ARUP

Job No. 264326	Sheet No.	Rev. Issue	
Job Title	Barmouth North Promenade OBC	Member/Location	
Calculation		Drg. Ref.	
Made by RJ/PA	Date 12/01/19	Chd. RC	

Screening Longlist of Options

Ref	SMP2 Policy	Option	Overview/Description	Life-Span: Epoch 1 (0-20 years)	Epoch 2 (20-50 years)	Epoch 3 (50-100 years)	Epoch 4 (Beyond 100 years)	Investment Objective	Critical Success Factor	Options Framework Filter	Comments	Shortlisting (Screening 1)
1	Walkaway (Do Nothing)	**Walkaway (Do nothing but monitor)**	Progressive structural failure of the sea-wall and revetment - unsealed joints, cracks and openings through corroded piles would be the most likely cause. Exposure and corrosion of the sheet piles will become more pronounced with more wave attacks and erosion of the beach expected at the toe. Overall foreshore bed levels along North Promenade are lowering and this lowering is expected to continue. Lack of credible groynes and coarser material in the upper foreshore along is likely to have accelerated the rate. This will increase the exposure of the sheet pile toe – affecting the stability of the structure. Frequent overtopping will be experienced, increasing in frequency and severity due to climate change. This will increase flows along the promenade and associated wash-out of material from beneath the sea-wall and revetment structures. This will impact on the stability and performance of the highway and secondary and tertiary flood walls. On-going deterioration will lead to failure of the sea-wall and revetment, leading to a breach in the defences and associated coastal flooding affecting the wider floodcell (encompassing the Heol-Y-Llan housing estate and central Barmouth). Existing highway drainage, culverts and outfalls (including flap-valves) associated with this section of the frontage will cease to operate effectivity without maintenance and the decline of the frontage. This will exacerbate drainage issues and potentially cause flooding upstream.								Residual life of the sea-wall and revetment is considered to be <10 years. Note, there is a high degree of uncertainty associated with this figure. In the absence of intervention, it is expected there will be a continued reduction in beach levels over the next 10 year period. There is a slight southerly near-shore drift of material, however this is very limited. It is noted that the winter storms of 2013/2014 caused a rapid reduction in beach levels. Future storms are expected to exacerbate beach levels significantly.	Economic Baseline
2	Buisness As Usual (Do Minimum)	**Business As Usual (Do minimum patch and repair)**	Existing 'as and when' programme of inspection and maintenance is continued by YGC. Works required on an increasingly regular basis – including filling of voids, sealing of joints and mortar replacement. Additional cracking or joint movement likely, resulting in further loss of granular material requiring joints and cracks to be regularly maintained. Frequent overtopping is expected to continue, and increase in frequency and severity as a result of climate change. Frequent repairs to the secondary and tertiary flood walls, and demountable flood barriers will be required. Monitoring, trigger levels and actions plans will need to be developed to support the activities outlined above. On-going deterioration will lead to failure of the sea-wall and revetment, leading to a breach in the defences and associated coastal flooding affecting the wider floodcell (encompassing the Heol-Y-Llan housing estate and central Barmouth).								Overall foreshore bed levels along North Promenade are lowering and this lowering is expected to continue. Increasing exposure of sheet pile toe will affect stability of structure. *Measures to protect or replace the sheet pile section and arrest the abrasion/ corrosion are likely to be significant and not considered a do-minimum intervention.* Continued loss of the structural section means there is an expected residual life of <20 years.	Economic Baseline
3a	Hold the Line	**Business As Usual (+) – Extend life-span of existing structure and general improvements**	**Sub-option: Increase the design life of the sea-wall structure by improving the toe of the structure** Undertake works to refurbish the sheet piled toe of the sea-wall and revetment – to reduce the rate of wash-out of fines. Toe level should be designed to allow changes in bed level, if beach nourishment is not contemplated.								General activities to pro-long the life-spans of the assets along the frontage and improve general performance. The rate of overtopping would not be reduced and it will still present on-going hazards to the promenade. The activities would not reduce the lowering of beach levels along the foreshore. As a result, and considering climate change, overtopping rates are expected to increase.	Shortlisted
			Sub-option: Secondary and tertiary flood wall, demountable barriers and drainage improvements Improve structural stability of the flood walls and the associated drainage (along the highway and sea-wall) to improve performance during overtopping events, and pro-long the life-span of the structures.									Shortlisted
3b	Hold the line	**Business As Usual (++) - Improvements to standard of protection of sea-wall**	**Sub-option: Higher vertical sea wall** Increase height of sea-wall to provide increased protection against storm events								Ability to raise the sea-wall may be affected by amenity value of the frontage. Potential raising of the sea-wall may be limited by the structural integrity of the piled foundations. This option would require a full structural assessment of the existing asset for a full refurbishment of the toe and crest structures (as outlined in 3a).	Shortlisted
			Sub-option: Recurve wave wall to reduce rate of overtopping								This option would require a full structural assessment of the existing asset for a full refurbishment of the toe and crest structures (as outlined in 3a).	Shortlisted
			Sub-Option: Add rock-armour or larger beach material To provide protection to the sheet pile toe through rock armour or larger cobbled material								Rock armour will reduce overtopping and beach draw-down. Rock toe should be considered in combination with increasing wall height and wave recurve. This option would require a full structural assessment of the existing asset for a full refurbishment of the toe and crest structures (as outlined in 3a).	Shortlisted
			Sub-option: Water Retaining Bund Raising the promenade and adjacent highway								A water retaining bund, through raising the promenade and adjacent highway is not considered to provide appropriate amenity benefits and is not considered to be appropriately affordable to YGC. It is recommended that any bunds are considered as part of improving the tertiary flood wall (see option 3a).	Discounted
			Sub-option: Widen rock revetment to reduce overtopping								A stepped revetment may not reduce overtopping – and could cause the waves to ramp up again, whilst also increasing the footprint of the structure along the frontage. As such, it is not considered value for money. This option is discounted as it doesn't elign with the CSFs.	Discounted
4	Hold the Line	**Offshore Rock Breakwaters and Beach Recharge**	The construction of rock breakwaters offshore to dissipate wave energy offshore and to reduce overtopping by significant levels. Coarser beach re-charge material would be introduced to promote and encourage a sustainable beach level.								The groynes would need to be extended far into the inter-tidal zone to be effective and it is likely beach nourishment would be needed alongside the refurbishment. This option could consider the use of rock groynes or refurbishment of the existing timber structures. They further limit the ability of residents and tourists to walk along the beach.	Shortlisted
5	Hold the Line	**Groynes and beach nourishment (revetment may be considered, as appropriate)**	Construction of shore-linked groynes (rocks or refurbish existing) to hold the placement of cobbles and larger material to protect the sea-wall and revetment. Option to add a revetment to reduce scour and abrasion. (If groynes are effective, then revetment is likely not to be required)								Due to lack of sediment, groynes will not be effective without recharge and would need to extend further offshore to more effectively retain sediment. Beach recharge could provide an effective solution (working with natural processes) but choice of material key to its success. Beach drawdown particularly at the northern section of the frontage has occurred during the past decades but coarser material north of the promenade has been less mobile. Therefore, the use of cobbles and larger material, held in place by the groynes, could afford increased protection of the frontage. However, beach recharge particle size needs to be carefully considered against amenity value and walking along the beach.	Shortlisted
6	Managed Realignment	**Defence line-set further back**	**Sub-Option: New line of defence set back at the caravan park** New line of defence beyond the railway line								This option would result in the Loss of Network Rail line– re-profiling of route would be required, any movement of the railway line would require an act of Parliament through legislation, and high-level conversations with government. Recognising the neighbouring SMP2 Policies for 'Hold the Line' for Llanaber and Barmouth Sotuh and the wider strategic fit within Barmouth (particuarly around maintaining transport links to the wider region); this option has been discounted as it doesn't align with the CSFs.	Discounted
			Sub-Option: New line of defence set back at the Network Rail line New line of defence to protect the railway line, allowing the area directly behind the sea-wall to be subject to erosion.								Flood protection would be needed for neighbouring frontages else they'd back outflanked and subject to increased flood-risk. Rock groynes could be required to aid the creation of a more stable natural bay (just north of Heol-Y-Llan housing estate and one to the north of the frontage). A northern rock groyne may be required to protect shingle ridge and therefore the SMP2 'Hold the Line' Policy for Llanaber. Further considerations for South Barmouth - SMP2 'Hold the Line' Policy; this area is located within the flood-cell for North Barmouth.	Yes
7	Hold the Line	**Beach re-charge with material from Barmouth South Promenade**	Move material from Barmouth South Promenade (i.e. sand-dunes) to the northern extents of the frontage to improve protection and reduce the wind-blown sand issues experience in central Barmouth.								The dune material is unsuitable for nourishment on this frontage. The majority of the sediment in the dunes is fine and therefore would likely be drawn down and transported rapidly	Discounted
8	Hold the Line	**Sand Engine**	Beach nourishment offshore and the sand is then moved onto the frontage over the years by the action of waves, wind and currents along the coast. This material would provide protection of the frontage.								A sand engine has potential to work from a coastal process point of view but would rely on a detailed understanding of the sediment transport regime. The performance and requirements for on-going maintenance will have less certainty. Significant environmental considerations mean this option may not be viable; including: - Barmouth is surrounded by two SACs: Lleyn Peninsula and the Sarnau (West Wales Marine) Harbour Porpoise. It is very unlikely that NRW would support this option. - Significant amount of environmental analysis and assessment required, which is considered to be unachievebale in this context. This option is discounted as it doesn't elign with the CSFs.	Discounted
9	Managed Realignment	**No further defence structure**	Existing defences are removed and the fore-shore is allowed to retreat back along the coastline.								Beach rollback, expected to retreat to natural levels. Considered to be a walkaway scenario, it is envisioned some active intervention and structures would be required to support the transition to Barmouth South (SMP2 Policy Unit 11.14) and Llanaber (SMP2 Policy Unit 11.16). Option could pose significant risk to public health and safety without associated measures. This option is discounted as it doesn't align with the CSFs.	Discounted
10	Hold the Line	**Property Level Protection**	Provide property level protection to properties most at risk of flooding								This option is discounted as it doesn't align with the CSFs. However, it is recognised as potentially a complimentary option to support wider measures within the long-listing.	Discounted
11	Hold the Line	**Shortline Management All Units**	Not within present scope of Barmouth North Promenade OBC									Discounted

Ref	Constructability: Construction programme	Material Source	Health&Safety Risk	Costs & Performance: Construction Cost	Maintenance	Cost:Benefit	Environmental Impact	Applicability: Design life & Return Period	Amenity, Recreation and Access	Stakeholder acceptability	Shortlisting (Screening 2)	
1	N/A	N/A	Failure of promenade and high probability of flood incident.	None	Regular monitoring of erosion procesess & management would be required over the appraisal period. Works to ensure public safety along the promenade (as a result of the loss of the assets) may be required.	Significant damages considered to be encountered	The walk away option could lead to environmental impacts on the Pen Llyn ar Sarnnau SAC, the presence of the existing unmaintained infrastructure and defences would prevent a natural regression of the foreshore. The failure of the existing surface water and foul drainage systems could also lead to pollution marine incidents.	Likely failure due to structural defects and erosion at the northen end of the promenade. Frequency of overtopping increasing due to sea level rise.	No improvement. Loss of promenade and sea walls defences amenity and function	Loss of promenade amenity and does not meet OBC objectives.	Economic Baseline	In the absence of remedial works to address erosion at the toe of the defences, it is considered that the status-quo Business As Usual scenario shares the Walkaway scenario's risk. As such, they have been considered as one baseline scenario going forwards.
2	N/A	Local source for remedial or maintenance works.	Risk to the public due to the likely failure of the existing defences at the northern end of the promenade.	Low - works to refurbish the sheet piles are considered outside of the scope of this option.	High - Monitoring, inspection and mitigation plan for the remaining life of the structure. Ability to maintain defences as structural condition worsens.	Significant damages to be encountered	No significant environmental impacts are predicted as part of this option, as little would change from the existing situation. All environmental impacts would be limited to minimal temporary construction type impacts associated with any minor repair work.	Lower design life for existing structures. Risk of structural failure of existing defences.	No improvements.	Minimal change or improvement	Economic Baseline	
3a	Potentially shorter and easier programme than other options	Likely to be locally sourced	Medium - Risk to the workforce due to the coastal and Tidal workings conditions	Medium	Medium-Monitoring, inspection and mitigation plan for the remaining life of the structure.	Medium - Would not provide betterment to existing standard of protection despite significant cost.	No significant environmental impacts are predicted as part of this option, as little would change from the existing situation. All environmental impacts would be limited to minimal temporary construction type impacts associated with any minor repair work	Recommended in association with other options. Not considered to be suitable for lifetime of project as independent option.	Maintains amenity value of frontage, with opportunity to improve public realm, aesthetics and landscaping.	Protects the amentiy value of the fronage.	Shortlisted	Investment in 3a was considered equivalent to the BAU (without addressing risk of breach (pile failure)) and has a short residual life. From a stakeholder engagement perspective, YGC considered they should be seeking an improvement/betterment from the scheme as opposed to just refurbishing the existing structure / extending the life-span. Arup identified the potential risk to life which would justify this approach to Welsh Government. Option 3a and 3b are to be considered as one option going forwards.
	Potentially complex modifications to existing drainage network could lead to lengthy programme.	Likely to be locally sourced	Disruption to the use of the promenade during construction	Medium	Medium-Monitoring, inspection and mitigation plan for the remaining life of the structure.	Medium		Recommended in association with other options. Not considered to be suitable for lifetime of project as independent option.	Improvements to drainage network and opportunities to improve public realm, aesthetics and landscaping.	Opportunities to improve the attractiveness of promenade.	Shortlisted	
3b	Potentially shorter and easier programme than other options	Likely to be locally sourced	Medium - Disruption to the use of the promenade during construction	High/medium	Medium - Inspection and routine maintenance required, particuarly following storm events	Medium	The environmental impacts associated with this option would be mainly concentrated on the seaward side of the prom structure. While the landward side of the prom structure would be see some conduction work, no environmentally sensitive receptors have been noted here. The creation of a rock revetment would involve the direct loss of beach habitat directly adjacent to the Pen Llyn ar Sarnnau SAC. Mudflats and Sandflats are a future of the site, with the whole of the North Prom frontage being directly adjacent to the Sandflat feature. A full assessment of any direct or indirect impacts on this feature would be required as part of a Habitat Regulations Assessment (HRA) for the option.. Holding the line and improving the standard of protection will invariably lead to extending the lifetime of the structure into the 2nd and 3rd epoch. This measure would lead to the long term loss of habitat from the SAC through coastal squeeze and would need to be compensated for inline with the HRA for the SMP. Whilst this impact may not be directly compensated within the scheme, it would need to feed into a wider compensatory measures package	Recommended in association with other options. Not considered to be suitable for lifetime of project as independent option.	Ability to raise the sea-wall may be affected by amenity value of the frontage.	Ability to raise the sea-wall may be affected by amenity value of the frontage.	Shortlisted	
	Potentially shorter and easier programme than other options	Likely to be locally sourced	Medium - Disruption to the use of the promenade during construction	High/medium	Medium - Inspection and routine maintenance required, particuarly following storm events	Medium		Recommended in association with other options. Not considered to be suitable for lifetime of project as independent option.	Limited impact on existing frontage; would look to reduce overtopping and maintain amenity value of frontage	Limited impact on existing frontage	Shortlisted	
	Potentially shorter and easier programme than other options	Likely to be locally sourced	Medium - Risk to the workforce due to the coastal and Tidal workings conditions	Medium	Medium - Monitoring and inspection plan for the remaining life of the structure and beach level.	Medium		Recommended in association with other options. Not considered to be suitable for lifetime of project as independent option.	Larger material or rock armour may limit walking along the shore-front adjacent to the defences.	Larger material may be less attractive along frontage.	Shortlisted	
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4	Substantial work required. Tidal working restrictions will apply (and possibly seasonal to reduce impact on amenity).	Medium - Potential issues with sources of materials, transportation (e.g. by road or barrage) and access to site (particularly when working inter-tidal zones). These options are likely to be expensive.	Medium/High Risk to the workforce due to the coastal and Tidal workings conditions.	High/medium	Medium-Monitoring and inspection plan for the remaining life of the structure.	Medium	Any offshore structure is likely to be placed within the Pen Llyn ar Sarnnau SAC and is likely to affect the sandflat feature of that site resulting in same direct habitat loss and a further change in the localised sediment movement. This change would need to the dully assessed and understood as part of the Habitats Regulations Assessment should this option be perused. There could be challenges with constructing the structures (on the shoreline/seabed) due to the presence of the SACs (see below) and sensitive habitats. Refer to limitations identified for Discounted Option: Sand Engine.	Magnitude of construction determined by level of protection required.	Potentially improves or maintains the beach amenity, however (as described opposite) may be unslightly.	Potentially unattractive and reduce visibility of users to the sea	Shortlisted	The groynes and offshore breakwater options are effectively undertaking the same purpose – i.e. stabilising beach material. It was agreed this should be considered as one option within the Shortlist. there are a number of configurations which the groynes and off-shore breakwaters could comprise. The type of structure (i.e. timber/rock groynes) and beach recharge material (i.e. shingle, cobbles) would impact on the length, height and number of the overall structures. This would impact on cost and viability. The most effective combination of arrangements would be identified. It is envisioned measures to protect or replace the sheet pile section (Option 3a) would be required.
5	Substantial work required. Tidal working restrictions will apply (and possibly seasonal to reduce impact on amenity).	Medium - Potential issues with sources of materials, transportation (e.g. by road or barrage) and access to site (particularly when working inter-tidal zones). These options are likely to be expensive.	Medium/High Risk to the workforce due to the coastal and Tidal workings conditions.	High/medium	Medium-Monitoring and inspection plan for the remaining life of the structure.	Medium	If the rock groynes extent to within then Pen Llyn ar Sarnnau SAC, leading to some direct habitat loss from the sandflats feature. The HRA process would need to fully assess the impact of the direct habitat loss and the effect of the groynes on sediment movement within the area. The impact of the introduction of new sediment into the area would needed to be understood As noted above the sediment type, grain size and origin would be key considerations.	Magnitude of construction determined by level of protection required.	May limit walking along the shore-front to the northern extents of the frontage.	Potentially unattractive rock structures along the frontage.	Shortlisted	
6											Discounted	Discounted
	Long-term programme, considered to be a long-term measure.	Likely to be sourced locally.	Risks of flooding to properties and public safety related to removal or abandonment of existing defences.	High - works required to ensure public safety following decomissioning of existing defences. Further measures required to protect the neighbouring SMP2 Policy Units of 'Hold the Line' from flooding and coastal erosion.	High - Monitoring, inspection and mitigation plan for the duration of the appraisal period	Medium	The managed re-alignment of the foreshore would lead to some loss of the existing hinterland habitat, while this would need to be considered and assessed, the existing habitat is generally of low ecological value being largely developed. The re-alignment option would lead to a change in the existing conditions within the adjacent Pen Llyn ar Sarnnau SAC. Whilst these changes would need to fully understood as part of the HRA, they could potentially be deemed to be of conservation benefit to the SAC through the creation of a more natural bay feature and associated intertidal habitats.	Recommended in association with other options. Considered to be a longer-term measure.	Whilst the amenity value of the promenade in this location will be lost, there may be an increase in the width of the shore-front providing a different amenity value.	Loss of properties is likely to concern local residents.	Yes	YGC, Arup and ABPmer highlighted uncertainty around how this option would work in the context of Barmouth North Promenade. However, as it is a Policy recommendation of the SMP2, it is taken forward for shortlisting to understand the implications in more detail
7											Discounted	Discounted
8											Discounted	Discounted
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