United Utilities

Environmental and Social Costs of Water Resources Management Plan 2019 Manchester and Pennine Resilience Options

Revised Final Report (Redacted)

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Amec Foster Wheeler Environment
& Infrastructure UK Limited

Report for

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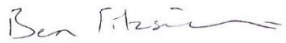

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1. Introduction

1.1 Overview

United Utilities is currently finalising its Water Resources Management Plan 2019 (WRMP19). Once approved, the WRMP will set out the strategy for water resource and demand management to ensure supplies of safe, clean drinking water are maintained to customers throughout the company's region over the period 2020 to 2045 and beyond.

United Utilities published its Draft WRMP for consultation between 2nd March and 25th May 2018. The Draft WRMP set out United Utilities' Preferred Plan for WRMP19, including preferred resource management and demand management options designed to enhance leakage reduction, improve levels of service for drought permits and orders and support water trading. These were based on a number of strategic choices for consultation on the plan. United Utilities also identified, and included in its Draft WRMP, five solutions to address the resilience risks associated with the regional aqueduct system (which transfers water from the Lake District to supply the Manchester and Pennine areas including south Cumbria and Lancashire). At that stage, United Utilities' preferred Manchester and Pennine Resilience solution had not been determined.

In this context, and as part of the process of selecting the preferred Manchester and Pennine Resilience solution, Amec Foster Wheeler Environment and Infrastructure UK Ltd (Amec Foster Wheeler, now Wood) was commissioned to undertake an assessment of the Environmental and Social Costs (E&S costs) of the five potential solutions identified by United Utilities and their component resilience options. The E&S costing was undertaken to present the scale of environmental and social impact of the various options and solutions. In doing so, it helped to inform the selection of the preferred Manchester and Pennine Resilience solution (Solution D).

This document presents the E&S costs (valuation) of the Manchester and Pennine Resilience solutions. The assessment supplements the report 'Environmental and Social Costs of Water Resources Management Plan 2019 Supply-Demand Options' (August 2018).

1.2 United Utilities' Revised Draft Water Resources Management Plan 2019

Draft Water Resources Management Plan 2019

In developing the Draft WRMP, United Utilities forecast the future demand for water and available supply (the supply-demand balance) for the 25 year period to 2045. The baseline demand forecast was calculated using the latest data, tools and methods including the current population and local authority growth forecasts, and accounted for the potential impacts of climate change. Taking into account this baseline demand forecast, alongside water availability, dry weather demand and target headroom, United Utilities determined that there would be a surplus in all three of the company's water resource zones (WRZs) in a dry year over the planning horizon of WRMP19 (the Strategic Zone, North Eden Zone, and Carlisle Zone).

Whilst there was forecast to be enough water to meet demand over the period of WRMP19, following the Water Resources Planning Guidelines[1], consideration was given to using the forecast surplus, with possible new source or demand management investment, to explore strategic choices for the WRMP.

United Utilities' Preferred Plan for WRMP19 set out in the Draft WRMP incorporated four strategic choices, as follows:

- Enhance leakage reduction by a total of 80 megalitres per day (Ml/d) over the planning period;

[1] Environment Agency and Natural Resources Wales (2018) *Water Resources Planning Guideline*. Available at: https://cdn.naturalresources.wales/media/686174/interim-wrpg-update-july18-final-changes-highlighted.pdf [Accessed August 2018].

- Improve levels of service for drought permits and orders from 1 in 20 years to 1 in 40 years (moving from 5% to 2.5% annual risk);
- Increase resilience, through the Manchester and Pennine Resilience solution; and
- Commitment to continue to explore national water trading.

The Draft WRMP Preferred Plan comprised a combination of resource management and demand management options designed to achieve these four strategic choices and maintain and enhance the supply-demand balance. To identify these measures, United Utilities first considered an unconstrained list of options. These options were deliberately selected to cover as wide a range of option types as possible and represented all of the ways in which United Utilities could manage supply and demand. These unconstrained options were subject to preliminary (Primary) screening to identify a list of feasible options, i.e. options that could realistically be implemented in the next 25 years. The feasible options were then assessed in terms of their financial, environmental and social costs. These costs were compared using a standard water industry method that allows quantified information about environmental and social effects of options to be compared with financial data. The feasible options were then ranked based on their combined costs. Informed by this assessment, ongoing discussion with stakeholders, and the outcomes of the Strategic Environmental Assessment (SEA), Habitats Regulations Assessment (HRA) and Water Framework Directive (WFD) Assessment, this list was refined through an additional round of (secondary) screening from which the Preferred Plan options were identified.

The Preferred Plan developed for the Draft WRMP included the strategic choice to enhance resilience to non-drought hazards; the largest resilience risk identified being that associated with the regional aqueduct system that supplies water from the Lake District to the Greater Manchester and Pennine areas including parts of Lancashire and south Cumbria. United Utilities identified that the aqueduct condition is deteriorating over time and presents a risk in terms of both water quality and water supply to Greater Manchester and areas of the Pennines. This risk could, in the future, result in a widespread water quality incident (for example, advice to boil water for drinking purposes for over a million properties) or loss of supply to many thousands of properties for an extended period. The development of solutions to address the risks of aqueduct deterioration (and its consequences) to the Strategic Resource Zone is collectively referred to as 'Manchester and Pennine Resilience'. At the Draft WRMP stage, United Utilities' preferred Manchester and Pennine Resilience solution had not been determined.

Revised Draft Water Resources Management Plan 2019

Following consultation on the Draft WRMP, United Utilities has reviewed its Preferred Plan for WRMP19 in light of consultation responses, ongoing stakeholder engagement (including with other water companies), an update to the supply-demand balance and the findings of the environmental assessments; as a result, the Preferred Plan contained in the Draft WRMP has been modified. In particular, in response to consultation responses, additional customer research, further exploration of leakage options and innovations, and a tightening of the supply-demand balance (showing a very small deficit forecast in the Strategic Resources Zone at the end of the planning horizon), United Utilities has further enhanced its leakage reduction aspirations. United Utilities has also confirmed the proposed solution for water supply resilience to non-drought hazards.

The revised Preferred Plan includes the following strategic choices:

- Adopt an enhanced leakage reduction comprising a total of 190 Ml/d over the planning period, a reduction of just over 40% from the baseline position of 448Ml/d. By the end of 2024/25 United Utilities plan to reduce leakage by at least 67 Ml/d, or 15%;
- Improve level of service for drought permits and orders to augment supply from 1 in 20 years to 1 in 40 years (moving from 5% to 2.5% annual average risk); and
- Increase resilience to other hazards, specifically for the regional aqueduct system associated with the Manchester and Pennine Resilience scheme. This involves completing Solution D, which involves rebuilding all single line sections of the relevant aqueduct;

It should be noted that the revised Preferred Plan does not include a water trading component. This is because a water trade from the North West is not included in the preferred plans of other water companies at

this stage. However, water trading remains United Utilities' preference and the company will continue to work with others on water trading beyond WRMP19 towards the WRMP24 planning round.

1.3 Manchester and Pennine Resilience

As highlighted in **Section 1.2**, as part of the Preferred Plan for WRMP19, United Utilities will seek to address the resilience risk associated with the regional aqueduct system which supplies water from the Lake District to the Manchester and Pennine areas including south Cumbria and Lancashire. The development of solutions to address the risks of aqueduct deterioration (and its consequences) to the Strategic Resource Zone is collectively referred to as 'Manchester and Pennine Resilience'.

Resilience Solutions

As set out in **Section 1.1**, five potential Manchester and Pennine Resilience solutions were identified by United Utilities. These solutions are listed below:

- **Solution A (FM20-SO4):** New sources and targeted repair of Tunnel 5 and Tunnel 6 (T05 and T06) of the existing aqueduct, supported by uprating the West East Link Main (WELM) and construction of a new associated break tank near Bolton in conjunction with a new abstraction from the River Irwell and an associated new water treatment works (WTW) (similar to water resources Option WR141).
- **Solution B (C29):** New tunnel sections T05 and T06 and partial UV and metals treatment at existing United Utilities facilities along the length of the existing Manchester and Pennine Aqueduct.
- **Solution C (FM15-SO4b):** Convert the Manchester and Pennine Aqueduct to raw water supply and build new WTWs at Bury and in the Ribble Valley.
- **Solution D (C11):** New tunnel sections T01, T02, T03, T04, T05 and T06.
- **Solution E (C17):** New tunnel sections as for Solution D, plus use of new and existing sources requiring WTW and associated pipelines varying in length from 100 m to over 8 km. The new sources are similar to water resources Options WR049a/b and WR141.

The five solutions offer varying degrees of risk reduction, are significantly different in terms of technical and geographical scope, and would give rise to varying levels and types of environmental effects.

To support United Utilities' decision making, and to ensure consistency between the assessment of the Manchester and Pennine Resilience solutions and the feasible options contained in the Draft WRMP, the component options that make up each solution as well as the solutions themselves were subject to E&S costings, SEA, HRA and WFD Assessment.

The outcomes of these assessments, together with consultees' views on the Draft WRMP19, were used to inform the selection of the preferred Manchester and Pennine Resilience solution (Solution D).

Resilience Options

Following Primary Screening and ranking of over 300 options (consistent with the approach adopted to the identification of feasible (constrained) options for the Draft WRMP), United Utilities identified a total of 34 resilience options, different combinations of which formed the five potential Manchester and Pennine Resilience solutions. These options are listed and described in **Table 1.1** together with the respective solution(s) to which they relate.

Table 1.1 Resilience Options

Ref	Option	Description	Solution(s)
3	Manchester and Pennine Aqueduct to Raw: 2 Stage filtration (Bury)	This option would involve the development of a new 2 stage filtration Water Treatment Works (WTW) at an existing site in the Bury area in order to provide increased resilience. In conjunction with Options 212, 213, 214, 301, 303, 306 and 382, it would form part of the overall solution which covers the requirements for the Manchester and Pennine Aqueduct becoming a raw water aqueduct. In addition to the new WTW, the scheme would require new abstraction/ pumping from a Bulk Supply Point (BSP) to the new WTW, pumping from the new WTW to existing treated water storage, and the demolition of the existing connection mains.	• Solution C
37-38	Manchester and Pennine Aqueduct section T05 to T06	This option would provide protection against structural failure of an existing single pipe section of the Manchester and Pennine Aqueduct and would be used for the conveyance of treated water. This option would involve the construction of new 2.6m diameter conduits and a 2.85m diameter tunnel for a total length of approximately 19.3km, and new connection chambers and isolating penstocks.	• Solution B
37-42	Manchester and Pennine Aqueduct sections T01 to T06	This option would provide protection against structural failure of an existing single pipe section of the Manchester and Pennine Aqueduct and would be used for the conveyance of treated water. This option would involve the construction of new 2.6m diameter conduits and a 2.85m diameter tunnel for a total length of approximately 51.9km, and new connection chambers and isolating penstocks.	• Solution D • Solution E
46	WELM Uprate to 150Ml/day	This option would provide additional connectivity for treated water. It would involve the construction of a 3.1Ml break tank and intermediate pumping facilities to enable the transfer of 150 Ml/d.	• Solution A • Solution E
112	Manchester and Pennine Aqueduct Outage (4 weeks) for installation of connections	This option would involve implementing Manchester and Pennine Aqueduct outage for a period of 4 weeks to facilitate the installation of connections. There would be no new development associated with this option.	• Solution B • Solution D
212	Manchester and Pennine Aqueduct to Raw (Newton-in-Bowland)	Under this option, raw water would be taken directly from the Manchester and Pennine Aqueduct (without treatment) for treatment at a new WTW in the Newton-in-Bowland area. In conjunction with Options 3, 213, 214, 301, 303, 306 and 382, it would form part of the overall solution which covers the requirements for the Manchester and Pennine Aqueduct becoming a raw water aqueduct. The option would involve the construction of a new 2 stage filtration WTW together with a new connection from the Aqueduct to the WTW and pumped supply to an existing aqueduct. The new WTW is expected to treat an average of 41 Ml/d, with a maximum treatment capacity of 60 Ml/d.	• Solution C
213	Manchester and Pennine Aqueduct to Raw (Clayton-le-Moors)	Under this option, raw water would be taken directly from the Manchester and Pennine Aqueduct (without treatment) for treatment at a new WTW in the Clayton-le-Moors area. In conjunction with Options 3, 212, 214, 301, 303, 306 and 382, it would form part of the overall solution which covers the requirements for the Manchester and Pennine Aqueduct becoming a raw water aqueduct.	• Solution C

Ref	Option	Description	Solution(s)
		The option would involve the construction of a new 2 stage filtration WTW together with a new connection from the Manchester and Pennine Aqueduct to the WTW inlet, a pumping station and circa 2.8km pipeline from the WTW to two BSPs.	
214	Manchester and Pennine Aqueduct to Raw (Haslingden)	Under this option, raw water would be taken directly from the Manchester and Pennine Aqueduct (without treatment) for treatment at a new WTW in the Haslingden area. In conjunction with Options 3, 212, 213, 301, 303, 306 and 382, it would form part of the overall solution which covers the requirements for the Manchester and Pennine Aqueduct becoming a raw water aqueduct. The option would involve the construction of a new 2 stage filtration WTW together with new connections from the Manchester and Pennine Aqueduct to the WTW inlet and from the WTW to an existing pumping station.	• Solution C
215	Alternative Supply: Raw water transfer and WTW (Clayton-le-Moors)	This option would provide additional raw water from the River Ribble (under a new abstraction licence) and additional water treatment capacity in the Clayton-le-Moors area. The option, in conjunction with Options 216, 217 and 218, would provide additional abstraction/treatment facilities to facilitate Solution E. The option would require a new abstraction point, circa 9.1km of 800m main to a new 3 stage WTW and a pumping station.	• Solution E
216	Alternative Supply: Raw water abstraction and WTW (Haslingden)	This option would provide additional raw water from the River Irwell (under a new abstraction licence) and additional water treatment capacity in the Haslingden area. The option, in conjunction with Options 215, 217 and 218, would provide additional abstraction/treatment facilities to facilitate Solution E. The option would require a new abstraction point and pumping station, circa 1.0km of 450mm main to a new 3 stage WTW and a new connection from the WTW to an existing BSP.	• Solution A • Solution E
217	Alternative Supply: Raw water transfer and WTW (Newton-in-Bowland)	This option would provide additional raw water from an aqueduct and additional water treatment capacity in the Newton-in-Bowland area. The option, in conjunction with Options 215, 216 and 218, would provide additional abstraction/treatment facilities to facilitate Solution E. The option would require a new connection to the raw water aqueduct, circa 5.3km of 700mm diameter pipeline to transfer water from the connection point and a new 3 stage WTW and pumping station.	• Solution E
218	Alternative Supply: Raw water transfer and WTW (Preston)	This option would redirect raw water from the River Wyre to additional water treatment capacity in the Preston area. The option, in conjunction with Options 215, 216 and 217, would provide additional abstraction/treatment facilities to facilitate Solution E. The option would require a connection to the raw water feed from the River Wyre and pumping from the connection point via circa 8.5km of 800mm main to a new 3 stage WTW. A new pumping station would also be constructed at the WTW site to feed water from the WTW into an existing aqueduct via circa 4.4km of 700mm pipeline.	• Solution E
238	Metals & UV treatment of BSPs: Bury	This option seeks to provide treatment of metals, cryptosporidium and/or E.Coli to the treated water which is being siphoned off the Manchester and Pennine Aqueduct. The option would require the construction of a new 2 stage WTW in the Bury area.	• Solution B

Ref	Option	Description	Solution(s)
260	Ribblesdale South Well Isolation	This option would enable the isolation of the downstream section T05 for rehabilitation. It would require a new valve chamber constructed around existing siphon pipes in the Clitheroe area and a new valve house over the chamber. The option would also require a new access road.	• Solution A
261	Haslingden Well Isolation	This option would enable the isolation of the downstream section T06 for rehabilitation. It would require a new 12.5mID shaft on an existing 2.59mID conduit in the Haslingden area with two isolating penstocks and provision for downstream tunnel access. The option would also require a new control kiosk and access road.	• Solution A
296	T05 targeted repair 2025	This option would target section T05 for remedial works (tunnel lining) in order to provide greater structural support to the wider water distribution network. Under the option, approximately 100m of section T05 would undergo tunnel lining which would involve the installation of steel liner. The installation of two new access shafts (5m diameter/110m deep) would be required to facilitate the proposed works. It should be noted that the installation of tunnel liners would subsequently decrease the diameter of the Manchester and Pennine Aqueduct, e.g. reduced water flow, thus further hydraulic analysis is required to confirm the minimum acceptable diameter to support/maintain present operation.	• Solution A
297	T06 targeted repair 2025	This option would target section T06 for remedial works (tunnel lining and conduit lining) in order to provide greater structural support to the wider water distribution network. It is proposed that an approximate 200m of section T06 would undergo conduit lining which would involve the installation of steel reinforcement cages sprayed with concrete lining whilst 200m of the tunnel would receive tunnel lining. The installation of four new access shaft/chambers (5m diameter/110m deep) would be required. Additionally, there is a risk that it may be necessary to rebuild a cracked conduit bridge (approx 30m) in addition to implementing a new settled conduit configuration as additional ancillary works. It should be noted that the installation of conduit/tunnel liners would subsequently decrease the diameter of the Manchester and Pennine Aqueduct, e.g. reduced water flow, thus further hydraulic analysis is required to confirm the minimum acceptable diameter to support/maintain present operation.	• Solution A
301	Lunesdale Siphon BSPs North	This option seeks to provide additional connectivity for treated water via existing pipework to a treated water storage facility in the Kendal area and onwards to the north end of the Lunesdale Siphon where it would be intercepted by a proposed new pipeline connecting to existing BSPs. In conjunction with Options 3, 212, 213, 214, 303, 306 and 382, it would form part of the overall solution which covers the requirements for the Manchester and Pennine Aqueduct becoming a raw water aqueduct. The option would require pipelines from the treated water storage facility to the Manchester and Pennine Aqueduct in the vicinity of the BSPs in the Kirkby Lonsdale area in addition to increased storage provision at the existing treated water storage facility (from 0.75Ml to 9.0Ml).	• Solution C
303	Lunesdale Siphon BSPs South	This option would increase connectivity for treated water through Manchester and Pennine Aqueduct outage on a permanent basis. In conjunction with Options 3, 212, 213, 214, 301, 306 and 382, it would form part of the overall solution which covers the requirements for the Manchester and Pennine Aqueduct becoming a raw water aqueduct.	• Solution C

Ref	Option	Description	Solution(s)
		The options would require new sections of pipeline between BSPs in the Bentham area. The option would also require: a new pumping station in the Bentham area; additional 9Ml storage at an existing treated water storage facility near Lancaster; modification to a pumping station in the Morecambe area to accommodate permanent usage; and the abandonment of existing facilities.	
306	Ribblesdale Siphon BSPs North	This option would adapt the connectivity of the treated water network with BSPs in the Clitheroe area being permanently supplied via an existing aqueduct and pumping stations using existing network infrastructure. In conjunction with Options 3, 212, 213, 214, 301, 303 and 382, it would form part of the overall solution which covers the requirements for the Manchester and Pennine Aqueduct becoming a raw water aqueduct. The option would require a new circa 2.9km reinforcing pipe (250mm diameter) to support the new configuration between the BSPs and the aqueduct. Some existing pipelines would be abandoned.	• Solution C
348	Metals & UV Treatment of BSPs: Lunesdale Siphon (1)	This option would involve the construction of a new WTW with second stage rapid gravity filters (RGF) for metals removal and UV treatment in the Kirkby Lonsdale area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat 2.48 Ml/d.	• Solution B
349	Metals & UV Treatment of BSPs: Lunesdale Siphon (2)	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Kirkby Lonsdale area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat 2.9 Ml/d.	• Solution B
350	Metals & UV Treatment of BSPs: Lunesdale Siphon (3)	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Kirkby Lonsdale area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat an average of 0.36 Ml/d, with a maximum treatment capacity of 0.57 Ml/d.	• Solution B
351	Metals & UV Treatment of BSPs: Lunesdale Siphon (4)	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Wrayton area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat an average of 5.59 Ml/d, with a maximum treatment capacity of 6.04 Ml/d.	• Solution B
352	Metals & UV Treatment of BSPs: Lunesdale Siphon (5)	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Bentham area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat 0.01 Ml/d.	• Solution B
353	Metals & UV Treatment of BSPs: Lunesdale Siphon (6)	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Bentham area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage,	• Solution B

Ref	Option	Description	Solution(s)
		mixers and analysers. The new WTW is expected to treat 0.01 Ml/d.	
354	Metals & UV Treatment of BSPs: Hodder Siphon	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Newton-in-Bowland area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat an average of 40.86 Ml/d, with a maximum treatment capacity of 45.28 Ml/d.	• Solution B
355	Metals & UV Treatment of BSPs: Ribblesdale Siphon (1)	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Clitheroe area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat an average of 0.02 Ml/d, with a maximum treatment capacity of 0.03 Ml/d.	• Solution B
356	Metals & UV Treatment of BSPs: Ribblesdale Siphon (2)	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Clitheroe area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat an average of 4.09 Ml/d, with a maximum treatment capacity of 5.05 Ml/d.	• Solution B
357	Metals & UV Treatment of BSPs: Ribblesdale Siphon (3)	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Clitheroe area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat an average of 2.10 Ml/d, with a maximum treatment capacity of 2.17 Ml/d.	• Solution B
358	Metals & UV Treatment of BSPs: Ribblesdale Siphon (4)	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Clayton-le-Moors area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat an average of 33.51 Ml/d, with a maximum treatment capacity of 43.05 Ml/d.	• Solution B
359	Metals & UV Treatment of BSPs: Ribblesdale Siphon (5)	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Accrington area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat an average of 5.23 Ml/d, with a maximum treatment capacity of 6.83 Ml/d.	• Solution B
360	Metals & UV Treatment of BSPs: Haslingden	This option would involve the construction of a new WTW with second stage RGF for metals removal and UV treatment in the Haslingden area in order to treat water siphoned off the Manchester and Pennine Aqueduct. This would also involve associated works including pumping, chemical dosing/storage, mixers and analysers. The new WTW is expected to treat an average of 8.97 Ml/d, with a maximum treatment capacity of 9.96 Ml/d.	• Solution B
382	Manchester and Pennine Aqueduct to Raw: WTW reduced flow	This option would reduce the flow of a WTW in the Kendal area from 570 Ml/d to 80 Ml/d whilst continuing to provide treated water to existing BSPs. In conjunction with Options 3,	• Solution C

Ref	Option	Description	Solution(s)
		212, 213, 214, 301, 303 and 306, it would form part of the overall solution which covers the requirements for the Manchester and Pennine Aqueduct becoming a raw water aqueduct. The option would require: modifications and refurbishment of the existing WTW to maintain the existing process but at a reduced flow of 80 Ml/d; new connections to a new inlet tank (total length circa 8km); new UV disinfection process; new final water chemical dosing and storage in bunded area – replaced existing due to new outlet position; sodium bisulphite dosing and storage for de-chlorination of start up to waste line and pre UV disinfection (prevention of fouling); dual process streaming of works to minimise plant shut-downs and ensure 50% of max flow can be maintained at all times; and a new valve chamber and new twin outlet pipelines from the WTW to supply existing BSPs.	

Abbreviations:
BSP: Bulk Supply Point
DMA: District Metered Area
RGF: Rapid Gravity Filters
SR: Service Reservoir
WTW: Water Treatment Works

1.4 Environmental and Social Costing

All investments that a water company makes to improve the service that it provides to customers need to be assessed and presented so that regulators, customers and investors understand not only the rationale for investing, but also can be assured that the investments are appropriate and offer good value. United Utilities has prepared an Options Assessment to support its AMP7 and longer term WRMP strategy. The company identified the need to invest to increase its water resource base and to continue managing demand effectively. In this context, all the feasible WRMP options have been assessed in terms of their E&S costs.

The resilience options and solutions form another part of United Utilities' plan to increase its resilience. Whilst these options do not fall within the remit of the WRMP process *per se*, they have been assessed using the same approach and broad methodology to that applied to the WRMP options. This report clarifies the bespoke adjustments to the method adopted in recognition of the different type of options considered and presents the results of the E&S costings for the resilience options and solutions.

1.5 Purpose of this Report

This report presents the methodology used to assess, and the results of, the E&S costings of the resilience options and solutions identified by United Utilities. The report should be read in conjunction with the report 'Environmental and Social Costs of Water Resource Management Plan 2019 Supply-Demand Options' which provides more detail regarding the overall approach.

In the same way that the WRMP options were subject to a 'Lite' Assessment (only a sub-set of options were subject to a full assessment where there were no particularly dominant cost categories), the Lite Assessment methodology has also been applied to the resilience options. The rationale for this approach is the same in that it is possible to account for the majority of costs by identifying and analysing only the most relevant and dominant cost criteria. The key output of this work is the qualitative E&S cost assessment at the solution scale, which is based on indicative, quantified E&S costs assessment. The qualitative step, intended to aid decision making, has been identified as an additional useful tool (beyond that delivered for the WRMP options) relevant to the nature of the resilience options. This is explained further and justified within this report.

1.6 Structure of this Report

This report is structured as follows:

- **Section 1** describes the background and purpose of this report;
- **Section 2** describes the methodology used to assess the resilience options;
- **Section 3** presents a summary of the environmental and social impacts as costed for each of the resilience options and resilience solutions identified by United Utilities.

2. Methodology

2.1 Overview

The approach taken to assessing the E&S costs (impacts) of the resilience options and solutions is similar to that adopted for the assessment of the feasible options considered in preparing the Draft WRMP.

Due to the large number of feasible options submitted by United Utilities and third parties, a risk based approach was taken to identify those options for which a smaller number of components would be assessed (based on dominant cost categories), and to undertake cost assessment across the wider range of Benefits Assessment Guidance (BAG)[2] categories only for those options where costs are more evenly distributed across categories. The BAG, initially produced by the Environment Agency in 2003 and updated to include a User Guide in 2012, allows a desktop analysis of environmental and social costs and benefits. It requires impacts to be described qualitatively and, where appropriate, monetary values attributed to those potential impacts. The BAG uses a benefit transfer approach, whereby information on environmental and social costs are taken from published data (for example, from willingness to pay studies) and applied to the option under consideration. The approach provided a robust set of costs, enabling options to be differentiated in terms of costs; this approach has also been applied to the resilience options.

United Utilities produced an engineering workbook and scope definition document for each resilience option. Amec Foster Wheeler reviewed this information to identify the various components that could potentially impact the environment or social issues as set out within the BAG. Whilst the approach of applying a 'Lite' assessment (focusing on the dominant cost drivers) is consistent with that adopted for the feasible WRMP options, due to the inherent differences between the two sets of options, there are some slight differences in terms of the BAG categories applied (see **Section 2.2**).

The assessment of the resilience options has comprised four stages, as follows:

1. Selection of BAG categories;
2. Option analysis to collate E&S cost input data (E&S includes carbon);
3. Quantitative assessment of E&S using the BAG approach (Indicative Monetised Assessment);
4. Qualitative valuation of E&S based on the Indicative Monetary Assessment.

Stages 1 to 3 were undertaken following the same approach as for the feasible WRMP options. Stage 4 was an additional stage introduced in recognition of the limitations of the BAG approach in order to capture or reflect the scale of uncertainty surrounding the long-term monetised impacts of landscape intrusion (for example, in National Parks or Areas of Outstanding Natural Beauty (AONB), and the far reaching economic effects of high profile recreational fishing in the region.

Stage 3 can be used to support an indicative based Average Incremental Social Cost (AISC) but this should be viewed with caution as long-term landscape aspects may be over-emphasised and angling impacts (Option 215) significantly under-emphasised.

The resilience options were assessed individually and the results combined to produce Indicative Monetised Assessments and Qualitative Valuations for the five solutions.

2.2 Selecting BAG Categories for the 'Lite' Assessment of Resilience Options

Whilst the overall 'Lite' approach is consistent with that adopted for the assessment of the feasible WRMP options, it was not considered appropriate to apply the exact same set of BAG cost categories to the resilience options; whereas the WRMP feasible options were typically dominated by abstractions and

[2] Environment Agency (2003) *Guidance. Assessment of Benefits for Water Quality and Water Resources Schemes in the PR05 Environment Programme*.

comparatively minor supporting infrastructure, the resilience options are much more significantly infrastructure dominated. A key initial step in the assessment process was to therefore identify what the dominant cost drivers are likely to be given the nature of the options being assessed.

Taking into account the scope/nature of the resilience options, nine individual option components were identified and these are listed in **Table 2.1** together with the sections of the BAG User Guide and individual BAG categories that could be relevant. This list includes all potential BAG categories, not specifically those that are likely to dominate the cost impacts.

Table 2.1 Option Components and Initial Review of Relevant BAG Sections and Cost Categories

Component	BAG section	BAG category	Relevance/significance dependent on
Outage impact on customer	Part 5: Works related impacts	5.4: Property based disamenity	Whether the option would impact on customers.
New abstraction	Part 2: Rivers & Groundwaters	2.2 Informal recreation 2.3 Angling 2.5 In-stream recreation	Only relevant to options 215 and 216
Discharge to the environment	N/a there is no section in the Guidance which coves this. (*Volumetric/quality issues are identified in the WFD assessment*).	N/a	N/a
Construction of new asset: Water treatment works or pumping station	Part 5: Works related impacts	5.2: Land-take (works) 5.3: Landscape 5.5: Traffic 5.6: Carbon (energy & global warming)	Whether UU already owns the land to be affected. Location and footprint of new buildings. Any permanent impacts on transport network.
Upgrade existing treatment processes	Part 5: Works related impacts	5.6: Carbon (energy & global warming)	None – assumes all treatment related options will have a significant carbon footprint.
Lay new pipelines/conduits (third party land / operational pumping issues)	Part 5: Works related impacts	5.3: Landscape 5.4: Property based disamenity 5.5: Traffic 5.6: Carbon (energy & global warming)	Mitigation plans Risk of customer supply interruptions.
Construction on existing assets (e.g. new connections)	Part 5: Works related impacts	5.6: Carbon (energy & global warming)	None – assumes all construction will have a significant carbon footprint.
Water storage (new or enhanced) excludes small scale treatment tanks	Part 3: Reservoirs Part 5: Works related impacts	3.2 (Formal) recreation 3.3 Heritage, Archaeology, Landscape 3.5: Land-take (reservoir) 5.2: Land-take (works) 5.3: Landscape 5.5: Traffic	Type of storage (e.g. service reservoir or raw water) Location and size of storage Land ownership
Tunnel	Part 2: Rivers & Groundwaters	2.9 Biodiversity	These tunnel options do not include new river or groundwater abstractions but the BAG Works Related Impacts section does not include a biodiversity element but major tunnelling works could impact on biodiversity. These options were examined to identify if any of the works intersect designated sites.

*Land-take was initially considered for inclusion in the Lite assessment due to the number of options requiring purchase of additional land to build assets. BAG guidance (Part 5, Section 2) refers to the environmental and social cost of land-take reflecting the opportunity

loss (i.e. what the land would otherwise be used for). The BAG also states that where a water company builds on its own land, the opportunity costs are its value in the next best use (i.e. agricultural if in open countryside, or recreational/residential if the site is in an urbanised area). It advises that the purchase cost represents the opportunity cost. At this stage, no data is available to confirm the cost of purchase and retrospective consideration (following the indicative monetary and qualitative social and environmental valuation) suggests the land-take social costs would not be sufficiently significant for inclusion in the Lite assessment.

Once the option scopes had been reviewed and the full list of relevant BAG categories identified, the option descriptions were considered on an individual basis to determine whether the likely impacts could represent a dominant E&S cost. This task concluded that all options should be costed in terms of carbon and traffic related impacts, whilst a smaller number of options were identified as also requiring landscape or other aspects to be costed.

Table 2.2 presents the outcome of this exercise. The results of the initial option scope comparison to BAG categories are presented in **Appendix A**.

Table 2.2 'Lite' Categories per Resilience Option

Options	BAG categories Included in 'Lite' assessment	BAG category sub-components*
3, 46, 112, 260, 261, 296, 297, 306	BAG 5.5: Traffic BAG 5.6: Carbon	Congestion; accident risk, HGV movements (air pollution), noise impacts, community severance (pedestrian/cyclist disruption).
37-42, 212, 213, 214, 216, 217, 218, 238, 301, 303, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 382	BAG 5.3: Landscape impacts BAG 5.5: Traffic BAG 5.6: Carbon	
215	BAG 2.3: Angling BAG 5.5: Traffic BAG 5.6: Carbon	

*Complete list

2.3 Population

Central to E&S costing is the size of the population that could be affected. Whilst individual assessments apply assumptions to the proportion of the population that would be affected by an option, total population is a critical data input.

In this context, the resilience options were plotted in GIS to identify the relevant counties in which they are located. **Table 2.3** lists the Office for National Statistics (ONS) population data per county (2015 mid-year data) used in the assessment.

Table 2.3 ONS Population Data (all counties supplied by UU)

County	Total population	Adult population	Adult population density (Adults/km^2)
Cheshire East	375,392	300,407	258
Cheshire West and Chester	333,917	267,687	284
Cumbria	500,094	406,977	57
Lancashire	1,191,691	946,175	307
Greater Manchester	2,756,162	2,134,347	1673

County	Total population	Adult population	Adult population density (Adults/km^2)
Merseyside	1,398,030	1,117,740	1367

Nb. The analysis confirmed that the resilience options only directly affect Cumbria, Lancashire, and Greater Manchester.

2.4 Assessing Traffic Related Impacts

As highlighted above, traffic related impacts (works related) were considered relevant to all resilience options due to the potential for construction activities to directly disrupt parts of the road network and, more generally, due to the congestion and associated impacts arising from HGV movements. The BAG identifies five individual traffic related impacts and these were reviewed to ascertain their relevance to the Lite assessment.

Table 2.4 lists the five sub-components, the criteria used to determine if the component was sufficiently significant to warrant assessment, and a summary of the sub-components assessed per resilience option. The relevance criteria used by Amec Foster Wheeler are adapted from Part 5, Section 5 of the BAG, recognising that it is not possible to quantify as per the BAG criteria but that conditions and assumptions can be made.

Table 2.4 Traffic Related Sub-components

Sub-component	BAG criteria	Relevance criteria	Options assessed
Traffic congestion	Will it cause queuing, reduce speeds by >5%, increase traffic volumes by >10%? If not do not include.	Congestion considered if construction would: i) directly impact the road network (e.g. pipeline routes intersecting roads). B-roads represent lower threshold. Disruption of smaller lanes, private roads not appropriate for Lite assessment; ii) involve prolonged activity through an urban area (e.g. building a WTW in an area where access would have to be through an urban area).	37/38 (both sections), 37/42 (all sections), 46, 214, 215, 216, 218, 301, 360.
Accident risk		Only relevant where large levels of associated transportation activity would be required (e.g. a reservoir). Default assumption was that this would not be relevant. This is in line with the assumptions applied to the feasible WRMP options.	None
HGV movements (air pollution)		Only relevant if the option involves sizeable capital works in urban areas. Default assumption was that this would not be relevant. This is in line with the assumptions applied to the feasible WRMP options.	None
Noise impacts		Only relevant if the option involves large construction works, high numbers of HGVs, or dislocation of traffic on to currently quiet roads. Default assumption was that this would not be relevant. This is in line with the assumptions applied to the feasible WRMP options.	None
Community severance (disruption to pedestrian/cyclists' journey patterns)		Severance considered if construction would: i) directly impact the road network within an urban area for a	3, 37/38, 214

Sub-component	BAG criteria	Relevance criteria	Options assessed
		prolonged period, i.e. more than 1 week. This component was costed for the WRMP demand management options (to reflect the more direct impact that urban Active Leakage Control activities can have on roads and pavements).	

Determining whether the resilience options would be likely to generate significant traffic related E&S costs was only possible once the option details and their likely interaction with urban areas were understood. The information required to populate these categories was collated during the option review process (GIS analysis) and so became quantitatively available in the model. However, where the impacts were shown to be negligible, these were removed from the overall Lite cost assessment (in the same way that other BAG components had been excluded on the basis of not contributing to the dominant cost drivers).

Temporary (construction only) or permanent (operational) impacts

For the traffic related impacts (congestion and community severance), the impacts would only be felt during the construction period itself and were costed on this basis. The longer term carbon impacts of operational vehicles are included in the E&S Lite assessment.

2.5 Assessing Landscape Impacts

The 'Lite' approach to assessing landscape impacts (environmental and social costs) was based on Part 5, Section 3.2 of the BAG. The first stage of the assessment involved determining if landscape was sufficiently significant to be included in the Lite assessment for each resilience option, taking into account whether the option under consideration would result in the development of new infrastructure that would be visible to either users or local residents. If the option description confirmed that a new WTW or pipeline would be built, then this triggered landscape as a potential relevant impact.

It was expected that the significance of any impact would be highly dependent on the landscape in which an option would be located and the details of the proposed development. Therefore, all options triggered by Stage 1 were assessed in more detail (Stage 2). Two main aspects were considered in order to assess the landscape cost of these options:

1. The type of landscape that would be affected; and
2. The level of intrusion that the option could generate.

The type of landscape that would be affected

GIS layers of options (point, line and polygon) were examined to identify where any components of an option would intersect designated or other significant landscapes, and satellite imagery used to assess the general context of the option (i.e. proximity to recreational areas, residential areas, urban areas).

The BAG subdivides Regional/National, Honeypot and Local site types into Fair, Moderate, and High Importance (i.e. creating nine possible landscapes to choose from), each with estimated visitor rates and assumed distance from the site within which people will visit. The purpose of this is to allocate a radius within which people could be affected by temporary or permanent disruption or change to the landscape.

For the purpose of the Lite assessment, this was simplified into four key types, plus a 'none' category to recognise sites with no distinguishable interest points. **Table 2.5** sets out the landscape type options, the radius of influence, and the rationale used to determine which landscape is relevant to each resilience option.

Table 2.5 Landscape Types, Rationale and Visitor Assumptions

Landscape type	BAG definition	Amec Foster Wheeler definition	Radius of influence (km)	Visit rate per adult per year
Regional/National site (high importance)	Connected to tourist sites, in National Parks, AONBs, etc.	Intersects or adjacent to an AONB, National Park or World Heritage Site.	60	2
Regional/National Site (low importance)	(No explicit distinction between Fair, Moderate, and High)	Intersects or adjacent to a scheduled monument within the landscape.	20	9
Honeypot site	Visitors travel by car, there is some special attraction and there are facilities such as a car park and toilets at the site.	More official site, e.g. with picnic benches/toilets, includes golf courses/clubs.	3	17
Local park	Visitors travel mainly by foot and the site has no special attractions.	General open space e.g. suitable for dog walking/playing sports (informal), or an actual park.	1	21
None	n/a	Located on land already owned by United Utilities (i.e. developing on an existing site), or in open-countryside that does not meet any of the above criteria.	0.2	21

Regional (moderate) importance was excluded on the basis that High importance sites include most major features, with less significant features being absorbed into low or honeypot sites. Visitor/interest rates are based on BAG assumptions applied to local population data rather than arbitrary annual visitor rates as listed in the BAG. This negated the need to subdivide landscape types in low, moderate, and high.

For options that intersect different areas (e.g. tunnelling or pipelines, or assets in more than one location) the most significant landscape type was selected in the costing model rather than assessing the multiple various impacts (i.e. a precautionary approach and to avoid double counting).

Type and level of intrusion that the option could generate

The landscape assessment included the likely type and level of intrusion of the infrastructure to be built/installed, given its nature and scale and taking into account likely forms of mitigation. The assessment assumed that United Utilities would adopt standard mitigation practices to minimise landscape impacts (i.e. that pipelines would be subterranean and that new buildings would include landscaping improvements if necessary (e.g. tree planting).

The BAG guidance provides two types of intrusion to choose from, with a transfer 'cost' value for each:

- From undeveloped or greenfield to constructed (e.g. building a new WTW or pumping station). The BAG transfer value provided is £3.20 **per local resident** per year. This value was taken from a 1992 study and so has been uplifted to 2017 values using the multiplier factor 1.97 (£6.30).
- From no intruding pipelines to intrusion resulting from pipelines. The BAG transfer value provided is £1.33 **per visitor** per year. This value was taken from a 1998 study and so has been uplifted to 2017 values using the multiplier factor 1.67 (£2.22).

  The local residents or visitors number is calculated based on the county population density and the radius of interest (based on the landscape type affected (see **Table 2.5**), using the formula as provided in Part 5, Section 3 of the BAG:

  Population = 3.14 x distance (km^2) x adult population density.

The final step to calculate affected local resident values is to apply the assumption of annual visits per adult to the 'site' per year, e.g. an option affecting a local park would affect a population within 1km of the site, and the annual adult visit rate would be 21 visits per year (see **Table 2.5**).

The final stage of the landscape assessment determined the likely scale of intrusion and therefore the proportion of the BAG transfer cost that should be applied. The approach taken was adapted from the suggested 'Willingness to Pay reduction' approaches in the BAG guidance. Actions that will result (after assumed mitigation) in an unsightly outcome are assumed to incur 100% of the transfer value, whilst any that could have an 'exceptional' visual outcome would incur 0%. **Table 2.6** confirms the landscape intrusion scales included in the assessment, the rationale for selecting the intrusion level, and the proportion of transfer value that would be incurred. The Lite assessment applied a slightly simplified form of the intrusion scale provided in the BAG (Part 5, Section 3.2, Table 3.2).

The intrusion scale was used in combination with the landscape type and the radius of influence to calculate the social cost of the ultimate impact on the affected landscape, i.e. the most cost would be incurred by an option in a 'high' regionally important landscape with an 'unsightly' level of intrusion.

Table 2.6 Landscape Intrusion Scale and Proportions of Transfer Value Cost Incurred

Landscape intrusion scale (BAG)	Amec Foster Wheeler definition	% of transfer value incurred
Unsightly	Works will remain visible and in an attractive area.	100%
Undistinguished	Not used.	75%
Slight intrusion	New external features but on an existing utility site, e.g. a new WTW, pumping station, or service reservoir etc.	50%
Distinguished / attractive	Not used.	25%
Superb / excellent	Excellent / little intrusion: New minor external features but on an existing utility site, largely unnoticeable.	10%
Spectacular / exceptional	Exceptional / no intrusion: Works that would not be seen, e.g. in an existing building.	0%

Temporary (construction only) or permanent (operational) impacts

Whether an option would have only a short-term temporary visual impact on the landscape, or a longer-term permanent impact depends on the type of option. Subterranean pipelines are assumed to have negative landscape impacts during construction (and potentially during any future replacement / repair work) but generally once the work is complete, it is assumed the landscape would return to its baseline condition.

New tunnel options would replicate existing tunnelling but ultimately these options would permanently modify the landscape in which they are located (particularly at the entry/exit points). However, it is assumed that the duration of the tunnel lengths would be subterranean and so the total impacts are expected to be relatively minor. Therefore, only short-term impacts have been assessed for pipeline/tunnel options.

Options that include development of new surface features, such as WTWs have been assessed in terms of both short and long-term impacts. In line with the approach to the assessment of the feasible WRMP options, long-term is defined as 80 years.

2.6 Angling

The potential for the resilience options to impact on angling was only considered where an abstraction was included within the option scope (i.e. only Options 215 and 216). The Water Framework Directive (WFD) assessment of the resilience options was used to determine the significance that abstraction would have on the affected waterbodies. Only Option 215 was identified as having a medium hydrological impact and so the E&S costing assessment only researched information on angling levels and angling clubs in the context of the River Ribble.

The Ribble (and the Mid Ribble in particular) is a very popular catchment for recreational fishing with far reaching economic benefits (with regards to the sectors benefiting and the geographic area served). Angling clubs on the Ribble report very high local and visitor numbers from across the country, fishing for high quality Salmon and Trout. Whilst the abstraction from the Ribble associated with Option 215 would only be periodic (up to 6 months at a time, annual frequencies are not yet determined) a 41 Ml/d abstraction from the Ribble would have major impacts on the quality (or perceived quality) of recreational fishing in this area. The approach to reviewing impacts on angling as set out in the BAG is not considered sufficient to capture and reflect all the potential impacts of this option (e.g. impact on tourist angling, hotels and other tourism services in the local and wider area that benefit from the high quality of angling at this site are not considered); the BAG categories are limited to the costs/benefits in terms of the angling experience only. For this reason, it was decided to incorporate the effects on angling for this option within the qualitative valuation stage.

2.7 Carbon Assessment

The method adopted for the quantification and monetisation of carbon arising from the implementation and operation of each resilience option is consistent with that used to assess the Draft WRMP resource management options. The key components included in the assessment were:

- Embodied carbon in materials (typically capex activity);
- Carbon emitted by vehicles involved in the construction or implementation of a resilience option and in the operational activity following implementation (based on the assumption that 50% of United Utilities' fleet involved in both construction and operation is average rigid diesel HGV); and
- Carbon emitted during the various stages of putting water into supply.

The Department for Business, Energy, and Industrial Strategy (BEIS) has provided guidance on how to apply the Treasury Green Book supplementary appraisal guidance on valuing energy use and greenhouse gas GHG emissions carbon prices[3]. This includes conversion factors to convert property and road fuel types (and quantities) to carbon dioxide equivalent (CO_2e). The assumption of 0.32 kg CO_2e per km is the standard Defra conversion factor for a Class iii Diesel Light Van (1.75 to 3.5 tonnes).

The carbon for all options was categorised in terms of fixed and variable, and traded and non-traded:

- Carbon covered by traded carbon prices:
  - Emissions derived from grid power use;
  - Embodied carbon.
- Carbon covered by non-traded carbon prices:
  - Vehicle emissions.

This was necessary in order to apply the carbon prices provided by BEIS to the calculated annual tonnages of carbon.

[3] See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/602657/5._Data_tables_1-19_supporting_the_toolkit_and_the_guidance_2016.xlsx [Accessed July 2017].

Government carbon data profiles the traded and non-traded price of carbon up to 2100 (i.e. over an 80-year period). This assessment costed options over an 80-year lifespan. All costs, including carbon, are discounted to a present value at a rate of 3.5% per annum until 2049, 3.0% until 2094, and 2.5% beyond that point.

United Utilities calculated the embodied carbon per supply option (tonnes CO_2e) together with the estimated number of HGV movements required to construct each resilience option. An average estimate of 50 km per vehicle movement was applied; this reflects the full range of short and long journeys that would be involved:

- Some materials can be sourced from local suppliers and may therefore only involve vehicle movements of several kilometres;
- Bespoke equipment such as treatment processes may need to be transported from elsewhere in the United Kingdom or further afield.

Emissions from energy use

United Utilities provided estimates of energy usage in kilowatt hours (kWh)/Ml for each option. Annual energy use (kWh/annum) for options that have operational energy needs, was determined using the annual potential capacity (daily capacity (Ml/d) provided by United Utilities was multiplied by 365.25). This assumes that utilisation is 100%, allowing for equal comparison between options. However, the percentage utilisation assumption can be easily altered in the underlying calculations, allowing United Utilities to scale the use of each option as operational management is defined. This is consistent with the method used in the costing of supply options for the draft WRMP.

The annual energy consumption in kWh was converted to emissions in CO_2e using updated energy conversion factors from the Treasury Green Book supplementary appraisal guidance. The factor used in 2012 was a single value of 0.59 kg CO_2e per kWh, but the latest guidance provides a projected variable factor, reflecting the expected change in energy mix to more renewable sources over the next 80 years.

Operational vehicle movements

United Utilities provided an estimate of the annual number of operational HGV movements required once options have been implemented. The carbon emissions associated with these vehicle movements was assessed using the same approach as described for construction vehicle movements (including the assumed distance travelled).

3. Results of the Assessment

3.1 Resilience Options

Indicative Monetised Assessment and Qualitative Valuation

As explained in **Section 2**, a BAG based quantified assessment has been used as the basis of a qualitative overview (to support decision making whilst recognising some of the limitations of the BAG costing approach). **Table 3.1** presents the six qualitative thresholds in this context and how have been applied to the individual resilience options, and at the combined solution scale. **Table 3.2** presents the detail of the carbon, landscape, and traffic indicative monetised costs per option. It should be noted that the indicative monetised costs are not categorised in comparison with the CAPEX and OPEX costs presented elsewhere by United Utilities.

It should be noted that due to company commercial confidentiality reasons, the cost figures have been redacted from this section.

Table 3.1 Qualitative Valuation Categories[4]

	Individual option scale	Solution scale
Benefit		
Nil / Negligible impact		
Low cost (little impact)		
Moderate cost (impact)		
High cost (impact)		
Very high cost (impact)		

Some of the assessments return very negligible costs (almost nil). These occur when an option is anticipated to impact a non-distinguishable landscape with an associated very small radius of interest (active visitor numbers are almost nil), or when construction activities are only expected to intersect highways for a very short time. In the qualitative assessment, these are removed from the process via inclusion within a 'Nil impact' category.

[4] Cost figures redacted, company confidential information.

Table 3.2 E&S assessment of individual options (Indicative Monetised Assessment)[5]

Option Name	No.	Embodied carbon (tonnes CO_2e)	Tonnes CO_2e during first year of operation*	E&S Landscape		E&S Traffic (congestion)		80-year NPV (£)				
				Construction	Operation (annual)	Construction	Operation (annual)	Construction carbon	Operational carbon	Construction E&S	Operational E&S	Total E&S and carbon NPV
Manchester and Pennine Aqueduct to Raw: 2 Stage filtration (Bury)	3	44,678	2,480									
Manchester and Pennine Aqueduct section T05 to T06	37 38	210,666 *	0									
Manchester and Pennine Aqueduct sections T01 to T06	37 38 39 40 41 42	951,285 *	57									
WELM Uprate to 150Ml/day	46	1,252	0									
Manchester and Pennine Aqueduct Outage (4 weeks) for	112		0									

[5] Cost figures redacted, company confidential information.

Option Name	No.	Embodied carbon (tonnes CO_2e)	Tonnes CO_2e during first year of operation*	E&S Landscape		E&S Traffic (congestion)		80-year NPV (£)				
				Construction	Operation (annual)	Construction	Operation (annual)	Construction carbon	Operational carbon	Construction E&S	Operational E&S	Total E&S and carbon NPV
installation of connections												
Manchester and Pennine Aqueduct to Raw (Newton-in-Bowland)	212	8,037	607									
Manchester and Pennine Aqueduct to Raw (Clayton-le-Moors)	213	10,483	681									
Manchester and Pennine Aqueduct to Raw (Haslingden)	214	5,907	79									
Alternative Supply: Raw water transfer and WTW (Clayton-le-Moors)	215	27,800	558									
**This option also has a significant angling component that is not sufficiently captured by the BAG approach. Cost/value consideration illustrated in Qualitative Valuation result.												
Alternative Supply: Raw water abstraction and WTW (Haslingden)	216	5,968	26									
Alternative Supply: Raw water transfer	217	17,325	115									

Option Name	No.	Embodied carbon (tonnes CO_2e)	Tonnes CO_2e during first year of operation*	E&S Landscape		E&S Traffic (congestion)		80-year NPV (£)				
				Construction	Operation (annual)	Construction	Operation (annual)	Construction carbon	Operational carbon	Construction E&S	Operational E&S	Total E&S and carbon NPV
and WTW (Newton-in-Bowland)												
Alternative Supply: Raw water transfer and WTW (Preston)	218	27,146	648									
Metals & UV treatment of BSPs: Bury	238	11,181	3,156									
Ribblesdale South Well Isolation	260	4,511	0									
Haslingden Well Isolation	261	2,031	0									
T05 targeted repair 2025	296	20,086	0									
T06 targeted repair 2025	297	38,175	0									
Lunesdale Siphon BSPs North	301	3,797	0									
Lunesdale Siphon BSPs South	303	1,839	4									
Ribblesdale Siphon BSPs North	306	801	0									

Option Name	No.	Embodied carbon (tonnes CO_2e)	Tonnes CO_2e during first year of operation*	E&S Landscape		E&S Traffic (congestion)		80-year NPV (£)				
				Construction	Operation (annual)	Construction	Operation (annual)	Construction carbon	Operational carbon	Construction E&S	Operational E&S	Total E&S and carbon NPV
Metals & UV Treatment of BSPs: Lunesdale Siphon (1)	348	2,127	56									
Metals & UV Treatment of BSPs: Lunesdale Siphon (2)	349	2,174	61									
Metals & UV Treatment of BSPs: Lunesdale Siphon (3)	350	1,848	36									
Metals & UV Treatment of BSPs: Lunesdale Siphon (4)	351	2,670	101									
Metals & UV Treatment of BSPs: Lunesdale Siphon (5)	352	1,652	28									
Metals & UV Treatment of BSPs: Lunesdale Siphon (6)	353	1,652	28									
Metals & UV Treatment of BSPs: Hodder Siphon	354	5,203	552									

Option Name	No.	Embodied carbon (tonnes CO_2e)	Tonnes CO_2e during first year of operation*	E&S Landscape		E&S Traffic (congestion)		80-year NPV (£)				
				Construction	Operation (annual)	Construction	Operation (annual)	Construction carbon	Operational carbon	Construction E&S	Operational E&S	Total E&S and carbon NPV
Metals & UV Treatment of BSPs: Ribblesdale Siphon (1)	355	1,662	28									
Metals & UV Treatment of BSPs: Ribblesdale Siphon (2)	356	2,579	92									
Metals & UV Treatment of BSPs: Ribblesdale Siphon (3)	357	2,092	53									
Metals & UV Treatment of BSPs: Ribblesdale Siphon (4)	358	3,394	243									
Metals & UV Treatment of BSPs: Ribblesdale Siphon (5)	359	2,543	101									
Metals & UV Treatment of BSPs: Haslingden	360	2,170	77									
Manchester and Pennine Aqueduct to Raw: WTW reduced flow	382	10,076	266									

*Carbon data provided as total for sub-elements. E&S costs assessed for each sub-element.
Note that total operational carbon emissions (tonnes CO_2e) are presented only for the first year of full operation. Use of 80-year profiled energy conversion factors from BEIS mean that carbon emissions differ each year even if energy use remains constant. Year 1 of operation for each option is presented to illustrate easily comparable results.

3.2 Resilience Solutions

Table 3.3 uses the same data as shown in **Table 3.2** but applies this at the solution level using the solution scale 'Qualitative Valuation' colour coding system as set out in **Table 3.1**. In this way, the overall costs of the solutions can easily be compared whilst being able to identify the components that are contributing the most. The resilience solution with the highest E&S costs is Solution B (C29) (due to the long-term landscape impacts), whilst Solution A (FM20-S04) has the lowest E&S costs.

Table 3.3 E&S assessment of resilience solutions[6]

Solution	Component	Net Present Value (£)	Qualitative assessment
C17	Construction		Low cost
	Operation		High cost
	Carbon Construction		High cost
	Carbon Operation		Moderate cost
	Total E&S NPV		**Overall: High E&S cost**
C11	Construction		Low cost
	Operation		Nil / Negligible
	Carbon Construction		High cost
	Carbon Operation		Nil / Negligible
	Total E&S NPV		**Overall: High E&S cost**
C29	Construction		High cost
	Operation		Very high cost
	Carbon Construction		Moderate cost
	Carbon Operation		Moderate cost
	Total E&S NPV		**Overall: Very high E&S cost**
FM20-S04	Construction		Nil / Negligible
	Operation		Nil / Negligible
	Carbon Construction		Low cost
	Carbon Operation		Nil / Negligible
	Total E&S NPV		**Overall: Low E&S cost**
FM15-S04b	Construction		Moderate cost
	Operation		High cost
	Carbon Construction		Low cost
	Carbon Operation		Moderate cost

[6] Cost figures redacted, company confidential information.

Solution	Component	Net Present Value (£)	Qualitative assessment
	Total E&S NPV		**Overall: High E&S cost**

Appendix A
Selection of BAG Categories

Section 2.2 describes how the engineering scopes provided for each resilience option were examined in order to identify the parts of BAG guidance that are relevant, and of those which categories were applied in the Lite Assessment. **Table A1** presents the outcome of the initial scope/BAG assessment, and **Table A2** presents the outcome of the categories for Lite assessment selection procedure. The details of the engineering scopes are not included here for security reasons.

Table A1 Significant option components identified per option with associated BAG categories

	Option components:	New WTW and/or new pumping station	Upgrade existing WTW processes	New pipelines / conduits	New connections / valve isolations	New storage (reservoir/bankside, not small scale treatment)	New tunnels	New abstraction
Option	**BAG categories:**	**5.2, 5.3, 5.5, 5.6**	**5.6**	**5.3, 5.4, 5.5, 5.6**	**5.6**	**3.2, 3.3, 3.5, 5.2, 5.3, 5.5,**	**2.9, 5.2, 5.3, 5.5, 5.6**	**2.2, 2.3, 2.5**
3	✓	×	✓	✓	×	×	✓	×
37/38 (37)	×	×	✓	✓	×	✓	×	×
37/38 (38)	×	×	✓	✓	×	✓	×	×
37/42 (39)	×	×	✓	✓	×	✓	×	×
37/42 (40)	×	×	✓	✓	×	✓	×	×
37/42 (41)	×	×	✓	✓	×	✓	×	×
37/42 (42)	×	×	✓	✓	×	✓	×	×
46	×	×	×	✓	×	×	×	×
112	×	×	×	×	×	×	×	×
212	✓	×	✓	✓	×	×	✓	×
213	✓	×	✓	✓	×	×	✓	×
214	✓	×	✓	✓	×	×	✓	×
215	✓	×	✓	×	×	×	✓	✓
216	✓	×	✓	✓	×	×	✓	✓
217	✓	×	✓	✓	×	×	✓	×
218	✓	✓	✓	✓	×	×	✓	×

	Option components:	New WTW and/or new pumping station	Upgrade existing WTW processes	New pipelines / conduits	New connections / valve isolations	New storage (reservoir/bankside, not small scale treatment)	New tunnels	New abstraction
Option	**BAG categories:**	**5.2, 5.3, 5.5, 5.6**	**5.6**	**5.3, 5.4, 5.5, 5.6**	**5.6**	**3.2, 3.3, 3.5, 5.2, 5.3, 5.5,**	**2.9, 5.2, 5.3, 5.5, 5.6**	**2.2, 2.3, 2.5**
238	✓	✗	✗	✗	✗	✗	✓	✗
260	✗	✗	✗	✓	✗	✗	✗	✗
261	✗	✗	✗	✓	✗	✗	✗	✗
296	✗	✗	✗	✓	✗	✗	✗	✗
297	✗	✗	✗	✓	✗	✗	✗	✗
301	✗	✗	✓	✓	✓	✗	✗	✗
303	✗	✗	✓	✓	✓	✗	✗	✗
306	✗	✗	✓	✓	✗	✗	✗	✗
348	✓	✓	✗	✗	✗	✗	✓	✗
349	✓	✗	✓	✓	✗	✗	✓	✗
350	✓	✗	✓	✓	✗	✗	✓	✗
351	✓	✗	✓	✓	✗	✗	✓	✗
352	✓	✗	✓	✓	✗	✗	✓	✗
353	✓	✗	✓	✓	✗	✗	✓	✗
354	✓	✗	✓	✓	✗	✗	✓	✗
355	✓	✗	✓	✓	✗	✗	✓	✗
356	✓	✗	✓	✓	✗	✗	✓	✗
357	✓	✗	✓	✓	✗	✗	✓	✗
358	✓	✗	✓	✓	✗	✗	✓	✗
359	✓	✗	✓	✓	✗	✗	✓	✗
360	✓	✗	✓	✓	✗	✗	✓	✗
382	✗	✓	✓	✓	✓	✗	✗	✗

Key to BAG categories:

2.2 Informal recreation

2.3 Angling

2.5 In-stream recreation

2.9 Biodiversity

3.2 Reservoir based recreation

3.3 Heritage, archaeology, and landscape (reservoir development)

3.5 Land-take (reservoir development)

5.2 Land-take (other works development)

5.3 Landscape impacts (other works development)

5.4 Property based disamenity

5.5 Traffic related impacts

5.6 Carbon (energy and global warming)

Table A2 Selection of BAG categories for Lite assessment

	BAG categories: Dominant for Lite assessment?											
Option	**2.2**	**2.3**	**2.5**	**2.9**	**3.2**	**3.3**	**3.5**	**5.2**	**5.3**	**5.4**	**5.5**	**5.6**
3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No	No	n/a	No	Yes
37/38 (37)	n/a	n/a	n/a	No	n/a	n/a	n/a	n/a	Yes	n/a	Yes	Yes
37/38 (38)	n/a	n/a	n/a	No	n/a	n/a	n/a	n/a	Yes	n/a	Yes	Yes
37/42 (39)	n/a	n/a	n/a	No	n/a	n/a	n/a	n/a	Yes	n/a	Yes	Yes
37/42 (40)	n/a	n/a	n/a	No	n/a	n/a	n/a	n/a	Yes	n/a	Yes	Yes
37/42 (41)	n/a	n/a	n/a	No	n/a	n/a	n/a	n/a	Yes	n/a	Yes	Yes
37/42 (42)	n/a	n/a	n/a	No	n/a	n/a	n/a	n/a	Yes	n/a	Yes	Yes
46	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes
112	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
212	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No	No	n/a	No	Yes
213	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
214	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	Yes	Yes
215	No	Yes (operational)*	No	No	n/a	n/a	n/a	Yes	Yes	n/a	Yes	Yes
216	No	No	No	No	n/a	n/a	n/a	Yes	Yes	n/a	Yes	Yes
217	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
218	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	Yes	Yes
238	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
260	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No	n/a	No	Yes
261	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	n/a	No	Yes
296	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	n/a	No	Yes

	BAG categories: Dominant for Lite assessment?											
Option	**2.2**	**2.3**	**2.5**	**2.9**	**3.2**	**3.3**	**3.5**	**5.2**	**5.3**	**5.4**	**5.5**	**5.6**
297	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	n/a	No	Yes
301	n/a	n/a	n/a	n/a	No	No	No	Yes	Yes	n/a	Yes	Yes
303	n/a	n/a	n/a	n/a	No	No	No	Yes	Yes	No	No	Yes
306	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No	Yes	n/a	No	Yes
348	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
349	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
350	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
351	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
352	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
353	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
354	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
355	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
356	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
357	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
358	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
359	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	No	Yes
360	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes	Yes	n/a	Yes	Yes
382	n/a	n/a	n/a	n/a	No	No	No	Yes	Yes	n/a	No	Yes

*BAG process considered too limited to adequately recognise the full potential of E&S costs. Resolved by qualitative assessment

Table A3 Selection commentary

Option	Category	Dominant	Commentary
215	2.2	No	The WFD assessment reports that a new abstraction could have a medium impact on hydrological regime of the River Ribble. The abstraction would be in the Clitheroe area. It is assumed that more than a medium hydrological impact would be required to drive significantly noticeable impacts on informal recreation, i.e. walking along the river bank etc.
216	2.2	No	The WFD assessment reports that the new surface water abstraction from the River Irwell near Haslingden would have a maximum of 5.1 Ml/d. In the ALS water is identified as available at all flows (Q30, Q50, Q70 and Q95), given the size of the abstraction is relatively small any impact on the hydrological regime of the River Irwell would be minimal.
215	2.3	Yes	The WFD assessment identified two relevant waterbodies. The surface waterbody is from the confluence of the Calder to the tidal point. The proposed abstraction point is ~50m d/s of the confluence therefore has the potential to impact on the whole waterbody (which currently supports good hydrological regime). The WFD assessment concluded that (a maximum 41 Mld) abstraction would have a medium level of impact on flow (this is relatively large in size and could have a

Option	Category	Dominant	Commentary
			prolonged/widespread impact). A short distance d/s of Old Langho operates the Ribchester and District Angling Club.
216	2.3	No	There are reports that a Manchester based 5 star hotel runs fishing trips to this area. However, The WFD assessed flow impact of 5 Mld abstraction to be minor - so it is assumed not to have a significant impact on fishing, and there is a popular angling site further d/s near Prestwich N. Manchester.
215	2.5	No	See comment for Angling in terms of hydrological impact. The local River Ribble Canoe club advertises that it utilises the Lancaster Canal (not impacted by flow u/s in the Ribble) although this does not discount activity on the river itself.
216	2.5	No	See comment for Angling in terms of hydrological impact. 5 Mld is unlikely to be a major risk to fishing quality. WFD assessment that flow regime impact will be small is taken to assume that water based activities would largely be unaffected.
215	2.6	No	A medium to low impact on hydrological regime may have environmental impacts but these are unlikely to translate into significant 'low flow' disamenity.
216	2.6	No	Insufficient visual change expected to arise from the abstraction (insufficient to trigger disamenity)
215	2.7	No	EPR licensing system would mitigate the risk. However, d/s abstractors have not been analysed.
216	2.7	No	The WFD assessment reports that flow impacts would be relatively small. However d/s abstractions have not been analysed.
215	2.8	No	There is insufficient activity or infrastructure associated with the option to impact on heritage / landscape.
216	2.8	No	There is insufficient activity or infrastructure associated with the option to impact on heritage / landscape.
(37)	2.9	No	Tunnelling activity could cause construction period disruption but the section does not intersect a designated area, and any impacts would only be temporary. Impacts are not considered significant to dominate the E&S costs.
(38)	2.9	No	Tunnelling activity could cause construction period disruption but the section does not intersect a designated area, and any impacts would only be temporary. Impacts are not considered significant to dominate the E&S costs.
(39)	2.9	No	Tunnelling activity could cause construction period disruption but the section does not intersect a designated area, and any impacts would only be temporary. Impacts are not considered significant to dominate the E&S costs.
(40)	2.9	No	Tunnelling activity could cause construction period disruption and is within the Bowland Fells SSSI. Some minor impacts could occur due to construction vehicles but most tunnelling work would be subterranean. Any impacts would only be temporary. Impacts are not considered significant to dominate the E&S costs.
(41)	2.9	No	Tunnelling activity could cause construction period disruption but the section does not intersect a designated area, and any impacts would only be temporary. Impacts are not considered significant to dominate the E&S costs.
215	2.9	No	Tunnelling activity could cause construction period disruption but the section does not intersect a designated area, and any impacts would only be temporary. Impacts are not considered significant to dominate the E&S costs.
215	2.9	No	Tunnelling activity could cause construction period disruption but the section does not intersect a designated area, and any impacts would only be temporary. Impacts are not considered significant to dominate the E&S costs.
301	3.2	No	The option is to increase the size of a service reservoir. This will not impact on recreational facilities (positively or negatively).

Option	Category	Dominant	Commentary
303	3.2	No	The scope doesn't explicitly confirm that the supplementary additional storage would also be of treated water in a service reservoir - but the nature of the option suggests this. Therefore no impact on recreation.
382	3.2	No	The scope does not explicitly state that the new bunded storage area would be a service reservoir (treated water) but the option description suggests this would be the case. Therefore no impact on recreation.
301	3.3	No	No heritage sites within significant distance of the proposed development route.
303	3.3	No	No heritage sites within significant distance of the proposed development route.
382	3.3	No	No heritage sites within significant distance of the proposed development route.
301	3.5 and 5.2	No	[Land-take subsequently removed from consideration – see Table 2.1] It is not clear how much larger the service reservoir would need to be but land purchase would be required.
303	3.5 and 5.2	No	[Land-take subsequently removed from consideration – see Table 2.1] It is not clear how much larger the service reservoir would need to be. UU owns a small parcel of land but land purchase would be required.
382	3.5 and 5.2	No	[Land-take subsequently removed from consideration – see Table 2.1]. The scope text suggest that the service reservoir would be replacing an existing one. However it is not explicitly clear if the new reservoir would be on UU-owned land.
3	5.3	No	Construction is not through a significant site and pipelines will be underground.
37 - 40	5.3	Yes	It is assumed that digging tunnels will impact the landscape - although it is also assumed that the end result will mirror the existing tunnels which are not visible on the surface.
41 - 42	5.3	Yes	Include these sections but Landscape costs will be much lower (not in the AONB).
212	5.3	No	Providing additional connectivity is unlikely to impact landscape significantly.
213, 214, 216, 218, 238, 348-360	5.3	Yes	New WTW could impact landscape – extent depends on landscape type and intrusion scale.
215	5.3	Yes	Landscape impacts would be temporary, and pipeline would be subterranean.
217	5.3	Yes	New WTW and pipelines could impact landscape – extent depends on landscape type and intrusion scale.
301	5.3	Yes	Temporary impacts from pipelines and temp and longer-term impacts from a larger service reservoir.
303	5.3	Yes	Some new pipelines (temporary impact), a new storage facility. Likely location of the 9 Ml service reservoir can be seen on the site layout tab of the PBD - actual sizing has not been done but you would expect it to fit in that given area.
306	5.3	No	This option would use existing infrastructure.
381	5.3	Yes	Developments at the proposed WTW would be within an existing site. The new connections from the reservoirs to an inlet tank and the new twin pipeline could cause temporary disruption and visual impact.
3, 212, 213, 217, 238-297, 303-359, 382	5.5	No	Post assessment interaction between the option (or any potential need to transport construction materials) and the road network or urban areas was found to be very small.
37-46, 214-216, 218, 301, 360	5.5	Yes	Option delivery likely to intersect directly with highways network (excludes options that would intersect motorways as UU delivery model is designed to not require lane closures), or urban areas.
All	5.6	Yes	Carbon assessment is necessary for all options