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Reminder of Project Aims

- Develop a realistic and prioritised Investment Plan for Southwold Harbour
- Investment Plan to:
 - “advise on options to address the future function, operation and survivability of the **Southwold Harbour Entrance** in the broader context of estuary management”*
- Key Issues:
 - Poor condition / performance of South Pier
 - Mooring conditions at North Wall
 - Influence of future estuary tidal prism on sustainability of Harbour entrance structures

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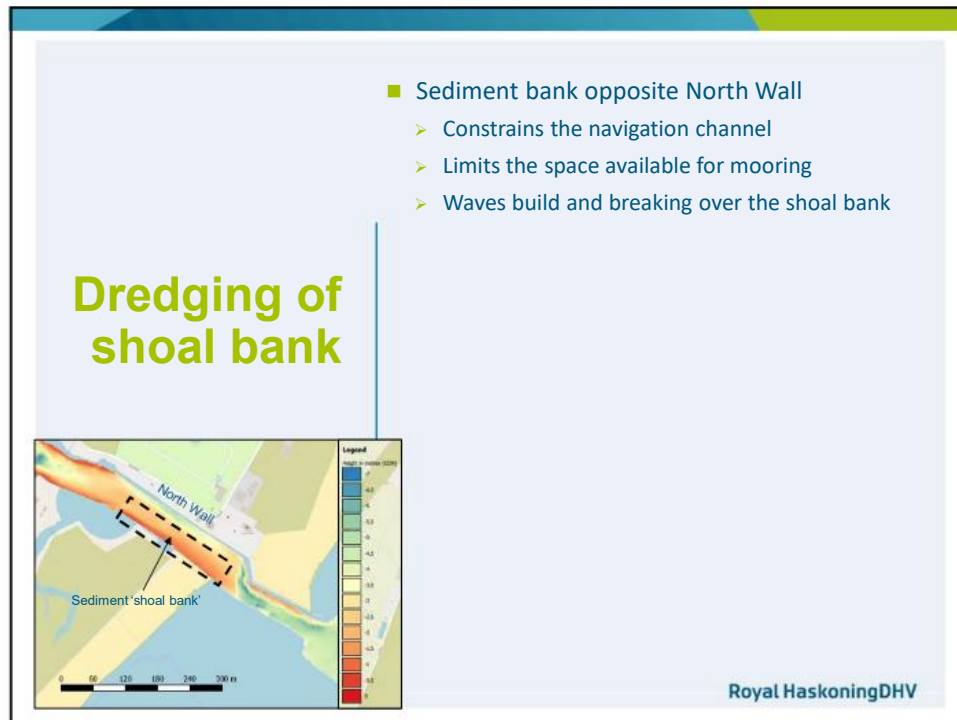
Key Issues for Discussion

- What do we want to get from this meeting?
 - Should the proposal for dredging of the shoal bank be taken forward?
 - Should the preferred option include a rock groyne to narrow the channel? If so, where should this be located?
 - What do the findings from the culvert assessment mean for the preferred option for replacement of the South Pier?

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Development of shoal bank

- Historic evidence of sediment blocking entrance and accumulating to north and south of channel
- Formation of shoal bank?
 - Shape of the Knuckle, area of lower flow velocity
 - Dunwich Creek disturbs downstream flows
 - Sediment released when timber piling installed
 - Sediment from Dunwich Creek
 - Offshore sediment driven into harbour during storms

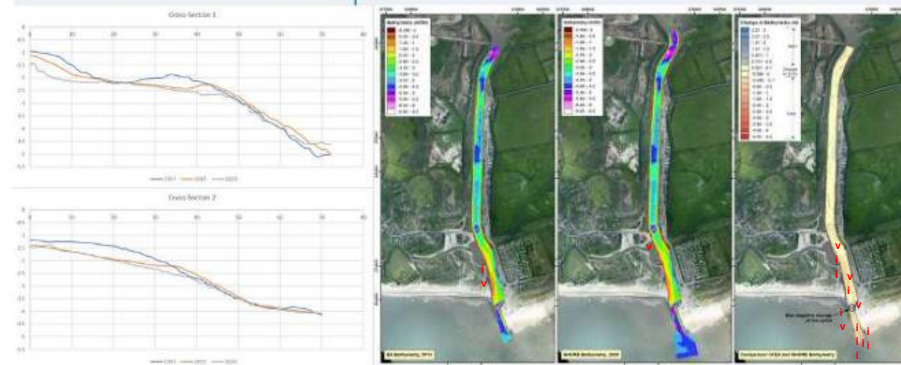


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Harbour bathymetry

- Comparison of 2013 and 2020 surveys:
 - Limited change in bed levels in entrance channel and at North Wall
 - 0.5m reduction in crest level of shoal bank
 - Width of bank varies
 - Possible slight extension or migration of shoal bank towards the entrance channel



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Dredging of shoal bank

■ Proposal to dredge shoal bank:

- Aiming to increase mooring at North Wall
- Initial review of benefits / constraints
- Further assessment needed, incl modelling

Potential impacts of dredging	
Benefits	Constraints
Increased width for navigation	Changing flow velocity and direction could impact navigation
More space for mooring at N Wall	Increased wave disturbance in inner harbour
Improved access to inner harbour	May require maintenance dredging
Dredged material could be re-used (S Pier works, eroded areas)	Further works needed to N Wall to enable safe mooring
Relatively low cost	Hard/compact material in channel and/or shoal bank?
	Licence needed for dredging?

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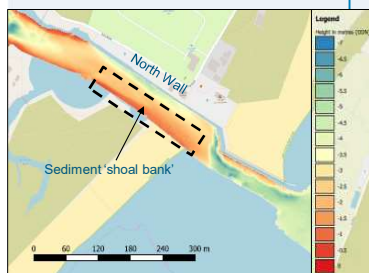
Dredging of shoal bank

■ Proposal to dredge shoal bank:

- Aiming to increase mooring at North Wall
- Initial review of benefits / constraints
- Further assessment needed, incl modelling

■ Issues considered :

- Impact on tidal flows (North Wall, entrance channel)
- Impact on wave conditions (North Wall, upstream)
- Related 'narrow channel' option
- maintenance requirements
- consent requirements



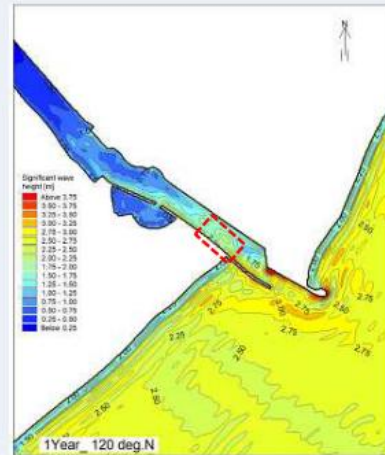
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Wave Modelling

■ Removal of shoal bank with existing South Pier:

- Waves won't build / break in this area
- Increased wave reflection, higher waves at N Wall
- Increased wave penetration into inner harbour
- Deeper water can sustain larger waves

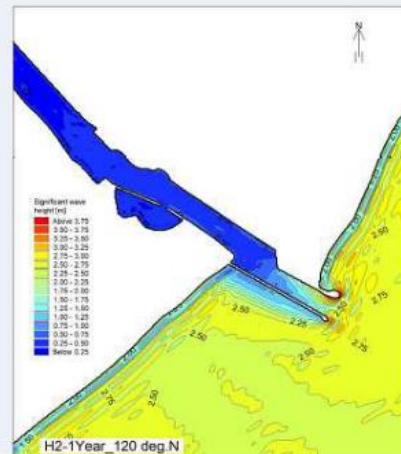


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Wave Modelling

■ With a rock breakwater:

- Breakwater reduces wave energy in outer harbour
- Shoal bank has less influence on wave conditions
- Removal of shoal bank would not change wave conditions at the North Wall
- Narrow channel reduces wave penetration upstream



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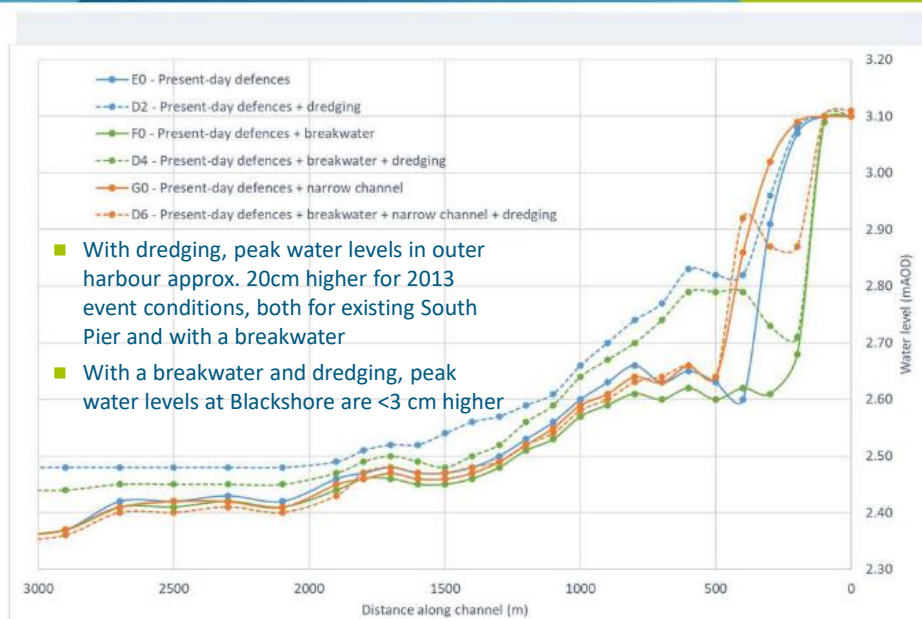
Tidal Modelling

- Additional modelling:
 - Outer harbour dredged to -4.0mODN
 - Narrow channel option considered (2 locations)
- Peak water levels:
 - Bank acts to narrow the channel
 - With dredging, peak water levels in outer harbour approx. 20cm higher for 2013 event conditions, for existing South Pier and with a breakwater
 - With breakwater and dredging, peak water levels at Blackshore <3 cm higher

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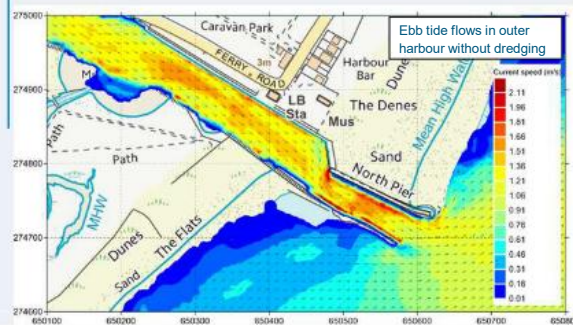
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Tidal Modelling

■ Tidal flow velocity:

- Flow velocities over the bank are less than in the deeper part of the channel
- Shape of Knuckle influences flow velocity and direction, would continue with bank removed
- Peak flow velocities past the North Wall would reduce with dredging
- Slight increase in peak flow velocities upstream



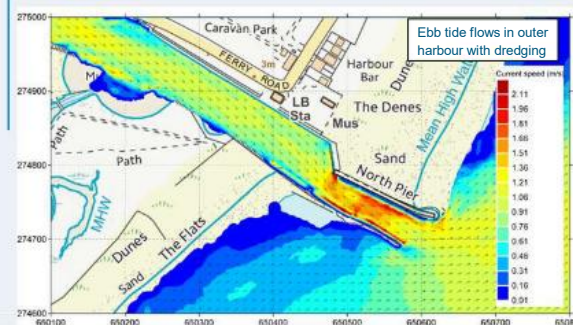
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Tidal Modelling

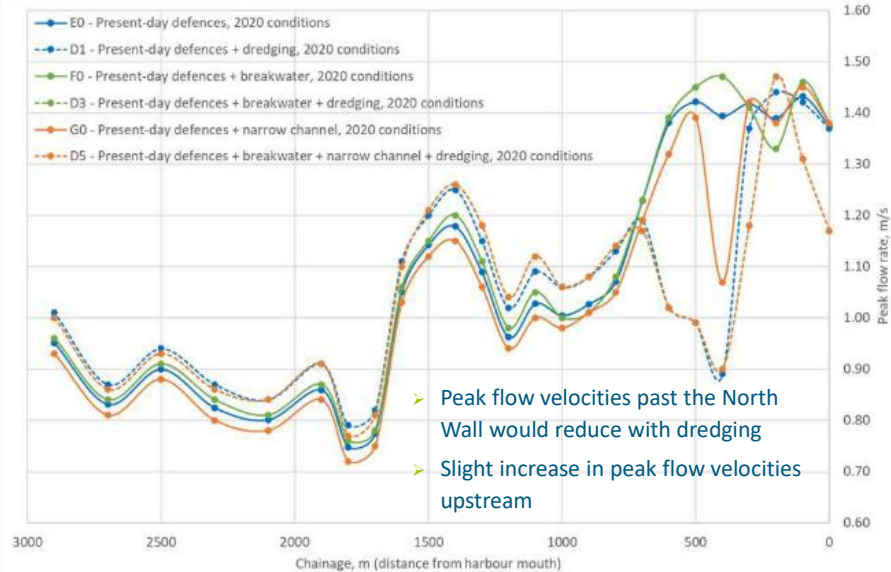
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Narrow channel option

- Option proposed in earlier stakeholder meeting
- Rock groyne to extend the narrowed channel
 - Previous modelling for rock groyne at Location 2
 - Constraints flow into estuary, reduces upstream water levels
- Mixed views on whether/where to narrow the channel

Benefits	Constraints
Upstream peak water levels would be lower with rock groyne.	Navigation impacts of narrowed channel.
Position of rock structure may help with vessel turning?	Increased tidal flows around the rock structure, navigation and scour risks.
Reduced wave penetration into inner harbour	Rock structure reduces space available for mooring, particularly for locations 2 and 3.
Sediment accumulation to either side of the rock structure could improve stability of groyne and South Training Arm.	Access to lifeboat station restricted (Location 2) Sediment may accumulate either side of the rock structure, which could further restrict navigation and require maintenance dredging.



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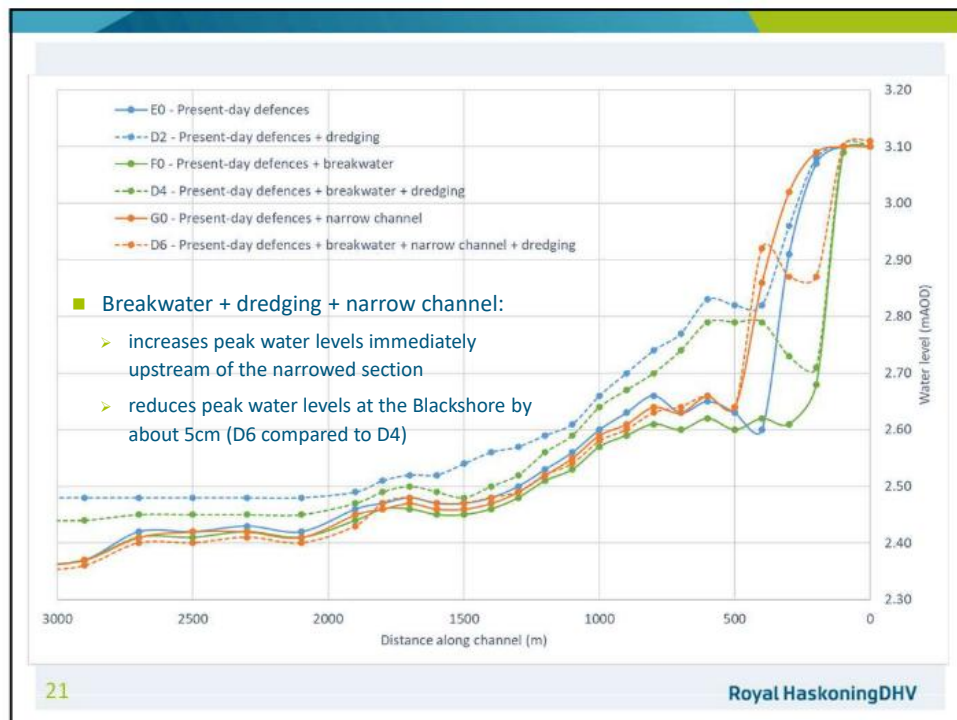
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Narrow channel option

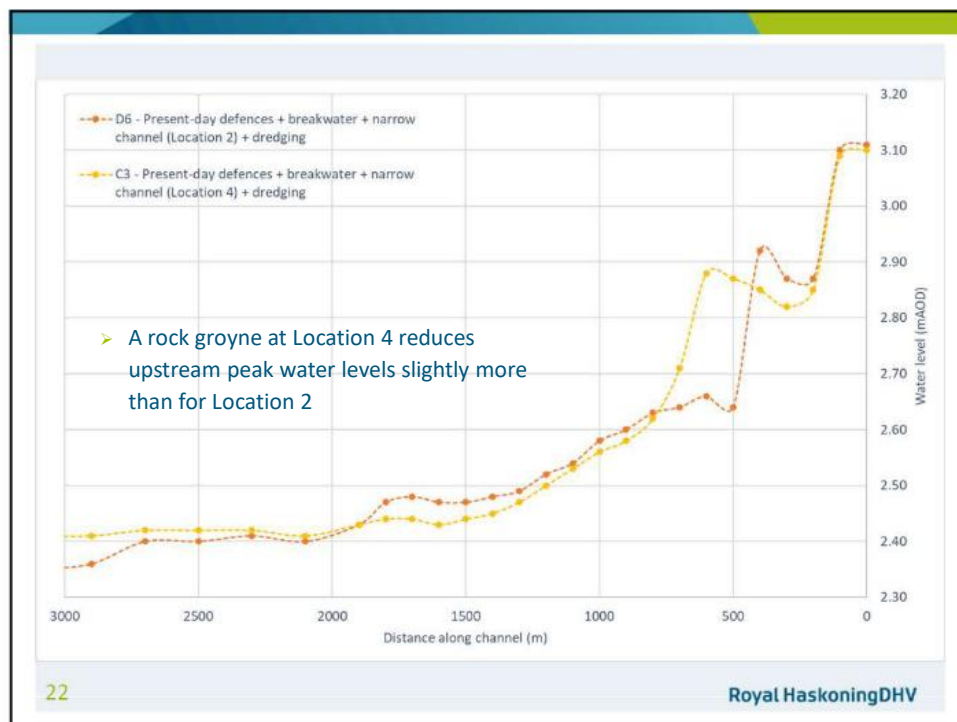
- Additional modelling of dredging option considered the impact of a narrowed channel.
- Narrowing the channel with a rock groyne replicates the effect that the shoal bank currently has on upstream water levels.
- Breakwater + dredging + narrow channel:
 - Increases peak water levels immediately upstream of the narrowed section
 - Reduces peak water levels at the Blackshore by about 5cm
 - A rock groyne at Location 4 reduces upstream peak water levels slightly more than for Location 2
- ***Narrow channel at Location 4 recommended if dredging proposals are progressed.***

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- Discussion - Narrow channel at Location 4 is recommended if dredging proposals are progressed. Constraints at this location?



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Maintenance & consents requirements

- Continued sediment deposition would be expected in the future
 - Rate of sediment deposition depends on frequency of north-easterly storms, and volume of sediment discharged from Dunwich Creek.
 - Monitoring by regular bathymetric survey is recommended.
- A Marine Licence is expected to be required to undertake the proposed dredging:
 - Maintenance dredging has not been undertaken to the harbour within the past 10 years.
 - Environmental assessment would be required, supported by sediment sampling and analysis.
 - Licence process would take 6 months to 1 year, could combine with approvals for works to South Pier.

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Conclusions - dredging

- Removing the shoal bank would improve conditions for navigation in the outer harbour and increase space for mooring at the North Wall.
- The shoal bank narrows the channel and acts to reduce upstream peak water levels:
 - Peak water levels would be higher after dredging.
- Conditions in the entrance channel are unchanged.
- Flow velocities in the outer harbour are reduced, impact on upstream flow velocities is limited.
- A rock groyne to narrow the channel replicates the influence of the shoal bank:
 - A rock groyne upstream of Dunwich Creek is recommended if dredging proposals are progressed (*subject to discussions*).
- A marine licence application, supported by an environmental assessment and sediment sample analysis, would need to be completed to enable the shoal bank to be removed.
- Bathymetric surveys required to monitor bed levels and requirement for maintenance dredging.

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Culverts through rock breakwater



- Previous recommendation for South Pier:
 - Replace with rock armour breakwater
 - Box culverts to replicate 'windows'
 - Additional modelling recommended to assess hydrodynamic performance of culverts
- Issues to be considered:
 - Tidal flow through box culverts
 - Wave penetration through culverts
 - Wave energy dissipation by rock breakwater

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Modelling of culverts – tidal flow

- Additional tidal modelling for box culverts:
 - Existing 'windows' and the proposed culverts both create cross-flows into the entrance channel
 - BUT with limited influence on overall flow conditions

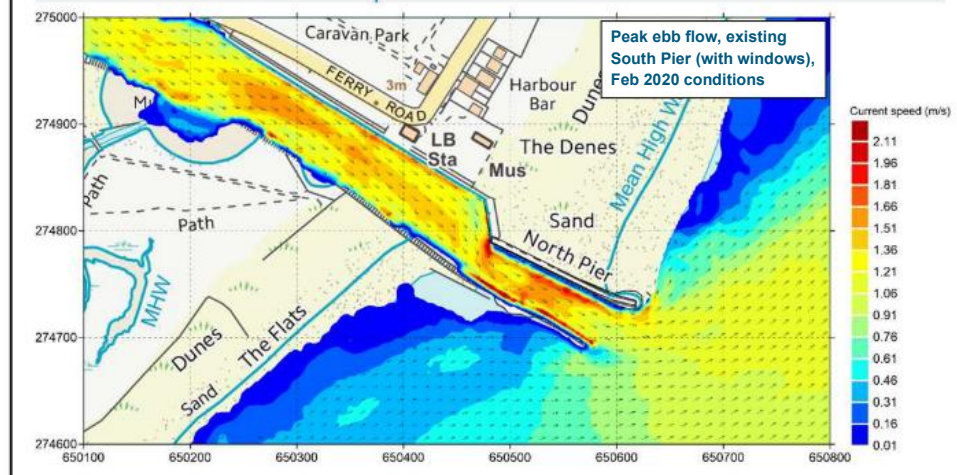
Option		Tide level (m ODN)	
Harbour entrance	Estuary defences	1.49 (2020)	2.04 (RCP2.5, 2020)
Present-day South Pier	Present-day defences	✓	✓
Solid S Pier / Rock Breakwater	Present-day defences	✓	✓
Rock breakwater, 3 culverts	Present-day defences	✓	✓
Rock breakwater, 5 culverts	Present-day defences	✓	✓

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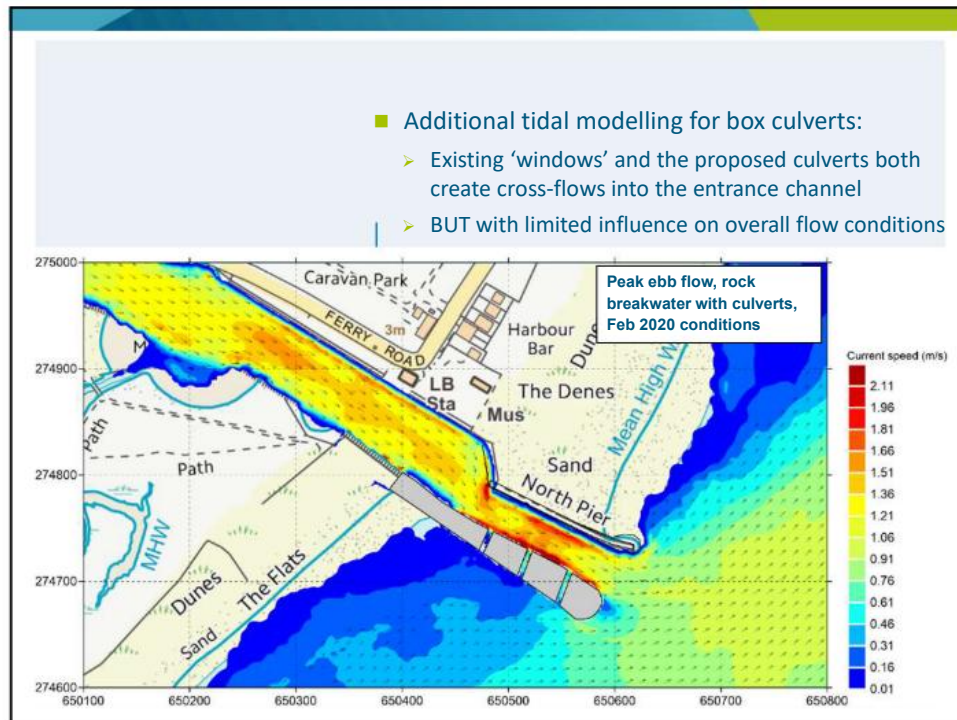
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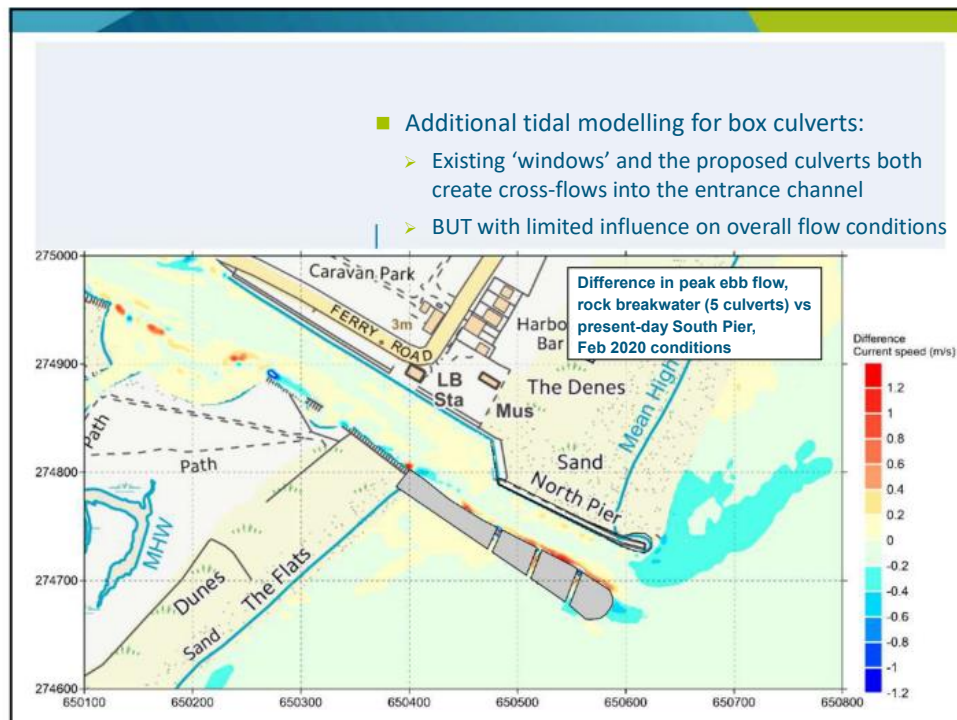
- Additional tidal modelling for box culverts:
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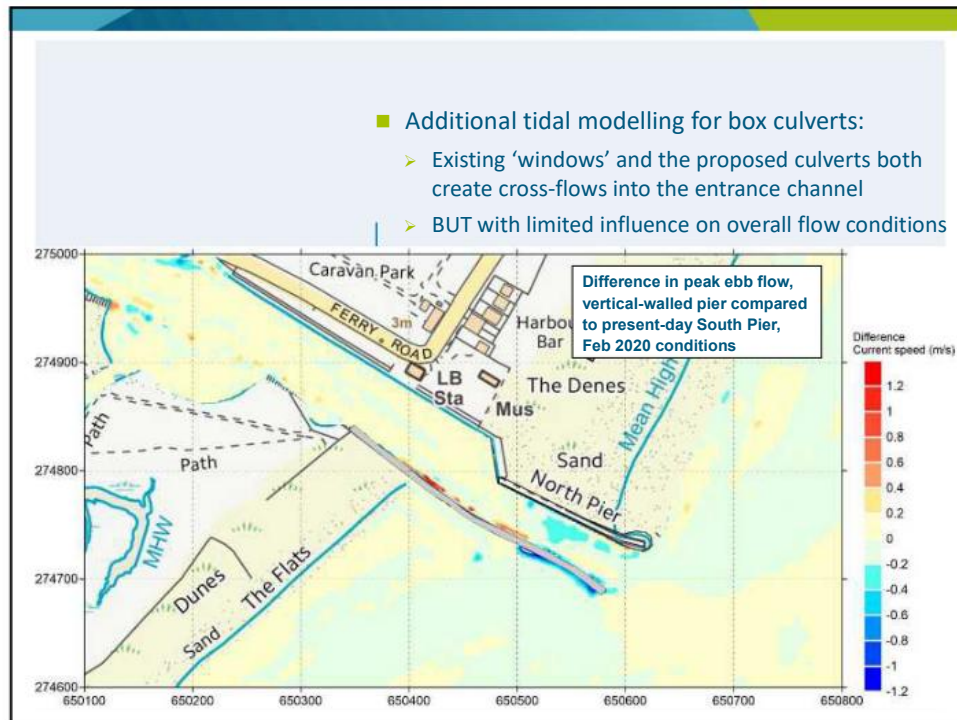
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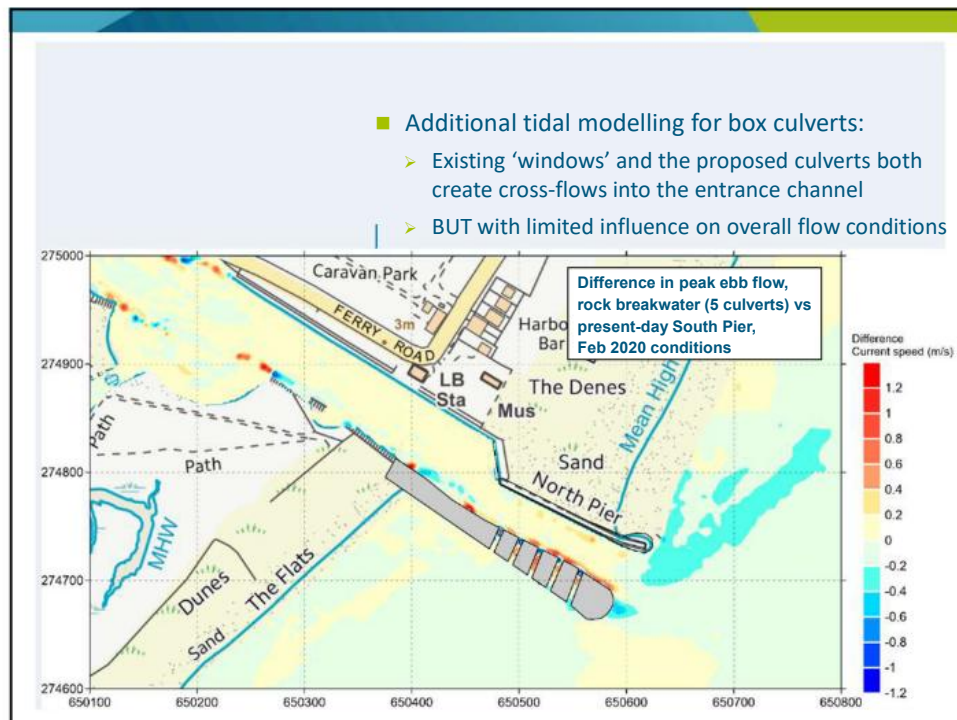
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Modelling of culverts

■ Tidal flow through box culverts:

- Existing 'windows' and the proposed culverts both create cross-flows into the entrance channel
- BUT with limited influence on overall flow conditions

Option		Tide level (m ODN)	
		1.49 (2020)	2.04 (RCP2.5, 2020)
Harbour entrance	Estuary defences		
Present-day South Pier	Present-day defences	✓	✓
Solid S Pier / Rock Breakwater	Present-day defences	✓	✓
Rock breakwater, 3 culverts	Present-day defences	✓	✓
Rock breakwater, 5 culverts	Present-day defences	✓	✓

■ Wave penetration through culverts:

- Culverts would dissipate wave energy
- Wave-generated currents could occur
- Risk of unpredictable water jets into channel
- Would require detailed 3D modelling

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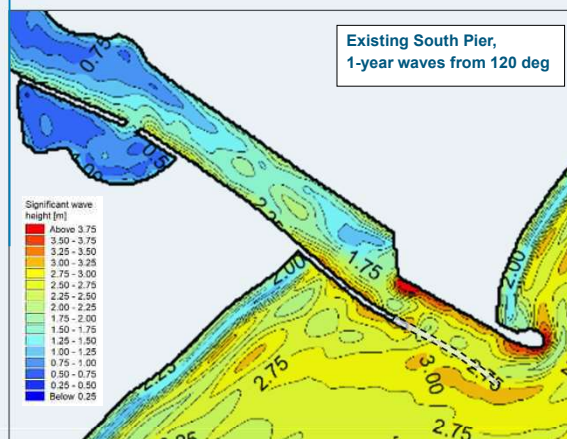
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Wave energy dissipation

■ Windows in South Pier:

- Gradual change from disturbed conditions in open sea to calmer in the channel
- Limits reflection from the South Pier
- Prevents swell waves from building along the wall



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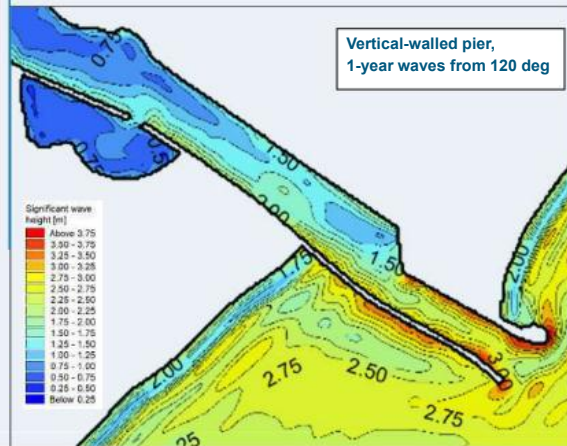
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AS0 **Add figures**
Amy Savage, 2023-02-20T15:41:34.883

Wave energy dissipation

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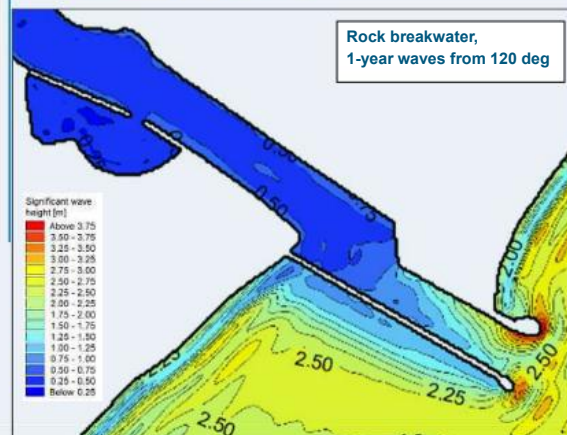
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Wave energy dissipation

■ Rock breakwater significantly improves wave conditions in entrance channel:

- Dissipates wave energy
- Reduces wave reflection
- More influence on conditions in channel than a cross-flow from culverts

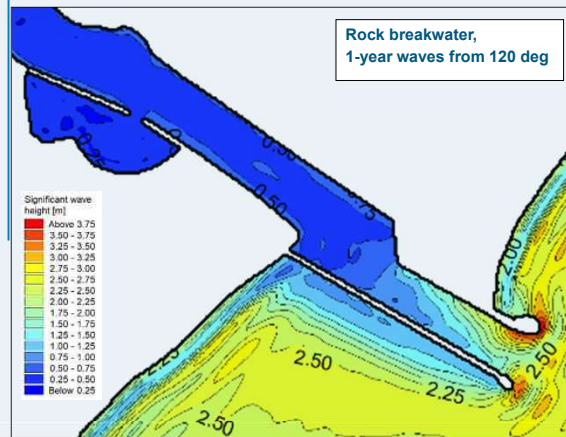


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Wave energy dissipation

- Wave height reduces rapidly:
 - >60% reduction in wave height halfway along South Pier compared to mouth of channel
 - Risk to navigation from rapid change in conditions?
 - Discussion – wave conditions with breakwater



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Conclusions - culverts

- For discussion:
 - Box culverts through the proposed rock breakwater are no longer recommended.
 - A rock breakwater is still the preferred (technical) solution for replacement of the South Pier.
 - The breakwater could be designed to optimise wave conditions at the harbour entrance.

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Next Steps for Harbour Entrance Structures

1. Conclude preferred option for South Pier, dredging and rock groyne
2. Confirm costs/risks re. North Pier and timber fenders
3. Finalise Investment Plan report
4. Environmental assessment and consultation (could include dredging)
5. Outline design development
6. Updated cost estimate (contractor input recommended – note inflation risks)
7. Business Case preparation (costs and benefits – scope depends on requirements for funding)

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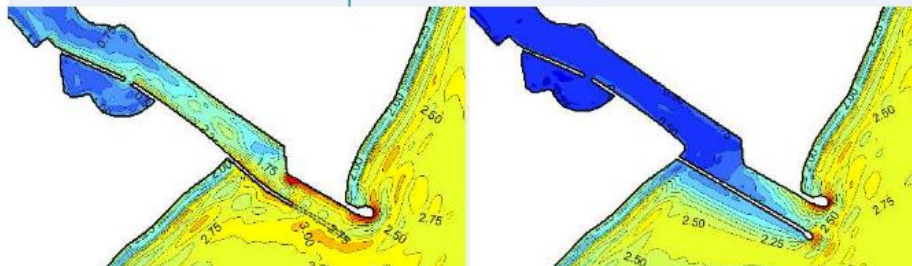
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Harbour Entrance Structures

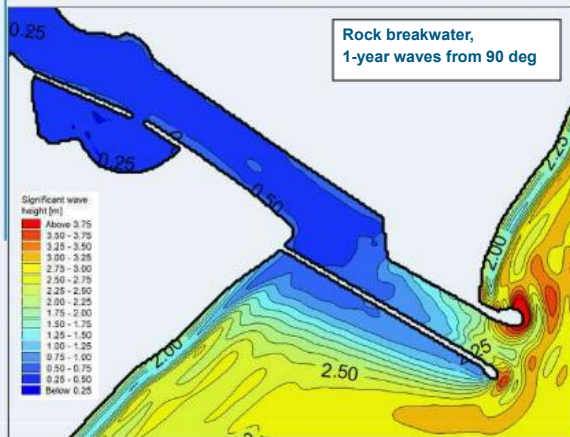
- Rock breakwater to replace South Pier:
 - Improved wave conditions in entrance channel and at North Wall
 - Design to address future scour risk
 - **Cost estimate £11.5M** (fender costs TBC)
- Like-for-like replacement
 - No change to wave conditions at North Wall or in entrance channel
 - **Cost estimate £13.1M**



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Wave energy dissipation

- Wave height reduces rapidly:
 - >60% reduction in wave height halfway along South Pier compared to mouth of channel
 - Risk to navigation from rapid change in conditions?
 - Discussion – wave conditions with breakwater

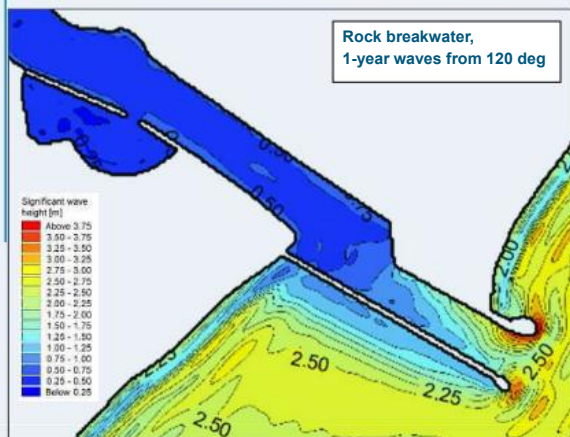


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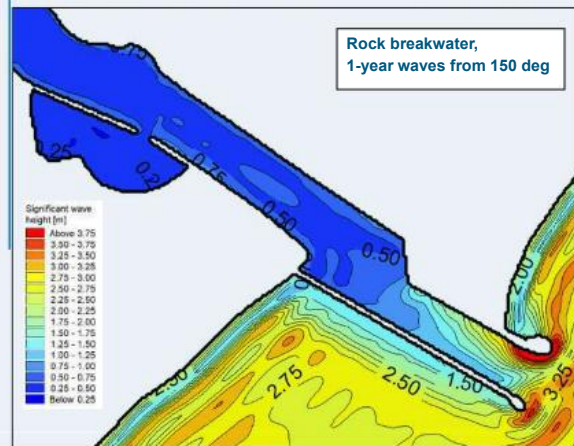
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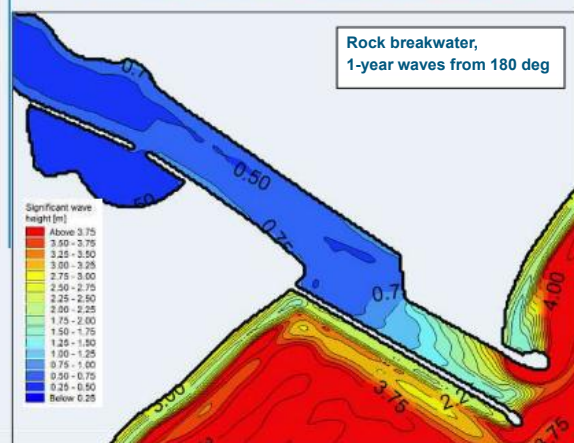
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Confirming the preferred option for the flood banks



- Model runs to confirm the preferred spillway solution (3 further runs are within scope):
 - i. Allow spill of flood water into Robinson's Marsh
 - ii. Reduced spillway length (reduced costs / phasing)
 - iii. Confirm flood bank levels, include breach of dunes
- Other outstanding actions:
 - Check flow rates at harbour entrance
 - Confirm present standard of protection provided by estuary flood banks, review overtopping process
 - Cost estimate for preferred passive spillway option
 - Confirm preferred option, update report and issue
- Recommendation:

Defence improvements and spillway

 - Limited raising of defences (Robinsons / Tinkers only)
 - Phased approach possible, would not prevent future improvement works
 - Cost estimate to be completed

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Next Steps for the flood banks

Management Plan for the Estuary Flood Banks

- Condition assessment of embankment defences
- Topographic survey of flood banks (Robinsons, Tinker's, Harbour Road)
- AS0 Develop maintenance and management plan, addressing breach risk
- Update capital cost estimate for preferred option, maintenance cost estimate for other flood banks
- Engagement with environmental stakeholders and landowners, followed by environmental assessment
- Business Case for the preferred option, to support funding applications

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Slide 45

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Slide 46

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