

Assessment of liquefaction hazard of reclaimed land in Wellington

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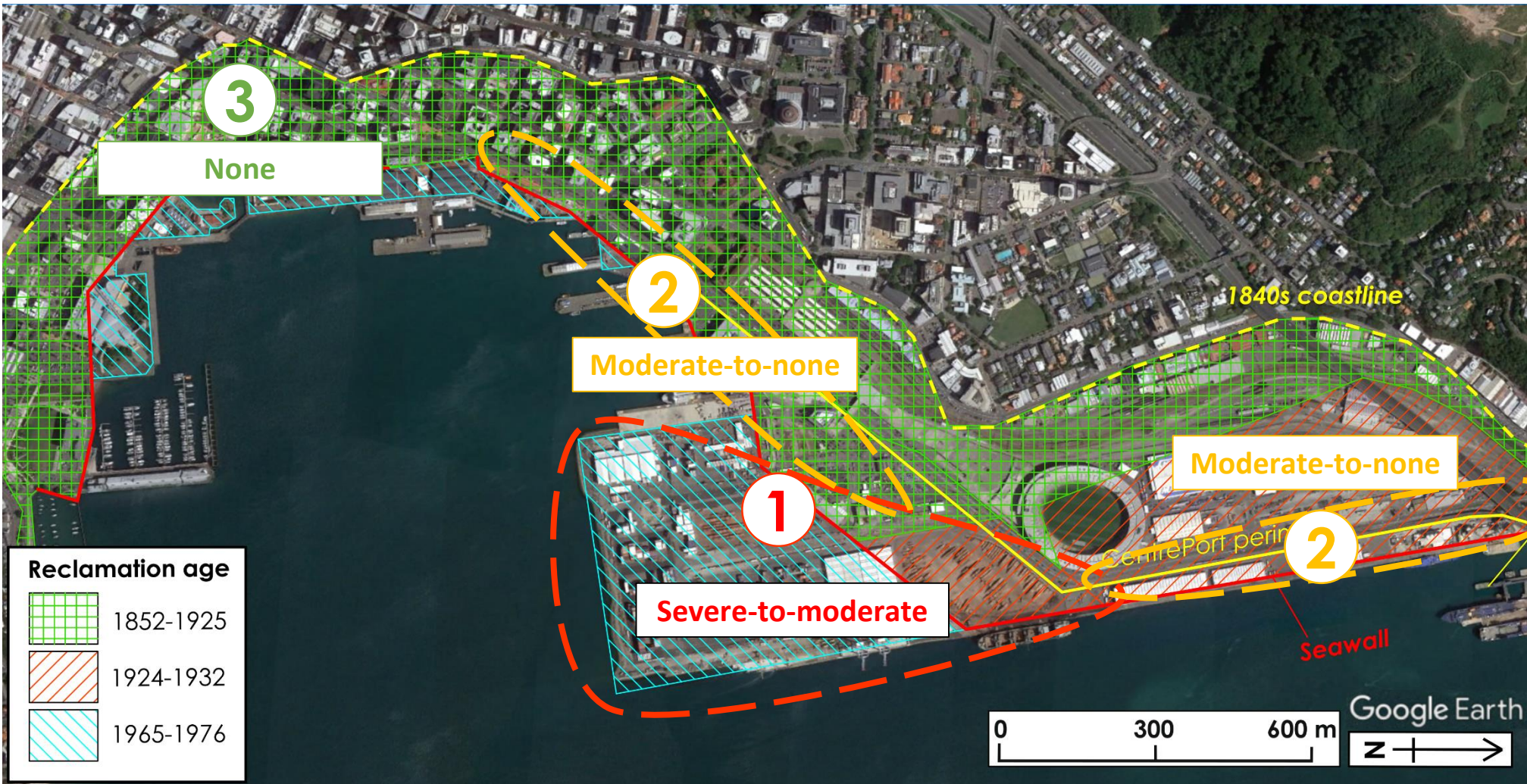
*with Misko Cubrinovski, Ribu Dhakal, Sean Rees, Mark Stringer, Chris de la Torre (UC), Jon Bray (UC Berkeley),
and thanks to McMillan Drilling, Tiffany Palmer – CentrePort, Derek Baxter, Zac Jordan, Alex Robertson – WCC...*

Central Wellington Reclamations



- Highly variable deposits, often w/o records of materials employed for reclamation
 - Developed without considering liquefaction hazard
- Inherited vulnerabilities

2016 Kaikōura EQ: Ground Damage



Thick ejecta



Settlement of fill

Cubrinovski et al. (2017)
NZSEE Bulletin

UC Field Investigations

1. Understand ground conditions at CentrePort

- Soil profiles?
- Where are liquefiable and non-liquefiable fills?

2. Characterize cyclic resistance of fills

- CPT testing + borehole sampling

- Compare different fills

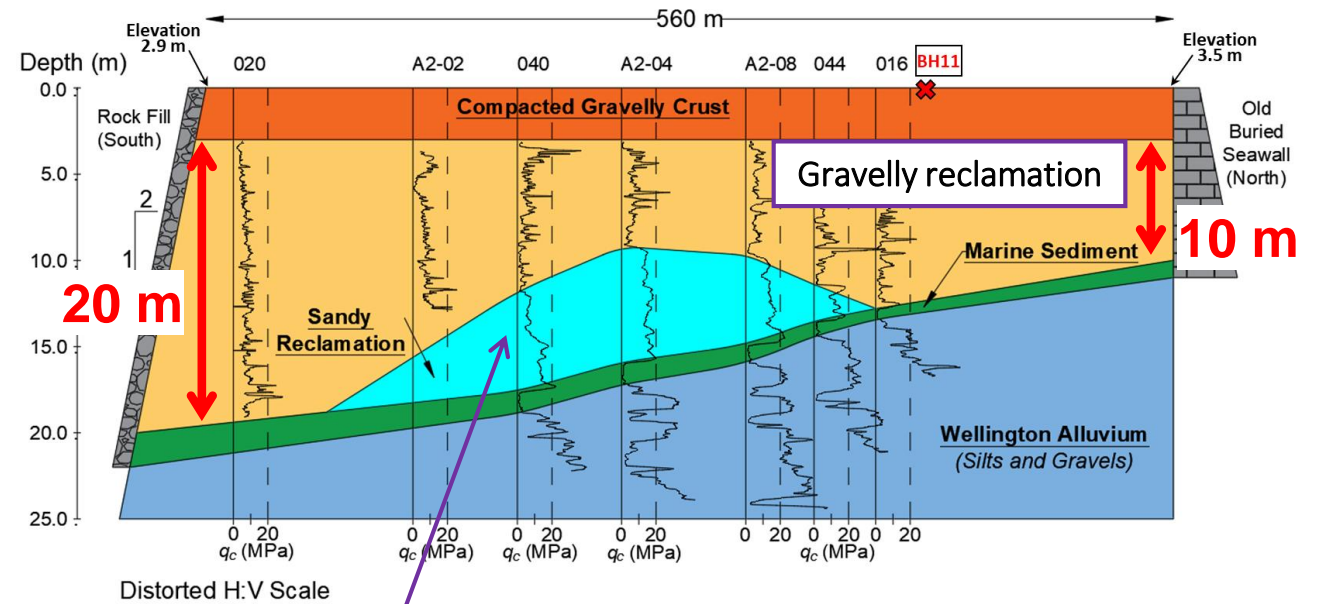
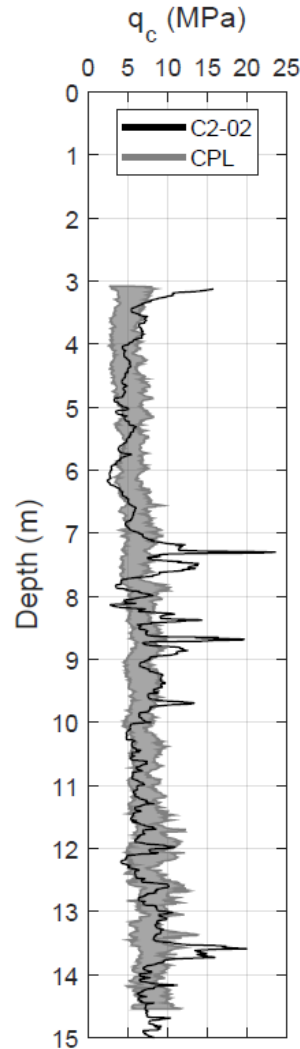
- First estimate of liquefaction resistance from empirical relationships

- In the lab – “undisturbed” samples

- Compare against field testing estimates

- Input for numerical analyses

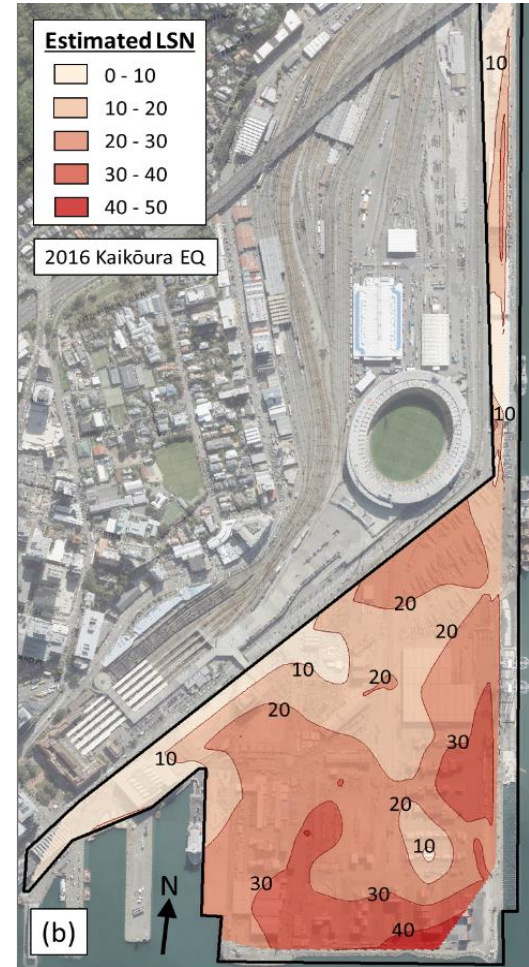
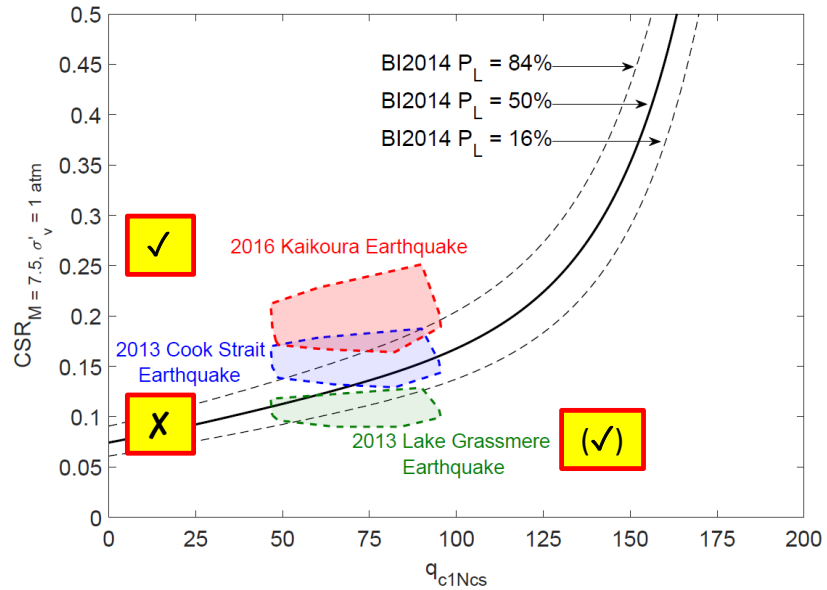
2017-2019: Site Characterization



Clean sand fill

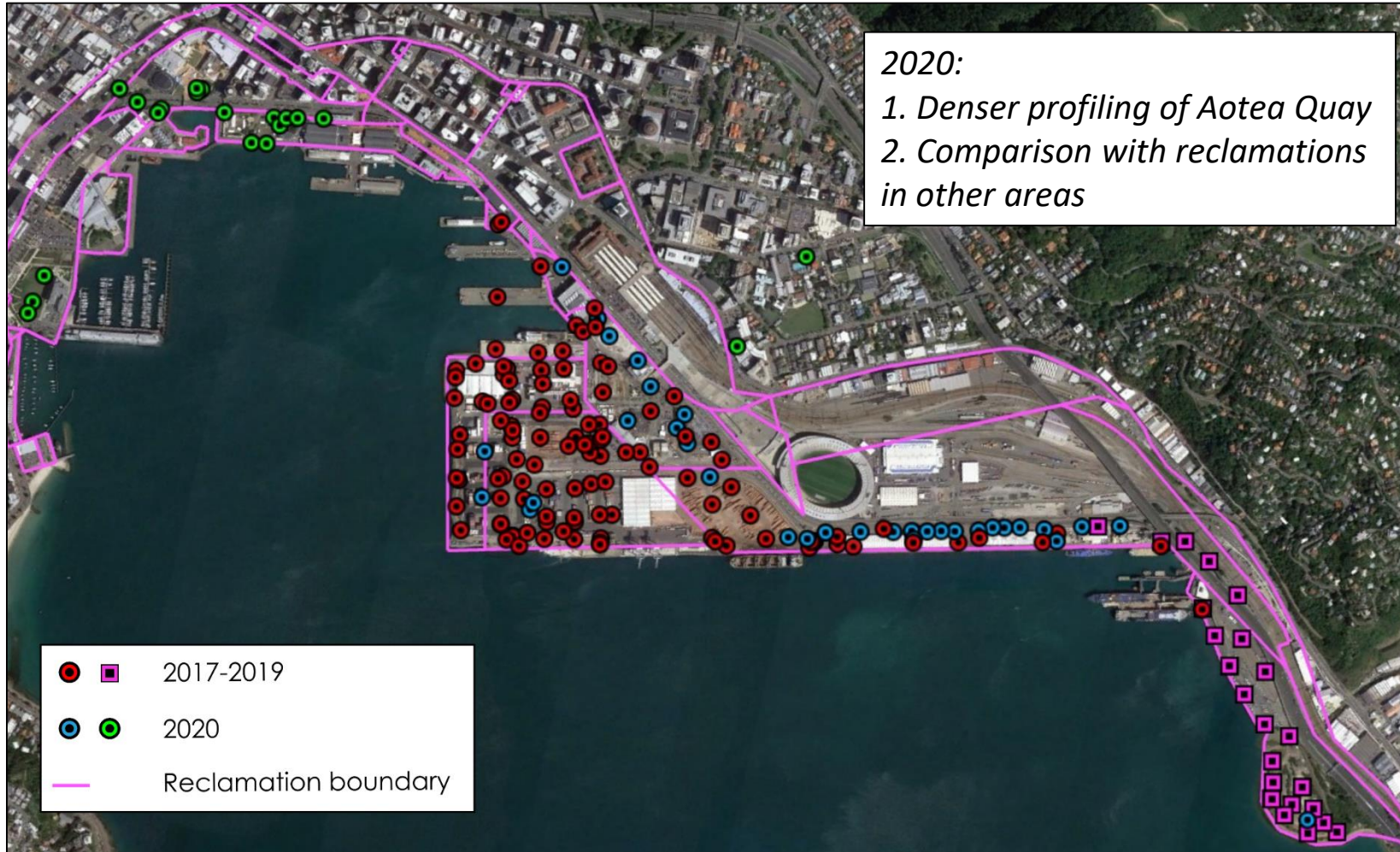
- Sand-silt controlled matrix
- Indicates performance during Kaikoura EQ

2017-2019: Liquefaction Assessment

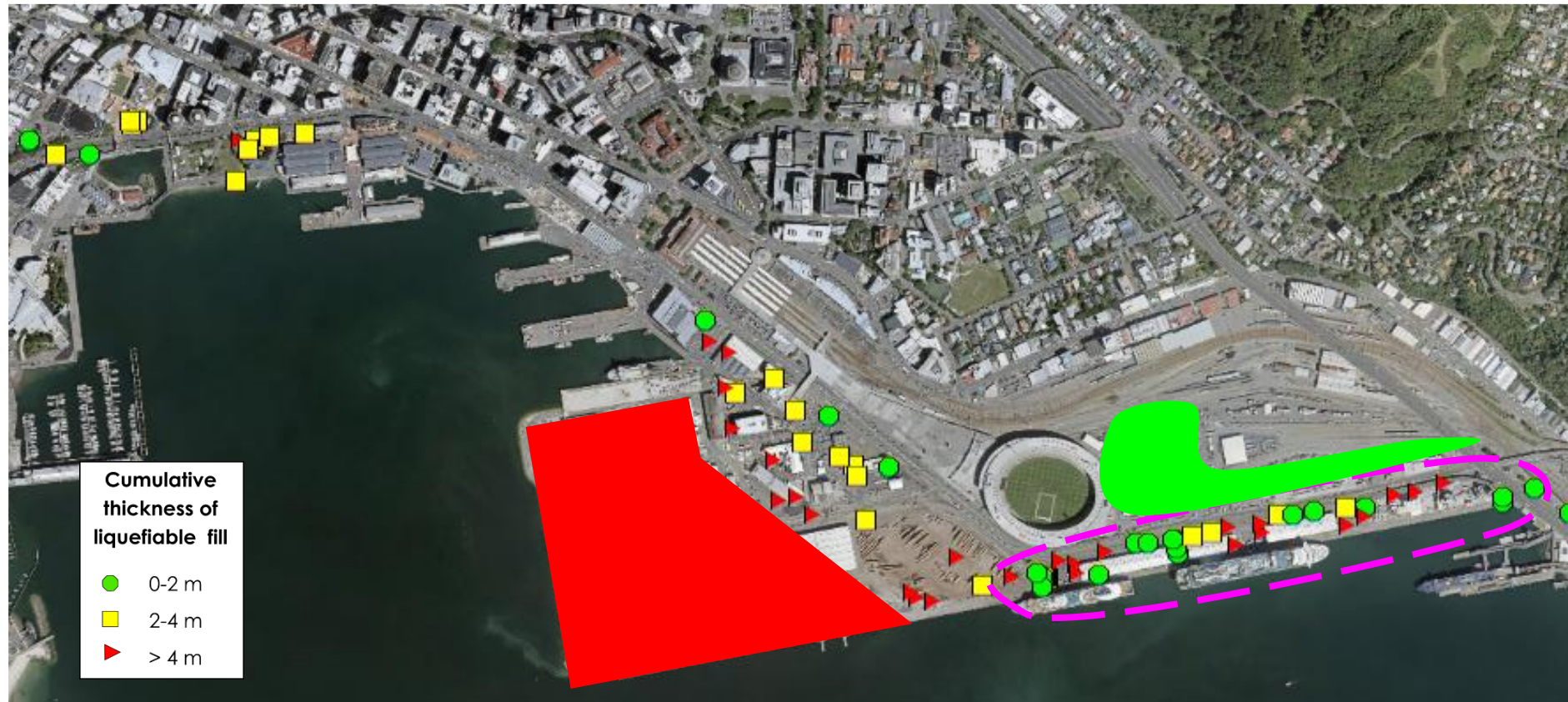


- ✓ Increase damage southwards
- ✓ Less damage in eastern part
- ✓ Overall moderate-to-severe damage
- ✗ Disagreement northwards

2020 CPT investigations



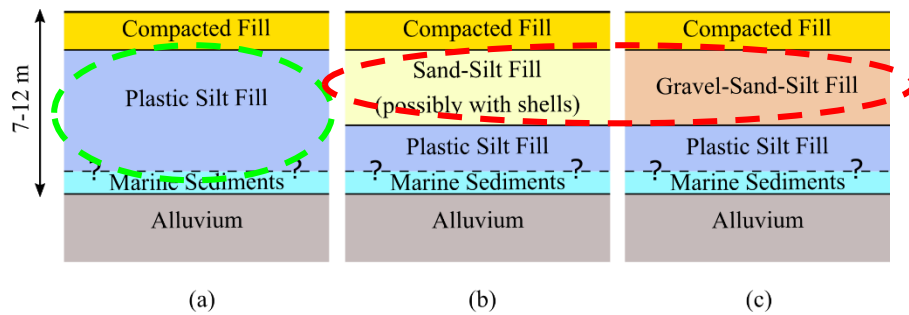
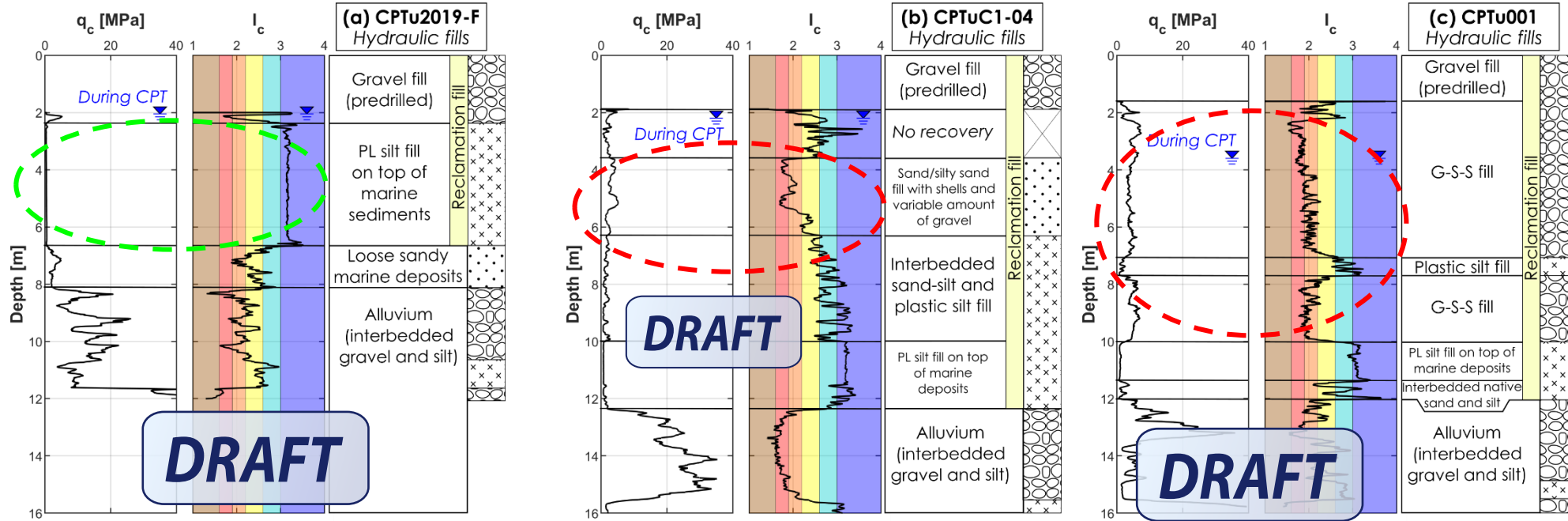
Liquefiable fills ($I_c < 2.6$): where?



Aotea Quay reclamation:

- Consisting for the most part of non-liquefiable, plastic silt fills
- Up to 9 m of loose, liquefiable fills in 200-m long sections close to seawall
- Northern part of Aotea Quay performed relatively well
- Non-uniform spatial distribution of liquefiable fills
- Retaining structure

Soil profiles along Aotea Quay

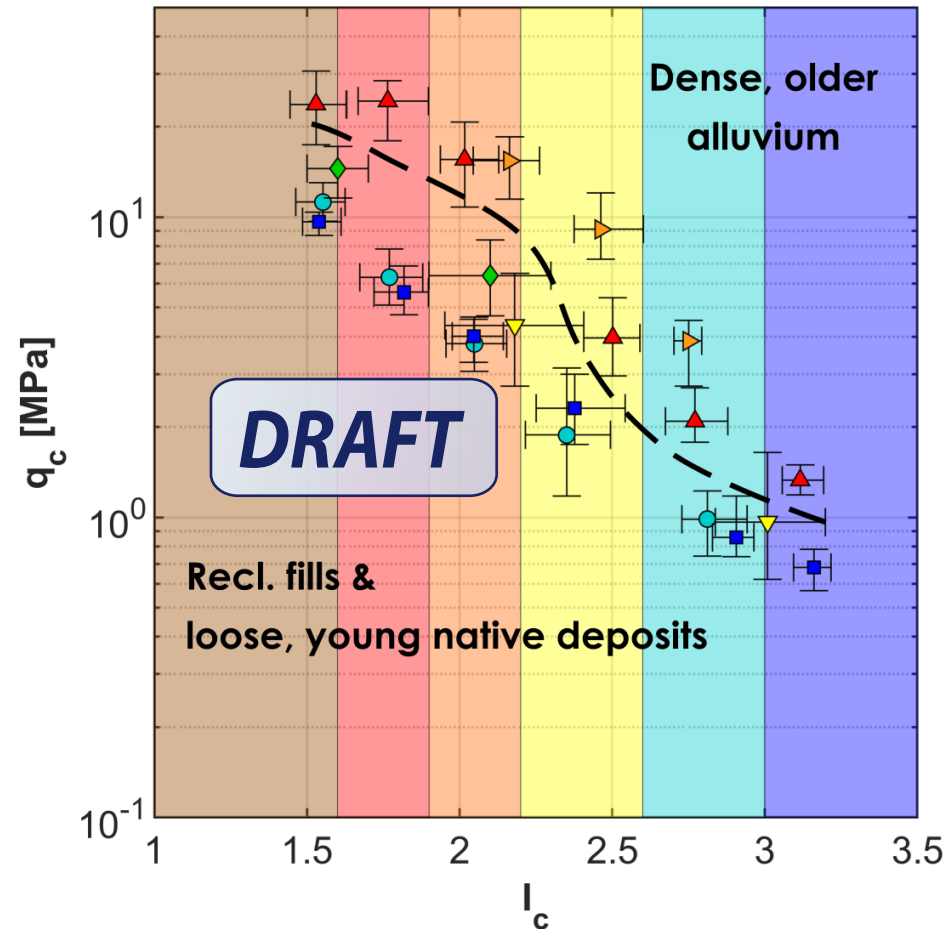


Hydraulic fill reclamation
(1924-1932)

Liquefiable hydraulic fills:

- Sand-silt fill with shells (and sometimes gravel)
- Gravel-sand-silt fill
- Similar q_c and I_c

CPT characterization of reclamation fills



Reclamation fills

- ◆ Thorndon gravelly reclamation
- 1902-1916 gravelly reclamation, CentrePort
- Aotea Quay (excl. Log Yard)

Native deposits

- ▲ } Dense alluvium
- ▶ } Dense alluvium
- ▼ Marine sediments and other loose shallow deposits

q_c as function of I_c :

- Similar q_c for different reclamations
- Thorndon fills have slightly greater q_c (for given I_c)

Lab testing

Thorndon reclamation gravelly fills

- Ongoing testing on reconstituted specimens (UTokyo, UMichigan)

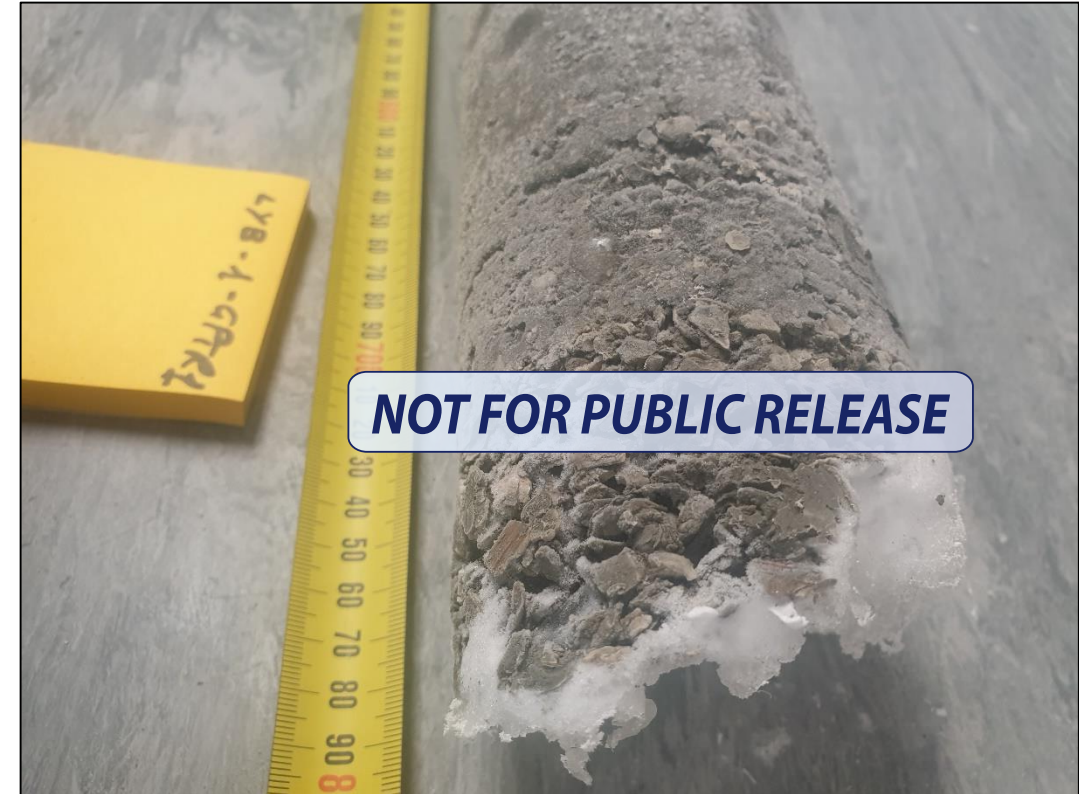
Aotea Quay hydraulic fills. CTX at UC on Dames & Moore/Gel-Push sample cores of:

- Liquefiable fills (g-s-s fills, shelly sandy fills)
- Non-liquefiable plastic silty fills

Currently testing plastic fills from N end of AQ



Work in progress



Questions?