Lang Lang Foreshore Caravan Park Coastal Adaptation Pathway

V5, 13 Nov 2024

Introduction

BMT has assessed the seawalls at the Lang Lang Foreshore Caravan Park for DEECA, which concluded many of the seawalls are in poor condition with a high risk of failure. Before the repair designs are commenced, an adaptation study is required to consider if, and for how long, these walls will be needed.

This Coastal Adaptation Pathway Study considers how the site and its use as a caravan park will be impacted by rising sea levels and what actions are available to mitigate the impacts of sea level rise, in accordance with the *Victoria's Resilient Coast 2100*+ (VRC) guidelines. The outcome is an adaptation pathways which provides a 'road map' for how the site, and its various uses, may be adapted to climate change over the next 80 years.

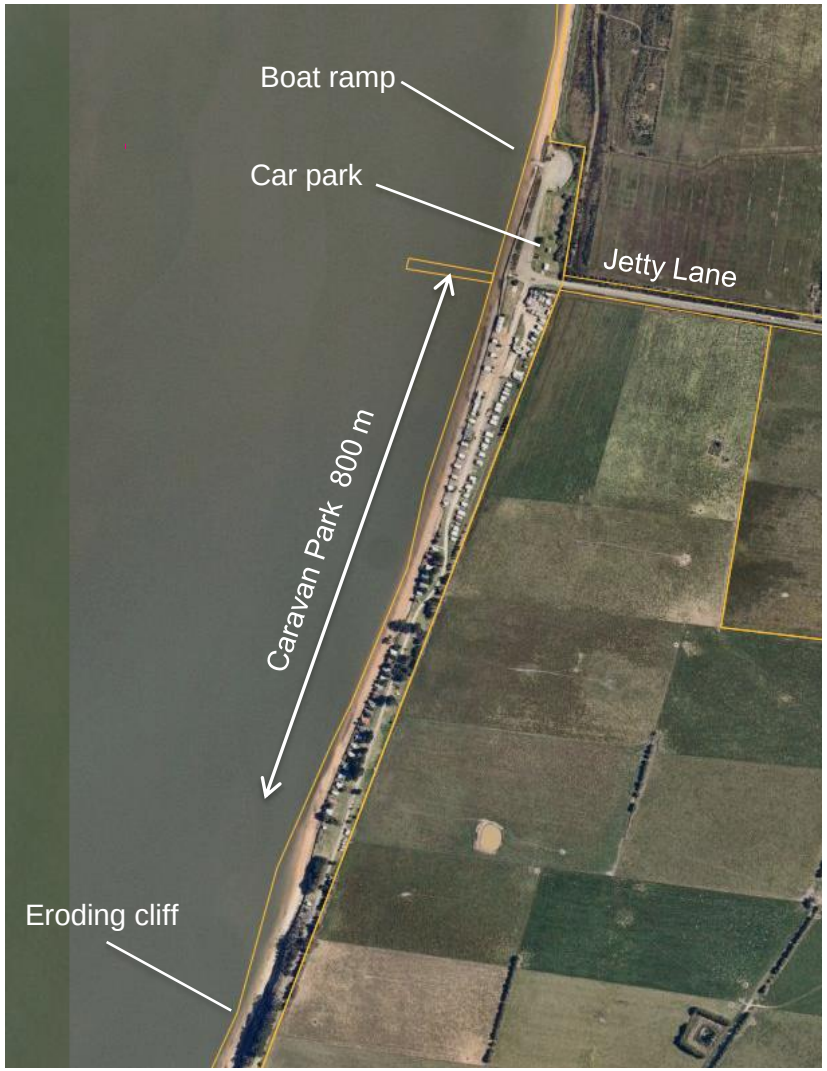
The 7 stages of the adaptation planning process from the Victoria's Resilient Coast 2100 *guidelines*

The Site

Lang Lang Foreshore Caravan Park is located on coastal reserve on the eastern side of Westernport (at the end of Jetty Lane) and stretches along 800m of coastline.

There are a mix of private boatsheds, permanent caravans, caravan sites and a few cabins for rent. Most of the coastline is protected by seawalls in poor condition and inspections have identified these as high risk.

The gate, office and majority of facilities are located at the northern end of the site which is low-lying and subject to frequent coastal inundation. The land elevation rises towards the south.



Community Values

Community Values were identified through literature review, site surveys and onsite discussions with Committee of Management (CoM), caravan park managers, and local DEECA officers. Key values were identified:

- **Beach amenity** – walking, fishing, swimming and passive recreation
- **Caravan park** - camping and picnic spots within proximity to water
- **Public boat ramp** for trailable boats, beach launching for small craft – jet skis / kayaks
- **Community uses** – football club training, swimming, Good Friday Appeal fun run, gatherings, exercise, personal trainers, school camps, horse riding on beach, CFA training
- **Privately owned structures –** Boat sheds, cabins, vans and annexes on Crown land along both sides of the road
- **Heritage area** – site of previous swimming pool and pier
- Western Port **RAMSAR** site

Coastal Hazards Assessment

‘Coastal Hazards’ occur when coastal processes (eg: waves, tides, sediment transport, erosion) impact on the assets, values or uses of the coast, e.g. high tide floods the caravan park damaging buildings and forcing evacuation of campers.

The VRC guidelines defines 8 different coastal hazards. The importance of each for the Lang Lang site has been reviewed by BMT based on site inspection, previous studies and review air photos and topography data.

Category (VRC Guidelines)	Coastal process / hazard	Importance at Lang Lang
Erosion	**Short-term erosion** – event-based erosion of sediment and recovery	Low
	Long-term erosion (recession) – progressive retreat of shoreline position over time	High – already occurring in areas with no seawall and will increase with sea level rise
Accretion	Short- or long-term build-up of sediment in a localized area	Low
Inundation	**Storm tide inundation** – temporary event-based inundation (including tide, storm surge and wave runup)	High – already occurring due to wave overtopping of the seawall, and will increase with sea level rise
	Permanent inundation – regular or persistent inundation by the regular tidal cycle	High – low lying areas will be inundated by sea level rise in future
Estuary dynamics	Changes in form and processes associated with estuarine and tidal areas	Low
Off-shore sediment dynamics	Changes in form and processes associated with offshore bathymetry and sediment transport	Low
Saline intrusion	Movement of saltwater into freshwater aquifers/groundwater	Medium – important due to septic on site

Coastal Inundation Hazard

The current frequency of coastal inundation (flooding) was described by the caravan park managers. This can be categorised into 3 different scales:

- **‘Nuisance’ flooding** from waves overtopping the seawall at some water-front sites occurs monthly. Minor or no disruption. Flood extents not mapped as this level of flooding does not drive adaptation.
- ‘**Minor’ flooding** occurs when a large volume of water overtops the seawall and pools in low-lying areas flooding the rotunda and closing the road. Occurs approx. 6 times/year.
- ‘**Major’ flooding** – deeper flooding over floor of toilet blocks, rotunda, BBQs and laundry. Flooding extends into the paddock landward of the caravan park. Occurs approx. once every 10 years.

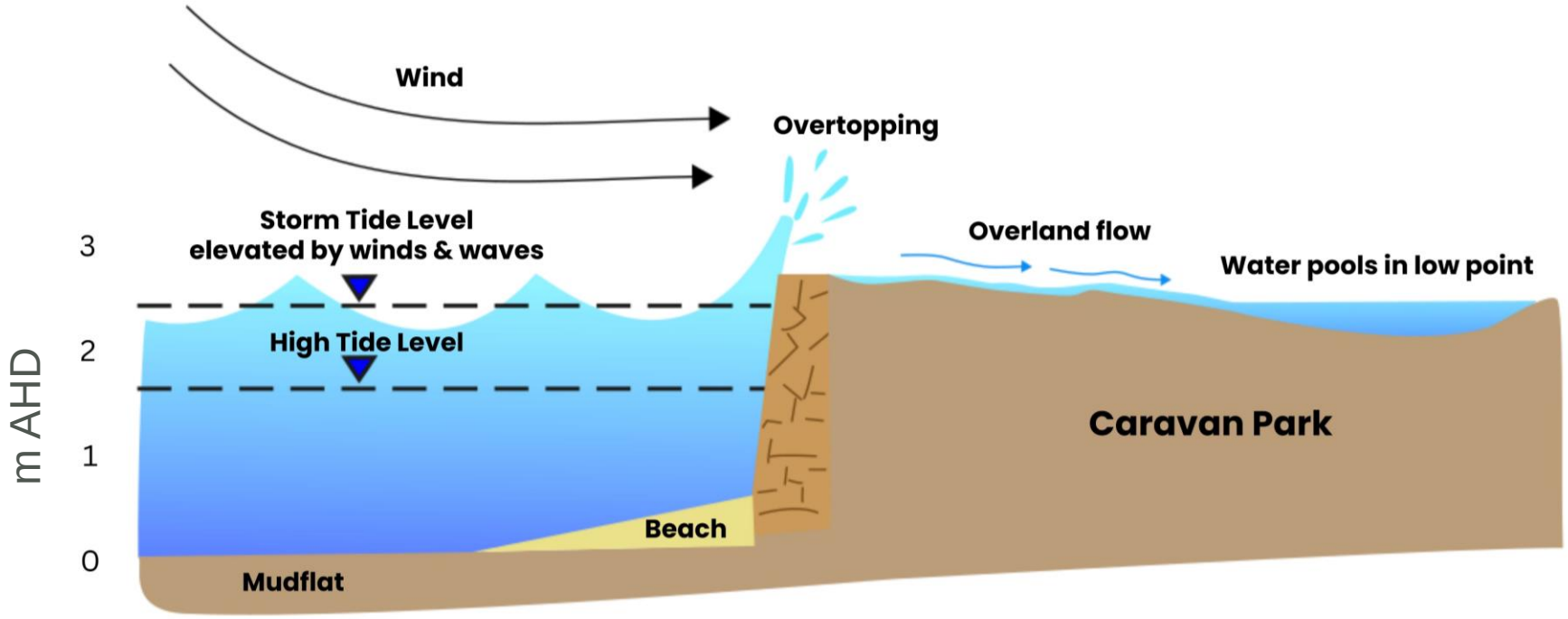
Nuisance Flooding

Minor Flooding

Major Flooding – July 2023

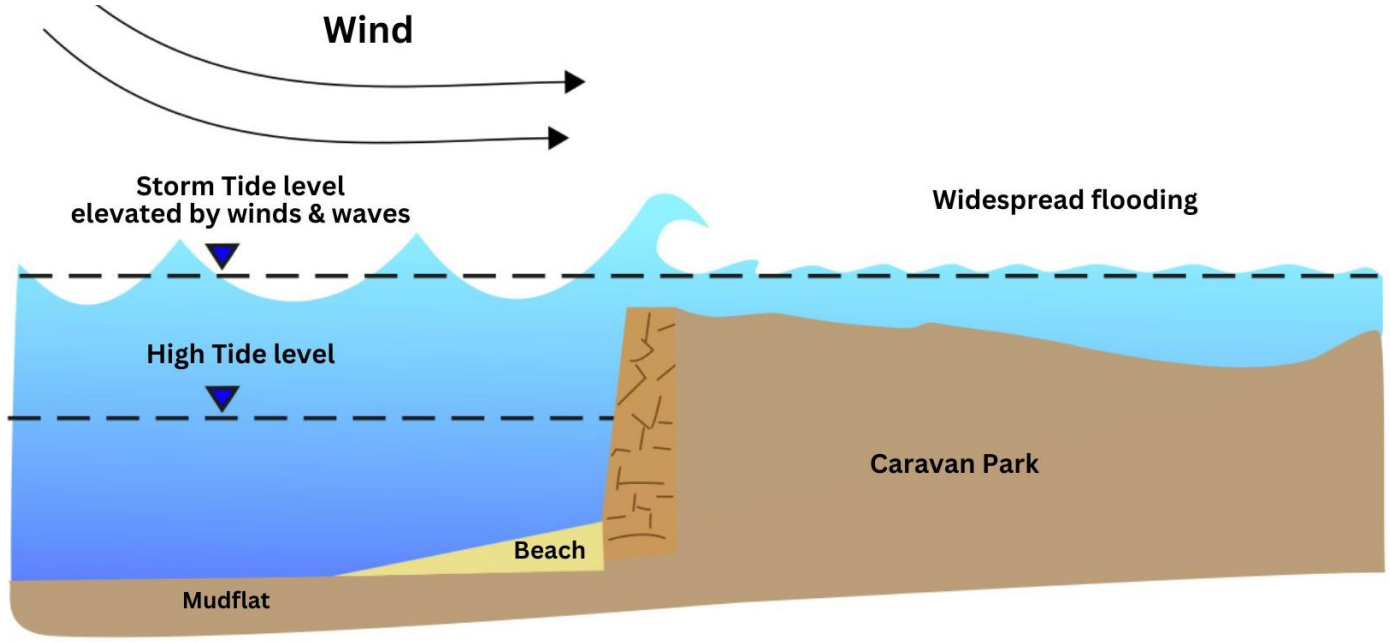
Source

Primary Flooding Mechanism – Waves Overtopping Seawall



A combination of high tide, westerly wind and possibly surge from Bass Strait elevates the water level at Lang Lang. If the wind is strong enough, large waves form and break over the seawall in a process known as ‘overtopping’. This water then flows down hill to pool in low areas (mainly along the road). The high coastal water level also means drains are ineffective and the water cannot escape until the tide goes down.

Secondary Flooding Mechanism – Storm Tide Over Wall



If the storm tide level (a combination of high tide, westerly wind setup and possibly surge from Bass Strait) rises above the wall it would result in a much higher volume of water entering the caravan park, relative to wave overtopping alone, and cause wide-spread flooding.

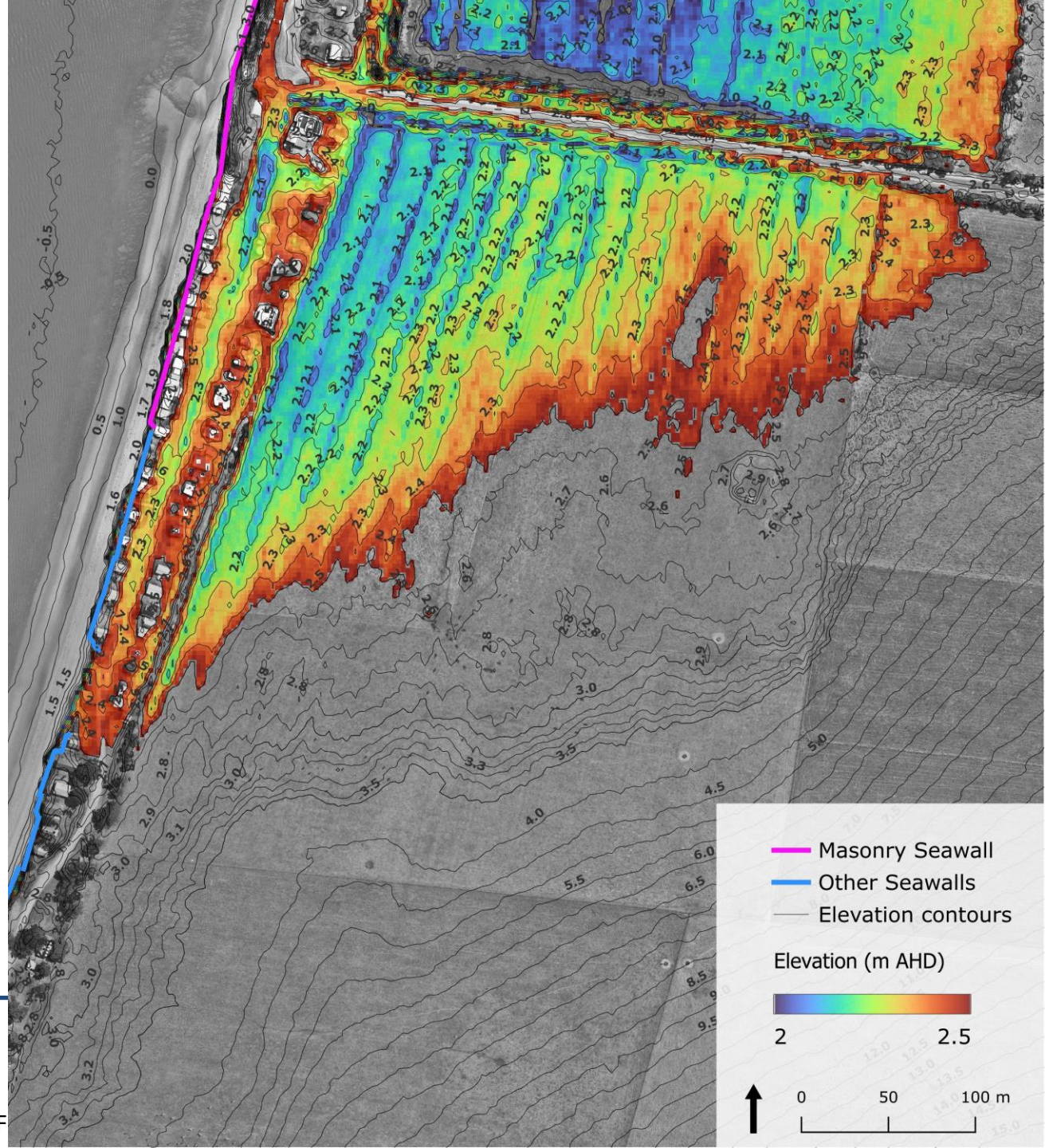
Rainfall in the local catchment (the hillside behind the caravan park) may also contribute to flooding - this was believed to be a factor in the July 2023 event.

Site Topography

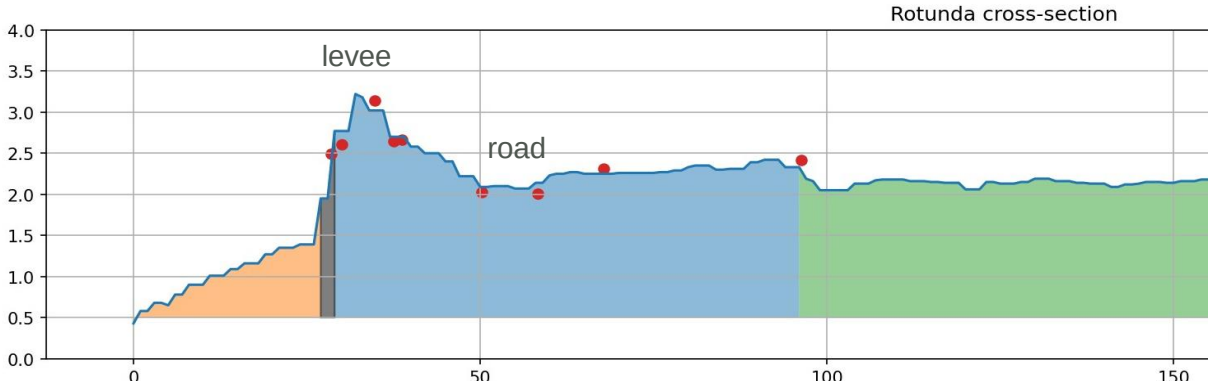
A major factor controlling the extent and depth of inundation is the topography (land levels) of the site, and this has been used to map the extents of the flood hazard.

This figure illustrates the topography of the area, focusing on low-lying areas in the northern part of the site.

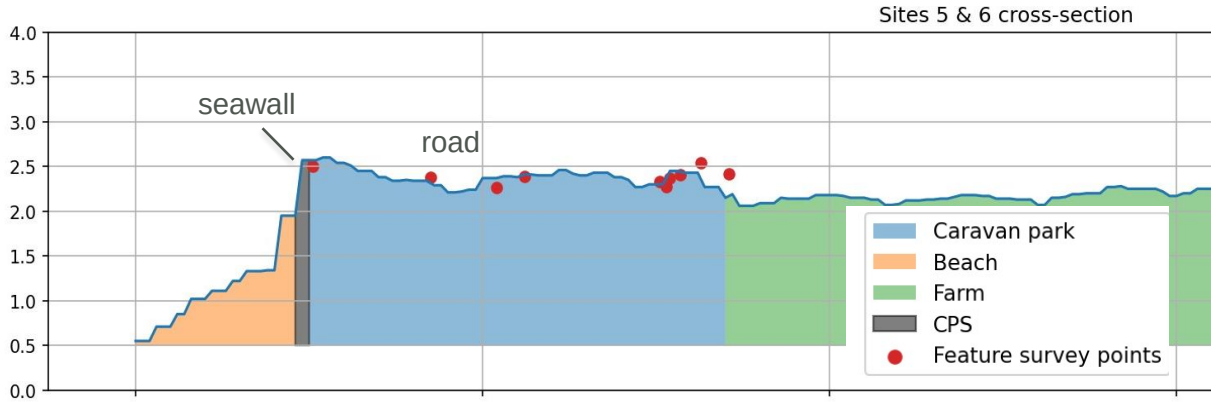
- Contours show the elevation above Australian Height Datum (AHD) (which is approx. mean sea level).
- The coloured areas are below the crest level of the masonry seawall (2.5m AHD)
- Lowest elevations are shown in blue, these are the areas most susceptible to flooding and pooling of water. Areas include the road just inside the park gate.



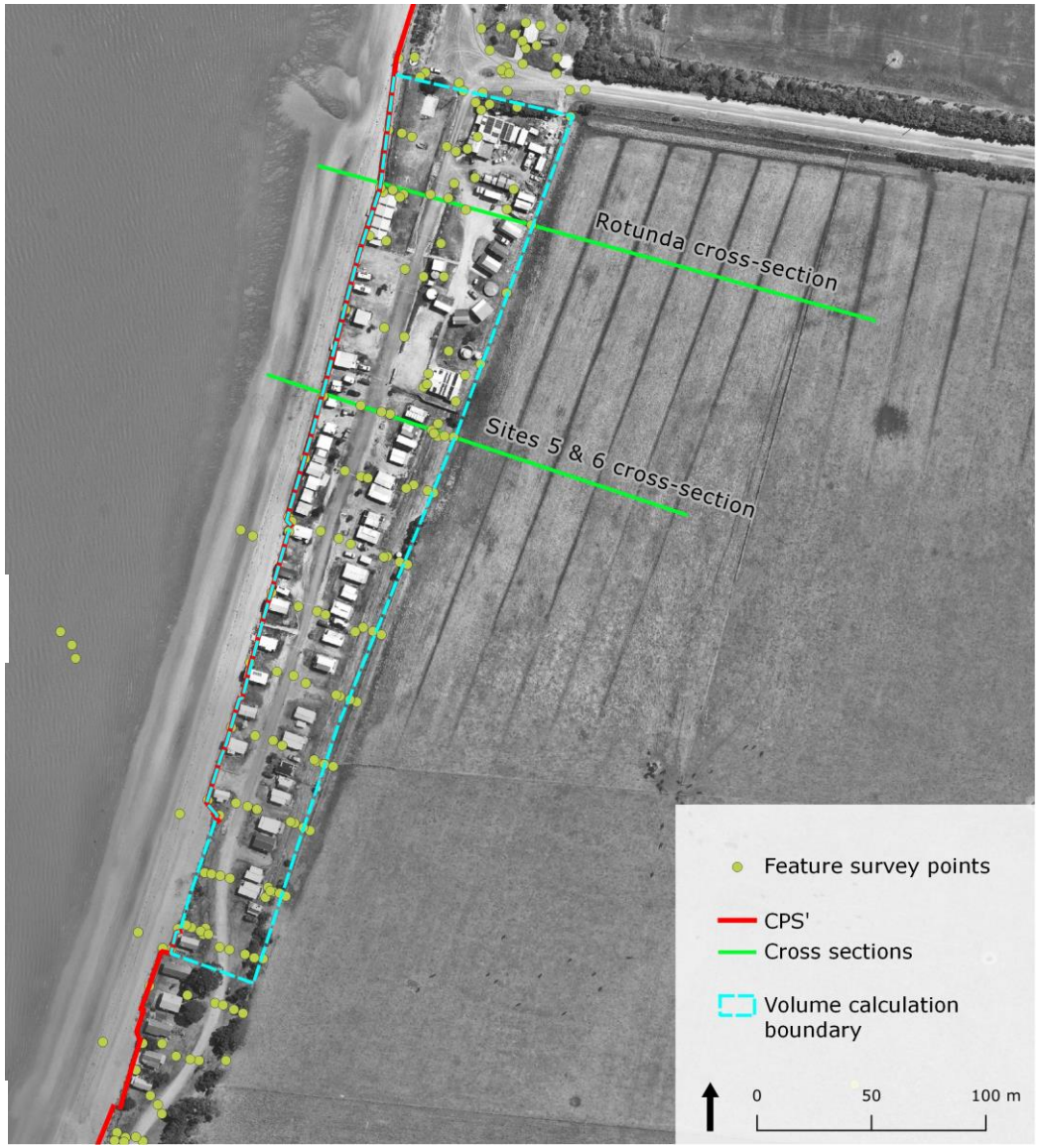
Topographic Cross Sections



Cross section north of the rotunda where there is a coastal levee which limits overtopping. Note the low level of the road, which where water pools first.



Cross section at sites 5 & 6. This is the lowest point on the seawall and the location where overtopping first occurs. Note the caravan park is lower than the wall (CPS) and the farmland is lower still.



Minor Flooding Hazard Extent

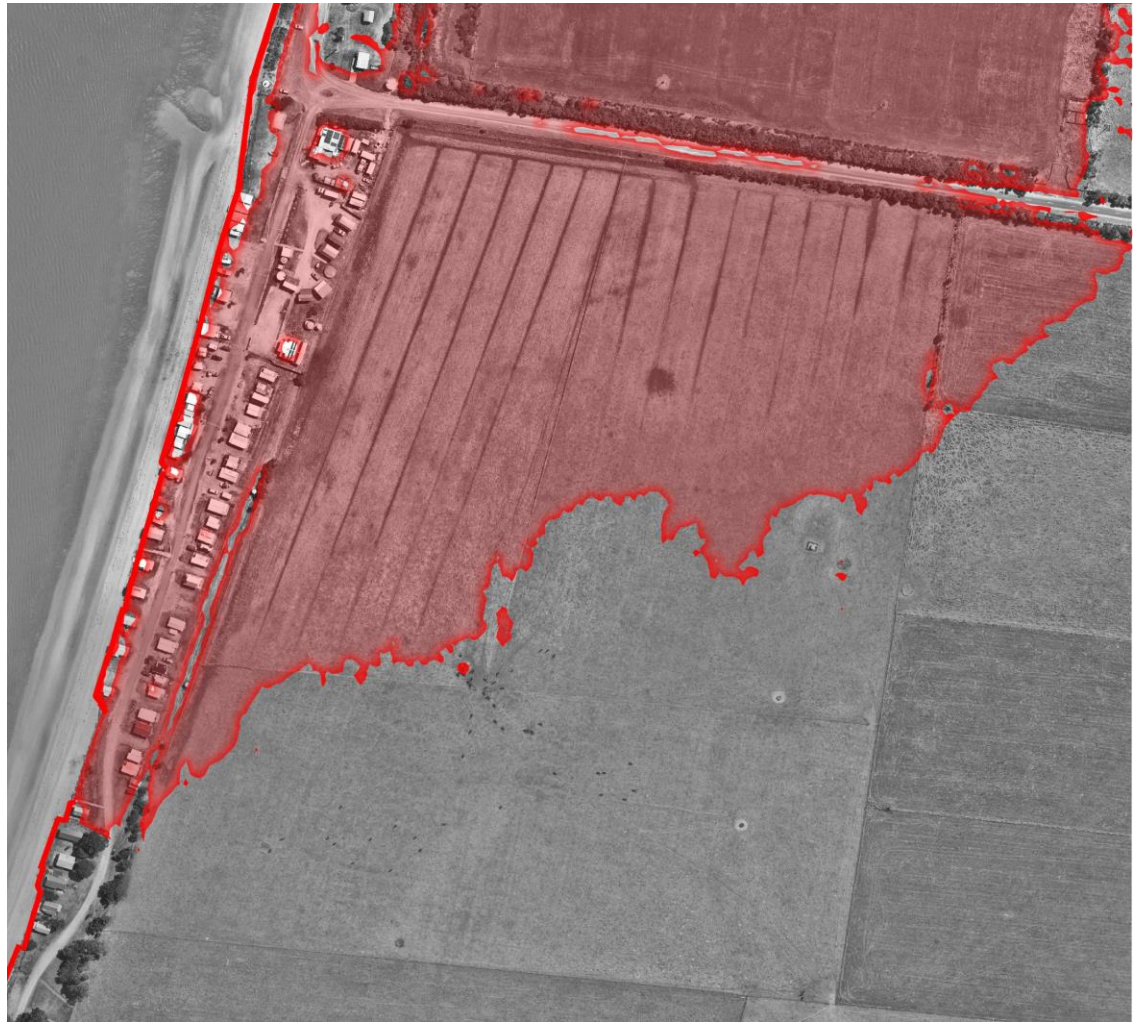
Minor flooding occurs when wave overtopping fills low areas of the site and rises until the water spills over into the paddock (approximately 2.4m AHD)

- The minor flooding extent is mapped as the area of the caravan park below 2.4m AHD
- Currently occurs around 6 times per year, with varying depth and extent, up to approx. 0.3m on the road.

Major Flooding Hazard Extent

Major Flooding occurs with higher overtopping in extreme storms, combined with catchment rainfall, and or due to storm tide over the wall. Flooding is much more widespread.

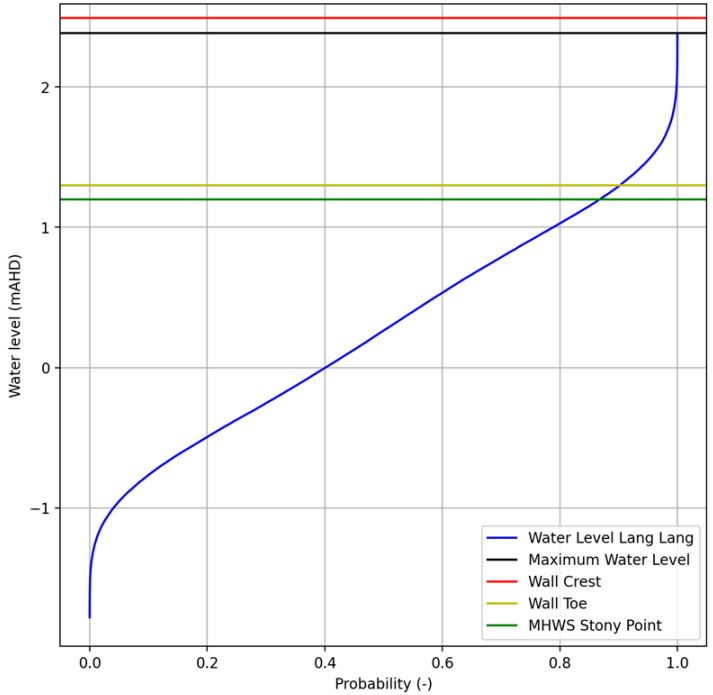
- The major flooding extent is mapped at an elevation of 2.6m AHD. Higher levels will be possible in future with projected sea level rise
- Currently occurs ~ Once every 10 yrs. Depth up to 0.5m on the road



Water Level and Overtopping Modelling

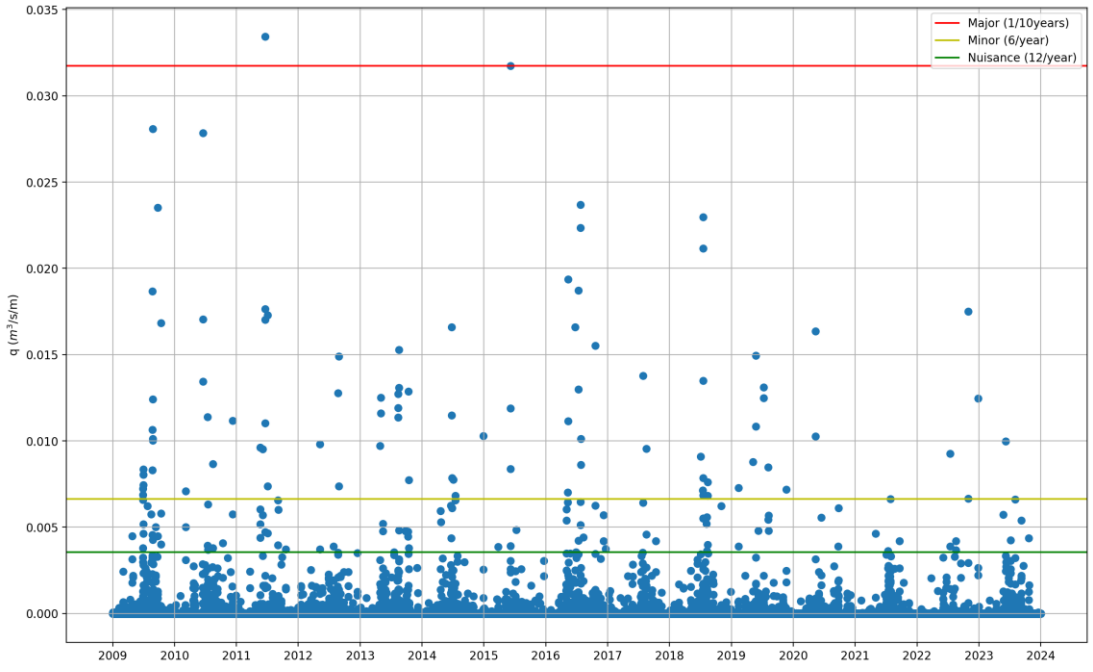
15 years (2009 – 2024) of hourly water levels and wave heights at Lang Lang were modelled to understand the frequency of overtopping and how it will change with sea level rise. The modelling indicates that, for current conditions:

- The storm tide level (i.e. water level without waves) did not go over the top of the wall – indicating that storm tide flooding is currently rare.
- Overtopping occurs very frequently.



Plot at left shows the modelled water level occurrence curve (blue), without waves, for the 15 years simulated. The highest water level is only a few cm below the crest of the wall (red line)

Plot at right shows a time series of predicted wave overtopping volume (using the method of Pullen et. al. (2007) from the EuroTop manual). Lines define thresholds for nuisance, minor and major flooding, based on frequency of occurrence. Very small amounts of overtopping occur frequently, these are just splashes and do not cause flooding

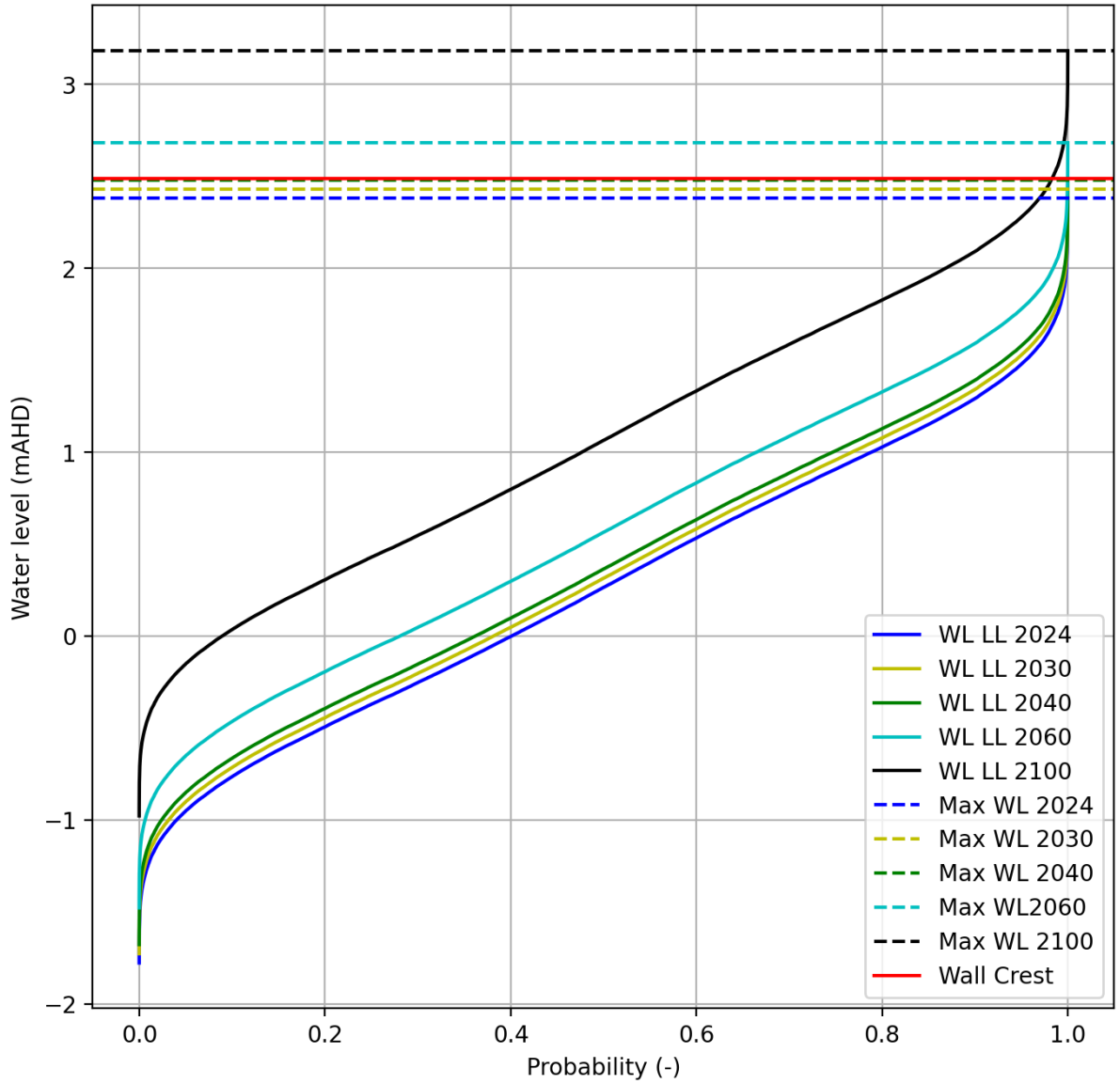


Impact of Sea Level Rise

Increments of sea level rise were added to the water level occurrence curve

- After 2040, the 10% AEP storm tide is predicted to be over the top of the seawall crest (shown in red), resulting in major flooding.
- The frequency of this major flooding will increase with further sea level rise

Wave overtopping was also calculated with increments of sea level rise, resulting in much more frequent overtopping – see results on next slide



Predicted Frequency of Inundation with Sea Level Rise

Year	2024	2030	2040	2060	2100
SLR (m increase from 2024)	0	0.05	0.1	0.3	0.8
Frequency of **Nuisance flooding** from overtopping	12 per yr	16 per yr	21 per yr	49 per yr	185 per yr
Frequency of **Minor flooding** from overtopping	6 per yr	8 per yr	11 per yr	28 per yr	128 per yr
Frequency of **Major flooding** from overtopping	1 per 10 yrs	1 per 4 yrs	1 per 2 yrs	4 per yr	23 per yr
Annual Exceedance Probability (AEP) of **Major flooding** from storm tide over wall *(This calculation excludes impact of overtopping waves and local rainfall; therefore, it is an underestimate of flooding probability)*	0% AEP	0.3% AEP	2.1% AEP	60% AEP (approx. 1 per year)	99% AEP (approx. 5 per year)
Observed AEP of **Major Flooding** *(from consultation with Park Managers)*	~10% AEP				

Coastal Erosion Hazard

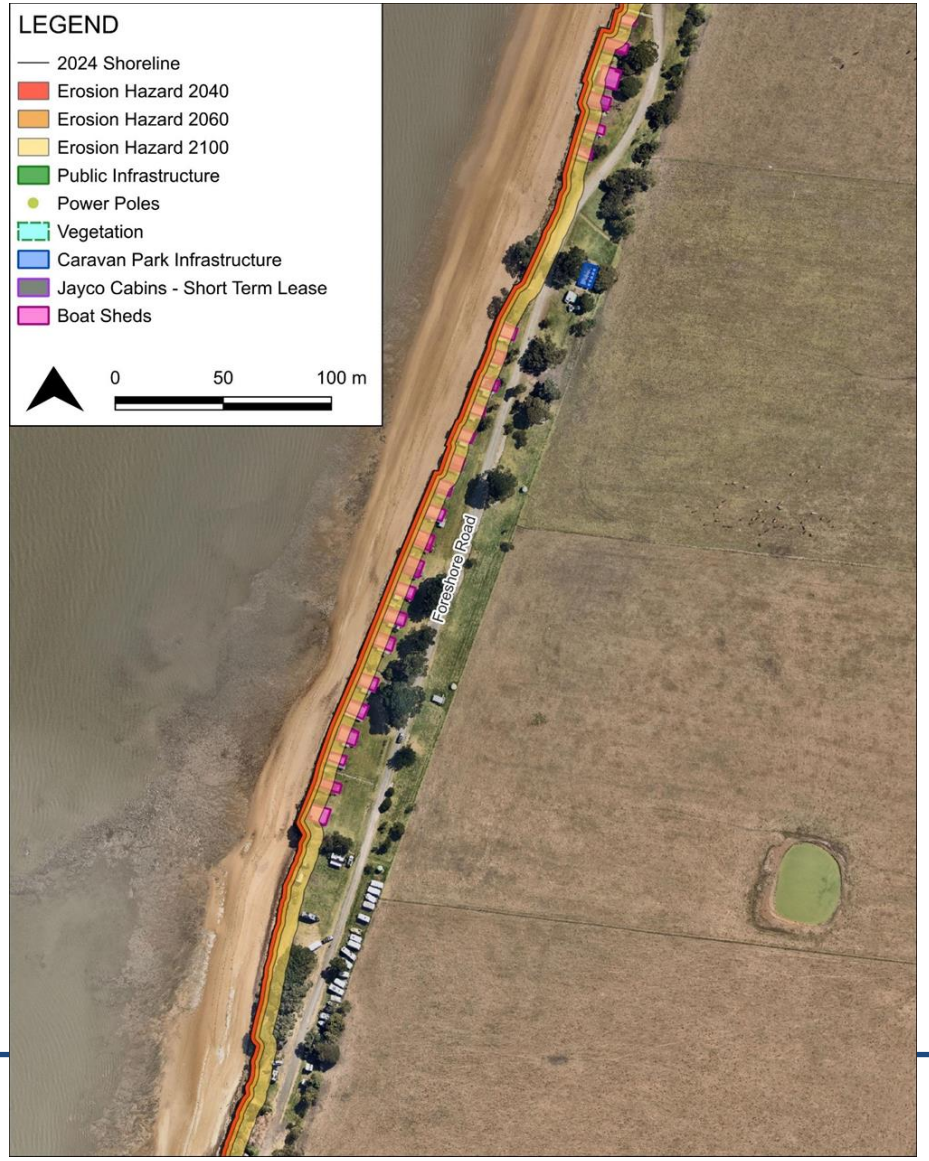
Coastal erosion is occurring in areas not protected by seawalls. The shoreline consists of peaty/clay soil which formed in the freshwater swamps that lined the northern and eastern side of Western Port before they were drained for farming. These soils are vulnerable to erosion from seawater.

Analysis of air photos between 2010 and 2024 indicates:

- erosion is long-term and not cyclical
- unprotected banks are eroding at ~ 0.12 m/year
- Based on current rates, erosion of ~2m by 2040 and ~ 4.0m by 2060 is projected.
- Rates may be higher with sea level rise.

Sinkholes were observed behind many of the seawalls, indicating erosion is occurring even where walls are present.

Coastal Erosion Hazard



Adaptation Actions and Adaptation Options

In considering adaptation actions, land managers in Victoria are guided by the directions in the Marine and Coastal Policy (2020), including an order of consideration for strategic actions and using a pathways approach to defining short- and longer-term actions:

VMACP Strategic Actions	Description
1. Non-intervention	Allow marine and coastal processes and the hazards they may pose
2. Avoid	Locate new uses, development and redevelopment away from areas that are or will be impacted by coastal hazards.
3. Nature-based methods	Nature-based methods use the creation or restoration of coastal habitats for hazard risk reduction.
4. Accommodate	Structures can be designed to reduce the exposure to or decrease the impact of coastal hazard risk.
5. Retreat	Existing structures, assets or uses may be decommissioned or relocated away from areas that are or will be negatively impacted by coastal hazards.
6. Protect (major engineering works)	Existing physical barriers are enhanced, or new ones constructed to mitigate the impact of coastal hazards. Protect is an option of last resort; it is often expensive, its benefits tend to be very localised, and it frequently transfers the problem to nearby areas.

Adaptation Actions are individual measures that could be implemented to help manage coastal hazard risk, including planning controls, land use changes and engineering interventions. They are not mutually exclusive, and often a suite of actions is required to effectively manage coastal hazard risk over time, enabled through an adaptation pathways approach.

Adaptation Options are a suit of coordinated actions (one or several actions) that are implemented together to effectively manage coastal hazard risk at the site. Most options will only be effective for a finite period in the face of rising sea levels.

Adaptation Pathways are plans or 'roadmaps' which define how the options may be implemented over time, with decision points and trigger values for each of the options. Generally, the pathway starts with minor, low-intervention options then builds to the more major high-intervention options like retreat.

Adaptation Actions

First-pass review of potentially feasible adaptation actions for Lang Lang, based on VMACP and the VRC guidelines:

VMACP Classification	Possible Action	Shortlisted (Y / N)
Non-intervention	• Progressive closure with minimal intervention consistent with public safety	Y
Avoid	• Avoidance is not an option for development/infrastructure already present in the hazard zones.	N
	• Avoid further development in hazard exposed areas.	Y
Nature-based	• Supported littoral vegetation (hybrid option – offshore breakwater)	Y
Accommodate	• Raise road	Y
	• Raise floor levels	Y
	• Modify drainage network	Y
	• Put all structures on piles and allow erosion and flooding to occur. Access to buildings will be lost, campsites will be unusable.	N
Retreat	• Reconfigure site to allow progressive retreat	Y
Protect	• Upgrade seawall and/or revetment	Y
	• Levees / Dyke around site to prevent inundation – expensive to construct and maintain, will detract from site character (views and beach access) and will eventually be overwhelmed.	N

Avoid further development in hazard exposed area

- Land Use Planning and consideration of planning updates to avoid current and future risk at the site.
- Including no future development in hazard exposed areas i.e. no future boat shed leases
- Current boat sheds do not comply with planning rules. Upgrades will not be approved

VMACP Classification	Approval / Timeframe	Environmental Impact	Social Impact / Cultural	Cost
Avoid	~	✓	×	✓

Supported Littoral Vegetation

This hybrid action involves an offshore rock breakwater and mangrove planting to reduce wave height and overtopping

- Hybrid option – both protect and nature-based in VCMP hierarchy.
- Effectively reduces overtopping, but not storm tide inundation. Therefore, only effective to about 2040.
- To protect 1km of shoreline could be $10 to 20m – this cost is probably not viable.
- **Loss of beach amenity/community value** due to planting mangrove forest – significant change to coastal character

DAUPHIN ISLAND SHORELINE RESTORATION *MOBILE COUNTY, ALABAMA, USA*

Mangroves in Western Port

VMACP Classification	Approval / Timeframe	Environmental Impact	Social Impact / Cultural	Cost
Hybrid Nature-based/ Protect	✗	✓	✗	✗

✓ = Positive effect on criteria
~ = Not applicable / relevant or has minimal effect
✗ = Negative effects on criteria

Raise Road

Raise ~ 400m of road by up to 0.5m in affected area to avoid minor flooding.

- Maintains access during inundation events, but does not reduce the frequency of events impacting the park
- Could support transition to less intensive uses - eg camping only
- Consider alternative access routes from Jam Jerrup

VMACP Classification	Approval / Timeframe	Environmental Impact	Social Impact / Cultural	Cost
Accommodate	✗	~	~	✗

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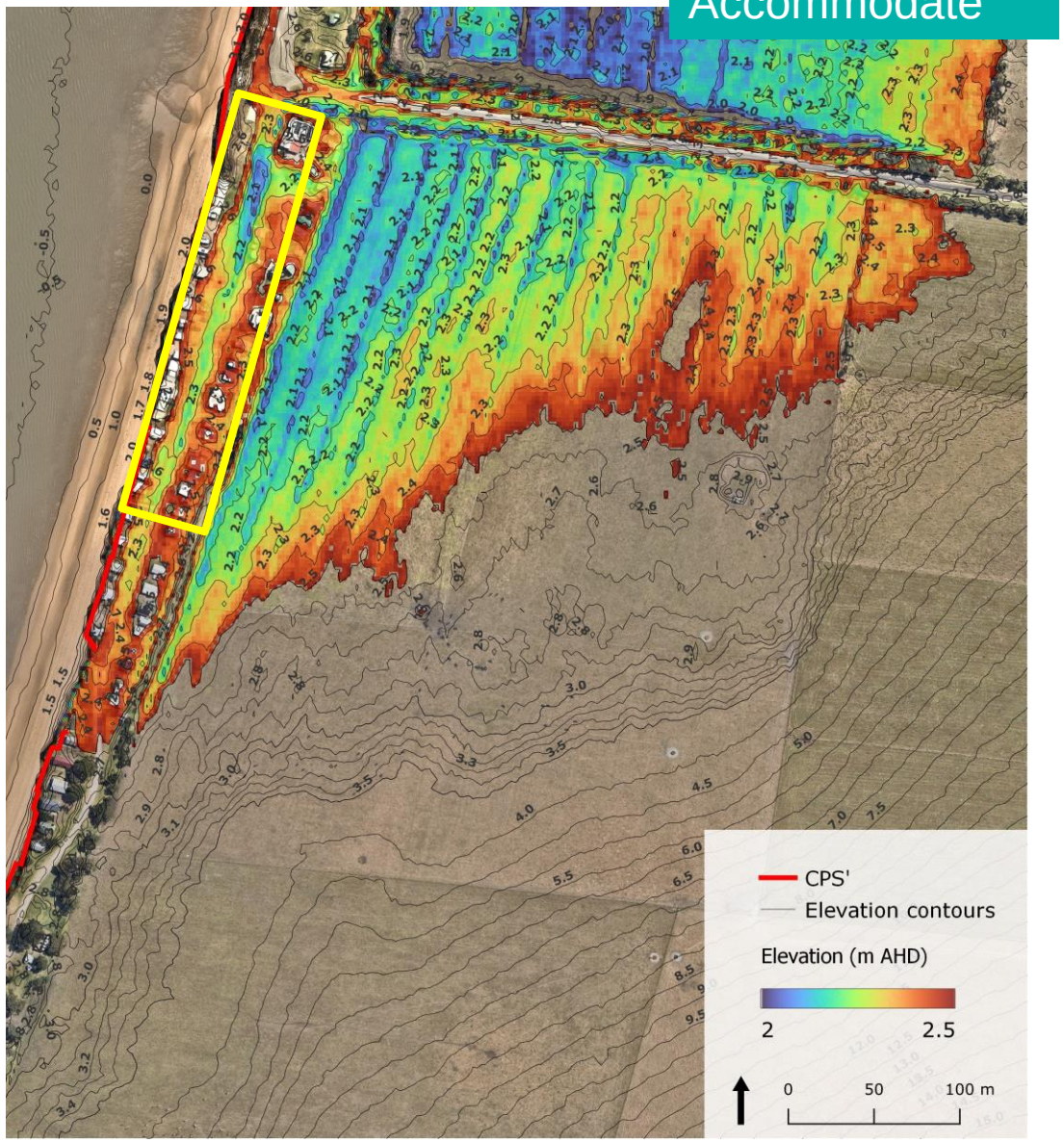
Raise floor levels and fill low areas

Raise floor levels of public buildings subject to frequent inundation, eg laundry, rotunda, amenities blocks, park office.

- Flood-proof service infrastructure
- May involve replacing some buildings – cost unknown
- Raising floor levels of private boat sheds would not be funded by DEECA. These buildings do not comply with planning rules. Upgrades unlikley be approved.

Low areas of the park could also be filled to reduce inundation frequency for camping sites. This would be very expensive and difficult to approve

VMACP Classification	Approval / Timeframe	Environmental Impact	Social Impact / Cultural	Cost
Accommodate	✗	~	✓	✗



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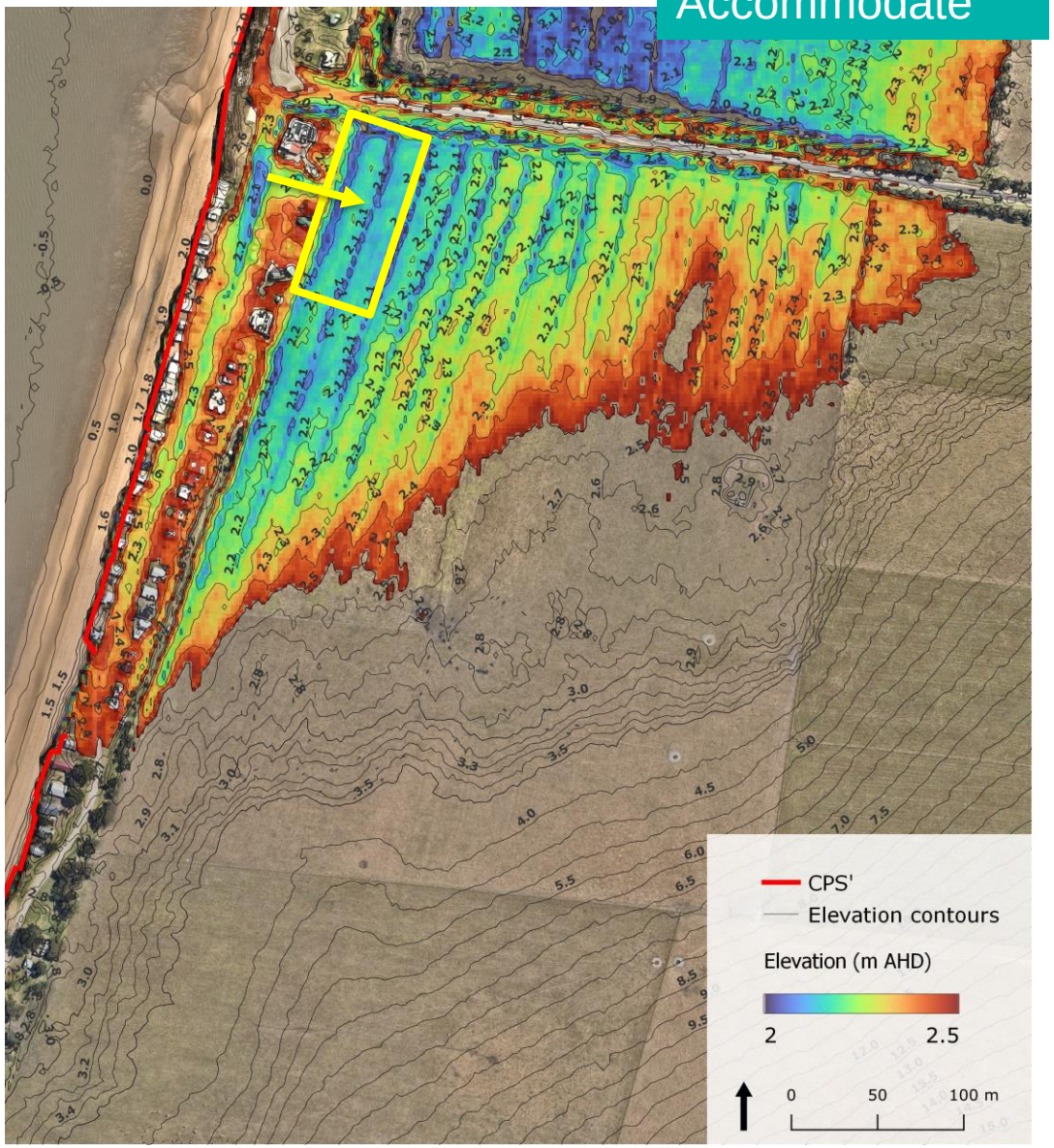
Modify Drainage Network

Modify drainage network so that overtopping water flows to low point in paddock – this becomes a salt marsh retention basin (yellow box)

- Effective for overtopping inundation, but not storm tide inundation which will occur with increasing frequency from around 2040
- Requires land acquisition – potential opportunity for business owner
- Funding for upgrading stormwater, drainage and the transition will not be available from DEECA



VMACP Classification	Approval / Timeframe	Environmental Impact	Social Impact / Cultural	Cost
Accommodate	✗	~	✓	✗

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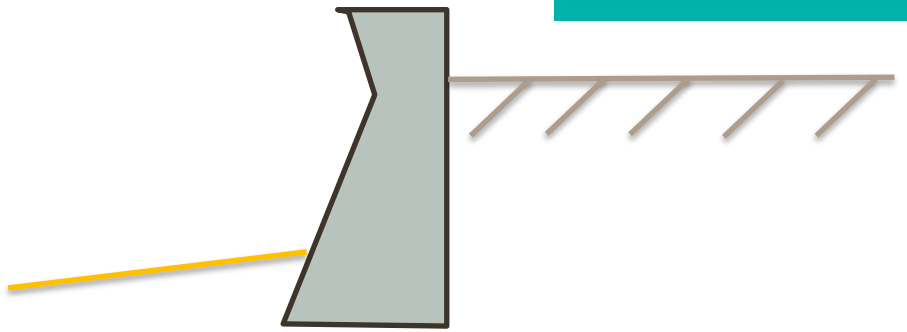
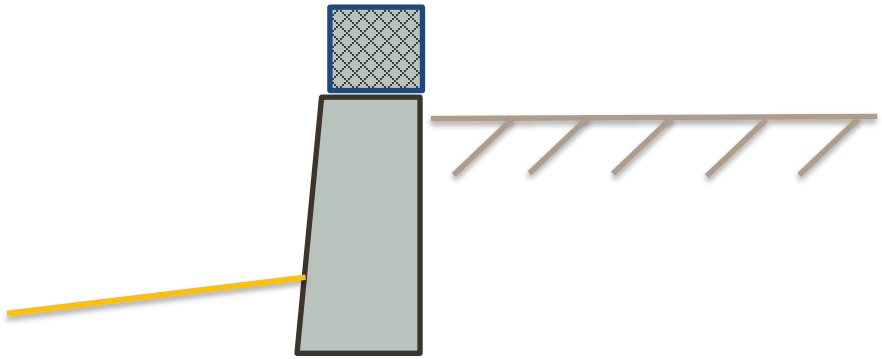
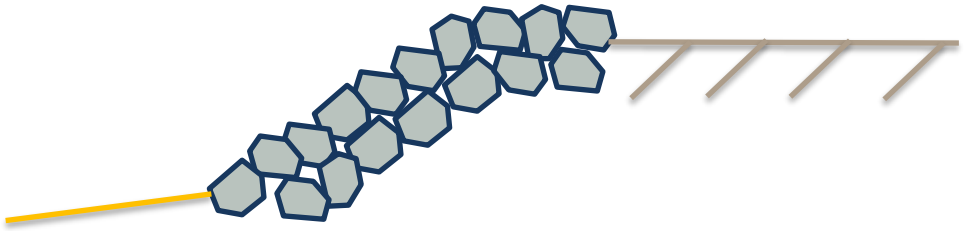
Upgrade seawall and / or revetment

Upgrade seawalls to protect against erosion and/or raise crest of seawalls to reduce overtopping

- Effective at preventing erosion and reducing overtopping, but not effective for storm tide inundation likely to occur from 2040
- Cost likely to be $1 to 3 million for 360m of masonry seawall. This seawall protects only a small portion of the site.
- Other seawalls are protecting private assets – DEECA will not fund upgrades
- This action will lead to loss of beach access and amenity over time due to submergence by sea level rise







VMACP Classification	Approval / Timeframe	Environmental Impact	Social Impact / Cultural	Cost
Protect	✓	~	×	×

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× = Negative effects on criteria

Adaptation Option Pathways

Option	Actions	Effective Timeframe from 2024 – How long could the Caravan Park stay operational?	Preliminary Cost Estimations
1. Progressive Closure	• Progressively close and fence-off damaged building and sites and decommission when they pose as a safety hazard	10 to 20 years	$300k to $600k for demolition / clean up
2. Minor short-term protection works	• Repair and raise existing masonry seawall protecting public facilities at northern end of site to mitigate flooding due to overtopping • In other areas private boat sheds / cabins / vans may be removed or seawalls repaired at owner's expense	20 to 30 years	$1 – 3 million
3. Protect in Place – Major works	• Rebuild 1000m seawall with higher crest • Fill northern section of park (raise road and floor levels) • Modify drainage • **Not viable due to cost and misalignment with VMCAP**	30 to 40 years	$10 – 30 million
4. Staged retreat	• Relocate facilities in the northern section of park to privately owned land • Remove private boat sheds / cabins / vans to allow coastal retreat • New amenities and access • DEECA will not provide funds, but could be an opportunity for a commercial operator	80 to 100 years	$10 – 20 million

Progressive Closure with Minimal intervention

Allowing natural coastal processes to continue resulting in progressive closure of caravan park and landward migration of coastline and coastal vegetation. Minimal intervention to maintain public safety.

- Flooding will become more frequent; Minor flooding monthly by 2040. Major flooding impacting most of the park facilities / amenities (office, toilets, laundry etc.) every couple of years by 2040.
- Seawall failures will occur, leading to undermining and damage to structures (public rotunda and private boat sheds), loss of caravan sites and beach access – possible in next 10 years
- Continuing erosion of unprotected shoreline – reduction/loss of camping areas.
- Progressive closure and fencing of unsafe areas.
- Closure of the park occurs when disruption and repair costs from flooding become unsustainable. Likely within 20 years.
- Removal of infrastructure and rehabilitation of foreshore could be explored further at a later stage - this would be needed to maintain beach amenity for community recreation.

VMACP Classification	Approval / Timeframe	Environmental Impact	Social Impact / Cultural	Cost
Non-Intervention	~	~	✗	✓

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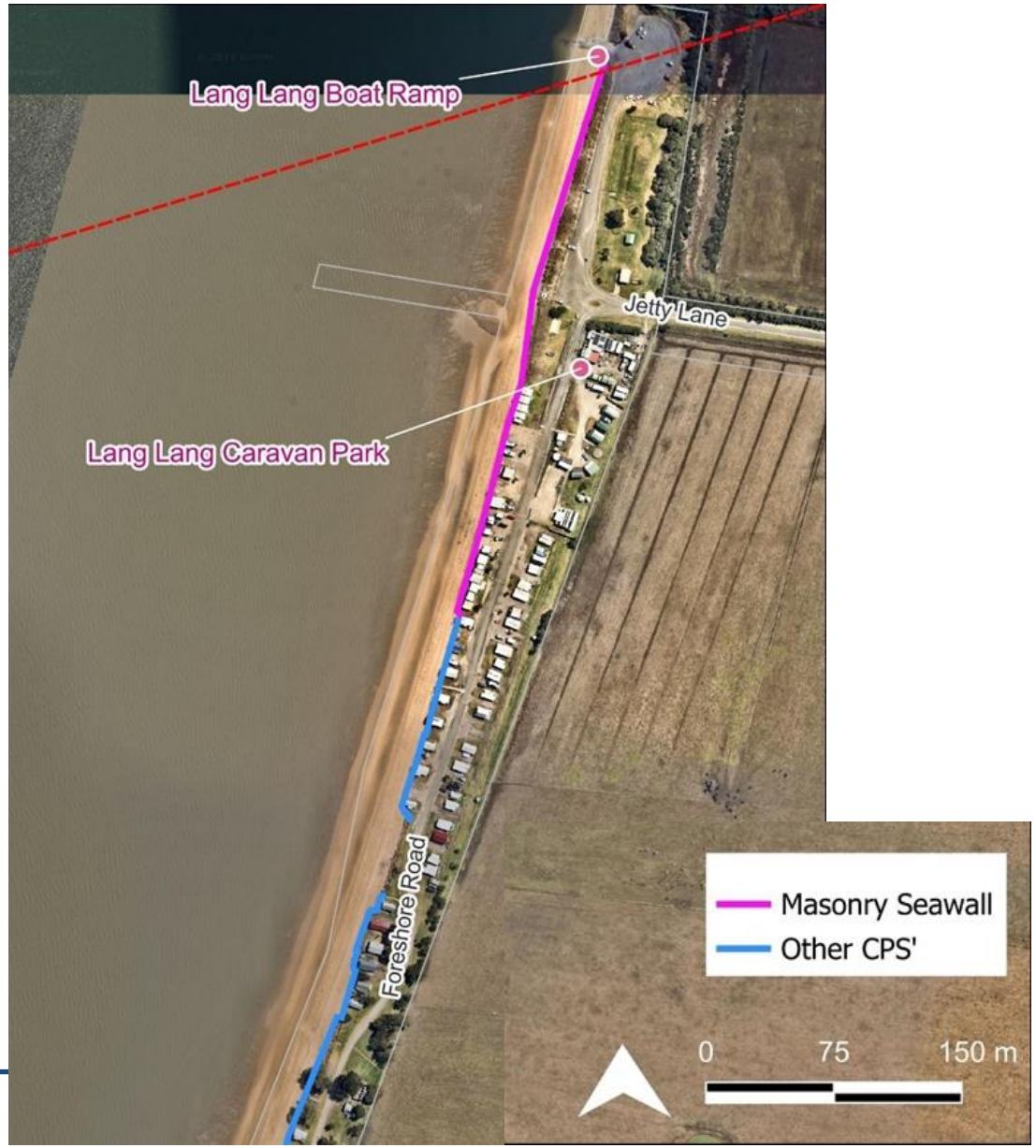
✗ = Negative effects on criteria

Minor short-term protection works

Upgrade masonry seawall only to protect against erosion and/or raise crest of seawalls to reduce overtopping

- Effective at preventing erosion and reducing overtopping, but not effective for storm tide inundation
- Cost likely to be $1 to 3 million for 360m of masonry seawall. This seawall protects only a small portion of the site.
- Boat sheds use can continue to around 2040 where safe, but upgrades or repair of seawalls will not be funded or approved
- Erosion and storm tide inundation likely to force closure by around 2040. Similar to the minimal intervention timeframe, but in this option there is a reduction in minor flooding for 15 years before 2040.

VMACP Classification	Approval / Timeframe	Environmental Impact	Social Impact / Cultural	Cost
Protect	✓	~	×	×



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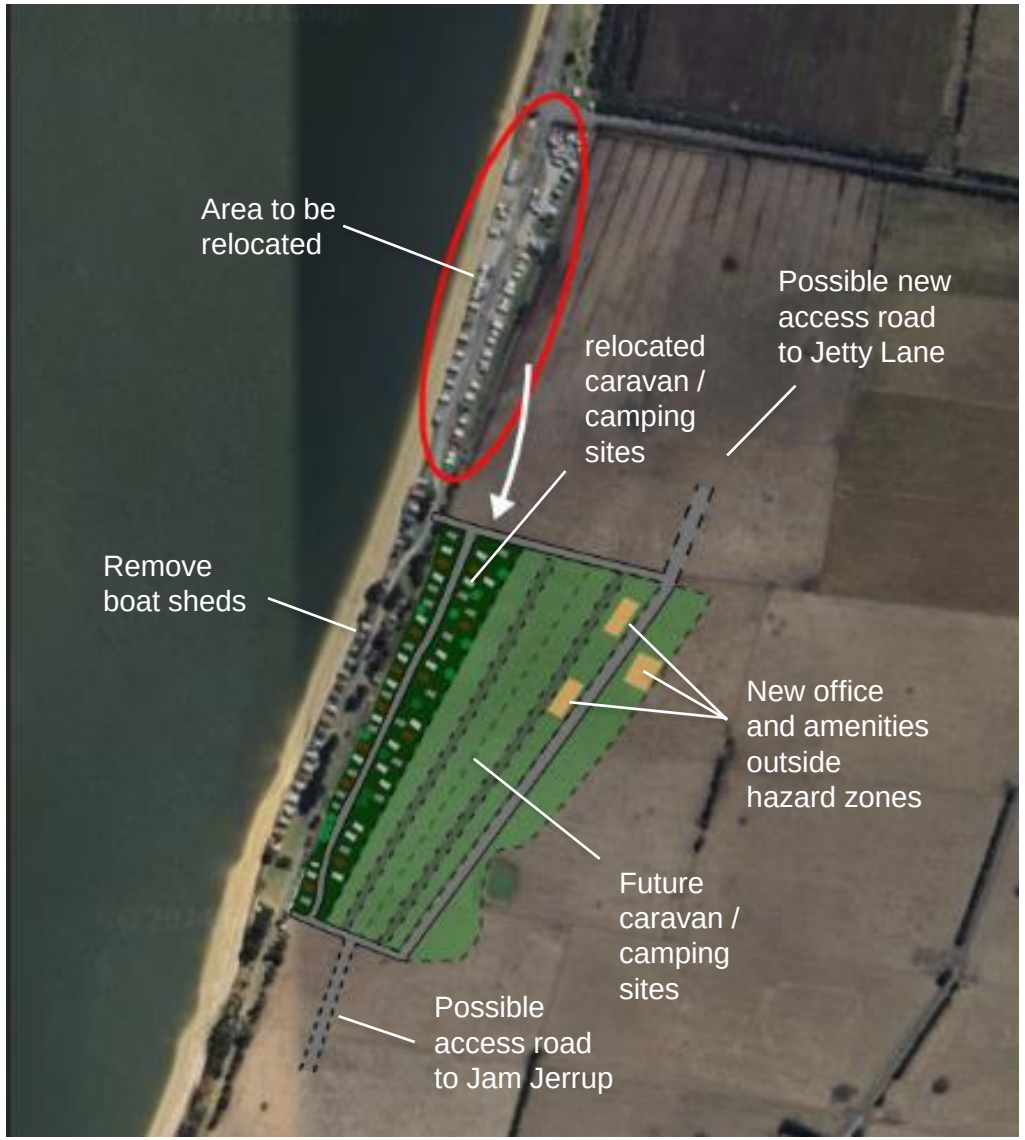
Staged Retreat

Relocate the low-lying northern half of park to privately owned land, then progressively retreat the campsites up the hill as sea levels rise and shoreline recession continues.

- Requires purchasing privately owned land and relocation of facilities, costs within $10 – 20 million. DEECA will not provide funds, could be an opportunity for a commercial operator.
- Each row of campsites can be progressively decommissioned as sea level rises and new rows added further landward.
- Currently there are many private boat sheds, cabins, annexes with individual seawalls in this area that would need to be removed to free up foreshore space for public camping and recreation, and to allow natural coastal retreat. Timing to be further investigated.
- This approach maintains beach amenity and foreshore area for recreation to at least 2100.
- New access road, office, amenities block, services and other permanent facilities located up the hill outside 2100 hazard zones.

VMACP Classification	Approval / Timeframe	Environmental Impact	Social Impact / Cultural	Cost
Retreat	✗	✓	✓	✗



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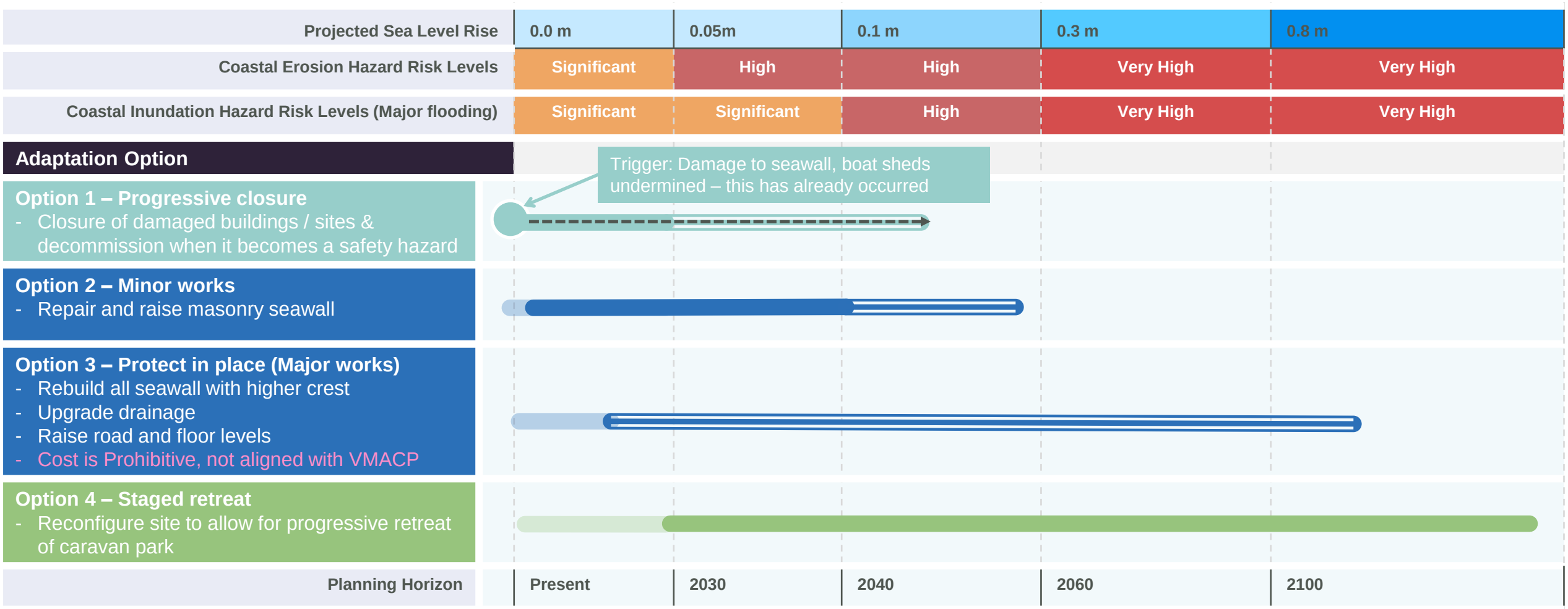
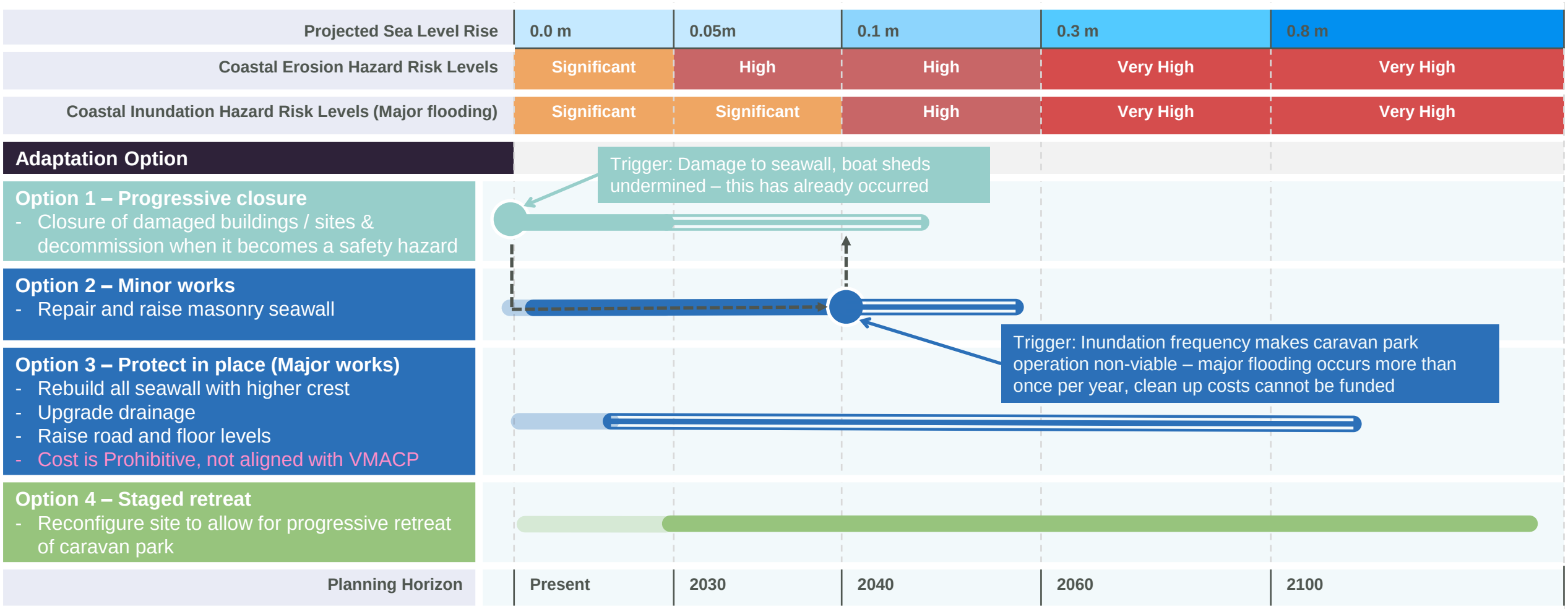

Projected Sea Level Rise
0.0 m
0.05m
0.1 m
0.3 m
0.8 m
Coastal Erosion Hazard Risk Levels
Significant
High
High
Very High
Very High
Coastal Inundation Hazard Risk Levels (Major flooding)
Significant
Significant
High
Very High
Very High
Adaptation Option
Trigger: Damage to seawall, boat sheds undermined – this has already occurred
Option 1 – Progressive closure
- Closure of damaged buildings / sites & decommission when it becomes a safety hazard
Option 2 – Minor works
- Repair and raise masonry seawall
Option 3 – Protect in place (Major works)
- Rebuild all seawall with higher crest
- Upgrade drainage
- Raise road and floor levels
- Cost is Prohibitive, not aligned with VMACP
Option 4 – Staged retreat
- Reconfigure site to allow for progressive retreat of caravan park
Planning Horizon
Present
2030
2040
2060
2100
LEGEND
Decision trigger point
Option preparation time
Option effective timeline
Option reducing in effectiveness
Recommended adaptation pathway
Alternative adaptation pathway
Non-intervention
Avoid
Nature Based
Accommodate
Retreat
Protect


Projected Sea Level Rise
0.0 m
0.05m
0.1 m
0.3 m
0.8 m
Coastal Erosion Hazard Risk Levels
Significant
High
High
Very High
Very High
Coastal Inundation Hazard Risk Levels (Major flooding)
Significant
Significant
High
Very High
Very High
Adaptation Option
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- Upgrade drainage
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- Cost is Prohibitive, not aligned with VMACP
Trigger: Inundation frequency makes caravan park operation non-viable – major flooding occurs more than once per year, clean up costs cannot be funded
Option 4 – Staged retreat
- Reconfigure site to allow for progressive retreat of caravan park
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2040
2060
2100
LEGEND
Decision trigger point
Option preparation time
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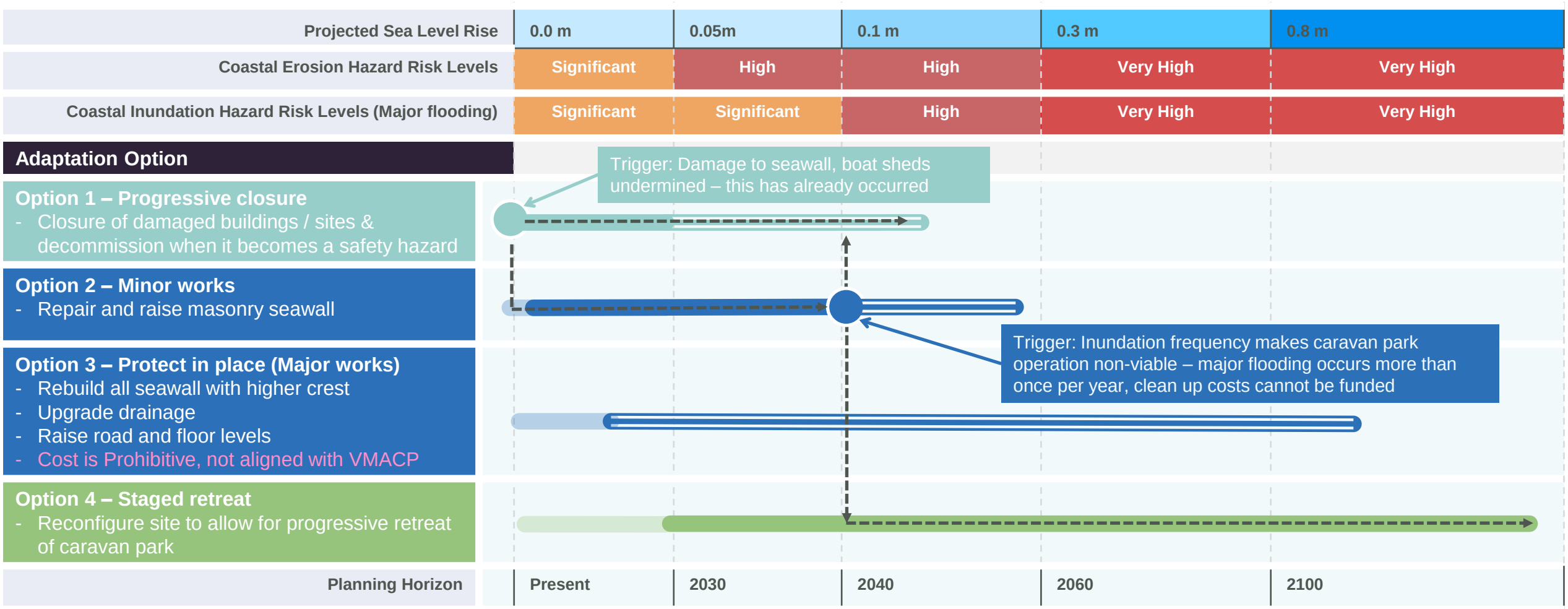
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