IN THE HIGH COURT OF NEW ZEALAND
AUCKLAND REGISTRY

CIV-2021-404-1618

I TE KŌTI MATUA O AOTEAROA
TĀMAKI MAKAURAU ROHE

UNDER	the Judicial Review Procedure Act 2016
IN THE MATTER OF	an application for judicial review
BETWEEN	**ALL ABOARD AOTEAROA INCORPORATED** Applicant
AND	**AUCKLAND TRANSPORT** First Respondent
AND	**THE REGIONAL TRANSPORT COMMITTEE FOR AUCKLAND** Second Respondent
AND	**AUCKLAND COUNCIL** Third Respondent

AFFIDAVIT OF TIMOTHY RAYMOND NAISH
December 2021

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AFFIDAVIT OF TIMOTHY RAYMOND NAISH

I, Timothy Raymond Naish, of Wellington, Climate and Earth Scientist, affirm –

1. I am a Professor in Earth Sciences in the Antarctic Research Centre (**ARC**) at Victoria University of Wellington. I was Director of the ARC between 2008 and 2018.

2. I make this affidavit in support of All Aboard Aotearoa Incorporated's application for judicial review in relation to decisions made by Auckland Transport, the Regional Transport Committee for Auckland and Auckland Council concerning the Regional Land Transport Plan.

3. I confirm that I have read and complied with the Code of Conduct for Expert Witnesses in preparing this affidavit.

Qualifications and experience

4. I hold a PhD in Earth Sciences from the University of Waikato. I specialise in climate and sea-level science, including: climate and sea-level variability during warmer-then-present climates of the past using geology and ice cores (paleoclimatology); global and New Zealand sea-level prediction; polar (Antarctic) ice sheet dynamics and global sea-level variability; climate change impact assessment; climate data and numerical model integration; and climate science policy.

5. My key professional roles include:

   (a) Convenor of the Scientific Committee on Antarctic Research (**SCAR**), Strategic Research Programme – Instabilities and Thresholds in Antarctica (**INSTANT**);

   (b) Member of the Australian Government's National Advisory Committee for Climate Change Science;

   (c) Convenor of the World Climate Research Programme (**WCRP**) – Melting Ice & Global Consequences Grand Challenge; and

   (d) NZ/Australia representative on the Science Evaluation Panel of the International Ocean Discovery Programme (**IODP**).

6. I have published more than 120 peer-reviewed scientific articles in the world's leading journals on climate, Antarctic and ocean science. A copy of my CV is in the schedule to this affidavit.

7. My professional experience in the field includes:

   (a) Serving as the lead author for the Intergovernmental Panel on Climate Change (**IPCC**) in respect of the 5th Assessment Report (2010-2013);

   (b) Participating in the scoping meeting of the Special Report on 1.5°C of Global Warming (2017);

(c) Acting as an expert reviewer of the Special Report on the Ocean & Cryosphere in a Changing Climate (2019); and

(d) Co-authoring the National Climate Science Strategy for Australia (2019).

8. Currently, I am co-leader of New Zealand Sea Rise Research Programme and leader of the Ice, Atmosphere, Ocean Programme in the New Zealand Antarctic Science Platform, both of which are funded by the Ministry of Business Innovation & Employment.

9. I am a fellow of the Royal Society of New Zealand. My scientific achievements have been recognised by numerous awards, prizes and medals including the New Zealand Antarctic Medal, the 2019 Prime Minister's Science Prize, and the International Tinker-Muse Prize for Antarctic Science and Policy.

10. Over the last ten years I have advised and contributed to many reports for New Zealand's central and local government entities and agencies on climate change science, risk and impacts.

Instructions

11. I make this affidavit having read the affidavit that Professor William Steffen has made for the purpose of this proceeding, and I agree with the scientific basis of the evidence he provides.

12. My affidavit builds on his evidence. I am instructed to address the following particular issues:

(a) The key findings in the IPCC's latest report (the Working Group 1 Report of AR6);

(b) The potential for abrupt and irreversible climate change;

(c) The particular impacts of climate change on New Zealand and Auckland;

(d) The Paris Agreement;

(e) New Zealand's Zero Carbon Act;

(f) The Climate Change Commission's advice to the Government; and

(g) New Zealand's Nationally-Determined Contribution under the Paris Agreement.

Key findings in the IPCC's latest report

13. The IPCC is the United Nations body charged with assessing the science related to climate change. Its purpose is to provide policymakers with regular scientific assessments on climate change, its implications and potential future risks.

14. Since its establishment in 1988, the IPCC has published five Assessment Reports (**ARs**) and is presently completing its sixth. Each Assessment Report reflects the work of approximately 900 authors who are recognised scientific experts carefully nominated and selected by governments. The reports go through five drafts that are rigorously peer-reviewed by scientists, experts and governments. The IPCC's ARs represent the international scientific consensus on climate change.

15. The nature of the IPCC AR process, the length of time between reports, the need for scientific consensus, and the careful treatment of uncertainty, means they are usually conservative in their assessments. I can confirm, based on my experience and understanding of the scientific literature, that the evidence below represents a conservative consensus position of the scientific community on climate change.

16. The IPCC's first instalment of AR6 (Working Group 1) Report was released in August 2021.[1] The Summary for Policymakers states more strongly than ever the urgent need to rapidly reduce greenhouse gas emissions:

    (a) "It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred."

    (b) "The scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years."

    (c) "Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since AR5."

    (d) "Improved knowledge of climate processes, paleoclimate evidence and the response of the climate system to increasing radiative forcing gives a best estimate of equilibrium climate sensitivity of 3°C with a narrower range compared to AR5." The latest generation of climate models is more sensitive than those used in AR5, which means there is more warming from a given release of CO_2. Doubling of atmospheric CO_2 concentration above preindustrial levels causes 3°C of global warming in AR6. In AR5 it was 2.5°C.

    (e) "Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO2 and other greenhouse gas emissions occur in the coming decades."

    (f) "Many changes in the climate system become larger in direct relation to increasing global warming. They include increases in

[1] https://www.ipcc.ch/report/ar6/wg1/

the frequency and intensity of hot extremes, marine heatwaves, and heavy precipitation, agricultural and ecological droughts in some regions, and proportion of intense tropical cyclones, as well as reductions in Arctic sea ice, snow cover and permafrost."

(g) "Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events."

(h) "Under scenarios with increasing CO_2 emissions, the ocean and land carbon sinks are projected to be less effective at slowing the accumulation of CO_2 in the atmosphere."

(i) "Many changes due to past and future greenhouse gas emissions are irreversible for centuries to millennia, especially changes in the ocean, ice sheets and global sea level."

(j) "In the longer term, sea level is committed to rise for centuries to millennia due to continuing deep ocean warming and ice sheet melt, and will remain elevated for thousands of years. Over the next 2,000 years, global mean sea level will rise by about 2 to 3 m if warming is limited to 1.5°C, 2 to 6 m if limited to 2°C and 19 to 22 m with 5°C of warming, and it will continue to rise over subsequent millennia."

(k) "Due to relative sea level rise, extreme sea level events that occurred once per century in the recent past are projected to occur at least annually at more than half of all tide gauge locations by 2100."

17. Since AR5, estimates of remaining carbon budgets have been improved by a new methodology. The AR6 (Working Group 1) Report reaffirms with high confidence the AR5 finding that there is a near-linear relationship between cumulative anthropogenic CO_2 emissions and the global warming they cause. Each cumulative 1,000 Gt (gigatonnes) of CO_2 emissions is assessed to likely cause a 0.45°C increase in global surface temperature. This means we can only release up to 400 $GtCO_2$ of additional carbon to the atmosphere in order to have a 67% chance of stabilising global warming below 1.5°C. This also means we can only release up to 1,150 $GtCO_2$ of additional carbon to the atmosphere in order to have a 67% chance of stabilising global warming below 2°C. At the current rate of emissions (38 $GtCO_2$/year, 50$GtCO_2$e/year), the 1.5°C threshold could be exceeded within 11 years (from 2020).

Approximate global warming relative to 1850–1900 until temperature limit *(°C)**(1)	Additional global warming relative to 2010–2019 until temperature limit *(°C)*	Estimated remaining carbon budgets from the beginning of 2020 *($GtCO_2$)* *Likelihood of limiting global warming to temperature limit*(2)*					Variations in reductions in non-CO_2 emissions*(3)
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

18. What is abundantly clear from the AR6 (Working Group 1) Report is that the weight of scientific estimates further strengthens our understanding that all aspects of the climate system are being influenced by continued emissions of greenhouse gases. What has changed since the AR5 report is that 300 $GtCO_2$ has been added to the atmosphere, and "unless there are immediate, rapid and large-scale reductions in greenhouse gas emissions, limiting global warming to 1.5°C will be beyond reach".

19. The AR6 (Working Group 1) Report presents five new illustrative emissions scenarios, termed "Shared Socio-economic Pathways" (**SSPs**). The SSPs are outlined in terms of global average temperature change (Table 1 below) and atmospheric CO_2 (Figure 1 below). Which SSP is realised depends on how much more CO_2 is emitted.

Possible climate futures

	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
Scenario	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

Paris climate agreement future

Worst case future

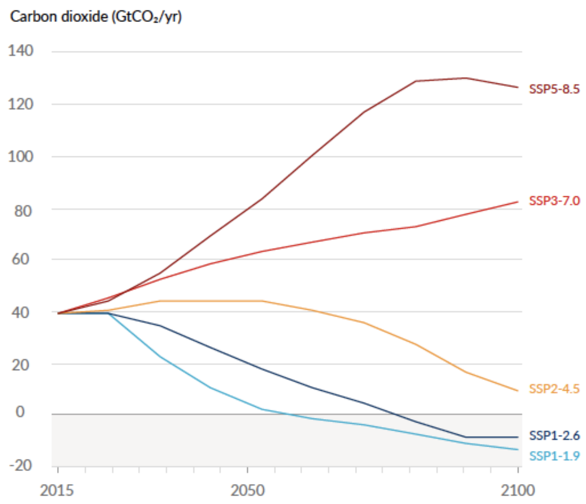

Table 1; Figure 1: Near-, mid- and long-term estimates of global mean temperature for future emission scenarios described in text. (From AR6.)

The potential for abrupt and irreversible climate change

20. While the relationship between Earth's surface temperature and total cumulative carbon emissions may be near-linear, the response of the Earth system is not. Some climate system components are slow to respond, such as the deep ocean overturning circulation and the ice sheets. The AR6 (Working Group 1) Report says, "it is virtually certain that irreversible, committed change is already underway for the slow-to-respond processes

as they come into adjustment for past and present emissions. The paleoclimate record indicates that tipping elements exist in the climate system where processes undergo sudden shifts toward a different sensitivity to forcing" (page TS-71).

21. For many aspects of the Earth system, evidence for abrupt change is limited, but deep ocean warming, acidification and sea-level rise are committed to ongoing change for millennia after global surface temperatures initially stabilise and are irreversible on human time scales This is stated by the IPCC in the AR6 (Working Group 1) Report with very high confidence.

22. This is of particular concern for the marine sectors of the Antarctic Ice Sheet. These sit on bedrock below sea level and are losing mass at an accelerating rate where they are in contact with a warming ocean. 93% of the heat generated by the energy imbalance due to anthropogenic global warming has been taken up by the ocean, and up to 65% of that ocean heat uptake is in the Southern Ocean that encircles Antarctica.

23. Antarctica's floating ice shelves play a stabilising role, holding back the dynamic flow of the ice sheet into the ocean, thus slowing the rate of global sea-level rise. Both paleoclimate records and numerical modelling of the potential future behaviour of the Antarctic ice sheet indicate that the loss of Antarctica's ice shelves is a tipping element. Beyond this point, which appears to be between 1.5-2°C of global warming, rapid and irreversible loss of the ice sheet can occur resulting in long-term commitment of as much as 20m global mean sea-level rise over the coming millennia, at rates of up to 2m global mean sea level per century.

24. Due to "deep uncertainty" in the key rate-determining processes captured by only a few ice sheet models, the AR6 Working Group 1 report has "low confidence" in the tipping point being crossed this century, but states that global mean sea-level rise above the likely range – approaching 2m by 2100 and 5m by 2150 under a very high greenhouse gas emissions scenario (SSP5-8.5) – cannot be ruled out due to deep uncertainty in ice sheet processes. This is shown in Figure 2 below, from AR6 Working Group 1 Report.

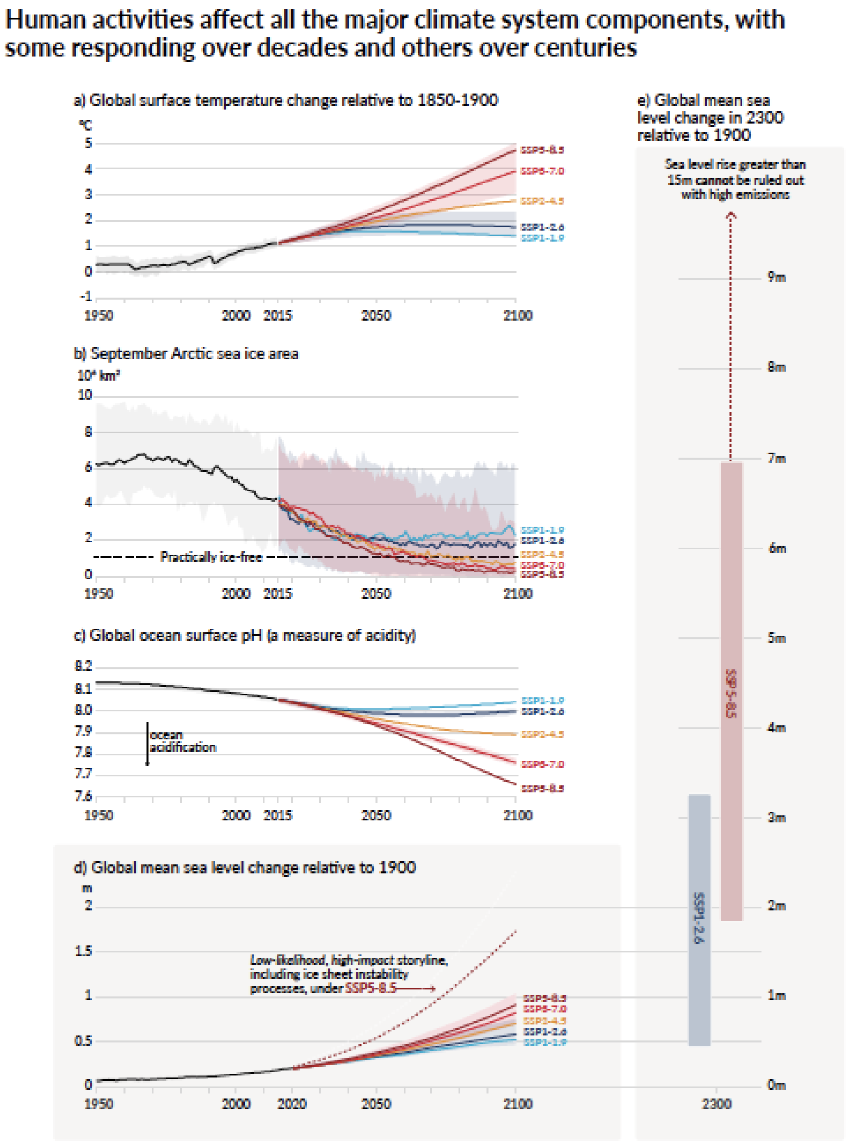

Figure 2: Selected climate impact drivers (CIDs) under illustrative emission scenarios (SSPs) shown in Figure 1. (Note long-term commitment to global sea-level rise under all scenarios) (From AR6 Summary for Policymakers.)

The particular impacts of climate change on New Zealand and the Auckland region

25. The following impacts of climate change on New Zealand and Auckland are summarised from:

(a) The Ministry for Environment's Coastal Hazards and Climate Change Guidance for Local Government, 2017 with update from Te tai pari o Aotearoa - NZ SeaRise Programme;[2]

(b) The NIWA Report on Coastal Flooding Exposure for New Zealand (lead R. Paulik);[3]

[2] https://www.searise.nz/event-details/2020/11/24/te-tai-pari-o-aotearoa-new-estimates-of-future-sea-level-along-new-zealands-coastline
[3] https://deepsouthchallenge.co.nz/research-project/national-flood-risks-climate-change/

(c) The National Climate Change Risk Assessment for New Zealand (**NZCCRA**) (https://environment.govt.nz/assets/Publications/Files/national-climate-change-risk-assessment-method-report.pdf);

(d) The NIWA summary of the NZCCRA (https://niwa.co.nz/adaptationtoolbox/regionalprojections); and

(e) The IPCC's Assessment Report 5 and AR6 (Working Group 1) Report, which set out the generic implications of regional climate change.

26. With further global warming, every region in the world is projected to increasingly experience concurrent and multiple changes in climatic impact-drivers (e.g. sea-level rise, drought, flood, extreme events). Changes in several climatic impact-drivers would be more widespread at 2°C compared to 1.5°C global warming. For example, extreme heat thresholds relevant to agriculture and health are projected to be exceeded more frequently at higher global warming levels. This is predicted with high confidence by the IPCC (AR6 (Working Group 1) Report).

27. According to the IPCC, by 2060 global sea levels will have risen by 20 to 30cm with no additional warming. By 2100 global sea levels will be on average 50 or 60 cm higher under the best-case scenarios of global warming stabilising at 1.5°C and 2°C respectively (i.e. SSP1-1.9 and SSP2-2.6) (AR6 (Working Group 1) Report).

28. For many places on the New Zealand coastline, the best-case scenario means a one in 100-year coastal flooding event will occur every year by 2060. This will have major impacts on coastal communities, ports and infrastructure. Further, moderate and "nuisance" coastal flooding events (e.g. associated with king tides) will become even more common, occurring several times a year for that same sea-level rise.

29. However, low-lying parts of the Auckland region may well suffer adverse effects at considerably lower rises in sea level, due to the increasingly regular damage from flooding events (direct or indirect coastal inundation from rainfall and river flooding or via groundwater rising) in low-lying pockets. Considering tides only, putting aside storm events, the rising sea level will result in an increasing percentage of normal high tides exceeding given present-day design for coastal infrastructure and roads.

30. A recent high-resolution analysis of vertical land movements, measured by space-borne radar altimetry satellites and calibrated to local permanent geographical positioning stations, shows large regions of Auckland are subsiding at up to 3 mm per year. This will contribute an additional 25cm of sea-level rise by the end of the century, resulting in actual local sea-level rise of up to 90cm by 2100 in a best-case scenario. This would expose much of Auckland's coastal communities, roads, bridges, ports, jetties and wharves to significant risk with implications for adaptation decision making including hard defences (sea walls) or managed retreat.

31. In contrast, under a worst case-scenario (SSP 8.5), where emissions continue to rise and are unrestricted by mitigation policy, actual local sea-level rise for many parts of Auckland will be +1.4m by 2100, and under the IPCC's "low confidence AR6 scenario a rise of +2.4m by 2100 cannot be ruled out.

32. The risk exposure, defined as the quantified potential losses, of 1.5m of sea-level rise around New Zealand is $19 billion for replacement buildings, affecting 133,000 people, 382 critical facility buildings, 1547 jetties and wharves, 5 airports, 2,121 km of roads and 46 km of railway.

33. Table 2 (below) shows the risk exposure due to annual coastal flooding in Auckland and Northland based on present day assets. Note that the present day annual extreme (1% probability) risk exposure becomes an annual event with 30cm of sea-level rise predicted by 2060.

Table 1-1: National and regional level exposure of elements at risk to ESL1 for present-day MSL on land with available LIDAR DEM coverage.

Region*	Population (#)	Buildings		Transport			Electricity (National Grid)			Three-Waters		Land Cover (km²)		
		Building (#)	Replacement Value (2016 NZD$ Billion)	Roads (km)	Railway (km)	Airports (#)	Transmission Lines (km)	Structures (#)	Sites (#)	Pipelines (km)	Nodes (#)	Built	Production	Natural or Undeveloped
Northland	2,275	2,645	0.54	74.2	3.8	0	5.8	5	0	93.2	3,047	2.6	61.5	12.7
Auckland	2,837	1,790	0.61	48	10.1	1	21.3	21	0	131.0	5,396	2.2	86.7	21.1

Table 2: Exposure of national and regional infrastructure and built assets at risk of the 1% (100 year) annual coastal flood at present day sea-level (Source = footnote 3)

34. In addition to sea-level rise, the following climate changes and hazards are projected for the upper North Island by 2090 under global warming of 2.7˚C (SSP2-4.5), and under global warming of 4.4˚C (SSP5-8.5) based on the NIWA summary of the NZCCRA.

(a) Average air and coastal mean temperatures will rise by ~1.25˚C (5.5% change) by 2090 and ~2. 85˚C (13%) by 2090.

(b) Increase of 15-20 (>25˚C) more hot days/year by 2090 and 25-30 more hot days/year (>25˚C) by 2090.

(c) 5-10 more dry days/year. Increase in 6-12 dry days/year for most of Auckland by 2090. Under SSP5-8.5, 10-20 more by 2090. Increase in precipitation-evaporation deficit of 60-100mm by 2090 (SSP2-4.5), 100-150mm by 2090 (SSP5-8.5). Climate drought severity is projected to increase. Time spent in drought in eastern and northern New Zealand is projected to double or triple by 2040 (RCP4.5, ~2050).

(d) For SSP2-4.5, there is increased fire risk. Increase in days with very high and extreme fire danger index from around 0-700%. Very high and extreme fire danger: central and eastern areas, increase of +50%. Northland decreases by -20%. For SSP5-8.5, there is increased fire risk. Very high and extreme fire danger for most areas of >150%.

(e) Larger than national average increases in rainfall intensity projected. Moderately extreme daily precipitation (99th percentile of wet days) increases. Very extreme daily precipitation increases in frequency. Short duration (1-in-100-year, 1 hour duration) extreme rainfalls increase +13.6% for every 1˚C increase. Long duration rainfall events (1-in-2-year, 120 hour duration) increase +4.8% for every 1˚C increase. Intensity of extra tropical cyclones projected to increase. Under SSP5-8.5 mean annual rainfall decreases by 10%.

(f) In summary, Auckland and Northland will get warmer and drier than the national average, and will experience a significant increase in extreme weather events, such as rainfall, drought, fire and cyclones.

(g) Marine heatwaves projected to increase in frequency and intensity with ongoing atmospheric and ocean warming.

The Paris Agreement

35. The Paris Agreement was adopted in December 2015 under the United Nations Framework Convention on Climate Change (**UNFCCC**).

36. The Paris Agreement sets out to improve upon and replace the Kyoto Protocol, an earlier international treaty designed to curb the release of greenhouse gases which contribute to global warming. The Paris Agreement entered into force on 4 November 2016 and has been signed by 195 countries and ratified by 191.

37. Key aspects of the Paris Agreement include:

(a) *Long-term temperature goal* (Art. 2) – The Paris Agreement, in seeking to strengthen the global response to climate change, reaffirms the goal of limiting global temperature increase to well below 2°C, while pursuing efforts to limit the increase to 1.5°C.

(b) *Global peaking and 'climate neutrality'* (Art. 4) – To achieve this temperature goal, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognising peaking will take longer for developing country Parties. This ought to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of the century.

(c) *Mitigation* (Art. 4) – The Paris Agreement establishes binding commitments by all Parties to prepare, communicate and maintain a Nationally Determined Contribution to greenhouse gas emission reductions (**NDC**) and to pursue domestic measures to achieve them. It also prescribes that Parties shall communicate their NDCs every 5 years and provide information necessary for clarity and transparency. To set a firm foundation for higher ambition, each successive NDC will represent a progression beyond the previous one and reflect the highest possible ambition. Developed countries should continue to take the lead by undertaking absolute economy-wide reduction targets, while developing countries should continue enhancing their mitigation efforts, and are encouraged to move toward economy-wide targets over time in the light of different national circumstances.

(d) *Adaptation* (Art. 7) – The Paris Agreement establishes a global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change in the context of the temperature goal of the Paris Agreement. It aims to significantly strengthen national adaptation efforts, including through support and international cooperation. It recognises that adaptation is a global challenge faced by all. The Paris Agreement provides that all Parties should engage in adaptation, including by formulating and implementing National Adaptation Plans, and should submit and periodically update an adaptation communication describing their priorities, needs, plans and actions. The adaptation efforts of developing countries should be recognised.

New Zealand's Zero Carbon Act

38. New Zealand has committed to do its part in reducing emissions in line with the Paris Agreement through the Climate Change Response (Zero Carbon) Amendment Act 2019 (**Zero Carbon Act**), which provides a framework by which New Zealand can develop and implement clear and stable climate change policies that contribute to the global effort under the Paris Agreement to limit the global average temperature increase to 1.5°C above pre-industrial levels.

39. The Zero Carbon Act:

(a) Establishes a system of emissions budgets to act as stepping stones towards the long-term target;

(b) Requires the Government to develop and implement policies for climate change adaptation and mitigation;

(c) Establishes a new, independent Climate Change Commission (**Commission**) to provide expert advice and monitoring to help keep successive governments on track to meeting long-term goals; and

(d) Sets a new domestic greenhouse gas emissions reduction target for New Zealand to:

(i) reduce net emissions of all greenhouse gases (except biogenic methane) to zero by 2050; and

(ii) reduce emissions of biogenic methane to 24-47% below 2017 levels by 2050, including to 10% below 2017 levels by 2030.

The Commission's advice to the Government

40. The purposes of the Commission are:

(a) To provide independent, expert advice to the Government on mitigating climate change (including through reducing emissions of greenhouse gases) and adapting to the effects of climate change; and

(b) To monitor and review the Government's progress towards its emissions reduction and adaption goals.

41. The Commission issued its final advice to the Government on 31 May 2021.[4] The advice addresses the Government's first three emissions budgets, and the direction for its emission reduction plan 2022-2025.

42. The first emissions budget covers the 4-year period from 2022 – 2025, while the second and third budgets are five years, covering 2026 – 2030 and 2031 – 2035. They are:

(a) Budget 1 - 290 MtCO_2e;

(b) Budget 2 - 312 MtCO_2e;

(c) Budget 3 - 253 MtCO_2e.

43. By Budget 3 annual average emissions will be reduced to 50.6 MtCO_2e/yr. By 2035, these budgets would produce a 36% reduction in net emissions, relative to 2019.

44. Despite the Commission's advice to the Government, the Commission's proposed emissions budget for New Zealand of -27% (-36% net, after forest carbon removals) by 2035 is not consistent with the mitigation pathway to keep global warming below 1.5°C without an overshoot.

45. The IPCC Special Report on Global Warming of 1.5°C shows that global emissions need to reduce by 50% by 2030 to avoid an overshoot. The latest scientific research implies that a temporary overshoot on the way to net zero emissions may affect a number of planetary tipping points, including irreversible melt down of polar ice sheets and rapid release of carbon from frozen ground. Leading research institutions are working with governments around the world to increase NDCs to ensure a mitigation pathway that avoids overshoot.[5]

New Zealand's NDC tabled at COP26.

46. New Zealand's updated NDC (announced on 4 November 2021, and tabled at UNFCCC COP 26) aims to reduce net greenhouse gas emissions to 50% below gross 2005 levels by 2030. This corresponds to 41% when managed using a multi-year emissions budget starting from New Zealand's 2020 emissions target.[6]

47. Prior to this, New Zealand's NDC was to reduce net emissions to 30% below 2005 gross emissions levels, over the 2021-2030 period. This NDC was assessed by the Climate Change Commission as incompatible with contributing to global efforts to limit global warming to 1.5°C.

[4] https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/ [[307.2755]]
[5] 50x30 initiative (https://www.50x30.net/)
[6] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/New%20Zealand%20First/New%20Zealand%20NDC%20November%202021.pdf

48. New Zealand's updated NDC was informed by the Climate Change Commission's advice to the Government (but, as noted above, it still falls short of what is required to avoid an overshoot 1.5°C of global warming on the way to net carbon zero by 2050.

49. New Zealand plans to achieve its updated (2021-2030) NDC target by prioritising domestic emissions reductions across all sectors and greenhouse gases, and increasing CO_2 removals through forestry. It plans to supplement its efforts by using international carbon markets with environmental integrity. Cooperating with other countries will enable us to contribute to greater global emissions reductions.

50. The largest contributors to New Zealand's emissions are agriculture (48%) and energy (42%) sectors. Within that transport accounts for 21% of emissions and is growing the fastest.

SWORN at Wellington this 21 day of December 2021 before me:

Timothy Raymond Naish

Adelaide Gabriel McCluskey
Solicitor
Wellington

A solicitor of the High Court of New Zealand

AM
TRN

SCHEDULE – TIMOTHY NAISH CV

1a. Personal details				
Full name	*Title* Prof.	*First name* *Timothy*	*Second name(s)* *Raymond*	*Family name* Naish
Present position	Professor Antarctic Research Centre (0.7 FTE)			
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Personal website (if applicable)	http://www.victoria.ac.nz/antarctic/about/staff/timothy-naish			

1b. Academic qualifications

1985-1988 BSc (Earth Sciences), University of Waikato
1989-1990 MSc (1st class Hons), (Earth Sciences) University of Waikato
1992-1996 DPhil (Earth Sciences), University of Waikato

1c. Professional positions held

2020-2023	Secondment to Antarctica NZ, as Programme Leader, Ice-ocean-atmosphere, Antarctic Science Platform (0.3FTE).
2008-2017	Professor, Antarctic Research Centre, Victoria University of Wellington.
2017- 2018	RSNZ James Cook Research Fellow (on 2 year sabbatical from ARC Directorship)
2008-2017	Director of the Antarctic Research Centre & Professor in Earth Sciences, Victoria University of Wellington (0.8-0.95 FTE)
2012-2014	Deputy Pro-Vice Chancellor of the Faculties of Science Engineering, Architecture and Design, Victoria University of Wellington (0.2 FTE).
1998-2016	Research /Senior/Principal Scientist, GNS Science (1.0-0.05 FTE), Lower Hutt
2009-2013	Director, Joint Antarctic Research Institute, Wellington
2005-2008	Associate Professor and Deputy Director (0.2-0.4 FTE), Antarctic Research Centre, Victoria University of Wellington.
1996-1997	Australian Research Council Post-Doctoral Fellowship, James Cook University of Northern Queensland
1990-1995	Assistant Lecturer, Department of Earth Sciences, University of Waikato

1d. Present research/leadership/professional speciality

Science expertise:

- Improving projections of future sea-level change for anticipating and managing the impacts for New Zealand
- Antarctic and global climate change
- Climatology from glaciated and non-glaciated continental margins.
- Specialising in reconstruction of past sea-level and ice volume variability.
- Climate change impact assessment.
- Data and numerical model comparison and integration.
- Science-policy interface and transfer.

1e. Total years research experience	25 years

1f. Professional distinctions and memberships (including honours, prizes, scholarships, boards or governance roles, etc) (Prizes & awards are bolded)	
2019	**Prime Minister's Science Prize, $500,000. Leader of the Melting ice & Rising Seas Team**
2019	Invited to give keynote presentation at the Antarctic Parliamentarians Assembly, Whitehall, London, UK.
2018	Appointed to lead the Grand Challenge (Melting Ice & Global Consequences), World Climate Research Programme (WCRP).
2018	Appointed to the NZ Tertiary Education Commission PBRF evaluation committee
2018-	Convenor of Scientific Committee on Antarctic Research, new strategic research programme – INSTANT – Instabilities & Thresholds in Antarctica
2017-	Awarded and leader of $7M Grant (MBIE – NZ Sea Rise Programme) to develop improved location-specific sea-level rise projections for NZ.
2017-	Presented SCAR Science Lecture – "What does the Paris Climate Agreement mean for Antarctica" to the 40th Antarctic Treaty Consultative Meeting, Beijing, China May, 24th
2016-	Appointed by the Australian Government to the National Advisory Committee for Climate Change Science.
2016-	**Awarded RSNZ James Cook Fellowship**
2016 -	Invited to scoping meeting for Intergovernmental Panel on Climate Change special report on 1.5°C, 15-18th September, WMO Headquarters, Geneva, Switzerland
2015	Appointed co-chair of the Scientific Committee on Antarctic Research (SCAR), Past Antarctic Ice Sheets Programme.
2015	Appointed to Chilean Research Funding Agency (CONICYT) FONDAP Programme international assessment panel to assess proposals and select a Centre of Research Excellence US$10M in Antarctic Research.
2015-2016	Earth Sciences, Editor-in-Chief of the Journal *Antarctic Science*, Cambridge University Press.
2014	**Elected Fellow of the Royal Society of New Zealand**
2014	**Tinker-Muse Prize for Excellence in Antarctic Science and Policy (USD$100,000)**
2014	**Victoria University Research Excellence Award**
2014-	NZ/Australia Representative on the Science Evaluation Panel of the International Ocean Discovery Programme (IODP)
2013	**Victoria University Public Contribution Award**
2007 -	NZ Universities PBRF - A-Grade Researcher
2005-	Lead Principal Investigator on 4 RSNZ Marsden Funded Projects ~$3.5M.
2002- 2013	Chair of the International ANDRILL Science Committee.
2010-13	Lead Author, Intergovernmental Panel on Climate Change (IPCC) AR5, WG1
2009-12	Royal Society of New Zealand Marsden Fund Council Member and Convenor of the Earth Science and Astronomy Assessment Panel
2011	**Finalist, Dominion Post Wellingtonian of the Year Awards**
2011	**My ex-PhD student and post-doctoral research fellow, Dr Rob McKay, was awarded 2011 Prime Minister's MacDiarmid Emerging Scientist Prize**
2005-11	Co-Chief Scientist of the international ANDRILL McMurdo Ice shelf Project.
2010-11	US National Academy of Sciences, National Research Council Committee to review US scientific ocean drilling programs and make recommendations on a future US$1B science plan to National Science Foundation.
2010	**New Zealand Antarctic Medal (Royal New Zealand Honour, New Year 2010)**
2005-10	Leader, $5M FRST ANDRILL Programme
2009	**New Zealand Science and Technology Medal (Royal Society of New Zealand)**
2008	**James Lee Wilson Award for Excellence in Sedimentary Geology by the SEPM (international Society of Sedimentary Geology).**
2006	**Geological Society of New Zealand, McKay Hammer awarded for most meritorious contribution to New Zealand Earth Sciences in the last 2 calendar years**
1999-2010	Member of the Editorial Board of the Elsevier Journal, Sedimentary Geology
1998	**Royal Society of New Zealand, Hamilton Prize**

Total number of *peer reviewed* publications and patents	Journal articles	Books, book chapters, books edited	Conference proceedings	Patents
	120	12		

- 9624 career citations, h-index=45 (Google Scholar, includes Masson-Delmotte et al., 2013 IPCC Report Chapter) n=200
- 4800 career citations, h-index=38 (Scopus) n=109
- 3691 career citations, h-index=33 (Web of Science) n=83

Selected relevant publications

- Grant, G.R., **Naish, T.R.,** Dunbar, G.B., Stocchi, P., Kominz, M.A., Kamp, P.J.J, Tapia, C.A., McKay, R.A., Levy, R.H., Patterson, M.O. accepted. The amplitude and origin of sea-level variability during the Pliocene. *NATURE.*
- Levy, R.H., Meyers, S.R., **Naish, T.R**., Golledge, N.R., McKay, R.M., Crampton, J.S., DeConto, R.M., De Santis, L., Florindo, F., Gasson, E.G.W., Harwood, D.M., Luyendyk, B.P., Powell, R.D., Clowes, C., Kulhanek, D.K. 2019. Antarctic ice-sheet sensitivity to obliquity forcing enhanced through ocean connections *NATURE GEOSCIENCE*, DOI: 10.1038/s41561-018-0284-4
- Grant, G., Sefton, J.P., Patterson, M.O., **Naish, T.R.,** Dunbar, G., Hayward, B., Morgans, H.E.G., Alloway, B.V., Seward, D., Tapia, C.A., Prebble, J.G., Kamp, P.J.J., McKay., R., Ohneiser, C., Turner, G.M., 2018. Mid- to late Pliocene (3.3-2.6 Ma) global sea-level fluctuations recorded on a continental shelf transect, Whanganui Basin, New Zealand. *QUATERNARY SCIENCE REVIEWS*. 201, 241-260.
- Patterson, M., Mckay, R., **Naish, T**. et al., 2018. A southwest Pacific perspective on long-term global trends in Pliocene-Pleistocene stable isotope records. *PALEOCEANOGRAPHY.* doi.org/10.1029/2017pa003269
- Shakun, J.D., Corbett, L.B., Bierman, P.R., Underwood, K., Rizzo, D., Zimmerman, S.R., Caffee, M., **Naish, T.,** Golledge, N., Hay, C., 2018. Minimal East Antarctic Ice Sheet retreat onto land during the past 8 million. *NATURE, 558, 284-287*
- Rintoul, S.R., Chown, S.L., DeConto, R., England, M., Fricker, H., Masson-Delmotte, V**., Naish, T.,** Siegert, M., Xavier, J. C. accepted. Choosing the future of Antarctica. *NATURE, 558, 233-240*
- Golledge, N., Thomas, Z., Levy, R., N**aish, T.,** Kowalewski, D., Fogwill, C., 2017. Antarctic climate and ice sheet configuration during the early Pliocene interglacial 4.23 Ma. *CLIMATE OF THE PAST.* (13) 7, 959-975.
- Golledge, N., Levy, R.L., McKay, R., **Naish, T.** 2017. East Antarctic Ice Sheet vulnerable to Weddell Sea warming. *GEOPHYSICAL RESEARCH LETTERS*, 44, 2343-2351.
- McKay, R., Golledge, N.R., Maas, S., **Naish, T.,** Levy, R., Dunbar, G., Kuhn, G., 2016. Antarctic marine ice-sheet retreat in the Ross Sea during the early Holocene. *GEOLOGY*. doi:10.1130/G37315.1.
- Crampton, J., Cody, R., Levy, R., Harwood, D., McKay, R., **Naish, T**., 2016. Southern Ocean phytoplankton turnover in response to stepwise Antarctic cooling over the past 15 million years. *PROCEEDINGS OF THE NATIONAL ACADEMIES OF SCIENCES*. www.pnas.org/cgi/doi/10.1073/pnas.1600318113
- Galeotti, S., DeConto, R., **Naish, T.,** Stocchi, P., Florindo, F., Pagani, M., Barrett P., Bohaty, S., Lanci, L., Pollard, D., Sandroni, S., Talarico, F., Zachos, J., 2016, Antarctic Ice-Sheet variability across the Eocene-Oligocene boundary climate transition**.** *SCIENCE 352, 6281, 76-80*
- Levy, R & 25 others (incl. **Naish, T.**) Antarctic ice sheet sensitivity to atmospheric CO_2 variations during the Early-Middle Miocene. In press. *PROCEEDINGS OF THE NATIONAL ACADEMIES OF SCIENCES*. www.pnas.org/cgi/doi/10.1073/pnas.1516030113
- Golledge, N., Koweleski, D., **Naish, T.,** Levy R., Fogwill, C., Gasson, E., 2016. The multi-millennial Antarctic commitment to future sea-level rise. *NATURE. 526, 421-425.*

- McKay, R.M., Barrett, P.J., Levy, R.S., **Naish, T.R.,** Golledge, N. and Pyne, A. 2016. Antarctic Cenozoic climate history from sedimentary records: ANDRILL and beyond. *PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY OF LONDON A,* vol 374, issue 2059.
- Kennicutt, C and 69 others (including **Naish, T. R**.), 2014. Comment: Six priorities for Antarctic Science. *NATURE*, 512, 23-25.
- Patterson, M., McKay, R., **Naish, T**., Escutia, C., Jimenez-Espejo, F., Raymo, R., Meyers, S., Tauxe, L., and Brinkhuis. H. 2014 Orbital forcing of the East Antarctic Ice Sheet during the Pliocene and Early Pleistocene. *NATURE GEOSCIENCE*, 7, 841-847.
- Masson-Delmotte, V., M. Schulz, A. Abe-Ouchi, J. Beer, A. Ganopolski, J. F. González Rouco, E. Jansen, K. Lambeck, J. Luterbacher, **T. Naish**, T. Osborn, B. Otto-Bliesner, T. Quinn, R. Ramesh, M. Rojas, X. Shao and A. Timmermann, 2013: Information from Paleoclimate Archives. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T. F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P. M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- **Naish, T.,** and D. Zwartz. 2012. Palaeoclimate: Looking back to the future. *NATURE CLIMATE CHANGE* 2 (5): 317-8.
- Miller, K. G., J. D. Wright, J. V. Browning, A. Kulpecz, M. Kominz, **T. R. Naish,** B. S. Cramer, Y. Rosenthal, W. R. Peltier, and S. Sosdian. 2012. High tide of the warm Pliocene: Implications of global sea level for Antarctic deglaciation. *GEOLOGY* 40 (5): 407-10.
- **Naish, T. R.** & 56 others, 2009. Obliquity-paced Pliocene West Antarctic Ice Sheet Oscillations, *NATURE*, 458, 322-328.
- **Naish, T. R**., & 28 others. 2001. Orbitally induced oscillations in the East Antarctic ice sheet at the Oligocene/Miocene boundary, *NATURE*, 413, 719-723. (200 citations)
- **Naish, T. R.** & Wilson, G., 2009. Constraints on the amplitude of Mid-Pliocene (3.6–2.4 Ma) eustatic sea-level fluctuations from the New Zealand shallow-marine sediment record. *PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A.* (367, 169-187. doi:10.1098/rsta.2008.0223.
- McKay, R., **Naish, T**., Carter, L., Riesselman, C., Sjunneskog, C., Winter, D., Dunbar, R., Sangiorgi, F., Warren, C., Pagani, M., Schouten, S., Willmott, V., Levy, R., DeConto, R., Powell, R. 2012. Antarctic and Southern Ocean Influences on Late Pliocene cooling. *PROCEEDINGS OF THE NATIONAL ACADEMIES OF SCIENCES*, 109, 6423-642.
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- Pillans, B.J and **Naish , T.R**., 2004. Defining the Quaternary. *QUATERNARY SCIENCE REVIEWS*, 23, 2271-2282.
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