PRICE

Seawater Flooding Adaptation Pathways for Yorke Peninsula Settlements

Stage 2: Adaptation Options

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Photograph of Price seafront supplied by Coast Protection Branch.

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Document history:

Project stage	Version	Date	Reviewed	Approved
Adaptation Options	Draft	14th Sep, 2015	JK 6th Sep, 2015	MW 7th Oct 2015

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GLOSSARY

ADAPTATION

Adaptations are actions taken to help communities and ecosystems cope with actual or expected changes in climate conditions.

AHD

AHD is an acronym for Australian Height Datum. When a measurement is accompanied with the letters AHD it indicates a height above mean sea level. Mean sea level was adopted in 1971 by the National Mapping Council of Australia at 0.00 AHD. For example, 3.2m AHD is 3.2 metres above mean sea level. AHD tide levels are different to the fishing charts which are called Chart Datum (CD). A subtraction of 1.45 metres from tide chart will give the correct AHD height.

ARI

ARI is an acronym for Average Return Interval and is a theoretical calculation of the probability of the return of a particular event based on observations of the past. In relation to severe storm events the longer the interval the higher the storm surge height is predicted to be. For example, a 1 in 100 year storm surge would be higher than a 1 in 50 year or 1 in 10 year storm surge height. It is important to remember that this is just a theoretical calculation and there is nothing preventing a 1 in 100 year flood happening twice in one week.

DEM

DEM is an acronym for Digital Elevation Model. The digital elevation model used in this study was created from an aircraft that bounced millions of infra-red light beams to the ground and then created a digital topographical map from the reflected beams. This digital map is combined with aerial photography and can be used to display the height of land features. A Digital Terrain Model (DTM) is a type of DEM that has been specifically prepared for flood modelling.

EROSION

Erosion is where action of the sea moves sand and vegetation from the shoreline so that the dune system is weakened. When the frontal dune system is significantly weakened it may completely erode away and the shoreline moves inland.

STORM SURGE

A storm surge is usually the combination of the highest tide (king tide), the action of the waves, and the height the water is raised when pushed up the beach, especially when driven by a high winds. The combination of these factors is given a height AHD and used by planners to work out at what height buildings and infrastructure should be placed along the shore.

1. Introduction

In February 2015 the Yorke Peninsula Council commissioned Mutual Projects Pty Ltd T/A Integrated Coastal Management to undertake the *Seawater Flooding Adaptation Pathways* study, a project jointly funded by the Commonwealth Natural Disaster Resilience Program, the Coast Protection Board, and the Yorke Peninsula Council. The aim of the project is to identify the seawater flooding risks, assess current flood protection infrastructure and provide recommendations for future action to cater for seawater flooding. The project will also improve community awareness of the risks associated with current and future seawater flooding. The sites under investigation are Clinton, Price, Pine Point (Billy Goat Flat) and Coobowie which are all situated along the eastern coast of the Yorke Peninsula and are considered by Council to be locations of risk.

1.1 Investigative framework

This study utilises the *Local Government Association Coastal Adaptation Decision Pathways Investigative Framework* which was originally developed in 2012, and trialled at Onkaparinga and Mallala Councils. In 2013, the investigative framework was utilised in the *District Council of Mallala's Coastal Settlements Adaptation Study,* and subsequently amended to reflect the findings of that project. Each settlement is reviewed within the following framework:

1. Establish settlement history.
2. Analyse existing sea-flood protection.
3. Analyse the impact of sea-flood scenarios.
4. Analyse emergency access and egress.
5. Establish profile of the assets at risk.
6. Identify current policy framework.
7. Explore liability issues.
8. Propose adaptation actions.

1.2 Staging of the project

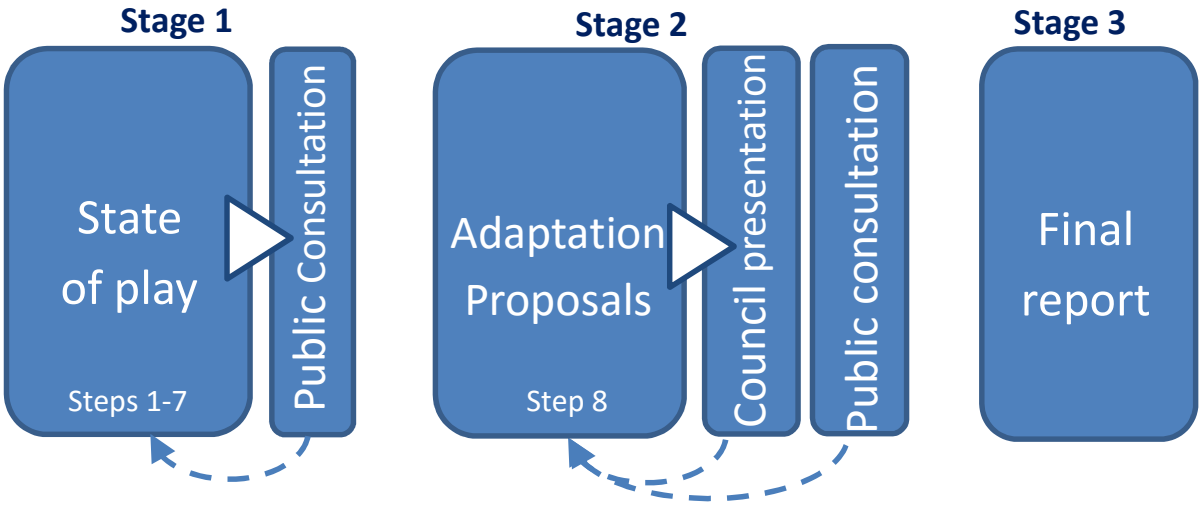
The process is to be undertaken in three main stages (**Figure 1:1**):

Stage 1: State of Play Report (Steps 1 – 7)

Stage 1 evaluates and reports the current and future threat. The community consultation process in Stage 1 reports *to* the community about the potential for sea level rise but also actively requests information *from* the community to create the full 'sea-flood risk picture' (See also Section 3).

Stage 1 is now complete and this report represents the findings of Stage 2.

Figure 1:1 The coastal adaptation study is conducted in three stages[1]



Stage 2: Propose adaptation options (Step 8)

Stage 2 proposes adaptation options in draft form and reports these to the Council, and then to the community by way of a second public meeting. Adaptation proposals are generally framed within the five broad ways human settlements can adapt to rising sea levels:

- **Protect:** use various means such as construction of sea walls, beach sand replenishment or installation of drainage swales to protect existing development;
- **Accommodate:** use means such as raising buildings or protecting buildings from flooding;
- **Retreat:** abandon settlements and move development inland in the face of rising sea levels. The concept of 'retreat' is also known as 'planned retreat'.
- **Defer:** threats have been assessed, and perhaps costs and options analysed but there are valid reasons to wait until to a later date to act.
- **Do nothing:** ignore the risks and do nothing.

Stage 3: Final reporting

Responses from the Council and the community from Stage 2 are taken into account for the final report. Stage 3 provides a final report to Council that includes an explanation of the adaptation options, a suggested prioritisation for action, and preliminary engineering solutions and estimated costs (where possible).

[1] Adapted from coastal analysis tool, *Dealing with the impacts of sea level rise on coastal assets (2012) (Western & Kellett)*

1.3 Reporting and consultation

While the scope of the *Seawater flooding adaptation pathways for Yorke Peninsula Cou*ncil covers the four settlements of Clinton, Price, Pine Point (Billy Goat Flat) and Coobowie, adaptation responses options available to each settlement are reported separately. This report contains the adaptation options for:

Price.

Figure 1:2 Location Map: Price, Yorke Peninsula[2]

In preparing the adaptation options in this report the following agencies and individuals were consulted:

- James Guy, Department of Energy, Water, and Natural Resources,
- Dwayne Werfel, Yorke Peninsula Council, Works Supervisor (North),
- Geoff Fisher, Australian Water Environments (AWE), on 2nd June, 2015 inspected Price settlement and environs, also reviewed the adaptation proposals and offered technical advice on 26th August, 2015,
- Geoff Wilde, Managing Director, Geoff Wilde Earthmoving.

[2] http://www.naturemaps.sa.gov.au/maps/viewer.aspx?site=NatureMaps

1.4 Methodology

Adaptation responses in this study take into account: the nature of the threat, the protection of infrastructure, the safety of people, and the appropriate timing of response until 2100.

1.4.1 Adaptation responses that relate to the nature of the threat.

Other than depth of water, additional factors that influence the impact of a flood on a settlement are: the velocity of the water (speed), the duration of the flood (how long it lasts), and the topography of the settlement. How much warning is possible for possible flooding is a factor that enables the settlement to prepare for the flood more effectively. The general characteristics of a sea-flood in the Price region are shown in **Table 1:1**.

Table 1:1 Sea flood characteristics for Price coastal region.

Flood characteristic	Price region
Depth of water	Shallow
Velocity of water	Low, due to tidal action and ocean terrain
Wave action	Minimal due to depth of water and friction of 2.2kms of mangrove and samphire
Direction of water	From the east (water fills the area on the northern side of the causeway first)
Duration of flood	Short 1-2 hours relating to combination of tide and storm surge
Warning	Predictable as flood will relate to tide.

To contextualise the flood risk in the Price region, **Table 1:2** illustrates how insurance companies may discount their flood risk when adequate flood warning can be provided and the community is prepared to deal with a flood. For example, where the community is experienced and there is a greater warning time than 12 hours, the predicted actual cost of damages can be discounted by 0.4 (Victorian Government, 2000).

Table 1:2: Proposed ratios of actual:potential damages (Victorian Government, 2000)

Warning time	Experienced community	Inexperienced community
Less than 2 hour	0.8	0.9
2 to 12 hours	Linear reduction from 0.8 at 2 hours to 0.4 at 12 hours	0.8
Greater than 12 hours	0.4	0.7

Historically, storm surges that have threatened settlements in the Price coastal region have been in conjunction with the highest astronomic tide (often referred to as a 'king tide') which would in the majority of cases, provide a greater than 12 hour warning period. In summary, and based on historical data, the flood threat is normally related to predictions of high tides, likely to be of low intensity in relation to velocity of water, and of short duration.

Finally, adaptation responses are proposed and analysed using the three one in one hundred ARI scenarios provided in the State of Play report (**Table 1:3**). These scenarios assist in providing the context from which to make decisions that relate to the viability and also the timing of responses.

Table 1:3 Price - 1 in 100 annual return events, with allowance for sea level rise

	2015	2050	2100
Storm surge (at king tide)	2.6m	2.6m	2.6m
Wave set up	0.1m	0.1m	0.1m
Wave run up	0.0m	0.0m	0.0m
Sea level rise	0.1m	0.3m	1.0m
Totals (AHD)	**2.8m**	**3.0m**	**3.7m**

1.4.2 Adaptation responses that relate to infrastructure and people.

Infrastructure

In proposing adaptation responses, Councils are required to take the long view. For example, a house constructed today is likely to have a life span of 60 to 80 years, so future risks from actions of the sea are required to be taken into account in current planning policies. Councils are also required to take into account Coast Protection Board policy and advice. Such policy includes being able to demonstrate that development is capable of being protected for the sea-flood risk for the 1 in 100 ARI event adopted for 2050, but also that reasonable steps can be taken to adapt the development to the sea-flood risk for the 1 in 100 ARI event adopted for 2100 (Coast Protection Board, 2004).

People

Adaptation responses should also take into account the safety of people in a flood event. These include warning and emergency procedures, the ability of people to be able to move safely away from the flood, and the ability of emergency vehicles and personnel to move into the settlement.

1.4.3 Adaptation responses that take into account time

The *State of Play Report* has already analysed the possible impact of the three 1 in 100 ARI flood scenarios (2015, 2050, 2100) upon the settlements. It is proposed here to draw upon that data and deal with adaptation responses in the following order:

- What level of protection can be realistically provided (at current threat, 2050 threat, 2100 threat).
- Where protection falls short, what accommodation responses can be employed?
- Where protection and accommodation strategies fall short, what longer term retreat options should be employed (if any)?

Finally, responses canvassed within this report may be implemented over the coming decades but also may be contingent on each other. For example, a protection strategy employed now may mean that other accommodation strategies are not required until a later date. The limitation of a protection strategy may mean that accommodation or retreat strategies are required to cater for that shortfall later in the century. **Figure 1.3** provides a pictorial overview of the adaptation strategy.

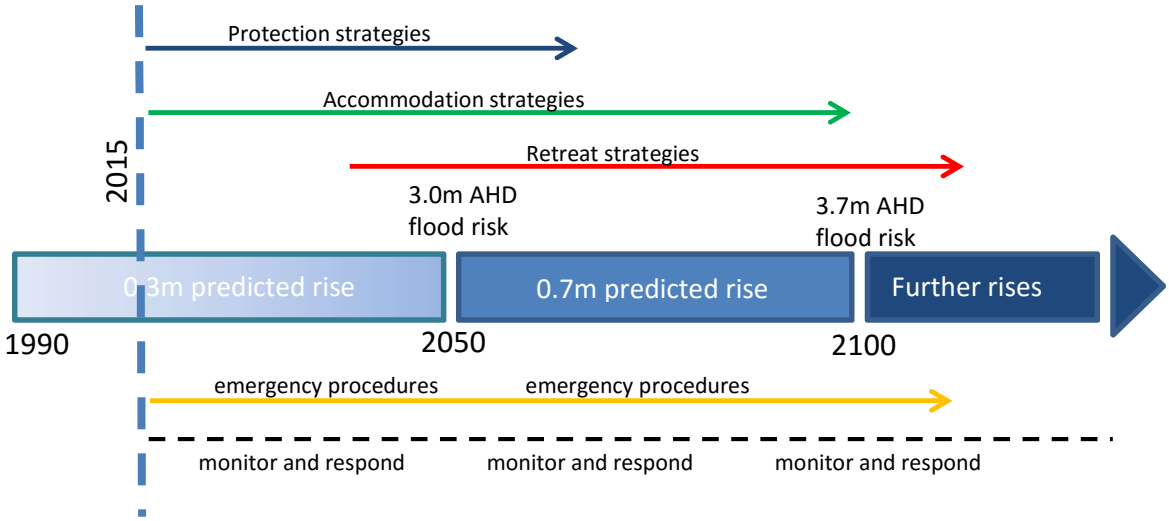


Figure 1:3 Adaptation responses are time related and sometimes contingent on each other but also contingent on the rate of sea level rise which is to be monitored over time (M. Western, 2015).

1.4.4 Adaptation responses that do not take into consideration:

- The effect of rising sea levels on ground water within Price (although the State of Play report found that the majority of Price was elevated well above the sea-flood levels).
- The potential for a rain flood event either combined or not combined with a king tide (although the State of Play report found that there was a low correlation between sea-flooding events and rain flooding events).
- The possibility of a sea-flood event caused by unforeseen event such as a tsunami.

2. Price protection options

The following preliminary conclusions can be made in relation to the protection system at Price (see also State of Play report, p.32):

- The general topography of Price indicates that the majority of dwellings and infrastructure are not likely to be vulnerable to flooding over the duration of this century.
- Price is not likely to be vulnerable to lateral erosion which would undermine the integrity of the settlement over longer periods of time.
- The highest level of flood water in the last 15 years is likely to have been 2.50m AHD on 25th April, 2009. This correlates with the third highest flood event that occurred in the Gulf St Vincent since 1940 (and only 5cms short of the highest event on 4th July, 2007, which for reasons unknown was not experienced in the Price region).
- The caravan park levee was installed in 2001 at a height of 2.60m to 2.7m. The levee has never been overtopped but water did enter through the southern side of the caravan park in 2009. Subsequent to the 2009 event, a narrow top at height 2.8m – 2.9m AHD was installed to the levee and a new bund installed to the southern side of the caravan park.
- The causeway floods two or three times a month in winter time. Due to the water filling up the northern side of the causeway more rapidly than the southern side, scouring is occurring on the southern side when the water flows across the causeway as it seeks to equalise its level.
- There is anecdotal evidence that lower sections of the playground become inundated although the DEM modelling of the flood height 2.50m AHD demonstrates that this may be a rare event (such as the 25th April, 2009 event).
- Significant over-land storm water flooding is unlikely due to the installation of a diversion system to the north of Price and there is no correlation between rain events and sea-flooding events which may compound the flooding problem.
- In rain events water some water accumulates on the eastern end of Fowler Tce, and within the caravan park, and also on the road between Price and Cheetham Salt.

2.1 What level of protection can be realistically provided to cater for the sea-flood risk at 2100 (3.7m AHD)?

In brief, the findings of State of Play report were (north to south):

- Water would overtop the bund adjacent the golf course at varying depths but would be unlikely to flow back into Price.
- Water would severely overtop the caravan park bund by 0.8m to 1.0m and would flood the caravan park up to depths of 1.6m.
- The community facilities would be flooded up to depths of 1.2m (but much shallower adjacent Fowler Tce).
- The road from Price to Cheetham Salt would be inundated to 0.3m to 0.4m
- Generally the residential section would not be affected apart from southern corner where water may flow across the road at depth 0.2m.
- Seawater would flow through stormwater outlets on Fowler Road
- The causeway to the boat ramp which is regularly flooded in current circumstances would be over-topped by 1.8m AHD.

Figure 2:1 Flood mapping for sea-flood scenario 1 in 100 ARI event of 3.7m AHD (2100 scenario).

Rendition of Sea-flood scenario from DEM (M. Western, 2015)

Conclusion:

Price generally

Protection options are generally viable for the Price settlement anywhere to the north-west of Fowler Tce to cater for the flood-risk at 2100. Fowler Tce could easily be raised 0.3m (or conversely very low height bund installed adjacent the road). The bund adjacent to the golf course could also be easily raised at low cost. Therefore it is concluded that sections of Price north-west of the line of Fowler Tce have viable protection options over the next 100 years.

Caravan Park

To raise the caravan park bund to cater for the 2100 sea-flood scenario may not be realistic for two reasons. First, the amenity would be diminished within the caravan park with a substantially higher bund (**Figure 2:2**). Second, if the sea level does increase as predicted, there is nothing to suggest that it won't keep rising past 2100, thereby rendering the defences at 3.7m AHD ineffective. Therefore any longer term planning for the caravan park should consider relocation (at least of the lower section).

Figure 2:2 Illustration of the bund required to protect the caravan park for 2100 sea-flood scenario.

Community facilities on Fowler Terrace

The land where the community facilities are located is a little more elevated than the caravan park and as a public space could cater for interim flooding. However, if the sea level does increase as predicted, then there is nothing to suggest that it won't keep rising past 2100, increasing the ongoing flood threat to the community facilities area. Therefore, any longer term planning for buildings and facilities in this area (replacement or new), should take into consideration the longer term sea-flood risk.

Causeway to boat ramp

The causeway to the boat ramp is likely to have become unusable by 2100 as it is currently over-topped about once a month. It is not deemed to be a realistic option to raise the existing road to cater for the 2100 sea-flood scenario.

2.2 What level of protection can be realistically provided to cater for the sea-flood risk at 2050 (3.0m AHD)?

In brief, the findings of State of Play report were:

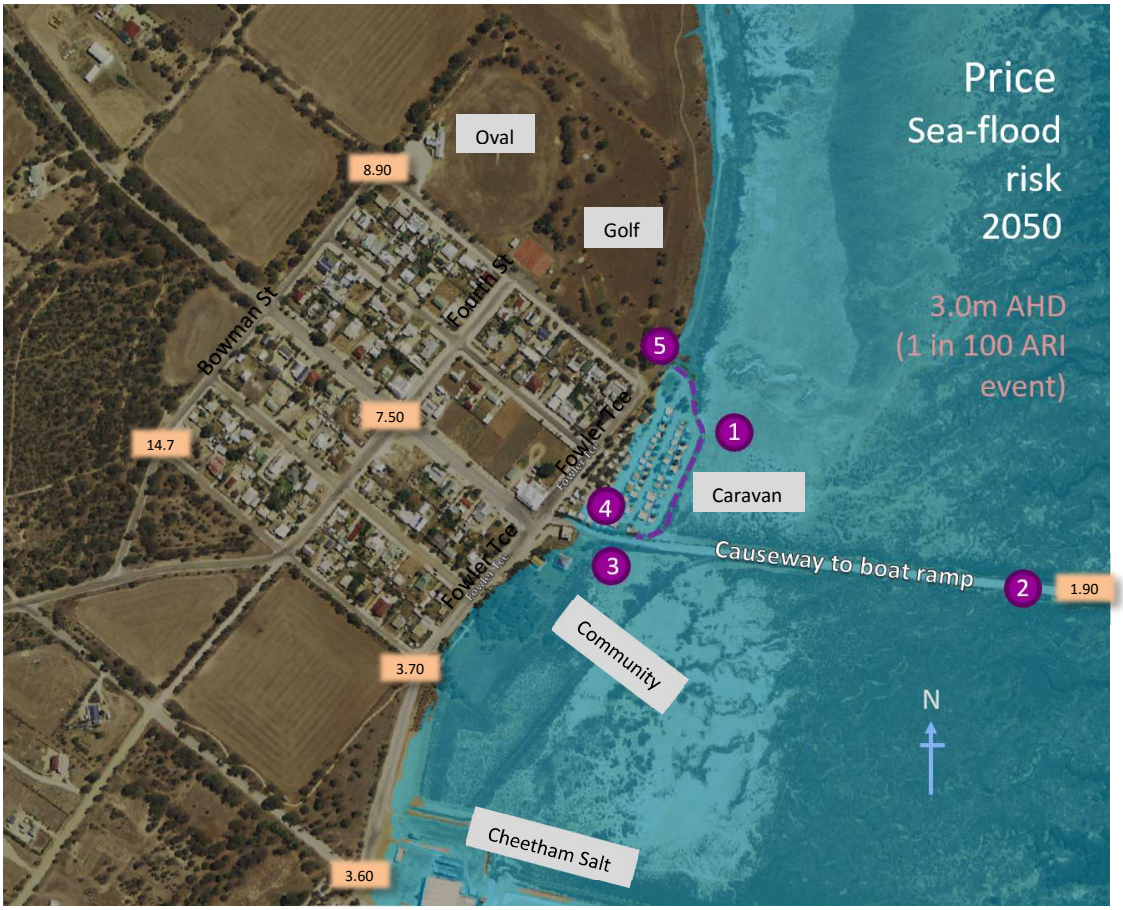
- Water would overtop the caravan park bund at depths of 0.1 – 0.3m and the caravan park would be inundated up to depths of 0.9m.
- Water would inundate the community area at low height (up to 0.3m in the playground area and 0.0m AHD adjacent the BBQ area).

In contrast to the 2100 sea-flood scenario, protection options should be considered for the caravan park and other works undertaken to increase resilience:

- Protection measures are feasible and likely to be effective,
- Protection of development to cater for the 2050 flood scenario (3.0m AHD) is Coast Protection Board policy (Coast Protection Board, 2012),
- Installation of protection measures now will provide a 30-40 year time in which data can be tracked over time to assess the rate of change in sea level.

The location of the proposed protection measures are depicted in **Figure 2:3**.

Figure 2:3 Flood mapping for sea-flood scenario 1 in 100 ARI event of 3.0m AHD (2050 scenario).



Rendition of Sea-flood scenario from DEM (M. Western, 2015)

2.3 Protection options for Price

Note, the cost estimates provided below have been prepared based on very limited data and without engineering design calculations. They are therefore indicative only and have been prepared to assist council with the setting of priorities. They should not be relied on for budgeting or construction cost management purposes.

1. Raise the existing caravan park bund to 3.0m AHD (see also State of Play Report pps 22-25).

- Existing bushes to be pruned back
- Existing loose top to be removed
- Raised added section to be 'keyed in' to the existing levee (see **Figure 2:5**)

Figure 2:3 Existing profile of bund of the caravan park (heights AHD).

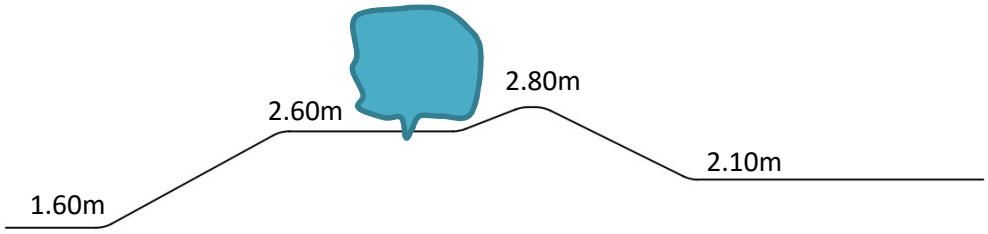


Illustration by M. Western, 2015

Figure 2:4 Photographic depiction of existing profile of the bund of the caravan park

Photograph (M. Western, 2015)

Figure 2:5 Proposed profile of bund of the caravan park (heights AHD).

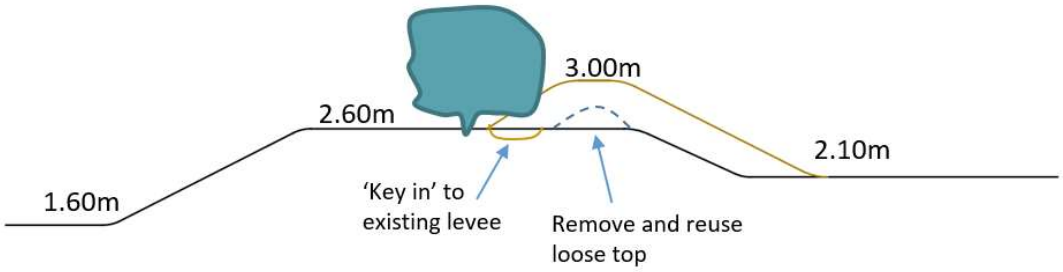


Table 2:1 Preliminary cost calculation: raise caravan park levee to 3.00m AHD

Location	Existing elevation	Levee height increase	Levee length	Area of profile face	Volume (approx) m^3	*Cost per m^3	Cost (approx)
Caravan park	2.6 m to 2.7m AHD	0.4m	240m	1.00m^2	240m^3	$40	$9,600[3]

2. Raise the existing causeway road by 0.3m (see also State of Play report p. 29,30)

The purpose of these works is to substantially decrease frequency of the flooding currently experienced and to increase the longevity of the road and boat ramp. Anecdotal reports suggest that the boat ramp suffers inundation about once a month and the southern side is showing signs of increased erosion. Raising the road by 0.3m would not eliminate all flooding, but is likely almost eliminate it under current circumstances. To contextualise, the highest level of water into Price area in the last eighty years is likely to have been at 2.50m AHD on 25th April, 2009, and should such an event occur again, the raised road would only be inundated by 0.2m[4]. In the long term, if seas rise as predicted, the road would eventually become unusable. However, the raising of the road could increase the longevity of the road by 30 to 40 years.

Two culverts should be installed to facilitate environmental flows between the two sides of the road.

A decision to raise the road is likely to take into consideration the community benefit which the boat ramp serves to the Yorke Peninsula as the first boat ramp accessible on the gulf by a standard motor vehicle (refer also State of Play Report p. 29,30).

[3] Council works department estimated $3,700 which equates to $15 per m^3. A higher rate of $40.00 per m^3 has been utilised to cover possible contingencies.
[4] Further work could be undertaken to ascertain more accurately how raising the road would relate to high water events.

Figure 2:6 Sections of causeway and boat ramp parking area to be raised by 0.3m.

Inset Photograph: Stephen Goldsworthy (Yorke Peninsula Council) 2015

Table 2.2 Preliminary cost calculation: raise boat ramp road to 2.3m AHD

Location	Existing road elevation	Raise	Length	Width (inc batter)	Area	Volume	Unit cost	Estimated cost[5]
Causeway	2.00m	0.3m	1200m	8m	9600m^2	2900m^3	$52	$151,314
Boat ramp		0.3m			800m^2	240m^3	$92	$ 22,034
Culverts	x2 (not costed, contingency sums)						$10,000	$20,000
Estimate:					Total			$193,348

[5] Costs for raising of causeway and boat ramp areas estimated by Geoff Wilde Earth Moving. Culverts have not been costed but a contingency sum included.

3. Change direction of slope of road to causeway (see also State of Play report p. 25)

The State of Play report noted that storm water currently runs down the eastern side of the access road to the causeway and threatens to erode the bund adjacent the caravan park. Changing the direction of the slope of the road will cause the water to run to the western side of the road and empty into the samphire flat without causing undue erosion.

Figure 2:7 Stormwater erosion at the causeway entrance adjacent the caravan park bund

Photograph: Mark Western, 2015

Figure 2:7 Sections of causeway and boat ramp parking area to be raised by 0.3m.

Geoff Wilde Earthmoving has provided preliminary cost estimate to change the direction of the slope, rip and remove existing spray seal, rebuild to levels shown, apply new spray seal at a cost of $17,274 (Works Department of Yorke Peninsula Council estimated the works at $4,600).

4. Widen existing bund between road and caravan park and raise to 3.0m AHD (see also State of Play report p. 25)

The existing bund is very narrow and deficient in height to cater for the 2050 risk. At the same time as (2) above is completed, the bund should be increased in width and raised to 3.0m AHD. Heights of the current levee are shown at **Figure 2:7** above.

Figure 2:8 Existing bund adjacent caravan park to be widened and raised to 3.0m AHD.

Photograph: Mark Western, 2015

Figure 2:9 Examples of cross section of road and bund combined

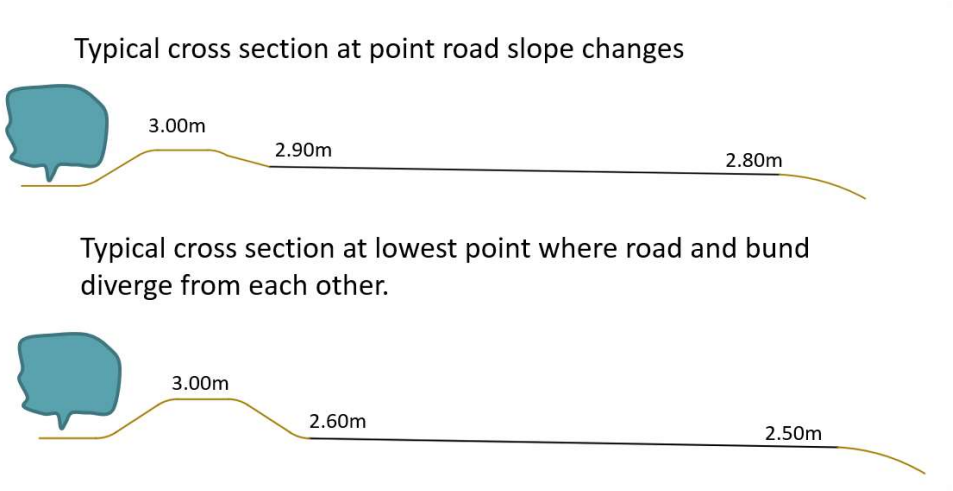


Illustration: Mark Western, 2015

Geoff Wilde Earthmoving has provided preliminary cost estimate to widen and increase the height of the bund at $6570.

5. Install means to prevent sea-water from flowing up stormwater outlets

With the increase of sea levels, sea water will eventually flow back into the township through storm water outlets. Storm water outlets are positioned under Fowler Tce at the southern end and empty into the samphire flat. On the northern end of Fowler Tce, water flows into a gully and empties into the samphire flat (**Figure 2:10**). A simple method of dealing with this problem would be to install a 'tidal flap' mechanism that would close in sea-flood events.

However, a water reclamation project on the northern end of Fowler Tce would allow storm water to be captured and be reused, as well as deal with this potential problem.

It is not anticipated that sea-water will enter through storm water outlets for a decade or more and therefore these options have not been costed. However, a storm water reclamation project may be reason to bring this adaptation option forward due to other benefits to the community.

Figure 2:10 Storm water outlet and possible location for a storm water reclamation project

Photograph: Mark Western, 2015

3. Price Accommodation Options

Price is not likely to be at risk from the current sea-flood threat (2015) apart from minor flooding of the community facilities area (around the playground area). Therefore accommodation options are not required at this time.

Caravan Park

However, should the caravan park bund not be raised, flooding into that region will become more likely over the coming decades. As noted above, a community that is prepared to deal with a flood is likely to suffer much less in financial terms, and also less likely to suffer human tragedy (p. 5). Further, a prudent community prepares for emergency events that may fall outside of its historical context as 'mother nature' does not necessarily adhere to ARI tables.

It is evident from the existing signage at the caravan park that emergency procedures currently exist. It is recommended these procedures be reviewed to ascertain if they are adequate enough to cater for unforeseen sea-flood events.

Figure 3:1 Price caravan park emergency assembly point

Photograph: Mark Western, 2015

The causeway road to the boat ramp

The causeway currently undergoes frequent flooding and with rising sea levels this frequency will increase. In the recent extreme event on the 25th April 2009, the causeway was flooded at depths of 0.5–0.6m. It is recommended that three flood depth markers be installed to the causeway road to notify persons of the depth of flood water[6].

[6] Likely costs $2,000. Flood depth markers are available from www.advancedroadsigns.com.au/Flood-Height-Marker-2m-lengths-p/g9-22-2.htm at cost of $150 each.

4. Price Retreat Options

The data from tide gauges at Port Stanvac and Thevernard have shown the sea level in this region has been rising at an average of 4.3mm per year over the past 20 years. For the sea to rise 0.7m in the second half of this century as predicted, would require an average rate of rise of 14mm per year. In reality this rate is likely to be much lower than 14mm at 2050, and much higher than 14mm per year at 2100. Therefore, between now and 2060-2070 it should be possible to monitor the rate of increase and adjust predictions accordingly. There are two possible scenarios that will emerge from the monitoring in this time frame:

- If the rate of change of sea level rise does not increase and the predictions for 2100 are proven to be inaccurate, then at the very least as a result of implementing the adaptation strategies above, Price would have become a far more resilient community and prepared for any unforeseen flood event.

- If the rate of change of sea level rise does accelerate and the predictions prove accurate, then the lower sections of Price can expect to be inundated far more frequently as the century approaches its close and facilities such as the caravan park may require relocation.

As noted above (p. 10), the main residential settlement of Price should be able to be protected at reasonable cost well into the next century. However, ongoing monitoring should occur over the coming decades to quantify this aspect more fully. Should the rate of sea level rise faster than anticipated, the lower sections of the residential sections north-west of Fowler Terrace may require planning changes.

5. Price Adaptation Costs (preliminary)

The cost estimates provided below have been prepared based on very limited data and without engineering design calculations. They are therefore indicative only and have been prepared to assist council with the priority setting processes. They should not be relied on for budgeting or construction cost management purposes. **Table 5:1** is a summary of the adaptation options for Price grouped according to the categories of *protect, accommodate, or retreat*.

Table 5:1 Summary of adaptation options for Price

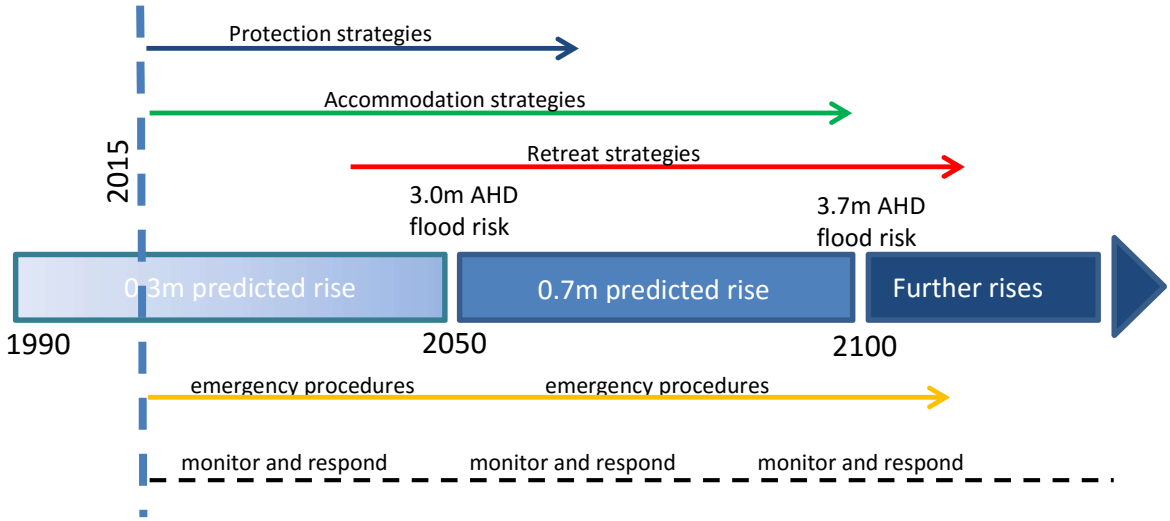
	Adaptation options	Approximate cost	Reference pp.
Protect	Raise existing caravan park bund to 3.0m AHD	$9,600	12
	Raise the existing causeway road by 0.3m	$193,000	13
	Change direction of the slope of the road to the entry of the causeway (adjacent caravan park)	$17,000	15
	Widen existing bund between the road and caravan park and raise to 3.0m AHD	$6,500	16
	Install tidal flap to point storm water exits to the samphire flat (northern side of caravan park) or install storm water reclamation project.	Not costed	17
Accommodate	Check caravan park sea-flood emergency procedures	Not costed	18
	Install flood depth markers to the boat ramp causeway.	$2000	18
Retreat	Subject to monitoring that quantifies the rate of sea level rise, relocate the caravan park (or at least the lower portion). In relation to infrastructure and buildings in the community area, make decisions based on long term sea level rise policy levels.	Not costed.	19

Within all of these adaptation options is the option to 'defer' or 'do nothing'. For example, cost may prohibit the implementation of a protection measure and therefore the project is deferred. In other cases, the risk might be deemed so minor that 'do nothing' is adopted.

6. Price – Timing and prioritisation

7.1 Timing of adaptation options

In general, **Figure 6:1** illustrates how the different protection, accommodation, and retreat options interrelate over time. Sea level rise and erosion are monitored over time and response made accordingly. Emergency procedures are always in place and amended according to the conditions. When protection measures become inadequate, accommodation options mitigate the risk. Subject to ongoing monitoring longer term decisions are made in relation to the viability of the settlement itself.



7.2 Prioritisation of adaptation options

Prioritisation of adaptation options is based on the following criteria:

- First, warning and emergency procedures to ensure people are safe.
- Second, begin changes to planning policy (if required) as this process takes time, and the life span of infrastructure is long.
- Third, implement monitoring systems because these are not onerous, and the Council may be liable without them.
- Fourth, provide protection works to protect Price for the current sea-flood risk.
- Fifth, provide protection works to protect Price for the sea-flood risk for 2050.

Subject to Council and community input the following prioritisation in **Table 6:1** is recommended for Price.

Table 6:1 Prioritisation and responsible entities for adaptations at Price

	Adaptation response	Risk rating and other priority factors	Response time	Map reference
1.	Review the emergency procedures for the caravan park which should be maintained even if protection options are implemented.	Such procedures are a wise response to living adjacent to an unpredictable threat.	Within 1 year	NA
2.	Install flood depth markers to the boat ramp causeway.	Flood depth markers will increase awareness and safety of drivers.	Within 1 year	NA
3.	Implement monitoring systems to assess the state of protection bunds (suggest annual inspection should be adequate and a qualified engineer conducts an inspection every 5 years)	A duty of care exists for the condition of bunds	Within 1 year	NA
4.	Raise to 3.0m AHD and widen the existing bund between the caravan park and the access road to the causeway.	The existing bund is below the current sea-flood risk level and is of unknown integrity	1-2 years	4
5.	Change the slope of the access road to the causeway at the same time that (4) is implemented.	It is logical to undertake (4) and (5) together, and changing the slope of the road will protect the bund from storm water erosion.	1-2 years	3
6.	Raise the caravan park bund to 3.0m AHD	The current height of the bund is likely to be adequate for the current risk, but the added top is of unknown integrity.	1-2 years.	1
7.	Raise the causeway and portion of the boat ramp area by 0.3m.	The causeway is frequently inundated and with rising sea levels this will be exacerbated. The western side of the causeway is currently being eroded. A decision will need to be made about whether the causeway is to be retained or lost.	2-5 years	2
8.	Install tidal flaps where storm water exits to the samphire flat and/or install storm water reclamation project.	As the sea continues to rise, sea-water will flow back through storm water outlets. This is likely to be a current threat at Price. However, the benefit so of a stormwater	5-10 years	5

		reclamation project may warrant this adaptation option a higher priority.		
9.	Subject to monitoring that quantifies that the rate of sea level rise, relocate the caravan park (or at least the lower portion). In relation to infrastructure and buildings in the community area, make decisions based on long term sea level rise policy levels.	Long term decision making for the caravan park and community area should take into account long term projections and monitoring of sea level rise.	30-40 years	NA

7. Community consultation

A community consultation meeting was held at the Port Clinton community hall on 18th August 2015 at 2.30pm for residents of Price and Port Clinton to attend. While three persons attended the first community meeting on 14th April, no-one from Price attended the second community meeting on 18th August, 2015.

Subsequent to the first community in April, two of the three participants at that meeting were met on location at Price and more comprehensive feedback was obtained at this time.

The non-attendance of participants from Price may also reflect that information from the first community meeting was given that indicated that the residential section of Price was more elevated and not likely to suffer inundation from sea level rise over this century.