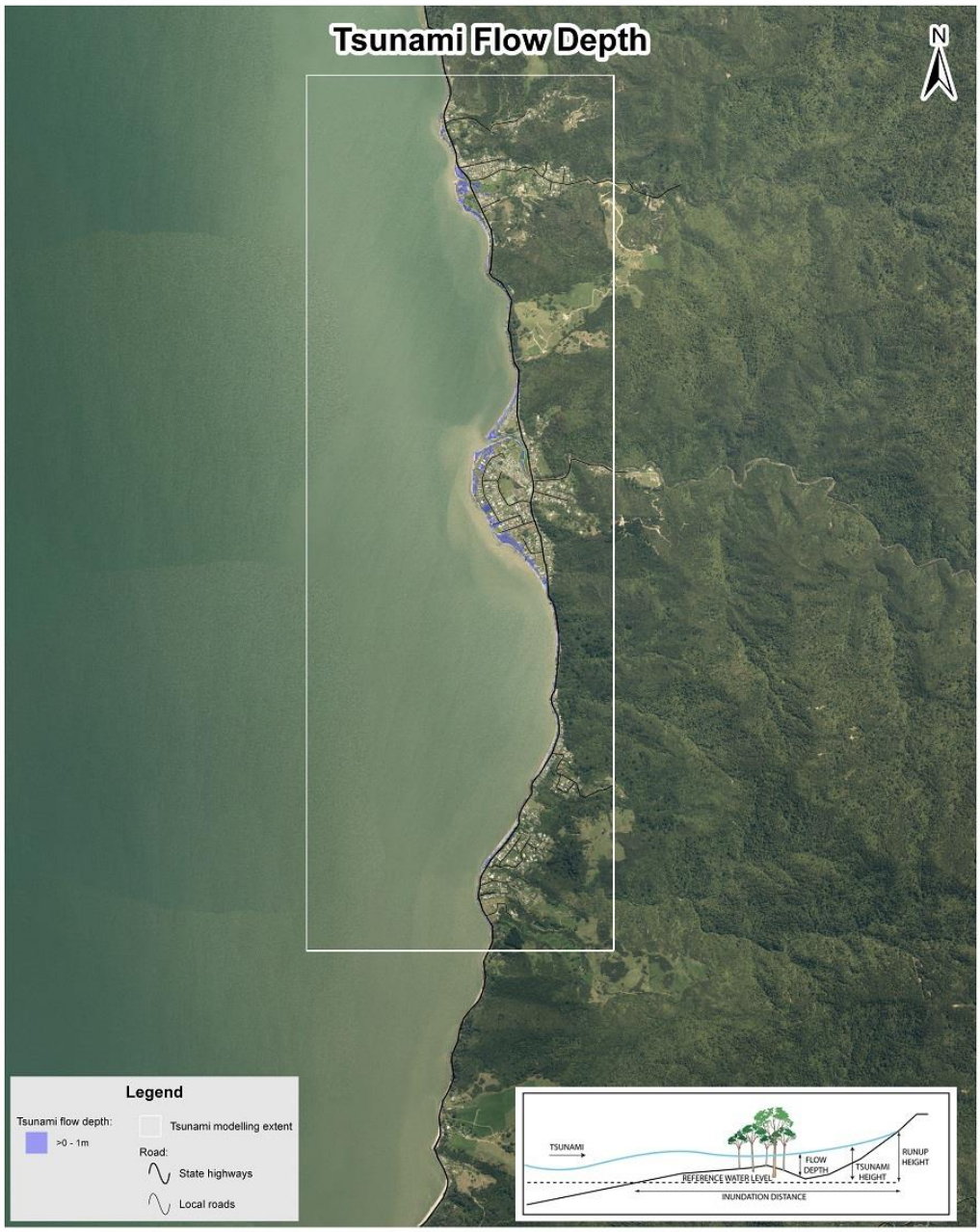
Waiomu, Te Puru and Ngarimu Bay tsunami hazards



Acknowledgements and Disclaimers

1. Source reference: Borrero, J. (2019). Numerical Modelling of Tsunami Inundation in Firth of Thames. eCoast Limited, Raglan.
2. Due to the unpredictability of tsunami, the example used in these images represents a possible 'worst case' and is used as guidance only. A larger tsunami event cannot be discounted.
3. © Waikato Regional Aerial Photography Service (WRAPS) 2017. Imagery sourced from Waikato Regional Council. Licensed under CC BY 4.0.
4. Map shows inundation above tide level at Mean High Water Springs.

The flow depth classification applies to areas above the tide level used in this scenario.

Te Puru, Firth of Thames tsunami modelling – distant event

Tsunami source: A 1960 Chilean-type tsunami positioned along the central coast of Peru

0 500 1,000 1,500 m

Scale at A0
= 1:9,000

Created by: A Jeffries
Date: 17/05/2019
Version: 1
Job no., file: REQ145008 Tsunami Firth of Thames - Te Puru.aprx

Waikato Regional Council
Te Kaunihera ā Rohe o Waikato

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Purpose

To summarise tsunami hazards information for the Waiomu, Te Puru and Ngarimu Bay communities:

- Where do tsunami come from?
- How long do tsunami waves take to arrive in Waiomu, Te Puru and Ngarimu Bay from the various sources?
- What impacts do tsunami have on the communities?

Source reference

This summary draws on information contained within the following technical report:

Borrero, J.C. (2018). *Numerical Modelling of Tsunami Inundation in the Firth of Thames*. eCoast Limited, Raglan.

The full report is available here:
http://www.waikatoregion.govt.nz/tsunamistrategy

What is a tsunami?

A tsunami is a series of water waves most commonly caused by seafloor earthquakes. Tsunami waves are different to wind-generated waves in that they are a transfer of energy, and usually travel a lot further inland than wind-generated waves.

Where do tsunamis come from?

Tsunamis caused by seafloor earthquakes occur most commonly around tectonic plate boundaries, particularly around the Pacific 'Ring of Fire'. Tsunamis can also occur along undersea fault lines that lie just offshore, whether associated with a plate boundary or not.

Waiomu, Te Puru and Ngarimu Bay have three primary sources of tsunami:

- 'Local source' from the Kerepehi Fault
- 'Regional source' from the Tonga-Kermadec Trench just off East Cape
- 'Distant source', most commonly from large earthquakes in South America.

An overview of the tsunami sources, wave arrival times and potential inundation in Waiomu, Te Puru and Ngarimu Bay is provided in the following pages.

Further information

Further general information about tsunami hazards is available at:
http://www.waikatoregion.govt.nz/tsunami

THAMES COROMANDEL DISTRICT COUNCIL

Work to identify tsunami hazards on the Coromandel Peninsula west coast and Firth of Thames is a joint initiative between Thames Coromandel District Council and Waikato Regional Council.

Waikato REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

Local source tsunami from the Kerepehi Fault

The Kerepehi Fault

A large earthquake along the offshore portion of the Kerepehi Fault is thought to be capable of generating a tsunami. The size of tsunami waves and their arrival time at Waiomu, Te Puru and Ngarimu Bay depends largely upon the size and position of the earthquake event.

Figure 1 shows the five fault segments considered in the technical report. Of the five faults considered, a magnitude (Mw) 7.1 earthquake rupturing along 16km of segment 'D2' has the largest potential impact on the Waiomu, Te Puru and Ngarimu Bay communities. This scenario is considered the 'maximum credible event' for Waiomu, Te Puru and Ngarimu Bay from the Kerepehi Fault.

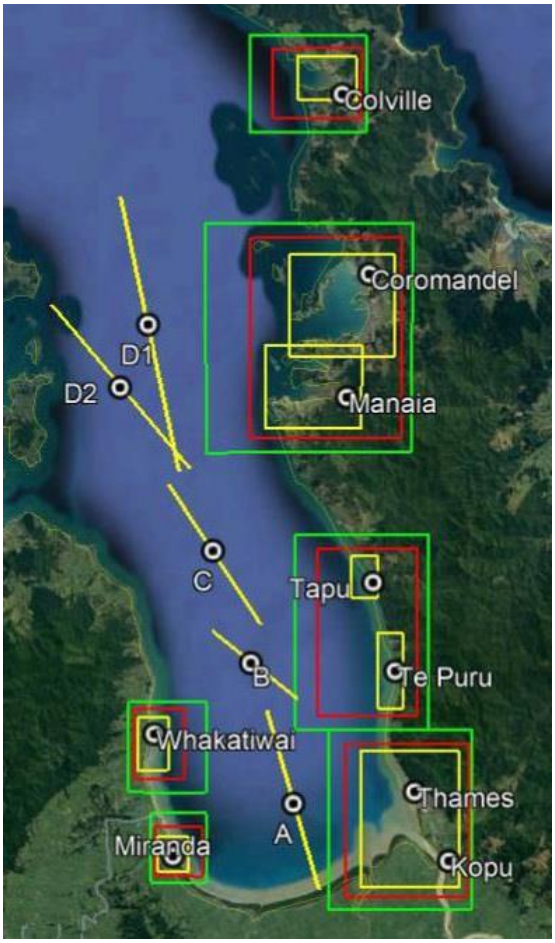

Figure 1: The five Kerepehi Fault segments considered within the technical report

How long does it take for local source waves to arrive at Waiomu, Te Puru and Ngarimu Bay?

Assuming a maximum credible earthquake along segment 'D2', Figure 2 shows that:

- Water levels begin to rise about 30 minutes following the earthquake, and reach a peak of around 1.4m above the existing water level around 55 minutes following the earthquake
- The second wave is the largest, and that water levels continue to rise and fall rapidly for at least six hours due to on-going wave arrivals.

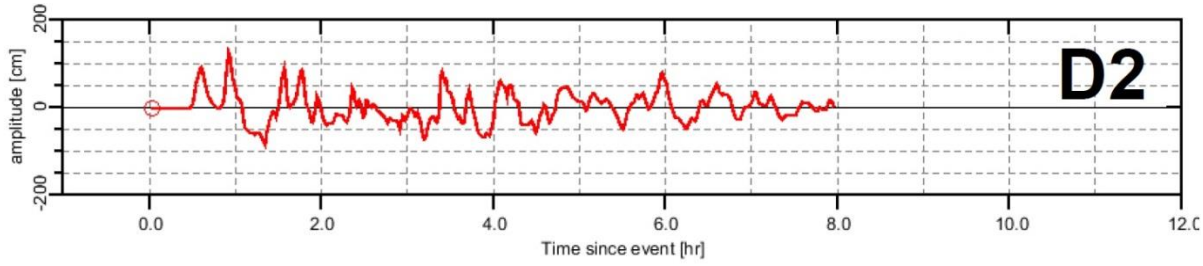

Figure 2: Wave arrival times and inundation levels from segment 'D2'

Inundation maps: impact of local source tsunami on Waiomu, Te Puru and Ngarimu Bay

Figures 3, 4 and 5 (overleaf) show the potential inundation from a maximum credible earthquake on segment 'D2' of the Kerepehi Fault. It is important to note that the maps:

- Assume wave arrival at Mean High Water Springs (the highest level that spring tides reach on average over a period of time)
- Only show inundation of land areas that are normally above sea level.

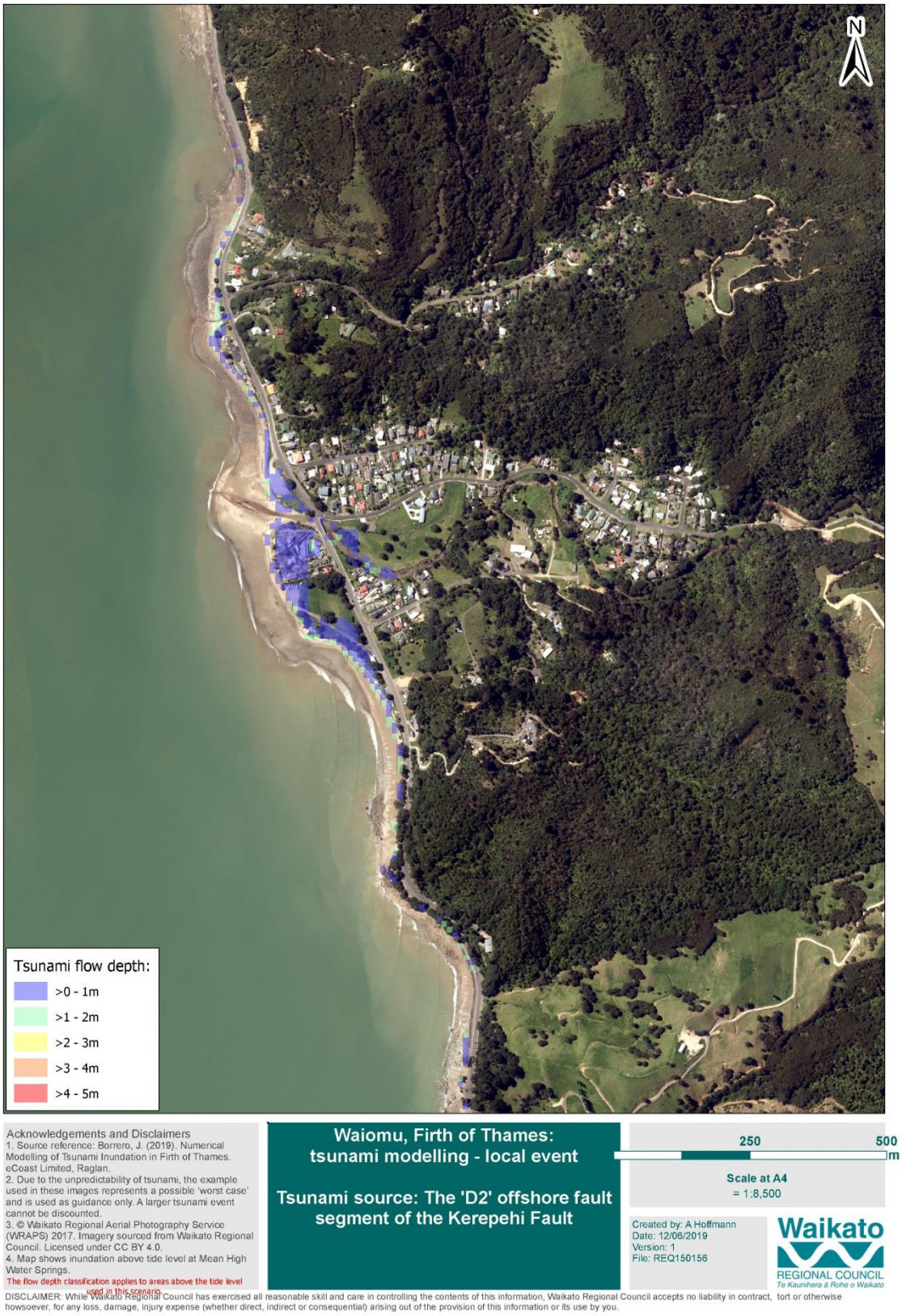

Figure 3: Waiomu
Kerepehi Fault potential inundation from a maximum credible earthquake on segment 'D2'

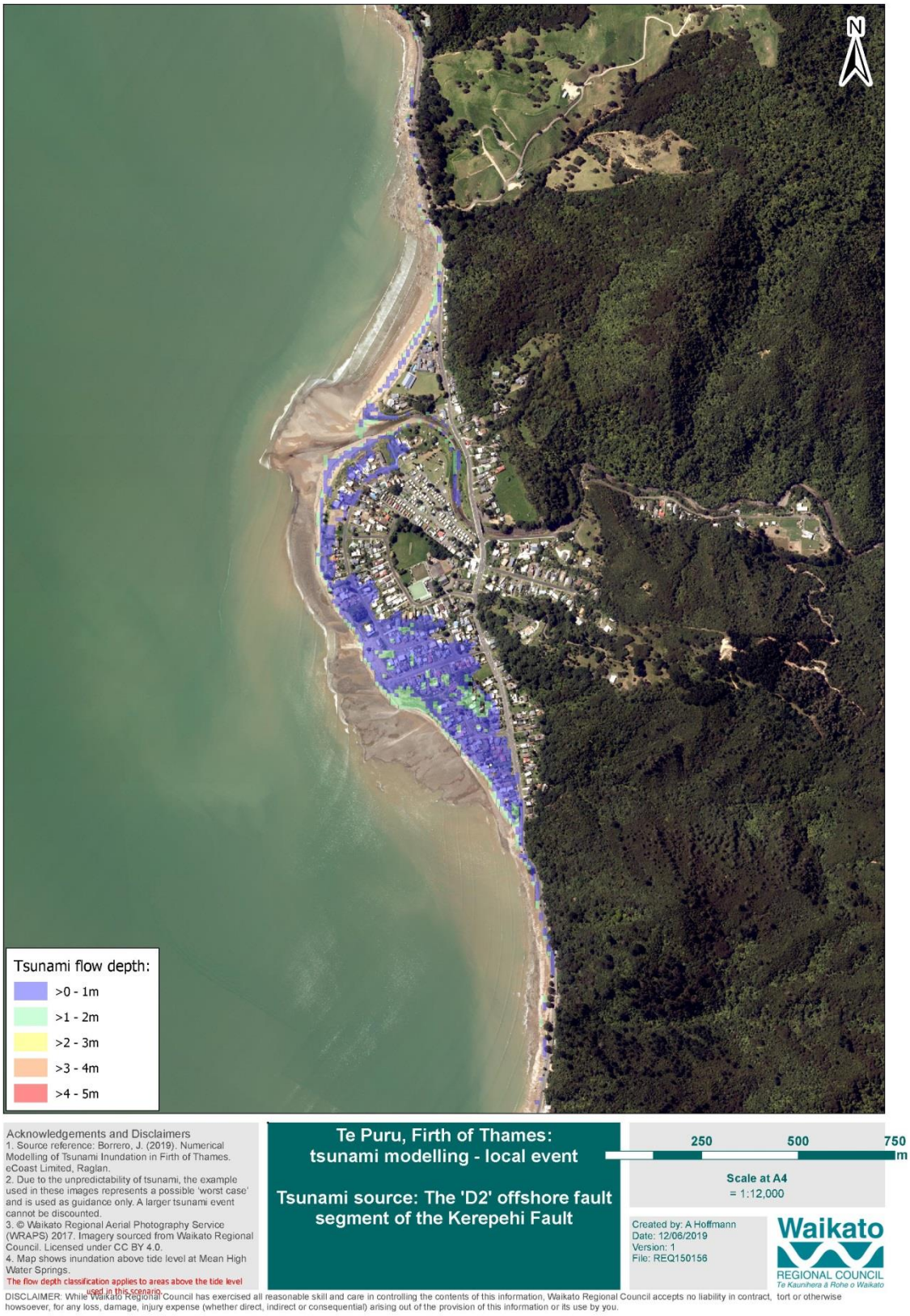

Figure 4: Te Puru

Kerepehi Fault potential inundation from a maximum credible earthquake on segment 'D2'

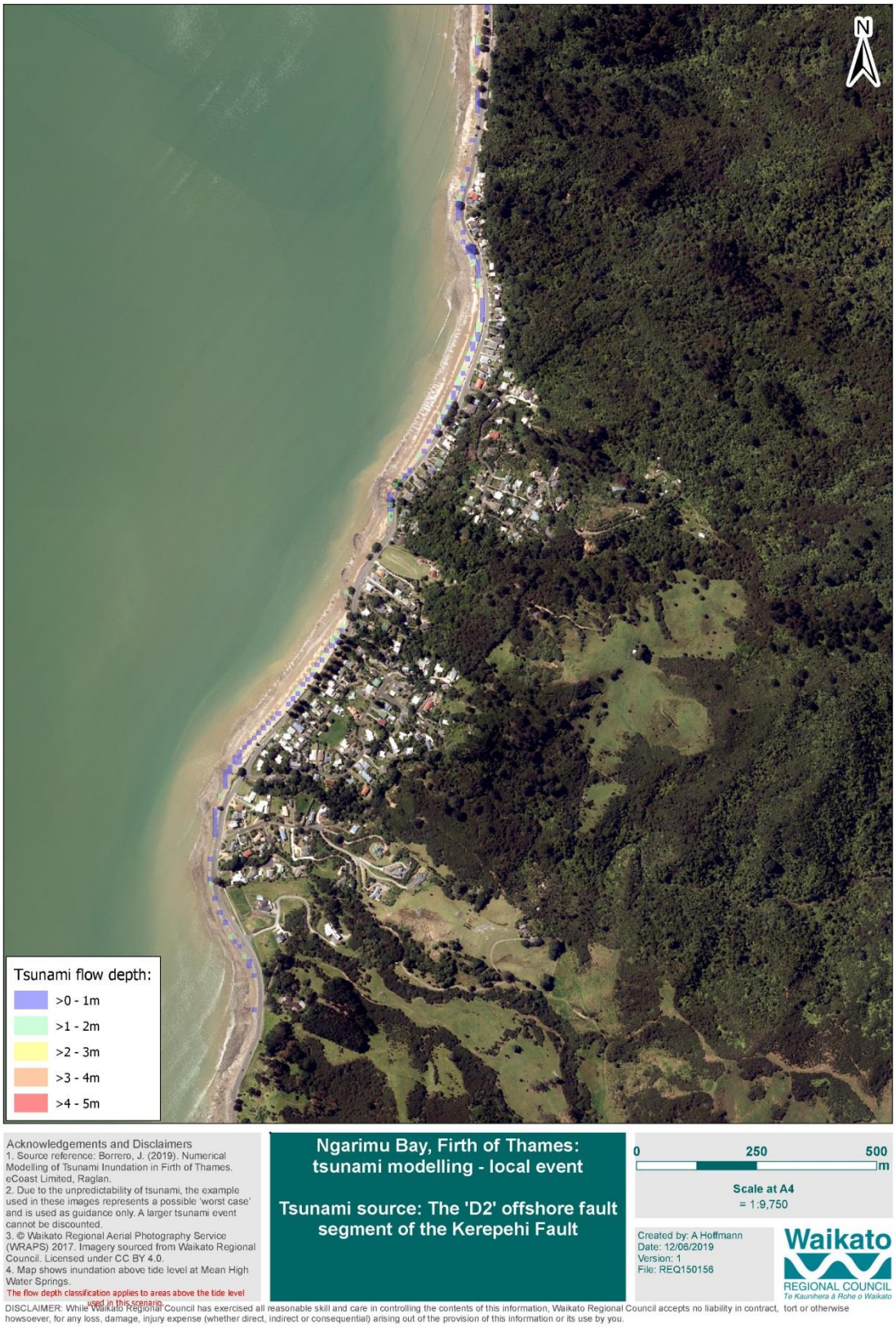

Figure 5: Ngarimu Bay

Kerepehi Fault potential inundation from a maximum credible earthquake on segment 'D2'

Regional source tsunami from the Tonga-Kermadec Trench

The Tonga-Kermadec Trench

The Tonga-Kermadec Trench is a subduction zone at a convergent tectonic plate boundary, where the Pacific Plate is being subducted underneath the Australian Plate. A large earthquake along the Tonga-Kermadec Trench to the north-east of New Zealand represents the most significant near-source tsunami threat for the Eastern Coromandel Peninsula, but will also affect the Firth of Thames, including Waiomu, Te Puru and Ngarimu Bay.

The technical report considers that a magnitude (Mw) 8.9 earthquake rupturing along a 450km segment of the Tonga-Kermadec Trench just off East Cape to be a 'maximum credible event' (see Figure 6). This event is similar to the Tohoku earthquake and tsunami that occurred in Japan in 2011.

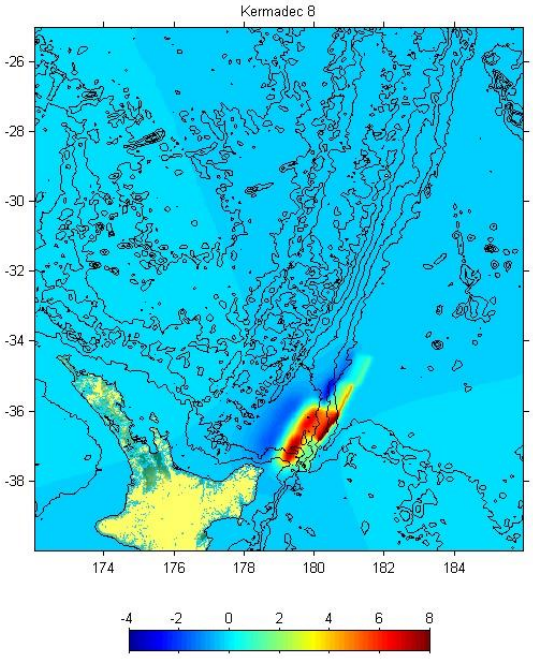

Figure 6: The 'maximum credible event' from the Tonga-Kermadec Trench. This event is a similar magnitude and nature to the 2011 Japan tsunami

How long does it take for regional source waves to arrive at Waiomu, Te Puru and Ngarimu Bay?

Assuming the magnitude (Mw) 8.9 earthquake described above, Figure 7 shows that:

- Water levels begin to fall just over two hours following the earthquake, then rise and fall rapidly (6-8 times per hour) for at least six hours
- The second (and largest) wave rises to about 1.2m around the three-hour mark, and another large wave of the same height arrives around four hours following the earthquake.

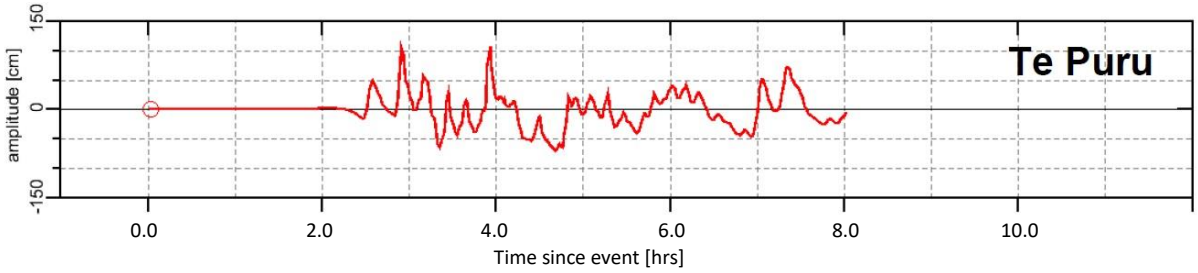

Figure 7: Wave arrival times and inundation levels from the Tonga-Kermadec Trench (at MHWS)

Inundation maps: impact of regional source tsunami waves on Waiomu, Te Puru and Ngarimu Bay

Figures 8, 9 and 10 (overleaf) show the potential inundation from a maximum credible earthquake on the Tonga-Kermadec Trench. It is important to note that the maps:

- Assume wave arrival at Mean High Water Springs (the highest level that spring tides reach on average over a period of time)
- Only show inundation of land areas that are normally above sea level.

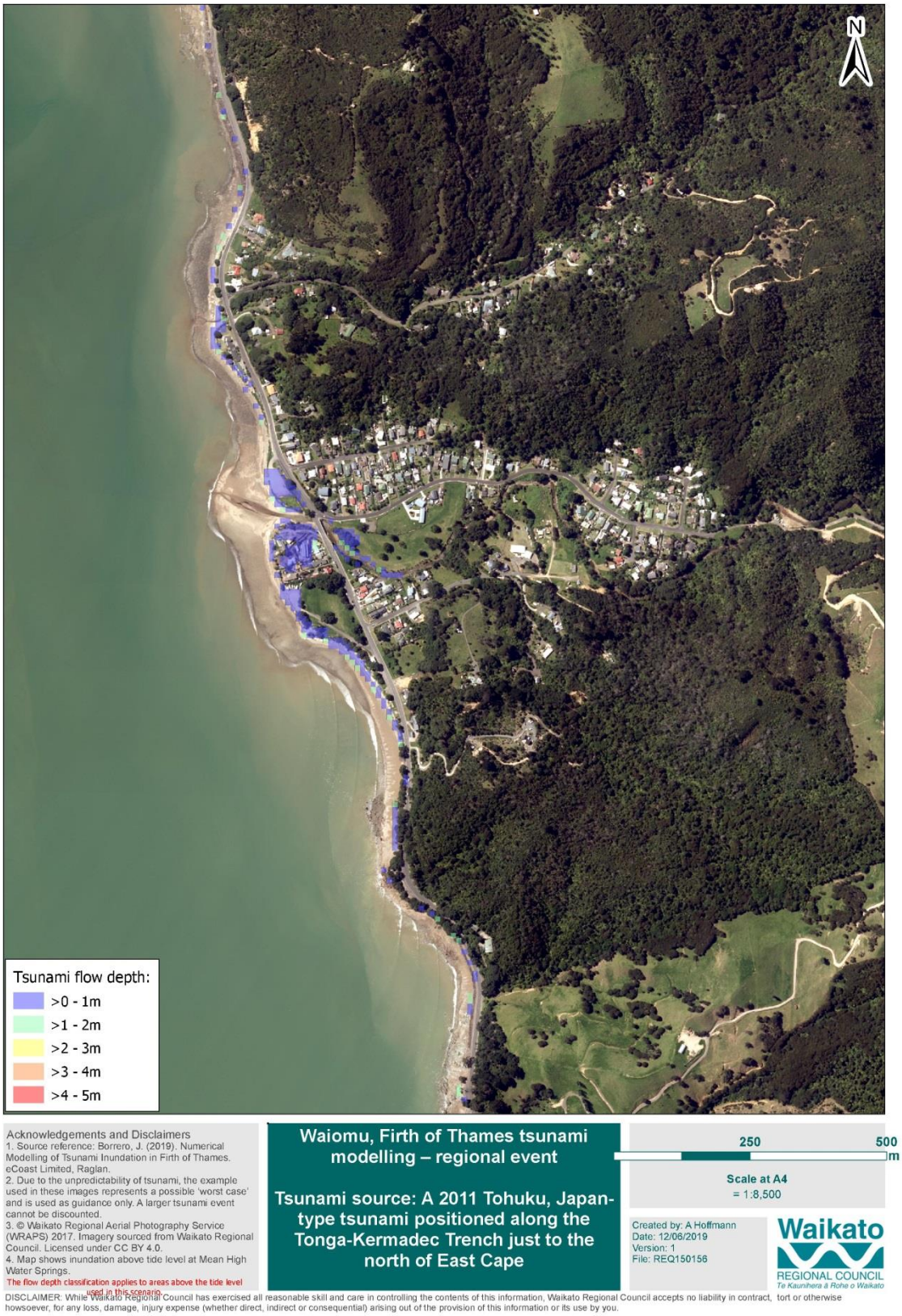

Figure 8: Waiomu

Potential inundation from a maximum credible earthquake on the Tonga-Kermadec Trench

Figure 9: Te Puru

Potential inundation from a maximum credible earthquake on the Tonga-Kermadec Trench

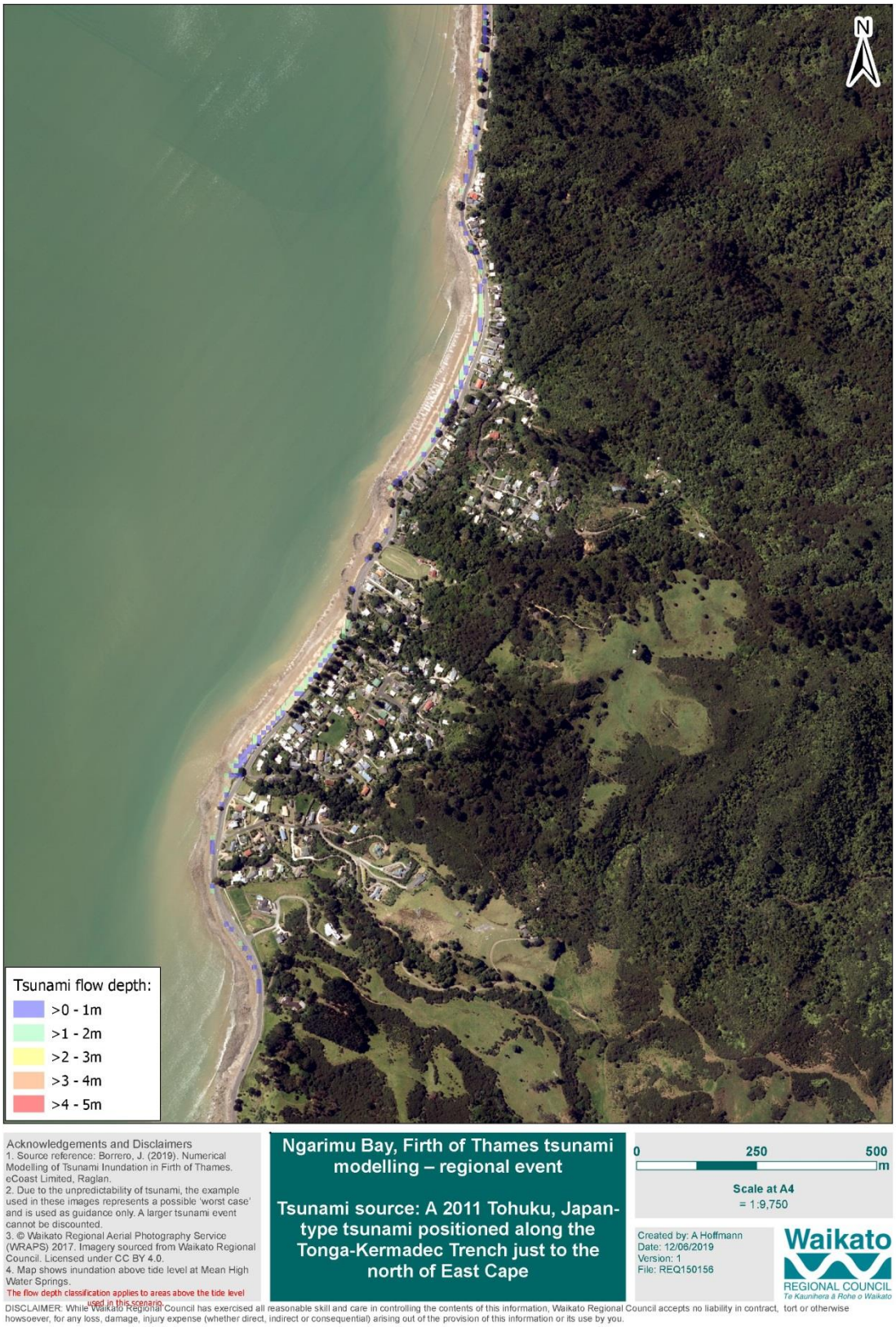

Figure 10: Ngarimu Bay

Potential inundation from a maximum credible earthquake on the Tonga-Kermadec Trench

Distant source tsunami from South America

South American sources

Previous studies have indicated that tsunamis produced by large earthquakes along the South American Subduction Zone have the greatest impact of all the distant tsunami sources on New Zealand.

The technical report considers three scenarios from South America (see Figure 11):

1. The 1960 Valdivia, Chile earthquake (magnitude ~9.2)
2. The 1868 Arica, Chile and Southern Peru earthquake (magnitude ~9.4)
3. 'FF7', a theoretical variant of the 1960 Valdivia earthquake placed in Central Peru (magnitude ~9.2).

Of the three scenarios considered, the FF7 earthquake has the most impact on Waiomu, Te Puru and Ngarimu Bay at Mean High Water Springs, although this *impact is far lower* than the local and regional sources.

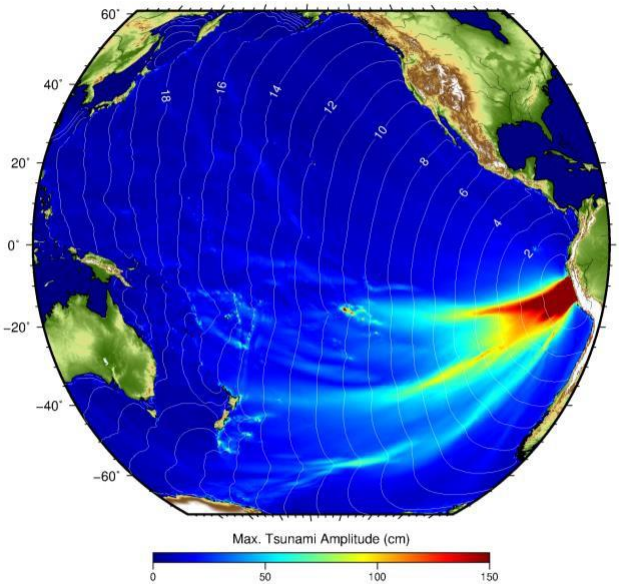

Figure 11: Map of the 'FF 7' variant of the 1960 Chilean earthquake, placed in Central Peru

How long does it take for distant source waves to arrive at Waiomu, Te Puru and Ngarimu Bay?

Assuming the 'FF7' scenario, Figure 12 shows that:

- Water levels begin to rise about 16.5 hours following the earthquake, then rise and fall rapidly (5-6 times per hour) for at least 14 hours following the first wave arrival
- The initial wave is small at 0.15m, and the maximum inundation level of 0.6m above the existing water level occurs on the fifth wave, 90 minutes after the arrival of the first wave.

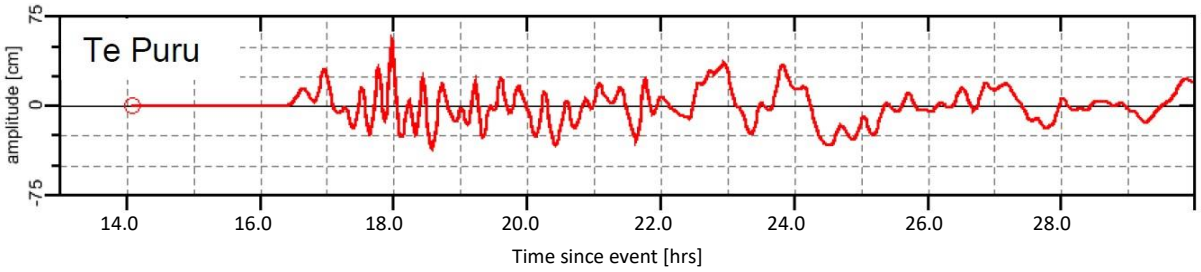

Figure 12: Wave arrival times and inundation levels from the 'FF 7' distant source scenario

Inundation maps: impact of distant source tsunami waves on Waiomu, Te Puru and Ngarimu Bay

Figures 13, 14 and 15 (overleaf) show the potential inundation from a maximum credible earthquake from the Central Peru region of South America. It is important to note that the maps:

- Assume wave arrival at Mean High Water Springs (the highest level that spring tides reach on average over a period of time)
- Only show inundation of land areas that are normally above sea level.

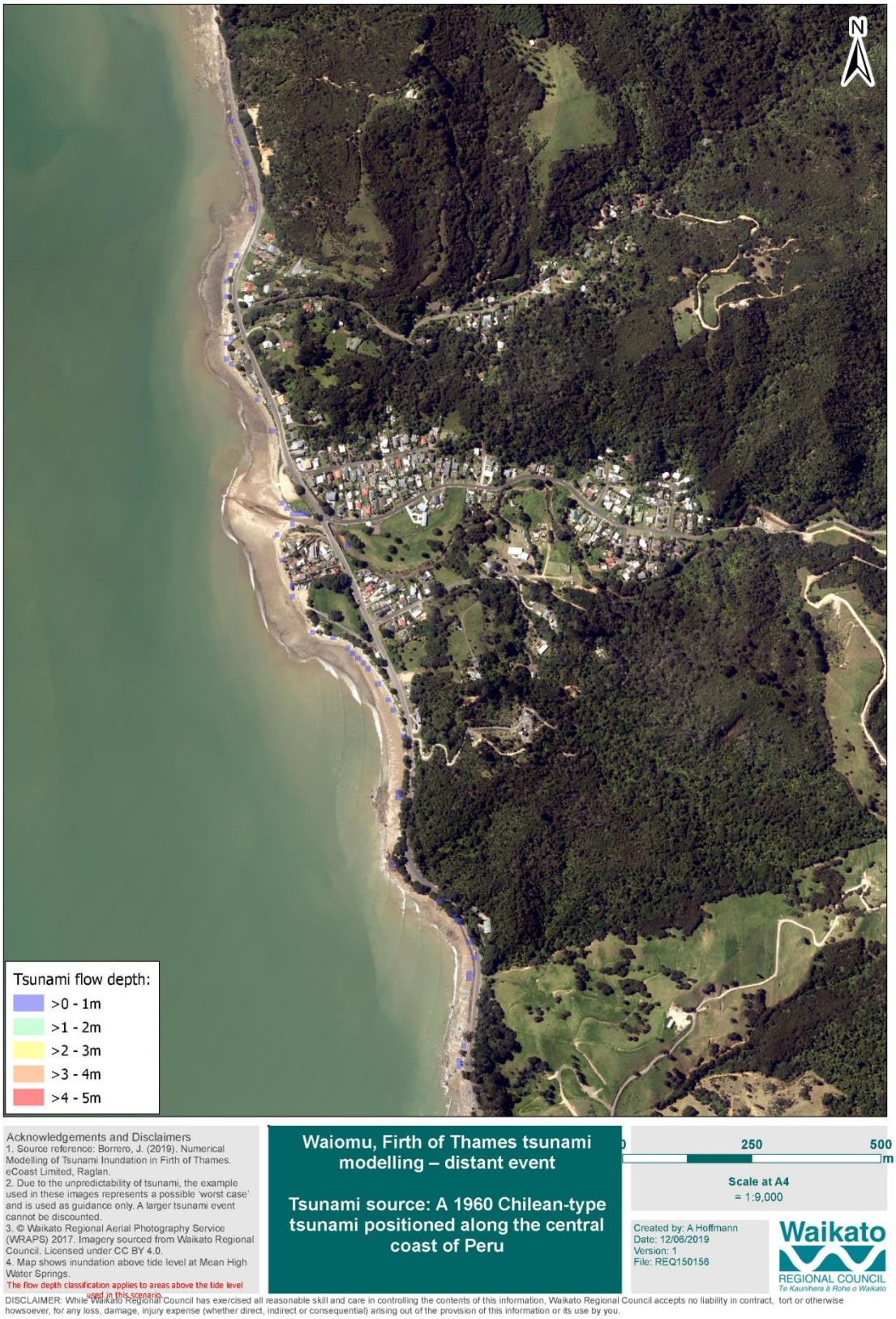

Figure 13: Waiomu

Potential inundation from a maximum credible earthquake from Central Peru in South America

Figure 14: Te Puru

Potential inundation from a maximum credible earthquake from Central Peru in South America

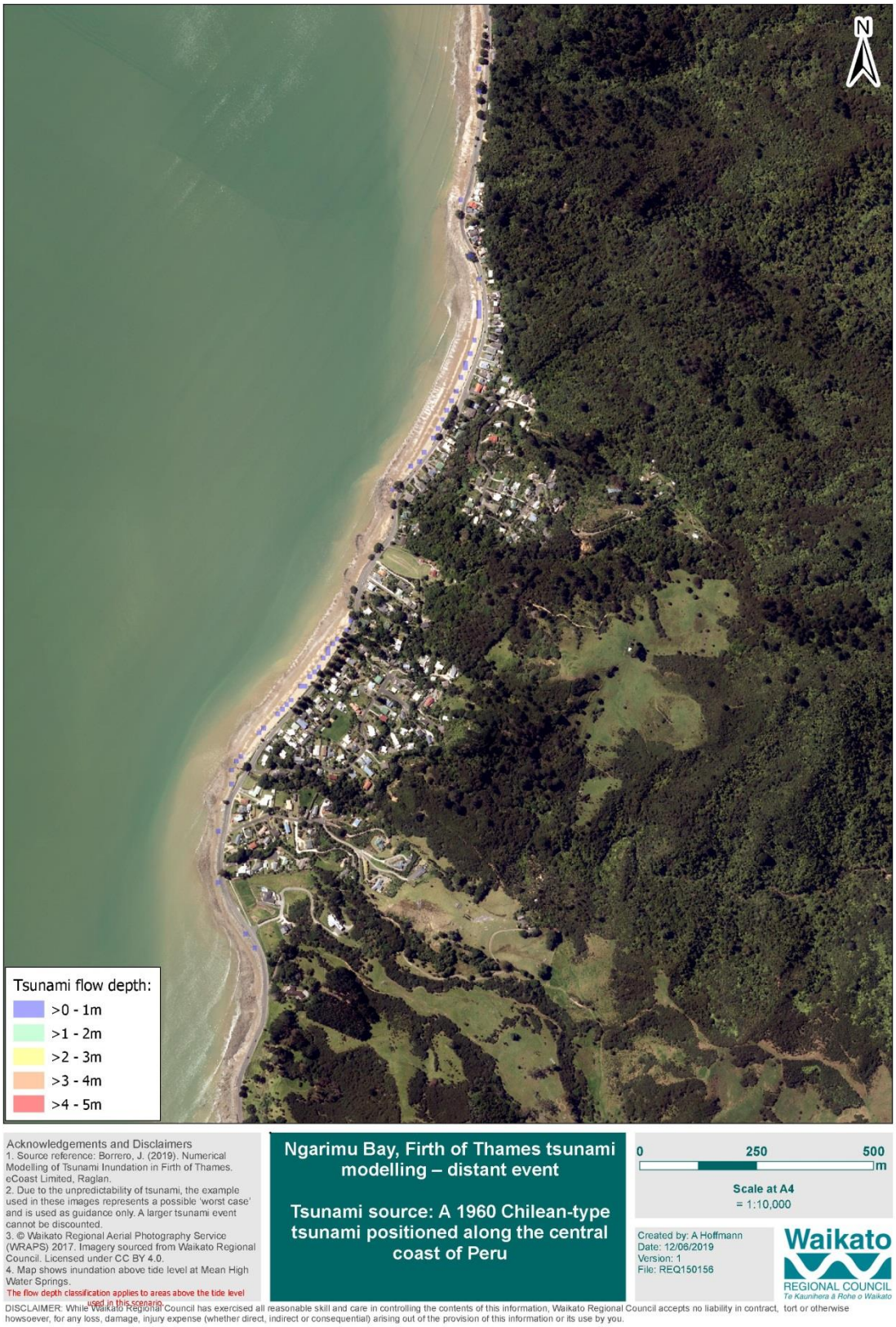

Figure 15: Ngarimu Bay

Potential inundation from a maximum credible earthquake from Central Peru in South America