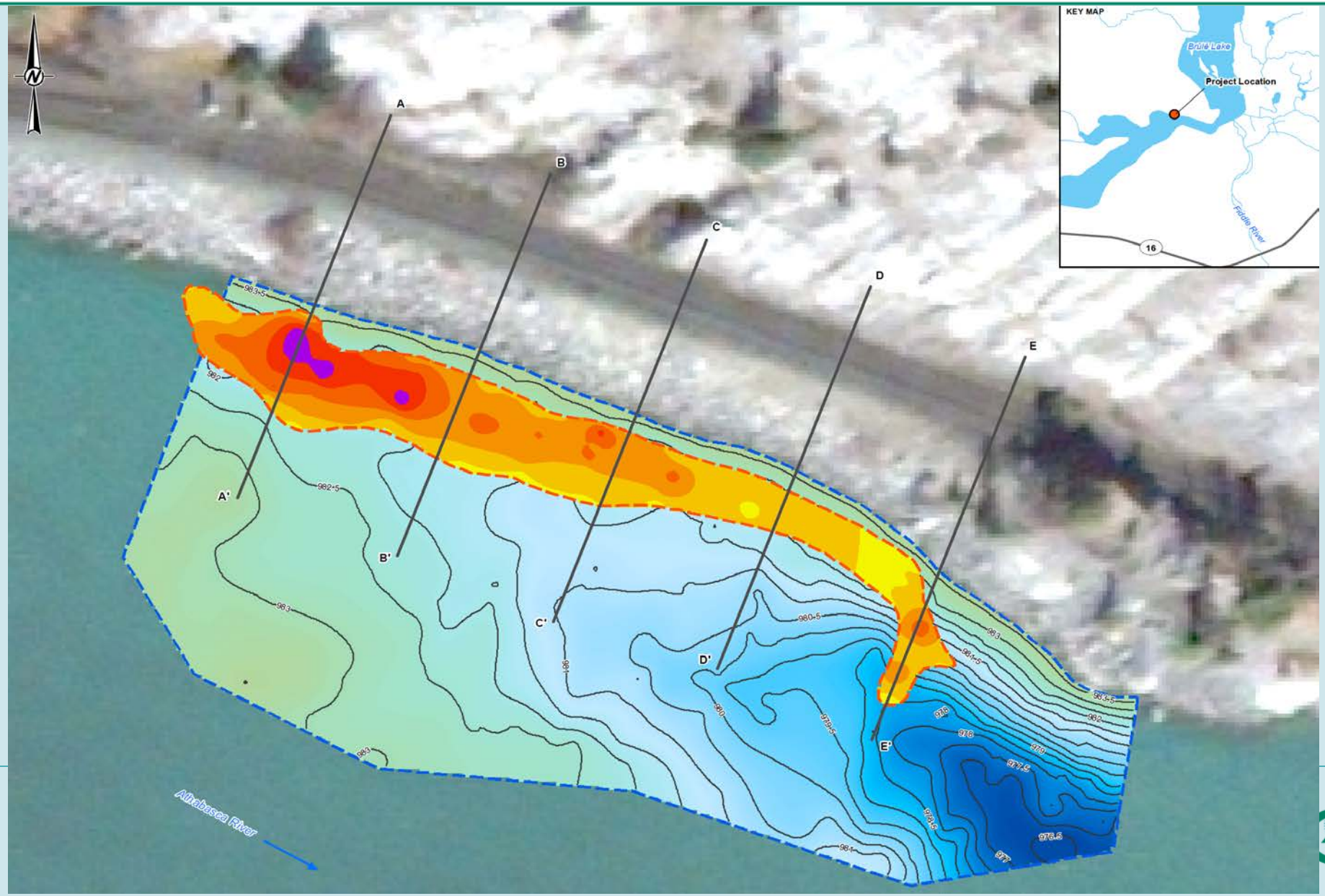
Flow Model at Time of Derailment



Flow Model at Spring Freshet

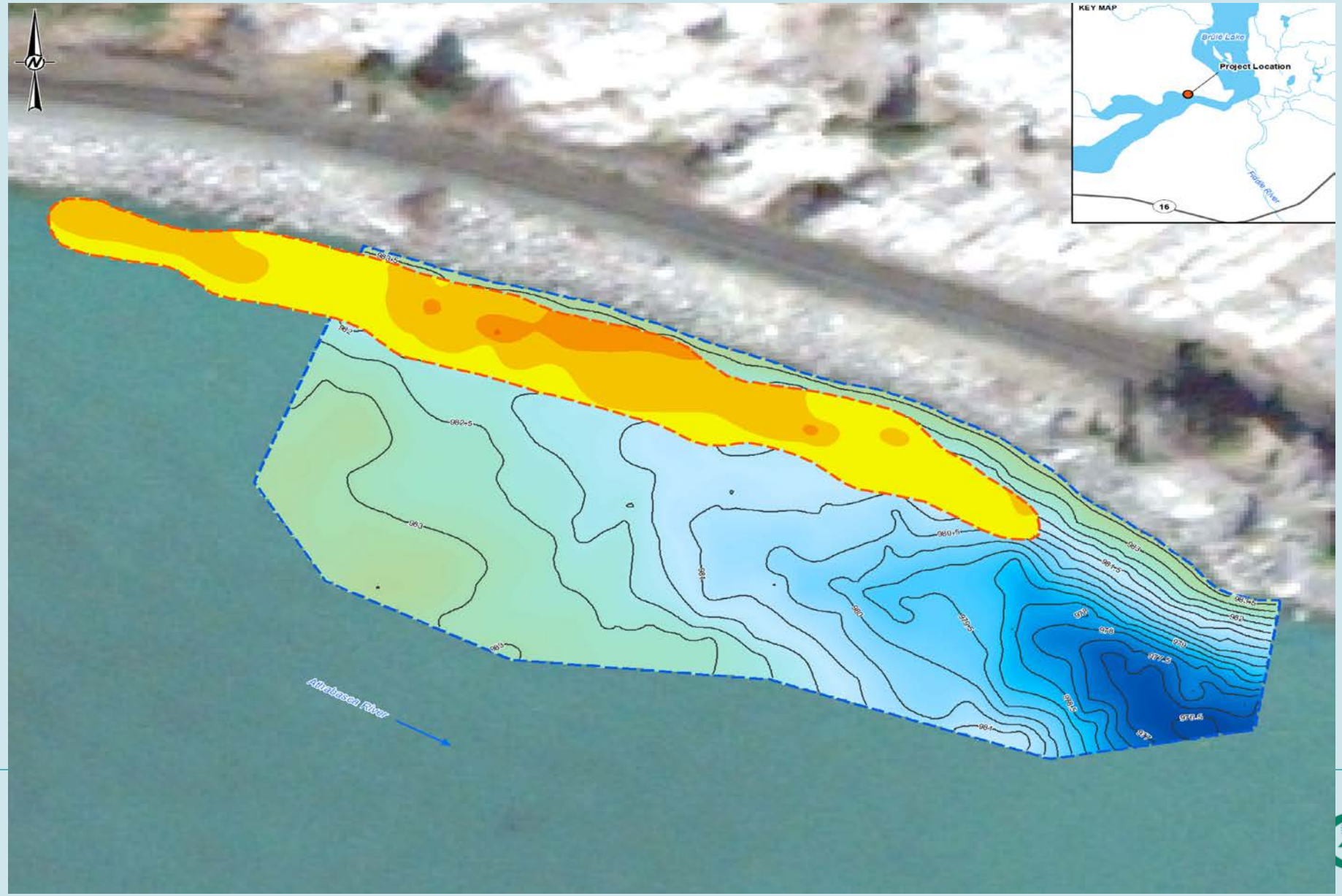


River Bathymetry and Wheat Deposition



Submerged Wheat Recovery

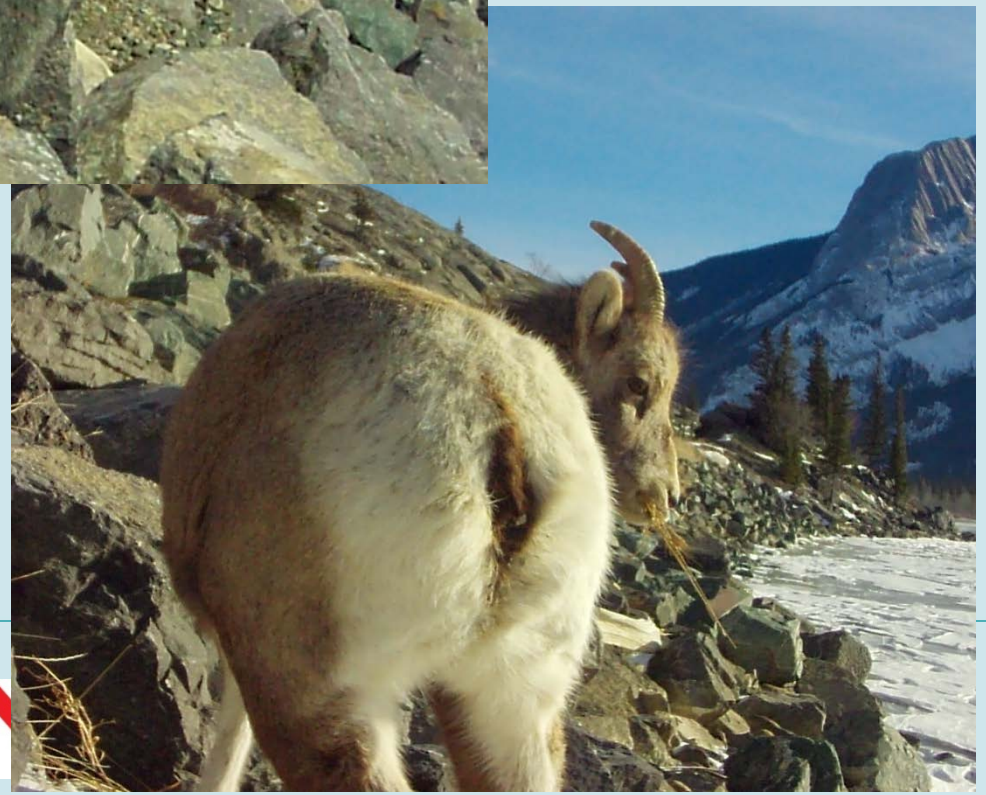
Post-Recovery Dive Survey

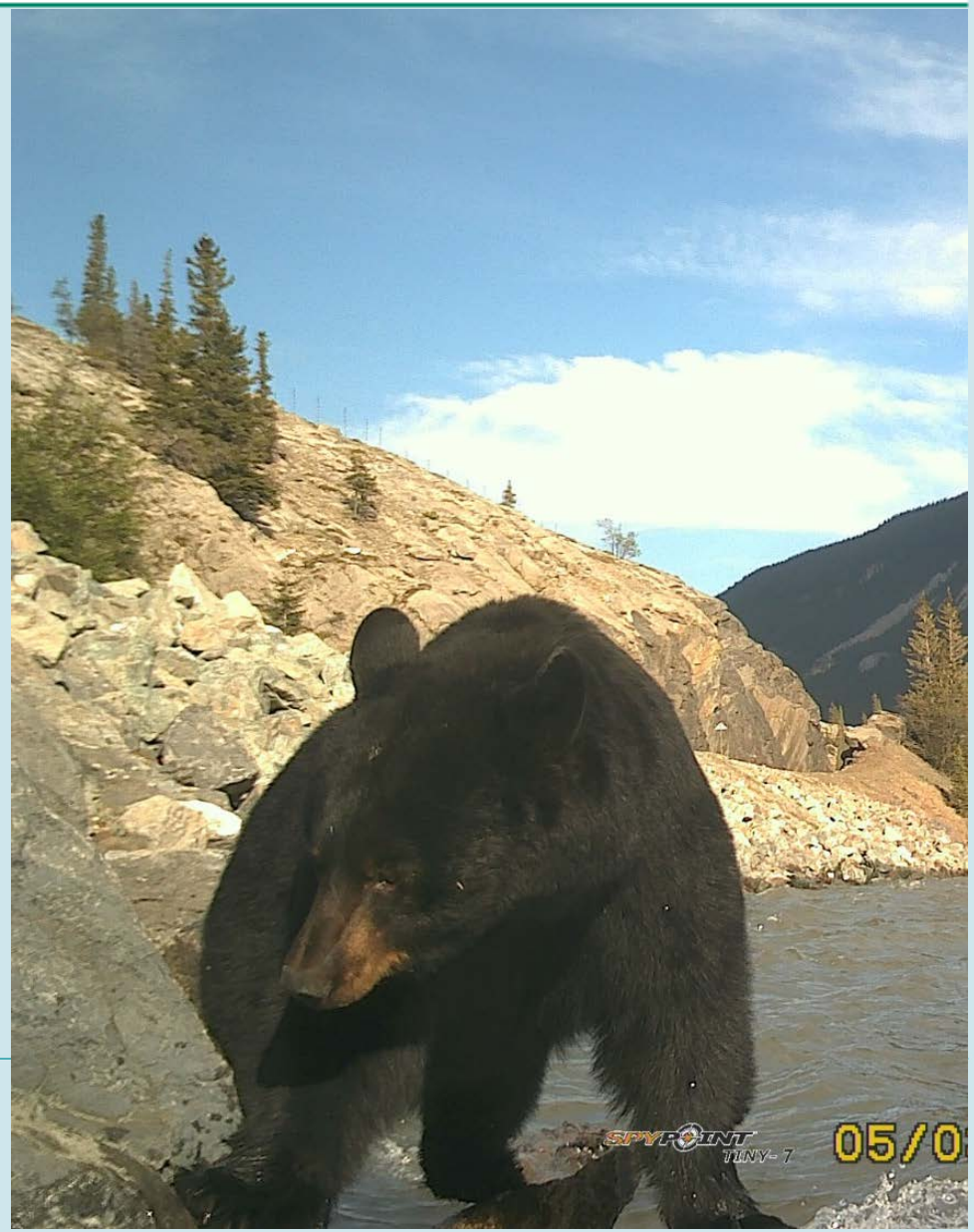


Monitoring of the Site

- Monitoring, maintaining and downloading wildlife cameras deployed on-Site
- Instream water quality monitoring during all instream rail car removal efforts
- Collecting analytical water quality data from the Site, upstream and downstream of the Site with Brûlé Lake on a monthly basis from June 2016 to February 2017

Wildlife Monitoring





Water Quality

Laboratory-measured pH	Dissolved Chloride (Cl)
Laboratory-measured Specific Conductivity	Dissolved Calcium (Ca)
Bicarbonate (HCO_3)	Dissolved Iron (Fe)
Carbonate (CO_3)	Dissolved Magnesium (Mg)
Hydroxide (OH)	Dissolved Manganese (Mn)
Alkalinity (PP as $CaCO_3$)	**Orthophosphate (P)**
Alkalinity (Total as $CaCO_3$)	**Dissolved Phosphorus (P)**
Anion Sum	**Total Phosphorus (P)**
Cation Sum	Dissolved Potassium (K)
Hardness ($CaCO_3$)	Dissolved Sodium (Na)
Ion Balance	Dissolved Sulphate (SO_4)
Total Ammonia (N)	Total Dissolved Solids
Dissolved Nitrate (NO_3)	Total Suspended Solids
Nitrate plus Nitrite (N)	Turbidity
Dissolved Nitrite (NO_2)	**Biochemical Oxygen Demand**
Dissolved Nitrite (N)	**Un-Ionized Ammonia (NH3) as N @ 15C**
Dissolved Nitrate (N)	pH @ 15C
Nitrogen, Kjeldahl	

Post-Freshet Dive Survey

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Conclusion

- Recognizing R&D opportunities can result in both innovative approaches and reduce environmental impacts and costs
- R&D opportunities can arise in any scope of work allowing for the advancement of scientific knowledge