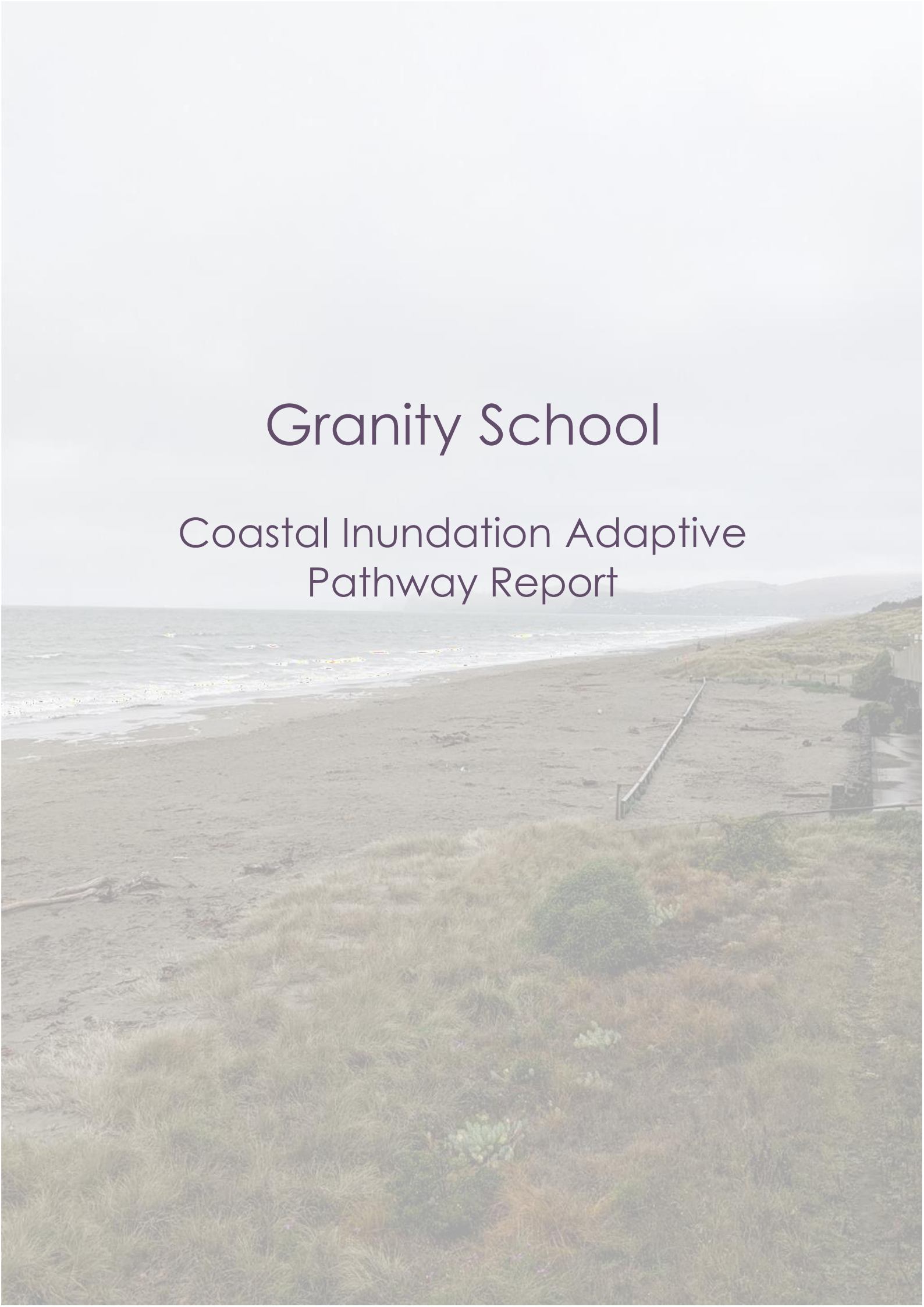
Granity School

Coastal Inundation Adaptive Pathway Report



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Adaptive Pathway: Granity 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	Granity School
School ID	3192
MoE Region	Southern
Number of buildings on school site	2

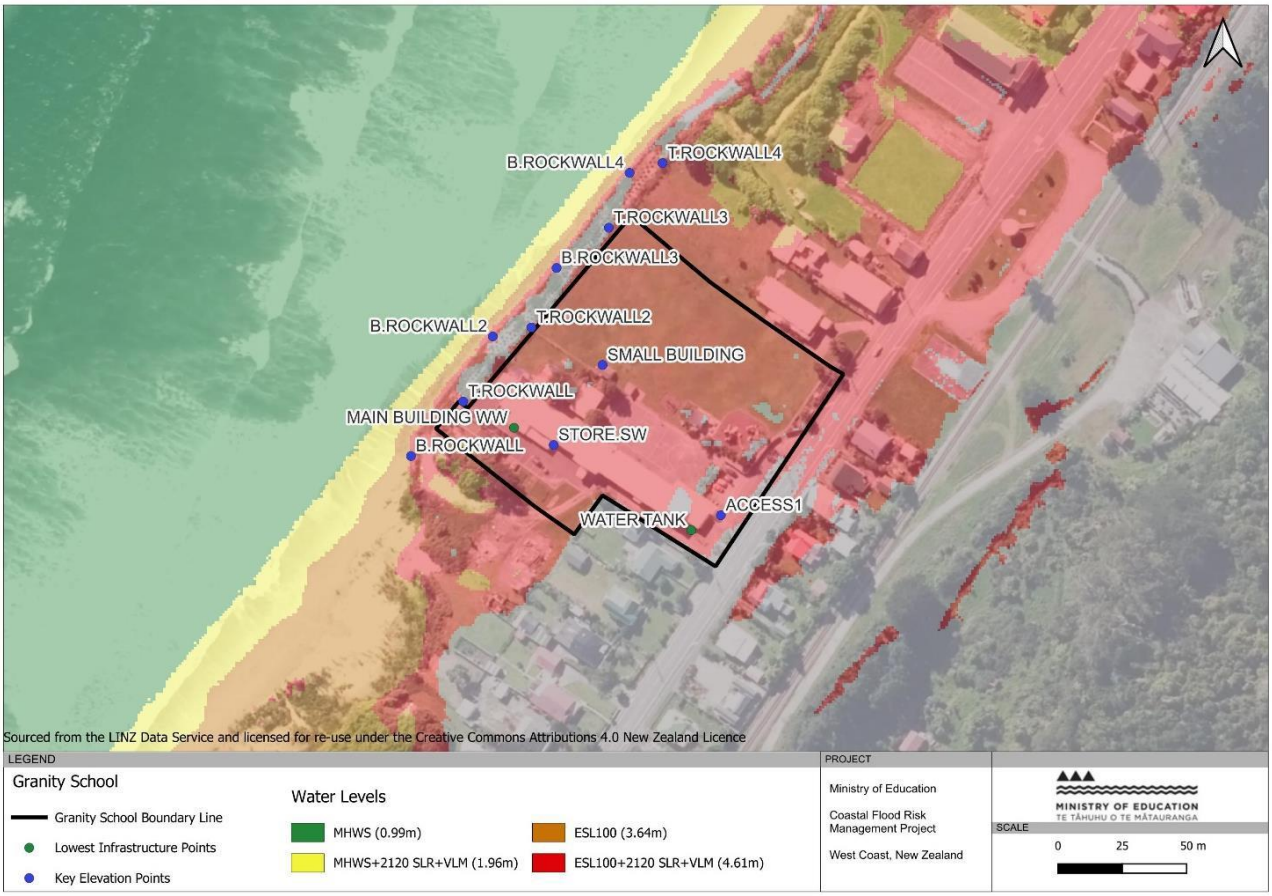

Figure 1 - Map of Granity School with the indicative inundation zones based on land elevation from LiDAR.

Latitude	-41.630018
Longitude	171.85248
Community Setting	School grounds at same elevation as the community, therefore likely to have similar flooding issues from the coast. The surrounding water bodies are the Tasman Sea / Te Tai-o-Rēhua, and Ngakawau River ~3.0 km to the north.
Community Emergency Hub	No – Granity School is not a Community Emergency Hub
General Subsidence/Tectonics information	The Granity area is subsiding at a current rate of -0.14 mm per year (Site 6105) (NZSeaRise Takiwa Programme, 2022).

Key Elevation Points

Note: Points are in NZVD 2016.

Access / Egress Points	Vehicle and Pedestrian Access (ACCESS1) – 4.48 m	
Lowest Finished Floor Levels	Block D Northwest (SMALL BUILDING) – 4.14 m	Block A Southwest (STORE.SW) – 4.30 m
Lowest Infrastructure levels	Wastewater Gully Trap Block A South (MAIN BUILDING WW) – 4.34 m	Potable Water Tank (WATER TANK) – 4.40 m
Coastal Defences	Top of Rock Wall South (T.ROCKWALL1) – 4.42 m	Top of Rock Wall (T.ROCKWALL2) – 4.61 m
	Top of Rock WALL (T.ROCKWALL3) – 4.48 m	Top of Rock Wall North (T.ROCKWALL4) – 4.85 m

Water Levels[1] (current and future)

Note: Points are in NZVD 2016.

MHWS	0.99 m	ESL100 + 2050 SLR *(+VLM)*[2]	3.89 m
MHWS + 2120 SLR (+VLM)[3]	1.96 m	ESL100 + 2070 SLR *(+VLM)*[4]	4.04 m
ESL100	3.64 m	ESL100 + 2120 SLR *(+VLM)*[5]	4.61 m

[1] These values are considered to be an underestimate as they do not account for all of the potential components that contribute to inundation events known to be impacting the Granity School site. In particular, the capability of wave run-up events to impact the school site. This is particularly prudent given the proximity of the school to a high energy West Coast beach system. Wave run-up potential is also likely compounded by the poor condition of the existing coastal protection structure and historical erosion issues.
[2] This reference level is the ESL100 (3.64 m) with the 2050 (+VLM) SLR scenario (0.25 m) added to it.
[3] This reference level is the MHWS (0.99 m) with the 2120 (+VLM) SLR scenario (0.97 m) added to it.
[4] This reference level is the ESL100 (3.64 m) with the 2070 (+VLM) SLR scenario (0.40 m) added to it.
[5] This reference level is the ESL100 (3.64 m) with the 2120 (+VLM) SLR scenario (0.97 m) added to it.

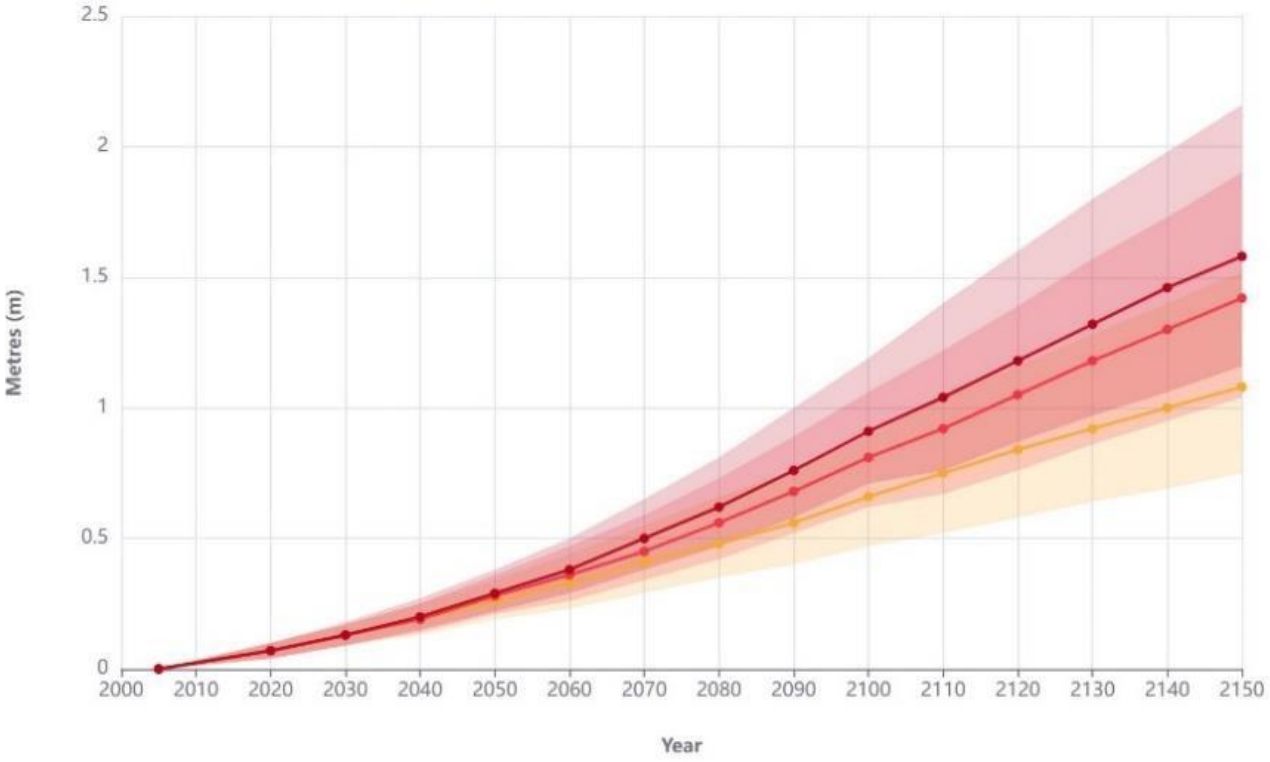

Figure 2 - Sea level rise (SLR) increments[6] with vertical land movement under potential climate change scenarios (SSP2-4.5+VLM in orange, SSP3-7.0+VLM in red and SSP5-8.5 in deep red) and likely confidence intervals (faded colour blocks) ((NZSeaRise Takiwa Programme, 2022). MfE (2022) recommends that 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 Granity School are listed in Appendix C of this document and are summarised below.

The West Coast Regional Council (WCRC) have commissioned multiple reports to understand the level of exposure and the level of risk of the area to coastal hazards into the future. Through the Long-Term Plan, WCRC will work with communities to manage coastal hazards. As the potential cost implications from possible solutions are a significant issue for many communities, solutions are typically short term in nature and have considerable cost and risk implications. 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. However, there is no specific evidence (as of yet) in these plans if they may include works to west coast coastline adjacent to Granity School.

It is recommended that Granity 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.

[6] 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.

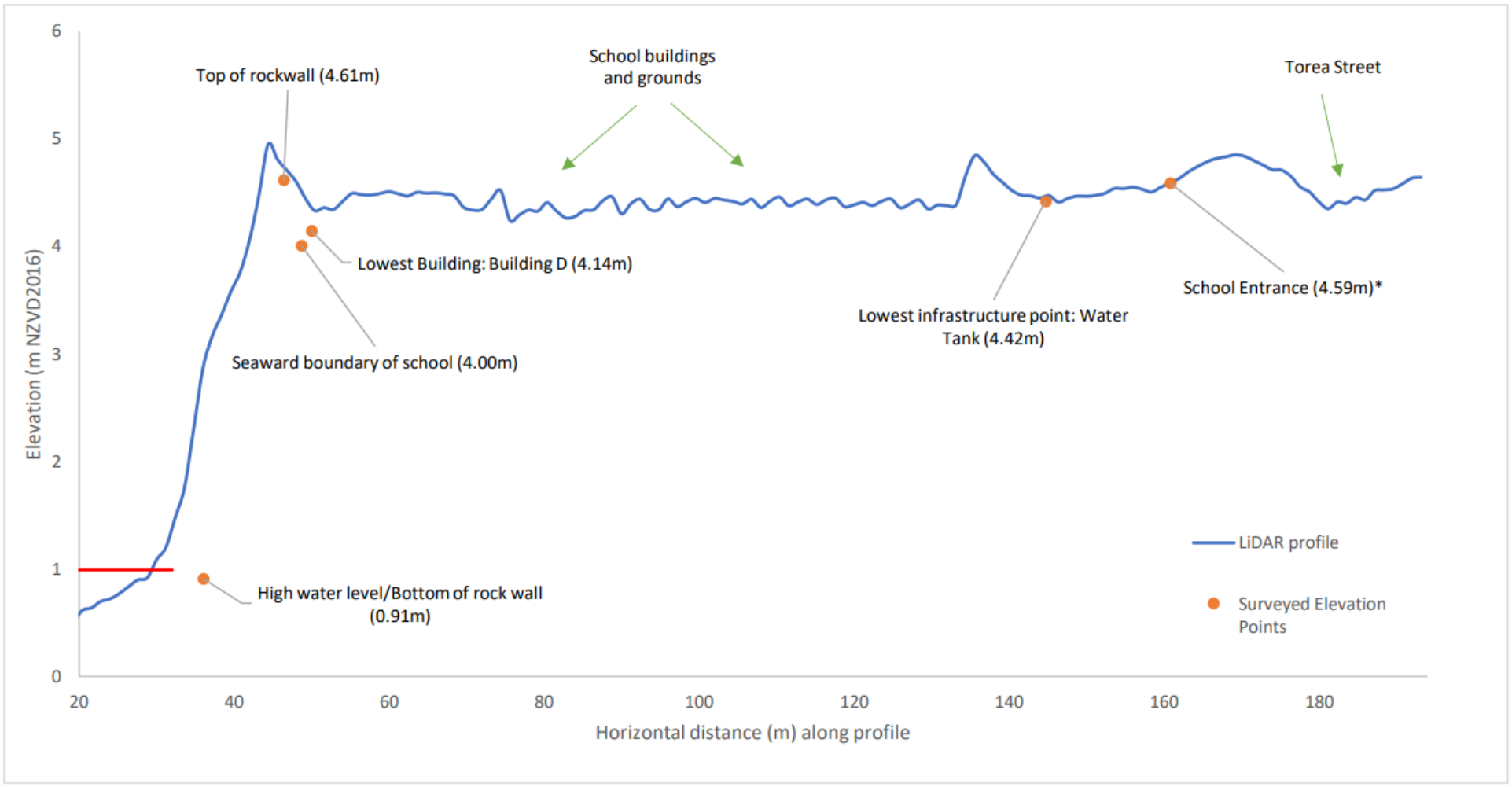

Figure 3 –Indicative profile extracted from LiDAR (1m DEM) and surveyed elevation points on site

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Risk of Coastal Inundation (Past/Current/Future)

See Appendix B for further information.

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

Other Hazards

School anecdotal evidence

Anecdotal coastal overtopping of the rock wall occurs about once every three years, based on on-site discussions with the principal who has been there for approximately 18 months (prior to September 2022). Sea spray is often seen coming over the rock wall whenever there are large storm surges.

Within the principal's time at the school, the school experienced coastal overtopping/inundation on June 13th 2022, where waves were recorded overtopping the rock wall onto the school field. Based on hindcast data an approximate 3.0 m high tide coincided with a 7.7 m westerly swell over this event. The overtopping experienced during this event is likely to be due to the associated wave run-up on top of the storm surge, however calculations of wave-run up have not been undertaken. During this event the school's flax and fence at the top of the rock wall was damaged and rocks from the rock wall were thrown onto the school grounds. On site observation also revealed the displacement of the rocks. Major erosion of the top of the rock wall also occurred during this event. The school was not closed during this event as it did not cause flooding to the inside of the school buildings.

The school swimming pool was previously located at the south-western corner of the school grounds along the coastline; however, this has been removed due to significant damage from rocks and coastal overtopping.

Infrastructure

There is no existing infrastructure (State Highways, railways) located between the school and the coast. The school site is located directly adjacent to the shoreline.

Other types of flooding

Pluvial flooding has occurred on the school courtyard during heavy rainfall; however, this has not affected school buildings.

A neighbouring property has experienced flooding from full capacity stormwater drains, but this has not affected the school.

Ngakawau River approximately 3 km north of the school grounds, can flood properties around it and may impact access to the school on a regional level, however, does not flood the school site.

Erosion

Significant evidence of erosion of the coastline during on-site surveys.

Erosion was observed on site along the top of the rock wall, where rocks had been displaced and the lower membrane of the rock wall was exposed in multiple places. Evidence of 'end-effect' erosion south of where the rock wall ends, where the shoreline is located approximately

50 m further inland than the shoreline at the rock wall.

More detailed investigation 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 Granity 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 Granity School should be considered to help address the threat from current coastal overtopping and erosion of the coastal protection structure. In the future, the long-term pathway for Granity School should consider the staged 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 pathway is supposed to be adaptive and is therefore subject to monitoring. This includes the local school site and community, as well as the Ministry of Education reviewing how the preferred pathway is responding to rising sea levels. 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 Granity School considers the coastal inundation (flooding) risk and does not consider/include the impact of pluvial and fluvial inundation, and the demographic changes associated with the school roll and unforeseen events.

Preferred Adaptive Pathway – Short Term (Present-2050)

Pathway Approach	Managed Retreat	
Preferred Pathway	Small-scale building relocation within the current land parcel will enable the current site to be used in the short-term. This includes partial relocation of the most seaward building.	
Trigger Points	Small-scale building relocation has been triggered and plans to begin work should be considered.	

Preferred Adaptive Pathway – Medium Term (2050-2070)

Pathway Approach	Managed Retreat	
Preferred Pathway	Building relocation within the current land parcel may enable the current site to be used in the medium-term. Monitoring of the effect on the parts of land closest to the sea should be maintained.	
Trigger Points	Building relocation within the current land parcel could be triggered when the seaward parts of the land package, as well as the rock wall, show further signs of erosion.	

Preferred Adaptive Pathway – Long Term (2070-2120)

Pathway Approach	Managed Retreat	
Preferred Pathway	Consider the managed retreat school buildings to a new land parcel away from all coastal flood hazards.	
Trigger Points	Managed retreat could be triggered when coastal overtopping or flooding occurs as the rock wall and bund is no longer effective at keeping coastal waters off the school site at all. An indicative timeframe for this trigger point is from 2060 and may depend on the erosion of the rock wall and beachfront.	

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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 and continue current emergency management and environmental monitoring activities to existing level of service.
	L 	Consider improvements to the rock wall . The Granity school site juts out, against the natural shape of the coast and a new consent may be required. Improvements may be difficult or cost prohibitive.
Medium Term	L 	Consider improvements to the rock wall. -The Granity school site juts out, against the natural shape of the coast and a new consent may be required. Improvements may be difficult or cost prohibitive.
Long Term	O 	Consider the managed retreat of the school to a new land parcel away from all flood and coastal hazards.

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

Current Vulnerability to MHWS:

Granity School has a medium-high vulnerability to coastal inundation under current MHWS (0.99 m). No buildings or infrastructure surveyed are at an elevation above the referenced level for MHWS, however it has been classified as medium to high vulnerability based upon site-observations and the given uncertainty with the referenced additional water level components.

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

Granity School has a medium-high vulnerability to coastal inundation under MHWS with the SSP3-7.0+VLM 2120 SLR scenario (1.96 m). No buildings or infrastructure surveyed are at an elevation above the referenced level for this predicted event, however it has been classified as medium to high vulnerability based upon site-observations and the given uncertainty with the referenced additional water level components.

Current Vulnerability to ESL100:

Granity School has a medium-high vulnerability to coastal inundation under the current day ESL100 scenario (3.64 m). No buildings or infrastructure surveyed are at an elevation above the referenced level for this predicted event, however it has been classified as medium to high vulnerability based upon site-observations and the given uncertainty with the referenced additional water level components.

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

Granity School has a medium-high vulnerability to coastal inundation under ESL100 with the SSP3-7.0+VLM 2050 SLR scenario (3.89 m). No buildings or infrastructure surveyed are at an elevation above the referenced level for this predicted event, however it has been classified as medium to high vulnerability based upon site-observations and the given uncertainty with the referenced additional water level components.

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

Granity School has a medium-high vulnerability to coastal inundation under ESL100 with the SSP3-7.0+VLM 2070 SLR scenario (4.04 m). No buildings or infrastructure surveyed are at an elevation above the referenced level for this predicted event, however it has been classified as medium to high vulnerability based upon site-observations and the given uncertainty with the referenced additional water level components.

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

Granity School has a high vulnerability to coastal inundation under ESL100 with the SSP3-7.0+VLM 2120 SLR scenario (4.61 m). The vulnerable buildings and infrastructure surveyed below the referenced level for this predicted event:

- All infrastructure surveyed (except for Block A heat pump)
- All FFL's of buildings surveyed (except for Block A northwest and Block A north)

The ESL100 with the SSP3-7.0+VLM 2120 SLR scenario (4.61 m) greater than the elevation of the top of the southern sections of the rock wall, therefore the potential for coastal inundation from overtopping is high.

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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) are building their knowledge about the effects of climate change and sea level rise on the coast at Granity. They have had multiple reports prepared for them to help understand the coastal hazards in Granity under current and future climates.

- Allis, M. (2016a). Adapting to coastal change at Granity, Ngakawau and Hector. NIWA Client Report HAM2016-012, prepared for West Coast Regional Council.
- Allis, M.J. (2016b). Letter note to WCRC (Paulette Birchfield) on advice in Adapting to coastal change at Granity, Ngakawau and Hector (NIWA, 2016) for community meeting 22-Nov 2016. 4p.
- Ramsay, D. (2006) Managing and Adapting to Coastal Erosion on the West Coast: Granity. Prepared for West Coast Regional Council, NIWA Client Report HAM2006-153. This report outlines a number of potential measures as a basis for future discussion between the regional council and the residents of Granity, which could assist in reducing the impact, and/or slowing down the rate of coastal retreat of the gravel barrier along the coastal frontage of Granity.

The 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 Granity is a high-risk CHA. Within the Granity CHA, it states that residential properties and the school in Granity are affected by coastal inundation and erosion. This report also highlights that Granity is a CHA where the state highway 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. However, no works are stated regarding coastal protection at Granity.
- 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.

Buller District Council

BDC provided a preliminary Risk Analysis for Granity Landslides in 2022 that indicated areas that landslide risk exists from the sea bluffs.

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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.