Ingeniørgeologi og fundering i Qaanaaq

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Qaanaaq

NAALAKKERSUISUT
GOVERNMENT OF GREENLAND

GAMMA REMOTE SENSING

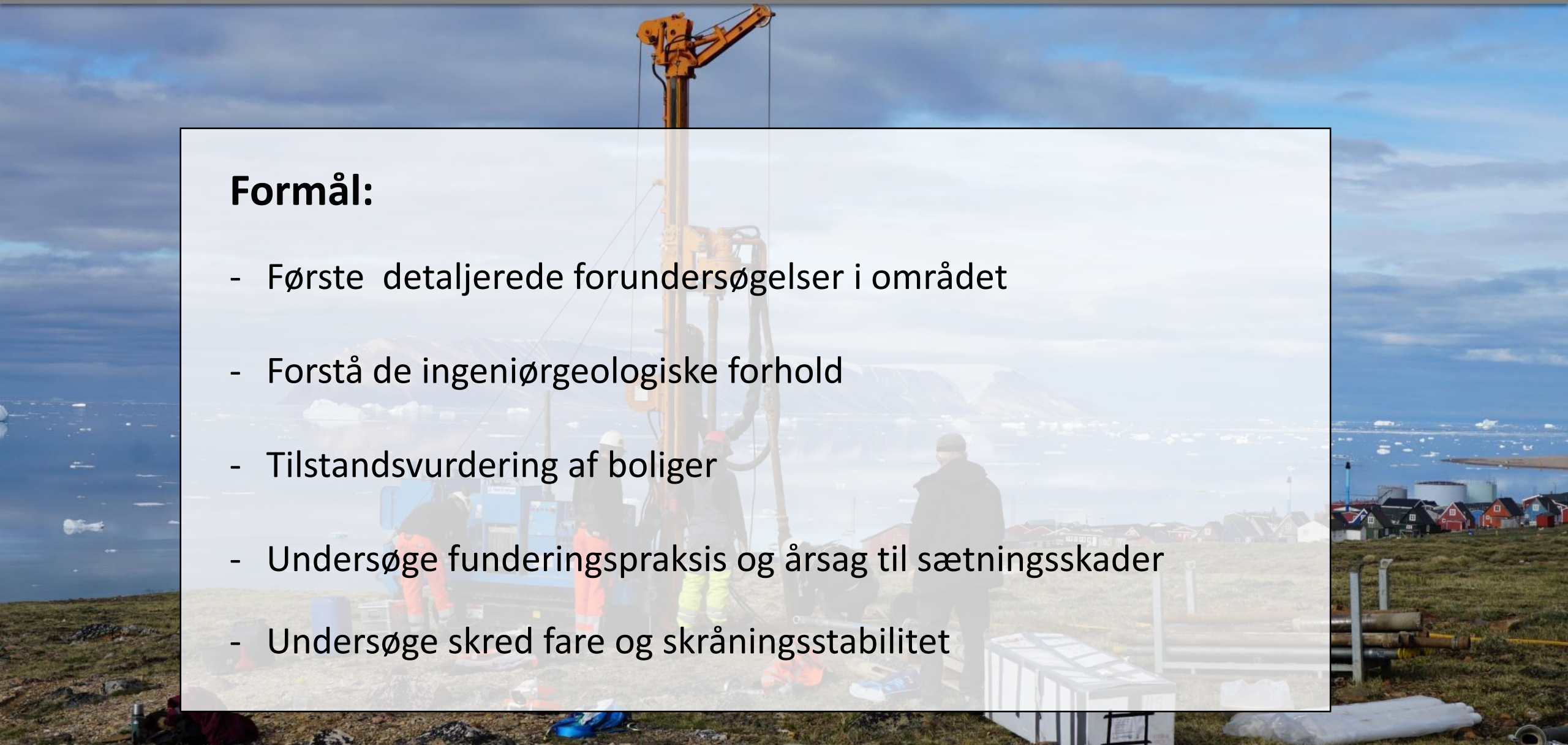
NUKISSIORFIIT

CENPERM Center for Permafrost

ASIAQ GREENLAND SURVEY

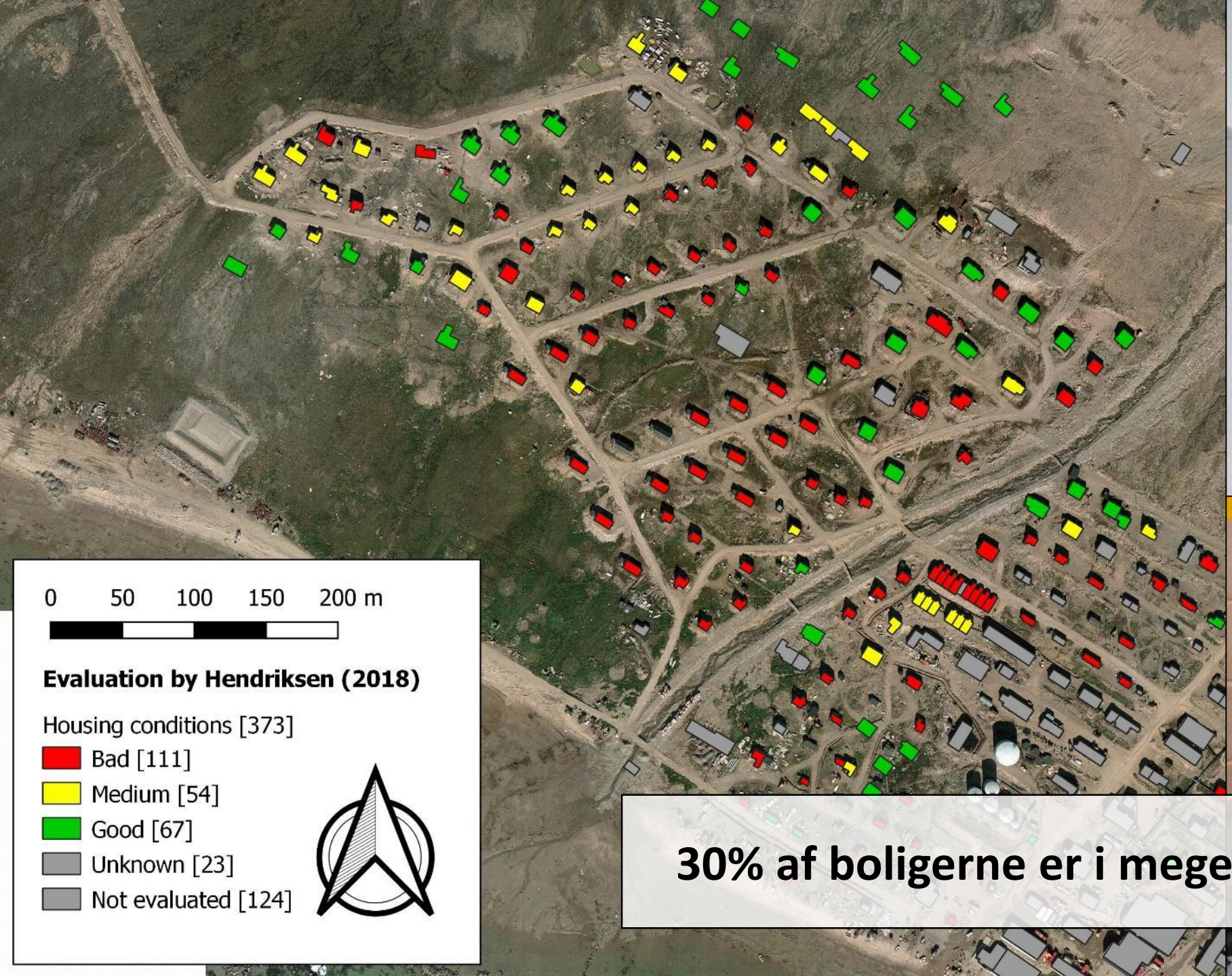
DTU

Forundersøgelser i Qaanaaq



Formål:

- Første detaljerede forundersøgelser i området
- Forstå de ingeniørgeologiske forhold
- Tilstandsvurdering af boliger
- Undersøge funderingspraksis og årsag til sætningsskader
- Undersøge skred fare og skråningsstabilitet



30% af boligerne er i meget dårlig tilstand!

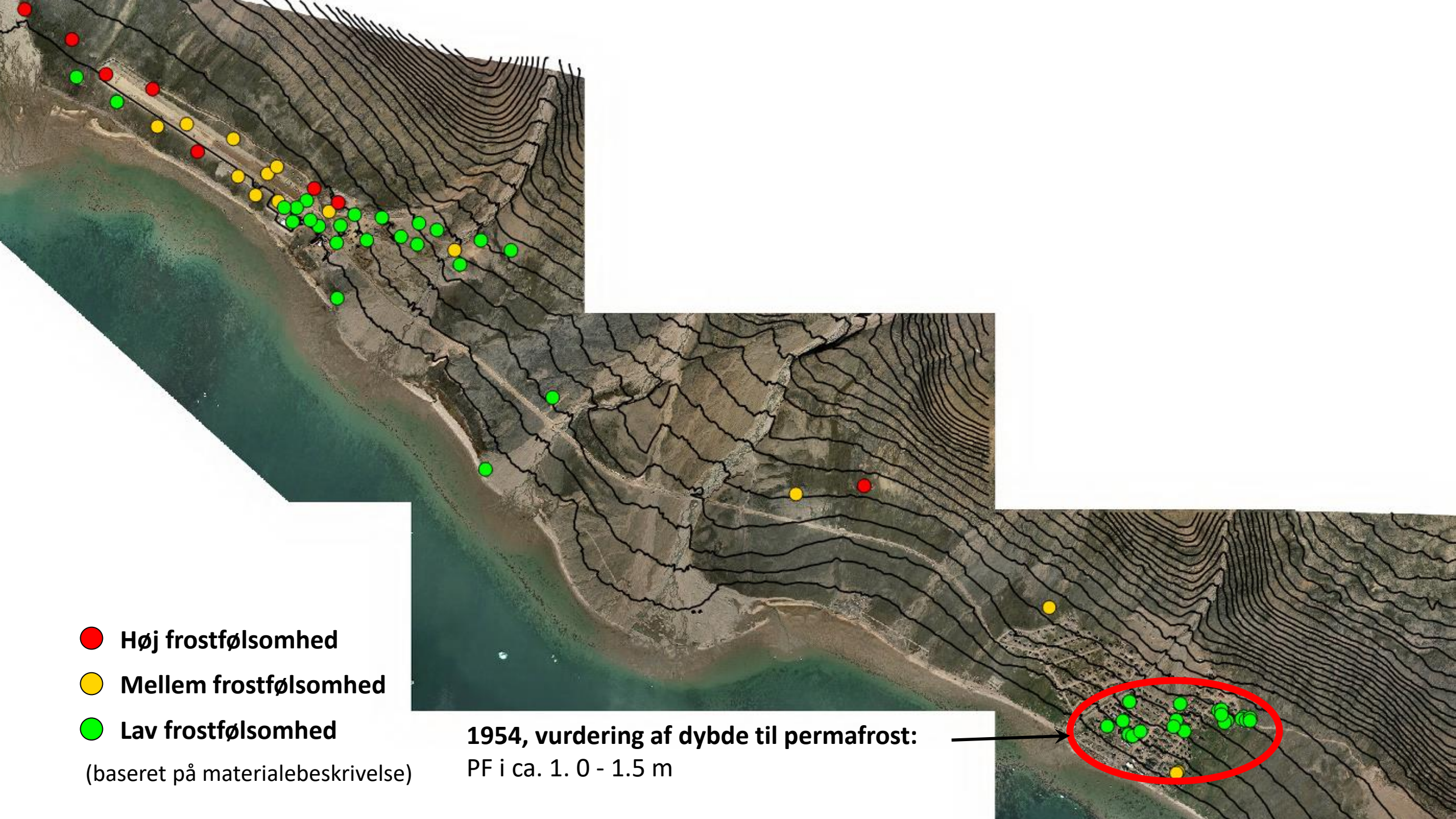

1953


1961

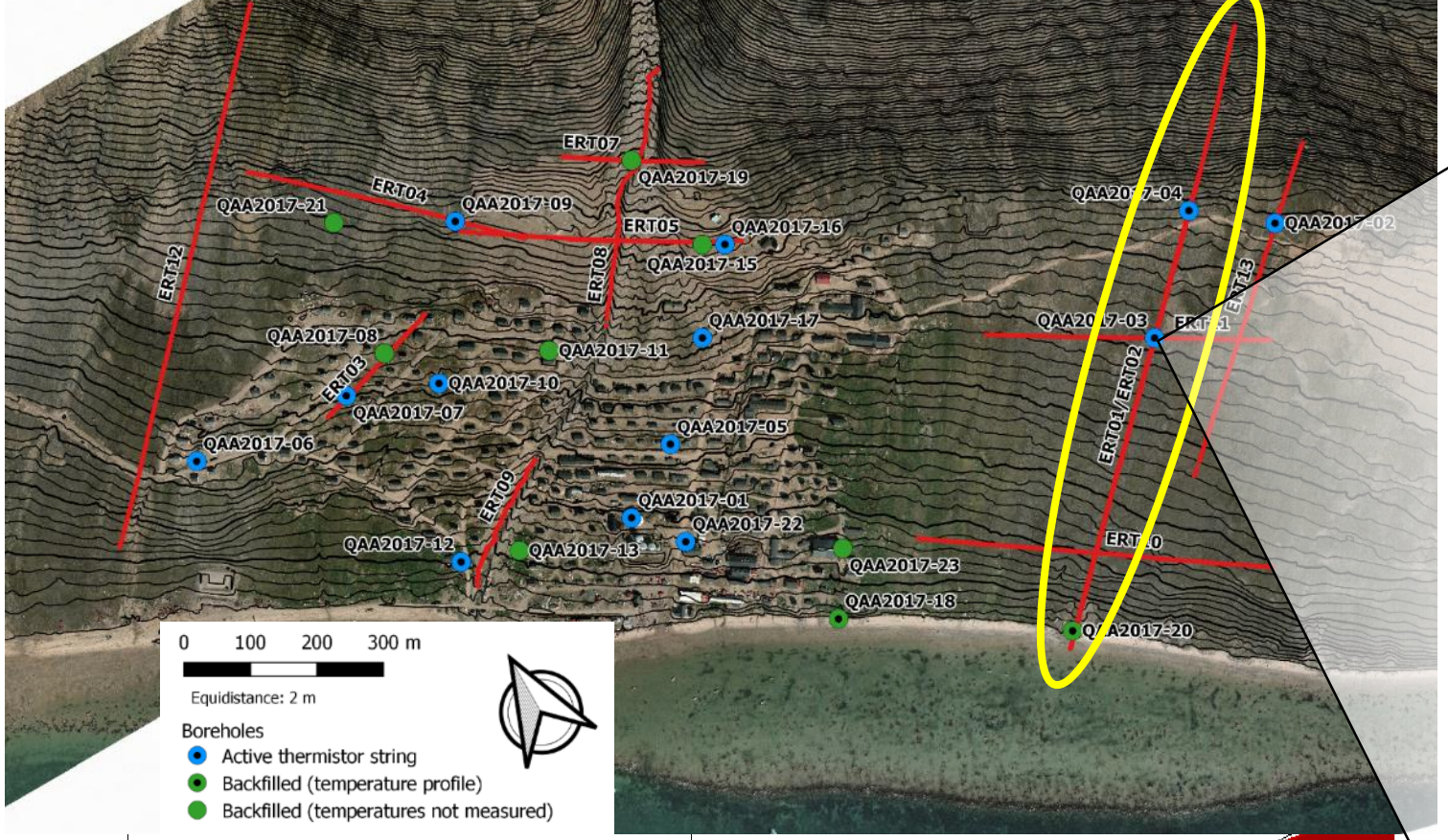

1968

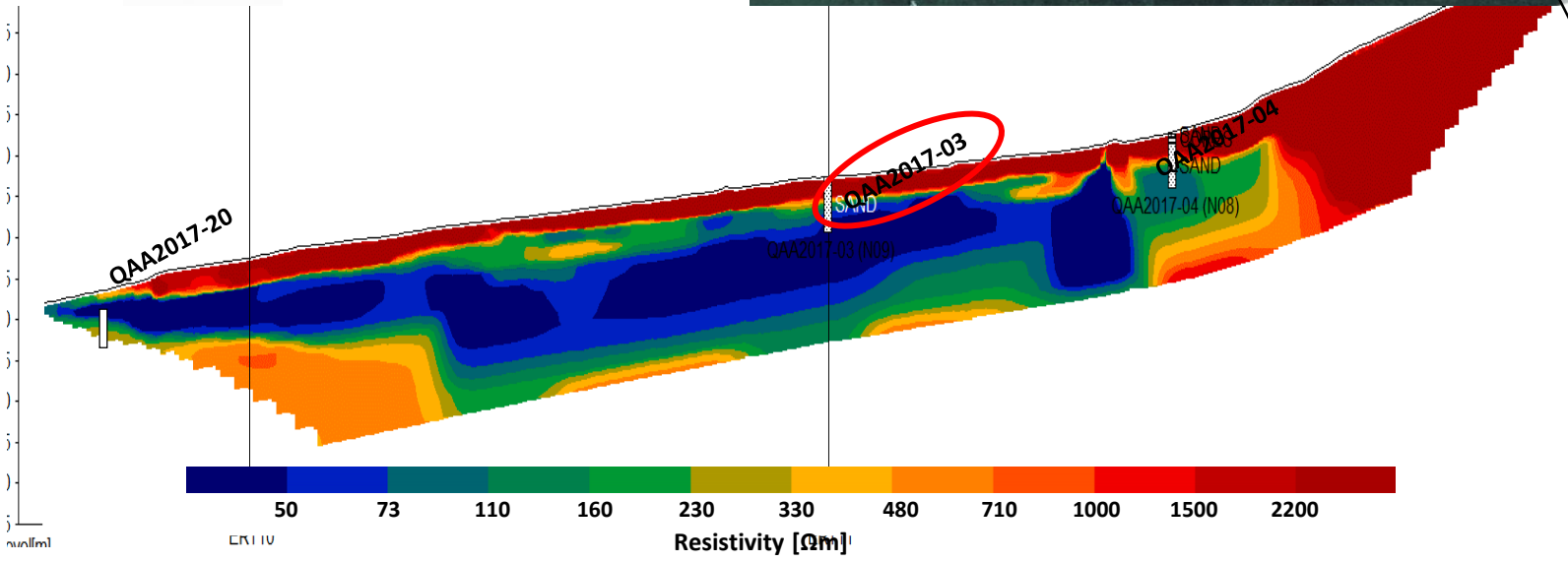
1981

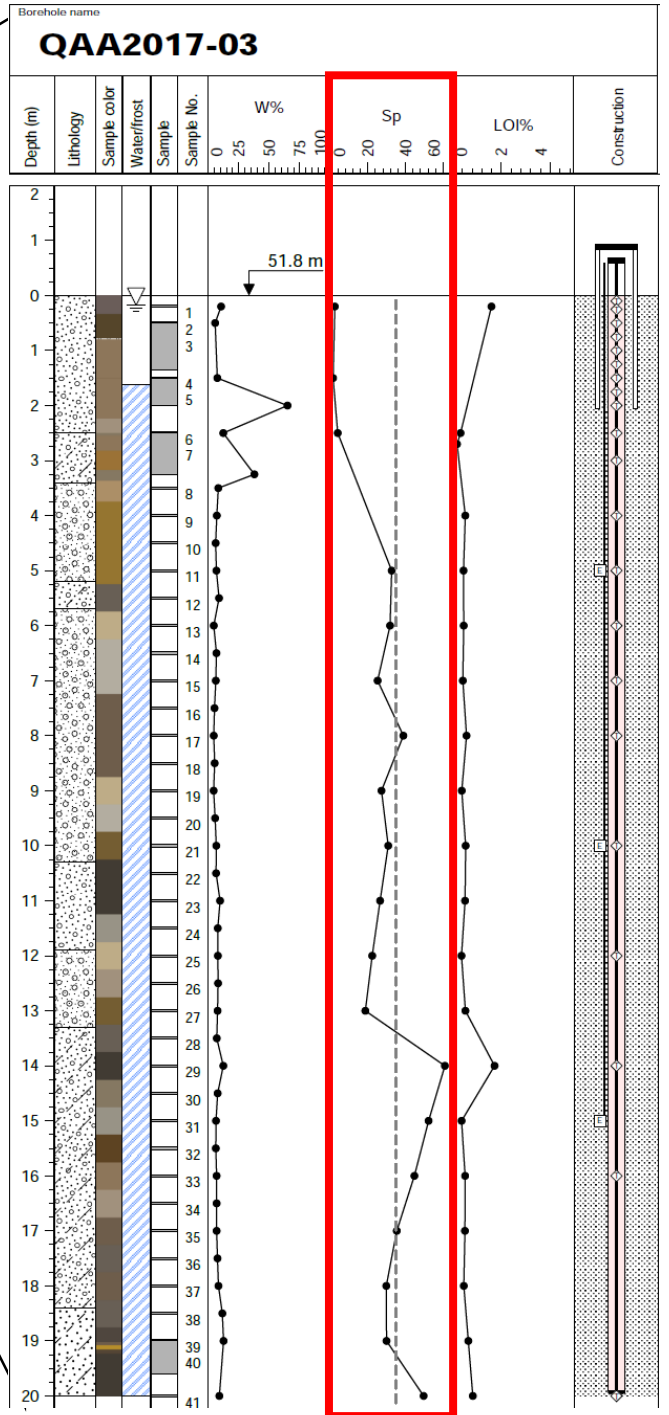

1997


Høj frostfølsomhed
Mellem frostfølsomhed
Lav frostfølsomhed
(baseret på materialebeskrivelse)
1954, vurdering af dybde til permafrost:
PF i ca. 1. 0 - 1.5 m

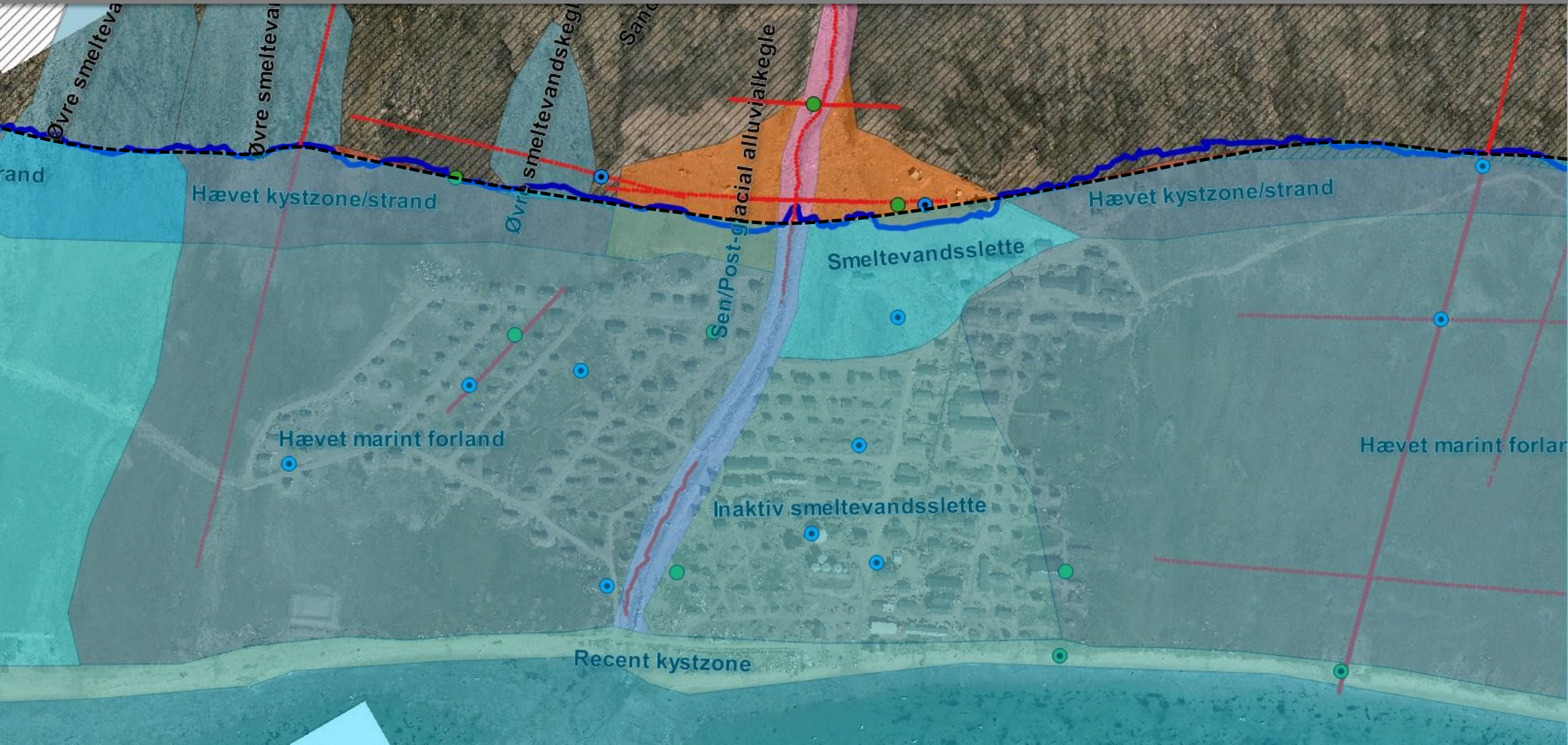

ERT07
QAA2017-19
ERT04
QAA2017-21
QAA2017-09
ERT05
QAA2017-16
QAA2017-15
ERT08
ERT12
QAA2017-04
QAA2017-02
ERT13
QAA2017-03
ERT11
QAA2017-17
QAA2017-08
QAA2017-11
ERT03
QAA2017-10
QAA2017-07
QAA2017-06
QAA2017-05
ERT01/ERT02
ERT09
QAA2017-01
QAA2017-22
QAA2017-12
QAA2017-13
ERT10
QAA2017-23
QAA2017-18
QAA2017-20
0
100
200
300 m
Equidistance: 2 m
Boreholes
Active thermistor string
Backfilled (temperature profile)
Backfilled (temperatures not measured)


ERT07
QAA2017-19
QAA2017-21
ERT04
QAA2017-09
ERT05
QAA2017-16
QAA2017-15
ERT12
ERT08
QAA2017-08
QAA2017-17
QAA2017-11
ERT03
QAA2017-10
QAA2017-07
QAA2017-06
QAA2017-05
ERT09
QAA2017-01
QAA2017-22
QAA2017-12
QAA2017-13
QAA2017-23
QAA2017-18
QAA2017-20
QAA2017-04
QAA2017-02
QAA2017-03
ERT13
ERT01/ERT02
0 100 200 300 m
Equidistance: 2 m
Boreholes
Active thermistor string
Backfilled (temperature profile)
Backfilled (temperatures not measured)

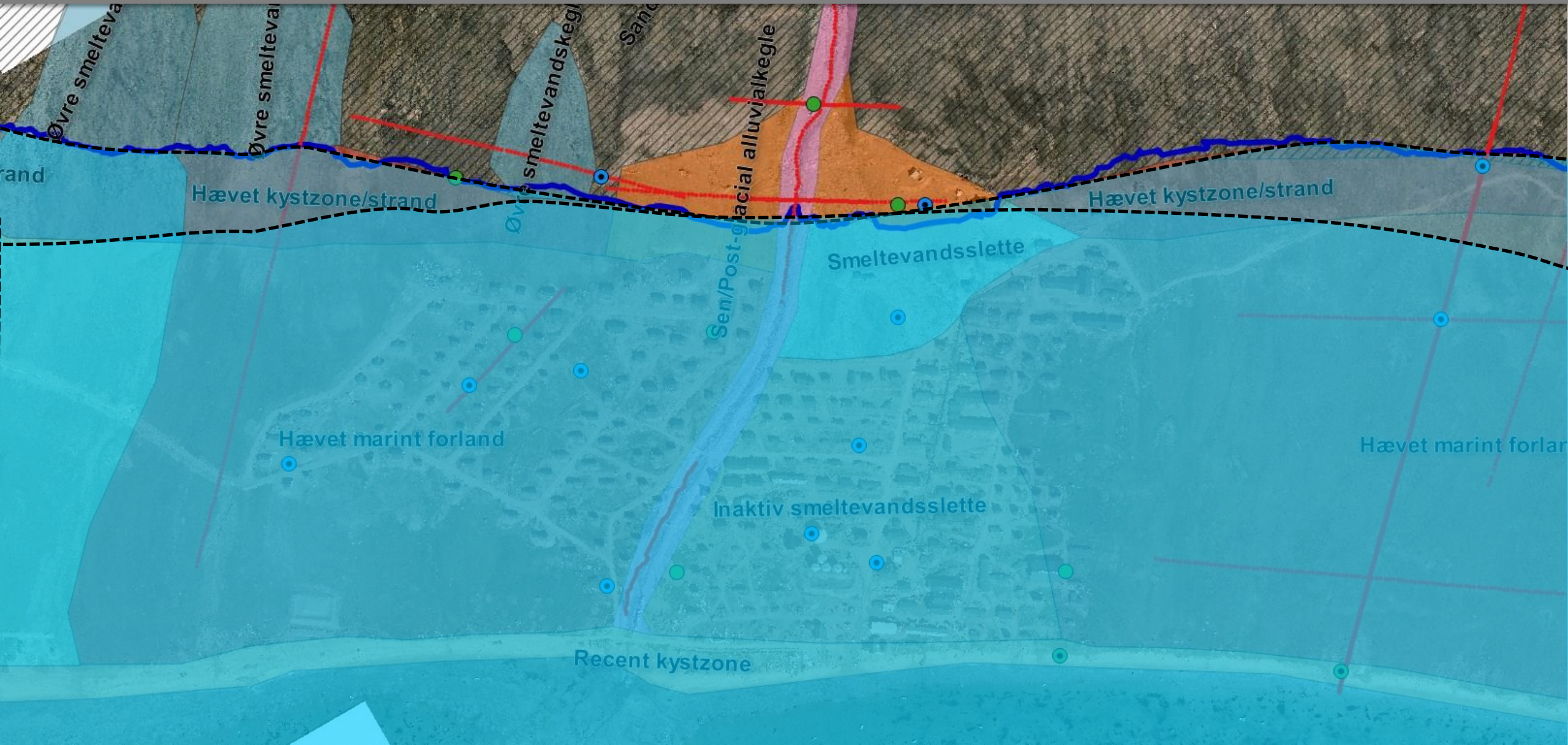

QAA2017-20
QAA2017-03
QAA2017-04
SAND
QAA2017-03 (N09)
QAA2017-04 (N08)
50 73 110 160 230 330 480 710 1000 1500 2200
Resistivity [Ωm]

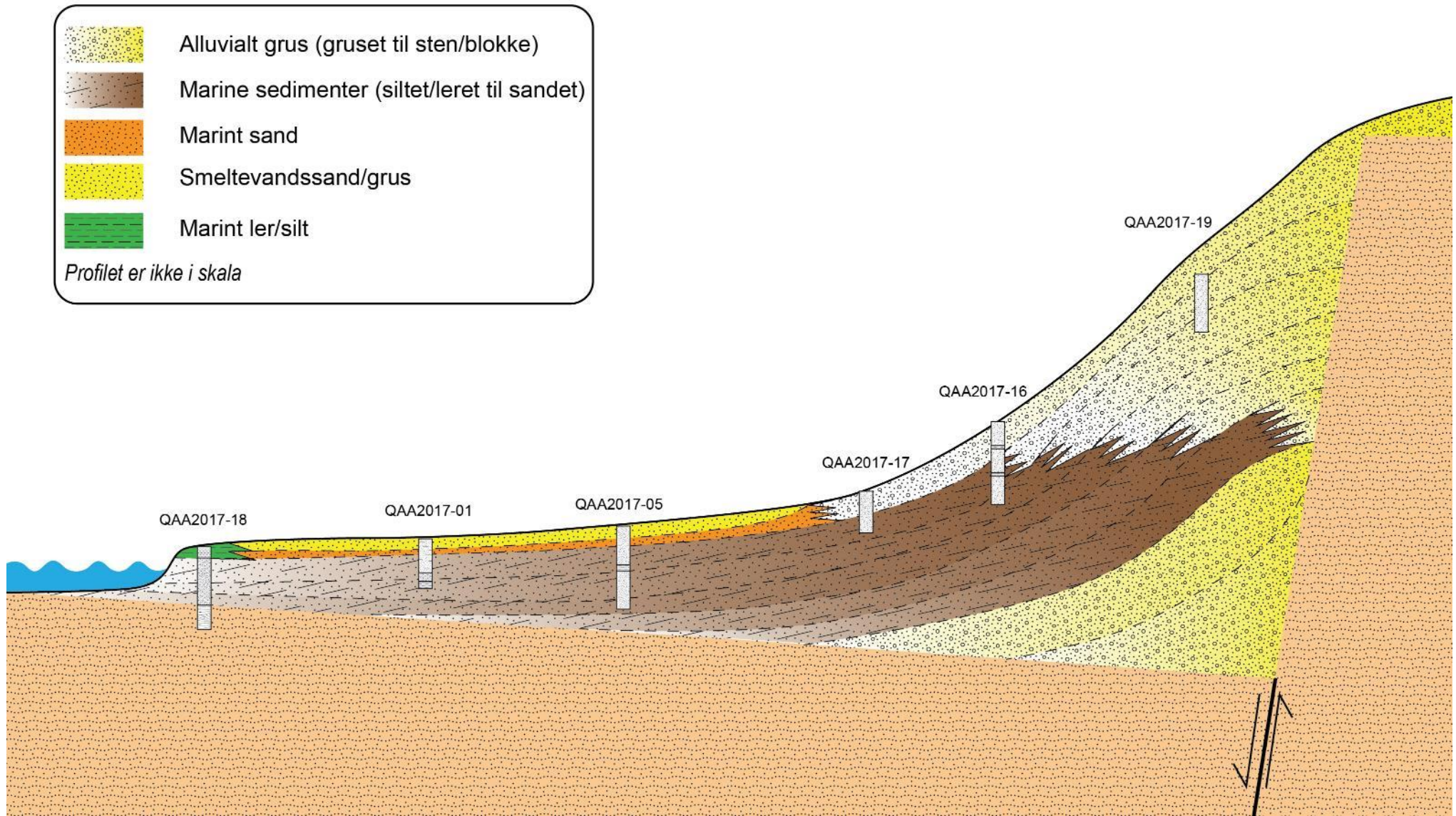

Borehole name
QAA2017-03
Depth (m)
Lithology
Sample color
Water/frost
Sample
Sample No.
W%
Sp
LOI%
Construction
51.8 m

Qaanaaq

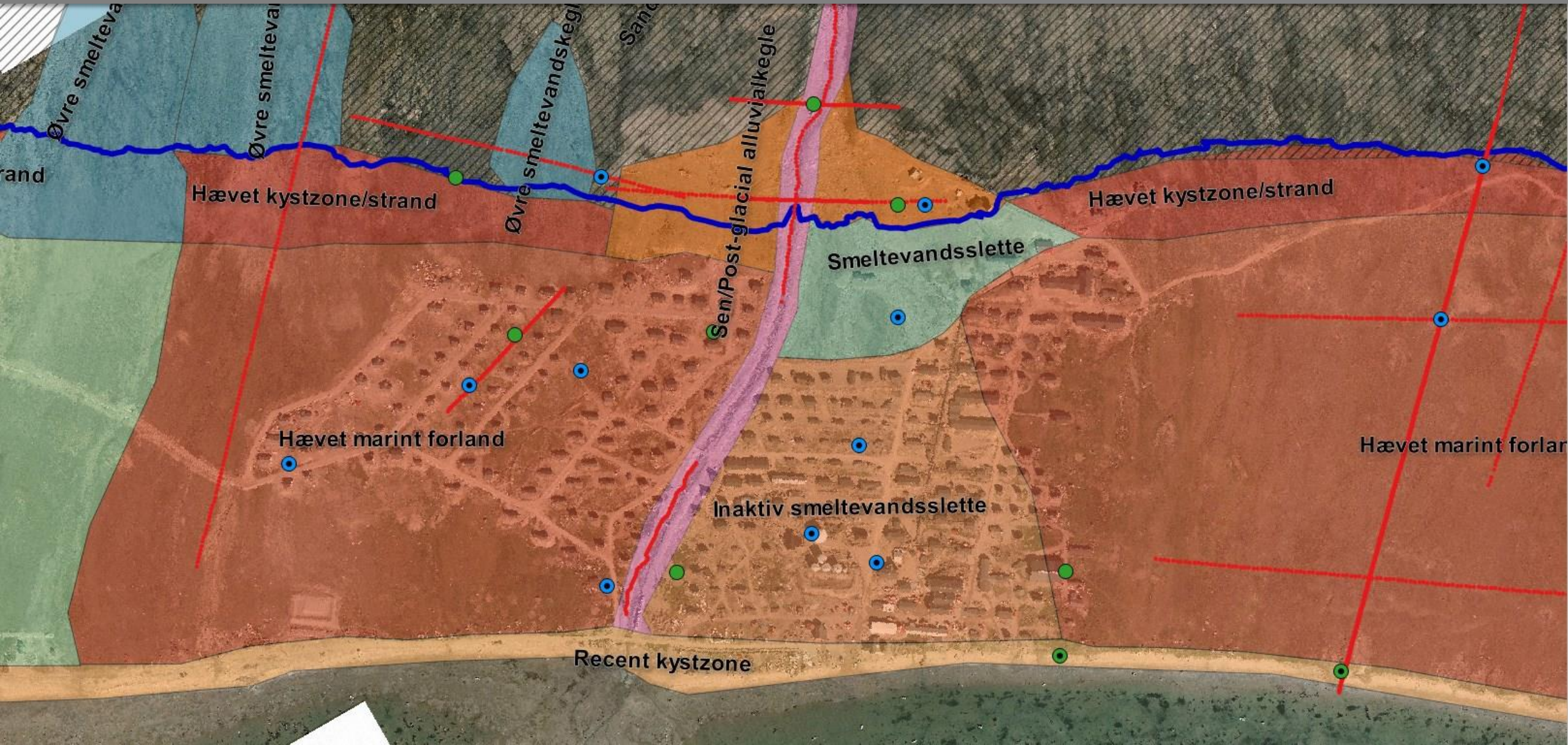

Øvre smelteva
Øvre smelteva
Øvre smeltevandskegl
Sand
Sen/Post-glacial alluvialkegle
rand
Hævet kystzone/strand
Hævet kystzone/strand
Smeltevandsslette
Hævet marint forland
Hævet marint forlan
Inaktiv smeltevandsslette
Recent kystzone

Geomorfologi

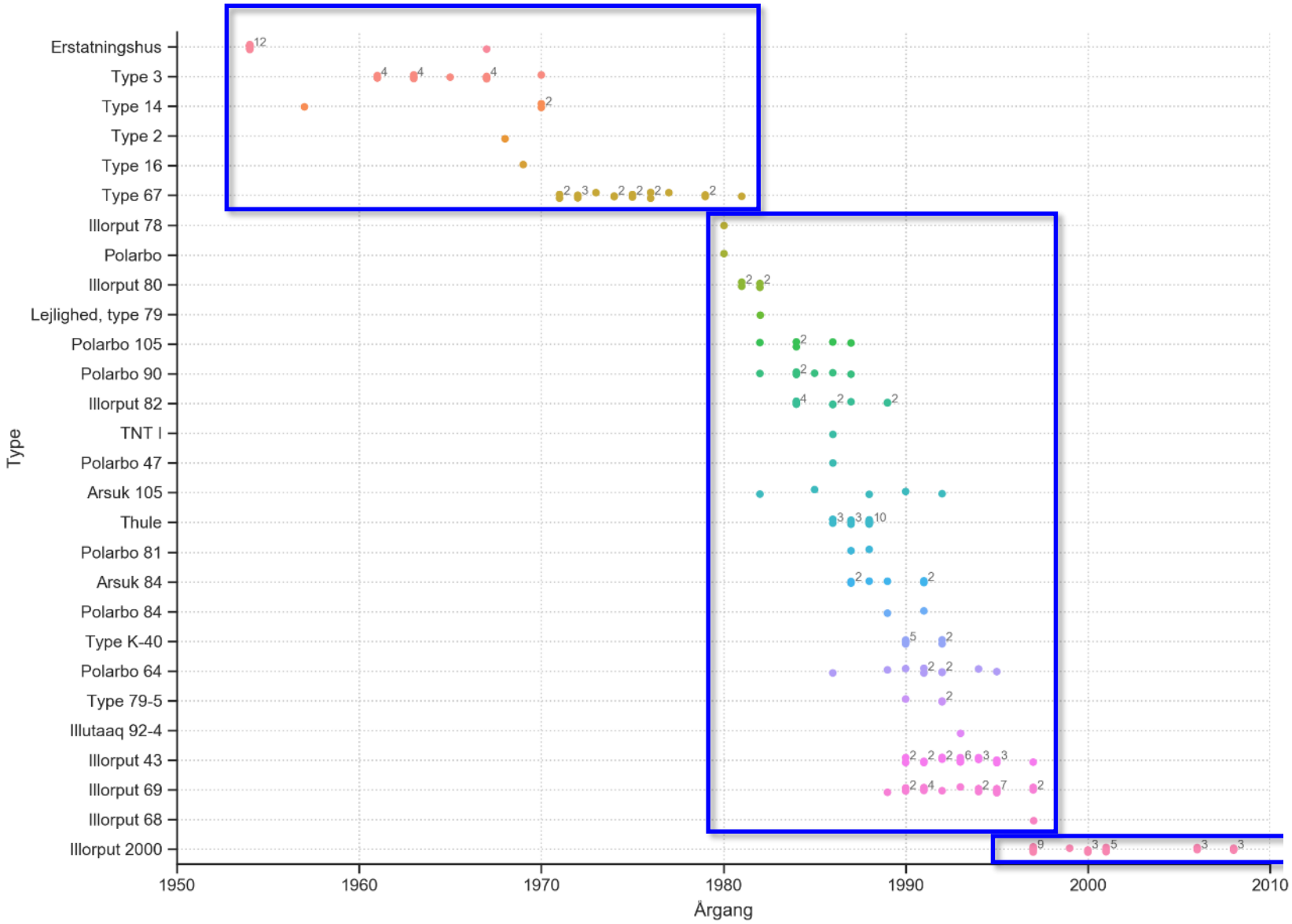



Alluvialt grus (gruset til sten/blokke)
Marine sedimenter (siltet/leret til sandet)
Marint sand
Smeltevandssand/grus
Marint ler/silt
Profilet er ikke i skala
QAA2017-19
QAA2017-16
QAA2017-17
QAA2017-05
QAA2017-01
QAA2017-18

Geomorfologi

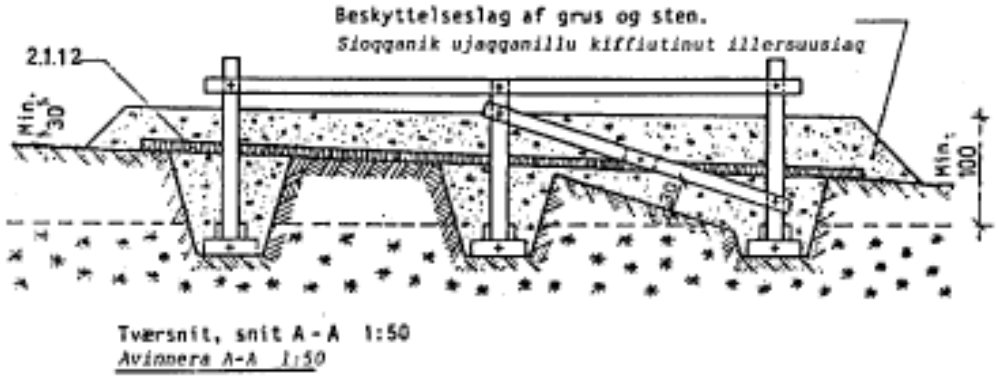


Bebyggelsens historik



Bebyggelsens historik

År	HUSTYPE	FUK	Afgravning	Pudehøjde
1956	**Funderingsarbejder i Qaanaaq i 1956**	1.7 m.u.f.t. 20 cm under PFS (fremskrivning)	1.7 m.u.f.t. 20 cm under PFS (fremskrivning)	Terræn udjævnes
1957	**BSU Type 2**	n.d.	2 m.u.t.	n.d.
???	**BSU Type 5**	n.d.	2 m.u.t.	n.d.
1957	**BSU Type 14**	n.d.	2 m.u.t.	n.d.
1957	**BSU Type 16**	n.d.	2 m.u.t.	n.d.
1980	**GTO Type 67**	25 cm over PFS	PFS (bæredygtigt niveau)	0.75 m.o.t.
1982	**Illorput 82**	30 cm under PFS	30 cm under PFS	min 0.3 m.o.t. min 1 m.o. PFS
1983	**GTO Type 79-5**	0 m.u.t.	0.5 m.u.t.	0.75 m.o.t.
1984	**Polarbo 64**	Udføres som Polarbo 81		
1984	**Polarbo 81**	1.5 m.u.t.	n.d.	n.d.
1989	**Illorput 43**	30 cm under PFS	30 cm under PFS	min 0.3 m.o.t. min 1 m.o. PFS
1989	**Illorput 69**	30 cm under PFS	30 cm under PFS	min 0.3 m.o.t. min 1 m.o. PFS
1997	**Illorput 2000-2**	1.2 m.u.t.	1.5 m.u.t.	0.2 m.o.t.
1997	**Illorput 2000-1**	1.2 m.u.t.	1.5 m.u.t.	0.2 m.o.t.
2014	**Nye boliger Qaanaaq**	1.5 m.u.f.t.	2.0 m.u.f.t.	0 á 2 m.o.t.

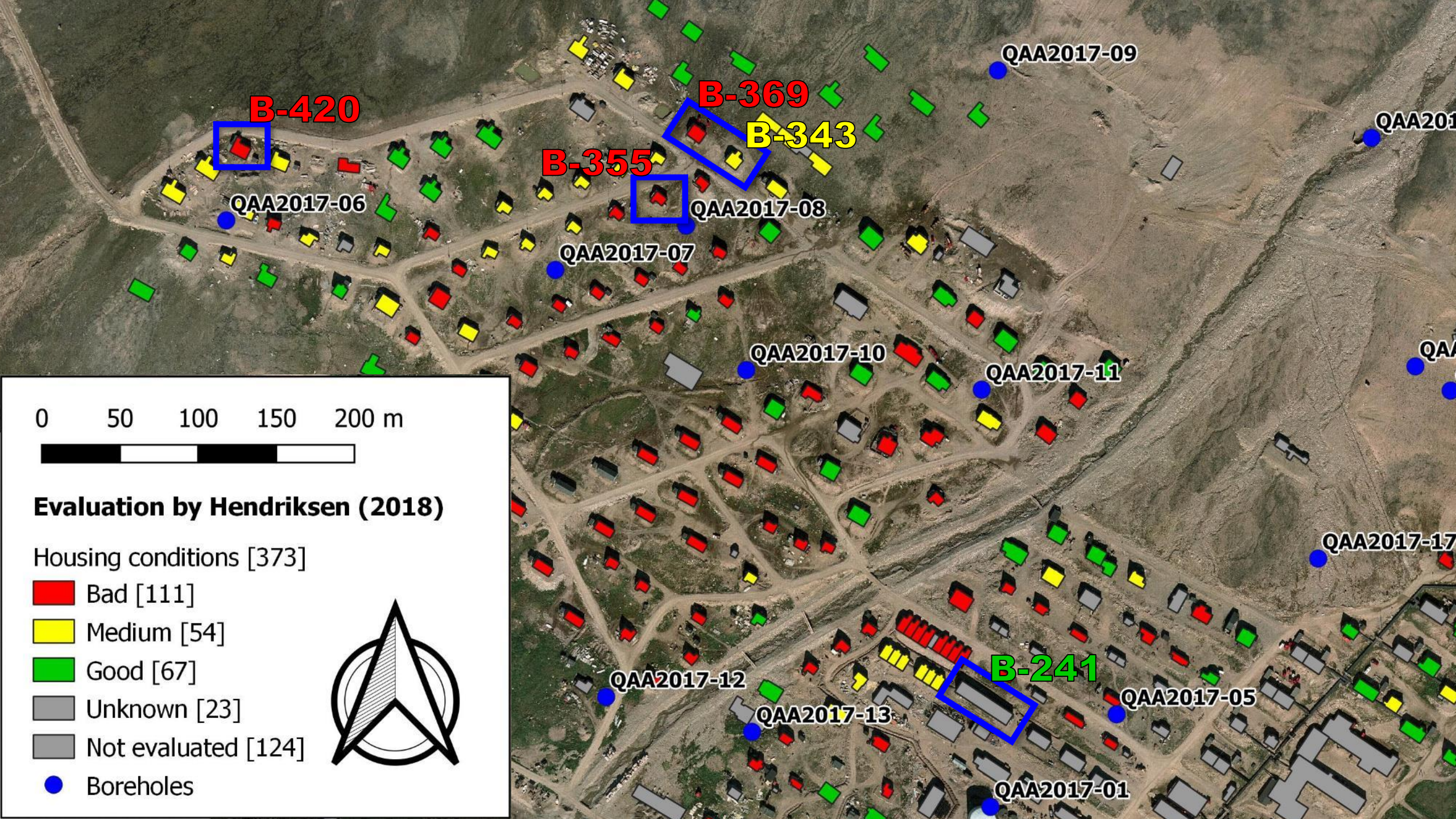


Funderingsdybde: 0.2-0.3 m under PFS

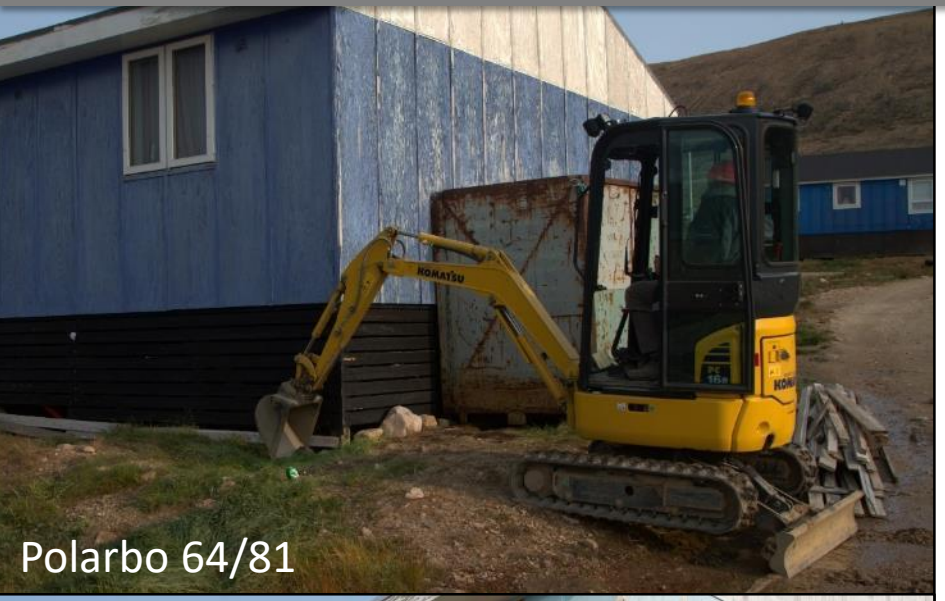
GTO vurdering 1954/1956: 1.0-1.5 m ALT

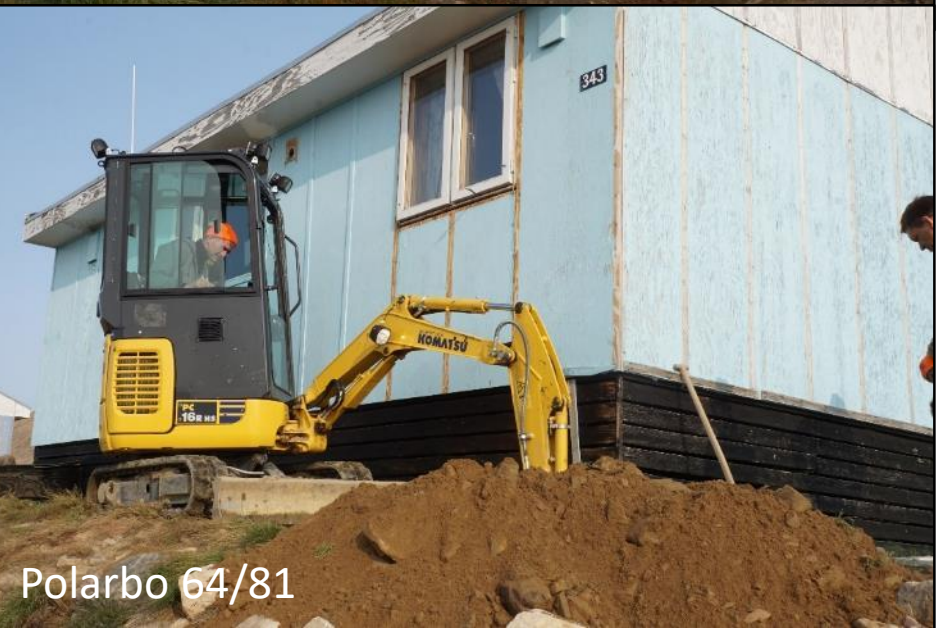
Temperaturstigning +2C siden 1950'erne

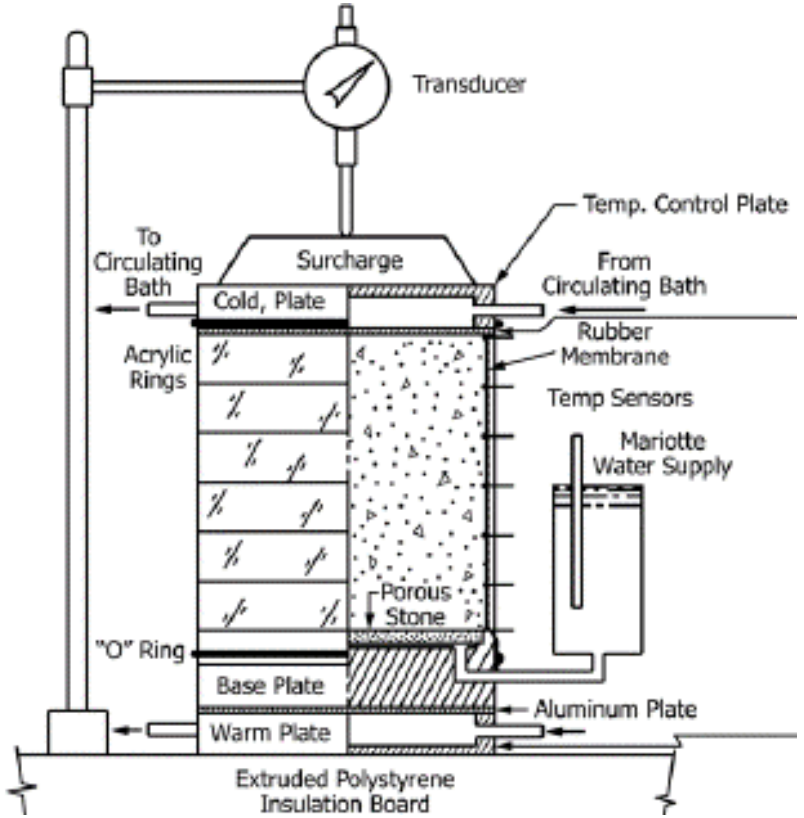
Aktivlag Tykkelse 2019 (ALT): 1.89±0.43 m
(min: 1.2 m / max: 2.9 m)


B-420
B-369
B-343
B-355
QAA2017-09
QAA2017-06
QAA2017-08
QAA2017-07
QAA2017-10
QAA2017-11
QAA2017-17
B-241
QAA2017-12
QAA2017-13
QAA2017-05
QAA2017-01
0 50 100 150 200 m
Evaluation by Hendriksen (2018)
Housing conditions [373]
Bad [111]
Medium [54]
Good [67]
Unknown [23]
Not evaluated [124]
Boreholes

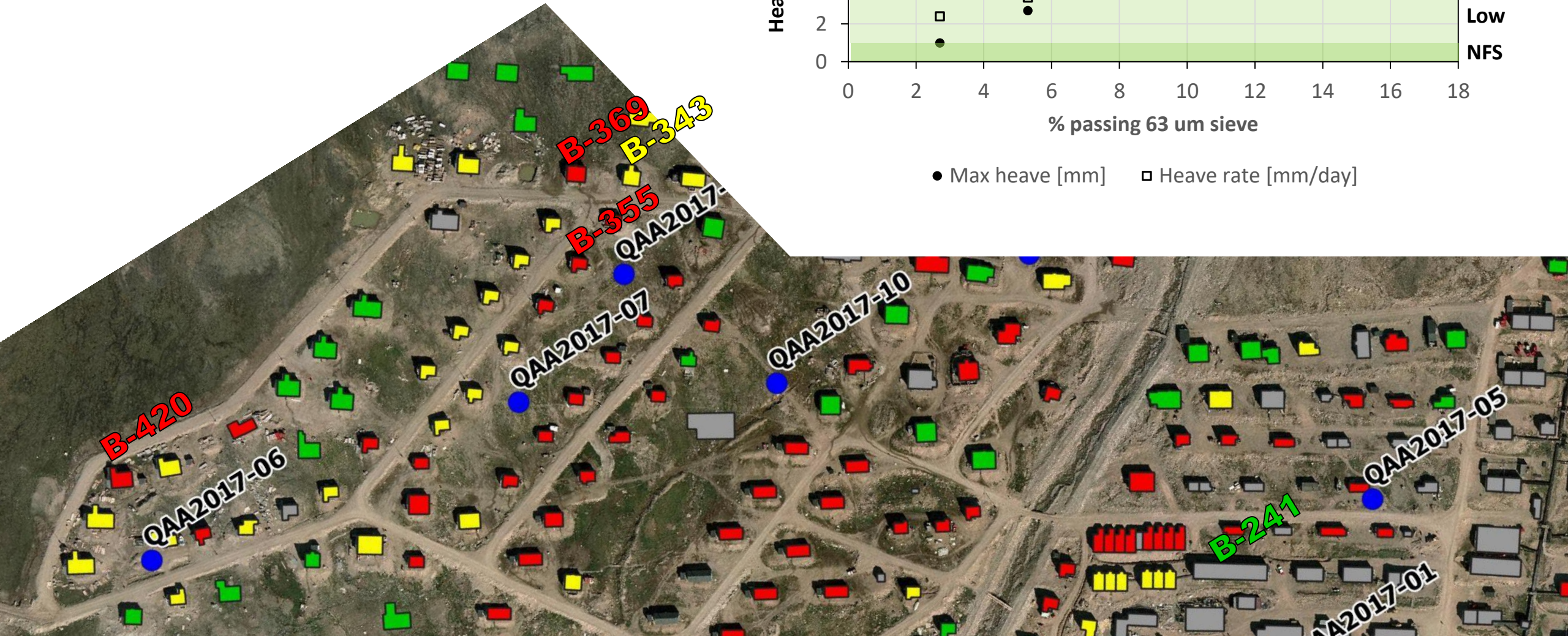
Frost heave testing

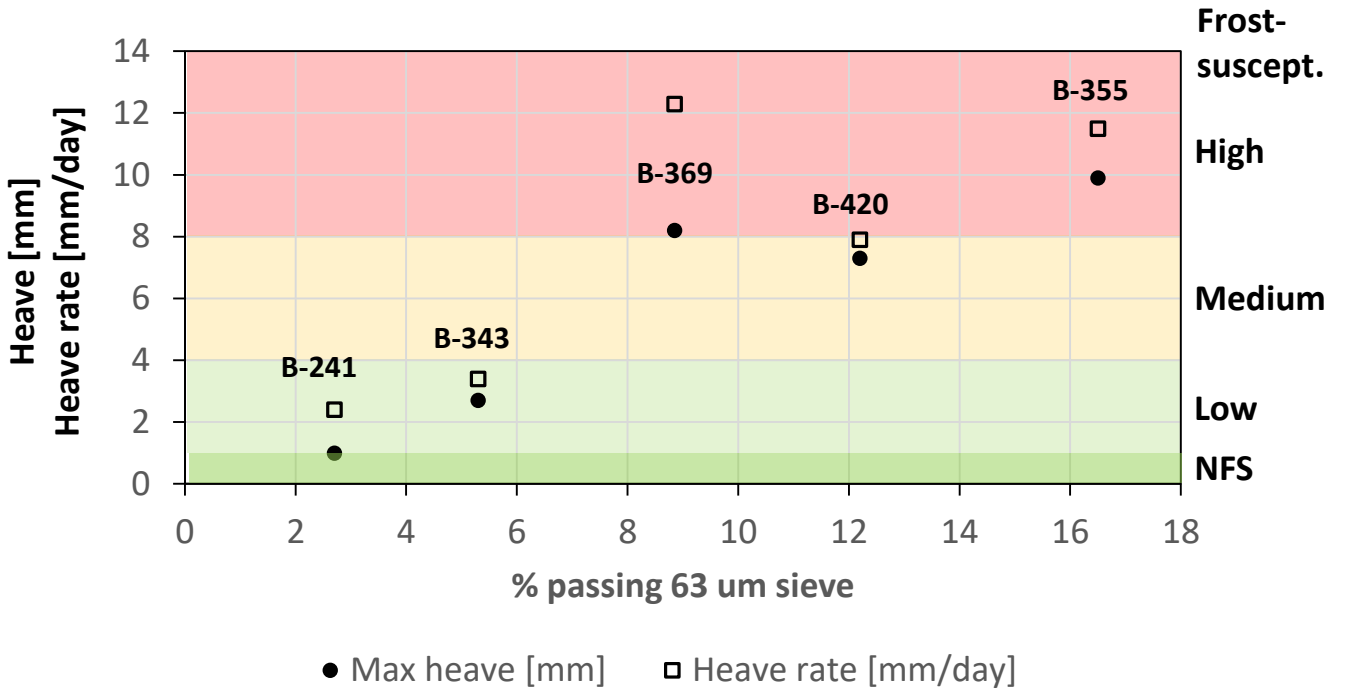


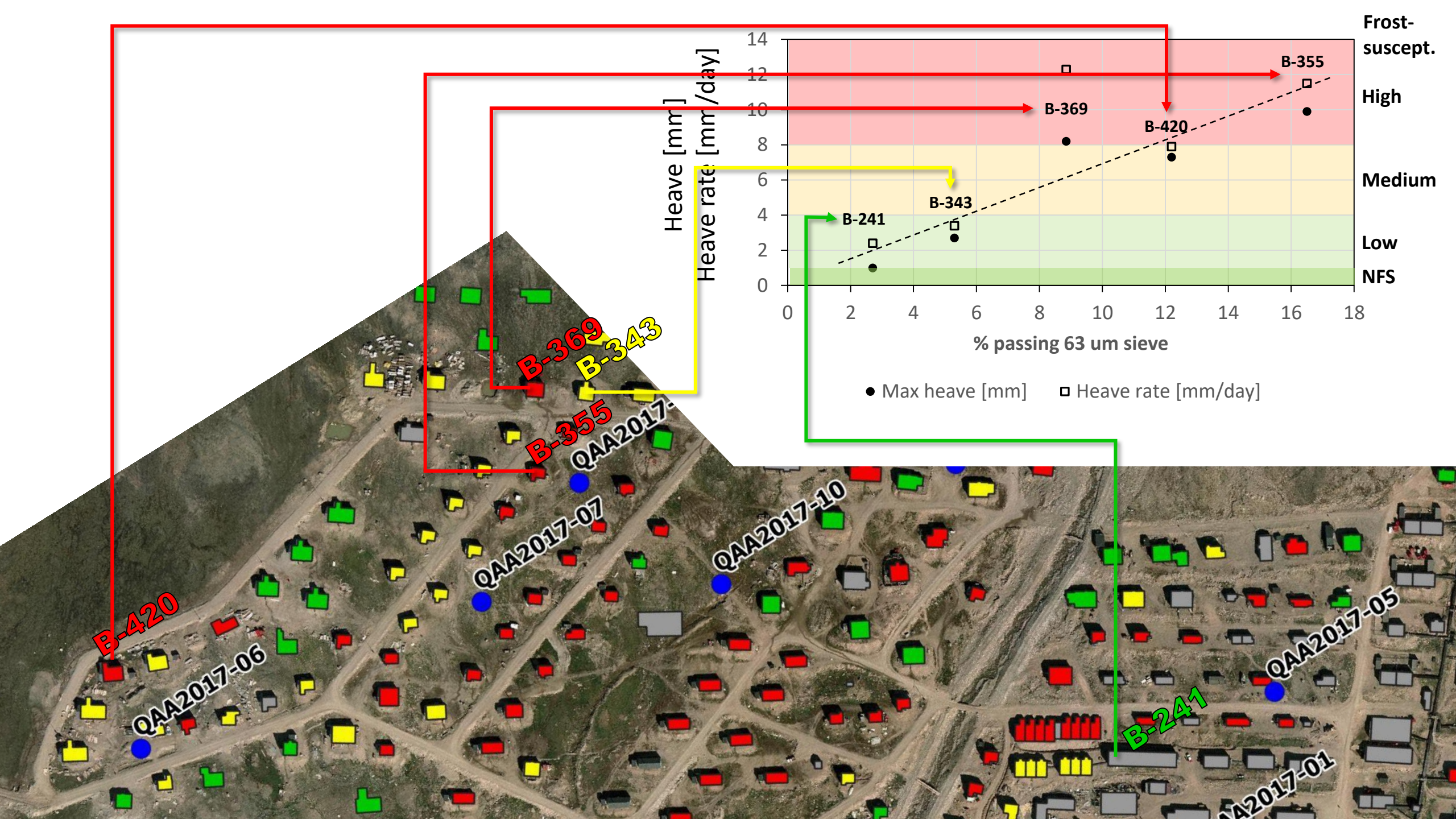




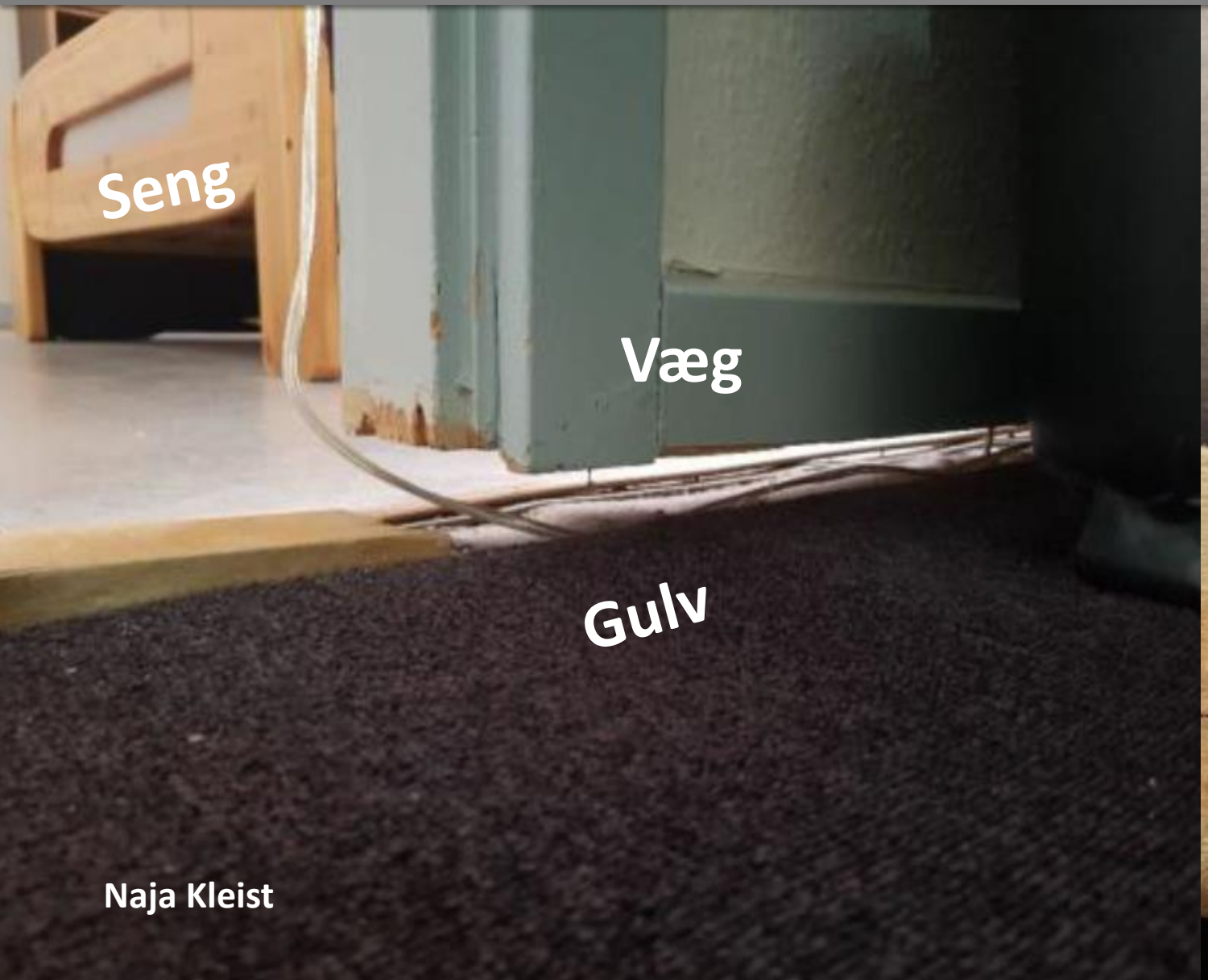
Frost heave testing






Heave [mm]
Heave rate [mm/day]
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
% passing 63 um sieve
B-355
B-369
B-420
B-343
B-241
Frost-suscept.
High
Medium
Low
NFS
Max heave [mm]
Heave rate [mm/day]
B-420
B-369
B-343
B-355
QAA2017-
QAA2017-07
QAA2017-10
QAA2017-06
QAA2017-05
B-241
QAA2017-01

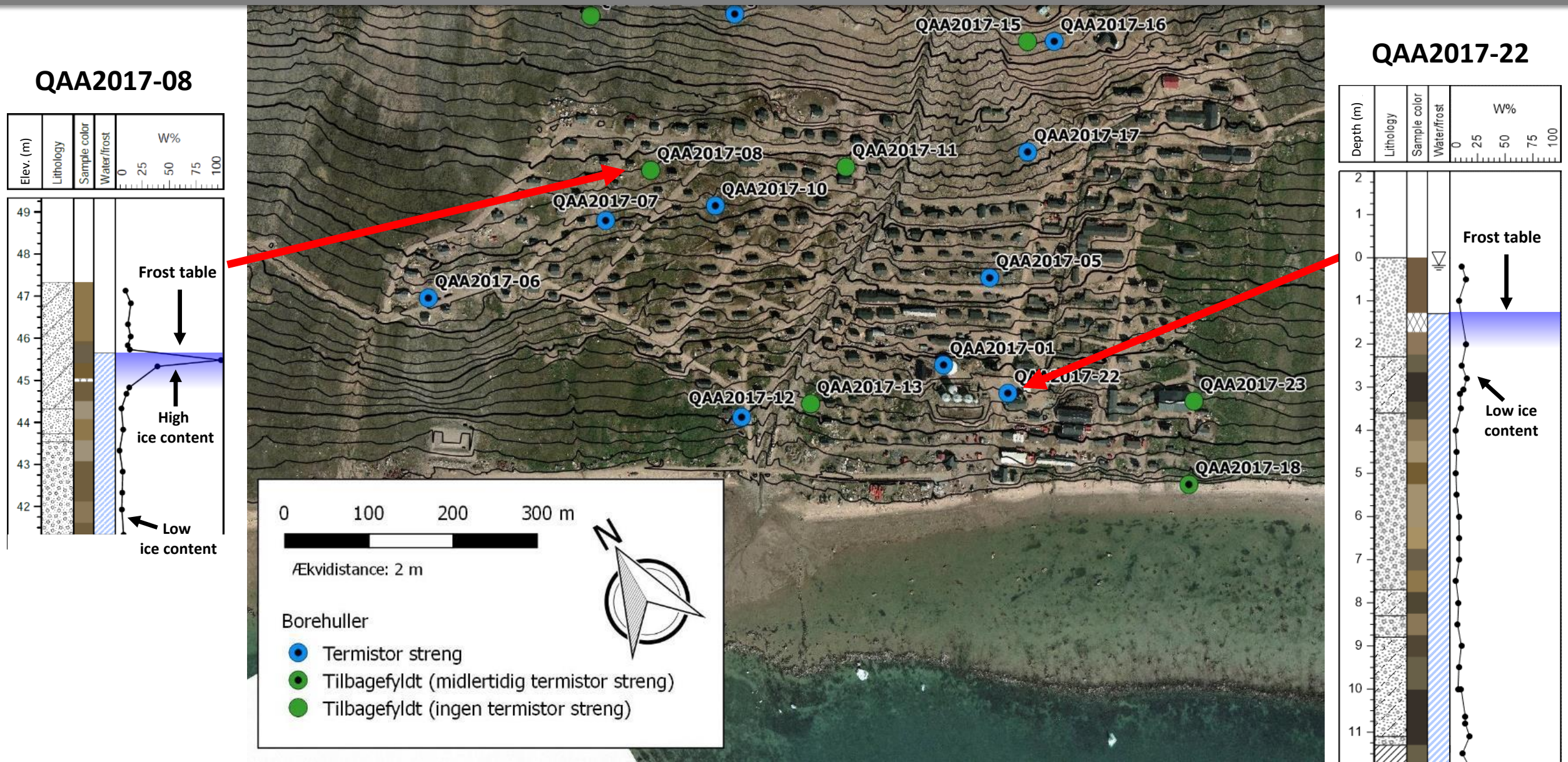
Nogle observerede skader



Naja Kleist

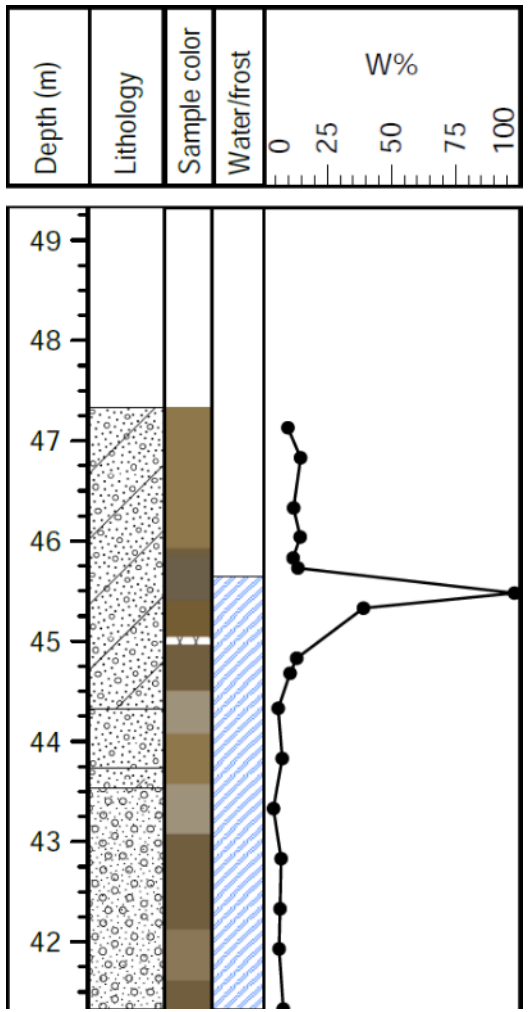
Emilie Olsen

Ice content in the permafrost



Mulig funderingsløsning

QAA2017-08



Konklusioner

- Kompliceret mix af marine, glaciale og alluviale sedimenter
- Permafrost: approx -8.5 C @ 20 m (ZAA), ALT: 1.5-2.5 m
- Near surface variation in ice content, low ice contents at depth
- InSAR analysis unable to identify significant slope movement
- Foundation issues relate mainly to poor construction practices
- Simple solutions available: gravel pad, or concrete pile foundations

Qujanaq!

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