COUNTY DONEGAL
FLOOD RELIEF SCHEMES

Comhairle Contae Dhún na nGall
Donegal County Council

Tionscadal Éireann
Project Ireland
2040

OPW Oifig na nOibreacha Poiblí
Office of Public Works

rps MAKING COMPLEX EASY

CASTLEFINN FRS

Climate Change Adaptation Plan

IBE1760 Rp027
Castlefinn FRS CCAP
F02
29th January 2024

rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
D01	Draft	S. O'Neill B. Quigley	M. Wilson	A. Jackson	10/02/2023
DF01	Draft Final	S. O'Neill B. Quigley	M. Wilson	A. Jackson	11/08/2023
F01	Final	S. O'Neill B. Quigley	M. Wilson	A. Jackson	08/11/2023
F02	Final	B. Quigley	M. Wilson	A. Jackson	29/01/2024

Approval for issue

Andrew Jackson  29 January 2024

Prepared by:

RPS

Brendan Quigley
Technical Director

Elmwood House
74 Boucher Road, Belfast
Co. Antrim BT12 6RZ

T +44 2890 667 914
E brendan.quigley@rpsgroup.com

Prepared for:

The Office of Public Works and Steering Group

Contents

Tables

Figures

Appendices

Appendix A – MRFS Costing

Appendix B – HEFS Costing Summaries

Appendix C – Amended Preferred Option Costing

1 INTRODUCTION

Climate change and other future catchment changes are predicted to have a significant effect on flood risk when considered over the design life of a flood relief scheme (50 years). The Intergovernmental Panel on Climate Change (IPCC) has reported that for a 1.5°C rise in temperature, the global mean sea level could rise by up to approximately 1m by 2100, and projections of more intense Atlantic storms could potentially increase surge events and wave heights. Met Éireann has predicted that in Ireland the autumns and winters may become wetter, with a possible increase in heavy precipitation events of approximately 20%. This will likely lead to increased flood flows and water levels in rivers and watercourses. In addition, future urbanisation may increase the rate of run-off behind flood defences and into the receiving watercourses which Flood Relief Schemes (FRS) are designed to protect against.

1.1 Objectives

The main objectives of the Climate Change Adaptation Plan are to:

1. Assess and consider the potential impacts of climate change in the development and design of the options for a Preferred Scheme
2. Identify Potential Future Schemes or Adaptation Pathways to maintain the design Standard of Protection (SoP) under the future scenarios.
3. Assess the Potential Future Schemes or Adaptation Pathways in terms of their robustness in the face of uncertainty and their cost effectiveness. The assessment also considers other non-monetary benefits through a simplified Multi-Criteria Analysis (MCA).
4. Identify monitoring requirements and trigger points at which Adaptation Actions may be required.
5. Ensure that the need for adaptation is fully embedded in the delivery of the Scheme.

The CCAP is intended to be consistent with the guidance outlined in the OPW's 'Climate Change Sectoral Adaptation Plan, Flood Risk Management' (OPW, 2015)[1] and also Donegal County Council's Climate Adaptation Strategy[2].

[1] https://www.gov.ie/en/publication/97984b-climate-change-and-sectoral-adaptation-plan/

[2] https://www.donegalcoco.ie/services/environment/climateaction/climateadaptation/

2 POTENTIAL IMPACT OF CLIMATE AND OTHER FUTURE CHANGES

Climate change projections have been implemented within the project for two potential future scenarios which can be taken to represent the year 2100. The Mid-Range Future Scenario (MRFS) represents the central projections for the impact of climate and other future catchments changes, such as urbanisation and land-use changes, on Flood Risk Management in Ireland. The High-End Future Scenario (HEFS) represents projections at the high end of what could happen if the worst climate and catchment changes are realised.

For the River Finn catchment (Cast_03) it is anticipated that peak flows will increase by 22% in the MRFS. 20% of this compound growth[3] is attributable to climate change and a further 1% is attributable to future urbanisation of the catchment which is expected to be low in this rural catchment. For the HEFS, peak flows are projected to increase by 39% with 30% attributable to climate change and 7% attributable to urbanisation.

For the Bridge Burn (Cast_05) catchment it is anticipated that peak flows will increase by 37% in the MRFS. 20% of this compound growth is attributable to climate change and a further 15% is attributable to future urbanisation of the catchment which is expected to be high in this small catchment draining the north-western outskirts of the settlement. For the HEFS peak flows are projected to increase by 133% with 30% attributable to climate change and 79% attributable to urbanisation.

For the Castlefinn watercourse (Cast_12) catchment it is anticipated that peak flows will increase by 88% in the MRFS. 20% of this compound growth is attributable to climate change and a further 57% is attributable to future urbanisation of the catchment which is expected to be high in this small catchment draining the north-eastern outskirts of the settlement. For the HEFS peak flows are projected to increase by 104% with 30% attributable to climate change and 57% attributable to urbanisation.

For the Tievebrack Stream (Cast_09) catchment it is anticipated that peak flows will increase by 20% in the MRFS. 20% of this compound growth is attributable to climate change and a further 0.3% is attributable to future urbanisation of the catchment which is expected to be very low in this rural catchment to the south of the town. For the HEFS peak flows are projected to increase by 31% with 30% attributable to climate change and 1% attributable to urbanisation.

For the Corcullion Stream (Cast_14) catchment it is anticipated that peak flows will increase by 23% in the MRFS. 20% of this compound growth is attributable to climate change and a further 2% is attributable to future urbanisation of the catchment which is expected to be very low in this rural catchment to the south of the town. For the HEFS peak flows are projected to increase by 39% with 30% attributable to climate change and 7% attributable to urbanisation.

A summary of how these increased flows translate into increased flood risk is shown in Table 2.1.

[3] Note compound growth is calculated by multiplying the components of growth, e.g. 4% growth on top of 20% growth = 1.04 x 1.20 = 1.25, i.e. 25%

Table 2.1 Summary of Flood Risk in Present Day, MRFS and HEFS scenarios

Scenario	No. of Properties at Risk at 1% AEP	Average 1% AEP Property Flood Depth	Sum Annual Average Damage (AAD)	Sum Present Value Damage (PvD)	Present Value Benefit (PvB_Cap)
Present Day	17 Residential 16 Commercial	0.51m	€456,657	€9,809,940	€5,324,493
MRFS	37 Residential 20 Commercial	0.89m	€1,040,568	€22,353,475	€8,369,551
HEFS	41 Residential 21 Commercial	0.91m	€4,236,980	€91,018,812	n.a.[4]

The effect of these increases on the flood extent and in terms of properties affected are shown in Figure 2.1 and Figure 2.2.

[4] Note that Present Value Benefit and Benefit Cost Ratios for the HEFS Scheme are not available based on the limited flood event scenarios which have been modelled.

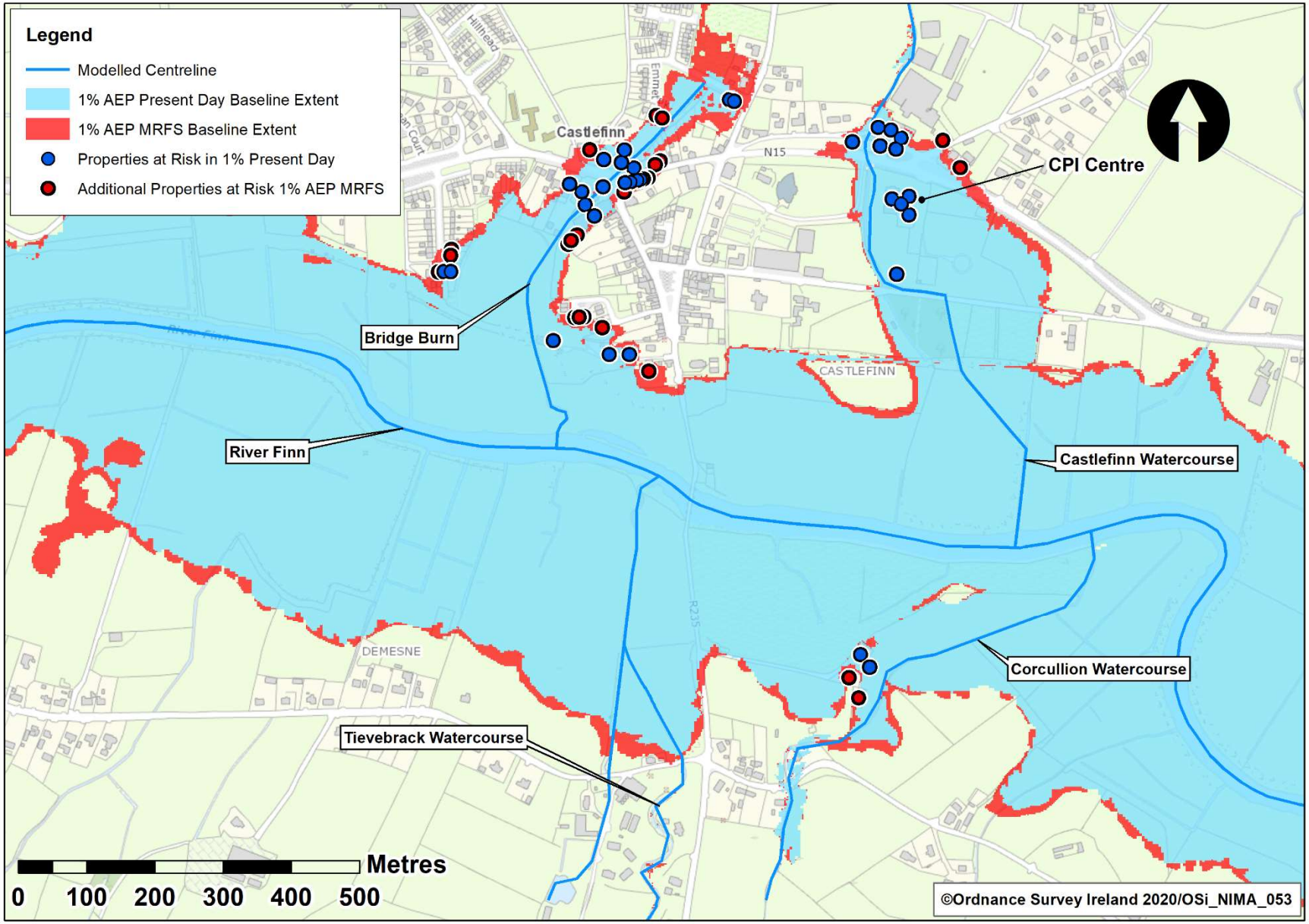


Figure 2.1 Impact on Flood Extents and Properties in the Mid-Range Future Scenario

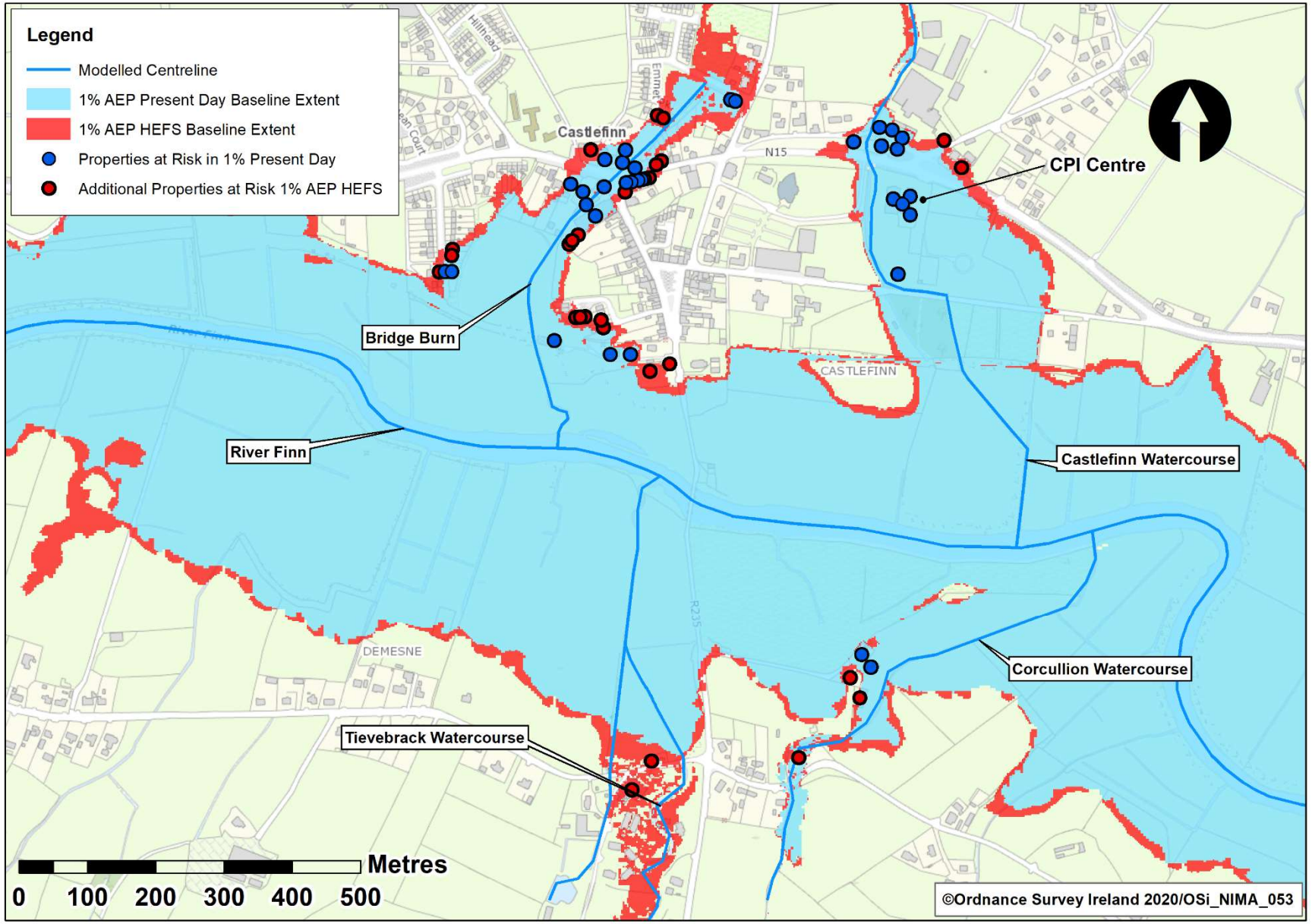


Figure 2.2 Impact on Flood Extents and Properties in the High-End Future Scenario

2.1 Adaptability of Identified Options

Three options were identified for the Castlefinn FRS. A summary of the options and their assessed adaptability is provided below in Table 2.2.

Table 2.2 Castlefinn FRS Option Adaptability

Option	Description	How would this option be adapted?	MCA Option Adaptability Score (-5 to 5)
1	Two earth embankments (with culverts) are to be constructed on either side of the R235 south of the town along the old railway line. The earth embankment to the southwest is 375m and to the southeast is 210m in length. The embankments are on average 3.75m high. The culvert of the Bridge Burn which flows under the N15 / R235 junction outside McGlynns will be re-built with a higher flow capacity. The culvert of the Castlefinn watercourse which flows from north to south under the N15 before emerging adjacent to the Castlefinn Partnership Initiative (CPI) Centre will be rebuilt with a higher flow capacity. A third earth embankment (length = 400 m, avg. height = 3.75) and wall (length = 62 m, avg. height = 1.55 m) will be constructed around the CPI Centre. Included in option 1 is the relocation of one settlement and outbuilding to the south of the River Finn.	Walls and Embankments increased in height and length	3 (Option is adaptable at moderate cost)
2	Includes the earth embankments to the south of the town along the old railway lines. Culvert upgrades of the Bridge Burn as per option 1 but reduced upgrade on the Castlefinn watercourse. Two flood storage areas are proposed upstream of Castlefinn on the Castlefinn Watercourse. A 2.06m flood embankment will retain flood waters in a topographical depression adjacent to a farm in the middle catchment with a culvert and weir providing the flow attenuation. A smaller area of floodplain storage to the east of the CPI Centre is also proposed. Included in option 2 is the relocation of one settlement and outbuilding to the south of the River Finn.	Walls and Embankments increased in height and length. This option is considered less adaptable as storage capacity may be exceeded in the future. This may result in further excavation of storage units and possible encroachment on surrounding land.	2 (Option is adaptable at high cost)

Option	Description	How would this option be adapted?	MCA Option Adaptability Score (-5 to 5)
3	The earth embankment along the railway line to the southwest of the town is retained from options 1 and 2, as are the culverts on the Bridge Burn and the Castlefinn watercourse. The significant difference in option 3 is the replacement of the earth embankment to the south of the CPI Centre (in options 1 and 2) with a sheet piled wall around the CPI. The length of the sheet piled wall required is 422 m at an average height of 2.03 m.	Walls and Embankments increased in height and length	3 (Option is adaptable at moderate cost)

2.2 Preferred Option

The development of options and the identification of the Preferred Option are set out within the Castlefinn FRS Option Development Report[5]. Option 1 was determined as the Preferred Option based on economic, technical, social, and environmental criteria (shown in Figure 2.3). The Preferred Option is to provide a 1% AEP Standard of Protection (SoP). The 1% AEP is equivalent to a 1 in 100-year return period based on present day flood frequency conditions.

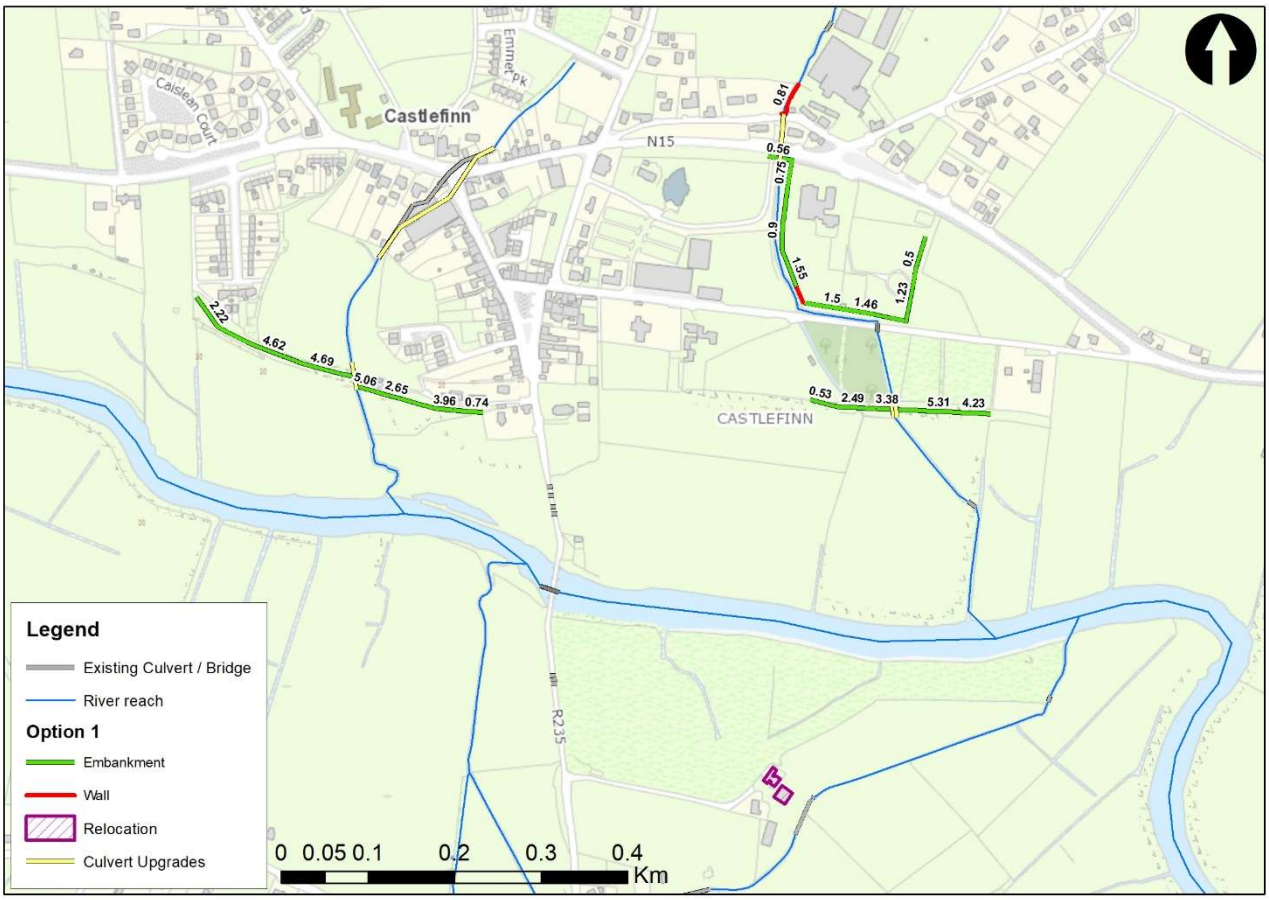


Figure 2.3 Preferred Option for Castlefinn FRS

The Preferred Option consists of a total of 985m of flood walls and embankment in three locations to protect from flood waters from the River Finn; intersecting the Bridge Burn (375m) in the southwest of Castlefinn, intersecting the Castlefinn Watercourse (210m) in the southeast of Castlefinn, and surrounding the CPI centre (400m). Embankment heights are on average 1.15m high at the CPI Centre rising to over 5m for portions of the Finn embankments in the southeast and southwest of the town. Watercourse culverts will be constructed through the Finn embankments to convey the Bridge Burn and Castlefinn Watercourse through the embankments. The downstream headwalls will be fitted with non-return (flapped) outfalls. There are also 62m

[5] Castlefinn Flood Relief Scheme Options Report, document no. IBE1760 Rp023 available at:

https://countydonegalfrs.ie/castlefinnfrs/documents

of reinforced concrete flood walls proposed in areas where an embankment cannot be accommodated, due to existing constraints, at the CPI Centre and adjacent to the farmyard upstream of the N15 on the Castlefinn Watercourse. These walls will be on average 0.95m in height.

It is proposed to abandon the existing culvert on the Bridge Burn and build an entirely new 1200mm diameter culvert along a new route 190m in length. The existing route passes under or very close to existing houses and the new route will avoid this by going through the access road into the Nena Models factory. It is proposed to reconstruct the 55m long Castlefinn Watercourse culvert under the N15. The new culvert will be 1350mm in diameter.

Property relocation is proposed for two properties south of the River Finn at Coolyslin.

The Preferred Option includes an allowance for freeboard to account for uncertainty in the analysis. In terms of walls this is in the form of crest levels increased by 540mm and between 560mm and 740mm for embankments.

Due to the effects of climate change and future urbanisation of the catchments it is predicted that the Standard of Protection of the scheme will reduce over time. Over the anticipated design life of a scheme (50 years), it is predicted that the scheme SoP will reduce from 1% AEP (100-year return period) to 3.2% AEP (31-year return period) in the MRFS. The SoP will reduce to 5.3% AEP (19-year return period) in the HEFS. The reducing SoP is shown in Figure 2.4 for both future scenarios.

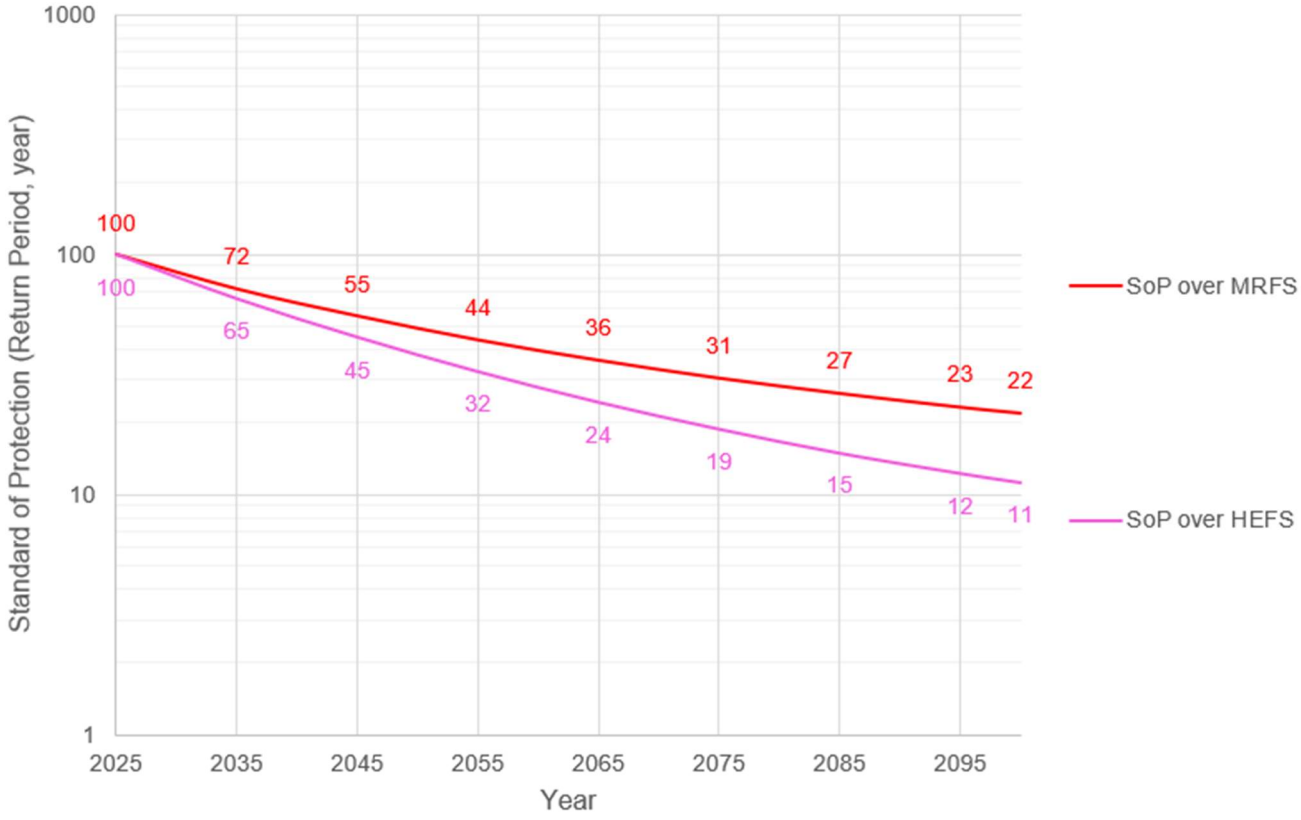


Figure 2.4 Reduction in SoP over time

A key point from Figure 2.4 is that over the design life of the scheme (up to 2075) it is likely that even with freeboard, the SoP of the scheme will drop below 1% AEP (1 in 100 year) without adaptation.

If a flood event exceeding the scheme SoP were to occur, the failure mechanism would be overtopping of the flood walls and embankments and at the headwalls of the upgraded culverts. Overtopping of structures, particularly embankments, could lead to secondary failures such as slope failure leading to rapid inundation of the defended areas.

3 POTENTIAL ADAPTATION PATHWAYS

3.1 Adaptation Measures

The flood mechanisms on all watercourses are not independent. The River Finn drives a backwater effect on all of the tributaries within the Scheme Area. However, the flood mechanisms on the tributaries are independent of one another and there are limited measures which can be employed in directly defending against the River Finn. For these reasons, the measure screening and assessment considers each of the five watercourses in isolation.

The range of potential adaptation measures can be determined from the Castlefinn FRS Option Development[6] Report and the Castlefinn FRS – NbS-CM Feasibility Report[7]. These are summarised below in Table 3.1.

Table 3.1 Initial list of Potential Adaptation Measures

Measure	River Finn	Bridge Burn Stream	Castlefinn Watercourse	Corcullion Watercourse	Tievebrack Watercourse
Do nothing	✓	✓	✓	✓	✓
Relocate Properties	✗	✗	✗	✓	✓
Upstream Storage	✗	✗	✓	✗	✗
Walls and Embankments	✓	✓	✓	✓	✓
Increase Conveyance – upgrade culverts	✗	✓	✓	✓	✓
Nature-based Solutions to Catchment Management	✗	✗	✗	✗	✗

3.1.1 Do nothing

The ‘Do nothing’ measure is retained as a potential measure if monitoring determines that future scenarios are not realised within the design life of the scheme and sufficient freeboard is retained. As noted in relation to the Preferred Option (Section 2.2) it is likely that the SoP of the scheme will deteriorate below the design 1% AEP SoP within the design life, even with freeboard taken into account.

3.1.2 Relocate Properties

The ‘Relocate Properties’ measure was considered in the scheme option development and two properties to the south of the River Finn on the Corcullion Watercourse are included for relocation in the Preferred Option. Relocation removes the need for future adaptation.

[6] Castlefinn Flood Relief Scheme Options Report, document no. IBE1760 Rp023

[7] Castlefinn FRS – NbS-CM Feasibility Report, document no. IBE1760 Rp037

Both available at: https://countydonegalfrs.ie/castlefinnfrs/documents

Properties on the north side of the River Finn are defended under the Preferred Option. Screening within the Optioneering found that it is not considered economically viable or socially acceptable to remove properties which form the fabric of the town settlement itself.

There are, however, further properties to the south on both the Corcullion and Tievebrack watercourses which are at risk in the MRFS and HEFS. Two buildings (one commercial and one residential) become impacted in the MRFS on the Corcullion Watercourse while a further three buildings (one commercial and two residential) become impacted in the HEFS on the Corcullion and Tievebrack Watercourses. Relocating commercial buildings in Castlefinn may be more challenging given there are unlikely to be readily available relocation properties or sites within the Scheme Area.

3.1.3 Upstream Storage

'Upstream Storage' was found to be technically feasible on the Castlefinn Watercourse, and suitable areas were identified upstream during option development (Option 2 in the Castlefinn FRS Optioneering Report). The upstream storage solution on the Castlefinn Watercourse was not taken forward as the Preferred Option due to uncertainty derived from coarse datasets but remains a technically feasible measure and could form part of the adaptation plan for the Castlefinn Watercourse. It is estimated that approximately 50,000m^3 of storage is required within the catchment to mitigate the impact of the MRFS. GIS analysis has identified suitable topographic depression in the lower and middle catchment where this can be accommodated.

Hydrological analysis and GIS analysis of the topography did not identify any topographical depressions or suitable topography which could be adapted to achieve sufficient storage upstream of the at-risk areas on the Bridge Burn, Tievebrack or Corcullion watercourses.

3.1.4 Walls and Embankments

'Walls and Embankments' make up a large part of the Preferred Option. Increasing their height is a potential adaptation measure for properties at risk from the River Finn and Castlefinn Watercourse. Due to space constraints, increasing the height of embankments around the CPI may not be possible without increased land take from the CPI Centre and encroachment into parking and garden areas. To increase embankment heights in the future, sufficient foundations would need to be implemented for the Preferred Option. To ensure adaptive capacity is maintained throughout the scheme life, some earth embankments proposed for the FRS around the CPI may need to be replaced with walls.

On the Tievebrack and Corcullion watercourses, up to five properties are at risk in the future scenarios which are not at risk in the Present Day. As the Preferred Option proposes the relocation of two properties in this area the Preferred Option does not propose any protection to the other receptors which become affected in the MRFS and HEFS. While it may be economically justifiable to relocate residential properties, relocating the commercial properties at risk may not be possible. Hard defences such as earth embankments and/or flood walls may therefore form part of the adaptation plan for the Tievebrack and Corcullion watercourses.

3.1.5 Increase Conveyance

'Increase Conveyance' makes up a large part of the Preferred Option. Increasing conveyance in the River Finn channel through periodic dredging as an adaptation measure is not environmentally acceptable or technically viable to achieve the target SoP. Increased conveyance on the Castlefinn Watercourse could form part of the adaptation plan with adaptive capacity being built into the Preferred Option, i.e., increasing the size of the culvert under the N15. For the Bridge Burn, increasing conveyance through increasing the size of the culvert may prove difficult due to space restrictions stemming from sub-surface service networks. A twin or box culvert system could form part of the adaptation plan on the Bridge Burn. There are existing culvert and bridge structures on the Tievebrack and Corcullion watercourses which are undersized to convey the future scenario flood flows. Increasing conveyance capacity on these culverts could form part of the adaptation plan for these watercourses. Increasing conveyance capacity of the culvert at Chapel / Hollow Road does not reduce the flooding at this location as flooding is caused by water backing up rather than the conveyance capacity of the structure under the road.

Increasing the conveyance in isolation on these culverts for the smaller watercourses is, in most cases, not going to provide the full SoP. For example, in the Bridge Burn and Castlefinn Watercourse the mechanism whereby the watercourses back-up when locked out of the Finn cannot be alleviated through increasing culvert capacity.

3.1.6 Nature-based Solutions to Catchment Management

The Nature-based Solutions for Catchment Management (NbS-CM) feasibility assessment found that the most NbS-CM potential was in the upper catchment of the River Finn. However measures which reduce the flood flows and volumes on the River Finn do not achieve the required Standard of Protection due to the backwater flood mechanism coming from the Foyle downstream. NbS-CM was found to have low potential in the tributary catchments and cannot provide the required Standard of Protection.

NbS-CM cannot provide the required Standard of Protection for Castlefinn to be considered as part of the scheme and is therefore also screened out as an adaptation measure.

3.1.7 Shortlisted Measures

The adaptation measures which could form part of the adaptation plan are summarised in Table 3.2.

Table 3.2 Shortlisted Adaptation Measures

Measure	River Finn	Bridge Burn Stream	Castlefinn Watercourse	Corcullion Watercourse	Tievebrack Watercourse
Do nothing	✓	✓	✓	✓	✓
Relocate Properties	✗	✗	✗	✓	✓
Upstream Storage	✗	✗	✓	✗	✗
Walls and Embankments	✓	✓	✓	✓	✓
Increase Conveyance – upgrade culverts	✗	✓[1]	✓[1]	✓[1]	✓[1]
No. of possible measures	2	3	4	4	4

Note [1]: Cannot provide full SoP in isolation. Must be combined with other measures.

3.2 Dependencies, Timing and Trigger Points

The need for adaptation of the FRS is dependent on the future impact of climate change on flood flows and levels. There is high uncertainty in how climate and other catchment changes may translate into increases in peak flows and volumes across the range of flood events. In the case of the tributary watercourses affecting Castlefinn, there is also high uncertainty in the present-day flood flows and volumes to begin with. The need, timing and scale of adaptation of the FRS for Castlefinn carries high uncertainty, particularly in the case of flood risk driven by the tributaries.

3.2.1 Monitoring and Trigger Points

The nearest hydrometric gauging station is located upstream of Castlefinn at Ballybofey (station no. 01043), operated by the OPW and situated roughly 15 km upstream of Castlefinn. The Ballybofey station underpinned the hydrological analysis that informed the Castlefinn FRS. There is also a water level only gauging station downstream of Castlefinn at Clady (in Northern Ireland). This gauge is suitable for monitoring and assessing the backwater effect emanating from the Foyle downstream which is known to be a key driver of flood risk at Castlefinn. Monitoring of the risk in the River Finn will be based on the data obtained from the gauging stations at Ballybofey and Clady.

In the case of the tributaries affecting Castlefinn there are no gauging stations to monitor the present-day flows or the impact of future scenarios. This would make it very difficult to determine trigger points for adaptation in the future or to pursue a 'do nothing' approach. To enable monitoring of the tributary watercourses it is suggested that two gauging stations are installed on the Castlefinn watercourse and the Tievebrack watercourse. Any impacts observed on the Castlefinn and Tievebrack watercourses could be considered to be representative of the Bridge Burn and Corcullion watercourses respectively. The installation of four gauging stations, one on each tributary, is considered unrealistic. The locations of existing and proposed gauging stations are shown in Figure 3.1.

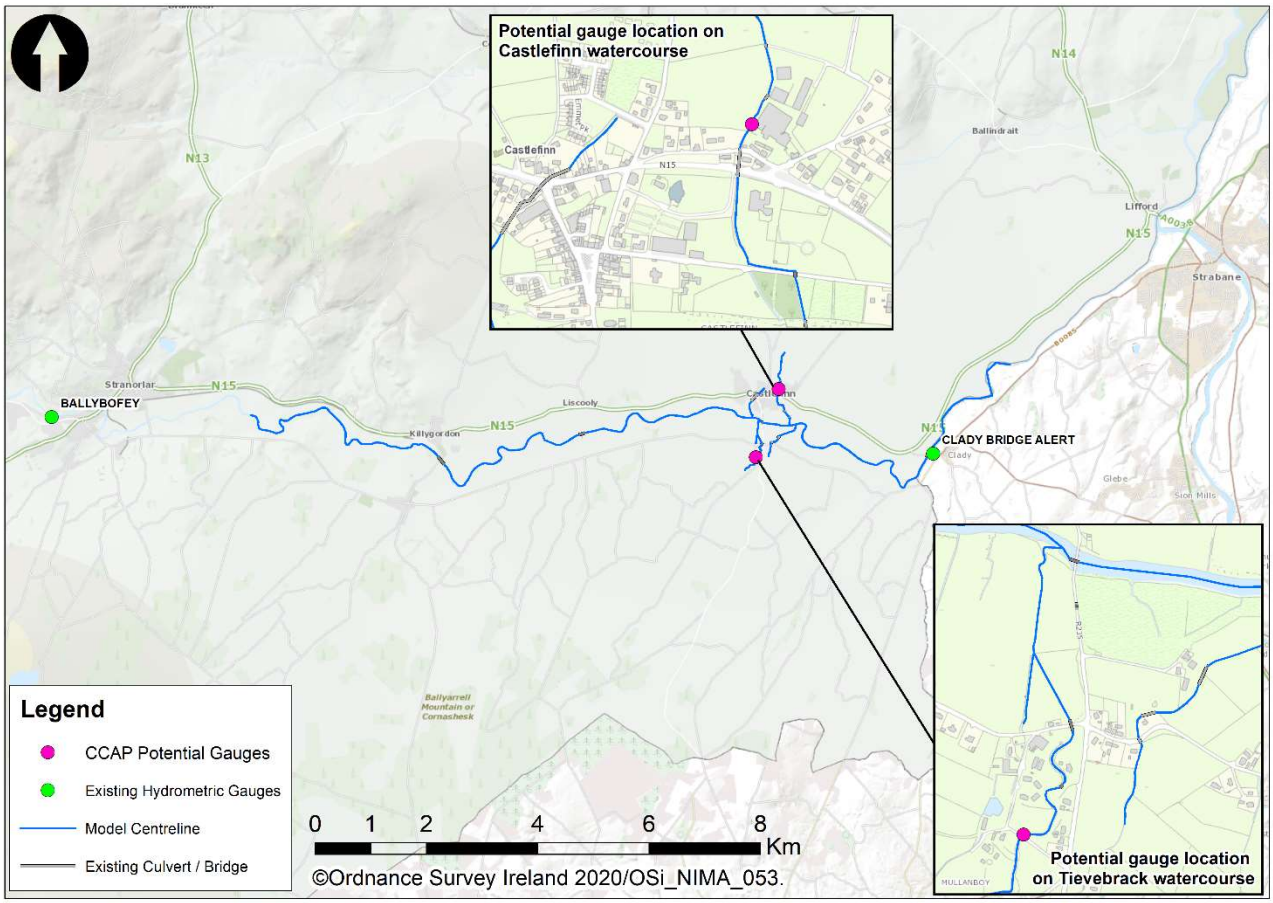


Figure 3.1 Potential Tributary Gauging Station Locations

Monitoring entails the analysis of the flood flow data to ensure the design SoP is maintained with sufficient freeboard. This could be undertaken after the collection of ten years of flow data for a robust comparison against the design (FRS) flows. This would be repeated periodically afterwards depending on the findings of the first review. A suitably qualified hydrologist should be appointed to monitor the progression of climate change through the data and decide if trigger points have been met.

Trigger points for action on adaptation measures based on hydrometric data could include:

- Review of the Q_{med} value - if it increased by more than 5% from the scheme design value, determined from the Stage I hydrological analysis.
- Flood frequency – if the flood frequency curve, up to the period of record (e.g. 10 years or 30 years) is more than 5% steeper than the scheme design growth curve.
- Hydrograph width / volume – if the observed flood hydrograph shape is significantly wider (e.g. 20% greater volume) than the scheme design hydrograph shape.

Significant flood event occurrences should also prompt a review of event data against the design model performance to validate or otherwise the hydraulic analysis. Such a review could involve:

1. Recording and measurement of maximum flood levels (e.g. wrack marks) at defences following a significant event.
2. Flood frequency analysis to determine the frequency of the flood event using the hydrometric data.
3. Review of the equivalent design model event peak water level against the recorded measurement to determine if the freeboard is compromised.

Ultimately the trigger points will be confirmed by the hydrologist based on the review of the data and also the latest guidance, projections, and monitoring of the progression of climate change regionally, nationally, and globally.

Review and confirmation of the trigger points will ensure that appropriate action will be taken at the right time (to be determined by the appointed hydrologist). Responsibility must be assigned for ensuring awareness of trigger points being reached or approached. It is a recommendation of this plan that the appointed hydrologist liaises with DCC Flood Relief Schemes Unit or equivalent in this work.

3.2.2 Do Nothing

The 'Do Nothing' measure for the River Finn would be dependent on the monitoring of flood flows on the River Finn over a long-term period. Hydrological uncertainty is fairly low at Castlefinn however the modelled defence heights were still found to be moderately sensitive to the upper bound sensitivity test flows. The freeboard has been increased by 60mm on top of the standard 500mm for the proposed embankments. Figure 2.4 shows that even considering the freeboard, the SoP of the defences will drop below the 1% AEP in both future scenarios by the end of the design life (2075). The central projection is therefore that adaptation of these defences will be required. Continued monitoring may, however, find that climate change scenarios are not realised and if that is the case the 'Do Nothing' approach can be maintained.

In the case of the tributaries the level of flood risk is highly uncertain and as a result, the freeboard has been increased by 240mm on top of the standard 300mm for walls / 500mm for embankments applied for uncertainty where defences are proposed. If a hydrometric gauging station is in place, the uncertainty would be reduced over time, potentially allowing the additional freeboard to absorb the impact of climate and future changes which may be observed and a 'Do Nothing' approach to be followed. Conversely, the gauge may determine that a higher freeboard is required and climate change impacts are significant. If this occurs the 'Do Nothing' measure would be abandoned in favour of an intervention to maintain the design SoP.

3.2.3 Upstream Storage

'Upstream Storage' is a standalone future scheme that could be implemented upstream of the CPI on the Castlefinn watercourse, as well as a small storage area at the CPI itself. As it is independent of the measures proposed in the Preferred Option its implementation does not require any adjustments to the Preferred Option in year 0. If a gauging station is installed on the Castlefinn watercourse (Section 3.2.1) this measure could be implemented at a time determined through monitoring and analysis after a suitable period of data collection (e.g. 10 years). If a gauging station is not installed and upstream storage is the preferred measure then it is

assumed for costing purposes it would need to be installed by year 15 of the FRS at the latest due to deterioration of the SoP.

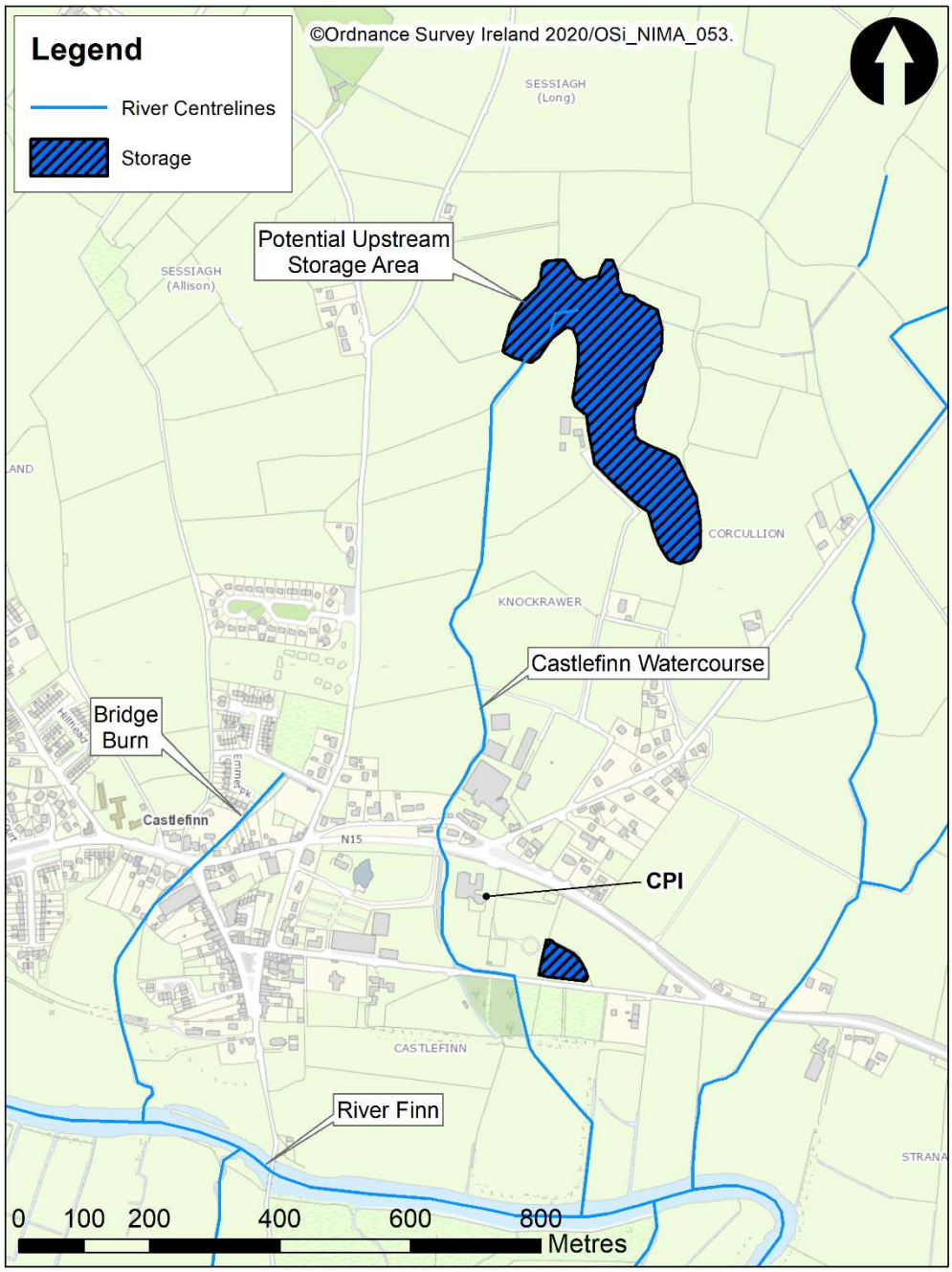


Figure 3.2 Potential Upstream Storage Area on the Castlefinn Watercourse and at the CPI centre

3.2.4 Walls and Embankments

'Walls and Embankments' are part of the preferred option. Adaptation would see the heights of these 'Walls and Embankments' increased and extended to ensure the future scenario flows do not bypass the defences. In places, additional defences will be needed where the future scenarios place additional areas of Castlefinn at risk. Increasing the height of walls is dependent on an adequate foundation being present to support

increased wall heights. Increasing the height of embankments is dependent on a suitable area available for the increased footprint to support the increased height. It is not economically viable, socially or environmentally acceptable to re-construct the 'Walls and Embankments' (i.e. from scratch) at a later date; it would be considered a failure of the FRS. This is a significant constraint on this adaptation measure as it needs to be included in the FRS from the outset. If the larger foundations are included as part of the FRS, this adaptation measure could be implemented if and when monitoring and analysis determine or where monitoring is not available, by year 15 of the FRS.

The need for larger foundations to build in adaptive capacity of embankments and walls in the Preferred Option raises concern around the CPI Centre. Increasing the foundation of the earth embankment around the CPI will result in land encroachment on the CPI carpark. Whether or not this is acceptable to the CPI, it poses the risk of implementing a maladaptive feature as part of the FRS. To avoid maladaptation and maintain adaptive capacity of the scheme, it would be suggested that part of the earth embankment around the CPI is replaced in the Preferred Option with a flood defence wall.

The increased extents of walls and embankments required and the new wall and embankment heights required for the MRFS and HEFS are shown in Figure 3.3 to Figure 3.8

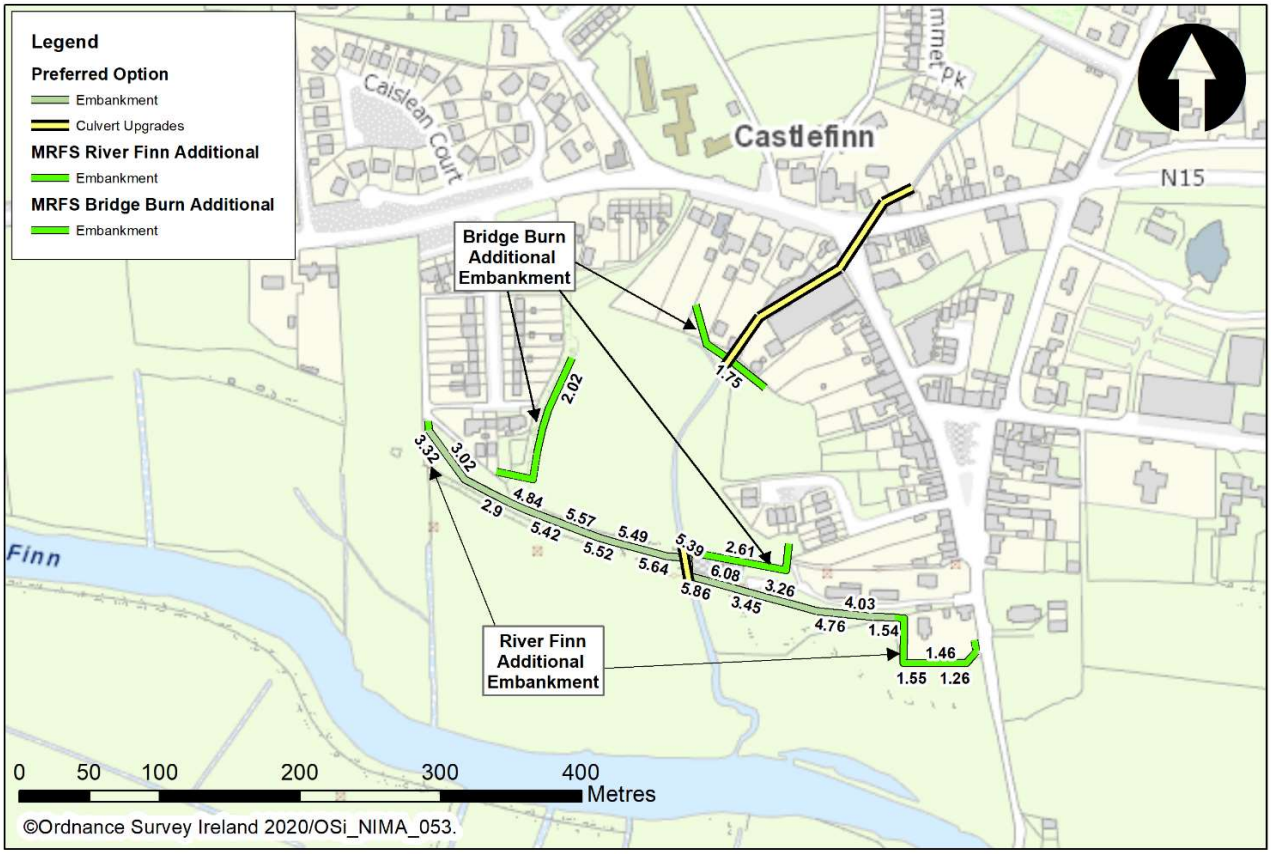


Figure 3.3 Additional Defences and Defence Height (from Lowest Ground) for MRFS at West of Castlefinn

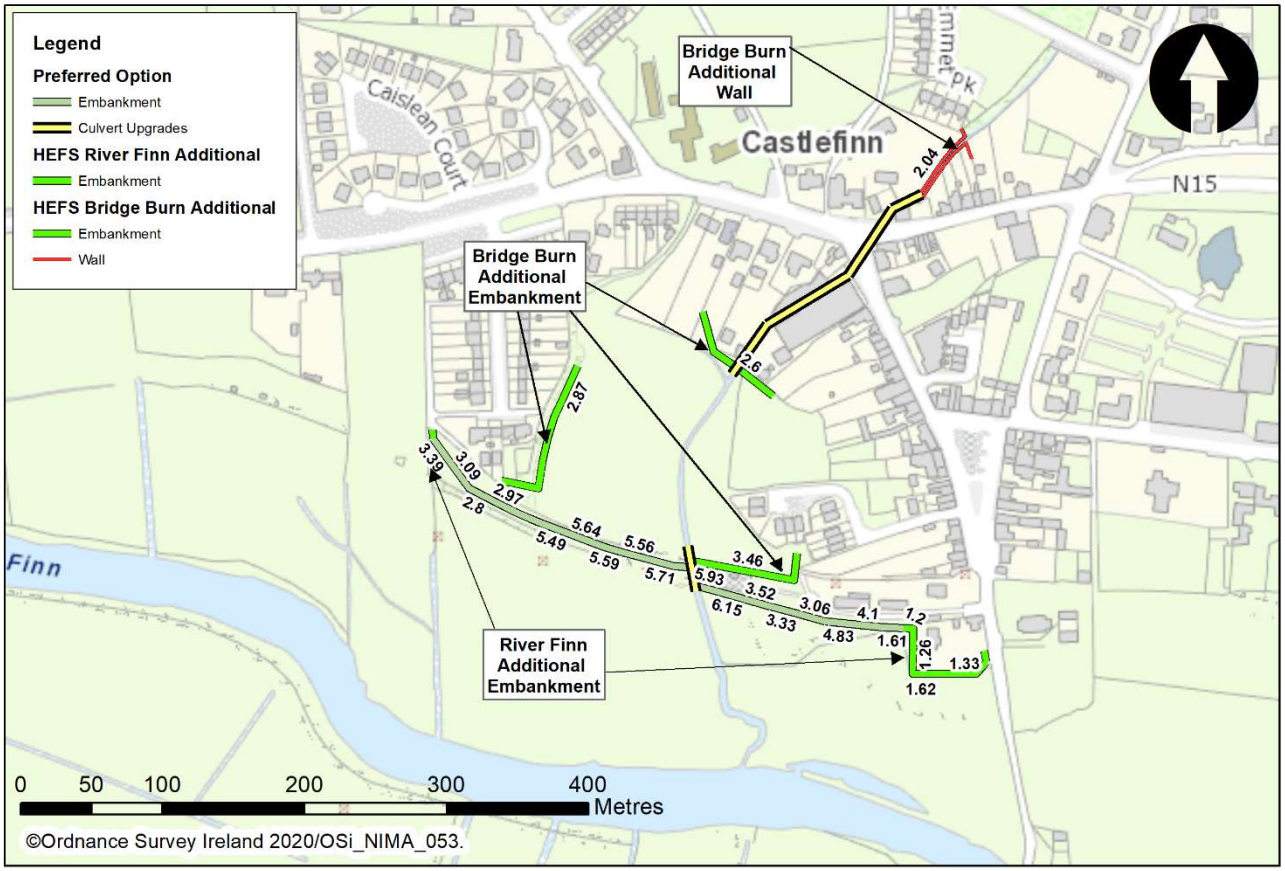


Figure 3.4 Additional Defences and Defence Height (from Lowest Ground) for HEFS at West of Castlefinn

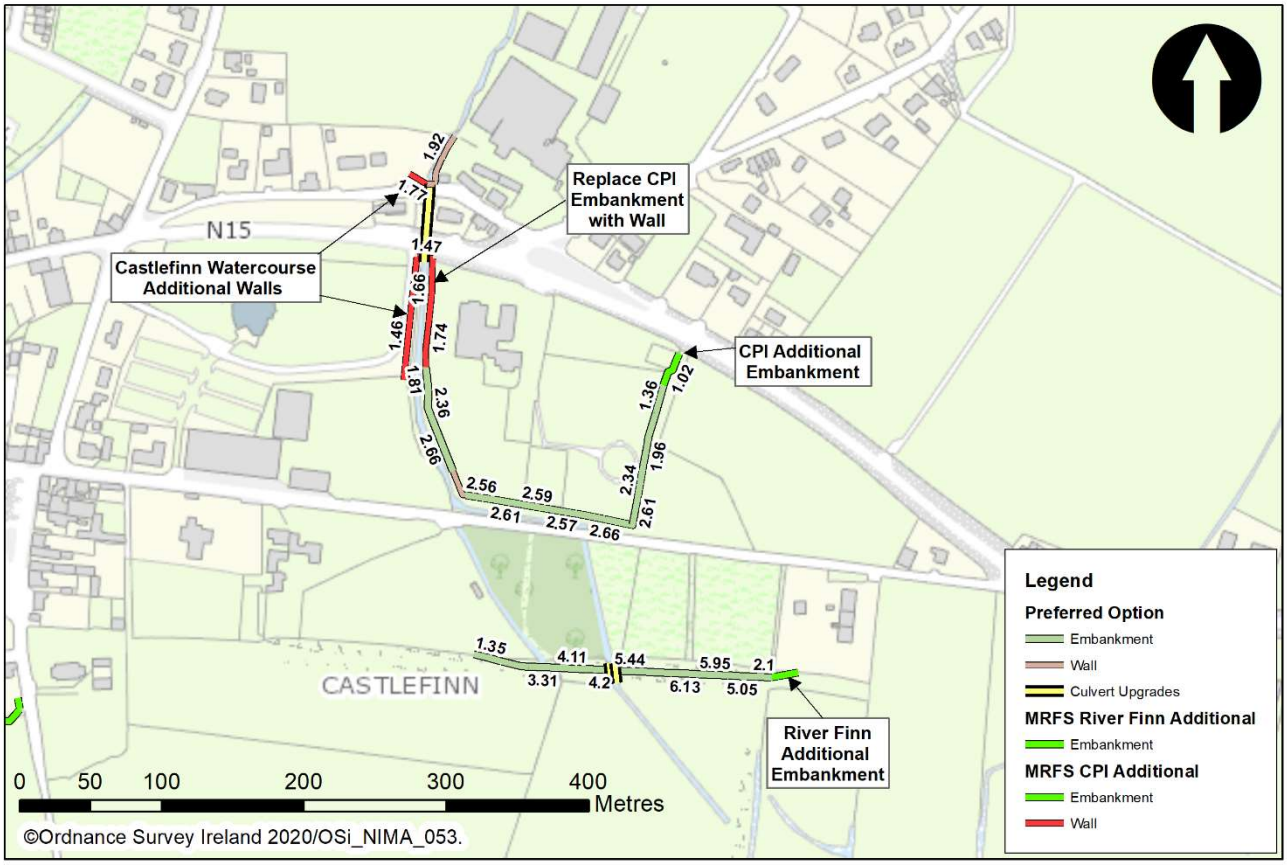


Figure 3.5 Additional Defences and Defence Height (from Lowest Ground) for MRFS at East of Castlefinn

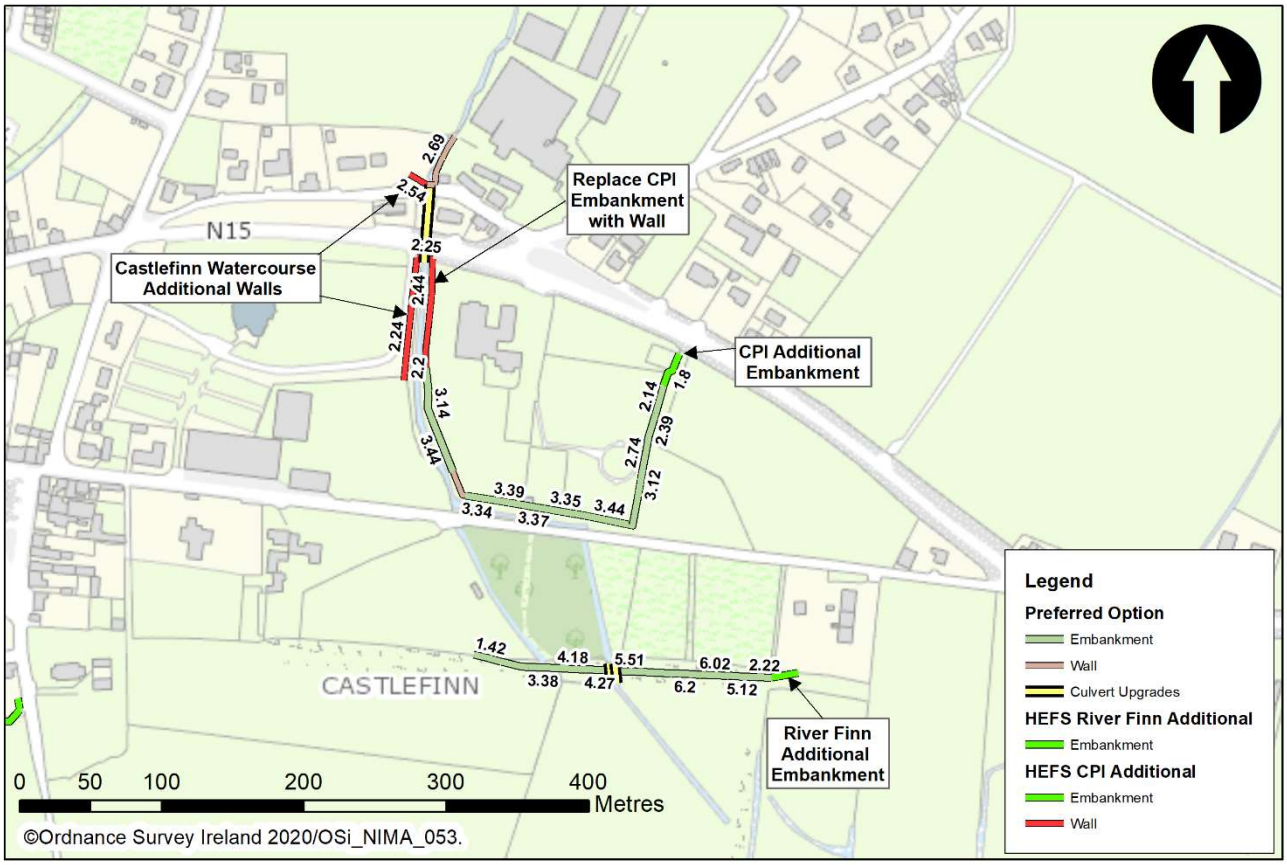


Figure 3.6 Additional Defences and Defence Height (from Lowest Ground) for HEFS at East of Castlefinn

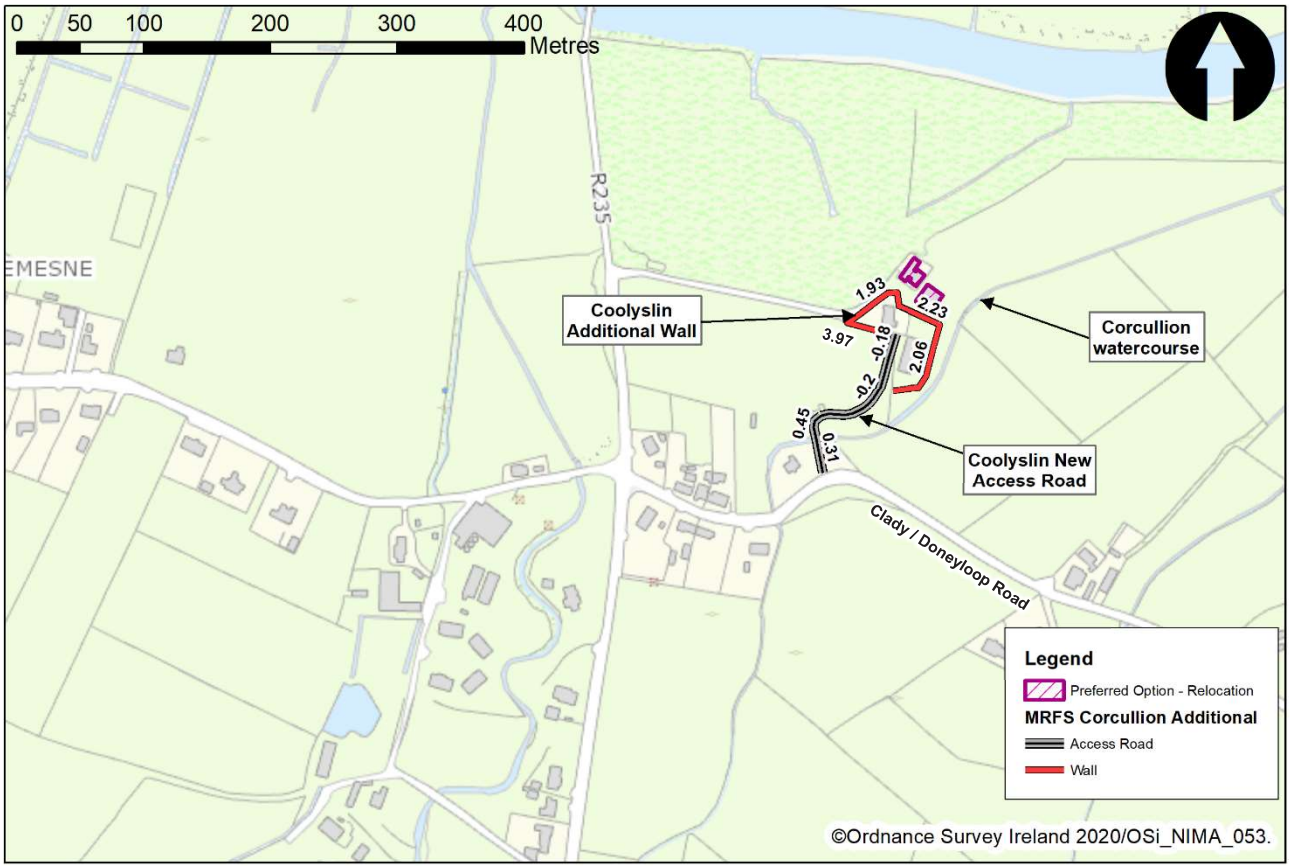


Figure 3.7 Additional Defences and Defence Height (from Lowest Ground) for MRFS at South of Castlefinn

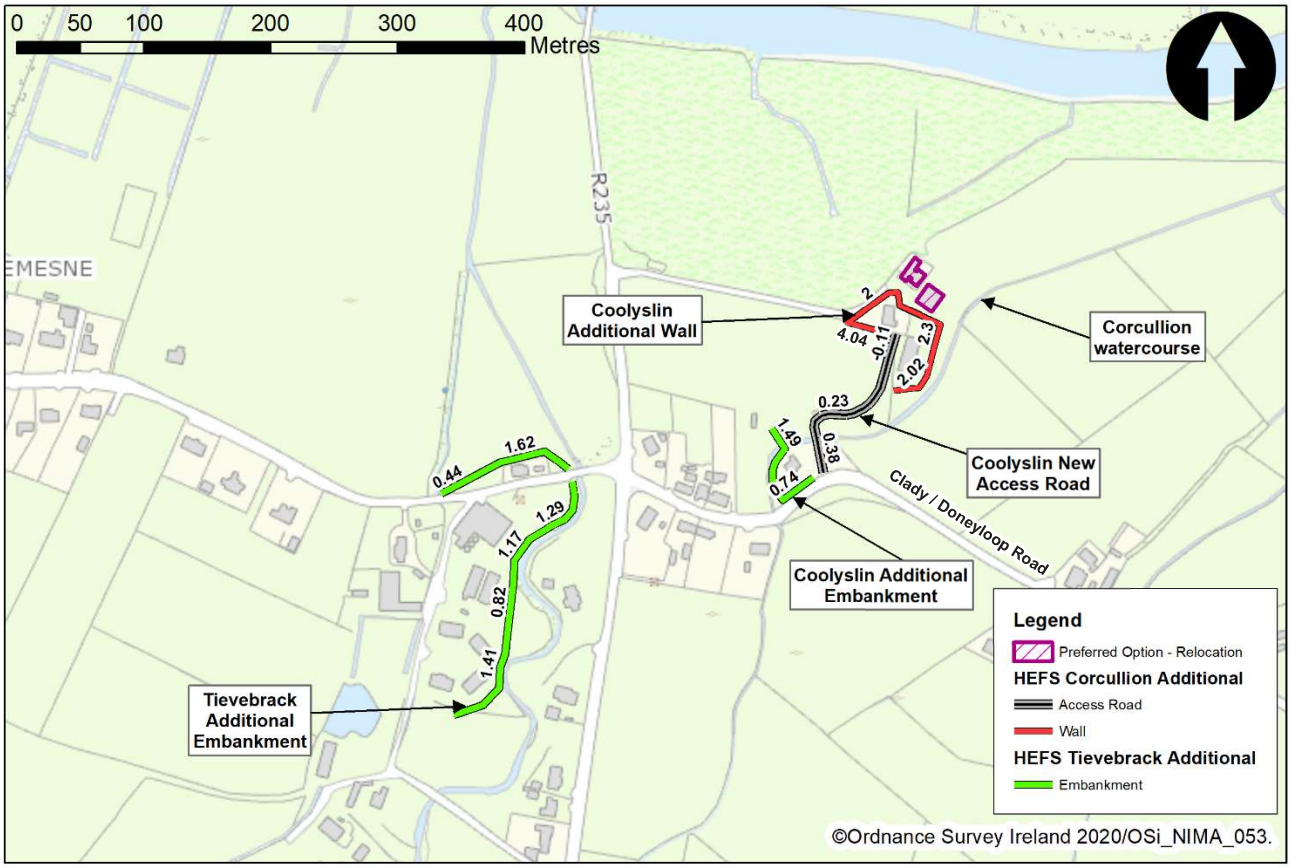


Figure 3.8 Additional Defences and Defence Height (from Lowest Ground) for HEFS at South of Castlefinn

3.2.5 Increase Conveyance

Increased conveyance for Castlefinn means the upsizing of culverts in conjunction with upgrades to walls and embankments to facilitate the HEFS flood flows and volumes i.e. it is not a standalone measure. On the Bridge Burn this means increasing the proposed culvert size from a 1200mm diameter to a 1.0m x 2.0m box culvert. On the Tievebrack and Corcullion watercourses, new upgrades are required to culverts and bridges. The upgrades required are shown in Figure 3.9.

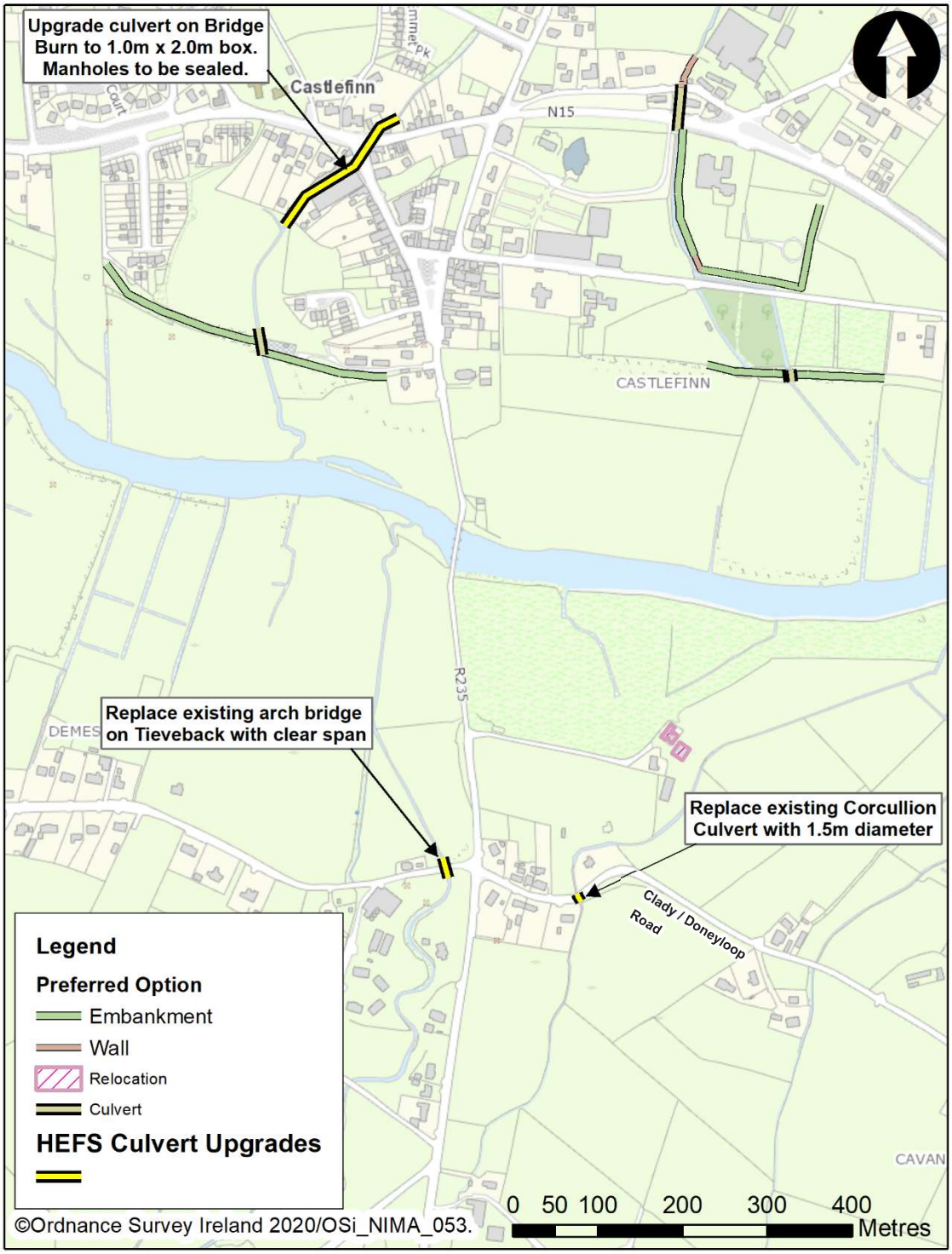


Figure 3.9 Potential Culvert Upgrades required for the HEFS

The cost of allowing for increased culvert sizes to convey the future scenario flows is small if delivered as part of the FRS. In other words, the cost of laying a culvert of larger dimensions now is relatively small compared to laying a smaller culvert now and digging it up and replacing it in the future. It is not economically viable or environmentally acceptable to re-construct the culvert now and again at a later date during the scheme design life; it could be considered a failure of the FRS. If increased conveyance on the Bridge Burn is the preferred adaptation measure then it should be delivered at the outset of the FRS in the form of the culvert sized to convey the HEFS flows. For the culvert upgrades required to the south of the River Finn, these would be carried out as part of standalone works in this area, subject to monitoring and trigger points. Or where monitoring is not available, by year 15 of the FRS.

3.2.6 Relocation of Properties

Relocation of properties in the MRFS is relevant to the two further properties that are not part of the preferred option in the settlement cluster at Coolyslin (four buildings). For the HEFS two further properties are considered suitable for relocation. One residential property is located to the south of Coolyslin adjacent to the Corcullion watercourse and the other residential property is adjacent to the Tievebrack watercourse but at risk from the Finn flooding mechanism. The four suitable properties are shown in Figure 3.10.

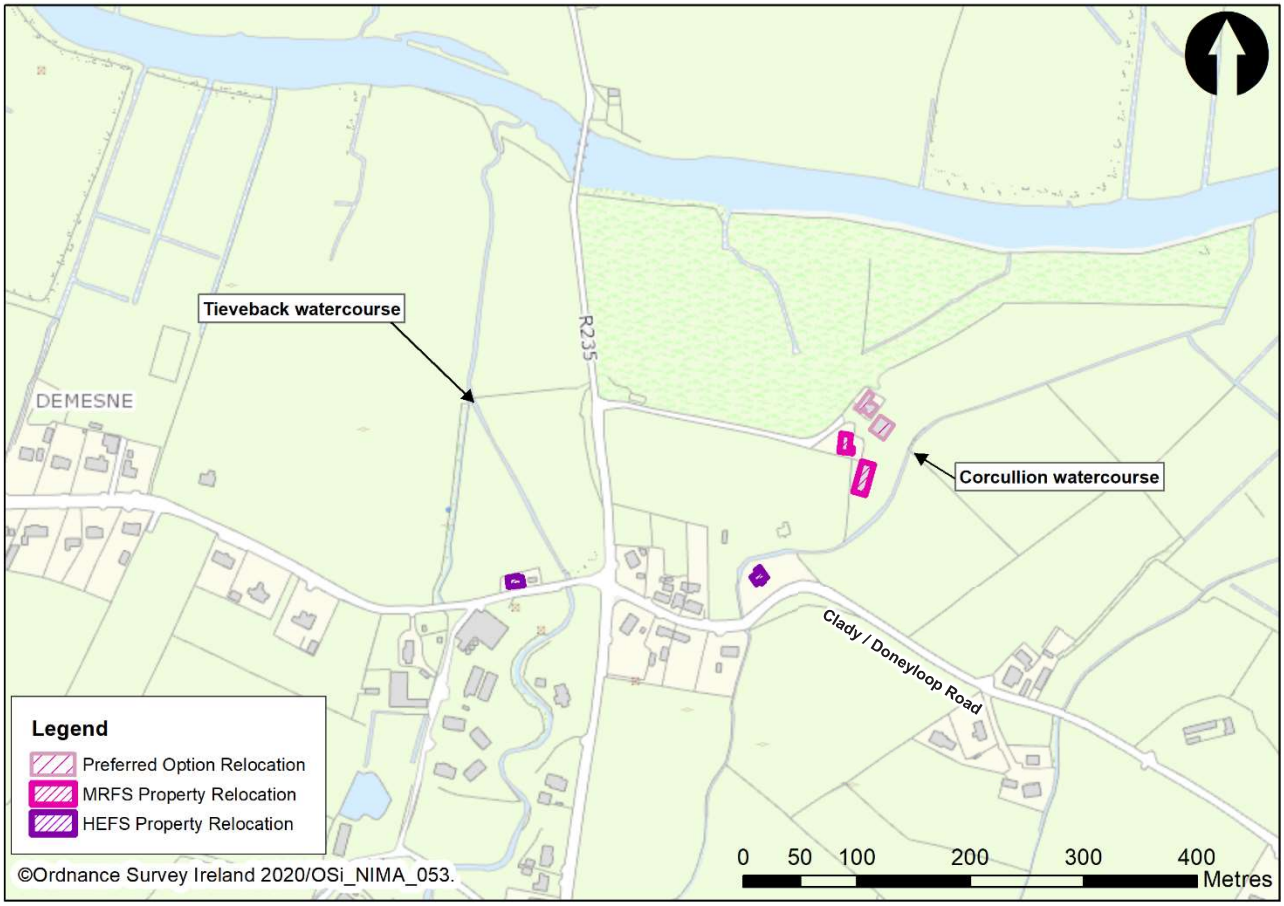


Figure 3.10 Additional Relocation of Properties required for the MRFS and HEFS

An industrial building at risk from the Tievebrack watercourse, is not considered suitable due to being an industrial / warehousing building with no suitable relocation / replacement site readily available within the scheme area.

3.3 Identification of Adaptation Option Pathways

The identification of adaptation pathways is presented separately for the five watercourses / areas to avoid the need to assess an overly large number of combinations and to ensure the issues at each watercourse / area do not become lost in a Scheme Area approach.

All of the pathways displayed in the following sections assume that monitoring is available upon which to base the adaptation decision and trigger points.

If additional monitoring is not installed on the tributary watercourses, as set out in Section 3.2.1, then full adaptation to the HEFS will need to be provided within the scheme design life to guarantee the SoP is maintained. This applies to the Castlefinn watercourse, Bridge Burn, Corcullion and Tievebrack watercourses. Monitoring on the River Finn is already in place.

3.3.1 River Finn

Adaptation pathways for River Finn (Figure 3.11) are limited to 'Do nothing' or adapt the Preferred Option 'Walls and Embankments' as outlined in Figure 3.3 to Figure 3.6. Walls and embankments would be extended by 127m in the MRFS and crest levels increased by typically 800mm. In the HEFS these crest heights would be increased by a further 70mm.

The walls and embankments adaptation pathway requires that the Finn Preferred Option embankment foundations are designed and constructed in Year 0 for future adaptation.

The walls and embankments adaptation pathway is dependent on monitoring to determine their need and trigger point for implementation. If trigger points are not reached, then the scheme will follow the 'Do Nothing' path throughout its design life. The first review and analysis of the data would be undertaken ten years after FRS implementation.

Further reviews would be undertaken depending on the results of the first review. Reviews would consider the estimated level of freeboard available at year ten and the likely progression of climate and other catchment changes depending on the data. A second review is shown on the figures at year 30 for indicative purposes.

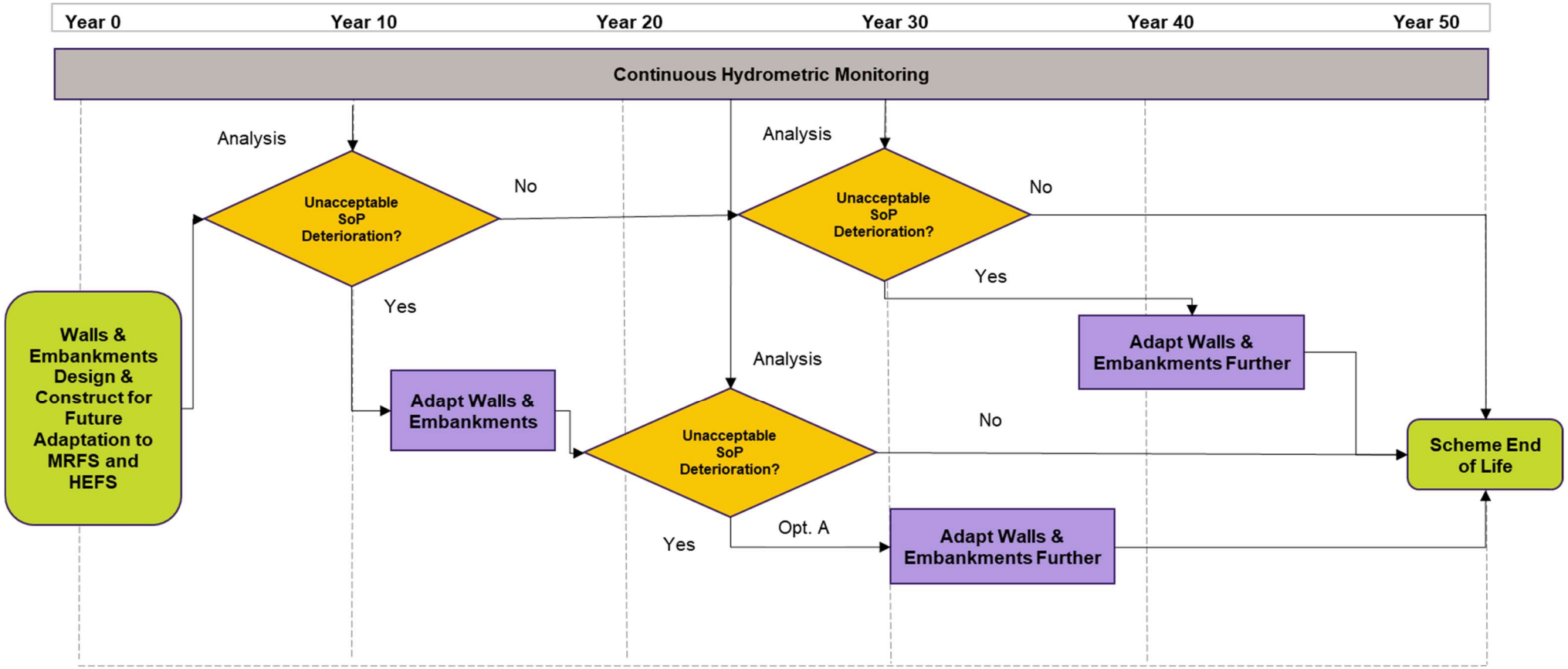


Figure 3.11 River Finn Walls and Embankments Adaptation Pathway

3.3.2 Castlefinn Watercourse

Adaptation on the Castlefinn Watercourse can be defined as a number of pathways. These are described in Sections 3.2.3 and 3.2.4 representing adaptation pathways centred on walls and embankments (Figure 3.3 to Figure 3.6) and upstream storage (Figure 3.2) if trigger points are met. If trigger points are not met then the 'Do nothing' pathway will be followed.

Note that the walls and embankments adaptation measures suggested for the Castlefinn Watercourse refers to the suggested walls and embankments around and upstream of the CPI centre in the Preferred Option. The embankment south of the CPI centre along the railway line is considered in the River Finn adaptation measures.

The walls and embankments adaptation pathway requires that embankment foundations are designed and constructed in Year 0 for future adaptation. The technical screening of the walls and embankments adaptation measures also found that part of the proposed embankment, adjacent to the car park on the western edge of the CPI site, identified in the Preferred Option is not adaptable. Therefore a further requirement of this adaptation pathway is that this embankment is changed to a wall in the preferred option (i.e. Year 0).

Walls and embankments would be extended by 127m in the MRFS and crest levels increased by typically 1100mm. In the HEFS these crest heights would be increased by a further 780mm.

The storage measures can only provide adaptation up to the MRFS by providing approximately 50,000m^3 as shown in Figure 3.2. Adaptation to the HEFS under a storage led pathway would only be provided through adaptation of the walls and embankments downstream at the CPI and farm upstream of the N15 in addition to the upstream storage.

All of the adaptation pathways are dependent on monitoring to determine their need and trigger points for implementation. If trigger points are not reached, then the scheme will follow the 'Do Nothing' path throughout its design life. The first review and analysis of the data would be undertaken ten years after FRS implementation.

Further reviews would be undertaken depending on the results of the first review. Reviews would consider the estimated level of freeboard available at year ten and the likely progression of climate and other catchment changes depending on the data. A second review is shown on the figures at year 30 for indicative purposes.

The walls and embankments led adaptation pathway is set out in Figure 3.12 and the storage led adaptation pathway is set out in Figure 3.13.

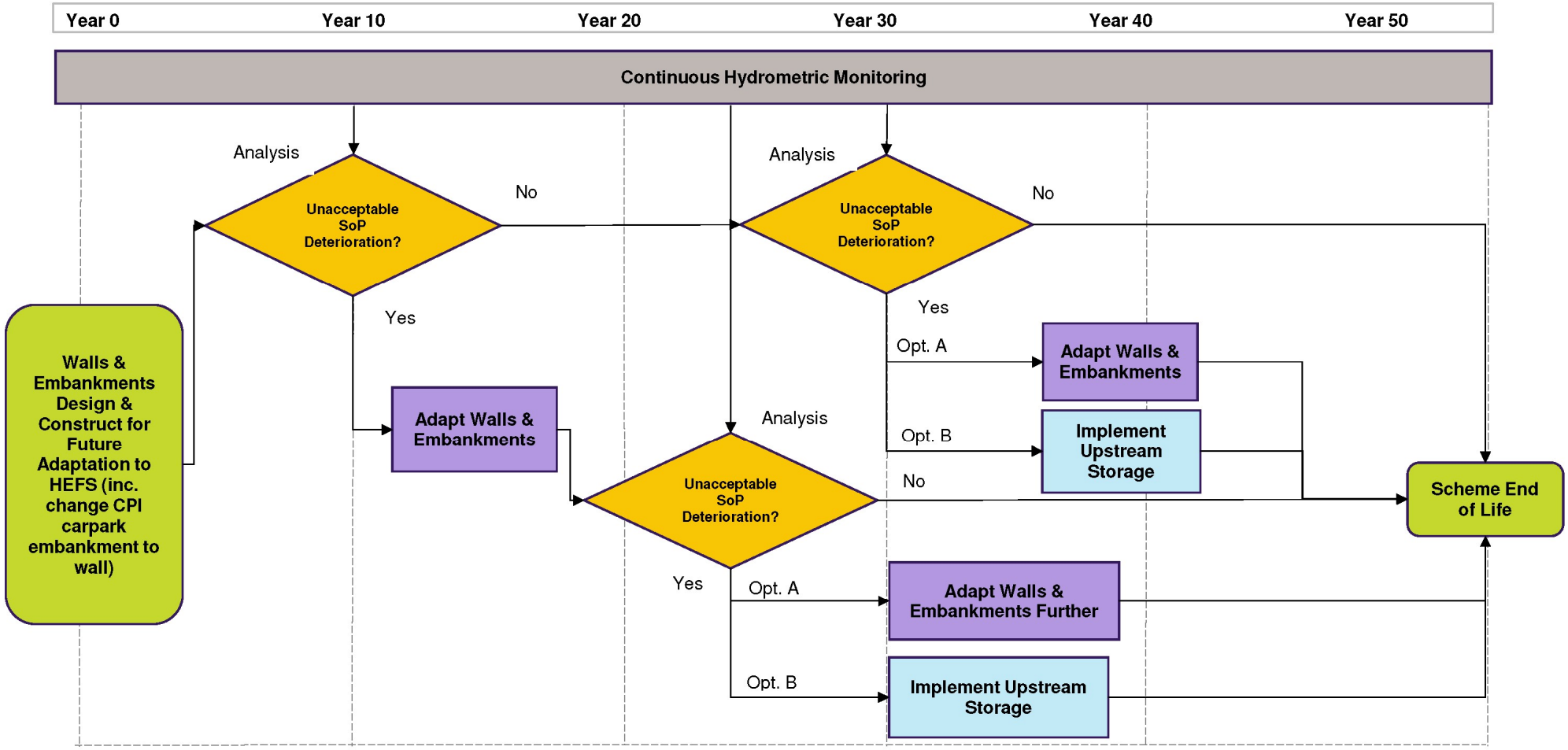


Figure 3.12 Castlefinn Watercourse Walls and Embankments led Adaptation Pathway

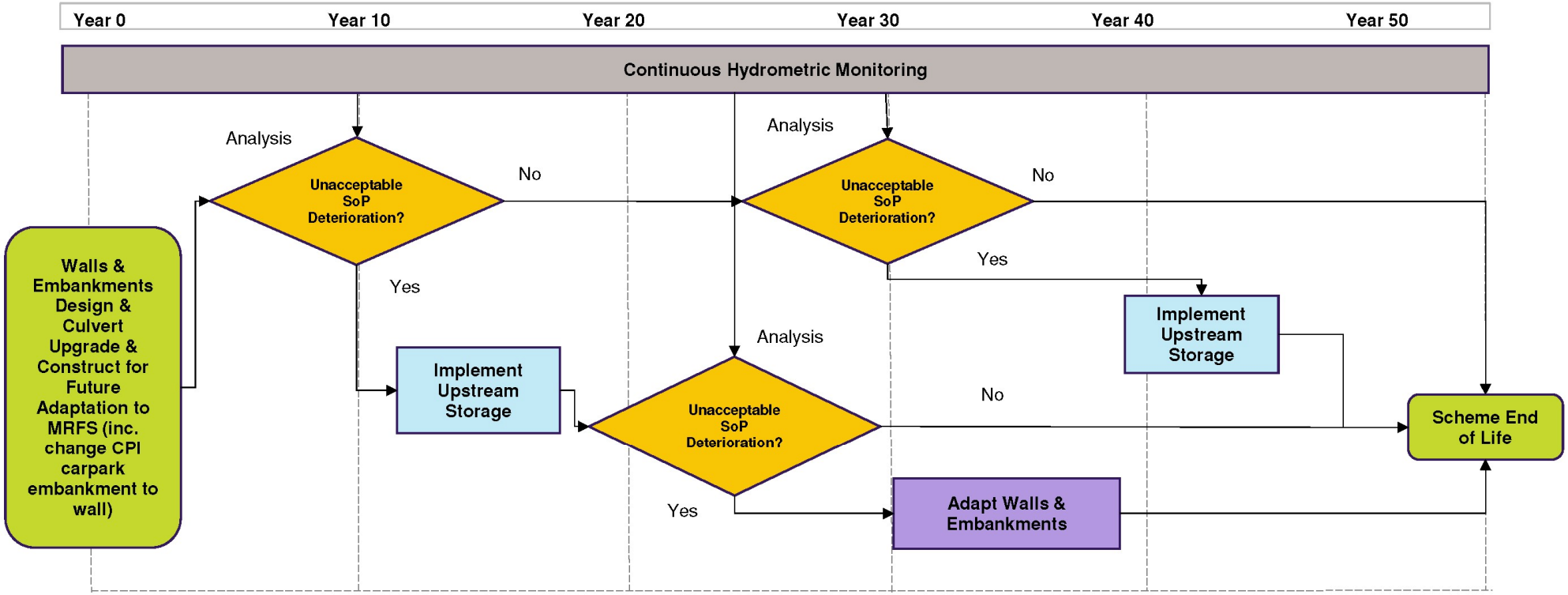


Figure 3.13 Castlefinn Watercourse Storage led Adaptation Pathway

3.3.3 Bridge Burn

Adaptation on the Bridge Burn can be defined as a number of pathways. These are described in Sections 3.2.4 and 3.2.5 representing adaptation pathways centred on walls and embankments (Figure 3.3 to Figure 3.6) and increased conveyance (Figure 3.9) if trigger points are met. If trigger points are not met then the 'Do nothing' pathway will be followed.

Note that the walls and embankments adaptation measures suggested for the Bridge Burn do not consider the adaptation of the preferred option large embankment at the old railway line in the west of the town. This is considered under the River Finn adaptation pathways.

The walls and embankments measure sees 293m of new embankment with an average height of 2.13m constructed in the MRFS. In the HEFS a further 123m of wall would be required upstream of the culvert under the N15 at an average height of 2m. The embankment constructed to the MRFS standard would need to be raised by a further 850mm. The culvert at McGlynns would need to be upsized to a 1.35m diameter circular or 2.0m x 1.0m wide box for the HEFS. If this adaptation pathway is preferred it is assumed the increased culvert capacity would be provided at the outset (Year 0). Further adaptation would be needed on the Bridge Burn culvert for the HEFS SoP including sealing manholes and fitting non-return valves from drainage discharge points to the Bridge Burn culvert. Some stormwater pumping may be required for the systems discharging to the Bridge Burn culvert if large pluvial events occurred at the same time as a fluvial flood event.

The adaptation pathways are dependent on monitoring to determine their need and trigger points for implementation. If trigger points are not reached, then the scheme will follow the 'Do Nothing' path throughout its design life. The first review and analysis of the data would be undertaken ten years after FRS implementation.

Further reviews would be undertaken depending on the results of the first review. Reviews would consider the estimated level of freeboard available at year ten and the likely progression of climate and other catchment changes depending on the data. A second review is assumed within the pathways at year 30 for indicative purposes.

The walls and embankments led adaptation pathway is set out in Figure 3.14.

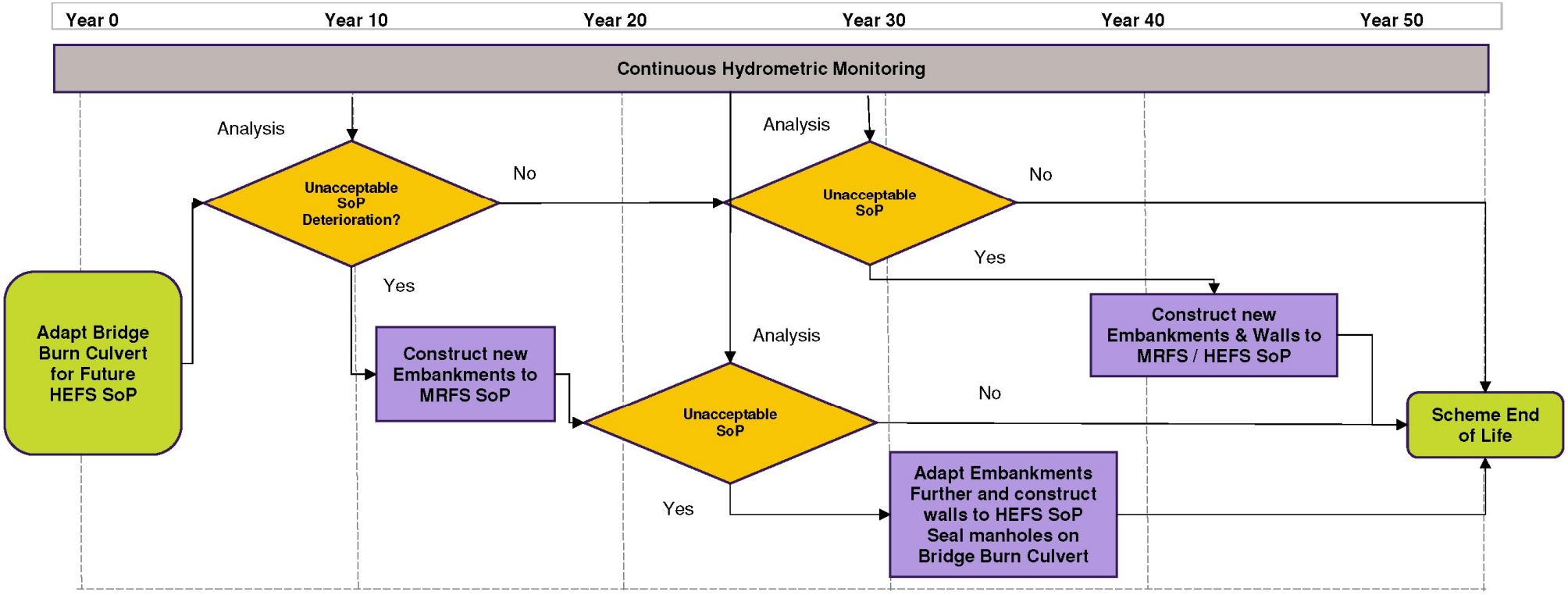


Figure 3.14 Bridge Burn Walls and Embankments + Increased Conveyance led Adaptation Pathway

3.3.4 Corcullion Watercourse

Adaptation on the Corcullion watercourse can be defined as a number of pathways. These are described in Sections 3.2.4 to 3.2.6 representing adaptation pathways centred on walls and embankments (Figure 3.3 to Figure 3.6), increased conveyance (Figure 3.9) and relocation of property (Figure 3.10) if trigger points are met. If trigger points are not met, then the 'Do nothing' pathway will be followed.

The walls and embankments measure sees 194m of new walls with an average height of 2.36m constructed in the MRFS. The walls and embankments measure also sees 148m of new road constructed to access the properties from the south. The existing road and a stretch of the R235 at the junction are completely flooded in both future scenarios. The most cost-effective access is therefore provided from higher ground to the south via a proposed new access road

In the HEFS the average wall height would increase to 2.43m. Note that wall heights are given from the lowest ground level adjacent and, in the case of this area, this is the lower level of the field surrounding the properties. Wall heights will be much lower as viewed from the property side. In the HEFS a new embankment is required to protect a property upstream of the Coolyslin properties. The embankment is 94m long with an average height of 1.15m.

Relocation of properties would see the relocation of the two remaining properties at the Coolyslin settlement (two are proposed to be relocated as part of the Preferred Option) for the MRFS and HEFS. A further residential property is at risk in the HEFS. Alternatives to relocating this property are:

- upgrading the culvert under the Doneyloop / Clady Road, just upstream of the property to a circular 1.5m diameter (or equivalent capacity box culvert section) or;
- constructing 94m of embankment at an average height of 1.16m around the property boundary to prevent flood waters from spilling into the property.

The adaptation pathways are dependent on monitoring to determine their need and trigger points for implementation. If trigger points are not reached, then the scheme will follow the 'Do Nothing' path throughout its design life. The first review and analysis of the data would be undertaken ten years after FRS implementation.

The relocation of properties pathway and the walls and embankments pathway for the two properties at Coolyslin are considered mutually exclusive. There is not a reasonable scenario where the FRS would commit to the protection of the properties through extensive walls and a new access road at Coolyslin only to relocate the properties at a later date. The relocation pathway removes the need for any future measures.

Further reviews would be undertaken depending on the results of the first review. Reviews would consider the estimated level of freeboard available at year ten and the likely progression of climate and other catchment changes depending on the data. A second review is assumed within the pathways at year 30 for indicative purposes.

The walls and embankments led adaptation pathway is set out in Figure 3.15 and the relocation led adaptation pathway is set out in Figure 3.16.

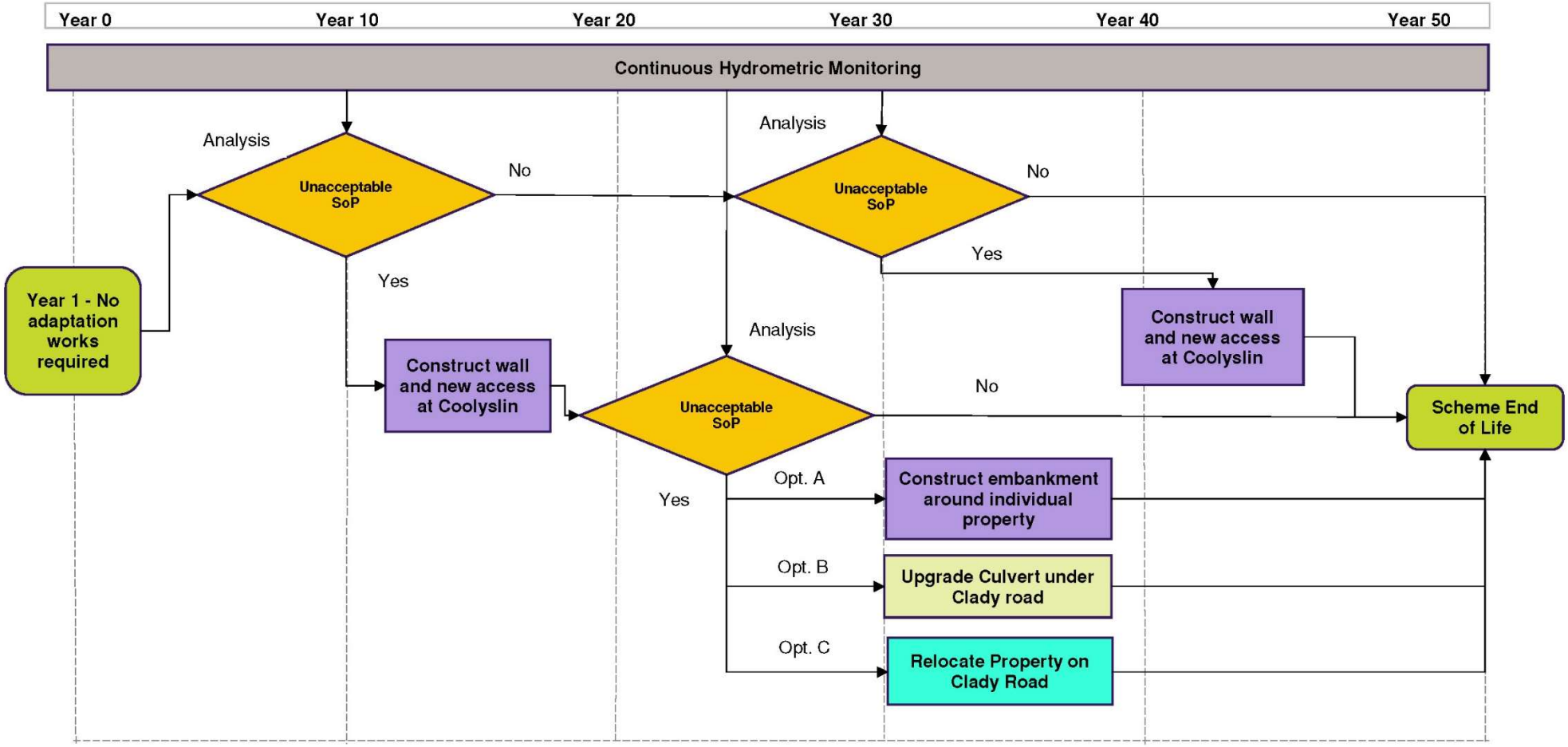


Figure 3.15 Corcullion Walls and Embankments led Adaptation Pathway

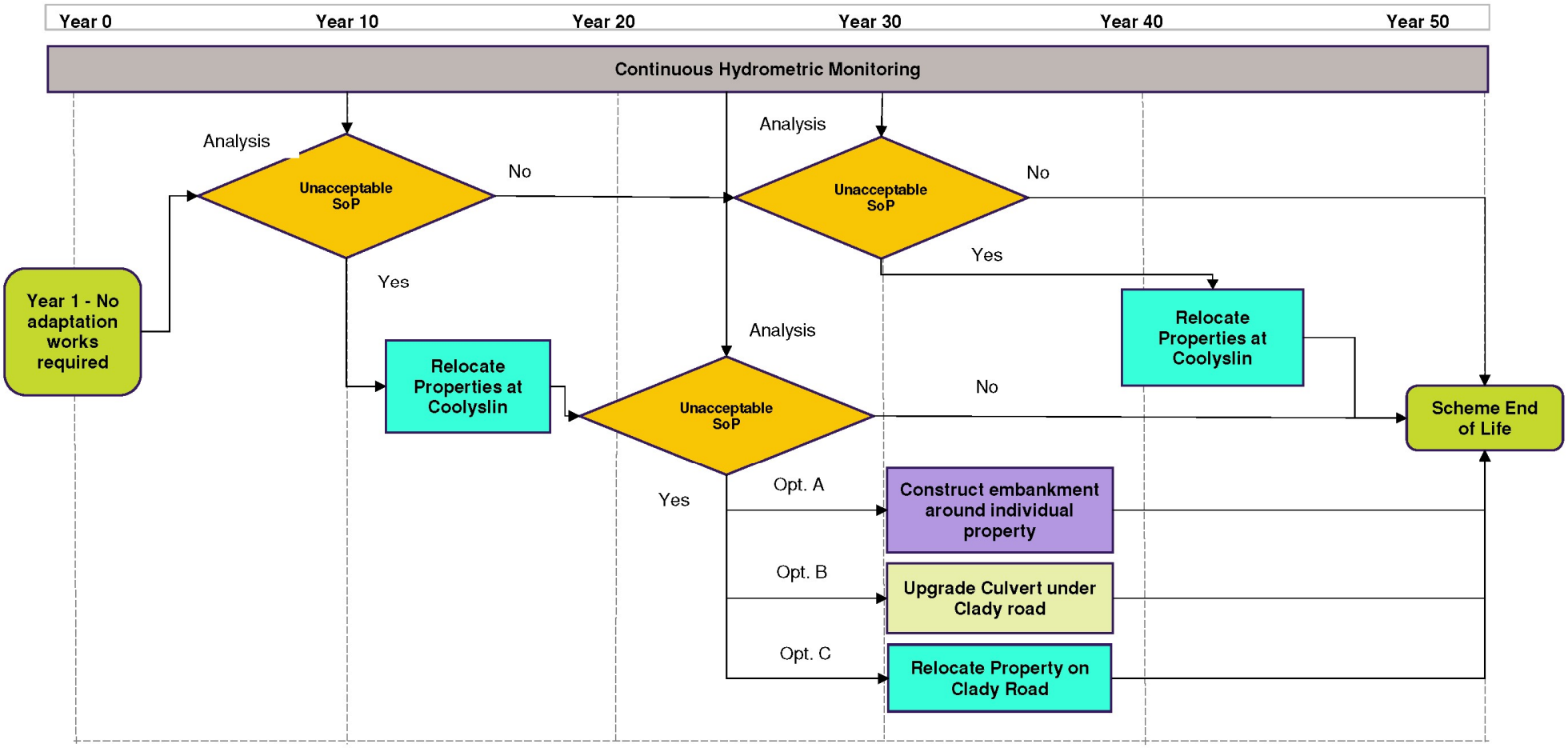


Figure 3.16 Corcullion Relocation led Adaptation Pathway

3.3.5 Tievebrack Watercourse

Adaptation for the Tievebrack watercourse is only required for the HEFS. Two potential options / pathways have been identified. The first involves the construction of a new embankment 341m in length at an average height of 1.2m on the left bank of the Tievebrack watercourse returning around the rear (north) of a property accessed off the Carn View Road (towards Ballybofey) running parallel to the River Finn. The stone arch bridge close to this property would also need to be reconstructed as a clear-span bridge.

The second option pathway sees only 229m of embankment constructed along the left bank of the Tievebrack watercourse at an average height of 1.16m. The residential property to the north of the road would be relocated.

The adaptation pathways are dependent on monitoring to determine their need and trigger points for implementation. If trigger points are not reached, then the scheme will follow the 'Do Nothing' path throughout its design life. Only one review and analysis of the data would be undertaken thirty years after FRS implementation. The review would consider the estimated level of freeboard available at year thirty and the likely progression of climate and other catchment changes depending on the data.

The embankments and bridge replacement adaptation pathway is set out in Figure 3.17 and the embankments and property relocation adaptation pathway is set out in Figure 3.18.

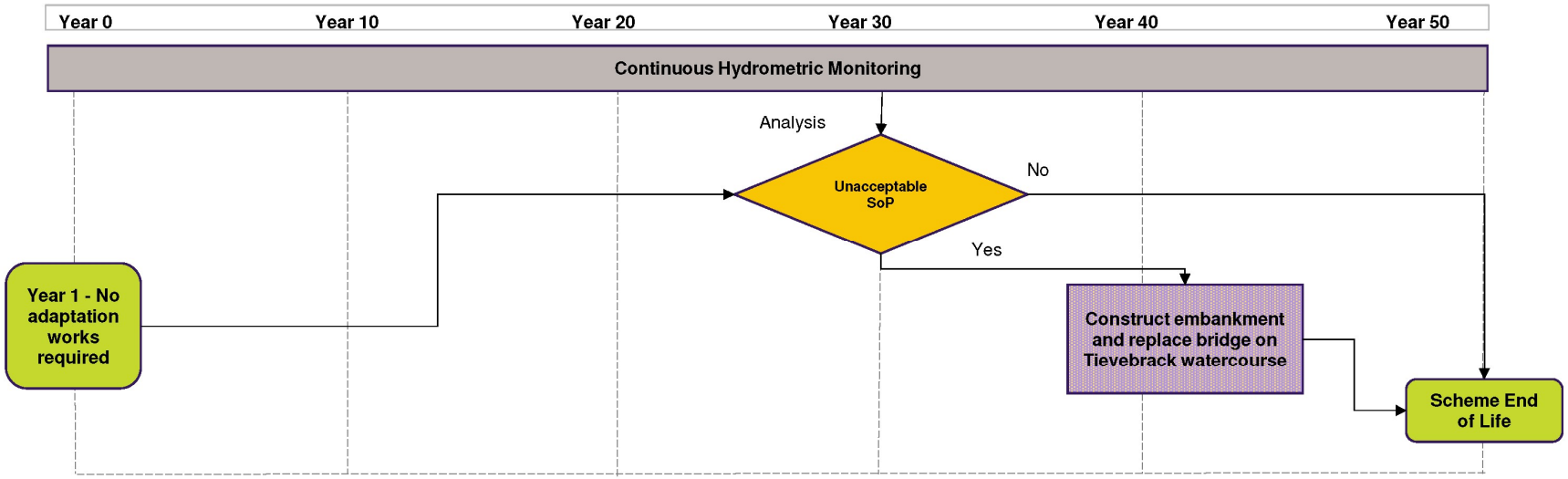


Figure 3.17 Tievebrack Embankments and Bridge Replacement Adaptation Pathway

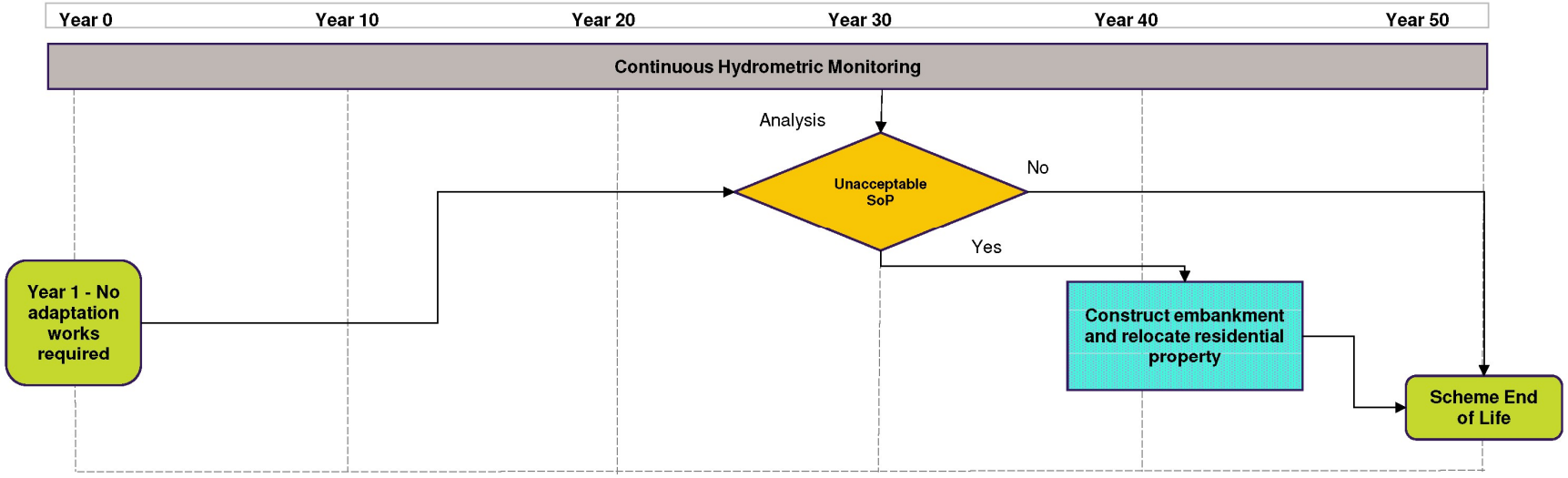


Figure 3.18 Tievebrack Embankments and Property Relocation Adaptation Pathway

4 APPRAISAL OF POTENTIAL ADAPTATION OPTION PATHWAYS

An assessment of the anticipated performance of each Adaptation Option Pathway for each watercourse was undertaken to evaluate quantitatively how well each pathway performs in terms of:

- Economic Appraisal
- Multi-Criteria Analysis carried out through a simplified MCA

These assessments are set out below.

4.1 River Finn

4.1.1 Economic Appraisal

For the River Finn only increasing the heights and lengths of hard defences (embankments) can provide the ability to adapt the scheme to maintain the SoP if the MRFS or HEFS are realised. The need for adaptation will be dependent on monitoring flood flows and levels in the River Finn.

The Whole Life Cost of adapting the FRS to the MRFS is €1.67M and €1.80M for the HEFS.

4.1.2 Multi-Criteria Analysis

A simplified Multi-Criteria Analysis has been undertaken for the River Finn pathway (Table 4.1)

Table 4.1 Multi-Criteria Analysis of Adaptation Options for River Finn

	Walls and Embankments Adaptation Pathway	
Criteria	Assessment	Score
Technical		
Disruption in the scheme area due to construction	Heavy construction works, mainly in the agricultural fields on the southern edge of the town during the FRS design life.	-1
Operation and Maintenance Risk	Increased structure heights leading to slight increase in OandM risk.	-1
Level / certainty of protection provided	Can provide the full level of protection needed for MRFS and HEFS. Uncertainty is moderate / low	2
Economic		
Economic impact on agricultural land	Additional flood volumes generated in future scenarios will be displaced onto agricultural lands. Very small impact over a 'do nothing' scenario where defences are overtopped.	-1
Social		
Landscape and Visual Impact	Moderate increased visual impact from embankments in the Finn floodplain. Not visible from most viewpoints around the town.	-1
Environmental		
Carbon impact	Significant construction works. Extensive use of heavy plant during the construction phase.	-2
Impact on Biodiversity	Significant impact on habitats and species as adaptation works will require extension and widening of embankments through a further construction phase during the design life. No in-channel works but works close to watercourses linked hydrologically to the SAC.	-2

Criteria	Walls and Embankments Adaptation Pathway Assessment	Score
WFD objectives	No significant impact on WFD objectives over and above FRS.	0
Total MCA-Lite Score		-6

Score	Description
3	Very Positive
2	Positive
1	Slightly Positive
0	Neutral/Not Significant
-1	Slightly Negative
-2	Negative
-3	Very Negative

The only adaptation pathway available for the River Finn, increasing the height and length of embankments scores negatively across most criteria. In particular, the need to do a future construction phase will have a significant environmental impact. It may be the case that this is not needed if monitoring of the existing gauge data does not determine a significant change in flood risk.

4.2 Castlefinn Watercourse

4.2.1 Economic Appraisal

For the Castlefinn watercourse there are two potential adaptation pathways available to maintain the SoP if the MRFS and HEFS are realised. These are centred on adapting the walls and embankments at and upstream of the CPI Centre or implementing storage upstream on the Castlefinn watercourse. The walls and embankments pathway retains the potential of implementing upstream storage if adaptation to the HEFS is required. The upstream storage pathway requires adaptation to the walls and embankments at the CPI Centre in addition to the upstream storage to maintain the SoP in the HEFS. The need for adaptation will be dependent on monitoring of flood flows via a new gauge to be installed on the Castlefinn watercourse.

A summary of the Whole Life Cost for both pathways is shown in Table 4.2. The costs listed are adaptation costs only and consider the additions to the initial FRS to ensure it is adaptable (e.g. bigger foundations for walls) and for the future works to adapt the scheme to maintain MRFS or HEFS SoP.

Table 4.2 Summary of Whole Life Cost of Castlefinn watercourse Adaptation Pathways

	Pathway 1 – Walls and Embankments Led	Pathway 2 – Upstream Storage Led
MRFS	€1.01M	€ 2.45M
HEFS	€1.54M	€ 2.87M

4.2.2 Multi-Criteria Analysis

A simplified Multi-Criteria Analysis has been undertaken for the Castlefinn watercourse adaptation pathways (Table 4.3).

Table 4.3 Multi-Criteria Analysis of Adaptation Options for Castlefinn Watercourse

	Pathway 1 – Walls and Embankments Led		**Pathway 2 – Upstream Storage Led**	
Criteria	Assessment	Score	Assessment	Score
Technical				
Disruption in the scheme area due to construction	Heavy construction works in Castlefinn during the FRS design life.	-3	Heavy construction works, mainly upstream of Castlefinn during the FRS design life.	-1
Operation and Maintenance Risk	Increased structure heights leading to slight increase in O&M risk.	-1	Significant increased maintenance on impoundment structure upstream. Increased risk of blockage on flow control culvert. Ineffective maintenance leading to failure could lead to rapid flooding of the community downstream.	-2

Level / certainty of protection provided	Can provide the full level of protection needed for MRFS and HEFS subject to implementation of adaptability measures at outset of FRS (e.g. adequate foundations).	1	Can provide MRFS Standard of Protection (SoP) but must be combined with walls and embankment increases at CPI to provide HEFS SoP.	-1
Economic				
Economic impact on agricultural land	Additional flood volumes generated in future scenarios will not generally be displaced onto agricultural lands.	0	Significant impact to large area of agricultural lands required for upstream storage area.	-1
Social				
Landscape and Visual Impact	Significant visual impact with defence heights in and around CPI Centre rising to between 1.4m and 2.7m in the MRFS and 1.8m to 3.4m in the HEFS.	-2	Minimal visual impact in the MRFS, limited to views in the upstream rural catchment. Further intervention needed in HEFS with walls and embankments increased at CPI.	-1
Environmental				
Carbon impact	Significant construction works and high use of concrete in providing additional foundations at outset and for extension of walls. Extensive use of heavy plant during construction phase.	-3	Significant construction works to construct upstream storage dam although low use of concrete. Extensive use of heavy plant during construction phase.	-2
Impact on Biodiversity	Minimal impact on habitats and species as adaptation works will take place at existing structures, out of channel. Some increased impact at outset to accommodate future adaptation and some impact during the construction works.	-1	Minimal impact on habitats with works taking place in upper catchment within agricultural land.	-1
WFD objectives	No significant impact on WFD objectives over and above FRS.	0	Potential slight improvements in water quality arising from attenuation. Potential negative impacts during the construction phase due to significant earthworks adjacent to the watercourse.	0
Total MCA-Lite Score		-9		-9

Score	Description
3	Very Positive
2	Positive
1	Slightly Positive
0	Neutral/Not Significant
-1	Slightly Negative
-2	Negative
-3	Very Negative

Both adaptation pathways for the Castlefinn watercourse score the same (-9, negative) in the MCA. The Walls and Embankments led pathway is however significantly cheaper and provides greater certainty going forward. The upstream storage pathway is impacted by uncertainty in both its effectiveness and its cost and this is reflected in the score and costing.

It is recommended that the Walls and Embankments led pathway is followed for the adaptation of the scheme. It should be noted that this pathway retains the flexibility to pursue the upstream storage measure in the future if the HEFS is realised. However, it is prudent that the scheme makes allowance in Year 0 for the adaptation of the Walls and Embankments to give flexibility for the future.

4.3 Bridge Burn

4.3.1 Economic Appraisal

For the Bridge Burn there is only one adaptation pathway available to maintain the SoP if the MRFS and HEFS are realised. This involves adding new embankments to protect properties on the western side of the town from flood waters in the Bridge Burn as they are prevented from discharging through the Finn embankments. The flows and consequently the overall flood volumes in the Bridge Burn are predicted to increase substantially putting additional properties in the area at risk in the MRFS. In the HEFS a larger culvert, an upgrade from 1200mm to a 1350mm daimeter or 1.0m x 2.0m box, is required to convey the flows. Even with the larger culvert the volume of water backing up is such that it backs up through the Bridge Burn culvert requiring additional walls upstream of the inlet and the sealing of manholes in the vicinity of the N15 road junction / in front of McGlynns. The need for adaptation will be dependent on monitoring of flood flows via a new gauge to be installed on the Castlefinn watercourse.

The Whole Life Cost of adapting the FRS to the MRFS is €0.62M and €1.44M for the HEFS.

4.3.2 Multi-Criteria Analysis

A simplified Multi-Criteria Analysis has been undertaken for the Bridge Burn adaptation pathway (Table 4.4).

Table 4.4 Multi-Criteria Analysis of Adaptation Options for Castlefinn Watercourse

	Bridge Burn - Walls and Embankment Led Adaptation Pathway	
Criteria	Assessment	Score
Technical		
Disruption in the scheme area due to construction	Heavy construction works, mainly in the agricultural fields on the southern edge of the town during the FRS design life.	-1
Operation and Maintenance Risk	Increased infrastructure requiring maintenance leading to slight increase in OandM risk.	-1
Level / certainty of protection provided	Can provide the full level of protection needed for MRFS and HEFS. High uncertainty in residual drainage risk on the western side of Castlefinn.	0
Economic		
Economic impact on agricultural land	Slight increase in risk to agricultural land.	-1
Social		
Landscape and Visual Impact	Moderate increased visual impact from embankments in the west of the town. Only visible from a few viewpoints at rear of properties.	-1
Environmental		
Carbon impact	Significant construction works. Extensive use of heavy plant during construction phase.	-2
Impact on Biodiversity	Significant impact on habitats and species as adaptation works will require new embankments during a further construction phase during the design life. In-channel works for HEFS hydrologically linked to the SAC.	-2
WFD objectives	Potential negative impacts during construction phase due to significant works adjacent to the watercourse	-1
Total MCA-Lite Score		-9

Score	Description
3	Very Positive
2	Positive
1	Slightly Positive
0	Neutral/Not Significant
-1	Slightly Negative
-2	Negative
-3	Very Negative

The only adaptation pathway available for the Bridge Burn, based on constructing new embankments for the MRFS with new walls and culvert upgrades required for the HEFS, scores negatively across most criteria. In particular, the need to do a future construction phase will have a significant environmental impact. It may be the case that this is not needed if monitoring of the existing gauge data does not determine a significant change in flood risk.

4.4 Corcullion Watercourse

4.4.1 Economic Appraisal

For the Corcullion watercourse there are two potential adaptation pathways available to maintain the SoP if the MRFS and HEFS are realised. These are centred on how the remaining properties at the settlement at Coolyslin are protected in the MRFS. This is either by defending them with walls and forming a new access from the south or relocating the properties. In the HEFS a further property to the south is at risk and the measures available are either protecting it with embankments, upgrading the culvert just upstream or relocating the property.

The need for adaptation will be dependent on monitoring of flood flows via a new gauge to be installed on the adjacent Tievebrack watercourse.

A summary of the Whole Life Cost for both pathways is shown in Table 4.5.

Table 4.5 Summary of Whole Life Cost of Castlefinn watercourse Adaptation Pathways

	Pathway 1 – Walls Led			Pathway 2 – Relocation Led		
MRFS	€0.81M			€ 0.52		
HEFS	+ Embankments	+ Culvert Upgrade	+ Relocation	+ Embankments	+ Culvert Upgrade	+ Relocation
	€0.88MM	€0.91M	€0.98M	€0.57M	€0.61M	€0.68M

4.4.2 Multi-Criteria Analysis

A simplified Multi-Criteria Analysis has been undertaken for the Corcullion watercourse adaptation pathways (Table 4.6).

Table 4.6 Multi-Criteria Analysis of Adaptation Options for Corcullion Watercourse

	Pathway 1 – Walls Led		**Pathway 2 – Relocation Led**	
Criteria	Assessment	Score	Assessment	Score
Technical				
Disruption in the scheme area due to construction	Heavy construction works affecting a small local area outside the main town.	-2	Demolition works but only affecting the properties at risk.	-1
Operation and Maintenance Risk	New high walls leading to an increase in OandM risk.	-2	No OandM Risk - properties relocated out of the floodplain. Reduced risk for community and emergency responders.	1

Level / certainty of protection provided	Can provide the full level of protection needed for MRFS and HEFS. Significant uncertainty associated with this small watecourse.	1	Complete protection against all scenarios as properties completely removed from floodplain.	3
Economic				
Economic impact on agricultural land	Small to negligible increase in flood risk to agricultural lands from floodplain displacement. Offset by the protection provided to agricultural buildings.	0	No increase in flood risk to agricultural lands. Potential disruption through relocation of agricultural building.	0
Social				
Landscape and Visual Impact	Significant visual impact with defence heights as viewed from viewpoints in the vicinity will be high (typically over 2m). Limited to a small area.	-1	No visual impact. Removal of properties from the Finn Valley landscape character area may provide benefit.	1
Environmental				
Carbon impact	Significant construction works and high use of concrete for extensive flood walls. Extensive use of heavy plant during construction phase.	-3	Demolition works will involve the use of heavy plant during demolition phase. May be offset by the reduction in remedial works following flooding.	-1
Impact on Biodiversity	Works mainly restricted to already developed small settlement. Adjacent to SAC however with potential for the works area to encroach in SAC	-2	Demolition works adjacent to SAC. This will complete the removal of the settlement adjacent to SAC and provide the opportunity for increased biodiversity.	0
WFD objectives	No in-channel works but construction adjacent to the watercourse providing hydrological linkage to the Finn.	-1	Demolition works close to the watercourse providing hydrological linkage to the Finn but the removal of the settlement could reduce pressure on the water body.	0
Total MCA-Lite Score		-10		3

Score	Description
3	Very Positive
2	Positive
1	Slightly Positive
0	Neutral/Not Significant
-1	Slightly Negative
-2	Negative
-3	Very Negative

The walls led adaptation pathways for the Corcullion watercourse scored negatively (-10) in the MCA whereas the relocation pathway scored slightly positive (+3). The relocation pathway is also significantly cheaper and provides greater certainty going forward.

It is recommended that the relocation pathway is followed for the adaptation of the scheme. Monitoring and analysis of the risk will determine if adaptation to the HEFS is required within the scheme design life. If it is, the selection of the further adaptation measure for the additional property should be decided following consultation with the affected property owner. The assumed preferred measure at this stage is to upgrade the culvert under the Clady / Doneyloop road as this would protect the road also.

4.5 Tievebrack watercourse

4.5.1 Economic Appraisal

For the Tievebrack watercourse there are two adaptation pathways available but they are only triggered if the HEFS is realised. Both pathways involve building a new embankment along the left bank of the watercourse. One property to the north of the road affected by the Finn can either be protected through an embankment and replacing the stone arch bridge with a new clear span or by relocating the property. The need for adaptation will be dependent on monitoring of flood flows via a new gauge to be installed on the Castlefinn watercourse.

A summary of the Whole Life Cost for both pathways is shown in Table 4.7.

Table 4.7 Summary of Whole Life Cost of Tievebrack watercourse Adaptation Pathways

	Pathway 1 – Embankments + Bridge Replacement	Pathway 2 – Embankments + Property Relocation
HEFS	€0.67M	€ 0.27M

4.5.2 Multi-Criteria Analysis

A simplified Multi-Criteria Analysis has been undertaken for the Tievebrack watercourse adaptation pathways (Table 4.8).

Table 4.8 Multi-Criteria Analysis of Adaptation Options for Tievebrack Watercourse

	Pathway 1 – Embankments + Bridge Replacement		**Pathway 2 – Embankments + Property Relocation**	
Criteria	Assessment	Score	Assessment	Score
Technical				
Disruption in the scheme area due to construction	Construction works affecting a small local area. Bridge replacement represents significant disruption for the local community.	-2	Construction and demolition works affecting a small local area.	-1
Operation and Maintenance Risk	Embankments require additional ongoing inspection and maintenance. Reduced blockage risk from the new bridge and therefore reduced OandM requirements at that location.	-1	Embankments require additional ongoing inspection and maintenance. Reduced length from pathway 1.	-1
Level / certainty of protection provided	Can provide the full level of protection needed for MRFS and HEFS. High uncertainty on the small ungauged watercourse.	0	Can provide the full level of protection needed for MRFS and HEFS. High uncertainty on the small ungauged watercourse. Full protection / no uncertainty regarding risk to the relocated property.	1

Economic				
Economic impact on agricultural land	Small to negligible increase in flood risk to agricultural lands from floodplain displacement.	-1	Small to negligible increase in flood risk to agricultural lands from floodplain displacement. Reduced further due to relocation.	0
Social				
Landscape and Visual Impact	Low visual impact with low defence heights.	-1	Low visual impact with low defence heights	-1
Environmental				
Carbon impact	Significant construction works. Extensive use of heavy plant during construction phase.	-2	Significant construction and demolition works. Extensive use of heavy plant.	-2
Impact on Biodiversity	Works to take place within mainly agricultural land and residential properties. In-channel works (bridge replacement) have the potential for temporary impact on aquatic habitats and downstream SAC.	-2	Works to take place within mainly residential properties. Some potential impact due to proximity to SAC.	-1
WFD objectives	In-channel works in the watercourse providing hydrological linkage to the Finn.	-2	No in-channel works. Demolition works adjacent to SAC with hydrological pathways.	-1
Total MCA-Lite Score		-11		-6

Score	Description
3	Very Positive
2	Positive
1	Slightly Positive
0	Neutral/Not Significant
-1	Slightly Negative
-2	Negative
-3	Very Negative

The embankment and property relocation adaptation pathway has both a lower whole-life cost and scores less negatively within the MCA.

It is recommended that the embankment and property relocation pathway be followed for the adaptation of the scheme if the HEFS is likely to be reached. Monitoring and analysis of the risk will determine if adaptation to the HEFS is required within the scheme design life.

4.6 Summary of Preferred Pathway

The preferred adaptation pathways for the five areas / watercourses considered are shown below in Table 4.9.

Table 4.9 Preferred Adaptation Pathways

	MRFS Adaptation Description	MRFS Adaptation Whole Life Cost	HEFS Additional Adaptation Description	HEFS Adaptation Whole Life Cost
River Finn	Additional 127 m of earthen embankments required. Increase height of FRS embankments by 800mm.	€ 1,673,510	Increase crest heights of earthen embankments by a further 70mm	€ 1,798,734
Castlefinn watercourse	Replace embankment with a wall along CPI car park and extend up the other side of the watercourse (along church access). Total walls and embankments extension 127m and crest levels increased by typically 1100mm	€ 1,007,036	Increase crest heights of walls and earthen embankments by a further 780mm **Or** Develop upstream storage scheme	€ 1,540,242 (€ 2,866,943)
Bridge Burn	293m of new embankment with an average height of 2.13m.	€ 621,130	123m of new wall upstream of the culvert, average height of 2m. Raise MRFS embankments by a further 850mm. Culvert upgraded to 2.0m x 1.0m wide box.	€ 1,436,602
Corcullion watercourse	Relocate two remaining properties at Coolyslin	€ 523,717	Upgrade culvert under Doneyloop / Clady Road	€ 608,089
Tievebrack watercourse	-	-	229m of new embankment with an average height of 1.16m and relocate residential property.	€ 270,278
Total		**€ 3,825,393**		**€ 5,653,945 - € 6,980,646**

Table 4.10 gives a summary of the economic appraisal, including whole life costs for if the MRFS and HEFS are realised. For the MRFS it is assumed that the adaptation measures are triggered in Year 10 and delivered in Year 11 for costing purposes. This could conceivably be at any time in the design life of the scheme which has a significant bearing on the whole life costs due to the discount rate (4% per annum) applied. If adaptation measures are only triggered late in the design life then their present-day, whole-life cost is significantly lower. The Benefit Cost Ratios for the MRFS schemes can therefore be considered to be conservative.

For the HEFS it is assumed that the adaptation measures are triggered in Year 30 and delivered in Year 31 for costing purposes.

Table 4.10 Summary of the Economic Appraisal of the Preferred Adaptation Pathways

	Preferred Adaptation Pathway
Present-Day Scheme – Whole Life Cost	€ 6,569,602
Present Value Benefit (PvB) of Preferred Option	€ 6,108,655
Benefit Cost Ratio (BCR) of Present Day Scheme	0.93
MRFS Scheme - Whole Life Cost	€ 10,394,995
Present Value Benefit (PvB) of Adapted MRFS Scheme	€ 7,534,537
Benefit Cost Ratio (BCR) of Adapted MRFS Scheme	0.72
HEFS - Whole Life Cost	€ 12,223,547 to € 13,550,248

Note that Present Value Benefit and Benefit Cost Ratios for the HEFS Scheme are not available based on the limited flood event scenarios which have been modelled.

5 PREFERRED SCHEME AND FUTURE SCHEMES

For each watercourse, the costs and a simplified MCA determined the best adaptation pathway which have been combined to identify the amendments required for adpatability of the FRS and also what potential future schemes for the MRFS and HEFS might look like.

5.1 Required Amendments to the Preferred Option

The Climate Change Adaptation Plan development has identified several amendments to the Present Day Preferred Option. These are to be designed for and delivered at the outset of the FRS (Year 0) and become part of the Preferred Option. These include:

- Amendment of the preferred form of defence along the car park at the western side of the CPI Centre. 96m of embankment with an average height of 0.95m is to be replaced by a reinforced concrete flood wall with an average height of 0.75m.
- Amendment of the preferred new culvert (192m) for the Bridge Burn from a 1200mm diameter circular culvert to either a 1350mm circular culvert or 1m x 2m box culvert such that it can convey flows up to the HEFS SoP.
- Additional land take upstream within the CPI Centre of 1,023m^2 to facilitate future expansion / extension of earthen flood embankments.
- Additional land for the River Finn flood embankments of 6,013m^2 to facilitate future expansion / extension of earthen flood embankments.

These adaptation changes will result in increased Whole Life Costs to the scheme of €120,799. This reduces the Present Day BCR of the FRS to 0.91.
Figure 5.1 shows the preferred adaptability amendments to be made to the Castlefinn FRS Preferred Option.

5.2 Preferred Future MRFS Scheme

The future MRFS Scheme would see an additional 127 m of earthen embankments required to extend the length of the FRS embankments. The present day FRS embankments would be increased in height by approximately 800mm. The embankment system along the Finn would be on average 3.2m above ground level but with a maximum height of 6.1m,

On the Castlefinn watercourse walls would need to be extended up along the other side (right bank) of the watercourse, along the church access to the west of the CPI Centre. There would be some minor extension to the embankments at the CPI Centre. Total extension to walls and embankments in this area would be 127m in length with crest levels increased by approximately 1100mm. The walls and embankments at the area around the CPI would be an average of 2.0m above ground level with a maximum height of 2.7m.

In the west of the town (Grahamsland) 293m of new embankment would be required with an average height of 2.13m to protect from flooding from the Bridge Burn where it is locked out from the Finn with flood levels building up in this area.

The two remaining properties at the Coolyslin settlement, a residential property and an agricultural / industrial warehouse would be relocated.

Figure 5.2 shows the preferred MRFS Scheme

5.3 Preferred Future HEFS Scheme

The future HEFS Scheme would see the MRFS Scheme embankments increased in height by a further 70mm. The embankment system along the Finn would be on average 3.3m above ground level but with a maximum height of 6.2m.

On the Castlefinn watercourse (at the CPI, church grounds and farm upstream of N15) the walls and earthen embankments would be increased by a further 780mm above the MRFS Scheme. The walls and embankments would be an average of 2.7m above ground level with a maximum height of 3.4m.

Alternatively an upstream storage scheme could be developed to attenuate flows further up the catchment, retaining flood waters until such times as water levels in the River Finn recede. A total of 60,000m^3 of storage would be required. The cost of such works are much greater than the works to increase the heights of the walls and embankments downstream however such an option may be preferable if the impact of the increased wall and embankment heights downstream is deemed too great. The cost of such works is subject to great uncertainty as it is outside the area for which detailed survey information is available. A further study would be required to analyse and prove such a solution to the required level of detail. It may determine such works to be more cost effective than has estimated in this plan.

Along the Bridge Burn, upstream of the culvert which runs under the N15 at McGlynns 123m of new wall would be required. The average height of these walls would be 2m. The MRFS Scheme embankments (Grahamsland) would be raised by a further 850mm taking them to an average height of 2.98m.

To the south of the River Finn a culvert under the Doneyloop / Clady Road would be upgraded to a new 1.5m diameter culvert to protect one property downstream.

Along the Corcullion watercourse 229m of new embankment would be required with an average height of 1.16m. One residential property on the north side of the road would be relocated.

Figure 5.3 shows the preferred HEFS Scheme and Figure 5.4 shows the alternative scheme with the upstream storage.

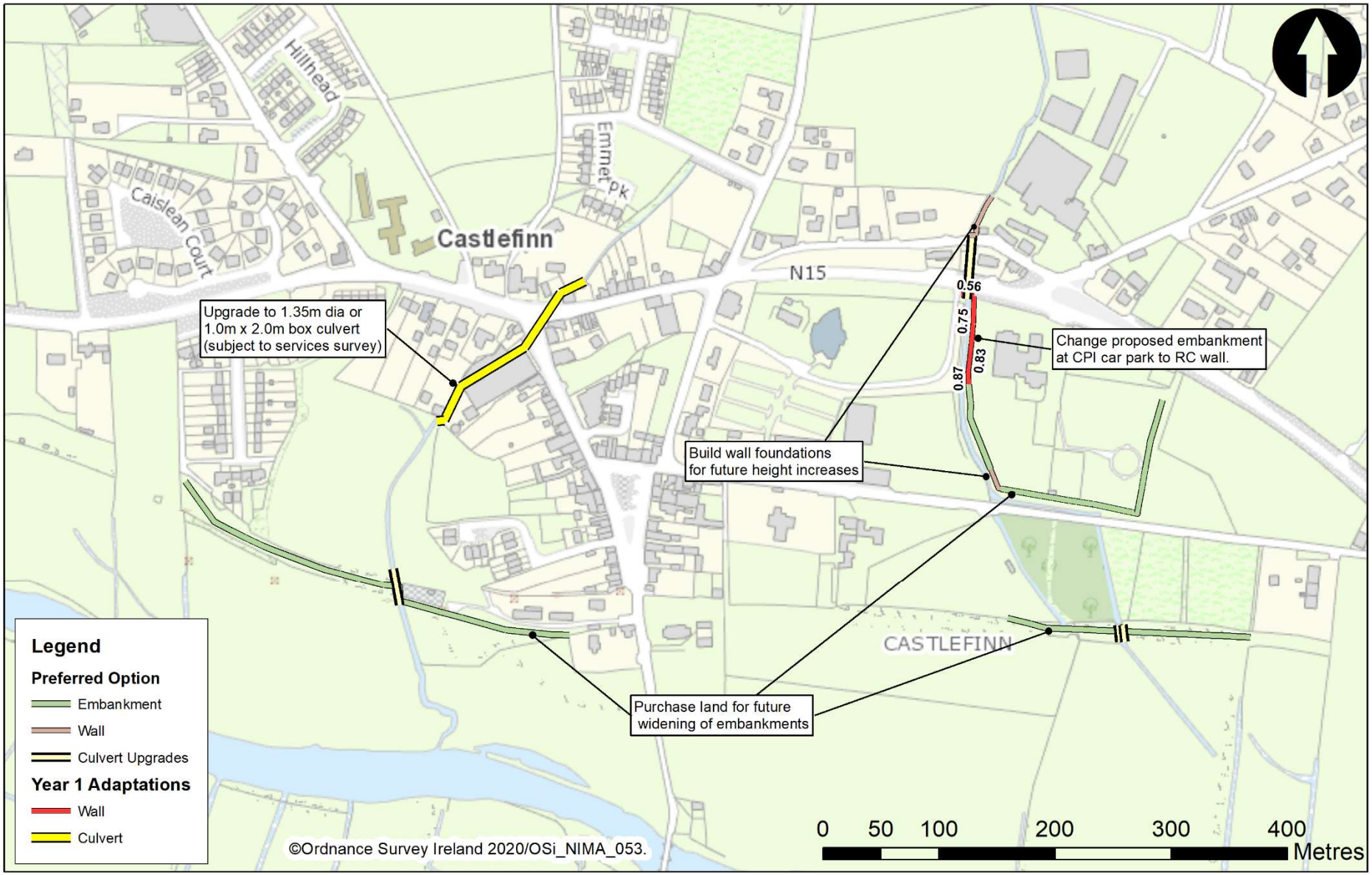


Figure 5.1 Preferred Year 0 Castlefinn FRS Adaptability Amendments

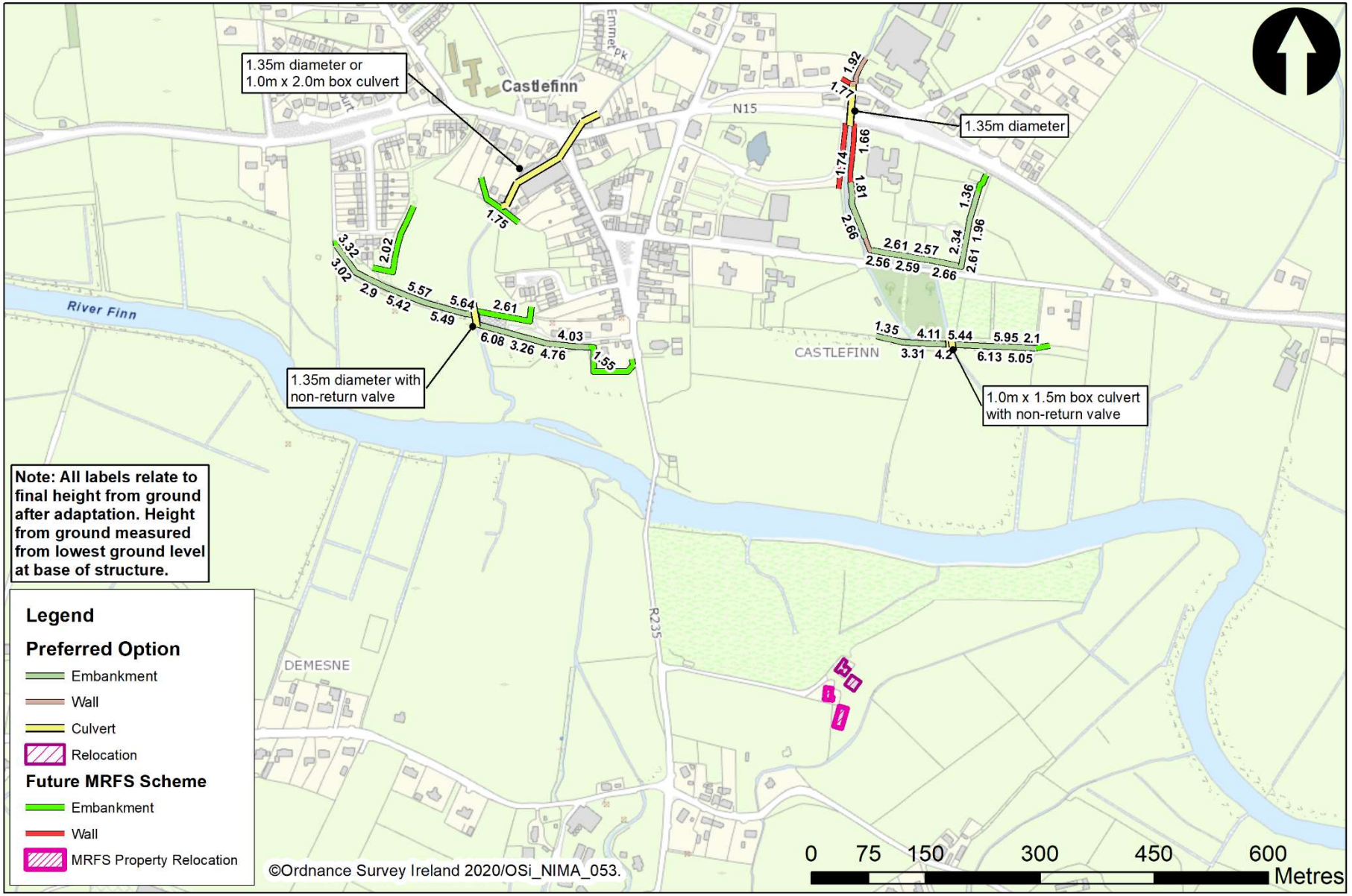


Figure 5.2 Preferred MRFS Future Scheme

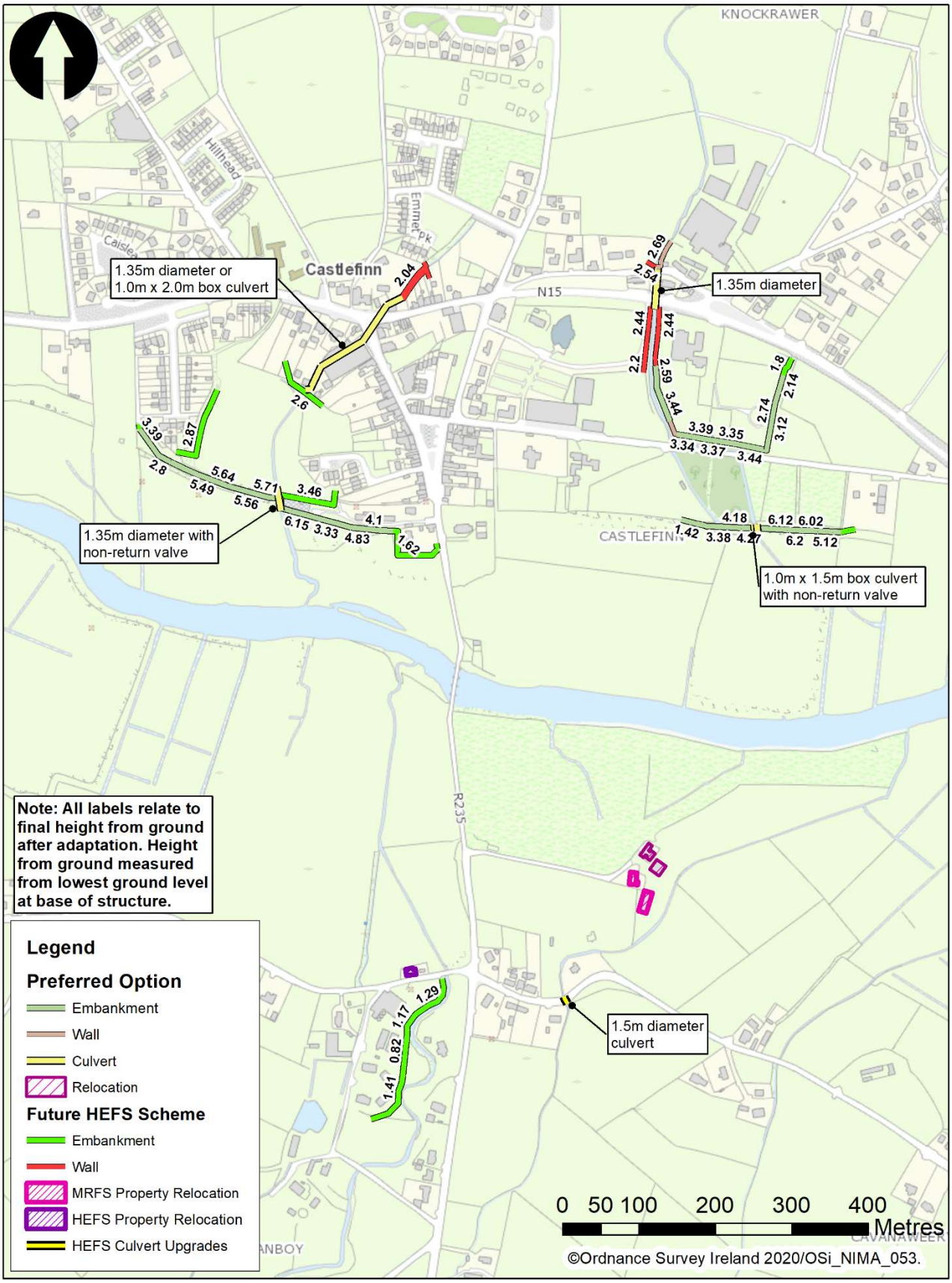


Figure 5.3 Preferred HEFS Future Scheme

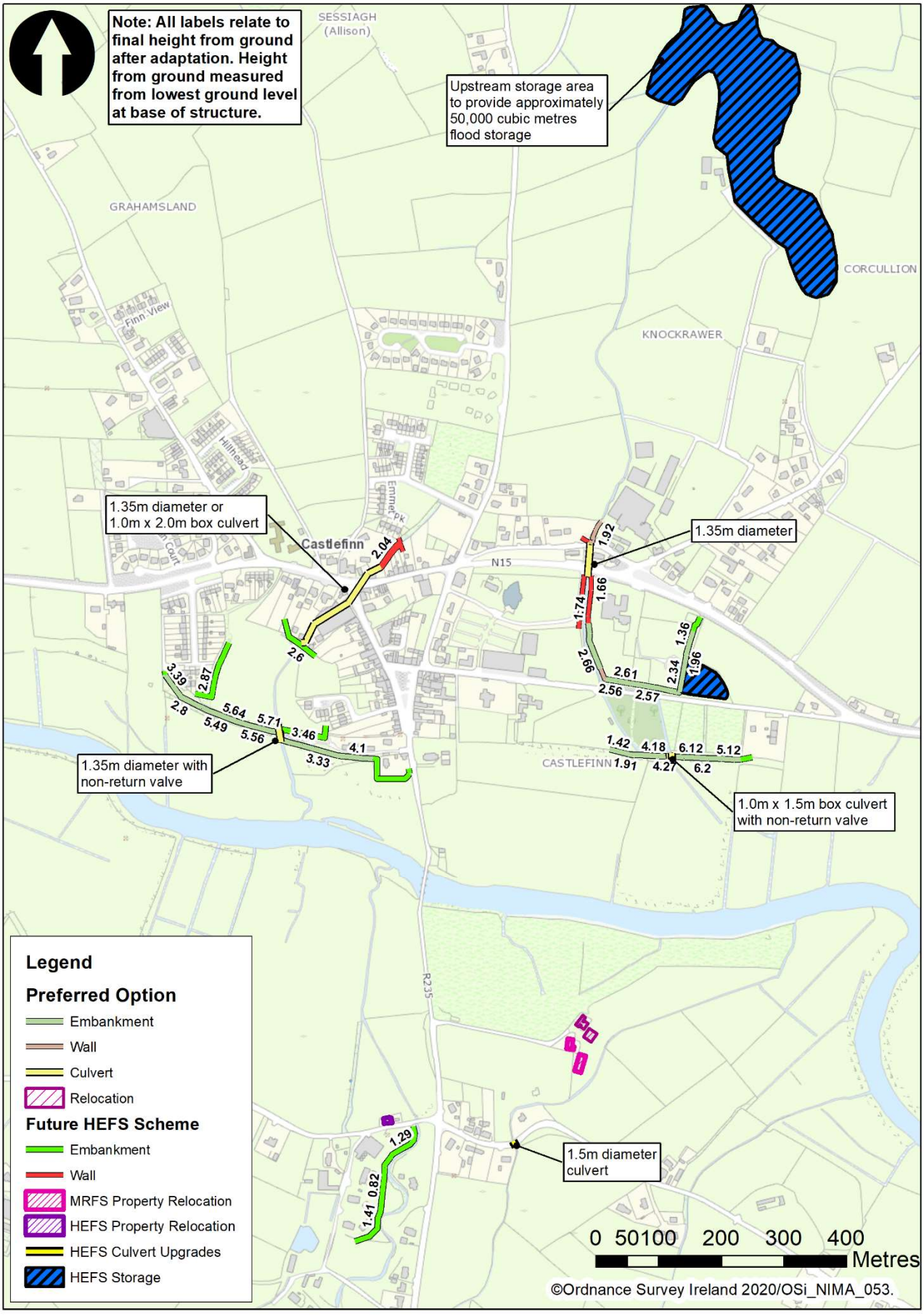


Figure 5.4 Alternative HEFS Future Scheme

Appendix A

MRFS Costing

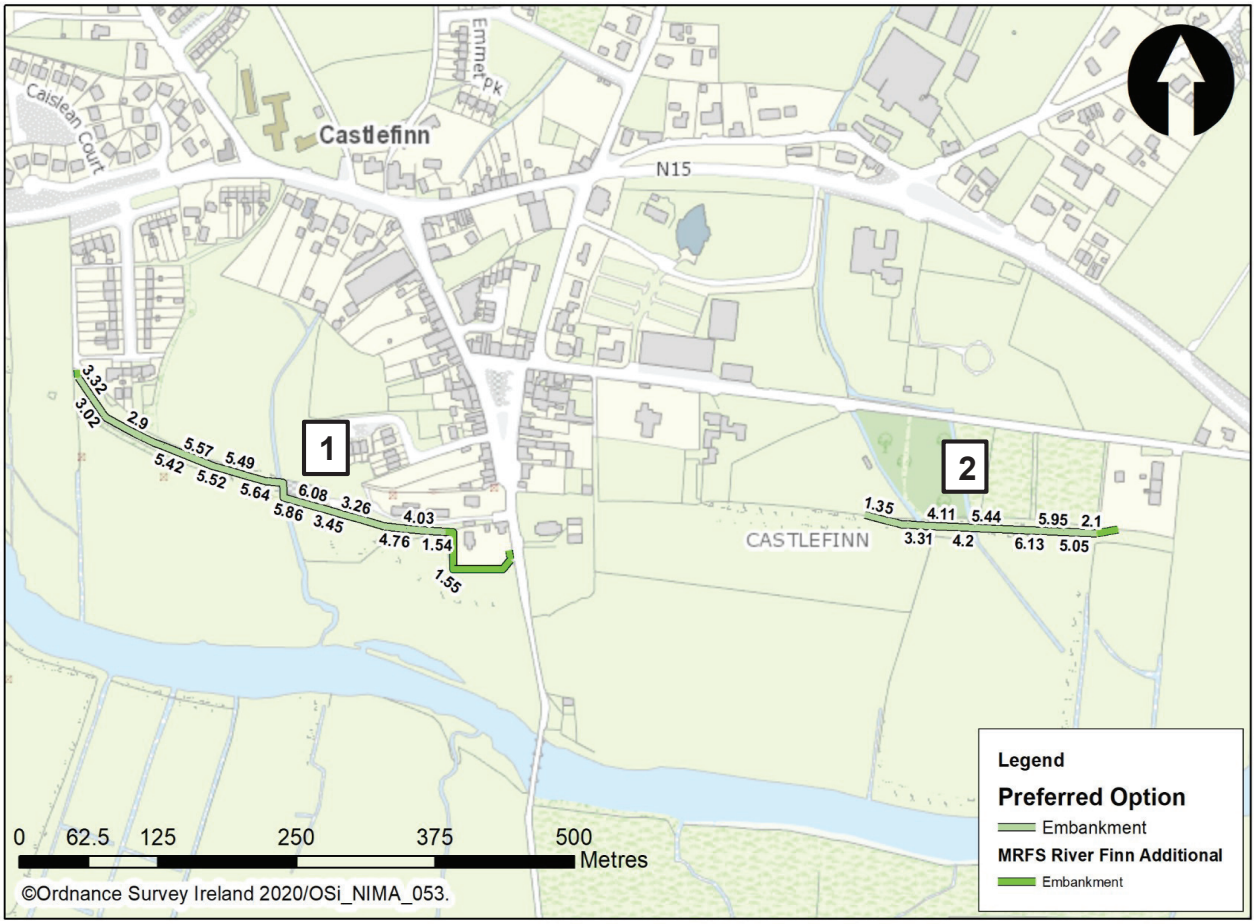
Option Description - Finn - MRFS Hard Defence

MRFS option considers hard defences as an adaptation to be implemented to the preferred scheme of flood embankments

List of elements

1. Flood embankment
2. Flood embankment

Sketch of Option



Element 1 Construction Costs

Bridge Burn Area - Earth Embankment

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Embankment Volume	14,483	m³			
Clay core Volume	6,615	m³			
Cutoff Volume	375	m³			
Footprint Area	6,840	m²	**Additional Footprint**	**4,667**	**m²**
Surface Area	7,170	m²			
Length	375	m²			
Max Height	6.19	m			
Volume of old embankment	4101	m³			

Clashes

Category	Type	Decsription	Quantity
Utility	Electricity OH cables		
Utility	WwTW		
Environmental	Invasive species		
Infrastructure	Electricity OH cables		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Land compensation	3.126	acre	€15,000	Prev. Job	€46,897
2	Clearance - Vegetation killing	0.752	ha	€230	Prev. Job	€173
3	Clearance - Invasive species	0.752	ha	€5,000	Prev. Job	€3,762
4	Clearance - trees	50	no.	€90	Prev. Job	€4,500
5	Clearance - Site clearance & disposal	0.752	ha	€14,000	Prev. Job	€10,534
6	Excavation - Topsoil strip & stockpile	2257	m³	€8	Prev. Job	€18,058
7	Excavation - Cutting (inc old embankment)	375	m³	€5	Prev. Job	€1,886
8	Disposal - Cutting (inc old embankment)	375	m³	€26	Prev. Job	€9,615
9	Filling - Provision of topsoil	2,151	m³	€30	Prev. Job	€64,530
10	Filling - Topsoil (300mm depth)	2,151	m³	€9	Prev. Job	€18,284
11	Filling - Provision of clay fill	6,615	m³	€35	Prev. Job	€231,525
12	Filling - Placing of clay fill	6,615	m³	€15	Prev. Job	€99,225
13	Filling - Provision of outer fill	3,767	m³	€25	Prev. Job	€94,175
14	Filling - Placing of outer fill	7,868	m³	€10	Prev. Job	€78,680
15	Geotextile mat	7,170	m²	€4	Prev. Job	€28,680
16	Finishing - Grassing out	7,887	m²	€1	Prev. Job	€8,281

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
17	Culvert through embankment (1.2m dia) - inc excavation, supports and backfilling	31	m	€510	Prev. Job	€15,810
18	Headwall and outlet	2	no.	€10,000	Prev. Job	€20,000
19	Trash Screen	1	no.	€10,000	Prev. Job	€10,000
20	Flap valve	1	no.	€10,000	Prev. Job	€10,000
21	Haul Road	225	m²	€90	Prev. Job	€20,250
22	Drainage	375	m	€35	Prev. Job	€13,125
					Total construction cost	€807,989
					Original construction cost	€788,969
					Additional Cost in Year 1	**€19,020**

Element 1 Construction Costs

Bridge Burn Area - Earth Embankment

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Additional Embankment Volume	13,104	m³	Adapted Embankment Volume	27,587	m³
Additional Clay core Volume	5,245	m³	Adapted Clay Core Volume	11,860	m³
Additional Cutoff Volume	108	m³	Adapted Cutoff Volume	483	m³
Additional Footprint Area	4,667	m²	Adapted Footprint Area	11,507	m²
Additional Surface Area	3,811	m²	Adapted Surface Area	10,981	m²
Additional Length	108	m²	Adapted Length	483	m
Max Height	6.20	m			
Volume of old embankment	0	m³			

Clashes

Category	Type	Decsription	Quantity
Utility	Electricity OH cables		
Utility	WwTW		
Environmental	Invasive species		
Infrastructure	Electricity OH cables		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Land compensation	0.000	acre	€15,000	Prev. Job	€0
2	Clearance - Vegetation killing	0.513	ha	€230	Prev. Job	€118
3	Clearance - Invasive species	0.513	ha	€5,000	Prev. Job	€2,567
4	Clearance - trees	20	no.	€90	Prev. Job	€1,800
5	Clearance - Site clearance & disposal	0.513	ha	€14,000	Prev. Job	€7,187
6	Excavation - Topsoil strip & stockpile	1540	m³	€8	Prev. Job	€12,321
7	Excavation - Cutting (inc old embankment)	108	m³	€5	Prev. Job	€543
8	Disposal - Cutting (inc old embankment)	108	m³	€26	Prev. Job	€2,769
9	Filling - Provision of topsoil	1143	m³	€30	Prev. Job	€34,299
10	Filling - Topsoil (300mm depth)	1143	m³	€9	Prev. Job	€9,718
11	Filling - Provision of clay fill	5245	m³	€35	Prev. Job	€183,575
12	Filling - Placing of clay fill	5245	m³	€15	Prev. Job	€78,675
13	Filling - Provision of outer fill	7859	m³	€25	Prev. Job	€196,475
14	Filling - Placing of outer fill	7859	m³	€10	Prev. Job	€78,590

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
15	Geotextile mat	3811	m²	€4	Prev. Job	€15,244
16	Finishing - Grassing out	4192	m²	€1	Prev. Job	€4,402
17	Culvert Extension (1.2m dia)	6	m	€510	Prev. Job	€3,060
18	Headwall and outlet	1	no.	€10,000	Prev. Job	€10,000
19	Trash Screen	0	no.	€10,000	Prev. Job	€0
20	Flap valve	1	no.	€10,000	Prev. Job	€10,000
21	Haul Road	225	m²	€90	Prev. Job	€20,250
22	Drainage	108	m	€35	Prev. Job	€3,780
					Total construction cost	**€675,373**

Element 2 Construction Costs

Castlefinn Area - Earth Embankment

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Embankment Volume	10,179	m³			
Clay core Volume	4,445	m³			
Cutoff Volume	210	m³			
Footprint Area	4,525	m²	**Additional Footprint**	**1,346**	**m²**
Surface Area	4,747	m²			
Length	210	m²			
Max Height	5.23	m			
Volume of old embankment	9404	m³			

Clashes

Category	Type	Description	Quantity
Utility	Not known		
Environmental	Invasive species		
Infrastructure	None identified		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Land compensation	1.595	acre	€15,000	Prev. Job	€23,927
2	Clearance - Vegetation killing	0.498	ha	€230	Prev. Job	€114
3	Clearance - Invasive species	0.498	ha	€5,000	Prev. Job	€2,489
4	Clearance - trees	50.0	no.	€90	Prev. Job	€4,500
5	Clearance - Site clearance & disposal	0.498	ha	€14,000	Prev. Job	€6,969
6	Excavation - Topsoil strip & stockpile	1493	m³	€8	Prev. Job	€11,946
7	Excavation - Cutting (inc old embankment)	210	m³	€5	Prev. Job	€1,056
8	Disposal - Cutting (inc old embankment)	210	m³	€26	Prev. Job	€5,384
9	Filling - Provision of topsoil	1424	m³	€30	Prev. Job	€42,723
10	Filling - Topsoil (300mm depth)	1424	m³	€9	Prev. Job	€12,105
11	Filling - Provision of clay fill	4445	m³	€35	Prev. Job	€155,575
12	Filling - Placing of clay fill	4445	m³	€15	Prev. Job	€66,675
13	Filling - Provision of outer fill	0	m³	€25	Prev. Job	€0
14	Filling - Placing of outer fill	5734	m³	€10	Prev. Job	€57,340
15	Geotextile mat	4747	m²	€4	Prev. Job	€18,988
16	Finishing - Grassing out	5222	m²	€1	Prev. Job	€5,483
17	Culvert through embankment (1.0 x 1.5m box) - inc excavation, supports and backfilling	62	m	€510	Prev. Job	€31,620
18	Headwall and outlet	4	no.	€10,000	Prev. Job	€40,000

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
19	Trash Screen	1	no.	€10,000	Prev. Job	€10,000
20	Flap valve	1	no.	€10,000	Prev. Job	€10,000
21	Haul Rad	540	m²	€90	Prev. Job	€48,600
22	Drainage	210	m	€35	Prev. Job	€7,350
					Total construction cost	**€562,844**
					Original construction cost	**€557,359**
					Additional Cost in Year 1	**€5,486**

Element 2 Construction Costs

Castlefinn Area - Earth Embankment

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Additional Embankment Volume	4,936	m³	Adapted Embankment Volume	15,115	m³
Additional Clay core Volume	1,949	m³	Adapted Clay Core Volume	6,394	m³
Additional Cutoff Volume	20	m³	Adapted Cutoff Volume	230	m³
Additional Footprint Area	1,346	m²	Adapted Footprint Area	5,871	m²
Additional Surface Area	1,417	m²	Adapted Surface Area	6,164	m²
Additional Length	20	m²	Adapted Length	230	m
Max Height	6.13	m			
Volume of old embankment	0	m³			

Clashes

Category	Type	Description	Quantity
Utility	Not known		
Environmental	Invasive species		
Infrastructure	None identified		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Land compensation	0.000	acre	€15,000	Prev. Job	€0
2	Clearance - Vegetation killing	0.148	ha	€230	Prev. Job	€34
3	Clearance - Invasive species	0.148	ha	€5,000	Prev. Job	€740
4	Clearance - trees	50.0	no.	€90	Prev. Job	€4,500
5	Clearance - Site clearance & disposal	0.148	ha	€14,000	Prev. Job	€2,073
6	Excavation - Topsoil strip & stockpile	444	m³	€8	Prev. Job	€3,553
7	Excavation - Cutting (inc old embankment)	20	m³	€5	Prev. Job	€101
8	Disposal - Cutting (inc old embankment)	20	m³	€26	Prev. Job	€513
9	Filling - Provision of topsoil	425	m³	€30	Prev. Job	€12,753
10	Filling - Topsoil (300mm depth)	425	m³	€9	Prev. Job	€3,613
11	Filling - Provision of clay fill	1949	m³	€35	Prev. Job	€68,215
12	Filling - Placing of clay fill	1949	m³	€15	Prev. Job	€29,235
13	Filling - Provision of outer fill	2987	m³	€25	Prev. Job	€74,675
14	Filling - Placing of outer fill	2987	m³	€10	Prev. Job	€29,870
15	Geotextile mat	1417	m²	€4	Prev. Job	€5,668
16	Finishing - Grassing out	1559	m²	€1	Prev. Job	€1,637

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
17	Culvert through embankment (1.0 x 1.5m box) - inc excavation, supports and backfilling	6	m	€510	Prev. Job	€3,060
18	Headwall and outlet	2	no.	€10,000	Prev. Job	€20,000
19	Trash Screen	0	no.	€10,000	Prev. Job	€0
20	Flap valve	1	no.	€10,000	Prev. Job	€10,000
21	Haul Rad	540	m²	€90	Prev. Job	€48,600
22	Drainage	20	m	€35	Prev. Job	€700
					Total construction cost	**€319,540**

Operation and Maintenance

The various elements of this option will have associated operation and maintenance (O&M) costs. Costs are dependant on the responsible body (eg local authority, government body, private party), the complexity of the element (eg moving parts, high precision tolerances), and the robustness of the element (eg rate of degradation, risk of collapse).

Bridge Burn Area - Earth Embankment

Annual O&M cost	€	108
Assumptions	Cost based on a rate of €2,725/km/year. Maintenance includes for vegetation control, inspections, vermin control, back drainage improvements.	

Castlefinn Area - Earth Embankment

Annual O&M cost	€	20
Assumptions	Cost based on a rate of €2,725/km/year. Maintenance includes for vegetation control, inspections, vermin control, back drainage improvements.	

Total O&M Annual Costs

O&M costs per year	**€**	**128**

Whole Life Cost

Design Life

Bridge Burn Area - Earth Embankment	50yrs
Castlefinn Area - Earth Embankment	50yrs

Financial Assumptions

Financial period	50yrs
Discount rate	4%

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
0	1.000			-	-
1	0.962	24,506		23,563	-
2	0.925			-	-
3	0.889			-	-
4	0.855			-	-
5	0.822			-	-
6	0.790			-	-
7	0.760			-	-
8	0.731			-	-
9	0.703			-	-
10	0.676			-	-
11	0.650	994,913		646,277	-
12	0.625		128	-	80
13	0.601		128	-	77
14	0.577		128	-	74
15	0.555		128	-	71
16	0.534		128	-	68
17	0.513		128	-	66
18	0.494		128	-	63
19	0.475		128	-	61
20	0.456		128	-	58
21	0.439		128	-	56
22	0.422		128	-	54
23	0.406		128	-	52
24	0.390		128	-	50
25	0.375		128	-	48
26	0.361		128	-	46
27	0.347		128	-	44
28	0.333		128	-	43
29	0.321		128	-	41
30	0.308		128	-	39
31	0.296		128	-	38
32	0.285		128	-	36
33	0.274		128	-	35
34	0.264		128	-	34
35	0.253		128	-	32
36	0.244		128	-	31
37	0.234		128	-	30
38	0.225		128	-	29
39	0.217		128	-	28
40	0.208		128	-	27
41	0.200		128	-	26
42	0.193		128	-	25
43	0.185		128	-	24
44	0.178		128	-	

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
45	0.171		128	-	22
46	0.165		128	-	21
47	0.158		128	-	20
48	0.152		128	-	19
49	0.146		128	-	19
50	0.141		128	-	18
				€ 669,840	**€ 1,628**

Finn Area - MRFS HD Summary

PV Basic Construction Costs (BCC)				**€669,840**
PV Construction Costs (year 1)				
	Bridge Burn Area - Earth Embankment		€18,289	
	Castlefinn Area - Earth Embankment		€5,275	
PV Construction Costs (year 11)				
	Bridge Burn Area - Earth Embankment		€438,709	
	Castlefinn Area - Earth Embankment		€207,567	
Preliminary Costs		17% of BCC	€ 115,097	
Ground Investigation		5% of BCC	€ 33,492	
Overall construction cost (OCC)				**€ 818,429**
Design & Envronmental Fees		8.6% of OCC	€ 70,385	
Site Supervision Fees		8% of OCC	€ 65,474	
	Total Fees		€ 135,859	
Archaeology & Environmental Mitigation		10% of OCC	€ 81,843	
Percent for Art		1% of OCC	€ 8,184	
PV Operation and Maintenance Costs (50yrs)			€ 1,628	
	Total		€ 91,656	
Sub-total				**€ 1,045,944**
Optimism Bias		60%	€ 627,566	
Total Cost				**€ 1,673,510**

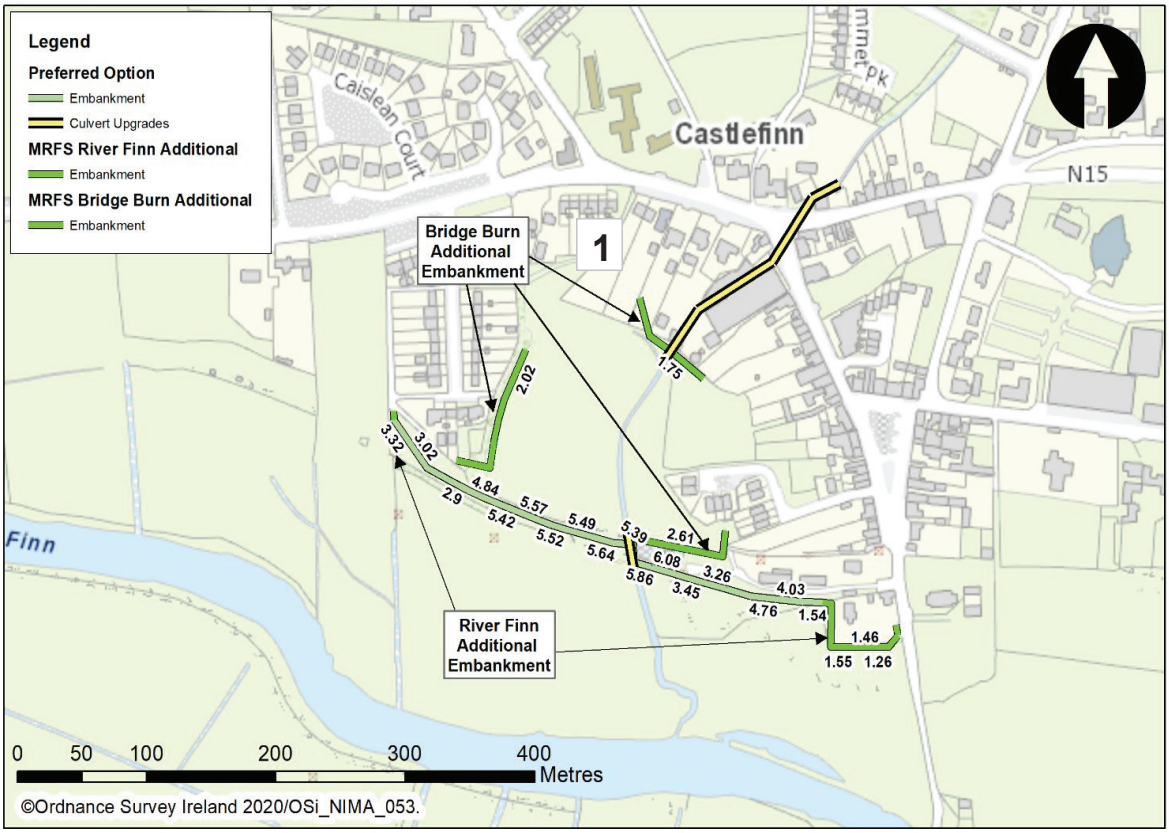
Option Description - Bridge Burn - MRFS Hard Defences

MRFS option considers hard defences as a future scheme to be implemented with the preferred scheme of culvert upgrade on the Bridge Burn.

List of elements

1. Flood embankment

Sketch of Option



Element 1 Construction Costs

Bridge Burn - Earth Embankment

Quantities generated from GIS modelling and a standard embankment cross sectional makeup. Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Embankment Volume	5,635	m^3
Clay core Volume	2,905	m^3
Cutoff Volume	293	m^3
Footprint Area	3,123	m^2
Surface Area	4,531	m^2
Length	293	m^2
Max Height	2.61	m
Volume of old embankment	0	m^3

Clashes

Category	Type	Description	Quantity
Utility	Not known		
Environmental	Invasive species		
Infrastructure	None identified		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Land compensation	0.849	acre	€15,000	Prev. Job	€12,728
2	Clearance - Vegetation killing	0.344	ha	€230	Prev. Job	€79
3	Clearance - Invasive species	0.344	ha	€5,000	Prev. Job	€1,718
4	Clearance - trees	3.0	no.	€90	Prev. Job	€270
5	Clearance - Site clearance & disposal	0.344	ha	€14,000	Prev. Job	€4,809
6	Excavation - Topsoil strip & stockpile	1031	m^3	€8	Prev. Job	€8,245
7	Excavation - Cutting (inc old embankment)	293	m^3	€5	Prev. Job	€1,474
8	Disposal - Cutting (inc old embankment)	293	m^3	€26	Prev. Job	€7,513
9	Filling - Provision of topsoil	1359	m^3	€30	Prev. Job	€40,779
10	Filling - Topsoil (300mm depth)	1359	m^3	€9	Prev. Job	€11,554
11	Filling - Provision of clay fill	2905	m^3	€35	Prev. Job	€101,675
12	Filling - Placing of clay fill	2905	m^3	€15	Prev. Job	€43,575
13	Filling - Provision of outer fill	2730	m^3	€25	Prev. Job	€68,250
14	Filling - Placing of outer fill	2730	m^3	€10	Prev. Job	€27,300
15	Geotextile mat	4531	m^2	€4	Prev. Job	€18,124
16	Finishing - Grassing out	4984	m^2	€1	Prev. Job	€5,233
17	Drainage	293	m	€35	Prev. Job	€10,255
					Total construction cost	**€363,580**

Operation and Maintenance

The various elements of this option will have associated operation and maintenance (O&M) costs. Costs are dependant on the responsible body (eg local authority, government body, private party), the complexity of the element (eg moving parts, high precision tolerances), and the robustness of the element (eg rate of degradation, risk of collapse).

Bridge Burn - Earth Embankment

Annual O&M cost	€	798
Assumptions	Cost based on a rate of €2,725/km/year. Maintenance includes for vegetation control, inspections, vermin control, back drainage improvements.	

Total O&M Annual Costs

O&M costs per year	**€**	**798**

Whole Life Cost

Design Life

Bridge Burn - Earth Embankment	50yrs

Financial Assumptions

Financial period	50yrs
Discount rate	4%

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
0	1.000			-	-
1	0.962			-	-
2	0.925		-	-	-
3	0.889		-	-	-
4	0.855		-	-	-
5	0.822		-	-	-
6	0.790		-	-	-
7	0.760		-	-	-
8	0.731		-	-	-
9	0.703		-	-	-
10	0.676		-	-	-
11	0.650	363,580		236,175	-
12	0.625		798	-	499
13	0.601		798	-	480
14	0.577		798	-	461
15	0.555		798	-	443
16	0.534		798	-	426
17	0.513		798	-	410
18	0.494		798	-	394
19	0.475		798	-	379
20	0.456		798	-	364
21	0.439		798	-	350
22	0.422		798	-	337
23	0.406		798	-	324
24	0.390		798	-	311
25	0.375		798	-	300
26	0.361		798	-	288
27	0.347		798	-	277
28	0.333		798	-	266
29	0.321		798	-	256
30	0.308		798	-	246
31	0.296		798	-	237
32	0.285		798	-	228
33	0.274		798	-	219
34	0.264		798	-	210
35	0.253		798	-	202
36	0.244		798	-	195
37	0.234		798	-	187
38	0.225		798	-	180
39	0.217		798	-	173
40	0.208		798	-	166
41	0.200		798	-	160
42	0.193		798	-	154

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
43	0.185		798	-	148
44	0.178		798	-	142
45	0.171		798	-	137
46	0.165		798	-	131
47	0.158		798	-	126
48	0.152		798	-	122
49	0.146		798	-	117
50	0.141		798	-	112
				€ 236,175	**€ 10,157**

Bridge Burn Area - MRFS HD Summary

PV Basic Construction Costs (BCC)				**€236,175**
	Bridge Burn - Earth Embankment		€236,175	
Preliminary Costs		20% of BCC	€ 48,293	
Ground Investigation		5% of BCC	€ 11,809	
Overall construction cost (OCC)				**€ 296,277**
Design & Envronmental Fees		8.6% of OCC	€ 25,480	
Site Supervision Fees		8% of OCC	€ 23,702	
	Total Fees		€ 49,182	
Archaeology & Environmental Mitigation		10% of OCC	€ 29,628	
Percent for Art		1% of OCC	€ 2,963	
PV Operation and Maintenance Costs (50yrs)			€ 10,157	
	Total		€ 42,748	
Sub-total				**€ 388,206**
Optimism Bias		60%	€ 232,924	
Total Cost				**€ 621,130**

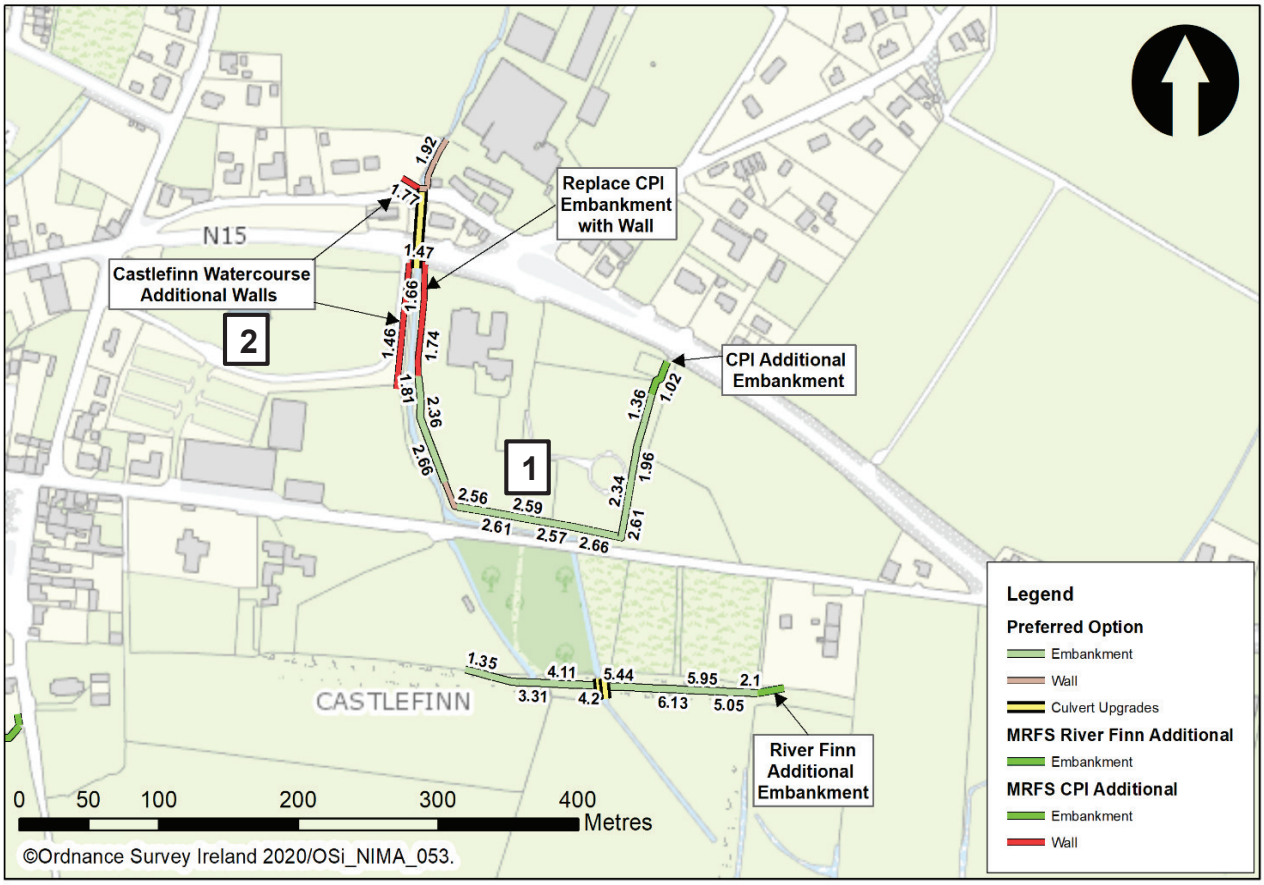
Option Description - CPI Centre - MRFS Hard Defences

MRFS option considers hard defences as an adaptation to the preferred scheme of culvert upgrade and hard defences around the CPI centre.

List of elements

1. CPI bund
2. Flood Wall

Sketch of Option



Element 5 Construction Costs

Castlefinn Area - CPI bund

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Embankment Volume	2,710	m^3			
Clay core Volume	1,860	m^3			
Cutoff Volume	400	m^3			
Footprint Area	3,033	m^2	**Additional Footprint**	**1,023**	**m^2**
Surface Area	3,205	m^2			
Length	400	m^2			
Max Height	1.60	m			

Clashes

Category	Type	Description	Quantity
Utility	Not known		
Environmental	Invasive species		
Infrastructure	None identified		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1.	Land compensation	1.102	acre	€15,000	Prev. Job	€16,530
2.	Clearance - Vegetation killing	0.334	ha	€230	Prev. Job	€77
3.	Clearance - Invasive species	0.334	ha	€5,000	Prev. Job	€1,668
4.	Clearance - Site clearance & disposal	0.334	ha	€14,000	Prev. Job	€4,671
5.	Excavation - Topsoil strip & stockpile	1001	m^3	€8	Prev. Job	€8,007
6.	Excavation - Cutting	400	m^3	€5	Prev. Job	€2,012
7.	Disposal - Cutting	400	m^3	€26	Prev. Job	€10,256
8.	Filling - Provision of topsoil	962	m^3	€30	Prev. Job	€28,845
9.	Filling - Topsoil (300mm depth)	962	m^3	€9	Prev. Job	€8,173
10.	Filling - Provision of clay fill	1860	m^3	€35	Prev. Job	€65,100
11.	Filling - Placing of clay fill	1860	m^3	€15	Prev. Job	€27,900
12.	Filling - Provision of outer fill	850	m^3	€25	Prev. Job	€21,250
13.	Filling - Placing of outer fill	850	m^3	€10	Prev. Job	€8,500
14.	Geotextile mat	3205	m^2	€4	Prev. Job	€12,820
15.	Finishing - Grassing out	3526	m^2	€1	Prev. Job	€3,702
16.	Drainage	400	m	€35	Prev. Job	€14,000
17.	Garden Reinstatement	180	m^2	€140	Prev. Job	€25,200
					Total construction cost	**€258,711**
					Original construction cost	**€254,541**
					Additional Cost in Year 1	**€4,170**

Element 5 Construction Costs

Castlefinn Area - CPI bund

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Additional Embankment Volume	3,089	m³	Adapted Embankment Volume	5,799	m³
Additional Clay core Volume	1,470	m³	Adapted Clay Core Volume	3,330	m³
Additional Cutoff Volume	19	m³	Adapted Cutoff Volume	306	m³
Additional Footprint Area	1,023	m²	Adapted Footprint Area	4,056	m²
Additional Surface Area	1,116	m²	Adapted Surface Area	4,321	m²
Additional Length	19	m²	Adapted Length	306	m
Max Height	2.70	m			

Clashes

Category	Type	Description	Quantity
Utility	Not known		
Environmental	Invasive species		
Infrastructure	None identified		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

Description	Quantity	Unit	Rate	Source	Total
1. Land compensation	0.000	acre	€15,000	Prev. Job	€0
2. Clearance - Vegetation killing	0.113	ha	€230	Prev. Job	€26
3. Clearance - Invasive species	0.113	ha	€5,000	Prev. Job	€563
4. Clearance - Site clearance & disposal	0.113	ha	€14,000	Prev. Job	€1,575
5. Excavation - Topsoil strip & stockpile	338	m³	€8	Prev. Job	€2,701
6. Excavation - Cutting	19	m³	€5	Prev. Job	€96
7. Disposal - Cutting	19	m³	€26	Prev. Job	€487
8. Filling - Provision of topsoil	335	m³	€30	Prev. Job	€10,044
9. Filling - Topsoil (300mm depth)	335	m³	€9	Prev. Job	€2,846
10. Filling - Provision of clay fill	1470	m³	€35	Prev. Job	€51,450
11. Filling - Placing of clay fill	1470	m³	€15	Prev. Job	€22,050
12. Filling - Provision of outer fill	1619	m³	€25	Prev. Job	€40,475
13. Filling - Placing of outer fill	1619	m³	€10	Prev. Job	€16,190
14. Geotextile mat	1116	m²	€4	Prev. Job	€4,464
15. Finishing - Grassing out	1228	m²	€1	Prev. Job	€1,289
16. Drainage	19	m	€35	Prev. Job	€665
17. Garden Reinstatement	180	m^2	€140	Prev. Job	€25,200
				Total construction cost	**€180,120**

Element 6 Construction Costs

Castlefinn WC Flood walls

Quantities generated from GIS modelling and a standard flood wall cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

1	Working Area	**809**	m²
2	Footprint	**186**	m²
3	Base Volume	**75**	m³
4	Stem Volume	37	m³
5	Stem Face	92	m²
6	Exposed Stem Face	61	m²
7	Length	62.22	m²

Clashes

Item	Category	Type	Description	Quantity
1	Utility	Not known		
2	Environmental	Invasive species		
3	Infrastructure	None identified		
4	Land use	Not known		
5	Land access	Not known		
6	Ground contamination	Not known		
7	Soil conditions	Not known		

Cost Breakdown

Item	Description	Quantity	Unit	Rate	Source	Total
1	Clearance - Vegetation killing	0.081	ha	230	Prev. Job	€19
2	Clearance - Site clearance & disposal	0.081	ha	14,000	Prev. Job	€1,133
3	Excavation - Topsoil strip & stockpile	809	m³	3.00	Prev. Job	€2,427
4	Excavation - Cutting	186	m³	5.03	Prev. Job	€936
5	Disposal - Cutting	186	m³	25.64	Prev. Job	€4,769
6	Base Slab - Concrete	75	m³	200	Prev. Job	€15,000
7	Base Slab - Reinforcement	6	t	1,500	Prev. Job	€8,888
8	Base Slab - Trench fill	19	m³	150	Prev. Job	€2,790
9	Base Slab - Formwork	25	m³	100	Prev. Job	€2,489
10	Wall - Concrete	37	m³	200	Prev. Job	€7,384
11	Wall - Reinforcement	3	t	1,500	Prev. Job	€4,375
12	Wall - Formwork	185	m²	100	Prev. Job	€18,462
13	Wall - Finish (Granite)	122	m²	80	Prev. Job	€9,792
14	Drainage	62	m	70	Prev. Job	€4,355
					Total construction cost	**€82,818**
					Original construction cost	**€70,410**
					Additional Cost in Year 1	**€12,408**

Element 6 Construction Costs

Castlefinn WC Flood walls

Quantities generated from GIS modelling and a standard flood wall cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

1	Working Area	2,691	m²
2	Additional Footprint	544	m²
3	Additional Base Volume	218	m³
4	Additional Stem Volume	248	m³
5	Additional Stem Face	620	m²
6	Additional Exposed Stem Face	481	m²
7	Additional Length	215.00	m²

Clashes

Item	Category	Type	Description	Quantity
1	Utility	Not known		
2	Environmental	Invasive species		
3	Infrastructure	None identified		
4	Land use	Not known		
5	Land access	Not known		
6	Ground contamination	Not known		
7	Soil conditions	Not known		

Cost Breakdown

Item	Description	Quantity	Unit	Rate	Source	Total
1	Clearance - Vegetation killing	0.269	ha	230	Prev. Job	€62
2	Clearance - Site clearance & disposal	0.269	ha	14,000	Prev. Job	€3,767
3	Excavation - Topsoil strip & stockpile	2691	m³	3.00	Prev. Job	€8,073
4	Excavation - Cutting	544	m³	5.03	Prev. Job	€2,736
5	Disposal - Cutting	544	m³	25.64	Prev. Job	€13,948
6	Base Slab - Concrete	218	m³	200	Prev. Job	€43,600
7	Base Slab - Reinforcement	17	t	1,500	Prev. Job	€25,833
8	Base Slab - Trench fill	54	m³	150	Prev. Job	€8,160
9	Base Slab - Formwork	86	m³	100	Prev. Job	€8,600
10	Wall - Concrete	248	m³	200	Prev. Job	€49,600
11	Wall - Reinforcement	20	t	1,500	Prev. Job	€29,388
12	Wall - Formwork	1,240	m²	100	Prev. Job	€124,000
13	Wall - Finish (Granite)	962	m²	80	Prev. Job	€76,960
14	Drainage	215	m	70	Prev. Job	€15,050
					Total construction cost	**€409,778**

Operation and Maintenance

The various elements of this option will have associated operation and maintenance (O&M) costs. Costs are dependant on the responsible body (eg local authority, government body, private party), the complexity of the element (eg moving parts, high precision tolerances), and the robustness of the element (eg rate of degradation, risk of collapse).

Castlefinn Area - CPI bund

Annual O&M cost	€	19
Assumptions	Cost based on a rate of €2,725/km/year. Maintenance includes for vegetation control, inspections, vermin control, back drainage improvements.	

Castlefinn WC Flood walls

Annual O&M cost	€	215
Assumptions	Cost based on a rate of €2,725/km/year. Maintenance includes for vegetation control, inspections, vermin control, back drainage improvements.	

Total O&M Annual Costs

O&M costs per year	**€**	**234**

Whole Life Cost

Design Life

Castlefinn Area - CPI bund	50yrs
Castlefinn WC Flood walls	50yrs

Financial Assumptions

Financial period	50yrs
Discount rate	4%

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
0	1.000			-	-
1	0.962	16,578		15,940	-
2	0.925			-	-
3	0.889			-	-
4	0.855			-	-
5	0.822			-	-
6	0.790			-	-
7	0.760			-	-
8	0.731			-	-
9	0.703			-	-
10	0.676			-	-
11	0.650	589,898		383,186	-
12	0.625		234	-	146
13	0.601		234	-	141
14	0.577		234	-	135
15	0.555		234	-	130
16	0.534		234	-	125
17	0.513		234	-	120
18	0.494		234	-	116
19	0.475		234	-	111
20	0.456		234	-	107
21	0.439		234	-	103
22	0.422		234	-	99
23	0.406		234	-	95
24	0.390		234	-	91
25	0.375		234	-	88
26	0.361		234	-	84
27	0.347		234	-	81
28	0.333		234	-	78
29	0.321		234	-	75
30	0.308		234	-	72
31	0.296		234	-	69
32	0.285		234	-	67
33	0.274		234	-	64
34	0.264		234	-	62
35	0.253		234	-	59
36	0.244		234	-	57
37	0.234		234	-	55
38	0.225		234	-	53
39	0.217		234	-	51
40	0.208		234	-	49
41	0.200		234	-	47

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
42	0.193		234	-	45
43	0.185		234	-	43
44	0.178		234	-	42
45	0.171		234	-	40
46	0.165		234	-	39
47	0.158		234	-	37
48	0.152		234	-	36
49	0.146		234	-	34
50	0.141		234	-	33
			€	399,126	€ 2,977

CPI Centre Area - MRFS HD Summary

PV Basic Construction Costs (BCC)				**€399,126**
PV Construction Costs (year 1)				
		Castlefinn Area - CPI bund	€4,009	
		Castlefinn WC Flood walls	€11,931	
PV Construction Costs (year 11)				
		Castlefinn Area - CPI bund	€117,003	
		Castlefinn WC Flood walls	€266,184	
Preliminary Costs		18% of BCC	€ 71,843	
Ground Investigation		5% of BCC	€ 19,956	
Overall construction cost (OCC)				**€ 490,925**
Design & Envronmental Fees		8.6% of OCC	€ 42,220	
Site Supervision Fees		8% of OCC	€ 39,274	
	Total Fees		€ 81,494	
Archaeology & Environmental Mitigation		10% of OCC	€ 49,093	
Percent for Art		1% of OCC	€ 4,909	
PV Operation and Maintenance Costs (50yrs)			€ 2,977	
	Total		€ 56,979	
Sub-total				**€ 629,398**
Optimism Bias		60%	€ 377,639	
Total Cost				**€ 1,007,036**

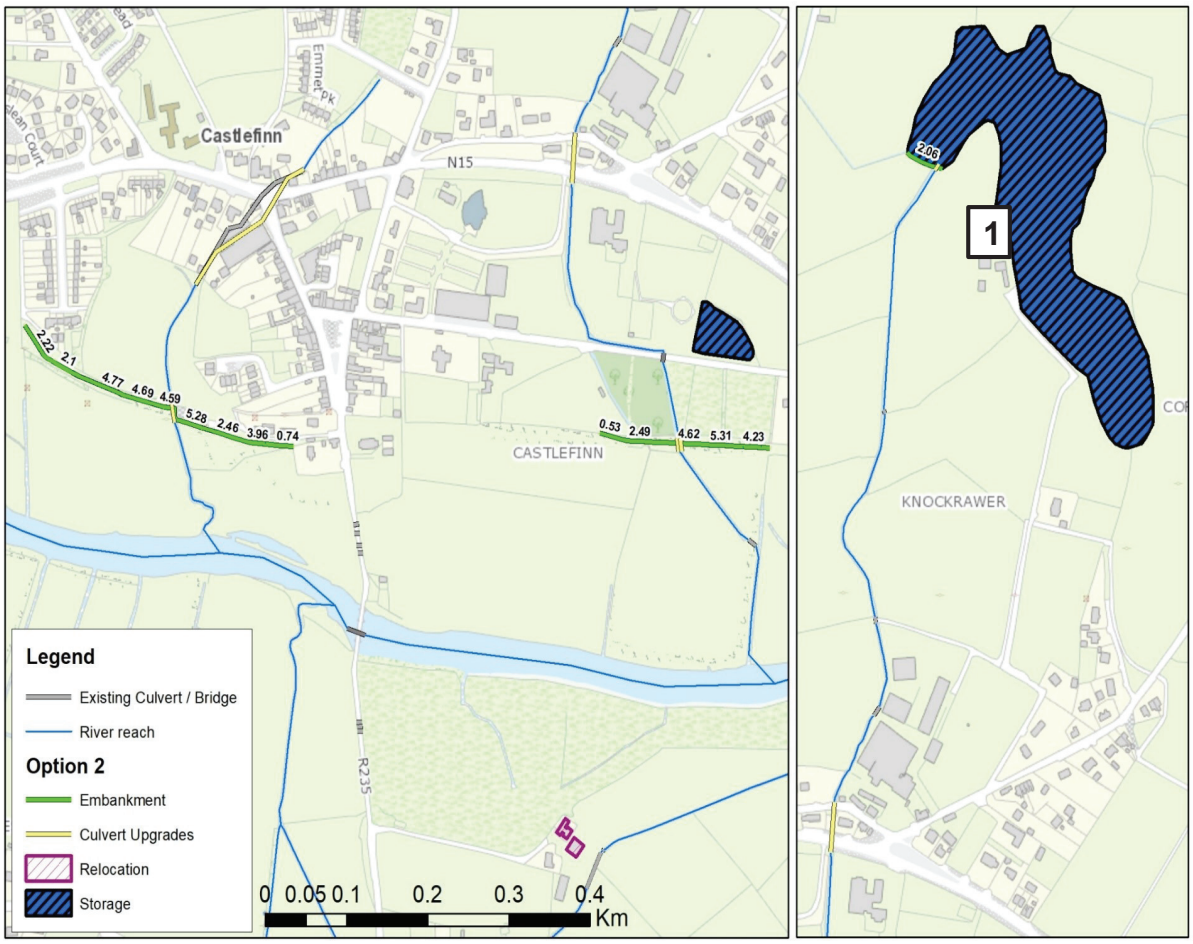
Option Description - CPI Centre - MRFS Upstream Storage

MRFS option considers upstream storage as a future scheme to be implemented with the preferred scheme of culvert upgrade and hard defences around the CPI centre.

List of elements

1. Flood Storage (Upstream)

Sketch of Option



Element 1 Construction Costs

Castlefinn WC Area - Upstream Storage

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Embankment Volume	476	m³
Clay core Volume	286	m³
Cutoff Volume	50	m³
Footprint Area	666	m²
Land Compensation Area	85,482	m2
Surface Area	697	m²
Length	50	m²
Max Height	2.00	m
Impoundment excavation area	40,000	m²

Clashes

Category	Type	Description	Quantity
Utility	Not known		
Environmental	Invasive species		
Infrastructure	None identified		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Land compensation	23.225	acre	€10,000	Prev. Job	€232,254
2	Clearance - Vegetation killing	0.073	ha	€230	Prev. Job	€17
3	Clearance - Invasive species	0.073	ha	€5,000	Prev. Job	€366
4	Clearance - trees	0.0	no.	€90	Prev. Job	€0
5	Clearance - Site clearance & disposal	0.073	ha	€14,000	Prev. Job	€1,026
6	Excavation - Topsoil strip & stockpile	12,000	m^3	€11	Prev. Job	€126,000
7	Excavation - Cutting	40,000	m^3	€11	Prev. Job	€420,000
8	Disposal - Cutting	40,000	m^3	€15	Prev. Job	€580,000
9	Embankment excavation - Topsoil strip & stockpile	220	m³	€8	Prev. Job	€1,758
10	Embankment excavation - Cutting (inc old embankment)	50	m³	€5	Prev. Job	€252
11	Disposal - Cutting (inc old embankment)	50	m³	€26	Prev. Job	€1,282
12	Embankment filling - Provision of topsoil	209	m³	€30	Prev. Job	€6,273
13	Embankment filling - Topsoil (300mm depth)	209	m³	€9	Prev. Job	€1,777
14	Embankment filling - Provision of clay fill	286	m³	€35	Prev. Job	€10,010
15	Embankment filling - Placing of clay fill	286	m³	€15	Prev. Job	€4,290
16	Embankment filling - Provision of outer fill	0	m³	€25	Prev. Job	€0
17	Embankment filling - Placing of outer fill	190	m³	€10	Prev. Job	€1,900

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
18	Embankment geotextile mat	697	m²	€4	Prev. Job	€2,788
19	Embankment finishing - Grassing out	767	m²	€1	Prev. Job	€805
20	Culvert through embankment (1.0 x 1.5m box) - inc excavation, supports and backfilling	12	m	€510	Prev. Job	€6,120
21	Headwall and outlet	2	no.	€10,000	Prev. Job	€20,000
22	Trash Screen	0	no.	€10,000	Prev. Job	€0
23	Flap valve	0	no.	€10,000	Prev. Job	€0
24	Haul Road	615	m²	€90	Prev. Job	€55,350
					Total construction cost	**€1,472,267**

Operation and Maintenance

The various elements of this option will have associated operation and maintenance (O&M) costs. Costs are dependant on the responsible body (eg local authority, government body, private party), the complexity of the element (eg moving parts, high precision tolerances), and the robustness of the element (eg rate of degradation, risk of collapse).

Castlefinn WC Area - Upstream Storage

Annual O&M cost	€	472
Assumptions	Cost based on a rate of €472/culvert/year. Maintenance includes for inspections, vegetation and trash clearance, minor repair work	

Total O&M Annual Costs

O&M costs per year	**€**	**472**

Whole Life Cost

Design Life

Castlefinn WC Area - Upstream Storage	50yrs

Financial Assumptions

Financial period	50yrs
Discount rate	4%

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
0	1.000			-	-
1	0.962			-	-
2	0.925			-	-
3	0.889			-	-
4	0.855			-	-
5	0.822			-	-
6	0.790			-	-
7	0.760			-	-
8	0.731			-	-
9	0.703			-	-
10	0.676			-	-
11	0.650	1,472,267		956,357	-
12	0.625		472	-	295
13	0.601		472	-	283
14	0.577		472	-	273
15	0.555		472	-	262
16	0.534		472	-	252
17	0.513		472	-	242
18	0.494		472	-	233
19	0.475		472	-	224
20	0.456		472	-	215
21	0.439		472	-	207
22	0.422		472	-	199
23	0.406		472	-	192
24	0.390		472	-	184
25	0.375		472	-	177
26	0.361		472	-	170
27	0.347		472	-	164
28	0.333		472	-	157
29	0.321		472	-	151
30	0.308		472	-	146
31	0.296		472	-	140
32	0.285		472	-	135
33	0.274		472	-	129
34	0.264		472	-	124
35	0.253		472	-	120
36	0.244		472	-	115
37	0.234		472	-	111
38	0.225		472	-	106
39	0.217		472	-	102
40	0.208		472	-	98
41	0.200		472	-	95
42	0.193		472	-	91
43	0.185		472	-	87

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
44	0.178		472	-	84
45	0.171		472	-	81
46	0.165		472	-	78
47	0.158		472	-	75
48	0.152		472	-	72
49	0.146		472	-	69
50	0.141		472	-	66
				€ 956,356.84	**€ 6,004.65**

CPI Centre Area - MRFS US Storage Summary

PV Basic Construction Costs (BCC)			**€956,357**
PV Construction Costs (year 11)			
	Castlefinn WC Area - Upstream Storage	€956,357	
Preliminary Costs	20% of BCC	€ 190,653	
Ground Investigation	5% of BCC	€ 47,818	
Overall construction cost (OCC)			**€ 1,194,827**
Design & Envronmental Fees	8.6% of OCC	€ 102,755	
Site Supervision Fees	8% of OCC	€ 95,586	
Total Fees		€ 198,341	
Archaeology & Environmental Mitigation	10% of OCC	€ 119,483	
Percent for Art	1% of OCC	€ 11,948	
PV Operation and Maintenance Costs (50yrs)		€ 6,005	
Total		€ 137,436	
Sub-total			**€ 1,530,604**
Optimism Bias	60%	€ 918,363	
Total Cost			**€ 2,448,967**

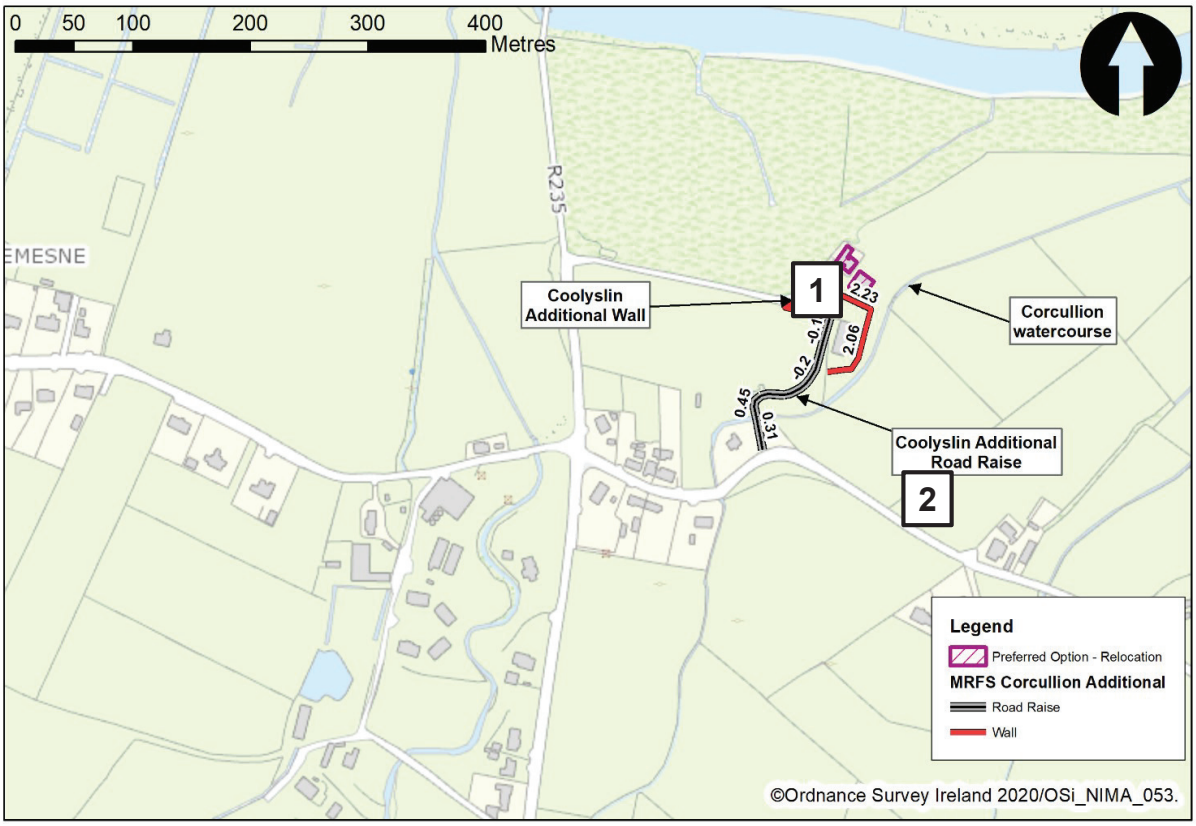
Option Description - Castlefinn - MRFS Hard Defence

MRFS option considers hard defences as a future scheme to be implemented with the preferred scheme of property relocation.

List of elements

1. Flood wall
2. Road raise

Sketch of Option



Element 1 Construction Costs

Corcullion Area - Flood Wall

Quantities generated from GIS modelling and a standard flood wall cross sectional makeup. Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Working Area	2,580	m²
Footprint	638	m²
Base Volume	255	m³
Stem Volume	224	m³
Stem Face	560	m²
Exposed Stem Face	463	m²
Length	194	m

Clashes

Category	Type	Area	Length
Utility	Not known		
Environmental	Invasive species		
Infrastructure	None identified		
Land use	Not known		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Clearance - Vegetation killing	0.258	ha	€230	Prev. Job	€59
2	Clearance - Site clearance & disposal	0.258	ha	€14,000	Prev. Job	€3,612
3	Excavation - Topsoil strip & stockpile	2,580	m³	€3	Prev. Job	€7,740
4	Excavation - Cutting	638	m³	€5	Prev. Job	€3,209
5	Disposal - Cutting	638	m³	€26	Prev. Job	€16,358
6	Base Slab - Concrete	255	m³	€200	Prev. Job	€51,000
7	Base Slab - Reinforcement	20	t	€1,500	Prev. Job	€30,218
8	Base Slab - Trench fill	64	m³	€150	Prev. Job	€9,570
9	Base Slab - Formwork	78	m³	€100	Prev. Job	€7,768
10	Wall - Concrete	224	m³	€200	Prev. Job	€44,800
11	Wall - Reinforcement	18	t	€1,500	Prev. Job	€26,544
12	Wall - Formwork	1,120	m²	€100	Prev. Job	€112,030
13	Wall - Finish (Granite)	926	m²	€80	Prev. Job	€74,080
14	Drainage	194	m	€70	Prev. Job	€13,595
					Total construction cost	**€400,583**

Element 2 Construction Costs

Corcullion Area - Road Raise

Quantities generated from GIS modelling and a standard road and embankment cross sectional makeup. Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Embankment Volume	163	m³
Clay core Volume	0	m³
Cutoff Volume	0	m³
Footprint Area	1,038	m²
Surface Area	1,022	m²
Crest Area	740	m²
Length	148	m
Max Height	0.45	m

Clashes

Category	Type	Area	Length
Utility	Electricity OH cables		
Environmental	None identified		
Infrastructure	Access road		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Land compensation	0.282	acre	€25,000	Prev. Job	€7,051
2	Clearance - Vegetation killing	0.114	ha	€230	Prev. Job	€26
3	Clearance - Site clearance & disposal	0.114	ha	€14,000	Prev. Job	€1,599
4	Excavation - Topsoil strip & stockpile	343	m³	€8	Prev. Job	€2,740
5	Excavation - Cutting	0	m³	€5	Prev. Job	€0
6	Disposal - Cutting	0	m³	€26	Prev. Job	€0
7	Filling - Provision of topsoil	307	m³	€30	Prev. Job	€9,198
8	Filling - Topsoil (300mm depth)	307	m³	€9	Prev. Job	€2,606
9	Filling - Provision of clay fill	0	m³	€35	Prev. Job	€0
10	Filling - Placing of clay fill	0	m³	€15	Prev. Job	€0
11	Geotextile mat	1,022	m²	€4	Prev. Job	€4,088
12	Finishing - Grassing out	1,124	m²	€1	Prev. Job	€1,180
13	Drainage	148	m	€35	Prev. Job	€5,180
14	Cold Milling	148	m	€1.50	Prev. Job	€222
15	45mm Hot Rolled Asphalt, HTA 35/14F Surface Course	740	m²	€11.28	Prev. Job	€8,347
16	Binder Course Cold Milling	740	m²	€2.00	Prev. Job	€1,480
17	55mm Asphalt Concrete, AC20 DBM Binder Course	740	m²	€8.24	Prev. Job	€6,098

18	100mm Asphalt Concrete, AC32 DBM Base	740 m²	€15.18 Prev. Job	€11,233
19	350mm Type 3 Granular Sub Base	740 m²	€22.40 Prev. Job	€16,576
20	250mm Capping Layer	740 item	€21.33 Prev. Job	€15,784
			Total construction cost	**€93,408**

Operation and Maintenance

The various elements of this option will have associated operation and maintenance (O&M) costs. Costs are dependant on the responsible body (eg local authority, government body, private party), the complexity of the element (eg moving parts, high precision tolerances), and the robustness of the element (eg rate of degradation, risk of collapse).

Corcullion Area - Flood Wall

Annual O&M cost	€	97
Assumptions	Cost based on a rate of €0.5/m/year. Maintenance includes for vegetation control, inspections.	

Corcullion Area - Road Raise

Annual O&M cost	€	403
Assumptions	Cost based on a rate of €2,725/km/year. Maintenance includes for vegetation control, inspections, vermin control, back drainage improvements.	

Total O&M Annual Costs

O&M costs per year	**€**	**500**

Whole Life Cost

Design Life

Corcullion Area - Flood Wall	50yrs
Corcullion Area - Road Raise	50yrs

Financial Assumptions

Financial period	50yrs
Discount rate	4%

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
0	1.000			-	-
1	0.962			-	-
2	0.925			-	-
3	0.889			-	-
4	0.855			-	-
5	0.822			-	-
6	0.790			-	-
7	0.760			-	-
8	0.731			-	-
9	0.703			-	-
10	0.676			-	-
11	0.650	493,992		320,888	-
12	0.625		500	-	313
13	0.601		500	-	301
14	0.577		500	-	289
15	0.555		500	-	278
16	0.534		500	-	267
17	0.513		500	-	257
18	0.494		500	-	247
19	0.475		500	-	238
20	0.456		500	-	228
21	0.439		500	-	220
22	0.422		500	-	211
23	0.406		500	-	203
24	0.390		500	-	195
25	0.375		500	-	188
26	0.361		500	-	180
27	0.347		500	-	174
28	0.333		500	-	167
29	0.321		500	-	160
30	0.308		500	-	154
31	0.296		500	-	148
32	0.285		500	-	143
33	0.274		500	-	137
34	0.264		500	-	132
35	0.253		500	-	127
36	0.244		500	-	122
37	0.234		500	-	117
38	0.225		500	-	113
39	0.217		500	-	108
40	0.208		500	-	104
41	0.200		500	-	100
42	0.193		500	-	96
43	0.185		500	-	93
44	0.178		500	-	89

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
45	0.171		500	-	86
46	0.165		500	-	82
47	0.158		500	-	79
48	0.152		500	-	76
49	0.146		500	-	73
50	0.141		500	-	70
				€ 320,888	**€ 6,366**

Corcullion Area - MRFS HD Summary

PV Basic Construction Costs (BCC)				**€320,888**
PV Construction Costs (year 11)				
		Corcullion Area - Flood Wall	€260,211	
		Corcullion Area - Road Raise	€60,676	
Preliminary Costs		18% of BCC	€ 56,819	
Ground Investigation		5% of BCC	€ 16,044	
Overall construction cost (OCC)				**€ 393,751**
Design & Envronmental Fees		8.6% of OCC	€ 33,863	
Site Supervision Fees		8% of OCC	€ 31,500	
	Total Fees		€ 65,363	
Archaeology & Environmental Mitigation		10% of OCC	€ 39,375	
Percent for Art		1% of OCC	€ 3,938	
PV Operation and Maintenance Costs (50yrs)			€ 6,366	
	Total		€ 49,679	
Sub-total				**€ 508,793**
Optimism Bias		60%	€ 305,276	
Total Cost				**€ 814,068**

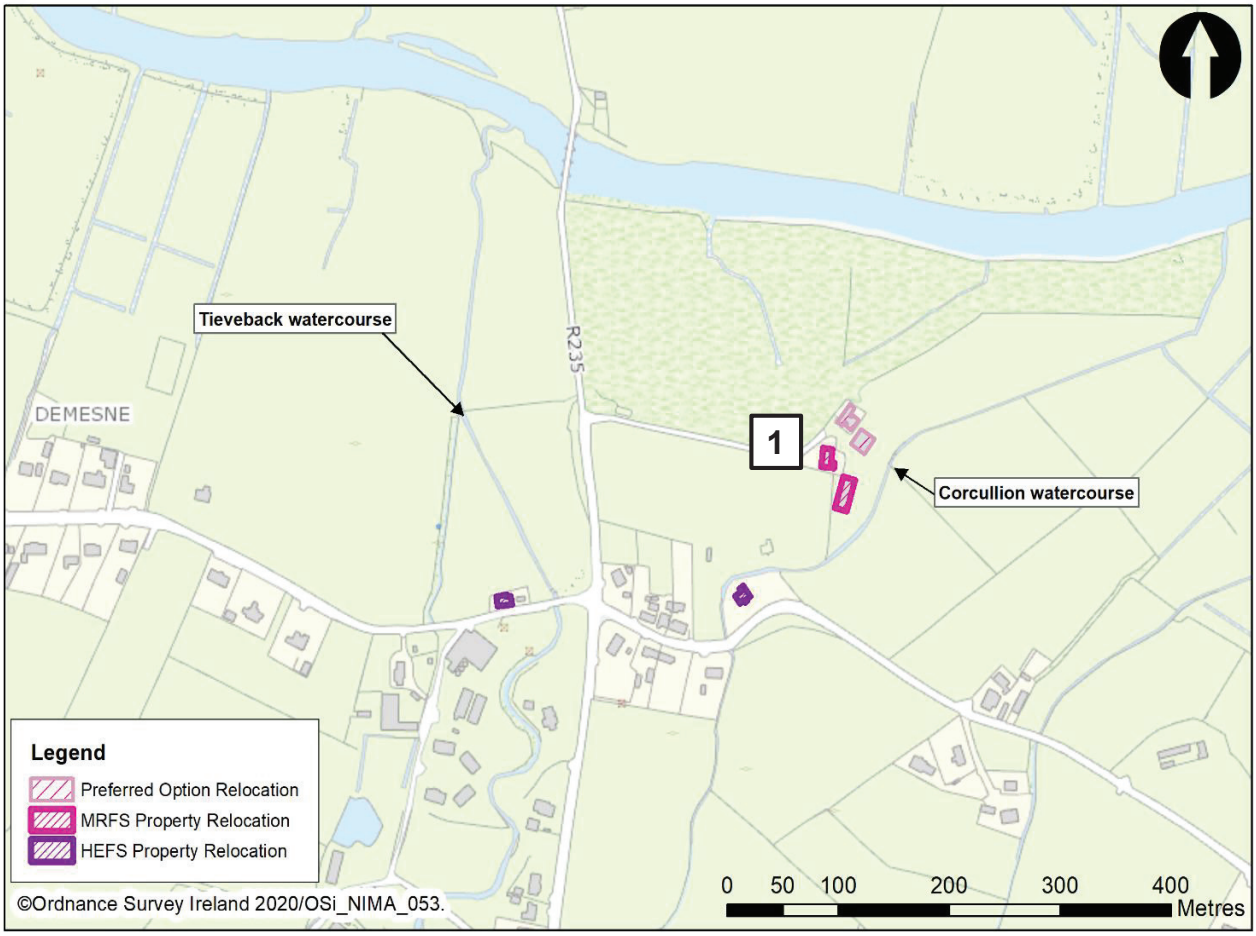
Option Description - Castlefinn - MRFS Relocation

MRFS option considers further property relocation as a future scheme to be implemented with the preferred scheme of property relocation.

List of elements

1. Property Relocation

Sketch of Option



Element 1 Construction Costs

Property relocation

Quantities generated from GIS modelling. Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Number of properties	1	no.
Size of house	350	m³

Clashes

Category	Type	Area	Length
Utility	general services	1	
Infrastructure	None identified		
Environmental	Not known		
Land use	Not known		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	New houses	1.0	no.	€ 141,918	Data	€141,918
2	Outbuildings	1.0	no.	€81,894	Data	€81,894
3	Relocation costs and administration	1.0	no.	30%	Data	€67,144
4	Demolition of buildings	800	m³	€17	Prev. Job	€13,840
5	Decommisioning of services	1	no.	€10,000	Prev. Job	€10,000
					Total construction cost	**€314,796**

Operation and Maintenance

No operation and maintenance costs assumed with property relocation

Whole Life Cost

Design Life

Property relocation	50yrs

Financial Assumptions

Financial period	50yrs
Discount rate	4%

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
0	1.000		-	-	-
1	0.962		-	-	-
2	0.925		-	-	-
3	0.889		-	-	-
4	0.855		-	-	-
5	0.822		-	-	-
6	0.790		-	-	-
7	0.760		-	-	-
8	0.731		-	-	-
9	0.703		-	-	-
10	0.676		-	-	-
11	0.650	314,796	-	204,485	-
12	0.625		-	-	-
13	0.601		-	-	-
14	0.577		-	-	-
15	0.555		-	-	-
16	0.534		-	-	-
17	0.513		-	-	-
18	0.494		-	-	-
19	0.475		-	-	-
20	0.456		-	-	-
21	0.439		-	-	-
22	0.422		-	-	-
23	0.406		-	-	-
24	0.390		-	-	-
25	0.375		-	-	-
26	0.361		-	-	-
27	0.347		-	-	-
28	0.333		-	-	-
29	0.321		-	-	-
30	0.308		-	-	-
31	0.296		-	-	-
32	0.285		-	-	-
33	0.274		-	-	-
34	0.264		-	-	-
35	0.253		-	-	-
36	0.244		-	-	-
37	0.234		-	-	-
38	0.225		-	-	-
39	0.217		-	-	-
40	0.208		-	-	-
41	0.200		-	-	-
42	0.193		-	-	-

Year	Discount factor	Construction	O&M	PV Construction	PV O&M
43	0.185		-	-	-
44	0.178		-	-	-
45	0.171		-	-	-
46	0.165		-	-	-
47	0.158		-	-	-
48	0.152		-	-	-
49	0.146		-	-	-
50	0.141		-	-	-
				€ 204,485	**€ -**

Corcullion Area - MRFS Relocation Summary

PV Basic Construction Costs (BCC)				**€204,485**
PV Construction Costs (year 11)				
Property relocation			€204,485	
Preliminary Costs		20% of BCC	€ 41,813	
Ground Investigation		5% of BCC	€ 10,224	
Overall construction cost (OCC)				**€ 256,523**
Design & Envronmental Fees		8.6% of OCC	€ 22,061	
Site Supervision Fees		8% of OCC	€ 20,522	
	Total Fees		€ 42,583	
Archaeology & Environmental Mitigation		10% of OCC	€ 25,652	
Percent for Art		1% of OCC	€ 2,565	
PV Operation and Maintenance Costs (50yrs)			€ 0	
	Total		€ 28,218	
Sub-total				**€ 327,323**
Optimism Bias		60%	€ 196,394	
Total Cost				**€ 523,717**

Appendix B

HEFS Costing Summary

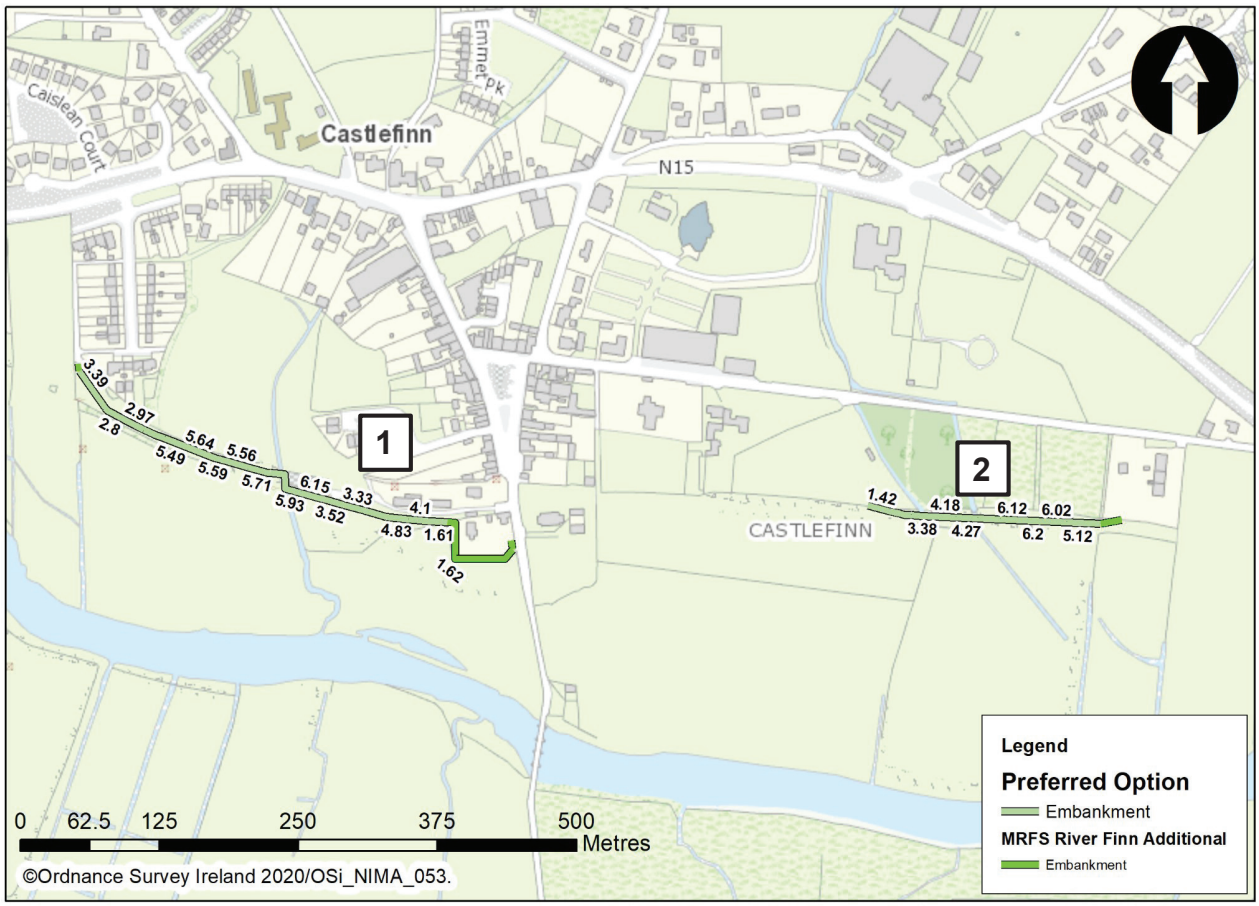
Option Description - Finn - HEFS Hard Defence

HEFS option considers hard defences as an adaptation to be implemented to the preferred scheme of flood embankments

List of elements

1. Flood embankment
2. Flood embankment

Sketch of Option



Finn Area - HEFS HD Summary

PV Basic Construction Costs (BCC)			**€720,041**
PV Construction Costs (year 1)			
	Bridge Burn Area - Earth Embankment	€19,084	
	Castlefinn Area - Earth Embankment	€5,667	
PV Construction Costs (year 11)			
	Bridge Burn Area - Earth Embankment	€475,092	
	Castlefinn Area - Earth Embankment	€220,198	
Preliminary Costs	17% of BCC	€ 123,723	
Ground Investigation	5% of BCC	€ 36,002	
Overall construction cost (OCC)			**€ 879,765**
Design & Envronmental Fees	8.6% of OCC	€ 75,660	
Site Supervision Fees	8% of OCC	€ 70,381	
	Total Fees	€ 146,041	
Archaeology & Environmental Mitigation	10% of OCC	€ 87,977	
Percent for Art	1% of OCC	€ 8,798	
PV Operation and Maintenance Costs (50yrs)		€ 1,628	
	Total	€ 98,403	
Sub-total			**€ 1,124,209**
Optimism Bias	60%	€ 674,525	
Total Cost			**€ 1,798,734**

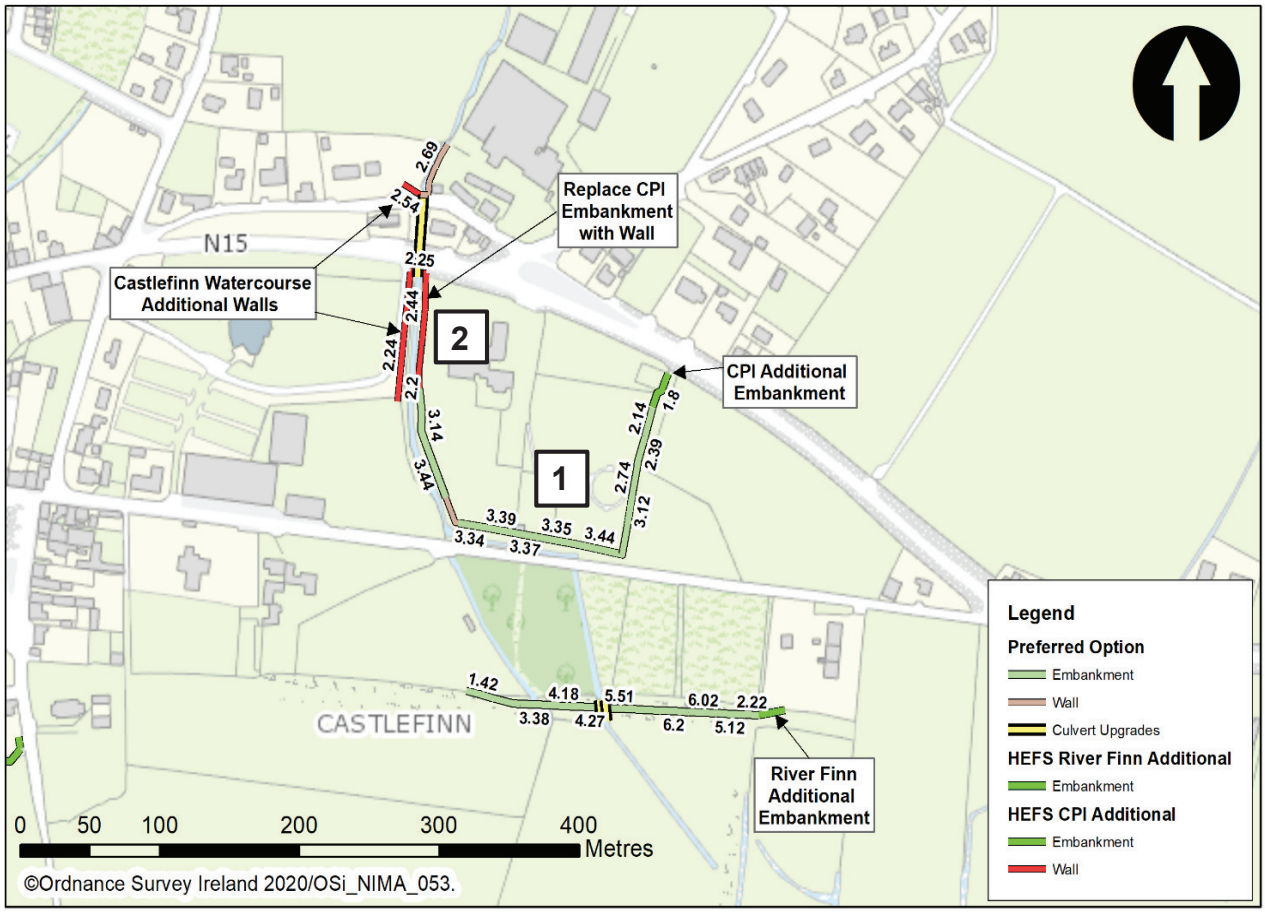
Option Description - CPI Centre - HEFS Hard Defences

HEFS option considers hard defences as an adaptation to the preferred scheme of culvert upgrade and hard defences around the CPI centre.

List of elements

1. CPI bund
2. Flood Wall

Sketch of Option



CPI Centre Area - HEFS HD Summary

PV Basic Construction Costs (BCC)				**€616,472**
PV Construction Costs (year 1)				
		Castlefinn Area - CPI bund	€8,684	
		Castlefinn WC Flood walls	€20,061	
PV Construction Costs (year 11)				
		Castlefinn Area - CPI bund	€234,073	
		Castlefinn WC Flood walls	€353,654	
Preliminary Costs		17% of BCC	€ 104,800	
Ground Investigation		5% of BCC	€ 30,824	
Overall construction cost (OCC)				**€ 752,096**
Design & Envronmental Fees		8.6% of OCC	€ 64,680	
Site Supervision Fees		8% of OCC	€ 60,168	
	Total Fees		€ 124,848	
Archaeology & Environmental Mitigation		10% of OCC	€ 75,210	
Percent for Art		1% of OCC	€ 7,521	
PV Operation and Maintenance Costs (50yrs)			€ 2,977	
	Total		€ 85,707	
Sub-total				**€ 962,652**
Optimism Bias		60%	€ 577,591	
Total Cost				**€ 1,540,242**

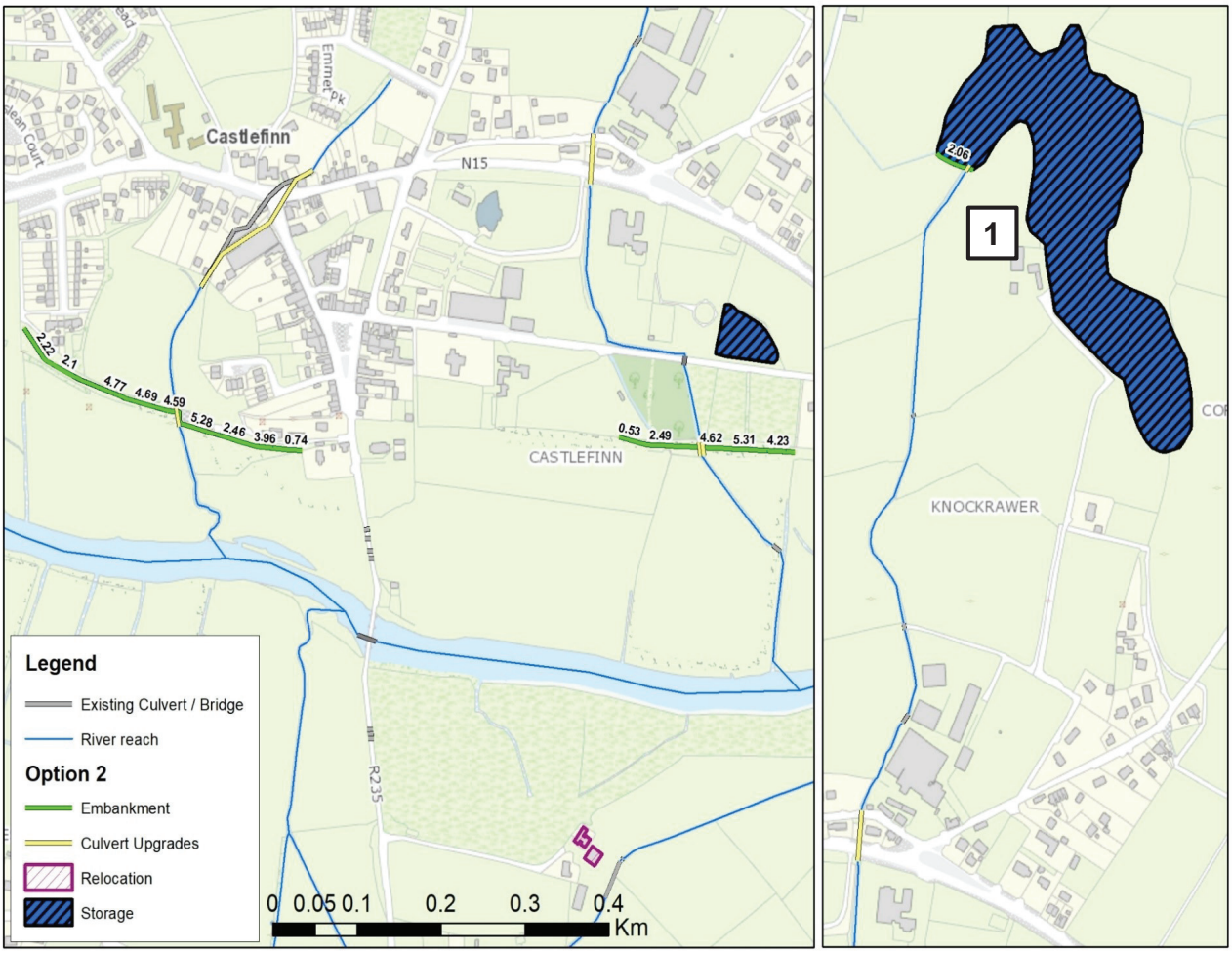
Option Description - CPI Centre - HEFS Upstream Storage

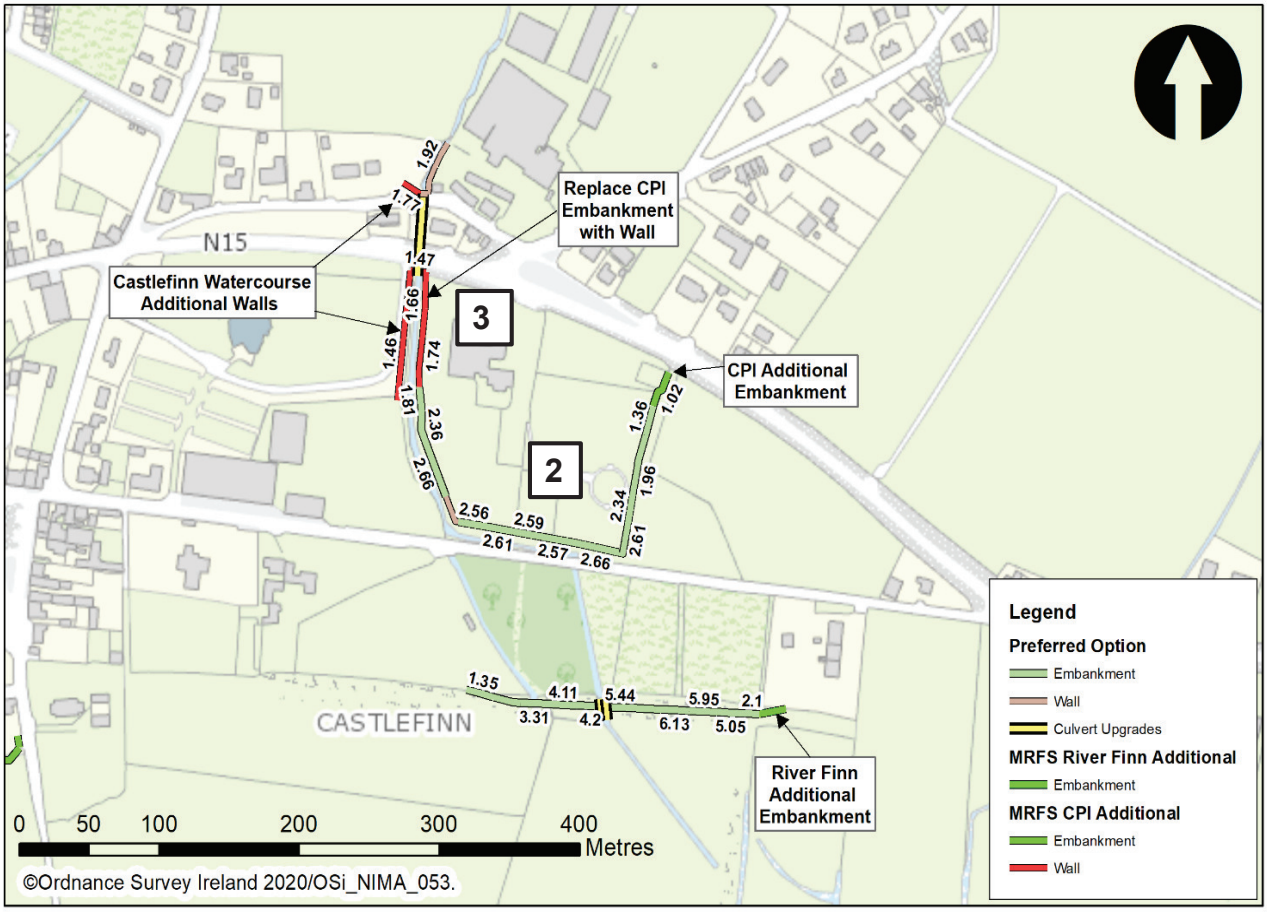
HEFS option considers upstream storage as a future scheme to be implemented with the preferred scheme of culvert upgrade and hard defences around the CPI centre.

List of elements

1. Flood Storage (Upstream)
2. Adapt CPI Embankment
3. Adapt CPI Walls

Sketch of Option




Replace CPI Embankment with Wall
Castlefinn Watercourse Additional Walls
CPI Additional Embankment
River Finn Additional Embankment
N15
CASTLEFINN
3
2
1.92
1.77
1.47
1.66
1.46
1.74
1.81
2.36
2.66
2.56
2.59
2.61
2.57
2.66
2.61
2.34
1.96
1.36
1.02
1.35
4.11
3.31
5.44
4.2
6.13
5.95
5.05
2.1
0 50 100 200 300 400
Metres
©Ordnance Survey Ireland 2020/OSi_NIMA_053.
Legend
Preferred Option
Embankment
Wall
Culvert Upgrades
MRFS River Finn Additional
Embankment
MRFS CPI Additional
Embankment
Wall

CPI Centre Area - HEFS US Storage Summary

PV Basic Construction Costs (BCC)			**€1,147,178**
PV Construction Costs (year 1)			
	Castlefinn Area - CPI bund	€4,009	
	Castlefinn WC Flood walls	€11,931	
PV Construction Costs (year 11)			
	Castlefinn WC Area - Upstream Storage	€956,357	
PV Construction Costs (year 31)			
	Castlefinn Area - CPI bund	€53,398	
	Castlefinn WC Flood walls	€121,483	
Preliminary Costs	17% of BCC	€ 195,020	
Ground Investigation	5% of BCC	€ 57,359	
Overall construction cost (OCC)			**€ 1,399,557**
Design & Envronmental Fees	8.6% of OCC	€ 120,362	
Site Supervision Fees	8% of OCC	€ 111,965	
Total Fees		€ 232,326	
Archaeology & Environmental Mitigation	10% of OCC	€ 139,956	
Percent for Art	1% of OCC	€ 13,996	
PV Operation and Maintenance Costs (50yrs)		€ 6,005	
Total		€ 159,956	
Sub-total			**€ 1,791,840**
Optimism Bias	60%	€ 1,075,104	
Total Cost			**€ 2,866,943**

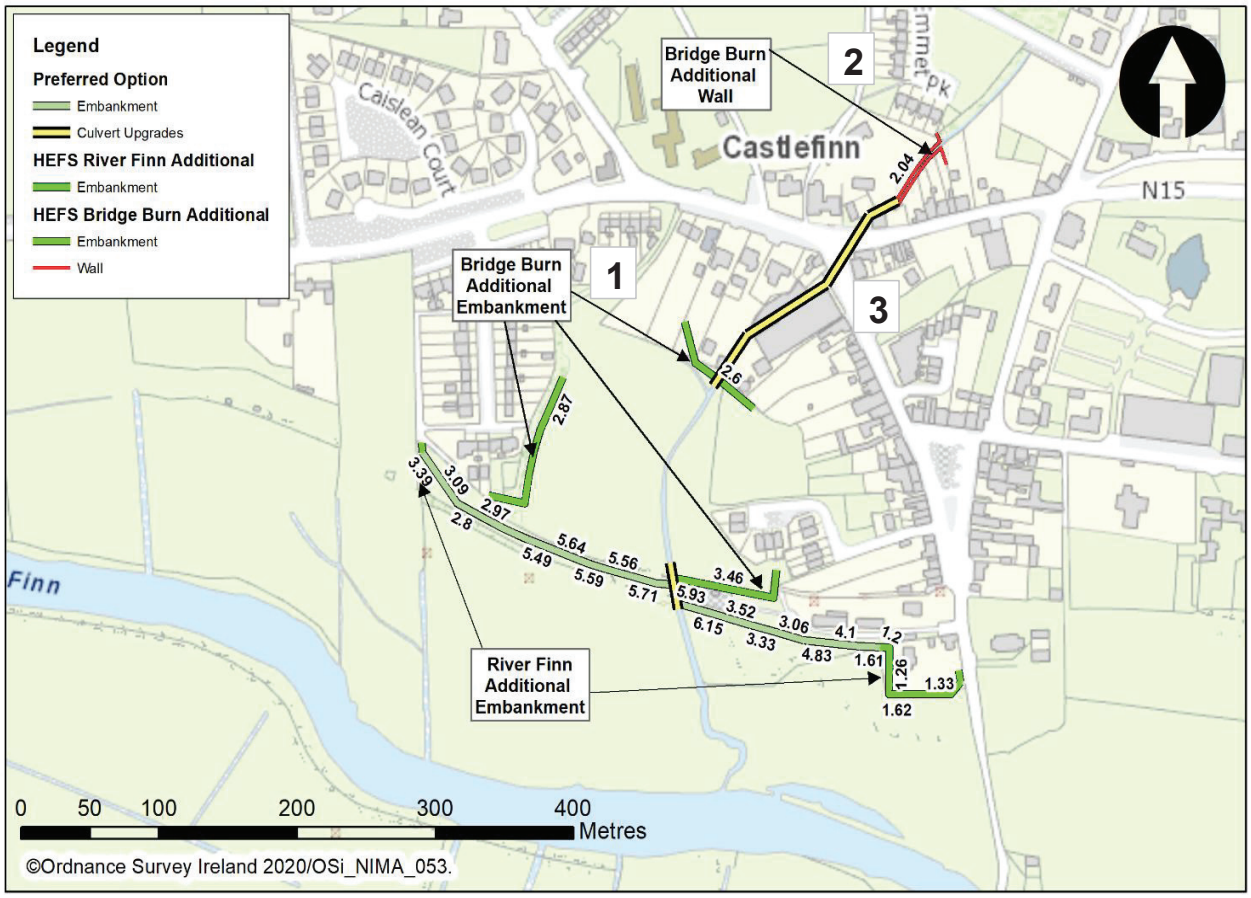
Option Description - Bridge Burn - HEFS HD + ICC

HEFS option considers hard defences and improved conveyance as an adaptation to the preferred scheme and a future scheme to be implemented with the preferred scheme of culvert upgrade on the Bridge Burn.

List of elements

1. Flood embankment
2. Flood wall
3. Culvert upgrade

Sketch of Option



Bridge Burn Area - HEFS HD + ICC Summary

PV Basic Construction Costs (BCC)				**€565,513**
PV Construction Costs (year 11)				
		Bridge Burn - Earth Embankment	€243,315	
PV Construction Costs (year 31)				
		Bridge Burn Area - Earth Embankment Adaptation	€77,579	
		Bridge Burn US - Flood Wall	€59,263	
		Bridge Burn Area - Culvert upgrade	€185,356	
Preliminary Costs		18% of BCC	€ 100,135	
Ground Investigation		5% of BCC	€ 28,276	
Overall construction cost (OCC)				**€ 693,923**
Design & Envronmental Fees		8.6% of OCC	€ 59,677	
Site Supervision Fees		8% of OCC	€ 55,514	
	Total Fees		€ 115,191	
Archaeology & Environmental Mitigation		10% of OCC	€ 69,392	
Percent for Art		1% of OCC	€ 6,939	
PV Operation and Maintenance Costs (50yrs)			€ 12,430	
	Total		€ 88,762	
Sub-total				**€ 897,876**
Optimism Bias		60%	€ 538,726	
Total Cost				**€ 1,436,602**

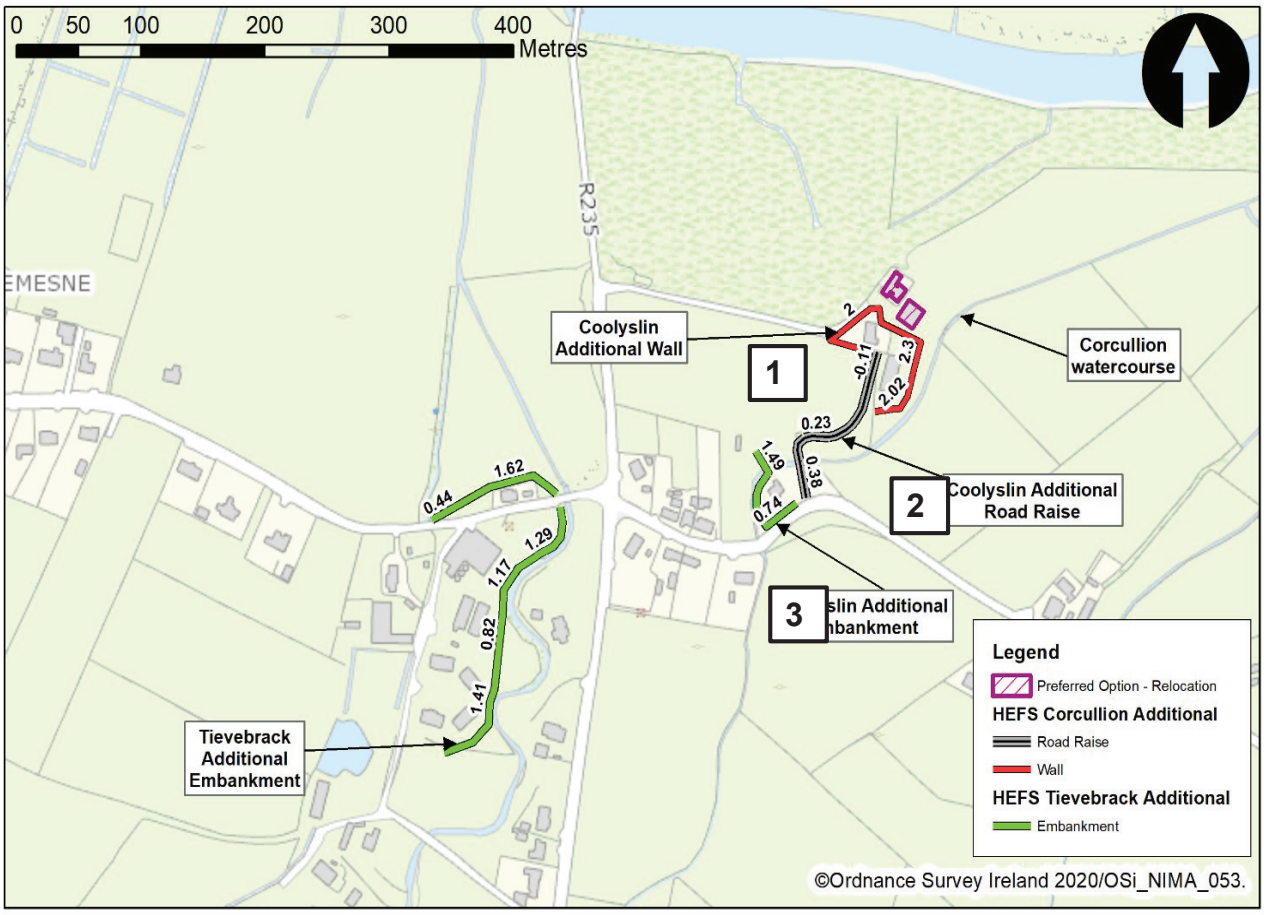
Option Description - Corcullion Arean - HEFS Hard Defence

HEFS option considers hard defences as a future scheme to be implemented with the preferred scheme of property relocation.

List of elements

1. Flood wall
2. Road raise
3. Flood embankment

Sketch of Option



Corcullion Area - HEFS HD Summary

PV Basic Construction Costs (BCC)			**€345,289**
PV Construction Costs (year 11)			
	Corcullion Area - Flood Wall	€266,242	
	Corcullion Area - Road Raise	€27,692	
PV Construction Costs (year 31)			
	Corcullion - Earth Embankment	€18,371	
Preliminary Costs	18% of BCC	€ 61,140	
Ground Investigation	5% of BCC	€ 17,264	
Overall construction cost (OCC)			**€ 423,694**
Design & Envronmental Fees	8.6% of OCC	€ 36,438	
Site Supervision Fees	8% of OCC	€ 33,895	
Total Fees		€ 70,333	
Archaeology & Environmental Mitigation	10% of OCC	€ 42,369	
Percent for Art	1% of OCC	€ 4,237	
PV Operation and Maintenance Costs (50yrs)		€ 7,406	
Total		€ 54,012	
Sub-total			**€ 548,039**
Optimism Bias	60%	€ 328,823	
Total Cost			**€ 876,862**

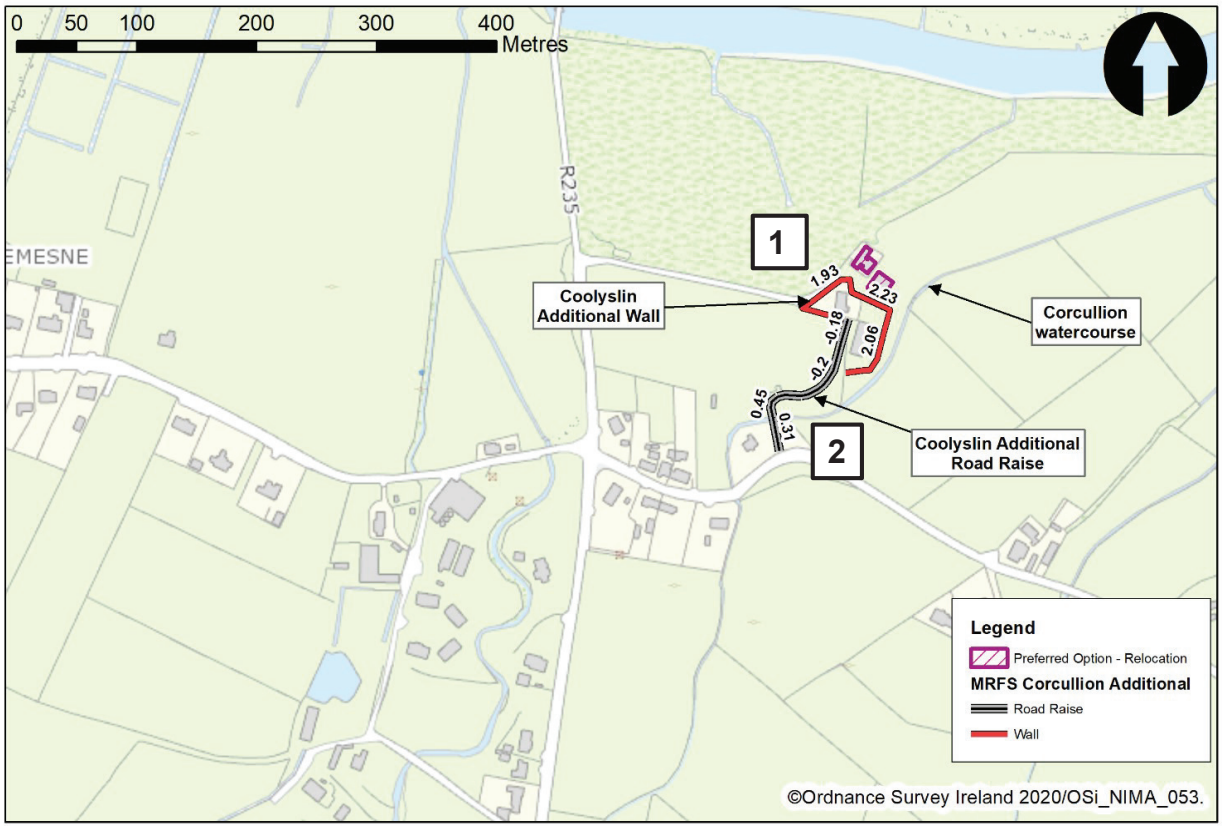
Option Description - Castlefinn - HEFS HD + ICC

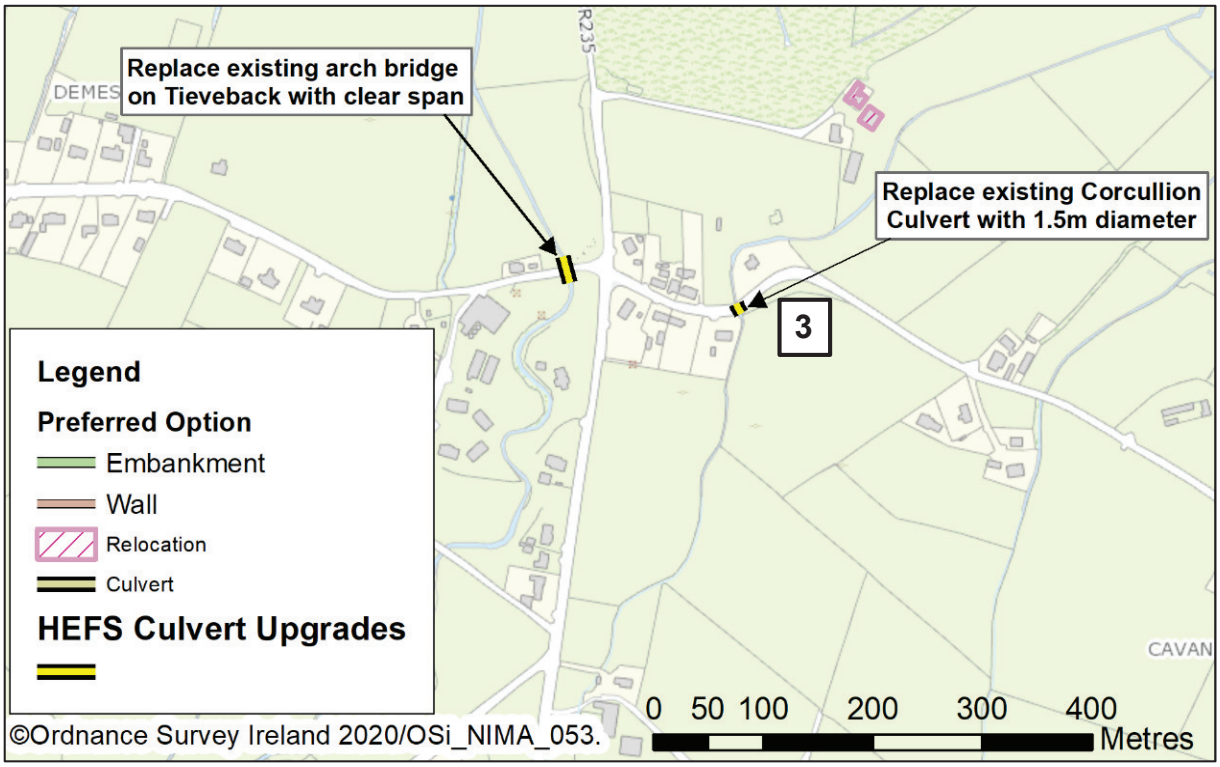
HEFS option considers hard defences and improved conveyance as a future scheme to be implemented with the preferred scheme of property relocation.

List of elements

1. Flood wall
2. Road raise
3. Culvert upgrade

Sketch of Option




Replace existing arch bridge on Tieveback with clear span
Replace existing Corcullion Culvert with 1.5m diameter
3
R235
DEMES
CAVAN
Legend
Preferred Option
Embankment
Wall
Relocation
Culvert
HEFS Culvert Upgrades
©Ordnance Survey Ireland 2020/OSi_NIMA_053.
0 50 100 200 300 400
Metres

Corcullion Area - HEFS HD + ICC Summary

PV Basic Construction Costs (BCC)				**€358,337**
PV Construction Costs (year 11)				
		Corcullion Area - Flood Wall	€266,242	
		Corcullion Area - Road Raise	€60,676	
PV Construction Costs (year 31)				
		Corcullion Area - Culvert upgrade	€31,419	
Preliminary Costs		18% of BCC	€ 63,450	
Ground Investigation		5% of BCC	€ 17,917	
Overall construction cost (OCC)				**€ 439,704**
Design & Envronmental Fees		8.6% of OCC	€ 37,815	
Site Supervision Fees		8% of OCC	€ 35,176	
	Total Fees		€ 72,991	
Archaeology & Environmental Mitigation		10% of OCC	€ 43,970	
Percent for Art		1% of OCC	€ 4,397	
PV Operation and Maintenance Costs (50yrs)			€ 8,632	
	Total		€ 57,000	
Sub-total				**€ 569,695**
Optimism Bias		60%	€ 341,817	
Total Cost				**€ 911,512**

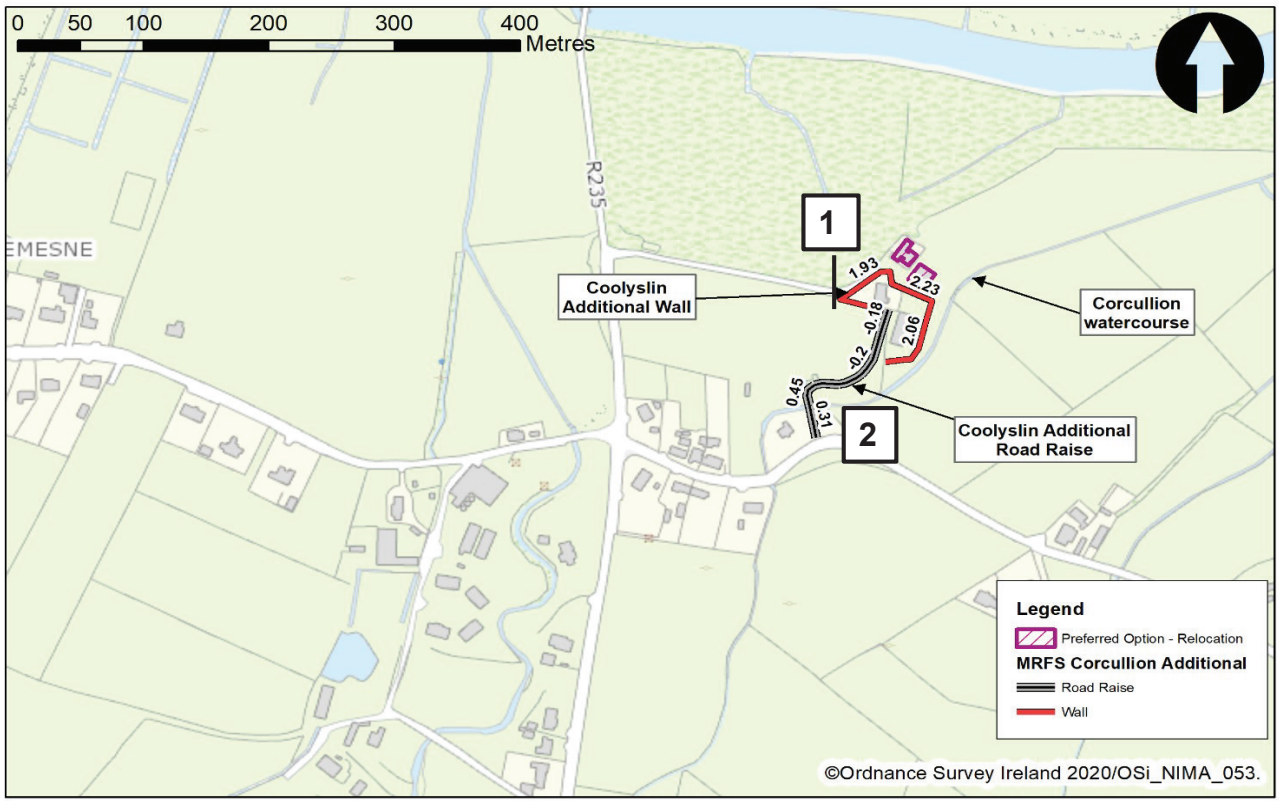
Option Description - Castlefinn - HEFS HD + Property Relocation

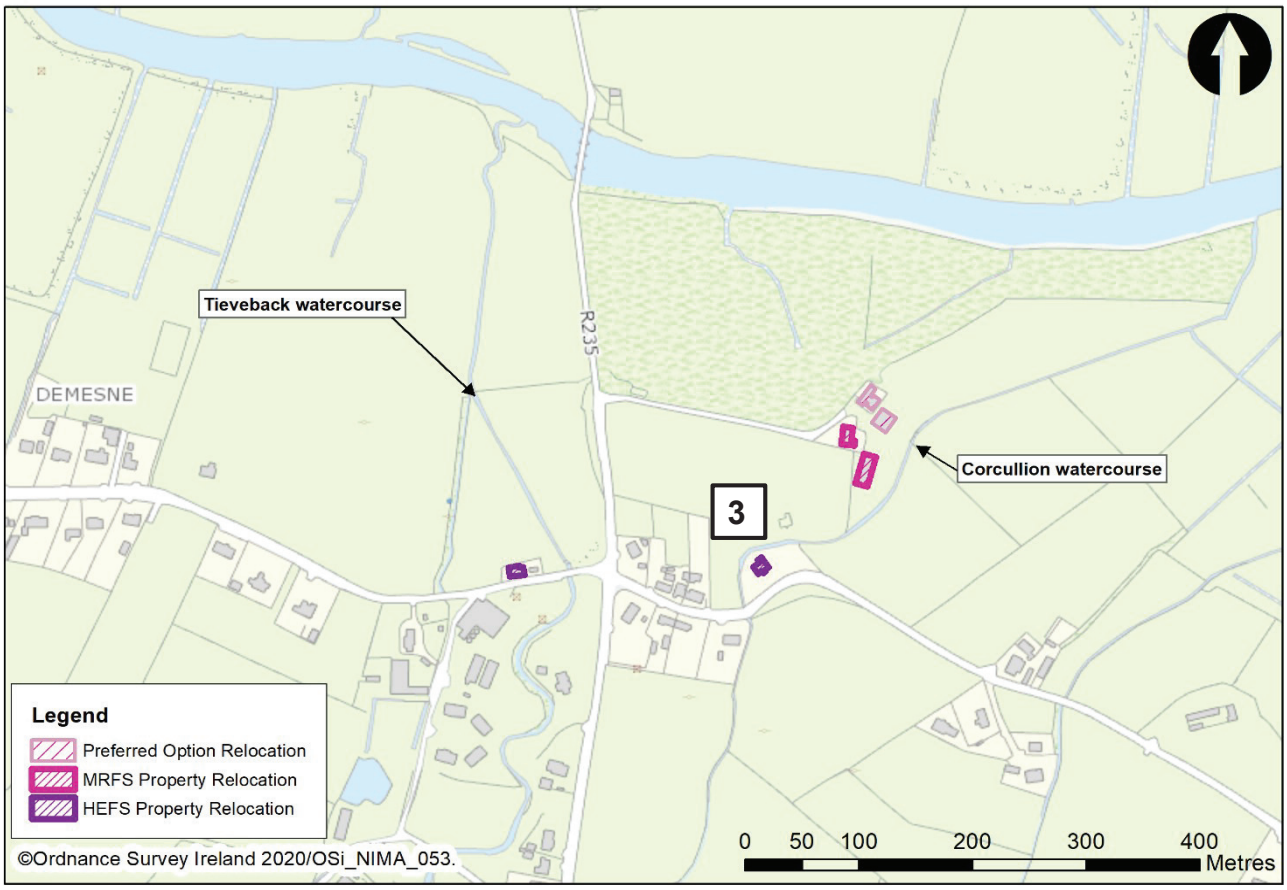
HEFS option considers hard defences andproperty relocation as a future scheme to be implemented with the preferred scheme of property relocation.

List of elements

1. Flood wall
2. Road raise
3. Property Relocation

Sketch of Option




Tieveback watercourse
R235
DEMESNE
Corcullion watercourse
3
Legend
Preferred Option Relocation
MRFS Property Relocation
HEFS Property Relocation
©Ordnance Survey Ireland 2020/OSi_NIMA_053.
0 50 100 200 300 400
Metres

Corcullion Area - HEFS HD + Relocation Summary

PV Basic Construction Costs (BCC)				**€386,372**
PV Construction Costs (year 11)				
		Corcullion Area - Flood Wall	€266,242	
		Corcullion Area - Road Raise	€60,676	
PV Construction Costs (year 31)				
		Property Relocation - 2	€59,455	
Preliminary Costs		18% of BCC	€ 68,415	
Ground Investigation		5% of BCC	€ 19,319	
Overall construction cost (OCC)				**€ 474,106**
Design & Envronmental Fees		8.6% of OCC	€ 40,773	
Site Supervision Fees		8% of OCC	€ 37,928	
	Total Fees		€ 78,702	
Archaeology & Environmental Mitigation		10% of OCC	€ 47,411	
Percent for Art		1% of OCC	€ 4,741	
PV Operation and Maintenance Costs (50yrs)			€ 6,366	
	Total		€ 58,518	
Sub-total				**€ 611,325**
Optimism Bias		60%	€ 366,795	
Total Cost				**€ 978,120**

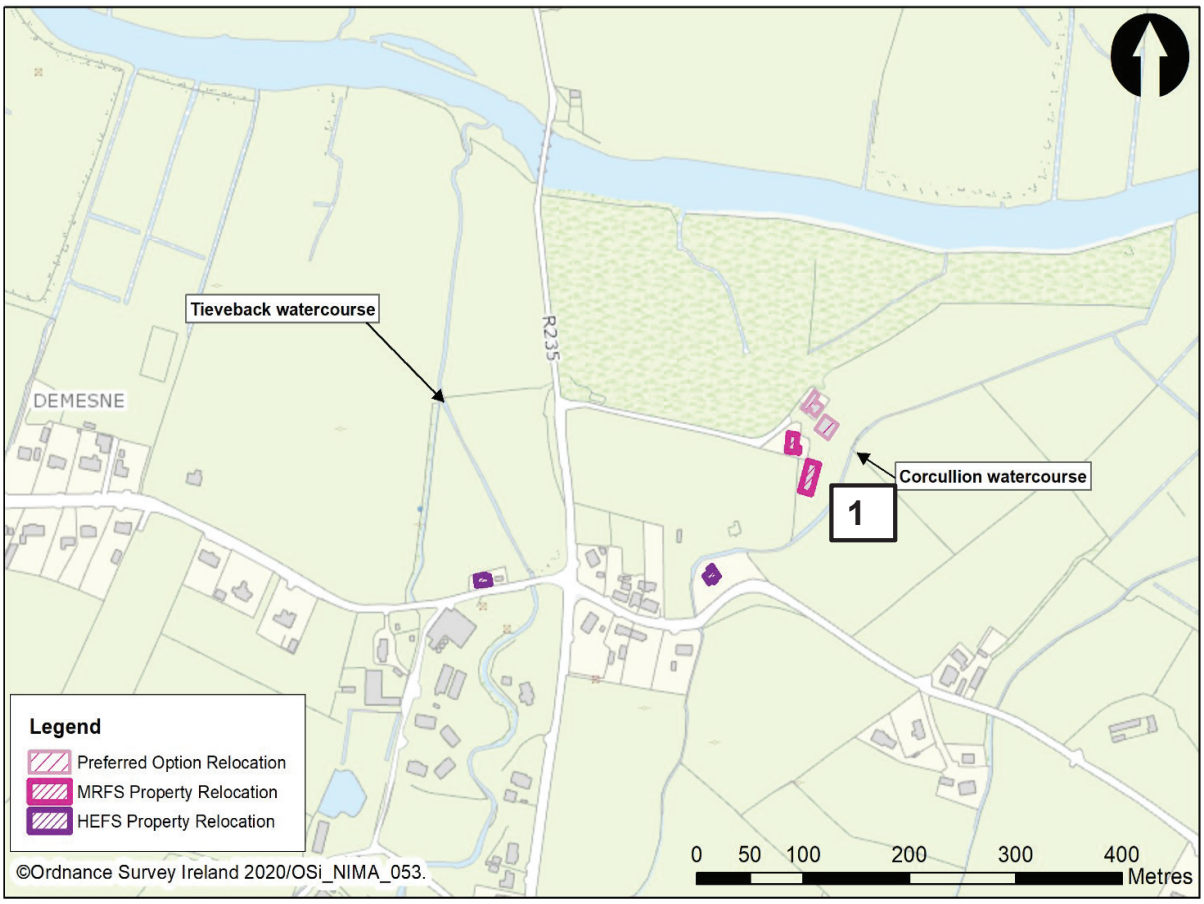
Option Description - Corcullion watercourse - HEFS Relocation + Hard Defence

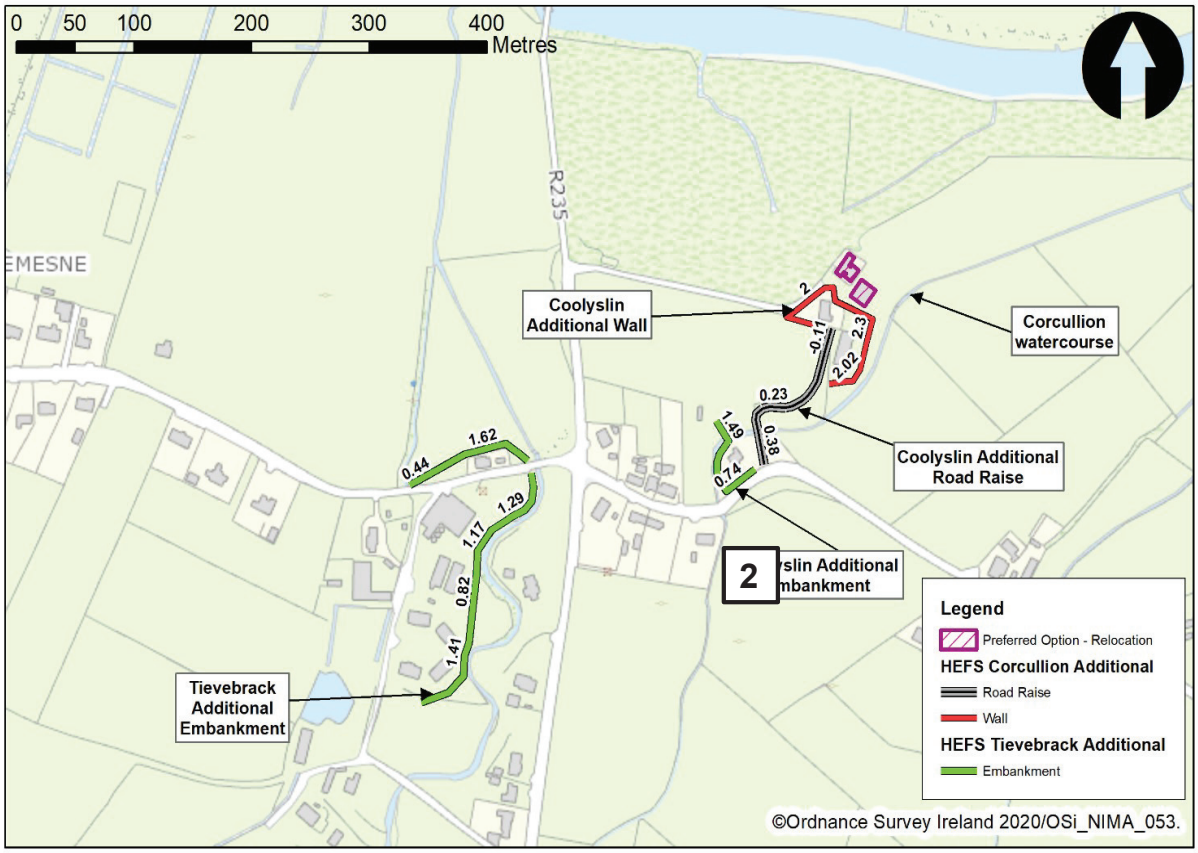
HEFS option considers further property relocation and a further flood embankment as a future scheme to be implemented with the preferred scheme of property relocation.

List of elements

1. Property Relocation
2. Additional Embankment

Sketch of Option




0 50 100 200 300 400
Metres
R235
EMESNE
Coolyslin Additional Wall
Corcullion watercourse
Coolyslin Additional Road Raise
2
Tievebrack Additional Embankment
2
0.44
1.62
1.29
1.17
0.82
1.41
0.74
1.49
0.38
0.23
0.11
2.02
2.3
Legend
Preferred Option - Relocation
HEFS Corcullion Additional
Road Raise
Wall
HEFS Tievebrack Additional
Embankment
©Ordnance Survey Ireland 2020/OSi_NIMA_053.

Corcullion Area - HEFS Relocation + Hard Defence Summary

PV Basic Construction Costs (BCC)				**€222,857**
PV Construction Costs (year 11)				
		Property Relocation - 1	€204,485	
PV Construction Costs (year 31)				
		Corcullion - Earth Embankment	€18,371	
Preliminary Costs		20% of BCC	€ 45,570	
Ground Investigation		5% of BCC	€ 11,143	
Overall construction cost (OCC)				**€ 279,569**
Design & Envronmental Fees		8.6% of OCC	€ 24,043	
Site Supervision Fees		8% of OCC	€ 22,366	
	Total Fees		€ 46,409	
Archaeology & Environmental Mitigation		10% of OCC	€ 27,957	
Percent for Art		1% of OCC	€ 2,796	
PV Operation and Maintenance Costs (50yrs)			€ 1,119	
	Total		€ 31,872	
Sub-total				**€ 357,849**
Optimism Bias		60%	€ 214,710	
Total Cost				**€ 572,559**

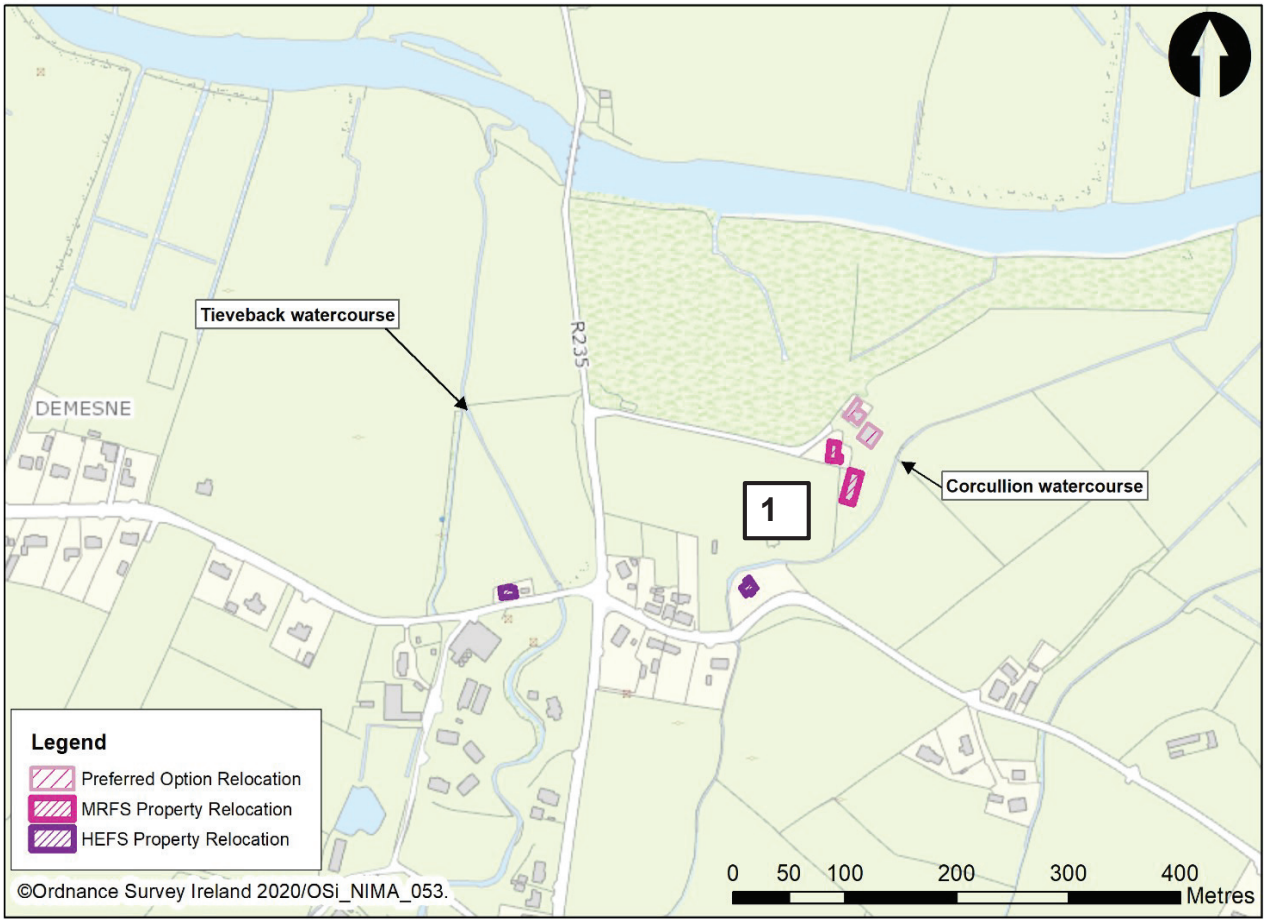
Option Description - Castlefinn - HEFS Relocation + Culvert Upgrade

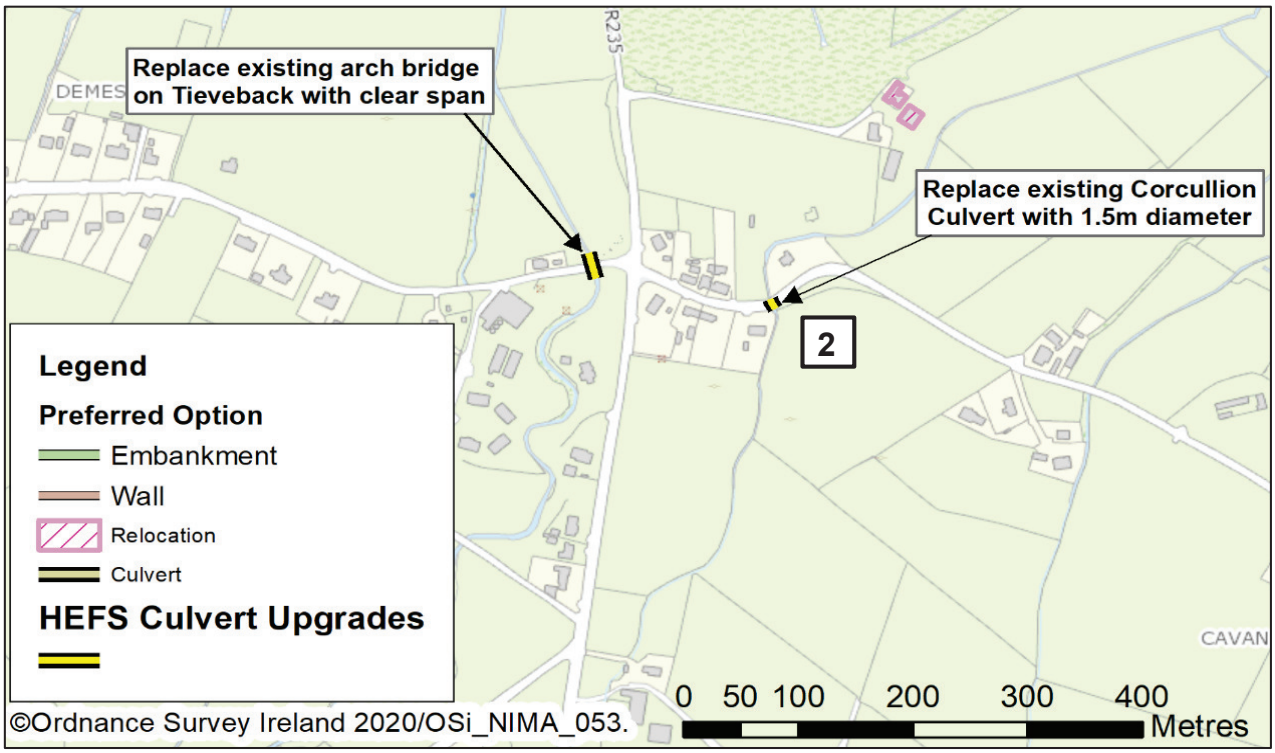
HEFS option considers further property relocation plus culvert upgrades as a future scheme to be implemented with the preferred scheme of property relocation.

List of elements

1. Property Relocation
2. Culvert Upgrade

Sketch of Option




Replace existing arch bridge on Tieveback with clear span
Replace existing Corcullion Culvert with 1.5m diameter
2
R235
DEMES
CAVAN
Legend
Preferred Option
Embankment
Wall
Relocation
Culvert
HEFS Culvert Upgrades
0 50 100 200 300 400
Metres
©Ordnance Survey Ireland 2020/OSi_NIMA_053.

Corcullion Area - HEFS Relocation + Culvert Upgrade Summary

PV Basic Construction Costs (BCC)				**€235,905**
PV Construction Costs (year 11)				
		Property Relocation - 1	€204,485	
PV Construction Costs (year 31)				
		Corcullion Area - Culvert upgrade	€31,419	
Preliminary Costs		20% of BCC	€ 48,238	
Ground Investigation		5% of BCC	€ 11,795	
Overall construction cost (OCC)				**€ 295,938**
Design & Envronmental Fees		8.6% of OCC	€ 25,451	
Site Supervision Fees		8% of OCC	€ 23,675	
	Total Fees		€ 49,126	
Archaeology & Environmental Mitigation		10% of OCC	€ 29,594	
Percent for Art		1% of OCC	€ 2,959	
PV Operation and Maintenance Costs (50yrs)			€ 2,439	
	Total		€ 34,992	
Sub-total				**€ 380,055**
Optimism Bias		60%	€ 228,033	
Total Cost				**€ 608,089**

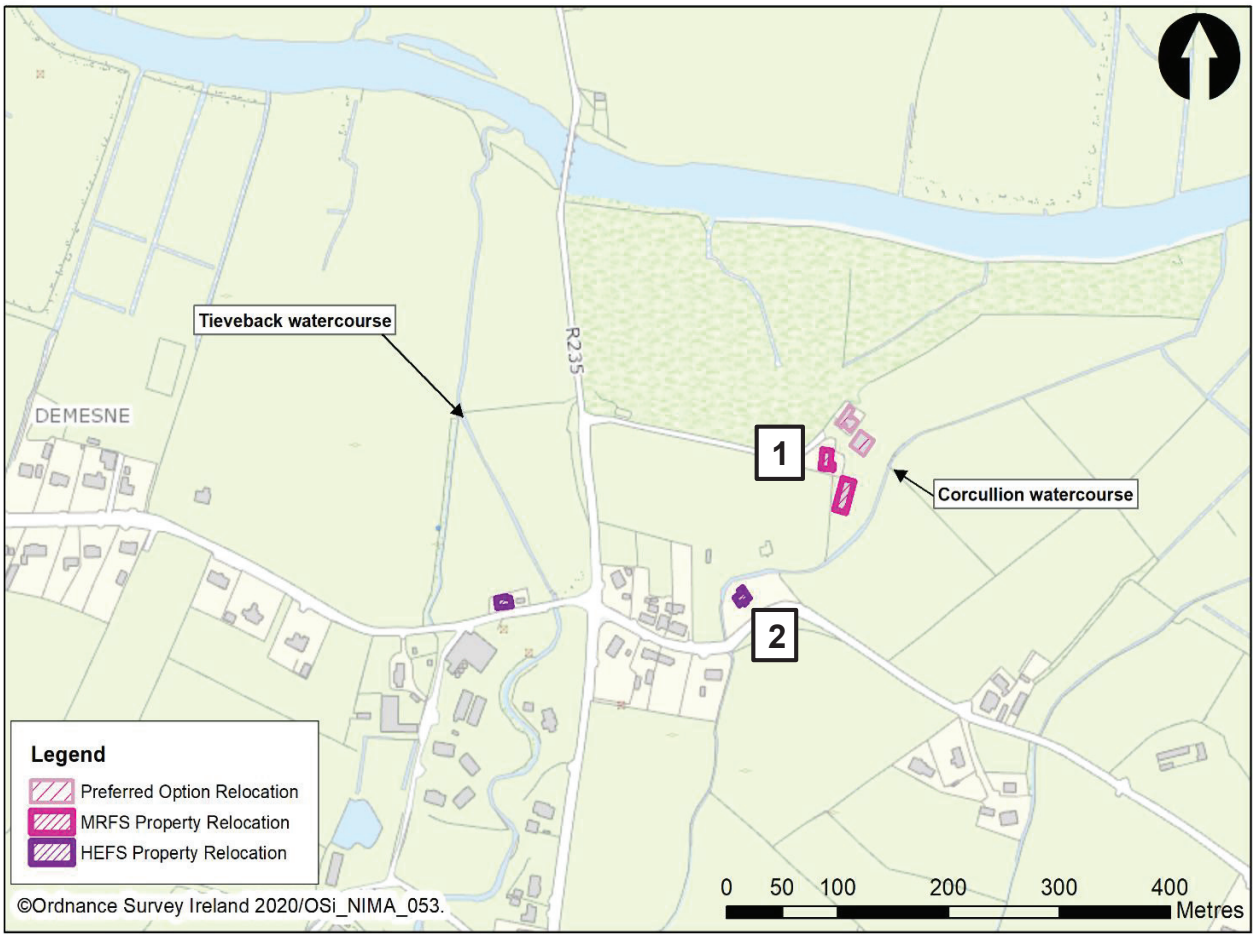
Option Description - Castlefinn - HEFS Relocation

HEFS option considers further property relocation as a future scheme to be implemented with the preferred scheme of property relocation.

List of elements

1. Property Relocation
2. Property Relocation

Sketch of Option



Corcullion Area - HEFS Relocation Summary

PV Basic Construction Costs (BCC)				**€263,940**
PV Construction Costs (year 11)				
		Property Relocation - 1	€204,485	
PV Construction Costs (year 31)				
		Property Relocation - 2	€59,455	
Preliminary Costs		20% of BCC	€ 53,970	
Ground Investigation		5% of BCC	€ 13,197	
Overall construction cost (OCC)				**€ 331,108**
Design & Envronmental Fees		8.6% of OCC	€ 28,475	
Site Supervision Fees		8% of OCC	€ 26,489	
	Total Fees		€ 54,964	
Archaeology & Environmental Mitigation		10% of OCC	€ 33,111	
Percent for Art		1% of OCC	€ 3,311	
PV Operation and Maintenance Costs (50yrs)			€ 0	
	Total		€ 36,422	
Sub-total				**€ 422,493**
Optimism Bias		60%	€ 253,496	
Total Cost				**€ 675,989**

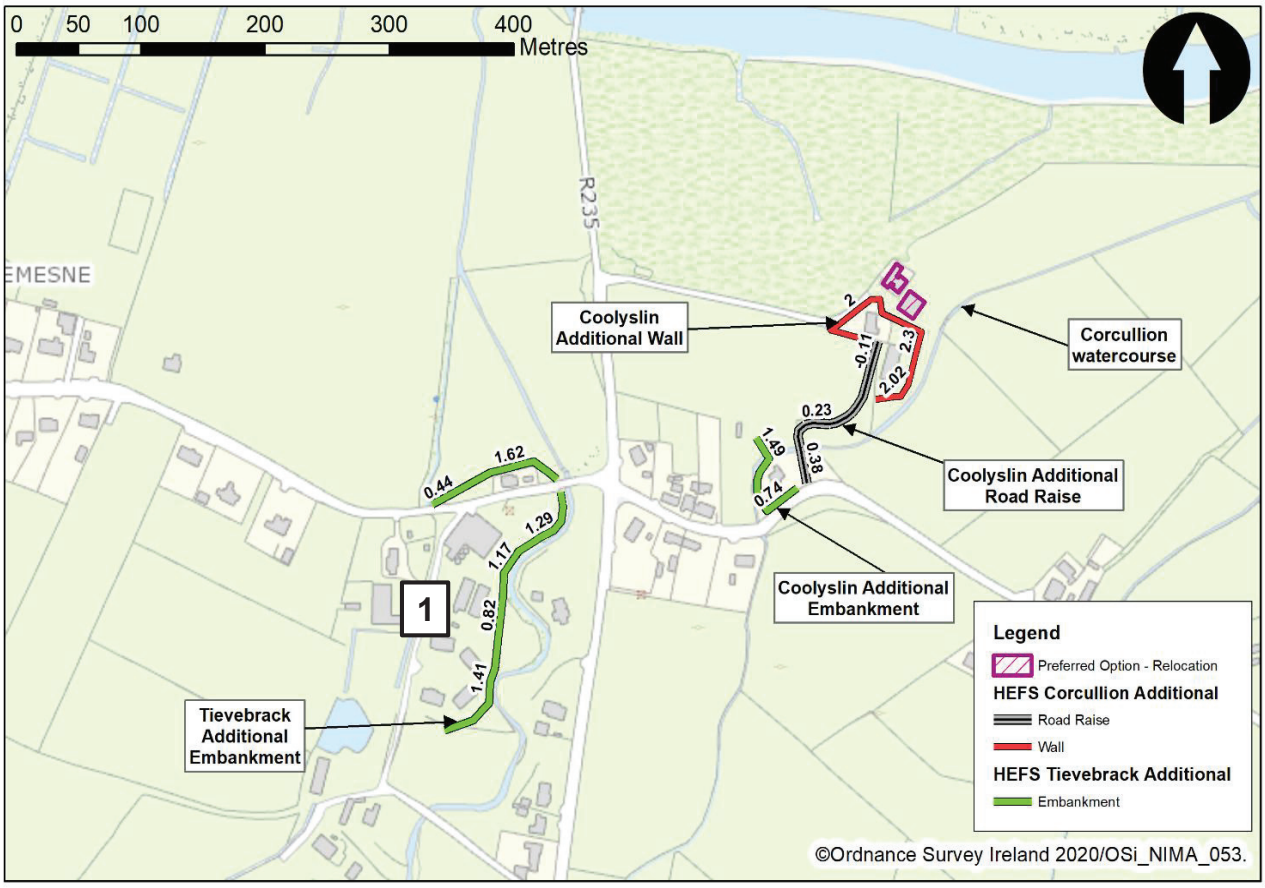
Option Description - Tievebrack - HEFS Hard Defence + Bridge Upgrade

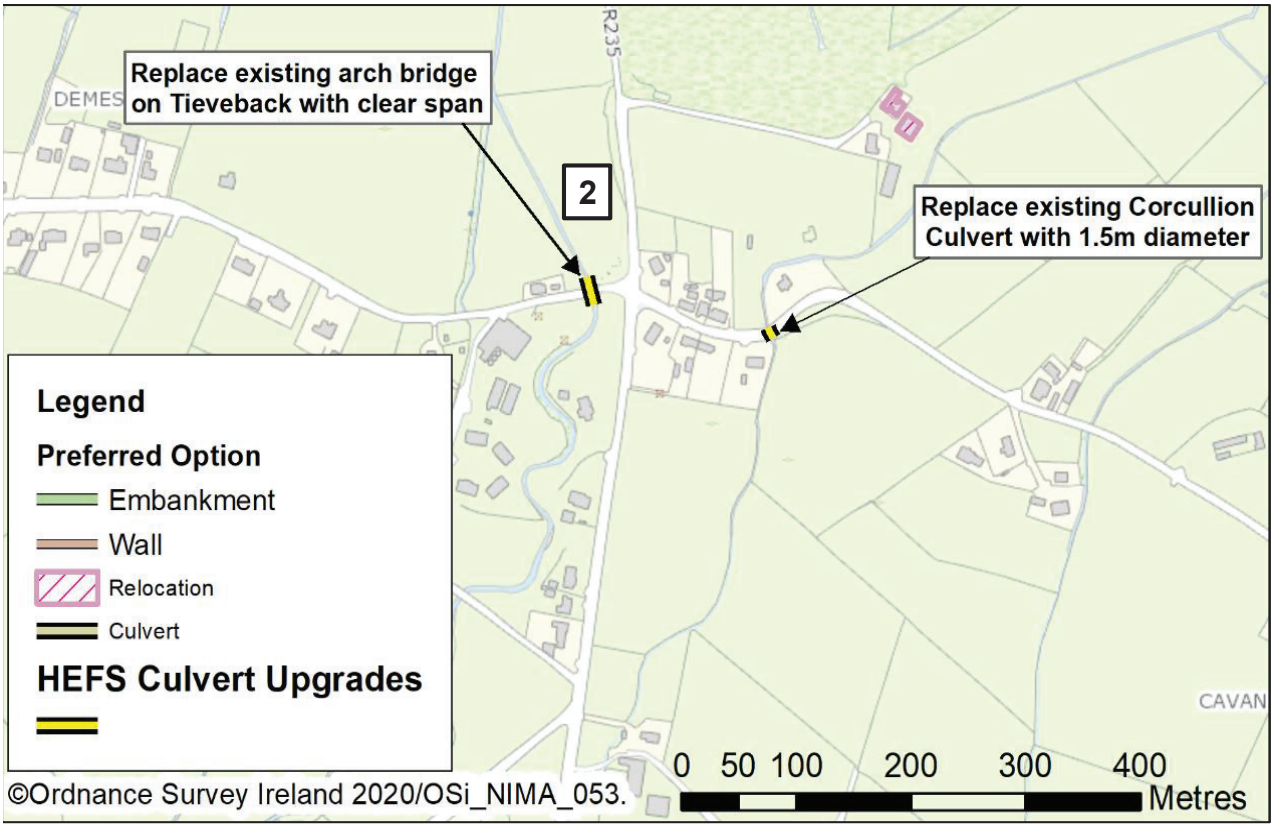
HEFS option considers hard defences and a bridge upgrade as future scheme to be implemented in addition to the preferred scheme

List of elements

1. Flood embankment
2. Bridge replacement

Sketch of Option




Replace existing arch bridge on Tieveback with clear span
2
Replace existing Corcullion Culvert with 1.5m diameter
R235
DEMES
CAVAN
Legend
Preferred Option
Embankment
Wall
Relocation
Culvert
HEFS Culvert Upgrades
0 50 100 200 300 400
Metres
©Ordnance Survey Ireland 2020/OSi_NIMA_053.

Tievebrack Area - HEFS HD + ICC Summary

PV Basic Construction Costs (BCC)				**€259,636**
PV Construction Costs (year 31)				
		Tievebrack - Earth Embankment	€69,491	
		Tievebrack - Bridge Replacement	€190,145	
Preliminary Costs		20% of BCC	€ 53,090	
Ground Investigation		5% of BCC	€ 12,982	
Overall construction cost (OCC)				**€ 325,708**
Design & Envronmental Fees		8.6% of OCC	€ 28,011	
Site Supervision Fees		8% of OCC	€ 26,057	
	Total Fees		€ 54,067	
Archaeology & Environmental Mitigation		10% of OCC	€ 32,571	
Percent for Art		1% of OCC	€ 3,257	
PV Operation and Maintenance Costs (50yrs)			€ 5,456	
	Total		€ 41,284	
Sub-total				**€ 421,059**
Optimism Bias		60%	€ 252,635	
Total Cost				**€ 673,694**

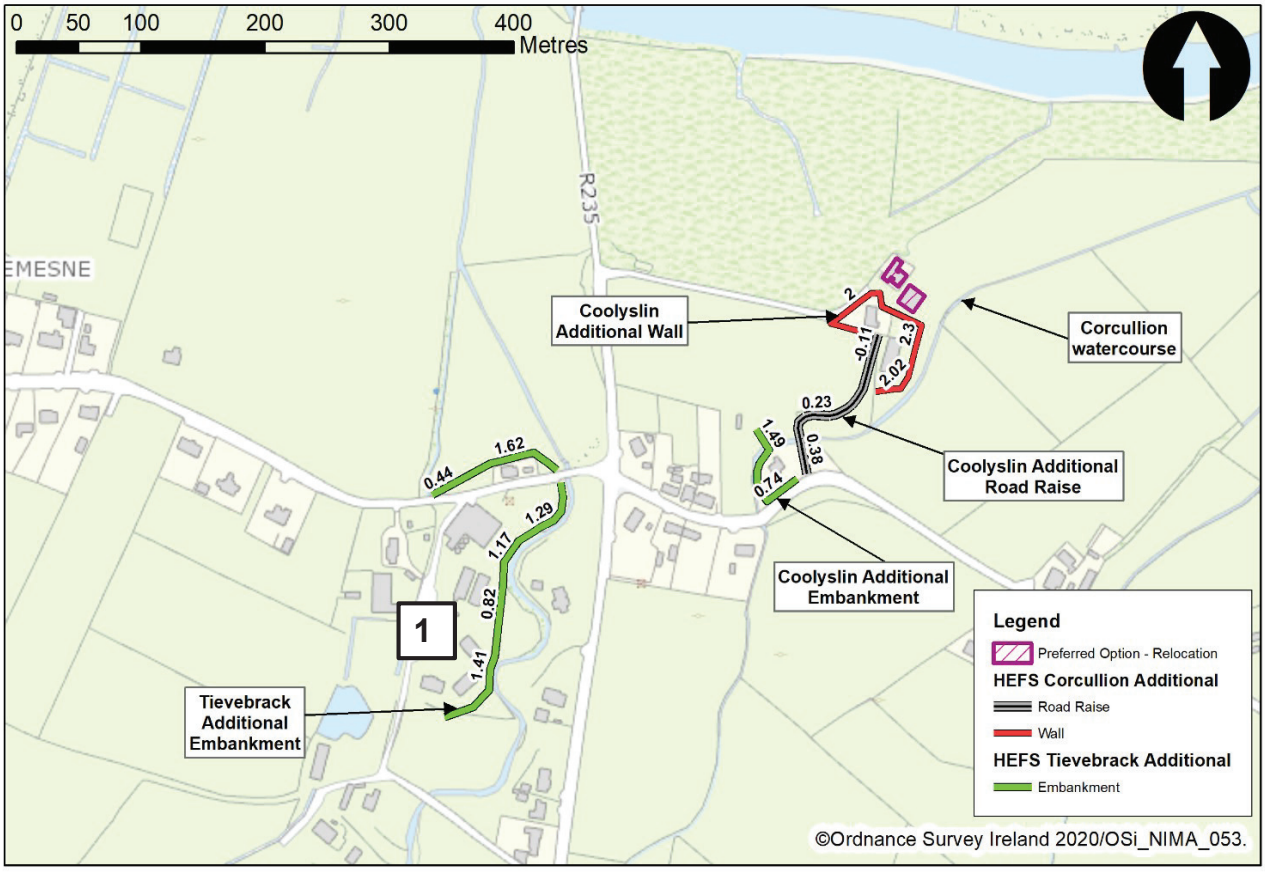
Option Description - Tievebrack - HEFS Hard Defence + Property Relocation

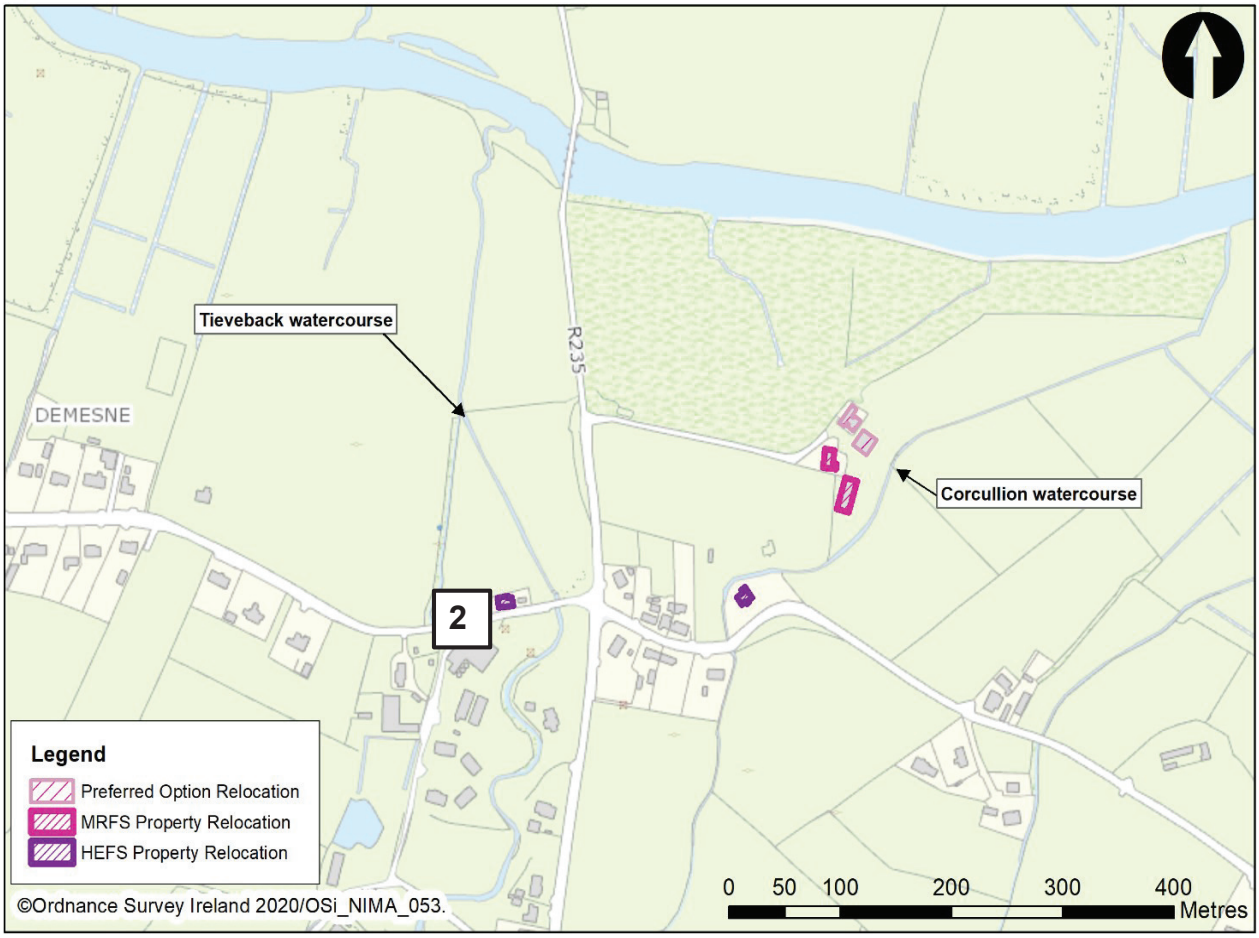
HEFS option considers hard defences and property relocation as future scheme to be implemented.

List of elements

1. Flood embankment
2. Property Relocation

Sketch of Option




Tieveback watercourse
R235
DEMESNE
Corcullion watercourse
2
Legend
Preferred Option Relocation
MRFS Property Relocation
HEFS Property Relocation
©Ordnance Survey Ireland 2020/OSi_NIMA_053.
0 50 100 200 300 400
Metres

Tievebrack Area - HEFS HD + Relocation Summary

PV Basic Construction Costs (BCC)				**€104,012**
PV Construction Costs (year 31)				
		Tievebrack - Earth Embankment	€44,558	
		Property Relocation - 3	€59,455	
Preliminary Costs		20% of BCC	€ 21,268	
Ground Investigation		5% of BCC	€ 5,201	
Overall construction cost (OCC)				**€ 130,481**
Design & Envronmental Fees		8.6% of OCC	€ 11,221	
Site Supervision Fees		8% of OCC	€ 10,438	
	Total Fees		€ 21,660	
Archaeology & Environmental Mitigation		10% of OCC	€ 13,048	
Percent for Art		1% of OCC	€ 1,305	
PV Operation and Maintenance Costs (50yrs)			€ 2,430	
	Total		€ 16,783	
Sub-total				**€ 168,924**
Optimism Bias		60%	€ 101,354	
Total Cost				**€ 270,278**

Appendix C

Amended Preferred Option Costing

Castlefinn FRS - Preferred Option (Post CCAP)

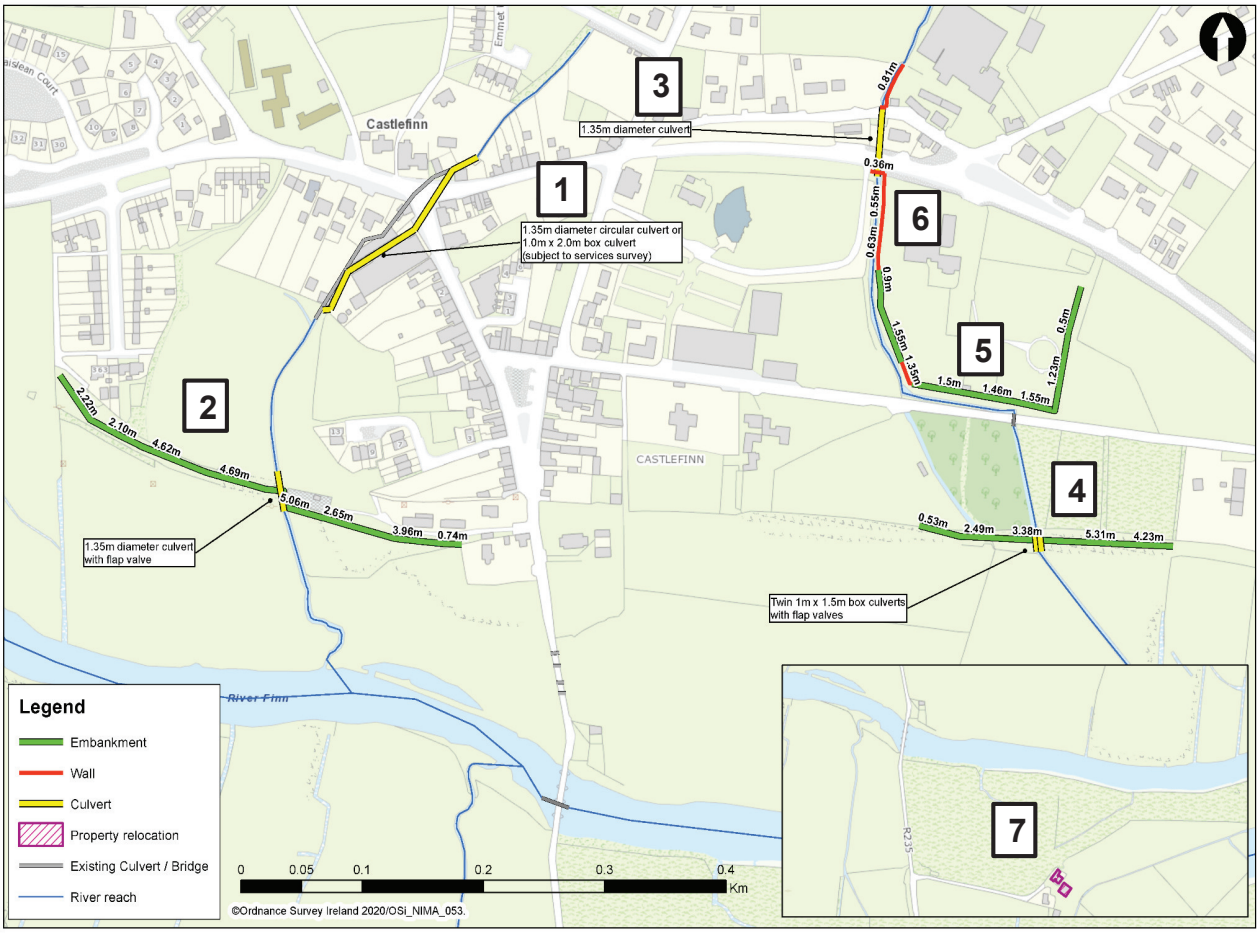
Shortlisted measures

The following measures have been selected through the Optioneering for the Castlefinn FRS. Further changes have been made to this preferred option following the Climate Change Adaptation plan. These measures can be combined to provide flood scheme providing the design SoP.
Measures have been grouped into three areas. The Bridge Burn Stream area, the Castlefinn WC area and the Corcullion Stream area.

List of elements

Bridge Burn	Castlefinn WC	Corcullion
1. Culvert upgrade	3. Culvert upgrade	7. Property Relocation
2. Flood embankment	4. Flood embankment	
	5. CPI bund	
	6. Flood Wall	

Sketch of Option



Element 1 Construction Costs

Bridge Burn Area - Culvert upgrade

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch).
Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Culvert length	193	m
Culvert diameter	1.4	m
Manholes	5	no.

Clashes

Category	Type	Description	Quantity
Utility	Sewer	IW Combined	60.00
Utility	Electricity & telephone OH	EIR fibre optic	60.00
Utility	Watermain	Iw Watermain	60.00
Infrastructure	National road crossing		
Infrastructure	Buildings adjacent		
Environmental	Not known		
Land use	Not known		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Site clearance (fences, street furniture)	0.965	ha	€14,000	Prev. Job	€13,510
2	Cold Milling	193	m	€1.50	Prev. Job	€290
3	Water main diversion	60	m	€1,500	Prev. Job	€90,000
4	Sewer diversion	60	m	€1,000	Prev. Job	€60,000
5	Fibre Optic diversion	60	m	€3,000	Prev. Job	€180,000
6	Electric pole move	1	no.	€10,000	Prev. Job	€10,000
7	Demolish shed	1	no.	€10,000	Prev. Job	€10,000
8	Culvert t (1.35m dia) - inc excavation, supports and backfilling	193	m	€1,020	Prev. Job	€196,860
9	Headwall and outlet	2	no.	€10,000	Prev. Job	€20,000
10	Trash Screen	1	no.	€10,000	Prev. Job	€10,000
11	Manhole - inc excavation, supports and backfilling	5	no.	€2,000	SPONS 2022	€10,000
12	45mm Hot Rolled Asphalt, HTA 35/14F Surface Course	579	m²	€11.28	Prev. Job	€6,531.12
13	Binder Course Cold Milling	579	m²	€2.00	Prev. Job	€1,158
14	55mm Asphalt Concrete, AC20 DBM Binder Course	579	m²	€8.24	Prev. Job	€4,771
15	100mm Asphalt Concrete, AC32 DBM Base	579	m²	€15.18	Prev. Job	€8,789
16	350mm Type 3 Granular Sub Base	579	m²	€22.40	Prev. Job	€12,970

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
17	250mm Capping Layer	579	m²	€21.33	Prev. Job	€12,350
18	250mm Capping Layer	579	item	€21.33	Prev. Job	€12,350
19	Reinstate garden	1	no.	€10,000	Prev. Job	€10,000
20	Construct shed	1	no.	€30,000	Prev. Job	€30,000
				Total construction cost		€699,579

Element 2 Construction Costs

Bridge Burn Area - Earth Embankment

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch).
Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Embankment Volume	14,483	m³
Clay core Volume	6,615	m³
Cutoff Volume	375	m³
Footprint Area	6,840	m²
Surface Area	7,170	m²
Length	375	m²
Max Height	6.19	m
Volume of old embankment	4101	m³

Clashes

Category	Type	Description	Quantity
Utility	Electricity OH cables		
Utility	WwTW		
Environmental	Invasive species		
Infrastructure	Electricity OH cables		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Land compensation	1.858	acre	€15,000	Prev. Job	€27,876
2	Clearance - Vegetation killing	0.752	ha	€230	Prev. Job	€173
3	Clearance - Invasive species	0.752	ha	€5,000	Prev. Job	€3,762
4	Clearance - trees	50	no.	€90	Prev. Job	€4,500
5	Clearance - Site clearance & disposal	0.752	ha	€14,000	Prev. Job	€10,534
6	Excavation - Topsoil strip & stockpile	2257	m³	€8	Prev. Job	€18,058
7	Excavation - Cutting (inc old embankment)	375	m³	€5	Prev. Job	€1,886
8	Disposal - Cutting (inc old embankment)	375	m³	€26	Prev. Job	€9,615
9	Filling - Provision of topsoil	2151	m³	€30	Prev. Job	€64,530
10	Filling - Topsoil (300mm depth)	2151	m³	€9	Prev. Job	€18,284
11	Filling - Provision of clay fill	6615	m³	€35	Prev. Job	€231,525
12	Filling - Placing of clay fill	6615	m³	€15	Prev. Job	€99,225
13	Filling - Provision of outer fill	3767	m³	€25	Prev. Job	€94,175
14	Filling - Placing of outer fill	7868	m³	€10	Prev. Job	€78,680
15	Geotextile mat	7170	m²	€4	Prev. Job	€28,680
16	Finishing - Grassing out	7887	m²	€1	Prev. Job	€8,281
17	Culvert through embankment (1.2m dia) - inc excavation, supports and backfilling	31	m	€510	Prev. Job	€15,810

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
18	Headwall and outlet	2	no.	€10,000	Prev. Job	€20,000
19	Trash Screen	1	no.	€10,000	Prev. Job	€10,000
20	Flap valve	1	no.	€10,000	Prev. Job	€10,000
21	Haul Road	225	m²	€90	Prev. Job	€20,250
22	Drainage	375	m	€35	Prev. Job	€13,125
					Total construction cost	€788,969

Element 3 Construction Costs

Castlefinn Area - Culvert upgrade

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Culvert length	55	m
Culvert diameter	1.3	m
Manholes	1	no.

Clashes

Category	Type	Description	Quantity
Utility	Sewer	IW Combined	30.00
Utility	Electricity & telephone OH	EIR fibre optic	30.00
Utility	Watermain	Iw Watermain	30.00
Infrastructure	National road crossing		
Infrastructure	Minor road crossing		
Environmental	Not known		
Land use	Not known		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Site clearance (fences, street furniture)	0.275	ha	€14,000	Prev. Job	€3,850
2	Cold Milling	25	m	€1.50	Prev. Job	€38
3	Water main diversion	30	m	€1,500	Prev. Job	€45,000
4	Sewer diversion	30	m	€1,000	Prev. Job	€30,000
5	Fibre Optic diversion	30	m	€3,000	Prev. Job	€90,000
6	Sewer pump station disruption	1	no.	€10,000	Prev. Job	€10,000
7	Culvert through embankment (1.35m dia) - inc excavation, supports and backfilling	55	m	€510	Prev. Job	€28,050
8	Headwall and outlet	2	no.	€10,000	Prev. Job	€20,000
9	Trash Screen	1	no.	€10,000	Prev. Job	€10,000
10	Manhole - inc excavation, supports and backfilling	1	no.	€2,000	SPONS 2022	€2,000
11	45mm Hot Rolled Asphalt, HTA 35/14F Surface Course	75	m²	€11.28	Prev. Job	€846
12	Binder Course Cold Milling	75	m²	€2.00	Prev. Job	€150
13	55mm Asphalt Concrete, AC20 DBM Binder Course	75	m²	€8.24	Prev. Job	€618

14	100mm Asphalt Concrete, AC32 DBM Base	75 m²	€15.18 Prev. Job	€1,139
15	350mm Type 3 Granular Sub Base	75 m²	€22.40 Prev. Job	€1,680
16	250mm Capping Layer	75 item	€21.33 Prev. Job	€1,600
17	Reinstate garden	1 no.	€10,000 Prev. Job	€10,000
			Total construction cost	€254,970

Element 5 Construction Costs

Castlefinn Area - CPI bund

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Embankment Volume	2,298	m^3
Clay core Volume	1,538	m^3
Cutoff Volume	296	m^3
Footprint Area	2,433	m^2
Surface Area	2,574	m^2
Length	296	m^2
Max Height	1.60	m

Clashes

Category	Type	Description	Quantity
Utility	Not known		
Environmental	Invasive species		
Infrastructure	None identified		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1.	Land compensation	0.661	acre	€15,000	Prev. Job	€9,914
2.	Clearance - Vegetation killing	0.268	ha	€230	Prev. Job	€62
3.	Clearance - Invasive species	0.268	ha	€5,000	Prev. Job	€1,338
4.	Clearance - Site clearance & disposal	0.268	ha	€14,000	Prev. Job	€3,746
5.	Excavation - Topsoil strip & stockpile	803	m^3	€8	Prev. Job	€6,422
6.	Excavation - Cutting (inc old embankment)	296	m^3	€5	Prev. Job	€1,490
7.	Disposal - Cutting (inc old embankment)	296	m^3	€26	Prev. Job	€7,596
8.	Filling - Provision of topsoil	772	m^3	€30	Prev. Job	€23,170
9.	Filling - Topsoil (300mm depth)	772	m^3	€9	Prev. Job	€6,565
10.	Filling - Provision of clay fill	1538	m^3	€35	Prev. Job	€53,844
11.	Filling - Placing of clay fill	1538	m^3	€15	Prev. Job	€23,076
12.	Filling - Provision of outer fill	759	m^3	€25	Prev. Job	€18,978
13.	Filling - Placing of outer fill	759	m^3	€10	Prev. Job	€7,591
14.	Geotextile mat	2574	m^2	€4	Prev. Job	€10,298
15.	Finishing - Grassing out	2832	m^2	€1	Prev. Job	€2,973
16.	Drainage	296	m	€35	Prev. Job	€10,369
16.	Garden Reinstatement	180	m^2	€140	Prev. Job	€25,200
					Total construction cost	€212,633

Element 4 Construction Costs

Castlefinn Area - Earth Embankment

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Embankment Volume	10,179	m³
Clay core Volume	4,445	m³
Cutoff Volume	210	m³
Footprint Area	4,525	m²
Surface Area	4,747	m²
Length	210	m²
Max Height	5.23	m
Volume of old embankment	9404	m³

Clashes

Category	Type	Description	Quantity
Utility	Not known		
Environmental	Invasive species		
Infrastructure	None identified		
Land use	Defence footprint		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	Land compensation	1.229	acre	€15,000	Prev. Job	€18,442
2	Clearance - Vegetation killing	0.498	ha	€230	Prev. Job	€114
3	Clearance - Invasive species	0.498	ha	€5,000	Prev. Job	€2,489
4	Clearance - trees	50.0	no.	€90	Prev. Job	€4,500
5	Clearance - Site clearance & disposal	0.498	ha	€14,000	Prev. Job	€6,969
6	Excavation - Topsoil strip & stockpile	1493	m³	€8	Prev. Job	€11,946
7	Excavation - Cutting (inc old embankment)	210	m³	€5	Prev. Job	€1,056
8	Disposal - Cutting (inc old embankment)	210	m³	€26	Prev. Job	€5,384
9	Filling - Provision of topsoil	1424	m³	€30	Prev. Job	€42,723
10	Filling - Topsoil (300mm depth)	1424	m³	€9	Prev. Job	€12,105
11	Filling - Provision of clay fill	4445	m³	€35	Prev. Job	€155,575
12	Filling - Placing of clay fill	4445	m³	€15	Prev. Job	€66,675
13	Filling - Provision of outer fill	0	m³	€25	Prev. Job	€0
14	Filling - Placing of outer fill	5734	m³	€10	Prev. Job	€57,340
15	Geotextile mat	4747	m²	€4	Prev. Job	€18,988
16	Finishing - Grassing out	5222	m²	€1	Prev. Job	€5,483
17	Culvert through embankment (1.0 x 1.5m box) - inc excavation, supports and backfilling	62	m	€510	Prev. Job	€31,620
18	Headwall and outlet	4	no.	€10,000	Prev. Job	€40,000

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
19	Trash Screen	1	no.	€10,000	Prev. Job	€10,000
20	Flap valve	1	no.	€10,000	Prev. Job	€10,000
21	Haul Rad	540	m²	€90	Prev. Job	€48,600
22	Drainage	210	m	€35	Prev. Job	€7,350
					Total construction cost	€557,359

Element 6 Construction Costs

Wall Upstream of N17 on Castlefinn Watercourse (inc. wall section at CPI)

Quantities generated from GIS modelling and a standard flood wall cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

1	Working Area	1,865	m²
2	Footprint	276	m²
3	Base Volume	110	m³
4	Stem Volume	85	m³
5	Stem Face	212	m²
6	Exposed Stem Face	133	m²
7	Length	159.00	m²

Clashes

Item	Category	Type	Description	Quantity
1	Utility	Not known		
2	Environmental	Invasive species		
3	Infrastructure	None identified		
4	Land use	Not known		
5	Land access	Not known		
6	Ground contamination	Not known		
7	Soil conditions	Not known		

Cost Breakdown

Item	Description	Quantity	Unit	Rate	Source	Total
1	Clearance - Vegetation killing	0.187	ha	230.00	Prev. Job	42.90
2	Clearance - Site clearance & disposal	0.187	ha	14,000.00	Prev. Job	2,611.38
3	Excavation - Topsoil strip & stockpile	1865	m3	3.00	Prev. Job	5,595.81
4	Excavation - Cutting	276	m3	5.03	Prev. Job	1,388.13
5	Disposal - Cutting	276	m3	25.64	Prev. Job	7,075.87
6	Base Slab - Concrete	110	m3	200.00	Prev. Job	22,078.00
7	Base Slab - Reinforcement	9	t	1,500.00	Prev. Job	13,081.22
8	Base Slab - Trench fill	28	m3	150.00	Prev. Job	4,139.55
9	Base Slab - Formwork	64	m3	100.00	Prev. Job	6,360.00
10	Wall - Concrete	85	m3	200.00	Prev. Job	16,992.00
11	Wall - Reinforcement	7	t	1,500.00	Prev. Job	10,067.76
12	Wall - Formwork	425	m2	100.00	Prev. Job	42,480.00
13	Wall - Finish (Granite)	266	m2	80.00	Prev. Job	21,268.80
14	Drainage	159	m	70.00	Prev. Job	11,130.00
					Total construction cost	**€164,311.41**

Element 7 Construction Costs

Property relocation

Quantities generated from GIS modelling and a standard embankment cross sectional makeup (see sketch). Rates generated from previous jobs, SPONS and the SEPA UCD as indicated below.

Quantities

Number of properties	1	no.
Size of house	350	m3

Clashes

Category	Type	Description	Quantity
Utility	general services		1.0
Infrastructure	None identified		
Environmental	Not known		
Land use	Not known		
Land access	Not known		
Ground contamination	Not known		
Soil conditions	Not known		

Cost Breakdown

	Description	Quantity	Unit	Rate	Source	Total
1	New houses	1.0	no.	€ 141,918.00	Data	€141,918
2	Outbuildings	1.0	no.	€81,894	Data	€81,894
3	Relocation costs and administration	1.0	no.	30%	Data	€67,144
4	Demolition of buildings	800	m3	€17	Prev. Job	€13,840
5	Decommisioning of services	1	no.	€10,000	Prev. Job	€10,000
				Total construction cost		**€314,796**

Operation and Maintenance

The various elements of this option will have associated operation and maintenance (O&M) costs. Costs are dependant on the responsible body (eg local authority, government body, private party), the complexity of the element (eg moving parts, high precision tolerances), and the robustness of the element (eg rate of degradation, risk of collapse).

Bridge Burn Area - Culvert upgrade

Annual O&M cost	€	582
Assumptions	Cost based on a rate of €582/culvert/year. Maintenance includes for inspections, vegetation and trash clearance, minor repair work	

Bridge Burn Area - Earth Embankment

Annual O&M cost	€	1,022
Assumptions	Cost based on a rate of €2,725/km/year. Maintenance includes for vegetation control, inspections, vermin control, back drainage improvements.	

Castlefinn Area - Culvert upgrade

Annual O&M cost	€	472
Assumptions	Cost based on a rate of €472/culvert/year. Maintenance includes for inspections, vegetation and trash clearance, minor repair work	

Castlefinn Area - Earth Embankment

Annual O&M cost	€	572
Assumptions	Cost based on a rate of €2,725/km/year. Maintenance includes for vegetation control, inspections, vermin control, back drainage improvements.	

Castlefinn Area - CPI bund

Annual O&M cost	€	807
Assumptions	Cost based on a rate of €2,725/km/year. Maintenance includes for vegetation control, inspections, vermin control, back drainage improvements.	

Wall Upstream of N17 on Castlefinn Watercourse (inc. wall section at CPI)

Annual O&M cost	€	80
Assumptions	Cost based on a rate of €0.5/m/year. Maintenance includes for vegetation control, inspections.	

Total O&M Annual Costs

O&M costs per year	**€**	**3,535**

Whole Life Cost

Design Life

Bridge Burn Area - Culvert upgrade	50yrs
Bridge Burn Area - Earth Embankment	50yrs
Castlefinn Area - Culvert upgrade	50yrs
Castlefinn Area - Earth Embankment	50yrs
Castlefinn Area - CPI bund	50yrs
Wall Upstream of N17 on Castlefinn Watercourse (inc. wall section at CPI)	50yrs
Property relocation	50yrs

Financial Assumptions

Financial period	50yrs
Discount rate	4%

Year	Discount factor	E&P	Construction	O&M	PV E&P	PV Construction	PV O&M
0	1.000	777,624			777,624	-	-
1	0.962		2,992,615		-	2,877,515	-
2	0.925			3,535	-	-	3,268
3	0.889			3,535	-	-	3,143
4	0.855			3,535	-	-	3,022
5	0.822			3,535	-	-	2,905
6	0.790			3,535	-	-	2,794
7	0.760			3,535	-	-	2,686
8	0.731			3,535	-	-	2,583
9	0.703			3,535	-	-	2,484
10	0.676			3,535	-	-	2,388
11	0.650			3,535	-	-	2,296
12	0.625			3,535	-	-	2,208
13	0.601			3,535	-	-	2,123
14	0.577			3,535	-	-	2,041
15	0.555			3,535	-	-	1,963
16	0.534			3,535	-	-	1,887
17	0.513			3,535	-	-	1,815
18	0.494			3,535	-	-	1,745
19	0.475			3,535	-	-	1,678
20	0.456			3,535	-	-	1,613
21	0.439			3,535	-	-	1,551
22	0.422			3,535	-	-	1,492
23	0.406			3,535	-	-	1,434
24	0.390			3,535	-	-	1,379
25	0.375			3,535	-	-	1,326
26	0.361			3,535	-	-	1,275
27	0.347			3,535	-	-	1,226
28	0.333			3,535	-	-	1,179
29	0.321			3,535	-	-	1,133
30	0.308			3,535	-	-	1,090
31	0.296			3,535	-	-	1,048
32	0.285			3,535	-	-	1,008
33	0.274			3,535	-	-	969
34	0.264			3,535	-	-	932
35	0.253			3,535	-	-	896
36	0.244			3,535	-	-	861
37	0.234			3,535	-	-	828
38	0.225			3,535	-	-	796
39	0.217			3,535	-	-	766
40	0.208			3,535	-	-	736
41	0.200			3,535	-	-	708
42	0.193			3,535	-	-	681

Year	Discount factor	E&P	Construction	O&M	PV E&P	PV Construction	PV O&M
43	0.185			3,535	-	-	655
44	0.178			3,535	-	-	629
45	0.171			3,535	-	-	605
46	0.165			3,535	-	-	582
47	0.158			3,535	-	-	560
48	0.152			3,535	-	-	538
49	0.146			3,535	-	-	517
50	0.141			3,535	-	-	497
					€ 777,624	**€ 2,877,515**	**€ 72,539**

Optimism Bias

The starting (upper bound) Optimism Bias for strategy costs (pre-feasibility stage) is 60%. The Optimism Bias (OB) consists of risk components. Each risk component contributes a pre-defined percentage of overall OB factor. These risk components can be reduced for individual strategies or schemes if demonstrable action to minimise risks has been taken, or other evidence provided that risks are not applicable to the degree indicated. In which case the revised sum of risk components should be divided by 100 and multiplied by 60 to obtain the new OB factor.

Risk Component		Definition	%	Adjustment comment	Adj %
Procurement	Late contractor involvement in design	Late involvement of the contractor in the design leads to redesign or problems during construction	1	No adjustment	1
	Dispute and claims occurred	Disputes and claims occur where no mechanisms exist to manage effectively adversarial relationships between project stakeholders	11	**Contract will provide a suitable mechanism to address disputes and claims**	**5**
	Other	Other factors that relate to procurement which affect the final project cost	1	No adjustment	1
Project-specific	Design complexity	The complexity of design (including requirements, specifications and detailed design) requires significant management, impacting on final project costs	4	**Design is not considered overly complex and is accounted for as an individual item in the option summary**	**2**
	Degree of innovation	The degree of innovation required due to the nature of the project requires unproven methods to be used	4	**No unproven methods being used**	**1**
	Environmental impact	The project has a major impact on its adjacent area leading to objection from neighbours and the general public	13	**Environmental contraints have been considered at optioneering stage. No major constraints identified**	**6**
	Other	Other project-specific factors which affect the final project cost	9	No adjustment	9
Client specific	Inadequacy of Business Case	The project scope changes as a result of the poor quality of requirement specifications and inadequate project scope definition	23	**An extensive project scope is being used with an established business case model. While risk remains it can be reduced.**	**12**
	Funding availability	Project delays or changes in scope occur as a result of the availability of funding (e.g. departmental budget spent or insufficient contingency funds)	2	No adjustment	2
	Project management team	The project management team's capabilities and/or experience impact on final project costs	1	No adjustment	1

	Poor project intelligence	The quality of initial project intelligence (e.g. preliminary site investigation, user requirements surveys etc.) impacts on the occurrence of unforeseen problems and costs	8	No adjustment	8
Environment	Public relations	A high level of effort is required to address public concern about the project, which impacts on the final project cost	5	**Engagement has already occurred to inform public of project. They are broadly supportive.**	**3**
	Site characteristics	The characteristics of the proposed environment for the project are highly sensitive to the project's environmental impacts (e.g. Greenfield site with badger setts, or contaminated brownfield site)	4	No adjustment	4
External influences	Economic	The project costs are sensitive to economic influences such as higher-than-expected construction cost inflation, oil price shocks etc.	5	**It is likely that project costs will be affected by construction cost inflation and oil price increases.**	**20**
	Legislation/regulations	The project costs are sensitive to legislation and regulation changes, e.g. health and safety and building regulations	4	No adjustment	4
	Technology	The project costs are sensitive to technological advancements, e.g. the effects of obsolescence.	4	**It is not expected that the project will be sensitive to technological advancements, constructions methods are well established.**	**2**
	Other	Other external influencing factors which affect the final project cost	1	No adjustment	1
		TOTAL	100	TOTAL	82
Optimism Bias -		**Upper Bound**	**60**	**Adjusted**	**49.2**

Castlefinn FRS - Preferred Option (Post CCAP) Summary

PV Construction Costs (year 1)				**€2,877,515**
Bridge Burn Area - Culvert upgrade	€672,672			
Bridge Burn Area - Earth Embankment	€758,624			
Castlefinn Area - Culvert upgrade	€245,163			
Castlefinn Area - Earth Embankment	€535,922			
Castlefinn Area - CPI bund	€204,454			
Wall Upstream of N17 on Castlefinn Watercourse (inc. wall section at CPI)	€157,992			
Property relocation	€302,688			
Preliminary Costs		15% of BCC	€ 436,010	
Ground Investigation		5% of BCC	€ 143,876	
Overall construction cost (OCC)				**€ 3,457,401**
Design & Envronmental Fees		8.6% of OCC	€ 297,336	
Site Supervision Fees		8% of OCC	€ 276,592	
	Total Fees		€ 573,929	
Archaeology & Environmental Mitigation		10% of OCC	€ 345,740	
Percent for Art		1% of OCC	€ 34,574	
PV Operation and Maintenance Costs (50yrs)			€ 72,539	
	Total		€ 452,853	
Sub-total				**€ 4,484,183**
Optimism Bias		49%	€ 2,206,218	
Total Cost				**€ 6,690,401**