United Utilities Water

DRAFT Drainage and Wastewater Management Plan 2023

Technical Appendix: Options Identification and Appraisal

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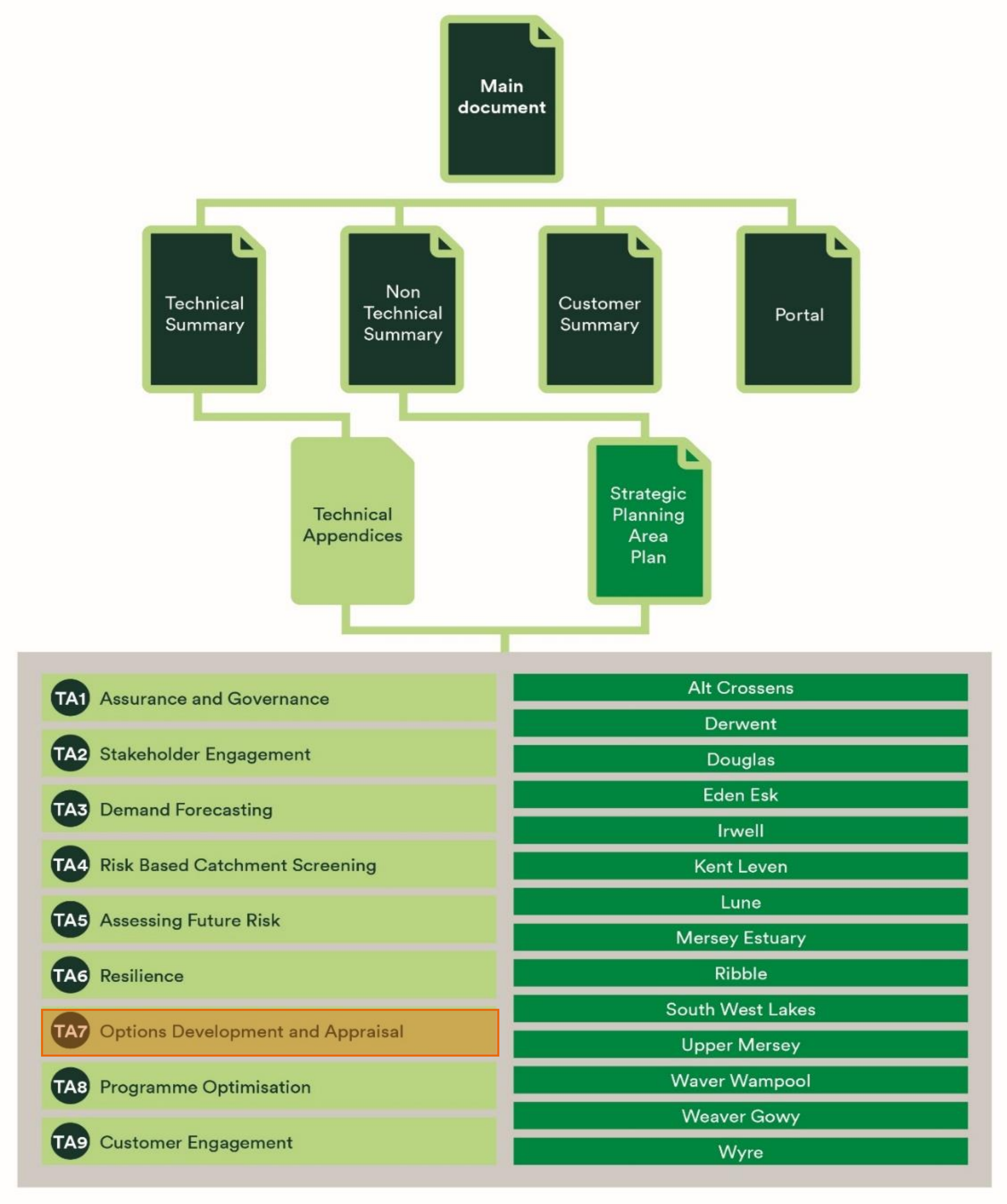
Water for the North West

Executive summary

This report is one of nine Technical Appendix documents which accompany the Drainage and Wastewater Management Plan (DMWP) Main Document and provides greater detail on the outputs of the assessments and the mechanisms used to derive the preferred near-, medium- and long-term plan. The options development and appraisal process form a fundamental part of the DWMP. This technical appendix includes details of:

- United Utilities Water's (UUW) options screening stages;
- how UUW identified options and considered options from others;
- UUW's decision-making criteria and how these decisions have been applied;
- how options impact on UUW's planning objectives;
- how options impact on customers, system resilience and the environment;
- a summary of UUW's preferred options;
- a discussion of extended and complex options; and
- identification of the strategic Tactical Planning Units (TPU).

Figure 1 DWMP document structure



Acronyms

For a list of acronyms, refer to document C0003.

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1. Introduction

1.1 Overview

1.1.1. This technical appendix provides an overview of the options identification and appraisal process from the identification of generic options through to the selection of preferred options. It is a direct sequel to Technical Appendix 5 – Assessing Future Risk (TA5) and includes detail of United Utilities Water's (UUW) screening stages, how UUW identified options and considered options from others, decision-making criteria and how these have been applied and a summary of the results.

1.1.2. The options development process is a fundamental part of the Drainage and Wastewater Management Plan (DWMP) and ensures that appropriate, plausible and innovative options are considered in the planning process to deliver robust and resilient drainage up to 2050 and beyond. Options development and appraisal have been carried out in accordance with the DWMP Framework Appendix D (Water UK, 2018).

1.1.3. Through the options development process UUW has:

- explored a full range of options including options which reduce demand (aligned with our Water Resources Management Plan (WRMP)) from customer use and rainwater (surface water) management. UUW has also explored options which optimise system operation, create additional sewer capacity, create additional treatment capacity and manage risk through catchment approaches;
- carried out external investigations to drive innovation and the consideration of alternative approaches. UUW has included for consideration not only our own options, but has reached out to other risk management authorities, water companies globally, academia, landowners, non-governmental organisations and suppliers, all of whom were invited to submit their ideas to manage long-term drainage and wastewater challenges;
- considered performance against all planning objectives, accounting for both the primary planning objective benefit and any consequential benefits to other planning objectives. UUW has developed an approach to understand potential scale of opportunity and costs and benefits at a strategic level, allowing the consideration of over 65,000 options; and
- considered the wider benefits to customers, system resilience and the environment, beyond UUW's planning objective targets. Considered environmental impacts of constructing and operating options including impact on designated sites; carbon; and natural capital.

1.1.4. A range of options have been considered with application at different scales:

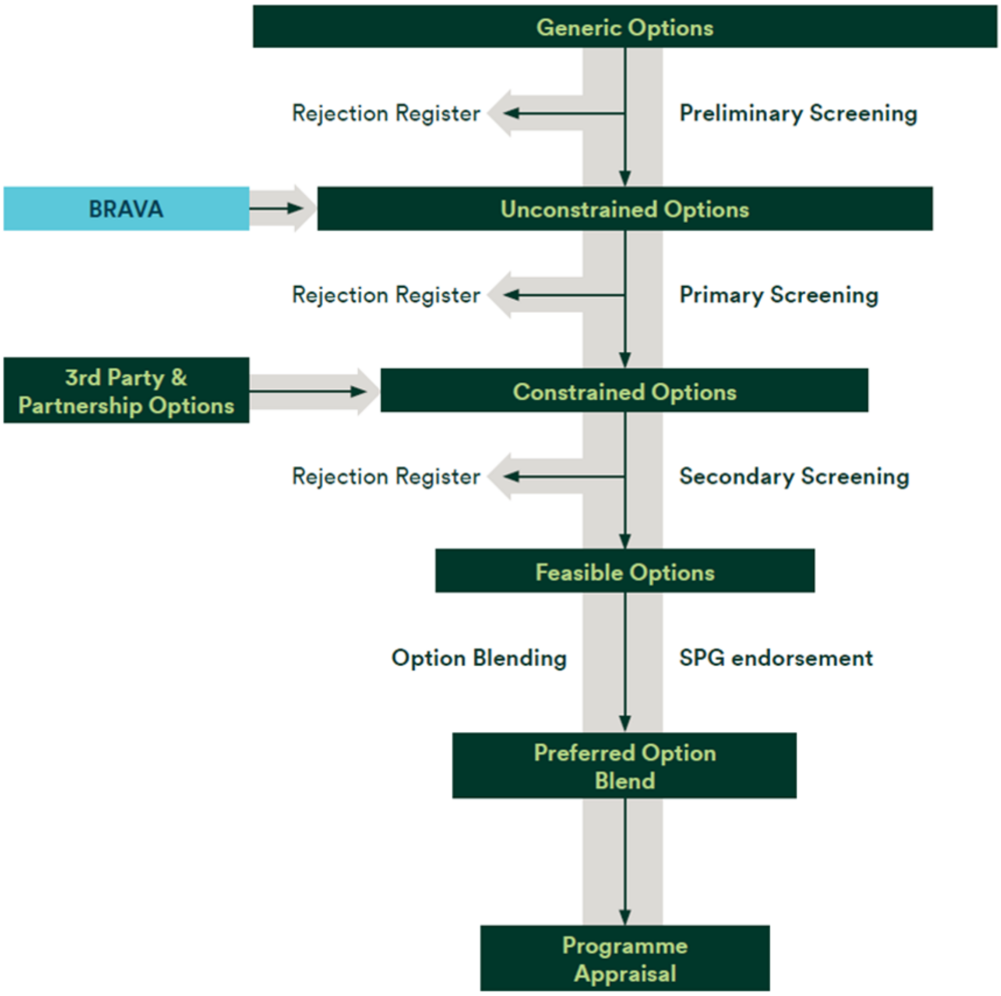
- regional options: options which can be applied regionally through programmes of work. For example, customer-side management options, operational strategies. Generally, while described as regional, these options are targeted in high priority areas through hot spotting and the characterisation of risks identified through the Baseline Risk and Vulnerability Study (BRAVA);
- strategic planning area options: options which can be applied at a 'strategic planning area' (SPA) scale. This includes catchment management options such as diffuse offsetting and flexible permitting as well as transfer options involving multiple tactical planning units; and
- tactical planning unit options: options which can be applied at a 'tactical planning unit' (TPU) scale, for example increasing wastewater treatment works capacity, delivery of sustainable drainage systems (SuDS) (underpinning this are options which relate to specific issues identified within the tactical planning unit).

2. Approach to options identification

2.1 Overview

2.1.1. Options development has followed an iterative approach, with multiple stages of screening to narrow down and reject 'unfeasible' options in each TPU. For each stage of screening and further development of options, the methodologies were developed internally. These set out the proposed approach and outputs, methodologies for screening and application of screening criteria and methodologies for cost, performance and benefits assessment. Figure 2 outlines the overall options development process which is described in detail in this technical appendix.

Figure 2 Options development process



2.1.2. The stages of the options process are outlined:

- **Generic options –** Section 3 describes how the generic options list was developed, considering a range of different option types covering the end-to-end drainage and wastewater system, and how options were screened based on their technical feasibility – this is the preliminary screening.
- **Unconstrained options –** Section 4 outlines how options were applied to each TPU based on constraints identified through BRAVA, and how geospatial analysis was used to determine the feasibility of the unconstrained options in each TPU and how screening was carried out to derive a smaller number of options – this is the primary screening.

- **Constrained options –** Section 5 describes how options were further developed to establish cost, performance against planning objectives and wider risks/benefits, and how this information informed further screening to derive a smaller list of 'feasible' options.
- **Feasible options –** Technical Appendix 8 **–** Programme Appraisal (TA8) describes how the constrained options were considered in combination with one another and against a hierarchy to determine the preferred option for each planning objective exceedance in each TPU.
- **Preferred options –** TA8 summarises the results of the options identification and appraisal stage and introduces programme appraisal, the next stage of the process.

3. Generic options

3.1 Overview

3.1.1. The first step in the options development process is to develop a list of generic options. The DWMP Framework outlines that generic options should "define a range of generic option types that may be utilised to address a wide range of exceedances" (Water UK, 2018).

3.1.2. UUW has developed generic options which comprise a range of approaches to address exceedances through the management of demand on, or capacity of, the system.

3.1.3. UUW has developed generic options with the following aims:

- be comprehensive and cover operational, capital maintenance and 'new' total expenditure (totex);
- consider innovation and new approaches or technologies;
- apply engineering judgement to ensure options are practical; and
- align to UUW's asset lifecycle management strategy.

3.1.4. UUW's initial list of generic options was based on the Water UK 'DWMP Options Development Task and Finish Group (TFG)' developed generic option list, derived from examples included in Appendix D of the DWMP framework (Water UK, 2018). The Options TFG generic options list was shared with the DWMP Water UK Steering Group for comment. How options aligned to the generic, high-level solutions outlined in the 'asset planning' section of UUW's asset lifecycle management strategy (Figure 3) was considered when developing this list further. UUW also engaged externally to consider options from the market (termed third-party options) through a number of market engagement activities (further described in section 3.2.1).

Figure 3 United Utilities Water's asset lifecycle management strategy

3.1.5. UUW has also engaged with a wide range of stakeholders and partners in the North West to drive understanding of where there may be opportunity to work collaboratively or deliver more benefit for customers. UUW's stakeholder engagement approach is set out in Technical Appendix 2 – Stakeholder Engagement (TA2) – an overview of how stakeholder engagement informed the development of partnership options is included in section 5.5 (Partnership Opportunities).

3.1.6. Six categories (termed management areas) have been considered when compiling the generic options. Four of the categories are referenced in the DWMP Framework Appendix D. An additional management area, Indirect Measures, was agreed by the Water UK Options Development TFG. The management areas are outlined in Table 1. The various sources utilised to develop our generic options are outlined in Figure 4.

Table 1 Option management areas for defining the generic options

Management area	Examples of option types
Customer-side management	Water efficiency, metering, customer engagement
Surface water management	Rainwater management (infiltration SuDS, surface water separation), surface water attenuation
Combined and foul sewer networks	Storage, optimisation, dynamic network management
Wastewater treatment	Additional treatment capacity, optimisation, catchment and nature-based solutions
Indirect measures	Influencing policy

Figure 4 Approach to sourcing options for the generic options list

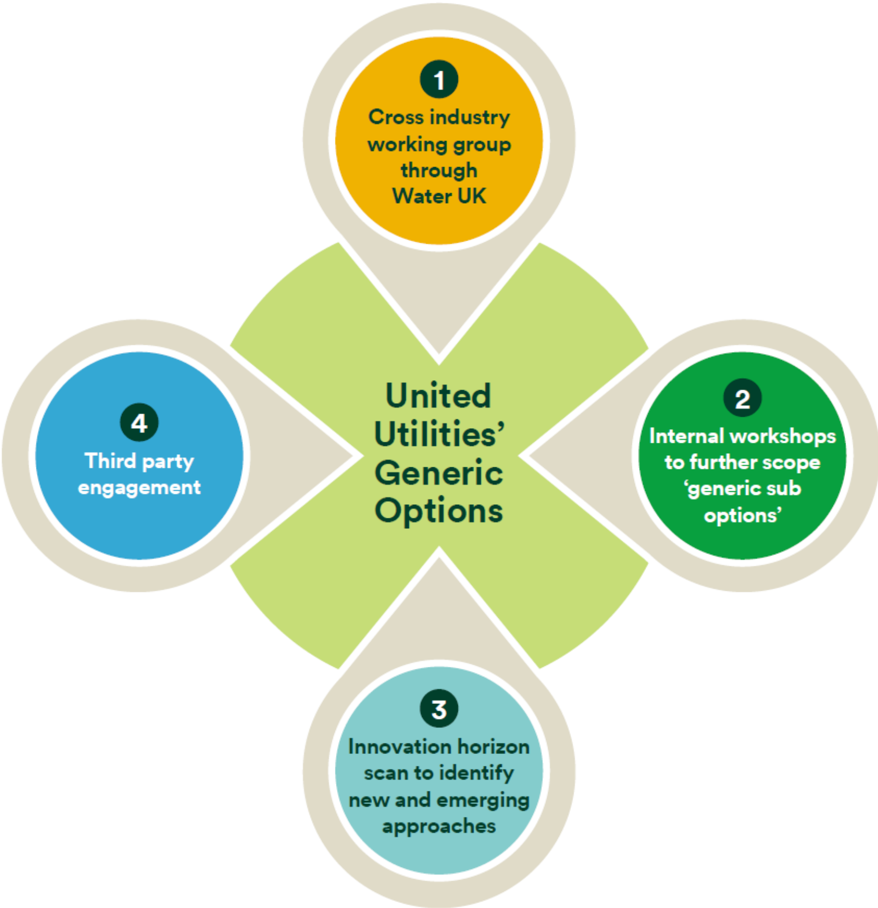


Table 2 Generic Options Development

Approach	Description	No. generic options	No. 'sub-options'
Cross-industry working group	Developed an initial list of generic options under 5 option management areas: combined and foul sewer systems, surface water, wastewater treatment, customer-side management and indirect measures. These were presented to the Water UK DWMP steering group for feedback and gained endorsement from national stakeholders.	41	0
Internal workshops with SMEs	Held workshops with internal Subject Matter Experts (SMEs) to agree generic options and develop 'generic sub-options'. *Note: a number of generic options were amalgamated at this stage and incorporated instead as two 'sub-options' under one generic option category.*	30	49
Innovation horizon scan	Worked with an independent supplier to identify new approaches and innovations from across the globe which should be considered within the DMWP.	n/a	8
Third-party engagement	Explored opportunities which had been submitted from third parties into our innovation pipeline. Gathered feedback via a Periodic Indicative Notice (PIN) issued to the market enquiring about opportunities for third parties to input to DWMP via 'Find a Tender'.	n/a	14
WRMP	Worked with colleagues responsible for the Water Resources Management Plan to identify shared opportunities and linked options.	n/a	20
Total		30	99

3.1.7. From this process 30 generic options were identified, with a further 99 generic sub-options. These are outlined in Appendix A.

3.2 Identification of generic options

3.2.1 Innovation horizon scan

3.2.1.1. To ensure a wide breadth of options were considered within UUW's generic options, an innovation horizon scan was carried out. The horizon scan focused on the development of five problem statements, covering all aspects of drainage and wastewater management. A study was undertaken for each problem statement to identify generic 'sub-options' and give examples of specific emerging solutions. Commentary on the technical feasibility and, where applicable, examples of technologies, systems or processes for that generic option have been identified. Timescale for implementation was also considered.

- **Problem statement 1:**
  What solutions can UUW implement to meet regulatory requirements whilst maximising wider environmental benefit to the North West?

  This problem statement identified options in the following sub-option categories:

  – strategic blue-green corridors; and

  – increase treatment capacity.

- **Problem statement 2:**
  How can UUW maximise the use of current capacity in the wastewater network given future increases in flow resulting from population growth and climate change?

  This problem statement identified options in the following sub-option categories:

  – water efficient measures;

  – greywater treatment and reuse;

  – foul water treatment and reuse;

  – intelligent network operation;

  – surface water management; and

  – treat/pre-treat in network.

- **Problem statement 3:**
  How can UUW prevent or proactively manage escapes of sewage from the wastewater network caused by customer behaviour?

  This problem statement identified options in the following sub-option categories:

  – sewer maintenance;

  – sewer rehabilitation; and

  – customer engagement.

- **Problem statement 4:**
  How can UUW maximise capacity of wastewater treatment works to prevent environmental deterioration as a result of increased flows and loads?

  This problem statement identified options in the following sub-option categories:

  – treat/pre-treat in network;

  – increase treatment capacity;

  - intelligent operation; and
  - surface water management.

- **Problem statement 5:**
  How can UUW improve performance at small wastewater treatment works (<2000 PE) given issues with ageing infrastructure?

  This problem statement identified options in the following sub option categories:

  - treat/pre-treat in network;
  - increase treatment capacity;
  - intelligent operation; and
  - surface water management.

3.2.1.2. Where options identified through this process were not currently technically feasible, they were fed into UUW's innovation ideas database for ongoing monitoring and consideration in future iterations of DWMP.

3.2.2 Third-party engagement: markets and alternative delivery mechanisms

3.2.2.1. Alongside UUW's own options, UUW has sought to develop and appraise external options that could be implemented to mitigate risks identified through BRAVA. Through market engagement UUW has invited third parties to submit proposals for ideas (e.g. managing surface water flows or diffuse pollution management) to be evaluated alongside those developed internally. UUW recognises that market engagement can drive innovative solutions and delivery mechanisms, and believes it is key to engage stakeholders in this process to ensure that opportunities to address risks in partnership and through alternative delivery routes are identified.

3.2.2.2. UUW has developed and implemented a programme of stakeholder engagement and communications activity seeking to collaborate with external stakeholders, to co-create alternative, innovative, and more efficient ways of reducing and resolving risk.

3.2.2.3. UUW sought options which are related to the management of surface water (e.g. through nature-based solutions), catchment water quality (e.g. through catchment management), demand and wastewater treatment/network capacity. Organisations were sought that could provide a range of measures including landowners/land users, organisations offering design and delivery services, and organisations offering ongoing operation and maintenance.

3.2.2.4. A series of communications were used to inform stakeholders of the key generic option types being sought by the DWMP and encouraging organisations to submit proposals. UUW adopted a digital-first engagement process that responded to social distancing restrictions in place due to COVID-19. These digital methods of engagement enabled us to reach a greater number of stakeholders from a wider geographical area and a broader mix of sectors than traditional face-to-face engagement would have enabled.

3.2.2.5. Communications used:

- UUW's collaboration portal to notify existing stakeholders;
- LinkedIn;
- trade journals; and
- emails sent to identified stakeholders.

Figure 5 Example communications used to engage with third-party organisations

3.2.2.6. As part of the engagement process, UUW reached out and made direct contact with nearly 200 stakeholders and targeted many more through the work undertaken via social media and trade media. In total, 15 options were received. UUW has carefully reviewed all feedback, options and ideas that have been submitted in response to its Third-Party Options Consultation to identify the best value and most viable solution for customers and stakeholders.

3.2.2.7. In the absence of face-to-face communication, due to COVID-19 restrictions, UUW wanted to ensure an equally engaging process for the consultation. A project portal webpage provided a central repository for all information relating to the consultation in a format that was interesting, interactive and easily accessible. All project communications signposted stakeholders to the portal page and ensured that a mix of organisations from a range of geographies were encouraged to participate.

3.2.2.8. The portal included the following information:

- an overview of the development of the DWMP;
- information about the Third-Party Options Consultation including the three project motion graphics;
- information about the webinar session and a form to register attendance;
- a straightforward form for submitting options to the UUW team;
- information about timescales for the submission of options; and
- contact details to ask further questions of the team.

3.2.2.9. In order to offer an opportunity for third parties to ask questions, a webinar was held. This included a presentation from the DWMP plan team, catchment systems thinking team and commercial team. The webinar provided an opportunity for people to hear more about the plan as well as an interactive Q&A session where people could ask questions about its development and the process for submitting options.

3.2.2.10. UUW's engagement generated encouraging levels of interest. Target stakeholders attended the webinar, the webpage received 200 views, and 15 potential options were submitted to the portal for consideration. Specifically, UUW received three catchment management options, one surface water management option and one capacity management option. Responses received are summarised in Figure 6.

3.2.2.11. Options submitted fell into three main categories:

- Surface water management options: opportunities to reduce the volume of surface water entering the sewer network
- Catchment management options: opportunities to prevent water quality deterioration in waterbodies by adopting a more integrated, catchment based approach rather than relying solely on 'end of pipe' solutions
- Capacity options: opportunities to provide additional wastewater treatment works and network capacity options

3.2.2.12. Measures involving managing demand from domestic or business customers to reduce the amount of foul water entering the sewer were encouraged, however no options were submitted in this category.

Figure 6 Responses to market engagement for options

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3.3 Preliminary options screening

3.3.1. A group of subject matter experts from UUW strategy, operations and engineering departments reviewed options in each of the management areas. The generic options were reviewed against the following criteria:

- Are the generic sub options comprehensive for this management area?
- Do the generic sub options consider new approaches and innovation?
- Are the options correctly attributed to issues?

3.3.2. A technical feasibility score was agreed as shown in Table 3.

Table 3 Technical feasibility score

Score	Description
1	No evidence of application of the approach or technology globally.
2	Limited application of the approach or technology globally. Benefits somewhat unknown or lacking evidence.
3	Approach or technology has been piloted in the UK Water Industry.
4	Benefits of the approach or technology are evidenced in the UK Water Industry. Approach has been delivered to some extent within United Utilities.
5	Approach or technology is widely available and embedded in the UK Water Industry. Asset standards and appropriate guidance are well established. There is experience of the approach in United Utilities Water.

3.3.3. Calibration was carried out by a central panel to ensure consistency of scoring. Fourteen generic sub-options were rejected on the basis of their technical feasibility (scores of 1 or 2) and 88 options were carried through to an unconstrained options assessment (see Section 4).

4. Unconstrained options

4.1 Overview

4.1.1. In order to understand which of the 88 unconstrained options were applicable in each TPU a number of steps were undertaken. The following steps were taken to prepare for the 'primary screening' of options:

- unconstrained options were categorised depending on the scale of their application: Regional, SPA, TPU and at the issue level;
- those which would be rolled out as a regional programme of work were automatically screened 'in' at this stage, these options must be assessed on their merit when utilised across areas and consequently can't be assessed on a site-by-site basis; and
- generic options were mapped against the relevant BRAVA. This allowed options to be considered in each TPU based on the exceedances identified through BRAVA – at this stage the option needed to contribute to reducing risk to some extent.

4.1.2. This approach ensured that a range of options were considered for the exceedances identified. During primary screening, TPU reviews were undertaken with operational and strategy colleagues to identify where bespoke approaches may be required, these sites were identified as potentially requiring strategic optioneering and are described in section 4.4.

4.2 Mapping issues to options

4.2.1. BRAVA were undertaken to understand modelled risk across TPUs, this process is outlined in Technical Appendix 5 – Assessing Future Risk (TA5). During BRAVA TPUs are assigned a score of 0, 1 or 2 across three design horizons (2020 (baseline), 2030 and 2050), where 0 indicates there is 'no concern', 1 indicates a 'potential area of focus' and 2 indicates an 'area of concern'.

4.2.2. Where a TPU scores 1 or 2 for any BRAVA the exceedance identified was included in an issues log and reviewed with operational colleagues to understand whether the exceedance is a new problem or the deterioration of an existing issue. It was agreed with operational and strategy colleagues which exceedances would be mitigated by projects undertaken during the investment period 2020–2025 or, in the case of operational issues, should be picked up through business as usual processes. The draft results for each BRAVA are summarised below, indicating the number of risks identified for each assessment.

4.2.3. UUW identified a need to carry out a series of options opportunities workshops to support the development of the unconstrained options. The aim of the workshops was to inform an optioneering strategy for each SPA and complete the primary screening of the unconstrained options. The workshops ensured that risks were considered strategically and not in isolation – the outputs identified integrated solution opportunities and areas where an adaptive approach to managing risk was required.

4.2.4. In order to determine which generic options were applicable in each TPU, the options were assessed by internal subject matter experts. The option types considered for each BRAVA exceedance are summarised in Table 5 (note, for this demonstration similar BRAVA assessments and option types have been grouped). Options highlighted as 'green' were considered for that group of BRAVA assessments, those which are grey were not.

Table 4 Number of TPUs requiring options development for each BRAVA assessment

BRAVA	Number of TPUs considered for options development		
	2020	**2030**	**2050**
Wastewater Treatment Works Capacity Risk	109	125	132
Dry Weather Flow Risk	59	80	80
Multiples of Flow Risk	58	66	67
Storm Overflow Performance	217	212	214
Pollution Risk	264	315	323
No Deterioration Risk	n/a	70	62
Bathing and Shellfish Water Spill Risk	23	18	19
Internal Flood Risk	300	303	306
External Flood Risk	245	257	282
Risk of Flooding in a Storm (1 in 50-year)	132	167	158
Open Space Flood Risk	213	224	251
Collapse Risk	247	263	292

Table 5 Option types considered per BRAVA assessment

Options considered for BRAVA assessments					
Option type	**Future WwTW Compliance (flow and load)**	**Flooding**	**No Deterioration**	**Bathing waters**	**Environmental (storm overflows)**
Customer engagement		✓		✓	✓
Network operation		✓		✓	✓
Sewer rehabilitation		✓		✓	✓
Property level resilience		✓		✓	✓
Network storage		✓		✓	✓
Network separation		✓		✓	✓
Increased WwTW capacity	✓		✓		
SuDS	✓	✓		✓	✓
WwTW decentralisation	✓	✓	✓		
WwTW rationalisation	✓		✓		
Catchment management initiatives	✓		✓		

In this table wastewater treatment works have been abbreviated to WwTW

4.2.5. In primary screening the unconstrained options were further assessed to understand the feasibility in each TPU. A number of tasks underpinned this stage in the process:

- carried out geospatial analysis: queries were run to undertake high level feasibility assessments for each option type in each TPU. This allowed us to quickly assess the likely feasibility of an option for a specific area based on objective rules;
- identification of opportunities for integrated wastewater management for the risks identified across or between TPUs and SPAs; and
- completion of an option matrix qualitatively assessing potential solutions against factors for success and certainty including:
  - (i) engineering feasibility (confidence in achieving required outcome);
  - (ii) technical feasibility;
  - (iii) cost effectiveness;
  - (iv) environmental risk or benefit (aligned to initial Strategic Environmental Assessment (SEA) screening indicators); and
  - (v) customer support (based on research undertaken prior to investment period 2020–2025).

4.2.6. UUW reviewed this information in options opportunity workshops, facilitated by an independent third party and attended by strategy, engineering and operational colleagues in order to:

- review the unconstrained mapping and assessment outputs;
- identify further opportunities for integrated and cross-catchment options based on local knowledge; and
- agree a constrained list of options for engineering input for each TPU.

4.2.7. This exercise formed our primary screening.

4.3 Geospatial analysis

4.3.1 Overview

4.3.1.1. One set of outputs from BRAVA was a series of geospatial maps showing the location of the identified risks in each TPU. The key risks identified in these maps were:

- flooding (hydraulic cause);
- flooding (other causes);
- sewer collapses;
- sewer blockages;
- pollution to watercourses;
- high spilling overflows (network and wastewater treatment works); and
- wastewater treatment works with compliance issues.

4.3.1.2. One of the main areas for which the geospatial maps were utilised was in the identification of surface water separation opportunities, as this is seen as a genuine alternative to ‘grey’ engineering solutions to hydraulic flooding and high spilling overflows. Using the risk clusters from BRAVA, a series of geospatial queries was undertaken in conjunction with OS mapping to identify the following opportunity types:

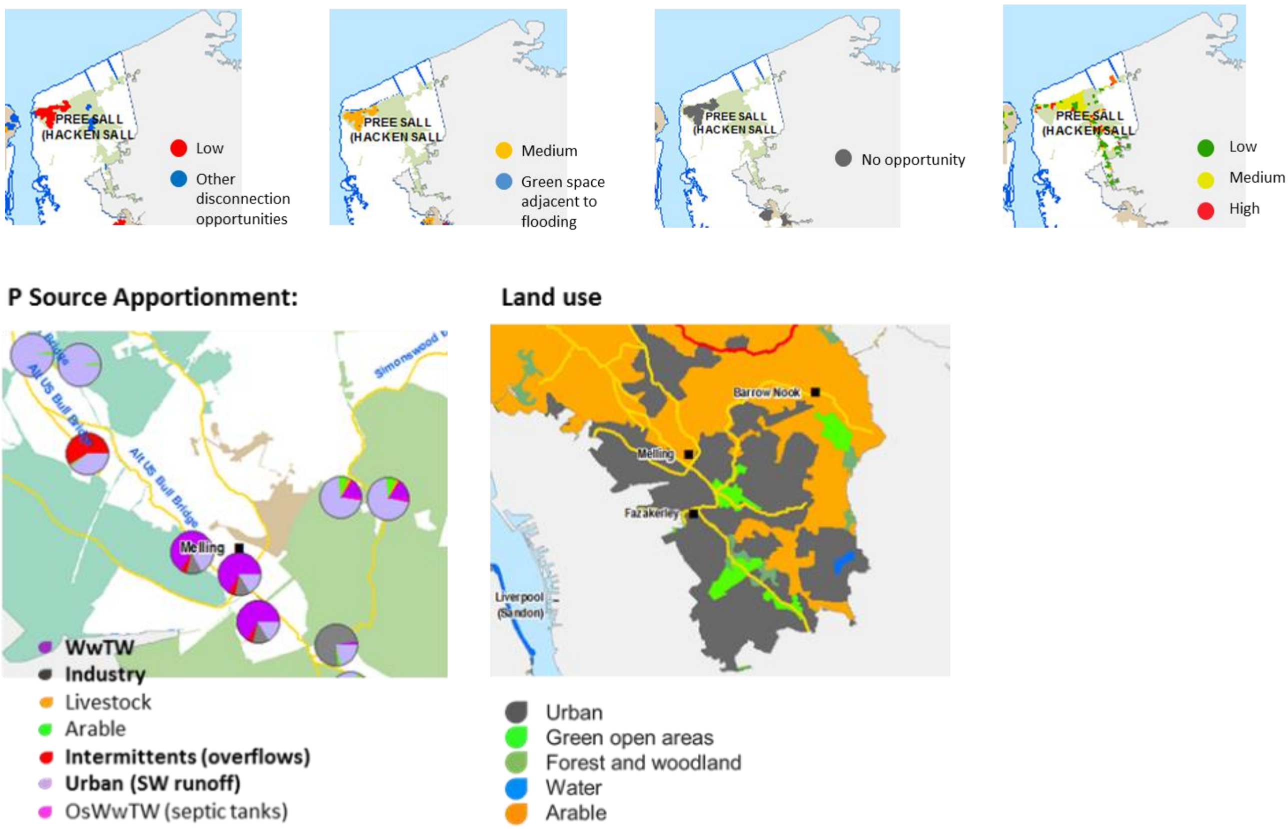
- opportunities for surface water (SW) disconnection – i.e. where an existing SW sewer connects directly into a foul/combined sewer;

- opportunities for SW separation – i.e. where combined sewers could be separated and a new SW sewer could be laid to a local watercourse;
- opportunities for SuDS – e.g. availability of green space that could be used for SuDS features such as swales or detention ponds;
- opportunities for catchment transfers – proximity of risk clusters to adjacent catchments with available hydraulic capacity;
- infiltration: sewer rehab/repair opportunity – based on verified hydraulic models;
- catchment contributions;
- natural flood management (NFM) mapping; and
- land use (CORINE land cover).

4.3.1.3. The other key benefit of the geospatial maps was to help identify potential linked schemes based on geographic proximity. This looked at different risk clusters that were located close together and hence where a scheme to resolve one risk may have a knock-on benefit for another. It is accepted that the risk clusters will not always be fully coincident with the root cause, and this is possibly more the case for hydraulic risks. However, this early identification of these opportunities may be used to assist in the targeting of interventions to achieve multiple benefits.

4.3.2 Outputs

Figure 7 Examples of outputs from geospatial analysis



4.4 Identification of locations requiring strategic optioneering

4.4.1. Locations which may require strategic optioneering are those with significant and complex growth, a high number of risks and multiple potential future scenarios. Some catchments are TPUs and others include multiple TPUs, but not necessarily a full SPA. The catchments are allocated depending on how the overall need(s) are best managed. For example, if there is potential for several TPUs to be impacted by a single large development, the combination of potential receiving networks for the development (or multiple networks if more than one connection can be made).

4.4.2. Different bespoke scenarios are applied to these catchments based on the needs and drivers of the catchments to understand the variability of risk as a first step for optioneering, so that the range of options developed can mitigate a different range of scenarios. More detail on how options are developed for these locations is in Section 7.

4.5 Primary options screening

4.5.1. In advance of the options opportunity workshops, the unconstrained options were assessed against the five principal criteria set out below. A red/amber/green (RAG) screening approach was taken at this stage to assign a qualitative score to each option type. The RAG assessment criteria are described below and it is noted that some are necessarily more subjective than others. For example, where the geospatial analysis (see Section 4.3) has informed an assessment, this provides a more quantitative assessment than say an assessment of likely third-party issues, which is naturally more qualitative.

Table 6 Primary screening criteria used to assess unconstrained options

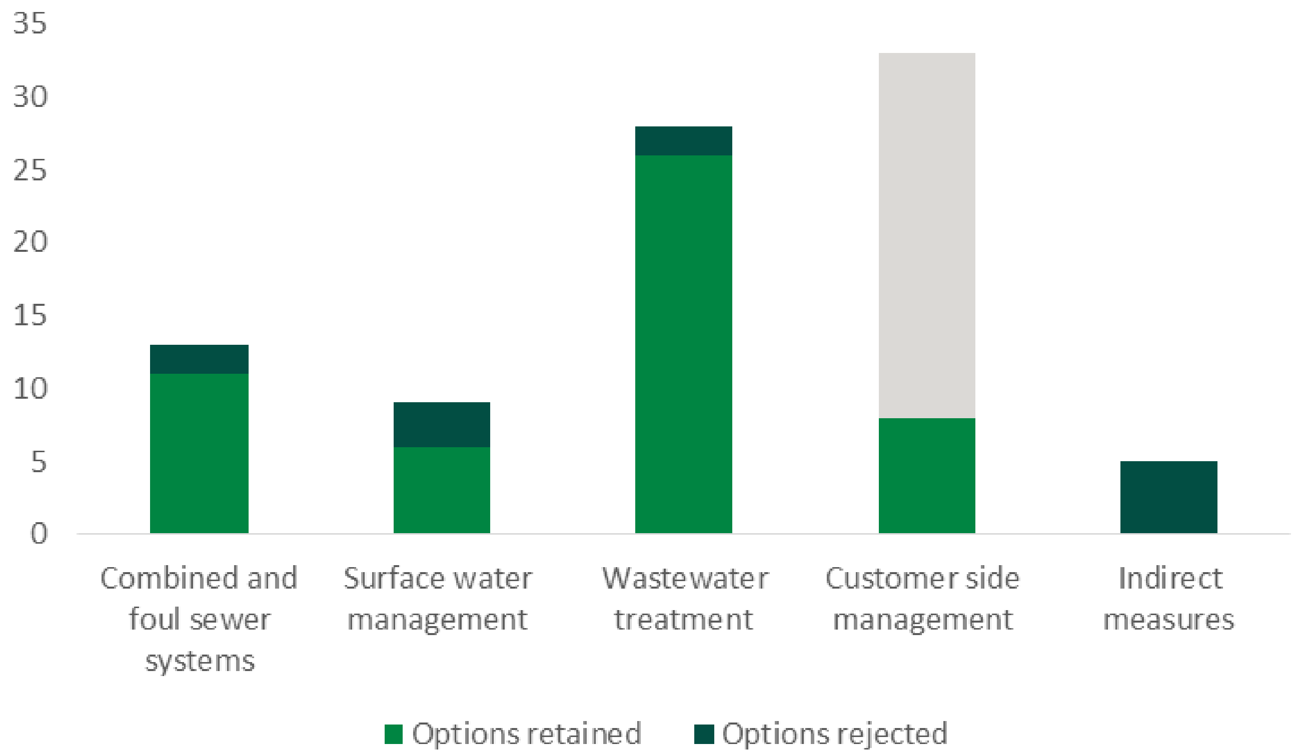
Primary screening criteria	Scoring
Engineering and cost	**Green** – Option type uses proven technology; good likelihood of implementation (informed by GIS assessments)
	Amber – More complex technology, or multi-site options
	Red – New or emerging technology; perceived high cost; implementation unlikely (based on GIS assessment)
Feasibility and risk	**Green** – High public acceptability, likely availability of land, e.g. within a UUW site
	Amber – e.g. Land purchases likely but possible; minor/uncontroversial planning conditions foreseeable
	Red – No land availability; significant planning or third-party issues; dependency on parallel options
Environment	**Green** – Low or positive environmental impact
	Amber – Neutral or uncertain environmental impact
	Red – High negative environmental impact
Performance	**Green** – Achieves desired outcome(s), provides additional system resilience
	Amber – Partially achieves outcome(s); neutral or uncertain impact on system resilience
	Red – Does not achieve risk reduction; has significant negative impact on other parts of the system
Operational	**Green** – Positive impact on compliance elsewhere in system
	Amber – Neutral or uncertain impact on compliance elsewhere in system
	Red – Negative impact on compliance elsewhere in system

4.5.2. Following the primary screening, consisting of the geospatial analysis and the options opportunity workshops, a further 12 option types were rejected, as shown in Table 7 and Figure 8.

Table 7 Option rejection: unconstrained to constrained

Management area	Number of unconstrained options	Number of options rejected
Combined and foul sewer systems	13	2
Surface water management	9	3
Wastewater treatment	28	2
Customer-side management	33	0 (note 25 considered regionally only)
Indirect measures	5	5 (considered non-quantifiable, qualitatively assessed)
TOTAL	**88**	**12**

Figure 8 Number of rejected options in each management area



5. Constrained options

5.1 Overview

5.1.1. Following primary screening, over 65,000 constrained options remained across 88 option types across all of the TPUs.

5.1.2. In order to reduce this down to a set of feasible options a further screening stage, secondary screening, was required.

5.1.3. The aim of the secondary screening process is to:

- determine the wider feasibility and potential risks of each constrained option within the spatial unit in which it is being considered;
- determine the viability of the technology, constructability, cost and benefits of the option within the spatial unit in which it is being considered;
- determine if the option achieves benefit against performance objectives, whether it's adaptable, has interdependencies and whether it provides resilience against future pressures;
- determine wider capital benefits/impacts of an option; and
- compile a list of options to take forward to feasible options assessment for the region, for each river catchment and each TPU, demonstrating how each option/spatial unit contributes to the overall plan.

5.1.4. Our approach to secondary screening was informed by the DWMP framework, SEA approach and engagement with our Strategic Planning Groups (SPGs). The following principles were applied to the secondary screening:

- any options which did not have broad customer support, such as tariff changes, were rejected immediately and no further information gathered at a TPU level. These options were only revisited at the TPU level for those areas identified as requiring strategic optioneering. Further detail on the options which did not have broad customer support can be found in Technical Appendix 9 – Customer Engagement (TA9);
- for remaining options, the following information was quantified:
  - financial cost capital expenditure (capex) and operation expenditure (opex);
  - performance benefits against planning objectives; and
  - carbon (operational and embodied).
- in addition a qualitative assessment was carried out for each option on:
  - resilience impact;
  - asset health impact;
  - constructability; and
  - six capital impact (natural, social, human, intellectual and manufactured).
- a consideration was then made for options where an opportunity for partnership had been identified through our engagement with the SPGs.

5.1.5. For some option types it was not possible to calculate high-level costs and benefits due to a lack of available data and maturity of the option e.g. NFM. Further studies and pilots will be required to ensure that these options can be included in future cycles of the DWMP.

5.1.6. Information was then collated and an initial 'cost benefit assessment' (CBA) calculated. This was considered alongside the qualitative assessment options and screened out if they did not meet one of the following criteria:

- CBA >1
- CBA > 0.75 plus a qualitative assessment scoring >=0
- CBA > 0.5 plus a qualitative assessment scoring >=1

5.1.7. Our approach to secondary screening aligns to the guidance given in the DWMP framework, as detailed in Table 8.

Table 8 Approach to secondary screening

Assessment category	Assessment sub-category	DWMP secondary screening criteria guidance description	How criteria have been considered in secondary screening assessment (SSA)
Feasibility and risk	Customer acceptability	Does the option address specific customer concerns?	Results from DWMP customer challenge groups which scored 15 'groups' of generic options. Social capital assessment included impact assessment of trust and reputation, quality, community, vulnerability, education and engagement. This assessment contributed to the six capital factor.
	Political acceptability	Does the option address regulatory requirements (local and strategic)?	Known work programmes to address regulatory requirements such as Water Industry National Environment Programme (WINEP) are accounted for in the plan.
	Timeline for implementation	Is a significant amount of work required to implement the option?	Timeline for implementation considered through the optimisation process, factored from operational or capital cost of the option.
	Dependencies	Does the option rely on, or provide an opportunity for, co-creation and implementation?	Partnership opportunities to address flooding and pollution were identified through strategic planning groups. In the SSA a 5% reduction in cost was applied where partnership opportunity has been identified. In the SSA, dependencies between options were identified and rules applied for the optimisation so one could not be chosen as a feasible option without its dependencies.
	Third parties	Does the option lend itself to third-party operators providing an alternative service?	15 options derived through third-party market engagement which included engagement with over 200 stakeholders.
	Planning and regulatory constraints	Are there site-specific issues that would need to be addressed (e.g. planning permission)?	Environmental and planning constraints are included in the site-specific environmental constraints assessment. An allowance was made for planning in the construction costs for all the construction projects.
Engineering and cost	Engineering complexity	How complex will the option be to develop from an engineering perspective? This should include consideration of staging/phasing of development.	Manufactured capital assessment included impact assessment of asset value, waste reuse, decommissioning, resilience and constructability. This assessment contributed to the six capital factor.
	Cost	Indicative costs based on more detailed investigations (low, medium, high).	During the secondary screening assessment (SSA), a high-level cost estimate was derived for each option, either at a TPU or cluster level, including capital and operational cost where relevant. Cost was an influential factor in the screening criteria.
Performance	Outcomes	Can the option deliver the desired outcome?	During the SSA, the benefit against each planning objective was derived for every option either at a TPU or cluster level, and a benefit value was assigned using the financial value per unit of planning objective achieved.
	Flexibility to adapt	Does the option provide a mechanism to change path depending on materialisation of risk?	There are different options that feed into the optimisation process, which are either dependent on or interdependent on other options and will be selected accordingly dependent on the scenario that optimiser is using.

	Resilience	Does the option increase resilience in the system above and beyond meeting desired outcomes?	The resilience assessment was used during the SSA to apply a resilience factor to all options which identifies where the option is likely to impact on the resilience of a TPU to pluvial/fluvial flooding, power or communications outages or low flows/first flush.
Operational	Operational	Does the option impact on wider compliance risk in the system?	All the options were considered against all the planning objectives to ensure that no unforeseen outcomes occurred, for example a worsening in performance.
Environmental	High level environmental assessment	It is recommended that companies undertake a high-level assessment of environmental and social impacts, including potential impact on designated features/water bodies and a Water Framework Directive (WFD) assessment for each option. The assessment will assist in the development of an overall programme level SEA option.	An environmental constraints assessment was undertaken to identify where it is likely to be more difficult to undertake construction work including protected areas and transport networks. 22 constraints were assessed for additional cost of working, benefits and dis-benefits against each of the nine categories in the options hierarchy and the percentage of risk in each TPU falling within each designation. There was also a six capital impact assessment as part of the SSA on every option, which included natural capital impact assessment of biodiversity, heritage, recreation etc.
	WFD	Consider under high level environmental assessment	Programmes of work to understand the WFD.
	Habitats Regulations Assessment		Included in the environmental constraints assessment.
	Sites of Special Scientific Interest/National nature reserves		Included in the environmental constraints assessment.
	Recreation		Included in the natural capital assessment.
	Cultural heritage		Included in the natural capital assessment.
	Flood risk		With flood risk being one of the planning objectives, the sewer flood risk benefit has been quantified as part of the SSA cost benefit calculation. The natural capital and resilience assessments also included impact on flood regulation and impact on resilience of the catchment against fluvial/pluvial flooding.
	National parks		Included in the environmental constraints assessment.
	Carbon		UUW considered carbon accounting of the options a key factor in their optimisation process and therefore operational and embodied carbon values were assigned to each option where relevant during the SSA. The carbon assessment was used in the optimisation process to determine the most carbon friendly scenario.
	Invasive species		Included in the natural capital assessment.

5.1.8. This resulted in over 5,000 remaining feasible options. The benefit provided by the remaining feasible options was not sufficient in all cases to meet planning objective targets for 2050. Therefore, some options, which did not meet cost benefit thresholds set out above, have been included in preferred option blends. These are, however, unlikely to be considered in the final proposed plan, once programme optimisation has taken place.

5.2 Assessing performance of options

5.2.1 Customer-side management

5.2.1.1. UUW has evaluated and developed a range of options relating to customer behaviour (domestic, commercial, and developers) and indirect measures. There were 34 unconstrained options in this category ranging from: metering, water efficiency, rainwater/greywater harvesting, education and engagement programmes, and influencing policy. The unconstrained list was screened to exclude options that had their potential benefits already accounted for in the demand forecast (through per capita consumption reductions accounted for in the WRMP). The screened options formed a constrained list for which desktop assessments were developed of the likely costs and benefits in each catchment.

5.2.1.2. To support the development of these options UUW has collected and analysed data including historic incidents and details of customer engagement trials. This was supplemented with supply-chain expertise, latest research, and publicly available data.

5.2.2 Indirect measures

5.2.2.1. A number of indirect options have been considered alongside the standard option development process. These 'indirect measure' options do not easily align to the standard template for option development to 'alleviate capacity in the wastewater treatment system'. In the context of the DWMP, an indirect measure is an option that is developed to help review strategies, policy changes or actions that fall outside of UUW's direct control. These options have the potential to affect delivery of the DWMP over the current 25-year planning horizon and beyond.

Table 9 Indirect measures

Measure	Description
Rainwater and greywater harvesting policy	Standardisation and ownership models for the installation and maintenance of rainwater/greywater harvesting technology.
Flood and Water Management Act (FWMA) 2010	• Influencing the implementation of Schedule 3 of the FWMA 2010; • Influencing the implementation of Section 42 of the FWMA 2010; • SuDS adoption capabilities under the FWMA 2010; and • Right of connection (Surface water to combined sewers) under the FWMA 2010.
Working with developers to reduce new surface water connections	Review of infrastructure charges to incentivise developers not to connect surface water to the existing public sewer.
Working with local councils to embed change	Engagement with planning teams to create guidance, supplementary planning documents and design codes to specify requirements for sustainable drainage.
Working with other infrastructure providers to agree strategic drainage plans	Drainage planning with other infrastructure providers (e.g. National Highways, Network Rail) to identify opportunities to collaborate and build resilience to climate change across all infrastructure in the North West.

5.2.3 Combined and foul sewer systems

5.2.3.1. A range of options to manage capacity in UUW's combined and foul sewer networks were evaluated:

5.2.3.2 Storage

5.2.3.2.1. Hydraulic model data was used to determine performance curves for estimating size of storage required to reduce the risk of predicted hydraulic flooding at cluster level (see Figure 9 for example clusters). Solution clusters were created from the model derived BRAVA 2D hydraulic flood zones defined by selecting properties that intersect with the flooding zones over 100mm depth (internal flooding threshold). Predicted flooding volumes for each return period for each cluster was also derived from the BRAVA results.

Figure 9 2D flood zones and all properties

Figure 10 Solution clusters and internal flooding properties

5.2.3.2.2. Six pilot catchments were used to develop a 'best fit' relationship between annualised flood risk (up to 50-year return period) and storage volume required at each cluster, which comprised a two-step approach, the first (Table 10) linking predicted flood volume to storage volume, and the second (Table 11) was the average reduction in annualised risk from each size storage solution.

5.2.3.2.3. Seven options (M1 to M50) were developed for each internal flooding cluster, the largest (M50) sized to resolve all predicted internal flooding in the cluster up to a 50-year return period storm event, down to the smallest (M1) which was sized to resolve all predicted internal flooding in a one-year event.

Table 10 Average storage to flood volume ratio for each return period

	M1	M2	M5	M10	M20	M30	M50
Storage to flood volume ratio	2.047	1.807	1.399	1.278	1.205	1.176	1.145

Table 11 Average risk reduction for each return period

	M1	M2	M5	M10	M20	M30	M50
Risk reduction	29.6%	38.0%	61.3%	80.5%	93.5%	98.1%	99.7%

5.2.3.2.4. Annualised flood risk benefit for external and open space flooding and reduction in number of properties at risk of 1 in 50-year flooding were also derived for the same clusters using the same relationships.

5.2.3.2.5. A cost curve based on previous engineering construction costs was used to determine the cost to implement storage tanks in each catchment based on the size of storage required. An embodied carbon value was applied to each storage tank based on estimated concrete required for each tank size to avoid flotation.

5.2.3.3 Storm overflows

5.2.3.3.1. A previous UUW study had been undertaken to estimate the volume of offline storage required at a given overflow to reduce the annual spill frequency to a range of target standards: 40, 20, 10, 1, 0. Algorithms were developed to determine this storage volume as a function of the baseline annual spill volume. Further algorithms were used for network (catchment) overflows and wastewater treatment works overflows.

5.2.3.3.2. All overflows have been classified based on whether or not they discharge to a sensitive water, and this determines their target spill frequency. Those discharging to a sensitive water have a target of five spills per annum, all other overflows have a target of 40 per annum.

5.2.3.3.3. As the original study did not explicitly define an algorithm for storage for five spills per annum, the DWMP has used the value at the midpoint between the one and ten spill volumes.

5.2.3.3.4. The cost curve defined for flooding storage has been used to determine the cost of storage within the network. An additional cost curve has been used to determine the cost of storage at wastewater treatment works.

5.2.3.3.5. The benefit of providing storage to achieve the target spill frequency has been estimated using the National Water Environment Benefits Survey (NWEBS) values. It is assumed that by achieving the standard, 1km of watercourse is improved by one WFD class (moderate to good).

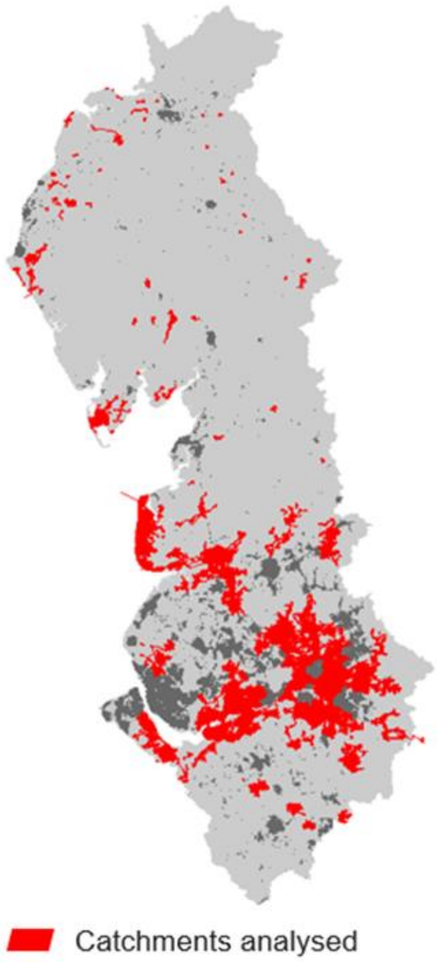
5.2.3.3.6. Due to legislative uncertainty in this area, to understand the potential implications of spill frequency targets the indicative volume of storage required to reduce overflow spill frequencies to a range of potential targets was investigated. To establish a range of indicative volumes the existing DWMP 2050 hydraulic model performance data for overflows was used and utilised the following parameters:

- annual spill frequency;
- annual spill volume;
- dry weather flow (DWF); and
- pass forward flow at first spill.

5.2.3.3.7. The performance data was based on the DWMP 2050 model and used a ten-year time series of rainfall that had been adjusted for future climate change. A realistic tank drain-down scenario was represented to recognise that storage tanks may not have fully emptied prior to follow-on rainfall events.

5.2.3.3.8. Data from over 500 overflows were analysed as part of the study, including both network overflows and treatment works storm tank overflows. Figure 11 shows how overflows were selected from a wide geographic range, and from large and small, urban and rural catchments.

Figure 11 The TPUs that were used in the storm overflow storage analysis



5.2.3.3.9. A series of relationships were derived from the data that allowed the baseline annual spill volume to be used as a predictor of the volume of offline storage required to achieve a given spill frequency target.

5.2.3.3.10. Table 12, and Table 13 show the indicative cost of achieving particular spill frequency targets. The data also allow calculation of the uplift multiplier from a baseline standard of 40 spills per year. For example, the cost of achieving a 20-spills per year standard across the whole region is 2.34 times the cost of a 40-spills per year standard.

Table 12 Ratios of 40 spills to cost in order to achieve annual spill frequency targets in UUW region

	40 spills per year	20 spills per year	10 spills per year	1 spill per year	0 spills per year
Ratio to 40 spills cost	1.00	2.34	3.93	10.16	13.42

Table 13 Ratios of 40 spills to cost in order to achieve annual bathing season spill frequency targets in UUW region

	40 spills per year	3 spills per bathing season	1 spill per bathing season
Ratio to 40 spills cost	1.00	0.47	0.89

5.2.3.4 Separation

5.2.3.4.1. Separation was considered for foul combined systems within the identified flooding risk clusters. Due to the nature of the analysis, suitable locations were identified using geo-spatial queries. Assumptions were made on the required storm water volume to be removed from the system based on available model outputs for a 30-year storm in order to calculate required pipe size for separation. Estimates needed to be made on length of sewer and outfall based on available modelled and geographic information system (GIS) data.

5.2.3.4.2. Due to the nature of this type of work not being previously carried out by UUW to any great extent, a number of assumptions needed to be made around costs, particularly around the disconnection of properties from the existing system. Costs were readily available for the laying of a new sewer (various diameter).

5.2.3.4.3. Similarly, the benefits of separation were assumed to correlate roughly with those observed through the implementation of SuDS schemes as there was no other available data to inform the calculations. As both options implement the removal of surface water from a combined system, this was deemed a fair approximation.

5.2.4 Proactive network operation

5.2.4.1 During the investment period 2020–2025 UUW has transformed wastewater network monitoring through the Dynamic Network Management (DNM) programme in 54 priority areas. DNM uses real-time data, artificial intelligence and machine learning to process data to help identify issues such as blockages and the rise of water in the sewer networks, so proactive action can be taken before issues impact customers or the environment.

5.2.4.2 Whilst this implementation of a systems thinking approach is novel, UUW is already seeing benefits from AMP7 rollout and anticipates further expansion across the network. Costs and benefits for further rollout have been derived from the costs and benefits that have been observed during the implementation of DNM in the initial 54 TPUs. This has supported the development of a cost curve, allowing the calculation of cost benefit assessments for all remaining drainage areas.

5.2.4.3 Based on current knowledge of the technology, a 10-year asset life has been assumed. As the technology underpinning DNM is innovative, UUW has forecast deflation in capital expenditure required for future expansion of DNM across the sewer networks resulting from anticipated growth, technological advances and ongoing innovation in this market.

5.2.5 Sustainable drainage

5.2.5.1 SuDS Studio™ geospatial outputs and hydraulic model analysis were used to identify potential opportunities for sustainable surface water drainage during the options stage of the DWMP. The SuDS Studio™ output includes 15 individual types of sustainable drainage technique each characterised by a cost per hectare of impermeable area removed from the existing drainage system, the size of the available opportunity for implementation and the likely uptake rate (see Table 14 for estimated uptake rate of the 15 individual option types) of the opportunities within a catchment.

5.2.5.2 The likely percentage uptake was multiplied against all available intervention opportunities of that type to generate a realistic potential area of removal and a corresponding volume reduction of surface water for each TPU based on a 30-year storm.

5.2.5.3 Hydraulic models were used in a number of trial catchments to test the impact of a range of surface water removal scenarios on predicted flooding across future design horizons. Initial results for the 2030 design horizon are demonstrated in Figure 12.

5.2.5.4 The results of the hydraulic model runs were used to develop a performance curve to relate reduction of contributing area into the network to reduction in predicted flood risk and overflow spill frequencies. The performance curve was used to extrapolate the results to the TPUs that were not modelled.

Table 14 Estimated uptake rates for SuDS options

Estimated SuDS option uptake rates			
Type of Option	Pessimistic % uptake	Optimistic % uptake	Average % uptake
Attenuation Pond	11	55	33
Attenuating Rain Gardens	9	20	15
Bioretention	2	38	20
Disconnect Downpipes	1	23	12
Filter Drains	8	28	18
Gravel Paving	17	21	19
Green Roof	19	19	19
Permeable Block Paving	15	21	18
Rain Garden Box	38	50	44
Rain Gardens (Surface)	10	20	15
Soakaway	20	20	20
Swales	9	73	41
Tree Pit	15	38	27
Water Butts	19	19	19
Wetland	11	55	33

5.2.5.5 A further trial was undertaken at a TPU to assess if applying the contributing area removal across the whole network gave a representative result of improvement to the flooding and overflow performance metrics through modelling specific opportunities identified using SuDS Studio™ data. The results of this analysis suggested that the results against the performance metrics at a TPU level were similar regardless of whether the options were modelled as specific opportunities or applied uniformly across the TPUs.

Figure 12 Results of flood volume and flood risk reduction through surface water removal in a trial catchment

[✂

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5.2.5.6 Using the output from the catchment-wide opportunity assessment to give a cost per hectare removed of each option, along with the estimated uptake rate and the performance curve, a cost was estimated for each type of option in each TPU, along with the monetised risk reduction of each option against the relevant hydraulic performance metrics to give a cost benefit ratio for each SuDS option.

5.2.5.7 One further step was required to feed the outputs of the SuDS assessment into secondary screening as the options in SuDS Studio™ did not directly align with the options identified in the DWMP options list and, therefore, each option identified was classified into one of the DWMP options before passing to secondary screening for the cost benefit analysis.

5.2.6 Wastewater treatment

5.2.6.1 Individual needs for wastewater treatment works are difficult to develop separate options for, due to dependences. For example, an increase in continuous flow may lead to hydraulic capacity risk, but would also have the potential to increase the environmental impact from the final effluent discharge and therefore potentially require a change to final effluent permit requirements. The tighter permit limit then drives the need for an increase in (or additional) treatment process.

5.2.6.2 Due to these dependences, options were developed with the full combination of identified needs that include: future flow and load (due to growth); future environmental permit requirements (based on future flow and load or due to environmental improvement criteria such as WINEP requirements) from the WFD, Urban Wastewater Treatment Directive (UWWTD), Bathing Water Directive or Habitats Regulations.

5.2.6.3 A range of options is reviewed to enhanced wastewater treatment works capacity and for most needs, alternative enhancement solutions developed, so there are two potential options (minimum) to address the combinations of risks.

5.2.6.4 In addition to this, specific option types are applied where there is the opportunity, these include:

- wetland treatment which was considered for the following: as storm treatment; as a full wastewater treatment works solution; as tertiary treatment;
- optimisation of the existing process units to create capacity within the process (usually a short-term solution);
- catchment nutrient balancing. This involves reducing diffuse input in the catchment that creates environmental capacity and therefore less stringent wastewater treatment works quality requirements at the treatment works (e.g. phosphorus removal);
- transfer solutions including enhancement at the receiving wastewater treatment works to address the risk of the additional flow and the associated permit limits that it could drive; and
- innovative treatment technologies, such as Nereda® and Reactive Media.

5.2.7 Application of cost and benefit

5.2.7.1 The cost and benefits are applied at a solution level, so include all elements of the solution that address compliance risk (due to growth) and environmental drivers.

5.2.7.2 The process solution design criteria used are:

- future population equivalent;
- future pass forward flows (with the assumption that a required standard multiple of incoming flow is to be treated);
- future final effluent permit limits for biochemical oxygen demand (BOD): ammonia; phosphorus and associated treatment processes;
- future ultraviolet requirement (bathing waters and shellfish); and
- future storm storage.

5.2.8 Sludge

5.2.8.1 The solutions developed for the wastewater treatment works risk also include additional sludge volumes as an output. An assumption is applied to include the sludge element as part of the option cost (and associated carbon impact), and the forecast additional sludge volumes used to develop the strategy for regional sludge management.

5.2.9 Strategic options

5.2.9.1 Rationalisation and decentralisation have been considered at key sites where there are significant challenges resulting from growth and climate change. These options are discussed in more detail in section 8 (areas that require strategic optioneering).

5.3 Costing

5.3.1. All options, aside from customer-side management and operational interventions, have been adjusted for inflation in line with the Price Review 2024 (PR24) base price of mid-2021. Over the period September 2021 – April 2022 inflation associated with indirect costs and commodities has risen significantly. Consequently, it is highly likely that the PR24 equivalent costs will be higher.

5.3.2 Customer-side management

5.3.2.1 The customer-side management and regional options costs were developed through a combination of UUW costing data provided by the customer engagement teams and industry available data from historic customer engagement programmes. Some of the option types utilised research papers as the basis of the costs which have been cited as part of the write of these options in the numerical outputs.

5.3.2.2 For a number of the customer-side management options a 20% optimism bias has been added to the cost elements to account for the inherent risk and number of assumptions made within the models.

5.3.3 Combined and foul sewer systems

Option N1.1 N4.1 Intelligent network operation and asset maintenance

5.3.3.1 For commercial sensitivity reasons, full assessment in relation to costings (supply, installation, maintenance, etc.) could not be undertaken. However, in the future it is expected that there will be cost reductions when the 'new' technology becomes more mainstream for a number of years until there is reinvestment to either replace 'existing' technology with 'existing' or 'similar' technology (i.e., DNM_v1.2) or completely invest in 'future' technology (i.e. DNM_v2.0). There will be a period of investment beyond current maintenance which, at present, is set to occur beyond the investment period 2025–2030.

5.3.3.2 In relation to the above, it was assumed that while a set number of monitors have been commissioned to date by UUW (approximately 19,000), in the future there will be a reassessment to determine if the number of monitors commissioned needs to be either increased or decreased. This may be due to various reasons, but may also include assessment to upgrade a number of monitors/equipment to provide more accurate recordings and analysis. Costs in relation to monitor/equipment relocation (i.e. whether it's more cost effective to relocate existing monitors vs installation of new monitors and leave existing monitors to run to failure) also needs to be taken into future consideration.

Option N5.1 – Sewer rehabilitation

5.3.3.3 The sewer serviceability programme (SSP) includes[✂]cost uplift to the direct cost of undertaking the activity of pre-cleanse, sewer clean, and structural CCTV survey. The direct costs in the supplied costing sheet did not contain any uplifts, therefore, for consistency with the SSP programme, a[✂]uplift was applied.

5.3.3.4 While direct costs have been supplied as part of the SSP programme, a separate costing sheet was utilised in which direct costs were broken down further based on pipe size. The SSP programme contains direct costs for three activities to sewer cleansing (pre-cleanse, sewer clean, and structural CCTV survey) in comparison with two activities in the costing sheet ('sewer jetting and CCTV'). The values stated in the UUW's SSP programme were utilised as part of costing this option.

5.3.3.5 It was assumed that this type of work remains unaffected by any UUW internal/external activities.

5.3.3.6 It was assumed that the activities of pre-cleanse, sewer clean, and structural CCTV survey within option N5.1 are undertaken as a package of works. This approach was assumed to provide the worst-case scenario when assessing total costs, even though a given intervention may not require all three activities for various reasons.

Option N.6 – Property level resilience (PLR)

5.3.3.7 At present, a nominal fixed value of [✂] has been assigned by UUW to install PLR measures. This cost may fluctuate in the future depending on, for example:

- advances in technology (materials and production methods) that reduce product costs;
- external activities beyond the control of UUW (e.g. gas and oil prices); and
- level of PLR measures per property may increase beyond the current[✂]due to the predicted future increase in the frequency of significant storm events per annum.

Option N7.1 – Enhanced operational maintenance

5.3.3.8 The direct costs associated with pre-cleanse, sewer clean, and structural CCTV survey within both SSP and Enhanced Targeted Maintenance (ETM) programmes are the same, however different cost uplifts have been applied ([✂]respectively). At the time of writing, it was assumed to be due to contractual variation. Consequently, the uplifts applied do not align with cost uplifts associated with other work packages.

5.3.3.9 While direct costs have been supplied as part of the SSP and ETM programmes, a separate costing sheet (in relation to the development of option N5.1 Sewer rehabilitation) was provided by UUW to the engineering team, in which direct costs were broken down further based on pipe size. The SSP and ETM programmes each contained the same direct cost for three activities (pre-cleanse, sewer clean, and structural CCTV survey) in comparison with two activities in the costing sheet ('sewer jetting and CCTV'). The values stated in the UUW SSP programme were utilised as part of costing this option.

5.3.3.10 It was assumed that this type of work remains unaffected by any UUW internal/external activities.

5.3.3.11 It was assumed that the activities of pre-cleanse, sewer clean, and structural CCTV survey within option N7.1 are undertaken as a package of works. This approach was assumed to provide the worst-case scenario when assessing total costs, even though a given intervention may not require all three activities for various reasons.

Option N9.1 – Sewer maintenance

5.3.3.12 At present, potential schemes that are added to the very small programme (VSP) are capped by £250k, however this value may be exceeded if a number of potential schemes are delivered together. It was assumed that this cap may fluctuate (potentially increase) in the future depending on external activities beyond the control of UUW, such as gas and oil prices, and material prices. Also, the cap includes associated uplifts to indicative costing, currently a factor of 3. Any amendment to this value may potentially either increase or decrease the amount of completed schemes per year.

5.3.3.13 It was assumed that this type of work remains unaffected by any UUW internal/external activities.

5.3.3.14 It was assumed that the activities of pre-cleanse, sewer clean, and structural CCTV survey within option N9.1 are undertaken as a package of works. This approach was assumed to provide the worst-case scenario when assessing total costs, even though a given intervention may not require all three activities for various reasons.

5.3.3.15 Some VSP activities may not require sewer cleanse due to the nature of the works required, however sewer cleanse has been included to provide the worst-case scenario when assessing total costs.

5.3.3.16 At the time of writing this report, the SSP programme included a[✂]cost uplift to the direct cost while the VSP programme included a cost uplift by a factor of 3.

Storage

5.3.3.17 Costs for the storage tanks have been derived from historical construction costs for network storm water storage tanks delivered by United Utilities Water. A cost curve was developed with 27 data points from historic projects that ranged in size from 200m³ to 63,500m³. A cost per m³ was calculated and developed into a cost curve to enable a quick assessment of cost for network storage options. The cost curve includes:

- [✂]
- [✂]
- [✂]
- [✂]
- [✂]
- [✂]
- [✂]

Sustainable drainage

5.3.3.18 As described in Section 5.2.5 the SuDS Studio™ geospatial polygon outputs were used to identify potential opportunities for sustainable surface water drainage within the hydraulic network model TPU boundaries. The SuDS Studio™ software utilised a bill of quantities (BoQ) breakdown of cost per unit for each option type. This was the basis of our costing exercise for these options. It was, however, necessary to uplift these costs to ensure the total project costs were being considered in any cost benefit analysis being undertaken. The model that was built to uplift the base construction costs included the following additions:

- [✂]
- [✂]
- [✂]
- [✂]
- [✂]
- [✂]

5.3.3.19 As more sustainable schemes are investigated and delivered, understanding of these costs is evolving and is likely to change in the future.

5.3.4 Wastewater treatment

5.3.4.1 The methodology developed for the pricing of the wastewater treatment options was to develop cost curves for each individual process to be added to the solution. The curves were built based on a pro-rata costing from the flow rates forecast through the works. The forecast permits were derived from the SIMulation of water quality in river CATchments (SIMCAT) model in combination with the Source Apportionment Geographical Information System (SAGIS) model. These models enabled the UUW process engineering team to create an itemised list of treatment stages required to meet any new permits, growth in the catchment or storm tank requirements. Algorithms were built into the calculations to generate costs for the solutions that the process engineers developed for each site.

5.3.4.2 The cost curves produced a direct works costs, this was then uplifted to reflect the full design and construction of the solutions, they also accounted for a risk percentage due to the high-level nature of the assessment for each wastewater treatment works. The following add-ons were included to uplift the direct works costs to a 'total project' cost:

- [✂]
- [✂]
- [✂]
- [✂]
- [✂]
- [✂]

5.3.4.3 Operational costs were also calculated for each treatment works solution based on the chemical consumption rates, power, taxes and maintenance. The impacts of bioresources operational expenditure are calculated and reported separately in line with the work package methodology.

5.3.4.4 Understanding of costs associated with nature-based solutions at wastewater treatment works (e.g. reed beds) is evolving as more sustainable drainage schemes are investigated and delivered. These costs are likely to change in the future.

5.4 Assessing wider benefits

5.4.1 Six capitals

5.4.1.1 To understand wider risks and benefits of each option type, UUW has carried out the six capitals assessment. It adopts a qualitative scoring approach due to the generic and high-level nature of the DWMP options. Conventionally, the six capitals assessment uses site specific information to assess metrics on a granular project level. The approach to assessing the six capitals within secondary screening has focused on strategic level interventions and is an initial step in the options process towards a best value assessment. The six capitals approach is set out in Figure 13. Note that financial capital was not assessed under the six capitals assessment as these values were quantified within the cost benefit assessment for options.

5.4.1.2 The assessment utilised a six capitals framework of impacts and dependencies. This draws on the framework developed for the assessment of AMP7 WIINEP options at Bolton Wastewater Treatment Works.

Figure 13 UUW's six capitals approach

5.4.1.3 The scoping exercise undertaken captured all the natural capital impacts and dependencies included within the Environment Agency's guidance on the WRMP and the guidance on developing and assessing options within the WINEP. For each impact/dependency that is in scope, options were scored according to the following scale:

- significant positive impact (score of 2);
- minor positive impact (score of 1);
- no overall impact (score of 0);
- minor negative impact (score of -1); and
- significant negative impact (score of -2).

5.4.1.4 The scoring was determined based on the nature of the option including whether it is a nature-based solution, involves land use change, or is a behavioural option. This was supplemented by information used and developed within secondary screening. In certain cases, the wider literature was consulted in order to justify certain scores within the assessment.

5.4.1.5 Where an option involved land use change, habitat data was considered using the Centre for Ecology and Hydrology's (CEH) land cover map. In particular, the proportion of different habitats within each TPU were considered in order to determine the dominant habitat type within each area. This was complemented by population data (in terms of population equivalent) which helped sense-check the dominant habitat type within TPUs that were not densely populated.

5.4.1.6 Table 15 provides a summary of the average score for each option area out of a maximum score of 52. The scores at the individual option level range between -17 and 32. These scores have been used alongside the cost-benefit analysis results for each option. The impacts/dependencies considered within the scope of the six capitals assessment are detailed in Appendix D.

Table 15 Average scores from six capitals assessment

DWMP option management area	Average score (maximum of 52)
Combined and foul sewer systems	-1
Customer-side management	13
Indirect measures	5
Surface water management	18
Wastewater treatment	3

5.4.1.7 The six capitals approach used in this assessment represents a step on UUW's journey to using a six capitals approach to assess and make decisions on best value. The learnings taken from this assessment have been invaluable in developing UUW's approach to assessing value for the investment period 2025–2030, and continue to embed a six capitals approach across our organisation. The material factors assessed in the DWMP, WRMP, WINEP and other strategic planning activity are aligned, with slight discrepancies in approach arising from differing stakeholder needs and regulatory requirements. A full description of our evolving framework for assessing value will be included in our business plan submission for the investment period 2025–2030.

5.4.2 Carbon

Customer-side management options

5.4.2.1 Table 16 shows whether an embodied or operational carbon assessment was undertaken for each of the option types.

Table 16 Carbon assessment undertaken for customer-side management options

Option type	Carbon assessment carried out?
Domestic rainwater harvesting (installation and renewals)	Assessment undertaken
Water butt (installation and renewals)	Assessment undertaken
Blue green roof	Unable to assess due to lack of available data
Engagement – trips to external venues e.g. schools, FOG	Assessment undertaken
Media messaging (various media)	Unable to assess due to lack of available data
Greywater technology	Unable to assess due to lack of available data

5.4.2.2 Embodied and operational carbon was assessed for each asset type as follows:

- Domestic rainwater harvesting (installation and renewals) – embodied carbon of each component of the rainwater harvesting equipment was evaluated based on the materials used in their construction. Operational carbon was assessed based on the repair, maintenance and replacement of the asset/its components over the asset lifespan, and the operational electricity and water consumption.
- Slimline water butt (installation and renewals) – embodied and operational carbon was assessed based on adopting assumptions from WP 3.2, as the water butt in WP 3.2 was very similar to this asset. As above, embodied carbon is assessed based on the materials that comprise the asset, and operational carbon based on repair, maintenance and replacement.

- Engagement – operational carbon was assessed based on the distance travelled to each site in different vehicle types (e.g. cars, vans), based on the round-trip distance from Lingley Mere to the site.
- Upstream management – Sustainable Drainage Systems (SuDS). An embodied carbon assessment of SuDS treatment options, based on bill of quantities (BoQ) and cost information for each asset type was undertaken. The assessment was calculated on a per unit basis.

5.4.2.3 Representative BoQ data was developed for options under the categories of Green Roof; Water Butt; Tree Pit; Attenuating Raingardens; Bioretention; Raingarden (surface); Raingarden (box); Disconnection of Downpipes; Gravel Pavement; Soakaway; Permeable Paving; Filter Drain; Swale; Pond; Wetland; and Inlet Outfall. The BoQ data was used to evaluate the embodied carbon for each of the options on a per unit basis (e.g. per m^2, per asset, etc), enabling the carbon assessment to be scaled to real design options.

Operational interventions

5.4.2.4 Assessment of three sewer maintenance and refurbishment options. The carbon assessment included embodied carbon emissions (structural CCTV Units and centrifugally cast concrete pipe (CCPP) liner) and the operational carbon emissions (sewer jetting and root cutting) associated with the maintenance and refurbishment activities.

Table 17 Carbon assessment undertaken for operational interventions

Option type	Carbon assessment carried out?
N4 – Enhanced targeting (dynamic network management)	Unable to assess due to lack of available data – further work is being undertaken to develop this data and inform a carbon assessment
N5 - Sewer rehab consisting of structural CCTV, sewer jetting, root cutting and CCPP lining activities	Assessment undertaken
N7 - Enhanced operational maintenance consisting of structural CCTV and sewer jetting	Assessment undertaken
N9 - Sewer maintenance consisting of structural CCTV and sewer jetting	Unable to assess due to lack of available data

5.4.2.5 In the N5 assessment, lengths of sewer and their respective sizes (diameters) were identified as requiring structural CCTV and sewer jetting, root cutting, lining maintenance and rehab within the assessment period. As part of the carbon assessment work, emission factors for each activity were determined using an internal inventory of carbon curves. The curves were developed for a range of sewer pipeline diameter sizes (based on the sizes assessed in the DWMP work) and were based on a per metre length basis. The curves represent emission factors and were subsequently applied to the lengths of sewer within each TPU.

5.4.2.6 The methodology described above was used for the N7 assessment, however, the emission factor curves were developed based on fewer activities and only included CCTV and sewer jetting.

5.4.2.7 Within both assessments, there is a proportion of sewer length within each TPU which is referred to as 'inferred length'. This length sum accounts for sewer within the catchment that does not have an identified diameter. This length of sewer was included within the assessment, assuming an 'average' diameter, and thus average emission factor for each respective option.

5.4.2.8 The output of the assessment is a total carbon emission per TPU for both N5 and N7 options. In addition, curves were developed for the range of sewer diameters for use in further assessments.

New asset: network storage

5.4.2.9 An embodied carbon assessment of below ground storm storage tanks was undertaken based on a general specification and sizing methodology.

Table 18 Carbon assessment undertaken for operational interventions

Option type	Carbon assessment carried out?
N2 - storage	Assessment undertaken

5.4.2.10 A storm storage tank calculator was developed to calculate the tank sizing requirements based on a user inputted storage volume requirement (and quantity) for a range of standard diameters. The calculator provided the total excavation volume and uplift weight. The carbon assessment methodology used the excavation volume and the Institution of Civil Engineers (ICE) v3 emission factor for aggregate and sand, assumed the uplift weight represented the total concrete required for each tank size and used the ICE v3 emission factor for precast concrete to determine the overall embodied carbon of the tank size. The assessment did not determine emissions associated with excavation material disposal etc.

5.4.2.11 The output of the assessment is a calculator that allows the user to input the required storage volume and tank quantity to determine embodied carbon for the range of standard tank diameters. The calculator also provides the 'variance' which informs the user if the tank diameter is suitable at the required storage volume – a negative variance indicates the tank does not have sufficient anti-float weight. In addition, the embodied carbon of all standard tank diameters for the following range of volumetric storage requirements has been assessed: 1, 100, 500, 1,000, 2,500, 5,000 and 10,000 m³.

New asset: wastewater treatment works assets

5.4.2.12 The embodied carbon assessment was undertaken for all wastewater treatment types within Table 19.

Table 19 Carbon assessment undertaken for new wastewater treatment works assets

Option type	Carbon assessment carried out?
W2.2 Primary treatment	Assessment undertaken
W2.3 Primary chemical dosing	Assessment undertaken
W2.4 Secondary chemical dosing	Assessment undertaken
W2.5 Activated sludge process (ASP)	Assessment undertaken
W2.6 Trickling filter	Assessment undertaken
W2.6 Wetland treatment	Assessment undertaken
W2.7 Tertiary solids removal	Assessment undertaken
W2.8 Tertiary nitrification	Assessment undertaken
W2.9 Tertiary disinfection	Assessment undertaken

5.4.2.13 Each sub-option included a number of separate assets represented by standard Process Flow Diagram (PFD) cost curve codes.

5.4.2.14 Within each sub-option is a number of predetermined treatment assets. These assets are described by the PFD cost curve codes. Additionally, for each sub-option, the assets listed were sized based on six size bands; 200, 1,000, 5,000, 20,000, 50,000 and 100,000 population equivalent (PE).

5.4.2.15 As part of the carbon assessment, the assets within the sub-options were assessed and appropriate carbon curves from a pre-developed inventory were selected to represent each asset. An example of this within W2.2 Primary treat is the UUW cost curve 'Primary Settlement Tanks (Circular)' – W300_257. To provide an accurate embodied carbon representation of the asset, a number of carbon curves including the civil tank structure and the tank scrapers etc. were selected and included. This methodology was applied to each UUW asset detailed within the assessment.

5.4.2.16 The output of the assessment is the total embodied carbon of each sub-option at the six size bands (and asset sizing provided). In addition, an embodied carbon calculator is provided for each sub-option which allows the user to enter individual asset sizes.

New asset (blue green): storm overflow reed bed

5.4.2.17 Embodied carbon was assessed for reed bed solutions on storm overflows. In this embodied carbon assessment, the total reed bed surface area requirement to provide storm discharge treatment across the TPU codes was assessed. The sizing of the wetland areas was not included as part of this carbon assessment. Wetland carbon curves from a pre-developed inventory were used to determine the embodied carbon associated with the wetland areas across the TPU. Fixed bed aeration type wetlands were used as this is a typically more embodied carbon intensive wetland.

5.4.3 Resilience

5.4.3.1 The DWMP resilience assessment was a high-level process to evaluate consequences that would directly impact on the company's planning objectives in respect of customers and the environment. All the resilience assessments were undertaken at the TPU level, where data was available, to determine whether each TPU was vulnerable to specific consequences. During the secondary screening phase, four of the resilience assessments were considered relevant to evaluate against specific options in the TPU areas that have been classified as 'not resilient to' from each assessment. The four evaluated were:

- Fluvial/coastal flood risk – Is the option expected to provide benefit or detriment if the TPU is not resilient against fluvial/coastal flooding?
- Power risk – Is the benefit from the option reduced due to the low resilience of the TPU to power outages? i.e. does the option rely on power?
- Communications risk – Is the benefit from the option reduced due to the low resilience of the TPU to communications outages? i.e. does the option rely on communications?
- Low flow and first flush – Is the option likely to provide benefit/detriment where the TPU is vulnerable to low flows/first flush. First flush refers to the impact of the first rainfall event following a dry period, resulting in debris which has built up in the sewer network during low flows being 'flushed' through to the treatment works. This can cause operational issues such as blinding of screens.

5.4.3.2 Aligned to the six capital assessment, a factor between -2 and 2 was applied to each option for each of the four assessments based on the option assessment and the TPU assessment, resulting in an overall resilience factor for each option between -8 and 8.

5.4.4 Asset health

5.4.4.1 Initially, consideration was given to the impact of the options developed on the Baseline Asset Health (BAH) of both line and point assets, however, the majority of process options that have been considered in the DWMP are growth options or compliance drivers, which require additional process streams or additional capacity on existing process streams, neither of which is likely to have any impact on asset health of existing assets. The only options likely to have a significant impact on process asset health is W4.1 – Replace existing treatment works with 'super works' which will have a significant impact on asset health at those wastewater treatment works. Therefore, the asset health assessment undertaken as part of the secondary screening is based on an evaluation of the option but does not consider the specific BAH in a Tactical Planning Unit (TPU).

5.4.4.2 The asset health assessment is consistent with the approach to resilience and the six capital assessment, where a positive/negative factor has been applied to each option type to enable prioritisation of options that are likely to reduce the baseline asset. A maximum of 2 and minimum of -2 can be achieved for each of the three elements of asset health, which are wellness, fitness and life expectancy for infrastructure and the same for non-infrastructure. Therefore, an overall asset health factor between -12 and 12 has been applied to each option.

5.4.4.3 UUW is developing an asset health strategy to stabilise baseline asset health. While some of the options, particularly those reducing peak flow in the network, will help towards achieving this, the majority of the process options will not make a contribution as they have primarily been focused towards growth and compliance drivers.

5.4.5 Constructability

5.4.5.1 Options were also scored based on their technical deliverability of options and where uplifted costs were complex, to reflect this. This review was undertaken by our engineering delivery team and checked and reviewed by a principal construction supervisor (PCS). The assessment scored the options on their ability to be delivered in a construction capacity only, so as not to double count any other benefits or constraints that were being measured within other parts of the assessment.

5.5 Engaging partners

5.5.1. Throughout DWMP development, UUW has engaged with partners through the strategic planning groups. As part of this engagement UUW undertook workshops with stakeholders including: Catchment Based Approach (CaBA) partnership hosts, Lead Local Flood Authorities (LLFAs), the Environment Agency, Highways Authorities and Natural England. In addition, UUW engaged separately with Network Rail and National Highways to understand collaboration opportunities.

5.5.2. The purpose of the opportunity identification workshops was to share risks identified through BRAVA and understand areas of shared risk and opportunities. The output from the workshops was a partnership opportunity pipeline. A full overview of our stakeholder engagement and how options were identified can be found in Technical Appendix 2 – Stakeholder Engagement (TA2). Table 20 summarises the partnership opportunities identified through the workshops.

Table 20 Partnership opportunities identified through SPG workshops

Type of opportunity	Type of option	Number of TPUs where potential opportunity was identified
Flooding	Sustainable drainage system	11
	Storage	13
Water quality	Education campaigns in schools	60
	Community engagement (e.g. what not to flush)	49

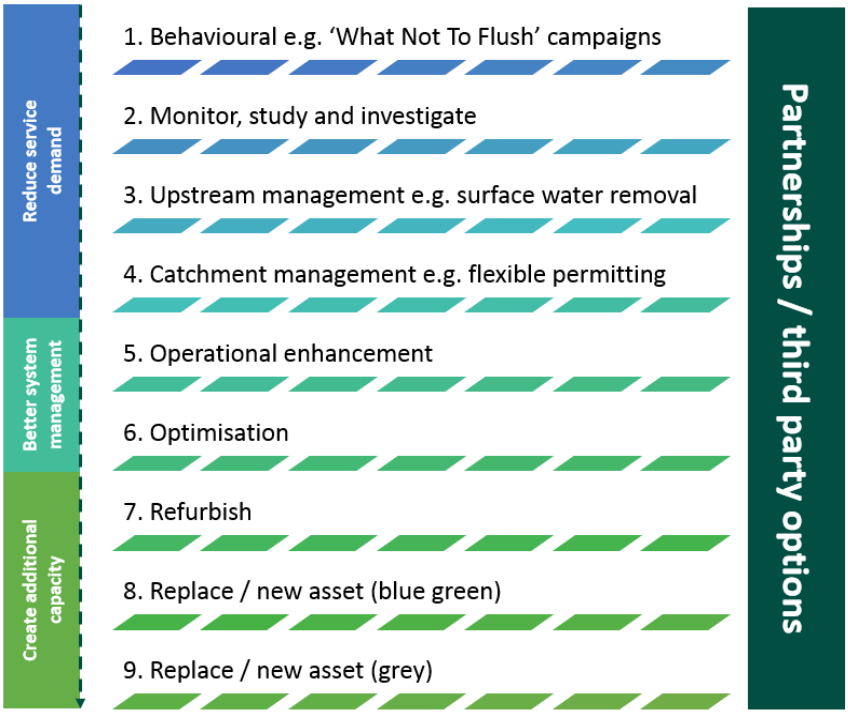
5.5.3. Opportunities on the partnership pipeline were considered during secondary screening. Where opportunities were identified for co-delivery of options to resolve flooding exceedances a decrease in cost was applied, on the basis that these solutions are more likely to secure partnership funding and allow a joint solution to be developed. A reduction in cost was applied to the cost of options in TPU areas where suitable potential opportunities have been identified. For flooding storage opportunities these cost reductions have been applied at clusters close to the opportunity location, and for all other options the reduction has been applied at the TPU level.

5.5.4. Where there are opportunities to deliver engagement and messaging campaigns through third parties (e.g. Groundwork and Rivers Trust organisations), it is recognised that these methods of engagement may have wider reach and success rates when delivered by an independent environmental charity. These options received a higher social capital score to reflect the added benefit of delivering through a third-party organisation.

5.6 Secondary screening outputs

5.5.5. Options included in a blend have been selected based on an options hierarchy of interventions. Options should be initially prioritised based on their priority within the options hierarchy (Figure 14), and their ability to meet a cost benefit threshold which takes into account the secondary screening score.

Figure 14 Options hierarchy



5.5.6. The maximum potential benefit that can be achieved against each planning objective based on the options developed during secondary screening is summarised in Table 21. For the storage and surface water options, only the option with the biggest benefit has been included where both options are chosen in any given area. Note that there may be other options that are exclusive or dependent on one another that have not been taken account of in Table 21.

5.5.7. For the surface water removal options, each type of SuDS solution has been assessed to determine the maximum benefit that could be achieved through that particular option. From this table it can be determined that the biggest benefit for flooding from SuDS solutions is through permeable block paving, rain gardens and swales.

Table 21 Planning objectives benefits that can be achieved from options developed during secondary screening

Option group	P01 Permit compliance	P02 WINEP	P03 Overflows	P04 Pollution	P05 Internal flood	P06 External flood	P07 Open space flooding	P08 1 in 50-year flooding	P09 Collapses
Catchment management initiatives	6	5	71						
Domestic and business customer education				16	167	905	179		
Enhanced operational maintenance				16	287	414	178		
Greywater treatment and reuse								58	
Increase capacity of existing networks			1232	347	1031	1118	9045	1214	
Increase treatment capacity	265	229							
Intelligent network operation				53	243	672	134		79
Modification of consent/permits	34	2							
Property Level Resilience (PLR)					273				
Sewer maintenance				382	1185	900	10		1258
Sewer rehab				2	15	6	2		
Surface water source control measures			233		244	194	24	74300	
Treatment works rationalisation	47	28							
Maximum benefit/risk reduction	**352**	**264**	**1536**	**816**	**3446**	**4209**	**9573**	**75572**	**1338**
Target benefit/risk reduction		**Compliance**		**151**	**1254**	**2517**	**251**	**0**	**600**

Table 22 Planning objectives benefits that can be achieved from SuDS solutions

	P05 a – Internal flooding hydraulic	P06 a – External flooding hydraulic	P07 a – Highway /Public Open Spaces flooding hydraulic	P08 – 1-in-50 flooding risk (no. of props)
Bioretention	3	9	1	3700
Disconnect Downpipes	10	17	2	6959
Filter Drains	41	43	4	14421
Gravel Paving	0	3	0	936
Green Roof	5	12	1	4847
Permeable Block Paving	109	95	10	34756
Rain Garden Box	24	23	4	9499
Soakaway	7	13	1	5715
Water Butts	0	4	0	1577
Attenuation Pond	2	7	1	2477
Swales	89	74	12	27383
Wetland	4	10	1	3735
Attenuating Rain Gardens	117	98	13	38580
Rain Gardens (Surface)	244	194	24	74300
Tree Pit	0	6	1	2294

5.5.8. The capitals assessment gives a total qualitative score for each option which is considered alongside the traditional cost benefit assessment as outlined in Figure 15. An option with a lower cost benefit score (between 0.5 and 0.75) will be brought through to feasible options if it has a net positive secondary screening score.

Figure 15 Cost benefit thresholds with a six capitals lens

5.5.9. A summary of the capitals assessment by option type is given in Table 23, which demonstrates that catchment management initiatives and surface water source control measures have been assessed as having the highest capital factor.

Table 23 Six capitals factor and asset health and resilience factor for each option type

	Six capitals factor (average)	Resilience and asset health factor (average)	Total factor applied
Catchment management initiatives	27	-1	26
Domestic and business customer education	11	2	13
Enhanced operational maintenance	3	4	7
Greywater treatment and reuse	11	1	12
Increase the capacity of existing networks	-9	2	-7
Increase treatment capacity	-2	-2	-4
Intelligent network operation	5	2	7
Modification of consent/permits	6	0	6
Property level resilience (PLR)	2	0	2
Sewer maintenance	3	3	6
Sewer rehab	-10	3	-7

5.5.10. Following secondary screening, over 5,000 feasible options remained which were deemed suitable for further consideration to form part of the preferred options. A wide variety of option types still remained at this stage.

6. Extended and complex options

6.1 Option complexity

6.1.1. As part of problem characterisation, an assessment of complexity factors is applied to understand the level of optioneering required. The assessment gives a score for demand (flow/load) risk and a score for supply (capacity) risk. (Details of how the scores are derived are in TA5). The scores are combined with strategic needs scores for each TPU to understand the level of concern, this level of concern (low, medium or high) is then used to define which locations require standard, extended or complex optioneering. Definitions of these categories are in Table 24.

Table 24 Levels of concern and level of optioneering

Level of concern	Options	Summary
Low	Standard	Standard approach to determine and justify interventions and investment proposals to ensure planning objectives are met (with additional future scenarios where appropriate).
Medium	Extended	Extended approach to optioneering including methods not previously widely used in drainage and wastewater planning, but have been utilised for specific catchments and deemed to be 'leading edge' of current planning approach or tested to proof of concept stage.
High	Complex	Consideration of going beyond extended approach to develop more advanced and complex methods of intervention not previously applied to wastewater management as standard. These solutions may still be being developed.

6.1.2. Multiple options and combinations of options have been developed for all risks highlighted through BRAVA, and have been developed to include additional needs identified through resilience assessments and horizon scanning.

6.1.3. This level of detail is sufficient to meet extended optioneering requirements for all TPUs.

6.1.4. Fourteen TPUs were identified as having a high level of concern and therefore requiring more complex option development. To understand what complex optioneering is required at these locations, an understanding of why it was identified as a high level of concern is reviewed, then options are developed appropriately. Standard options are expanded to include additional needs or targeted at areas with the highest risks.

6.1.5. Examples of the type of thing that generates the need for a more complex option is given below, with information on how these are addressed differently through option development.

Table 25 Examples of risks and solutions for complex options

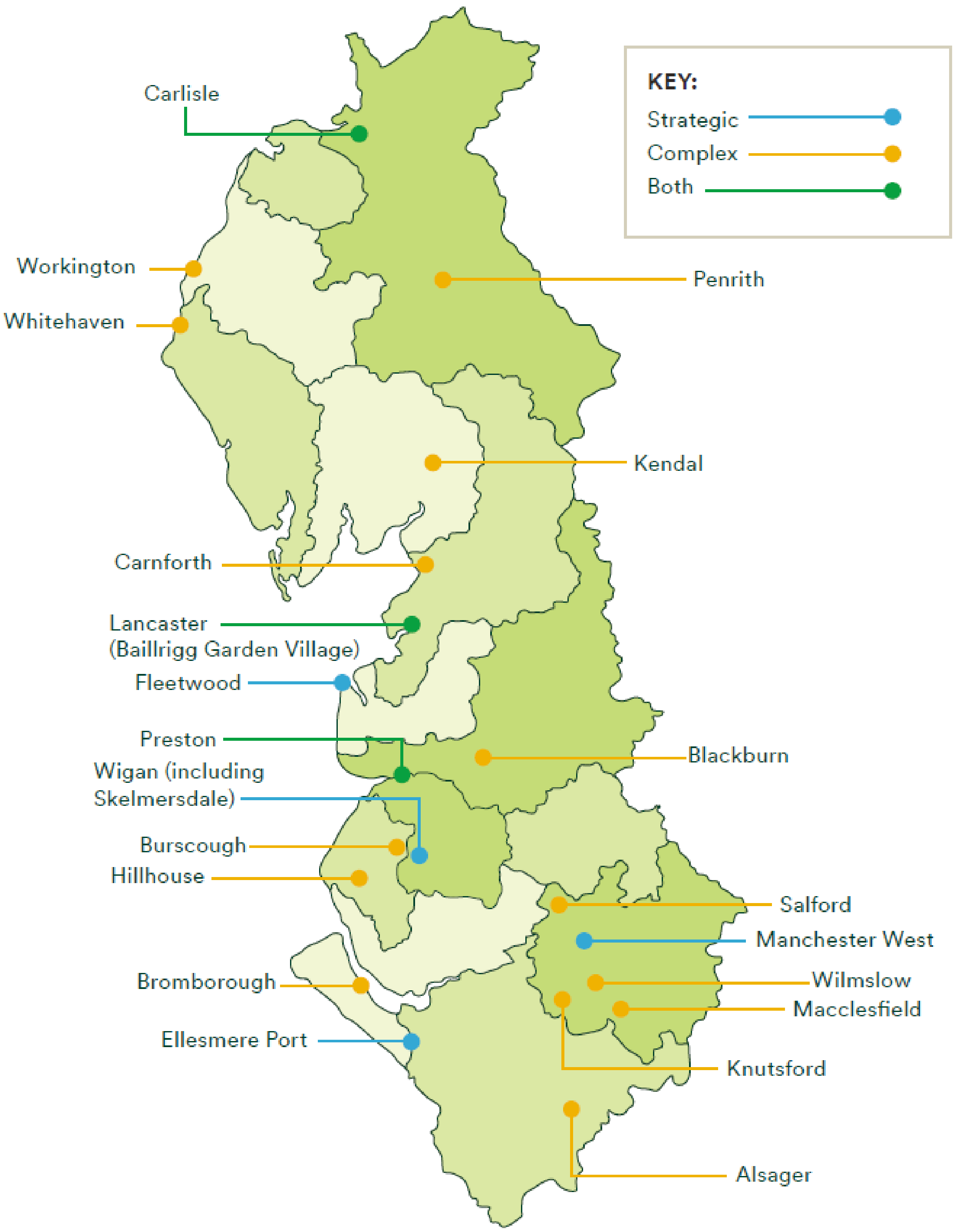
Complexity driver	Risk	Solutions to be developed
Growth uncertainty	Wastewater treatment works capacity	Enhancement option(s) for different growth scenarios
High level of flooding at specific network location with new development risk	Localised network capacity risk	Targeted network option(s) at this location, with standard solutions to address the remaining catchment risk(s)

7. Strategic tactical planning units

7.1 Strategic importance

7.1.1. In addition to TPUs identified as requiring complex option development. These catchments are those with high growth, a high number of risks and multiple potential scenarios. The locations are not restricted to the TPU level and some involve multiple TPUs where it is uncertain where the risk will be manifested. Some of these catchments include complex TPUs and therefore have a greater level of solution detail. The areas considered within strategic optioneering are outlined in Figure 16.

Figure 16 Tactical planning units requiring strategic optioneering

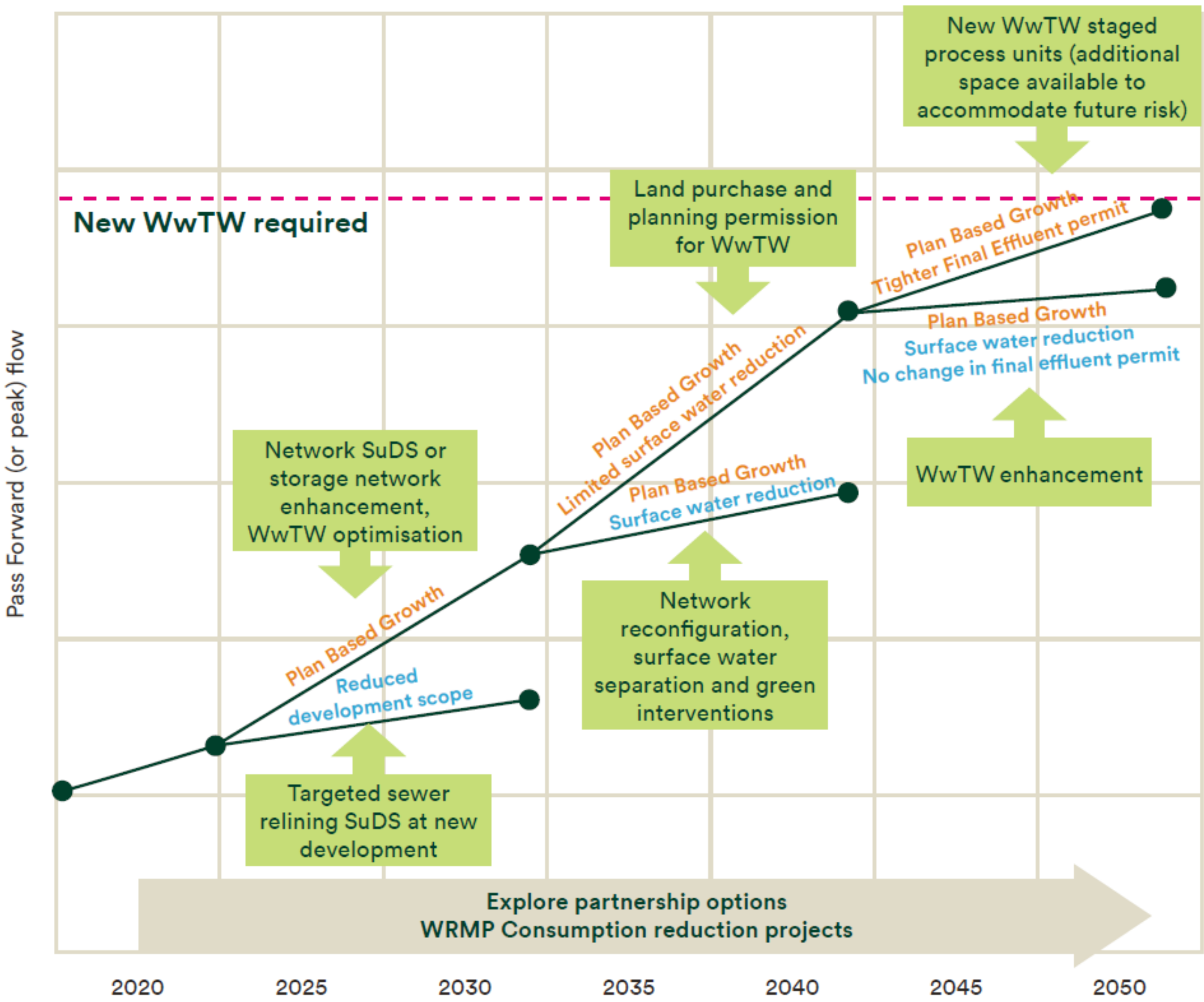


7.1.2. The catchments are allocated depending on how the overall need(s) are best managed. For example, a large new development at Carrington has multiple potential discharge locations and could have an impact on several TPUs over a 10-year timescale. Solutions are developed for different scenarios including transferring all additional flows to a single drainage area or enhancing individual treatment works to accommodate a portion of the demand. Feasibility of solutions is then reviewed.

7.1.3. As with this example, different bespoke scenarios are applied to all strategic optioneering catchments based on the driver identified to understand the variability of risk. A range of options are then developed within an adaptive plan to mitigate different potential scenarios.

7.1.4. An example of how this could be developed is shown in Figure 17 where the level of growth is a driver for alternative options as well as the effectiveness of options delivered earlier in the planning timescale.

Figure 17 Example of adaptive planning in a TPU



Appendix A Generic options rejection register

Management area	Generic option title	Option reference	Sub-option description	Technical feasibility (1-5)	carried through? (Y/N)	Reason for rejection
Combined and foul sewer systems	Cross-boundary transfer	N10.2	Utilise available capacity elsewhere by transferring flows to a neighbouring WASC's wastewater treatment works.	2	N	Rejected due to licensing and regulation complexities in transferring to another company. No process currently in place to identify capacity in neighbouring networks.
Combined and foul sewer systems	Increase the capacity of existing foul/ combined networks	N2.3	Storage tanks as standard under new build houses	1	N	Rejected due to ownership and ongoing maintenance issues. Instead look to development-wide opportunities.
Surface water management	Surface water pathway interception measures	SW2.2	Separate combined sewers and send surface water to groundwater (aquifer recharge)	2	N	Is aquifer recharge different to general infiltration (e.g. SuDS hierarchy)? ST: Can't go within 5m of property, require storage to allow for 50% drain down within 24hrs. Low rates of infiltration and high flow in a retrofit situation mean that this would not be feasible. Might be applicable at property level.
Wastewater treatment	Treat or pre-treat wastewater in the network	W1.3	Biological treatment at pumping stations or within the sewer network (to be returned to the network)	1	N	No known technologies which would be a valid pre-treatment to then return to the network.
Wastewater treatment	Treat or pre-treat wastewater in the network	W1.4	Primary settlement within the network (to be returned to the network)	1	N	No known technologies which would be a valid pre-treatment to then return to the network.

Wastewater treatment	Treat or pre-treat wastewater in the network	W1.5	Reedbed treatment at pumping stations or within the sewer network (to be returned to the network)	1	N	No known technologies which would be a valid pre-treatment to then return to the network.
Wastewater treatment	Modification of consent/ permits	W6.5	Outcome-related permits (e.g. aligned to WFD objectives)	1	N	At present there is no precedent for this. Further discussions are required with regulators in order to develop an approach. Could be potential for an AMP8 trial?
Wastewater treatment	Catchment management initiatives	W7.4	Intelligent catchment operation: watercourse dilution (i.e. increase upstream reservoir releases to reduce impact of wastewater treatment works load during dry weather)	2	N	Rejected due to unacceptable negative impacts on water resources and natural hydrological regimes
Wastewater treatment	Modification of consent/ permits	W6.3	Flexible permitting – flow-related permit	2	N	Need to further develop option and work with regulators – could be an opportunity to trial in AMP8.
Customer-side management	Foul treatment and reuse	CM8.1	Foul water treatment and reuse – existing households' blanket promotion	1	N	Technology requires further development to treat to required standard at household level
Customer-side management	Foul treatment and reuse	CM8.2	Foul water treatment and reuse – new households' blanket promotion	1	N	Technology requires further development to treat to required standard at household level
Customer-side management	Foul treatment and reuse	CM8.3	Foul water treatment and reuse – existing non-households' blanket promotion	2	N	Technology requires further development to treat to required standard at household level

Appendix B Customer-side management options

Option category	Option subcategory	Option ref	Details
Customer-side management	Metering	CM1.1	Metering (e.g. compulsory metering, installation achievements during stop tap repairs, refer a friend installation scheme, metering of sewerage flow, SMART meters) to reduce production of domestic wastewater
Customer-side management	Metering	CM1.2	Smart water meters linked to billing that promotes more careful use of water by consumers
Customer-side management	Water efficiency measures	CM2.1	Gamification – apps or interfaces that accompany hardware installations. For example, displaying water consumption at the tap, in the shower or on the scale of the whole household via a dashboard (link into smart home appliances)
Customer-side management	Water efficiency measures	CM2.2	Gamification – specific apps intended to reduce water use by children and wider customers. Customer receives feedback and motivational mechanisms via an app that will trigger a change in behaviour. This can come in the form of points, badges, leader boards, etc., which all generally reward good or efficient behaviour (link to smart home appliances)
Customer-side management	Rainwater harvesting	CM3.1	Domestic rainwater harvesting – existing households, to reduce surface water to sewers
Customer-side management	Rainwater harvesting	CM3.2	Domestic rainwater harvesting – new households – individual – supply and fit rain harvesting systems to help reduce external water use (reduce surface water to sewers)
Customer-side management	Rainwater harvesting	CM3.3	Domestic rainwater harvesting – new households – development level – supply and fit rain harvesting systems to help reduce external water use (reduce surface water to sewers)
Customer-side management	Rainwater harvesting	CM3.4	Commercial rainwater harvesting – non-household – supply and fit rain harvesting systems to help reduce external water use (reduce surface water to sewers)
Customer-side management	Rainwater harvesting	CM3.5	Commercial rainwater harvesting – non-household – targeting agriculture, sport and council-run facilities (reduce surface water to sewers)
Customer-side management	Tariffs and charges	CM4.1	Fees and tariff changes to incentivise reduced surface water runoff to sewers for non-household e.g. green roof discount, SuDS discount

Customer-side management	Tariffs and charges	CM4.2	Bill reductions for individual rainwater harvesting, to reduce surface water to sewers
Customer-side management	Tariffs and charges	CM4.3	Bill reductions for individual removal of impermeable surfaces (e.g. tarmac driveways), to reduce surface water to sewers
Customer-side management	Domestic and business customer education	CM5.1	Schools' programmes water cycle, wastewater treatment, what not to flush, water efficiency
Customer-side management	Domestic and business customer education	CM5.2	Targeted 'what not to flush' messaging via marketing (social media, leaflets in customer bills, general media e.g. TV) using CACI segments
Customer-side management	Domestic and business customer education	CM5.4	Business engagement via water retailers – FOG
Customer-side management	Domestic and business customer education	CM5.5	Promotion of 'fat capture' products to business customers
Customer-side management	Domestic and business customer education	CM5.6	Open wastewater treatment works for customers to visit (e.g. schools, guide groups, interested parties etc.)
Customer-side management	Domestic and business customer education	CM5.7	General 'what not to flush' messaging via marketing (social media, leaflets in customer bills, general media e.g. TV) using CACI segments
Customer-side management	Greywater treatment and reuse	CM6.1	Treated greywater reuse – existing households' blanket promotion
Customer-side management	Greywater treatment and reuse	CM6.2	Treated greywater reuse – new households' blanket promotion
Customer-side management	Greywater treatment and reuse	CM6.3	Treated greywater reuse – existing non-households' blanket promotion
Customer-side management	Water efficiency measures	CM7.1	Promote behavioural changes through distribution of customer guidance and advice to reduce production of domestic wastewater
Customer-side management	Water efficient appliances	CM7.2	Existing domestic water-saving retrofit products (distribution, installation through smart home products) to reduce production of domestic wastewater
Customer-side management	Water efficient appliances	CM7.3	Innovative domestic water-saving retrofit products (distribution, installation through smart home products) to reduce production of domestic wastewater
Customer-side management	Water efficient appliances	CM7.4	'Assured' low water footprint new developments – work with developers (to maximise water efficiency in designs) to reduce production of domestic wastewater

Customer-side management	Water efficient appliances	CM7.5	Promote/incentivise use of low flush toilets to reduce inputs to the sewer system. For example, cistern displacement devices (CDD); United Utilities currently provides these free of charge (namely Hippo and Save-A-Flush devices). Another example is vacuum toilets which can also be deployed in residential and commercial settings
Customer-side management	Water efficient appliances	CM7.7	Promote/incentivise water efficient shower measures to reduce water use. For example, aerating or atomising showerheads. Other measures include shower heads that change colour depending on the volume of water used compared to set thresholds.
Customer-side management	Water efficient appliances	CM7.8	Promote/incentivise water efficient tap measures to reduce water use. For example, smart taps that can provide the user with detailed information regarding their water use to encourage them to consume less (linked to gamification)
Customer-side management	Water efficient appliances	CM7.9	Promote/incentivise more efficient hot water tanks – a more energy efficient hot water tank will mean less water is wasted before the water reaches the required temperature (e.g. running the tap prior to washing up, running the shower before it gets to the required heat). Potential for a partnership opportunity with organisations looking at reducing energy consumption.
Indirect measures	Influencing policy	IM1.1	Influencing national and local policy, for example around growth and planning, surface water management etc.to provide benefit to the delivery drainage and wastewater services
Indirect measures	Influencing policy	IM1.2	Influence regulation to improve water efficiency standards in household appliances to reduce production of domestic wastewater
Indirect measures	Influencing policy	IM1.3	Working with councils and developers at large strategic developments to agree strategic drainage plan

Appendix C Wastewater treatment options

Option category	Option subcategory	Option ref	Details
Wastewater treatment	Treat or pre-treat wastewater in the network	W1.1	Chemical dosing at pumping stations or within the sewer network (to be returned to the network)
Wastewater treatment	Treat or pre-treat wastewater in the network	W1.2	Screening at pumping stations or within the sewer network (to be returned to the network)
Wastewater treatment	Treat or pre-treat wastewater in the network	W1.3	Biological treatment at pumping stations or within the sewer network (to be returned to the network)
Wastewater treatment	Treat or pre-treat wastewater in the network	W1.4	Primary settlement within the network (to be returned to the network)
Wastewater treatment	Treat or pre-treat wastewater in the network	W1.5	Reedbed treatment at pumping stations or within the sewer network (to be returned to the network)
Wastewater treatment	Increase treatment capacity	W2.1	Upgrade existing works using more intensive processes (e.g. enhancement of existing assets)
Wastewater treatment	Increase treatment capacity	W2.10	System optimisation (e.g. maximise use of capacity, recirculation etc.)
Wastewater treatment	Increase treatment capacity	W2.2	Add additional process streams (primary)
Wastewater treatment	Increase treatment capacity	W2.3	Add additional primary chemical dosing
Wastewater treatment	Increase treatment capacity	W2.4	Add additional secondary chemical dosing
Wastewater treatment	Increase treatment capacity	W2.5	Add additional process streams (secondary)
Wastewater treatment	Increase treatment capacity	W2.6	Add additional process streams (green – e.g. reed bed)
Wastewater treatment	Increase treatment capacity	W2.7	Add additional tertiary process streams: solids removal
Wastewater treatment	Increase treatment capacity	W2.8	Add additional tertiary process streams: other (e.g. nitrification)
Wastewater treatment	Increase treatment capacity	W2.9	Add additional process streams (UV)
Wastewater treatment	Increase treatment capacity	W2.11	Mobile treatment fleet (for decentralised treatment)
Wastewater treatment	Increase treatment capacity	W2.12	Tankering flows to larger wastewater treatment works during peak demand to support small wastewater treatment works compliance aligned to events/peak tourism
Wastewater treatment	Intelligent treatment works operation	W3.1	Monitoring of inlet and adjustment of processes based on incoming flow and load

Wastewater treatment	Intelligent treatment works operation	W3.3	Remote monitoring and control to reduce impact of discharges e.g. tidal discharge to allow for dispersion
Wastewater treatment	Intelligent treatment works operation	W3.2	Monitoring and control upgrades (could be real time or low cost)
Wastewater treatment	Treatment works rationalisation	W4.1	Replace existing treatment works and transfer flows to a large, centralised treatment works.
Wastewater treatment	Treatment works rationalisation	W4.2	Tankering to larger centralised treatment works
Wastewater treatment	Treatment works de-centralisation	W5.1	Construct new small-scale wastewater treatment works to reduce flows/loads on existing sites and networks
Wastewater treatment	Treatment works de-centralisation	W5.2	Third-party treatment of wastewater (for example, pre-treatment of trade effluent)
Wastewater treatment	Modification of consent/permits	W6.1	Flexible permitting – catchment consent
Wastewater treatment	Modification of consent/permits	W6.2	Flexible permitting – seasonal variations
Wastewater treatment	Modification of consent/permits	W6.3	Flexible permitting – flow-related permit
Wastewater treatment	Modification of consent/permits	W6.4	Flexible permitting – use of stretch targets (e.g. 1mg/l, with stretch of 0.5mg/l)
Wastewater treatment	Modification of consent/permits	W6.5	Outcome-related permits (e.g. aligned to WFD objectives)
Wastewater treatment	Modification of consent/permits	W6.6	Apply for change in flow permit (including: DWF, PFF and storm tank volumes)
Wastewater treatment	Catchment management initiatives	W7.1	Catchment nutrient balancing (CNB) – proportionate contribution offsetting
Wastewater treatment	Catchment management initiatives	W7.2	Partnerships with third-party organisations to reduce diffuse pollution risks through 'natural' catchment treatment processes (e.g. willow banks, leaky dams)
Wastewater treatment	Catchment management initiatives	W7.3	Intelligent catchment operation: e.g. watercourse dilution (i.e. increase upstream reservoir releases to reduce impact of wastewater treatment works load during dry weather)
Wastewater treatment	Catchment management initiatives	W7.4	Overflow treatment to discharge to environment (could be dosing or reedbed)

Appendix D Impacts/dependencies considered within the scope of the six capitals assessment

ID	Capital	Impact/dependency	In scope	Type	Rationale/driver
NC1	Natural	Crops	Yes	Benefit	Relevant to farmland
NC2	Natural	Livestock	Yes	Benefit	Relevant to grassland
NC3	Natural	Fisheries	Yes	Benefit	Relevant to rivers and lakes
NC4	Natural	Aquaculture	No	–	Not relevant/material
NC5	Natural	Wild foods	No	–	Not relevant/material
NC6	Natural	Timber	No	–	Not relevant/material
NC7	Natural	Energy (renewables)	No	–	Not relevant/ material as options do not include renewable energy such as wind and solar power
NC8	Natural	Biochemicals and medicines	No	–	Not relevant/material
NC9	Natural	Water supply	Yes	Benefit	Relevant to rivers, lakes, groundwaters
NC10	Natural	Fibres and ornamental resources	No	–	Not relevant/material
NC11	Natural	Genetic resources	No	–	Not relevant/material
NC12	Natural	Local climate regulation	No	–	Not relevant/material at this level of assessment
NC13	Natural	Global climate regulation	Yes	Benefit	Relevant to all habitats
NC14	Natural	Air quality regulation	Yes	Benefit	Relevant to all habitats
NC15	Natural	Flood regulation	Yes	Benefit	Relevant to woodland, wetland, etc. Related to natural flood management, as opposed to sewer flooding
NC16	Natural	Water quality	Yes	Benefit	Relevant to rivers, lakes, etc. Relevant to all measures as they involve improved management of wastewater which ultimately results in the improved quality of the water environment
NC17	Natural	Pollination	No	–	Not relevant/material at this level of assessment
NC18	Natural	Disease and pest control	No	–	Not relevant/material at this level of assessment
NC19	Natural	Noise regulation	No	–	Not relevant/material at this level of assessment
NC20	Natural	Soil quality regulation	Yes	Benefit	Relevant to all terrestrial habitats
NC21	Natural	Recreation	Yes	Benefit	Relevant to all habitats
NC22	Natural	Education	No	–	Captured under social capital
NC23	Natural	Heritage	No	–	Scoped out as it is considered as a constraint in the Strategic Environmental Assessment (SEA)
NC24	Natural	Visual and amenity	Yes	Benefit	Relevant to all habitats
NC25	Natural	Biodiversity	Yes	Benefit	Relevant to all habitats
SC1	Social	Trust and reputation	Yes	Benefit	Relevant to all options, and particularly nature-based solutions
SC2	Social	Wellbeing	Yes	Benefit	Relevant to all habitats
SC3	Social	Quality of service	Yes	Benefit	Relevant to options that deliver against multiple performance commitments (PCs) and planning objectives.
SC4	Social	Community and place	Yes	Benefit	Relevant to options that are nature-based solutions
SC5	Social	Vulnerability	Yes	Benefit	For options that involve reduction of bills or support to vulnerable customers
SC6	Social	Support and contribution	No	–	Not relevant/material
SC7	Social	Education (external to UUW)	Yes	Benefit	Predominantly for options that are nature-based and customer engagement solutions
SC8	Social	Engagement and networks	Yes	Benefit	Options that leverage and improve relationships with stakeholders, including through partnership working

ID	Capital	Impact/dependency	In scope	Type	Rationale/driver
HC1	Human	Jobs	No	–	Not relevant/material at this level of assessment
HC2	Human	Health and safety	Yes	–	Only applicable to options that prevent loss of life e.g. due to management of extreme flooding. Not applicable to staff or suppliers who implement options as it is considered that all options will be implemented safely
HC3	Human	Diversity and inclusion	No	–	Not relevant/material at this level of assessment
HC4	Human	Local economy	No	Benefit	Not relevant/material at this level of assessment
IC1	Intellectual	Data assets	Yes	Benefit	Relevant to options that directly utilise or generate data
IC2	Intellectual	Research and development	No	–	Likely to be correlated with data assets, as well as knowledge and learning, so scoped out
IC3	Intellectual	Knowledge and learning (internal to UUW)	Yes	Benefit	Predominantly for options that are nature-based solutions and/or involve innovation
IC4	Intellectual	Processes and efficiency	No	–	Scope out as this is vague and correlated with other impacts/dependencies
MC1	Manufactured	Asset value	No	–	Scope out as this is captured by capex and opex which are assessed separately
MC2	Manufactured	Waste use and reuse	No	–	Relevant for options which align with principles of circular economy e.g. sludge options. But this is scoped out since sludge options are not being assessed
MC3	Manufactured	Energy production	No	–	Relevant to energy production from sludge options. But these options are excluded so this impact is scoped out
MC4	Manufactured	Decommissioning	Yes	Cost	Penalises engineering solutions as they require capex renewal or decommissioning after some time, as opposed to nature-based solutions
MC5	Manufactured	Adaptability	Yes	Benefit	Penalises solutions which have a fixed lifetime or are inflexible, particularly if there are future pressures in a drainage area which will require flexible options. Generally penalises engineering solutions as opposed to nature-based solutions
–	Manufactured	Constructability	Yes	TBC	Assessed separately within secondary screening
C1		Capital Carbon	Yes	Cost	Costed within secondary screening where applicable to option

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