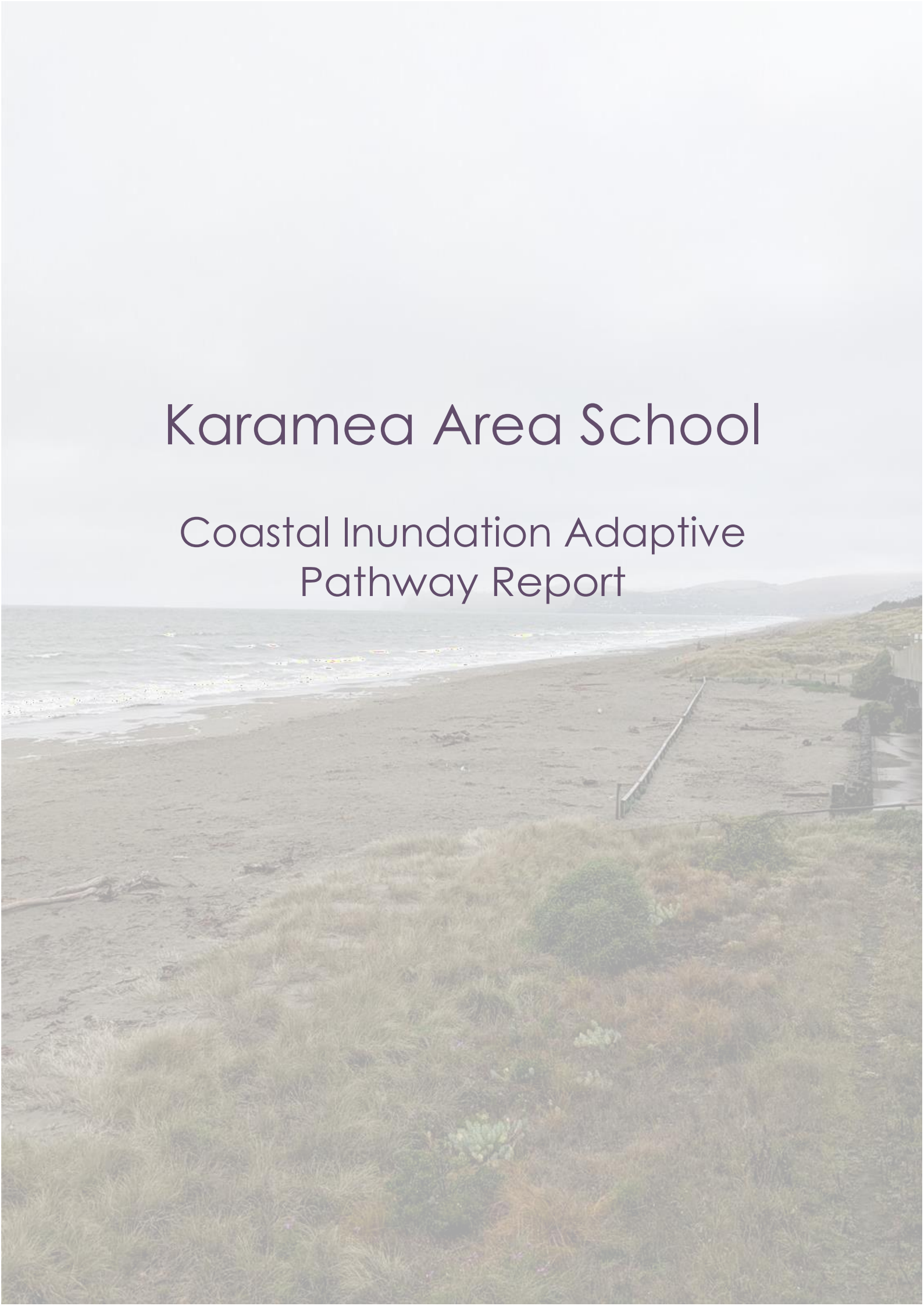
Karamea Area School

Coastal Inundation Adaptive Pathway Report



Adaptive Pathway: Karamea Area School

This adaptive pathway has been prepared for the Ministry of Education by WSP NZ Ltd. and is intended to advise possible adaptation pathways and give an indicative timeframe of these pathways in current and future climates.

This adaptive pathway document is required to be read with the "Guidance Document: Adaptive Pathway to Coastal Inundation" (WSP, 2023).

Site Overview

School Name	Karamea Area School
School ID	300
MoE Region	Southern
Number of buildings on school site	3

Figure 1 - Map of Karamea Area School and surrounding area and waterbodies.

Latitude	-41.249398
Longitude	172.11611
Community Setting	School grounds at same elevation as the community, therefore likely to have similar flooding from the coast. The surrounding water bodies are the Karamea River and the Tasman Sea / Te Tai-o-Rēhua.
Community Emergency Hub	Yes – Karamea Area School is a Community Emergency Hub
General Subsidence/Tectonics information	The Karamea area is subsiding at a current rate of -1.75 mm per year (Site 6136) (NZSeaRise Takiwa Programme, 2022).

Key Elevation Points

Note: Points are in NZVD 2016.

Access / Egress Points	Vehicle Access (Access 1) – 5.25 m	
Lowest Finished Floor Levels	Main School Building Southeast (BUILDING A) – 3.36 m	Technology Building (TECH BUILDING) – 3.38 m
Lowest Infrastructure levels	Stormwater Sump (SW1) – 2.81 m	Stormwater Sump (SW2) – 3.22 m
Coastal Defences	Stop bank along Karamea River (STOP BANK) – 5.51 m	Estuary Debris Line (ESTUARY 2) – 1.79 m

Water Levels (current and future)

Note: Points are in NZVD 2016.

MHWS	0.99 m	ESL100 + 2050 SLR *(+VLM)*[1]	4.05 m
MHWS + 2120 SLR (+VLM)[2]	2.15 m	ESL100 + 2070 SLR *(+VLM)*[3]	4.24 m
ESL100	3.73 m	ESL100 + 2120 SLR *(+VLM)*[4]	4.89 m

[1] This reference level is the ESL100 (3.73 m) with the 2050 (+VLM) SLR scenario (0.32 m) added to it.
[2] This reference level is the MHWS (0.99 m) with the 2120 (+VLM) SLR scenario (1.16 m) added to it.
[3] This reference level is the ESL100 (3.73 m) with the 2070 (+VLM) SLR scenario (0.51 m) added to it.
[4] This reference level is the ESL100 (3.73 m) with the 2120 (+VLM) SLR scenario (1.16 m) added to it.

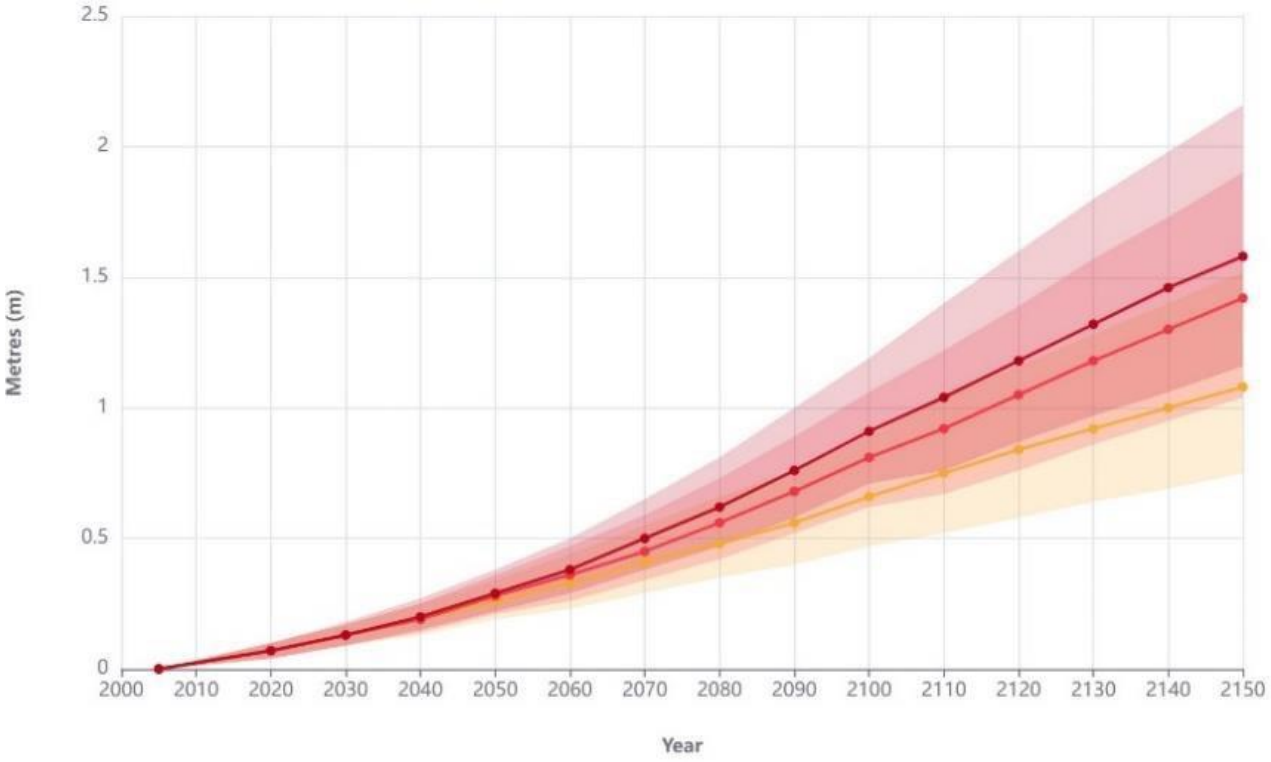


Figure 2 - Sea level rise increments[5] with vertical land movement under potential climate change scenarios (SSP2-4.5+VLM in orange, SSP3-7.0+VLM in red and SSP5-8.5 in deep red) and likely confidence intervals (faded colour blocks) (NZSeaRise Takiwa Programme, 2022). MfE (2022) recommends that the median (p50) SSP3-7.0+VLM is used.

Background / Summary of Coastal Inundation Risk

Local, district regional adaptation and infrastructure plans

The readily available relevant local, district and regional plans that provide guidance to understand and adapt to climate risks applicable to Karamea Area School are listed in Appendix C of this document and summarised below.

The West Coast Regional Council (WCRC) have identified in their Long-Term Plan that they will work with communities to manage coastal hazards. The potential cost implications from possible solutions are a significant issue for many communities, and typically solutions are short term in nature and have considerable cost and risk implication. WCRC has utilised external funding to inform decision-making, better understand the issue and examine the short-, medium- and long-term options to discuss with the community. These may include managed retreat, or other options, instead of traditional engineering solutions. The long-term solution will be balanced with meeting the immediate needs of the community, and providing time to allow for a meaningful long-term solution to be identified and socialized with the affected community. The plan identifies priority works for the community to improve their protection against flood impacts in Karamea. However, there is no specific evidence (as of yet) in these plans if they may include works to west coast coastline adjacent to Karamea Area School.

It is recommended that Karamea Area School and the Ministry of Education liaise with these parties to collaborate on appropriate mitigation/adaptation strategies for the school and its community and mana whenua.

[5] Sea level rise increments added to MHWS and ESL100 are the median values on the NZSeaRise programme charts as there are associated confidence intervals associated with each scenario.

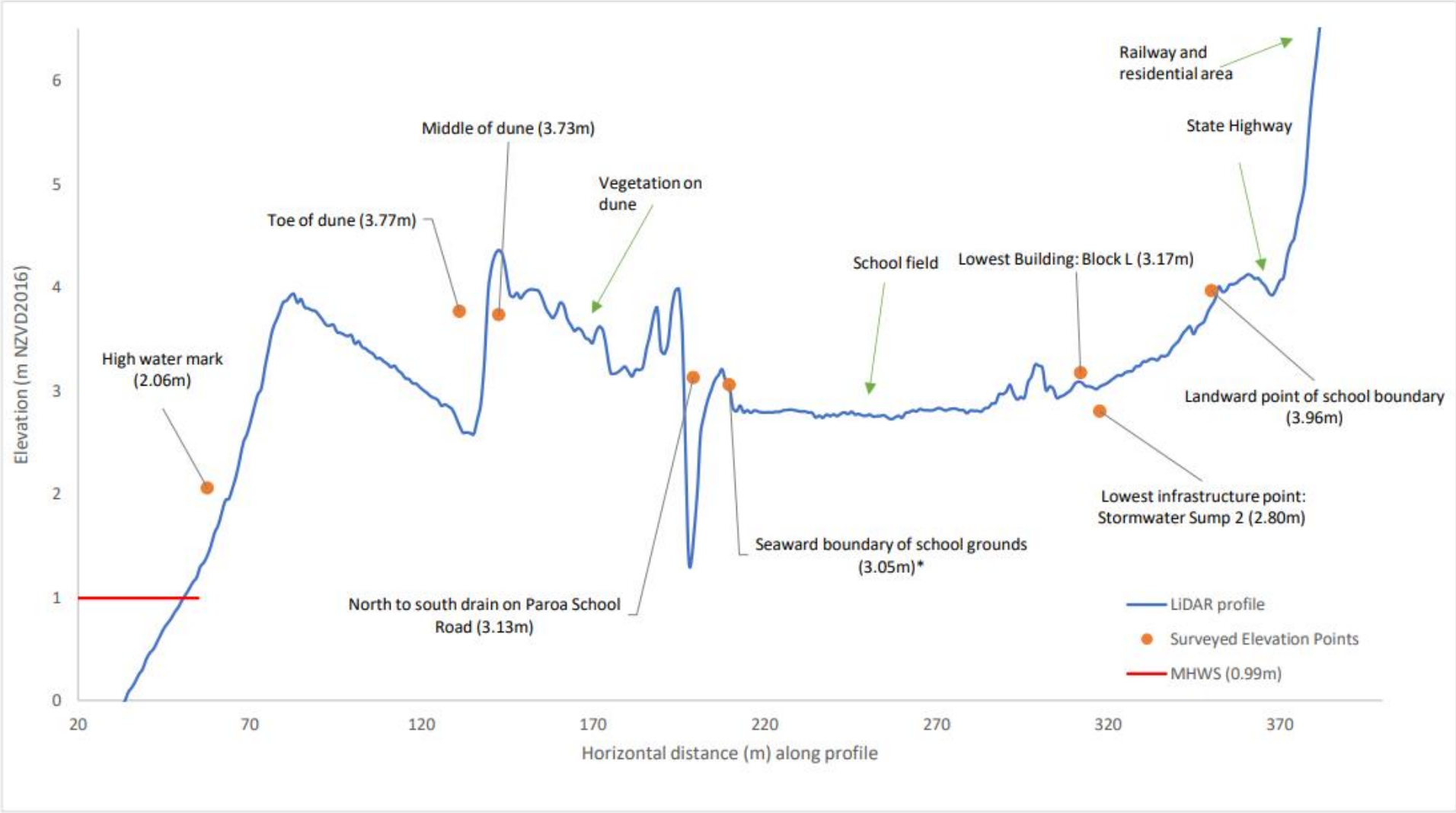


Figure 3 – Indicative profile extracted from LiDAR (1m DEM) and surveyed elevation points on site

Te Tāhuhu o te Mātauranga
Ministry of Education

Risk of Coastal Inundation (Past/Current/Future)

See Appendix B for further information.

	Vulnerability	
Period	**MHWS**	**ESL100**
Current	Low	Medium
Short-term (Present-2050)	-	Medium
Medium-term (2050-2070)	-	Medium
Long-term (2070-2120)	Low	Medium

Other Hazards

Anecdotal evidence

No recorded or anecdotal flooding from coastal inundation, based on on-site conversations with the school principal and administration or limited search online.

Infrastructure

Karamea River stop bank is located approximately 160 m to the south of the school site along the Karamea River. The residential area of the Karamea township is located between the school and the coast/estuary, where the school is approximately 1.5 km inland from the coast and approximately 600 m inland from the estuary.

Gravel extraction at the Karamea River mouth has reduced local flooding issues within the Karamea township as the river is now diverted straight out to the coast.

Other types of flooding

No recorded or anecdotal flooding from fluvial, pluvial nor stormwater sources on school site, based on on-site conversations with the school principal and administration.

Regional flooding from a combination of pluvial and fluvial sources around the Karamea township has restricted student and staff access to the school, however has not resulted in flooding of the school. As a result, the school was closed due to the possibility that staff and students may not be able to make it home. The potential for this regional fluvial flooding is likely to increase with potential climate change, however, is not considered in this report.

Erosion

No significant evidence of erosion along stop bank and estuary during on-site surveys. More detailed investigations into the long-term erosion trends of the stretch of coastline and the banks of the Karamea River is required to make an accurate judgement on the erosion potential of the beach, particularly associated with increasing sea levels.

Te Tāhuhu o te Mātauranga
Ministry of Education

Preferred Adaptive Pathway

The preferred adaptive pathway for Karamea Area School has been suggested due to its practicality, taking the school's current vulnerability into consideration as well as any future increase in vulnerability with predicted rises in sea level. The pathway anticipates the possibility of future community-level conversations and activities that the Ministry of Education and school should be aware of, and consider contributing to as well.

The short-term pathway for Karamea Area School should be considered to maintain the current level of service. In the future, the long-term pathway for Karamea Area School should be considered to help address the small-scale flooding issues, through relatively minor and cost-effective options.

The preferred adaptive pathway is subject to monitoring of the site and community, and monitoring of how the preferred pathway responds to sea level rise by the Ministry of Education. The adaptive pathway assumes that the Ministry of Education will review the adaptive pathway options at regular intervals (at least every 10 years), before significant change to school site, or after an inundation event.

Note: The preferred adaptive pathway suggested for Karamea Area School considers the coastal inundation (flooding) risk and does not consider/include the impact of pluvial and fluvial inundation, the erosion of the coastal shoreline, the demographic changes associated with the school such as the school roles and the forthcoming asset management interventions to enhance current school assets.

Preferred Adaptive Pathway – Short Term (Present-2050)

Pathway Approach	Business as Usual	
Preferred Pathway	Maintain infrastructure with particular importance placed on the stop bank, continue current emergency management and environmental monitoring activities to existing level of service.	
Trigger Points	Business As Usual activities have been triggered and should continue to maintain existing level of service.	

Preferred Adaptive Pathway – Medium Term (2050-2070)

Pathway Approach	Accommodate	
Preferred Pathway	Consider stormwater improvements on the school site (to reduce current exposure to other flooding hazards to the site).	
Trigger Points	Stormwater improvements could be triggered when flooding of school field located between the school and the stop bank or flooding to the access point to the school occurs. An indicative timeframe for these trigger points is from 2070.	

Preferred Adaptive Pathway – Long Term (2070-2120)

Pathway Approach	Accommodate	
Preferred Pathway	Consider stormwater improvements on the school site (to reduce current exposure to other flooding hazards to the site).	
Trigger Points	Stormwater improvements could be triggered when flooding of school field located between the school and the stop bank or flooding to the access point to the school occurs. An indicative timeframe for these trigger points is from 2070 or when there are upgrades to the river stop bank.	

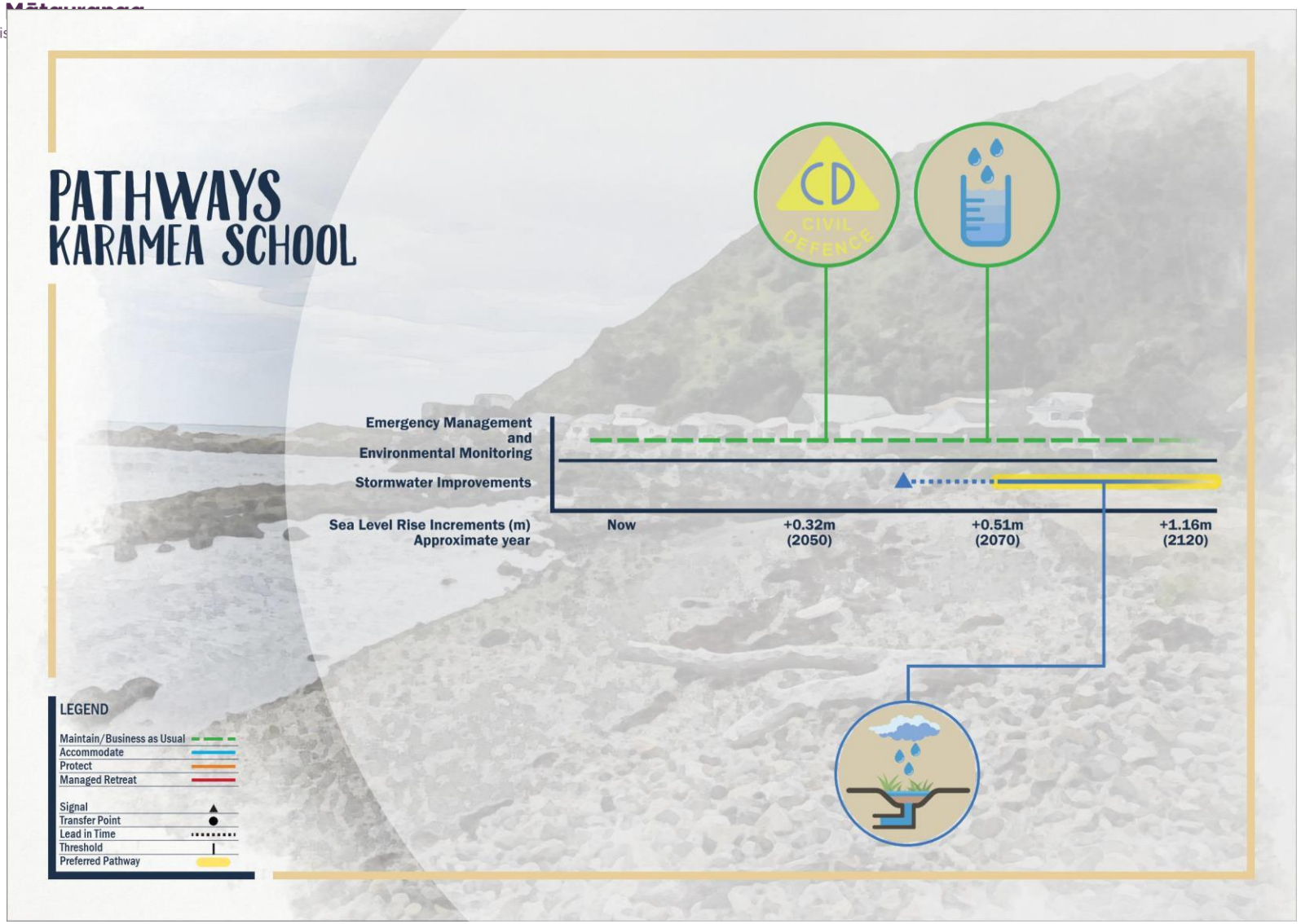


Figure 4 – Coastal Inundation Adaptation Pathway infographic for Karamea Area School

Te Tāhuhu o te Mātauranga
Ministry of Education

Appendix A: Adaptive Pathways

Short-list Options Considered

Note: Refer to Appendix A in the Guidance Document (WSP, 2023)

	Guidance document reference	Options considered
Short Term	A & B & C 	All current coastal inundation management activities continue. Maintain existing infrastructure, continue current emergency management and environmental monitoring activities to existing level of service.
Medium Term	A & B & C 	All current coastal inundation management activities continue. Maintain existing infrastructure, continue current emergency management and environmental monitoring activities to existing level of service.
	D 	Consider stormwater improvements on the school site (to reduce current exposure to other flooding hazards to the site)
Long Term	A & B & C 	All current coastal inundation management activities continue. Maintain existing infrastructure, continue current emergency management and environmental monitoring activities to existing level of service.
	D 	Consider stormwater improvements on the school site (to reduce current exposure to other flooding hazards to the site)

Te Tāhuhu o te Mātauranga
Ministry of Education

Appendix B: Risk of Coastal Inundation (Past/Current/Future)

Current Vulnerability to MHWS:

Karamea Area School has a low vulnerability to coastal inundation under current MHWS (0.99 m). No buildings, infrastructure or school access surveyed are vulnerable to coastal inundation as they are at an elevation above the referenced level for MHWS.

Long Term (2070-2120) Vulnerability to MHWS with SLR:

Karamea Area School has a low vulnerability to coastal inundation under MHWS with the SSP3-7.0+VLM 2120 SLR scenario (2.15 m). No buildings, infrastructure or school access surveyed are vulnerable to coastal inundation as they are at an elevation above the referenced level for this predicted event.

Current Vulnerability to ESL100:

Karamea Area School has a medium vulnerability to coastal inundation under the current day ESL100 scenario (3.73 m). The vulnerable buildings and infrastructure surveyed below the referenced level for this predicted event are:

- All infrastructure surveyed
- All FFL's of buildings surveyed
- All school access surveyed

The current day ESL100 (3.73 m) is lower than the elevation of the crest of the Karamea stop bank (5.51 m), therefore the potential for inundation due to expected overtopping from the Karamea River is low.

Short term (Present Day-2050) vulnerability to ESL100 with SLR:

Karamea Area School has a medium vulnerability to coastal inundation under ESL100 with the SSP3-7.0+VLM 2050 SLR scenario (4.05 m). The vulnerable buildings and infrastructure surveyed are below the referenced level for this predicted event:

- All infrastructure surveyed
- All FFL's of buildings surveyed
- All school access surveyed

The ESL100 with the SSP3-7.0+VLM 2050 SLR scenario (4.05 m) is lower than the elevation of the crest of the Karamea stop bank (5.51 m), therefore the potential for inundation due to expected overtopping from the Karamea River is low.

Medium term (2050-2070) Vulnerability to ESL100 with SLR:

Karamea Area School has a medium vulnerability to coastal inundation under ESL100 with the SSP3-7.0+VLM 2070 SLR scenario (4.24 m). The vulnerable buildings and infrastructure surveyed below the referenced level for this predicted event:

- All infrastructure surveyed
- All FFL's of buildings surveyed
- All school access surveyed

The ESL100 with the SSP3-7.0+VLM 2070 SLR scenario (4.24 m) is lower than the elevation of the crest of the Karamea stop bank (5.51 m), therefore the potential for inundation due to expected overtopping from the Karamea River is low.

Long term (2070-2120) Vulnerability to ESL100 with SLR:

Karamea Area School has a medium vulnerability to coastal inundation under ESL100 with the

SSP3-7.0+VLM 2120 SLR scenario (4.89 m). The vulnerable buildings and infrastructure surveyed below the referenced level for this predicted event:

- All infrastructure surveyed
- All FFL's of buildings surveyed
- All school access surveyed

The ESL100 with the SSP3-7.0+VLM 2120 SLR scenario (4.89 m) is lower than the elevation of the crest of the Karamea stop bank (5.51 m), therefore the potential for inundation due to expected overtopping from the Karamea River is low.

The overall viability of the school and the surrounding area is reliant upon the existence and maintenance of the Karamea River stop bank. Pressure on the stop bank is expected is increase sure to predicted sea level rise and frequency of to flood events. This assessment of school vulnerability has not accounted for the increased inundation potential from the combination of sea level rise related inundation and fluvial inundation events.

Te Tāhuhu o te Mātauranga
Ministry of Education

Appendix C: Local, district and regional adaptation and infrastructure plans

MfE's National Adaptation Plan:

National Adaptation Plan outlines a programme of work to support communities to better understand the climate impacts that affect them and adapt to build their resilience.

Waka Kotahi New Zealand Transport Agency

Waka Kotahi New Zealand Transport Agency (Waka Kotahi) release 'Tiro Rangi Climate Adaptation Plan' in December 2022. To ensure that the land transport system is resilient with climate change Waka Kotahi, in alignment with the National Adaptation Plan adaptation framework (avoid, protect, accommodate and retreat), will use a combination of these categories to effectively adapt in different locations and over different timescales. These adaptation strategies will be built into long-term planning to avoid ongoing expensive repairs, disruption and declining levels of service (date accessed 18/04/2023).

West Coast Regional Council

The West Coast Regional Council (WCRC) undertook a review of the Regional Coastal Plan and the existing 18 Coastal Hazard Areas (CHAs), to determine whether the current CHAs stay the same, whether any CHAs need to be removed, whether any new hazard areas need to be added and, if possible, highlight whether the hazard risk is low, medium, or high for the Te Tai o Poutini Plan. This report determined that the Karamea area is a medium-risk CHA. It highlights that wave overtopping flooding can affect low lying land during storms in the Karamea area, and that the estuary mouths close infrequently, but when they do it can result in flooding due to back up of water behind them. This report also highlights that Karamea is a CHA where State Highway 67 is vulnerable to coastal hazards.

WCRC Long Term Plan (LTP) 2021-2031 identifies cross-section studies and aerial photography of some coastal areas to be carried out, to monitor changing patterns in beach systems. This assists identification of what maintenance or additional protection is needed. This work will be undertaken as required depending on the urgency and seriousness of the risks and consequences. Within the LTP it states that new infrastructure requests are received from individual West Coast communities for WCRC to investigate and implement protection works. New infrastructure work over the last decade has largely related to coastal protection. The requests for new or improved infrastructure are not driven by population growth but a desire to maintain and protect property from the impacts of climate change.

- Infrastructure strategy in the LTP: This Strategy sets out WCRC's thirty-year plan for protection against river flooding, erosion and coastal inundation and the assets to deliver on this. The assets involved for flood protection, erosion control and coastal erosion include stop banks, groynes, sacrificial bunds, drainage channels, seawalls and river training works. The council has highlighted in the LTP that the cross-section and flood flow analysis undertaken for the Karamea township flood bank indicates that its current service potential is capable of containing less than the 1 in 50-year return period flood at some locations. Through the rating-districts five-year plan it identifies priority works for the community to improve their protection against flood impacts.

Through the LTP, WCRC will work with communities to manage coastal hazards. Potential cost implications from potential solutions are a significant issue for many communities. Typically, solutions are short term in nature and have considerable cost and risk implications due to the user-pays (based on benefits) model for funding such works. A feature of several

recent reports has been the inclusion of recommendations supporting managed retreat. WCRC has utilised EnviroLink funding to inform decision-making by better understanding the issue and examining the short-, medium- and long-term options to discuss with the community. These may include managed retreat, or other options, instead of traditional engineering solutions. The long-term solution will be balanced with meeting the immediate needs of the community, and providing time to allow for a meaningful long-term solution to be identified and socialized with the affected community.

WCRC are building their knowledge regarding the risk of flooding from the Karamea river due to the decrease flood protection of the stop banks and the closing of the river mouth to the coast. They have had reports prepared for them to help understand the coastal hazards due to these events occurring. In 2019, the WCRC completed upgrades the Karamea stop bank (area upstream of the school and not including stop bank adjacent to the school).

Te Tāhuhu o te Mātauranga
Ministry of Education

Glossary and Acronyms

Key term	Definition
Adaptation	The process taken to adjust to the impacts and risks of coastal inundation.
Adaptation approaches and options	Compendium of five approaches of physical climate change adaptation and resilience measures relevant for coastal inundation across Aotearoa New Zealand, which can help to support the Ministry of Education address the climate change impacts to schools from Coastal Inundation.
Annual exceedance probability	Annual Exceedance Probability (AEP) is the probability of an event occurring in any given year. i.e. a 1% AEP means there is a 1% chance in any given year of the event occurring. This means that on average 1 event of this size will occur every 100 years.
Climate change	Large-scale, long-term shifts in the planet's weather patterns and average temperatures
Climate change impacts	The consequences of climate change, both experienced and expected, for natural and human systems and environments.
Coastal inundation adaptation approaches/options	Practical things that can be done to adjust to, prepare for, respond to, and recover from coastal inundation impacts and risks.
Coastal inundation threshold/ reference water level event	Predicted water levels under current and future climate using the current day MHWS and ESL100 at each school location with SLR+VLM in 2050, 2070, and 2120 added.
Coastal inundation vulnerability	Identification of resources at risk from coastal inundation.
Extreme Sea Level (ESL100)	Extreme sea level from a storm which has a statistical 1% chance of being exceeded in any given year based on present day conditions.
Finished Floor Level (FFL)	Elevation level of the ground-floor of a building
Mean High Water Spring (MHWS)	The long term average of the highest high- tide that water levels reach at the time of spring tides.
Resilience	Capacity to prepare for, respond to, and recover from climate impacts and risks while incurring minimal damage to wellbeing, the economy, and the environment.
Shared Socioeconomic Pathways (SSP)	Range of future climate change pathways determined by a series of socio- economic assumptions that drive future greenhouse gas emissions.
Signal/Trigger	A point in time that allows any change that occurs to be monitored and to have a point on which to adapt. Signals/triggers highlight impending changes in risk.
SSP3-7.0	Climate change scenario under medium-high future emissions and warming (3°C warmer world). This scenario was used in the CIAPs.
Vertical Land Movement (VLM)	Rate per year (mm) by which the land is subsiding or uplifting.