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Economic Case Summary

Purpose. The Economic Case assesses how best to achieve the ORiW vision by comparing feasible strategic options across four appraisal pillars. The assessment is intended to identify the most preferred way forward for further development rather than identify a final engineering solution. It provides a structured basis for comparing options, understanding the trade-offs between them, and identifying the approach that offers the strongest overall balance of environmental and social outcomes, affordability, place-based and distributional effects, and risk, resilience and deliverability.

Optioneering. A structured optioneering process was undertaken to identify a shortlist of feasible strategic options capable of achieving the ORiW vision. The longlist was screened against the programme SMART objectives and Critical Success Factors before being developed into four strategic shortlist options based on alternative discharge locations (Windermere, River Leven, Ulverston and Barrow-in-Furness) and assessed across rising main, tunnel and hybrid conveyance configurations.

Pillar 1: Environmental and Social Value. All shortlisted options generate substantial environmental and social value, with amenity benefits from improved lake condition representing the dominant source of monetised benefits. Differences between options are primarily driven by the timing of benefit realisation, construction impacts and whole-life carbon emissions rather than the scale of the long-term environmental outcome achieved

Pillar 2: Whole-life Cost. Whole-life cost is a key differentiator between options, with conveyance method and discharge location driving most of the variation. The appraisal assumes an aspirational 2030 construction start date to provide a consistent basis for assessment; this is an appraisal assumption rather than a committed or validated programme date. Rising main options are generally the lowest-cost solutions, tunnel options the highest-cost, and hybrid options sit between the two, balancing cost with improved deliverability and reduced disruption.

Pillar 3: Place-based and Distributional Effects. Distributional impacts favour options where the long-term infrastructure burden and benefits fall on the same community and are least favourable where infrastructure burdens are transferred to more vulnerable communities. The assessment identifies Windermere as the strongest-performing location on distributional grounds, Ulverston as a manageable trade-off, and Barrow as the least favourable due to its higher concentration of deprivation and poorer health outcomes.

Pillar 4: Risk, Resilience and Deliverability. Deliverability, future adaptability and long-term resilience are critical considerations in identifying the preferred option. Rising main options are associated with substantial construction disruption and delivery risk, while the Ulverston Tunnel and Hybrid options provide the strongest balance of constructability, water quality confidence and long-term operational adaptability.

Conclusion. The Ulverston Hybrid Option provides the strongest overall balance of environmental outcomes, whole life cost, distributional acceptability and risk, resilience and deliverability, and therefore represents the best overall value for money. With an estimated whole-life cost of £3.9bn and a central BCR of 1.93, it is identified as the most preferred way forward at the current stage of assessment.

Next steps. Further evidence and option refinement are required before a preferred option can be confirmed at Outline Business Case stage. Priorities include additional water quality monitoring and modelling, amenity valuation research, discharge consent pre-application discussions, confirmation of engineering assumptions, and further testing of option sensitivities and design refinements including a robust assessment of the pre-construction development programme. In addition to this independent review options appraisal rationale and wider stakeholder engagement

1 Economic Case

1.1 Purpose and introduction

The Economic Case builds on the longlist appraisal, presented in the 'Only Rainwater into Windermere Longlist to Shortlist Report' (Jacobs Mott MacDonald, 2026b), and focuses on comparing the feasible shortlist of strategic options capable of achieving the objectives¹ of the Only Rainwater into Windermere (ORiW) programme. This short list is derived from an extensive optioneering process which drew from a long list of potential interventions – the process is summarised in section 1.3. The appraisal assesses the relative Value for Money (VfM) of short-listed options; the VfM assessment is comprised of environmental and social impacts, whole-life cost, place-based effects, and delivery confidence to identify the most preferred strategic way forward for further development.

At this stage of programme development, the purpose of the appraisal is to distinguish between alternative strategic approaches to identify a most preferred way forward rather than identify a final engineering solution. The assessment is therefore proportionate² to the maturity of the programme, recognising that further engineering design, environmental assessment (including water quality and flow monitoring and modelling), route optimisation, commercial development, stakeholder engagement and consultation will be undertaken before a preferred option is confirmed.

1.2 Appraisal framework

Following the longlist appraisal and shortlisting process (Jacobs Mott MacDonald, 2026a), the shortlist options are compared against a common baseline, representing committed Asset Management 8 (AMP8)³ investment with no further intervention. The appraisal is based on the principal strategic choices that differentiate the shortlisted options, and the appraisal logic is presented in Figure 1.1.

Value for Money (VfM) assessment of large infrastructure proposals at an early stage typically requires strategic choices that cannot be resolved through sole focus on monetised costs and benefits represented by a Benefit Cost Ratio (BCR). HM Treasury's definition of value for money extends beyond monetised costs and benefits to include performance against objectives and critical success factors, distributional impacts, and the risks and uncertainties that influence the likelihood of successful delivery (HM Treasury, 2026). The appraisal is therefore structured around four complementary pillars to ensure these factors are considered transparently alongside other VfM metrics when comparing options.⁴

¹ SMART objectives for the programme are set out in the Strategic Case, section 2.5.

² HM Treasury's Green Book (HM Treasury, 2026) requires appraisal to be proportionate to the maturity of decision-making. At this stage, the purpose of the appraisal is to distinguish between a feasible shortlist of strategic approaches rather than optimise a final engineering solution. At this stage of assessment, the only approval that would be sought would be for funding to support progression to more detailed assessment for the next funding approval stage such as Outline Business Case. Further engineering design, environmental assessment, commercial development and stakeholder engagement will reduce uncertainty and inform the subsequent confirmation of a preferred solution. See *The Green Book: Central Government Guidance on Appraisal and Evaluation* (HM Treasury, 2026), and HM Treasury, *Guide to Developing the Project Business Case (Five Case Model)* (HM Treasury, 2026).

³ AMP8 is the eighth five-year regulatory period for the privatised water sector in England and Wales, as established by Ofwat. It covers the period from 2025 to 2030.

⁴ HM Treasury's Green Book (HM Treasury, 2026) Section 2.30 states "The first step is to rank options by their summary metrics of social value. However, this initial ranking by itself is not sufficient to decide. The UK government does not choose projects solely based on which have the highest benefit-cost ratios." It goes on to say, "practitioners must consider several factors to make a balanced judgement about value for money. This includes not just monetisable costs and benefits, but also unmonetisable costs and benefits, risks and uncertainties, public sector cost, and distributional effects."

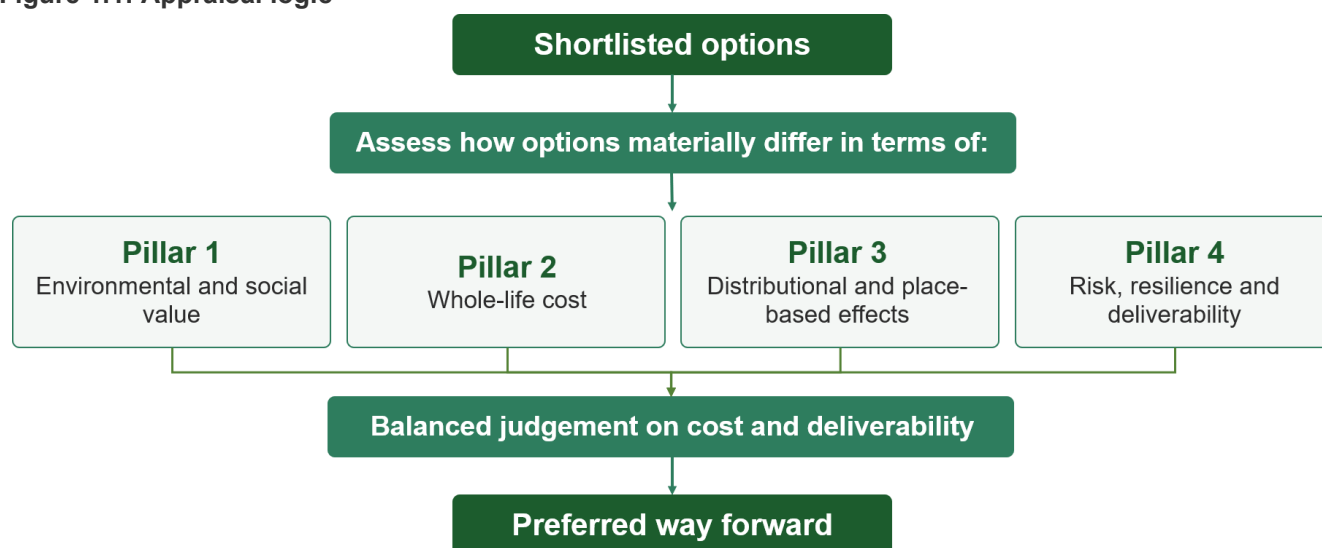
Value for Money in the Green Book

Value for money is the balanced judgement about the optimal use of public resources to achieve the objectives of a proposal. This judgement is based on consideration of the following factors:

- The performance of a proposal against its objectives and critical success factors. Options that do not deliver a proposal's objectives cannot represent value for money.
- The costs and benefits to society that are 'monetisable', and which can be expressed in monetary terms.
- The costs and benefits to society that are 'unmonetisable', and which cannot be expressed in monetary terms.
- The public sector financial impact of the proposal.
- How costs and benefits are distributed among different social groups and different places, where relevant.
- The risk and uncertainty inherent in the proposal: the chances of different degrees of success or failure in achieving the government's objectives, and the possibility that costs, benefits and distributional impacts will differ from those anticipated.

Source: HM Treasury Green Book.

Figure 1.1: Appraisal logic⁵



The four pillars organise the appraisal so that the factors which differentiate the options, over and above headline costs and benefits, are made explicit and considered consistently. Each pillar draws on established Green Book principles and supplementary guidance (HM Treasury, 2026):

- **Pillar 1 (Environmental and social value)** reflects the Green Book's treatment of social value and the valuation of environmental and non-market effects, including natural capital – where benefits and disbenefits are valued using Defra, Environment Agency, and Green Book supplementary guidance.
- **Pillar 2 (Whole-life cost)** reflects the core cost assessment - assessed on a whole-life basis.
- **Pillar 3 (Distributional and place-based effects)** reflects the Green Book's guidance on place-based analysis and distributional appraisal, which considers how infrastructure and benefits fall across different places and communities.

⁵ Note that Pillars 3 and 4 bring place based and deliverability considerations into the core of option selection. Pillar 3 aligns with Annex 3 of the Green Book, while Pillar 4 introduces a management case perspective.

- **Pillar 4 (Risk, resilience, and deliverability)**⁶ reflects the Green Book's treatment of uncertainty, risk and optimism bias (HM Treasury, 2013), alongside the deliverability and delivery-confidence considerations typically addressed within the Management Case of the Five Case Model. These factors are considered alongside the economic analysis because they influence the overall decision but are not fully captured elsewhere. This pillar assesses alignment with the Critical Success Factors defined in the Strategic Case and considers strategic, delivery and implementation risks that may materially affect the success of each option.

The purpose of presenting these as distinct pillars is to support a balanced judgement rather than reliance on a single summary metric. A higher benefit-cost ratio does not automatically make an option preferable if it carries materially greater delivery risk, or if the construction or infrastructure burden falls on a more vulnerable community or depends on a less resilient long-term solution. Equally, a more expensive option may represent better value once deliverability confidence and long-term performance are considered. Setting the pillars out explicitly allows these trade-offs to be seen and reasoned through, consistent with the proportionate, judgement-based appraisal the Green Book describes.

1.2.1 Basis for appraisal

The appraisal provides a consistent basis for comparing options and identifying the most preferred way forward. The appraisal:

- **Uses a common appraisal basis:** all options are assessed in 2025 prices, with discounting, optimism bias, risk, and a 100-year appraisal period applied consistently.
- **Assesses social value:** it considers impacts on overall social welfare, including environmental and social effects.
- **Takes account of deliverability and risk:** it considers deliverability, risk and longer-term system performance alongside monetised results.
- **Combines monetised and non-monetised evidence:** impacts are monetised where this can be done robustly and proportionately, with other material effects assessed qualitatively or semi-quantitatively rather than relying on economic metrics such as the Benefit Cost Ratio alone.

Costs assessed within the appraisal include capital, operating, maintenance, renewal and decommissioning costs, estimated on a whole-life basis using consistent assumptions across options. The basis for the cost and benefit assessment is set out in Table 1.1 below. All costs and benefits have been expressed in a consistent price base and in real terms. Construction cost estimates have been converted to the common price base using appropriate construction cost indices. For the purposes of the appraisal, a simplifying assumption has been made that costs remain constant in real terms thereafter, with no separate forecast of construction-specific relative price movements applied. Uncertainty in the level of future costs is considered through sensitivity analysis, which tests the impact of variation in costs on the appraisal results. For the next more detailed assessment stage of the project, we recommend that potential differential rates of inflation between project cost elements and the general rate of inflation be considered.

Table 1.1: Basis for appraisal

Core assumptions used in the appraisal	
Appraisal period	All monetised costs and benefits are in Present Value (PV) terms over 100 years.
Price base year	Costs and Benefits are presented in a 2025 price base. Whole Life Cost estimates have been converted to 2025 prices using construction cost inflation indices, while benefit and disbenefit values have been converted using the Office for National Statistics (ONS) Gross Domestic Product (GDP) Deflator (ONS, 2026).
Inflation	For the purposes of the appraisal, a simplifying assumption has been made that costs remain constant in real terms thereafter, with no separate forecast of construction-specific relative price movements applied. Uncertainty in the level of future costs is considered through sensitivity analysis, which tests the impact of variation in costs on the appraisal results.

⁶ At the current stage, deliverability is a critical factor in realising the benefits of the project. For this reason, it has been explicitly incorporated within the economic case to show the trade-off between cost and deliverability.

	The Green Book advises not to model inflation in an economic appraisal. This is to keep the analysis simple and compare like for like, channelling the focus on choosing an option. Therefore, costs for accounting purposes (which include inflation) can be found in the Financial Case.
Discount rate	The discount rate adapts costs and benefits into present values (2025 price base) in economic appraisal calculations to reflect society's preference to receive benefits sooner and pay costs later. The following Social Time Preference Rates are adopted: 3.5% to year 30, 3.0% from year 30 to 75, 2.5% thereafter (HM Treasury, 2026).
Optimism bias	Applied to capital costs (66% for construction, and 44% for replacement and maintenance), consistent with HM Treasury guidance for infrastructure programmes at Strategic Outline Case stage (HM Treasury, 2026). Not applied to operational costs as parameters driving variation are better understood and are expected to be captured within a risk uplift.
Risk	Site-specific risk and uncertainty allowances of 20% to 35% are applied to capital expenditure. A flat 30% contingency has been applied to operational costs to account for uncertainty and risk at this stage of design development ⁷ .
Baseline	Single common baseline of committed AMP8 investment (2025–2030) with no further capital intervention.
Construction start date	This Economic Case uses an assumed aspirational construction start date of 2030 to provide a consistent basis for appraisal; this is an aspirational assessment assumption rather than a committed or validated programme date. A robust assessment of the pre-construction development programme will be undertaken during the next phase of the project.

1.2.2 Baseline and intervention scenarios

The appraisal is anchored on two modelled environmental reference scenarios, common across options, which provide a consistent basis for assessment. The first is the committed AMP8 baseline, representing the environmental condition expected following delivery of committed wastewater investment. This forms the common baseline from which the benefits of all shortlisted options are measured. The second is the ORiW reference scenario ("No Sewage"), representing the environmental outcome achieved through the removal of treated wastewater discharges, intermittent wastewater discharges via storm overflows and urban runoff from the Windermere catchment. The shortlisted options represent different strategic approaches to achieving this outcome but have all been developed to achieve outcomes consistent with this reference scenario.

The committed AMP8 scenario is adopted as the common appraisal baseline. It reflects committed investment only; future regulatory changes, additional investment programmes or other uncommitted interventions are not assumed, because their scope, timing and funding remain uncertain. Holding the baseline constant ensures that the appraisal measures the additional impacts of ORiW only and does not attribute the benefits of committed AMP8 investment to the programme. The principal monetised benefit, amenity from improved lake condition (Section 2.4.1), is therefore measured as the incremental improvement from the committed AMP8 baseline to the ORiW reference scenario.

The environmental condition associated with each reference scenario is characterised using two complementary applications of the same underlying modelling framework. The Environment Agency's Nutrient Futures for Windermere (Environment Agency, 2026) models lake condition over the period 2076–2079 using the Met Office UK Climate Projections 2018 (UKCP18) high-emissions scenario (RCP8.5). The UK Centre for Ecology & Hydrology's Additional PROTECH Simulations for Windermere (UKCEH, 2026) applies the coupled SIMCAT-SAGIS catchment model and PROTECH lake model to present-day nutrient loads. Together, these provide a consistent assessment of lake condition under the committed AMP8 baseline across both present-day and long-term conditions, and of the additional improvements associated with the removal of in-scope wastewater, intermittent discharges and urban runoff.

The environmental condition of the reference scenarios is described using two complementary indicators:

- **WHO10 exceedance days** – the annual number of days on which cyanobacteria concentrations exceed the World Health Organization recreational guidance threshold of 10 µg/L chlorophyll-a; fewer exceedance days indicate lower bloom risk and improved recreational water quality.

⁷ These assumptions are derived from cost estimator data and further details are captured in the Pillar 2 assessment.

- **Ecological Quality Ratio (EQR)⁸** – the standard metric used by the Environment Agency to classify the ecological status of lakes under the Water Framework Directive (WFD). EQR expresses observed ecological condition relative to near-natural reference conditions on a scale from 0 to 1, and determines whether a water body achieves High, Good, Moderate, Poor or Bad status. For lakes, phytoplankton status is assessed using the UKTAG Phytoplankton Lake Assessment Tool (PLUTO)⁹, which is based on chlorophyll, phytoplankton composition and cyanobacteria bloom intensity, and on the normalised PLUTO scale the Good status boundary corresponds to an EQR of 0.6. Within this appraisal, EQR complements WHO10 exceedance by indicating whether reductions in bloom risk are accompanied by improvements in overall ecological condition.

Under the baseline modelled scenario, WHO10 exceedances are forecast to increase to an average of 24 annual days of exceedance by 2079 in the North Basin and 3 days in the South Basin (Environment Agency, 2026).

Table 1.2: Water quality modelling scenarios

Scenario (2076–2079 projections)	WHO10 days/yr North Basin	WHO10 days/yr South Basin	EQR North Basin	EQR South Basin	WFD status
Committed AMP8 baseline	24	3	0.61	0.68	Good
ORiW reference scenario (No Sewage)	0	0	0.73	0.80	Good (North) / High (South)

Note: Mean lake temperature rises by approximately 2°C to 2.5°C across both scenarios under the high-emissions projection. Source: Environment Agency Chief Scientist's Group, Nutrient Futures for Windermere (Environment Agency, 2026); projections for 2076–2079 under UKCP18 RCP8.5.

Near-term performance. The end state sought for Windermere is one in which there can be sustained confidence in the lake's future condition. Cyanobacteria bloom risk provides a clear and measurable indicator of whether that end state is likely to be achieved. The modelling above indicates that cyanobacteria bloom risk will remain following committed AMP8 investment. While the modelling shows an improvement relative to the present-day baseline, it does not decisively reduce the bloom-risk conditions of the lake.

This is clearest in the South Basin, where the central and sensitivity scenarios demonstrate a wide variation in predicted bloom-risk conditions under AMP8. Under the central scenario, WHO10 exceedances occur on eight days in one of the four modelled years and not in the other three. However, this outcome has limited environmental headroom: annual peak cyanobacteria concentrations in two of the non-exceeding years reach 9.3 and 9.8 µg/L, only marginally below the 10 µg/L threshold. UKCEH notes that, in terms of risk, a simulation just below the threshold is “virtually the same” as one just above it (UKCEH, 2026). Cyanobacteria also account for between 68% and 91% of total chlorophyll-a at the annual maximum.

The sensitivity testing demonstrates how the predicted AMP8 outcome changes when the phosphorus-input assumptions are varied. Under the +20% phosphorus sensitivity, WHO10 exceedances occur across three of the four modelled years, totalling 46 days, compared with eight days in one year under the central scenario. Under the +60% sensitivity, exceedances again occur in three of the four years and total 87 days. The maximum annual number of exceedance days increases from eight under the central scenario to 31 under the +20% sensitivity and 34 under the +60% sensitivity.

The UKCEH scenarios show that the predicted improvement under AMP8 is sensitive to the phosphorus inputs assumed, particularly where annual peak cyanobacteria concentrations under the central scenario remain close to the WHO10 threshold. This is particularly important in the context of recognised uncertainty in the underlying source-apportionment modelling, which does not fully represent short-term events such as storms. UKCEH specifically notes that the +20% and +60% phosphorus sensitivities go some way towards quantifying this

⁸ Environment Agency / UK Technical Advisory Group on the Water Framework Directive. Ecological status is expressed as an Ecological Quality Ratio, on a scale where “high status is represented by values relatively close to one ... and bad status by values relatively close to zero.” UKTAG, *Recommendations on Surface Water Classification Schemes* (2009).

⁹ UKTAG, Lake Assessment Method: Phytoplankton — Phytoplankton Lake Assessment Tool with Uncertainty Module (PLUTO). Metric EQRs for chlorophyll, phytoplankton composition and cyanobacteria bloom intensity are normalised to a common scale and averaged; the normalised Good status boundary is 0.6.

uncertainty. The sensitivity testing therefore provides important evidence on the robustness of the central AMP8 outcome regarding the uncertainty in the phosphorus inputs on which it depends.

UKCEH also undertook a separate sensitivity test for Windermere Wastewater Treatment Works under the Windermere Option. The 60% adjustment was informed by analysis of 2025 final-effluent sampling data, providing an empirical basis for the sensitivity tested. This observed variability was also considered in discussions when determining the wider +20% and +60% AMP8 sensitivity scenarios, providing a real-world basis for testing uncertainty in the phosphorus concentrations assumed under the central AMP8 scenario.

Increasing the phosphorus concentration from Windermere WwTW by 60%, while leaving all other AMP8 assumptions unchanged, increased WHO10 exceedances from eight days in one of the four modelled years to 60 days across three of the four years, with the maximum annual number increasing from eight to 32. This demonstrates both the sensitivity of the South Basin outcome to the phosphorus input assumed for Windermere WwTW and the wider importance of testing the resilience of the central AMP8 phosphorus assumptions.

The North Basin demonstrates the same underlying pattern. Under the central AMP8 scenario, exceedances occur in one of the four modelled years, with annual peak cyanobacteria concentrations ranging from 8.9 to 12.4 µg/L. Across the four modelled years, WHO10 exceedances total 10 days under the central scenario, increasing to 14 days under the +20% phosphorus sensitivity and 25 days under the +60% sensitivity. The maximum annual number of exceedance days increases from 10 under the central scenario to 11 under the +20% sensitivity and 18 under the +60% sensitivity, while exceedances occur in one, two and three of the four modelled years respectively. The recurrence of this pattern across both basins demonstrates that sensitivity to the phosphorus inputs assumed under AMP8 is a whole-lake issue, rather than one confined to the South Basin.

Overall, the modelling demonstrates across both basins that AMP8 is expected to deliver an improvement relative to the existing baseline. However, the scale and resilience of that improvement remain materially sensitive to uncertainty in the phosphorus inputs assumed. Across the eight basin-years modelled, summing exceedance days across the North and South Basins, AMP8 produces 18 WHO10 basin-exceedance days under the central scenario, increasing to 60 under the +20% phosphorus sensitivity and 112 under the +60% sensitivity. AMP8 therefore does not provide the sustained confidence in the lake's future condition sought as the end state, with bloom risk persisting across the modelled scenarios. UKCEH reaches the same conclusion, stating that “the AMP8 improvements will not remove the risk of cyanobacteria blooms” (UKCEH, 2026).

By comparison, the four ORiW scenarios produce zero WHO10 exceedance days in either basin in any modelled year. Peak concentrations remain below 4 µg/L in the North Basin and below the 2 µg/L reporting level in the South Basin. However, unlike the No Sewage scenarios (the Leven, Ulverston and Barrow-in-Furness Options), where the relevant wastewater nutrient inputs to the lake are removed, the Windermere Option remains dependent on the effluent quality achieved through enhanced treatment. The No Sewage outcome is therefore absolute in this respect, whereas the modelled outcome for enhanced treatment remains dependent on an assumed level of treatment performance that has not yet been sensitivity tested. Given the demonstrated sensitivity of the South Basin to phosphorus inputs from Windermere WwTW under the AMP8 treatment scenarios, future water quality modelling should include appropriate sensitivity testing of the enhanced-treatment effluent quality under the Windermere Option.

There are several implications for the water quality modelling results, which are important to consider:

- The evidence establishes a persistent gap. Committed AMP8 investment materially improves lake condition but does not restore it: under present-day conditions and under future climate, the lake remains at the threshold of bloom risk. The amenity benefit therefore reflects the improvement from the committed AMP8 baseline, which the modelling indicates continues to exhibit residual bloom risk, rather than from current conditions.
- The gap exists now and persists under climate change. The environmental rationale for intervention is not contingent on a particular future climate projection. The present-day modelling demonstrates a measurable shortfall under the committed AMP8 baseline, and the long-term modelling, using the same framework, indicates that this shortfall persists under future climate conditions. The climate change scenario chosen uses the median projection from a set of 12 climate model simulations (UKCEH, 2026) (Environment Agency, 2026) under the high-emissions scenario (RCP8.5), providing a central estimate of future climate conditions. This means that forecast cyanobacteria concentrations could be lower under a less impactful climate scenario. Modelling to test the sensitivity of this is not currently available, however, present day modelling, as explained, demonstrates that cyanobacteria concentrations sit just below the exceedance threshold. Consequently, the baseline is unstable compared to a removal of treated effluent and septic tank input, which establishes a

secure state for the lake according to UKCEH evidence, and advice. Nevertheless, it is recommended that further testing of performance under different climate scenarios be undertaken to test this conclusion and its impact on the Vfm.

- Removal of in-scope inputs is therefore the only modelled approach that consistently closes the gap. Treatment to the committed AMP8 standard leaves the lake at the threshold of bloom risk; only removal of in-scope inputs moves it decisively clear. These findings provide the environmental evidence supporting the programme objective of Only Rainwater into Windermere.
- Additional sensitivity testing confirms the persistence of residual risk under the AMP8 baseline. Additional PROTECH modelling undertaken in 2026 found that AMP8 materially improves lake condition relative to current observations, but cyanobacteria concentrations remain close to bloom-risk thresholds. Sensitivity tests applying higher phosphorus loads resulted in threshold exceedances returning in both basins, indicating that the AMP8 baseline remains vulnerable to uncertainty in nutrient loading assumptions. The modelling therefore reinforces the distinction between improvement and restoration, with the ORiW reference scenario delivering a materially greater reduction in bloom risk.

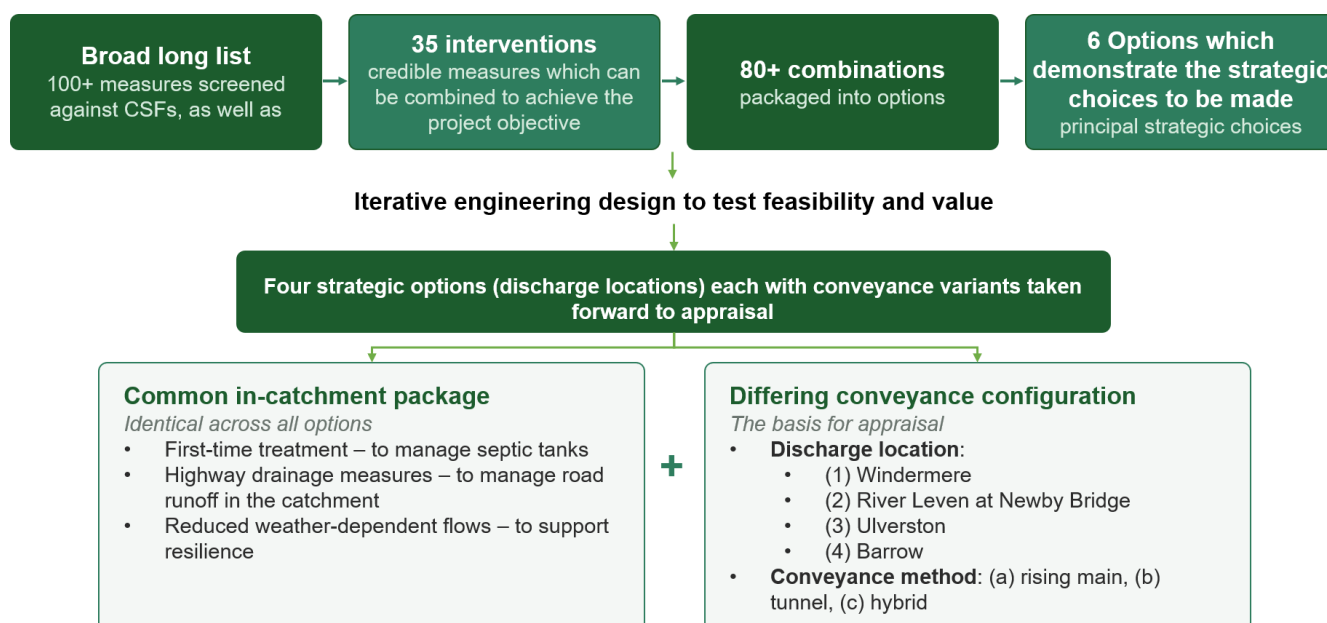
The shortlisted options have accordingly been developed to achieve this reference standard — eliminating cyanobacteria WHO10 exceedance in both lake basins and placing the lake on a trajectory towards Good or High ecological status under future climate conditions. How the programme objective is applied to distinguish between those options is set out in Section 1.3.

1.3 Options appraised

1.3.1 Arriving at a shortlist of options

A structured optioneering process was undertaken to identify an appraisal-ready set of distinct options. The longlist was deliberately broad, as reported in the ORiW Option Feasibility Report (Jacobs Mott MacDonald, 2026a), spanning the full range of potential measures from policy and regulatory levers to engineering interventions, including measures subsequently screened out as outside the scope or control of this programme. This was refined through screening against the SMART Objectives and Critical Success Factors (presented in the Strategic Case, section 2.5), then packaged and consolidated into strategic options, before being developed into appraisal-ready options through iterative engineering design. This produced four strategic options, representing four discharge locations, with option variants reflecting different conveyance and discharge configurations. A summarised graphic illustrating how options were developed is presented in Figure 1.2.

Figure 1.2: Option shortlisting process



1.3.2 Options short list and the Windermere case

A common package of measures is included within all shortlisted options. These measures address in-catchment, in-scope point source discharges and runoff pathways that contribute to water quality pressures within the Windermere catchment. They represent interventions that are required to meet programme objectives irrespective of the conveyance solution ultimately and are therefore treated as common costs and benefits across all options.

The common package includes first-time sewerage, first-time treatment, highway drainage improvements and measures to reduce weather-dependent flows. Together, these interventions reduce pollutant inputs from unsewered properties, septic tank discharges, highway runoff and infiltration-related sewer flows. They provide a consistent baseline level of environmental improvement across all options and ensure that all feasible options contribute towards the programme objective of reducing nutrient, wastewater and diffuse pollution pressures within the catchment. In developing this package of solutions care has been taken to prioritise green solutions where possible.

These measures are included in every option because they address sources of pollution that cannot be resolved solely through changes to conveyance, treatment capacity or transfer arrangements. As a result, the comparative appraisal focuses on the additional costs, benefits and risks associated with the variable elements of each option, while assuming delivery of the common package in all cases.

What distinguishes the strategic options is the treated water 'discharge location' and the treatment method, determined by the standard required to discharge at a location, and method for conveyance of treated and intercepted wastewater (Engineering Variant).

The appraisal includes a Windermere strategic option, representing the retention of final effluent to Lake Windermere following treatment to an enhanced standard. The Windermere option has been assessed alongside the shortlisted options using the same appraisal framework and evidence base, providing an important benchmark for understanding the relative costs, benefits, risks and wider trade-offs associated with retaining, rather than removing, treated wastewater discharge to the lake.

Table 1.3: Summary of shortlisted strategic options and engineering variants for appraisal

Strategic Options	Treatment location	Discharge location	What this achieves	Engineering Variants assessed
Windermere Option	Windermere WwTW	Lake Windermere catchment	Enhanced in-catchment treatment (which performs like other options) and treated discharge into Windermere	Rising main Tunnel
Leven Option	Windermere WwTW	River Leven downstream of the weir at Newby Bridge	In-catchment treatment with downstream treated discharge into the River Leven	Rising main Tunnel
Ulverston Option	Ulverston WwTW	Morecambe Bay	Export of wastewater flows to a regional treatment works including closing Windermere WwTW	Rising main Tunnel Hybrid
Barrow-in-Furness Option	New treatment facility near Barrow	Morecambe Bay	Export of wastewater flows to a regional treatment hub including closing Windermere WwTW	Rising main Tunnel Hybrid

Note: 'Hybrid' conveyance options entail the use of tunnelling within the Windermere catchment; which avoid substantial road closure, combined with rising main construction outside of the catchment. For example, 'Ulverston Hybrid' conveys waste and stormwater in the catchment, joining with a rising main outside of the catchment which carries it the rest of the way to Ulverston WwTW. All options include the repurposing and/or decommissioning of assets upstream of Windermere WwTW. All options include first time sewerage, first time treatment, highway drainage and work to reduced weather dependent flows.

1.3.3 Reading the rest of the Economic Case

With the shortlisted options and Windermere option established above, the remainder of this Economic Case is structured as follows.

- Sections 2 to 5 build the evidence base pillar by pillar:
 - Pillar 1** (Section 2) sets out the environmental and social value of the options;

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- **Pillar 2** (Section 3) the whole-life cost case;
 - **Pillar 3** (Section 4) the place-based and distributional effects; and
 - **Pillar 4** (Section 5) the risk, resilience and deliverability position, including the climate and consenting considerations introduced.
- Each pillar is self-contained and can be read on its own terms. Section 0 then draws the evidence from all four pillars together, presenting the summary results by option, the sensitivity analysis, and the reasoning behind identification of the most preferred way forward.

2 Pillar 1: Environmental and social value

2.1 Purpose and scope

This section sets out the environmental and social value created by the shortlisted options. It applies the Enabling a Natural Capital Approach (ENCA) (Defra, 2026) framework and the Environment Agency's Water Appraisal Guidance (Environment Agency, 2013) to identify material environmental and social impacts, monetise them where the evidence is sufficiently robust, and assess them qualitatively where monetisation is not proportionate or reliable.

The assessment covers:

- **Monetised benefits**, including amenity from improved lake condition, recreation and safety at other waterbodies, flood risk reduction and infrastructure rationalisation, as set out in Section 2.4;
- **Monetised disbenefits**, including transport disruption during construction, other construction-related disbenefits and whole life carbon emissions, as set out in Section 2.4; and
- **Qualitative effects**, including cultural services and other supporting services as set out in Section 2.5.

The purpose of the section is to show the scale of environmental and social value created by options which achieve the objectives of this programme, and to identify where that value is common across the shortlist or varies by option. It does not identify impacts from local economic activity (e.g. through tourism spend or GVA), other place impacts, delivery risk, or costs. These are assessed pillar by pillar and then aggregated into a combined summary in Section 6.

2.2 Approach and scope of this assessment

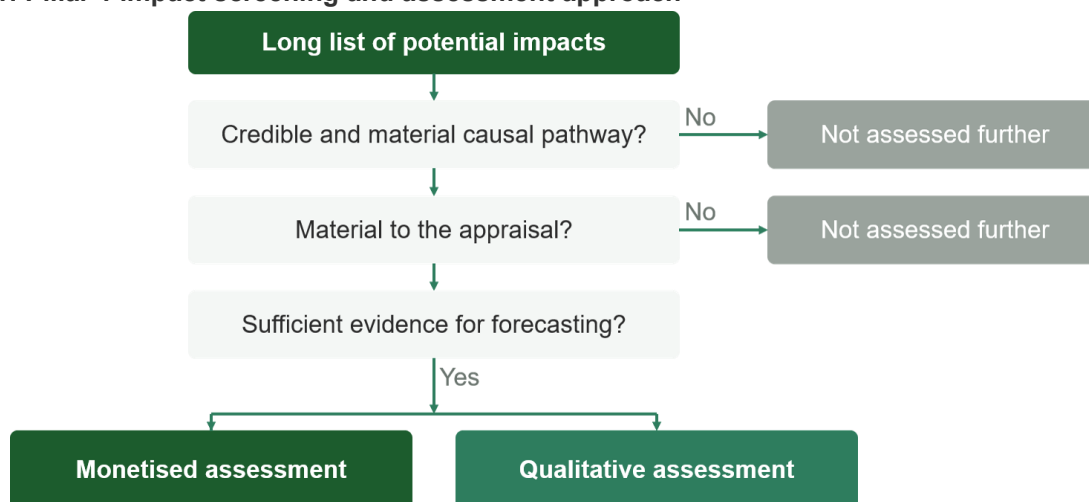
The assessment applied the scope set out in Section 2.1 through a staged screening process. The starting point was a long list of potential Pillar 1 (Environmental and Social) impacts, identified using ENCA (Defra, 2026) and the Environment Agency's Water Appraisal Guidance Appraisal Summary Table (Environment Agency, 2013).

The long list of potential impacts was screened against two tests:

- whether there is a credible and material causal pathway between the option and the impact; and
- whether the impact is likely to be material to the appraisal.

Impacts that passed both tests were taken forward for monetised or qualitative assessment, depending on the strength of the available evidence and the nature of the impact. Figure 2.1 summarises this screening and assessment process.

Figure 2.1: Pillar 1 impact screening and assessment approach



Pillar 1 impacts are monetised where the available evidence and stage of programme development support robust valuation. Where monetisation would imply a level of precision that the evidence cannot support, or where the

impact is cultural, institutional or strategic in nature, the impact is assessed qualitatively. Section 2.3 provides the assessment overview and shows how each impact category is treated in the appraisal.

2.3 Assessment overview

The potential impact screening process identified eleven impact categories for assessment under Pillar 1. These comprise monetised benefits, monetised disbenefits and qualitative effects. Table 2.1 summarises how each category is treated in the appraisal, including whether it is monetised or assessed qualitatively, the value range where available, and its role in differentiating between options. A short descriptor of how to read the ranges is captured in a note* under Table 2-1.

Table 2.1: Pillar 1 - Impact category and assessment approach summary

Impact category	Assessment approach	Estimated present value (2025) over 100-year appraisal period*	Appraisal role
Monetised benefits			
Amenity from improved lake condition	Monetised benefit	£3.6bn – £8.7bn	Dominant common benefit. Present value varies by timing of benefit realisation and valuation uncertainty.
Recreation and safety at other waterbodies	Monetised benefit	£157m – £475m	Material option differentiator. Subject to receiving water body effect uncertainty.
Water regulation (flood risk)	Monetised benefit	£2.7m - £22.7m	Minor option differentiator by engineering variant.
Infrastructure rationalisation (avoided costs)	Monetised benefit	£8.4m – £24.7m	Minor option differentiator. Varies by treatment configuration and rationalisation potential.
Transport disruption during construction	Monetised disbenefit	(£127.1m) – (£1.6m)	Material option differentiator by engineering variant.
Food production impacts	Monetised disbenefit	(£5.9m) – (£2.2m)	Common across options; range reflects valuation uncertainty.
Carbon sequestration impacts	Monetised disbenefit	(£6.5m) – (£1.3m)	Common across options; Minor option differentiator.
Construction health and safety	Monetised disbenefit	(£4.8m) – (£2.3m)	Common across options; range reflects valuation uncertainty.
Whole-life carbon emissions	Monetised disbenefit	(£278m) – (£39m)	Material option differentiator. Varies by construction, replacement and operational carbon.
Qualitative assessment			
Cultural services	Qualitative	—	Common qualitative benefit – non differentiating.
Supporting services (habitat)	Qualitative	—	Minor differentiator, benefit from safeguarding of lake habitats; common across options; mandatory 10% biodiversity net gain applies.

*Value ranges show either sensitivity ranges for impacts that are common across options, or the range of values across options where impacts differ by option. Where both apply, this is explained in the detailed assessment sections.

The assessment shows that amenity from improved lake water quality condition is the dominant source of monetised environmental and social value, accounting for between 89% and 94% of total monetised value across the shortlisted options. This estimate is based on a comprehensive review of evidence on the value households place on the use, enjoyment, and protection of lakes (including ones with national significance); alongside wider evidence on welfare gains associated with waterbody protection and improvement. Taken together, these values represent welfare gains which are closely aligned with the objectives of ORiW and constitute the principal source of quantified benefits within the appraisal.

The remaining monetised categories are materially smaller in scale, but they are still relevant to option comparison. They capture differences in the timing of benefit realisation, effects at other waterbodies, construction

disruption, whole life carbon emissions and other option-specific impacts. Qualitative effects are used where monetisation would not be proportionate or sufficiently robust at this stage, including cultural services and other supporting services.

The monetised assessment is set out in Section 2.4. The qualitative assessment is set out in Section 2.5.

2.4 Monetised benefit assessment

The monetised assessment estimates the environmental and social impacts that can be valued robustly at this stage. It includes benefits from improved lake condition, recreation and safety at other waterbodies, flood risk reduction and infrastructure rationalisation. It also includes monetised disbenefits from construction disruption, land use impacts, construction health and safety effects, and whole life carbon emissions. Full details on the approach and how double counting has been avoided is explained in Appendix A to this Economic Case (Pillar 1).

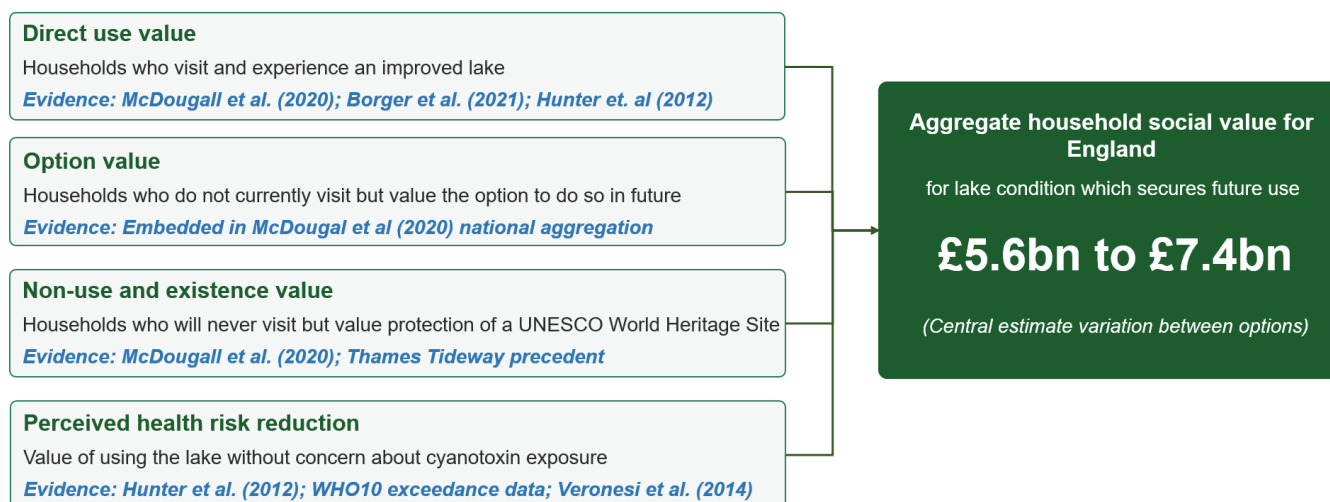
2.4.1 Amenity from water quality improvement in Lake Windermere

Amenity from improved lake condition captures the welfare value households place on the long-term improvement, protection and use of Lake Windermere. This includes value held by people who visit the lake, people who may visit in future, and people who value the protection of the lake even if they do not visit.

The valuation captures four overlapping sources of value:

- **Direct use value**, from households who visit Lake Windermere and benefit from improved water quality;
- **Option value**, from households who may wish to visit Lake Windermere in future;
- **Non-use and existence value**, from households who value the protection of Lake Windermere even if they do not visit; and
- **Perceived health risk reduction**, where improved water quality increases confidence in recreational use of the lake.

Figure 2.2: How Windermere's amenity value is captured over 100 years



Full details of how these values are derived, alongside how the process complies with rules set by Defra on the application of 'Value Transfer', are set out in Appendix E to this Economic Case. In summary, the value transfer estimate has been derived from McDougall et al. (2020), adjusted for income differences in the Windermere area, projected over time to reflect real household income growth, uprated to 2025 prices, and applied to households in England using a distance- and income-weighted aggregation approach to derive a central estimate. This reflects the evidence that social value declines with distance from the lake. Additional evidence has been gathered to triangulate the resulting valuation and test its appropriateness.

McDougall et al. (2020) was selected as the most directly comparable UK stated-preference study available for assessing public amenity benefits associated with large, nationally recognised, freshwater lakes. The study looks specifically at household social value across households in Scotland, for implementing a lakeside management

plan that would ensure path quality, lakeside access and lake views were preserved in their current condition at Loch Lomond and Loch Leven. We have assumed that this is an analogous welfare end state, to the amenity at Windermere for water quality improvement that would be enjoyed by households in England.

The value used from this study is not considered in isolation. The resulting estimate has been assessed against a wider body of valuation evidence identified through a broad evidence review. These studies use different valuation measures and relate to different interventions, but estimate welfare gains associated with broadly comparable outcomes, including improved or protected lake condition, recreation, access, visual amenity and environmental quality detail.

Considered along side these estimates, the valuation is credibly assumed to captures willingness to pay to secure and maintain long-term confidence in the lake's ecological condition and recreational value, rather than solely the value associated with improving environmental quality from poor to good status. Full details of the studies used to triangulate and validate the valuation are provided in the Appendices to this Economic case.

A single study is used to avoid the risk of double counting. Further steps are taken to remove bias and arrive at a the estimate.

- **Values are transferred to Windermere without applying a separate premium** for its national significance or World Heritage Site context. Lake Windermere is similar to Loch Lomond (Scotland) in terms of its national status for England, though arguably has a higher number of annual visitors, with fewer national alternatives in terms of large freshwater lakes;
- **Aggregation is restricted to households in England**, excluding potential non-use value held elsewhere in the UK;
- **Separate cyanobacteria specific social value is not added**, to avoid potential double counting with the wider amenity valuation we do not factor in 'in-lake recreation', which again could risk double counting. Instead, this value is used to support triangulation of the value used (detailed in Appendix E). It does not assume that ORiW will eliminate all algal blooms or address other water-quality pressures, including mercury, PFOS or PFAS. Non-harmful algal blooms may continue to affect the lake's visual amenity, while separate interventions may be required to address other contaminants. Any additional benefits arising from such future interventions would therefore need to be assessed separately to avoid double counting; and
- **Distance decay is applied to reduce values** for households further from Lake Windermere; capturing that use non-use values generally diminish with distance from the environmental asset.

Taken together, these assumptions aim to support a credible benefits estimate, which is proportionate, and aligned with published guidance on the use of value transfer (see Appendix E). It is recommended that the uncertainty inherent in this approach addressed at later stages of the business case through primary local, regional and national research. Table 2.2 sets out the sensitivity range for the amenity valuation.¹⁰

Table 2.2: Amenity benefit – estimated social value per household sensitivity analysis

Scenario	Social value assumption from (McDougall, et al., 2020) (£/household/yr, 2019 prices)	Social value assumption in Y0 (£/household/yr, 2025 prices)	Beneficiary population	Distance weighted aggregate present value range across options (£bn, 100-year appraisal period, 2025 prices)
Low case (lower bound social value, Loch Lomond)	£12.06	£16.27	England	£3.6bn - £4.8bn
Central case (preferred social value, Loch Lomond)	£18.72	£25.26	England	£5.6bn – £7.4bn
High case (mean social value, Loch Lomond)	£21.76	£29.36	England	£6.5bn - £8.7bn

Note: Loch Lomond refer to the case study lakes used in McDougall et al. (2020), from which the social values have been transferred.

¹⁰ To note: No separate construction phase disamenity has been applied to the amenity valuation. Construction related effects are captured separately through the monetised assessment of transport disruption, land use impacts, carbon effects and other construction related disbenefits in Section 4.4, so applying an additional temporary amenity disbenefit would risk double counting.

Table 2.2 presents the amenity value estimates derived from (McDougall, et al., 2020) which have been income adjusted from Scotland to Windermere, and inflated to 2025 prices. The study provides a lower-bound estimate alongside two alternative central estimates: a regression-based central estimate and a 'mean' estimate. The study identifies the regression-based estimate as the value which minimises the risk of either underestimating or overestimating amenity benefits. The low case therefore applies the lower-bound estimate to households in England, the central case applies the preferred regression-based estimate, and the high case applies the mean estimate.

Within each case, the range across options reflects differences in the timing of benefit realisation, with options that deliver the water-quality improvement earlier generating higher present values. The central case produces estimated amenity benefits of £5.6 billion to £7.4 billion across the shortlisted options. The low and high cases provide an indication of the uncertainty surrounding the amenity valuation and result in correspondingly lower and higher benefit estimates.

Given the inherent uncertainty associated with benefit transfer approaches, it is recommended that bespoke local, regional and national primary research be undertaken at the next stage to establish a Windermere-specific household social value for water quality improvements. This would provide a more robust evidence base for option selection and reduce the uncertainty associated with transferring values for different benefits from other contexts. Consumer research on affordability and acceptability including willingness to pay should also be undertaken, particularly in the context of current and anticipated increases in customer bills.

2.4.2 Recreation and safety at other waterbodies

This section captures recreation and safety at other waterbodies outside the main Lake Windermere amenity valuation. It covers affected upstream and downstream waterbodies where options remove, consolidate or relocate wastewater treatment works and storm overflow inputs. Double counting is avoided as it does not consider the amenity value associated with Lake Windermere (Section 2.4.1). The assessment applies Water Environment Benefits Survey¹¹ (Environment Agency, in preparation) (WEBS) values using step change analysis. As detailed water quality modelling has not been undertaken for each affected waterbody at this stage, the assessment uses first principles logic to identify where options are expected to improve water quality, prevent deterioration, or have no material effect. The analysis considers whether direct inputs are removed, whether upstream water quality improves, and whether a waterbody receives a new or increased treated effluent input at a higher treatment standard.

Under the central assessment, the estimated value ranges from **£315 million to £433 million** across options. The low and high sensitivity range is **£157 million to £475 million**.

Table 2.3: Recreation and safety benefits estimated at other waterbodies, highest and lowest value options (£m, 2025 prices, present value, 100-year appraisal period)

Option	Low (£m)	Central (£m)	High (£m)
Windermere, Tunnel - highest value option	£216m	£433m	£475m
Leven Rising Main - lowest value option	£157m	£315m	£345m

The highest-value configurations are tunnel-based options that improve conditions across a broader network of waterbodies. The lowest-value configurations are those where load reduction is concentrated at fewer upstream locations.

The values reflect differences across all affected waterbodies rather than solely the removal of wastewater inputs from Lake Windermere and its upstream catchment. While both the Windermere and Leven options remove wastewater inputs from Windermere and upstream waterbodies, under Leven options, the collected flows are discharged to the River Leven downstream of the weir at Newby Bridge. Consistent with the WEBS step-change methodology, this is treated as an 'incidental no deterioration' outcome rather than a 'deterioration-prevention' or 'status-improvement' benefit. The values presented should therefore be interpreted as reflecting the overall distribution of water quality effects across all affected waterbodies except Lake Windermere rather than the upstream water quality improvements alone.

¹¹ The WEBS methodology and values are currently undergoing updates. The updated WEBS method is expected to be released imminently. The appraisal described here is based on draft values and method supplied by the Environment Agency team developing the new WEBS method.

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The low, central and high columns show valuation sensitivity. The difference between options reflects the number and type of waterbodies affected, the assumed WEBS step change and the timing of benefit realisation. Options that affect a broader network of waterbodies, and realise benefits earlier, generate higher present values.

This category carries material uncertainty. The assessment is based on step change assumptions, not detailed receiving waterbody modelling. It does not directly assess changes in flow, dilution or WFD status. Morecambe Bay is included in the step change analysis for relevant Barrow options, but the downstream environmental impact of treated discharges has not yet been confirmed through detailed modelling. This should be tested with further flow and water quality monitoring and detailed water quality modelling at Outline Business Case stage alongside the River Leven, Leven Estuary and broader Morecambe Bay.

2.4.3 Flood risk

Flood risk captures the benefits of the interceptor sewer and surface water separation and sustainable drainage systems (SuDS) on surface water and sewer flood risk management at properties. The likely flood reduction benefits to properties are potentially reasonable, despite the focus of the project being on water quality improvements. All options are however unlikely to significantly reduce fluvial flooding – which is the main source of flood risk in the catchment (Environment Agency, 2009). Appendix A to this Economic Case provides further details of the applied methodology for assessing flood risk benefits.

Options to transfer wastewater out of the catchment have been investigated to understand the impact on lake levels – as reported in *Impact of Only Rainwater into Windermere on Lake Water Levels* (Jacobs Mott MacDonald, 2026c). Initial investigation suggests the options are likely to have a negligible impact on lake levels at times of high flow and therefore unlikely to impact flood risk management associated with rising lake levels.

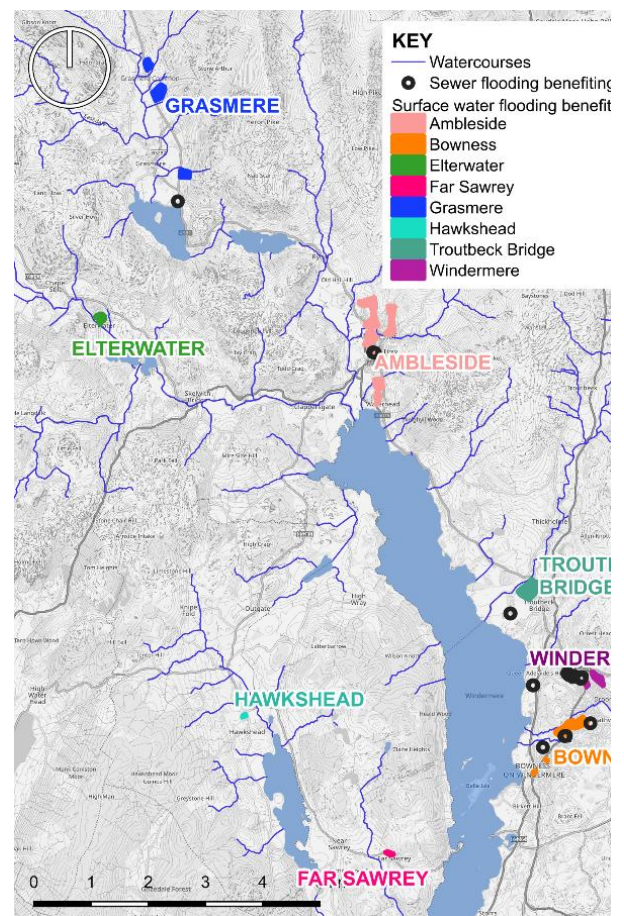
For the common in-catchment package surface water management measures, runoff is intercepted by the proposed SuDS before it enters watercourses and drainage infrastructure, reducing the likelihood of surface water flooding.

The interceptor sewer reduces sewer surcharge risk, by adding capacity to the sewer network and removing restrictions. The tunnel option provides a greater sewer flood risk reduction compared to the rising main, by providing greater capacity and removing restrictions at pumping stations, which exacerbate flood risk in the baseline.

The benefit has been assessed using Rapid Appraisal Tool for Economics (RATE) (Environment Agency, 2025), applied to baseline flood damage estimates derived from sewer network modelling and the Environment Agency surface water flood risk maps (Environment Agency, 2025). Only flood risk benefits to properties within the Windermere catchment have been considered.

The benefits vary by interceptor sewer conveyance type, but do not vary by discharge location. Under the central case, the assessment estimates the benefits of the tunnel/hybrid options are approximately £13.1m - £13.5m, compared to £6.8 - £7.5m for the rising main option. These ranges include the benefits of the surface water

Figure 2.3: Areas which may benefit from flood risk reduction¹²



¹² Contains OS data © Crown copyright via Europa: © 2026 Technologies Ltd. All rights reserved

management measures, which are common to all options. Table 2.4 sets out the central estimate and sensitivity range.

Table 2.4: Water regulation – estimated property flood risk reduction benefit sensitivity (£m, 2025 prices, PV, 100-year appraisal period)

Scenario	Low	Central	High
Rising main	£2.7m - £2.9m	£6.8m - £7.5m	£14.0m - £14.9m
Tunnel	£4.2m - £4.4m	£13.1m - £13.8m	£21.7m - £22.7m
Hybrid	£4.3m	£13.5m	£22.2m

This table includes the benefits from the surface water management measures and from the interceptor sewer options. The benefits from the surface water management measures on surface water flood risk is common across all options. The benefits of the interceptor sewer options on sewer flood risk varies by interceptor sewer conveyance type, but do not vary by discharge location. Only flood risk within the Windermere catchment has been considered. Source: EA RATE tool applied to sewer network flood risk modelling and EA surface water flood risk maps. Sensitivity tests vary the assumed level of protection delivered by the options.

The assessment is sensitive to the level of flood risk reduction delivered in practice. This will depend on the detailed design, location and capacity of the interceptor sewer and wastewater network assets and surface water management measures, which have not yet been confirmed. The estimate should therefore be treated as indicative and should be refined at Outline Business Case stage.

2.4.4 Infrastructure rationalisation (avoided costs)

Infrastructure rationalisation captures the avoided costs from consolidating wastewater treatment across fewer retained treatment sites. Up to 16 WWTWs could be repurposed based on evidence seen¹³. Where a works is consolidated, its treatment process is decommissioned, and the site is converted to a pumping station that transfers flow onward to the retained works. The benefit is the net reduction in cost, after allowing for the cost of operating and maintaining the replacement pumping station.

The options differ in the number of works consolidated and the location of retained treatment capacity.

- The Windermere and Leven Options retain Windermere WwTW as the treatment hub.
- The Ulverston and Barrow Options export treatment out of the catchment to Ulverston and Barrow-in-Furness respectively, allowing Windermere WwTW itself to be decommissioned or converted to a pumping station

The avoided cost increases with the degree of consolidation but does not rise proportionately to export distance. It reflects the specific set of works converted under each configuration, the cost of replacement pumping arrangements and the timing of benefit realisation. Table 2.5 sets out indicative ranges by configuration. It should be noted that Tunnel variants, due to additional capacity, allow for additional consolidation of treatment works.

Table 2.5: Infrastructure rationalisation: indicative avoided cost ranges estimated by configuration (£m, PV, 100-year appraisal period)

Option configuration	Indicative value range across discharge location variants (Central, £m, PV)	Rationale
In-catchment (Windermere options)	£9.6m - £11.4m	Catchment works converted to pumping stations; Windermere WwTW retained as treatment hub
Near-catchment (Leven Options)	£8.4m - £11.0m	Treatment retained at Windermere WwTW; discharge moved to the River Leven downstream of the weir at Newby Bridge
Export to Ulverston (Ulverston Options)	£12.3m - £18.4m	Treatment exported from the catchment; Windermere WwTW decommissioned or converted
Export to Barrow-in-Furness (Barrow Options)	£16.1m - £24.7m	Greatest degree of consolidation; highest net avoided cost

Indicative ranges at this stage of development. Values to be refined at Outline Business Case.

¹³ This is the maximum number of potential WWTWs decommissioned in all options; in this case for the Barrow (Tunnel) option.

The figures represent the net operating, maintenance and capital cost replacement savings arising from consolidating treatment activities across fewer wastewater treatment works. This benefit has been estimated as the difference between the future operating costs of the existing configuration and the costs associated with the consolidated configuration, including the operation and maintenance of any replacement pumping stations. As such, the benefit reflects only future avoidable expenditure and does not include any capital expenditure already incurred on existing assets.

Capital expenditure associated with assets that are decommissioned or repurposed is captured within the calculation. The infrastructure rationalisation benefit captures only future avoidable operating expenditure. The treatment of any remaining asset value, potential write off and associated regulatory implications will need to be agreed with Ofwat as part of the preferred option development and is discussed in the Financial Case.

2.4.5 Transport disruption during construction

After whole life carbon emissions, transport disruption during construction is the principal monetised disbenefit across the shortlist and the primary differentiator between engineering variants. All options require works on the A591/A592 corridor, the single transport spine connecting Ambleside, Windermere and Bowness, which is the primary access route for the visitor economy and the most disruption-sensitive section of the programme.

For rising main (open cut) construction on this corridor, Highway Authorities are unlikely to permit road closure during the tourist season, restricting works to approximately five winter months per year. The Deliverability Report (Jacobs Mott MacDonald, 2026d) estimates that open cut pipeline installation along the full catchment section could require ten or more consecutive winter periods, making rising main impracticable as the primary construction method on this corridor. Tunnel construction concentrates disruption at shaft and compound locations, does not require full road closure, and reduces the programme to a bounded delivery window. Table 2.6 sets out the central and range estimates by option. Appendix A to this Economic Case provides a detailed description of the method used to value transport disruption during construction.

Table 2.6: Estimated transport disruption to the A591/A592 during construction (£m, 2025 prices, PV, 100-year appraisal period)

Option	Discharge location	Engineering method	Low (£m)	Central (£m)	High (£m)
Rising main variants					
Windermere Rising Main	Windermere	Rising main	£61m	£81m	£121m
Leven Rising Main Option	River Leven downstream of the weir at Newby Bridge	Rising main	£64m	£85m	£127m
Ulverston Rising Main Option	Ulverston	Rising main	£64m	£85m	£127m
Barrow Rising Main Option	Barrow-in-Furness	Rising main	£64m	£85m	£127m
Tunnel and hybrid variants					
Windermere Tunnel	Windermere	Tunnel	£9m	£12m	£18m
Leven Tunnel	River Leven downstream of the weir at Newby Bridge	Tunnel	£9m	£12m	£18m
Ulverston Tunnel	Ulverston	Tunnel	£2m	£2m	£3m
Ulverston Hybrid	Ulverston	Hybrid	£2m	£2m	£3m
Barrow Tunnel	Barrow-in-Furness	Tunnel	£2m	£2m	£3m
Barrow Hybrid	Barrow-in-Furness	Hybrid	£2m	£2m	£3m

Values reflect disruption to the A591/A592 catchment corridor only. Disruption to other roads is common across all options and does not influence option selection. Source: Transport Assessment. Guidance methodology applied to Deliverability Report construction programme estimates.

Disruption to the A590, which connects the M6 to Ulverston and Barrow-in-Furness via Newby Bridge, has not been monetised in this assessment. The A590 is a principal strategic road and disruption to traffic can have widespread consequences, with limited alternative routes to accommodate diverted traffic. Full closure of the road would have significant transport disruption costs, and it is unlikely that this would be permitted by the Highways Authority. Current designs for the interceptor sewer options along the A590 towards Ulverston and Barrow-in-Furness incorporate methods and routes that do not require road closure – construction could be through less constrained farmland and delivered using trenchless techniques and methods that avoid highway constraints.

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Therefore, based on the designs as they stand, all options are not anticipated to drive transport disruption via closure of the A590.

The wide aggregate range in transport disruption across all options under the central case (£2 million to £85 million) reflects the engineering method distinction rather than option configuration. Confirmation of the engineering method at Outline Business Case stage will therefore materially change this assessment for every option. The relationship between engineering method, construction programme risk, and transport disruption is examined further in Pillar 4 (Section 5), where it is identified as the single most controllable delivery risk variable across the shortlist.

2.4.6 Other monetised disbenefits

Three further categories of monetised disbenefit are assessed:

- Food production losses;
- Carbon sequestration changes; and
- Construction health and safety effects.

All three are small in scale, broadly common across options, and do not materially differentiate between the shortlisted options. Table 2.7 summarises the ranges.

Table 2.7: Other estimated monetised disbenefits (£m, 2025 prices, PV, 100-year appraisal period)

Category	Low (£m)	High (£m)	Option differentiation
Food production losses	(£5.9m)	(£2.2m)	Limited, driven by common package
Carbon sequestration losses	(£6.5m)	(£1.3m)	Limited, driven by common package
Construction health and safety	(£4.8m)	(£2.3m)	Limited, common across all options and driven by volume of infrastructure.

Note: Disbenefit values shown in brackets. Ranges reflect variation in construction timing across options rather than differences in option design.

Food production losses arise from permanent and temporary land take associated with construction. The primary driver is the common in-catchment package, first-time sewerage, Reduced Weather Dependent Flows, and highway drainage which is applied consistently across all options. The variation in the range is driven primarily by differences in construction timing since options with shorter construction periods have shorter temporary impact periods.

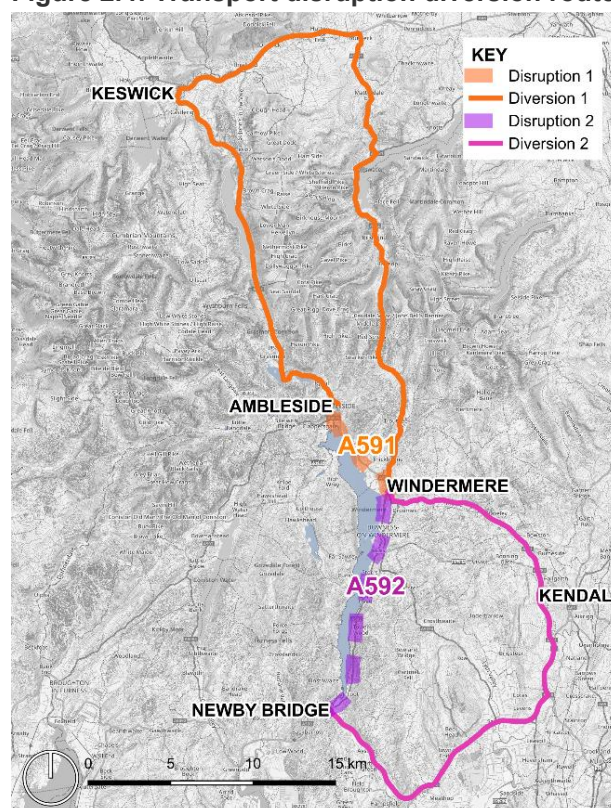
Carbon sequestration losses arise from the same construction land take, as permanent and temporary removal of vegetation reduces carbon storage potential. Construction health and safety effects reflect temporary hazards to contractors and the public during construction works, manageable through safe-by-design principles and a competent contractor.

Appendix A to this Economic Case provides further information on the methods used to value these disbenefits.

2.4.7 Whole-life carbon emissions

Whole life carbon emissions are assessed as a monetised disbenefit to the economy, environment and society throughout the lifecycle of the asset. This includes carbon emissions associated with the capital construction,

Figure 2.4: Transport disruption diversion routes¹⁴



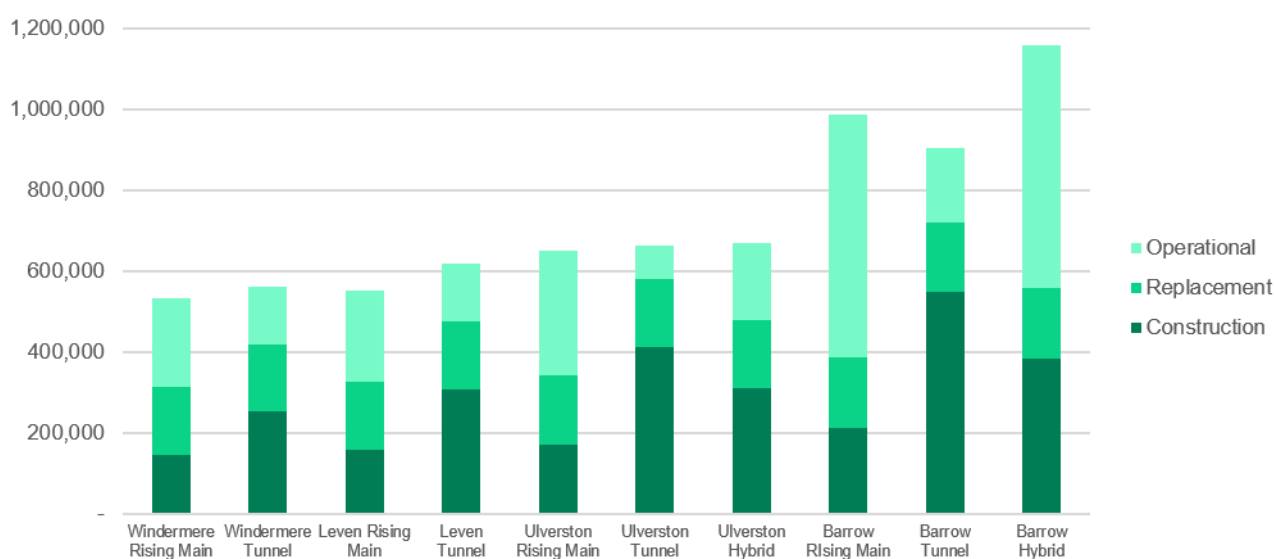
¹⁴ Contains OS data © Crown copyright via Europa: © 2026 Technologies Ltd. All rights reserved

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operation and maintenance, and demolition, renewal and replacement, using carbon prices (£/tCO₂e) from 'Valuation of energy use and greenhouse gas emissions guidance' (DESNZ, 2023), which is supplementary guidance to the HM Treasury Green Book (HM Treasury, 2026). Details of the method used to monetise this disbenefit are presented in Appendix A to this Economic Case.

Whole-life carbon emissions have been identified as a material monetised disbenefit but remain subject to ongoing quantification. The results show a clear gradient across the shortlist, with carbon costs increasing as options move from in-catchment to long-distance export. Embodied carbon in construction rises with the scale and complexity of infrastructure, with export options requiring longer transfer routes and larger conveyance assets. More significantly over the appraisal period, operational carbon emissions increase with pumping distance and system complexity, as longer transfer routes require sustained energy input for pumping and treatment over the 100-year appraisal period. Figure 2.5 shows the whole life carbon emissions by option and stage.

Figure 2.5: Estimated whole life carbon emissions, by option, tCO₂e



The results show estimated aggregated carbon emissions over the 100-year appraisal period from construction, replacement cycles, and operation. The central values indicate that the Windermere Options have the lowest whole-life carbon cost (£79m–£102m), with near-catchment configurations increasing modestly (£81m–£116m). Export to Ulverston results in a forecasted further step increase (£92m–£138m), while export to Barrow is estimated as materially higher (£131m–£186m), reflecting both the longer conveyance distance and the greater scale of terminal infrastructure required. Table 2.8 shows the total estimated cost of carbon emissions, split across construction, replacement and operation, using carbon prices (£/tCO₂e) from the HM Treasury Green Book (HM Treasury, 2026).

Table 2.8: Whole-life estimated carbon emissions, £m, PV 2025, 100-year appraisal period

Option	Construction	Replacement	Operational	Total
Windermere Rising Main	£41m	£15m	£23m	£79m
Windermere Tunnel	£71m	£15m	£15m	£102m
River Leven Rising Main	£44m	£15m	£22m	£81m
River Leven Tunnel	£87m	£15m	£15m	£116m
Ulverston Rising Main	£47m	£15m	£30m	£92m
Ulverston Tunnel	£115m	£15m	£9m	£138m
Ulverston Hybrid	£87m	£15m	£20m	£121m
Barrow Rising Main	£58m	£15m	£58m	£131m
Barrow Tunnel	£152m	£15m	£19m	£186m
Barrow Hybrid	£105m	£15m	£61m	£182m

2.5 Qualitative assessment of environmental and social impacts

The qualitative assessment covers impacts where monetary valuation would not be possible at this stage, because the value is cultural, institutional or strategic in nature, or because valuation now would imply a false precision. It identifies the environmental and social effects that are not monetised, and tests where options are differentiated on those grounds.

Impacts were identified through the ENCA framework (Defra, 2026) and Water Appraisal Guidance Appraisal Summary Table (Environment Agency, 2013) (Section 2.2). Where an impact has been monetised in Section 2.4, or where its welfare value is substantially captured within the amenity or recreation valuations, it is not separately scored here; any additional qualitative value is marginal above what is already captured, or too uncertain to isolate reliably. These categories are noted below:

- Provisioning services (food) and regulatory services (climate regulation), monetised in Section 2.4;
- Recreation, health and safety, and the welfare value of improved water quality, substantially captured within the amenity and recreation valuations (Sections 2.4.1 and 2.4.2);
- Local economy and employment effects assessed in Pillar 3.

The categories that remain genuinely qualitative are presented in Sections 2.5.1 to 2.5.3. The approach adopts the ENCA headings of cultural and supporting services. The notation key applies to all tables in this section; scores are relative to the baseline, in which lake condition continues to deteriorate.

Using the criteria outlined in Table 2.9, Sections 2.5.1 to 2.5.3 provide an overview of the reasoning behind the scales of change assigned.

Table 2.9. Qualitative indication of the scale of expected change

Major negative change	Minor negative change	Negligible change	Minor positive change	Major positive change
<<	<	—	>	>>
Major negative change expected – scale of impact is significant enough that it represents an expected material step change deterioration beyond other options.	Minor negative changes expected because of the option but not expected to be material enough to set it apart from other options.	There is not expected to be a material change from the existing baseline.	Minor positive changes expected because of the options but not expected to be material enough to set it apart from other options.	Major positive change expected – scale of impact is significant enough that it represents an expected material step change improvement over other option.

2.5.1 Cultural Services

Table 2.10: Cultural services – summary of qualitative benefits assessment

Benefit category	Option										
	Baseline	Windermere Options		Leven Options		Ulverston Options			Barrow Options		
		Rising Main	Tunnel	Rising Main	Tunnel	Rising Main	Tunnel	Hybrid	Rising Main	Tunnel	Hybrid
Cultural heritage	—	>	>	>	>	>	>	>	>	>	>
Aesthetic value	—	>	>	>	>	>	>	>	>	>	>
Intellectual and scientific value	—	>	>	>	>	>	>	>	>	>	>
Inspiration of art, folklore and architecture	—	>	>	>	>	>	>	>	>	>	>

Note: All options are expected to deliver broadly the same cultural benefit, with no differentiation between them. Cultural heritage scores could be considered moderate positive; but it has been assigned a minor positive score to retain the five-point scoring system. All remaining categories are minor positive.

Cultural heritage

Lake Windermere is deeply embedded in British cultural history and has inspired generations of artists, poets and writers including William Wordsworth, John Ruskin, Beatrix Potter and Arthur Ransome. It lies within the Lake District National Park, inscribed as a UNESCO World Heritage Site (WHS) in 2017 for its cultural landscape and its role in the Romantic Movement (UNESCO, 2017). The Lake District has played a defining role in shaping the UK’s environmental consciousness, from the Thirlmere campaign of 1876, where the principal of protecting nature for the nation was first widely argued, to its ongoing influence on global approaches to landscape conservation (Lake District National Park, 2015).

The World Heritage Committee has acknowledged progress on Lake Windermere’s water quality monitoring and encouraged continued effort (UNESCO, 2025). Deterioration of water quality may place long-term pressure on that status, although water quality alone is unlikely to lead to removal of the WHS designation. The lake also holds four “excellent” designated bathing waters under the Bathing Water Directive (Environment Agency, 2026). All options help protect the WHS and the bathing water quality of the lake. Construction carries a temporary risk to heritage assets, but as no option builds a treatment works in a new location within the WHS, permanent impacts are unlikely.

Aesthetic, scientific and artistic value

Beyond its WHS status, the lake’s aesthetic, scientific and artistic significance are anticipated to be positively affected by improved water quality. Algal blooms cause discoloured, cloudy and sometimes foul-smelling water that reduces the lake’s scenic appeal, and all options reduce bloom frequency – the value of which is captured in the amenity assessment.

Windermere is also one of the most intensively studied lakes in the world, with monitoring records dating back to the 1930s, the longest such dataset in the United Kingdom (Freshwater Biogological Association, 2024). Windermere has been continuously monitored since the Freshwater Biological Association was established at Wray Castle in 1929, producing the longest continuous freshwater record in the United Kingdom (Freshwater Biological Association, 2024) and underpinning the UK Centre for Ecology and Hydrology modelling that supports this appraisal. The value of that record depends on the lake’s condition: a lake held at the threshold of bloom risk documents managed decline, whereas a lake secured at Good mesotrophic status would provide a long-run record of recovery under climate change, monitored against a century-long baseline. Catchment-scale removal of wastewater inputs from a large lake has no precedent at this scale in the United Kingdom and would be of national scientific interest, with the potential to sustain and extend the research and educational activity the catchment already supports. The effect is assessed qualitatively: it depends on future third-party funding decisions, any public welfare value attaching to Lake Windermere as a scientific and cultural asset is already captured within the amenity valuation, and it is common across the shortlisted options rather than a point of differentiation

All options help safeguard the lake as a site for research, education and inspiration. These effects are positive but modest, with no differentiation between options.

There is no material differentiation between options on cultural services. Differences in construction footprint within the designated area are a matter of consenting risk and construction disruption, addressed in Pillars 4 and 3 respectively, rather than a difference in cultural value.

2.5.2 Supporting services

Table 2.11: Supporting services - summary of qualitative benefits assessment

Benefit category	Option										
	Baseline	Windermere Options		Leven Options		Ulverston Options			Barrow Options		
		Rising Main	Tunnel	Rising Main	Tunnel	Rising Main	Tunnel	Hybrid	Rising Main	Tunnel	Hybrid
Provision of habitat	—	>	>	>	>	>	>	>	>	>	>

Note: Minor positive reflects water quality improvements helping to tackle biodiversity loss, common across all options. Mandatory 10% biodiversity net gain obligation applies. No material differentiation between options.

Provision of habitat

Currently, it is anticipated that there is small positive impact on habitat from the project; despite the construction temporarily disrupting habitats which will take some time to recover. By safeguarding and improving water quality and ecological health, all options are estimated to help to enhance natural habitats and tackle biodiversity loss. The green infrastructure delivered through the common package is small and dispersed, although will introduce green space and habitats into urban areas, improving access to biodiversity.

Options or their components may affect habitats, including grassland, woodland, and water bodies, through construction activities and new above-ground infrastructure. Detailed design will seek to manage, avoid or mitigate these impacts and minimise any reduction in supporting ecosystem services. For example, risks to River Leven flows during very dry periods may require management measures to be incorporated into the design. Future design development will also need to avoid sensitive habitats, such as ancient woodland, where impacts may be difficult or impossible to replace, in accordance with relevant legislation and policy requirements.

ORiW's later stages of option design will consider these factors in more detail. Overall, the options are predominantly underground and are therefore expected to result in limited long-term changes to land use and habitat provision once construction sites have been reinstated and recovered. Appropriate mitigation measures will be developed to avoid, reduce or offset any residual impacts where necessary.

In accordance with legislation, where applicable options are subject to a 10% Biodiversity Net Gain (BNG) requirement under the Environment Act 2021. BNG may offset, and potentially exceed, the temporary habitat losses associated with construction activities. Separately, the programme is expected to deliver wider environmental benefits through improvements in water quality and reductions in wastewater-related pressures within the catchment. Applicable Biodiversity Net Gain requirements will be assessed separately using the statutory biodiversity metric. Wider ecological benefits from improved water quality are not included in the BNG calculation at this stage. The overall biodiversity effect is provisionally assessed as minor positive and common across the options, subject to ecological surveys, detailed design and formal environmental assessment.

2.5.3 Other benefits and impacts

A broad range of evidence supports the health, wellbeing and confidence improvements resulting from action to improve publicly accessible blue spaces. For example, At Combe Martin in Devon, a partnership-led catchment scheme improved a bathing water from 'Poor' to a consistent 'Good' classification, protecting the local tourist economy (Environment Agency, 2026). At Hastings, a multi-party scheme involving the water company, the Environment Agency, the local authority and a community campaign group restored a failing bathing water to 'Good', exceeding its target (Harris, 2016). A number of these benefits can be monetised, but are not, due to the risk of double counting with the amenity valuation set out in 2.4.1. The evidence base supporting both the amenity valuation, and wider potential benefits are explored in the appendices to this document.

No additional material benefits or impacts were identified that were not already captured through the monetised benefit assessment, Cultural Services, Supporting Services, Pillar 3 (Place-Based and Distributional Effects), or Pillar 4 (Risk, Resilience and Deliverability).

2.5.4 Overall qualitative findings

All options generate substantial positive qualitative value relative to the baseline: they protect the Outstanding Universal Value of a UNESCO World Heritage Site and its designated bathing waters, safeguard the lake's scientific and cultural significance and safeguard the condition of the lake to support a diverse range of habitats and species. Cultural and supporting services do not differentiate between options, as all achieve broadly equivalent long-term environmental outcomes.

3 Pillar 2: Whole-life cost

3.1 Purpose and scope

The purpose of Pillar 2 is to assess the whole-life cost implications of each shortlisted option and the extent to which each option supports an efficient and affordable long-term wastewater system for the Windermere catchment.

The assessment provides evidence on the relative cost performance of the shortlisted options over a 100-year appraisal period and forms one input to assessing the relative VfM of options and identifying the most preferred option based on current evidence. Cost performance is considered alongside the environmental, place-based, resilience and deliverability evidence presented in the other appraisal pillars.

The assessment covers:

- Capital expenditure associated with construction and enabling works;
- Operational expenditure over the appraisal period;
- Replacement and maintenance expenditure;
- Decommissioning costs, where relevant;
- The effect of common programme components and option-specific infrastructure requirements on total whole-life cost; and
- The treatment of risk, uncertainty and optimism bias in accordance with the appraisal methodology.

The purpose of this pillar is not to identify the lowest-cost option in isolation, but to understand the relative cost implications of alternative strategic approaches and how these contribute to overall value for money.

3.2 Assessment approach

The whole-life cost assessment has been undertaken using concept-level engineering designs developed for each shortlisted option. Cost estimates have been prepared using a combination of:

- Bottom-up estimating,
- Supplier quotations,
- Engineering judgement and
- Benchmarking against comparable wastewater infrastructure projects and industry datasets.

The assessment draws on hydraulic modelling, route development, treatment process design and asset requirements identified through the engineering optioneering process. Common programme components have been estimated consistently across all options, while option-specific costs reflect differences in conveyance strategy, treatment location, discharge location and associated discharge permit requirements, pumping requirements and operational arrangements.

The estimates are considered proportionate to the current stage of programme development and provide a reasonable basis for comparing the relative cost implications of the shortlisted options. However, the programme has not yet progressed to detailed design and further refinement is expected as route alignments, construction methodologies, ground conditions, consenting requirements and environmental mitigation measures become better defined.

Appendix B to this Economic Case provides further information on the methods and data used to estimate the Whole Life Cost.

3.2.1 Treatment of risk, uncertainty and optimism bias

The cost estimates have been developed in accordance with HM Treasury Green Book principles and include explicit allowances for risk, uncertainty and optimism bias (HM Treasury, 2026). The treatment of risk, uncertainty and optimism bias is reflected in costs as follows:

- Project-specific risk allowances have been incorporated within the capital cost estimates to reflect identified delivery risks associated with scope, engineering complexity, construction methodology and asset delivery.

These allowances have been informed by engineering assessment and risk review undertaken during option development.

- Site-specific risk and uncertainty allowances of 20% to 35% are also applied to capital expenditure as detailed in Appendix B of this Economic case. Operating expenditure includes a 30% contingency to reflect residual uncertainty
- In addition to project-specific risk allowances, optimism bias has been applied in accordance with Green Book guidance to reflect the residual uncertainty that remains at this stage of programme development. The uplifts are applied consistently across all shortlisted options.
 - Initial construction costs carry an optimism bias uplift of 66%, the Green Book upper bound for non-standard civil engineering, applied unreduced. This reflects the scale, technical novelty, and environmental sensitivity of the programme's principal infrastructure, and is consistent with Green Book guidance that adjustments below the upper bound should be made only where supported by firm empirical evidence (HM Treasury, 2013).
 - Capital maintenance and replacement costs carry a separate optimism bias uplift of 44%, the Green Book upper bound for standard civil engineering (HM Treasury, 2013). This lower rate reflects that renewals are recurring, asset-data-driven activities which may have lower novelty and delivery risk than first-of-a-kind or first-time construction. This means, replacement works may be more efficiently executed than original works. The capital maintenance profile comprises a mix of civil and mechanical/electrical works; in the absence of a reliable basis to disaggregate these, the standard civil upper bound has been adopted as a single conservative rate applied unreduced across the line. As there are cases where this may not be true, sensitivities on optimism bias are tested later in the Economic case.
- The assessment team considers these allowances to be appropriate and proportionate for the current stage of development. The estimates are based on concept-level designs supported by hydraulic modelling, route development, treatment process design, supplier engagement and bottom-up estimating for major programme components. Significant project risks have therefore been identified and quantified where possible before optimism bias has been applied.
- Programme-related uncertainty has also been addressed directly within the engineering and construction assumptions. For example, construction durations reflect the anticipated constraints associated with seasonal working, environmental restrictions and extended delivery programmes where relevant. As a result, no additional programme optimism bias has been applied beyond the project-specific risk allowances and Green Book optimism bias cost assumptions described above.

The resulting estimates provide a reasonable basis for comparing the relative cost implications of the shortlisted options, while recognising that further refinement will occur as design development, ground investigations, consenting activities and procurement strategies progress.

3.3 Cost components and appraisal basis

The whole-life cost estimates are built up from common programme components and option-specific components. This distinction is essential because common components explain a material share of total programme cost, while option-specific components explain most of the variation between options.

3.3.1 Common programme components

Common components are included in every option and do not materially differentiate the shortlist. They include:

- First time sewerage
- First time treatment
- Highway drainage
- Reduced weather dependent flow measures.

3.3.2 Option-specific cost drivers

The main option-specific cost drivers are:

- Conveyance method, whether rising main, tunnel or hybrid
- Route length and complexity

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- Terminal treatment location
- Pumping, power and operational requirements
- Construction duration and commissioning date
- Extent of asset consolidation enabled by each configuration.

Further details on cost drivers are set out in Appendix B to this Economic Case.

3.3.3 Appraisal basis

The assessment applies a common basis of appraisal, set out in Section 1.2.1. Costs are assessed over the 100-year appraisal period, in present value terms, using the agreed 2025 price base and discounting assumptions.

Reflecting the distinct risk profiles between initial construction and ongoing capital maintenance, a 66% uplift has been applied to initial capital costs, and 44% to replacement expenditure, while a 30% uplift has been applied to operational expenditure (HM Treasury, 2026). The costs include allowances for Environmental mitigation, both in the core cost and in the uncertainty/risk uplifts.

The sensitivity of the economic case to these assumptions is tested in Section 6.3, which confirms that the ranking of options is robust across the plausible range of optimism bias, since the uplifts apply equally to all options under consideration.

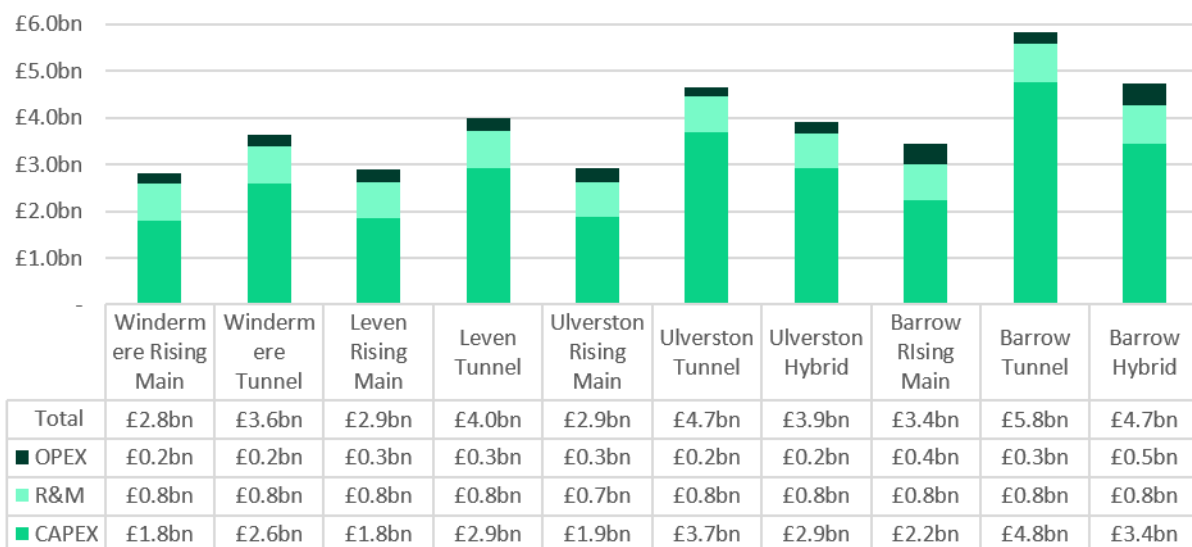
In addition to optimism bias, site-specific risk and uncertainty allowances of 20% to 35% are also applied to capital expenditure as detailed in Appendix B of this Economic Case. Operating expenditure includes a 30% contingency to reflect residual uncertainty. These allowances are based on cost-estimator advice and derive from historic projects.

The results in Section 3.4 should therefore be read as whole-life costs for each configuration, inclusive of an uplift for cost commensurate with this stage of the assessment; whilst noting that optimism bias is uncertain and looked at further through sensitivity analysis.

3.4 Whole life cost results

Figure 3.1 presents the whole-life cost results for each shortlisted option. Costs are shown by capital expenditure (CAPEX), replacement and maintenance expenditure (R&M), and operating expenditure (OPEX), with total whole-life cost reported in present value terms. These whole-life costs include optimism bias (66% for CAPEX and 44% for R&M), risk allowances (20% to 35% for CAPEX and R&M), and residual uncertainty uplifts (30% for OPEX).

Figure 3.1: Shortlist options estimated whole life costs, £bn 2025, PV, 100-year appraisal period



The results show that rising main variants have the lowest whole-life costs within each discharge location, while tunnel variants have the highest costs. Hybrid variants sit between the rising main and full tunnel options where they are available. This reflects the higher capital cost of tunnelled conveyance, partly offset in some cases by operating and asset rationalisation effects. The rising main option requires more maintenance and replacement activity over its lifetime, whereas although tunnels incur similar whole-life repair and maintenance costs (reflecting a 120-year asset life and repair expenditure of 5% every 30 years), their higher upfront capital cost means equivalent expenditure is associated with substantially less intervention and operational activity.

Table 3.1 sets out the difference between the rising main and tunnel variant at each discharge location.

Table 3.1: Comparison of estimated whole life costs, rising main versus tunnel, for the discharge locations, £bn 2025, PV, 100-year appraisal period

Discharge location	Rising main	Tunnel	Hybrid
Windermere	£2.8bn	£3.6bn	N/A
River Leven	£2.9bn	£4.0bn	N/A
Ulverston	£2.9bn	£4.7bn	£3.9bn
Barrow	£3.4bn	£5.8bn	£4.7bn

The cost of choosing a tunnel over a rising main grows with distance from Windermere, from 29% at Lake Windermere to 70% at Barrow.

Holding the conveyance method constant, whole-life cost generally rises as the discharge location moves further from Windermere. The pattern is not exact for the rising main variants, because the lower treatment and replacement cost at the Ulverston works partly offsets the longer conveyance route, leaving the Ulverston Rising Main Option (£2,924m) close to the Leven Rising Main Option (£2,904m). The lowest whole-life cost in the shortlist is Windermere Rising Main, the in-catchment rising main, at £2,810m. The highest is the Barrow Tunnel Option, at £5,836m.

The common components are a large part of every option's cost. This is why the totals vary less than the conveyance choice alone would suggest, and why two options with very different routes can sit close together on total cost.

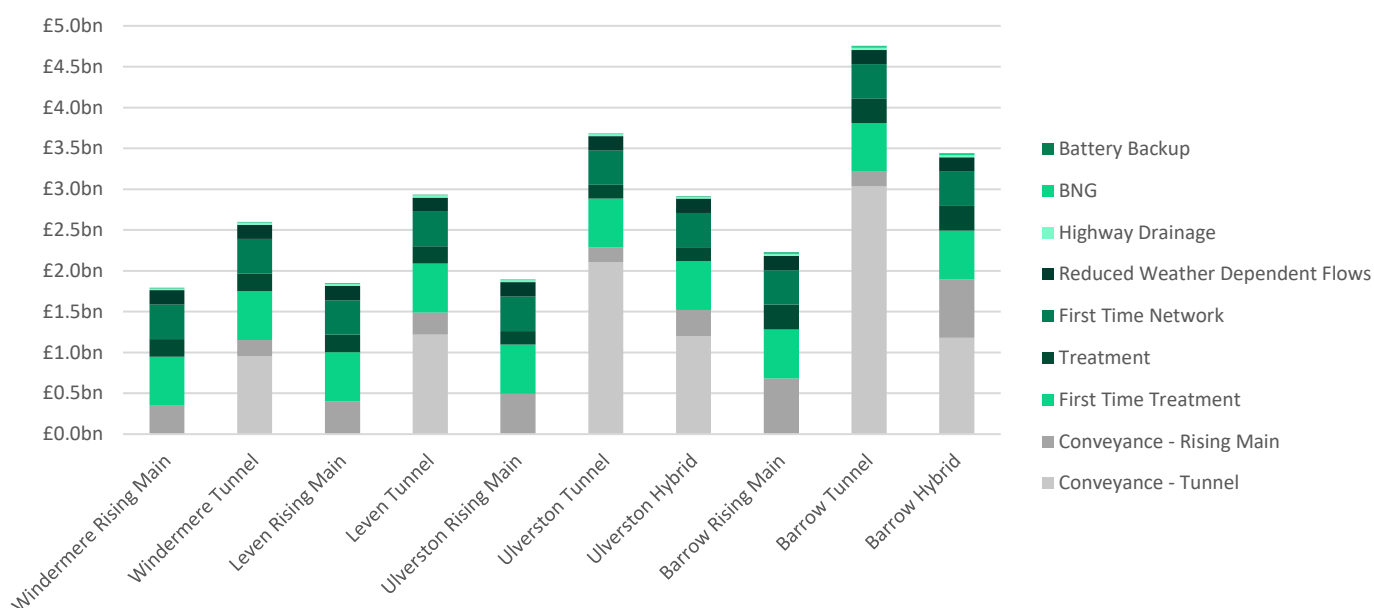
Due to the nature of the construction, a significant proportion of costs are common across all options, including:

- First time network
- First time treatment
- Highway drainage
- Reduced weather dependent flows.

These costs, amounting to ~£1.2bn CAPEX, do not influence option differentiation, meaning incremental differences are driven almost entirely by conveyance strategy and associated risk uplifts.¹⁵ In addition to this, the transfer works upstream of Windermere WwTW are also common to all options.

¹⁵ Whole life costs for these components have been aggregated and included in the total whole life cost for all options. This will be produced for the final Strategic Outline Case.

Figure 3.2: Total estimated construction costs breakdown by component, £bn 2025, PV – including Optimism Bias¹⁶



3.5 Summary of findings

Whole-life cost is the main point of difference between the options. The common components account for a large and broadly fixed share of total cost, so the differences between options come from the option-specific choices: conveyance method, route length, terminal location, pumping and operating requirements, construction duration, and the amount of asset consolidation each option allows.

Two patterns stand out:

- First, within each location the rising main is the cheapest option, the tunnel the most expensive, and the hybrid in between.
- Second, holding the method constant, cost generally rises with distance from Windermere, with the exception noted above for the Ulverston rising main. This is the case with one notable exception. The Ulverston hybrid, and Leven Tunnel option are broadly the same. The difference in whole life cost is driven by the higher construction and operational cost with the Windermere WwTW that the Leven option relies upon.

These results set the cost basis for the value for money judgement but do not select the most preferred option on their own. The cheapest options are the rising main variants, which Pillar 4 rates least favourably on deliverability. Cost and deliverability therefore point in different directions, and a lower whole-life cost does not make an option preferable where it carries greater delivery risk. The findings of this pillar are taken forward, with Pillars 1, 3 and 4, into the balanced judgement on the most preferred way forward.

The cost estimates represent the current concept design stage and are subject to further refinement as design, consenting requirements, ground investigations and delivery strategies are developed. Effective cost control will therefore be critical during subsequent stages of the programme, including maintaining scope discipline, reducing design uncertainty, engaging the supply chain early and actively managing project risks and contingencies.

¹⁶ Note: BNG stands for Biodiversity Net Gain

4 Pillar 3: Place-based and distributional effects

4.1 Purpose and scope

HM Treasury Green Book supplementary guidance (HM Treasury, 2026) recommends the incidence of costs and benefits across places to be assessed explicitly, since an aggregate net present value may conceal material differences in how impacts fall. This section presents an initial investigation of that analysis, alongside the aggregate assessment under Pillars 1 and 2. As the understanding of benefits and costs is improved, the place based distributional analysis should be refined as part of the development of the Outline Business Case.

The location of discharge determines which community hosts the long-term treatment infrastructure, but not the whole of the burden: the construction works (the in-catchment package and the conveyance corridor) fall substantially on the Windermere catchment under every option, and the focus of the long-term amenity benefit accrues there too – though as identified in the S2.4.1 assessment of amenity benefits, communities across the region and nation will all derive varying levels of amenity benefit from the lake's enhancement. What the distributional analysis must weigh primarily is where the long-term hosting burden falls relative to localised benefits, as distinct from the construction burden that is largely common across options and concentrated in the catchment.

The analysis seeks to understand several key factors related to infrastructure and the communities which are impacted by it - including:

- Whether and how the distributional dimension distinguishes between the host communities;
- What the burden (perceived or actual) and potential benefits are to those communities; and
- Whether place considerations differentiate between options.

In this context, "burden" should be understood broadly and is not limited to the physical presence of wastewater infrastructure. It may include, for example, the temporary effects of construction activity such as traffic disruption, noise, visual intrusion, spoil movements and impacts on local businesses and tourism, as well as longer-term considerations associated with hosting major treatment or discharge infrastructure. These could include changes to local amenity, landscape character, perceptions of place, future development constraints, operational traffic, environmental risks, or other effects that may be experienced or perceived by host communities. The significance of any such effects will depend on the detailed design, location and operation of options and has not yet been quantified. These matters should be explored in greater detail through stakeholder engagement and distributional impact assessment as part of Outline Business Case development.

As set out below, it does not by itself select the most preferred option, which is a matter for the balanced judgement across all four pillars; but it can make a more cost-beneficial option less preferable on place grounds.

4.2 Approach

For distributional analysis the three strategic options, and the Windermere options, impact three host communities and the degree to which these communities are impacted by these options is influenced by the characteristics which define those communities; the incidence of 'burden', and where benefit or community supporting economic activity may occur (addressed in section 4.5). The Windermere and Leven Options share the Windermere catchment (Windermere, Bowness and Ambleside – down to River Leven downstream of the weir at Newby Bridge), the Ulverston Option which impacts Ulverston, and the Barrow Option to Barrow-in-Furness. The engineering variants do not change the host community, so the analysis is structured by host location rather than by option.

The community profile of these areas is assessed from several primary sources:

- 2021 Census (ONS, 2021);
- Indices of Deprivation (IoD) 2025 (Ministry of Housing, Communities and Local Government, 2025); and
- Office of National Statistics (ONS) Small-Area Income Estimates (Financial Year Ending 2023) (ONS, 2025).

Indicators are at Lower Layer Super Output Area (LSOA) level, except age and income, which are published at Middle Layer Super Output Area (MSOA) level.

The ratings used for this analysis are presented in Table 4.1. Each option is assessed against the others in the shortlist, not against an absolute standard. A Red rating denotes that a stronger local benefit case is required, not that an option is unacceptable.

Table 4.1: Distributional effects rating definitions used for Pillar 3

Rating	Meaning
Green	Burden and benefit fall on the same host community, and the host is not nationally deprived, or sensitive to disruption
Amber	A mixed but defensible position: burden is exported to a community of comparable vulnerability, or a direct local benefit case is not yet established.
Red	Burden transferred to a host whose vulnerability is materially higher than the beneficiaries, and a direct local benefit case is not yet evidenced.

Each host community is characterised on four factors, applied consistently across the options. The full framework and decision rule, and rationale behind ratings are set out in the Appendix C to this Economic Case.

Table 4.2: Assessment factors

Factor	What it captures
Underlying vulnerability	The community's deprivation, health and income profile relative to the others.
Existing infrastructure burden	The treatment and discharge infrastructure the community already hosts.
Construction-disruption sensitivity	How exposed the community is to prolonged construction, given its economic base.
Burden-benefit alignment	Whether the community bearing the long-term burden also receives the key amenity benefit identified in Pillar 1.

Note: Construction disruption appears in three pillars for different reasons: Pillar 1 measures its disbenefit, Pillar 4 its delivery risk, and Pillar 3 its incidence, meaning which community bears it and how exposed that community is.

4.3 Distributional profile of the host communities

A comparative profile of the three host communities to inform the distributional assessment is set out in Table 4.3 across Windermere, Ulverston and Barrow, alongside the England benchmark. While the communities are broadly similar on many measures, the data highlight a small number of material differences that are relevant to the appraisal:

- The concentration of deprivation and poorer health outcomes in Barrow;
- Relative differences in economic activity and labour market between the communities; and
- Differences in income and age between Windermere and Barrow.

The analysis that follows focuses on these differentiating factors and their implications for how the long-term burden of each option aligns with community vulnerability.

Table 4.3: Verified community profile

Indicator	Windermere, Bowness & Ambleside	Ulverston	Barrow	England
65+ population share (age)	26.7%	22.2%	21.6%	18.6%
Median net annual household income	£33,384	£32,972	£31,141	~£37,100*
Households deprived 2+ dimensions	12.8%	14.6%	20.5%	18.2%
Households deprived 3+ dimensions	1.9%	2.8%	4.7%	4.0%
LSOAs in most deprived 10% (Ministry of Housing, Communities and Local Government, 2025)	0%	0%	18.8%	10%
LSOAs in most deprived 10% (health)	0%	0%	31.3%	10%
Residents in good/very good health	82.7%	80.9%	77.9%	~82%
Residents in bad/very bad health	4.4%	5.8%	7.2%	5.2%
Higher-skilled occupations (SOC 1–3) (ONS, 2020)	38.5%	46.1%	38.6%	~43%
Routine/manual occupations (SOC 8–9)	18.6%	16.7%	18.8%	17.5%
Qualified to NVQ Level 4+	37.2%	35.8%	24.8%	33.9%

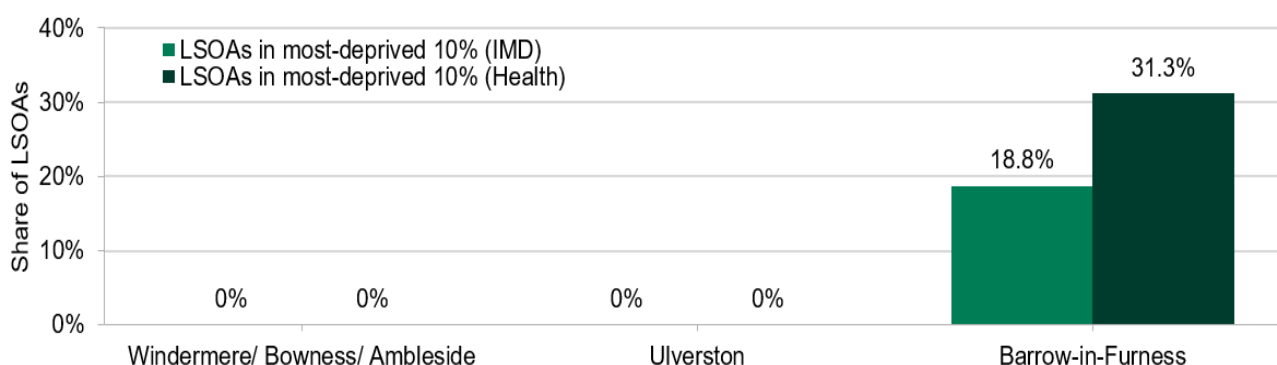
Source: 2021 Census (ONS, 2021), Indices of Deprivation (IoD) 2025 (Ministry of Housing, Communities and Local Government, 2025), Office of National Statistics (ONS) Small-Area Income Estimates (FYE 2023) (ONS, 2025),

*Note: England Average wage is a composite of multiple sources, which sit at an average of £37,100 annual income for England.

4.3.1 Concentration of deprivation

The Indices of Deprivation (Ministry of Housing, Communities and Local Government, 2025) provide the standard national measure of the geographic concentration of deprivation. The share of a community's small areas falling within the most-deprived decile nationally is a clear indicator of whether a community contains nationally significant deprivation. On this measure the three communities fall into two distinct groups rather than along a continuum. In Barrow, 18.8% of LSOAs fall within the most-deprived decile on the overall index and 31.2% on the health domain; in Windermere and Ulverston, no LSOAs fall within the most-deprived decile on either measure (Ministry of Housing, Communities and Local Government, 2025). This is the largest distributional difference in the evidence base and the principal point of differentiation between the Barrow option and the remaining options.

Figure 4.1: Concentration of deprivation: share of small areas in most-deprived 10% nationally



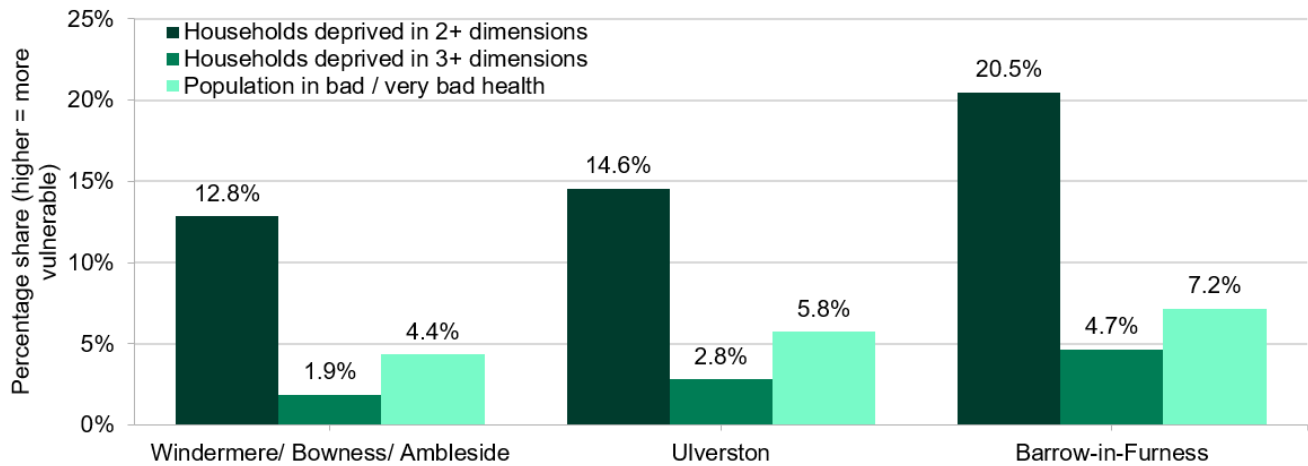
Source: Indices of Deprivation (IoD) 2025 (Ministry of Housing, Communities and Local Government, 2025)

4.3.2 Household deprivation and health

On multi-dimensional household deprivation and general health, the three communities form a gradient. Barrow is the most exposed on each measure: 20.5% of households are deprived in two or more dimensions, and 7.2% of residents report bad or very bad health, compared with 12.8% and 4.4% respectively in Windermere (Ministry of Housing, Communities and Local Government, 2025). Ulverston sits marginally above Windermere on these measures, but the difference is small relative to the difference between either community and Barrow. The evidence does not support characterising Ulverston as a notably deprived community; it indicates that Ulverston is

broadly comparable to the Windermere catchment, and that Barrow is distinct from the other two communities on these measures.

Figure 4.2: Community vulnerability profile



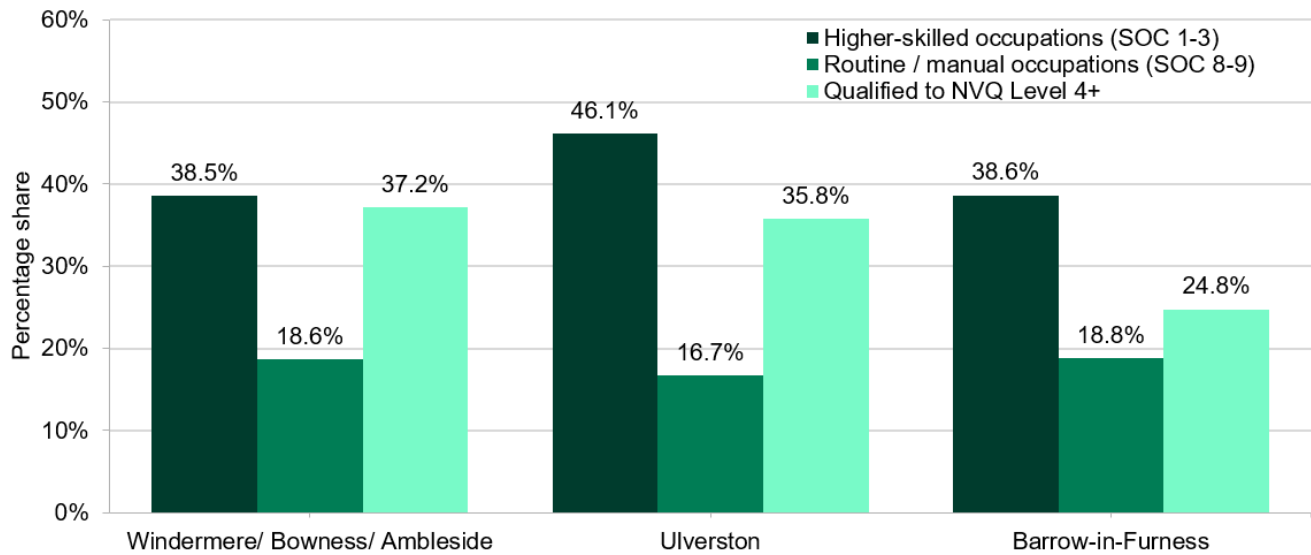
Source: Indices of Deprivation (IoD) 2025 (Ministry of Housing, Communities and Local Government, 2025)

4.3.3 Economic structure and labour market

The labour market is the one dimension on which the three communities differ in a way that differentiates options, because it governs whether construction employment could become a genuine local benefit. Employment is the principal channel through which hosting and building infrastructure could return direct benefit to a host community, and the skills composition of the local labour market determines whether construction and operational employment is captured locally or accrues to workers travelling from elsewhere. Ulverston has the highest share of higher-skilled occupations of the three communities (46.1%, compared with 38.5% in Windermere and 38.6% in Barrow) and a qualifications profile close to that of Windermere. Barrow has the lowest share of residents qualified to NVQ Level 4 or above (24.8%, below the national figure of 33.9%) and a labour market weighted towards manual and industrial occupations, with manufacturing accounting for approximately 18% of resident employment and construction approximately 8% (Ministry of Housing, Communities and Local Government, 2025).

Of the three communities, Barrow has the labour market structure with the greatest potential able to absorb sustained construction employment, which represents the most plausible basis for a direct local benefit under an export option. The capacity to absorb employment is, however, distinct from realised benefit. The extent to which construction employment would reach the relevant economically inactive cohorts depends on procurement and local-content arrangements that are to be established, and small-area industry data is available only for Barrow at this stage. It is notable that given the distance between Barrow and other locations, such as Ulverston; labour opportunities may support Barrow workers regardless of where the location of works is finally set.

Figure 4.3: Community economic structure and labour absorptive capacity



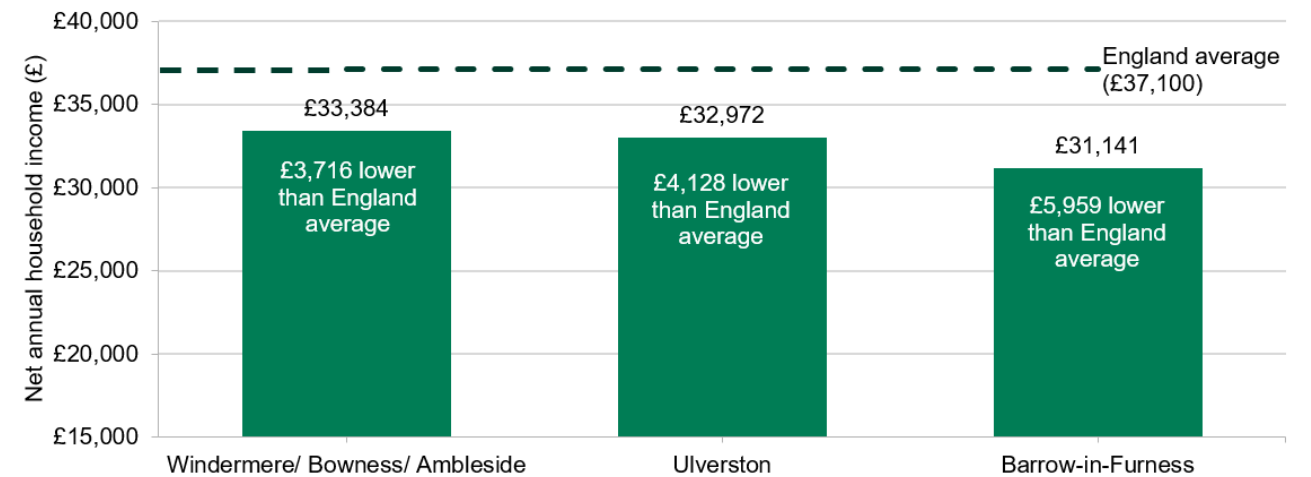
Source: Indices of Deprivation (IoD) 2025 (Ministry of Housing, Communities and Local Government, 2025)

4.3.4 Income and age profile

Annual income does not differentiate the host communities; this similarity is itself the finding. All three fall below the England figure of approximately £37,100, within a narrow band: Windermere at £33,384, Ulverston at £32,972 and Barrow at £31,141. Barrow is the lowest, at approximately £6,000 below the England figure but only approximately £2,000 below the other two communities (ONS, 2025).

Age is the exception that carries a consequence: Windermere has the oldest population (26.7% aged 65 or over, compared with 21.6% in Barrow (ONS, 2021)), which is material to its sensitivity to prolonged construction disruption in a tourism-dependent economy. That sensitivity informs the construction-disruption dimension of the distributional assessment (Section 2.4.5Error! Reference source not found.), while the magnitude of disruption and the associated delivery risk are assessed under Pillars 1 and 4 respectively.

Figure 4.4: Community median net household annual income compared to England (ONS financial year ending 2023)



Source: Office of National Statistics (ONS) Small-Area Income Estimates (FYE 2023) (ONS, 2025)

4.4 Distributional performance and its bearing on the assessment

The rising-main, tunnel and hybrid variants within a given location share the same host community and the same distributional profile, so the variants are indistinguishable on distributional grounds. The cost and delivery-risk differences between them are assessed under Pillars 1 and 4.

At Windermere, burden and benefit are aligned: the host of the long-term infrastructure is also the beneficiary, and the largely common construction burden falls on that same community. Ulverston hosts the exported infrastructure without being the primary beneficiary/or the first receiver of the benefit to the lake, but its vulnerability is comparable to Windermere's. Barrow also hosts without being the focal point of the primary benefit and is the only one of the three communities to contain nationally significant concentrations of deprivation and poor health (Ministry of Housing, Communities and Local Government, 2025). The ordering on distributional performance is therefore Windermere, then Ulverston, then Barrow.

Where an option performs more strongly on cost and benefits yet places the long-term burden on a more vulnerable host, its distributional performance counts against it: modestly for an export to Ulverston, materially for an export to Barrow. This is one input to the four-pillar judgement, not a ranking of the options, and it forecloses no option. One distributional matter remains outstanding: the absence of a confirmed direct local benefit case for Ulverston, which holds the Ulverston rating at Amber and is the principal item to resolve before Outline Business Case.

4.5 Place-based local economic effects

The options also generate local economic activity, in construction and operational employment and in additional visitor expenditure from an improved lake. These flows are excluded from the welfare cost-benefit assessment and the benefit-cost ratio, because at the national level they are substantially transfers rather than net welfare gains. They are set out here for a place-based reason rather than a value-for-money one: to show where the activity accrues, which turns out to reinforce the distributional asymmetry already identified. The activity concentrates on Windermere, the community that also captures the amenity benefit, rather than on the export hosts that carry the long-term infrastructure burden.

There is also the potential for new wastewater treatment works to unlock land development, and hence economic growth, in the host communities. This would be incumbent on evidencing that the existing works have insufficient capacity to support development demand.

4.5.1 Visitor-economy activity

Evidence supports that confidence in the Lakes status should support an increase in visitor numbers – raising the frequency of recreational visits. There is no directly applicable estimate of visitor response to a Water Framework Directive (WFD) class change. The closest available evidence as an indicative proxy. Börger et al. (2021), a contingent-behaviour study across 14 EU Member States, found that a one-level improvement in bathing-water quality is associated with approximately 6.7% more recreational visits per person per year. This figure relates to the Bathing Water Directive's classification rather than the WFD, and the two systems are not directly equivalent; it is used here only as an indicative guide to the order of magnitude of visitor response to a perceptible one-step improvement in water quality, applied illustratively to the modelled WFD improvement from Good to High set out in the Environment Agency's Nutrient Futures for Windermere report (Environment Agency, 2026). It should be noted that there is uncertainty with this estimate as it uses Bathing Water improvements (of which four are designated 'Excellent', in Windermere) as a proxy for what would happen with a change in perception from complete removal of wastewater input to the Lake.

On that indicative basis, applying an uplift of approximately 6.7% to the current visitor baseline of 3.5 million annual visits implies an increase in the order of 380 thousand additional visits per year once the improvement is realised. At an estimated £52.29 of visitor expenditure per visit, this is equivalent to additional visitor spending in the order of £8.75 million per year by 2050. This activity accrues to the Windermere lakeside economy under every option, because it follows the amenity improvement rather than the discharge location; it does not accrue to the export host communities. In place terms it reinforces the distributional asymmetry identified above: Windermere captures both the amenity benefit and the associated visitor activity, while the export hosts (Ulverston and Barrow) host the long-term treatment infrastructure without sharing in either.

Economic Case

These figures are presented as an indicative, place-based illustration of where economic activity accrues. They are an estimate of gross visitor expenditure, which at the national level is substantially a transfer, and are therefore not included in the welfare cost-benefit assessment or the benefit-cost ratio.

4.5.2 Construction and operational employment

The programme also generates employment: a temporary but multi-year increase during construction, and a smaller permanent baseline in operation. Based on the analysis; direct annual construction employment activity ranges from approximately £24.9 million to £86.2 million depending on the option and engineering method, with operational employment of approximately £11.0 million to £15.1 million per year thereafter. After standard additionality adjustments (12% leakage and 75% displacement), the net additional employment is materially smaller than the gross figure.

The degree of additionality is place dependent. Barrow has a strong industrial, engineering and manufacturing base, including a nationally significant defence sector (Barrow Rising, 2025). While this creates opportunities for local businesses and workers to participate in major infrastructure delivery, it may also mean a higher proportion of employment is drawn from an already active and skilled labour market rather than from currently unemployed residents. The extent to which construction and operational employment would result in net additional local economic benefits depends on future procurement approaches, workforce availability, upskilling and local-content commitments. The potential employment benefit is therefore recognised but is not currently relied upon in the ratings.

A further consideration applies to Barrow. Because this employment derives from construction and operational activity rather than from hosting the discharge, it does not require Barrow to host the infrastructure: where labour can travel to the works, the employment activity could in principle accrue to Barrow under options that do not place the long-term hosting burden upon it. This is a credible argument rather than an evidenced labour-market finding, but it indicates that the potential economic upside for Barrow and the distributional burden of hosting is separable: the upside need not be obtained by siting infrastructure in the most vulnerable host.

Taken together, the two strands fall in different places. Visitor-economy activity accrues to Windermere; construction employment accrues partly to a commutable distance from the construction corridor and the host community. Neither strand enters the welfare assessment; both are presented to complete the place-based picture and to indicate where a confirmed local benefit case might be developed.

4.5.3 Ulverston and Barrow local impacts

Potential growth-enabling effects were investigated as part of this assessment. Wastewater infrastructure can in principle enable housing and employment development where treatment capacity is a binding constraint on planned growth, a mechanism recognised in national policy (UK Government, 2025). The present assessment has not confirmed that treatment or permit capacity at Ulverston or Barrow constrains planned growth at either location. Accordingly, no direct, enabled, local growth benefit is assumed or credited in the appraisal.

However, there is clear evidence of ongoing industrial and development investment across the area, which may be supported by additional headroom. In Ulverston, this includes the planning intent for the North Lonsdale Road site following its acquisition by BAE Systems in October 2025 (BBC, 2025) and the Canal Foot opportunity identified in Appendix C to this Economic Case; in Barrow, the workforce growth and housing need set out in the ten-year plan for the town (Barrow Rising, 2025). Although wastewater infrastructure is one component of the infrastructure supporting growth, no evidence has yet been identified that additional treatment capacity provided through this programme is necessary to support currently planned development in either community.

If distributional rating for the host community. On current evidence, no such benefit is established and the ratings in Table 4.4 remain unchanged.

Should subsequent work identify a binding capacity constraint, the costs and benefits of providing additional headroom through ORiW should be assessed incrementally against the investment required to meet growth in the absence of the programme. Any confirmed programme-attributable benefit could inform the local benefit case and

4.5.4 Downstream communities and the Leven Estuary local impacts

For the Ulverston and Barrow Options, removal of the treated discharge from Windermere reduces the load conveyed via the River Leven to the Leven Estuary, a designated Ramsar site. Any resulting improvement for estuary-adjacent communities and for bathing and shellfish waters would improve, local amenity. The Pillar 1

assessment identifies – based on a high-level logic-based model; that at a minimum the removal and enhanced treatment would support prevention of deterioration at adjacent waterbodies to Ulverston and Barrow. This is the place dimension of effects assessed under Pillar 1 and will be tested through the downstream modelling identified for OBC.

4.5.5 Distributional ratings by option

Table 4.4 sets out the distributional rating for each option and its basis. The ratings are defined in Table 4.1 and inform the Pillar 3 column of the summary assessment in Section 6.1. They characterise the incidence of burden and benefit, but do not constitute a recommendation on option selection.

Table 4.4: Adopted Pillar 3 distributional rating by option

Option	Host location	Long-term burden–benefit position	Rating	Basis
Windermere Option	Windermere, Bowness and Ambleside	Burden and benefit fall on the same community; the host is not nationally deprived.	Green	Most closely aligned distributional position. Construction-disruption sensitivity is high (tourism economy, seasonal constraint) the community bearing the disruption is also the beneficiary. It should be noted that the average age is higher in this catchment; if material differences in disruption between the Windermere/Leven Options and Ulverston are evidenced; the rating would become Amber.
River Leven Option	Windermere, Bowness and Ambleside	Common host community; the discharge point moves to a small downstream community that may bear a localised effect without benefit.	Green	The equity consideration is limited and shares the Windermere profile.
Ulverston Option	Ulverston	Burden exported to a community of broadly comparable vulnerability to Windermere that does not receive the benefit.	Amber	The host is not nationally deprived (no LSOAs in the most-deprived decile). The consideration is the export of burden without benefit. Constrained to Amber by the absence of a confirmed direct local benefit case.
Barrow Option	Barrow	Burden exported to the most vulnerable of the three hosts; the host does not receive the benefit.	Red	Materially adverse: 18.8% of LSOAs in the most-deprived IMD decile and 31.2% in the most-deprived health decile; lowest income and qualifications. Potential construction-employment benefit is plausible but not yet evidenced.

Note on the basis of the ratings. The ratings reflect four factors applied consistently across the options: community vulnerability, existing infrastructure burden, construction-disruption sensitivity, and the long-term alignment of burden and benefit (Appendix C to this Economic Case). Construction-period disruption is included as a distributional factor because its incidence differs markedly between the host communities. This is distinct from, and complementary to, the assessment of its magnitude as a disbenefit under Pillar 1 and of the associated delivery risk under Pillar 4.

4.5.6 Evidence requirements for Outline Business Case

The following matters, if resolved, could affect the ratings, and are required for the distributional assessment to be completed at Outline Business Case:

- Further investigation to confirm a direct local benefit case (including any local construction-employment or local-development commitments from industry), which could materially strengthen the case for upgrading treatment capacity in either community.
- Stakeholder engagement and community representations, which the present quantitative analysis precedes, and which may refine the findings.
- Small-area industry data for Windermere and Ulverston (currently available only for Barrow), to enable the labour market assessment to be applied consistently across the three communities.

4.6 Conclusions

Based on initial analysis, the options may allocate an equivalent benefit and a comparable burden to different communities, and the distributional incidence therefore differs between them. The verified evidence suggests that the three candidate host communities are broadly similar, each being somewhat less affluent and somewhat older than the England average, except for the concentration of deprivation in Barrow, which is materially greater than in the other two communities.

The distributional analysis identifies some potential for distributional impacts to be a material differentiator between options, as well as factors which should be further investigated at a later stage of business case development. It finds, for host communities, that:

- the Windermere catchment, for the Windermere and Leven options are where burden and benefit are aligned – but the communities are potentially more sensitive to any disruption;
- the Ulverston option, where burden may be exported to a community of comparable economic development; and;
- Barrow, where burden may be exported to the only host containing nationally significant concentrations of deprivation and poor health.

Where an option performs more strongly on cost (Pillar 2) and benefit (Pillar 1) but places the long-term burden on a more vulnerable host, this weakens its overall position, relative to the Windermere and Leven Option; marginally in the case of Ulverston, and materially in the case of Barrow.

This distinction underpins the appraisal's preference (Section 0) for export to Ulverston over export to Barrow: the difference between the two is driven by the concentration of deprivation in Barrow rather than by any broad difference in affluence.

This finding is subject to an important qualification. Across most indicators, the differences between the host communities are relatively modest. The distributional case therefore turns primarily on the concentration of deprivation in Barrow and on the unresolved local benefit case for Ulverston, rather than on a generalised proposition of deprivation across the export hosts.

5 Pillar 4: Risk, resilience and deliverability

Scope caveat: pre-application engagement not yet undertaken. This assessment has been prepared without pre-application engagement with key regulatory bodies or approvers, including National Highways, Natural England, or the Planning inspectorate. Ratings rest on analysis of known constraints and the ORiW Deliverability Report (Jacobs Mott MacDonald, 2026d), and reflect what is known at this stage on currently available, largely open-source evidence. They are a current reading, not a settled position: early engagement with the statutory bodies is a prerequisite for the next stage. The relative positions set out below may change as the evidence matures.

5.1 Purpose and scope

Pillar 4 assesses risk, resilience and deliverability. It considers the extent to which each option can be consented, constructed and operated reliably over the 100-year appraisal period, and therefore the degree of confidence that the intended outcomes of ORiW can be achieved and sustained.

The focus of this assessment is on delivery confidence rather than value generation (Pillar 1). The shortlisted options are designed to deliver comparable long-term environmental outcomes; what differentiates them in this pillar is the probability of successfully realising those outcomes on programme and throughout the programme lifespan, given constraints in construction, consenting, and long-term operation.

The assessment therefore addresses a single question: *on current evidence, how do the options compare in terms of risk, deliverability and resilience over the life of the asset?*

This pillar informs the most preferred way forward, presented at this stage of the business case as part of a balanced judgement that considers value for money, place-based impacts and deliverability. It characterises where delivery risk concentrates, how the options differ on it, and what must be resolved before any option can be finally selected at the next stage. Because much of the consenting evidence depends on engagement that has not yet taken place, the assessment relies primarily on open-source information, construction evidence, and limited water-quality evidence. The ORiW Deliverability Report (Jacobs Mott MacDonald, 2026d) is the primary source for the construction and environmental-constraint evidence, complemented with water-quality modelling and assessment, further relevant documents are listed in the Pillar 4 appendix (Appendix D).

5.1.1 How this assessment works

Delivery confidence is assessed on three dimensions:

- **Constructability:** the complexity and risk associated with constructing each option, including site access, phasing, ground conditions and buildability.
- **Consent and water quality:** the complexity, risk and uncertainty associated with obtaining the required consents (though the assessment of this is only indicative at this stage), and discharge-permit and water-quality risk associated with each discharge, and the complexity of the consenting envelope.
- **Operational adaptability:** the reliability of operation, and the degree of flexibility preserved as standards tighten and the climate changes over the 100-year period; this related directly to critical success factors.

Two underlying variables determine these dimensions:

- The construction method (rising main, tunnel or hybrid); and
- the discharge and treatment location, which sets the receiving environment and the consenting envelope.

The assessment draws on water-quality and receiving-environment modelling, the engineering specifications and programme assumptions set out in the ORiW Deliverability Report, and expert input on construction, consenting and operational matters. Where a judgement rests on evidence that has not yet been tested with the statutory bodies, that limitation is stated.

The Pillar 4 delivery-confidence ratings are presented in Table 5.1. The ratings are used to describe each option's relative position on a dimension; they are judgement-based, not the output of a weighted scoring model, and are designed to inform discussion rather than to deterministically select or score options. The Pillar 4 scale is five-point because delivery confidence varies on a spectrum where half-steps carry information; this differs from the

three-point distributional scale in Pillar 3. The Pillar 4 delivery-confidence ratings are reported in Section 3 alongside the outputs from the other Pillars.

Table 5.1: Delivery-confidence rating scale used for Pillar 4

Rating	What it means
Green	Clearly lower risk than the alternatives, positively established on current evidence. No option reaches this threshold at SOC. Lower risk than most options on current evidence, subject to confirmations at the next stage.
Amber	Mixed but seemingly manageable; position comparable to the alternatives, with proportionate unresolved risk. Weaker than most options on current evidence, with a material unresolved risk on the dimension.
Red	Materially greater risk than all other options. Used here only for rising-main construction. A Red does not mean undeliverable: the Deliverability Report (Jacobs Mott MacDonald, 2026d) identifies no project-stopping issues at SOC.

5.2 Delivery context

Three constraints apply to every shortlisted option, as shown in the Deliverability Report (Jacobs Mott MacDonald, 2026d). They do not differentiate the options, since they apply to all, but they inform the interpretation of the option-level differences.

5.2.1 The northern catchment corridor is uniquely constrained

All options convey flows through the corridor between Ambleside, Bowness, Windermere WWTW and the southern end of the lake. The corridor runs through the Lake District National Park and UNESCO World Heritage Site (UNESCO, 2017) along the A591 and A592, which are principal tourist roads, which the Roads Authority is unlikely to allow or consent planned summer season road closures. Open-cut construction of a twin pipeline could require ten or more consecutive winter working periods; the longer Leven Option corridor could require at least fourteen (Jacobs Mott MacDonald, 2026d). This corridor is discussed further in the constructability and delivery section presented in Section 5.3.

5.2.2 The consenting environment is evolving

Environmental Impact Assessment is expected to be replaced by Environmental Outcomes Reports (Ministry for Housing Community and Local Government, 2026) within the programme's pre-application window, adding regulatory uncertainty for all options. Discharges to Morecambe Bay (the Ulverston and Barrow Options) bring Habitats Regulations Assessment (UK Government, 2017), a higher bar than conventional planning balance. There are a range of recent reforms (for example the Planning and Infrastructure Act 2025) and forthcoming reforms which may impact the degree of regulation on consents governing options. Therefore, on current evidence the consenting differences between options are described but, ahead of pre-application engagement, held provisionally.

5.2.3 The asset must perform across a changing climate for 100 years

The appraisal period for this programme is 100 years. UKCP18 projections (Met Office, 2018) show material increases in storm-flow intensity and coastal and tidal exposure in North West England over this horizon. A configuration that concentrates all exposure at one constrained site carries a different long-term risk profile from one that achieves structural separation to a larger estuarine receiving environment. That distinction drives the operational-adaptability dimension presented in Section 5.5.

5.3 Constructability and delivery

Relevance to delivery confidence. The programme passes through the constrained northern corridor, and the construction method determines whether delivery takes the form of a bounded two-to-three-year tunnel drive or an extended programme of seasonal open-cut working. It is the principal source of differentiation in the chapter, since it rests on construction logic rather than on consents that have yet to be tested.

Rising main (open cut) along the A591/A592 is regarded as potentially impracticable, as a primary method for the catchment section of any option, requiring substantial disruption to local and tourist traffic according to the

Deliverability Assessment (Jacobs Mott MacDonald, 2026d). The Deliverability Assessment states that highway authorities are unlikely to permit tourist-season closure, restricting work to roughly five months a year (October to March), so the catchment drive alone would extend across ten or more consecutive winters, and the longer Leven Option corridor across fourteen or more where a rising main is chosen. Each winter restart introduces remobilisation risk, contractor-retention risk, inflation exposure and prolonged consent uncertainty. Rising mains are also subject to greater route and construction uncertainty, due to reliance on open cut works within an existing highway corridor. The presence, condition and location of buried services are not yet fully understood. They may require additional utility diversions, redesign or activity creating higher uncertainty around cost and deliverability than the tunnel or hybrid.

Tunnelling removes the seasonal constraint, enabling year-round working; hybrid, which tunnels through the catchment and is open cut beyond, bounds the worst case to the catchment section and is available to the export options (export options being the Ulverston and Barrow Options which take effluent out of the catchment to Ulverston or Barrow).

Because a rising main may be impracticable, for the catchment section, every rising-main configuration carries a Red construction rating; hybrid and in-catchment tunnel options are rated as Amber. Tunnel export options rated as Amber/Green. The rating is therefore a function of method, broadly consistent across discharge locations, although the longer export corridors extend rising-main exposure further. The table covers all ten shortlisted variants assessed for programme risk, i.e. the risk of delay to the programme evidenced by frequency of closure and relative disruption impacts.

Table 5.2: Construction¹⁷ duration/disruption assessment

Option variant	Method	Construction duration/disruption	Rating
Windermere Rising Main	Rising main	Impacts catchment corridor; 10+ winters of seasonal open-cut construction; tourist-season closure required.	Red
Windermere Tunnel	Tunnel	Year-round construction; predictable timeframe; work will be focussed at the existing Windermere WwTW site.	Amber
Leven Rising Main	Rising main	20km Ambleside–River Leven downstream of the weir at Newby Bridge corridor closes key road; 14+ winters; undesirable as primary method.	Red
Leven Tunnel	Tunnel	Year-round construction; predictable timeframe; work will be focussed at the existing Windermere WwTW.	Amber
Ulverston Rising Main	Rising main	Catchment section undesirable, longest sustained downstream open cut beyond it.	Red
Ulverston Tunnel	Tunnel	Year-round construction; predictable timeframe; work will be focussed at the existing Windermere WwTW. Disruption not completely mitigated	Amber/Green
Ulverston Hybrid	Hybrid	Tunnel through catchment, open cut beyond where seasonal constraint does not combine, low risk of rising main disruption out of catchment.	Amber
Barrow Rising Main	Rising main	Catchment section impracticable; longest export corridor.	Red
Barrow Tunnel	Tunnel	Works able to progress year-round.	Amber/Green
Barrow Hybrid	Hybrid	Tunnel through catchment, open cut beyond; most complex terminal works.	Amber

Confirmation of the engineering method is the single most consequential delivery decision and should be taken early in the next stage of the programme development. The option-level dimensions that follow assume tunnel or hybrid as the recommended method. The construction and deliverability rating for every rising main option is Red.

¹⁷ In the context of this assessment, constructability assesses how options perform relatively in term of the extent to which they can be physically delivered within the constraints of the project environment, and the degree to which the construction method, programme exposure, working-space limitations and access constraints affect relative confidence in delivery

5.4 Consenting complexity and water quality

Relevance to delivery confidence. The discharge location determines two distinct matters: the water-quality risk associated with the discharge, and the complexity of the discharge permit consent required to authorise it. These do not necessarily move together and distinguishing them is essential to a sound reading of this dimension. The water-quality position is supported by monitoring and modelling and can be stated at this stage; the consenting-complexity position depends on engagement that has not yet taken place and is therefore held provisionally. However, further flow and water quality monitoring and modelling is recommended for the OBC stage before a preferred option can be confirmed.

The consenting position is likely to evolve substantially as the programme progresses through further design development, regulatory engagement and environmental assessment. At this stage, any assessment of consenting complexity should be viewed as provisional and indicative rather than determinative of consentability. While factors such as geographical footprint, interaction with designated sites and the overall scale of infrastructure can provide an indication of the likely complexity of the consenting process, greater complexity does not necessarily imply a lower likelihood of securing consent. More material at this stage is the relative water quality position of each option, including whether there is evidence of deterioration in the receiving water environment and the extent to which this may create consenting risk or constrain an option's ability to progress. The current assessment therefore places significant weight on water quality outcomes as an option cannot proceed without a discharge permit, while recognising that the understanding of consenting requirements and risks may change materially as engagement with regulators, additional evidence gathering and design maturity progress.

5.4.1 Consenting complexity (provisional)

The consenting envelope widens from the Windermere to the Barrow Option, a high-level assessment based on publicly available information is set out below demonstrating how complexity potentially increases with the scale of build (the 'envelope').

Taken together, based on current evidence and option design, the export discharges provisionally perform stronger on water quality but have higher consenting complexity due to a large footprint, while the in-catchment discharges have less consenting complexity (again in terms of footprint) but are more constrained on water quality performance and more exposed to future tightening of standards due to the site being less adaptable. This does not consider potential design adjustments which could mitigate risks – such as moving discharge location later (see considerations to be explored for OBC stage in section 6.4). The combined current reading is set out below.

- The Windermere Option has the narrowest envelope (in-catchment, with some key environmental constraints common to all options, including functional linkages with European designated habitats and WFD compliance considerations) but potentially the greatest exposure to future tightening of lake standards as Windermere's status draws regulatory attention (UNESCO, 2017).
- The Leven Option inherits that envelope and adds Leven discharge considerations (WFD and HRA (UK Government, 2017) as well as additional terrestrial habitat considerations south of the River Leven at downstream of the weir at Newby Bridge.
- The Ulverston Option presents a broader consenting envelope than the Windermere and Leven Option and adds the HRA consideration of discharge into the Morecambe Bay SAC/SPA (GOV.UK, 2017) though the use of the existing Ulverston outfall should limit direct construction impacts as is understood at this stage of the assessment. Modifications to this option which mitigate this risk should be considered at OBC stage (see section 6.4).
- The Barrow Option is considered to have the largest consenting envelope: the greatest multiplicity of European and national designations (GOV.UK, 2017) whilst the Deliverability Report identifies the construction of a new Barrow outfall as leading direct construction impacts on the Morecambe Bay SAC/SPA. This represents a key additional HRA impact pathway the implications of which would need to be discussed and tested with Natural England (as would all options).
- This does not consider potential mitigations to the performance risk associated with the Windermere Option. For example, a sequential build.

5.4.2 Water quality

All options are designed to stringent discharge standards¹⁸; the relevant questions are the degree of headroom each option leaves and whether any deterioration in receiving-water quality is implied. Overall, the Windermere and the Leven Option perform less favourably than the Ulverston and Barrow Options, due to the risk of not achieving the programme's objective and the risk of water deterioration to a degree which impacts future consentability (as is the case with the Leven Option, discharge into the Leven).

5.4.2.1 Key finding on Windermere discharge

The Windermere Option retains a treated wastewater discharge to Windermere and therefore may have a higher risk of not meeting the objective of the programme. In addition, it relies on sustained treatment performance to achieve the intended lake outcome over the appraisal period. The assessment identifies four considerations relevant to delivery confidence.

- **Reliance on advanced treatment performance.** The Windermere Option requires one of the most stringent wastewater discharge standards proposed for a UK wastewater treatment works. The proposed treatment process is intended to perform materially better than permit requirements and there is international precedent for comparable levels of performance. However, sustained delivery at this standard remains relatively unproven in the UK and therefore carries greater performance uncertainty than options which remove the wastewater discharge from Windermere altogether.
- **Dependence on a constrained site.** The Windermere WwTW is the most spatially constrained terminal in the shortlist. Future tightening of environmental standards, climate-related pressures or operational upgrades would need to be accommodated within the same site footprint. This limits flexibility to adapt the system over time relative to the export options, which benefit from greater separation between treatment location and receiving environment.
- **Continued dependence on treatment performance to maintain lake outcomes.** Current modelling indicates broadly similar average cyanobacteria and ecological outcomes across the shortlisted options. However, the Windermere Option remains dependent on long-term treatment performance at a sensitive lake discharge location to maintain those outcomes. By contrast, the Leven, Ulverston and Barrow Options remove the wastewater discharge from Windermere entirely, reducing reliance on treatment performance as the primary mechanism for protecting lake water quality.
- **Implications for bathing water confidence and public trust.** Windermere contains designated bathing waters and remains subject to significant public, regulatory and political scrutiny. Under the Windermere Option, maintaining confidence in lake water quality depends on sustained operational performance at a single treatment location. While compliance can be achieved, this creates a more visible and concentrated performance risk than options which remove the wastewater discharge from the lake altogether, under current proposed option designs.

Taken together, under current proposed designs, these factors suggest that the Windermere Option may perform worse against the core objective for the programme and additionally, is more dependent on sustained treatment performance and future adaptation of a constrained site, meaning it falls short of a core Critical Success Factor around future resilience. This provides less long-term resilience and flexibility than the viable options, particularly in the context of future regulatory change, climate uncertainty and the programme's objective of future-proofing Windermere.

5.4.2.2 Key finding on Leven discharge – Leven Option

The River Leven discharge downstream of the weir at Newby Bridge (Leven Option) carries early modelled deterioration in phosphorus and ammonia¹⁹ within the River Leven water body. Whether this is within consentable bounds is unclear. Current results are considered 'borderline' and present a real material risk of not being consentable which will require further testing at a next stage. Discharge to the River Leven will mean discharge at

¹⁸ The performance conditions proposed under each option are presented in Table 6-2 of the *Option Feasibility Report* (Jacobs Mott MacDonald, 2026a). The Technically Achievable Limits (TAL) are: 5mg/l for biological oxygen demand, 15mg/l for total suspended solids, 1mg/l for ammonium-nitrogen, 3-5mg/l for total nitrogen, 0.25mg/l for total phosphorus.

¹⁹Source: ORIw water-quality / receiving-environment modelling and Environment Agency bathing-water classifications. Bloom-recurrence, phosphorus and ammonia, and bathing-water figures to be cited to the modelling and classification sources at the next stage of programme development.

a new site increasing WFD compliance risk and the requirement for HRA on the Leven. Discussion with the EA suggests that more evidence would be required to determine whether this option would not be consentable. Consequently, preapplication process may improve or worsen the relative risk rating for this option.

5.4.2.3 Key finding on Ulverston and Barrow discharge – Ulverston and Barrow Options

The Ulverston and Barrow Options discharge to, estuarine or coastal receiving waters with greater assimilative capacity than Lake Windermere or the River Leven. Current evidence has not identified equivalent deterioration effects, but detailed flow and water-quality modelling is required to confirm the receiving-water impacts, available headroom and resilience to future standards at each discharge location.

5.4.2.4 Conclusion: consent and water quality

Based on the evidence set out above, export discharges perform more strongly on water quality, while in-catchment discharges are more constrained and more exposed to future tightening of standards.

Within this, the River Leven discharge (Leven Option) presents the most uncertain consenting position, reflecting modelled deterioration in receiving water quality. Whilst current modelling suggests that deterioration would not change the WFD class of the Leven (currently 'High'), there is an elevated level of scrutiny given it is a new discharge site, which may have additional HRA requirements. The Windermere Option retains a narrower consenting envelope but relies on sustained high treatment performance at a sensitive lake receptor with limited headroom. While remaining consentable, this creates a thinner margin for compliance and a higher residual risk to achieving and maintaining the programme objective. It also represents a weaker alignment with the programme objective and depends on long-term operational performance to maintain confidence in lake outcomes.

Export options (Ulverston and Barrow Options) benefit from greater assimilative capacity and no modelled deterioration, providing a stronger and more resilient water-quality position. They do, however, introduce a broader consenting envelope, including potential HRA requirements associated with Morecambe Bay and associated designations.

At this stage, the consenting position for the export options remains uncertain. The evidence required to demonstrate a materially more complex or lower-likelihood consenting outcome, through pre-application engagement on Morecambe Bay and the Roosecote outfall, has not yet been established. Consenting therefore remains the single largest provisional element within this assessment.

On this basis, consenting complexity is a marginal differentiator at this stage. The ratings below therefore place greater emphasis on relative water-quality risk performance.

Table 5.3: Consenting assessment

Strategic Option	Rating	Assessment
Windermere Option	Amber	Tight lake discharge permit at the leading edge of UK practice, with limited headroom and a marginally higher risk of algal-bloom recurrence than other options. The lake holds designated bathing waters classified Excellent, so the discharge relies on continuous UV disinfection to protect that status: a concentrated resilience exposure the estuarine discharges do not carry to the same degree of risk. Offset by the narrowest consenting envelope and no new HRA, but the most exposed to future tightening of lake standards. This risk is clear; however, this is under current option design; mitigations which may change this assessment should be considered at OBC stage.
Leven Option: River Leven south of the weir	Amber/Red	Rated Amber/Red because it is the only option for which current modelling indicates deterioration in receiving-water quality (phosphorus and ammonia in the River Leven), and it adds compliance complexity, through triggering further Leven WFD assessment and HRA. The significance of the potential water quality deterioration has not yet been established through regulatory engagement and may prove consentable. The rating reflects a weaker current evidence position, not a conclusion that the discharge is unacceptable. Even if confirmed consentable, it would remain the weakest water-quality position, since the Windermere Option avoids the Leven interface and the Ulverston Option carries no modelled deterioration.
Ulverston Option	Amber/Green	Estuarine discharge headroom and no modelled deterioration (best water-quality position). Morecambe Bay HRA and A590 designations widen the envelope, but the case is bounded, with no direct construction impact at the outfall.
Barrow Option	Amber	Shares the estuarine water-quality advantage, offset by the widest designations envelope of any option and possible direct construction impact at the Roosecote Sands outfall. It is rated Amber rather than Amber/Red because the evidence required to justify a materially worse rating, namely pre-application engagement on Morecambe Bay and the Roosecote outfall, has not yet been gathered; on current evidence the rating cannot be refined further, and the inability to do so is itself a material finding.

5.5 Operational adaptability

Relevance to delivery confidence. The asset must operate reliably and retain the capacity to adapt to tightening standards and a changing climate over the 100-year asset life. The principal distinction is structural separation: whether treatment remains concentrated at the constrained Windermere site or is relocated to a site with the spatial and receiving-environment capacity to adapt.

The Windermere Option discharge concentrates all treatment at the most constrained terminal, where ancient woodland, sloping topography and limited space (Jacobs Mott MacDonald, 2026d) mean that future growth or tighter standards would have to be accommodated on the same site, and all climate exposure falls on a single lake discharge. Based on the current design, this is the weakest operational and adaptability position, and the least amenable to futureproofing. Tighter standards or additional treatment would require in-situ retrofit on a constrained site, and operational resilience is concentrated at a single works. Whilst this is the case under current option design mitigations may be explored at a later stage of business case development, such as building an outfall to a different location at a later stage.

The Leven Option discharging downstream of the weir at Newby Bridge relocates the point of discharge to the River Leven but retains treatment at the existing Windermere WwTW, and so inherits the same constrained-site limitation as the Windermere Option: any future tightening of standards or growth in load must be accommodated by in-situ upgrade within the same restricted footprint, structural separation from the constrained terminal is not achieved, and operational resilience remains concentrated at a single treatment works, without the relocation optionality or added redundancy that an export terminal would provide. The greater dilution available in the Leven lowers the treatment standard required relative to the lake, which eases the capacity constraint at the works, but

this is a marginal easing of load rather than a resolution of the site's adaptability and resilience limitations. The Leven Option therefore combines a weaker discharge position (the modelled Leven deterioration discussed in Section 5.4) with the Windermere-site limitation and is on that basis less resilient than the export options.

The Ulverston discharge removes dependence on the Windermere site and benefits from greater assimilative capacity and headroom. The regional footprint is less constrained. However, longer conveyance increases pumping and power dependency, and the position depends on confirming terminal capacity, power and land requirements, including the planning status of the former GSK site at North Lonsdale Road (AOL, 2025).

The Barrow discharge presents the strongest regional-platform potential, but entails the largest single-asset commitment, the longest asset chain, and a coastal tidal-saltmarsh terminal that concentrates future climate exposure at a single point (Jacobs Mott MacDonald, 2026d).

Table 5.4: Operational adaptability assessment

Strategic Option	Rating	Assessment
Windermere Option	Amber/Red	Under proposed design all treatment remains concentrated at the most constrained site in the short list, with future growth, climate adaptation requirements and tighter environmental standards needing to be accommodated within a single treatment location. Weakest on futureproofing under current proposed design, due to site constraints, and if future adaptation revolves around adapting this site. However further mitigations could be explored at later at OBC, such as the build of outfalls to locations downstream as risk increases.
Leven Option: River Leven downstream of the weir at Newby Bridge	Amber/Red	Treatment remains at the constrained Windermere WwTW; and inherits many of the adaptability constraints as the Windermere Option. Relocating the discharge point provides some operational benefit but does not leave structural separation between treatment and the receiving environment.
Ulverston Option	Amber/Green	Structural separation, estuarine capacity and a contained but potentially expandable regional footprint. Contingent on confirmed Ulverston terminal capacity, power and land.
Barrow Option	Amber	Option 4 offers the greatest expansion potential, these advantages are offset by the longest asset chain, greatest pumping dependency and concentration of climate and operational exposure at a single coastal terminal.

5.6 Summary, ratings and conclusions

The ratings across the three dimensions are summarised below. The differences are evident but modest: no option component carries a red rating except where rising main is the construction method. The final ratings (table 5-6) are derived from previous evidence.

Table 5.5: Summary ratings by strategic option

Dimension	Windermere Option	Leven Option	Ulverston Option	Barrow Option
Constructability (tunnel/hybrid)	Amber	Amber	Amber/Green	Amber
Consent and water quality	Amber	Amber/Red	Amber/Green	Amber
Operational adaptability	Amber/Red	Amber/Red	Amber/Green	Amber

Table 5.6: Summary ratings by option variant delivery confidence

Variant	Method	Overall delivery-confidence position
Windermere Rising Main	Rising main	Red
Windermere Tunnel	Tunnel	Amber/Red
Leven Rising Main	Rising main	Red
Leven Tunnel	Tunnel	Amber/Red
Ulverston Rising Main	Rising main	Red
Ulverston Tunnel	Tunnel	Amber/Green
Ulverston Hybrid	Hybrid	Amber/Green
Barrow Rising Main	Rising main	Red
Barrow Tunnel	Tunnel	Amber
Barrow Hybrid	Hybrid	Amber

5.6.1 Evidence that would change the ratings

Key evidence gaps remain and affect the confidence of this assessment.

Ulverston WwTW (wastewater treatment works) capacity and permit headroom have not been confirmed on a basis that can be relied upon. Pre-application HRA (Habitats Regulations Assessment) scoping with Natural England for Morecambe Bay has not taken place. The consenting route remains uncertain, including whether the scheme would proceed through a Development Consent Order (DCO) or a Town and Country Planning Act (TCPA) application, and the associated environmental assessment requirements have yet to be confirmed. For Barrow, terminal ground conditions and the Roosecote outfall have not been investigated. The constraint data used in this chapter is largely derived from open sources and has not been validated with statutory bodies. The current ratings are therefore appropriate for this stage but remain subject to confirmation at a next stage as well as consideration of risk mitigations through design – recommendations on potential investigations that will support this are included in Section 6.4.

5.6.2 Conclusion

The Pillar 4 assessment identified differences between the shortlisted options across constructability, water quality and consentability, as well as operational adaptability. While all shortlisted options can deliver substantial improvements relative to the baseline, they do so through materially different system configurations and with different levels of resilience to future uncertainty.

The assessment identified greater delivery uncertainty for the rising main variants due to their reliance on prolonged open-cut construction within constrained highway corridors. These options are more exposed to buried-services risk, programme delay and disruption impacts than the tunnel and hybrid alternatives. This uncertainty affects confidence in delivery timescales and the timely realisation of programme benefits.

The Leven option remains a credible option and can achieve the programme objectives. However, like the Windermere Option, it retains treatment at Windermere WwTW and therefore remains dependent on future adaptation at the most constrained site in the shortlist.

The Windermere Option is required to maintain exceptionally high treatment performance throughout the 100-year appraisal period at the most spatially constrained site in the shortlist. While the proposed standard is considered achievable, future adaptation opportunities are more limited than for the export options should regulatory standards tighten or operational requirements change. Combined with the marginally higher risk of bloom recurrence identified in the modelling, this results in a lower level of confidence that the programme objectives can be sustained over the long term. The Leven Option provides some benefits through relocation of the discharge point but introduces a new discharge site with potential deterioration risks within the River Leven, creating additional consenting complexity.

The Ulverston and Barrow Options provide structural separation between wastewater treatment and the Windermere receiving environment, reducing dependence on the Windermere site and providing greater flexibility

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to accommodate future regulatory, environmental and operational change. Both therefore perform more strongly against the programme's Future-Proofing Critical Success Factor than the in-catchment alternatives.

Overall, the Ulverston Tunnel and Hybrid options perform most strongly across the combined Pillar 4 assessment criteria, providing the most favourable balance between constructability, water quality confidence and long-term operational adaptability. This is based on current evidence, and further evidence, as well as consideration of option design may alter this finding.

6 Economic Case: results, sensitivities and conclusion

6.1 Summary of results

At early stages of business case development, the purpose of the economic assessment is to confirm that a feasible shortlist offering value for money exists, and to identify a lead or most preferred option within it to focus further development. Final selection follows at Outline Business Case stage, on more detailed analysis.

This Economic Case has compared ten option variants against a common baseline of committed AMP8 investment: eight shortlisted variants spanning three discharge locations (the River Leven downstream of the weir at Newby Bridge, Ulverston and Barrow-in-Furness), each with rising-main, tunnel and, where available, hybrid conveyance, together with the Windermere Option in rising-main and tunnel form, assessed on the same basis.

The comparison uses the four-pillar framework set out in Section 1:

- Pillar 1 (Environmental and social value);
- Pillar 2 (Whole-life cost);
- Pillar 3 (Place-based and distributional effects); and
- Pillar 4 (Risk, resilience and deliverability).

Table 6.1 summarises the results of the economic case. Monetised benefits and whole-life costs are present values over the 100-year appraisal period, discounted, in 2025 prices, under the central scenario. Net present social value (NPSV) is PV benefits minus PV costs; the benefit-cost ratio (BCR) is PV benefits divided by PV costs. The central amenity valuation carries a sensitivity range of £5.6bn to £7.4bn across eligible options.

For Pillar 3, ratings reflect whether the long-term infrastructure burden falls on more vulnerable communities and whether that burden is aligned with the communities closest to the focal point of the principal benefits. For Pillar 4, ratings reflect relative confidence that the option can be delivered and continue to perform over the long term, taking account of engineering complexity, consenting requirements, programme risk, operational resilience and future adaptability.

Table 6.1: Summary of estimated economic case results

Option	NPSV (£m) Pillar 1 minus Pillar 2 (£m-2025)	BCR (Pillar 1 divided by Pillar 2)	Pillar 1 Monetised benefits (£m-2025)	Pillar 2 Whole life costs (£m- 2025)	Pillar 3 Place impacts	Pillar 4 Delivery Confidence
Windermere, rising main	+3,783	2.35	6,593	2,810	Green	Red
Windermere, tunnel	+4,149	2.14	7,778	3,630	Green	Amber/Red
River Leven, rising main	+2,882	1.99	5,787	2,904	Amber	Red
River Leven tunnel	+3,534	1.89	7,518	3,984	Amber	Amber/Red
Ulverston, rising main	+2,870	1.98	5,794	2,924	Amber	Red
Ulverston, tunnel	+2,850	1.61	7,514	4,664	Amber	Amber/Green
Ulverston, hybrid (most preferred)	+3,632	1.93	7,545	3,914	Amber	Amber/Green
Barrow, rising main	+2,328	1.68	5,770	3,442	Red	Red
Barrow, tunnel	+1,446	1.25	7,283	5,836	Red	Amber
Barrow, hybrid	+2,792	1.59	7,522	4,730	Red	Amber

Note on interpretation: Monetised Benefits and Whole Life Costs are present value (PV), discounted, 2025 prices, Central scenario from analysis completed. NPSV (net present social value) is PV Benefits minus PV Costs. BCR is PV Benefits divided by PV Costs. The Central-scenario amenity valuation carries a sensitivity range (£5.6bn to £7.4bn). Pillar 3 and Pillar 4 entries characterise distribution and delivery confidence respectively and do not by themselves select the preferred option.

6.2 Reading the results

Every assessed variant delivers a positive net present social value under the central scenario, with benefit-cost ratios ranging from 1.25 to 2.35. The evidence gathered to date on the shortlist therefore supports a value for money case for achieving the programme objectives, and the question for the remainder of this section is which option represents the best use of resources in delivering them.

Consistent with Green Book guidance, that question is not settled by the summary metrics alone. Value for money is a balanced judgement across monetised and unmonetised costs and benefits, the public sector financial impact, distributional effects, and the risk and uncertainty inherent in the proposal, including the chances of different degrees of success or failure in achieving the objectives (HM Treasury, 2026). All ten variants are carried through the analysis that follows on a common basis.

All variants considered, achieve a similar lake outcome; consequently, the key differentiators between them, are driven by conveyance method and discharge location.

6.2.1 Conveyance method

Conveyance does not depend on the choice of discharge location and variants differ substantially on cost and benefit. All rising-main variants, including the Windermere Rising Main, are potentially impracticable due to road expected road closures, and other disruption, as a primary construction method on the A591/A592 corridor (Section 5.3). Within each location the conveyance variants form an incremental sequence, rising main, hybrid, tunnel, representing increasing use of tunnelled construction.

At Ulverston, moving from the Rising Main to the Hybrid Option adds approximately £1.0 billion in whole-life cost and approximately £1.8 billion in monetised benefits, giving an incremental benefit-cost ratio of approximately 1.75. This principally reflects earlier benefit realisation arising from a shorter and more certain construction programme. Moving from the Hybrid to the full Tunnel Option adds approximately £750 million in whole-life cost without generating additional monetised benefits.

The analysis therefore supports tunnelling through the constrained Windermere catchment but provides less support, on monetised costs and benefits alone, for extending the tunnel beyond the catchment where rising-main construction through less constrained land and trenchless technology can avoid road closure. On current evidence, the Hybrid Option provides the strongest balance of cost and delivery confidence where it is available. Further design development is required to confirm the feasibility of the rising-main section and that material traffic, and community disruption can be avoided.

Pure Rising Main variants requiring road closures within the Windermere catchment are less preferred on value-for-money and delivery-risk grounds. The comparison of discharge locations therefore focuses on the Tunnel and, where available, Hybrid variants as the configurations with greater delivery confidence on current evidence.

6.2.2 Discharge location

Under central modelling, all assessed options are designed to eliminate cyanobacteria WHO10 exceedance in both basins and place the lake on a trajectory securing Good or High ecological status under future climate conditions over the long term. The modelled end states are similar; the options differ in the risk attached to achieving and sustaining them.

The Windermere Tunnel shows the strongest monetised position, with approximately £284 million lower whole-life cost than the next cheapest Tunnel or Hybrid option which removed treated effluent from Windermere. It is also the only option that retains a treated discharge into Lake Windermere: its outcome depends on sustained operation of a highly stringent treatment standard, at the most spatially constrained site in the assessment, over the full appraisal period, with future tightening of standards absorbed at the lake itself.

The options that remove the discharge achieve the outcome structurally rather than through sustained treatment performance alone and relocate treatment to sites with greater potential capacity to adapt. On current evidence and based on the proposed option designs, the Windermere Option's whole-life cost saving is accompanied by greater long-term performance risk against the programme objective. It is therefore less preferred than the export options.

Among the deliverable options that remove the discharge from the lake – achieving the highest likelihood of achieving the programme objectives - the Ulverston Hybrid Option has both the lowest whole-life cost (£3,914 million, against £3,984 million for the Leven Tunnel Option and £4,664 million for the Ulverston Tunnel Option)

and the highest monetised benefits, alongside the strongest delivery-confidence rating; the alternatives cost more and deliver less. Taking the four pillars together, the Ulverston Hybrid Option offers the strongest available balance of monetised performance, alignment with the programme objectives, distributional acceptability and confidence of delivery, and is identified as the current lead option.

6.2.3 Sequential decision logic which identifies the most preferred way forward

The assessment combines monetised evidence on environmental and social value and whole-life costs with qualitative assessment of place-based impacts, deliverability, resilience and future adaptability.

Conclusions are based on the overall balance of evidence. No single option performs most strongly against every criterion. Instead, the appraisal applies a sequential decision logic, with each question narrowing the preferred option set.

Table 6-2 summarises the key questions, the supporting evidence, and the implication of each for option preference; it should be read as a decision framework rather than a scoring matrix, as no single criterion determines the preferred option in isolation. These questions were discussed by the Steering Group, who have agreed that the most preferred way forward at this stage should be the Ulverston Hybrid Option – subject to further evidence and assessments which will be necessary at Outline Business Case stage.

Table 6.2 Sequential comparison and decision logic for selecting the most preferred way forward

Decision question	What the appraisal found	Implication for option preference
1. How do options compare in terms of performance for Lake Windermere?		
Do environmental outcomes for Windermere strongly differentiate between options?	All options are modelled as achieving a near removal of Cyanobacteria Bloom risk, characterised by WHO10 threshold exceedance over the long term. Achieving the programme objective requires the intended lake outcome to be sustained over the 100-year appraisal period. Based on current designs all shortlisted options deliver broadly similar modelled outcomes; the Pillar 4 assessment identifies a higher risk of the Windermere Option not achieving and sustaining that outcome. Potential design mitigations have not been assessed and should be considered at OBC.	The appraisal places greater weight on confidence that estimated outcomes can be sustained over the 100-year appraisal period, alongside resilience, future adaptability, deliverability, distributional effects and value for money. This means that the Windermere Option performs worse on water quality risk relative to other options – based on current designs. <i>Pillar 1 Environmental and social value</i> <i>Pillar 4 Deliverability and risk</i>
2. Which option provides the strongest confidence in delivery of the environmental outcomes for Lake Windermere?		
Should treatment remain at Windermere WwTW?	By discharging to the River Leven downstream of the weir at Newby Bridge, the Leven Option diverts treated effluent away from Lake Windermere but retains treatment at Windermere WwTW, the most spatially constrained treatment site in the shortlist. Under the option as currently defined, future growth, regulatory tightening and operational upgrades would need to be accommodated at that site. The Ulverston and Barrow Options relocate treatment to sites with greater potential flexibility to respond to future change. Future adaptability and resilience are therefore important differentiators in the appraisal.	Treatment and discharge of waste and stormwater at Ulverston or Barrow are more preferred over the Leven Option on future adaptability and resilience grounds. They provide structural separation from Windermere WwTW and remove dependence on the most constrained treatment site in the shortlist. The Leven Option does not carry the same adaptability advantage, though it remains a credible option. <i>Future adaptability and resilience captured in Pillar 4</i>

Decision question	What the appraisal found	Implication for option preference
Does the discharge location affect long-term confidence?	The discharge locations present different confidence profiles: Windermere Current modelling indicates broadly similar average lake outcomes, but the Pillar 4 assessment identifies greater reliance on sustained treatment performance at a stringent permit level. River Leven: This would introduce treated effluent at a new discharge location. Current modelling identifies a potential Water Framework Directive no-deterioration concern requiring further assessment and regulatory engagement. The associated treatment requirements also result in higher estimated operating costs than the Ulverston and Barrow discharge locations. Ulverston: This uses an existing discharge location in the Leven Estuary, which has greater assimilative capacity than the River Leven. Current evidence has not identified equivalent deterioration effects, but further receiving-water modelling is required. Barrow: This uses an existing marine discharge location in Morecambe Bay with substantial assimilative capacity. Current evidence has not identified equivalent deterioration effects, but further receiving-water modelling is required.	The Windermere and The River Leven discharge location carry additional receiving-water and cost uncertainty that further weakens the Windermere and Leven Option relative to the Ulverston and Barrow Options. The cumulative confidence case across Stage 2 strengthens preference for options that relocate both treatment and discharge from Windermere. <i>Receiving-water risk and resilience captured in Pillar 4</i>
3. Which out of catchment option performs best?		
Which out-of-catchment option performs best?	All Ulverston and Barrow variants (Tunnel, Rising Main and Hybrid) achieve the strategic benefit of relocating treatment and discharge away from Windermere. The distributional assessment distinguishes the two based on the anticipated potential infrastructure burden placed on the respective host communities and the strength of the local benefit case. Ulverston presents a manageable distributional trade-off and lower whole-life costs, lower whole life carbon, than the Barrow variants. For Barrow, the infrastructure burden falls on the community with the highest vulnerability and deprivation in the shortlist, and the local economic benefit case has not yet been sufficiently evidenced to offset this.	Ulverston provides the strongest estimated overall balance of strategic fit, distributional acceptability and value for money among the relocated-treatment locations based on the analysis. This is a positive case for Ulverston, grounded in distributional and cost evidence, rather than simply a case against Barrow. This narrows preference towards the Ulverston Options. <i>Distributional/place based, impacts considered in Pillar 3</i>
Why Tunnelling and Hybrid approaches are preferred	Rising-main variants typically contain materially greater delivery risk from reliance on prolonged open-cut construction through constrained corridors. Construction on the A591 and A592 along the eastern Windermere shore and through Bowness town centre would require road closures could disrupt local communities. This creates buried-services risk, programme delay and consenting uncertainty. Tunnel and hybrid variants reduce this estimated exposure by avoiding reliance on open-cut construction through constrained highway corridors.	Tunnel and hybrid variants provide stronger estimated delivery confidence than rising-main alternatives. This narrows preference towards the Ulverston Tunnel and Hybrid Options. <i>Delivery risks, and disruption considered across Pillars 1 and 4</i>

Decision question	What the appraisal found	Implication for option preference
Why the Ulverston Hybrid rather than the Ulverston Tunnel Option?	The Ulverston Tunnel Option carries a higher estimated whole-life cost (£4,664m PV, 2025) than the Ulverston Hybrid Option (£3,914m PV, 2025). The Ulverston Hybrid Option uses a hybrid approach combining a tunnel section with a rising-main section running south of Haverthwaite through less constrained farmland. Further engineering assessment supported that this section may be delivered using trenchless techniques including micro-tunnelling, pipe jacking and directional drilling, avoiding the highway constraints that drive delivery risk elsewhere. This should be tested further and confirmed at OBC stage.	The Ulverston Hybrid Option achieves a stronger balance between estimated delivery confidence and value for money than the Ulverston Tunnel Option. The hybrid rising-main section does not carry the estimated delivery risk associated with rising-main variants elsewhere, because it runs through a less constrained corridor using trenchless construction. The Ulverston Hybrid Option is preferred over the Ulverston Tunnel Option. <i>Cost and delivery confidence considered across Pillars 2 & 4</i>
How does the best performing out of catchment option compare against the Windermere Option	The Windermere Option retains a treated discharge to Lake Windermere. It is nevertheless assessed in full against the appraisal framework. The appraisal finds that, while it performs strongly against several criteria, it provides lower estimated delivery confidence, future adaptability and long-term resilience than the options that relocate treatment and discharge away from Windermere. However, later stages of business case development should consider mitigations to this risk.	The Windermere Option is retained as a benchmark within the appraisal. It is presented for reference to illustrate the implications of retaining, rather than removing, the treated wastewater discharge to Lake Windermere. <i>Resilience and adaptability considered in Pillar 4.</i>
Ulverston Hybrid Option as the most preferred way forward	Based on evidence assessed, the appraisal does not identify a single option that performs most strongly against every criterion. Instead, the evidence points to a sequential option preference logic. It emerges that Rising Main solutions may cause a level of disruption which renders them impracticable. Relocating treatment and discharge of wastewater away from Windermere WwTW provides greater estimated long-term confidence and programme alignment. Relocating treatment from away from Windermere WwTW may provide greater future adaptability and resilience. Among the options that relocate both treatment and discharge, Ulverston performs more favourably than Barrow on estimated distributional and cost grounds. Within the Ulverston options, tunnel and hybrid conveyance provide greater estimated delivery confidence than rising-main alternatives, and the Ulverston Hybrid Option provides a stronger balance between Value for Money, delivery confidence and whole-life cost than the Ulverston Tunnel Option. On this basis, the Ulverston Hybrid Option provides the strongest overall balance across the appraisal pillars and is identified as the most preferred way forward , subject to further development at a later stage. This is potentially followed by the Leven Option, and then the Windermere Option.	

6.3 Sensitivity analysis and uncertainties

Sensitivity analysis tests whether the most preferred option, the Ulverston Hybrid Option, remains robust under plausible variation in the assumptions most material to the appraisal. Consistent with Green Book guidance (HM Treasury, 2026), the purpose is to test value for money which has a broad definition, including performance against objectives, place, and risk – as well as whether uncertainty could alter the balance of evidence that supports the most preferred way forward (see Section 1 for the full definition). The analysis distinguishes two kinds of uncertainty: quantitative uncertainty in the appraisal assumptions, which can be tested through sensitivity analysis, and strategic uncertainty, where the evidence required to settle a question has not yet been gathered (Section 6.3.3). The quantitative tests focus on the assumptions that combine the greatest influence on the result with the greatest uncertainty at this stage. Two assumptions meet that test for the most preferred option:

- The amenity social value, which drives the dominant benefit and rests on a benefit transfer pending the primary valuation study; and
- Construction cost, where estimates are at concept design stage and the optimism bias assumption is itself, a judgement tested against reference-class evidence.

Each test is an illustrative stress, not a forecast, and because the principal uplifts apply consistently across the shortlist, the tests bear on the absolute strength of the case rather than the ranking of options.

6.3.1 Switching values

Table 6.3 presents the change in each key assumption required for the Ulverston Hybrid Option to achieve a BCR of 1.0, the point at which benefits equal costs, under the central scenario. The corresponding thresholds under the low and high scenarios are also shown.

Table 6.3: Switching values to BCR dropping to unity (1.00), Ulverston Hybrid (central scenario)

Parameter	Central value	Value at BCR = 1.00	Required change	Assessment
Whole-life cost (£m PV)	3,914	7,545	+3,632 (+93%)	Substantial headroom; would require costs to nearly double after 66%/44% optimism bias already applied
Construction cost (£m PV)	2,914	6,546	+3,632 (+125%)	Substantial headroom; exceeds the reference-class 80 th percentile probability overrun (see Section 6.3.2)
Core national household benefit from securing the environmental quality of the lake (£/hh/yr)	25.26	12.67	-12.59 (-50%)	Switching value sits below the evidence-based lower-bound transfer value of £16.27

The above table shows the variation required from central assumptions in order that the costs equal the benefits for the Ulverston Hybrid option. It should be noted, that for the core national household benefit, the social value, would need to reduce to £12.59 per household for residents close to Windermere. This sits below, the lower-case sensitivity of £16.27 per household, showing that a variation in the central benefit estimate would need to be below the lower sensitivity we have presented; for the option to cease to be cost beneficial. The implication is that the cost beneficially of the project, considering social value for households, is robust; however, given the uncertainties associated with transfer

6.3.2 Optimism bias sensitivity and whole-life cost range testing

The appraisal applies the Green Book upper-bound optimism bias uplifts unreduced: 66% on initial construction (non-standard civil engineering) and 44% on replacement and maintenance (standard civil engineering). The closest published reference-class analogue for early-stage tunnelling-led infrastructure is the DfT/Oxford Global Projects (2021) Fixed Links class. This evidence indicates an average cost overrun of around 55% at Strategic Outline Business Case stage, while the higher end of observed outcomes is considerably larger, at around 123%. The applied 66% construction uplift therefore already exceeds the average historical overrun. The stress test examines a more severe scenario by increasing the construction optimism bias uplift from 66% to 120%, broadly consistent with the higher-end outcomes observed in the reference-class evidence. A compound variant applies the same 120% uplift across construction, replacement and maintenance. As the Fixed Links evidence relates to construction costs rather than lifecycle costs, this is presented as a deliberate compound stress test rather than a reference-class-based assumption.

Table 6.4: Optimism bias stress tests, Ulverston Hybrid (BCR by scenario)

Test	Low	Central	High
As appraised (66% construction / 44% R&M)	1.20	1.93	2.25
Construction OB increased to 120% (~RCF80)	0.96	1.55	1.81
Compound stress: 120% on construction and R&M	0.89	1.43	1.67

Under central assumptions, the identified preferred option remains value for money under both the optimism bias and whole-life cost stress tests. The BCR falls from 1.93 to 1.55 under the construction optimism bias stress and to 1.43 under the compound optimism bias stress (Table 6.4).

A separate whole-life cost range test demonstrates that the option remains above a BCR of 1.0 under a 50% increase in whole-life costs in accordance with AACE Class 4 estimates (AACE, 2020), with the central BCR reducing to 1.29, while a 30% reduction in whole-life costs increases the central BCR to 2.75 (Table 6.5). The ranking of options is unchanged because the cost uplifts apply consistently across the shortlist. Only when severe cost escalation is combined with the lower-bound benefit valuation does the BCR fall below 1.00.

Table 6.5: Whole-life cost range testing, Ulverston Hybrid (BCR by scenario)

Test	Low	Central	High
As appraised	1.20	1.93	2.25
Whole-life cost (+50%)	0.80	1.29	1.50
Whole-life cost (-30%)	1.71	2.75	3.21

6.3.3 Strategic uncertainties: evidence still to be gathered

A second class of uncertainty cannot be tested by varying appraisal parameters, because it concerns evidence that has not yet been gathered rather than assumptions that might vary. These strategic uncertainties do not lend themselves to switching values; they are resolved by the evidence programme. The material items are:

- The significance of the modelled River Leven deterioration, which determines whether the Leven Option consenting position is as constrained as currently assessed;
- Pre-application engagement with the statutory bodies, on which every Pillar 4 consenting rating is provisional; confirmation of Ulverston terminal capacity, permit headroom, power and land requirements, including the status of the former GSK site; and
- The Environment Agency WEBS methodology update, on which the other waterbodies benefit values currently rest in draft form; and the consenting route itself (DCO, TCPA or the incoming Environmental Outcomes Report regime).
- Detailed engineering design which confirms that the Ulverston Hybrid option does not cause road/traffic disruption.

None of these items, on current evidence, point away from the most preferred option, but each could alter the balance of evidence at Outline Business Case, and they collectively define the evidence programme set out in Section 7.

6.3.4 Interpretation

Under central assumptions the economic case carries substantial headroom: costs would need to nearly double, or outturn to exceed the reference-class P80, or the core valuation assumption to fall below its evidence-based lower bound, before benefits no longer exceeded costs for the most preferred option. The case is challenged in a low-benefit scenario, where the BCR of 1.20 (Table 6.4) demonstrates that under these constraints, the central scenario remains above unity. The low scenario combines lower-bound valuation assumptions with unchanged costs and therefore represents a downside stress rather than the central expectation. This is an important analytical vulnerability in the Economic Case and underlines why the primary social value study is identified as evidence to consider for the Outline Business Case (Section 7); as it will convert the appraisal's principal assumption from a transferred value into direct evidence before the preferred option is confirmed.

6.3.5 Conclusion - a feasible short list to take forward to a next stage of assessment, and a lead or most preferred way forward

The assessment confirms a feasible shortlist offering value for money: every assessed variant delivers a positive net present social value under the central scenario. The shortlisted options deliver broadly similar environmental outcomes for the lake; differences in monetised benefits are driven principally by delivery timing, with options that can be implemented sooner realising benefits earlier and therefore achieving higher present values under the discounting framework. The appraisal therefore places weight on resilience, future adaptability, deliverability, distributional effects and value for money.

The Windermere Tunnel carries a lower whole-life cost than the Ulverston Hybrid Option, approximately £284 million lower in present value terms, but it is the only option that retains a treated discharge into Lake Windermere, relying on sustained treatment performance at the most constrained site in the assessment over the full appraisal period. On current evidence that cost advantage is accompanied by a higher long-term performance risk to the programme objective, and it is not identified as the lead option.

Among the options that remove the discharge, the Ulverston and Barrow Options are superior to the Leven Option on resilience and future adaptability grounds: they establish new treatment capacity with greater flexibility to respond to future growth, regulatory change and operational requirements. The Leven Option remains a credible option capable of achieving the programme objectives, but it continues to rely on treatment at Windermere WwTW and is associated with modelled receiving-water deterioration and the consenting uncertainty that follows. Mitigations for these risks should be considered at OBC stage – see section 6.4.

Between these options, Ulverston performs more strongly than Barrow on distributional and cost grounds. Within the Ulverston options, tunnelled and hybrid conveyance provide greater delivery confidence than rising-main alternatives, and the Ulverston Hybrid Option provides a comparable level of delivery confidence to the fully tunnelled option at approximately £750 million lower whole-life cost. This is consistent with the incremental analysis in Section 6.1: the step from rising-main to tunnelled construction through the constrained corridor is justified by earlier benefit realisation, while extending tunnelling beyond the corridor adds cost with no additional monetised benefit.

No single option performs most strongly against every criterion. Taking account of the evidence across the four appraisal pillars, the Ulverston Hybrid Option provides the strongest overall balance of environmental outcomes, resilience, deliverability, distributional acceptability and value for money, and is identified as the most preferred way forward at the current stage.

This position remains subject to the strategic uncertainties identified throughout the Economic case and the associated evidence requirements recommended in 6.4. None of the outstanding evidence requirements is currently judged to undermine the case for progressing the Ulverston Hybrid Option as the most preferred way forward; collectively, they define the principal evidence programme required to confirm, refine or amend the preference through further assessment at Outline Business Case.

6.4 Next steps

6.4.1 Validation and evidence development

Progression of the Economic Case to or at the Outline Business Base (OBC) stage is dependent on several activities that underpin key assumptions and drive the robustness of the appraisal:

- **Amenity valuation.** Completion of the primary valuation study represents a critical activity, given the sensitivity of the value for money assessment to this assumption. The study should undertake local, regional and national research to validate the current benefit-transfer methodology and test the geographical reach of benefits associated with improvements to Lake Windermere. The research should specifically examine:
 - the extent to which social value varies with distance from Windermere;
 - the influence of household income distribution on social value estimates;
 - the relationship between tourism, recreation and amenity values and the potential for overlap between benefit categories; and
 - customer affordability and acceptability including willingness to pay in the context of increasing household water bills and other household costs.

The results should be used to confirm, refine or replace the current distance-decay, income-adjustment and wider benefit assumptions adopted within the Economic Case, providing a stronger evidence base for the Business Case. Benefits should also be assessed using a method similar to that used for assessing the Water Industry National Environmental Programme (WINEP).

- **Water quality and modelling assurance.** Further development and validation of modelling outputs is required to confirm the relative performance of options and test key sensitivities such as climate change; this includes further flow and freshwater and coastal water quality monitoring before more detailed water quality modelling of all receiving water to confirm conclusions drawn at this stage. This will also support the discharge permit pre-application process.

- **Receiving water and consenting evidence.** Development of the evidence base for downstream impacts is necessary to support findings in this Economic case and to support pre application, and application processes for discharge.
- **Discharge consent** pre-application process undertaken for discharge sites being considered.
- **Distributional and local economic impacts.** Strengthen the evidence base for place-based and distributional effects, including confirmation of the direct local benefit case for the Ulverston and Barrow host communities, alongside assessment of wider economic impacts.
- **Customer affordability and acceptability.** Undertake bespoke customer research, aligned with Ofwat and CCW guidance, to assess affordability, acceptability and social value. A positive benefit-cost ratio should not be assumed to indicate majority customer support.
- **Conduct of any necessary statutory tests** including testing of options against further DEFRA or regulatory environmental standards
- **Engaging with statutory and other stakeholders** on consenting requirements.
- **Testing of further sensitivities** including test of the appraisal outcomes under a WINEP aligned methodology.
- **Independent review** of the optioneering process, option design

6.4.2 Preferred option refinement

The following activities should be undertaken to optimise the current preferred option, reduce identified risks and improve confidence in the preferred approach before confirmation at OBC stage:

- **Engineering definition and construction approach.** Confirmation of key engineering assumptions, including conveyance approach, will influence cost, disruption, programme risk and the balance of appraisal outcomes.
- **Option design optimisation and efficiency testing.** Further develop and test strategic options, their scope, design or delivery approach to identify opportunities to mitigate risks identified in this Economic Case. It is recommended that investigation is conducted into whether options can be modified to manage risks identified, for example whether outfall locations can be changed over time. This should include assessment of a sequential adaptive approach to delivery of the infrastructure as well as refinements to the Ulverston option to treat Windermere transfer flow only.
- **Consider refinement of options** based on updated analysis and emerging evidence.
- **An assessment of the need for compensatory water abstraction** for each strategic option.

6.4.3 Future programme development

Further work will be required to strengthen the robustness of the cost, risk and wider programme assumptions and support development of the Business Case:

- **The approach for writing off decommissioned assets** will need to be agreed with Ofwat.
- **Cost and risk development.** Refine capital and operational cost estimates, including development of more detailed assumptions, quantification of risk and uncertainty, and refinement of optimism bias.
- **Whole-life carbon assessment.** Further develop and validate whole-life carbon estimates, including refinement of construction and operational emissions and alignment with policy and carbon pricing assumptions.
- **Support to programme development.** Provide economic input to ongoing programme development, including refinement of options, testing of assumptions and support to decision-making. This includes a robust assessment of the pre-construction development programme.
- **Monitoring and evaluation framework.** Further develop the approach to monitoring and evaluation, development of a Theory of Change and defining how benefits will be measured, tracked and evaluated over time.

Economic Case

These activities will support development of a more robust and assured Economic Case, enabling confirmation or redesign and reselection of the preferred approach, strengthened evidence of value for money, and greater confidence in deliverability and outcomes as the programme progresses to the next phase.

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