Navigating the New Arctic:
Landscape evolution and adapting to change in ice-rich permafrost systems

Dr. Donald A. (Skip) Walker, P.I. (NSF Award 1928237)

Pt. Lay: 50 Years

Landscape Evolution

How do changes in climate, snow, water, vegetation, disturbance, and time influence the thawing or stabilization of ground ice?

Adapting to Change

How can Arctic communities plan for and adapt to changes in these evolving permafrost landscapes?

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).

The Team

Overview

- Using Pt. 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.

Infrastructure Rapidly Failing

- Water system failed and is being abandoned. One of three water tanks failed during the winter.
- Water supply lake lost due to river cutting through ice wedge.
- Homes being abandoned due to thawing permafrost.
- Water storage tank failed.

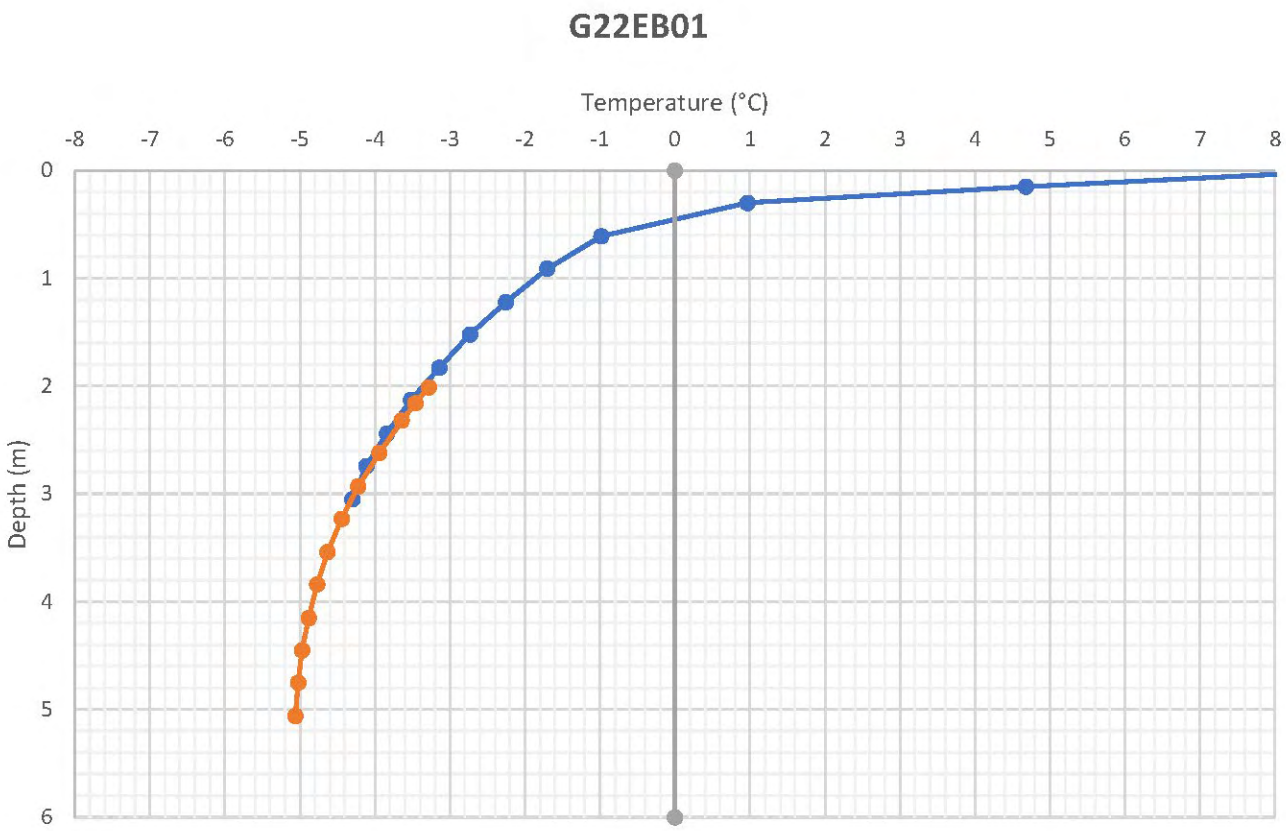
Permafrost Drilling

Coring with the SIPRE corer (10 boreholes)

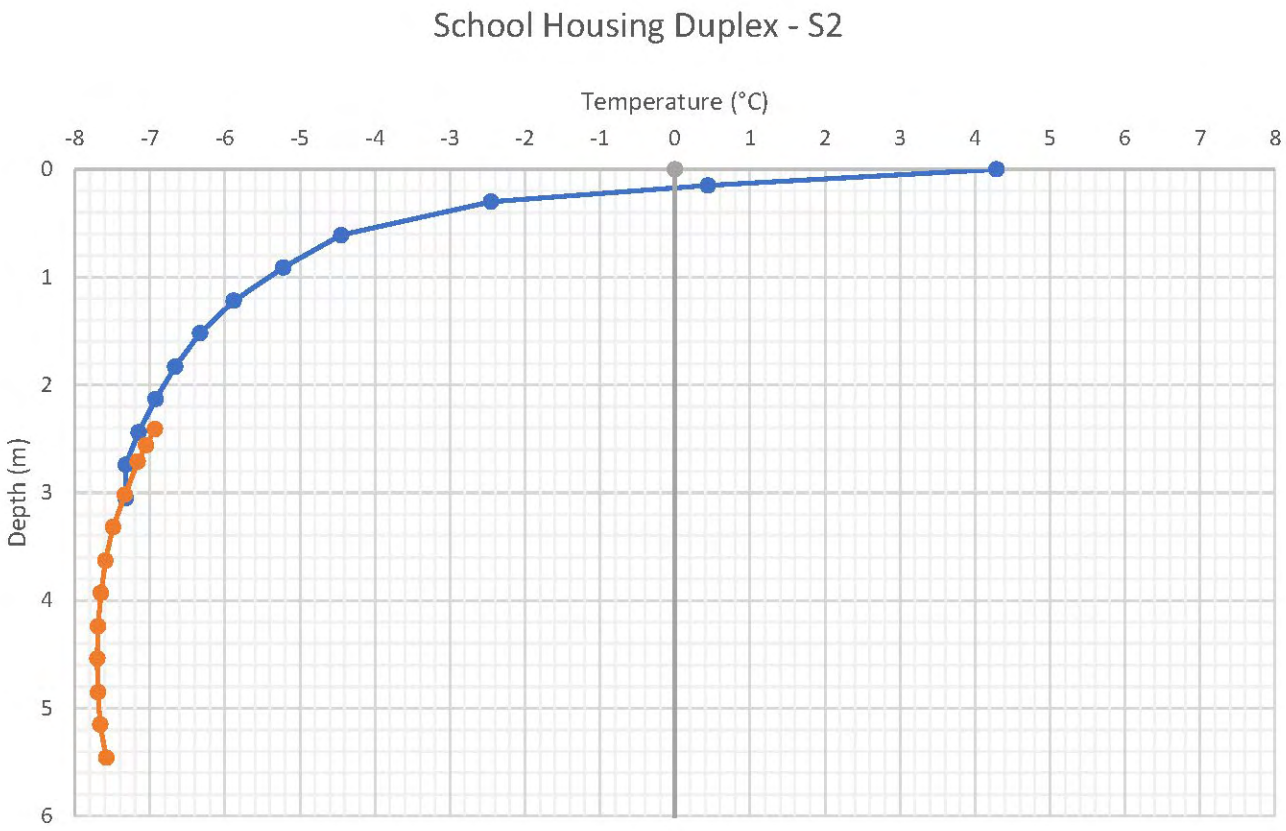
Drilling with the Kovacs auger (19 boreholes)

Augering Ice Wedges to determine their depth.

Coring and Analysis



Permafrost Temperatures


School Housing Duplex - S2
Temperature (°C)
-8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8
Depth (m)
0 1 2 3 4 5 6


Duplex_W1
Duplex_S2
School
G22WS04
G22EB03
G22EB01
Point Lay
Thermistor String Locations
Roads
0 500 1,000 2,000
Feet
N

UAV Remote Sensing Observations

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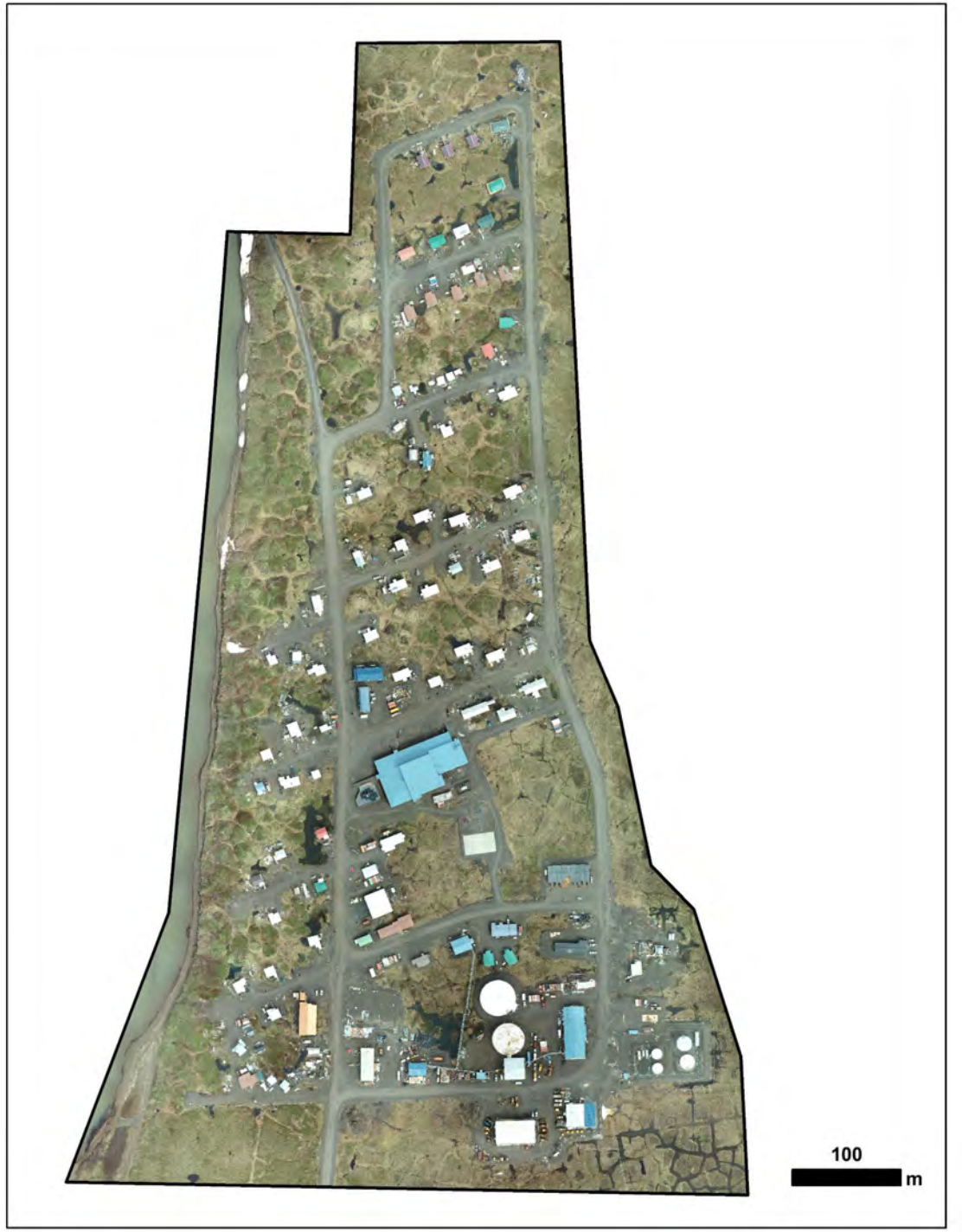
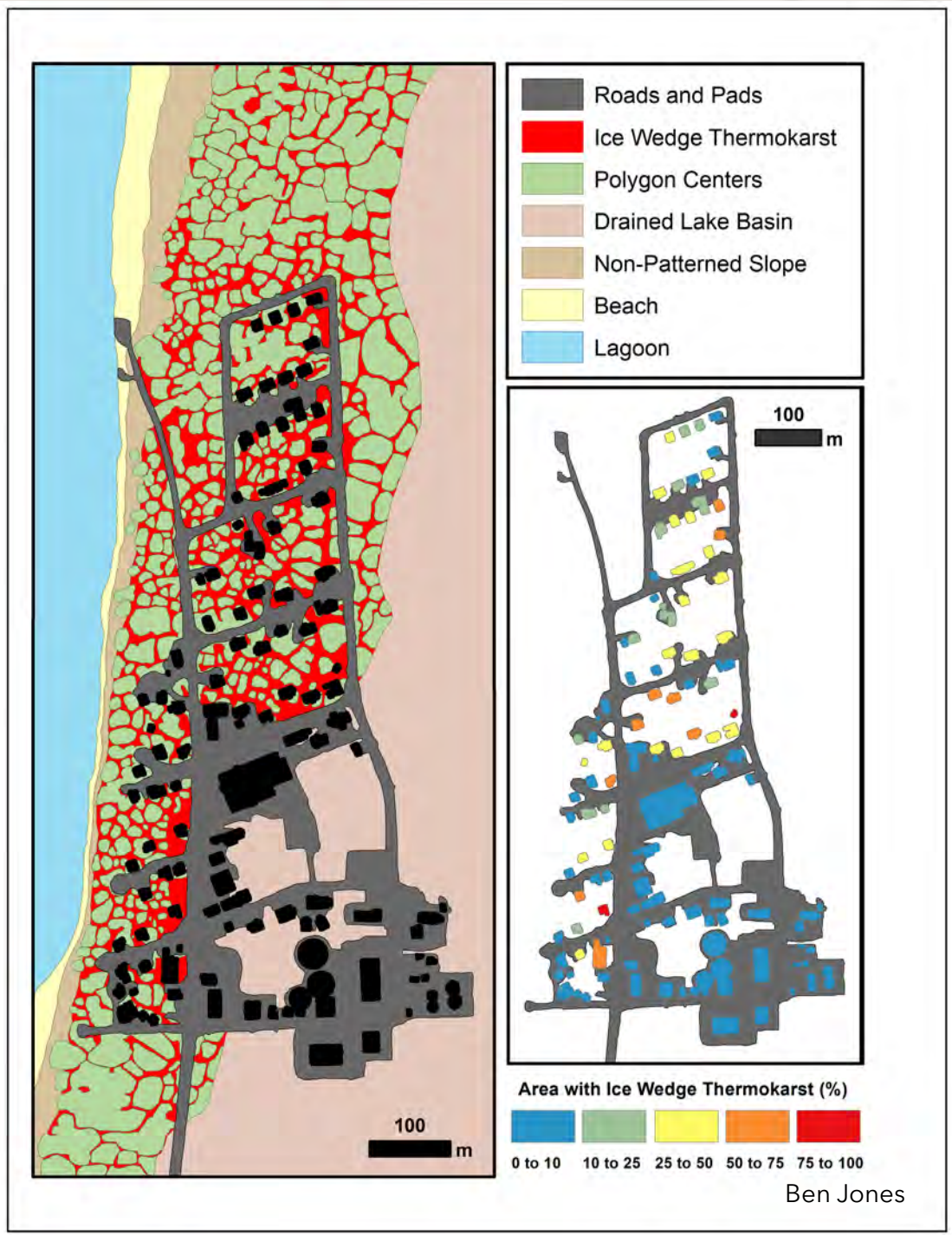
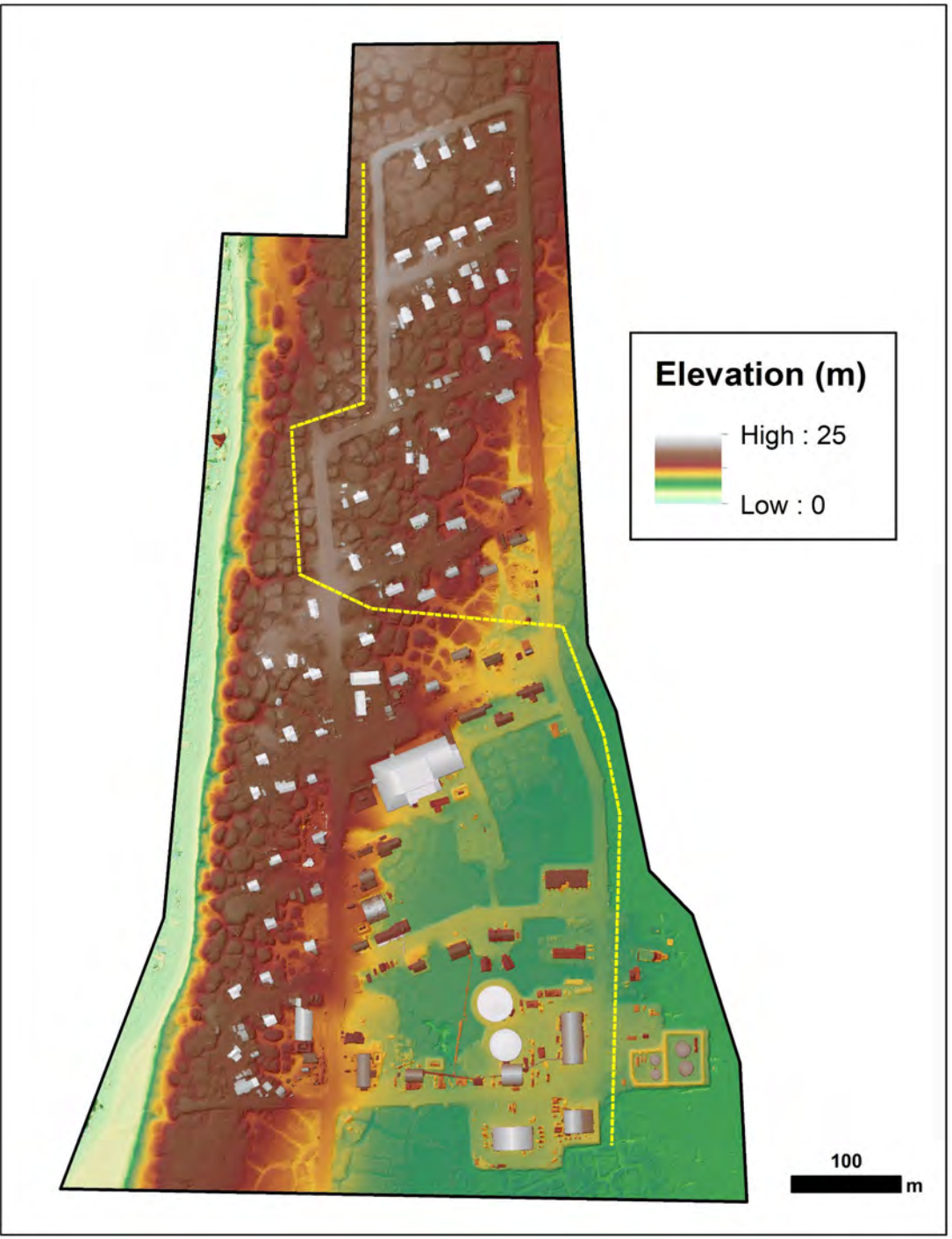
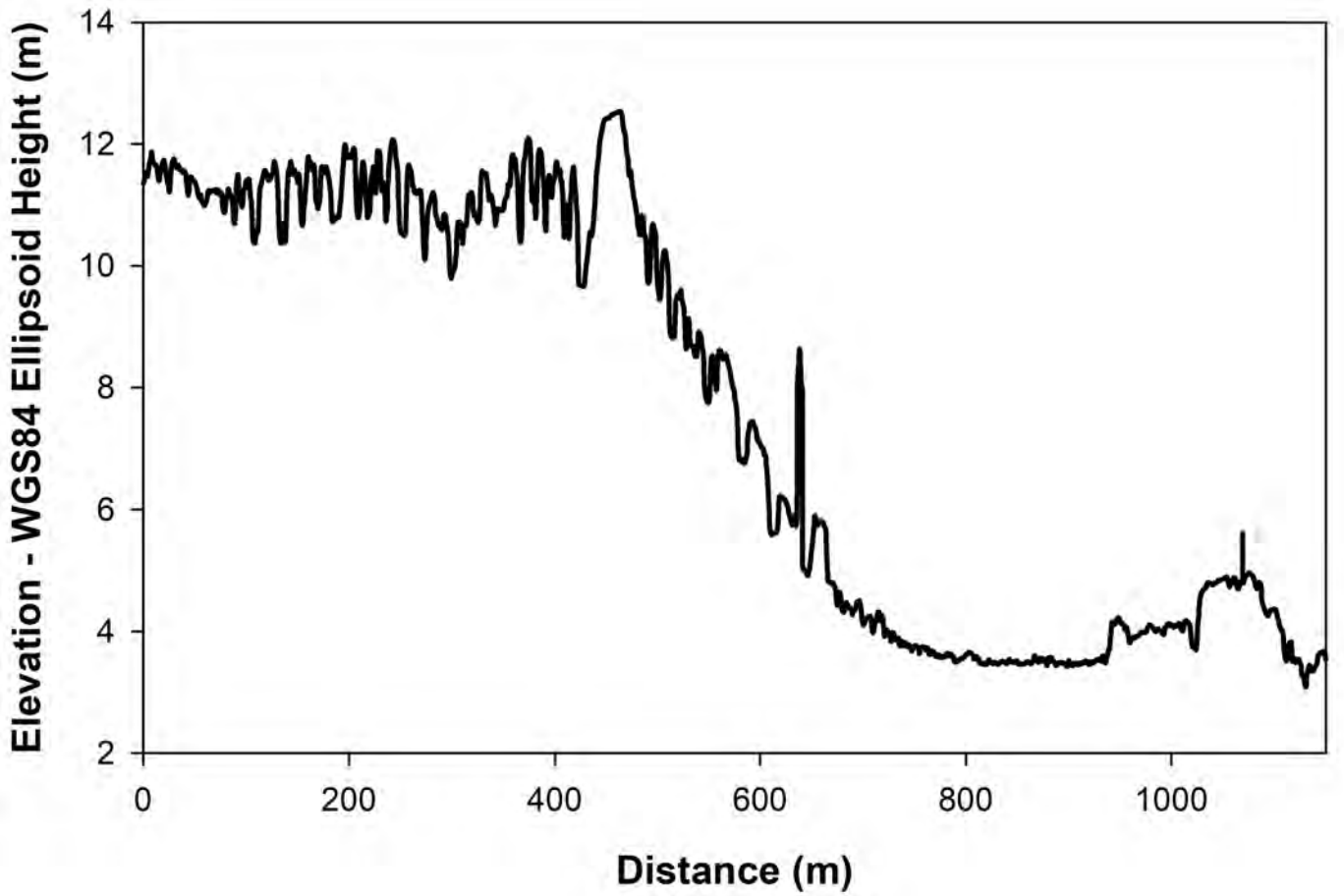
High resolution orthographic map of Pt. Lay using a UAV



- The community is underlain by yedoma to the north and east and by a drained lake basin to the south and east.
- The terrain to the north is similar, but a little flatter.
- Ice wedges go to sea level and below. (about 12 meters.)
- Much less ice in drained lake basin, but wedge ice found in thermokarst mound. (a bit surprising)
- Note the areas located in the drained lake basin on a thick gravel pad exhibit far less ice wedge thermokarsts.

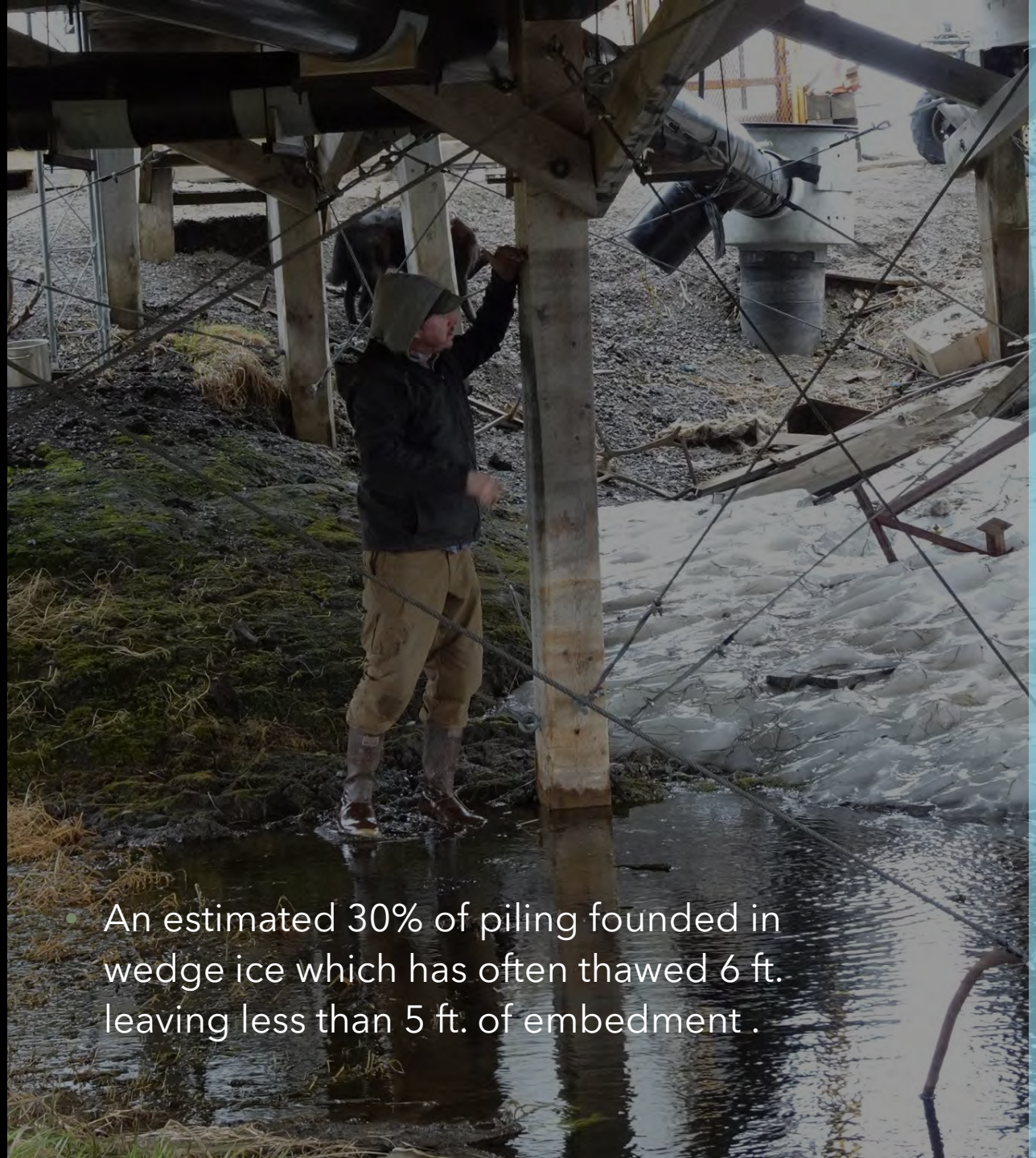






Using the elevation maps elevation profiles can be produced for any transect desired.

Fill quantities can also be computed.



- An estimated 30% of piling founded in wedge ice which has often thawed 6 ft. leaving less than 5 ft. of embedment .

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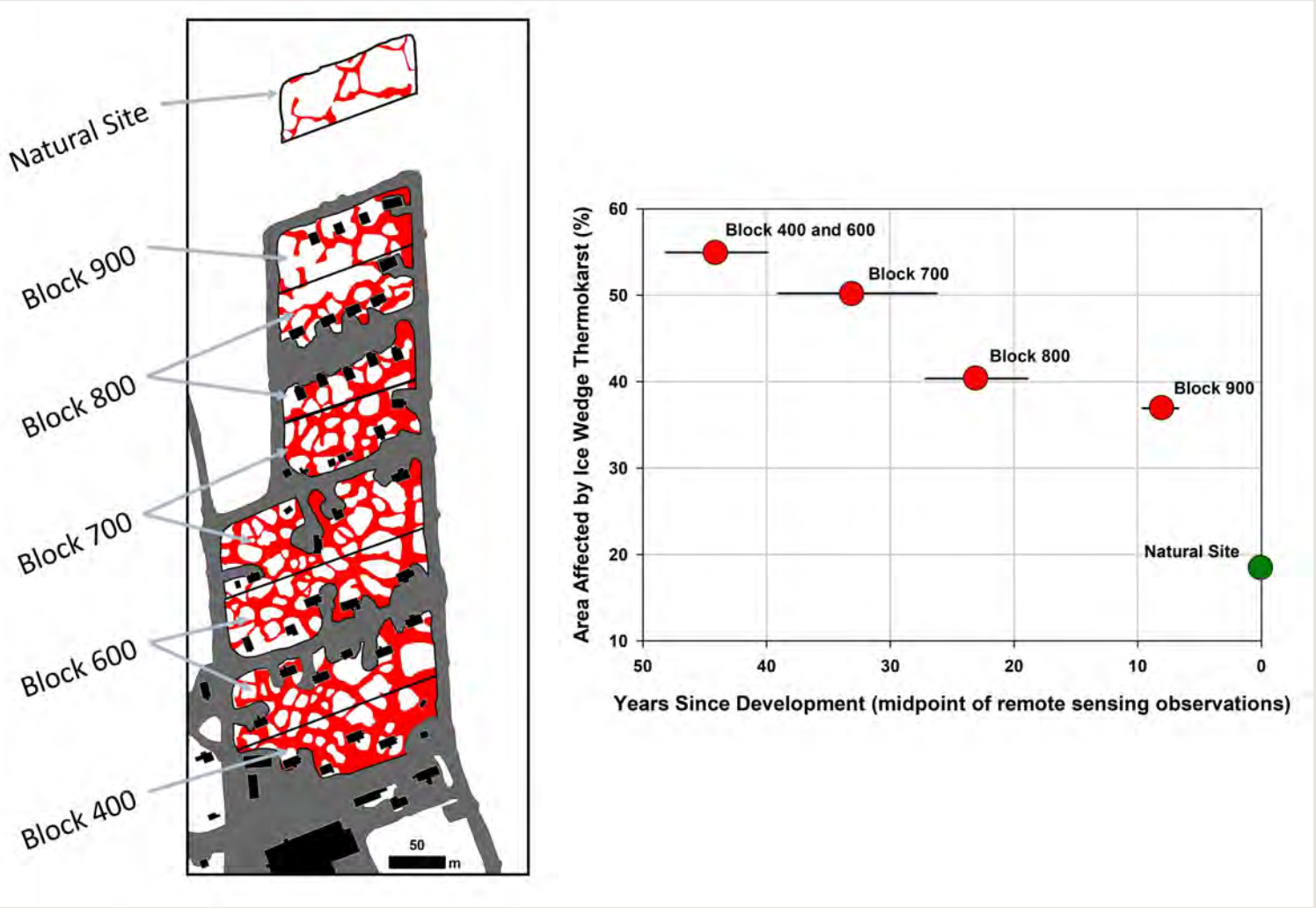
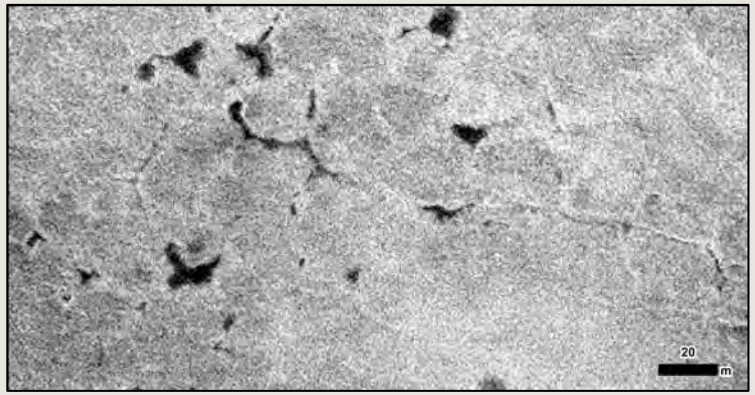
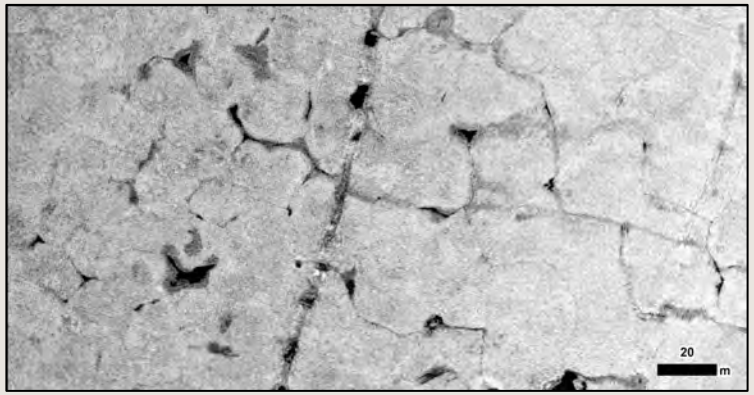
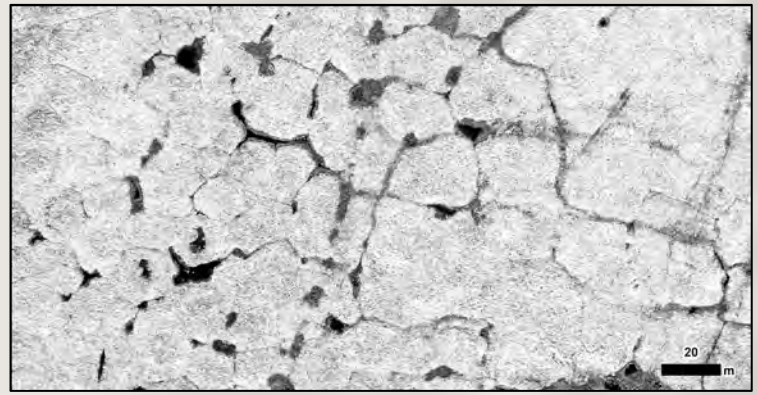
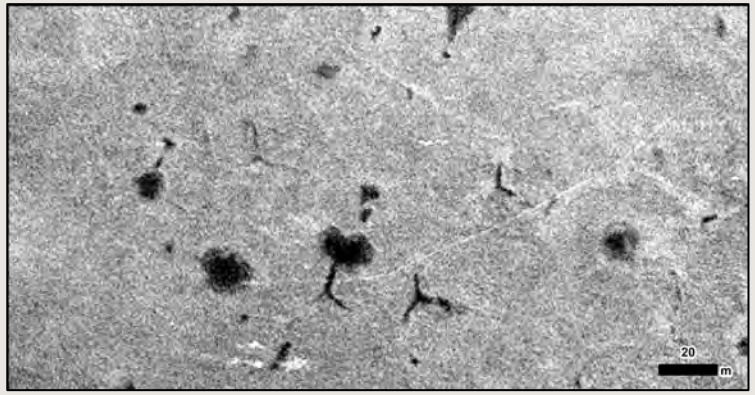
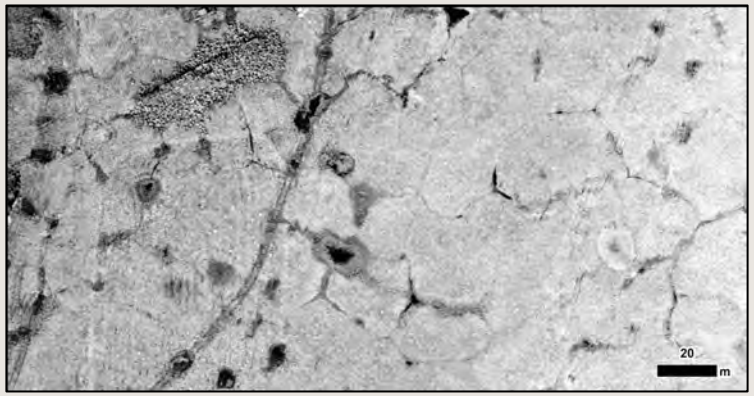
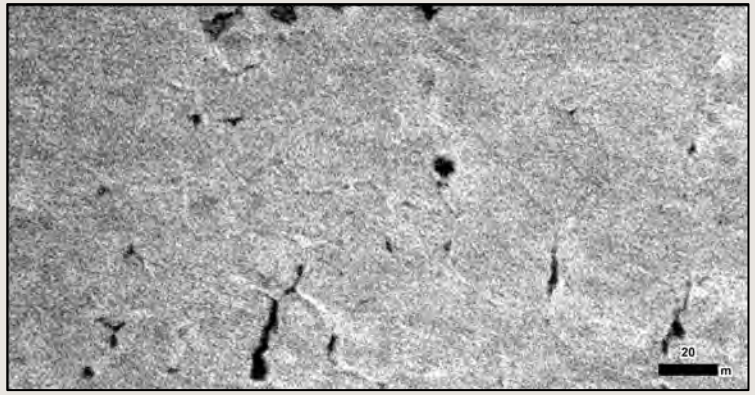
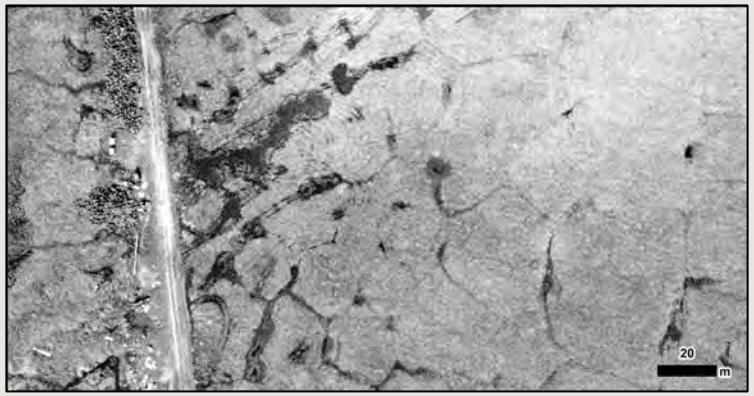
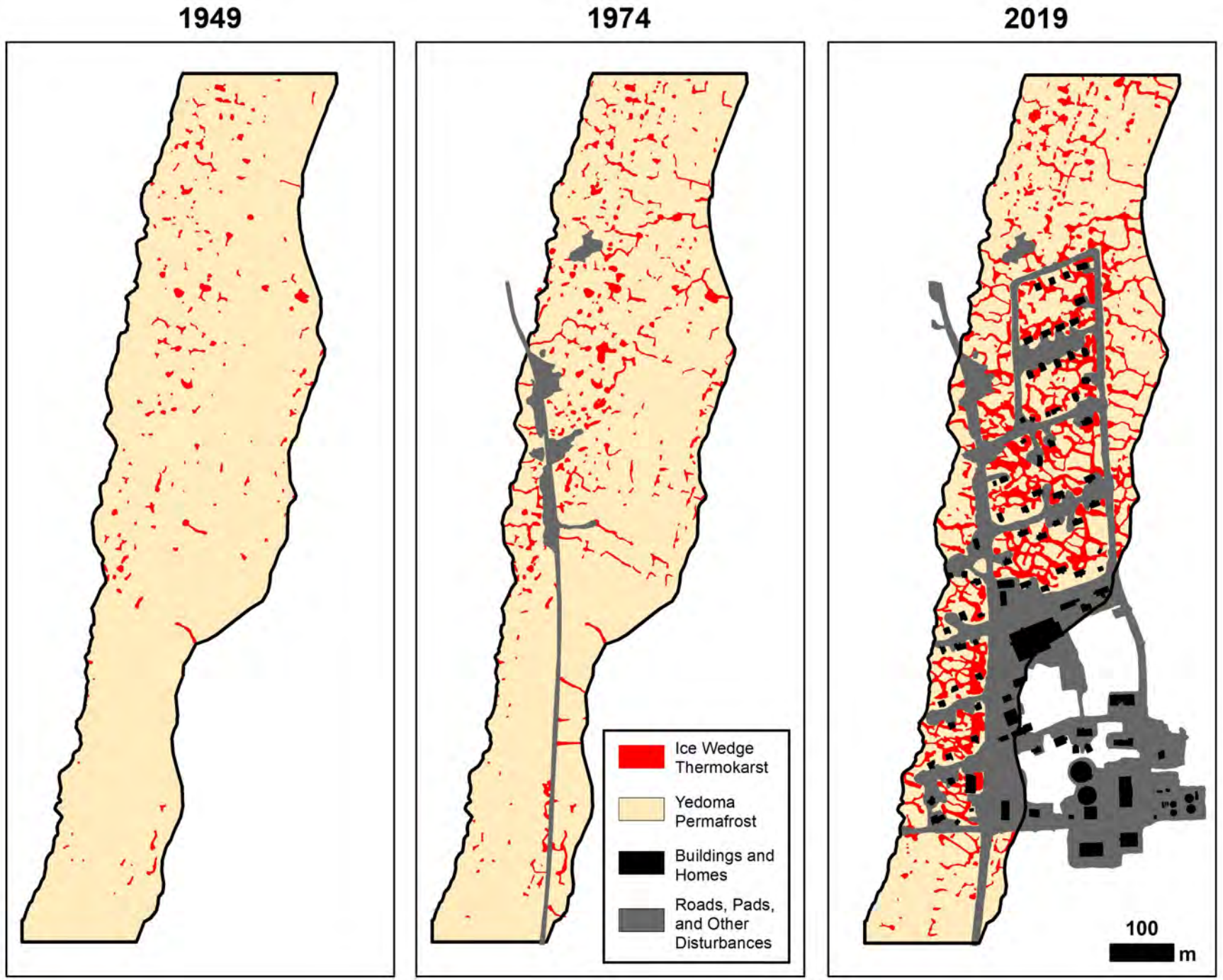
Some are entirely founded on ice.

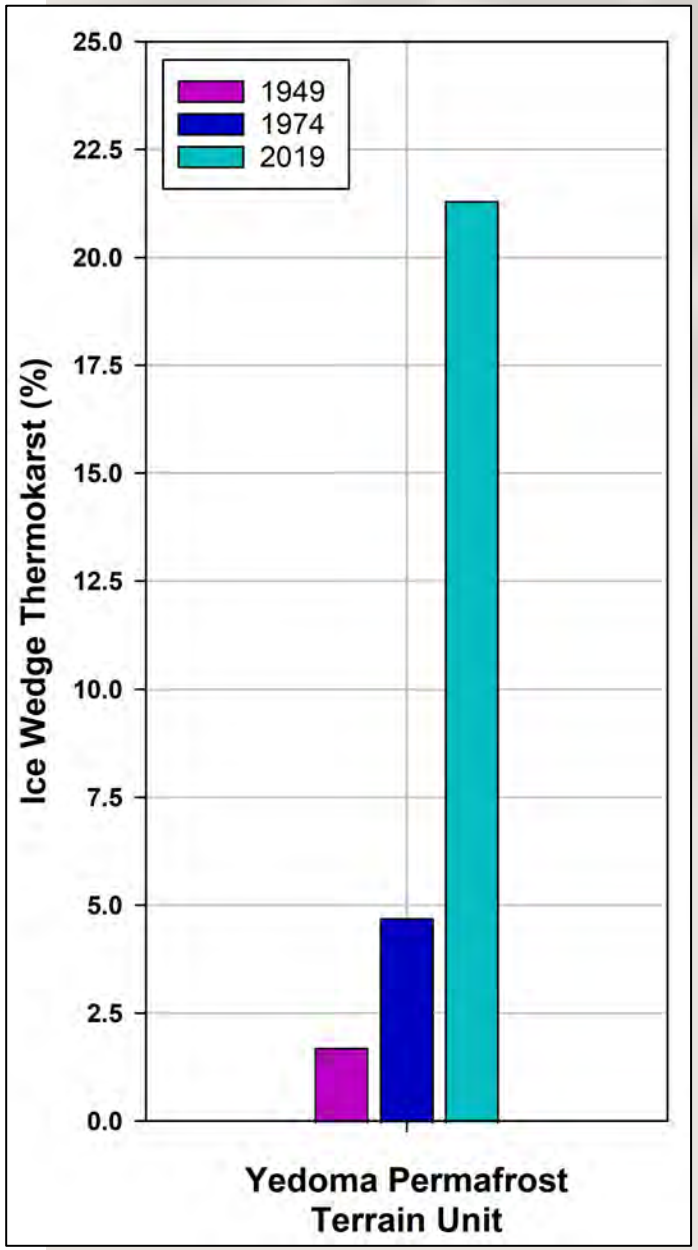
There is a tendency to blame the failing infrastructure entirely on climate change.



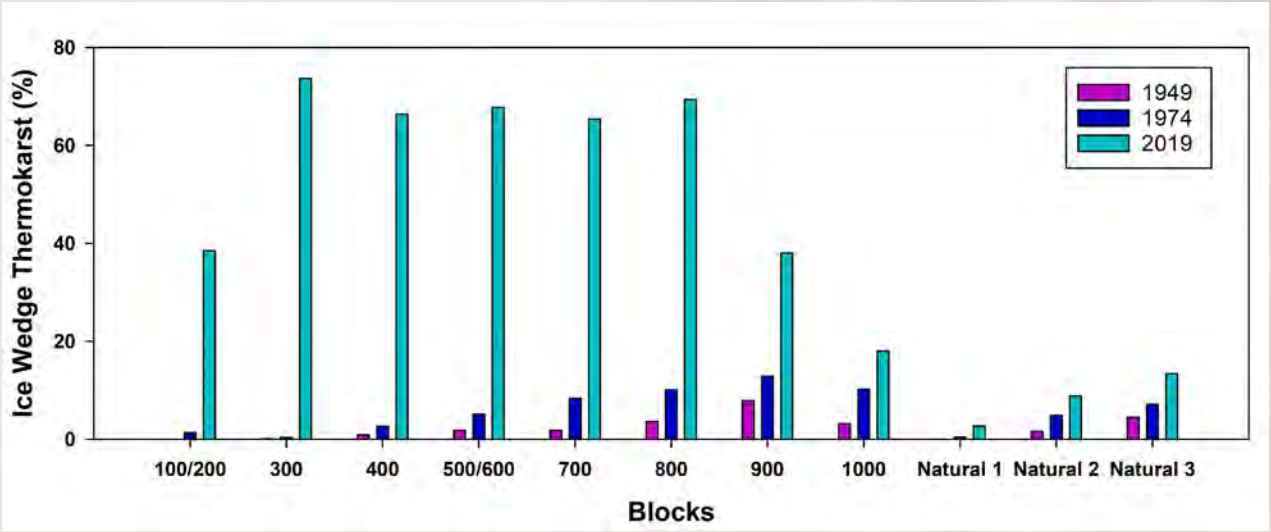
As the age of disturbance increases, the area of thermokarsts increases, and condition of the structures deteriorates. Note the undisturbed areas where the 1000 blocks are proposed has much lower thermokarst area even though the terrain is similar indicating that the infrastructure is the major stressor.

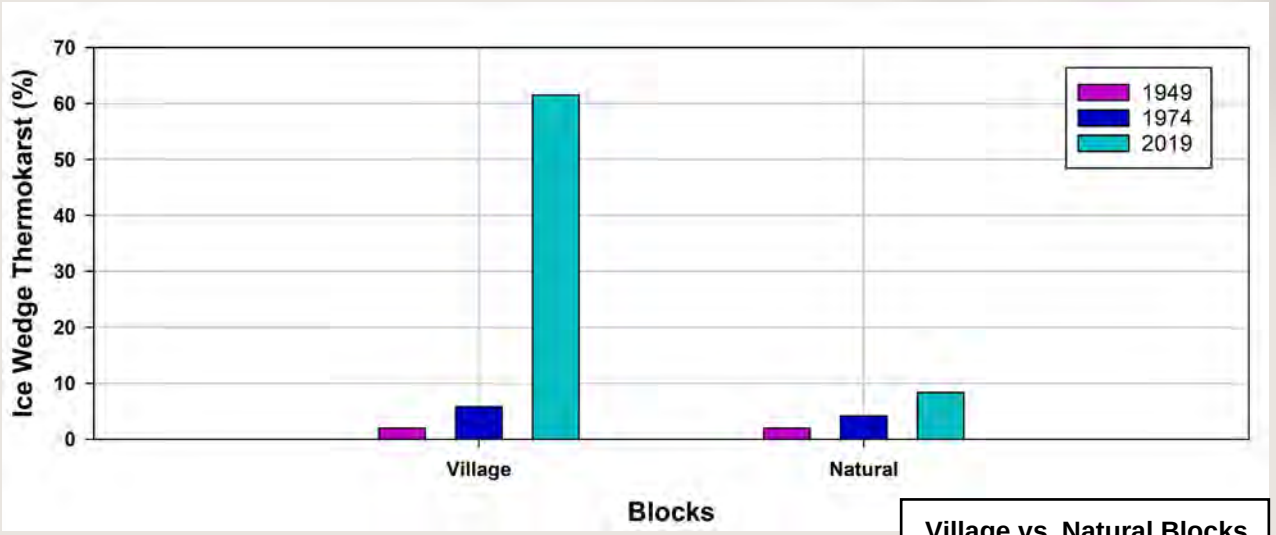
1949	1974	2019
		
		
		


1949
1974
2019
Ice Wedge Thermokarst
Yedoma Permafrost
Buildings and Homes
Roads, Pads, and Other Disturbances
100
m


1949
1974
2019
Ice Wedge Thermokarst (%)
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
Yedoma Permafrost
Terrain Unit

Percent of each "block area" with ice wedge thermokarst in 1949, 1974, and 2019

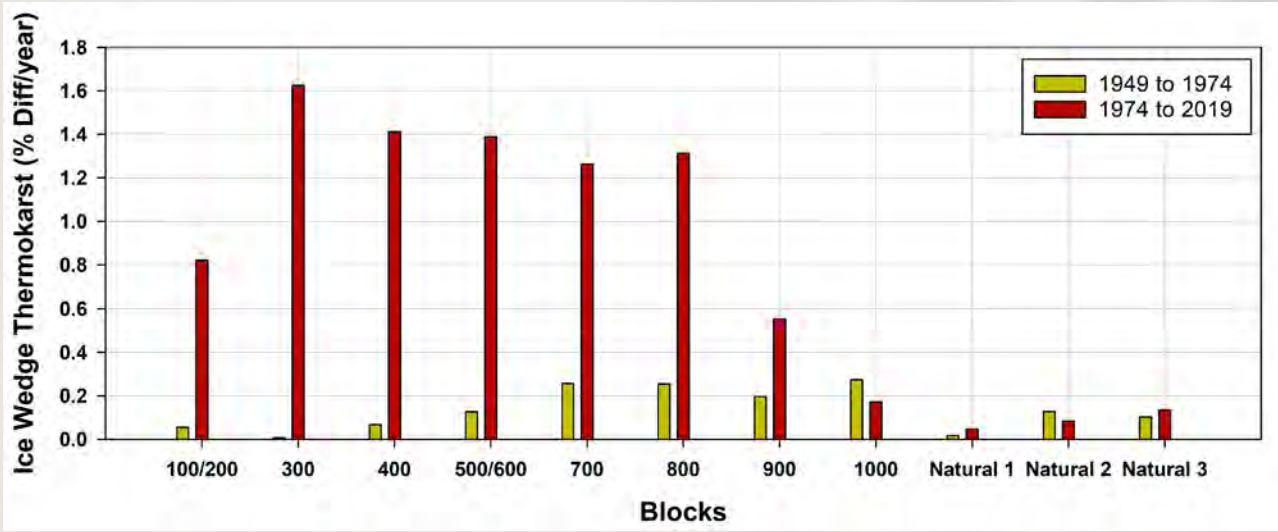


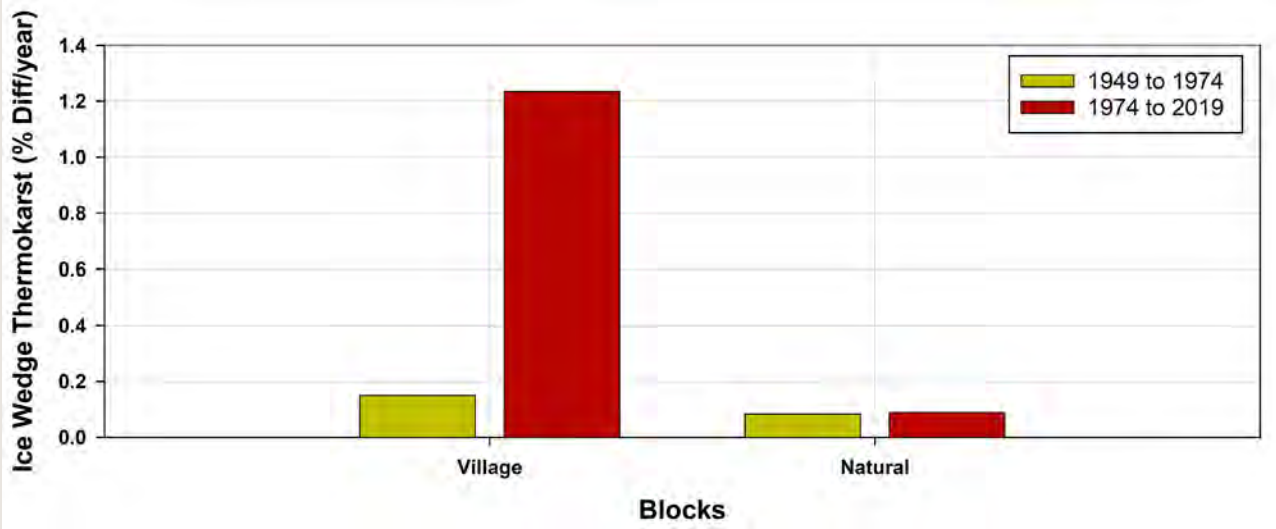


Village vs. Natural Blocks

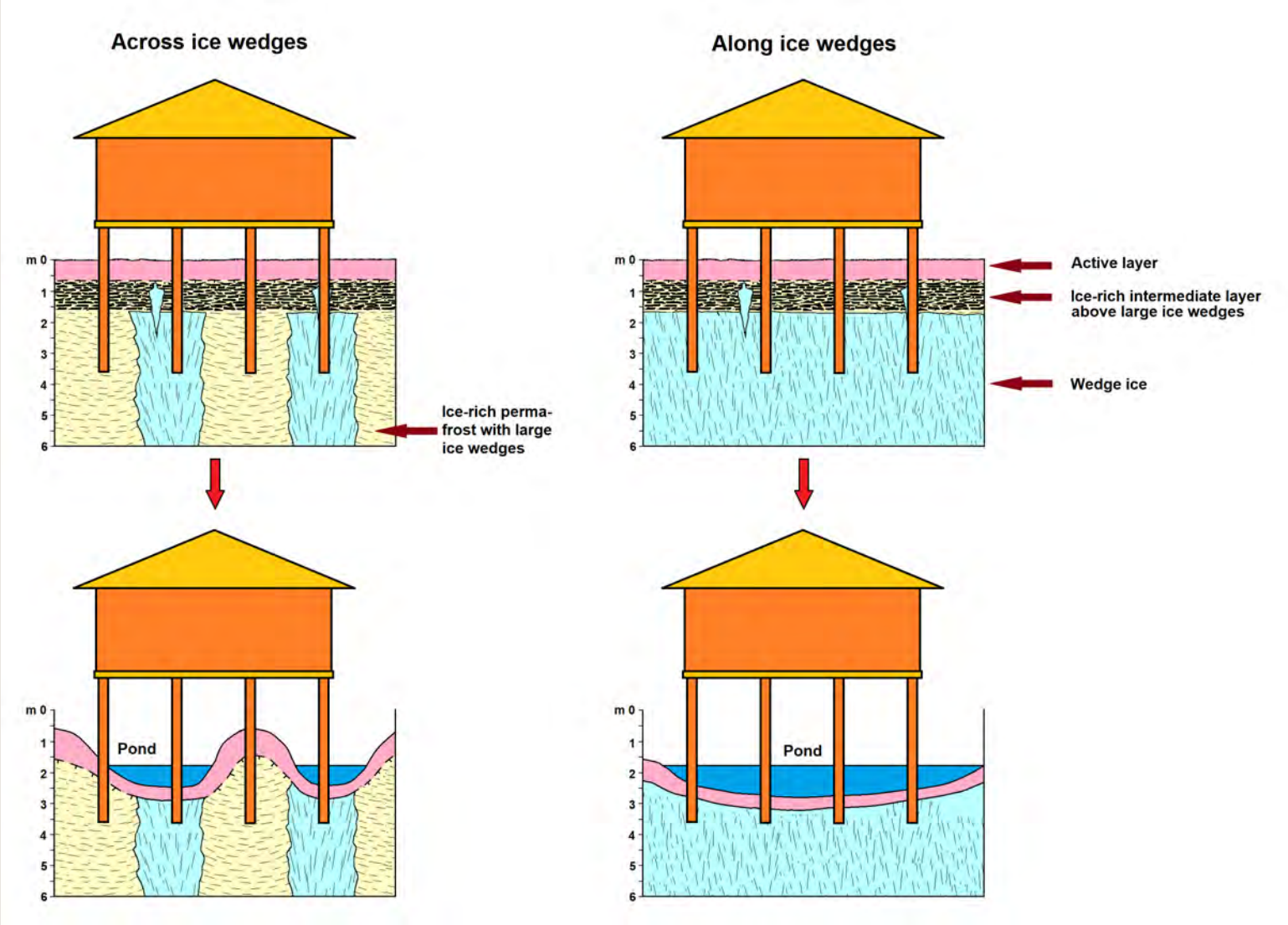
1949 – 0.2% higher
1974 – 38% higher
2019 – 625% higher

Percent difference of each “block area” per year in two time periods





Decrease of pile embedment in permafrost



Recommendations

- There are engineering solutions that must begin soon.
- Fill 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. Use simple drilling by trained personnel to determine the location and depth of wedges.
- When possible, found piling in mounds.
- Implement an active maintenance program.

Conclusions

- 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 major driver, we cannot ignore climate change in our decision process.

2023 Field Plans

July 21 and/or July 27 meetings in Utqiagvik:

- Discuss work plan
- Joint or separate meetings (housing, public works, CIPM)

July 22-26 in Point Lay (NEED LODGING!)

- Permafrost cores by drained thaw lake and graveyard
- Landform/terrain and permafrost mapping
- Drone survey to ground truth mapping and characterize drained thaw lake basin
- Materials samples from freshwater lake basin and near graveyard to assess different options for fill
- 3D filming and visualization of key buildings (Olaf Kuhlke)
- Community open house (barbecue?), Sunday July 23?

Permafrost & Infrastructure Symposium:

- July 28-Aug 1 in Utqiagvik
- July 30 walking tour and community listening session in Point Lay