[redacted]

MEMORANDUM

To [redacted]

From [redacted]

Date 18 July 2022

Subject 169A Princes Highway, Port Fairy - Rivers Run Development Impact Assessment

1 OVERVIEW AND PURPOSE

Over the last 12 years there have been numerous flood modelling and mapping projects focussing on the Moyne River and Port Fairy. Water Technology originally developed a MikeFlood hydraulic model during the Port Fairy Regional Flood Study and the following Sea Level Rise Assessments (Water Technology, 2008/2012). This was then transferred to SOBEK with changes to the ocean boundary by Cardno in 2020. Amendments were then made to the Cardno model by HARC in 2021 to better capture elements of the original Port Fairy Regional Flood Study modelling, and this model was used to develop layers for the proposed C69 Amendment to the Moyne Shire Council Planning Scheme.

Within the C69 Amendment it is understood the proposed Land Subject to Inundation (LSIO) and Flood Overlay (FO) layers were developed by the following inundation scenario:

- 5% AEP Moyne River modelled design flood – flows extracted from the Port Fairy Regional Flood Study (Water Technology, 2008).
- 1% AEP design ocean storm surge – extracted from the Port Fairy Hazard Assessment (WRL, 2013).
- 1.2 m Sea Level Rise (notional 2100 case).

There have been two review documents prepared by Water Modelling Solutions (WMS), an initial review of the Cardno modelling used to produce layers for the planning scheme amendment commissioned by Moyne Shire Council, followed by a comparison of the Cardno and Water Technology modelling commissioned by Glenelg Hopkins CMA.

The major point of difference between the two models, according to WMS in their June 2020 memo to GHCMA, was the ocean boundary applied to the South West Passage. For this, the Cardno modelling used a much higher water level due to a different approach in its determination (based on analysis by WRL in their 2013 coastal hazard study). Water Technology maintains the view that the ocean boundary conditions developed by WRL and adopted by Cardno for the South West Passage are overly conservative and do not accurately reflect a reasonable assessment of flood risk in the lower Moyne River.

The impact of various development arrangements at 169A Princes Highway, Port Fairy (the Rivers Run development, also referred to as the Subject Site) has been determined using a modified version of the Port Fairy Regional Flood Study modelling using the lower ocean boundary in the South West Passage. As part of a revised design of the Subject Site the Port Fairy Regional Flood Study model has been modified to include the higher Cardno adopted design water level in the South West Passage and rerun for existing conditions and with the inclusion of the latest Subject Site development plans.

The purpose of these this memo is to document the outcomes of this modelling and demonstrate what, if any, impact the proposed development has on design flood levels on adjoining or nearby properties and discuss the basis and context of the proposed LSIO and FO layers.

2 DEVELOPMENT OVERVIEW

The Rivers Run development is on the northern edge of the Moyne River floodplain and Belfast Lough, as shown in Figure 2-1. A neutral cut and fill balance across the site has been achieved at the level of the 1% AEP design storm surge and 5 % AEP design riverine flood with the inclusion of 1.2 m sea level rise (SLR). The cut-fill balance has been achieved through the excavation of a Soakage Basin, a Sediment Basin and numerous culverts and raised roads. Further detail around the development plans can be sourced from the Greening Structural and Civil plans, reference Job Number 18-058, Drawing FP02, as shown in Figure 2-2. The Greening Structural and Civil plans also show building floor levels and access and egress within the proposed development meet the requirements of Glenelg Hopkins CMA.

Figure 2-1 169A Princes Highway, Port Fairy

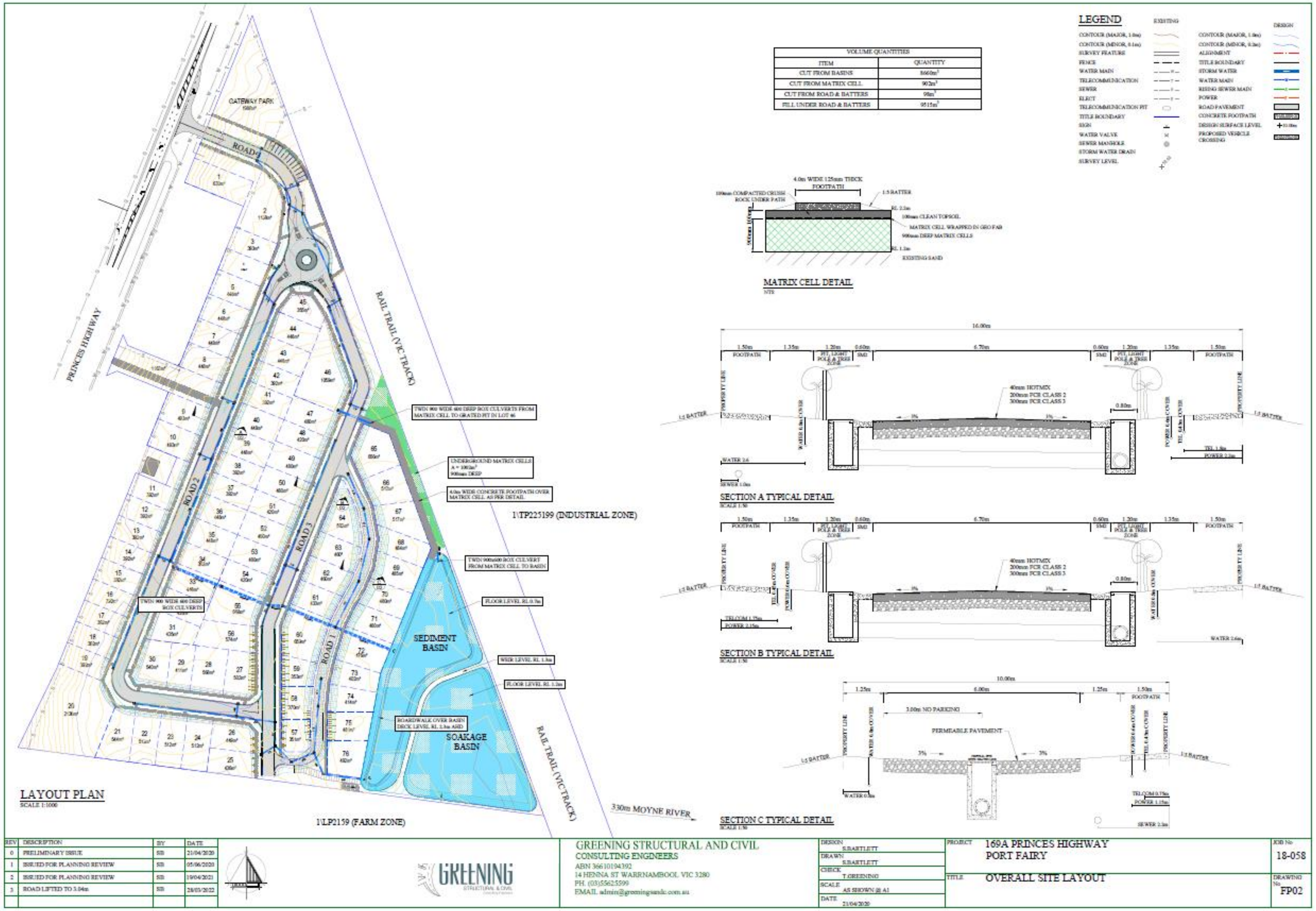


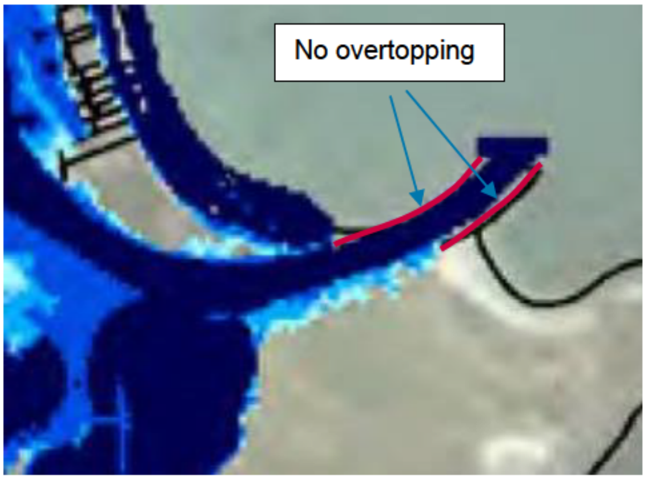
Figure 2-2 Development plans

3 MODELLING

3.1 Overview

As discussed in Section 1, the Port Fairy Regional Flood Study model was modified to include the same South West Passage water level boundary as used by Cardno in the development of the C69 planning layers. The model was run for both existing conditions and with the inclusion of the Rivers Run development conditions, using a 1% AEP storm surge, 5% AEP riverine flood and a 1.2 m sea level rise scenario. The existing conditions modelling determined a peak 1% AEP water level of 3.21 m AHD, this is slightly lower than the Glenelg Hopkins CMA supplied water level on the site of 3.34 m AHD. The difference in these water levels is likely to do with misrepresentations in the Cardno/HARC modelling when the model was transferred from MikeFlood to SOBEK. The most obvious inconsistency is the Moyne River mouth boundary, where the Cardno model did not allow overtopping of the Moyne River training walls near the river entrance. Testing of this misrepresentation indicates an 8 cm water level influence within Belfast Lough.

Modelling completed as part of the Port Fairy Regional Flood Study had impermeable training walls along Moyne River mouth, with water unable to overtop them. This was the case because the ocean boundary was not high enough for the training walls to be overtopped. The revised water level boundary adopted by Cardno for the South West Passage is higher than the training walls and hence they will overtop. This was updated in the revised modelling presented in this memo. The Cardno modelling appears to artificially restrict the Moyne River mouth capacity. How this has been represented in each model is shown below in Figure 3-1.



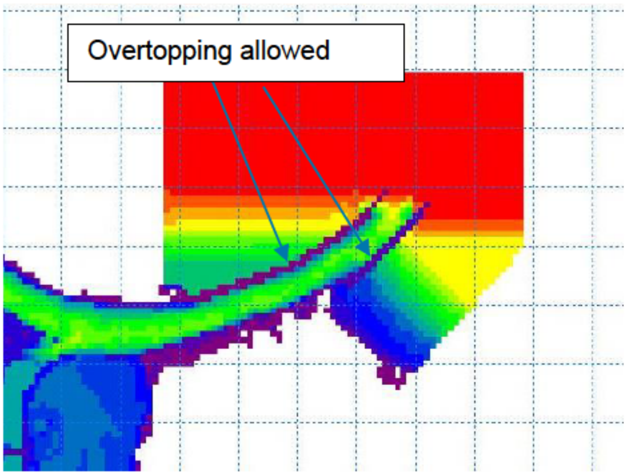


Figure 3-1 Comparison of the Cardno (left) and Water Technology (right) Moyne River mouth model representation.

Regardless of this difference and comparison across the two models, the assessment for this project was completed by comparing existing conditions modelled water levels to those modelled for development conditions. This means any minor difference in the absolute peak flood levels modelled does not meaningfully impact the relative assessment of the development compared to current conditions.

3.2 Results

The change in modelled water levels was determined by subtracting the existing conditions peak modelled water levels from those determined in the development scenario.

This calculation is shown below:

Developed 1% AEP water levels with Basin Full – Existing 1% AEP water levels

The resulting water depth grid shows positive values where there has been an increase in peak water levels and a negative value were there has been a decrease.

The change in water levels is shown in Figure 3-1 and Figure 3-2 at a zoomed out and zoomed in perspective respectively.

The results show no change in modelled water levels greater than 1 cm outside of the development area (the water level change in Belfast Lough is around 0.1 mm), there are also no areas which become inundated or inundation free outside of the development. Within the development parcel, several areas have become inundated and are inundation free due to the changes in land surface associated with the proposed development.

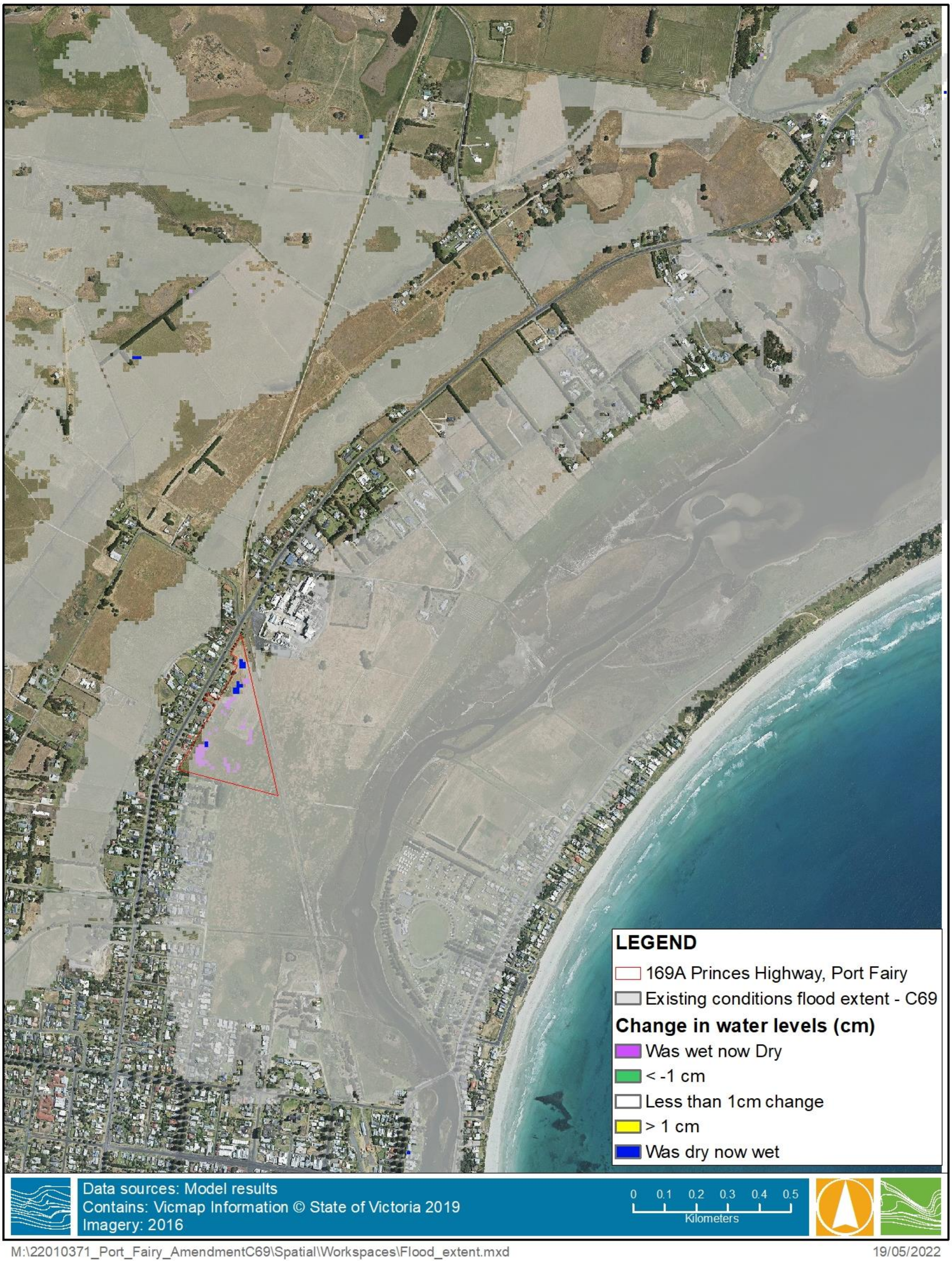


Figure 3-2 Change in water levels due to the proposed Rivers Run development (1% AEP storm surge, 5% AEP riverine flooding in a 1.2 m sea level rise scenario)

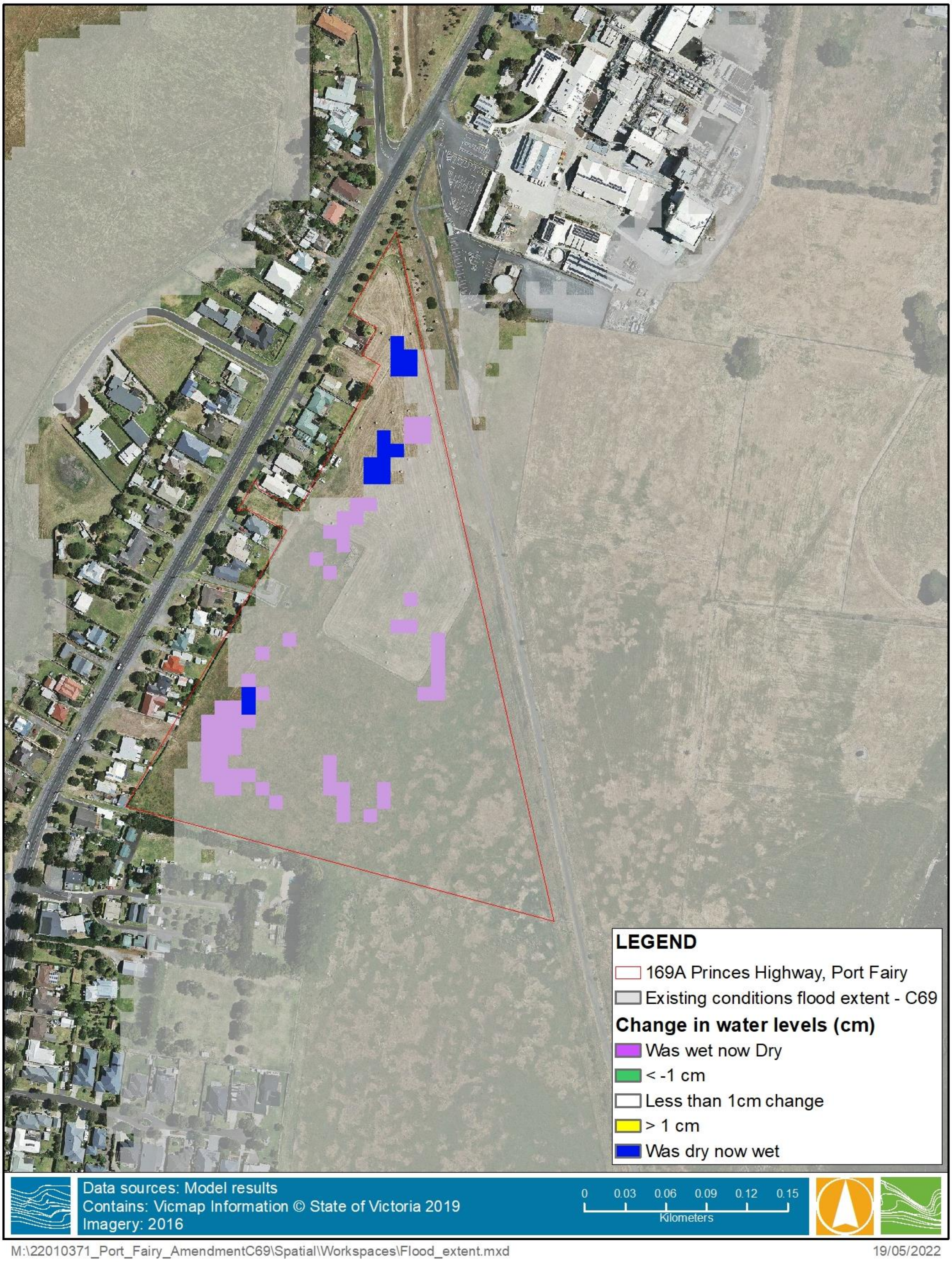


Figure 3-3 Change in water levels due to the proposed Rivers Run development (1% AEP storm surge, 5% AEP riverine flooding in a 1.2 m sea level rise scenario)

4 LSIO AND FO CONSIDERATIONS

As discussed in Section 1, the proposed C69 FO and LSIO controls are based on a range of inputs including a 1.2 m SLR plus storm surge, notionally representative of predicted conditions in 2100. This is a highly conservative scenario, with the 1.2 m SLR assumption applied by Council at 2100 not supported by the best available science and data. There are a range of projected sea level rise values at 2100 depending on the scenario selected. The IPCC (draft Sixth Assessment report 2021) scenarios are as follows:

- SSP1-1.9: emissions rapidly decline to net zero by about 2050, and become negative after that
- SSP1-2.6: emissions decline to net zero by about 2075, and become negative after that
- SSP2-4.5: emissions rise slightly, before declining after 2050, but not reaching net zero by 2100
- SSP3-7.0: emissions rise steadily to become double their current amount by 2100
- SSP5-8.5: emissions rise steadily, doubling by 2050 and more than tripling by the end of the century

SSP stands for “Shared Socioeconomic Pathways” and the numbers after refer to the previously defined IPCC representative concentration pathways (RPCs) which reflect the increased rate of energy (e.g. stored as heat) trapped in the Earth system by the increased concentrations of greenhouse gases. The RCPs can be correlated with ranges of predicted average global temperature increase over time. As can be seen from the scenario descriptions above, SSP5-8.5 essentially assumes a “do nothing” scenario where emissions rise dramatically. This is not likely to occur as many countries across the world have already committed to significant reductions in greenhouse gas emissions (Paris Agreement, Glasgow Pact etc). Figure 4-1 below shows a range of potential temperature outcomes in 2100. Current science suggests with existing policy settings we are likely to reach around 3 degrees of warming by 2100 (Australian Academy of Sciences publication “The risks to Australia of a 3°C warmer world”, 2021). Three degrees of warming by 2100 is broadly reflected by the SSP2-4.5 scenario in the IPCC assessments.

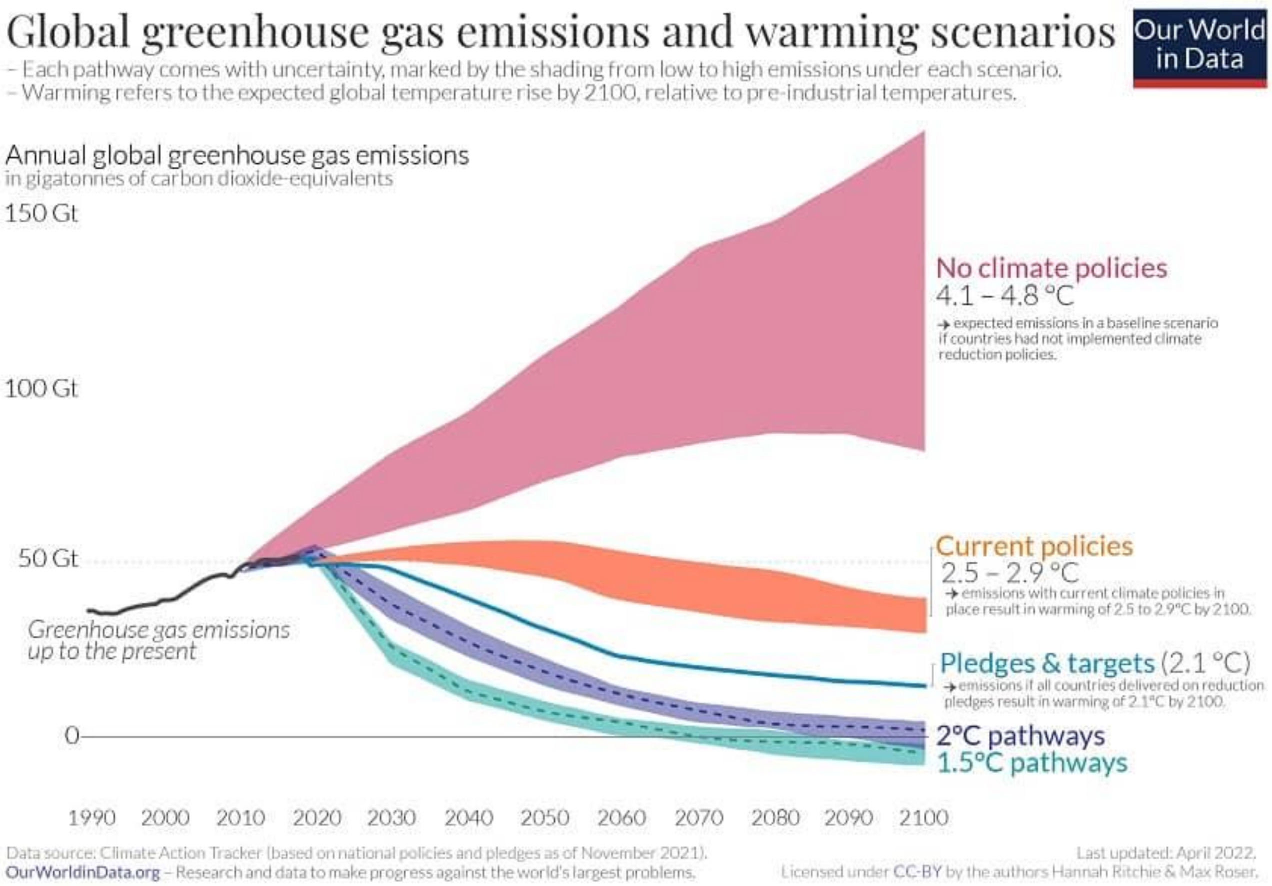


Figure 4-1 Range of Global Temperature Futures

Figure 4-2, Figure 4-3 and Figure 4-4 show excerpts from the NASA global seal level rise predictions for 2100, which are part of the IPCC 6th Assessment.

These show that the SSP2-4.5 scenario predicts 0.54 m SLR at 2100, this is arguably the most likely under the present emissions trajectory. The more conservative SSP5-8.5 scenario (essentially a do-nothing case which is not consistent with current global response to climate change) predicts a level of 0.72 m in 2100. This is consistent with data from the [Climate change and sea-level rise in the Australian region | CoastAdapt] website developed by the National Climate Change Adaption Research Facility (NCCARF) with funding from the Australian Government through the Department of the Environment and Energy. This shows (Figure 4-4) a level of 0.59 m for Melbourne for 2090, which is consistent with a level well below 1.2 m in 2100, demonstrating an extreme level of conservatism in the adopted scenario for both LSIO and FO.

Water Technology is presently undertaking coastal hazard studies around Australia (WA, NSW & QLD), we are not aware of any jurisdiction across Australia that is adopting anything above 0.9 m as a 2100 SLR component of planning level controls.

While the LSIO is a trigger for review of development in the context of potential flood hazard, the FO is much more restrictive, preventing any intensification of development through subdivision. The LSIO includes allowances for developments to manage their flood risk through design of earthworks (and other measures) and the adoption of elevated floor levels to minimise risk. These opportunities do not exist within the FO. The currently proposed C69 amendment largely covers the Rivers Run development with FO, based on the adoption of a highly conservative 1.2 m SLR scenario. This is highly restrictive and does not allow for a flexible adaptation pathway for climate change considerations.

The Floodway Overlay is not intended to apply to areas of coastal inundation. Neither the schedule to the FO or Planning Practice Note 12 (PN12) “Applying the Flood Provisions in Planning Schemes A guide for councils”, mention sea levels or the coast. Rather there is reference to floodplains and rivers throughout each document.

Under “Types of flooding” in PN12 it says that:

*“Floods in Victoria are usually caused by heavy or prolonged rainfall, which can result in either **‘mainstream flooding’** or **‘stormwater flooding’**. These two types of flooding are the basis of the flood zone and overlays in planning schemes.”* (emphasis added)

Furthermore PN12 then states:

“Other types of flooding such as flooding associated with the failure of dams or water-supply systems are not specifically addressed in planning schemes.”

This confirms that when the overlays and associated schedules were developed, coastal flooding was not contemplated as one of the drivers of flooding to be associated with the planning scheme. This is not to suggest that these overlays, in the absence of any other mechanism in the planning scheme, should not be used for this purpose, however it does mean that their use for such purposes needs to be carefully considered and applied. In this regard, simply applying riverine rules and methods to coastal flood situations may not be appropriate.

Section 44.03 Floodway Overlay in the Moyne Planning Scheme, specifies the following purpose (among others):

To identify waterways, major floodpaths, drainage depressions and high hazard areas which have the greatest risk and frequency of being affected by flooding.

This sets the criteria for the FO being hazard, but also frequency. In the consideration of applying the FO with climate change conditions in 2100, the frequency aspect is objectively not met. 1% AEP design storm conditions are not frequent and in the case of SLR will not occur at that frequency for decades (or longer given the extreme SRL level proposed).

The Melbourne Water provides the following description on their website (Overlays explained | Melbourne Water). This suggests that Melbourne Water’s position is that Floodway Overlays are associates with waterways and not open coasts.

Floodway Overlays (FO) - These apply to land that's identified as carrying active flood flows associated with waterways and open drainage systems. This overlay is categorised by depths in excess of one metre.

The DELWP Guidelines for Development in Flood Affected Areas (February 2019) offers the following description of the Floodway Overlay

Floodways are those parts of the floodplain that are important for the discharge or storage of water during major floods. They are usually aligned with naturally defined waterways, channels and depressions and often carry relatively deep and high velocity flows.

It is clear from the above that neither DELWP nor Melbourne Water include risk of flooding from coastal mechanisms as a driver for the Flood Overlay. This is because coastal flooding is typically not sensitive to storage or conveyance characteristics which are the dominant processes in flood wave propagation.

It is reasonable to have a conservative trigger for flood hazard development assessment within areas of potential future inundation (triggered by the LSIO). For example, it is sometimes proposed to apply the designated flood level plus freeboard as the planning trigger extent. This can ensure that fringing lots, just outside the designated flood extent, do not end up with floor levels below their neighbouring properties inside the flood extent.

However, largely preventing development without the opportunity to consider flood hazard mitigation (by controls within the FO) is inappropriate. Particularly without consideration of the reality that the scenario adopted is highly unlikely to eventuate over a reasonable planning horizon (by 2100). It would be more appropriate for the Rivers Run development to be within the LSIO, enabling proper consideration of flood hazard mitigation and assessed fully against the current and potential future inundation scenarios.

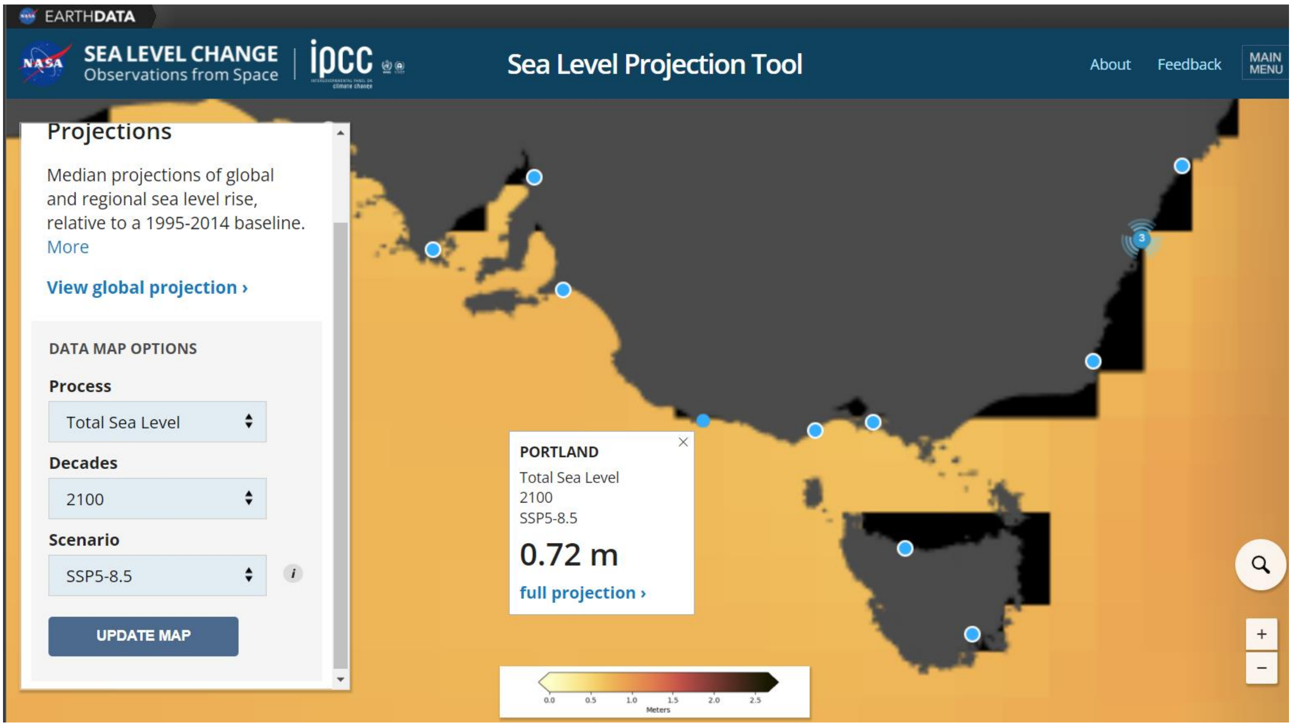


Figure 4-2 Predicted Sea Level Rise (NASA, source: https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool)

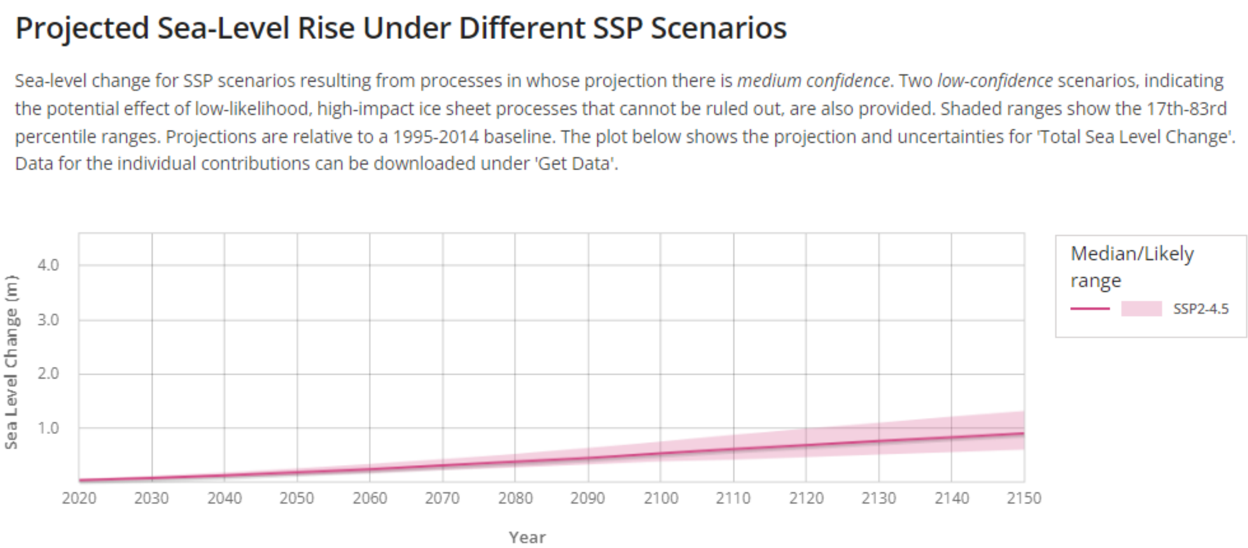


Figure 4-3 Projected Sea Level Rise under mid-range global mean temp. increase (~3 deg by 2100)

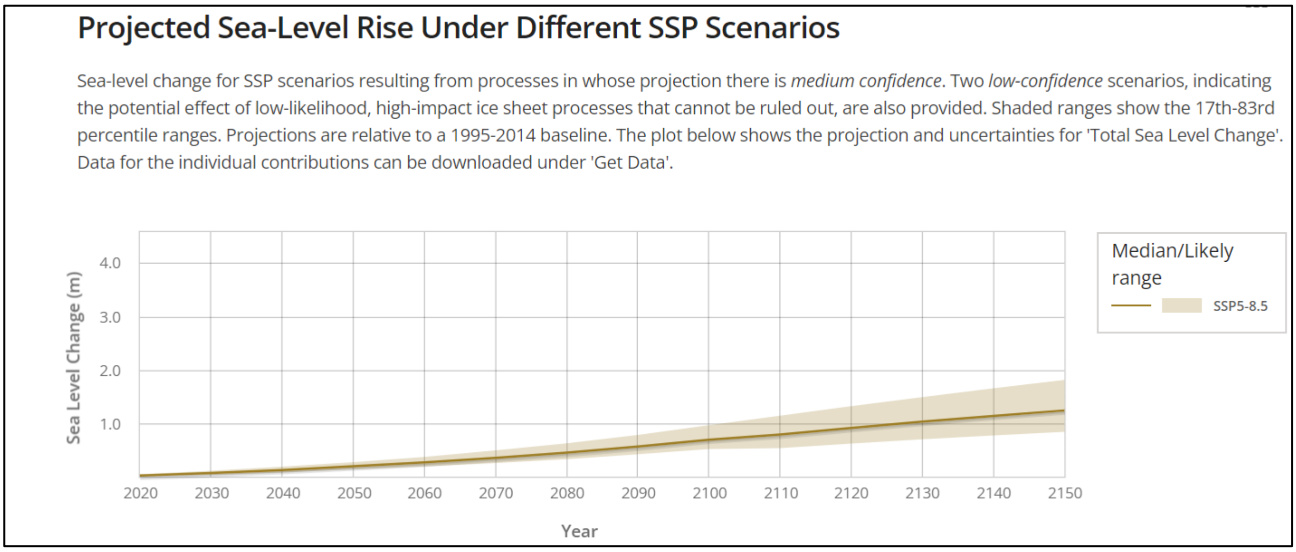


Figure 4-4 Portland SLR Predictions

City	2030 RCP 4.5	2090 RCP 4.5	2090 RCP 8.5
Adelaide	0.12 (0.08 to 0.16)	0.45 (0.28 to 0.63)	0.60 (0.39 to 0.83)
Brisbane	0.13 (0.09 to 0.18)	0.47 (0.31 to 0.65)	0.65 (0.45 to 0.87)
Darwin	0.12 (0.08 to 0.16)	0.47 (0.30 to 0.65)	0.62 (0.41 to 0.85)
Hobart (Spring Bay)	0.13 (0.09 to 0.18)	0.48 (0.31 to 0.66)	0.66 (0.45 to 0.89)
Melbourne (Stony Point)	0.11 (0.07 to 0.16)	0.44 (0.27 to 0.62)	0.59 (0.38 to 0.81)
Perth (Fremantle)	0.12 (0.07 to 0.16)	0.46 (0.28 to 0.65)	0.61 (0.39 to 0.84)
Sydney	0.13 (0.09 to 0.18)	0.47 (0.30 to 0.65)	0.66 (0.45 to 0.88)

Table 3: Sea-level projections (in m) for 2030 under the intermediate (RCP4.5) concentration scenario, and for 2090 under the intermediate (RCP4.5) and high (RCP8.5) concentration scenarios with the confidence interval (10th and 90th percentile) given in brackets. Source: Webb and Hennessy 2015.

Figure 4-5 CoastAdapt SLR Predictions

A review of the proposed Flood Overlay plans suggests they are poorly defined. An example is provided in Figure 4-6 below. This shows a highly fragmented presentation of FO and LSIO areas. It would be highly impractical to interpret such a map at a lot-by-lot basis. The numerous small islands of LSIO and FO are not meaningful in the broader context of the mapping.

We believe that most of the FO3 area withing the Subject Site could be replaced with LSIO4. A new FO mapping extent defined by a revised set of criteria based on existing flood risks and reviewed depth/hazard parameters would be appropriate for the broader Amendment area, including the subject site. With the focus on riverine flooding for the FO, assessment using flood-dominated conditions rather than ocean dominated conditions would be appropriate. It is expected that such a layer would be similar to the existing FO.

The LSIO extent could be based on either the 1.2 m or 0.8 m SLR criteria. In either case we consider the 0.8 m scenario is the most appropriate one to apply at present for the setting of planning levels and impact assessments related to permits. Freeboard can then be applied as appropriate by the CMA and Council (typically between 300 mm and 600 mm). We understand the present draft of the Local Floodplain Development Plan does not apply freeboard to the proposed planning levels which is not consistent with good floodplain management practice.

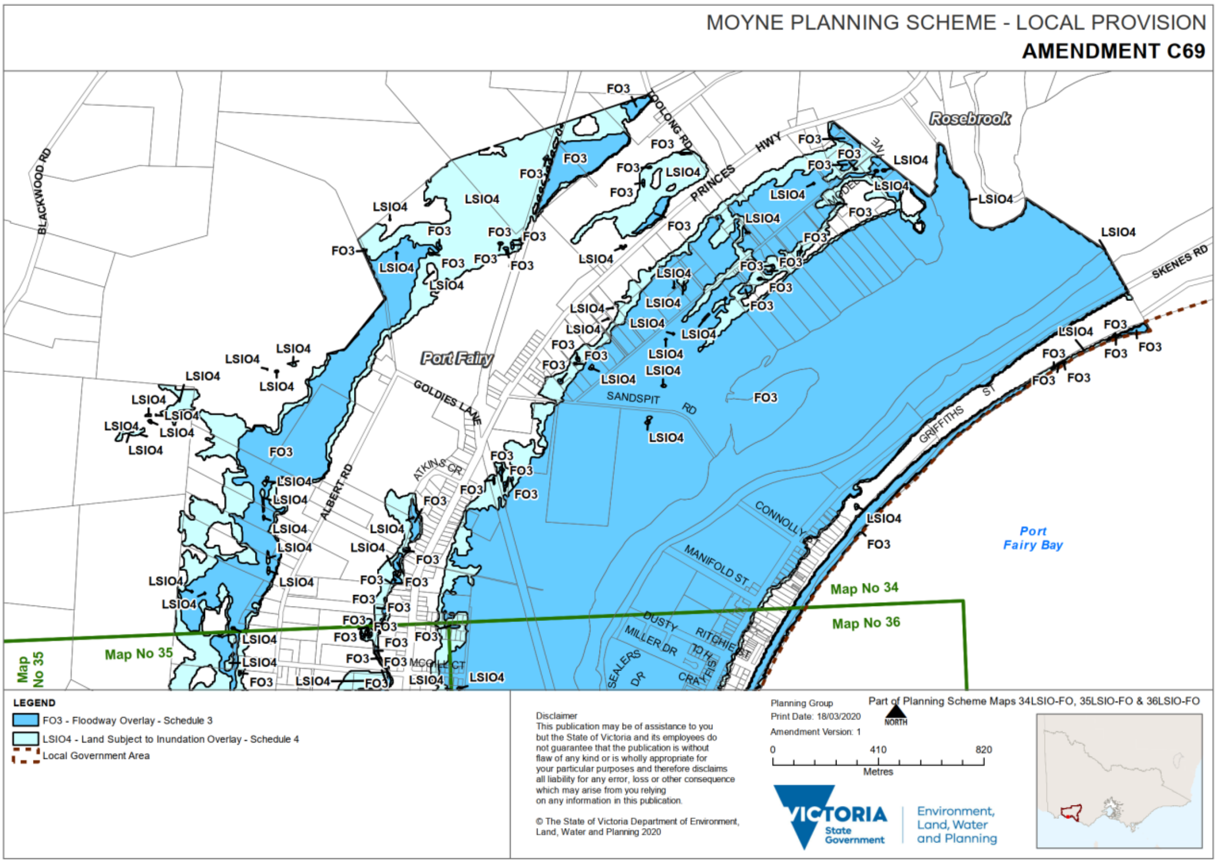


Figure 4-6 Example proposed Overlay Map

5 SUMMARY

Water Technology has modelled existing conditions and proposed developed conditions for the same design event scenario as adopted for the Moyne Shire Council Planning Scheme Amendment C69 (1% AEP storm surge, 5% AEP riverine flooding in a 1.2m sea level rise). It is noted that the modelling produces a water level 130 mm lower than the level provided from the HARC modelling used by Council, and it is suspected this is due to the HARC models incorrect assumption regarding the training walls at the river mouth.

The modelling shows no adverse impact on water levels within Belfast Lough or the Moyne River floodplain as a result of the proposed development.

Previous modelling for the proposed development using a 1% AEP riverine flood event and a 10% AEP storm surge has indicated the proposed Rivers Run development is able to readily meet the standard floodplain management criteria and earthworks within the site have a limited impact on water levels within Belfast Lough.

The adoption of a 1.2 m SLR scenario for an LSIO layer on the River Run development site (and across the broader Amendment area) is considered conservative but can allow for consideration of development and associated flood hazard mitigation measures through the referral process. Regardless of the ultimate LSIO extent (and causative SLR scenario adopted), I consider the 0.8 m SLR case is the appropriate scenario to be applied for planning decisions in Port Fairy at present.

The proposed FO layer is overly conservative, largely preventing development in a scenario which is not currently predicted to occur by 2100 on the best available science. The FO is not a planning layer that is intended for or generally applied in relation to coastal hazard and as such should reflect flood-dominated inundation conditions, rather than coastal-dominated. A more appropriate option would be to allow consideration of the proposed development mitigation measures in accordance with the LSIO requirements rather than those within the FO.