Living on Ice-rich Permafrost:
50 years to a slow-moving disaster in Point Lay, Alaska

Tribal Resilience Learning Network | April 19, 2023

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50 years of history and change
due to climate and infrastructure

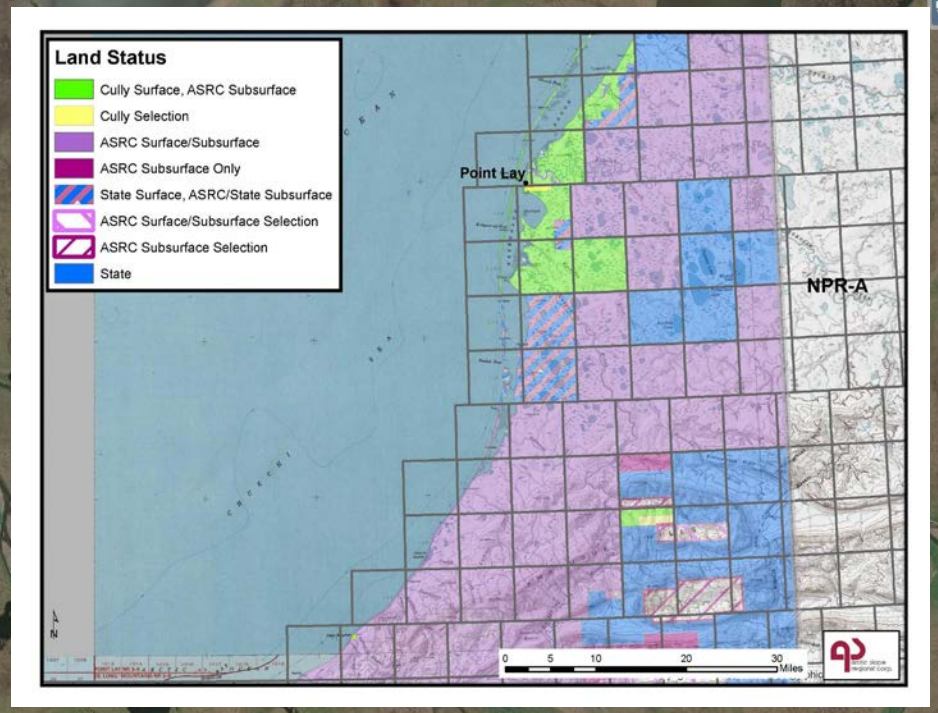
Point Lay, Alaska

History of Relocation

original

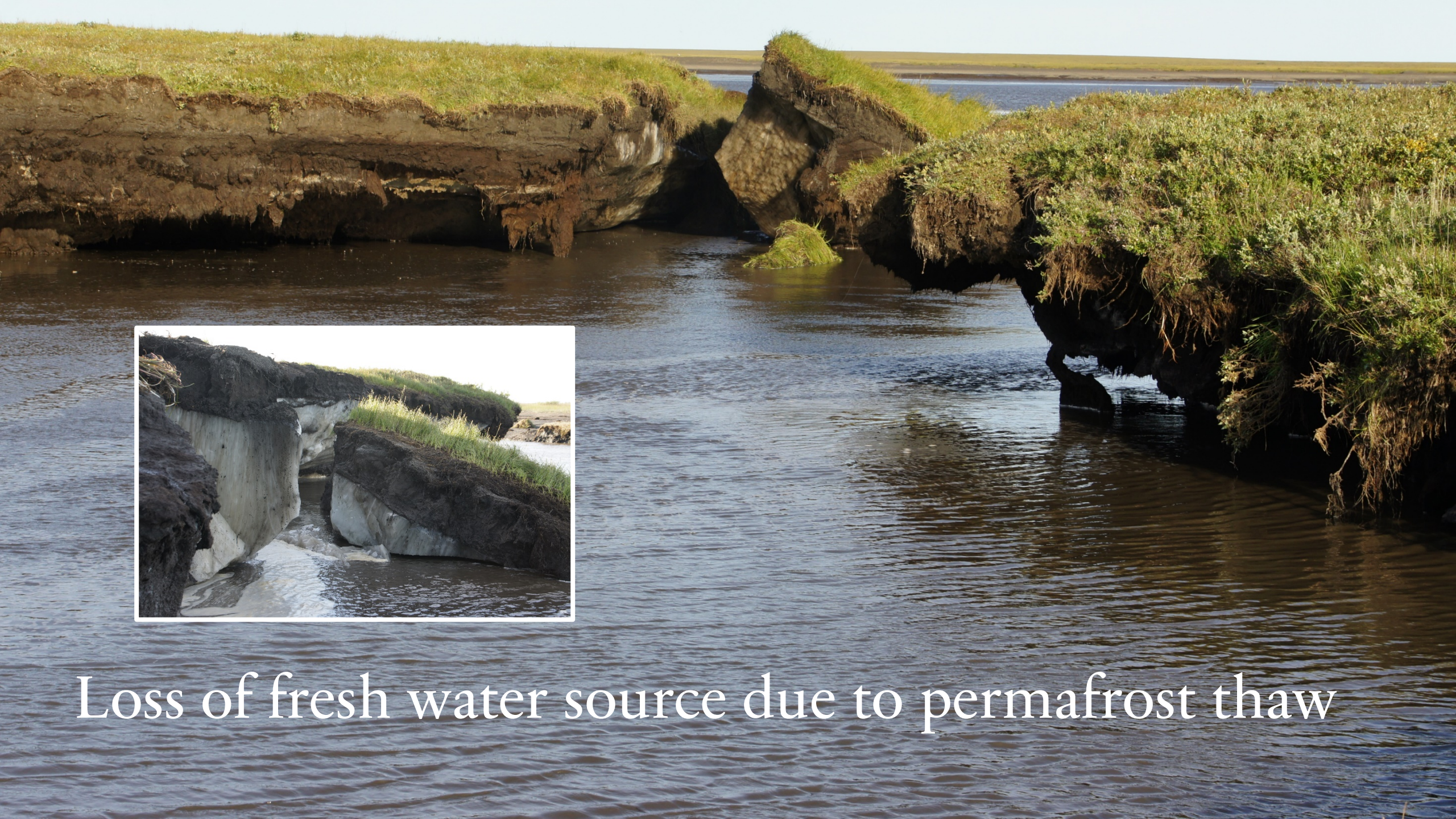
1972

1980



The village grows…

Where snow accumulates the tundra thaws



Loss of fresh water source due to permafrost thaw

Drained lake reveals DEW line debris

Water Storage tank failure

Lost 1 million gallon tank
due to unmonitored thermosiphon
failure and ground subsidence

Water main ruptures / fire hydrant failure / sinkholes

Water & sewer failures / abandoned homes, washeteria

Thermokarst & Ponding

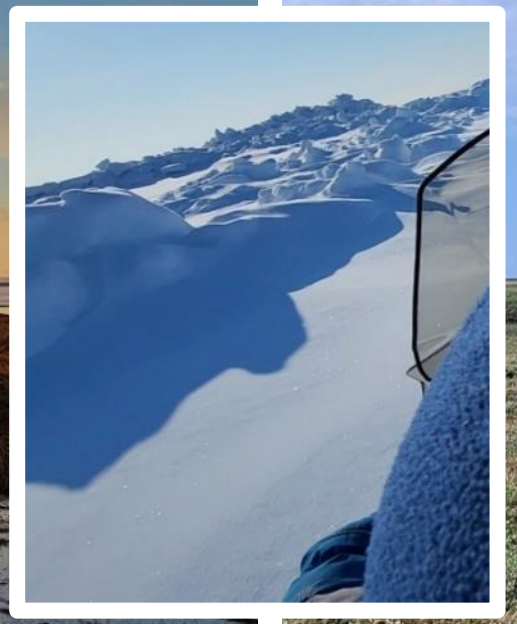
One story houses become two stories

And yet…

Community life, subsistence, health & safety

KUOIQSIK CURTIS

Impacts on summer & winter travel and subsistence activities



Lake breach cut access to a primary hunting trail

Coastal erosion / Loss of coastal trails

Ice cellar failure

Walrus haul out

Other risks to life, health & safety

BILLY CONNOR

2022 research activities, findings and recommendations

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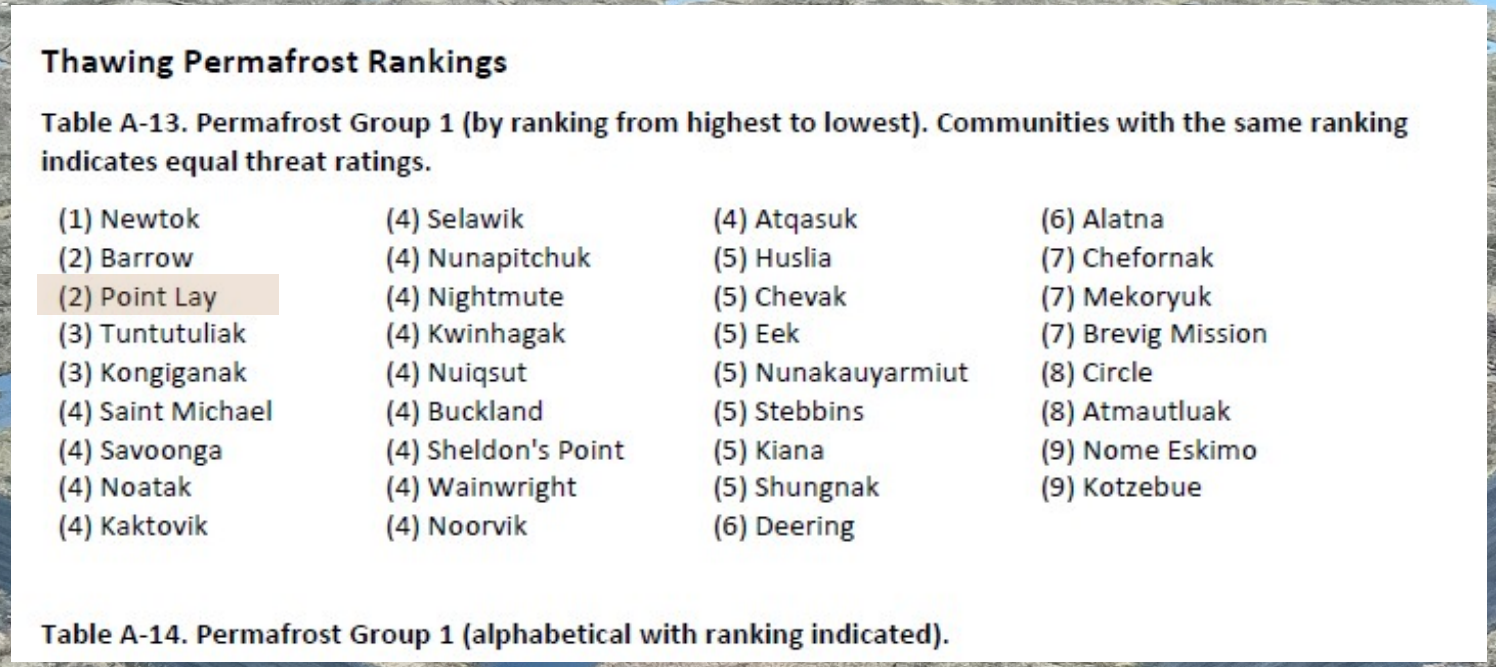
June 2022

Alaska Communities Vulnerable to Permafrost Related Hazards

Alaska Vulnerability Assessment

Sponsored by the Denali Commission



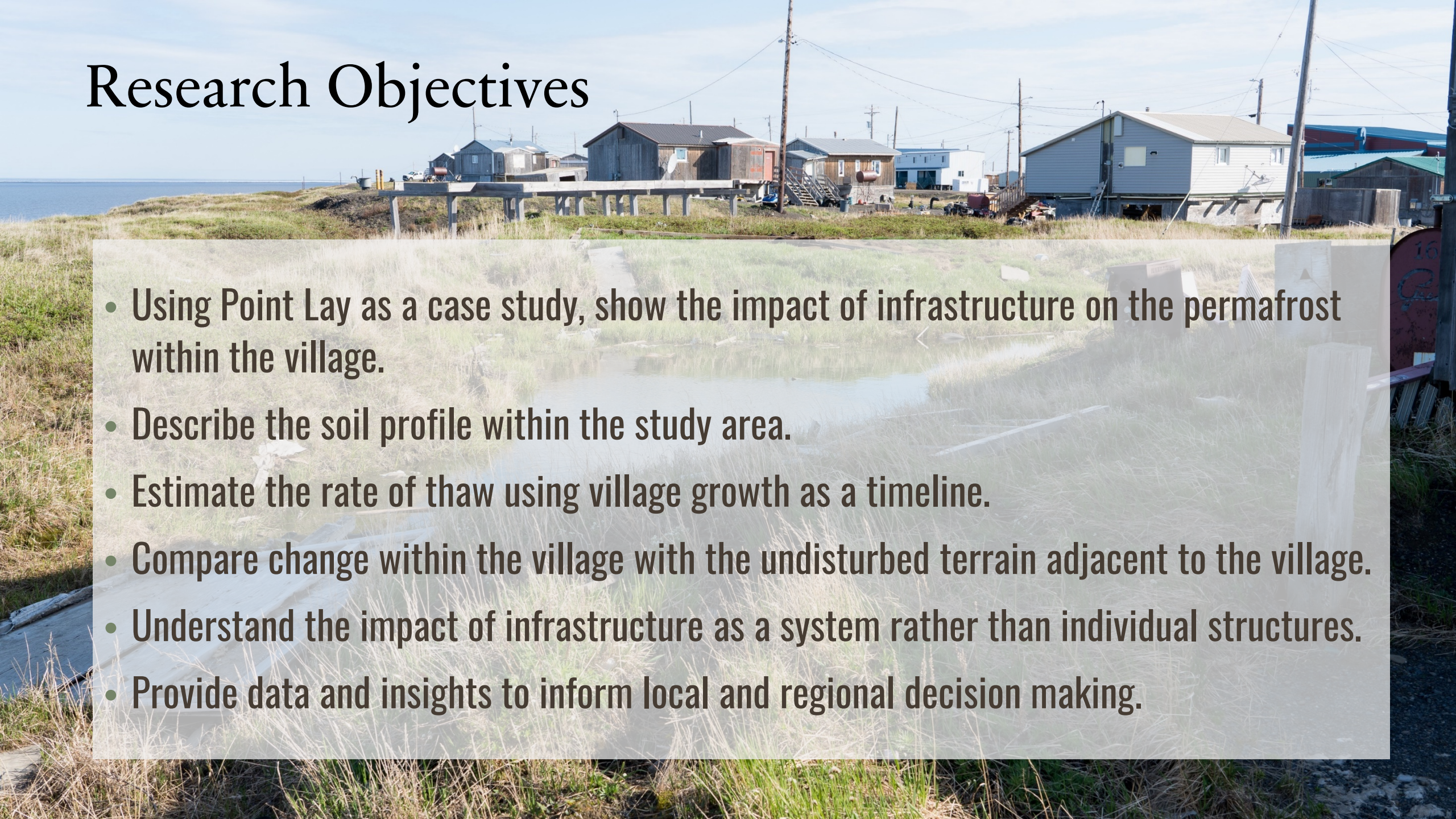
Thawing Permafrost Rankings

Table A-13. Permafrost Group 1 (by ranking from highest to lowest). Communities with the same ranking indicates equal threat ratings.

(1) Newtok	(4) Selawik	(4) Atqasuk	(6) Alatna
(2) Barrow	(4) Nunapitchuk	(5) Huslia	(7) Chefornak
(2) Point Lay	(4) Nightmute	(5) Chevak	(7) Mekoryuk
(3) Tuntutuliak	(4) Kwinhagak	(5) Eek	(7) Brevig Mission
(3) Kongiganak	(4) Nuiqsut	(5) Nunakauyarmiut	(8) Circle
(4) Saint Michael	(4) Buckland	(5) Stebbins	(8) Atmautluak
(4) Savoonga	(4) Sheldon's Point	(5) Kiana	(9) Nome Eskimo
(4) Noatak	(4) Wainwright	(5) Shungnak	(9) Kotzebue
(4) Kaktovik	(4) Noorvik	(6) Deering	

Table A-14. Permafrost Group 1 (alphabetical with ranking indicated).

Research Objectives



- Using Point Lay as a case study, show the impact of infrastructure on the permafrost within the village.
- Describe the soil profile within the study area.
- Estimate the rate of thaw using village growth as a timeline.
- Compare change within the village with the undisturbed terrain adjacent to the village.
- Understand the impact of infrastructure as a system rather than individual structures.
- Provide data and insights to inform local and regional decision making.

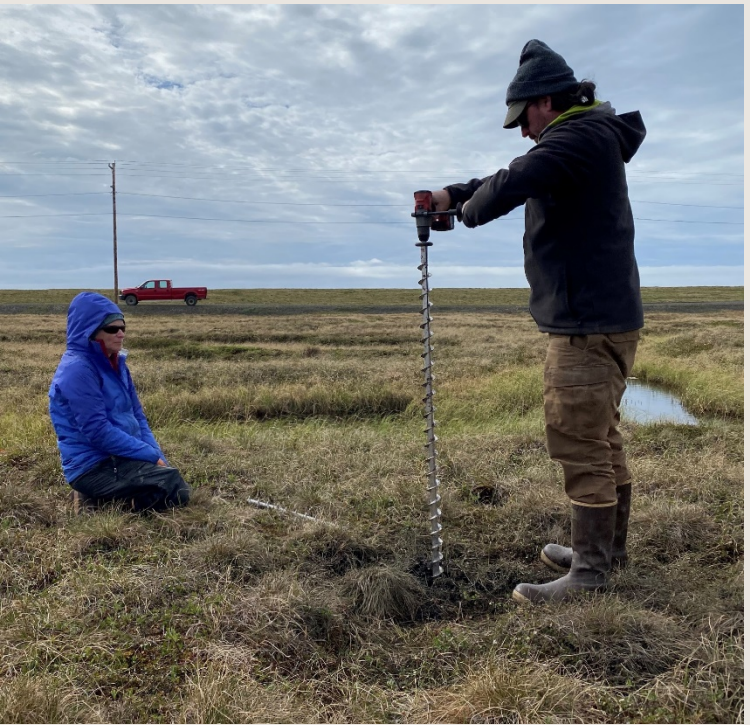
Community Interviews

Perceptions of landscape change, impacts on daily life, concerns, best practices for engagement

(with Tracie Curry, Northern Social-Environmental Research)

1. Local expert, NSB Assembly
2. Fire chief, S&R
3. Mayor's Office liaison
4. Lifelong resident, elder, Tribal president
5. Power Plant Operator, hunter
6. Young adult leader, village store clerk

Permafrost coring and ice wedge auguring to characterize ground ice content and depth



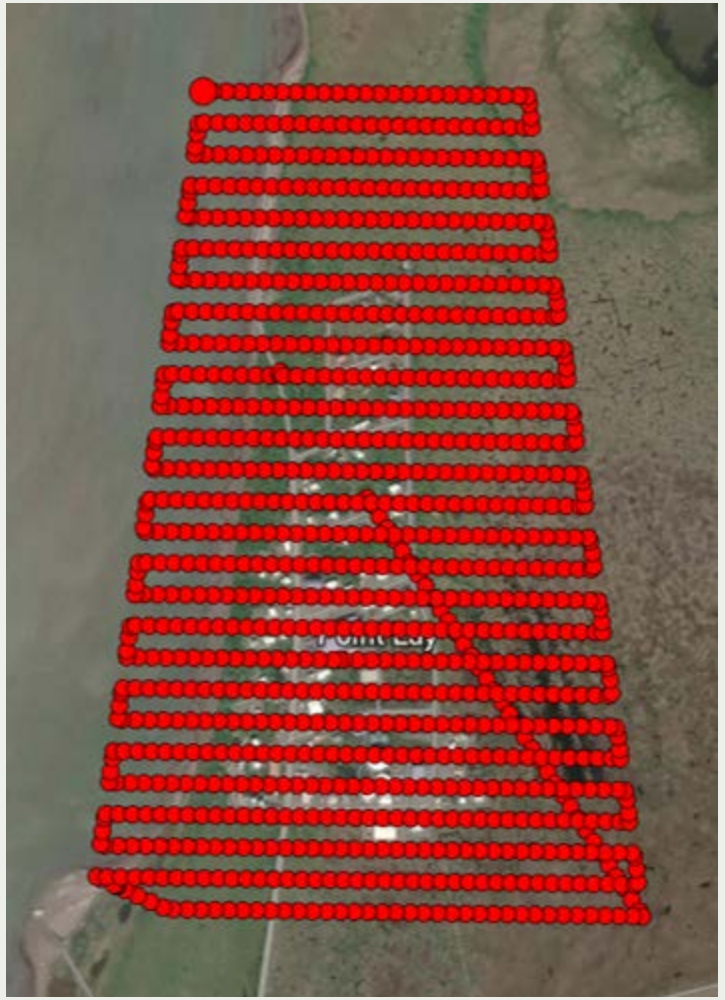
Findings

Most of the community is underlain by YEDOMA: a fine-grained, ice-rich permafrost. penetrated by large ice wedges. Ice wedges go to sea level and below (about 12 meters).

Wedge-content in yedoma may exceed 50% by volume. Thaw settlement may reach nearly 40% of the permafrost's thickness without taking ice-wedge volume into account.

Ground-ice content in the undeveloped area north of town is similar. Though the terrain is currently flatter, it would be vulnerable to thermokarst and thermal erosion if developed.

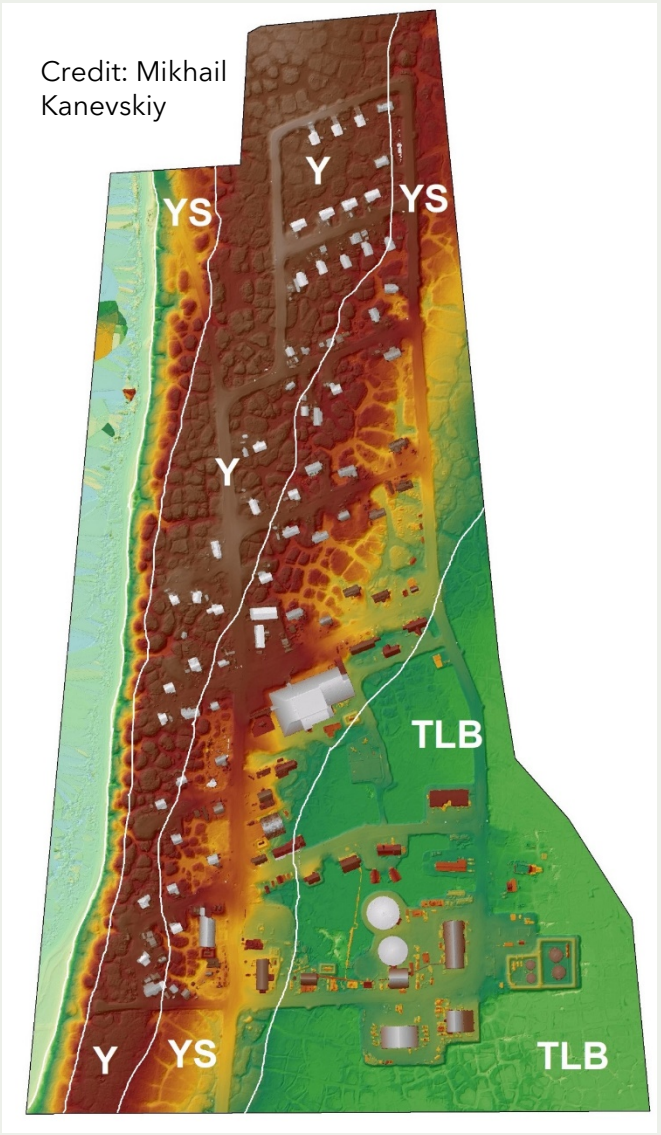
There is much less ice in the drained lake basin south and east of town. Ice wedges are much smaller and ice content usually not exceeding 15-20%. These low-lying basins are prone to flooding.



UAV survey of townsite

Using a quadcopter drone, we flew a survey grid over Point Lay with data tied down to WGS84 UTM Zone 3N Ellipsoid Heights

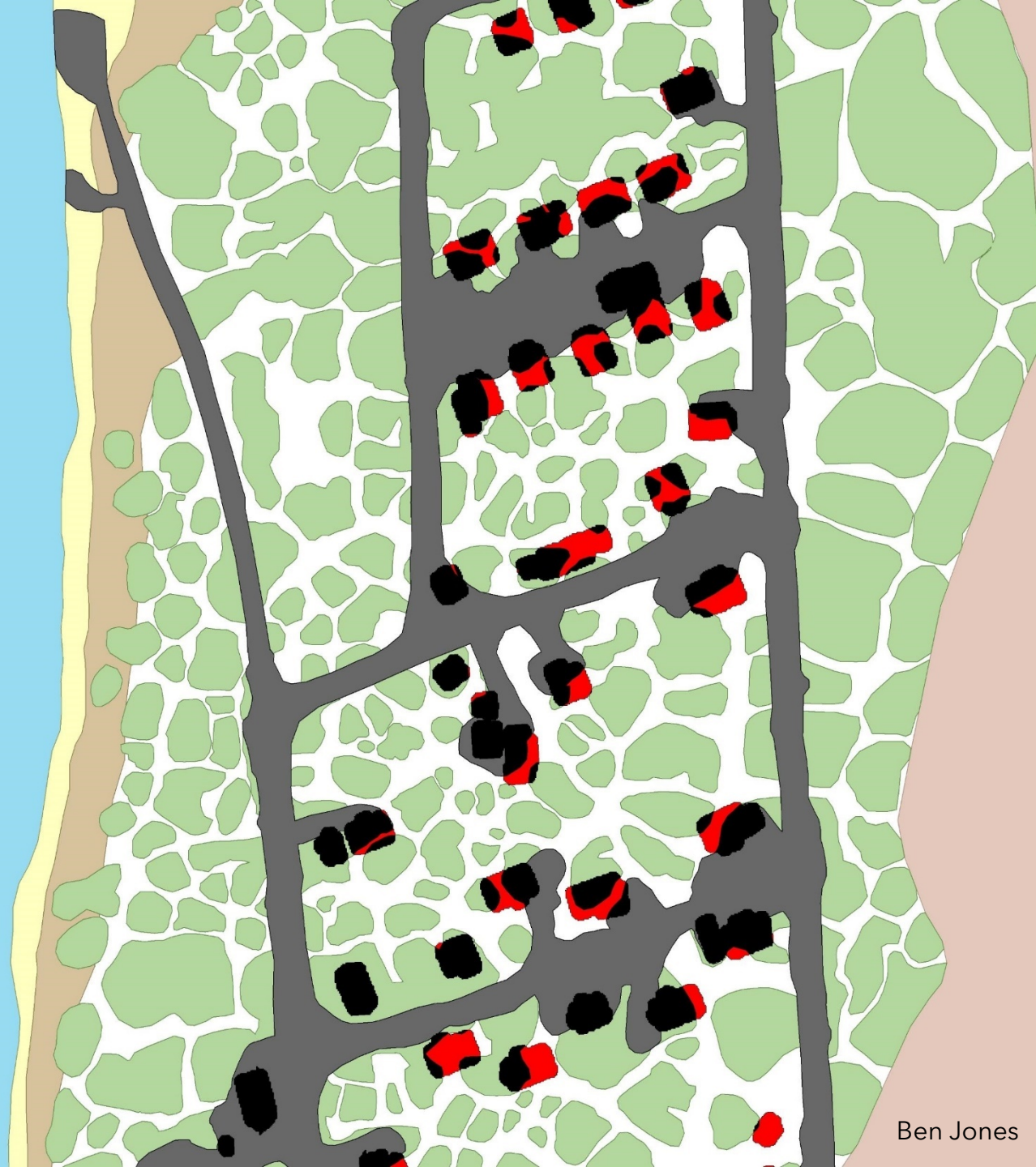
High-resolution drone data and imagery yielded a variety of research products with direct applications for community planning.



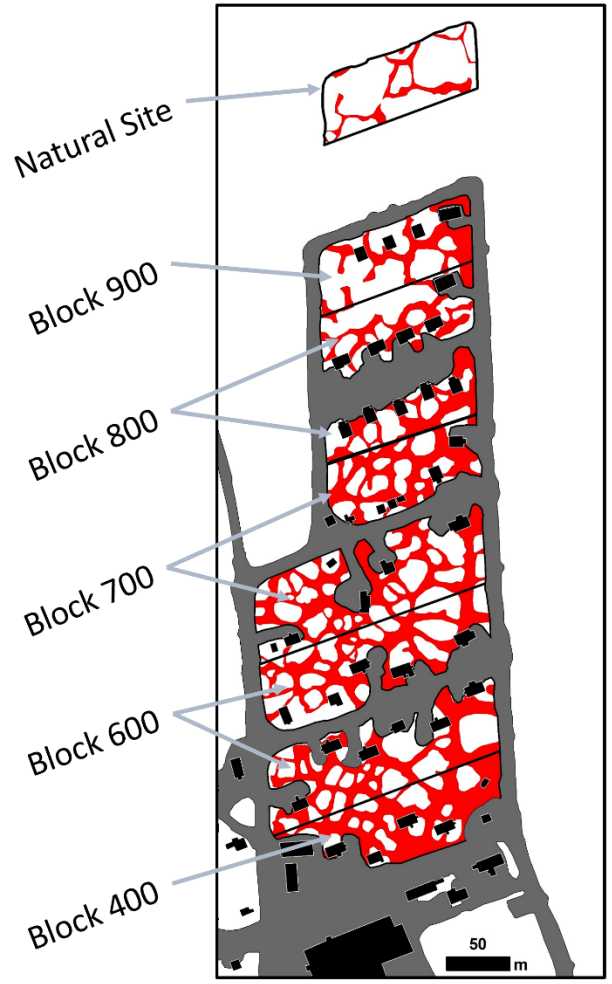
Digital terrain model: main yedoma surfaces (Y), yedoma slope (YS), and thaw lake basin (TLB)

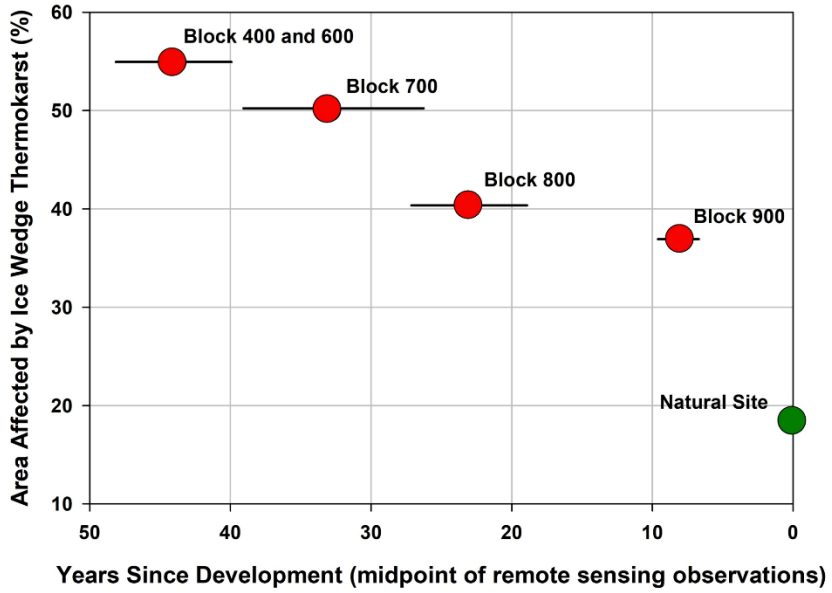
LEFT: Estimating the area of ice-rich permafrost (in red); RIGHT: The portion of the footprint of each home impacted by thermokarst.

An estimated 30% of piling founded in wedge ice which has often thawed 6 feet, leaving only 3 to 5 feet of embedment .



Ben Jones





Credit: Ben Jones

Infrastructure accelerates permafrost thaw and thermokarst

As the age of disturbance increases (moving north to south in the townsite), thermokarst increases and the condition of the structures deteriorates.

Note the “natural site” at top where the next housing blocks are proposed has much smaller area affected by thermokarst (green dot), even though the terrain is similar. This indicates that infrastructure is the major stressor.

There is a tendency to blame the failing infrastructure on climate change.

Takeaways

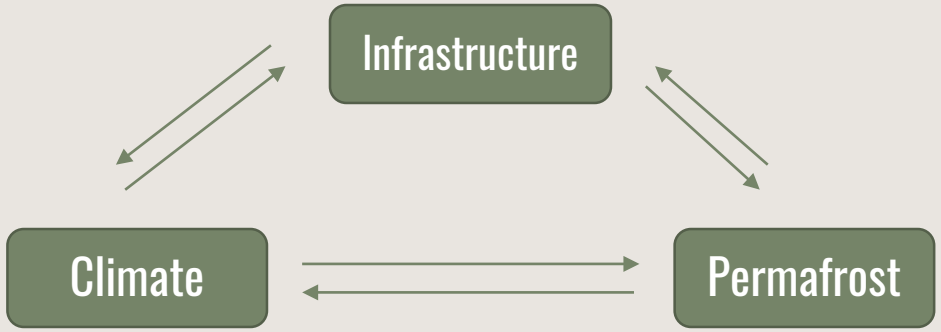
The permafrost thawing in the village is driven primarily by the infrastructure:

- Increased snow drifting and snow storage
- Increased ponding
- Increased heat input direct and indirect
- Altering of insulation provided by vegetation

We must begin to consider the cumulative impacts of infrastructure in community planning.

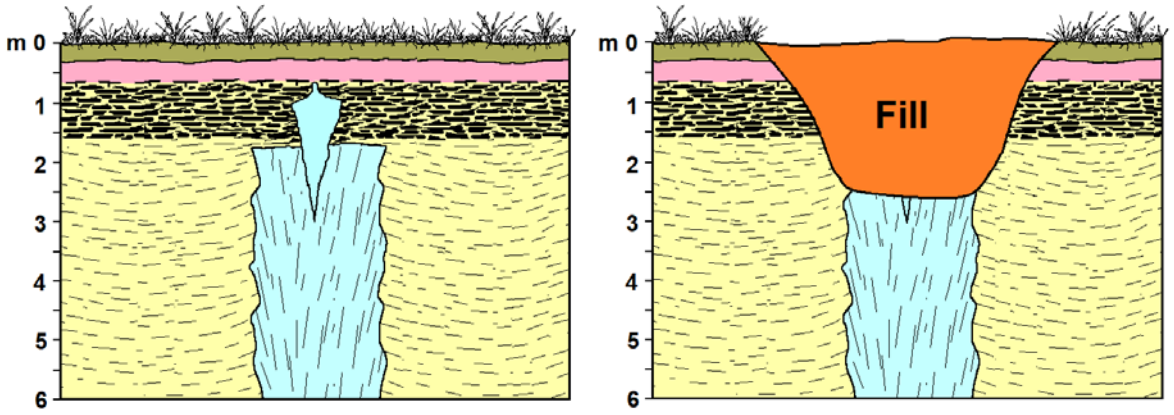
While infrastructure is the primary driver, we cannot ignore climate change in our decision process. It is really a system.

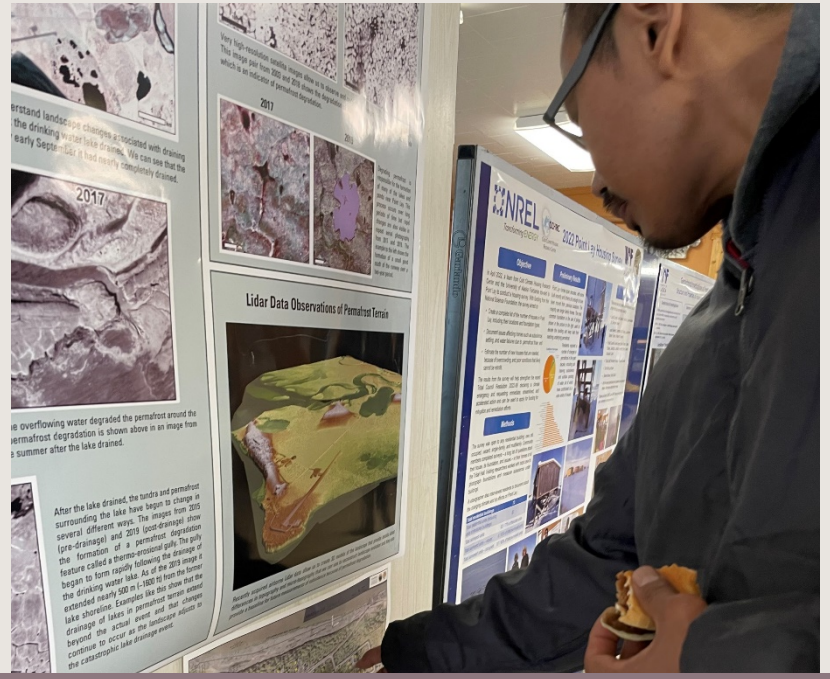
Permafrost doesn't really care where the heat comes from.



Recommendations

- There are engineering solutions that must begin soon.
- Fill ice wedge troughs with fine grain soil to protect against further degradation.
- Build new construction on a soil pad after removing the upper portion of the ice wedges.
- Piling embedment should be at least 25 ft. More when founded in ice wedges.
- When possible, found piling in mounds between wedges.
- Implement an active maintenance program.





Outreach & Engagement

- Community Open House & Barbecue
- Local Steering Committee
- Regional Advisory Group Meetings
- Meetings with North Slope Borough Mayor's Office, planning, public works, CIPM, TNHA Housing Authority and other involved in Point Lay housing and water-sewer and projects
- Presentation at July 2022 design charrette for new water-sewer system

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- The Transition Zone of Upper Permafrost: The Frontline for Permafrost Changes across Climate and Landscape Gradients (Award 1820883)
- Causes and Consequences of Catastrophic Thermokarst Lake Drainage in an Evolving Arctic System (Award 1806213).


Questions?