

## Appendix E5

### MA24.1 Strategic options to be assessed under FCERM-AG economic assessments

Policy Unit: MA24.1	Option Description
<b>Option 1a</b> <b>No Active Intervention</b>	<p>There are a small number of private assets at risk from erosion or flooding. In the long term erosion risk will increase to a small number of properties within this unit. Damaged property demolition may be covered by the Coastal Erosion Assistance Grant' administered through the EA subject to available funding.</p>
<b>Option 1b</b> <b>No Active Intervention (with H&amp;S)</b>	<p>There are assets at risk from erosion or flooding. In the long term erosion risk will increase to a small number of properties within this unit. Removal of damaged property for public safety is included in this option. Damaged property demolition may be covered by the Coastal Erosion Assistance Grant' administered through the EA subject to available funding.</p>
<b>Option 2</b> <b>Adaptive Management</b> <b>(Property Roll Back Scheme)</b>	<p>There would be no hard engineering solutions on the coastline required for this option; however removal of damaged property would be required. A property roll back scheme would involve abandonment of parts of the farmhouse storage and include the allowance of planning for replacement buildings on the property owners land or other land identified by the National Park Authority. This option falls under 'Adaptive Management'. This option would require part funding from the North York Moors National Park Authority. Damaged property demolition may be covered by the Coastal Erosion Assistance Grant' administered through the EA subject to available funding.</p>
<b>Option 3</b> <b>Active Intervention Improve</b> <b>(Rock Armour)</b>	<p>Rock armour at the toe of the cliff at places where individual property requires protecting, namely Abbey Farm storage buildings. This could be considered as an engineering option for this section of coast. It must be noted that it is not known how effective this would be as weathering to the upper section of the cliff would still occur, therefore possibly not providing a total solution.</p>

### MA25.1 Strategic options to be assessed under FCERM-AG Economic Assessment

Policy Unit: MA25.1	Option Description
<b>Option 1a</b> <b>No Active Intervention</b>	<p>There are few properties and assets at risk from coastal erosion in the medium term (20 to 50 years). In the long term, erosion risk will increase to a small number of properties within this unit. Damaged property demolition may be covered by the Coastal Erosion Assistance Grant' administered through the EA subject to available funding.</p>
<b>Option 1b</b> <b>No Active Intervention (with H&amp;S)</b>	<p>There are few properties and assets at risk from coastal erosion in the medium term (20 to 50 years). In the long term, erosion risk will increase to a small number of properties within this unit. Removal of damaged property for public safety is included in this option and could be funded by 'Coastal Erosion Assistance Grant' administered through the EA subject to available funding.</p>
<b>Option 2</b> <b>Adaptive Management</b> <b>(Property Roll Back Scheme)</b>	<p>There would be no specific engineering solutions on the coastline required for this option; however removal of damaged property would be required. A property roll back scheme would involve abandonment of parts of the residential and commercial property and include the allowance of planning for replacement buildings on the property owners land or land made available by the North York Moors National Park Authority. The first residential and commercial damages will be at approximately year 2012, therefore the scheme to release land for planning should be implemented before this time. Should climate change increase the rate of coastal erosion and cliff failures along this section, then this option will seek to ensure that the coastal communities adapt to the changing conditions. This option falls under the 'Adaptive Management' option. This option would require funding from the North York Moors National Park Authority. Damaged property demolition costs may be covered by the Coastal Erosion Assistance Grant' administered through the EA subject to available funding.</p>
<b>Option 3</b> <b>Active Intervention Improve</b> <b>(Rock Armour)</b>	<p>Rock armour at the toe of the cliff at places where property requires protecting, particularly at the Whitby Light House and Coast Guard area. This could be considered as a feasible engineering option for this section of coast. It must be noted that it is not known how effective this would be as weathering to the upper section of the cliff would still occur, therefore possibly not providing a total solution. Public funds would be required for this.</p>

**MA25.2 Strategic options to be assessed under FCERM-AG Economic Assessment.**

Policy Unit: MA25.2 (a)	Option Description
<p><b>Option 1a</b> <b>No Active Intervention</b></p>	<p>There are approximately 60 residential and commercial properties at risk from erosion in this Unit in the long term (100 years) (42 in the southern Village and 18 in the northern Village). The first assets affected will be residential houses and will likely to be lost in the short term (0-20 years). Further assets will be lost in the medium to long term.</p>
<p><b>Option 1b</b> <b>No Active Intervention (with H&amp;S)</b></p>	<p>There are approximately 60 residential and commercial properties at risk from erosion in this Unit in the long term (100 years) (42 in the southern Village and 18 in the northern village). The first assets affected will be residential houses and will likely to be lost in the short term (0-20 years). Further assets will be lost in the medium to long term. Continued monitoring and investigations will be required with this option to ensure public safety. Signs and removal of damaged assets will be required to also ensure public safety.</p>
<p><b>Option 2</b> <b>Active Intervention Maintain/ Adaptive Management</b> <b>(Property Roll Back Scheme and drainage investigation in northern section of Village and Capital Improvement to Coastal Defence Assets in the southern section of Village)</b></p>	<p>A property roll back scheme would involve abandonment of parts of the residential and commercial property and include the allowance of planning for replacement buildings on the property owners land or land made available by North York Moors National Park Authority. A drainage investigation would also be required to identify ownership of drainage assets lost or affected by the coastal erosion and possible remedial works to delay erosion. The first stage for this scheme would be to identify ownership of assets for the entire drainage network located in the northern section of Robin Hoods Bay Village. Once ownership has been established, each of the operating authorities, including Yorkshire Water, would then carry out drainage investigations using 'in pipe CCTV' on the assets under their ownership as part of the second stage. The third stage would be to commission a scheme for each of the authorities to carry out repair works to drainage displaying all sources identified as contributing to the ground water levels. This would be completed as part of their existing maintenance programmes. A surface water diversion scheme would also be required to divert drainage flows to outfall at a lower part of the village to alleviate cliff saturation which could delay the onset of erosion to the 18 properties in the northern part of the Village. A low risk of a deep seated cliff failure still remains with this option in the northern part of the Village where there is uncertainty as to the effect of drainage exfiltration on water levels at rock head.</p> <p>This option will also involve capital improvement schemes to the coastal defence assets in the southern section of the Village (NFCDD asset no. 1221D901D1003C01, 1221D901D1003C02, 1221D901D1003C04, 1221D901D1003C05, 1221D901D1003C06 and 1221D901D1003C10) (see Appendix E2.3 for asset information). Should climate change increase the rate of coastal erosion and cliff failures along this section, then this option will seek to ensure that the coastal communities adapt to the changing conditions. This option would require a full asset condition assessment to reduce project cost uncertainties when maintaining existing defences.</p>
<p><b>Option 3</b> <b>Active Intervention Maintain</b> <b>(Northern Village drainage Investigation with deep rooted vegetation slope stabilising and Capital Improvement to Coastal Defence Asset in the southern Village)</b></p>	<p>The first stage for this scheme would be to identify ownership of assets for the entire drainage network located in the northern section of Robin Hoods Bay Village. Once ownership has been established, each of the authorities, including Yorkshire Water, would then carry out drainage investigations using 'in pipe CCTV' on the assets under their ownership as part of the second stage. The third stage would be to commission a scheme for each of the authorities to carry out works to drainage displaying all sources possibly contributing to the ground water levels. This would be completed as part of their existing maintenance programmes. A surface water diversion scheme would also be required to divert drainage flows to outfall at a lower part of the village to alleviate cliff saturation. Also, as part of this option, deep rooted vegetation would be planted on the coastal slope as far as practicable inland using all available space including existing properties (owners consent will be required for this). This option only seeks to reduce coastal erosion rates on the cliff fronting the Mount Pleasant area and does not provide a complete coastal protection solution. A low risk of a deep seated cliff failure still remains with this option in the northern part of the Village where there is uncertainty as the effect of drainage leaks on water levels at rock head.</p> <p>This option would also include a capital improvement works to provide concrete patching and facing work to the current manmade coastal defence assets in the southern section of the village (NFCDD asset no. 1221D901D1003C01, 1221D901D1003C02, 1221D901D1003C04, 1221D901D1003C05, 1221D901D1003C06 and 1221D901D1003C10) (see Appendix E2.3 for asset information). To provide protection in the long term (to 100 years), capital</p>

improvement would be required every 30 years until 2070. This option would require a full asset condition assessment to reduce project cost uncertainties.

**Option 4**

**Active Intervention Maintain**

**(Capital Improvement to Coastal Defence Assets in the southern section of Village)**

This option would require capital improvement works to provide concrete patching and facing work to the current manmade coastal defence assets in the southern section of the village. (NFCDD asset no. 1221D901D1003C01, 1221D901D1003C02, 1221D901D1003C04, 1221D901D1003C05, 1221D901D1003C06 and 1221D901D1003C10) (see Appendix E2.3 for asset information). This option would not provide protection for the long term (to 100 years) and would not include any improvement works to other undefended areas in the northern part of the Village. This would only protect the village as a whole for 15 years before property is lost from the northern section of the Village and existing defences in the south begin to deteriorate from the initial capital improvement. This option would require a full asset condition assessment to reduce project cost uncertainties.

**Option 5**

**Active Intervention Improve**

**(Soil nailing and horizontal drainage installation with a capital improvement scheme to existing defence assets)**

Installation of a grid of soil nails on the coastal slope would increase the stability of the slope. Given the potential for deep seated failure it is anticipated that the nails would need to be in excess of 20m and spaced typically at 2m horizontal spacing and 1m vertically, giving a minimum of 1500 nails/100m length of slope treated. The nails are anchored at the surface by a patrix plate and the entire surface would be meshed/netted. This option would also include a capital improvement works to provide concrete patching and facing work to the current manmade coastal defence assets in the southern section of the village (NFCDD asset no. 1221D901D1003C01, 1221D901D1003C02, 1221D901D1003C04, 1221D901D1003C05, 1221D901D1003C06 and 1221D901D1003C10) (see Appendix C3 for asset information). This option would provide protection for the short term (0-20 years) and would not include any improvement works to other undefended areas in the Village. To provide protection in the medium to long term (to 90 - 100 years), capital improvement would be required every 30 years until 2070. This option would require a full asset condition assessment to reduce project cost uncertainties.

**Option 6**

**Active Intervention Improve**

**(Contiguous bored pile wall with a capital improvement scheme to existing defence assets)**

This option would include piles into the rock with installation of anchors through the capping beam. A preliminary calculation, using the 'Reward' software, indicates an embedment length of 44m for the piles where the clay slope is 31m high (depth to bedrock 31m) and 22m where the clay slope is 12m high (depth to bedrock 12m). This option would also include a maintenance works to provide concrete patching and facing work to the current manmade coastal defence assets in the southern section of the village (NFCDD asset no. 1221D901D1003C01, 1221D901D1003C02, 1221D901D1003C04, 1221D901D1003C05, 1221D901D1003C06 and 1221D901D1003C10) (see Appendix E2.3 for asset information). This option would provide protection for the short term (0-20 years) and would not include any improvement works to other undefended areas in the village. To provide protection in the medium to long term (to 100 years), maintenance would be required every 30 years until 2070. This option would require a full asset condition assessment to reduce project cost uncertainties.

**MA25.2 Strategic options to be assessed under FCERM-AG Economic Assessment**

Policy Unit: MA25.2 (b)	Option Description
<p><b>Option 1a</b> <b>No Active Intervention</b></p>	<p>There are approximately 60 residential and commercial properties at risk from erosion in this Unit in the long term (100 years) (42 in the southern part of the Village and 18 in the northern Village). The first assets affected will be residential houses and will likely to be lost in the short term (0-20 years). Further assets will be lost in the medium to long term.</p>
<p><b>Option 1b</b> <b>No Active Intervention (with H&amp;S)</b></p>	<p>There are approximately 60 residential and commercial properties at risk from erosion in this Unit in the long term (100 years) (42 in the southern Village and 18 in the northern village). The first assets affected will be residential houses and will likely to be lost in the short term (0-20 years). Further assets will be lost in the medium to long term. Continued monitoring and investigations will be required with this option to ensure public safety. Signs and removal of damaged assets will be required to also ensure public safety.</p>
<p><b>Option 2</b> <b>Active Intervention Maintain/ Adaptive Management</b> <b>(Property Roll Back Scheme and drainage investigation in northern section of Village and Capital Improvement to Coastal Defence Assets in the southern section of Village)</b></p>	<p>A property roll back scheme would involve abandonment of parts of the residential and commercial property and include the allowance of planning for replacement buildings on the property owners land or land made available by North York Moors National Park Authority. A drainage investigation would also be required to identify ownership of drainage assets lost or affected by the coastal erosion and possible remedial works to delay erosion. The first stage for this scheme would be to identify ownership of assets for the entire drainage network located in the northern section of Robin Hoods Bay Village. Once ownership has been established, each of the operating authorities, including Yorkshire Water, would then carry out drainage investigations using 'in pipe CCTV' on the assets under their ownership as part of the second stage. The third stage would be to commission a scheme for each of the authorities to carry out repair works to drainage displaying all sources identified as contributing to the ground water levels. This would be completed as part of their</p>

existing maintenance programmes. A surface water diversion scheme would also be required to divert drainage flows to outfall at a lower part of the village to alleviate cliff saturation which could delay the onset of erosion to the 18 properties in the northern part of the Village. A low risk of a deep seated cliff failure still remains with this option in the northern part of the Village where there is uncertainty as to the effect of drainage exfiltration on water levels at rock head.

This option will also involve capital improvement schemes to the coastal defence assets in the southern section of the Village (NFCDD asset no. 1221D901D1003C01, 1221D901D1003C02, 1221D901D1003C04, 1221D901D1003C05, 1221D901D1003C06 and 1221D901D1003C10) (see **Appendix e2.3** for asset information). Should climate change increase the rate of coastal erosion and cliff failures along this section, then this option will seek to ensure that the coastal communities adapt to the changing conditions. This option would require a full asset condition assessment to reduce project cost uncertainties when maintaining existing defences.

The first stage for this scheme would be to identify ownership of assets for the entire drainage network located in the northern section of Robin Hoods Bay Village. Once ownership has been established, each of the authorities, including Yorkshire Water, would then carry out drainage investigations using 'in pipe CCTV' on the assets under their ownership as part of the second stage. The third stage would be to commission a scheme for each of the authorities to carry out works to drainage displaying all sources contributing to the ground water levels. This would be completed as part of their existing maintenance programmes. A surface water diversion scheme would also be required to divert drainage flows to outfall at a lower part of the village to alleviate cliff saturation. Also, as part of this option, deep rooted vegetation would be planted on the coastal slope as far as practicable inland using all available space including existing properties (owners consent will be required for this). This option only seeks to reduce coastal erosion rates on the cliff fronting the Mount Pleasant area and does not provide a complete coastal protection solution. A low risk of a deep seated cliff failure still remains with this option in the northern part of the Village where there is uncertainty as to the effect of drainage leaks on water levels at rock head.

This option would also include a capital improvement works to provide concrete patching and facing work to the current manmade coastal defence assets in the southern section of the village (NFCDD asset no. 1221D901D1003C01, 1221D901D1003C02, 1221D901D1003C04, 1221D901D1003C05, 1221D901D1003C06 and 1221D901D1003C10) (see **Appendix E2.3** for asset information). To provide protection in the long term (to 100 years), capital improvement would be required every 30 years until 2070. This option would require a full asset condition assessment to reduce project cost uncertainties.

This option would require capital improvement works to provide concrete patching and facing work to the current manmade coastal defence assets in the southern section of the village. (NFCDD asset no. 1221D901D1003C01, 1221D901D1003C02, 1221D901D1003C04, 1221D901D1003C05, 1221D901D1003C06 and 1221D901D1003C10) (see **Appendix E2.3** for asset information). This option would not provide protection for the long term (to 100 years) and would not include any improvement works to other undefended areas in the northern part of the Village. This would only protect the village as a whole for 15 years before property is lost from the northern section of the Village and existing defences in the south begin to deteriorate from the initial capital improvement. This option would require a full asset condition assessment to reduce project cost uncertainties.

Installation of a grid of soil nails on the coastal slope would increase the stability of the slope. Given the potential for deep seated failure it is anticipated that the nails would need to be in excess of 20m and spaced typically at 2m horizontal spacing and 1m vertically, giving a minimum of 1500 nails/100m length of slope treated. The nails are anchored at the surface by a patrix plate and the entire surface would be meshed/netted. This option would also include a capital improvement works to provide concrete patching and facing work to the current manmade coastal defence assets in the southern section of the village (NFCDD asset no. 1221D901D1003C01, 1221D901D1003C02, 1221D901D1003C04, 1221D901D1003C05, 1221D901D1003C06 and 1221D901D1003C10) (see **Appendix E2.3** for asset information). This option would provide protection for the short term (0-20 years) and would not include any improvement works to other undefended areas in the Village. To provide protection in the medium to long term (to 90 - 100 years), capital improvement would be required every 30 years until 2070. This option would require a full asset condition assessment to reduce project cost uncertainties.

This option would include piles into the rock with installation of anchors through the capping beam. A preliminary calculation, using the 'Reward' software, indicates an embedment length of 44m for the piles where the clay slope is 31m high (depth to bedrock 31m) and 22m where the clay slope is 12m high (depth to bedrock 12m). This option would also include a maintenance works to provide concrete patching and facing work to the current manmade coastal defence assets in the southern section of the village (NFCDD asset no. 1221D901D1003C01, 1221D901D1003C02, 1221D901D1003C04, 1221D901D1003C05, 1221D901D1003C06 and 1221D901D1003C10) (see **Appendix E2.3** for asset information). This option would provide protection for the short term (0-20 years) and would not include any improvement works to other undefended areas in the village. To provide protection in the medium to long term (to 100 years), maintenance would be required every 30 years until 2070. This option would require a full asset condition assessment to reduce project cost uncertainties.

### Option 3

#### Active Intervention Maintain

**(Northern Village drainage Investigation with deep rooted vegetation slope stabilising and Capital Improvement to Coastal Defence Asset in the southern section of Village)**

### Option 4

#### Active Intervention Maintain

**(Capital Improvement to Coastal Defence Asset in the Southern Village)**

### Option 5

#### Active Intervention Improve

**(Soil nailing and horizontal drainage installation with a capital improvement scheme to existing defence assets)**

### Option 6

#### Active Intervention Improve

**(Contiguous bored pile wall with a capital improvement scheme to existing defence assets)**