Jacobs Challenging today. Reinventing tomorrow.

Presentation to PICHTR and OIST:
International Approaches to Climate Change Planning and Adaptation in built and Natural Environments
10 March 2021

Christchurch Multi-Hazards Climate Change Adaptation

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Christchurch Multi-Hazards Climate Change Adaptation

Project Outline

Completed → Mapping and Prioritisation of Multi-Hazards

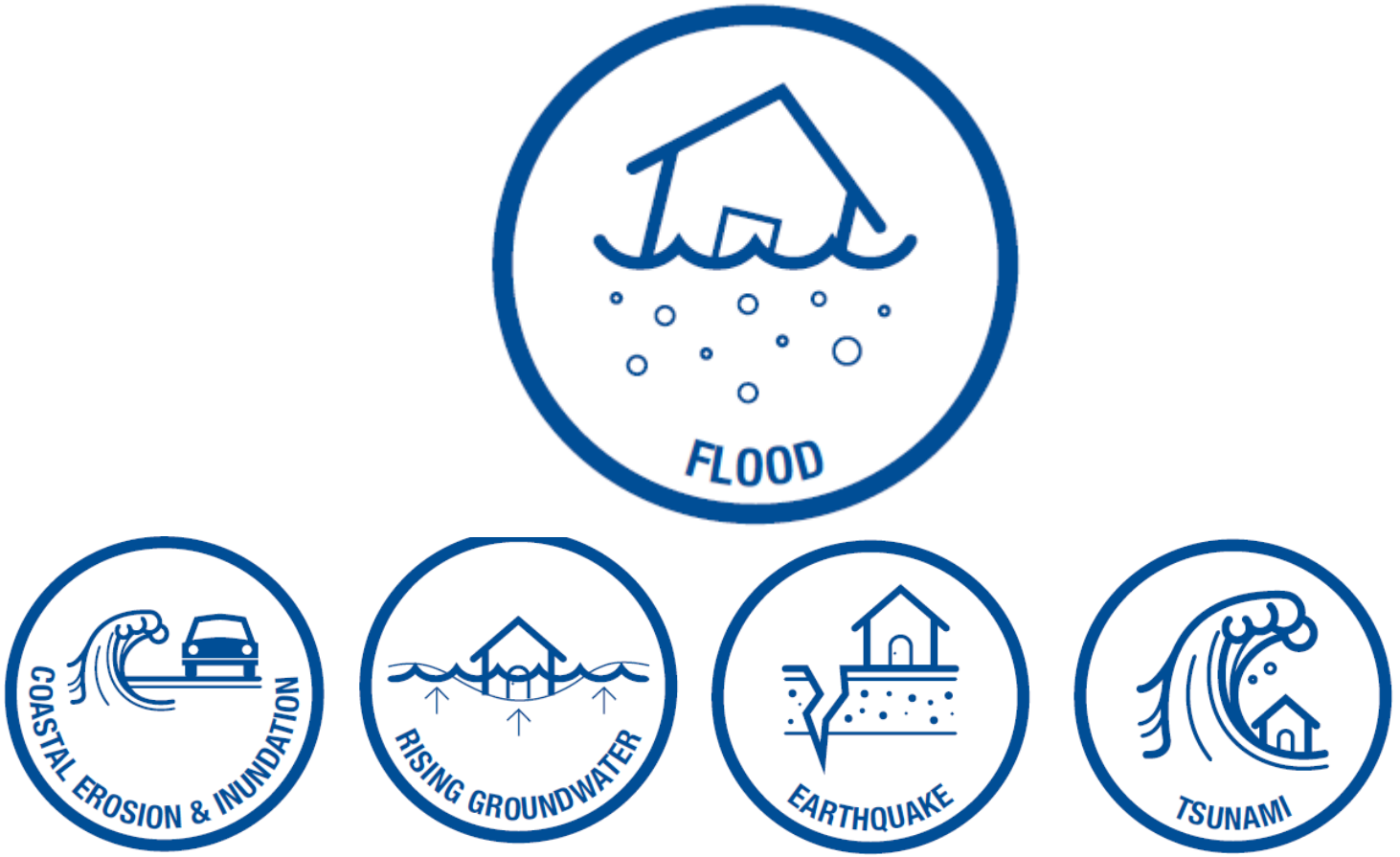
Modelling in progress → Define Changing Baseline Flood Risk

Decision-making exercise → Develop and Assess Pathway Components

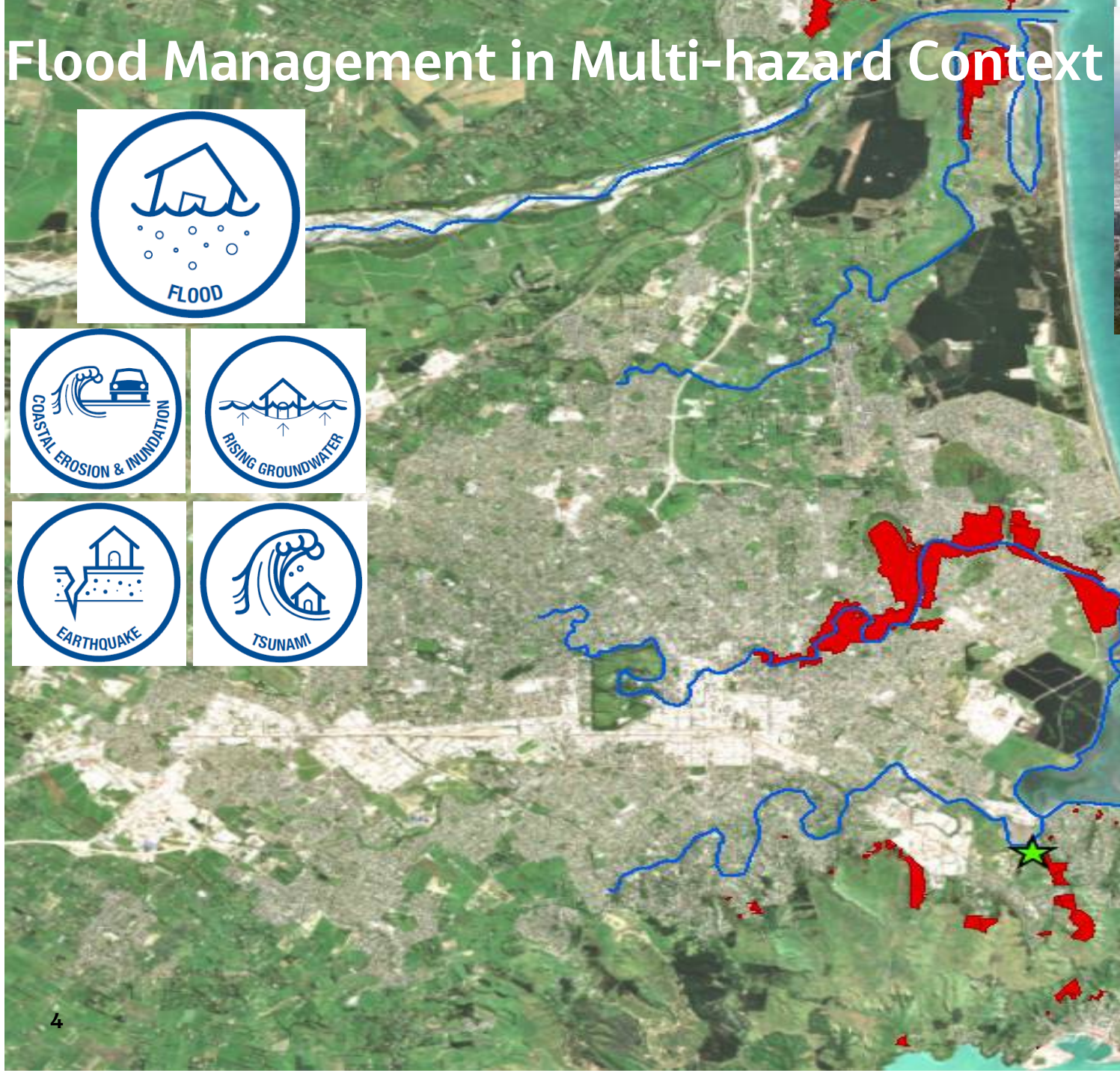
Develop Adaptive Flood Management Pathways

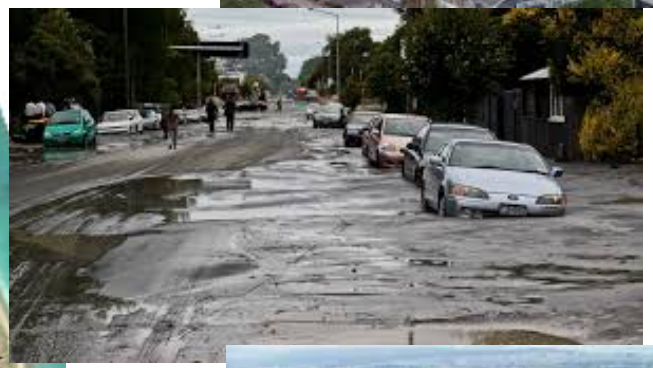
Flood Management in Multi-hazard Context

*The aim of the **multi-hazards** study is to develop **adaptive flood management plans** for the downstream tidally-influenced areas of Christchurch City*

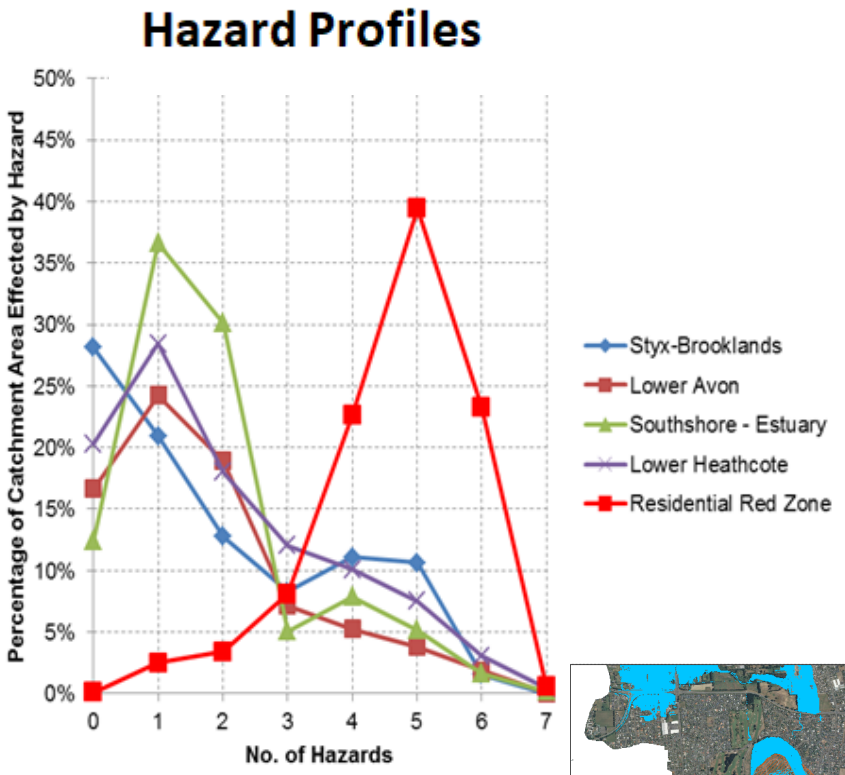


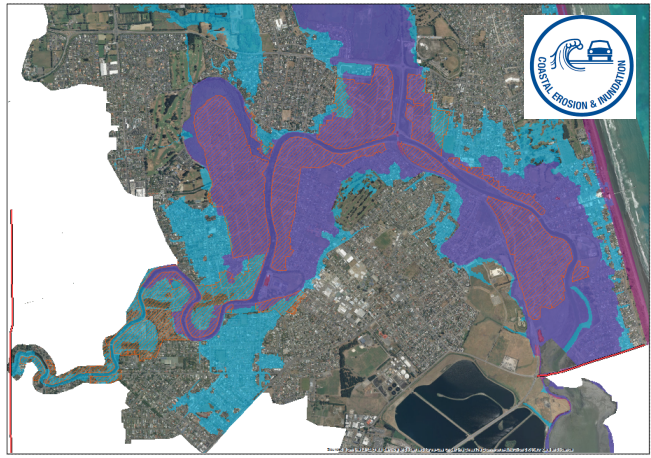
Flood Management in Multi-hazard Context

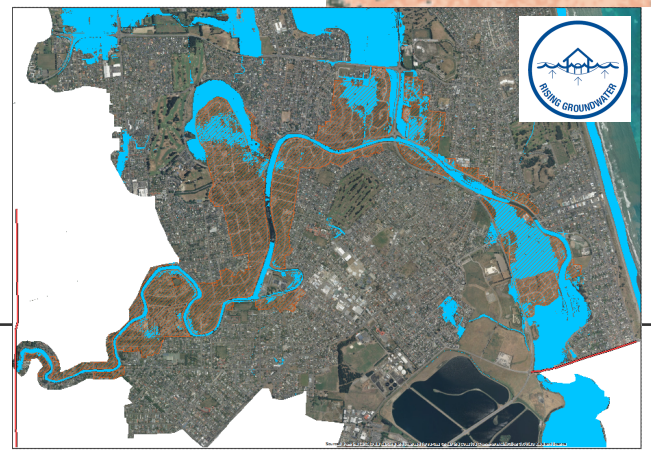


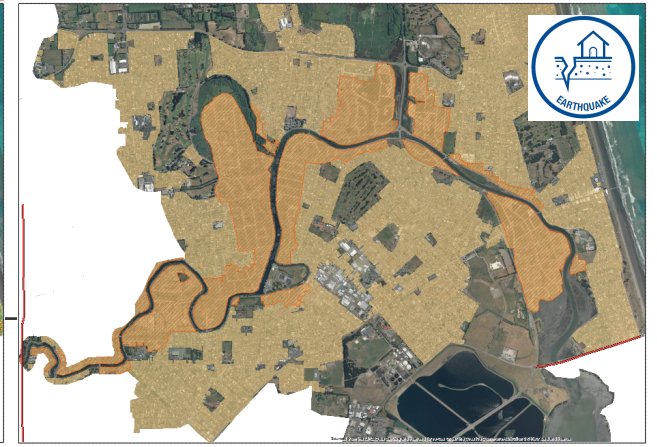


Multi-hazard Spatial Co-existence









Temporal Coincidence

Initial Quantitative assessment of -Likelihood - Consequence

Hazard	Likelihood of Temporal Co-incidence with FPF Event	Consequence of Co-incidence for Exacerbating Flooding
Coastal Storm	High	High
Snow and Hail Event	Low	Moderate (blocked drains, change antecedent conditions)
Extreme Wind Event	Low (except for coastal storms)	Low (except for coastal storms)
Future Coastal Erosion	High	High
Future Coastal Inundation	High	High
Distant Source Tsunami	Low	High
Regional Source Tsunami	Low	High
Local Source Tsunami	Low	High
Local Christchurch Earthquake	Low	High
Regional Canterbury Earthquake	Low	High
Distant Southern Alps Earthquake	Low	High
High Ground water Levels	High	High
Hill slope Instability	Moderate (erosion in extreme rainfall event)	Low
Waimakariri Flood – stopbank contained	Low	Moderate (mouth migration)
Waimakariri Flood – stopbank breached	Low	High

Cascades

Initial Quantitative assessment of
- Likelihood
- Geomorphic Permanence
- Consequence

Hazard	Cascade Likelihood	Cascade Geomorphic Permanence	Cascade Consequence for Exacerbating Flooding
Coastal Storm	High	Moderate (estuary/river mouth migration)	Moderate (estuary/river mouth migration)
Snow and Hail Event	Low	Nil	Low (only if very short term cascade of events)
Extreme Wind Event	Moderate	Nil	Nil
Future Coastal Erosion	High	High	High
Future Coastal Inundation	High	High	High
Distant Source Tsunami	Low	High (estuary/river mouth, estuary infrastructure)	High (estuary/river mouth, estuary infrastructure)
Regional Source Tsunami	Low	Moderate (less likelihood of permanent impacts)	Moderate
Local Source Tsunami	Low	Uncertain	Uncertain
Local Christchurch Earthquake	High	High (liquefaction, vertical displacement)	High
Regional Canterbury Earthquake	High	Moderate (liquefaction, vertical displacement)	Moderate
Distant Southern Alps Earthquake	High	Moderate (liquefaction, vertical displacement)	Moderate
Future High Ground water Levels	High	High permanent high water table	High
Hill slope instabilities	Moderate	High	Low limited ability to get in river channel/estuary
Waimakariri Flood-stopbank contained	Moderate	Moderate (mouth migration)	Moderate mouth migration)
Waimakariri Flood –stopbank breached	Low	Moderate	Moderate

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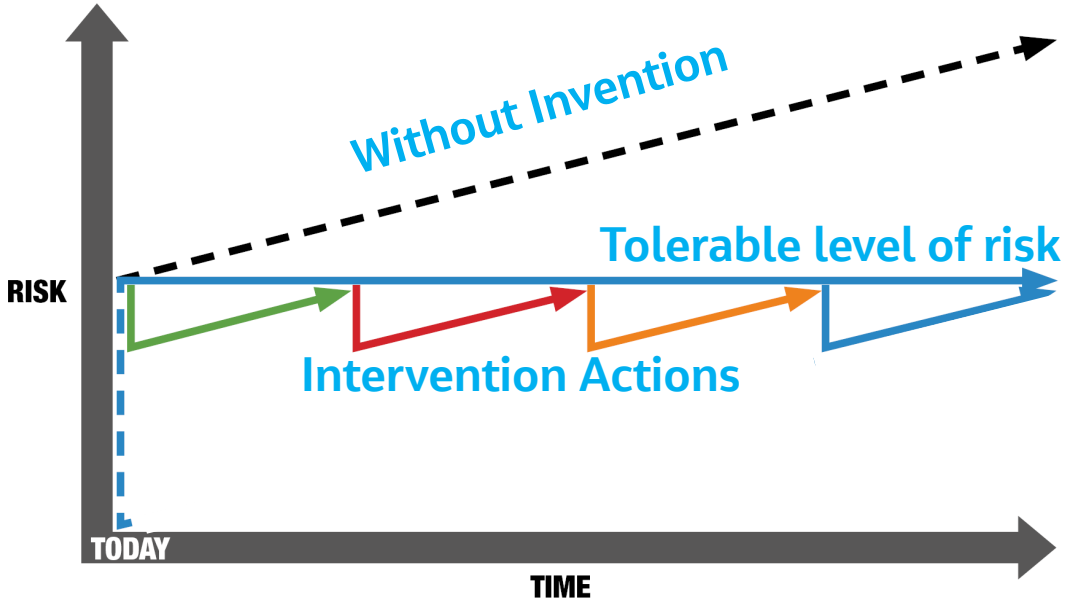
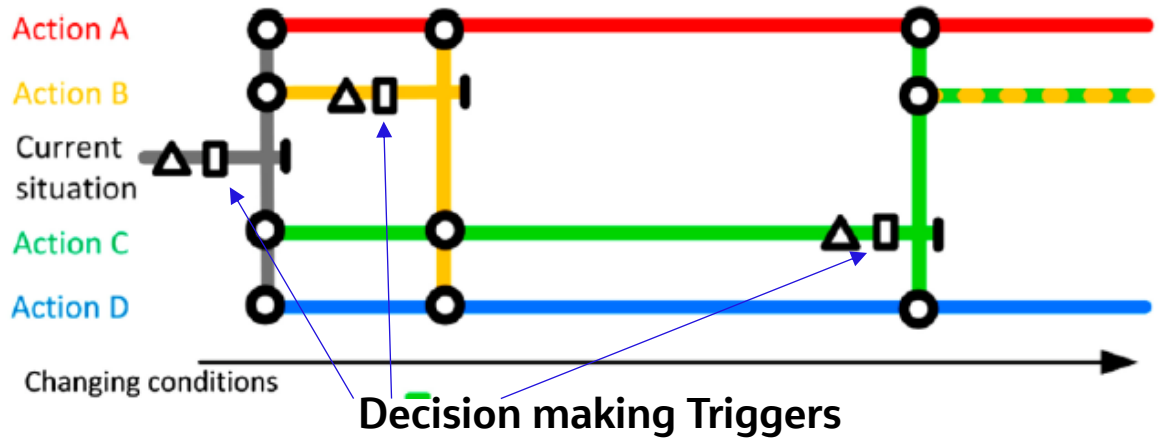
Schedule of Changing Baseline Flood Risk Modelling (Coincidence & Cascade)

Climate Change	Development	Groundwater	Coastal Erosion	Earthquake
Today	Existing	Existing	Existing	☒
2030 – 2040				☒
2060 - 2090				☑
2100 - 2150				☑
2150+				☒
Extreme				☒

End Outcome - Adaptation Pathways (The theory and in practice)





- Need to understand communities' **tolerance** to risk
- Likely **combination of actions** required at any point in time
- Many factors will determine a **preferred action**, and may change with time

Decision Making Board Exercise/Game

Adaptive Pathway Planning Sea Level Rise Increments

Sea Level Rise	+ 0.0m	+ 0.28m	+ 0.45m	+ 1.06m
Timeline (RCP 8.5)	2020	2050	2070	2120
Policy Options				
	District Plan Provisions (Do Minimum) ✓ Protects (Floor Levels) 90 MCA +8 Capital Cost ($M PV) $0	District Plan Provisions (Do Minimum) ✓ Protects (Floor Levels) 25 MCA +8 Capital Cost ($M PV) $0	District Plan Provisions (Do Minimum) ✓ Protects (Floor Levels) 0 MCA +8 Capital Cost ($M PV) $0	District Plan Provisions (Do Minimum) ✓ Protects (Floor Levels) 0 MCA +8 Capital Cost ($M PV) $0
	Room for the River (Managed Retreat) ✓ Protects (Floor Levels) 200 MCA +10 Capital Cost ($M PV) $60	Room for the River (Managed Retreat) Protects (Floor Levels) 1000 MCA +10 Capital Cost ($M PV) $5	Room for the River (Managed Retreat) Protects (Floor Levels) 1800 MCA +10 Capital Cost ($M PV) $5	Room for the River (Managed Retreat) Protects (Floor Levels) 2300 MCA +10 Capital Cost ($M PV) $5
Source Options				
	Tidal Control (Barrier and Stopbanks) Protects (Floor Levels) 500 MCA -4 Capital Cost ($M PV) $310	T… S…	…ontrol (Barrier and …nks) ✓ …rotects (Floor Levels) 1100 MCA -4 …Capital Cost ($M PV) $0	
	Tidal Control (River Mouth Pump Station & Stopbanks) Protects (Floor Levels) 500 MCA -3 Capital Cost ($M PV) $310	T… P… MCA -3 Capital Cost ($M PV) $72	MCA -3 Capital Cost ($M PV) $27	…ontrol (River Mouth …Station & Stopbanks) …Protects (Floor Levels) 2900 MCA -3 Capital Cost ($M PV) $2
Pathway Options				
	Stopbanks (Temporary) Protects (Floor Levels) 200 MCA -3 Capital Cost ($M PV) $15	Stopbanks (Temporary) Protects (Floor Levels) 600 MCA -3 Capital Cost ($M PV) $3	Stopbanks (Temporary) Protects (Floor Levels) 1300 MCA -3 Capital Cost ($M PV) $1	Stopbanks (Temporary) Protects (Floor Levels) 2300 MCA -3 Capital Cost ($M PV) $0
	Stopbanks (Permanent) Protects (Floor Levels) 500 MCA 0 Capital Cost ($M PV) $333	Stopbanks (Permanent) Protects (Floor Levels) 1000 MCA 0 Capital Cost ($M PV) $77	Stopbanks (Permanent) Protects (Floor Levels) 1800 MCA 0 Capital Cost ($M PV) $29	Stopbanks (Permanent) Protects (Floor Levels) 2900 MCA 0 Capital Cost ($M PV) $3
Receptor Options				
	Individual Property Protection Protects (Floor Levels) 210 MCA -1 Capital Cost ($M PV) $63	Individual Property Protection Protects (Floor Levels) 0 MCA -1 Capital Cost ($M PV) $0	Individual Property Protection Protects (Floor Levels) 0 MCA -1 Capital Cost ($M PV) $0	Individual Property Protection Protects (Floor Levels) 0 MCA -1 Capital Cost ($M PV) $0

Tidal Control (Barrier and Stopbanks) ✓

Protects (Floor Levels)	500
MCA	-4
Capital Cost ($M PV)	$310

Positive	>=9
Slight Positive	+3 to +8
Neutral	-2 to +2
Slight Negative	-8 to -3
Negative	<=-9

Residual risk after actions at each snapshot

Basecase floor levels at risk & damage estimate

Snapshots of Sea Level Rise

terfa

		+ 0.28m 2050	.45m 2070	+ 1.06m 2120
Future EQ				
Cumulative Basecase Floor Levels At Risk	00	1,000	1,800	2,900
Cumulative Basecase Damages ($M)		$71	$146	$164
Cumulative Residual Floor Levels at Risk	210	-315	-315	-315
Cumulative Residual Damages ($M)	$17	$17	$17	$0

✓ Option Selected for that period

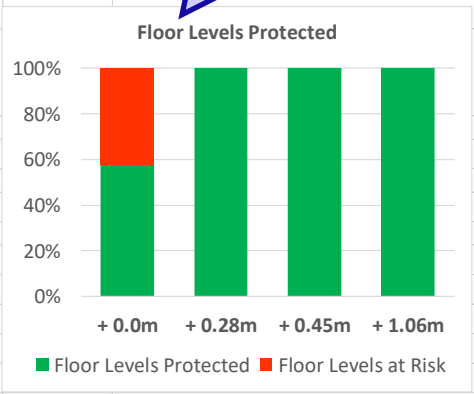
Clear Pathway | Toggle EQ Rows | Toggle Property Access

25% Future EQ Increase in Risk and Costs

$300,000

5% Discount

Quick-look "success" of pathway



Key pathway metrics incl. cost & overall MCA

NUMBER OF FLOOR LEVELS PROTECTED	2,900	100%
RESIDUAL FLOOR LEVELS AT RISK	0	0%
TOTAL COST ($M PV)	$132	
COST PER FLOOR LEVEL PROTECTED ($ PV)	$45,423	
OVERALL MCA SCORE	4	

Policy Options

	+ 0.0m	+ 0.28m	+ 0.45m	+ 1.06m
District Plan Provisions (Do Minimum)	✓	✓	✓	✓
Protects (Floor Levels)	90	25	0	0
MCA	+8	+8	+8	+8
Capital Cost ($M PV)	$0	$0	$0	$0
Room for the River (Managed Retreat)	✓			
Protects (Floor Levels)	200	400	[illegible]	2300
MCA	+10	+10	+10	+10
Capital Cost ($M PV)	$60	$28	$34	$5

Resistance Options

	+ 0.0m	+ 0.28m	+ 0.45m	+ 1.06m
Tidal Control (Barrier and Stopbanks)		✓	✓	✓
Protects (Floor Levels)	500	1000	800	1100
MCA	-4	-4	-4	-4
Capital Cost ($M PV)	$310	$72	$0	$0
Tidal Control (River Mouth				

Actions ticked on/off modify above metrics

Action benefit & costs updated to reflect actions already chosen

Thank You

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