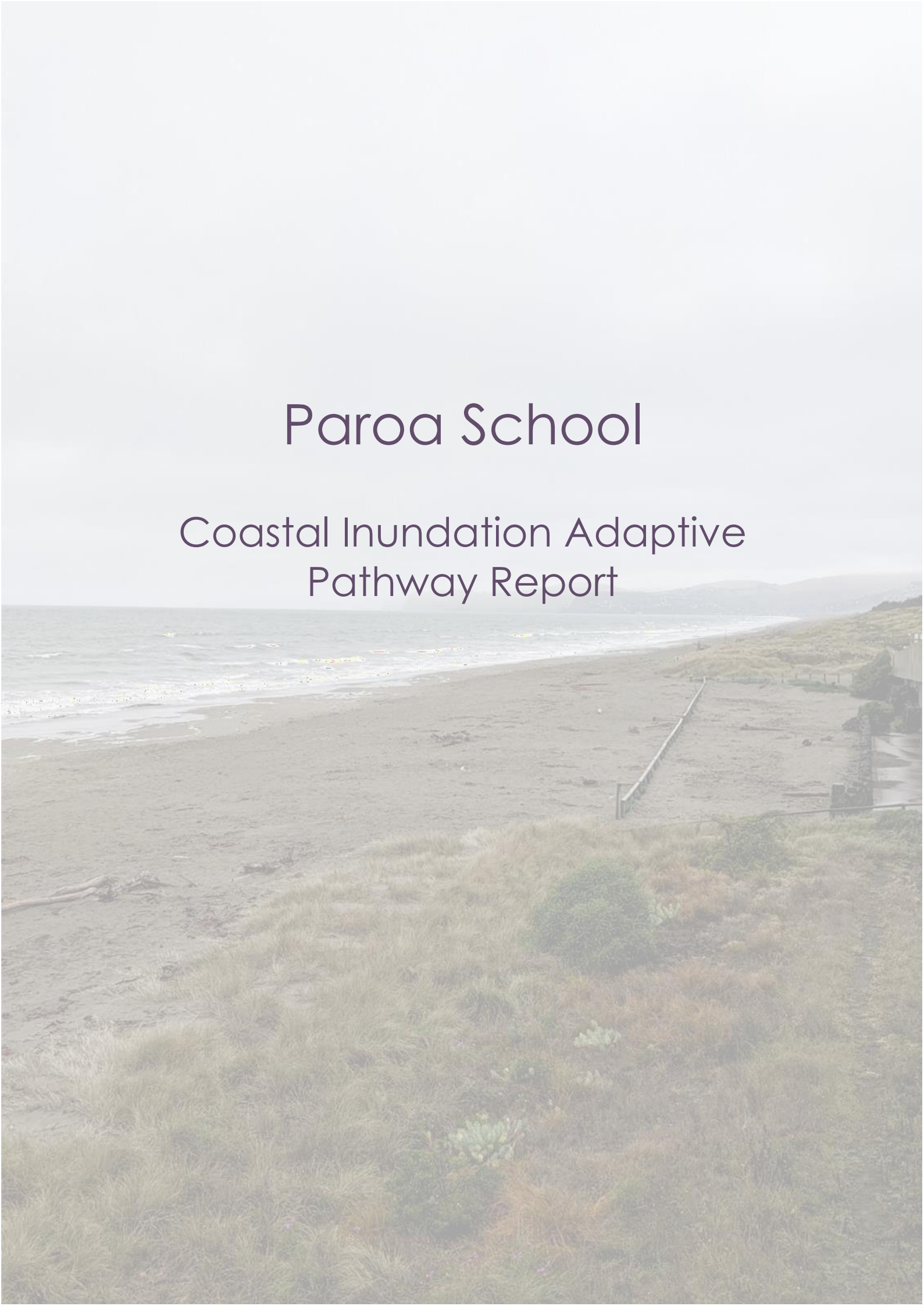
Paroa School

Coastal Inundation Adaptive Pathway Report



Adaptive Pathway: Paroa 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	Paroa School
School ID	1529
MoE Region	Southern
Number of buildings on school site	6

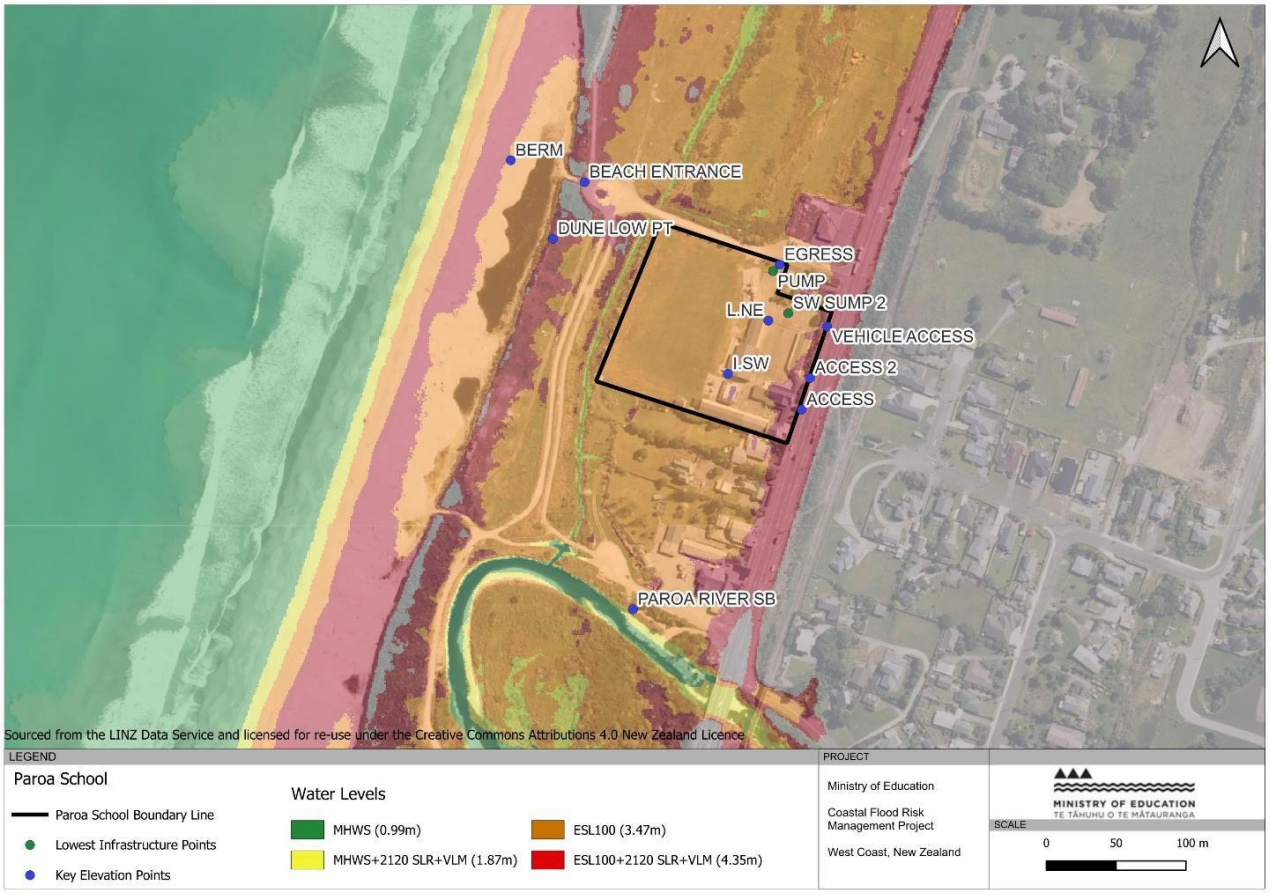


Figure 1 - Map of Paroa School with the indicative inundation zones based on land elevation from LiDAR.

Latitude	-42.509697
Longitude	171.168468
Community Setting	School grounds at a lower elevation than the surrounding community, therefore likely to experience a more significant impact from coastal inundation. Surrounding water bodies are the Tasman Sea / Te Tai-o-Rēhua, Saltwater Creek and the Paroa School Road drains.
Community Emergency Hub	No – Paroa School is not a Community Emergency Hub.
General Subsidence/Tectonics information	The Paroa area is uplifting at a current rate of 0.285 mm per year (Site 6032) (NZSeaRise Takiwa Programme, 2022).

Key Elevation Points

Note: Points are in NZVD 2016.

Access / Egress Points	Pedestrian Access (Access 1) – 3.82 m	Pedestrian Access (Access 2) – 3.96 m
	Vehicle Access via State Highway 6 (VEHICLE ACCESS) – 3.98 m	Vehicle egress via Paroa School Road (EGRESS) – 2.60 m
Lowest Finished Floor Levels	Block I Southwest (I-SW) – 3.32 m	Block L Northeast (L-NE) – 3.71 m
Lowest Infrastructure levels	Pump Shed (PUMP) – 2.72 m	Stormwater Sump (SW SUMP 2) – 2.80 m
Coastal Defences	Low Point in Vegetated Gravel Dune (DUNE) – 3.73 m	Gravel Storm Berm (BERM) – 3.77 m

Water Levels (current and future)

Note: Points are in NZVD 2016.

MHWS	0.99 m	ESL100 + 2050 SLR *(+VLM)*[1]	3.68 m
MHWS + 2120 SLR (+VLM)[2]	1.91 m	ESL100 + 2070 SLR *(+VLM)*[3]	3.85 m
ESL100	3.47 m	ESL100 + 2120 SLR *(+VLM)*[4]	4.39 m

[1] This reference level is the ESL100 (3.47 m) with the 2050 (+VLM) SLR scenario (0.23 m) added to it.
[2] This reference level is the MHWS (0.99 m) with the 2120 (+VLM) SLR scenario (0.92 m) added to it.
[3] This reference level is the ESL100 (3.47 m) with the 2070 (+VLM) SLR scenario (0.38 m) added to it.
[4] This reference level is the ESL100 (3.47 m) with the 2120 (+VLM) SLR scenario (0.92 m) added to it.

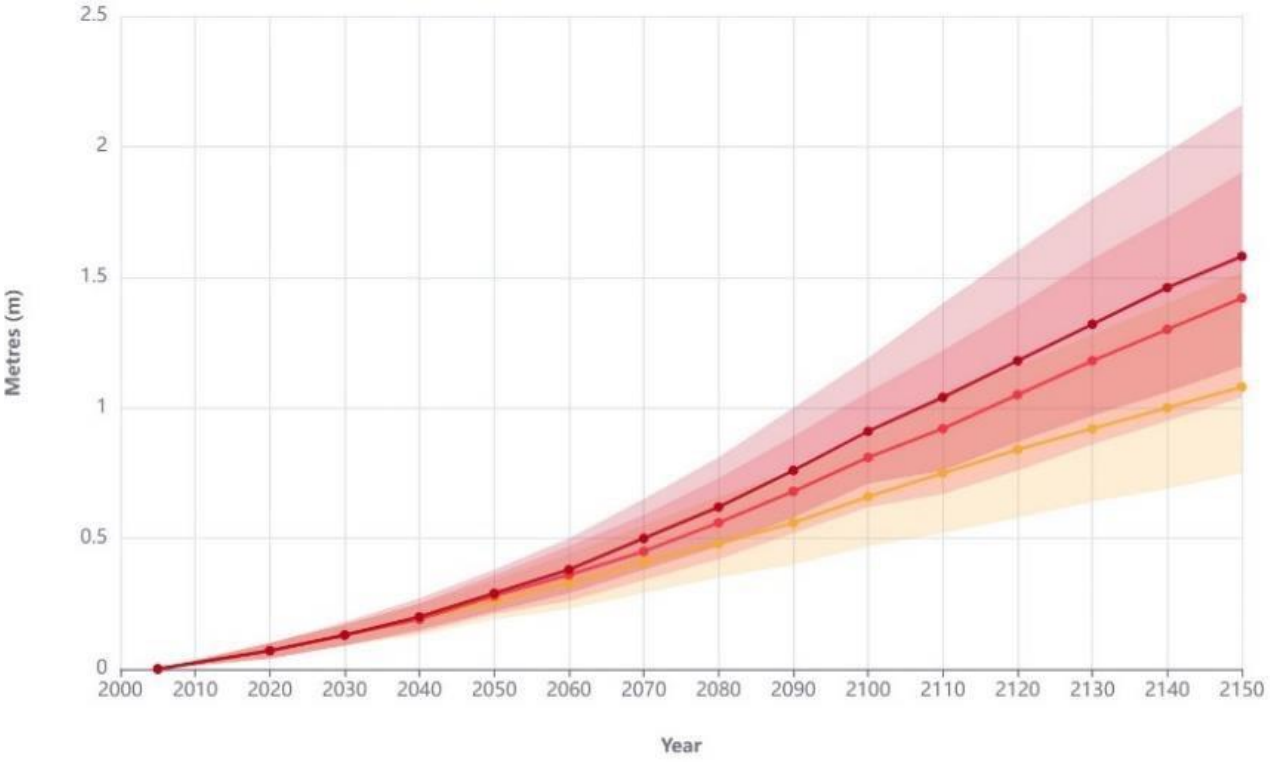


Figure 2 - Sea level rise (SLR) increments[5] with vertical land movement under potential climate change scenarios (SSP2-4.5+VLM in orange, SSP3-7.0+VLM in red and SSP5-8.5 in deep red) and likely confidence intervals (faded colour blocks) (NZSeaRise Takiwa Programme, 2022). MfE (2022) recommends that 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 Paroa School are listed in Appendix C of this document.

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 council intends to manage the mouth of the New River and Saltwater Creek (just located south of school), where it will re-open the mouth if it becomes blocked, which causes flooding to nearby properties including the school (this generally occurs once or twice per year). However, no works are stated with regard to Paroa coastal protection works.

[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.

It is recommended that Paroa 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.

Elevation Profile

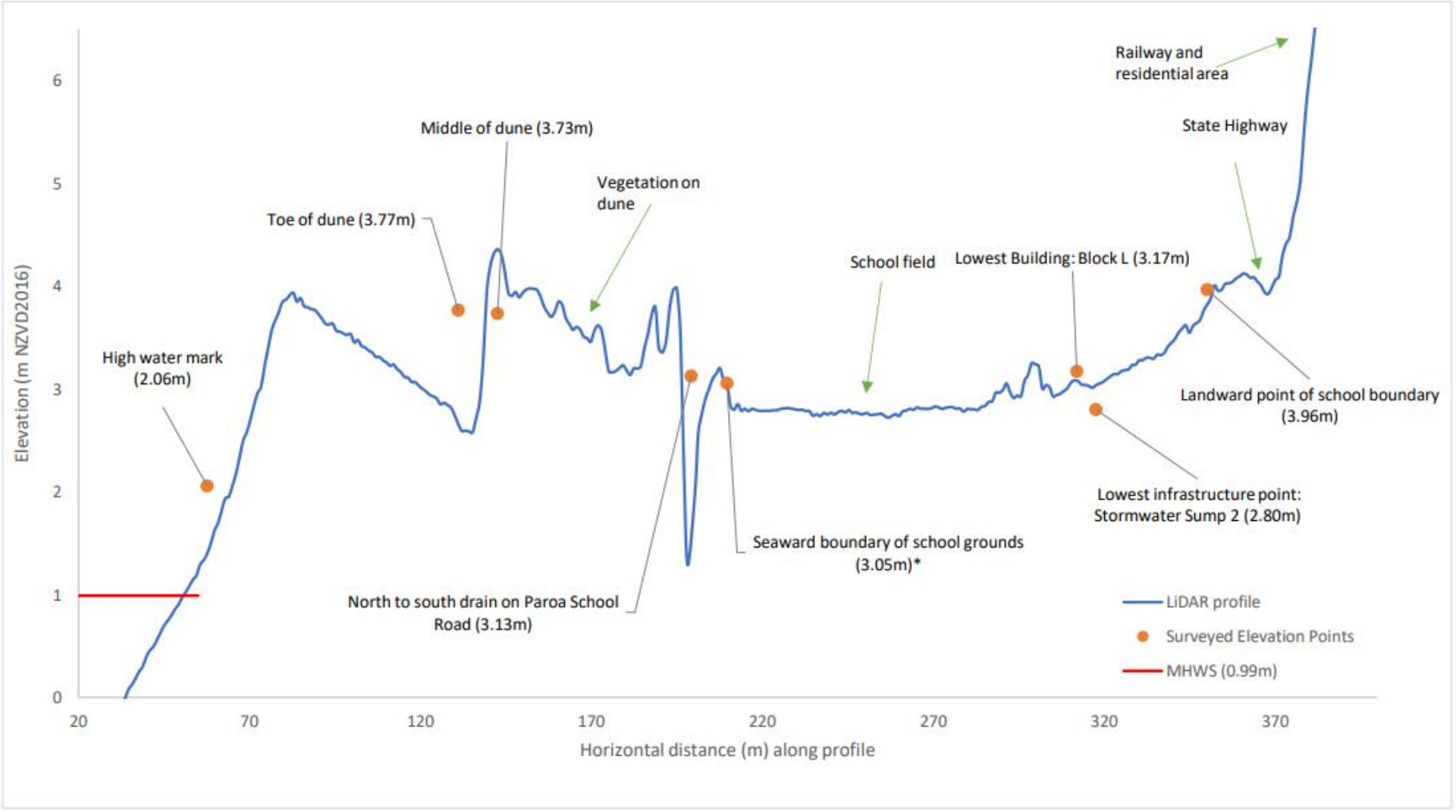


Figure 3 – Indicative profile extracted from LiDAR (1m DEM) and surveyed elevation points on site

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)	-	High
Long-term (2070-2120)	Low	High

Other Hazards

Anecdotal evidence

Flooding directly from the coast was recorded at the school on 15th June 2022, where the western boundary of the school field and Paroa School Road were inundated with sea foam, likely from the associated wave run-up associated with a significant swell event.

In August 2018, November 2021 and in February 2022, the school field and carpark experienced flooding. School administration could not confirm a direct source, however stated that these events occurred when spring high tides and heavy rainfall events occurred simultaneously. The dates of these events have been confirmed that they coincide with dates of spring high tides.

Infrastructure

No existing infrastructure (stop banks, State Highways, railways) is located between the school and the coast. A council operated footpath and drain is located between the school site and the coastline.

Other types of flooding

No anecdotal or recorded flooding from fluvial sources.

As mentioned above school has experienced flooding from a combination of coastal and pluvial sources. On-site observations in September 2022, revealed that the stormwater sumps on the school grounds were filled with sediment. The sediment filled sumps may result in poor drainage of the school site, and therefore may result in flooding during heavy rainfall.

Erosion

Evidence of coastal erosion was observed during on-site surveys along the vegetated gravel berm, where scarping had occurred. More detailed investigations into the long-term erosion trends of the stretch of coastline is required to make an accurate judgement on the erosion potential of the beach, particularly associated with increasing sea levels.

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Preferred Adaptive Pathway

The preferred adaptive pathway for Paroa 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 Paroa School should be considered as it should help address the small-scale flooding issues, through relatively minor and cost-effective options. In the future, the long-term pathway for Paroa School should consider the managed retreat and raising of the school buildings away from all flood hazards to ensure that the school is out of all flood hazard zones and can continue to be used by the community.

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. As it is adaptive, it also suggests/assumes that the Ministry of Education will review the pathway options at regular intervals (*at least* every 10 years), before significant changes to school site, or, after a coastal inundation event.

The preferred adaptive pathway suggested for Paroa 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	Accommodate	
Preferred Pathway	Consider stormwater improvements on the school site (to reduce current exposure to other flooding hazards to the site) and raising infrastructure. Poor maintenance of on-site infrastructure also contributes to these incidents, and we recommend that these activities are enhanced.	
Trigger Points	Stormwater improvements and raising infrastructure have already been triggered and action for these improvements should be considered now to reduce existing site level flooding (other sources).	

Preferred Adaptive Pathway – Medium Term (2050-2070)

Pathway Approach	Protect	
Preferred Pathway	Consider building flood exclusion defences (temporary and permanent) around the school site allowing for continued community access.	
Trigger Points	The building of the flood exclusion defences (temporary or permanent) could be triggered when coastal water causes flooding at the school site twice per year. An indicative timeframe for when this could occur is from 2035.	

Preferred Adaptive Pathway – Long Term (2070-2120)

Pathway Approach	Managed Retreat	
Preferred Pathway	Consider the managed retreat of the school to new site landward of State Highway 6 and the railway and away from all flood hazards.	
Trigger Points	The managed retreat of the school could be triggered when the flood exclusion defences no longer provide protection to the school or when coastal inundation impacts the continued operation of the school. An indicative timeframe for when this could be triggered and investigations into new site outside of hazard zones is from 2050.	

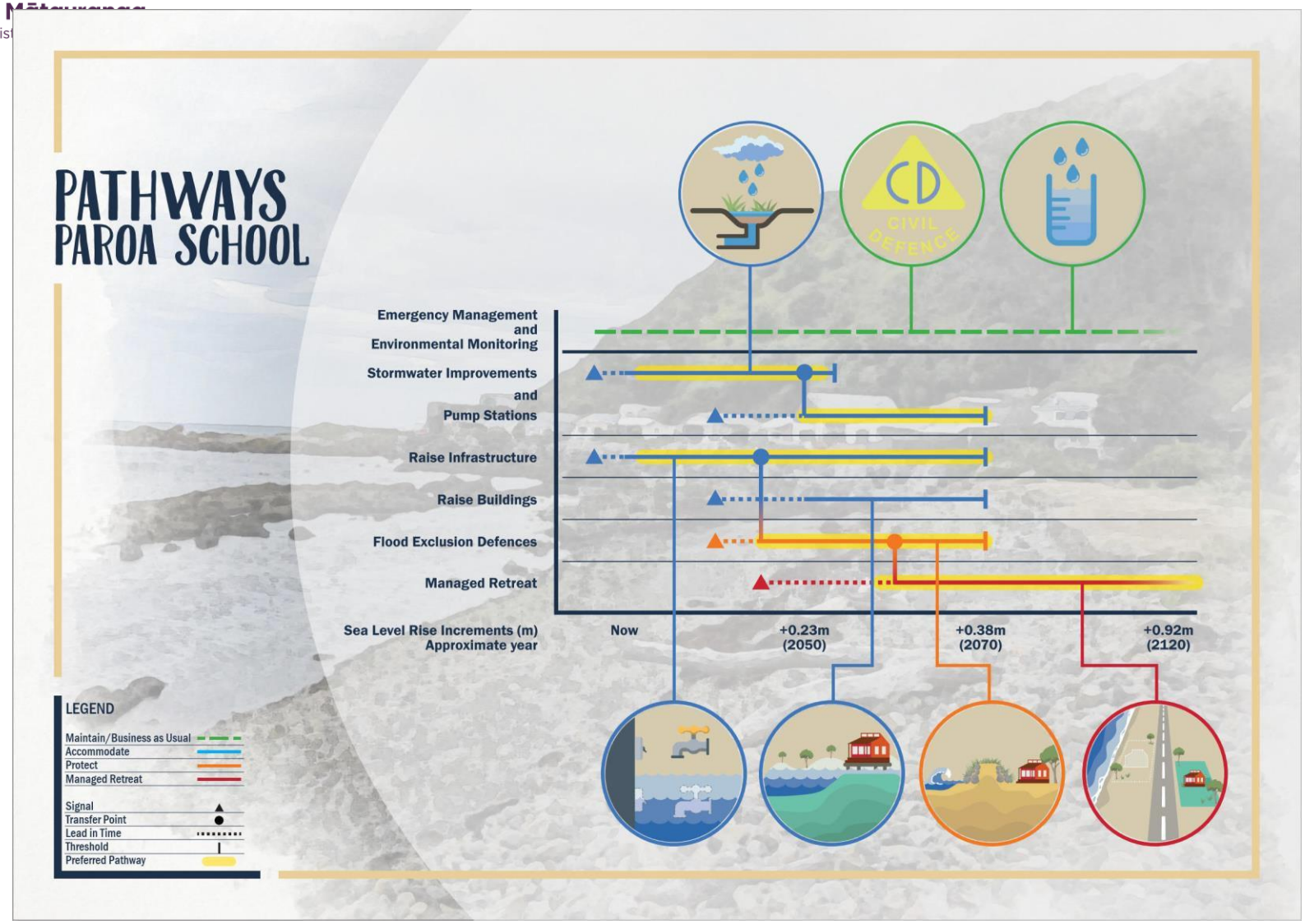

Figure 4 – Coastal Inundation Adaptation Pathway infographic for Paroa School

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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 with particular importance placed on cleaning on-site stormwater drains and 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).
	D 	Consider raising infrastructure at risk.
Medium Term	E 	Consider raising the finished floor levels of all buildings to at least 4.0 m
	D 	Consider stormwater improvements on the school site through a pump station (to reduce current exposure to other flooding hazards to the site).
	M 	Consider building flood exclusion defences around the school site allowing for continued community access.
Long Term	O 	Consider the managed retreat of the school to new school site landward of State Highway 6 and the railway away from all flood and coastal hazards.

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

Current Vulnerability to MHWS:

Paroa School has a low vulnerability to coastal inundation under current MHWS (0.99 m). No buildings or infrastructure 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:

Paroa School has a low vulnerability to coastal inundation under MHWS with the SSP3-7.0+VLM 2120 SLR scenario (1.91 m). No buildings or infrastructure surveyed are vulnerable to coastal inundation as they are at an elevation above the referenced level for this predicted event.

Current Vulnerability to ESL100:

Paroa School has a medium vulnerability to coastal inundation under the current day ESL100 scenario (3.47 m). The vulnerable buildings and infrastructure surveyed below the referenced level for this predicted event are:

- Vehicle access vis Paroa School Road (2.60 m)
- Stormwater Sump 1 (3.0 m)
- Stormwater Sump 2 (2.80 m)
- Pump Shed (2.72 m)
- FFL's of Block I southwest (3.32 m)
- School Playing Field (2.55 m)

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

Paroa School has a medium vulnerability to coastal inundation under ESL100 with the SSP3-7.0+VLM 2050 SLR scenario (3.70 m). The vulnerable buildings and infrastructure surveyed are below the referenced level for this predicted event:

- Vehicle access vis Paroa School Road (2.60 m)
- Stormwater Sump 1 (3.0 m)
- Stormwater Sump 2 (2.80 m)
- Pump Shed (2.72 m)
- FFL of Block I southwest (3.32 m)
- School Playing Field (2.55 m)
- Beach access point via Paroa School Road (3.64 m)

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

Paroa School has a high vulnerability to coastal inundation under ESL100 with the SSP3-7.0+VLM 2070 SLR scenario (3.85 m). The vulnerable buildings and infrastructure surveyed below the referenced level for this predicted event:

- Vehicle access vis Paroa School Road (2.60 m)
- Pedestrian Access 1 (3.82 m)
- All infrastructure surveyed (except for Block A heat pump)
- FFL of Block I southwest (3.32 m)
- FFL of Block I east (3.75 m)
- FFL of Block L northeast (3.71 m)
- School Playing Field (2.55 m)

The ESL100 with the SSP3-7.0+VLM 2070 SLR scenario (3.83 m) is above than the elevation of the vegetated berm (3.73 m) and storm berm (3.77 m) therefore there is the potential for

inundation due to expected overtopping.

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

Paroa School has a high vulnerability to coastal inundation under ESL100 with the SSP3-7.0+VLM 2120 SLR scenario (4.39 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 points surveyed

The ESL100 with the SSP3-7.0+VLM 2070 SLR scenario (4.35 m) is above than the elevation of the vegetated berm (3.73 m) and storm berm (3.77 m) therefore there is the potential for inundation due to expected overtopping.

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

MfE's National Adaptation Plan:

The 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).

KiwiRail

KiwiRail have identified through their Sustainability Strategy 2022-2025 that they have an objective targeted to improve their understanding of climate change impacts, and that the adaptation requirements and management plans are in place for existing assets and new capital projects.

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 Paroa is a medium-risk CHA. Within the CHA, it states that State Highway 6 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. It highlights that the council intends to manage the mouth of the New River and Saltwater Creek (just located south of school), where it will re-open the mouth if it becomes blocked, which would cause risk of flooding to nearby properties including the school (this generally occurs once or twice per year). However, no works are stated in regard to Paroa coastal protection works.
- 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.

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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.